Chapter 4: Emissions Controls Analysis – Design and Analytical Results

Synopsis

This chapter documents the illustrative emission control strategy we applied to simulate attainment with the alternative standards being analyzed for the proposed SO_2 NAAQS. Section 4.1 describes the approach we followed to select emissions controls to simulate attainment in each geographic area of analysis. Section 4.2 summarizes the emission reductions we simulated in each area based on current knowledge of identified emission controls, while Section 4.3 presents the air quality impacts of these emissions reductions. Section 4.4 discusses the application of additional controls, beyond the level of control already assumed to be in place for the analysis year[1], that we estimate will be necessary to reach attainment in certain monitor areas. Section 4.5 discusses key limitations in the approach we used to estimate the optimal control strategies for each alternative standard.

The proposal would set a new short-term SO_2 standard based on the average of the 99th percentile of 1-hour daily maximum concentrations from three consecutive years. The proposal would set the level of this new standard within the range of 50 to 100 parts per billion (ppb). The proposal also requests comment on a standard level as high as 150 ppb. OMB Circular A-4 requires the RIA to contain, in addition to analysis of the impacts of the proposed NAAQS, analysis of a level more stringent and a level less stringent than the proposed NAAQS. As a lower bound, however, we chose an alternative primary standard of 50 parts per billion (ppb). This level captures the largest number of geographic areas that may be affected by a new SO_2 standard. Our analysis of this hypothetical scenario is meant to approximate the most comprehensive set of control strategies that areas across the country might employ to attain. (Note that we chose 50 ppb as an analytic lower bound well before decisions were made about either the proposed range, or the range for requesting public comment.)

For the range of alternative standards, we analyzed the impact that additional emissions controls applied to numerous sectors would have on predicted ambient SO_2 concentrations, incremental to the baseline set of controls. Thus the modeled analysis for a revised standard focuses specifically on incremental improvements beyond the current standards, and uses control options that might be available to states for application by 2020. The hypothetical modeled control strategy presented in this RIA is one illustrative option for achieving emissions reductions to move towards a national attainment of a tighter standard. It is not a

[1] Note that the baseline or starting point for this analysis includes rules that are already "on the books" and will take affect prior to the analysis year, as well as control strategies applied in the recent PM and Ozone NAAQS RIAs.

recommendation for how a tighter SO_2 standard should be implemented, and states will make all final decisions regarding implementation strategies once a final NAAQS has been set.

Generally, we expect that the nation will be able to make significant progress towards attainment of a tighter SO_2 NAAQS without the addition of new controls beyond those already being planned for the attainment of existing $PM_{2.5}$ standards by the year 2020. As States develop their plans for attaining these existing standards, they are likely to consider adding controls to reduce sulfur dioxide, as SO_2 is a precursor to both $PM_{2.5}$. These controls will also directly help areas meet a tighter SO_2 standard.

As part of our economic analysis of the tighter SO_2 standard, our 2020 analysis baseline assumes that States will put in place the necessary control strategies to attain the current $PM_{2.5}$ standards. The cost of these control strategies was included in the RIAs for those rulemakings. We do not include the cost of those controls in this analysis, in order to prevent counting the cost of installing and operating the controls twice. Of course, the health and environmental benefits resulting from installation of those controls were attributed to attaining those standards, and are not counted again for the analysis of this SO_2 standard.

It is important to note also that this analysis does not attempt to estimate attainment or nonattainment for any areas of the country other than those counties currently served by one of the 488 monitors in the current network. Chapter 3 explains that the current network is focused on longer terms indicators that that included in this proposal.

Finally, we note that because it was not possible, in this analysis, to bring all areas into attainment with the alternative standards in all areas using only identified controls, EPA conducted a second step in the analysis, and estimated the cost of further tons of emission reductions needed to attain the alternative primary NAAQS. It is uncertain what controls States would put in place to attain a tighter standard, since additional abatement strategies are not currently recognized as being commercially available. We should also note that because of data and resource limitations, we are not able to adequately represent in this analysis the impacts of some local emission control programs such as discussed in Chapter 3.

4.1 Developing the Identified Control Strategy Analysis

The 2020 baseline air quality estimates revealed that 57 monitors in 34 counties had projected design values exceeding 50 ppb. We then developed a hypothetical control strategy that could be adopted to bring the current highest emitting monitor in each of those counties into attainment with a primary standard of 50 ppb by 2020. (For more information on the development of the air quality estimates for this analysis see Chapter 3.) Controls for three emissions sectors were included in the control analysis: Non-Electricity Generating Unit Point Sources (nonEGU), Non-Point Area Sources (Area), and Electricity Generating Unit Point Sources (EGU). Each of these sectors is defined below for clarity.

- NonEGU point sources as defined in the National Emissions Inventory (NEI) are stationary sources that emit 100 tons per year or more of at least one criteria pollutant. NonEGU point sources are found across a wide variety of industries, such as chemical manufacturing, cement manufacturing, petroleum refineries, and iron and steel mills.
- Area Sources[2] are stationary sources that are too numerous or whose emissions are too small to be individually included in a stationary source emissions inventory. Area sources are the activities where aggregated source emissions information is maintained for the entire source category instead of each point source, and are reported at the county level.
- Electricity Generating Unit Point Sources are stationary sources of 25 megawatts (MW) capacity or greater producing and selling electricity to the grid, such as fossil-fuel-fired boilers and combustion turbines.

It should be noted that no SO_2 controls are applied to onroad and nonroad mobile sources because mobile source measures to reduce sulfur content from diesel engine rules will be well-applied in onroad and nonroad mobile source fleets by 2020, and thus there is little capability to achieve further reductions for this analysis beyond those described in this report.

We began the control strategy analysis by applying controls to EGUs first before applying controls to other sources. We applied controls in this sequence for the following reasons: 1) there are many more SO_2 emissions from EGUs than from non-EGU sources in the areas included in this analysis, and 2) SO_2 reductions from EGUs are less costly than from other source categories included in this analysis. Chapter 6 provides a table showing that the EGU control costs for SO_2 as estimated for this analysis have a lower annual cost/ton compared to those from the non-EGU point and area source categories.

The air quality impact of the needed emissions reductions was calculated using impact ratios as discussed further in Chapter 3 (section 3.2.1). The results of analyzing the control strategy indicate that there were 26 areas projected not to attain 50 ppb in 2020 using all identified control measures. To complete the analysis, EPA then extrapolated the additional

[2] Area Sources include the nonpoint emissions sector only.

emission reductions required to reach attainment. The methodology used to develop those estimates and those calculations are presented in Section 4.4.

4.1.1 Controls Applied for EGU Sector

The baseline in this RIA for EGUs is the control strategy used in the Final Ozone NAAQS RIA that was completed in March 2008. The baseline strategy was developed to simulate attainment for the Ozone NAAQS in 2020. This strategy also accounted for extensive reductions in SO_2 emissions from EGUs as implemented in the Clean Air Interstate Rule (CAIR). While the US District Court for District of Columbia has remanded the CAIR, it still is in full effect. No additional controls for SO_2 are implemented in the baseline.

Consistent with the baseline, the Integrated Planning Model (IPM) version 3.0 was used to develop the background for the control strategy applied for the alternative standard of 50 ppb. Historically, EPA has used the IPM model to assess the cost and effectiveness of additional EGU controls. Due to time and resource limitations, EPA decided to only perform a single IPM run focused on the tightest alternative standard of 50 ppb. We used this IPM run as the means of identifying the units which needed to be controlled to assist an area to meet the various standard alternatives. The end result of this approach mimics an approach which may be used by individual states as they try to apply targeted controls on EGUs which affect attainment in a specific area.

In this analysis, EGU controls applied to uncontrolled coal-fired units of size 100 MW and larger within the 50 km radius of violating monitors. Each unit has given the option of retrofitting with a Wet Flue Gas Desulfurization (FGD) scrubber with 95 percent SO_2 reduction efficiency or retire. This control measure is applicable to coal-fired EGUs with unit capacities above 100 MW. No controls were applied to EGUs under 100 MW unit capacity because EPA currently has insufficient data to estimate the impact of SO_2 controls on such small sources.

Detailed background information on both the EGU control strategy used in the Final Ozone NAAQS RIA, CAIR and IPM is included in the Final Ozone NAAQS RIA (see sections 3a.3.1 and 3a.3.2 of the RIA at http://www.epa.gov/ttn/ecas/ria.html). More information on the SO_2 measures can be found in the documentation for the IPM.[3]

[3] http://www.epa.gov/airmarkt/progsregs/epa-ipm/index.html

4.1.2 Controls Applied for the NonEGU Point and Area Sectors

NonEGU point and Area control measures were identified using AirControlNET 4.2[4,5] as well as the Control Strategy Tool[6] (CoST). AirControlNET has been used for developing control strategies as part of the PM NAAQS, Ozone NAAQS, and Lead NAAQS RIAs. To reduce nonEGU point SO_2 emissions, least cost control measures were identified for emission sources within 50 km of the violating monitor (see Chapter 3 for rationale). Area source emissions data are generated at the county level, and therefore controls for this emission sector were applied to the county containing the violating monitor.

The SO_2 emission control measures used in this analysis are similar to those used in the $PM_{2.5}$ RIA prepared about three years ago. FGD scrubbers can achieve 90% control of SO_2 for non-EGU point sources and 95 percent for utility boilers. Spray dryer absorbers (SDA) are another commonly employed technology, and SDA can achieve up to 90% control of SO_2. For specific source categories, other types of control technologies are available that are more specific to the sources controlled. The following table lists these technologies. For more information on these technologies, please refer to the AirControlNET 4.2 control measures documentation report.[7]

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[4] See http://www.epa.gov/ttnecas1/AirControlNET.htm for a description of how AirControlNET operates and what data are included in this tool.

[5] While AirControlNET has not undergone a formal peer review, this software tool has undergone substantial review within EPA's OAR and OAQPS, and by technical staff in EPA's Regional offices. Much of the control measure data has been included in a control measure database that will be distributed to EPA Regional offices for use by States as they prepare their ozone, regional haze, and PM2.5 SIPs over the next 10 months. See http://www.epa.gov/particles/measures/pm_control_measures_tables_ver1.pdf for more details on this control measures database. In addition, the control measure data within AirControlNET has been used by various States and Regional Planning Organizations (RPOs) such as the Lake Michigan Air District Commission (LADCO), the Ozone Transport Commission (OTC), and the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) as part of their technical analyses associated with SIP development over the last 3 years. All of their technical reports are available on their web sites.

[6] See http://www.epa.gov/ttn/ecas/cost.htm for a description of CoST.

[7] For a complete description of AirControlNET control technologies see AirControlNET 4.2 control measures documentation report, prepared by E.H. Pechan and Associates. May 2008.

Table 4-1: Example SO_2 Control Measures for Non-EGU Point Sources Applied in Identified Control Measures Control Strategy Analyses[a]

Control Measure	*Sectors to which These Control Measures Can Be Applied*	*Control Efficiency (percent)*	*Average Annualized Cost/ton (2006$)*
Wet and Dry FGD scrubbers and SDA	ICI boilers—all fuel types, kraft pulp mills, Mineral Products (e.g., Portland cement plants (all fuel types), petroleum refineries	90—FGD scrubbers or SDA	$800-$8,000—FGD $900 – 7,000—SDA
Increase percentage sulfur conversion to meet sulfuric acid NSPS (99.7% reduction)	Sulfur recovery plants	75 to 95	$4,000
Sulfur recovery and/or tail gas treatment	Sulfuric Acid Plants	95-98	$1,000 – 4,000
Cesium promoted catalyst	Sulfuric Acid Plants with Double-Absorption process	50%	$1,000

Sources: AirControlNET 4.2 control measures documentation report (May 2008), and Comprehensive Industry Document on Sulphuric Acid Plant, Govt. of India Central Pollution Control Board, May 2007. The estimates for these control measures reflect applications of control where there is no SO_2 control measure currently operating except for the Cesium promoted catalyst.

In applying these SO_2 controls, we employ a decision rule in which we do not apply controls to any non-EGU source with 50 tons/year of emissions or less. This decision rule is the same one we employed for such sources in the $PM_{2.5}$ RIA completed three years ago. The reason for applying this decision rule is based on a finding that most point sources with emissions of this level or less had SO_2 controls already on them. This decision rule aids in gap filling for a lack of information regarding existing controls on nonEGU sources. In addition, we also apply the decision rule that we do not apply SO_2 controls that yield emission reductions of 50 tons/year or less. We apply this decision rule in order to reduce the number the sources affected our non-EGU control strategies to those sources whose reductions are relatively more cost-effective.

The analysis for non-EGUs mostly applied controls to the following source categories: industrial boilers, commercial and institutional boilers, sulfuric acid plants (both standalone and at other facilities such as copper and lead smelters), mineral products (primarily aluminum plants and cement kilns) and petroleum refineries. These source categories are the most prevalent SO_2 emitters in the areas included in this analysis.

4.1.3 Data Quality for this Analysis

The estimates of emission reductions associated with our control strategies above are subject to important limitations and uncertainties. EPA's analysis is based on its best judgment for various input assumptions that are uncertain. As a general matter, the Agency selects the best available information from available engineering studies of air pollution controls and has set up what it believes is the most reasonable framework for analyzing the cost, emission changes, and other impacts of regulatory controls.

4.2 SO_2 Emission Reductions Achieved with Identified Controls Analysis

We identified illustrative control strategies that might be employed to reduce emissions to bring air quality into compliance with the alternative standard being analyzed. As part of this exercise, we considered the cost-effectiveness of various control options and selected the lowest cost controls, based on available cost information. Applying identified control measures, we were able to illustrate attainment for most, but not all of the areas. [8]

Table 4.2 presents the emission reductions achieved through applying identical control measures, both by sector and in total. As this table reveals, a majority of the emission reductions were achieved through EGU emission controls. As indicated in this table, the estimate emission reductions from the identified controls applied in this analysis under the 50 ppb alternative standard in 2020 are 759,000 tons. About 550,000 tons of the reductions are from EGUs, and 209,000 are from non-EGU point sources. For the other alternative standards, the total emission reductions in 2020 are estimated to range from 160,000 tons to 439,000 tons. For all of these standards, this analysis shows that roughly 60 to 70 percent of these reductions are from EGUs. All of the remaining reductions obtained come from non-EGU point sources except for the 50 and 75 ppb standards where a very small portion (below 0.2 percent) of reductions comes from area sources.

[8] As will be discussed below, the application of identified controls was insufficient to bring all monitor areas into compliance with the alternative standards.

Table 4.2: Emission Reductions from Identified Controls in 2020 in Total and by Sector (Tons) [a, b] for Each Alternative Standard

	50 ppb	75 ppb	100 ppb	150 ppb
Total Emission Reductions from Identified Controls:[c]	760,000	439,000	343,000	162,000
EGUs	550,000	317,000	256,000	119,000
Non-EGUs	209,000	122,000	87,000	44,000
Area Sources	1,000	100	0	0

[a]All estimates rounded to two significant figures. As such, totals may not sum down columns.
[b] All estimates provided reflect the application of the identified control strategy analysis, incremental to a 2020 baseline of compliance with the current PM2.5 standards, and the necessary emission reductions estimated for attainment as shown in Chapter 2 for the areas covered by this analysis.
[c]These values represent emission reductions for the identified control strategy analysis. There were locations not able to attain the alternative standard being analyzed with identified controls only.

Table 4.3 presents the emission reductions by individual non-EGU point source category in 2020. As this table shows, the majority of reductions are from industrial boilers, with the percent of non-EGU point source reductions from industrial boilers ranging from 52 (150 ppb) to 67 (50 ppb). Sulfuric acid plants are the source category with the next highest percent of reductions (14 percent at 50 ppb, 45 percent at 150 ppb).

Table 4.3: Emission Reductions from Identified Controls By Non-EGU Point Source Category in 2020 in Total (Tons) [a, b] for Each Alternative Standard

	50 ppb	75 ppb	100 ppb	150 ppb
Total Non-EGU Emission Reductions from Identified Controls:[c]	209,000	122,000	87,000	44,000
Industrial Boilers	139,000	82,000	54,000	23,000
Sulfuric Acid Plants	29,000	24,000	21,000	20,000
Commercial/Institutional Boilers	24,000	13,000	12,000	0
Petroleum Refineries	26,000	10,000	1,000	1,000
Mineral Products	7,000	5,000	200	100

[a]All estimates rounded to two significant figures. As such, totals may not sum down columns.
[b] All estimates provided reflect the application of the identified control strategy analysis, incremental to a 2020 baseline of compliance with the current PM2.5 standards, and the necessary emission reductions estimated for attainment as shown in Chapter 2 for the areas covered by this analysis.
[c]These values represent emission reductions for the identified control strategy analysis. There were locations not able to attain the alternative standard being analyzed with identified controls only.

Table 4.4 presents the SO_2 emissions reductions realized in each geographic area under the control strategies applied for the alternative standard of 50 ppb and also for the other three alternative standards.

Table 4.4: Emission Reductions by County in 2020 for Each Alternative Standard Analyzed [a]

State	County	Emission Reductions (annual tons/year)			
		50 ppb	75 ppb	100 ppb	150 ppb
Arizona	Gila Co	8,100	8,100	8,100	8,100
Delaware	New Castle Co	8,500			
Georgia	Chatham Co	18,000	18,000	18,000	
Idaho	Bannock Co	620			
Illinois	Cook Co	97,000	84,000	84,000	
Illinois	Madison Co	27,000	22,000		
Illinois	St Clair Co	47,000			
Illinois	Sangamon Co	590			
Illinois	Tazewell Co	28,000	28,000	23,000	
Illinois	Wabash Co	6,500			
Illinois	Will Co	56,000			
Indiana	Floyd Co	8,600			
Indiana	Fountain Co	4,000			
Indiana	Jasper Co	24,000			
Indiana	Lake Co	79,000	65,000		
Indiana	Morgan Co	6,100			
Indiana	Porter Co	54,000			
Indiana	Warrick Co	13,000			
Indiana	Wayne Co	4,600	4,600	4,600	
Iowa	Linn Co	4,200	4,200		
Iowa	Muscatine Co	5,400	5,400	5,400	
Kansas	Wyandotte Co	24,000			
Kentucky	Jefferson Co	8,600	5,500		
Kentucky	Livingston Co	48,000			
Louisiana	East Baton Rouge Par	36,000			
Missouri	Greene Co	450	450		
Missouri	Jackson Co	11,000	11,000	11,000	
Missouri	Jefferson Co	87,000	87,000	87,000	87,000
Missouri	St Louis	95,000			
Montana	Yellowstone Co	1,200			
Nebraska	Douglas Co	3,400			
New Mexico	San Juan Co	1,700			
New York	Chautauqua Co	5,700			
New York	Erie Co	2,900	2,900		
New York	Madison Co	160			
New York	Monroe Co	230			
North Carolina	New Hanover Co	9,700			
Ohio	Clark Co	2,200			
Ohio	Cuyahoga Co	29,000			
Ohio	Hamilton Co	21,000			
Ohio	Lake Co	26,000	26,000	26,000	
Ohio	Summit Co	19,000	19,000	19,000	8,800
Oklahoma	Muskogee Co	20,000			
Pennsylvania	Blair Co	790			
Pennsylvania	Northampton Co	8,900	5,200		

State	County	Emission Reductions (annual tons/year)			
		50 ppb	75 ppb	100 ppb	150 ppb
Pennsylvania	Warren Co	5,700	5,700	5,700	5,700
South Carolina	Lexington Co	9,900	8,100		
Tennessee	Blount Co	6,400			
Tennessee	Bradley Co	7,800	1,700		
Tennessee	Montgomery Co	1,100	1,100	1,100	
Tennessee	Shelby Co	9,200			
Tennessee	Sullivan Co	70,000	64,000	49,000	49,000
Texas	Harris Co	36,000			
Texas	Jefferson Co	11,000	3,300		
West Virginia	Hancock Co	13,000			
Wisconsin	Brown Co	14,000			
Wisconsin	Oneida Co	7,500	7,500	5,800	3,900

[a] All estimates rounded to two significant figures.
* Indicates a county that does not reach attainment of the alternative standard using identified controls.

4.3 Impacts Using Identified Controls

As discussed in Chapter 3, we estimated the overall change in ambient air quality achieved as a result of each of the control strategies identified above using an impact ratio of emission reductions to air quality improvement. Table 4.5 presents a detailed breakdown of the estimated ambient SO_2 concentrations in 2020 at each of the 57 counties under the alternative standards.

According to the data presented in Table 4.5, thirty-one of the 57 monitor areas are expected to reach attainment with the alternative standard of 50 ppb following implementation of the identified control strategy. For 26 areas, identified controls are not sufficient to reach attainment with the alternative standard of 50 ppb. However, there are fewer areas that do not reach attainment with the other standards as shown in Table 4.6. There are twelve areas out of attainment with the 75 ppb alternative standard, 8 areas out of attainment with the 100 ppb alternative standard, and only 2 out of attainment with the 150 ppb alternative standard.

For the areas projected to violate the NAAQS with the application of identified controls, we assume that emission reductions beyond identified controls will be applied, as discussed further below.

Table 4.5: 2020 SO_2 Design Values after Application of Identified Controls for Alternative Standards

State	County	Design Value After Application of Identified Controls			
		50 ppb	75 ppb	100 ppb	150 ppb
Arizona	Gila Co	172.7*	172.7*	172.7*	172.7*
Delaware	New Castle Co	50.4			
Georgia	Chatham Co	83.8*	83.8*	84.9*	
Idaho	Bannock Co	44.8			
Illinois	Cook Co	30.0	39.3	39.3	
Illinois	Madison Co	66.7*	72.8		
Illinois	St Clair Co	34.4			
Illinois	Sangamon Co	69.9*			
Illinois	Tazewell Co	81.8*	81.8*	95.1*	
Illinois	Wabash Co	48.3			
Illinois	Will Co	29.2			
Indiana	Floyd Co	61.2*			
Indiana	Fountain Co	49.5			
Indiana	Jasper Co	46.2			
Indiana	Lake Co	50.2	58.0		
Indiana	Morgan Co	50.3			
Indiana	Porter Co	39.9			
Indiana	Warrick Co	50.0			
Indiana	Wayne Co	115.8*	115.8*	115.8*	
Iowa	Linn Co	74.7*	74.7		
Iowa	Muscatine Co	108.6*	108.6*	108.6*	
Kansas	Wyandotte Co	37.7			
Kentucky	Jefferson Co	67.4*	71.1		
Kentucky	Livingston Co	25.1			
Louisiana	East Baton Rouge Par	44.7			
Missouri	Greene Co	79.0*	79.0*		
Missouri	Jackson Co	116.5*	116.5*	116.5*	
Missouri	Jefferson Co	146.0*	146.0*	146.0*	146.4
Missouri	St Louis	21.8			
Montana	Yellowstone Co	56.1*			
Nebraska	Douglas Co	60.6*			
New Mexico	San Juan Co	65.6*			
New York	Chautauqua Co	43.4			
New York	Erie Co	79.5*	79.5*		
New York	Madison Co	51.8*			
New York	Monroe Co	50.3			
North Carolina	New Hanover Co	50.5*			
Ohio	Clark Co	59.9*			
Ohio	Cuyahoga Co	27.4			
Ohio	Hamilton Co	43.2			
Ohio	Lake Co	57.6*	57.6	57.6	
Ohio	Summit Co	114.7*	114.7*	114.7*	145.1
Oklahoma	Muskogee Co	28.4			
Pennsylvania	Blair Co	50.3			
Pennsylvania	Northampton Co	66.5*	75.4		

State	County	Design Value After Application of Identified Controls			
		50 ppb	75 ppb	100 ppb	150 ppb
Pennsylvania	Warren Co	166.4*	166.4*	166.4*	166.4*
South Carolina	Lexington Co	49.9	55.3		
Tennessee	Blount Co	56.0*			
Tennessee	Bradley Co	44.8	75.0		
Tennessee	Montgomery Co	138.2*	138.2*	138.2*	
Tennessee	Shelby Co	47.0			
Tennessee	Sullivan Co	44.8	54.5	81.6	81.6
Texas	Harris Co	36.3			
Texas	Jefferson Co	44.4	68.8		
West Virginia	Hancock Co	47.1			
Wisconsin	Brown Co	48.7			
Wisconsin	Oneida Co	49.7	49.7	78.8	113.1

* Indicates a county that does not reach attainment of the alternative standard using identified controls.

Table 4.6 Number of Areas Projected to be in Nonattainment for Each Alternative Standard After Application of Identified Controls in 2020[a]

	50 ppb	75 ppb	100 ppb	150 ppb
Number of Areas Needing Emission Reductions Beyond Identified Controls	26	12	8	2

[a] There are 57 areas included in this analysis.

4.4 Emission Reductions Needed Beyond Identified Controls

As shown through the identified control strategy analysis, there were not enough identified controls for every area in the analysis to achieve attainment with a 50 ppb alternative standard nor the other alternative standards in 2020. Therefore additional emission reductions will be needed for these areas to attain these alternative standards. Table 4.7 shows the emission reductions needed beyond identified controls for counties to attain the alternative standards being analyzed. The total emission reductions for full attainment of each alternative standard are also included in this table. Table 4.8 presents the emission reductions needed for each area beyond identified controls for each alternative standard. Chapter 6 presents the discussion of extrapolated costs associated with the emission reductions needed beyond identified controls.

Table 4.7: Total Emission Reductions and those from Extrapolated Controls in 2020 in Total and by Sector (Tons) [a] for Each Alternative Standard

	50 ppb	75 ppb	100 ppb	150 ppb
Total Emission Reductions from Identified and Unidentified Controls	1,061,000	566,000	404,000	165,000
Total Emission Reductions from Unidentified Controls	301,000	127,000	61,000	2,600
Unidentified Reductions from EGUs	217,000	91,000	46,000	1,900
Unidentified Reductions from non-EGUs	84,000	36,000	15,000	700
Unidentified Reductions from Area Sources	75	30	0	0

[a] All estimates rounded to two significant figures.

Table 4.8 Emission Reductions Needed Beyond Identified Controls in 2020

State	County	Emission Reductions Needed Beyond Identified Controls (annual tons/year)			
		50 ppb	75 ppb	100 ppb	150 ppb
Arizona	Gila Co	8,000	6,400	4,800	1,500
Georgia	Chatham Co	12,000	3,000		
Illinois	Madison Co	14,000			
Illinois	Sangamon Co	6,700			
Illinois	Tazewell Co	13,000	2,700		
Indiana	Floyd Co	12,000			
Indiana	Wayne Co	18,000	11,000	4,300	
Iowa	Linn Co	6,100			
Iowa	Muscatine Co	19,000	11,000	2,700	
Kentucky	Jefferson Co	14,000			
Missouri	Greene Co	4,000	500		
Missouri	Jackson Co	33,000	21,000	8,200	
Missouri	Jefferson Co	49,000	36,000	23,000	
Montana	Yellowstone Co	1,400			
Nebraska	Douglas Co	6,100			
New Mexico	San Juan Co	6,300			
New York	Erie Co	7,800	1,100		
New York	Madison Co	1,100			
North Carolina	New Hanover Co	53			
Ohio	Clark Co	4,700			
Ohio	Lake Co	4,100			
Ohio	Summit Co	22,000	13,000	4,900	
Pennsylvania	Northampton Co	6,600			
Pennsylvania	Warren Co	8,400	6,600	4,800	1,200
Tennessee	Blount Co	3,100			
Tennessee	Montgomery Co	20,000	14,000	8,600	

[a] All estimates rounded to two significant figures.

4.5 Key Limitations

The estimates of emission reductions associated with the control strategies described above are subject to important limitations and uncertainties. We summarize these limitations as follows:

- *Actual State Implementation Plans May Differ from our Simulation*: In order to reach attainment with the proposed NAAQS, each state will develop its own implementation plan implementing a combination of emissions controls that may differ from those simulated in this analysis. This analysis therefore represents an approximation of the emissions reductions that would be required to reach attainment and should not be treated as a precise estimate.

- *Current PM2.5 Controls in Baseline*: Our 2020 analysis year baseline assumes that States will put in place the necessary control strategies to attain the current $PM_{2.5}$ standards. As States develop their plans for attaining these standards, their SO_2 control strategies may differ significantly from our analysis.

- *Use of Existing CMAQ Model Runs*: This analysis represents a screening level analysis. We did not conduct new regional scale modeling specifically targets to SO_2; instead we relied upon impact ratios developed from model runs used in the analysis underlying the $PM_{2.5}$ NAAQS.

- *Analysis Year of 2020*: Data limitations necessitated the choice of an analysis year of 2020, as opposed to the presumptive implementation year of 2017. Emission inventory projections are available for 5-year increments; i.e. we have inventories for 2015 and 2020, but not 2017. In addition, the CMAQ model runs upon which we relied were also based on an analysis year of 2020.

- *Unidentified controls*: We have limited information on available controls for some of the monitor areas included in this analysis. For a number of small non-EGU and area sources, there is little or no information available on SO_2 controls.