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.

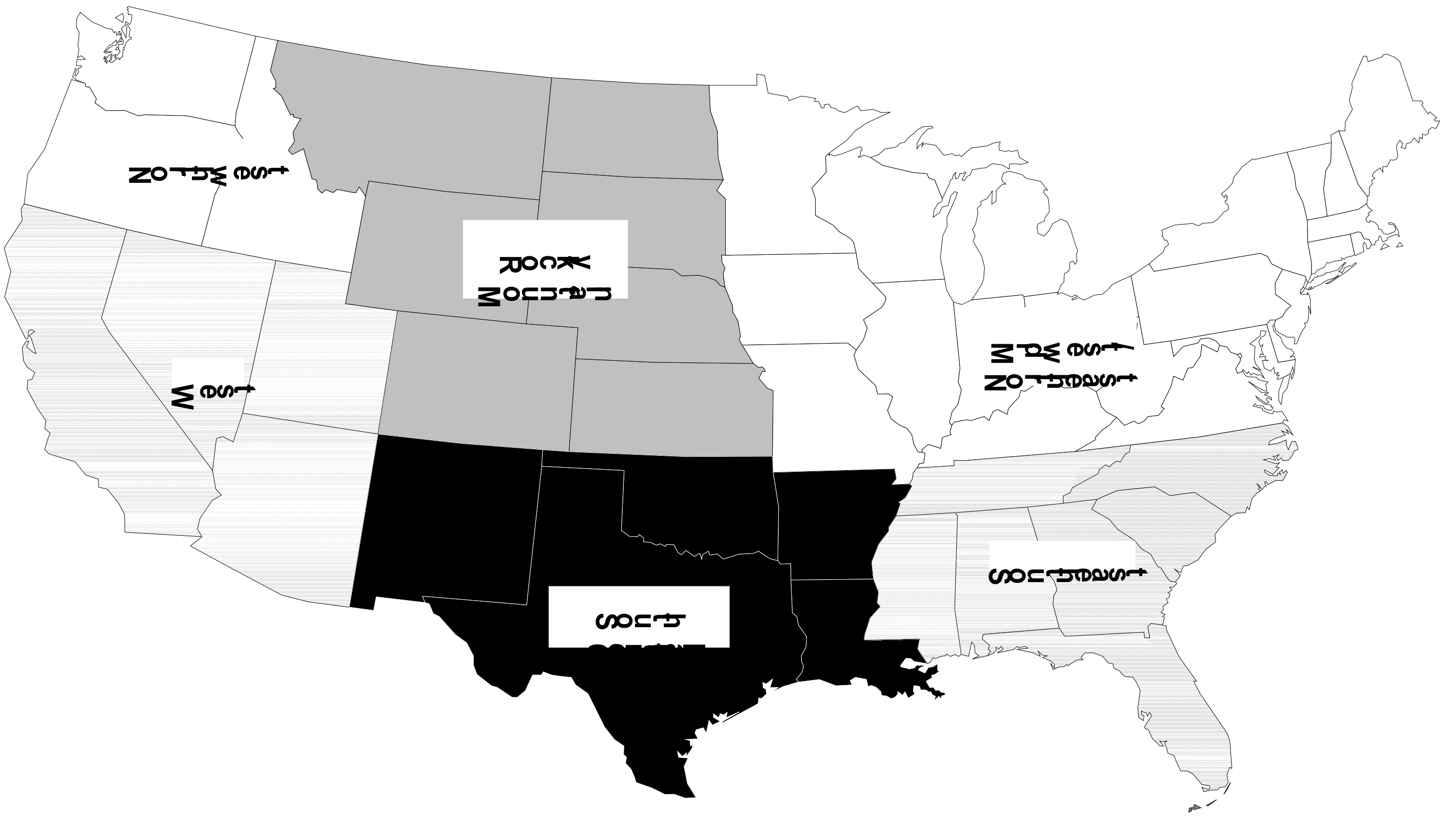
For achieving alternative $PM_{2.5}$ standards, control measure selection is modeled using a broader *regional* approach that is more appropriate for addressing air quality problems caused by trans-boundary pollution transport. The fine particle precursors that make up $PM_{2.5}$ can be transported over 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

Control Regions in [illegible] Model



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)	0.154×10^{-7}	0.191×10^{-8}	0.392×10^{-9}	0.147×10^{-7}
Point (250-500m)	0.258×10^{-8}	0.243×10^{-9}	0.518×10^{-10}	0.277×10^{-8}
Area Sources	0.224×10^{-7}	0.267×10^{-8}	0.546×10^{-9}	0.215×10^{-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

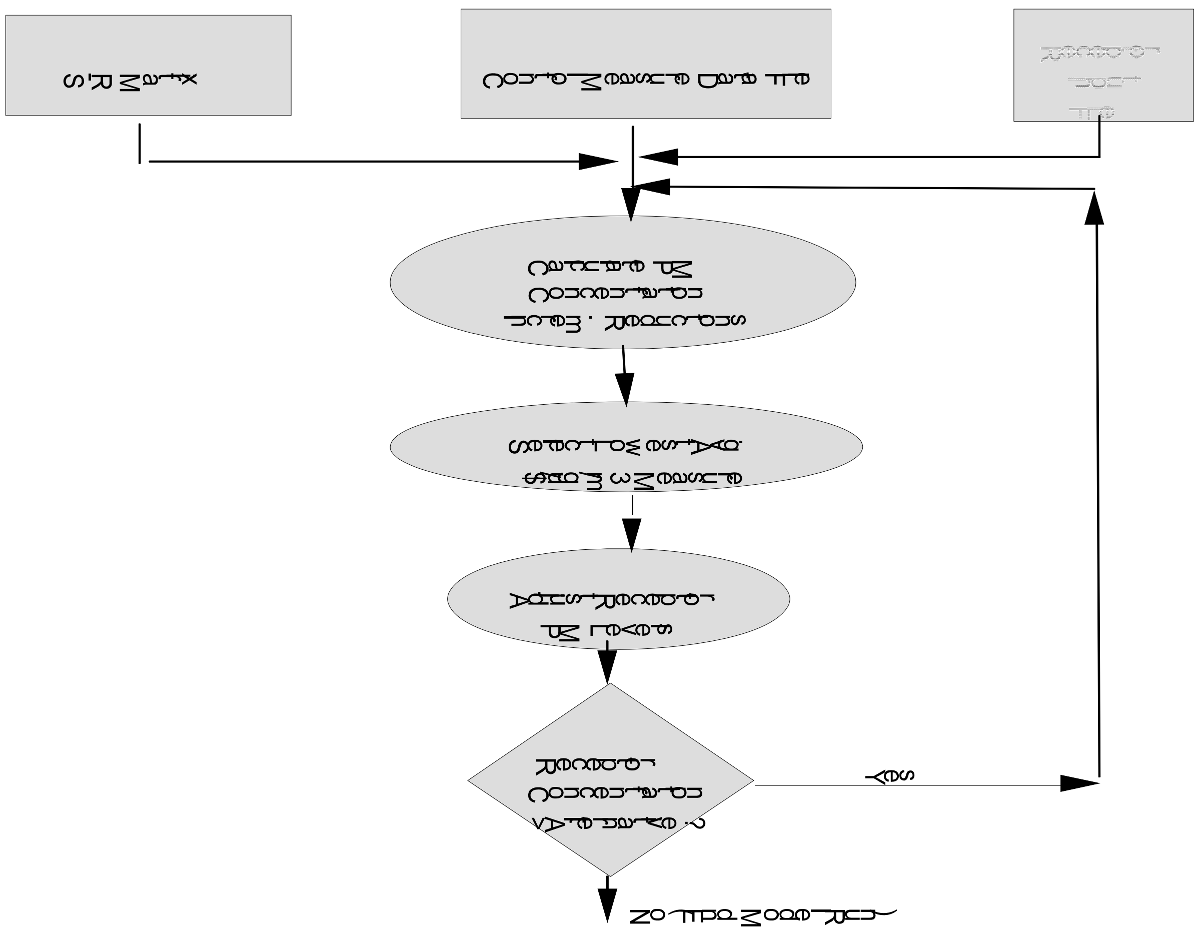
This file contains the starting total county-level normalized PM_{10} and $PM_{2.5}$ concentrations for the 2010 CAA baseline emissions scenario. The normalization procedure used to calibrate predicted concentrations to actual monitor data is described in Chapter 4.

6.3.5 Optimization Routine

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

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

Step 2. 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 ($\mu g/m^3$)

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/m³)

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/m³. 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/m³ (U.S. EPA, 1996, p. IV-13). The IMPROVE monitoring network's measurements of soil dust generally shows average concentrations less than 1 µg/m³. Therefore, it is not unreasonable to expect biogenic concentrations in the western United States to generally be below 3 µg/m³. 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/m³ 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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U.S. Environmental Protection Agency (1996a), Analyzing Electric Power Generation Under the CAAA. Office of Air and Radiation; Washington, D.C.; July.

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U.S. Environmental Protection Agency (1997), PM2.5 Composition and Sources, Prepared for FACA National and Regional Strategies Workshop. Office of Air Quality Planning and Standards; Research Triangle Park, N.C.; June 16, 1997.

7.0. EMISSION REDUCTION AND COST IMPACTS FOR OZONE ALTERNATIVES

7.1 RESULTS IN BRIEF

Based on projected emissions levels for the year 2010, this analysis estimates that 10 nonattainment areas (112 counties) are projected to need additional reductions beyond those currently mandated in the Clean Air Act (CAA) and those needed to partially achieve the current ozone standard, to meet the selected 0.08 4th Max. ozone national ambient air quality standard (NAAQS). The control cost associated with achieving partial nationwide attainment of the selected ozone NAAQS is estimated to be $1.1 billion (1990 dollars). Due to overlap between projected $PM_{2.5}$ nonattainment counties and ozone nonattainment areas, some control measures may produce air quality benefits for both standards that result in cost efficiencies.

7.2 INTRODUCTION

This chapter presents the methodology and results for the ozone NAAQS alternatives emissions and control cost impacts analysis. This analysis projects emission reductions resulting from additional controls needed by the year 2010 to attain the alternative ozone standards presented in Chapter 3. Emissions changes, which are translated into 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 promulgated standard is addressed in Chapter 10. The following sections in this chapter cover:

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

7.3 EMISSION REDUCTION AND COST IMPACT ANALYSIS METHODOLOGY

This analysis estimates the emission reductions and control costs for achieving air quality improvements necessary to attain alternative ozone NAAQS in projected nonattainment areas. The analysis methodology uses the nonattainment area-specific emissions inventory, the nonattainment area-specific emission reduction targets for volatile organic compounds (VOC) and nitrogen oxides (NOx), and the database of available control measures.

Since the 2010 CAA baseline projection indicates that several areas do not attain the current ozone standard, control measures are applied to address nonattainment of the current ozone standard. The methodology used to assess the impact of the current ozone standard is identical to the methodology used for the new ozone standard alternatives. The results of the current ozone standard analysis are presented and discussed in Appendix C.

Control measure selection for the alternative 8-hour ozone standards is not incremental to the current 1-hour ozone standard, consequently the current and new ozone standards are evaluated incremental to the 2010 CAA baseline. The analysis is designed this way because in some areas, the 8-hour standards are modeled to require significantly different emission reduction targets. For instance, to attain the current ozone standard in at least one of the modeled areas, both VOC and NOx reductions must be achieved from the 2010 CAA baseline. For the least stringent 8-hour standard analyzed, this same area is modeled to require only VOC reductions from the 2010 CAA baseline. For areas like this example, some control measures selected to meet the multiple pollutant goals of the current ozone standard may not be optimal for making progress toward the proposed 8-hour standards. Since both the current and new ozone standards are evaluated incremental to the 2010 CAA baseline, to obtain the incremental cost of the new standards, the cost of area-specific control measures that are duplicated in the 8-hour analysis is subtracted from the cost of the 8-hour standards.

Table 7.1 indicates the number of initial projected ozone nonattainment areas for which control measures are selected for the analysis year 2010. The first set of columns in this table shows the number of projected areas relative to the 2010 CAA baseline. The third column shows the number of projected nonattainment areas that are not also projected to be nonattainment for the current ozone standard.

Table 7.1 Initial Projected Number of Ozone Nonattainment Areas (and Associated Counties)

Standard	Incremental to 2010 CAA Baseline	Unique to Alternative Standard[a]
0.08 5th Max.	15 (167)	5 (85)
0.08 4th Max.	19 (203)	10 (112)
0.08 3rd Max.	28 (278)	19 (189)

a Number of areas that are not initially projected to be nonattainment for the current ozone standard.

7.3.1 Control Measure Selection in Projected Ozone Nonattainment Areas

Control measure selection in this analysis is modeled using an approach for achieving the ozone standards that simulates current ozone standard implementation practices. 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.

This analysis relies on a combination of national and local control measures to achieve incremental improvements in ozone air quality from the 2010 CAA baseline. Air quality goals are translated into area-specific VOC and NOx emission reduction targets. The targets are established based on air quality modeling and recent ambient ozone monitoring data. The methodology used to establish these emission reduction goals improves upon methods used in the 1996 Regulatory Impact Analysis (RIA) of the proposed ozone NAAQS, and in some areas results in significantly different targets. Emission reduction targets are developed from a series of Regional Oxidant Model (ROM) matrix runs (i.e., simulations of across-the-board VOC and NOx reductions). The targets are expressed in terms of percent reduction in anthropogenic VOC and/or NOx emissions beyond emission levels corresponding to 2007 emission projections and

CAA-mandated controls (U.S. EPA, 1997a). Adjustments are made to these targets to account for the impacts of the regional NOx control strategy (i.e., the OTAG NOx cap and NLEV), and emissions growth and control to the year 2010 (U.S. EPA, 1997b). It should be noted that the solution set of emission reduction targets for projected nonattainment areas is not unique. This RIA models one emission reduction solution among many potential solutions.

A range of national measures that could be applied to reduce VOC and/or NOx on a broad scale were explored. Several VOC-oriented national measures such as more stringent VOC-content limits on consumer solvents and reformulated gasoline (RFG) were considered, but ultimately not included, because the national cost of implementing these measures was very high relative to the VOC reductions achieved in initially projected nonattainment areas. Though not included as national measures, the consumer solvent and RFG control measures are available in this analysis as *local* control measures.

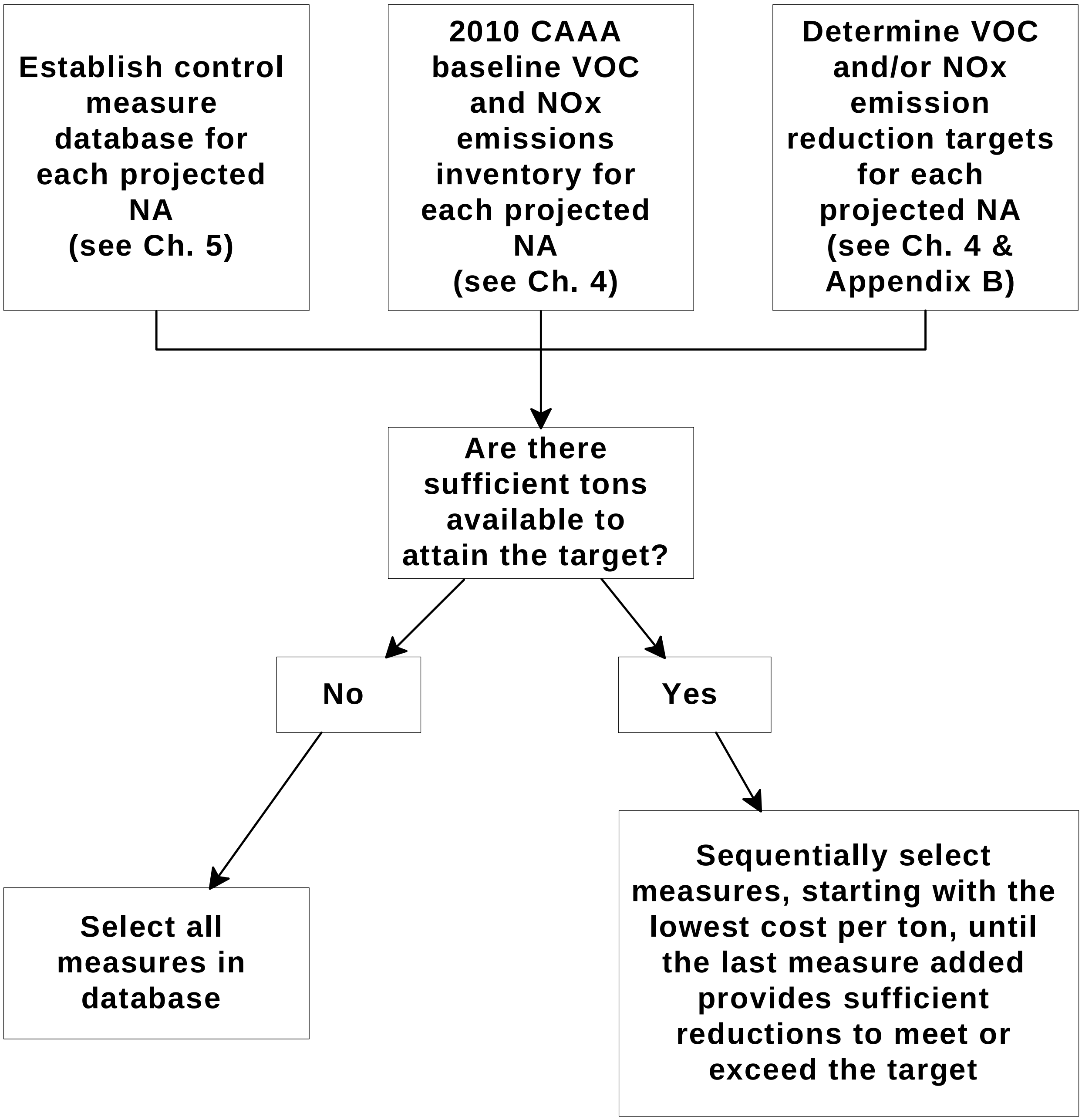
Changes in vehicle or engine emission standards were also explored. These measures are best applied at the national level because it would be expensive and difficult for vehicle and engine manufacturers to comply with a patchwork of standards applied at the local level. Also, because motor vehicles and engines are mobile, much of the benefit of vehicle or engine emissions standards applied at the local level could be lost to immigration of dirtier vehicles or engines into the local area. More stringent Tier 2 light duty truck standards are included as a national control measure to achieve widespread reductions in both VOC and NOx emissions. Chapter 5 contains a detailed discussion of this control measure. This control measure is referred to as the National Ozone Strategy in this RIA. Emission reductions for the National Ozone Strategy are estimated for every county in the nation, including counties in projected nonattainment areas. The reductions occurring in projected nonattainment areas are credited toward achievement of the areas' emission targets.

After reductions due to the National Ozone Strategy are credited in each projected nonattainment area, local control measures are applied. Figure 7.1 shows the basic elements of the local nonattainment area control strategy selection process. Local measures are rank ordered by increasing average annual incremental cost per ton of reduction of the target pollutant[1]. Control measures are restricted to those with an average annual incremental cost of $10,000 per ton or less. Section 7.3.2 provides further discussion of this control measures selection threshold. Control measures are selected from this list until the sum of all reductions meets or exceeds the targeted reductions established for that nonattainment area. In areas with both VOC and NOx targets, both targets must be met. In many instances, for the analysis presented in this chapter, all available measures are selected before the emissions target is reached resulting in *residual nonattainment* of the NAAQS.

After the initial round of control measure selection, areas that achieve their targets are reviewed to determine where over control can be reduced. For areas where the last measure selected results in over control, measures with a higher average annual incremental cost per ton (with less reduction) are evaluated, or less costly measures eliminated in order to minimize over control. Changes to the initial set of selected control measures are only made if the total annual cost for the area also declines.

See Chapters 5 and 6 for a discussion of average annual incremental cost per ton and how it relates to control measure selection.

Figure 7.1
Local Ozone Control Strategy Selection Process



In areas with both VOC and NOx reduction targets, a review is also conducted to determine whether unselected measures reducing both VOC and NOx are more cost-effective than selected measures that reduce only one pollutant. Changes to the initial set of selected control measures are only made if the total annual cost for the area also declines.

7.3.2 Control Measure Selection Cost per Ton Threshold

Control measures with an average annual incremental cost per ton of VOC or NOx of $10,000 (1990 dollars) or less are the only ones considered for the analysis results reported in this chapter[1]. Since the ozone cost analysis is generally designed to simulate current implementation practices, this threshold provides a realistic estimate of the highest incremental cost impact that affected entities might face. To date, States generally have not chosen to require existing sources to apply control measures with incremental costs above this threshold. For instance, the South Coast Air Quality Management District (SCAQMD), which manages the most severe ozone nonattainment area in the United States, does not currently apply VOC or NOx control measures with an average annual incremental cost above $11,100 per ton (1990 dollars) (SCAQMD, 1996).

Since most areas do not have an ozone problem as severe as the South Coast (i.e., $10,000 may be too high for some areas), and because it is possible that future implementation of more stringent ozone standards may require more costly control measures (i.e., $10,000 may be too low for some areas in the future), Appendix D includes a sensitivity analysis on a range of control measure selection thresholds. Thresholds of $7,000 per ton, $20,000 per ton, and no cut-off are examined. Generally, given the full set of control measures in the control measure database and the target sets for each projected nonattainment area, the level of reductions achieved and progress toward full attainment is relatively insensitive to the alternative cost

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The control measure database used in this analysis does contain control measures with an average annual incremental cost per ton greater than $10,000. These are generally measures affecting point sources that have low-concentration pollution streams and/or relatively stringent baseline control levels. The $10,000 average annual incremental cost per ton threshold was not used in the 1996 RIA of the proposed ozone NAAQS.

thresholds.

7.4 EMISSION REDUCTION IMPACT RESULTS

This section presents the emission reduction results for the analysis of alternative ozone standards. Included are estimates of the total emission reductions from each projected ozone nonattainment area resulting from national and local control measures, and the estimated change in the attainment status for the areas initially projected not to attain alternative ozone standards. 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 ozone standard, and the second state being the year 2010 with actions taken to meet a new ozone standard. The costs reported in this analysis represent the difference in cost between these two states.

Table 7.2 presents the estimated ozone season daily VOC and NOx emission reductions achieved by the National Ozone Strategy (more stringent Tier 2 light duty truck standards) and local control measures for each alternative ozone standard. The National Ozone Strategy provides only a small fraction of the total VOC emission reductions, but a slightly larger fraction (8 to 10 percent) of the total NOx emission reductions.

Table 7.2 Summary of Ozone Season Daily VOC and NOx Reductions in Ozone Nonattainment Areas

Standard	National Ozone Strategy Reductions[a] (ozone season tons per day)		Local Control Measure Reductions (ozone season tons per day)			
			Incremental to 2010 CAA Baseline		Incremental to Current Ozone Standard	
	VOC	NOx	VOC	NOx	VOC	NOx
0.08 5th Max.	16	46	1,146	393	536	111
0.08 4th Max.	18	53	1,422	582	812	297
0.08 3rd Max.	24	71	1,862	803	1,252	518

a Reductions are incremental to the 2010 CAA baseline.

Table 7.3 shows the national summary of ozone nonattainment area emission reduction targets and the reductions achieved in the analysis of each alternative standard. Both the number of projected ozone nonattainment areas increases and the amount of reduction needed in each area increases with the level of stringency of the standard. This table shows that the combination of the National Ozone Strategy and local control measures that meet the average annual incremental cost per ton control measure selection threshold of $10,000 are able to achieve on average from 37 to 43 percent of the VOC reduction target, and 22 to 24 percent of the NOx reduction target. Since areas that are estimated to be in residual nonattainment for the current ozone standard are a subset of the areas included in the 0.08 5th Max. and 0.08 3rd Max. analyses, full attainment of the current ozone standard would increase the average percent reduction achieved for the alternative ozone standards relative to the targets.

Table 7.3 National Summary of Local VOC and NOx Emission Reduction Targets and Reductions Achieved[a]

Standard	2010 CAA Baseline Emissions (tons per day)		Target Reductions (tons per day)		Reductions Achieved Relative to Targets (tons per day)		Percent Achieved Relative to Targets	
	VOC	NOx	VOC	NOx	VOC	NOx	VOC	NOx
0.08 5th Max.	7,450	5,143	2,667	1,722	1,149	408	43%	24%
0.08 4th Max.	7,913	6,040	3,455	2,529	1,308	582	38%	23%
0.08 3rd Max.	10,278	8,022	4,598	3,648	1,706	803	37%	22%

a Emission reduction targets and achieved reductions are incremental to the 2010 CAA Baseline. Reductions in pollutants not targeted in each area are not included in this table since in the methodology used in this analysis they are not assumed to reduce ozone concentrations. Only control measures with an average annual incremental cost of $10,000 per ton or less are included in this analysis.

Table 7.4 provides more detail on the distribution of reductions achieved as a percent of reductions needed for each alternative standard. For the 0.08 5th Max. standard, 3 out of 15 areas are projected to reach full attainment. For the 0.08 3rd Max. standard, 1 out of 28 areas is projected to reach full attainment. The nonattainment areas represented for the current ozone standard are a subset of the nonattainment areas presented for the set of alternative 0.08 ppm standards. Areas that are in residual nonattainment for the current standard make little or no additional progress under the alternative 0.08 ppm standards.

Table 7.5 indicates the number of projected nonattainment areas that do not reach the target reduction levels after all control measures less than $10,000 per ton are selected. These residual nonattainment areas are counted incremental to both the 2010 CAA baseline and to the nonattainment areas for the current ozone standard.

Table 7.4 Distribution of VOC and NOx Emission Reductions Achieved as a Percent of Reductions Needed[a]

Standard	Number of Initial Nonattainment Areas Achieving the Specified Progress[b]						Total Number of Areas
	< 20%	20 - 40%	40 - 60%	60 - 80%	> 80%	Full Attain-ment	
Current Standard	1	3	3	0	1	1	9
0.08 5th Max.	3	7	2	0	0	3	15
0.08 4th Max.	3	9	2	2	1	2	19
0.08 3rd Max.	6	13	5	1	2	1	28

a Reductions achieved as a percent of reductions needed for target pollutants only (see Table 7.3).
b Number of areas incremental to the 2010 CAA baseline. Only control measures with an average annual incremental cost of $10,000 per ton or less are included in this analysis.

Table 7.5 Number of Residual Ozone Nonattainment Areas

Standard	Incremental to 2010 CAA Baseline	Unique to Alternative Standard[a]
0.08 5th Max.	12	6
0.08 4th Max.	17	10
0.08 3rd Max.	27	19

a Number of areas that are not projected to be residual nonattainment for the current ozone standard.

7.5 COST IMPACT RESULTS

This section presents the incremental annual control cost associated with additional control measures modeled to meet alternative ozone standards. Two components comprise the incremental annual cost. The first component is the cost of the National Ozone Strategy (more stringent Tier 2 light duty truck standards). The second component is the cost associated with application of local VOC and/or NOx control measures in each of the projected ozone nonattainment areas.

Table 7.6 presents the national costs of the alternative ozone standards. These costs are calculated incremental to partial attianment of the current ozone standard. Using the additional control measures modeled for this analysis, not all areas are projected to attain the alternative standards. For this reason, the costs presented in this section are characterized as *partial attainment* costs. The national cost of the National Ozone Strategy (i.e., more stringent Tier 2 light duty truck standards) is estimated to be $300 million (1990 dollars). The total cost of partial attainment of the ozone standards, including both national and local control measures, is estimated to be $890 million to $1.4 billion (1990 dollars).

Table 7.7 National Summary of Partial Attainment Control Cost for Alternative Ozone Standards

Control Measure	Annual Control Cost (Millions 1990$)[a]		
	0.08 5th Max.	0.08 4th Max.	0.08 3rd Max.
National Ozone Strategy	330	330	330
Local Control Measures	560	780	1,000
Total	890	1,100	1,400

a Costs are incremental to partial attainment of the current ozone standard. Only control measures with an average annual incremental cost of $10,000 per ton or less are included in this analysis. Totals may not agree due to rounding.

7.6 ESTIMATING OZONE IMPACTS AFTER ATTAINMENT OF AN ALTERNATIVE $PM_{2.5}$ STANDARD

Many of the VOC and NOx control measures selected in the $PM_{2.5}$ cost analysis can also reduce ozone concentrations. Any $PM_{2.5}$-related VOC and/or NOx reductions occurring both inside and outside ozone nonattainment areas may impact ozone air quality, and the number or stringency of "ozone-specific" emission control measures that must be employed to meet new ozone standards. 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 7.8 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 4th Max. alternative, 14 of the initial 19 ozone nonattainmet areas contain at least one county projected to be nonattainment for the selected $PM_{2.5}$ 15/65 alternative. 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 outside but near ozone nonattainment areas due to $PM_{2.5}$ control may also influence ozone air quality inside ozone nonattainment areas.

Table 7.8 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 4th Max.	**$PM_{2.5}$ 15/65**	19 (203)	102	30 (14)
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 $PM_{2.5}$ 15/50 alternative has on attaining the 0.08 3rd Max. ozone alternative. Reductions occurring inside ozone nonattainment areas from control measures selected in the $PM_{2.5}$ analysis are credited toward each ozone nonattainment areas' targets. The control measures selected in the $PM_{2.5}$ analysis are not available for selection again in the ozone analysis 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 $PM_{2.5}$ 15/50 alternative is likely to further reduce the incremental cost of control for the 0.08 3rd. Max. ozone alternative.

7.7 ANALYTICAL LIMITATIONS, UNCERTAINTIES, AND POTENTIAL BIASES

Because a quantitative uncertainty cannot be assigned to every input, the total uncertainty in the emission reduction 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 emission target methodology to overstate or understate initial nonattainment in specific areas.

To model the costs of achieving potential air quality standards, control measures are selected from the control measure database using incremental cost effectiveness as the sole criterion. As noted previously in Section 6.7, cost-effectiveness, as used in this analysis, is a limited metric. Even if these cost per ton figures 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. State and local agencies may use criteria other than cost effectiveness in selecting control measures, and given more time and knowledge of local conditions, should be able to more accurately estimate the costs and emission reductions of the control options modeled in this analysis.

In areas where there is both a $PM_{2.5}$ and an ozone concern, States may recognize solutions that jointly address these problems, thereby reducing the overall cost of implementing both standards. Further, the analysis presented in this chapter does not adequately account for the potential effect on ozone air quality of control measures modeled in the $PM_{2.5}$ analysis. This is due both to shortcomings in available ozone air quality modeling, and the fact that only partial attainment of $PM_{2.5}$ standards is modeled.

7.8 REFERENCES

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8.0. VISIBILITY AND COST IMPACT ANALYSIS OF PROPOSED REGIONAL HAZE ALTERNATIVES

8.1 RESULTS IN BRIEF

The proposed regional haze (RH) program is designed to ensure reasonable progress toward the national visibility goal. It allows broad discretion on the part of the States in determining control measures to be imposed based on statutory criteria. Under the structure of the proposed RH rule, the States are able to consider the cost of emission reduction strategies in light of the degree of visibility improvement to be achieved. For this Regulatory Impact Analysis (RIA) the individual decisions on effectiveness of each of the control strategies applied in each region is modeled in a very limited way. Therefore the cost estimates presented in this report for meeting the presumptive visibility target are likely high estimates of actual implementation costs. The actual control cost of the proposed RH rule is likely to lie somewhere between zero and the estimates for the presumptive targets presented in this report.

Based on projected emissions levels for the year 2010 and progress toward attainment of the current ozone standard and the new $PM_{2.5}$ NAAQS (as estimated in Chapter 6), this analysis estimates that 76 mandated Class I areas need additional reductions to meet a presumptive target of improving the most impaired days (average of the 20 percent highest days) 1.0 deciview from 2000 to 2010. This analysis also estimates that 58 Class I areas need additional reductions to meet an alternative target of improving the most impaired days 1.0 deciview from 2000 to 2015 (i.e., an average of a 0.67 deciview improvement from 2000 to 2010). The additional cost of any implementation of the proposed RH rules will vary depending on the visibility targets submitted and approved as part of State plans. If targets are adjusted through that process to parallel the implementation programs for the new ozone and PM standards, the costs for meeting the adjusted targets in those areas will be borne by the ozone and PM programs. In this analysis costs are estimated assuming no changes in the presumptive target of 1.0 deciview improvement over 10 years for every mandatory Class I Federal area, or an alternative target of 1.0 deciview improvement over 15 years (i.e., an average 0.67 deciview improvement over 10 years). The additional control cost associated with meeting the presumptive 1.0 deciview target in 48 of these areas, and partial achievement in 28 areas is estimated to be \$2.7 billion (1990 dollars). The additional control cost associated with meeting the alternative presumptive 0.67 deciview target in 41 of these areas, and partial achievement in 17 areas is estimated to be \$2.1 billion (1990 dollars). In summary, the expected control cost associated with the proposed RH rule ranges from \$0 to a maximum of \$2.7 billion.

The estimate of the incremental cost of alternative presumptive visibility targets are also affected by: 1) an analysis baseline that understates the visibility progress achieved by CAA mandated controls and implementation of a new ozone standard over the period 2000 to 2010; 2) the inability to model full attainment of the selected $PM_{2.5}$ 15/65 standard; and 3) how close some of the residual Class I area counties are to natural background conditions. These factors suggest that the actual cost of achieving visibility improvements incremental to the selected ozone and $PM_{2.5}$ standards should be lower.

8.2 INTRODUCTION

This chapter presents the visibility improvements and cost impacts of proposed alternative RH targets. This analysis estimates the projected costs (in 1990 dollars) of installing, operating, and maintaining those additional controls needed by the year 2010 to meet the presumptive visibility targets in our nation's Class I designated areas. The following sections in this chapter cover:

- Cost analysis methodology;
- Visibility improvements and cost results for alternative RH targets; and
- Analytical uncertainties, limitations, and potential biases.

8.3 COST ANALYSIS METHODOLOGY

This analysis estimates the emission reductions and control costs for achieving the alternative presumptive visibility improvement targets described in Chapter 3. Since Class I areas rarely contain emissions sources, and because pollutants that degrade visibility can be transported over long distances by prevailing winds, controls must be imposed on sources located outside of Class I areas that contribute to visibility degradation in Class I areas.

The analysis is confined to the 141 Class I areas located in 121 counties in the 48 contiguous States. Further, the set of Class I areas is subdivided into the same six regions defined for the particulate matter (PM) analysis. The boundaries of these six control regions are depicted in Chapter 6 in Figure 6.2. The boundaries of these regions are delineated to reflect both the meteorological conditions that influence the long-range transport of visibility precursors and the locations of their major sources (e.g., electric utilities). Control measure selection is limited to emission sources in each control region. In addition, selection of some control measures that primarily affect coarse particles (i.e., particles greater than 2.5 microns) is limited to the county containing the Class I area. This limitation prevents control measures that have a minor affect on visibility (e.g., fugitive dust control for unpaved roads) from being selected in counties that are relatively distant from Class I areas.

The baseline for the RH analysis is the projected emissions inventory from the analysis of the selected $PM_{2.5}$ 15/65 standard and the remaining set of control measures that are not already selected in that analysis. Chapter 6 presents the analysis of the $PM_{2.5}$ 15/65 standard.

If the RH rule is finalized on schedule, the first period for which visibility improvements are to be evaluated is estimated to be the years 2000 through 2010. In order to evaluate visibility improvements, visibility monitors must be established in the Class I areas of concern, and it is likely to take a few years to establish these monitors. Ideally, this Regulatory Impact Analysis (RIA) would evaluate the potential improvements in visibility over the ten year period from 2000 to 2010, and would account for emission reductions achieved from current CAA mandated controls (e.g., Title IV sulfur dioxide (SO_2) cap on utility sources) and due to promulgated $PM_{2.5}$ and ozone NAAQS. However, this requires developing a year 2000 emissions inventory and a set of control measure impacts incremental to the year 2000. Instead, the RH analysis takes advantage of the 2010 emissions inventory and incremental control measure database established for the $PM_{2.5}$ and ozone analyses discussed in Chapters 6 and 7.

Control costs for attaining the alternative presumptive visibility improvement targets are evaluated incremental to attainment of the promulgated $PM_{2.5}$ standard. If a Class I area is projected to meet the presumptive visibility improvement target in the year 2010 as a result of $PM_{2.5}$-related control measures, no additional control is needed. However, if the goal is not met, additional control measures are modeled. This baseline provides conservative estimates (i.e., potentially overstates) of the cost of achieving alternative visibility goals for two reasons. First, the progress achieved by measures related only to $PM_{2.5}$ control through the year 2010 does not include progress achieved due to measures already mandated under the 1990 CAA, or progress achieved due to controls needed to meet the new ozone standard. These control measures, which are not in the baseline of the RH analysis, may contribute to further visibility improvement from 2000 to 2010. Second, applying the set of control measures included in the $PM_{2.5}$ analysis results in residual nonattainment for some areas. To the extent that these areas are actually able to achieve additional reductions to attain the $PM_{2.5}$ standard, further visibility improvements may also be realized.

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 the 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, a 7 percent real interest rate was used, in accordance with Office of Management and Budget guidance.

8.3.1 Estimating Visibility

Decreases in visibility are often directly proportional to decreases in light transmittance in the atmosphere (Trijonis et al., 1990). Light transmittance is attenuated by scattering and absorption by both gases and particles. The light-extinction coefficient is a measure of the total fraction of light that is attenuated per unit distance (Sisler, 1996):

$$b_{ext} = b_{Ray} + b_{sp} + b_{ag} + b_{abs}$$

where:

b_{ext}	=	total light extinction coefficient (1/Mm),
b_{Ray}	=	light extinction coefficient due to natural Rayleigh scatter (1/Mm),
b_{sp}	=	light extinction coefficient due to scattering by particles (1/Mm),
b_{ag}	=	light extinction coefficient due to absorption by gases (1/Mm), and
b_{abs}	=	light extinction coefficient due to absorption by particles (1/Mm).

The light extinction coefficient is calculated by multiplying the concentration of an aerosol species by its light-extinction efficiency, and summing over all species.

The term b_{Ray} refers to the natural Rayleigh scatter from air molecules, mainly nitrogen and oxygen. Depending on altitude, this term has a value of 9 to 12 Mm^{-1} (inverse megameters) (Sisler and Malm, 1994).

The term b_{sp} can be broken into the various species of fine and coarse particles that scatter light. Because fine particles are much more efficient at light scattering than coarse particles, several fine particle species are specified, whereas coarse particles are kept as one category. Fine particles with significant light-extinction efficiencies include sulfates, nitrates, organic carbon, elemental carbon (soot), and soil (Sisler, 1996).

A complicating factor for sulfates, nitrates, and some organic compounds is that these aerosols are hygroscopic, i.e., they absorb water, which greatly enhances their light-scattering abilities. The amount of water absorbed is a function of the relative humidity. A relationship between the relative humidity and scattering efficiency for ammonium sulfate aerosols has been developed, and is also applied to ammonium nitrate aerosols (Sisler, 1996). Recent research indicates that organics are not hygroscopic to weakly hygroscopic (Sisler, 1996) and thus in this analysis, the light scattering efficiency for organics is not assumed to be a function of the relative humidity.

A detailed expression for b_{sp} can thus be written (Sisler, 1996):

$$b_{sp} = 3f(RH) \cdot [SULFATE] + 3f(RH) \cdot [NITRATE] + 4[OMC] + 1[SOIL] + 0.6[CM]$$

where:

3	=	dry scattering efficiency of sulfate and nitrates (m^2/g),
f(RH)	=	function describing scattering characteristics of sulfates and nitrates, based on the relative humidity (unitless),
[*SULFATE*]	=	concentration of ammonium sulfate aerosols ($\mu g/m^3$),
[*NITRATE*]	=	concentration of ammonium nitrate aerosols ($\mu g/m^3$),
4	=	dry scattering efficiency of organic mass from carbon (m^2/g),
[*OMC*]	=	concentration of organic aerosols ($\mu g/m^3$),
1	=	dry scattering efficiency of soil (m^2/g),
[*SOIL*]	=	concentration of fine soil ($\mu g/m^3$),
0.6	=	dry scattering efficiency of coarse particles (m^2/g), and
[*CM*]	=	concentration of coarse particles ($\mu g/m^3$).

The function *f(RH)* is calculated as follows:

$$f(RH) = t_0 + t_2(1/(1-RH))^2 + t_3(1/(1-RH))^3 + t_4(1/(1-RH))^4$$

where:

RH	=	relative humidity, and
t_x	=	parameters presented in Table 8.1 below.

Table 8.1 Parameter Determining the Effect of Relative Humidity on Visibility

Season	t_0	t_2	t_3	t_4
Spring	0.7554	0.3091	-0.0045	-0.0035
Summer	0.5108	0.4657	-0.0811	0.0043
Autumn	-0.0269	0.8284	-0.1955	0.0141
Winter	1.1886	0.2869	-0.0332	0.0011
Annual	0.5176	0.5259	-0.0947	0.0056

Source: Table 5.1, Sisler, 1996.

The term b_{ag} represents absorption due to gases; NO_2 is the only major light-absorbing gas in the lower atmosphere. This component is assumed to be negligible since concentrations of NO_2 are expected to be negligible in rural areas (Sisler and Malm, 1994) which is generally applicable for Class I areas. However, this may be a poor assumption for locations close to significant NO_x emission sources, such as power plants or urban areas (Sisler, 1996).

The final term of the light-extinction coefficient equation, b_{abs}, represents absorption of light by elemental carbon. This term represents approximately 30 percent of the non-Rayleigh extinction budget (Sisler, 1996). Recent research has indicated that direct measurements of absorption by the laser integrated plate method (LIPM) are much more accurate than using absorption estimates based on mass concentrations of light-absorbing carbon. For that reason, this analysis bases b_{abs} on empirical data from monitored sites in the IMPROVE network.

Once the light-extinction coefficient is determined, the visibility index called deciview (*dv*) can be calculated (Sisler, 1996):

$$dv = 10 \cdot \ln(b_{ext} \cdot 10^{-3} / 0.01\,km^{-1})$$

where:

10^{-3} = constant to convert Mm^{-1} to km^{-1}.

A change of one *dv* represents a change of approximately ten percent in b_{ext}, "which is a small but perceptible scenic change under many circumstances" (Sisler, 1996, p.1-7).

8.3.2 Estimating the Effect of Control Measures on Visibility

Given the available data available from the IMPROVE monitoring network and the changes in sulfate, nitrate, and primary PM emissions modeled using the source-receptor (S-R) matrix described in Chapter 6, light extinction (b_{ext}) is calculated using the following equation:

$$b_{ext} = b_{Ray} + 3f(RH) \cdot [SULFATE] + 3f(RH) \cdot [NITRATE] + 4[OMC] + 1[SOIL] + 0.6[CM] + b_{abs}$$

The S-R matrix provides concentration estimates of ammonium sulfate (SULFATE), ammonium nitrate (NITRATE), and coarse mass ($CM = PM_{10} - PM_{2.5}$). A common assumption for light scattering by background gases (b_{Ray}) is 10 Mm^{-1}. Appendix E provides estimates for f(RH), OMC, SOIL, and b_{abs} based on summary data from 43 relevant IMPROVE monitoring sites between 1992-1995. For Class I areas without monitoring data, values are assigned based on either the closest monitored site or an average of up to three proximate monitored sites. The values are assumed constant in this analysis, even though it is known that certain types of control measures may affect the baseline levels of OMC and b_{abs}. The exact relationship between these factors and specific control measures has not been established, and therefore these values are held constant.

8.3.3 Selecting Control Measures with the Regional Haze Optimization Model

The RH optimization model works in a manner similar to the PM optimization model discussed in Chapter 6. However, in this case, the receptor county of interest contains a Class I area, and reductions in $PM_{2.5}$ precursors at the receptor are translated into improvements in visibility (i.e., reductions in light extinction). Control measures that are not already selected in the PM analyses are available for the RH analysis.

The optimization routine developed for this analysis employs the following steps:

Step 1. The remaining control measures in the incremental control measure data file are sorted by source number, precursor pollutant controlled, and cost per ton of pollutant reduced.

Step 2. The *incremental* improvement in visibility is calculated *for each Class I area county* for the least costly (on a cost per ton basis) control measure for each individual source/pollutant combination.

Step 3. The measure with the *lowest average cost per increment of visibility improvement* is selected and the deciview levels at each receptor are adjusted to reflect implementation of the selected measure.

Step 4. Steps 2 through 3 are repeated until all input receptors meet the target level *or* all remaining measures are exhausted. The same $1 billion per microgram per cubic meter control measure selection threshold that is used in the PM optimization model is also used in the RH optimization model.

Step 5. Adjust final post-control visibility predictions in all Class I areas nationwide to account for the trans-boundary effect of control measures selected outside each control region.

8.3.4 Scaling Annual Average Deciview Values Relative to Average Peak Values

As proposed, the RH rule suggests a 1.0 deciview change in the average deciview value of the 20 percent worst days over a ten year period. However, the S-R matrix used to estimate pollution concentrations that contribute to RH formation, outputs annual average values for the pollutants of concern (ammonium sulfate, ammonium nitrate, and primary PM_{10} and $PM_{2.5}$). This analysis uses the most recent monitoring data from Class I areas to translate a 1.0 deciview change in the 20 percent worst days to an equivalent change for an annual average day. Appendix E contains the data used to make this calculation.

The average of the 20 percent worst days each year is also be referred to as the 90th percentile value, and can be compared to the annual average or mean value. The ratio of the 90th percentile deciview value to the mean deciview value varies by Class I area. Based on the most recent IMPROVE data, the average ratio of the 90th percentile deciview value to the mean deciview value for all Class I areas is 1.4. Therefore, a 1.0 deciview change in the average of the 20 percent worst days correlates to a 0.7 deciview change in the annual average day (1.0 divided by 1.4). Similarly, a 0.67 deciview change in the 20 percent worst days correlates to a 0.5 deciview change in the annual average day (0.67 divided by 1.4). These annual average equivalent targets are used in this analysis.

8.3.5 Baseline Visibility

The visibility baseline in this analysis is represented by the estimated visibility improvement between the 2010 CAA baseline case and the post-$PM_{2.5}$ 15/65 case. Table 8.2 summarizes the visibility measurements in terms of deciviews for the two cases. As the table shows, the average visibility improvement in the annual average deciview value for counties containing Class I areas in the Midwest/Northeast and the Southeast regions is more than the target of 0.7 deciviews.

Table 8.2 Projected Annual Average Deciview Values by Control Region

Region	No. of Counties Containing Class I Areas	2010 CAA Baseline	2010 Post-$PM_{2.5}$ 15/65	Average Annual Deciview Improvement
Midwest/Northeast	16	23.1	21.2	1.9
Southeast	13	22.5	21.1	1.4
South Central	14	16.8	16.4	0.4
Rocky Mountain	30	17.6	17.1	0.5
Northwest	18	19.3	19.0	0.3
West	30	17.8	17.3	0.5
Nation	121	19.1	18.3	0.8

Table 8.3 indicates the number of Class I area counties for which additional control measures may be needed incremental to the baseline (i.e., incremental to partial attainment of the $PM_{2.5}$ 15/65 standard). Nearly all Class I area counties in the Midwest/Northeast and Southeast regions are projected to meet the alternative presumptive visibility improvement targets without any additional controls beyond partial attainment of the selected $PM_{2.5}$ 15/65 standard. However, a majority of the Class I area counties located in the South Central, Northwest and West regions are projected to need additional reductions to meet the alternative goals. For the more stringent 1.0 deciview target, a majority of the Class I areas in the Rocky Mountain region are also

Table 8.3 Number of Class I Area Counties <u>Not</u> Achieving Alternative Visibility Goals in the Baseline

Control Region	Number of Class I Area Counties	Number of Class I Area Counties After $PM_{2.5}$ 15/65 Control	
		1.0 Deciview Goal Over 15 Years (0.67 Deciview Target)	1.0 Deciview Goal Over 10 Years (1.0 Deciview Target)
Midwest/Northeast	16	0	0
Southeast	13	0	1
South Central	14	11	11
Rocky Mountain	30	14	27
Northwest	18	17	18
West	30	16	19
Nation	121	58	76

projected to need additional reductions. These areas also have the highest proportion of predicted biogenic aerosol emissions, which places them closer to natural conditions than other regions. This would tend to support establishing alternative targets for these areas.

8.5 VISIBILITY IMPROVEMENT RESULTS

This section presents the incremental visibility improvements achieved for each alternative presumptive visibility improvement target in Class I area counties that did not achieve the goal in the baseline. Included are estimates of the additional number of Class I area counties that achieve the alternative presumptive visibility improvement targets, as well as the average improvement realized. As discussed in section 8.3.4, a 1.0 deciview improvement goal for the average 20 percent worst days is roughly equivalent to a 0.7 deciview improvement goal for the annual average day. Similarly, a 0.67 deciview improvement in the average 20 percent worst days is roughly equivalent to a 0.5 deciview improvement in the annual average day.

Table 8.4 presents the number of Class I area counties that initially do not achieve each alternative presumptive visibility improvement target and the estimated number of Class I area counties that are not able to achieve the goals after additional control measures are modeled.

Table 8.4 Estimated Number of Class I Area Counties That Do NOT Achieve Alternative Presumptive Visibility Improvement Targets and the Average Deciview Shortfall

Region	1.0 Deciview Goal Over 15 Years (0.67 Deciview Target)			1.0 Deciview Goal Over 10 Years (1.0 Deciview Target)		
	Baseline[a]	Post-Control[b]	Average Deciview Shortfall	Baseline[a]	Post-Control[b]	Average Deciview Shortfall
Midwest/Northeast	0	0	--	0	0	--
Southeast	0	0	--	1	0	--
South Central	11	3	0.16	11	9	0.18
Rocky Mountain	14	3	0.06	27	4	0.22
Northwest	17	1	0.12	18	2	0.20
West	16	10	0.16	19	13	0.29
Nation	58	17	0.14	76	28	0.23

a Baseline represents counties that do not achieve sufficient progress toward the visibility goal after considering partial attainment of the selected $PM_{2.5}$ 15/65 standard.

b Post-control represents counties that do not achieve sufficient additional progress toward the visibility goal after considering additional controls not already selected in the $PM_{2.5}$ 15/65 analysis.

Also shown is the average deciview shortfall for the counties that do not reach the goal. This table indicates that 28 of the 76 initially noncompliant Class I area counties are not able to achieve the 1.0 deciview goal, and 17 of the 58 initially noncompliant counties are not able to achieve the 0.67 deciview goal. The areas not able to achieve the goal are concentrated in the West and South Central control regions. The majority of the West region areas are in central and southern California and Arizona. Several of these counties are also residually nonattainment in the $PM_{2.5}$ 15/65 analysis based on the results presented in Chapter 6.

For the 28 areas not achieving the 1.0 deciview goal after controls are applied, the region wide annual average deciview shortfall ranges from 0.18 to 0.29, meaning that on average these areas achieved from 0.41 to 0.52 (i.e., 59 to 72 percent) of the 0.7 deciview improvement needed to reach the goal. For the 17 areas not achieving the 0.67 deciview goal, the region wide annual average deciview shortfall ranges from 0.03 to 0.25, meaning that on average these areas achieved from 0.25 to 0.47 (i.e., 50 to 94 percent) of the 0.5 deciview improvement needed to reach the goal.

8.6 COST ANALYSIS RESULTS

This section presents the cost of achieving alternative regional haze goals incremental to control achieved in the $PM_{2.5}$ 15/65 analysis. Under the structure of the proposed RH rule, the States are able to take into account costs for emissions reductions strategies in light of the degree of visibility improvement to be achieved. Therefore, high cost control measures that have only minor effects on visibility can be avoided. For some Class I areas, there may not exist any cost effective control measures that can be applied in the time period covered by this analysis. In these areas the incremental control costs of the proposed RH rule will be zero. The actual control cost of the proposed RH rule is likely to lie somewhere between the zero and the estimates for the presumptive targets presented in this report. Based on the control strategies selected by the Grand Canyon Visibility Transport Commission, the majority of which are currently part of implementation plans for other criteria polutants, the costs will be on the lower end of this range.

The incremental cost of the RH rule presented in this RIA is compromised by the residual nonattainment projected to exist for the analysis of the selected $PM_{2.5}$ 15/65 standard. An analysis that models full attainment of the $PM_{2.5}$ standard should reduce the incremental cost of a RH rule in areas where there is significant overlap.

Table 8.5 shows the total annual control cost of alternative presumptive RH targets incremental to the selected $PM_{2.5}$ 15/65 standard. For both target levels the largest fraction of the control cost is realized in the Rocky Mountain and Northwest regions. This seems logical since there are relatively few counties projected to be nonattainment for the selected $PM_{2.5}$ 15/65 standard in these regions. Therefore, less control and accompanying visibility improvement is achieved in these regions in the baseline analysis.

Table 8.5 Regional Haze National Control Cost Summary--Total Annual Cost[a] (million 1990 dollars)

Control Region	1.0 Deciview Goal Over 15 Years (0.67 Deciview Target)	1.0 Deciview Goal Over 10 Years (1.0 Deciview Target)
Midwest/Northeast	--	--
Southeast	0 - 70	0 - 150
South Central	0 - 440	0 - 490
Rocky Mountain	0 - 580	0 - 670
Northwest	0 - 710	0 - 1,000
West	0 - 320	0 - 420
Nation	0 - 2,100	0 - 2,700

a Costs are incremental to partial attainment of the selected $PM_{2.5}$ 15/65 standard. Totals may not agree due to rounding.

8.7 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.

As noted in Section 6.7 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.

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 visibility goal. 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.

8.8 REFERENCES

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9.0 DISCUSSION OF FULL ATTAINMENT COSTS

9.1 RESULTS IN BRIEF

Bringing all areas of the country into attainment of the 0.08 4th Max ozone standard by the year 2010 is estimated to cost $9.6 billion annually in 2010. This cost is incremental to the costs associated with full attainment of the current hourly ozone standard, and includes the costs outlined in Chapter 7.0 associated with bringing a portion of the projected ozone nonattainment areas into attainment with the 0.08 4th Max standard. The costs beyond the partial attainment costs would be associated primarily with a relatively few areas of the country that suffer from the worst air pollution and are in need of additional emission reductions to reach attainment.

Bringing all areas of the country into attainment with the $PM_{2.5}$ 15/65 standard by the year 2010 is estimated to cost $37 billion annually in 2010. This cost is incremental to the cost associated with full attainment of the current PM_{10} standard, and includes the costs outlined in Chapter 6.0 associated with bringing a portion of the projected $PM_{2.5}$ nonattainment counties into attainment. As in the case of ozone, the costs beyond the partial attainment costs would be associated primarily with a relatively few areas of the country that suffer from the worst air pollution and are in need of additional emission reductions to reach attainment.

This regulatory impact analysis (RIA) is a snapshot of potential annualized costs for 2010, estimating both partial and full attainment. The partial attainment cost analyses presented in Chapters 6.0 - 8.0 do not include potential costs associated with arbitrarily forcing all areas into attainment prior to the maximum statutory deadlines. The full attainment analysis discussed in this chapter brings all areas into attainment by 2010, slightly before the deadlines currently in the Clean Air Act (CAA) for some areas.

9.2 INTRODUCTION

This chapter presents a full attainment scenario for both the $PM_{2.5}$ and ozone standards. The costs and emission reductions associated with the partial attainment analysis of $PM_{2.5}$ outlined in Chapter 6.0 and partial attainment analysis of ozone in Chapter 7.0 are incorporated into this chapter's analysis. This full attainment analysis brings all areas into attainment by 2010, slightly before deadlines currently in the Clean Air Act (CAA) for some areas.

In reviewing these full attainment cost estimates, it is useful to keep several factors in mind. First, no analyses can accurately predict costs of control strategies for attainment goals 10 to 15 years in the future. In the case of new air quality standards, full attainment will not be finally required for 10-12 years after area designations (2012 for ozone, 2014 for PM). For a number of reasons, this is simply too long a time over which to assume accurate information related to implementation of the CAA. Historically, compliance costs over long time periods have consistently been overestimated.

The history of implementation of the CAA provides some context for this statement. Since 1970, the CAA has in many ways been a "technology-forcing" law. The obligation to meet the national air quality standards has created pressures and market opportunities for technology breakthroughs and continuous improvements. The result has been continued, affordable improvements in air quality across the country, even in the face of continued growth in the number of air pollution sources. This history, as well as a review of currently developing technologies, provides a sound basis for anticipating that technological progress will continue in response to new standards. Perhaps the most notable example of technological improvement that made past air quality improvements affordable was the introduction of catalytic technology for automobiles in the early 1970s. Predictions of economic chaos accompanied the setting of tailpipe emissions standards in the 1970 CAA, yet inexpensive catalytic technology made those standards achievable and affordable within a few years. However, for some of the areas with the most difficult air quality challenges, substantial technological advance is needed. Given EPA's modeling capabilities and assumptions of reductions required for attainment, these areas achieve approximately one third of the reductions needed to attain the new standards in 2010.

It is very difficult to predict technological improvements and their associated effects on cost because we have insufficient knowledge of which new technologies will be successful enough to have a meaningful impact on costs over the next ten to fifteen years--though history tells us such innovations will occur. One catalyst for such innovations will be the investments made to control greenhouse gases for climate change which will create a more energy efficient and less polluting economy.

Another factor which may have a significant downward influence upon actual costs relative to predicted costs is the likely replacement of many command and control pollution control systems with market-based pollution control systems. Since 1990, we have seen dramatic cost reductions associated with market-based programs. Examples of market-based air pollution control and their costs are included later in this chapter. The success of efforts such as the acid rain program under Title III of the CAA have led EPA and others to place primary reliance for implementing revised standards on new or expanded market-based programs. As a result, these approaches will likely be incorporated into new and existing control strategies at the local, regional, and national levels. Again, however, there are no clear means of incorporating the likely cost savings from these programs into current cost estimates.

A third factor which makes long-term estimates difficult, is the nature of implementation as laid out in the CAA. Under the Act, the primary responsibility for achieving national ambient air quality standards (NAAQS) falls to the states. Upon the setting of a new standard, the states begin a multi-year, sequenced process of monitoring and planning; the results of which are ultimately found in State Implementation Plans (SIPs). These SIPs are the blueprint of control strategies through which states meet their responsibility. While the federal government maintains primary responsibility for certain sources which are best controlled nationally (e.g., motor vehicles), and the CAA does provide some additional requirements, most decisions about which control strategies to utilize fall primarily to the states. This approach allows control decisions, including costs associated with those decisions, to be appropriately considered at the state and local level. But the variety of control strategies that may then be utilized in the hundreds of air quality districts across the country becomes quite difficult to incorporate into national cost estimates.

Because of the difficulty in knowing the true costs of control strategies to be implemented 10 to 15 years in the future, policy makers seeking guidance from this RIA must weigh the potential significance of predictions that, although estimates of quantified partial benefits (through 2010) clearly exceed estimates of partial costs for both pollutants, a full attainment benefit-cost comparison carries less certainty.

Looking out 10-15 years, technological breakthroughs are hard to predict. The presence of health-based air quality standards have in the past and likely will in the future accelerate the introduction of new technologies. These standards also motivate greater reliance on innovative regulatory/non-regulatory approaches as well, such as market-based strategies, pollution prevention, environmental management systems and energy-efficiency. These approaches also have the benefits of reducing greenhouse gases. In short, the analysis contained herein provides a basis for believing that during the next decade benefits resulting from efforts to meet both new air quality standards are likely to exceed costs.

In order to more fully inform policy makers and the public about cost and benefit implications, EPA intends to periodically update the analysis contained herein, both as monitoring and redesignation information becomes more complete, and as the 5-year cycle of review is completed again in 2002.

9.3 METHODOLOGY AND RESULTS

To provide policymakers with as much information as possible to aid implementation planning, a full attainment analysis of both standards (0.08 4th Max and $PM_{2.5}$ 15/65) is carried out. To estimate full-attainment of the ozone standard, additional specified and unspecified control measures are assumed for areas still needing further reductions after the initial set of measures outlined in Chapters 5.0 - 7.0 are applied. The specified measures consist primarily of controls already in use, and are intended as illustrations of additional measures that could be chosen by states or local areas.

After application of the initial set of control measures analyzed in Chapter 7.0, seventeen areas are estimated to need further NO_x or VOC emission reductions to reach full attainment of the 0.08 4th Max ozone standard. Table 9.1 shows the estimated additional ozone season daily and annual emission reductions associated with full attainment of the 0.08 4th Max ozone standard. To reach full attainment, these areas are estimated to need approximately 1,000 tons per day of additional VOC emission reductions and 1,700 tons of additional NO_x emission reductions per day. Additional specified control measures would reduce this inventory by approximately 60 tons per day of VOC and 580 tons per day of NO_x. The average incremental cost effectiveness of the additional control measures included in this part of the analysis is approximately \$3,200/ton of NO_x reduced and \$4,000/ ton of VOC controlled. Emission reductions for the remaining tons (those not attributable to a specified control measure) are assumed to cost an average of \$10,000/ton for both NO_x and VOC emissions.

The estimated full attainment annual cost of the 0.08 4th Max ozone standard is \$9.6 billion (1990\$) in the year 2010. This includes the \$1.1 billion partial attainment cost estimate outlined in Chapter 7.0, and approximately \$800 million of additional specified reduction costs and \$7.7 billion of unspecified reduction costs. Characterization of full attainment costs should be considered more uncertain than cost estimates associated with the partial attainment analysis. Inclusion of control measures and their associated costs in this full attainment analysis does not

Table 9.1 Ozone 0.08 4th Max Estimated Full Attainment Emission Reductions

Pollutant/ Emissions Sector	Ozone Season Daily Tons					Annual Tons				
	2010 CAA Baseline Emission Level	Partial Attainment Emission Level[b]	Full Attainment Emission Level	Emission Reductions from Additional Measures[c]	Emission Reductions from Unspecified Measures	2010 CAA Baseline Emission Level	Partial Attainment Emission Level[b]	Full Attainment Emission Level	Emission Reductions from Additional Measures[c,d]	Emission Reductions from Unspecified Measures[d]
VOC										
Area	4,754	3,656		10		1,591,566	1,292,961		3,281	
Mobile	1,412	1,161		0		481,942	389,007		136	
Nonroad	1,403	1,400		9		452,781	452,426		2,890	
Point	900	884		40		328,637	322,760		13,651	
Utility	19	19		0		6,347	6,347		0	
TOTAL[e]	8,489	7,121	6,087	59	975	2,861,273	2,463,501	2,111,924	19,958	331,619
Shortfall[f]			1,034	975	0			351,577	331,619	0
NOx										
Area	1,158	1,085		0		499,705	447,274		0	
Mobile	2,699	2,441		8		969,975	882,104		3,061	
Nonroad	1,644	1,644		294		551,373	551,373		113,313	
Point	912	636		60		326,871	226,520		23,273	
Utility	554	554		218		350,786	350,539		83,795	
TOTAL[e]	6,967	6,359	4,657	580	1,122	2,698,710	2,457,811	1,802,556	223,442	431,812
Shortfall[f]			1,702	1,122	0			655,255	431,812	0

a Emissions and projected reductions needed for 17 areas projected to be residual nonattainment after application of control measures modeled in Chapter 7.0. Characterization of full attainment emission reductions and how such emission reductions would be achieved should be considered more uncertain than emission reduction estimates associated with the partial attainment analysis. Inclusion of control measures in this full attainment analysis does not represent selection of such control measures in future implementation strategies. Measures are included for illustrative purposes only. All emission reductions and shortfalls are estimated incremental to attainment of the current ozone standard.

b Emission level after application of control measures modeled in Chapter 7.0 and presented in Appendix B.

c Emission reductions from control measures discussed in Chapter 9.0 and presented in Appendix F.

d Annual tons estimated from ozone season daily tons by multiplying by 340 for VOC, and 385 for NOx. These conversion factors are derived from the average ratio of annual tons to ozone season daily tons identified in the 2010 CAA baseline and partial attainment analyses.

e Totals may not agree due to rounding.

f Shortfall represents emission reductions still needed to achieve the established target levels (see Chapter 4 for a more information on emission targets).

represent selection of such control measures in future implementation strategies. Measures are included for illustrative purposes only. All costs are estimated incremental to attainment of the current ozone standard.

A rough full attainment annual cost estimate for the selected $PM_{2.5}$ 15/65 standard is \$36.7 billion (1990\$). This cost estimate is incremental to full attainment of the current PM_{10} standard and is obtained by using the information from the partial attainment analysis to derive an estimate of additional reductions needed in each control region to reduce $PM_{2.5}$ concentrations to the level of the selected standard. The full attainment analysis assumes that these additional emission reductions are obtained at \$10,000/ton (as is assumed in the ozone full-attainment cost analysis). Tables 9.2 shows the estimate of additional emission reductions needed to fully attain the PM standard. The cost estimate was derived by the following steps:

<u>Step 1</u>: For each control region, the total NOx, SO_2, VOC, and direct PM_{10} emission reductions achieved by control measures employed in the partial attainment analysis (excluding the National PM2.5 Strategy) and the average annual $\mu g/m^3$ improvement realized in the 67 counties still violating the $PM_{2.5}$ standard after application of the National $PM_{2.5}$ Strategy were calculated.

<u>Step 2</u>: Using the information from Step 1, the $\mu g/m^3$/ton reduced in each region was calculated.

<u>Step 3</u>: The average annual average $\mu g/m^3$ shortfall in each region for the 30 residual nonattainment counties was calculated and each region's $\mu g/m^3$/ton reduced estimate (from Step 2) was multiplied by the average annual average $\mu g/m^3$ shortfall in each region to obtain an estimate of the additional emission reduction needed to eliminate the shortfall.

<u>Step 4</u>: This additional emission reduction estimate (from Step 3) was multiplied by \$10,000 per ton to obtain a cost estimate incremental to a 2010 CAA baseline cost estimate of \$38.5 billion (1990\$).

Step 5: Eleven of 30 residual nonattainment areas for the $PM_{2.5}$ 15/65 standard are also projected to be in residual nonattainment for the current PM_{10} standard. The potential costs associated with the PM_{10} standard, $10.4 billion, was subtracted from the $38.5 billion estimate. The estimated annual cost of partial attainment of the $PM_{2.5}$ standard, $8.6 billion (outlined in Chapter 6.0), was added to this result. The final result is a $36.7 billion (1990$) full attainment annual cost estimate of the $PM_{2.5}$ 15/65 standard incremental to the current PM_{10} standard.

This approach assumes that additional control measures will be identified that will achieve a similar ambient reduction in particle species across a given modeling region as is achieved in the partial attainment cost analysis. The emissions inventory and control measure set used in the partial attainment cost analysis are not intended to represent the complete inventory or the complete set of potential control strategies. Therefore, using the linear relationship between control measure effectiveness and air quality improvement modeled in the partial attainment analysis may over- or under-estimate the additional air quality improvement achieved by actual additional reductions beyond partial attainment.

Table 9.2 Estimate of Additional Emission Reductions Needed to Fully Attain the $PM_{2.5}$ 15/65 Alternative

Control Region	Initial Nonattainment Counties[a]			Residual Nonattainment Counties[b]	
	Emission Reductions Achieved by Regionally Applied Control Measures[c] (tons/yr) [A]	Average Annual µg/m³ Reductions Achieved by Regionally Applied Control Measures [B]	Average Emission Reductions per µg/m³ Reduction [C = A ÷ B]	Average Annual µg/m³ Shortfall [D]	Estimated Emission Reductions Needed to Eliminate Shortfall[d] (tons/yr) [E = C × D]
Midwest/Northeast	3,176,259	3.1	1,024,600	1.6	1,588,129
Southeast	278,700	2.2	126,682	0.2	25,336
South Central	1,020,106	1.7	600,062	1.1	630,066
Rocky Mountain	923,841	2.0	461,920	1.7	762,169
Northwest	5,918	0.0	--	--	0
West	364,147	0.8	455,184	1.9	842,090

a Estimates in these columns are for 66 counties projected to be nonattainment after application of the National $PM_{2.5}$ Strategy.

b Estimates in these columns are for 30 counties projected to be nonattainment after application of control measures modeled in Chapter 6.0, and do not include reductions and air quality improvements achieved by the National $PM_{2.5}$ Strategy.

c Total NOx, SO_2, VOC, and direct PM_{10} emission reductions achieved by application of control measures modeled in Chapter 6.0, not including reductions achieved by the National $PM_{2.5}$ Strategy. Combining all precursor pollutants into a single total represents a gross simplification since different precursors have, among other distinctions, different marginal costs of control and different potential marginal contributions to progress toward attainment.

d The estimate of the additional reductions required to overcome shortfalls and attain the PM standards are highly uncertain. The estimates presented in this table represent gross oversimplifications of critical variables and are useful only for illustrative purposes. More definitive estimates of region- and source category-specific reduction requirements will not be available until emissions inventories, air quality modeling, and SIP planning processes are completed for individual nonattainment areas. The values in this column are extremely crude estimates which reflect gross oversimplification of the relationships between changes in emissions of various precursors and changes in ambient concentrations. In particular, these estimates embed the unrealistic assumptions that precursor emissions would be reduced in identical proportions and that ambient concentrations would change linearly in response to those proportional reductions in precursors. Neither of these two assumptions are likely to actually obtain. Furthermore, the actual reductions required to achieve attainment would be highly dependent on the sources of the reductions. This is because reductions achieved by different source categories would be distributed differently in terms of both release height and spatial dispersion. For example, mobile source reductions would be spatially dispersed but occur essentially at the bottom mixing layer, whereas utility emissions reductions would be more spatially concentrated but would occur at higher levels above the ground. Both of these factors influence ambient particulate matter formation and atmospheric transport; therefore tonnage reductions required to achieve full attainment in all areas may be different depending on the relative contributions of precursor reductions from different source categories. Totals may not agree due to rounding.

The additional specified control measures analyzed in this chapter include conventional control approaches, pollution prevention techniques, cleaner fuels and combustion processes. The measures primarily address control of ozone precursors. Many of these measures are currently technically available to emission sources in most nonattainment areas. They are not included in the analyses in Chapters 6.0 - 8.0 because they are not needed in most areas except the most polluted ones, but represent a reasonable set of additional controls which are likely to be cost effective for certain areas. For some measures, technology is currently available to implement these controls. In the future, after improved $PM_{2.5}$ inventories and source-receptor relationships are developed, it should be possible to conduct similar analyses of specified control measures for fine particulates.

The control measures analyzed in this section are divided into three sectors: 1) stationary point sources; 2) stationary area sources; and 3) mobile sources (both on-road and off-road). The cost of each measure is generally determined by examining the change in costs for one unit of the controlled source (e.g., one engine for mobile source technology measures, one gallon of fuel for reformulated fuel measures) and the associated tons reduced from that unit. The level of emissions remaining from specific source categories in areas still needing further reductions after the application of the first tier of measures is determined. The potential emission reductions available from the application of a measure are determined by applying a control factor to that level of residual emissions. In some cases, potential further reductions from certain source categories are calculated by estimating the number of units (i.e., non-road heavy duty diesel engines) located in these areas. Control measures are then applied to those sources still needing reductions. For some source categories, there is more than one control strategy identified and choices are made as to the most appropriate. These choices may or may not reflect actual local control choices. Some of the control measures assessed in this part of the analysis include but are not limited to the following:

- repowering existing vehicles with natural gas;
- retrofitting existing engines with improved technology;
- selective catalytic reduction for certain commercial marine engines and locomotives;
- electric-powered airport gate service equipment;

- lower-sulfur fuels for residential, industrial, commercial and mobile applications;more stringent leak, process vent and wastewater controls for refineries, chemical manufacturing plants, and treatment, storage and disposal (TSDF) facilities; and
- more stringent emission limits for utility boilers and internal combustion engines.

Additional information on the effectiveness and costs associated with these additional control measures can be found in Appendix F.1. The EPA recognizes that states and localities may consider some of this information as they undertake planning efforts to implement the NAAQS. In doing so, they should bear in mind caveats elsewhere in this RIA about the information and estimates presented. Second, it is important to note that the cost-effectiveness of a measure for a particular nonattainment area may vary from EPA's estimate of the cost-effectiveness estimates for nonattainment areas nationally. Third, EPA suggests avoiding comparisons of cost-effectiveness figures in this RIA between measures that control different pollutants, between measures that apply nationwide and those that apply only in non-attainment areas, and between year-round and seasonal measures. Such comparisons may be misleading. In the draft RIA accompanying the proposed revision to the ozone NAAQS, EPA asked for comment on the Agency's traditional calculation of cost effectiveness and two alternative methods of calculating cost effectiveness that have been suggested to the Agency. The traditional calculation compares total annual costs with total annual emissions reductions. The first alternative would compare total annual cost with emission reductions in nonattainment areas only. The second alternative would compare total annual cost with emissions reductions in nonattainment areas during peak ozone months of the year. Despite the request for comment, the Agency received no comments on this issue in the context of the RIA. Based on its own preliminary analysis and comments received in a separate rulemaking (National VOC Emission Standard for Consumer Products. Federal Register, 1996), EPA has concluded that each of the methods -- the traditional approach and both suggested alternatives -- raise issues requiring further consideration. As a result, EPA has not decided whether to recommend one or more of these cost-effectiveness measures as a valid way to compare control measures that are dissimilar in geographic scope (nationwide versus non-attainment areas) or period of applicability (year-round versus seasonal). EPA will continue to evaluate this issue in future rulemakings.

9.4 THE ROLE OF NEW AND EMERGING TECHNOLOGY IN NAAQS ATTAINMENT

During the course of implementing the CAA, many new technologies have been developed to control air pollution. Because of ongoing needs to offset growth in emissions sources, and because in some respects the CAA has been a technology forcing statute, air pollution control and prevention technologies are continuously under development and improvement. The result is a fairly rapid pace of innovation in the air pollution control sector. Ten years ago, technologies such as those listed below might not even have been contemplated. Today, they are successfully in use across the U.S. and throughout the world.

- Selective Catalytic Reduction (SCR) for NO_x emissions from power plants
- Gas reburn technology for NO_x
- Scrubbers which achieve 95 percent SO_2 control on utility boilers
- Reformulated gasoline
- Low-Emitting Vehicles (LEVs) that are far cleaner than had been believed possible in the late 1980s (an additional 95 percent reduction over the 1975 controls)
- Energy-efficiency improvements in industrial processes, commercial, residential and appliance applications
- Reformulated lower VOC paints and consumer products
- Sophisticated new valve seals and detection equipment to control leaks
- Water and powder-based coatings to replace solvent-based formulations
- Safer, cleaner burning, wood stoves
- Dry cleaning equipment which recycles perchloroethylene
- CFC-free air conditioners, refrigerators and solvents

The air pollution control and prevention market is large and growing. The demand for cleaner products and cleaner production processes that lower overall costs, combined with the necessity for improved air quality, create strong incentives for technological innovation and a growing market for such innovations. As the demand for more innovative, cost-effective and cost-saving technologies increases, new technologies will move from the research and development or pilot program phase to commercial availability. Table 9.3 contains a sample of emerging technologies that could play a significant role in successful attainment strategies. A more comprehensive listing of technology examples can be found in Appendix F.2.

Table 9.3 Examples of Emerging Technologies for Lower Emissions and Cheaper Control of VOCs, NO_x, and PM

Example Source Categories	Technology Name(s)
Electricity Generation	Thin film photovoltaics: amorphous silicon, cadmium telluride, thin-layered crystalline-silicon
	Fuel cells: proton exchange membrane, molten carbonate, phosphoric acid, solid oxide
	Wind power: improved airfoil materials and manufacturing techniques
Small engines	Clean air 2-stroke engines, vaporizing carburetors, alternative fuels for commercial engines/vehicles
On-road and non-road vehicles	Exhaust aftertreatment technology : vacuum insulated catalyst, plasma treatment, non-thermal plasma reactor, oxygen enrichment membrane
	Alternative fuels: medium duty truck cng conversion kit, propane/butane fuel blends, LNG technology for locomotives;
	Electric vehicles & batteries: advanced inductive electric vehicle, advanced batteries and charging systems
	New vehicle designs: Partnership for New Generation Vehicle,
Industrial Adhesives	Water-based aerosol adhesive, dual cure photocatalyst technology, non-acrylate systems, electron beam-curable epoxy resins for composites
Surface Coating	Polyurethane reactive (PUR) technology, new applications of water and powder based coating, zero-VOC industrial maintenance metal coating, micro-emulsion technology, new photo initiator systems, advances in transfer efficiencies, supercritical CO2 as a paint solvent

As referenced above, new and emerging technologies are expected to play a key role in future air quality management programs. In the 1990 Amendments to the CAA (CAA section 182(e)(5)), Congress expressly recognized that areas with the most serious air pollution problems can rely on new and developing technologies that are not available in the short term for purposes of demonstrating that they will attain the standards. This provision establishes interim milestones and relies on the existing attainment date as incentives to assure development and deployment of advanced technologies. Use of this provision has promoted investment in advanced technology research in the Los Angeles area. Some areas that will have the most difficulty attaining the new ozone and fine particulate matter standards may find a similar approach appealing. Before considering such an approach, a state should demonstrate that it will not attain the standard based on all reasonably available controls and needs to rely on innovative technologies as the basis for the remainder needed to reach attainment. EPA wishes to pursue an approach analogous to that established by Congress in section 182(e)(5), where states can provide appropriate assurances that such technologies will be available to be implemented in sufficient time for the area to attain the standard.

Beyond the control measures and associated emission reductions referenced in 9.3, some areas require further reductions. Air quality management areas and sources in these areas will seek these further reductions in a number of ways. Existing technology will play a key role for some sources, emerging technology for others. Innovations in both environmental policies, as well as commercial and industrial environmental management, will also play a major role.

Most of the emerging technologies that are highlighted in this section and in Appendix F-2 should be available for application at specific sources in locations needing further emissions reductions. Some of these measures, due to the specific economic characteristics of the industries involved, may make sense to implement on a national basis. The size of the eventual market for these emerging technologies will depend on their emission reduction potential, their ability to displace existing technology, and their potential to become part of an optimal regional or national air quality management strategy.

This analysis assumes the average cost of reductions achieved through this variety of unspecified methods is $10,000/ton. This compares with an average control cost for specified measures in this full attainment scenario of approximately $3,200/ton for NO_x and $4,000/ton for

VOC reductions. The relative high cost of the unspecified measures provides an ample margin to account for unknown analytical considerations associated with future projections and may tend to overestimate the actual final cost of full compliance.

The residual emission inventory present in areas after specified measures have been implemented will be comprised of a range of uncontrolled and controlled sources. Previously uncontrolled sources could be expected to utilize existing control strategies and technologies similar to those referenced in this analysis, among other solutions. Controlled sources may use emerging technologies designed to achieve even better environmental performance than the current level of technological control. Faced with a demand for lower emissions, industries often respond with more effective technological innovations like those outlined below. For example, the electric utility industry is considering moving from low-NOx burner designs to selective catalytic reduction of NOx emissions at potentially similar or reduced costs per ton and greater emissions reductions. The automotive industry employed a new generation of catalytic converter when required to reduce tailpipe emissions further.

This section provides a wealth of technological innovation examples actively being pursued for all types of sources of emissions. EPA believes that states and sources will utilize technologies that are the most cost effective and that act in synergy with the operations of the business or source itself. Although difficult to predict its eventual costs, future technologies will benefit from significant learning experience associated with present technological applications.

In addition to incremental innovations in the same type of pollution control technology (e.g., more efficient catalytic converters), many industries and sources seeking further improvements will implement altogether different types of solutions. A company or industry facing increasingly more stringent solvent emission limits, for example, is unlikely to seek ever more expensive add-on control devices. Instead they will seek substitutes such as non-volatile material inputs or process changes. Redesign of both products and processes becomes a likely operative part of this industry’s or company’s environmental solution. The advent of low- and zero-solvent paints and coatings is a prime example. Powder and water-based coating systems are being introduced in many industries, including the automotive manufacturing sector. Other substitutions, such as cleaner fuels, are commonplace and can be expected in the future as industries seek optimal solutions. Many companies find that these changes save them material, as well as, pollution control costs.

Such changes in environmental management practices are occurring today and will play a greater role in the future. Industrial environmental management strategies incorporate a broad spectrum of environmental solutions. Pollution prevention, material substitutions, cleaner process and product design, and improved material utilization are all acting to limit or eliminate the cost of pollution control. The demand for such innovations increases as the cost of traditional “add-on” solutions increases.

Environmental policy innovations are also being employed as efficient methods to provide cleaner air. Market-based policies, such as the acid rain emission trading system, are responsible for creating more efficient industry-wide environmental solutions. Localities, such as air quality management districts, are also implementing market-based emission reduction plans. Section 9.5.1 in this chapter describes how one such type of policy, “Clean Air Investment Funds,” may contribute to a more efficient regional air quality management plan. EPA intends to strongly encourage these approaches as a means of minimizing compliance costs.

Given the breadth of environmental improvement solutions available, the significant number of emission control measures available for well under $10,000/ton of emissions reduced, and the wealth of active technological innovation underway, a $10,000/ton estimate for emission reductions beyond those specified in this analysis may be a conservative (i.e., high) estimate of future costs in some areas. EPA will encourage and facilitate flexible implementation approaches, such as emissions trading programs, to help areas eliminate barriers to utilizing the most cost-effective reductions.

9.5 TRENDS AND FACTORS LEADING TO MORE COST-EFFECTIVE IMPLEMENTATION

9.5.1 Major Economic and Social Trends Affecting Future NAAQS Attainment Strategies

As illustrated in the preceding discussions, predicting the specific costs of meeting the new NAAQS in the year 2010 is, by its very nature, analytically difficult. Dynamic trends in the U.S. economy, in air quality modeling and in air pollution control strategies must all be taken into account. While the emission inventories contained within this analysis incorporate certain rates of economic growth, the analysis projects a "static" picture of the precise makeup of U.S. economic activity. Major trends currently reshaping the U.S. and world economy will continue to profoundly affect the makeup of our future economy and its resultant environmental impact. A majority of these trends will enhance a region's ability to attain the new air quality standards.

Thirteen years from now, we could expect the U.S. economy to be more efficient in its production processes and use of materials. We could expect information technologies and high-value added sectors of the economy to grow at faster rates than traditional manufacturing and higher-polluting sectors of the economy. The fastest growing industries today and for the foreseeable future release less pollutants to the environment on an industry-wide basis than do the slowest or negative growing sectors of the economy.

Table 9.4 summarizes some of these major trends, their implications and the potential relative effect on attaining the new air quality standards. Following the table are brief descriptions of each trend or factor.

Table 9.4
Major Trends and Factors Leading to More Cost Effective Implementation

Trend	Implication	NAAQS Attainment Impact
Economic Trends		

Table 9.4 (continued)
Major Trends and Factors Leading to More Cost Effective Implementation

Trend	Implication	NAAQS Attainment Impact
1) Increasing knowledge-intensity of the U.S. economy	Shift towards less polluting manufacturing processes and services industries.	Enhance implementation & lower costs
2) Globalization of trade and investment	Growing market for high value U.S. business, financial and environmental services.	Enhance implementation & lower costs
3) Widespread adoption of advanced information technologies	Enhanced efficiency in manufacturing processes and growth of new, less polluting, technology and services industries.	Enhance implementation & lower costs
4) Geographic dispersion of business locations within the U.S.	Growth in mobile source pollution from increases in shipping and commuting distances.	Impede implementation & raise costs
Environmental Management & Policy Trends		
5) Increased use of market-based policies such as clean air funds & emission trading	Lower control costs, increased technology innovation and earlier compliance are all possible through economic incentive policies.	Enhance implementation & lower costs
6) Development and implementation of regional air pollution control strategies	Provides area-wide focus, leading to optimization of control strategies based on greater recognition of air emission transport and transformation. Fosters cooperation.	Enhance implementation & lower costs
7) Introduction of new regulatory mandates for international greenhouse gases and new categories and sources of toxic chemicals	Reduction in emissions of PM and ozone precursors as a side result of changes in industrial activities due to new mandates.	Enhance implementation & lower costs
8) Improved corporate environmental management strategies.	Pollution prevention programs, waste minimization schemes, environmentally-improved product and process design and ISO-14000 type programs	Enhance implementation & lower costs
Energy Trends		
9) Increased energy efficiency	Reduction of the energy intensity of the economy will reduce air pollution associated with energy generation and consumption.	Enhance implementation & lower costs
10) Deregulation of electric utility industry	Possible increase in energy demand and lower prices for electricity may increase demand for cleaner sources of power under regional agreements.	Enhance implementation
Societal Trends		

Trend	Implication	NAAQS Attainment Impact
11) Increasing public concern with quality and preservation of the natural environment	Greater public willingness to support environmental protection efforts.	Enhance implementation
12) Development of local, state, national and international programs to monitor environmental quality	Increased integration of environmental protection concerns into economic development and other policy making processes.	Enhance implementation

<u>**Economic Trends**</u>

1) Increasing Knowledge-Intensity of the U.S. Economy

Today's economy is becoming more "knowledge based" as high skill, information-intensive activities comprise a larger and increasingly important part of business and industrial activity. As a result, service and high-technology industries are growing and there is an increasing focus on higher value-added manufacturing activities. These changes have positive implications for NAAQS implementation because many of these growth sectors consist of low polluting industries.

As economic forces are leading to growth in higher value activities, there has been a related trend away from pollution intensive industries to cleaner, more energy efficient industries. Most of the fastest growing industries are in the services sector, particularly health care, transportation, and high value business services such as engineering and research. These industries are generally low emitters of SO_2 and NO_x have moderate VOC emissions. In comparison, many of the slowest growing industries are in heavy manufacturing and have relatively higher emissions of all three pollutants.

2) Globalization of Trade and Investment

Another key force behind the transformation of the U.S. economy is globalization. Globalization is manifested in a number of ways. New international production networks, for example, allow firms to increase efficiency by sourcing different stages of production in the most cost effective locations around the world, in effect, creating a new international division of labor in which the U.S. will continue to be the location for the most advanced business activities. Growth of foreign markets for environmental and other advanced technology products and services is another factor. Currently, environmental industries employ more than one million workers. The world environmental market is booming and is expected to grow at a 7.3 percent average annual rate according to studies released in April, 1995, by the National Commission for Employment Policy (NCEP).

Some of this growth in international trade is showing up as increased demand for products by relatively heavily polluting U.S. industries. However, broader trends towards concentration of high value business activities in the U.S. are positive for the reduction of pollution emissions.

3) Widespread Adoption of Advanced Information Technologies

The widespread adoption of advanced information technologies is one of the main factors driving the creation of information-intensive, often low-polluting industries. It is also a main driver in helping manufacturing become more efficient and hence cleaner. Both of these trends enhance the ability of the economy to implement the NAAQS. Technologies such as computers, software, semiconductors, telecommunications services, and communications equipment have diffused throughout the economy. In 1984, less than 25 percent of the U.S. workforce used a computer on the job. By 1993, this number had nearly doubled, to 46 percent. Even in manufacturing, the numbers have risen to the point that by 1993, 42 percent of all workers in manufacturing industries used computers at work.

4) Geographic Dispersion of Business Locations within the U.S.

The shift of jobs to the service sector now occurring in the U.S. economy has reduced the role of central cities within most metropolitan areas. In addition, the decline of large, vertically-integrated factories means that the flow of materials from one processing stage to the next requires external freight transportation at the same time that the location of manufacturing industries has spread throughout the U.S. As a result, there is continuing growth of mobile source pollution despite technological improvements to reduce vehicle emissions. As the contemporary economy becomes more complex, transportation demand increases on a per capita basis. Vehicle Miles Traveled (VMT) for all road vehicles has more than doubled, on a per capita basis, since 1960. Although such VMT growth is accounted for in EPA's analysis and growing investment in transport planning measures is expected, continuation of this trend potentially impedes NAAQS attainment efforts.

5) Increased Use of Market-Based Policies such as "Clean Air Investment Funds" and Emission Trading

In addition to changes in the level of environmental standards and the types of compounds and industries that are regulated, some sweeping changes are occurring in the way environmental standards are being implemented. Several efforts are underway to create new regulatory processes that afford greater flexibility with the goal of lowering the costs of meeting environmental protection goals. These efforts include a variety of market-based incentive systems. Market-based systems to reduce pollutant emissions have been promoted for many years as an alternative to fixed regulatory standards. Such systems are expected to reduce the costs of compliance and induce more technological innovation in methods of reducing pollution.

National and regional market-based programs such as emissions trading may achieve pollution control goals at dramatically less expense because they allow firms that face high costs to purchase "extra" reductions from firms facing below-average control costs. This RIA models a SO_2 cap and trade program, but due to data limitations, does not attempt to model other potentially cost saving market-based programs. However, the lead and chlorofluorocarbon (CFC) phase-out plans and the Acid Rain program are all examples of the ability of national market-based programs to provide environmental protection at lower cost. With pollution control efforts pegged to the going price of allowances, rather than to the highest cost source, these market-based programs can promote both cheaper and faster compliance.

Continued experience with market programs indicates that they do lead to greater cost savings. For example, the cost of reduction in the CFC phaseout program, which used an allowance system, was at least 30 percent less than predicted. EPA's 1988 RIA estimated a 50 percent CFC phase-out regulation would cost a total of $2.7 billion ($3.55 per kilogram). A subsequent analysis performed in a 1992 RIA estimated that a 100 percent phase-out by 2000 would cost a total of $3.8 billion ($2.20 per kilogram). The most recent analysis conducted by EPA in a 1993 RIA estimated a 100 percent phase-out by 1996 would cost $6.4 billion ($2.45

per kilogram) for faster reductions and enhanced environmental benefits. The CFC example illustrates that, although phasing-out CFCs seemed a daunting challenge a decade ago, firms have eliminated CFCs faster and at lower cost.

In addition to EPA's experience, at least one nonattainment area has implemented a market-based program. In 1993, California's South Coast Air Quality Management District (SCAQMD) developed a market incentive approach known as the SCAQMD Regional Clean Air Incentives Market (RECLAIM) as an alternative to traditional command and control regulation - RECLAIM is perhaps the first very large-scale, multi-industry emissions trading program.

The goal of RECLAIM is two-fold: provide facilities with added flexibility in meeting emission reduction requirements, and lower the cost of compliance. RECLAIM covers emissions of both NO_x and SO_x, for at least 70 percent of the Los Angeles basin's stationary source emitters, by establishing facility mass emission limits. RECLAIM allows sources the flexibility to achieve prescribed emission reduction targets through process changes, installation of control equipment, emissions trading, or other methods (SCAQMD, 1993). The Second Annual Audit Report describes RECLAIM's successes including meeting its emission reduction goals, and developing an active trading market with "average prices of RECLAIM Trading Credits (RTCs)...well below the back-stop price of $15,000 per ton...$154 per ton for 1996 NO_x RTCs; $1,729 per ton for 2010 NO_x RTCs; $142 per ton for 1996 SO_x RTCs; and $2,117 per ton for 2010 SO_x RTCs." (SCAQMD, 1997).

EPA is actively pursuing and encouraging adoption of innovative approaches to air quality control, including use of economic incentive programs. Areas are expected to adopt market-based systems to meet their PM, ozone, and regional haze (RH) air quality goals because such systems allow emission reductions to be achieved using the most cost-effective controls. In addition, market-based programs provide continuous and powerful incentives to develop new technologies while achieving emission reductions which otherwise would not be available under the typical regulatory approach.

EPA intends to place heavy reliance for implementing revised standards on new or expanded market-based programs. Market-based systems potentially in place 10 years from now include:

- Clean Air Investment Funds (see below);
- Cap-and-trade systems for NO_x in eastern (Ozone Transport Assessment Group (OTAG)) and western (Grand Canyon) regions;
- Cap-and-trade system for SO_2 to implement fine particles standard (building on the current acid rain program); and
- Cap-and-trade systems for volatile organic compounds (VOC) in major metropolitan areas (modeled on Chicago program now being adopted);
- "Open market" trading to bring in cost-reducing emission control opportunities from smaller or unconventional sources outside of the cap-and-trade programs.

As cited above, another example of a market-based strategy that could reduce control costs without sacrificing pollution control is an investment fund strategy. Through a "Clean Air Investment Fund," states or EPA could allow firms facing high costs to pay into a fund rather than control emissions themselves. Fund revenues may then be used to purchase additional emission reductions from lower cost sources. The net result of this approach would be to facilitate continued progress on reducing pollution while simplifying compliance for sources choosing to pay into the Fund.

Consider an area which, for example, after implementing a significant emission control program, is left short of the necessary emission reductions it needs for attainment. The residual emission inventory is dominated by two types of emission sources: (a) relatively well-controlled major sources where the next increment of emission control can only be obtained for a relatively high $/ton marginal cost (e.g., $15,000/ton) and (b) uncontrolled minor sources, where the cost per ton of emission control is relatively small ($2,000-$5,000/ton), but the sources are traditionally not subject to control because they are too small and numerous to incorporate or outside the scope of existing regulatory policies for other reasons. The high dollar-per-ton source, faced with a relatively high emission control cost, could make a contribution to the Clean

Air Investment Fund at a predetermined price instead. The price or "deposit" would be less than the control cost they were facing, but greater or equal to the marginal control cost faced by sources regulated in earlier phases of the attainment strategy.

The Clean Air Investment Fund would then use these revenues to encourage other more cost-effective sources in the area to make reductions. Such inducements could come in many forms. The Fund could provide rebates for the purchase of cleaner products to replace older more polluting sources. Large-scale small engine (lawn mowers and other such equipment) buy back programs or funding the cost of mass transit vehicle engine retrofits are such other examples. Other investment opportunities for the Fund include: utility and industrial boiler SO_2 and NO_x reductions beyond the acid rain program levels for SO_2 and beyond the 0.15 lb/MMBTU limit for $NO_{x,}$ use of more stringent leak detection programs to control fugitive emissions at chemical plants, refineries, and other large sources of ozone and PM precursors, and additional use of low- or no-VOC coatings.

A Fund would give states and localities the ability to achieve emissions reductions from sources not currently regulated (such as voluntary efforts, e.g., buy-back programs) and through reductions in energy consumption or vehicle miles traveled in exchange for economic incentives. Clean Air Investment Funds also provide powerful incentives to develop new technologies since the developers would know that the resulting emission reductions could be sold to the Fund.

Because Clean Air Investment Funds have an ability to reach out to otherwise unregulated sources, they could greatly increase a region's ability to pull cost-effective emission reductions from a diverse set of sources into a strategy. A Fund with the authority to arrange for emission reductions from its own choice of unregulated sources is much more likely to succeed because of the incremental and selective nature of the program.

In addition to its active role in seeking out emission reductions, Clean Air Investment Funds have the advantage of facilitating the operation of a market-based system. The transaction costs of economic-incentive programs, such as locating potential sources of emission reductions and negotiating mutually agreeable terms, can be (or appear to be) large enough to discourage the use of trading systems. However, many of the difficulties in setting up emission allowance or cap and trade systems can be mitigated by a Clean Air Investment Fund because it allows sources to limit their dealings to an agency or third-party entity that is competitively neutral. The existence of a Fund also provides a limited guarantee that emission reductions will be available if needed, generally at a predictable cost. Thus, states may also choose to adopt a Clean Air Investment Fund as either a supplement to or a substitute for a cap and trade program.

A Clean Air Investment Fund is one example of innovative clean air policies that can help even the most difficult nonattainment areas improve their compliance situation. Current and proposed Fund programs, such as those in Sacramento, Ventura County California, Connecticut, Illinois, and El Paso, Texas/Juarez, Mexico, will provide invaluable experience for future programs. Over the next decade, economic incentive programs like Clean Air Investment Funds will likely become more commonplace as emission inventories are improved, experience expands, and the benefits associated with such systems are realized.

6) Development and Implementation of Regional Air Pollution Control Strategies

While national and local control strategies continue to be important in reducing air pollution, there is a relatively new focus on regional control strategies. On an area-wide level, we have learned through the work of the Ozone Transport Commission (OTC), OTAG, and the Grand Canyon Visibility Transport Commission, that air quality problems in many areas are a result of emissions transport and transformation and not local emissions alone. For example, OTC and OTAG developed potentially more cost-effective strategies than had been thought to be available -- both regions will be using a cap on NO_x emissions that should lower the overall cost. Consequently, regional measures are likely to be a critical component of many attainment strategies. Cooperative planning among all states, tribes, and localities contributing to common air quality problems is necessary to develop effective regional control plans.

In implementing the new PM and ozone NAAQS, EPA expects areas will develop regional control strategies unique to each area. These coordinated strategies should be carefully developed based on regional considerations. Thus, actual implementation strategies may be significantly more cost-effective than the local and broader-based strategies assessed in this RIA.

7) New Controls for International Greenhouse Gases and New Categories and Sources of Toxic Chemicals

Several new environmental policies, if implemented, would have an impact on future NAAQS implementation. These include:

- A potential new international agreement reducing greenhouse gas emissions would likely have significant impacts on ozone precursors and thus would further encourage types of emissions reductions related to the proposed new NAAQS. (See Trend 9 below).

- Introduction of new international regulatory regimes to govern Persistent Organic Pollutants (POPs) and Endocrine Disrupting Chemicals (EDCs). Actions on POPs and EDCs may affect plastics, manufacturing processes involving chlorine, agricultural pesticides containing cyclic organic substances, incineration of organic and chlorine compounds, and detergents. To some extent there is likely to be an interrelationship between control options for these substances and subsequent effects on PM and ozone.

- Expansion of reporting requirements under EPA's Toxic Releases Inventory System. Presently, seven more industries are being added to the TRIS: coal mining, metal mining, electric utilities, commercial hazardous waste treatment, petroleum bulk terminals, solvent recovery services, and chemical wholesalers. These industries are among some of the most significant producers of PM and ozone precursors. Based on previous TRI experience requiring these industries to report their toxics emissions will, by making the information public, lead to pollution reductions.

8) Improved Corporate Environmental Management Strategies

Corporations and other organizations are making a number of important changes to voluntarily contribute to the lowering of emissions through improved environmental management. Environmental management in business today is quickly becoming a vital part of overall business management strategies. Businesses are striving to reduce operating costs through improved efficiency, productivity, and reduced material and waste management costs. ISO 14000 Environmental Management Systems are expected to be an integral part of business strategies in the near future. Pollution prevention programs emphasizing source reduction and waste minimization are proliferating. Environmental accounting practices are identifying hidden, but previously unaccounted for, environmental costs associated with certain products and practices. This awareness is leading to a reduction or elimination of such costs. And finally, manufacturing processes and products themselves are increasingly being designed with environmental impacts in mind.

<u>Energy Trends</u>

9) Increasing Energy Efficiency May Lower Costs

The preceding analyses of the costs presented in this RIA are generally based on business-as-usual assumptions concerning the future demand for energy. Yet, energy consumption can be a major source of air pollution, including ozone and $PM_{2.5}$ precursors. To the extent that the energy intensity of the American economy can be significantly reduced through cost-effective investments in energy efficient technology, meeting any new emissions limitations will be easier and cheaper. One recent study, for example, suggested that the nation could cut the growth of energy use by 15 percent in the year 2010 at a net savings of about $530 per household per year. (Alliance to Save Energy, et al., 1997). Combined with the use of cleaner energy resources, this study indicated that energy efficiency investments would also lower NO_x and SO_2 emissions signficantly below their 1990 levels. This suggests that there is ample scope to increase the nation's energy efficiency, which will simultaneously improve overall economic productivity and reduce energy-related pollution.

The U.S. Climate Change Action Plan (CCAP) is an important step in an energy-related productivity strategy. The CCAP is designed to lower greenhouse gas (GHG) emissions which most scientists now believe contribute to global climate change. The majority of today's CCAP programs target end use energy demand in lighting, buildings, appliances, and industrial motors and processes. Current projections suggest that today's CCAP programs will reduce the expected growth of U.S. emissions that cause global climate change by 25 to 30 percent. The next stage of the U.S. national climate change mitigation policy will most likely continue to pursue a productivity-led investment strategy, but would do so in concert with policies that will unambiguously signal the need to avoid any increases in GHG emissions, and to even reduce emissions from current levels. In the international climate change negotiations, the U.S. is pursuing legally binding targets at a level considered to be "real and achievable." Such targets will help decrease not only GHG emissions, but also a variety of other air pollutants. Moreover, greater penetration of today's energy-efficiency technologies can also decrease American dependence on foreign oil, increase productivity of domestic industries, and promote U.S. leadership in the large and growing international market for advanced technologies. Perhaps most important, shifting capital from energy expenditures to new investments elsewhere in the economy would help drive economic growth, employment and consumer income.

10) Deregulation of Electric Utilities

The federal and state governments have taken steps to introduce deregulation into electric power markets. The Energy Policy Act of 1992 (EPAct) made several fundamental changes in the wholesale electricity markets, including: encouraging independent power producers to sell power in the wholesale market; allowing new market entrants such as power brokers and marketers to sell power; and ensuring open, non-discriminatory access to transmission services.

Similar actions at the retail level have encouraged greater competition, including provisions to allow consumers to choose the generation source and the local retail supplier of their electricity, much like consumers now choose their long-distance supplier in telecommunications. Due to the significant nature of these changes on how electricity is supplied to consumers, there is the great potential that consumers will opt for cleaner sources of electricity and markets will respond accordingly.

Societal Trends

11) Increasing Public Concern with Quality and Preservation of the Natural Environment

Increased affluence and mobility are creating a greater demand for communities with cleaner, safer environmental conditions. Indeed, "quality of life" is cited as an increasingly important criterion in business location decisions as firms, particularly in high-growth, technology-intensive industries, position themselves to compete for the best talent. This shift in public attitudes can be expected to have positive impact on NAAQS implementation as citizens become more willing to apportion the attention and resources necessary to address environmental problems.

Evidence of this trend in societal, and particularly, business attitudes is provided by a 1995 study by Arthur Andersen conducted as part of Fortune Magazine's report on the "Best Cities for Business." In this study, a selection of worldwide business leaders was asked about key factors in making site selection decisions for different types of business operations. The executives said that high quality of life was especially important for headquarters and research and development operations, i.e., for attracting knowledge-workers. Similarly, when Money Magazine polled a sample of readers about the things most important to them in selecting a place to live for the magazine's annual survey of "The Best Places to Live Today," clean water and clean air ranked at the top of the list above such things as low taxes, good schools, health care or local employment conditions.

12) Development of Local, State, National and International Programs to Monitor Environmental Quality

As the shift in public attitudes has become more pronounced, policy makers, economists, academics, and others have recognized a need to change economic and policy systems to incorporate new public attitudes and goals. As a result, there is increased integration of environmental protection concerns into economic development and other policy making processes. This change is reflected in the increasing inclusion of environmental data in measurement systems for ranking communities (e.g., the Well-Being Index published by American Demographics) and nations (e.g., the World Bank's sustainable wealth of nations measure). It is also reflected in the development of movements such as "sustainable communities" and EPA's Smart Growth Network. This shift in public attitudes and programs can be expected to have positive effects on the ability to implement new air quality standards as public interest in addressing environmental problems becomes more imbedded in customary decision making and planning processes.

9.5.2 Uncertainties in Estimating Compliance Costs Often Lead to Overestimates

Major environmental regulations, like other types of social regulation, entail social costs as well as benefits. However, under Congress' direction, some environmental regulations -- like the NAAQS -- must be based only on health considerations. The Agency believes that while it is inappropriate to consider costs in setting health based standards like the NAAQS, it is appropriate to consider the expected costs of implementation alternatives to guide states and localities as they make the difficult choices in deciding how to implement the standards. Developing accurate, unbiased estimates of the social costs of complying with or implementing a regulation is, thus, a key component in analyzing its likely impacts on society.

Many factors, however, such as the "static" nature of this analysis may lead to the overestimation of costs. For example, a firm's initial response to a new regulatory demand may be far less efficient than its later response to the same challenge. Analyses of this sort do not capture this learning curve effect and tend to overestimate costs. Similarly, technologies themselves change and become more optimal and efficient over time. These improvements and the effect they may have on lowering costs between early and mature stages of technology development are difficult to capture.

Concerning technology change, regulations themselves affect the rate and direction of technical innovation. As firms invest in new plants and equipment, they will take into account any regulatory changes that have occurred since the previous generation of investments was put in place. Less pollution intensive technologies or processes will become more attractive. Besides technological advances, another phenomenon affecting long-run compliance costs is the ability of the regulated community to learn over time to comply more cost-effectively with the requirements of the regulation. While in practice this effect is difficult to quantify separately from the effects of technological change, the combined effects on pollution abatement and control costs can be incorporated into regulatory compliance cost forecasts by applying an assumed rate of "learning" arising from both sources. This analysis does not incorporate such an assumption. The following discussion of the use of progress ratios for estimating future technology and compliance costs evaluates these notions further.

9.5.3 Use of Progress Ratios to Deflate Cost Estimates for Existing Technologies

As discussed in the preceding section, a more accurate cost estimate would account for technological advancement and learning curve effects. In fact, hundreds of studies confirm that new products and technologies decline in cost as they become accepted and widely adopted throughout the economy. The rate of decline varies among the different technologies. However, a common rule of thumb -- often referred to as a "Progress Ratio" -- is that each new doubling of output for a given technology will deflate the unit cost of that technology to about 80 percent of its previous value.

The fall in unit cost is the result of a variety of factors: (a) new knowledge that is continuously flowing into the production process; (b) economies of both scale and scope that can be achieved with increasing levels of output; (c) costs that fall with "learning by doing" even without any visible change in the physical capital used for production; and, finally, (d) the proliferation of service and distribution networks that reduce the cost to consumers using the new technologies. Thus, future estimates of energy and pollution control technology forecasts should anticipate some decline in the cost of these technologies over time; or more specifically, as a function of continued production and increased market share.

Estimates of Progress Ratios

Examples of progress ratios for various past and future technologies, either calculated or taken from the literature, are shown in the Table 9.5 below. Based upon the examples in this table, the progress ratios range from 67 to 98 percent. The example of a so-called "mature" technology such as the magnetic ballast shows a 98 percent progress ratio which means that costs are not falling very quickly at all. On the other hand, a more advanced technology for the same end use, in this case the more efficient electronic ballast, suggests a 90 percent progress ratio. The pollution control technologies in the above table -- including CFC substitutes and scrubbers -- appear to hover close to the 90 percent benchmark.

Table 9.5 Examples of Progress Ratios

Technology	Period	Cumulative Production	$COST_0$	$COST_t$	Progress Ratio
Electronic Ballasts	1986-1993	52.7 million	$37.65	$18.23	90%
Magnetic Ballasts	1977-1993	629.3 million	$7.86	$6.47	97%
Fluidized Bed Coal	1987-1992	n/a	n/a	n/a	95%
Gas Turbines	1987-1992	n/a	n/a	n/a	95%
Wind Turbines	1987-1992	n/a	n/a	n/a	90%
Integrated Circuits	1962-1968	$828 million	$50.00	$2.33	67%
Low-E Windows	1993-2010	11.3 bsf	$2.90	$1.20	86%
CFC Substitutes	1988-1993	8.9 billion tons	$3.55	$2.45	93%
Photovoltaics	1975-1994	516 MW	$75/watt	$4/watt	70%
Solar Thermal	1996-2020	800 MW	$3335/kW	$2070/kW	90%
Gasified Turbines	1997-2000	156 MW	$2000/kW	$1400/kW	84%
Scrubbers	1985-1995	85,700 MW	$129/kW	$122/kW	88%

The Influence of Progress Ratios on Potential Technology Costs for the NAAQS

In the current analysis only economies of scale are reflected in estimates of technology control costs in the year 2010. However, both the capital and operating costs of incremental control measures are likely to be affected by the impact of learning or experience curves. To the extent that experience curves are not reflected in such cost estimates, the cost of control technologies will be overstated. For example, let us assume that costs in the year 2010 are projected to be only 80 percent of the current projections -- because of cumulative experience in the production and installation of a given set of control technologies. If the year 2010 baseline cost projection is $1.5 million (in 1990 dollars) for a given technology, assuming a 20 percent drop as a result cumulative production experience would lower that cost estimate to $1.5 million * 0.80, or $1.2 million. The basis of this adjustment is the Progress Ratio.

9.6 REFERENCES

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10.0 ADMINISTRATIVE BURDEN AND COSTS ASSOCIATED WITH THE SELECTED OZONE AND PARTICULATE MATTER (PM) NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS), AND PROPOSED REGIONAL HAZE (RH) RULE

10.1 INTRODUCTION

10.1.1 Results in Brief

This chapter provides an estimate for the additional administrative cost of the joint ozone and PM NAAQS and RH rules to the Federal government, States, and sources of pollution (Federal and non-Federal). These additional costs are estimated relative to the analytical baseline of this regulatory impact analysis (RIA). In the prior ozone RIA, the Environmental Protection Agency (EPA) assumed the marginal administrative burden of the alternative ozone standards was not of sufficient magnitude to affect the discussion of total costs [US EPA 1996(b)]. This analysis supports that assumption. Given the national scope of the NAAQS and the degree of change in nonattainment areas (NA's), this section of the RIA estimates marginal costs of about $17 million for the selected ozone NAAQS, well within the range discussed in the previous RIA. While cost savings may occur between ozone and PM under a combined analysis, the administrative cost estimate for ozone is a reasonable approximation of the administrative cost for PM under a joint NAAQS scenario. Consequently, the 15/65 $PM_{2.5}$ marginal administrative cost estimates are of the same magnitude as those for ozone, or about $17 million. The $PM_{2.5}$ monitoring costs, for which EPA has agreed to pay, adds $20 million for a total $PM_{2.5}$ cost of about $37 million. The administrative strategy associated with the proposed RH target relies on PM efforts as much as possible. The expected additional administrative cost for RH is about $1 million.

10.1.2 Overview of Analysis

In addition to control costs, administrative burdens comprise one of the primary considerations when the EPA estimates the impact of a rulemaking. For industry-specific rulemakings, the Agency performs its burden analysis under the guidance of the Paperwork

Reduction Act (PRA), in a document entitled an Information Collection Request (ICR). An ICR provides policy makers with a tool for minimizing the administrative burden imposed by a rulemaking upon Federal Agencies, States, local governments, and sources of pollution.

In the case of NAAQS, States assume primary responsibility for designing the set of air quality management plans which will bring the State into attainment and/or keep it there. Once the Agency has set the standards, it must define the processes by which it will identify and oversee nonattainment areas. To aid in this process and make recommendations on implementation, the Agency has established a subcommittee on ozone, PM, and RH under the Federal Advisory Committee Act (FACA). Since this subcommittee has not completed its work, it has not provided final recommendations as to how the joint NAAQS should be implemented. Therefore, it is not possible to prepare an ICR at this time. Nevertheless, the Agency has estimated administrative costs to give the public some understanding of the possible implementation costs of these standards.

This RIA is not intended to fulfill the requirements of the PRA, nor should conclusions be drawn from it about the actual administrative burden and costs areas may incur as they develop attainment strategies that reflect different NA's economic, social, infrastructural, and political characteristics. This section presents an approximation of the additional administrative effects one might expect from the selected NAAQS and RH rule, based upon a hypothetical determination of NA's and control measures which may be selected by States when revising their State Implementation Plans (SIP's).

The remainder of this chapter contains sections which deal separately with each pollutant. Several sections at the end of this chapter have been reserved for combining all of the analyses and discussing limitations. Because monitoring is an integral part of the planning process, it is included in the following administrative burden analyses. The next section discusses the format and underlying assumptions applied to the NAAQS. Section 10.3 discusses the marginal administrative burden and costs for ozone. No change in the burden or cost of monitoring for ozone is anticipated.[1] Section 10.4 discusses the marginal administrative burden and costs associated with $PM_{2.5}$. Monitoring for PM has been estimated under a separate ICR [US EPA 1996(a)] and appears toward the end of the PM section. Section 10.5 discusses changes to the NAAQS format to accommodate differences in the RH rule, along with the incremental administrative burden and costs of the RH program. Since the Agency is proposing a separate rulemaking for RH, it will require a formal ICR. The results of that analysis are included in the RH section.

The concluding sections of this chapter discuss possible overstatements due to synergies between pollutants, potential over- and under-statements of administrative costs due to permitting considerations, and "bottom line" burden and cost estimates for the selected ozone and PM NAAQS and RH rule.

10.2 FORMAT

10.2.1 Respondent Types

For purposes of clarity in presentation this analysis follows the format generally used for ICR's, with several modifications. A typical ICR assesses burden and costs for three types of respondents - Federal, State, and Source. This analysis assesses burden and costs for four respondent groups:

- Administration and Oversight
    - **Federal Oversight** typically means the EPA, but for this analysis, it also includes the Department of Energy (DOE), the Department of Transportation (DOT), and other Federal organizations which oversee key pollutant source categories. For RH,

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[1] Personal conversations with OAQPS / EMAD, June 4, 1997 to June 5, 1997; documented in EPA memos (1 - 5) for the same days.

Federal oversight also includes Federal Land Managers (FLM's), who are responsible for maintaining air quality in Class I areas.

- **States**, NA's, and other levels of air quality management have been combined into one respondent category for this analysis, for reasons discussed in detail, below.

- Sources of Pollution

  - **Federally-owned sources of pollution**, (e.g., power plants on military bases), have special considerations which require separate analysis.

  - **Non-Federal respondents** include State and local government sources of pollution (e.g., unpaved county and local roads for PM and municipally-owned treatment works for ozone); non-profit sources of pollution, such as hospitals and clinics; and typical industrial and agricultural sources. Power generating utilities are not included in the ozone "Sources of Pollution" count because they have been included in the baseline and their administrative burden has been associated with other rules and guidances. However, $PM_{2.5}$ non-Federal sources include power generating utilities.

A third oversight respondent category was considered which would have assessed the burden imposed on NA's. However, upon further investigation, it was determined that while there are a number of examples where NA's have established their own management structure, there are probably just as many examples where they do not. Many counties in NA's perform their own analyses, most commonly with the help of State air quality analysts. Furthermore, while States do their own modeling and planning, many NA's do not, and those which model generally coordinate efforts with the States.[1] Consequently, good coordination of effort between States and their NA's is

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Personal conversation with OAQPS / OPSG 5/27, 1997; documented in EPA memos (6 and 7) 5/27/1997 and 5/28/1997.

assured and the analysis does not expand to include a separate respondent category for NA's. The burden associated with NA's and other local air quality management groups are included at the State respondent level without any loss of information.

Any area modeled as nonattainment in 2010 for PM or ozone, if it had been an NA at any time in the past for any criteria pollutant, is assumed to have a more developed air management infrastructure. Therefore, these areas should have burden levels consistent with existing NA's. All of the NA's identified for the three alternative ozone NAAQS had, at one time or another, been an NA for at least one of the criteria pollutants.[1] Therefore, it is not necessary to differentiate between new and existing ozone NA's for purposes of burden estimation.

Finally, while NA's work to reduce air pollution and meet Federally-determined minimum standards, areas in attainment may also monitor and evaluate air quality to avoid potential future costs associated with air quality degradation. Therefore, this analysis created an additional organizational subdivision to reflect these administrative differences, with each of the four respondent types represented within it. For sources in attainment areas, little additional burden is assumed. While States manage air quality in attainment areas, little additional responsibility will fall to sources as a result of changes in the NAAQS.

Most of the air quality related activities which may apply in attainment areas are already in place because of other parts of the Clean Air Act (CAA). Although there may be some unanticipated source burdens imposed by the new NAAQS in areas of attainment, this burden is assumed to be insignificant and this analysis does not assign burden hours to them.[2] For this chapter, two categories which could have an impact on attainment area sources are identified, both of which are subject to annualization.

Personal conversations with OAQPS / OPSG and Region IV, May 15, 1997; documented in EPA memos (#8, 9, and 10).

Personal conversation with OAQPS / OPSG 5/27, 1997; documented in EPA memos, (6 and 7), 5/27/1997 and 5/28/1997.

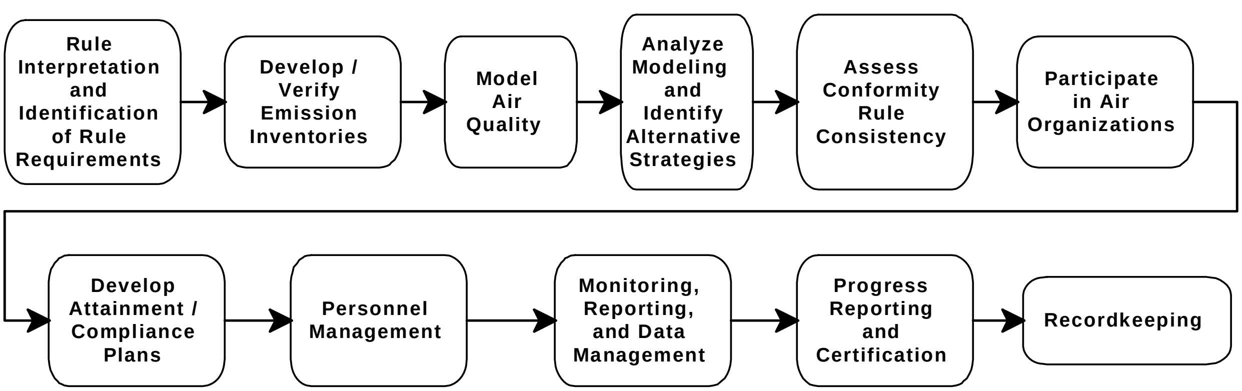
10.2.2. Definition of Burden Categories

To predict the steps necessary to fully implement the new PM and ozone NAAQS, the flow chart in Figure 10.1 is constructed. Each of the 11 blocks in the flow chart represents one or more of the burden categories attached to administration of the alternative ozone and PM standards listed in Tables 10.3 and 10.4. The flow chart and its associated burden categories present a reasonable approximation of what respondents are likely to do under the hypothetical scenario set up for this analysis.

10.2.2.1 <u>One-Time Administrative Costs</u>

Administrative costs are classified as either one-time or continuous or reoccurring costs. One-time costs relate to start-up activities which do not need to be repeated on a periodic basis. To create an annual cost of administration, reoccurring costs do not need to be adjusted to account for temporal differences. However, one-time costs reap benefits over the life of the program and should be spread out over that time frame. Therefore, the discounted net present value (NPV) of the cost is annualized into equal "payments" over the life of the program, using the following formulas: where

Figure 30.1 Flow Chart of Administrative Tasks



NPV is the cost associated with the one-time burden category, C_i is the cost incurred in year I, N is the life of the program, and AV is the annualized value. Costs within this analysis are in real $1990 dollars, subject to a 7 percent discount rate, in accordance with Federal requirements.

Figure 10.2 Annualization Formulas

$$\textit{Net Present Value:}\qquad NPV = \sum_{i=0}^{N} \left(\frac{C_i}{1.07^i} \right)$$

$$\textit{Annualized Value:}\qquad AV = NPV \left(\frac{.07\,(1.07^N)}{(1.07)^N - 1} \right)$$

Two burden categories were identified as one-time activities:

Interpret Rule / Identify New Requirements: This category includes research, acquisition, and assimilation of the rules and regulations necessary to understand the State's responsibilities with respect to meeting the alternative standards. Given promulgation of the PM and ozone NAAQS in 1997 and the projection of costs to the year 2010, this analysis applies a program life (N) of 13 years to this category.

Revise SIP's: Each State with an NA will have to revise its SIP. This burden category contains the data gathering, evaluation, and reporting necessary to develop new SIP's. Monitoring data necessary for determining areas of attainment and nonattainment for the new NAAQS will probably not allow SIP's to be revised until 2005. Therefore, this analysis amortized SIP revisions over a five year program life. No additional burden for States without ozone or PM NA's is assumed. Currently, 36 States have SIP's for visibility protection of mandatory Class I Federal areas. The RH provision will expand that requirement to all 50 States.

10.2.2.2. Reoccurring Administrative Costs

The Agency identified 14 burden categories which occur on an annual basis:

Evaluate / Improve Inventories: States create and manage inventories for SIP purposes, so the source burden for this category has been set at zero. As the requirement for new control measures increases with the selected NAAQS, States may need to develop new inventories, especially to mitigate air quality degradation in attainment areas. This category includes the additional hours necessary to develop and improve relevant inventories.

Data Gathering and Assembly: Other data need to be selected and formatted, along with the inventory data. These data include meteorology, often by the hour, including temperature, humidity, cloud cover, wind direction and speed, and the chemical composition of the air column. This category includes the burden of collecting and preparing such data.

Run Model: Running models includes set-up, dry runs, running the model, and troubleshooting activities for the output data derived from it. The PM and ozone require different models. The RH can utilize PM modeling and monitoring, as long as the data are speciated to a degree which allows for RH post processing to determine visibility changes. This category attempts to capture the economies of scale which occur between $PM_{2.5}$ modeling and monitoring and that of RH.

Evaluate / Interpret Modeling Results: This category includes the marginal change in quality assurance and reporting necessary for cross-pollutant purposes. This category also includes the development of technical documents and the evaluation and correction of reports made by others which reference model methodology and output. The same considerations discussed for economies of scale under the category "Run Model" apply here, as well.

Identify Alternative Control Strategies: Typically, NA's can achieve a given target by a number of alternative strategies. This category includes the identification, evaluation, and selection of alternative strategies.

Evaluate Strategies for Conformity: Federal and State management agencies must evaluate each alternative for its potential impact on regulations from other governmental bodies. This category includes the burden of identifying and resolving Conformity Rule conflicts.

Ozone/PM/RH Regional Groups: States and the EPA coordinate air quality efforts through a number of regional management groups [e.g., the Lake Michigan Ozone Study Group (LMOS), the Ozone Transport Assessment Group (OTAG), and the Grand Canyon Visibility Transport Commission (GCVTC)]. Although the FACA subcommittee has not made final recommendations, the additional burden associated with participating in regional management groups is expected to be low. This category includes the additional burden on State and local government members of new and existing regional ozone/PM groups for managing the new joint NAAQS. For the most part, RH managers do not participate in regional air quality management groups and any new activity in this category will probably be focused on the West. Sources of pollution participate in regional groups through trade associations or on a voluntary basis and their burden has not been included in this analysis. This burden category includes, but is not limited to: meeting attendance, air quality modeling for group purposes, and the production of reports and analyses for the regional group.

Public Hearings: This category includes the additional State burden required to organize, advertise, conduct, and transcribe public hearing information related to the new NAAQS in NA's.

Develop Regional Implementation Plans: Based upon the input of public hearings and regional management groups, States and local ozone, PM, and RH management areas will have to construct air quality management plans which address the broader geographical concerns of these groups. This category includes this burden.

Review / Revise Compliance Plans: Sources in NA's are required to develop plans which describe the steps they will undertake to bring themselves into compliance within required time limits. The change from the current to the selected PM and ozone NAAQS will necessarily change the status of many sources. This category measures the expected additional burden to sources in ozone and PM NA's for creating and revising compliance plans for submission to their State authority, as well as the review and approval of the State for those plans. Because areas in attainment do not create compliance plans, it is assumed the burden of compliance plans for sources in attainment areas is zero.

Development of Source Guidance Documents: This category includes the expected additional burden to States for creating source guidance documents to assist sources of pollution in their efforts to attain the alternative standards.

Monitoring and Reporting: This RIA assumes there will be only a slight change in the ozone monitor network by 2010, and some slight overall increase in monitor related tasks may occur for some States. For PM, the administrative burden and cost of monitors has been discussed under a separate ICR. This category includes the additional administrative burden associated with calibrating and certifying the monitor, and reporting data to Federal, State, and local respondents.

Prepare and Review Progress Reports: Each State must make periodic reports to the Agency on its progress toward reaching attainment of the standard, as well as describe any and all plans in each NA to improve and/or maintain their rate of progress. The States will also need to assess reasonable progress for RH. For their part, States must review and pass on these progress reports as part of their SIP requirements. This category includes the additional burden from these tasks which are expected to occur for NA's and State and local ozone and PM management groups.

Recordkeeping: This category includes changes in record keeping for States and sources of pollution that affect NA's and mandatory Class I Federal areas.

10.2.2.3 Estimating the Burden of Alternative NAAQS

Ranges of burden hours are established for each administrative category which serve as upper and lower bounds to the anticipated additional burden of that task, relative to the current ozone or PM standard. Because the analysis of burden per respondent weights the hours applied for the type of respondents in that category, the average of the upper and lower bounds is used for point estimate discussions. It is assumed that, for each respondent type, the effort required for areas in attainment should be less than that for areas of nonattainment. For example, States will have to re-evaluate their SIP plans to accommodate changes. For areas of nonattainment, these changes could account for some planning and coordination beyond that already required to meet the current NAAQS or a baseline activity. For attainment areas, however, a more cursory review of maintenance plans would probably be sufficient. Tables 10-3 and 10-4 display the set of burden categories expected under each NAAQS.

10.3 OZONE ADMINISTRATIVE BURDEN AND COST

10.3.1 Estimating the Number of Respondents for the Ozone NAAQS

Federal oversight generally refers to only the EPA, and most of the burden categories listed in Tables 10.3 and 10.4 refer to only one respondent. However, several categories may involve oversight by other agencies (e.g., DOT, DOE, Department of Defense). To accommodate multiple Federal agencies, if the description of the appropriate category has a number in parentheses at the end, that number indicates how many Agencies are included in the Federal estimation. For example, the Federal oversight component for "Evaluate Strategies for Conformity" was assigned a burden range of "M", which corresponds to a range of 21 to 40 hours. However, as many as eight Federal agencies could be involved in this process. Consequently, rather than a range of 21 to 40 hours, the Federal burden range for "Evaluate Strategies for Conformity" has an estimated range of 168 to 320 hours. Because this adjustment simplifies the calculations which go into translating per-respondent hours into total burden hours, for analytical purposes, Table 10-1 lists only one Federal respondent.

State oversight includes the 50 States, plus the District of Columbia. This analysis divided States into two subcategories for whether or not it contained an NA. States with both attainment and NA's are counted among those with NA's. As the stringency of the ozone standard increases, more areas become NA's, causing more Federal and non-Federal sources of pollution to fall within them. Likewise, the number of States which provide oversight to NA's must also increase. Table 10.1 displays the expected number of States with and without NA's for each 8- hour alternative ozone standard.

Table 10.1 The Projected Number of Respondents and the Distribution of States for Each Alternative Standard

		0.08 5th Max	0.08 4th Max	0.08 3rd Max
Oversight	Federal Oversight	1	1	1
	State Oversight (NAs)	18	25	29
	State Oversight (Attainment)	33	26	22
Sources of Pollution	Federal Sources (NA's)	52	58	77
	Federal Sources (Attainment)	160	160	140
	Non-Federal Sources (NAs)	5,200	7,300	8,500
	Non-Federal Sources	29,000	27,000	26,000

Federal sources include military installations, sources in Federally-managed permit programs on tribal lands and on the Outer Continental Shelf (OCS), Federal prisons, regional electric power organizations (e.g., the Tennessee Valley Authority), and other Federally-owned or leased buildings and compounds. Federal buildings and compounds generally do not have the type of emissions which would fall under the scope of the selected PM and ozone NAAQS and have been excluded from this analysis. As stated earlier, electrical power sources have been included in the baseline for ozone, but for PM, power generating utilities have been included in the inventory. Few Federal prisons fall under the scope of this NAAQS and have been excluded as well [US EPA 1996(b)]. The tribal and OCS sources also are not included in this analysis, but are expected to be small [US EPA 1997(b)]. Therefore, this Federal source discussion focuses on military installations. Not only do military establishments comprise a large percentage of the Federal sources identified, but they also have unique managerial considerations with respect to conformity and national defense. Table 10.2 displays the distribution of military installations across alternative ozone standards.

Table 10.2 The Distribution of Military Installations for Ozone Standards

	ARMY		NAVY		AIR FORCE		MARINES		TOTAL	
	NA's	**Attain**	**NA's**	**Attain**	**NA's**	**Attain**	**NA's**	**Attain**	**NA's**	**Attain**
0.08 5th	19	44	16	43	11	66	6	9	52	160
0.08 4th	19	44	21	38	12	65	6	9	58	150
0.08 3rd	26	37	31	28	14	63	6	9	77	130

Source: United States Department of Defense, 1996, 1997(a), 1997(b), 1997(c), 1997(d)

Non-Federal sources include industrial point source, mobile source, and area source emissions. A number of State-owned sources of pollution are identified in this analysis. These sources are incorporated into the non-Federal source category under the assumption they would require similar technical services from contractors as would a privately-owned source of pollution. Table 10.1 lists the number of sources which may be affected by each alternative discussed in the RIA. The national estimate for point, area, and mobile sources used to determine the number of sources in attainment areas came from the Agency's part 70 and 71 operating permits analyses [US EPA 1995, 1996(b)] .

10.3.2 Estimating the Per Respondent Burden for the Ozone NAAQS

The burden range assigned to each respondent type for each category represents the expected additional burden beyond what that respondent would have been expending to fully comply with the current standard. For example, the category for "Data Gathering and Assembly" generally refers to States. Federal efforts for the category refer to the maintenance and upkeep of the databases and additional inventories necessary for modeling purposes. These efforts are most likely independent of the actual standards in place, and therefore the Federal oversight burden has been set at zero. However, if new areas are designated nonattainment and additional controls are required for sources within those areas, each State will have to expand its set of model inputs to accommodate these additions. Given the nature of data management and modeling, the average State with NA's will most likely expend between 1 and 4 person-months in fulfilling these needs. In attainment areas, some States will likely gather additional data, and others will likely decide further effort in this area would not be useful. Therefore, on average, attainment area States will most likely expend between 1 and 20 hours in data gathering. Since sources of pollution do not have to model air quality, their burden is set at zero for all areas.

Table 10.3 Per Respondent Ozone Administrative Burden Estimations For One-time Burden Categories

	NA's				ATTAINMENT AREAS			
	Governments		Sources		Governments		Sources	
	Fed *	State	Fed	Non-Fed	Fed *	State	Federal	Non-Fed
Interpret Rule / Identify New Requirements	M	M	L	L	L	L	L	L
Revise SIPS	H	H	Ø	Ø	Ø	Ø	Ø	Ø

Ø Not Applicable (No Burden Hours)

L Low Burden (1 to 20 hours)

M Moderate Burden (21 to 40 hours)

H High Burden (41 to 160 hours)

Table 10.4 Per Respondent Ozone Administrative Burden Estimations for Reoccurring Burden Categories

	NA's				ATTAINMENT AREAS			
	Governments		Sources		Governments		Sources	
	Fed *	State	Fed	Non-Fed	Fed *	State	Federal	Non-Fed
Evaluate / Improve Inventories (2)	L**	M	Ø	Ø	L**	L	Ø	Ø
Data Gathering and Assembly	Ø	H	Ø	Ø	Ø	L	Ø	Ø
Run Model	L**	M	Ø	Ø	M**	L	Ø	Ø
Evaluate and Interpret Modeling Results	M*	M	Ø	Ø	L*	L	Ø	Ø
Identify Alternative Control Strategies	M*	H	Ø	Ø	Ø	Ø	Ø	Ø
Evaluate Strategies for Conformity (8)	M**	M	Ø	Ø	L**	L	Ø	Ø
Participate in Ozone / PM Regional Groups	M*	H	Ø	Ø	L	M	Ø	Ø
Public Hearings	Ø	H	Ø	Ø	Ø	Ø	Ø	Ø
Develop of Management Plans	Ø	M	Ø	Ø	Ø	Ø	Ø	Ø
Review / Revise Compliance Plans	Ø	H	L	L	Ø	Ø	Ø	Ø
Develop Source Guidance Documents	Ø	M	Ø	Ø	Ø	Ø	Ø	Ø
Prepare and Review Progress Reports	Ø	M	L	L	Ø	L	Ø	Ø
Record keeping	Ø	M	L	L	Ø	L	Ø	Ø

KEY:

Ø	Not Applicable (No Burden Hours)	*	Generally, the EPA, but includes other Agencies as well
L	Low Burden (1 to 20 hours) per year	**	Indicates advisory capacity
M	Moderate Burden (21 to 40 hours) per year		
H	High Burden (41 to 160 hours) per year		

There are 34,324 estimated pollution sources in the United States subject to monitoring [US EPA 1995]. These sources form the basis for the non-Federal source discussion of this analysis. Table 10-1 displays the distribution of sources between nonattainment and attainment areas for each alternative ozone standard.

Tables 10.3 and 10.4 display the range of estimated additonal burden expected for all respondents, relative to the NAAQS analytical baseline.

10.3.3 Determining the Marginal Administrative Burden to Respondents

The marginal administrative burden associated with each of the four respondent categories of this analysis is estimated by multiplying the range endpoints for each burden category by the appropriate number of respondents. For example, Table 10-4 estimates the State oversight burden for "Review / Revise Compliance Plans" in NA's to be between 41 and 160 hours. Table 10.1 shows the .08 5th ozone standard has 18 States with predicted NA's. Consequently, the estimated burden for this category ranges between 738 and 2,880 hours, with a point estimate (average) of 1,809 hours. The sum of all burden category estimations for States under the .08 5th standard results in a point estimate burden of about 17,000 hours. This estimate is a part of the State burden in Table 10.5, below.

Table 10.5 The Total Marginal Burden for the .08 5th Ozone Standard to All Respondents - Point Estimate

(in hours)

	Governments		Sources		TOTALS
	Federal	State	Federal	Non-Fed	
One-Time Categories	30	550	270	43,000	**44,000**
Annual Categories	220	16,000	1,600	160,000	**180,000**
TOTALS	**250**	**17,000**	**1,900**	**200,000**	**220,000**

*Numbers may not add to totals due to rounding

Table 10.6 The Total Marginal Burden for the .08 4th Ozone Standard to All Respondents - Point Estimate

(in hours)

	Governments		Sources		TOTALS
	Federal	State	Federal	Non-Fed	
One-Time Categories	30	740	270	43,000	**44,000**
Annual Categoreis	220	24,000	1,800	230,000	**250,000**
TOTALS	**250**	**22,000**	**2,000**	**270,000**	**290,000**

*Numbers may not add to totals due to rounding

Table 10.7 The Total Marginal Burden for the .08 3rd Ozone Standard to All Respondents - Point Estimate

(in hours)

	Governments		**Sources**		**TOTALS**
	Federal	**State**	**Federal**	**Non-Fed**	
One-Time Categories	30	800	270	43,000	**44,000**
Annual Categoreis	200	24,000	2,400	270,000	**290,000**
TOTALS	**230**	**25,000**	**2,700**	**310,000**	**330,000**

*Numbers may not add to totals due to rounding

The marginal administrative burden for the three alternative 8-hour ozone standards, relative to the burden imposed by the current standard, ranges between 28,000 hours for the lower bound estimate of the .08 4th standard and 634,000 hours for the upper bound estimate for the .08 3rd standard. Most of the burden falls to non-Federal sources. The Agency calculated point estimates of 226,000 and 337,000 hours for the .08 5th, and .08 3rd ozone standards, respectively. The estimated marginal administrative burden for the selected ozone standard ranges between 37,000 and 560,000 hours, with a point estimate of 298,000 hours.

An artifact of construction is that Federal governmental burdens and the annualized burdens for sources are the same for all three ozone standards. Federal governmental burdens are based upon only one respondent, as described above in 10.3.1, above. Therefore, the burden in each Federal category remains independent of the standard. For annualized burdens in sources of pollution, no additional burden is estimated to occur for attainment areas with regard to 5 year annualization category, “Revise SIP’s.” Therefore, the aggregation equation for “annualized” burden hours applied to each source type simplifies to the same equation: the number of sources times the 13-year annualization factor.

Table 10.8 shows the average burden for each respondent type under each alternative ozone standard. As with the total estimated burden to Federal oversight, the average Federal burden for oversight does not change across standards because there is only one respondent. State average burdens range from 342 to 486 hours, with the average burden steadily increasing as the number of NA's increases across standards. Sources of pollution have much lower average burdens, primarily because sources do not have many categories of responsibility.

Table 10.8 Respondent Average Burden for Alternative Ozone Standards
(in hours)

	Administration		Sources of Pollution	
Respondent Type (Number)	**Federal (1)**	**State (51)**	**Federal (214)**	**Non-Federal (34,324)**
TOTAL: .08 5th	250	340	9	6
TOTAL: .08 4th	250	430	10	8
TOTAL: .08 3rd	250	490	13	9

10.3.4 Estimating the Cost per Hour for Respondents

Historically, the Agency has considered State and Federal burden costs to be roughly the same, at $34 per hour. However, since 1993, the EPA has undertaken a number of new analyses which indicate a divergence between Federal and State wages. In the Compliance Assurance Monitoring (CAM) Rule [US EPA 1997(a)], EPA calculated State burden costs to be $40 per hour. The State and Territorial Air Pollution Program Administrators and the Association of Local Air Pollution Control Officers recently analyzed the cost of State Air Grant activities and used a per hour rate of $50. For consistency within its own analyses, $40 per hour is selected as the fully loaded State employee labor rate for this analysis.

Two compensation rates for non-Federal sources of pollution are applied , one for in-house management, the other for contracted experts. Recent analyses in support of the CAM Rule indicates that for many sources, the cost of contracted labor far exceeds these rates. Consequently, source burden costs in this analysis are determined for non-Federal sources as the cost of industrial administration, estimated at $60 per hour (fully loaded) in the CAM Rule RIA [US EPA 1997(a)].

The hourly cost of Federal oversight and Federal sources of pollution is estimated at its historically applied rate of $34 per hour. This is based upon the fully loaded wage of a full time equivalent at a GS-11 step 3, representing the pay rate for a fully qualified analyst operating in the Regions [US EPA 1992, 1995, 1997].

For purposes of this analysis, "fully loaded" means the wage reported includes the pay seen on the employee's pay check, the additional benefits and contributions of the employer, overhead (including office space and equipment, heating, etc.), and an approximation of secretarial and supervisory time applied to the employee. As stated above, the costs in this chapter are in real 1990 dollars to remain consistent with the costs in the remainder of the RIA.

10.3.5 Estimating the Marginal Administrative Cost of the New Ozone NAAQS

To determine the expected additional administrative cost which may occur as the result of a change from the current to a new ozone standard, each of the burden estimates in Tables 10.5, 10.6, and 10.7 are multiplied by the appropriate cost per hour, as discussed in section 10.3.4. Table 10.9 displays the point estimated marginal administrative costs associated with the additional burden which could be imposed by an alternative eight hour ozone NAAQS. As stated above, these estimates are hypothetical, based upon a series of predicted actions and limiting assumptions about what the actual implementation strategy for the new ozone NAAQS may look like. A more accurate approximation of the potential burden and costs of the new joint NAAQS must wait until the Agency's FACA subcommittee has made its recommendations and the part 51 implementation process has been completed.

The marginal administrative cost of the 8-hour ozone standards range between $1.5 million per year for the lower bound estimate for the .08 5th standard and $37.2 million per year for the upper bound estimate for the .08 3rd standard. As with burden estimates, over 98 percent of the costs are incurred by non-Federal sources. The Agency calculated point estimates of $13.2 million and $19.7 million for the .08 5th and .08 3rd ozone standards, respectively. The expected marginal administrative cost to respondents for the selected ozone standard ranges between $2 million and

$32.8 million, with a point estimate of $17.4 million. The large number of non-Federal sources, combined with the high cost per hour for non-Federal compensation, overwhelmed the total cost estimates for all forms of the standard.

Table 10.9 Total Marginal Costs for Alternative Ozone Standards to All Respondents - Point Estimate
(in thousands of $1990)

	Administration		Sources		TOTALS
	Federal	**State**	**Federal**	**Non-Federal**	
.08 5th	$8	$700	$65	$12,000	**$13,000**
.08 4th	$8	$900	$71	$16,000	**$17,000**
.08 3rd	$8	$1,000	$92	$18,000	**$19,000**

Note: Numbers may not add to totals due to rounding

10.4 PARTICULATE MATTER ADMINISTRATIVE BURDEN AND COSTS

10.4.1 Estimating the Administrative Burden and Costs for the $PM_{2.5}$ NAAQS

Table 10.10, below, displays the expected additional administrative burden and costs for the selected $PM_{2.5}$ standard. While $PM_{2.5}$ 15/65 requires a new monitoring system and planning process, its promulgation permits a dis-investment in PM_{10} monitoring [US EPA 1996(a)]. Furthermore, the cost categories listed for the ozone administrative burden, above, also apply to PM; but because $PM_{2.5}$ is a new pollutant, many PM categories must be analyzed separately from their ozone counterparts. For example, there is no model available at this time which simultaneously predicts PM and ozone air quality. To answer questions about PM and ozone interaction requires at least two separate modeling runs. Therefore, given the characteristics listed here, along with the relative size of the administrative costs of the NAAQS in comparison to its control costs, it is assumed the PM NAAQS-associated administrative costs are roughly the same as those associated with the ozone NAAQS. While the burden and cost for each rule may be the same when taken separately, clearly, there are opportunities for synergy to provide cost savings. . These cost savings can best be discussed in the context of a joint NAAQS implementation program. Tables 10.1, 10.2, 10.3, and 10.4 define the expected scope of the $PM_{2.5}$ analysis and the burden associated with each administrative category. The estimated $PM_{2.5}$ additional costs are listed in Table 10.10.

Table 10.10 The Marginal Non-Monitor Related Administrative Burden* and Cost of $PM_{2.5}$ 15/65 To All Respondents - Point Estimate**

*** (in hours per year)**
**** (in thousands of $1990)**

	Administration		Sources		TOTALS
	Federal	State	Federal	Non-Federal	
Administrative Burden	250	22,000	2,000	270,000	**290,000**
Administrative Cost	$8	$880	$71	$16,000	**$17,000**

Note: Numbers may not add to totals due to rounding

10.4.2 $PM_{2.5}$ Monitoring Costs

The Agency assessed the administrative, operations, and maintenance costs for $PM_{2.5}$ monitoring under a separate ICR [US EPA 1996(a)]. The costs in that ICR are included below in Table 10.11, with operations and maintenance costs determined by applying the cost-per-hour estimates described in 10.3.4. While the Agency's $PM_{2.5}$ monitoring ICR does not address a specific form of the standard, the analysis is representative of the expected levels one would expect to find under any of the alternatives described in this RIA.

Table 10.11 The Marginal Monitor Related Administrative Burden* and Cost for $PM_{2.5}$ 15/65 to All Respondents - Point Estimate**

*** (in hours per year)**
**** (in thousands of $1990)**

	Administration		TOTALS
	Federal	State	
Administrative Burden	24,000	490,000	**514,000**
Administrative Cost	$900	$19,000	**$20,000**

Source: US EPA 1996(a)
Note: Numbers may not add to totals due to rounding

10.4.3 Estimating the Total Burden and Costs for $PM_{2.5}$

Table 10.12 displays the total marginal administrative costs associated with the $PM_{2.5}$ 15/65 standard. As w incremental to the PM_{10} analytical baseline, net of any dis-investment in PM_{10} which may occur because of the new

Table 10.12 The Total Marginal Burden and Cost for $PM_{2.5}$ 15/65 to All Respondents - Point Estimate

*** (in hours per year)**
**** (in thousands of $1990)**

	Administration		Sources		TOTALS
	Federal	State	Federal	Non-Federal	
Total Burden	24,000	510,000	2,100	270,000	**800,000**
Total Cost	$890	$20,000	$71	$16,000	**$37,000**

Note: Numbers may not add to totals due to rounding

10.5 RH ADMINISTRATIVE BURDEN AND COSTS

10.5.1 Estimating the Number of Respondents for the RH Proposal

The Agency is proposing a separate RH rule, with its regulatory impact estimated as a part of this RIA. This section addresses the burden and costs of that rule, taking into consideration the following RH characteristics and making the following assumptions:

- To avoid duplication and costs, a high degree of State coordination between PM and RH is assumed. Therefore, this analysis treats RH as incremental to PM.

- PM emission inventories will be needed for RH implementation activities as well. To account for the effects of pollutant transport, PM inventories will be needed Statewide, and will need to include principal PM constituents (sulfate, nitrate, organic carbon, elemental carbon, and soil dust.) Therefore, part of the PM monitoring network may serve as an RH monitoring network as well. This analysis assumes monitors installed for $PM_{2.5}$ will be able to differentiate between particles for RH strategy planning purposes. RH targets apply for mandatory Class I Federal areas and areas identified through monitoring.

- Presently, visibility monitoring occurs in about 70 Class I areas, funded cooperatively by the EPA and Federal land management agencies. New $PM_{2.5}$ monitors can be sited at Class I areas which do not currently have monitoring to serve as "background" or "transport" monitors. In this way, cost savings can be realized through coordination of the visibility and $PM_{2.5}$ networks.

- REMSAD can model changes in PM concentrations and visibility at the same time through application of a post processor to calculate visibility changes in terms of deciviews. Therefore, it is assumed that PM modeling will provide most of the information needed for RH modeling purposes. The marginal burden for RH modeling relative to the burden expected for PM applies to just the application of the post processor.

- There are 156 mandatory Class I Federal areas in 35 States identified for the proposed RH target. The RH rule assumes all States either have a Class I area or contribute to the RH problem in some Class I areas [US EPA 1997(c)]. The scope of this RH analysis includes all 48 contiguous United States and the District of Columbia. Other American lands have been excluded from this analysis for consistency with the remainder of the chapter.[1]

10.5.2 Estimating the Per Respondent Burden for the Proposed Regional Haze Targets

Using the ozone and $PM_{2.5}$ burden assessment methodology in Tables 10.3 and 10.4 as a template, several adjustments are made to accommodate the differences between RH and the two NAAQS pollutants. First, the RH rule requires States to coordinate their planning with FLM's in charge of affected Class I areas. Therefore, a separate burden category is included for "Consultation and Coordination with Federal Land Managers." Next, the RH burden estimates apply primarily to the Federal and State oversight activities. Estimates of additional administrative burden to sources beyond those associated with implementation of the ozone and PM NAAQS are not included for RH in this analysis, because: (1) RH strategies will ultimately be implemented through State SIPs; and (2) there is significant uncertainty associated with estimating the number of sources which may be subject to RH specific strategies and requirements. The assessment in Tables 10.13, 10.14, and 10.15 applies to States and Federal oversight, not to sources of pollution.

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c.f. Code of Federal Regulations Title 40 part 81 section 400.

Table 10.13 Per Respondent Regional Haze Administrative Burden Estimations For One-time Burden Categories

	Federal	State
Interpret / Identify Requirements	M*	M
Add New Monitors	H	D
Adopt New Rules	N	R

N No Burden * Advisory Capacity
M Moderate Burden (21 to 40
R Ratio Burden (27 to 78 hours)
D Data Collection Burden (1,000 to 1,500 hours)

Table 10-14 Per Respondent Regional Haze Administrative Burden Estimations For Three-Year Burden Categories

	Federal	State
Develop / Revise Monitoring Plan	N	H
Review / Revise SIPs	H	H
Revise Monitoring Plan / Strategies	M	M
Add New Monitors	M	M
FLM Consultation	M	M
Public Hearings	L*	H
Progress Reports	N	M
Review / Revise Compliance Plans	N	H

N No Burden * Advisory Capacity
M Moderate Burden (21 to 40
R Ratio Burden (27 to 78 hours)
D Data Collection Burden (1,000 to 1,500 hours)

Table 10-15 Per Respondent Regional Haze Administrative Burden Estimations For Reoccurring Burden Categories

	Federal	States
Evaluate / Improve Inventories	PM	PM
Data Gathering and Assembly	PM	PM
Run Model **	L*	L
Evaluate / Interpret Model Results	M*	M
Identify Control Strategies ***	M*	H
O3 / PM / RH Regional Groups	M	M
Develop Source Guidance Documents	N	M
Monitoring / Reporting	L	M
Recordkeeping	L	M

N No Burden
L Low Burden (1 to 20 hours)
M Moderate Burden (21 to 40 hours)
H High Burden (41 to 160 hours)
PM PM Effort Used for Regional Haze Purposes

* Advisory
** REMSAD Post Processor
*** Primarily in t he West

The estimated range for the "R" burden level is 27 and 78 hours per year. A moderate burden range for RH participation in regional air quality organizations is established, primarily because States currently have a relatively low level of participation in regional groups, except in the West (e.g., the Grand Canyon Commission).

Figure 10.3 Weighted Average Burden Calculation for States for Regional Haze Rule Adoption

$$R_{Low} = \frac{(35 \times 21) + (17 \times 41)}{51}$$

$$R_{High} = \frac{(35 \times 40) + (17 \times 160)}{51}$$

10.5.3 RH Monitoring

The RH rule requires development of monitoring which is "representative" of RH conditions at every mandatory Class I Federal area subject to the rule. Visibility monitoring already occurs in approximately 70 of these areas through a cooperative inter-governmental program, at a cost of approximately $3 million per year. Monitoring in every mandatory Class I Federal area based on current technology would cost roughly $8 million per year for data collection and reporting. The RH proposal requires an assessment of "representative" modeling which is expected to be some level less than full monitoring at every mandatory Class I Federal area. The incremental monitoring cost for the RH program representative network ranges from $2 to $3 million per year, relative to current RH monitoring costs. For the 86 mandatory Class I Federal areas without monitoring, the average burden hours per State range between 1,000 and 1,500 in the first year of monitor installation. These values are included in Table 10.13 as burden range "D." When States re-evaluate their RH plans, the monitoring network in some mandatory Class I Federal areas may need to be adjusted. The expected average State burden for such adjustments would be much less than the original monitoring network installation. The Agency established the 3-year burden range for these adjustments as moderate.

10.5.4 Determining the Marginal Administrative Burden to Respondents

The RH rule's expected annual burden to respondents was calculated by the same means as that for ozone. In other words, the range of hours for each category is summed, annualizing where appropriate, and the total multiplied by 1 (for the total number of Federal respondents) or 51 (for the total number of State respondents). Table 10.16 displays the average burden per respondent and the total burden of the RH rule.

Table 10.16 Respondent Administrative Burden Estimations for Regional Haze - Point Estimate
(in hours per year)

	Burden - Point Estimate	
	Federal	**State**
Burden per Respondent	220	620
Total Burden	220	32,000

10.5.5 Estimating the Marginal Administrative Cost of the Proposed RH Targets

Table 10.17 displays the average administrative cost per respondent and the total administrative cost of the RH rule in real 1990 thousands of dollars.

Table 10.17 Respondent Administrative Cost Estimates for Regional Haze - Point Estimate
(in thousands of $1990 per year)

	Cost - Point Estimate	
	Federal	**State**
Cost per Respondent	$7	$25
Total Cost	$7	$1,100

10.6 UNCERTAINTY

10.6.1 Permitting Considerations

The Operating Permits Rule, codified in 40 CFR part 70, requires all States to develop permit fees at a level sufficient to fully reimburse the State for its administrative outlay for managing its permits program [US EPA 1992, 1995]. Given that much of the burden to States relates to administration of permit related activities (e.g., recordkeeping, monitoring, and modeling), these costs may be passed on to sources in the form of increased permit fees. While this does not change total costs, it redistributes them between respondent types.

10.6.2 Potential Over- and Understatements

Many sources have taken advantage of an EPA voluntary program which allows them to avoid permit requirements if they limit emissions to below major source levels.[1] Synthetic minors and other exempted sources would have no emissions reduction requirements under title V of the Clean Air Act Amendments of 1990. Consequently, the number of affected non-Federal sources may be less than the number of non-Federal sources identified in this chapter.

Conversely, the burden to non-Federal sources may be over- or underestimated because source counts and emissions projections to 2010 may differ from actual sources in many Standard Industrial Code classifications. This RIA's industrial point source and area source components contain information based on the 1985 National Acid Precipitation Assessment Program emission inventory, projected to 1990 based on historical Bureau of Economic Analysis (BEA) earnings and fuel use data. This does not take into account plant shut-down or start-ups, changes in operating

A source's classification as major or minor depends on their potential to emit, not actual emissions. Consequently, a source may be emitting at a minor source level (generally less than 100 tons per year (tpy), but varies with the severity of the nonattainment problem of the source's location) but have the potential to emit at a major source level if the source were to operate at an increased capacity. Such sources can seek exclusion from regulatory requirements by applying for status as a "synthetic minor" - a voluntarily limit on its emissions (generally by limiting productive capacity) to a level below the major source cut-off [US EPA 1995].

parctices and efficiency, or the installation of controls between 1985 and 1990 [E.H. Pechan 1997]. Furthermore, intrastate economic differences are not captured. Growth in PM_{10} emissions is estimated by applying particle size multipliers to total suspended particles (TSP) emission estimates. Given the dynamic nature of current technology, estimations of future growth based upon past trends may not be entirely appropriate. A common example of the potential for error is the growth rate in the computer industry over the past 20 years.

The PM regional group participation may be understated. Most regional groups focus on Eastern problems, where PM currently has little infrastructure. Assuming only marginal changes from the current levels of activity for PM with respect to the East presumes no relative change in importance for PM, which cannot be supported by the analyses in this RIA.

The category for "Public Hearings" may be underestimated as well, since public hearings can occur for section 105 and 110 grants as well as for SIP purposes.

10.7 TOTAL BURDEN AND COSTS FOR THE JOINT OZONE / PM NAAQS AND RH TARGET

The total burden and cost to all respondents can be found in Table 10-19. The expected marginal administrative costs associated with promulgation of the new ozone and PM NAAQS and the RH rule are about $55 million per year, requiring slightly more than a million additional burden hours from respondents.

Table 10.19 The Total Marginal Burden* and Cost ** [1]
for the Selected Ozone and $PM_{2.5}$ NAAQS
and Regional Haze Target to All Respondents - Point Estimate

*** (In thousands of hours)**
**** (Costs are in millions of $1990)**

	BURDEN	TOTAL COST
Ozone	300	**$17**
$PM_{2.5}$ Monitoring	520	**$20**
$PM_{2.5}$ Other	300	**$17**
RH	32	**$1**
TOTAL	1,200	**$55**

Marginal costs are additional costs beyond those required to meet the current PM_{10} standard.

10.8 REFERENCES

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