Draft For FLM Review

STATE IMPLEMENTATION PLAN
FOR
REGIONAL HAZE

State of Maine
Department of Environmental Protection
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Introduction

1.1 What is Regional Haze?

Haze is a form of air pollution that impairs visibility over a wide region, and is a problem affecting many areas throughout the U.S., especially national parks and wilderness areas. Average visual range in many parks in the western U.S. is 100–150 kilometers, or about one-half to two-thirds of the visual range that would exist without manmade air pollution. In most of the eastern half of the U.S., the average visual range is less than 30 kilometers, or about one-fifth of the visual range that would exist under natural conditions. Surveys have shown that visitors to national parks and wilderness areas consistently rank visibility and clear scenic vistas as one of the most important aspects of their experience.

The particle pollution that causes haze also poses a threat to human health, and it can cover an area of several hundred miles. Hazy days of summer are a result of human activity formed by emissions from many sources in a wide geographic area. The emissions come from power plants, factories, and vehicles that combine with moisture in the air. Haze is not just a summertime problem, it can occur at any time of the year.

Air pollution, including particulates (soot) and related gases (sulfur dioxide and nitrogen dioxide) can scatter and absorb light, limiting the distance that one can see and obscuring color and clarity. Visibility can often be reduced over large regions, and is therefore called regional haze.

Visibility impairment can be quantified using three different, but mathematically related measures: light extinction per unit distance (e.g., Mm^{-1})[1]; visual range (i.e., how far one can see); and deciviews (dv), a useful metric for measuring increments of visibility change that are just perceptible to the human eye. Each can be estimated from the ambient concentrations of individual particle constituents, taking into account their unique light-scattering (or absorbing) properties and making appropriate adjustments for relative humidity. Assuming natural conditions, visibility in the Northeast and Mid-Atlantic is estimated to be about 23 Mm^{-1}, which corresponds to a visual range of about 106 miles or 8 dv. Under current polluted conditions in the region, average visibility ranges from 103 Mm^{-1} in the south to 55 Mm^{-1} in the north; these values correspond to a visual range of 24 to 44 miles or 23 to 17 dv, respectively. On the worst 20 percent of days, visibility impairment in Northeast and Mid-Atlantic Class I areas ranges from about 25 to 30 dv.

The principal pollutants that affect fine particle formation, and thus contribute to regional haze, are sulfur oxides (SO_X), organic carbon (OC), nitrogen oxides (NO_X), volatile organic compounds (VOC), ammonia (NH_3), and particles with an aerodynamic diameter less than or equal to 10 and 2.5 μm (i.e., primary PM_{10} and $PM_{2.5}$). In the eastern U.S.

[1] In units of inverse length. An inverse megameter (Mm^{-1}) is equal to one over one thousand kilometers.

ammonium sulfate, formed from sulfur oxides and ammonia, is responsible for more than 50 percent of regional visibility impairment, and most regional control efforts are directed at reducing emissions of sulfur oxides.

1.2 Clean Air Act Regional Haze Requirements

Regional haze and visibility were first addressed in amendments to the Clean Air Act in 1977, when Congress added Section 169 (42 U.S.C. 7491) establishing forth the following national visibility goal:

> "Congress hereby declares as a national goal the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory Class I Federal areas which impairment results from man-made air pollution."

The "Class I" designation was given to each of 158 areas in existence as of August 1977 that met the following criteria:

- all national parks greater than 6000 acres
- all national wilderness areas and national memorial parks greater than 5000 acres
- one international park

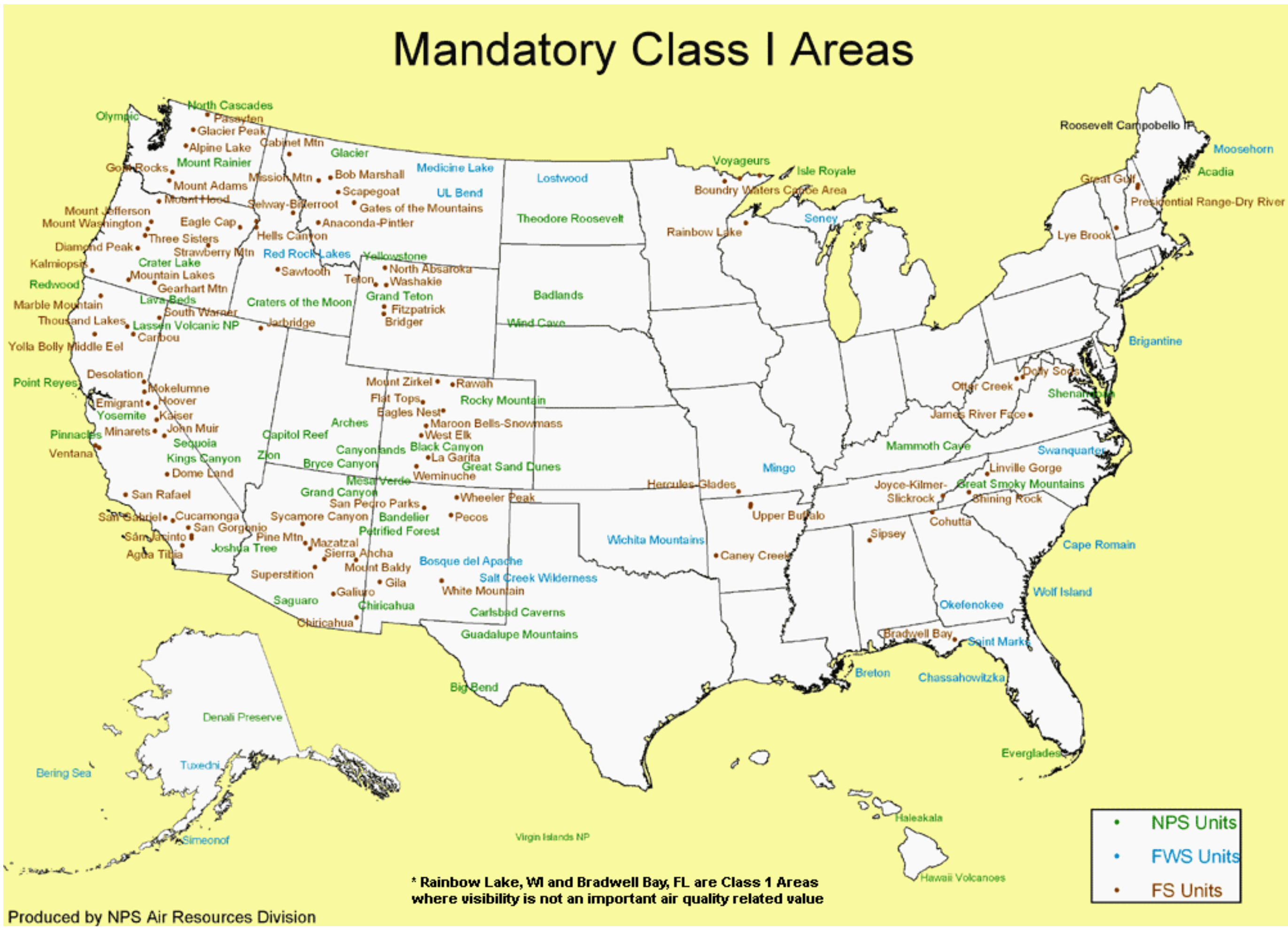
In 1980, Bradwell Bay, Florida, and Rainbow Lake, Wisconsin, were excluded for purposes of visibility protection as federal Class I areas. Figure 1-1 illustrates the 156 national park and wilderness areas that remain as Class I visibility protection areas.

Over the following years modest steps were taken to address the visibility problems in Class I areas. The control measures taken mainly addressed Plume Blight from specific pollution sources and did little to address regional haze issues in the Eastern United States.

When the CAA was amended in 1990, Congress added Section 169B (42 U.S.C. 7492), authorizing further research and regular assessments of the progress made so far. In 1993, the National Academy of Sciences concluded that "current scientific knowledge is adequate and control technologies are available for taking regulatory action to improve and protect visibility."

In addition to authorizing creation of visibility transport commissions and setting forth their duties, Section 169B(f) of the CAA mandated creation of the Grand Canyon Visibility Transport Commission (GCVTC) to make recommendations to EPA for the region affecting the visibility of the Grand Canyon National Park. The Grand Canyon Visibility Transport Commission (Commission) submitted its report to EPA in June 1996, following four years of research and policy development. The Commission report, as well as the many research reports prepared by the Commission, contributed invaluable information to EPA in its development of the federal regional haze rule.

Figure 1-1
Locations of Federally Protected Mandatory Class I Areas



1.3 The Federal Regional Haze Rule

The federal requirements that states must meet to achieve national visibility goals are contained in Title 40: Protection of Environment, Part 51 – Requirements for Preparation, Adoption, and Submittal Of Implementation Plans, Subpart P – Protection of Visibility (40 CFR 51.300-309)[2]. Known more simply as the Regional Haze Rule, these regulations were adopted on July 1, 1999, and went into effect on August 30, 1999. The rule seeks to address the combined visibility effects of various pollution sources over a

[2] The specific requirements for States' regional haze SIPs are set forth in 40 CFR 51.308, Regional Haze Program Requirements.

large geographic region, with the result that all states – even those without Class I areas – are required to participate in haze reduction efforts.

In consultation with the states and tribes, EPA designated five Regional Planning Organizations (RPO) to assist with the coordination and cooperation needed to address the haze issue. The Mid-Atlantic / Northeast states, including the District of Columbia, formed the Mid-Atlantic / Northeast Visibility Union (MANE-VU).[3]

EPA's Regional Haze Rule was the subject of considerable controversy, and was challenged on several legal grounds. On May 24, 2002 the U.S. Court of Appeals for the District of Columbia Circuit ruled on the challenge brought by the American Corn Growers Association against EPA's Regional Haze Rule of 1999. The Court remanded the BART provisions of the rule to EPA, and denied industry's challenge to the haze rule goals of natural visibility and no degradation requirements. On June 15, 2005, EPA finalized a rule addressing the Court's remand.

On February 18, 2005, the U.S. Court of Appeals for the District of Columbia Circuit issued another ruling vacating the Regional Haze Rule in part and sustaining it in part. For more information see *Center for Energy and Economic Development v. EPA*, no. 03-1222, (D.C. Cir. Feb. 18, 2005)("*CEED* v. EPA"). In this case, the court granted a petition challenging provisions of the Regional Haze Rule governing the optional emissions trading program for certain Western States and Tribes (the WRAP Annex Rule).

EPA's subsequent final rulemaking provided the following changes to the Regional Haze Regulations:

1. Revised the regulatory text in 40 CFR Section 51.308(e)(2)(i) in response to the *CEED* court's remand, to remove the requirement that the determination of BART "benchmark" be based on cumulative visibility analyses, and to clarify the process for making such determinations, including the application of BART presumptions for EGUs as contained in Attachment Y to 40 CFR 51.

2. Added new regulatory text in 40 CFR Section 51.308(e)(2)(vi), to provide minimum elements for cap and trade programs or alternative measures in lieu of BART.

3. Revised regulatory text in 40 CFR Section 51.309, to reconcile the optional framework for certain Western States and Tribes to implement the recommendations of the Grand Canyon Visibility Transport Commission (GCVTC) with the *CEED* decision.

3 A description of MANE-VU and a full list of its members is described in the Regional Planning Section of this SIP.

1.4 Regional Haze Planning After the Vacatur of CAIR

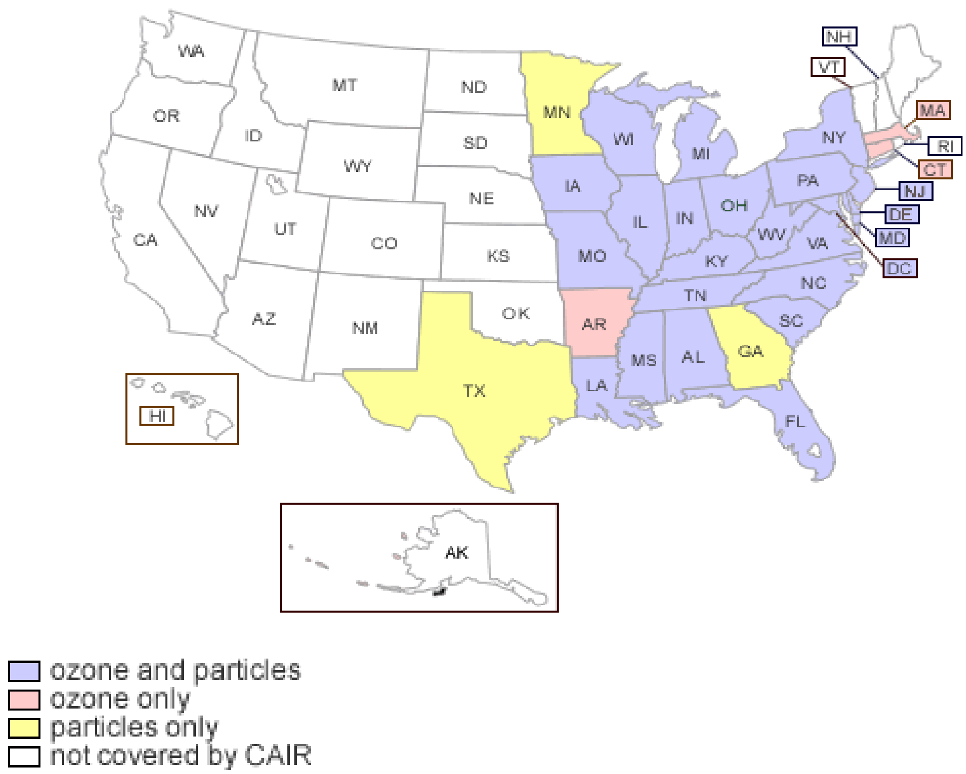
On March 10, 2005, EPA issued the Clean Air Interstate Rule (CAIR). This important federal rule was designed to achieve major permanent reductions in sulfur dioxide (SO_2) and nitrogen oxides (NO_x) emissions in the eastern United States through a cap-and-trade system using emission allowances. As promulgated, CAIR permanently caps emissions originating in 28 eastern states and the District of Columbia (Figure 1-2). Although Maine was not designated as a participating CAIR state, this program would greatly affect future air quality in the state.

According to EPA's CAIR website, SO_2 emissions in the affected states would be reduced by more than 70 percent from 2003 levels, and NO_x emissions by more than 60 percent from 2003 levels, upon full implementation of CAIR (See http://www.epa.gov/cair/). Resulting improvements in air quality would yield $85 to $100 billion in health benefits and nearly $2 billion in visibility benefits per year by 2015, and premature mortality would be substantially reduced across the eastern U.S.

This program came to an abrupt end, however, on July 11, 2008, when the U.S. Court of Appeals for the District of Columbia Circuit found that CAIR violated basic provisions of the Clean Air Act. The Court vacated CAIR in its entirety and remanded to EPA to promulgate a new rule consistent with the court's opinion. On September 24, 2008, EPA petitioned the D.C. Circuit for a rehearing or rehearing en banc on the vacatur of CAIR. Thereafter, the D.C. Circuit issued an order requesting briefs on the issue of whether any party is seeking vacatur of CAIR, and whether the court should stay its vacatur until EPA promulgates a revised rule. Maine, along with more than 20 other states, filed an amicus brief in support of staying the court decision vacating CAIR while EPA promulgates a revised rule that complies with the Court's decision. The states argued that because they "reasonably relied on CAIR in formulating long-term plans for improving air quality, in the short term, even a flawed rule is better than none at all."

The vacatur of CAIR presented a major difficulty for the individual states in attempting to comply with the Regional Haze Rule. Because CAIR formed the regulatory underpinnnings for most of the emission reductions that would produce visibility improvements in mandatory Class I areas, the probable demise of CAIR left a structural void around which states must build their regional haze SIPs. While all states have depended in varying degree on CAIR in the preparation of their Regional Haze SIPs, some Southeast states have relied almost entirely on CAIR to demonstrate compliance with the Regional Haze Rule. As a major ramification, the vacatur of CAIR invalidated EPA's decision that CAIR satisfies the requirements for Best Available Retrofit Technology (BART) for the affected sources. The vacatur of CAIR also called into question the validity of MANE-VU's and other RPO's emission inventories and air quality modeling studies already completed for the member state's regional haze SIPs.

Figure 1-2
States Covered by the Clean Air Interstate Rule



However, on December 23, 2008, the D.C. Circuit decided that "a remand without vacatur is appropriate in this case" because "notwithstanding the relative flaws of CAIR, allowing CAIR to remaining in effect until it is replaced by a rule consistent with our opinion would at least temporarily preserve the environmental values covered by CAIR." State of North Carolina v. EPA, No. 05-1244, slip op. at 3 (D.C. Cir. Dec. 23, 2008).

In light of this decision, Maine believes that future emissions and air quality levels will not be vastly different from the values predicted by MANE-VU's completed modeling, even though that modeling was based on implementation of CAIR and did not take into account the remand of CAIR to EPA. Consequently, the reasonable progress goals and long-term strategy developed for Maine's regional haze SIP still represent a defensible position from which to move forward with measures to improve visibility in Maine's Class I areas.

Further, Maine and the other MANE-VU states have maintained all along that the Regional Haze SIPs should look beyond the provisions of CAIR to identify additional emission control measures that could be effectively employed to mitigate regional haze. In this respect, Maine and the rest of MANE-VU stand apart form the other states in asserting that additional measures beyond CAIR are essential to meeting the established visibility goals at MANE-VU's Class I areas.

In describing Maine's present situation, it may be helpful to note that the remand of CAIR without vacatur is a complicating factor for the long-term, but does not present an impediment to making visibility progress in the near term. The salient points to consider are as follows:

- Because Maine is a non-CAIR state, CAIR does not directly affect any of Maine's proposed in-state visibility improvement control strategies.

- Maine will meet its "fair share" of emission reductions in comparison with other MANE-VU states and the original CAIR states, as Maine's long-term strategy demonstrates (See Section 12).

- Sources in upwind states release most of the pollutants contributing to visibility impairment at Maine's Class I areas. Therefore, Maine will continue to be dependent on mitigative actions by other states if visibility goals are to be achieved for these Class I areas.

- By the time the first regional haze SIP progress report, in 2013, the regulatory framework for the CAIR replacement should be clearer, and new modeling results should be available. It should then be possible to fine-tune regional haze plans to address any rule that EPA has promulgated to replace CAIR. Maine is committed to reviewing and updating its regional haze SIP as new information becomes available.

Given the D.C. Circuit's remand without vacatur of CAIR, Maine has chosen to retain appropriate references to CAIR in the completion of its Regional Haze SIP. We believe this will help to maintain continuity with the large body of completed work- much of it based on CAIR- that serves as the foundation for regional haze planning in the MANE-VU states.

1.5 Maine Class I Areas

Maine has three Class I areas: 1) Acadia National Park; 2) Moosehorn National Wildlife Refuge Wilderness Area; and 3) Roosevelt Campobello International Park (See Figure 1-3).

1.5.1 Acadia National Park

When Acadia National Park was designated in 1919, it was called Lafayette National Park and was the first national park designated east of the Mississippi River. Created with 6,000 acres of land, the park changed its name in 1929 and now encompasses about 40,000 acres of mixed ecology including Atlantic shoreline, mixed hardwood forests, spruce and fir forests, mountains, lakes and islands. Facilities at the park include 45 miles of carriage roads for walking and biking with 27 miles of scenic driving, plus 120 miles of hiking only trails, 2 campgrounds, a restaurant and 3 gift shops. Acadia averages 3 million visitors each year with the majority visiting during July and August (almost 700,000 visitors per month) and the fewest during December, January, and February (almost 38,000 visitors per month). Open year round, Acadia provides an abundance of recreational opportunities. The average park visitor stays at Acadia 1-4 days.

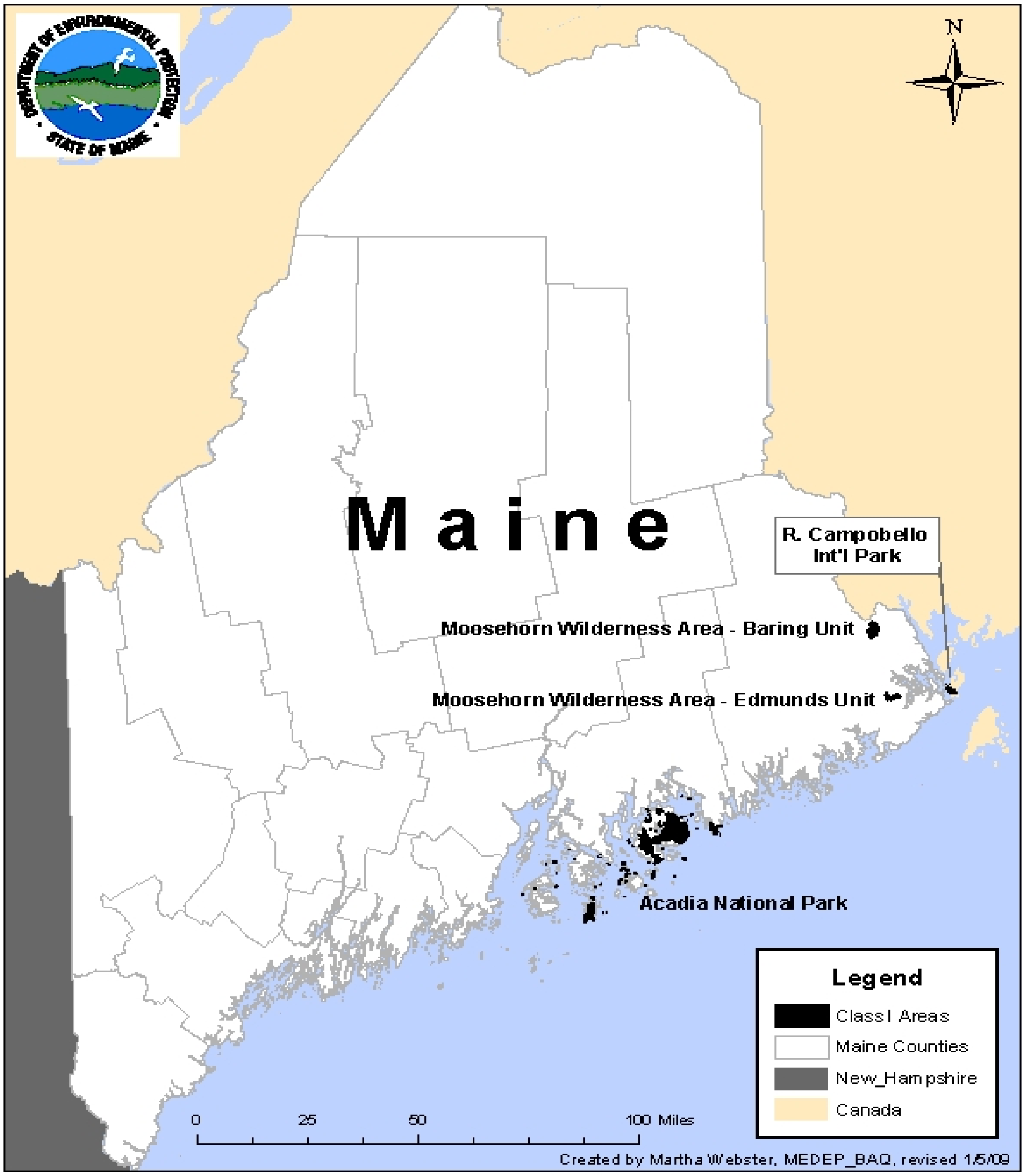
1.5.2 Moosehorn Wildernesss Area, Moosehorn National Wildlife Refuge

Moosehorn National Wildlife Refuge, which was officially established in 1937, is comprised of two units, the Baring Unit (17,200 acres) and the Edmunds Unit (7,200 acres). Within the refuge, a combined 7,460 acres of land (2780 acres from the Edmunds Unit and 4680 acres from the Baring Unit) are protected as a Class I wilderness area. The refuge includes rocky shores, rolling forested hills, lakes, bogs, and marshes that provide protected habitat and breeding grounds for migratory land and water birds. Moosehorn was the first migratory bird refuge to be established in what is now a chain of refuges extending south to Florida. It features American bald eagles, and the American woodcock among the more than 220 species of birds that have been spotted here. While birding is the primary attraction of Moosehorn Refuge, visitors also utilize over 50 miles of roads and trails for hiking, biking, cross country skiing, and snowmobiling. Non-motorized boats are also allowed access to streams and lakes in the refuge for fishing. In November, the refuge is open for white-tailed deer hunting. Education programs also draw visitors to the refuge, where wildlife biologists invite visitors to join them on bird banding operations.

1.5.3 Roosevelt Campobello International Park

Roosevelt Campobello International Park is the only international park in North America. The park is located on Campobello Island in Canada, but is of historical significance to the U.S. as the life-long summer home of President Franklin Delano Roosevelt. U.S. President Lyndon Johnson and Canadian Prime Minister Lester Pearson established the park on January 22, 1964 by international agreement. The park remains a symbol of neighborly relations between the U.S. and Canada, and of the importance of FDR's achievements to both nations. The Roosevelt Campobello International Commission manages the park. Commission members are appointed by the Governor General of the Council of Canada and by the U.S. President. The agreement splits equally all costs of development, operation, and management.
The park itself is a mixture of historic cottages and scenic natural landscapes. There are 8.4 miles of scenic roads in the park and 8 miles of walking paths. The grounds of the park include coastal headlands, rocky shores, beaches, wetlands, fields, forest, and the landscaped gardens of the cottages. The mix of habitat is excellent for a variety of migratory and shore birds. While the historic cottages are only open from Memorial Day to Columbus Day, the natural areas and visitor center are open year round.

Figure 1-3
Maine Class I Areas

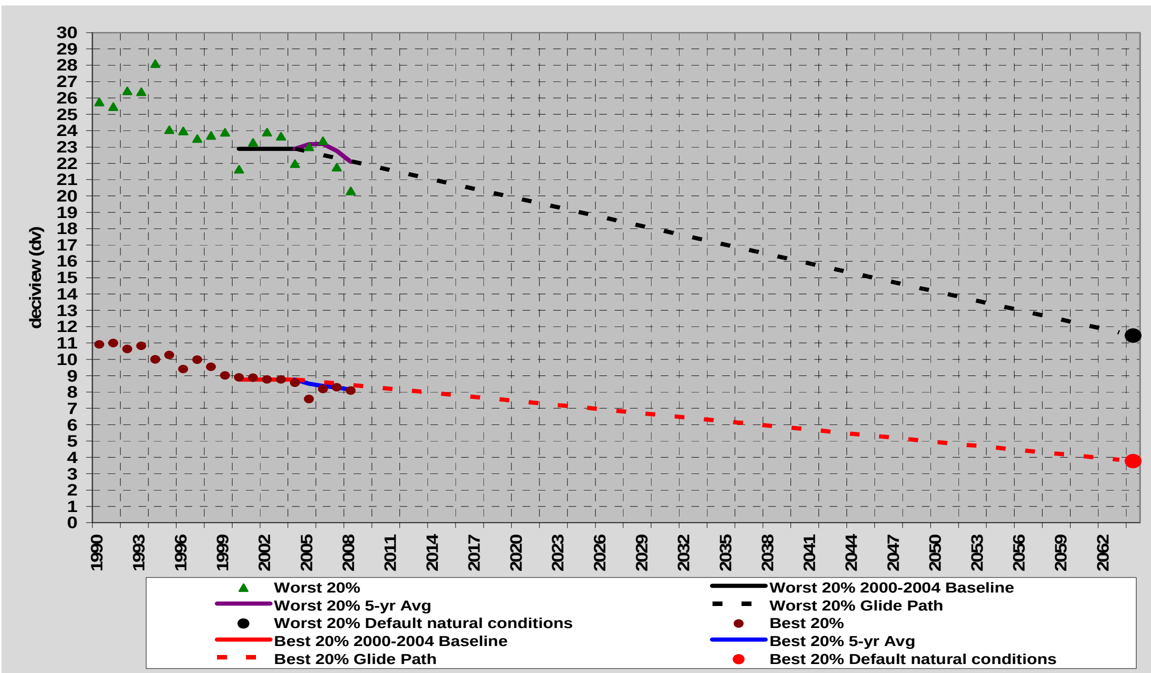


This unique historic, natural area attracts approximately 150,000 visitors annually, with most arriving in August. The National Park Service recommends visitors plan on 2 to 4 hours to view the cottages, and 8 or more hours for full appreciation of the natural areas. In addition to the historic setting, several recreational activities are permitted on the island. There are no admission fees for this park, although donations are accepted.

1.6 Visibility Trends at Maine Class I Areas

Figures 1-4 and 1-5 present recent visibility trends, baseline and natural conditions (in deciviews) at Acadia National Park, Moosehorn National Wildlife Refuge and Roosevelt Campobello International Park Class I areas for the 20 percent greatest and least impaired visibility days. The figures also illustrate the uniform rate of progress 'glide path' needed to reach natural background level goal established by the Clean Air Act. As of 2008, visibility conditions at all Class I areas in Maine are currently at or below the uniform rate of progress glide path.

Figure 1-4
Visibility Trends at Acadia National Park

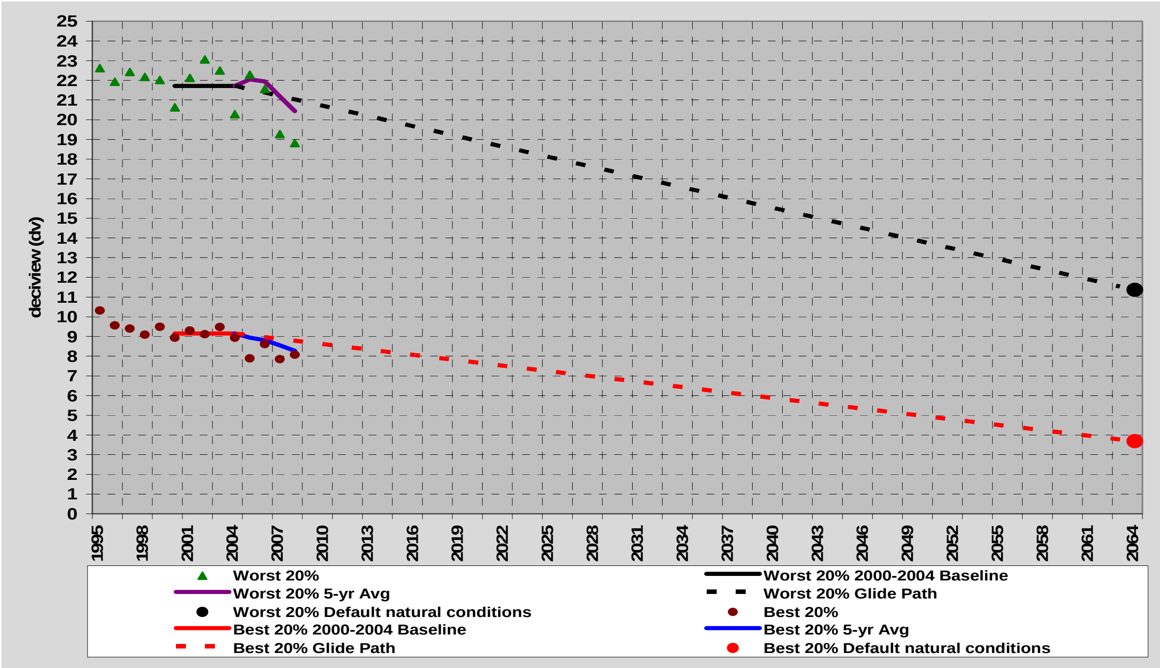


1.7 Sources of Regional Haze at Maine Class I Areas

In order to identify states where emissions are most likely to influence visibility in MANE-VU Class I areas, MANE-VU identified and evaluated the major contributors to regional haze at MANE-VU Class I areas as well as Class I areas in nearby regional planning organizations (RPOs). The MANE-VU findings are available in a report produced by the Northeast States for Coordinated Air Use Management (NESCAUM) entitled "Contributions to Regional Haze in the Northeast and Mid-Atlantic United States," August 2006, also known as the "Contribution Assessment" (Attachment A).

Based on that work, MANE-VU concluded that it was appropriate to define an area of influence including all of the states participating in MANE-VU, plus other states that contributed at least 2% of the modeled sulfate ion at MANE-VU Class I areas in 2002. Figures 1-6 and 1-7 illustrate modeled annual sulfate ion contribution at Acadia

Figure 1-5
Visibility Trends at Moosehorn National Wildlife Refuge and Roosevelt Campobello International Park[4]



National Park and Moosehorn National Wildlife Refuge in 2002 based on the use of REMSAD (Regional Modeling System for Aerosols and Deposition) modeling. The REMSAD modeling clearly shows that Maine Class I Areas are most influenced by emissions from the northern states and Canada[5].

Rather than relying solely on a grid-based source model, such as REMSAD, Maine utilized a variety of analytical and assessment tools to determine the sources of visibility impairment at Maine Class I areas, including Lagrangian (air parcel-based) source dispersion models, as well as a variety of data analysis techniques that include source apportionment models, back trajectory calculations, and the use of monitoring and inventory data. Using these techniques, the states in Table 1-1 were identified as causing or contributing two percent or more of the visibility impairment in Acadia National Park, Moosehorn National Wildlife Refuge, and Roosevelt Campobello International Park.

Additional information about procedures by which monitoring data and other information were used in determining the contribution of emissions from within these State to regional haze visibility impairment at MANE-VU Class I areas is included in Section 7 of the Maine State Implementation Plan for Regional Haze and in the MANE-VU Contribution Assessment in (Attachment A). Additional information on the sources of

[4] The Moosehorn National Wildlife Refuge IMPROVE monitor is also used for Roosevelt Campobello International Park.
[5] Note that the large "other" fraction of sulfates includes all sources outside the analysis domain, which includes some portions of the VISTAS and CENWRAP RPO, Northern and Western Canada, in addition to all other (e.g., intercontinental) sources of SO_2.

SO_2 emissions and why sulfur is the key pollutant targeted by MANE-VU and Maine is included in Section 8, Emissions Inventory.

Figure 1-6
Modeled Annual Sulfate Contribution at Acadia National Park in 2002 (percent contribution)

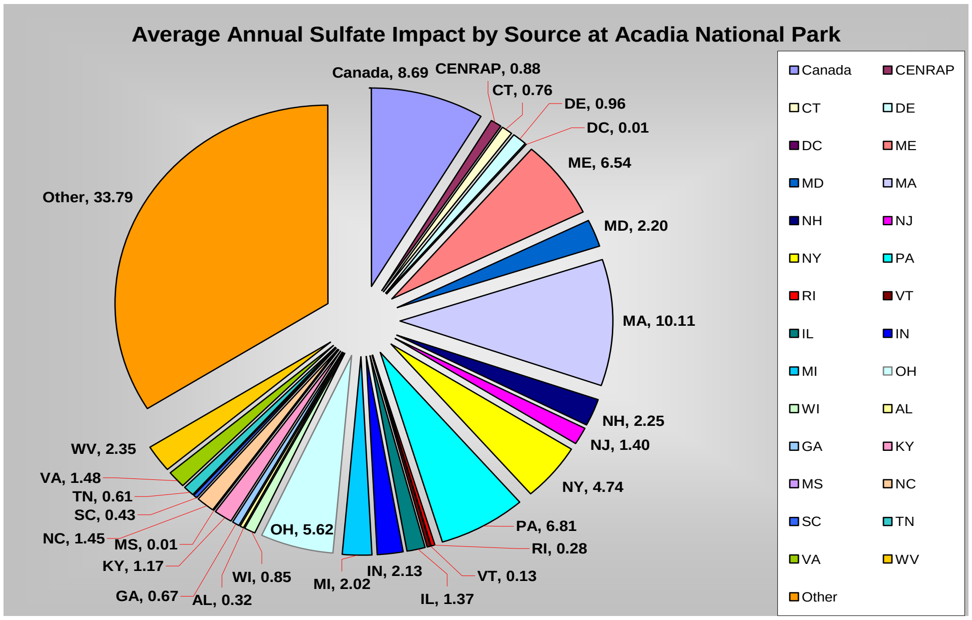
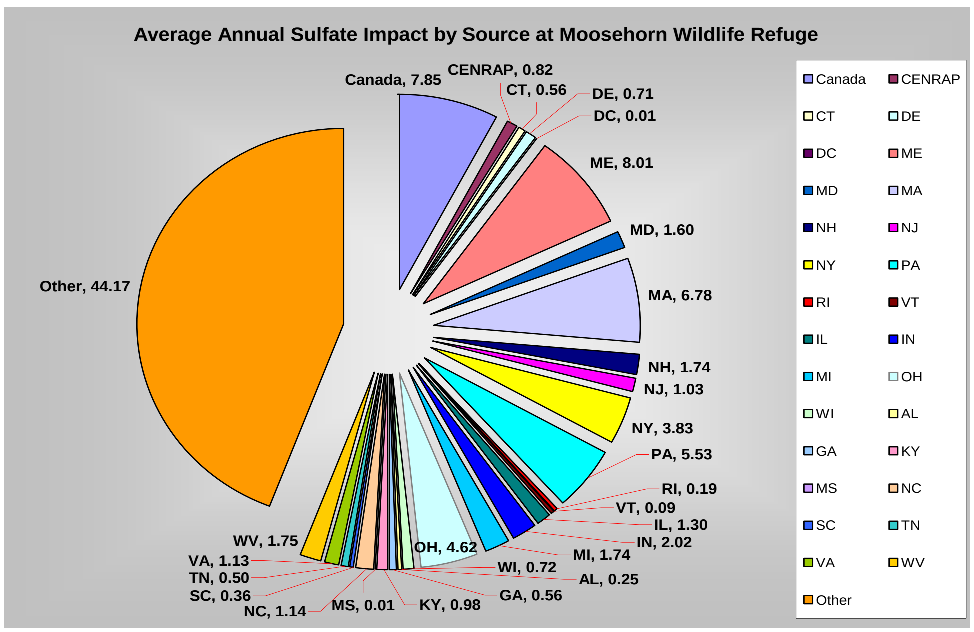


Figure 1-7
Modeled Annual Sulfate Contribution at Moosehorn National Wildlife Refuge and Roosevelt/Campobello International Park (percent contribution)



1.8 Class I Areas Affected

In accordance with 40 CFR Section 51.308(d)(4)(iii), emissions sources within the State of Maine affect Class I areas in Maine along with the Great Gulf and Presidential-Dry River Wilderness Areas in New Hampshire[6].

Table 1-1
States that Contribute to Visibility Impairment at Maine Class 1 Areas

State	Assessment Technique					
	MANE-VU Member	REMSAD	Q/D	Calpuff NWS	Calpuff MM5	% Time Upwind
Connecticut	X					
Delaware	X					
District of Columbia	X					
Georgia			X			
Illinois			X	X		X
Indiana		X	X	X	X	X
Kentucky			X	X	X	X
Maine	X	X		X		
Maryland	X	X	X			
Massachusetts	X	X	X	X	X	
Michigan		X	X	X	X	X
New Hampshire	X	X		X	X	
New Jersey	X					
New York	X	X	X	X	X	X
North Carolina			X		X	
Ohio		X	X	X	X	X
Pennsylvania	X	X	X	X		X
Rhode Island	X					
Tennessee					X	
Vermont	X					
Virginia					X	
West Virginia		X	X	X	X	X

[6] The modeled annual sulfate ion impact of Maine emissions at the Great Gulf and Presidential-Dry Wilderness Areas in New Hampshire is more than 2% of all modeled sulfate ion impacts.

2. General Planning Provisions and Commitment to Future Submittal

In accordance with 40 CFR Section 51.308(a) and (b), Maine is submitting this SIP to meet the requirements of EPA's Regional Haze Rule. This SIP addresses the core requirements of 40 CFR Section 51.308(d) and the Best Available Retrofit Technology (BART) components of 40 CFR Section 50.308(e). In addition, this SIP addresses requirements pertaining to regional planning, and state/tribe and Federal Land Manager (FLM) coordination and consultation.

40 CFR Section 51.308(f) requires the State of Maine to submit its SIP revision by July 31, 2018 and every ten years thereafter. Maine acknowledges and commits to this schedule.

40 CFR Section 51.308(g) requires Maine to submit a report to EPA every 5 years that evaluates progress toward the reasonable progress goal for each mandatory Class I area located within the state and each mandatory Class I area located outside the state that may be affected by emissions from within the state. Maine commits to submitting the first progress report, in the form of a SIP revision, no later than December 17, 2012.

Pursuant to 40 CFR Section 51.308(d)(4)(v), Maine also commits to making periodic updates to the emissions inventory (see Section 7), and will complete these updates to coincide with the progress reports.

Lastly, pursuant to 40 Section CFR 51.308(h), Maine will submit a determination of adequacy of its regional haze SIP revision whenever a progress report is submitted. Depending on the findings of its five-year review, Maine will take one or more of the following actions at that time, whichever actions are appropriate or necessary:

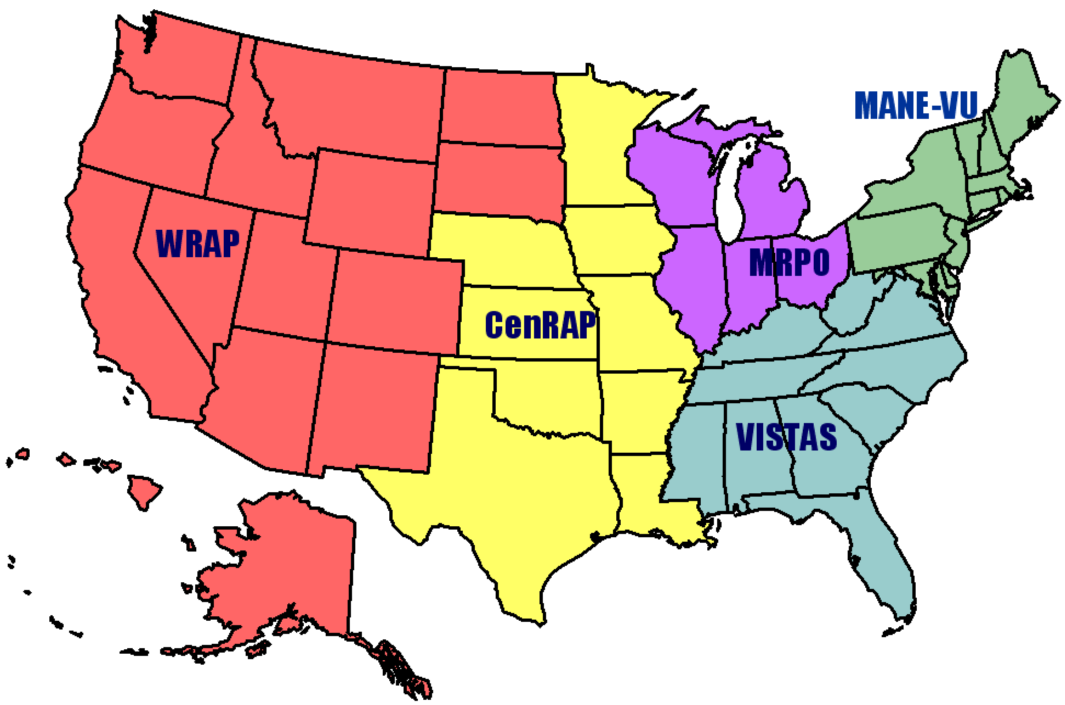
- If Maine determines that the existing State Implementation Plan requires no further substantive revision in order to achieve established goals for visibility improvement, it will provide to the EPA Administrator a negative declaration that further revision of the existing plan is not needed.
- If Maine determines that its implementation plan is, or may be, inadequate to ensure reasonable progress as a result of emissions from sources in one or more other state(s) which participated in the regional planning process, it will provide notification to the EPA Administrator and to those other state(s). Maine will also collaborate with the other state(s) through the regional planning process for the purpose of developing additional strategies to address any such deficiencies in its plan.
- If Maine determines that its implementation plan is, or may be, inadequate to ensure reasonable progress as a result of emissions from sources in another country, it will provide notification, along with available information, to the EPA Administrator.
- If Maine determines that the implementation plan is, or may be, inadequate to ensure reasonable progress as a result of emissions from sources within the State,

it will revise its implementation plan to address the plan's deficiencies within one year from this determination.

3. Regional Planning

In 1999, EPA and affected States/Tribes agreed to create five Regional Planning Organizations (RPOs) to facilitate interstate coordination on State Implementation Plans (SIPs) for regional haze. The RPOs and states/tribes within each RPO are required to consult on the development of emission management strategies directed towards visibility improvement in affected Class1 areas. Figure 3-1 illustrates the five RPOs—MANE-VU (Mid-Atlantic/Northeast Visibility Union), VISTAS (Visibility Improvement State and Tribal Association of the Southeast), MRPO (Midwest Regional Planning Organization), CenRAP (Central Regional Air Planning Association), and WRAP (Western Regional Air Partnership). As shown, Maine is part of MANE-VU.

Figure 3-1
EPA Designated Regional Planning Organizations (RPOs)



3.1 MANE-VU

MANE-VU's work is managed by the Ozone Transport Commission (OTC) and carried out by the OTC, the Mid-Atlantic Regional Air Management Association (MARAMA), and the Northeast States for Coordinated Air Quality Management (NESCAUM). The states, tribes and federal agencies comprising MANE-VU are listed in Table 3-1. Individuals from the states, tribes and federal agencies, along with the professional staff from OTC, MARAMA, and NESCAUM, make up the various committees and workgroups.

Table 3-1
MANE-VU Members

1. Connecticut	10. Pennsylvania
2. Delaware	11. Penobscot Nation
3. District of Columbia	12. Rhode Island
4. Maine	13. St. Regis Mohawk Tribe
5. Maryland	14. Vermont
6. Massachusetts	15. U.S. Environmental Protection Agency*
7. New Hampshire	16. U.S. National Park Service*
8. New Jersey	17. U.S. Fish and Wildlife Service*
9. New York	18. U.S. Forest Service*

*Non-voting members

MANE-VU established an active committee structure to address both technical and non-technical issues related to regional haze. The primary committees are:

- The Technical Support Committee (TSC), charged with assessing the nature and magnitude of the regional haze problem within MANE-VU, interpreting the results of technical work, and reporting on such work to the MANE-VU Board; and

- The Communications Committee, charged with developing approaches to inform the public about the regional haze problem in the region and making any recommendations to the MANE-VU Board to facilitate that goal.

In addition to the formal working committees, there are also three standing working groups of the TSC. They are broken down by topic area: Emissions Inventory, Modeling, and Monitoring/Data Analysis Workgroups.

MANE-VU also established a Policy Advisory Group (PAG), which met on an as-needed basis to provide advice to decision-makers on policy questions. Ultimately, decisions are made by the MANE-VU Board.

3.2 Regional Consultation

On May 10, 2006, MANE-VU adopted the "Inter-RPO State/Tribal and FLM Consultation Framework" (Attachment B). The Inter-RPO State/Tribal and FLM Consultation Framework established the principles presented in Figure 3-2, which were applied to the consultation and SIP development process by the MANE-VU states and tribes. The MANE-VU consultations addressed (among others) regional haze baseline determinations, natural background levels, and the development of reasonable progress goals, all of which are discussed at length in later sections of this SIP.

Figure 3-2
Summary of MANE-VU Principles for Regional Haze Planning

1) All State, Tribal, RPO, and Federal participants are committed to continuing dialogue and information sharing in order to create understanding of the respective concerns and needs of the parties.
2) Continuous documentation of all communications is necessary to develop a record for inclusion in the SIP submittal to EPA.
3) States alone have the authority to undertake specific measures under their SIP. This inter-RPO framework is designed solely to facilitate needed communication, coordination and cooperation among jurisdictions but does not establish binding obligation on the part of participating agencies.
4) There are two areas which require State-to-State and/or State-to-Tribal consultations ("formal" consultations): (i) development of the reasonable progress goal for a Class I area, and (ii) development of long-term strategies. While it is anticipated that the formal consultation will cover the technical components that make up each of these policy decision areas, there may be a need for the RPOs, in coordination with their State and Tribal members, to have informal consultations on these technical considerations.
5) During both the formal and informal inter-RPO consultations, it is anticipated that the States and Tribes will work collectively to facilitate the consultation process through their respective RPOs, when feasible.
6) Technical analyses will be transparent, when possible, and will reflect the most up-to-date information and best scientific methods for the decision needed within the resources available.
7) The State with the Class I area retains the responsibility to establish reasonable progress goals. The RPOs will make reasonable efforts to facilitate the development of a consensus between the State with a Class I area and other States affecting that area. In instances where the State with the Class I area can not agree with such other States that the goal provides for reasonable progress, actions taken to resolve the disagreement must be included in the State's regional haze implementation plan (or plan revisions) submitted to the EPA Administrator as required under 40 CFR §51.308(d)(1)(iv).
8) All States whose emissions are reasonably anticipated to contribute to visibility impairment in a Class I area, must provide the Federal Land Manager ("FLM") agency for that Class I area with an opportunity for consultation, in person, on their regional haze implementation plans. The States/Tribes will pursue the development of a memorandum of understanding to expedite the submission and consideration of the FLM's comments on the reasonable progress goals and related implementation plans. As required under 40 CFR §51.308(i)(3), the plan or plan revision must include a description of how the State addressed any FLM comments.
9) States/Tribes will consult with the affected FLMs to protect the air resources of the State/Tribe and Class I areas in accordance with the FLM coordination requirements specified in 40 CFR §51.308(i) and other consultation procedures developed by consensus..
10) The consultation process is designed to share information, define and document issues, develop a range of options, solicit feedback on options, develop consensus advice if possible, and facilitate informed decisions by the Class I States.
11) The collaborators, including States, Tribes and affected FLMs, will promptly respond to other RPO's/States'/Tribes' requests for comments.

The following points highlight several of the many ways MANE-VU member states and tribes have cooperatively addressed regional haze.

- **Budget Prioritization:** MANE-VU developed a process to coordinate MARAMA, OTC and NESCAUM staff in developing budget priorities, project rankings, and federal grant requests.
- **Issue Coordination:** MANE-VU establishes a conference call and meeting schedule for each of its committees and workgroups. In addition, the MANE-VU Directors regularly discuss pertinent issues.
- **SIP Policy and Planning:** MANE-VU states/tribes collaborated on the development of a SIP Template and the technical aspects of the SIP development process.
- **Capacity Building:** To educate its staff and members, MANE-VU included technical presentations on conference calls and organized workshops with nationally recognized experts. Presentations on data analysis, BART work, inventory topics, modeling, control measures etc. were an effective education, and coordination tool.
- **Routine Operations:** MANE-VU staff at OTC, MARAMA, and NESCAUM established a coordinated approach to: budget, grant deliverables/due-dates, workgroup meetings, inter-RPO feedback, etc.

40 CFR Section 51.308(d)(3)(i) requires the State of Maine to consult with other States/Tribes to develop coordinated emission management strategies. This requirement applies both where emissions from the State/Tribe are reasonably anticipated to contribute to visibility impairment in Class I areas outside the State/Tribe, and when emissions from other States/Tribes are reasonably anticipated to contribute to visibility impairment in Class I areas within the State/Tribe.

Maine consulted with other states and tribes by participation in the MANE-VU and inter-RPO processes that developed technical information necessary for development of coordinated strategies. Strategy development considered the impacts of the state and tribe's emissions on Class I areas within and outside the state or tribe and culminated in the adoption by MANE-VU on June 20, 2007 of the "Statement of the Mid-Atlantic/Northeast Visibility Union (MANE-VU) Concerning a Request for a Course of Action by States Within MANE-VU Toward Assuring Reasonable Progress."

The consultations between the MANE-VU states and other states/tribes and provinces occurred throughout much of 2007. Documentation of consultation meetings and calls is summarized below, in Figure 3-3, with further documentation provided in Attachment C.

Figure 3-3
Summary of Consultations

- MANE-VU Intra-Regional Consultation meeting, March 1, 2007
  - At this meeting, MANE-VU members reviewed the requirements for regional haze plans, preliminary modeling results, the work being done to prepare the MANE-VU report on reasonable progress factors, and control strategy options under review.
- MANE-VU Intra-State Consultation meeting, June 7, 2007
  - At this meeting the MANE-VU Class I states adopted a statement of principles, and all MANE-VU members discussed draft statements concerning reasonable controls within and outside of MANE-VU. Federal Land Managers also attended the meeting, which was open to stakeholders.
- MANE-VU Conference Call, June 20, 2007
  - On this call, the MANE-VU states concluded discussions of statements concerning reasonable controls within and outside MANE-VU and agreed on the statements called the MANE-VU "Ask," including a statement concerning controls within MANE-VU, a statement concerning controls outside MANE-VU, and a statement requesting a course of action by the U.S. EPA. Federal Land Managers also participated in the call. Upon approval, all statements as well as the statement of principles adopted on June 7 were posted and publicly available on the MANE-VU web site. The MANE-VU "Ask" was determined to represent Maine's needs for meeting Regional Haze rule requirements and was thus adopted as the Maine Regional Haze "Ask".
- MANE-VU Class I States' Consultation Open Technical Call, July 19, 2007
  - On this call, the MANE-VU / Maine "Ask" was presented to states in other RPOs, RPO staff, and Federal Land Managers, and an opportunity was provided to request further information. This call was intended to provide information to facilitate informed discussion at follow-up meetings.
- MANE-VU Consultation Meeting with MRPO, August 6, 2007
  - This meeting was held at LADCO offices in Chicago, Illinois and was attended by representatives of both MANE-VU and MRPO states as well as staff. The meeting provided an opportunity to formally present the MANE-VU / Maine "Ask" to MRPO states and to consult with them regarding the reasonableness of the requested controls. Federal Land Manager agencies also attended the meeting.
- MANE-VU Consultation Meeting with VISTAS, August 20, 2007
  - This meeting was held at State of Georgia offices in Atlanta and was attended by representatives of both MANE-VU and VISTAS states as well as staff. The meeting provided an opportunity to formally present the MANE-VU / Maine "Ask" to VISTAS states and to consult with them regarding the reasonableness of the requested controls. Federal Land Manager agencies also attended the meeting.
- MANE-VU – Midwest RPO Consultation Conference Call, September 13, 2007
  - This call was a follow-up to the meeting held on August 6 in Chicago and provided an opportunity to further clarify what was being asked of the MRPO states. The flexibility in the "Ask" was explained. Both MRPO and MANE-VU staff agreed to work together to facilitate discussion of further controls on ICI boilers and EGUs.
- MANE-VU Air Directors' Consultation Conference Call, September 26, 2007
  - This call allowed MANE-VU members to clarify their understanding of the "Ask" and to provide direction to modeling staff as to how to interpret the "Ask" for purposes of estimating visibility impacts of the requested controls.

3.3 Maine-Specific Consultation

On February 26, 2007, Maine sent letters formally requesting consultation under the Regional Haze Rule to each state shown through modeling to contribute to at least 2 percent of the sulfates to the Class I Areas in Maine and/or states located within MANE-VU (See Table 3-2). As a matter of procedure, every member state (plus the District of Columbia) of MANE-VU was requested to consult with Maine. Additional states from outside of MANE-VU were also requested to join our consultation, based on the results of the MANE-VU Contribution Assessment (Attachment A).

Table 3-2
States Contributing to Visibility Impairment at Class I Areas in Maine
(By Regional Planning Organization)

MANE-VU	VISTAS	MRPO
Connecticut	Georgia	Illinois
Delaware	Kentucky	Indiana
District of Columbia	North Carolina	Michigan
Maine	Tennessee	Ohio
Maryland	Virginia	
Massachusetts	West Virginia	
New Jersey		
New York		
Pennsylvania		
Rhode Island		
Vermont		

Formal inter-regional consultation meetings took place on August 6, 2007 in Rosemont, Illinois (for Midwestern states) and on August 20, 2007 in Atlanta (for Southern states). Consultation continues with the Midwestern states, seeking common approaches for reducing power plant emissions beyond the levels defined under the federal Clean Air Interstate Rule (CAIR), controls on industrial boilers, and cleaner burning fuels for mobile sources. While this consultation was mostly focused on the health benefits of reducing ozone and small particles, the measures would also result in visibility improvements.

3.4 The MANE-VU "Ask"

In addition to having a set of guiding principles for consultation (as described in Figure 3-2, above), MANE-VU needed a consistent technical basis for emission control strategies to combat regional haze. After much research and analysis, on June 20, 2007, MANE-VU adopted a set of documents (See Attachment D), which provide the technical basis for consultation among the interested parties and define the basic strategies for controlling pollutants that cause visibility impairment at Class I areas in the eastern United States:

- "Statement of the Mid-Atlantic / Northeast Visibility Union (MANE-VU) Concerning a Course of Action within MANE-VU toward Assuring Reasonable Progress"
- "Statement of the Mid-Atlantic / Northeast Visibility Union (MANE-VU) Concerning a Request for a Course of Action by States outside of MANE-VU toward Assuring Reasonable Progress"
- "Statement of the Mid-Atlantic / Northeast Visibility Union (MANE-VU) Concerning a Request for a Course of Action by the U.S. Environmental Protection Agency (EPA) Towards Assuring Reasonable Progress"

Together, these documents are known as the MANE-VU "Ask." Maine believes that these documents outline reasonable strategies for visibility improvement as required by the Clean Air Act, and fully supports the language and substance of these documents. The MANE-VU "Ask" is therefore the Maine "Ask". The particular emission management strategies that comprise the Ask are described, in detail, below.

3.5 Meeting the "Ask" – MANE-VU States

The member states of MANE-VU stated their intention to meet the terms of the "Ask" in their SIPs. Maine conditionally supports the SIPs of each of its fellow MANE-VU members, with this support contingent upon the adoption and implementation of regional haze emission control measures and programs satisfying the MANE-VU "Ask". The Ask for member states calls for each state to pursue the adoption and implementation of the following "emission management" strategies, as appropriate and necessary:

- **Timely implementation of BART requirements** in accordance with 40 CFR 51.308(e);

- **A low sulfur fuel oil strategy in the inner zone states** (New Jersey, New York, Delaware and Pennsylvania, or portions thereof) to reduce the sulfur content of: distillate oil to 0.05% sulfur by weight (500 ppm) by no later than 2012, of #4 residual oil to 0.25% sulfur by weight by no later than 2012, of #6 residual oil to 0.3 – 0.5% sulfur by weight by no later than 2012, and to further reduce the sulfur content of distillate oil to 15 ppm by 2016;

- **A low sulfur fuel oil strategy in the outer zone states** (the remainder of the MANE-VU region) to reduce the sulfur content of distillate oil to 0.05% sulfur by weight (500 ppm) by no later than 2014, of #4 residual oil to 0.25 – 0.5% sulfur by weight by no later than 2018, and of #6 residual oil to no greater than 0.5 % sulfur by weight by no later than 2018, and to further reduce the sulfur content of distillate oil to 15 ppm by 2018, depending on supply availability;

- **A targeted EGU strategy** for each of the top 100 electric generating unit (EGU) emission points or stacks, identified by MANE-VU as contributing to visibility impairment at each mandatory Class I area in the MANE-VU region. (The combined list for all seven MANE-VU Class I Areas contains 167 distinct emission points. Consequently, this strategy is sometimes referred to as the 167-stack strategy.) The targeted EGU strategy calls for a ninety-percent or greater reduction in sulfur dioxide (SO_2) emissions from all identified units. If it is infeasible to achieve that level of reduction from specific units, equivalent alternative measures will be pursued in such state[7]; and

- **Continued evaluation of other control measures,** including energy efficiency, alternative clean fuels, and other measures to reduce SO_2 and nitrogen oxide (NOx) emissions from all coal-burning facilities by 2018 and new source performance standards for wood combustion. These measures and other measures identified will be evaluated during the consultation process to determine if they are reasonable and cost-effective.

3.6 Meeting the "Ask" – Maine

Maine, being a MANE-VU member state, adopted the "Statement of the Mid-Atlantic/Northeast Visibility Union (MANE-VU) Concerning a Course of Action Within MANE-VU Toward Assuring Reasonable Progress" at the MANE-VU Board Meeting on June 7, 2007. Maine intends to meet the terms of this agreement by controlling its BART eligible sources with timely control strategies as well as adopting the low sulfur limits for "outer zone" MANE-VU states and targeted EGU strategies in the near future.

Maine has already obtained statutory authority to modify the sulfur in fuel limits in accordance with the MANE-VU Ask. The 124th Second Regular Session of the Maine Legislature (2010) adopted LD 1662, "An Act To Improve Maine's Air Quality and Reduce Regional Haze at Acadia National Park and Other Federally Designated Class I Areas," which implements the MANE-VU low sulfur fuel strategy in Maine. This legislation establishes a statewide sulfur limit for distillate fuels of 50 ppm in 2016, and 15 ppm in 2018. For residual (#6) fuel oil, the statewide sulfur limit will be reduced to 0.5% in 2018.

Maine has one oil-fired EGU (Wyman Station Unit #4) that is on the list of top 100 contributing EGUs, and this unit will use lower-sulfur fuel oil to comply with BART requirements by 2013. At this point in time, Maine does not believe that SO_2 emissions from this unit can be cost-effectively controlled at the 90-percent level of the Ask through add-on controls such as flue gas desulfurization because of the very low capacity factor[8]. In lieu of add-on controls for this unit, Maine will be requiring the use of 0.5 percent low-sulfur fuel oil providing an 84 percent reduction from baseline SO_2 emissions[9]. For more details, refer to Section 12.0, Long Term Strategy.

[7] For additional information on the targeted EGU strategy, see section 10.4.3, and Attachment W.
[8] The capacity factor for this unit averaged 11.35% during the period 2000-2007.
[9] Baseline (uncontrolled) sulfur concentrations for #6 fuel are assumed to be 3,000 ppm, or 3.0%.

3.7 Meeting the "Ask" – States Outside of MANE-VU

For consulting states outside the MANE-VU region, Maine agrees with the MANE-VU "Ask" requesting pursuit of the adoption and implementation of the following control strategies, as appropriate and necessary:

- **Timely implementation of BART requirements**, as described for the MANE-VU states;

- **A targeted EGU strateg**y, as described for the MANE-VU states, for the top 167 EGU stacks contributing the most to visibility impairment at mandatory Class 1 areas in the MANE-VU region, or an equivalent SO_2 emission reduction within each state[10];

- **Installation of reasonable control measures** on non-EGU sources by 2018 to achieve an additional 28% reduction in non-EGU SO_2 emissions beyond current on-the-books/on-the-way (OTB/OTW) measures, resulting in an emission reduction that is equivalent to that from MANE-V's low-sulfur fuel oil strategy; and

- **Continued evaluation of other measures** including measures to reduce SO_2 and nitrogen oxide (NOx) emissions from all coal-burning facilities by 2018 and promulgation of new source performance standards for wood combustion. These measures and other measures identified will be evaluated during the consultation process to determine if they are reasonable.

Maine looks for each consulting states to specifically address their responses to each element of the Maine/MANE-VU "Ask" in their Regional Haze SIPs.

Maine is concerned that non-MANE-VU states may not be inclined to easily adopt our "Ask" due to associated costs, conflicts, and relative lack of benefit within their jurisdictions. During consultations, MANE-VU members thought that some non-MANE-VU states were not going to pursue reductions beyond CAIR controls and BART.

There are some positive exceptions, however. Many states of the MRPO are working with MANE-VU states to investigate the potential for widespread low sulfur fuel use and controls on industrial boilers. Unfortunately, the low sulfur oil strategy does not lend itself very well to wide-spread application within the VISTAS states because they do not have the same degree of oil use and inventory infrastructure. States of both regions claim

[10] While many of the 167 identified stacks will be controlled under the Clean Air Interstate Rule (CAIR), cap and trade programs such as CAIR cannot, as currently formulated, ensure that specific stacks or contributing states will adequately reduce their emission contribution (as discussed in the July 11, 2008 U.S. Court of Appeals for the District of Columbia Circuit decision on CAIR). The MANE-VU strategy is designed to provide a guarantee that those units having the greatest impact on visibility in the MANE-VU region will be adequately controlled. It should also be noted that the MANE-VU strategy also includes stacks located in non-CAIR states (e.g., Wyman Station in Yarmouth, Maine).

that a substantial portion of the top 167 contributing EGU stacks will be controlled. However, instead of taking concrete actions on uncontrolled or under-controlled facilities, many of these states appear to be satisfied with meeting CAIR requirements and not looking beyond CAIR for additional emission reductions.

3.8 Meeting the "Ask" - EPA

Although the CAIR rule will result in substantial reductions in sulfur dioxide emissions from power plants in the Eastern United States, power plants will remain a significant source of visibility impairing pollutants in Maine and other MANE-VU Class I states. Maine supports the "Statement of the Mid-Atlantic / Northeast Visibility Union (MANE-VU) Concerning a Request for a Course of Action by the U.S. Environmental Protection Agency (EPA) Towards Assuring Reasonable Progress," which requests that EPA work with the eastern RPOs to develop a proposal for tightening the CAIR program to achieve an additional 18% reduction in SO_2 by no later than 2018. "

3.9 Technical Ramifications of Differing Approaches

MANE-VU states intended to develop a modeling platform that was common in terms of meteorology and emissions with each of the other nearby RPOs. The RPOs worked hard to form a common set of emissions with similar developmental assumptions. Even with the best of intentions, it became difficult to keep up with each RPO's updates and corrections. Each rendition of emissions inventory improved its quality, but because when even a single update was made to one RPO's emissions, each of the other RPOs then needed to adopt the updates. With each rendition, the revised emissions had to be re-blended with the full set of emission files for all associated RPOs in the modeling domain.

The RPOs also took differing perspectives on which version of the EGU dispatching model (IPM) to use. At the beginning of the process, Integrated Planning Model (IPM) version 2.1.9 was available, and EPA agreed to its use for emissions preparation. IPM version 3.0 subsequently became available and became EPA's preferred version because of its updated fuel costs. MRPO adopted IPM v3.0 for its use, but VISTAS stayed with IPM v2.1.9. Rather than develop non-comparative datasets for its previous IPM analyses, MANE-VU opted to also remain with IPM v2.1.9. Therefore, for each of the three eastern RPOs, differing emissions assumptions eventually worked their way into the final set of modeling assumptions.

MANE-VU's final modeling takes into account on-the-books/on-the-way (OTB/OTW) emissions programs for 2018, and goes further by also including additional reasonable controls in its region, as developed through the Maine/MANE-VU "Ask". It should be noted that other RPOs may not have included such measures in their final modeling and as a result may have been able to complete their analyses ahead of the MANE-VU member states. In these instances, there will be an inconsistency in that these states will not have adequately addressed our "Ask" in their SIPs.

3.10 Consultation Issues

40 CFR Section 51.308(d)(1)(iv) describes another consultation requirement for Class I States only. If a contributing State does not agree with a Class I State on its reasonable progress goal, the Class I State must describe in its SIP submittal the actions taken to resolve the disagreement.

While states without Class I areas are required to consult at the request of states with Class I areas, the Regional Haze Rule does not actually require that the states agree on a common course of action. Instead, if agreement cannot be reached, the disagreement needs to be described in each state's SIP along with a description of the actions taken to resolve the disagreement. As expected, most states willingly consulted with Maine and took Maine's regional haze "Ask" under serious consideration. In fact, all of the MANE-VU states worked together to strategize on how to develop a common approach to meeting the "Ask". All states involved in these discussions found that working together helped them to develop plans that would produce region-wide haze and health benefits. Lowering ambient $PM_{2.5}$ concentrations helped all the MANE-VU states meet the NAAQS as well as having direct benefits to public health and welfare.

Some states in the MRPO and VISTAS regions had interpretations of the requirements for BART and for establishing reasonable progress goals which differed from those in the MANE-VU states. Some states claimed that CAIR alone set the standard for reasonableness. By this rationale, any measure more expensive than CAIR (on a cost-per-ton basis) would not be reasonable. A uniform rate of progress was all that some states felt was required; and if that set of conditions could be met with CAIR, then no other measures need be considered. Maine is also concerned that some states may have performed modeling for the establishment of reasonable progress goals without including the effects of a rigorous BART determination for BART-eligible sources. It is apparent that the various regions of the country have differing interpretations of how the Regional Haze Rule should be applied.

In a letter to MANE-VU dated April 25, 2008 (Attachment E), VISTAS indicates that most actions beyond CAIR by states within this region would not be reasonable. MANE-VU takes a more rigorous position with respect to additional control measures – including the belief that controls on ICI boilers and use of low-sulfur fuels are reasonable measures and that it is not reasonable to assume reductions from EGUs for planning purposes unless they are explicitly incorporated into State Implementation Plan. More specifically, MANE-VU believes that a sector-wide average of 50 percent control on coal-fired boilers and 75 percent control on oil-fired boilers are reasonable targets that can be achieved cost-effectively. MANE-VU also believes that low sulfur fuels – even though they are less widely available in the Southeast U.S. than in the Northeast – still represent a reasonable control measure in light of the widespread requirement for use of such fuels throughout the MANE-VU region. The reasonableness of these additional controls is examined more fully in Section 11.0, Reasonable Progress Goals.

West Virginia expressed concern that while MANE-VU included a 28 percent reduction from the non-EGU sector, they (West Virginia) did not have any measures to meet this additional reduction requirement. West Virginia also indicated that the implementation of CAIR would provide significant emission reductions above and beyond those modeled by MANE-VU, and that these reductions should be creditable toward the 28 percent non-EGU sector "Ask". Maine believes that these additional EGU emission reductions should be creditable towards meeting the non-EGU emission reductions measure included in the MANE-VU "Ask," as long as they are not offset by additional increases in EGU emissions under the CAIR or other cap and trade program.

During the consultation process, disagreements were worked through as best as possible and are summarized below:

Issue: BART analyses and projected controls were not fully incorporated in the VISTAS emissions inventory provided to MANE-VU. VISTAS stated they would further review BART applicable controls.

> **Resolution:** In MANE-VU's modeling to determine reasonable progress goals, MANE-VU made no adjustments to controls in the VISTAS region to reflect application of BART beyond the information that VISTAS provided .

Issue: The low sulfur oil strategy adopted by MANE-VU elicited concerns from MRPO and VISTAS as being unreasonable because of the limited availability of low-sulfur fuel oil and the historically lower usage of this fuel within their regions.

> **Resolution:** MANE-VU agreed to modify the "Ask" to reflect a greater degree of flexibility and provide for alternative measures that would produce a comparable rate of emission reductions. Accordingly, the "Ask" for non-MANE-VU states was modified to provide for an overall 28 percent reduction in SO_2 emissions, wherever they were found to be reasonable. In MANE-VU's modeling to determine reasonable progress goals, SO_2 emissions from non-EGU sources in non-MANE-VU contributing states were reduced by this same amount.

Issue: MANE-VU received no response from other RPOs concerning non-EGU control measures that they considered reasonable.

> **Resolution:** As a default position, MANE-VU's modeling included emission adjustments for those regions based on MANE-VU's own analysis of which non-EGU control measures were reasonable (See Section 11, Reasonable Progress Goals).

Issue: The targeted EGU strategy was thought by some non-MANE-VU states to be too restrictive and too difficult to achieve. MANE-VU recognized that a 100 percent compliance with this portion of the "Ask" was unlikely to occur because the CAIR trading market would probably dominate. However, MANE-VU had hoped that non-MANE-VU states would make a more concerted effort toward meeting this request. MANE-VU did receive a partial list of facilities that were expected to comply.

Resolution: For the top contributing EGU stacks located within the MANE-VU, MRPO, and VISTAAS regions, expected emission reductions resulting from the "Ask" were distributed among facilities on the basis of recommendations received during inter- and intra-regional consultations. To maintain the CAIR emissions budget as predicted by the modeling, excess emission reductions (also predicted by the modeling) were uniformly added back to EGUs in all three regions.

While CAIR is the primary determinant of which EGUs among the top 167 stacks are to be fitted with emission controls, at the same time, MANE-VU recognized that these units are the primary sources affecting visibility in the MANE-VU states. For the initial planning, MANE-VU expects that, over time, these actual facilities will need to be controlled if significant improvements in visibility at affected Class I areas are to be realized.

MANE-VU believes that the goals of the "Ask" will be attained only by means of binding obligations to EGU emission reductions beyond what CAIR was expected to provide. MANE-VU therefore maintains that additional federal action is needed to achieve the visibility benefits shown to be feasible through sensitivity modeling (See Attachment P, "MANE-VU Modeling for Reasonable Progress Goals: Model Performance Evaluation, Pollution apportionment and Control Measure Benefits," Feb. 7, 2008) and demonstrated to be available at reasonable cost (See Attachment S, Alpine Geophysics, LLC, "Documentation of 2018 Emissions from Electric Generating Units in the Eastern United States for MANE-VU's Regional Haze Modeling," Revised Final Draft, April 28, 2008).

MANE-VU's position on this issue is formally expressed in its "Statement of the Mid/Atlantic/Northeast Visibility Union (MANE-VU Concerning a Request for a Course of Action by the U.S. Environmental Protection Agency (EPA) toward Assuring Reasonable Progress" adopted June 20, 2007. This statement, more commonly known as MANE-VU's National "Ask," is included in Attachment D. Although other RPOs did not adopt all of the same philosophies or processes for their regional haze Sips, the consultation process maintains a central role in regional haze planning. Maine is pleased with the significant opportunities identified for ongoing consultation with other states concerning long-term strategies, not only for regional haze mitigation, but also for improved air quality in general.

Maine and other MANE-VU states are committed to continuing consultation with states in the MRPO and VISTAS regions, through participation in the State Collaborative process, in which new regional control strategies are discussed to reduce future emissions of multiple pollutants of common regional concern.

4. State/Tribe and Federal Land Manager Coordination

40 CFR Section 51.308(f) requires the State of Maine to submit its SIP revision by July 31, 2018 and every ten years thereafter.

40 CFR Section 51.308(i) requires coordination between States/Tribes and the Federal Land Managers (FLMs). Opportunities have been provided by MANE-VU for FLMs to review and comment on each of the technical documents developed by MANE-VU and included in this SIP. Maine has provided agency contacts to the FLMs as required. In the development of this Regional Haze Plan, the FLMs were consulted in accordance with the provisions of 40 CFR Section 51.308(i)(2). The State of Maine has provided the FLMs an opportunity for consultation, in person and at least 60 days prior to holding any public hearing on the SIP. This SIP was submitted to FLMs on May 25, 2010 for formal review and comment.

In accordance with 40 CFR Section 51.308(i)(3) the State of Maine has received comments regarding the SIP from FLMs. Comments received from the Federal Land Managers on the Plan were addressed. The comments and responses are included in Attachment F of this plan.

40 CFR Section 51.308(i)(4) requires procedures for continuing consultation between the State/Tribe and FLMs on the implementation of the visibility protection program. The State of Maine will consult with the Federal Land Manager(s) on the status of the following implementation items:

1. Implementation of emissions strategies identified in the SIP as contributing to achieving improvement in the worst-day visibility
2. Summary of major new source permits issued
3. Status of State/Tribe actions to meet commitments for completing any future assessments or rulemakings on sources identified as likely contributors to visibility impairment, but not directly addressed in the most recent SIP revision
4. Any changes to the monitoring strategy or monitoring stations status that may affect tracking of reasonable progress
5. Work underway for preparing the 5-year review and / or 10-year revision
6. Items for FLMs to consider or provide support for in preparation for any visibility protection SIP revisions (based on a 5-year review or the 10-year revision schedule under EPA's RHR)
7. Summary of topics discussion (meetings, emails, other records) covered in ongoing communications between the State/Tribe and FLMs regarding implementation of the visibility program.

The consultation will be coordinated with the designated visibility protection program coordinators for the National Park Service, U. S. Fish and Wildlife Service and the U.S. Forest Service, and will consist of an annual report to the respective FLMs, along with an opportunity for an in-person or teleconference consultation.

40 CFR Section 51.308(g) requires the State of Maine to submit a report to the EPA every 5 years evaluating progress towards the reasonable progress goal for each Class I Federal area located within the State and in each Class I area located outside the State that may be affected by emissions from within the State. The first progress report is due 5 years from submittal of the initial implementation plan and must be in the form of implementation plan revisions.

In accordance with 40 CFR Section 51.308(h), at the time of the report submission, the State of Maine will also submit a determination of the adequacy of its existing Regional Haze SIP revision.

5. Assessment of Baseline and Natural Conditions (with Class I Areas)

5.1 Requirements, Data, and Methodology

Under the Clean Air Act, the Regional Haze SIPs must contain measures to make reasonable progress toward the goal of achieving natural visibility. Each state containing a Class I area must determine baseline and natural visibility conditions for their Class I area(s) in consultation with FLMs and states identified as containing sources whose emissions contribute to visibility impairment in Class I areas. Comparing baseline conditions to natural visibility conditions determines the uniform rate of progress that must be considered as states set reasonable progress goals for each Class I area.

The Interagency Monitoring of Protected Visual Environments (IMPROVE) program was initiated in 1985 to establish current visibility conditions, track changes in visibility, and help determine the causes of visibility impairment in Class I Areas. IMPROVE stands for Interagency Monitoring and Protected Visual Environments. IMPROVE data was used to calculate baseline and natural conditions for MANE-VU Class I areas.

Data from the following IMPROVE monitors (see the table below) is representative of Class I Areas in Maine[11]. As described in the Monitoring Section of this SIP, Maine accepts the IMPROVE designation of these sites as representative of Class I areas in Maine in accordance with 40 CFR Section 51.308(d)(2)(i).

Table 5-1
IMPROVE Information for Maine Class I Areas

Class I Area	IMPROVE Site	Location (latitude and longitude)
Acadia National Park	ACAD1	44.38, -68.26
Moosehorn Wilderness Area and Roosevelt campobello International Park	MOOS1	45.13, -67.27

Source: VIEWS (http://vista.circa.colostate.edu/views/), prepared on 7/06/06

In September 2003, EPA issued guidance for the calculation of natural background and baseline visibility conditions. The guidance provided a default method and describes certain refinements that states may wish to evaluate in order to tailor these estimates to a

[11] The IMPROVE program has utilized representative monitoring since its inception, since man-made structures such as monitoring sites are restricted in national wilderness areas. Since regional haze sources and impacts are distributed over broad geographic regions, a representative monitoring site does not need to be located in close proximity to the Class I area being represented. For additional information see "Spatial and Seasonal Patterns and Temporal Variability of Haze and its Constituents in the United States: Report III, Chapter 1 (http://vista.cira.colostate.edu/improve/Publications/Reports/2000/2000.htm).

specific Class I area if it is poorly represented by the default method. At that time, NESCAUM calculated natural visibility for each of the MANE-VU Class I areas using the default method for the 20 percent best and worst days. NESCAUM also evaluated ways to refine the estimates. Potential refinements included: increasing the multiplier used to calculate impairment attributed to carbon, adjusting the formula used to calculate the 20 percent best and worst visibility days, and accounting for visibility impairment due to sea salt at coastal sites. However, MANE-VU found that these refinements did not significantly improve the accuracy of the estimates and MANE-VU states desired a consistent approach. Therefore, default estimates were used with the understanding that use of the default methodology would be reconsidered as better scientific understanding warranted.

Once the technical analysis was complete, MANE-VU provided an opportunity to comment to federal agencies and stakeholders. The proposed approach was posted on the MANE-VU website on March 17, 2004 and a stakeholder briefing was held on the same day. Comments were received by Electric Power Research Institute, Midwest Ozone Group, the Appalachian Mountain Club, the National Parks Conservation Association, the National Park Service, and the U.S. Forest Service.

Several commenters supported the proposal and other comments addressed four main topics: the equation used to calculate visibility, the statistical technique used to estimate the 20 percent best and worst visibility days, the inclusion of transboundary effects and fires, and the timing of when new information should be included. All comments were reviewed and summarized by MANE-VU, and member state's Air Directors were briefed on comments, proposed response options, and implications.

The MANE-VU position on natural background conditions was issued in June 2004, and stated that, "Refinements to other aspects of the default method (e.g., refinements to the assumed distribution or treatment of Rayleigh extinction, inclusion of sea salt, and improved assumptions about the chemical composition of the organic fraction) may be warranted prior to submission of SIPs depending on the degree to which scientific consensus is formed around a specific approach…"

In 2006, the IMPROVE Steering Committee adopted an alternative reconstructed extinction equation to revise certain aspects of the default method. The aspects revised were scientifically well understood, and the Committee determined that revisions improved the performance of the equation at reproducing observed visibility at Class I sites.

In 2006, NESCAUM conducted an assessment of the default and alternative approaches for calculation of baseline and natural background conditions at MANE-VU Class I areas, and the baseline and natural conditions reported herein were calculated using the alternative method approved by the IMPROVE Steering Committee in 2006 (See the MANE-VU document, "Baseline and Natural Background Visibility Conditions: Considerations and Proposed Approach to the Calculation of Baseline and Natural Background Visibility Conditions at MANE-VU Class I Areas", (Attachment G**)**.

MANE-VU will continue to participate in further research efforts on this topic and will reconsider the calculation methodology as scientific understanding evolves.

5.2 Maine Baseline Visibility

The IMPROVE program has calculated the 20 percent worst baseline (2000-2004) and 20 percent best baseline conditions for each IMPROVE monitoring site at MANE-VU Class I Areas. These values are posted on the Visibility Information Exchange Web System (VIEWS) operated by the Regional Planning Organizations (available online at http://vista.cira.colostate.edu/views/). The values for the Maine Class I areas can be seen below in Table 5-2. Table 5-2 lists the baseline visibility for the 20 percent worst visibility days as a five-year average for 2000-2004 using the alternative IMPROVE algorithm approved in 2006 by the IMPROVE Steering Committee.

Table 5-2
Baseline Visibility for the 20 Percent Worst Days and 20 Percent Best Days for Five Years (from 2000-2004) in Maine Class I Areas

Class I Area (IMPROVE Monitor)	Year	20 Percent Worst Days Deciviews (dv)	20 Percent Best Days Deciviews (dv)
Acadia National Park	2000	21.64	8.89
	2001	23.28	8.87
	2002	23.91	8.77
	2003	23.65	8.77
	2004	21.98	8.56
Five Year Average		22.89	8.77
Moosehorn Wilderness Area and Roosevelt Campobello International Park	2000	20.63	8.93
	2001	22.13	9.3
	2002	23.06	9.12
	2003	22.5	9.48
	2004	20.28	8.93
Five Year Average		21.72	9.15

Source: VIEWS (http://vista.circa.colostate.edu/views), prepared on 10/16/07

5.3 Natural Visibility

A five year average (2000 to 2004) visibility in deciviews was calculated for each MANE-VU Class I area for the 20 percent best and 20 percent worst days in accordance with 40 CFR 51.308(d)(2) and detailed in the NESCAUM Baseline and Natural Background document found in Attachment G. The deciview visibility for the worst and best days are based on calculations and data included in Attachment G of this SIP.

Natural visibility represents the visibility for each Class I area representative of the conditions before human activities affected air quality in the area. Certain natural phenomena can reduce visibility. The Clean Air Act goal is to remedy visibility impairment resulting from human activity.

Table 5-3 displays the baseline visibility for the 20 percent worst and the 20 percent best visibility days based on the five-year average for 2000-2004, natural visibility for the 20 percent worst and the 20 percent best visibility days, and the difference between baseline and natural visibility conditions for the Maine Class I areas.

Table 5-3
Summary of Baseline Visibility and Natural Conditions for the 20 Percent Worst and 20 Percent Best Visibility Days for Maine Class I Areas

Class I Area	2000-2004 Baseline (dv)		Natural Conditions (dv)		Difference (dv)	
	Worst 20 %	Best 20 %	Worst 20 %	Best 20 %	Worst 20 %	Best 20 %
Acadia National Park	22.89	8.77	12.43	4.66	10.46	4.11
Moosehorn Wilderness Area and Roosevelt campobello International Park	21.72	9.15	12.01	5.01	9.71	4.14

Source: VIEWS (http://vista.circa.colostate.edu/views/), prepared on 6/22/2007

6. Monitoring Strategy

In the mid-1980's, the IMPROVE program (Interagency Monitoring of Protected Visual Environments) was established to measure visibility impairment in mandatory Class I areas throughout the United States. The monitoring sites are operated and maintained through a formal cooperative relationship between the U.S. EPA, National Park Service, U.S. Fish and Wildlife Service, Bureau of Land Management, and U.S. Forest Service. In 1991, several additional organizations joined the effort: State and Territorial Air Pollution Program Administrators and the Association of Local Air Pollution Control Officials (which now goes by The National Association of Clean Air Agencies), Western States Air Resources Council, Mid-Atlantic Regional Air Management Association, and Northeast States for Coordinated Air Use Management.

Data collected at these sites are used by land managers, industry planners, scientists, public interest groups, and air quality regulators to understand and protect the visual air quality resource in Class I areas. Most importantly, the IMPROVE program scientifically documents for American citizens, the visual air quality of their wilderness areas and national parks. Program objectives include:

- Establish current visibility and aerosol conditions in mandatory Class I areas.
- Identify chemical species and emission sources responsible for existing anthropogenic visibility impairment.
- Document long-term trends for assessing progress towards the national visibility goals.
- Provide regional haze monitoring representing all visibility-protected federal Class I areas where practical, as required by EPA's Regional Haze Rule.

6.1 Federal Regional Haze Monitoring Requirements

Section 51.308(d)(4) of EPA's Regional Haze Rule requires a monitoring strategy for measuring, characterizing, and reporting regional haze visibility impairment that is representative of all mandatory Class I Areas within the State of Maine. The monitoring strategy relies upon participation in the Interagency Monitoring of Protected Visual Environments (IMPROVE) network.

The State of Maine participates in IMPROVE network, and will evaluate the monitoring network periodically and make those changes needed to be able to assess whether reasonable progress goals are being achieved in each of Maine's mandatory Class I Areas.   Maine is committing to continued support of the IMPROVE network at Acadia National Park and Moosehorn National Wildlife Refuge.

40 CFR 51.308(d)(4)(i) requires states to establish additional monitoring sites or equipment as needed to assess whether reasonable progress goals are being achieved

toward visibility improvement at mandatory Class I areas. At this time, the current monitors are sufficient to make this assessment. Maine's commitment to maintain the current level of monitoring, and to expand monitoring and/or analysis should such action become necessary, will remain contingent on federal funding assistance.

40 CFR Section 51.308(d)(4)(ii) requires the inclusion of procedures by which monitoring data and other information are used in determining the contribution of emissions from within the State to regional haze visibility impairment at mandatory Class I Federal areas both within and outside the State. MANE-VU and the State of Maine accepts the contribution assessment analysis completed by NESCAUM entitled, "Contributions to Regional Haze in the Northeast and Mid-Atlantic States." (See Attachment A). We agree that NESCAUM is providing quality technical information by using the IMPROVE program data and the VIEWS site. Information about the use of the default and alternative approaches to the calculation of baseline and natural background conditions can be found in Section 5 "Assessment of Baseline, Natural and Current Conditions" of this SIP.

Maine commits to meet the requirements under 40 CFR Section 51.308(d)(4)(iv) to report to EPA visibility data for each of Maine's Class I Areas annually.

40 CFR Section 51.305 requires each state containing a mandatory Class I Federal area to include in its SIP a strategy for evaluating reasonably attributable visibility impairment (RAVI) in any such Class I Area by visual observation or other appropriate monitoring techniques. The plan must provide for the consideration of available visibility data and must provide a mechanism for its use. This requirement does not apply to the State of Maine because no specific sources have been identified as subject to RAVI requirements.

40 CFR Section 51.308(d)(4)(v) requires a statewide inventory of emissions of pollutants that are reasonably anticipated to cause or contribute to visibility impairment in mandatory Class I Federal areas within the State of Maine. The Emissions Inventory Section (Section 8) of this SIP addresses this requirement.

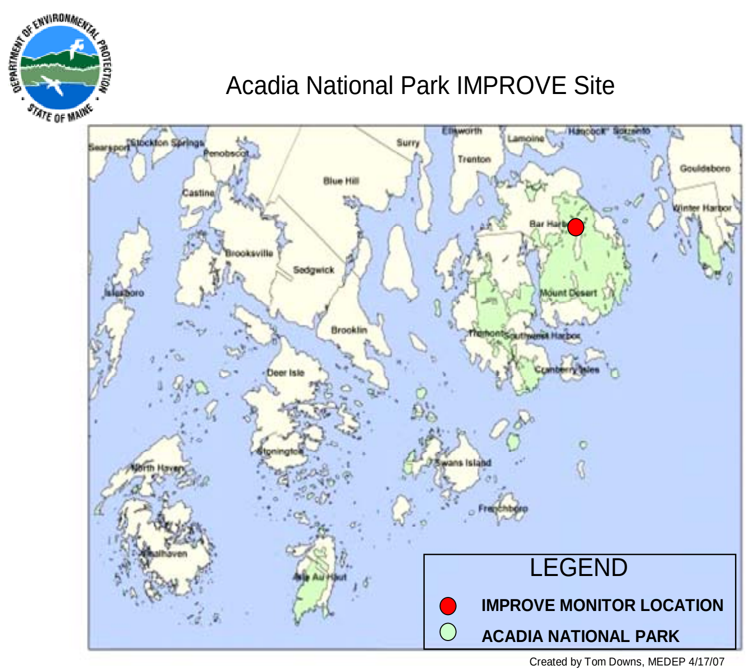
EPA's Regional Haze Rule (40 CFR Section 51.308(d)(4)(vi)) requires the inclusion of other monitoring elements, including reporting, recordkeeping, and other measures, necessary to assess and report visibility. While the State of Maine feels that the current IMPROVE network provides sufficient data to adequately measure and report progress toward the goals set for MANE-VU Class I sites that we contribute to, Maine has also found additional monitoring information useful to assess visibility and fine particle pollution in the region in the past. Examples of these data include results from the MANE-VU Regional Aerosol Intensive Network (RAIN), which provides continuous, speciated information on rural aerosol characteristics and visibility parameters; the EPA Clean Air Status and Trends Network (CASTNET), which has provided complementary rural fine particle speciation data at non-class I sites; the EPA Speciation Trends Network (STN), which provides speciated, urban fine particle data to help develop a comprehensive picture of local and regional sources; state-operated rural and urban speciation sites using IMPROVE or STN methods; and the Supersites program, which has provided information through special studies that generally expands our understanding of the processes that control fine particle formation and transport in the region. Maine will continue to utilize these and other data -- as they are available and fiscal realities allow -- to improve our understanding of visibility impairment and to document progress toward our reasonable progress goals under the Regional Haze Rule.

6.2 Monitoring Information for MANE-VU Class I Areas

6.2.1. Acadia National Park, Maine

The IMPROVE monitor for Acadia National Park (indicated as ACAD1) is located at Acadia National Park Headquarters in Maine at an elevation of 157 meters, a latitude of 44.38˚ and a longitude of -68.26˚. The haze data for Acadia National Park is collected by an IMPROVE monitor (ACAD1) that is operated and maintained by the National Park Service. The State considers the ACAD1 site as adequate for assessing reasonable progress goals of Acadia National Park and no additional monitoring sites or equipment are necessary at this time. The State routinely participates in the IMPROVE monitoring program by sending regional representatives to the IMPROVE meetings.

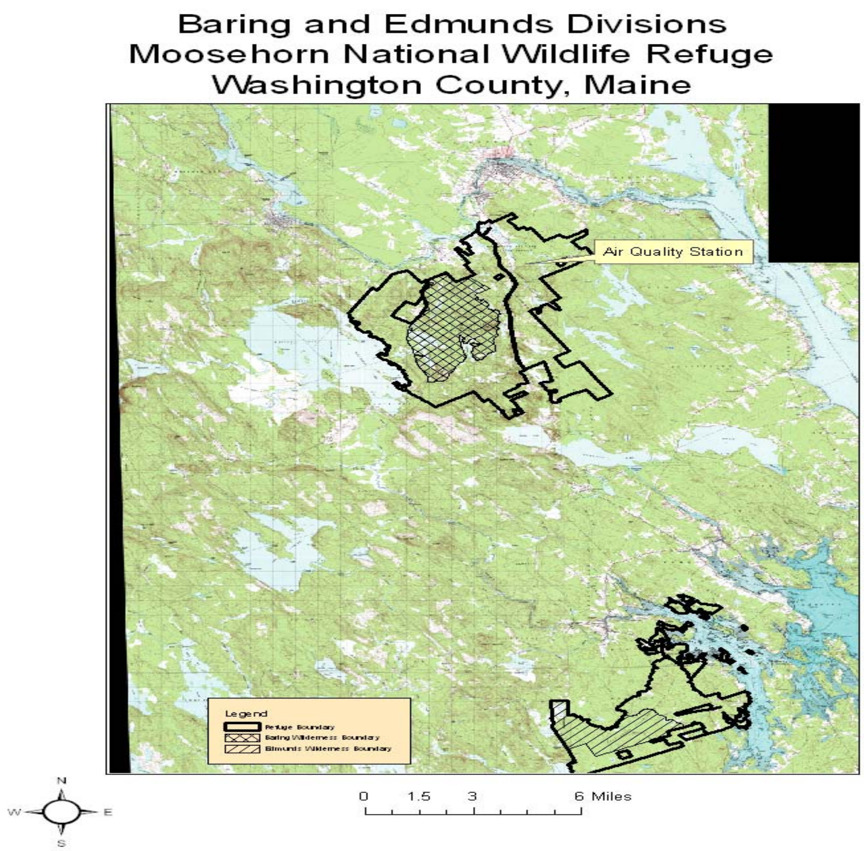
Figure 6-1
Map of Acadia National Park



6.2.2. Moosehorn Wilderness Area, Maine

The IMPROVE monitor for the Moosehorn Wilderness Area (indicated as MOOS1) is located near McConvey Road, about one mile northeast of the National Wildlife Refuge Baring Unit Headquarters in Maine at an elevation of 78 meters, a latitude of 45.13˚ and a longitude of -67.27˚. This monitor also represents the Roosevelt Campobello International Park in New Brunswick, Canada. The haze data for Moosehorn Wilderness Area is collected by an IMPROVE monitor (MOOS1) that is operated and maintained by the Fish & Wildlife Service. The State considers the MOOS1 site as the only current IMPROVE monitoring site in Maine adequate for assessing reasonable progress goals of the Moosehorn Wilderness Area and no additional monitoring sites or equipment are necessary at this time. The State routinely participates in the IMPROVE monitoring program by sending regional representatives to the IMPROVE meetings.

Figure 6-2
Map of the Baring and Edmunds Divisions of the Moosehorn National Wildlife Refuge and the IMPROVE Monitor

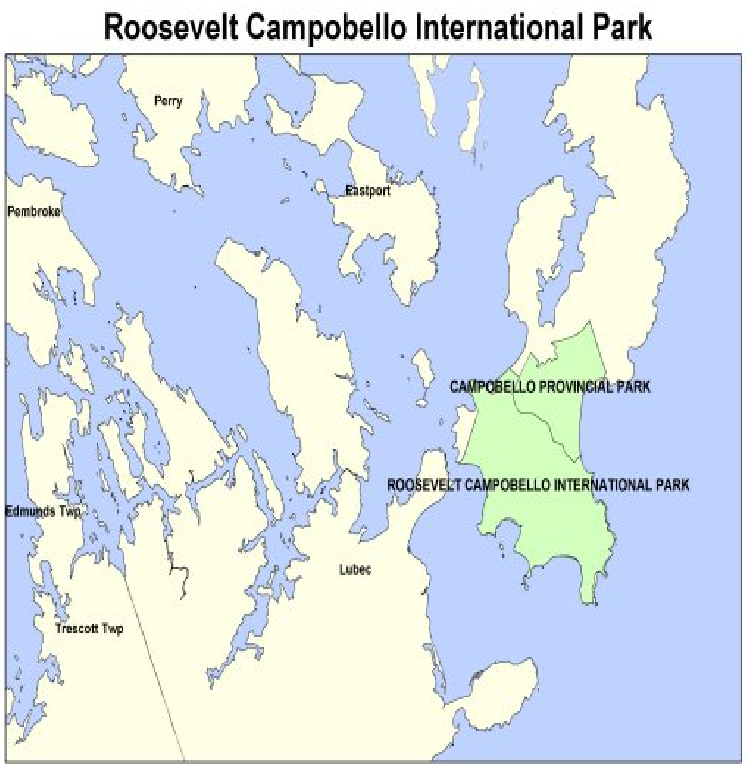


(source: The Refuge Manager at Moosehorn Wilderness Area)

6.2.3. Roosevelt Campobello International Park, New Brunswick, Canada

The IMPROVE monitor for the Moosehorn Wilderness Area is also the monitor for Roosevelt Campobello International Park (indicated as MOOS1) (see section 6.2.2, above). The State considers the MOOS1 site as the only current IMPROVE monitoring site in Maine or Canada adequate for assessing reasonable progress goals of Roosevelt Campobello International Park. No additional monitoring sites or equipment are necessary.

Figure 6-3
Map of Roosevelt Campobello International Park



7. Sources of Visibility Impairing Pollutants and Contribution Assessment

7.1 Visibility Effects of Particulate Matter

Visibility impairment in the eastern United States is primarily due to the presence of fine particles in the atmosphere which absorb and scatter light. Visibility impairing particle-light interactions are sensitive to the chemical composition of the particles involved, and also depend strongly on ambient relative humidity. Secondary particles, which form in the atmosphere through chemical reactions, are generally smaller than one micrometer (μm) which is the size range that is most effective at scattering visible light[12].

The degree of visibility impairment is expressed in deciviews, a unit-less value. The calculation of visibility impairment utilizes two equations, one to calculate light extinction coefficient (B_{ext}), and then its transformation into visibility impairment as expressed in deciviews (dv). The latest equation,[13] approved by the Interagency Monitoring of Protected Visual Environments (IMPROVE) Steering Committee, to calculate light extinction coefficient is:

The Extinction Equation

$$
\begin{aligned}
B_{ext} = {} & 2.2 \times f_S(RH) \times [\text{Small Sulfate}] + 4.8 \times f_L(RH) \times [\text{Large Sulfate}] \\
& + 2.4 \times f_S(RH) \times [\text{Small Nitrate}] + 5.1 \times f_L(RH) \times [\text{Large Nitrate}] \\
& + 2.8 \times [\text{Small Organic Mass}] + 6.1 \times [\text{Large Organic Mass}] \\
& + 10 \times [\text{Elemental Carbon}] + 1 \times [\text{Fine Soil Mass}] \\
& + 1.7 \times f_{SS}(RH) \times [\text{Sea Salt Mass}] + 0.6 \times [\text{Coarse Mass}] \\
& + \text{Rayleigh Scattering (Site Specific)} + 0.33 \times [NO_2\ (\text{ppb})]
\end{aligned}
$$

Where:

B_{ext} = The light extinction coefficient in inverse megameters [Mm^{-1}]

$f_s(RH)$ and $f_L(RH)$ = Humidity factor associated with small and large mode mass size distributions

$f_{ss}(RH)$ = Humidity factor associated with Sea Salt

The on-site air monitoring of visibility causing pollutants by the IMPROVE monitoring network is discussed in more detail in Section 6 of this document. In the extinction equation, total sulfate, nitrate and organic carbon compound concentrations are each divided into two particle size fractions, representing small and large size particle components. Site-specific Rayleigh scattering is calculated by IMPROVE for the

[12] The particles that contribute most to visibility impairment are also of concern under the health-based National Ambient Air Quality Standard (NAAQS) for fine particulate matter, which is defined as all particles with an aerodynamic diameter less than 2.5 μm.

[13] Review of the IMPROVE Equation for Estimating Ambient Light Extinction Coefficients - Final Report Jenny L. Hand and William C. Malm, March 2006

elevation of the site as well as annual average temperature of each IMPROVE monitoring site.

Once light extinction is calculated, visibility levels (in deciviews (dv)) can be calculated. The deciview equation is as follows:

The Deciview Equation

$$\text{Deciviews (dv)} = 10 \ln (b_{ext}/10)$$

Where:

ln is the natural log function and B_{ext} is calculated using the IMPROVE equation previously described. The calculated deciviews are unit-less values where the higher the value, the greater amount of visibility impairment exists.

The extinction and deciview equations were used to calculate the baseline and projected visibility impairment at Acadia National Park, Moosehorn Wilderness Area and Roosevelt Campobello International Park, and to set the progress goals as established in this Document.

7.2 Pollutants Contributing to Visibility Impairment at Class I Areas

The pollutants primarily responsible for fine particle formation, and contributing to regional haze, include SO_2, NO_2, VOCs, NH_3, PM_{10}, and $PM_{2.5}$. The MANE-VU Contribution Assessment (Attachment A) develops a conceptual model for regional haze in the Northeast and Mid-Atlantic states that identifies sulfate as the single most important constituent of haze forming fine particle pollution, and the principal cause of visibility impairment across the Northeast region. Sulfate alone accounts for anywhere from one-half to two-thirds of total fine particle mass on the 20 percent haziest days at all MANE-VU Class I sites, and 40 percent or more of total fine particle mass on the 20 percent clearest days.

After sulfate, organic carbon (OC) consistently accounts for the next largest fraction of total fine particle mass, contributing from 20-30 percent of total fine particle mass on the haziest days. Relative contributions to overall fine particle mass from nitrate (NO_3), elemental carbon, and fine crustal material (i.e., soil) are all smaller, generally under 10 percent of the total, with relative ranking of the three species varying with location. Nitrate plays a noticeably more important role at urban sites compared to Northeastern and Mid-Atlantic Class 1 sites.

Almost all particle sulfate originates from sulfur dioxide (SO_2) oxidation[14] and typically associates with ammonium (NH_4) in the form of ammonium sulfate (($NH_4(SO_4)$)).

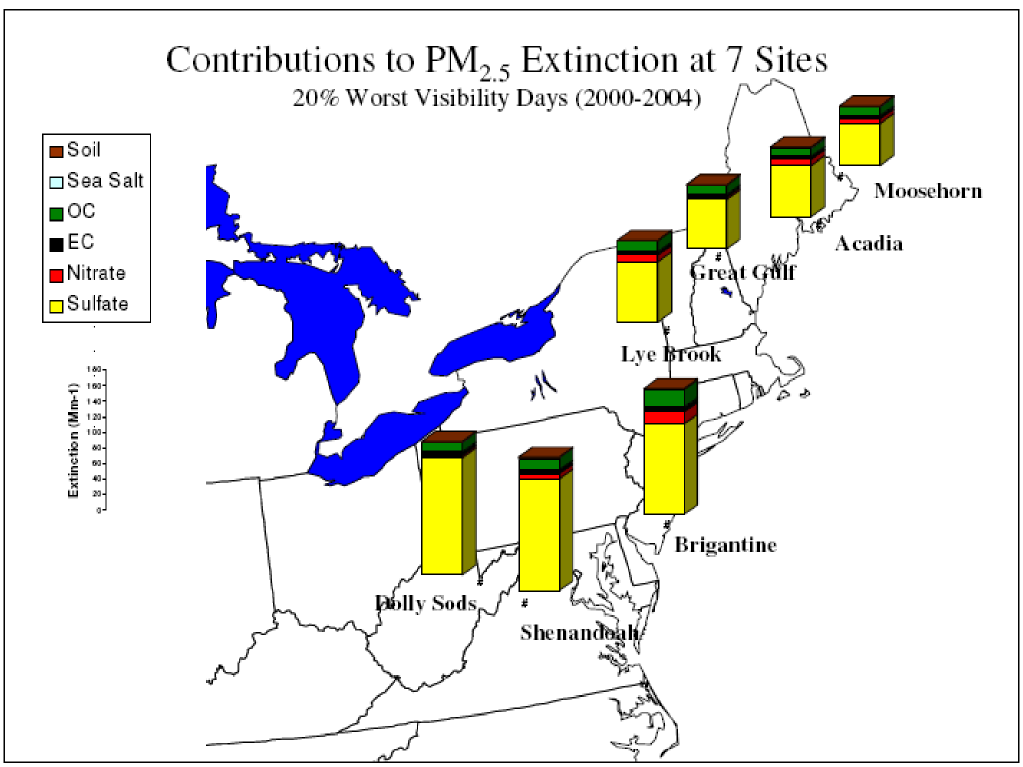
[14] Sulfate is produced from SO_2 in the atmosphere under two major pathways. In the gas phase, SO_2 is oxidized to sulfuric acid (H_2SO_4), ammonium bisulfate (NH_4HSO_4), or ammonium sulfate, depending on the availability of ammonia (NH_4). In the presence of small wet particles (typically smaller than fog), an aqueous phase process can oxidize SO_2 to sulfate extremely quickly (@ 10 percent per hour).

Approximately 95 percent of SO_2 emissions are from anthropogenic sources (primarily fossil fuel combustion), while the majority of ammonium comes from agricultural activities.

Sulfate is not only the dominant contributor to fine particle mass in the region, but also accounts for anywhere from 60 percent to almost 80 percent of the difference between fine particle concentrations on the clearest and haziest days at Northeastern and Mid-Atlantic Class I sites, including those in Maine. Some of the dominant components of total fine particle mass have an even larger effect when considering the differential visibility impacts of different particle species. Sulfate typically accounts for more than 70 percent of estimated particle-induced light extinction at Northeastern and Mid-Atlantic sites. Organic carbon is the second most important contributor to particle-induced light extinction on days with the greatest visibility impairment, with nitrate being the third greatest contributor to regional haze at Class I sites in the MANE-VU region, including those in Maine.

Figure 7-1 shows the dominance of sulfate in visibility extinction calculated from 2000-2004 baseline data for seven Northeast Class I Areas.

Figure 7-1
Contributions to PM2.5 Extinction at Seven Class I Areas



Given the dominant role of sulfate in the formation of regional haze in the Northeast and Mid-Atlantic Regions, MANE-VU concluded that an effective emissions management approach would rely heavily on broad-based regional SO_2 control measures in the eastern United States. The focus on SO_2 as MANE-VU's first priority makes sense not only because of its dominant role in regional haze but also because its emission sources are well understood. Moreover, the control measures needed for SO_2 emission reductions are readily available, cost-effective, and could be implemented quickly. On the basis of the scientific evidence, it is apparent that the bulk of haze-causing pollution can be eliminated by pursuing SO_2 emission controls.

Organic carbon was found to be the next largest contributor to haze after sulfate, however, in comparison with sulfate, the emission sources of organic carbon are diverse, variable, more diffuse, and less well understood. Organic carbon particulates can be emitted as a primary organic aerosol, or they can be formed as a secondary organic aerosol. Secondary organics are formed when volatile organic compound (VOC) emissions react with oxides of nitrogen in the presence of sunlight to form ozone, which acts as a catalyst for particulate formation. VOCs may also condense to from particulate organic carbon. For these reasons, MANE-VU considered organic carbon to be the subject of possible future control measures but not a specific target pollutant in the initial strategy to mitigate regional haze.[15]

7.3 Geographic Considerations and Haze Contribution Attribution

As noted in the Contribution Assessment (Attachment A), high levels of particle pollution in the eastern United States often causes hazy conditions extending over thousands of square kilometers (km^2). As a result, visibility is often impaired at even the most remote and pristine Class I areas.

To better identify the sources of visibility impairing pollutants, the MANE-VU Contribution Assessment utilized a variety of modeling, air quality data analysis, and emissions inventory analysis techniques to identify source categories and states that contribute to visibility impairment in MANE-VU and nearby Class I areas. The analytical and assessment tools utilized for the Contribution Assessment include Eulerian (grid-based) source models, Lagrangian (air parcel-based) source dispersion models, and a variety of data analysis techniques including source apportionment models, back trajectory calculations, and the use of monitoring and inventory data. Table 7-2 below, summarizes the methodological approaches of these analytical tools.

[15] Although sulfur is the primary regional haze pollutant of concern for this SIP, Maine has taken measures to address organic carbon emissions, primarily from residential wood burning activities. These measures are discussed in Section 12 "Long-Term Strategy ."

Table 7-2
Summary of Technical Approaches for Attributing State Contributions to Observed Sulfate in MANE-VU Class I Areas

Analytical Technique	**Approach**
Emissions/distance	Empirical
Incremental probability	Lagrangian trajectory technique
Cluster-weighted probability	Lagrangian trajectory technique
Emissions × upwind probability	Empirical/trajectory hybrid
Source apportionment approaches	Receptor model/trajectory hybrid
REMSAD tagged species	Eulerian source model
CALPUFF with MM5-based meteorology	Lagrangian source dispersion model
CALPUFF with observation-based meteorology	Lagrangian source dispersion model

7.3.1 Review of Technical Approaches

The MANE-VU Contribution Assessment and Appendices (Attachments A, A-1, A-2, A-3 and A-4) provide a detailed description of the multiple technical approaches used to assess regional haze (sulfate) contributions to the MANE-VU region. Following is a summary of four of these techniques.

I. Emissions/Distance

The emissions/distance empirical technique calculates the ratio of annual emissions (Q) to source-receptor distance (d), with the ratio (Q/d) which is then multiplied by a factor to account for the frequency effect of prevailing winds.[16] The geographic domain of the sources included in the Q/d study consisted of U.S. states in the CENRAP, MANE-VU, VISTAS, and MRPO regions. Canadian provinces in the lower eastern region were also included. The categories of SO_2 emission sources included in this analysis were area sources (e.g., residential boilers and heaters), non-road mobile sources (e.g., tractors and construction vehicles), and point sources (e.g., industrial smokestacks and power

[16] Aggregated over long periods of time and large geographic areas, the total atmospheric sulfate contribution from a specific source, state, or region should be approximately proportionate to its SO_2 emissions. For specific receptor locations, like a Class 1 visibility area, relative impacts decrease with increasing distance from the source. Impacts diminish over distance as pollutants are dispersed in the atmosphere and removed through deposition. For non-reactive primary pollutant emissions, the relationship between atmospheric concentrations and distance (d) can be approximated as a function of $1/d^2$. For secondary pollutants like sulfate, reductions in ambient concentrations that occur as a result of dispersion and deposition mechanisms are partially offset by the formation of secondary aerosol such that an increasing fraction of the remaining downwind sulfur is converted to aerosol sulfate. In these cases, the effects of distance are better characterized by the function 1/d. During regional sulfate episodes when sulfur conversion rates are enhanced by the presence of gas and aqueous-phase oxidants, pollutant concentrations decline even less rapidly with distance as accelerated aerosol formation rates work to both generate more sulfate and reduce the remaining sulfur available for deposition (deposition rates are roughly an order of magnitude slower for sulfate than for SO_2).

generation facilities). Results were calculated for seven receptors in the MANE-VU and VISTAS regions including: Acadia National Park, Brigantine Wilderness in the Forsythe Wildlife Preserve, Dolly Sods Wilderness, Lye Brook Wilderness, Moosehorn Wilderness, Presidential Range-Dry River Wilderness, and Shenandoah National Park.

To calculate the impact that each state had on a given receptor, the area and nonroad SO_2 emission sources were summed across the entire state, and the distance to the receptor site for those emission sources was calculated based on that state's geographic center, adjusted for population density. In this way, the area and non-road emissions were treated as a single point source located at the population-weighted center of each state. These impacts were then added to the impact of the point sources that were calculated individually. The sum of area, non-road, and point source impacts for each state was used to compare the contributions relative to other states in the eastern U.S. and parts of Canada.

The principal contributors to the MANE-VU receptors, according to this method, include the Midwestern states of Indiana and Ohio, as well as Pennsylvania and New York. This is due not only to the large emissions from these states, but also to the predominantly westerly winds that carry Midwest pollution eastward. Table 7-3 shows the relative contribution of eastern states and Canadian provinces on several receptor sites in the region.

Table 7-3
Annual average Sulfate Impact from Q/D (%)

RPO	State	Acadia	Brigantine	Dolly Sods	Great Gulf	Lye Brook	Moosehorn	Shenandoah
CANADA		**8.69**	**7.11**	**3.90**	**14.84**	**12.43**	**7.85**	**4.75**
CENRAP		**0.88**	**1.12**	**1.58**	**1.65**	**1.67**	**0.82**	**1.48**
MANE-VU		**36.17**	**34.83**	**14.81**	**27.83**	**31.78**	**30.08**	**20.59**
MANE-VU	Connecticut	0.76	0.53	0.04	0.46	0.55	0.56	0.06
	Delaware	0.96	3.20	0.30	0.63	0.93	0.71	0.61
	District of Columbia	0.01	0.04	0.01	0.01	0.02	0.01	0.04
	Maine	6.54	0.16	0.01	2.33	0.31	6.01	0.02
	Maryland	2.20	4.96	2.39	1.92	2.66	1.60	4.64
	Massachusetts	10.11	2.73	0.13	3.11	2.45	6.78	0.35
	New Hampshire	2.25	0.60	0.04	3.95	1.68	1.74	0.06
	New Jersey	1.40	4.04	0.27	0.69	1.44	1.05	0.46
	New York	4.74	5.57	1.32	5.66	9.02	3.85	2.03
	Pennsylvania	6.31	12.64	10.23	6.30	11.72	5.55	12.05
	Rhode Island	0.23	0.10	0.01	0.11	0.06	0.19	0.01
	Vermont	0.13	0.06	0.00	0.41	0.95	0.09	0.01
MIDWEST		**11.98**	**18.16**	**30.26**	**20.10**	**21.48**	**10.40**	**26.84**
MIDWEST	Illinois	1.37	1.62	2.56	2.52	2.43	1.30	2.47
	Indiana	2.13	3.29	5.40	3.94	3.93	2.02	5.23
	Michigan	2.02	2.77	3.24	3.66	3.67	1.74	3.20
	Ohio	5.62	9.11	17.98	6.33	9.96	4.62	14.67
	Wisconsin	0.35	1.16	1.03	1.42	1.49	0.72	1.07
VISTAS		**8.49**	**21.99**	**36.75**	**12.04**	**13.65**	**6.69**	**33.86**
VISTAS	Alabama	0.32	1.07	2.13	0.65	0.31	0.25	1.77
	Georgia	0.67	2.32	3.71	1.27	1.31	0.56	3.47
	Kentucky	1.17	2.22	4.39	1.99	2.23	0.98	4.34
	Mississippi	0.01	0.04	0.03	0.03	0.04	0.01	0.07
	North Carolina	1.45	4.19	4.29	1.66	1.39	1.14	4.76
	South Carolina	0.43	1.69	1.04	0.64	0.56	0.36	1.30
	Tennessee	0.61	1.56	3.41	1.11	1.23	0.50	2.73
	Virginia	1.43	4.30	2.32	1.52	1.95	1.13	6.20
	West Virginia	2.35	4.59	14.38	2.96	3.64	1.75	9.19
OTHER		**33.79**	**16.78**	**12.70**	**23.54**	**18.99**	**44.17**	**12.48**
TOTAL ($\mu g/m^3$)		**2.026**	**3.444**	**3.867**	**1.780**	**2.137**	**1.767**	**3.919**

From: *Table 8.2 of Contributions to Regional Haze in the Northeast and Mid-Atlantic United States, NESCAUM, 2006*

II. Emissions Times Upwind Probability

Another empirical approach utilized in the Contribution Assessment is the emissions times upwind probability technique, which multiplies the back-trajectory calculated residence time probability for a grid cell with the total emissions (over the same time period) for that grid cell[17]. This technique results in an emissions-weighted probability field that can be integrated within state boundaries to calculate the relative probabilities of each state contributing to pollution transport. Table 7-4 illustrates the average ranked contributions to several MANE-VU and VISTAS Class I areas.

Table 7-4
Annual Average Sulfate Impact from the Emissions x Upwind Probability Technique

RPO	State	Acadia	Brigantine	Dolly Sods	Great Gulf	Lye Brook	Moosehorn	Shenandoah
CANADA		**15.24**	**6.70**		**19.29**	**15.91**	**13.45**	**4.33**
CENRAP		**1.89**	**1.77**		**1.73**	**1.66**	**1.52**	**1.72**
CENRAP	Arkansas	0.12	0.24		0.15	0.15	0.15	0.20
	Iowa	0.38	0.27		0.27	0.28	0.28	0.25
	Kansas	0.00	0.00		0.00	0.00	0.00	0.00
	Louisiana	0.04	0.08		0.06	0.04	0.04	0.09
	Minnesota	0.56	0.33		0.38	0.44	0.44	0.22
	Missouri	0.80	0.85		0.87	0.75	0.62	0.95
	Texas	0.00	0.00		0.00	0.00	0.00	0.00
MANE-VU		**18.33**	**25.83**		**20.64**	**25.38**	**15.23**	**11.38**
MANE-VU	Connecticut	0.51	0.27		0.52	0.59	0.40	0.10
	Delaware	0.30	1.36		0.34	0.42	0.28	0.24
	District of Columbia	0.12	0.29		0.11	0.14	0.12	0.24
	Maine	1.49	0.08		0.68	0.26	1.53	0.05
	Maryland	1.32	3.06		1.31	1.31	0.96	2.29
	Massachusetts	1.10	0.33		0.86	0.81	0.90	0.12
	New Hampshire	1.21	0.17		1.48	0.72	0.77	0.06
	New Jersey	1.02	6.01		0.99	1.39	0.78	0.49
	New York	4.80	3.49		6.80	9.08	4.23	1.44
	Pennsylvania	6.21	10.71		7.10	10.36	5.07	6.33
	Rhode Island	0.11	0.05		0.08	0.08	0.09	0.02
	Vermont	0.14	0.03		0.37	0.23	0.10	0.01
MIDWEST		**17.35**	**19.55**		**20.67**	**21.63**	**15.56**	**22.03**
MIDWEST	Illinois	3.79	3.47		3.31	3.74	3.22	3.76
	Indiana	3.37	4.36		4.33	4.13	3.21	5.08
	Michigan	2.73	2.07		3.03	3.27	2.34	1.80
	Ohio	6.10	8.65		8.73	9.23	5.77	10.64
	Wisconsin	1.36	1.00		1.28	1.25	1.02	0.76
VISTAS		**13.40**	**29.37**		**14.14**	**16.43**	**10.07**	**48.06**
VISTAS	Alabama	0.72	1.32		0.63	0.71	0.39	2.14
	Georgia	1.40	3.21		1.06	1.54	0.72	4.73
	Kentucky	2.65	4.71		3.59	3.83	2.31	7.82
	Mississippi	0.04	0.10		0.06	0.06	0.03	0.12
	North Carolina	1.29	4.35		0.92	0.99	1.18	6.11
	South Carolina	0.72	1.64		0.42	0.41	0.44	1.62
	Tennessee	1.05	1.91		1.04	1.16	0.86	3.67
	Virginia	1.80	4.83		1.48	1.67	1.32	5.45
	West Virginia	3.74	7.31		4.94	6.05	2.81	16.39
OTHER[38]		**33.79**	**16.78**	**12.70**	**23.54**	**18.99**	**44.17**	**12.48**

From: *Table 8.5 of Contributions to Regional Haze in the Northeast and Mid-Atlantic United States, NESCAUM, 2006*

[17] A back trajectory is the path that an air parcel is calculated to have taken prior to arriving at a given receptor. The back trajectories utilized in this analysis were 72 hours in length, and have calculated endpoints, or locations, that specify the air mass path at hourly intervals. The endpoints from all trajectories were mapped into a matrix of residence times spent in the individual grid cells over the five year study period, with the result providing the likelihood that air spent time in a particular grid cell. By then multiplying the "residence time" by the MANE-VU SO_2 emission inventory for the grid cell, the contribution of each grid cell (and state) can be calculated.

III. REMSAD Tagged Species Modeling

Table 7-5 displays the results of an Eulerian source model (the REMSAD model) used to assess state-by-state and regional contributions to annual sulfate impacts in nine Class I areas. The Regional Modeling System for Aerosols and Deposition (REMSAD) is a three-dimensional Eulerian model designed to support a better understanding of the distributions, sources, and removal processes relevant to fine particles and other airborne pollutants. It calculates the concentrations of both inert and chemically reactive pollutants by simulating the physical and chemical processes in the atmosphere that affect pollutant concentrations. The basis for the model is an atmospheric diffusion equation representing a mass balance in which all of the relevant emissions, transport, diffusion, chemical reactions, and removal processes are expressed in mathematical terms.

Table 7-5
Average Annual Sulfate Impact at Northeast Class I Areas as Modeled Using REMSAD

RPO	State	Acadia	Brigantine	Dolly Sods	Great Gulf	Lye Brook	Moosehorn	Shenandoah
CANADA		**8.69**	**7.11**	**3.90**	**14.84**	**12.43**	**7.85**	**4.75**
CENRAP		**0.88**	**1.12**	**1.58**	**1.65**	**1.67**	**0.82**	**1.48**
MANE-VU		**36.17**	**34.83**	**14.81**	**27.83**	**31.78**	**30.08**	**20.59**
MANE-VU	Connecticut	0.76	0.53	0.04	0.48	0.55	0.56	0.08
	Delaware	0.96	3.20	0.30	0.63	0.93	0.71	0.61
	District of Columbia	0.01	0.04	0.01	0.01	0.02	0.01	0.04
	Maine	6.54	0.16	0.01	2.33	0.31	8.01	0.02
	Maryland	2.20	4.98	2.39	1.92	2.66	1.60	4.84
	Massachusetts	10.11	2.73	0.18	3.11	2.45	6.78	0.35
	New Hampshire	2.25	0.60	0.04	3.95	1.68	1.74	0.08
	New Jersey	1.40	4.04	0.27	0.89	1.44	1.03	0.48
	New York	4.74	5.57	1.32	5.68	9.00	3.83	2.03
	Pennsylvania	6.81	12.84	10.23	8.30	11.72	5.53	12.05
	Rhode Island	0.28	0.10	0.01	0.11	0.06	0.19	0.01
	Vermont	0.13	0.06	0.00	0.41	0.95	0.09	0.01
MIDWEST		**11.98**	**18.16**	**30.26**	**20.10**	**21.48**	**10.40**	**26.84**
MIDWEST	Illinois	1.37	1.82	2.56	2.52	2.42	1.30	2.47
	Indiana	2.13	3.29	5.40	3.94	3.93	2.02	5.23
	Michigan	2.02	2.77	3.24	3.88	3.67	1.74	3.20
	Ohio	5.62	9.11	17.98	8.33	9.96	4.62	14.87
	Wisconsin	0.85	1.16	1.08	1.42	1.49	0.72	1.07
VISTAS		**8.49**	**21.99**	**36.75**	**12.04**	**13.65**	**6.69**	**33.86**
VISTAS	Alabama	0.32	1.07	2.13	0.65	0.81	0.25	1.77
	Georgia	0.67	2.32	3.71	1.27	1.31	0.56	3.47
	Kentucky	1.17	2.22	4.89	1.99	2.22	0.98	4.34
	Mississippi	0.01	0.04	0.08	0.03	0.04	0.01	0.07
	North Carolina	1.45	4.19	4.29	1.88	1.89	1.14	4.78
	South Carolina	0.43	1.69	1.04	0.64	0.56	0.36	1.30
	Tennessee	0.61	1.56	3.41	1.11	1.23	0.50	2.73
	Virginia	1.48	4.30	2.82	1.52	1.95	1.13	6.20
	West Virginia	2.35	4.59	14.38	2.96	3.64	1.75	9.19
OTHER		**33.79**	**16.78**	**12.70**	**23.54**	**18.99**	**44.17**	**12.48**
TOTAL ($\mu g/m^3$)		**2.026**	**3.444**	**3.867**	**1.780**	**2.137**	**1.767**	**3.919**

From: *Table 8.1 of Contributions to Regional Haze in the Northeast and Mid-Atlantic United States, NESCAUM, 2006.*

As in the empirical analytical techniques, the REMSAD model identifies the States of Ohio, New York, and Pennsylvania as the predominant contributors to visibility impairment at MANE-VU Class I areas, including those in Maine. Unlike the previously-described empirical approaches, the REMSAD model identifies Maine as the single greatest contributor to visibility impairment at Maine Class I areas. [18]

IV. CALPUFF

A fourth approach to contribution assessment is the use of a dispersion model such as CALPUFF. CALPUFF is commonly used study the impacts of pollutant plumes or specific point source emissions on surrounding areas. While the geographic scale of these models has traditionally been limited to a few hundred kilometers because of a perceived lack of ability to accurately reproduce horizontal dispersion beyond these distances, recent advances in the CALPUFF system have resulted in improved performance over much greater distances. The Contribution Assessment provides specific information related to two CALPUFF platforms that have been developed for MANE-VU by the Vermont Department of Environmental Conservation (VT DEC) Air Pollution Control Branch and by the State of Maryland's Department of the Environment (MDE) and Department of Natural Resources (MDNR). The two platforms, one using MM5 meteorological inputs, and the other National Weather Service (NWS)-based meteorological data, were used to model the entire 2002 calendar year. These simulations have been configured to provide estimates for both individual source impacts and cumulative state impacts, and to allow for inter-platform comparisons.[19] The following table (Table 7-6) illustrates the contribution of emissions from individual states to overall sulfate levels at Acadia National Park.[20] Once again, Ohio, New York, Indiana and Pennsylvania are among the greatest contributors to sulfate levels at Maine Class I areas. Unlike the previous contribution assessment techniques, Massachusetts is identified as a major contributor to visibility impairment in Maine by the CALPUFF modeling.

7.3.2 Summary of Analytical Techniques for Contribution Assessment

By normalizing the results of the four different empirical and modeling techniques summarized above, MANE-VU was able to identify those states having the largest influence on sulfate levels at each Class I site. Figure 7-2, below, compares the normalized results using different techniques for ranking state contributions to sulfate levels at Acadia National Park. While there is some variation in the contribution estimates among the different assessment techniques employed, there is a general consistency of results from one method to another.

[18] It should be pointed out that the listed values for VISTAS, CenRAP, and Canada understate the actual percentage contributions from those regions because they count only emissions originating within the modeling domain (see Table 7-5). Actual contributions, especially in the case of CenRAP, would be considerably higher than stated. Differences between actual and stated values are aggregated into "Other" category. These findings highlight the importance of emissions from outside MANE-VU to visibility impairment inside the region.

[19] Overall, the CALPUFF modeling results to date demonstrate reasonably good comparability between the two platforms but they also suggest a consistent pattern of under prediction for one platform relative to the other.

[20] See Attachment A-4 for the ranked contribution of emissions from individual states to overall sulfate levels at Moosehorn NWR and other MANE-VU Class I areas.

Table 7-6
Contribution to Sulfate Levels at Acadia National Park Using the CALPUFF Model

	NWS-based Meteorology (VT DEC) µg/m³				MM5-based Meteorology (MDE/MDNR) µg/m³			
STATE	CEM PT	Non-CEM PT	Area/ Mobile	TOTAL PT	CEM PT	Non-CEM PT	Area/ Mobile	TOTAL
AL(a)	0.0086	0.0013	0.0003	0.0102	0.0139	0.0009	0.0011	0.0159
AR(a)	0.0039	0	0	0.0039	0.0054	0.0020	0.0010	0.0083
CT	0.0041	0.0012	0.0085	0.0138	0.0074	0.0011	0.0072	0.0156
DC	0.0001	0.0001	0.0002	0.0004	6.9E-05	0.0001	0.0003	0.0005
DE	0.0087	0.002	0.0008	0.0115	0.0093	0.0109	0.0018	0.0219
GA(a)	0.0142	0.0008	0.0005	0.0155	0.0259	0.0009	0.0019	0.0287
IA	0.0097	0.0122	0.0001	0.0219	0.0149	0.0120	0.0030	0.0299
IL	0.0342	0.0157	0.0004	0.0504	0.0486	0.0172	0.0034	0.0693
IN	0.0758	0.0103	0.001	0.087	0.1089	0.0119	0.0099	0.1307
KS(a)	0.0081	0	0	0.0081	0.0137	0.0012	0.0010	0.0159
KY	0.0411	0.0054	0.0023	0.0487	0.0632	0.0038	0.0069	0.0740
MA	0.0653	0.0127	0.0579	0.136	0.0860	0.1544	0.0773	0.3176
MD	0.0398	0.0019	0.0034	0.0451	0.0780	0.0062	0.0040	0.0882
ME	0.0032	0.0243	0.0294	0.057	0.0030	0.0356	0.0236	0.0622
MI	0.0611	0.0083	0.0031	0.0726	0.0656	0.0095	0.0093	0.0844
MN	0.0089	0.0043	0.0005	0.0137	0.0107	0.0022	0.0023	0.0151
MO	0.014	0	0	0.014	0.0215	0.0115	0.0041	0.0371
MS(a)	0	0.0002	0.0002	0.0003	0	0.0002	0.0002	0.0004
NC	0.0342	0.0081	0.0014	0.0437	0.0554	0.0057	0.0019	0.0630
ND(a)					0	0.0009	0.0012	0.0021
NE(a)	0.0017	0	0	0.0017	0.0028	0	0.0009	0.0037
NH	0.0386	0.0022	0.0071	0.0479	0.0666	0.0020	0.0065	0.0750
NJ	0.013	0.0025	0.0076	0.0232	0.0187	0.0033	0.0133	0.0354
NY	0.0577	0.0118	0.0505	0.12	0.0736	0.0363	0.0578	0.1677
OH	0.1402	0.0081	0.0013	0.1496	0.2248	0.0457	0.0055	0.2759
OK(a)	0.0059	0	0	0.0059	0.0071	0.0015	0.0006	0.0092
PA	0.1383	0.0196	0.0126	0.1706	0.2354	0.0214	0.0156	0.2725
RI	0	0	0.0074	0.0074	5.9E-06	0.0007	0.0043	0.0050
SC	0.0092	0.003	0.001	0.0132	0.0134	0.0036	0.0012	0.0182
SD(a)	0.0009	0	0	0.0009	0.0012	2.8E-05	0.0009	0.0022
TN	0.0192	0.0045	0.0024	0.0261	0.0286	0.0076	0.0031	0.0393
TX(a)	0	0	0	0	1.1E-05	0	2.3E-05	3.5E-05
VA	0.0319	0.0082	0.0007	0.0407	0.0389	0.0081	0.0029	0.0499
VT	0	0.0004	0.0169	0.0173	4.0E-06	0.0004	0.0026	0.0030
WI	0.0152	0.0196	0.0005	0.0353	0.0254	0.0085	0.0019	0.0358
WV	0.0583	0.0053	0.0006	0.0642	0.0865	0.0086	0.0016	0.0966
Canada(b)	0	0.1914	0	0.1914				
Totals	**0.96511**	**0.3854**	**0.21832**	**1.5688**	**1.45**	**0.44**	**0.28**	**2.17**

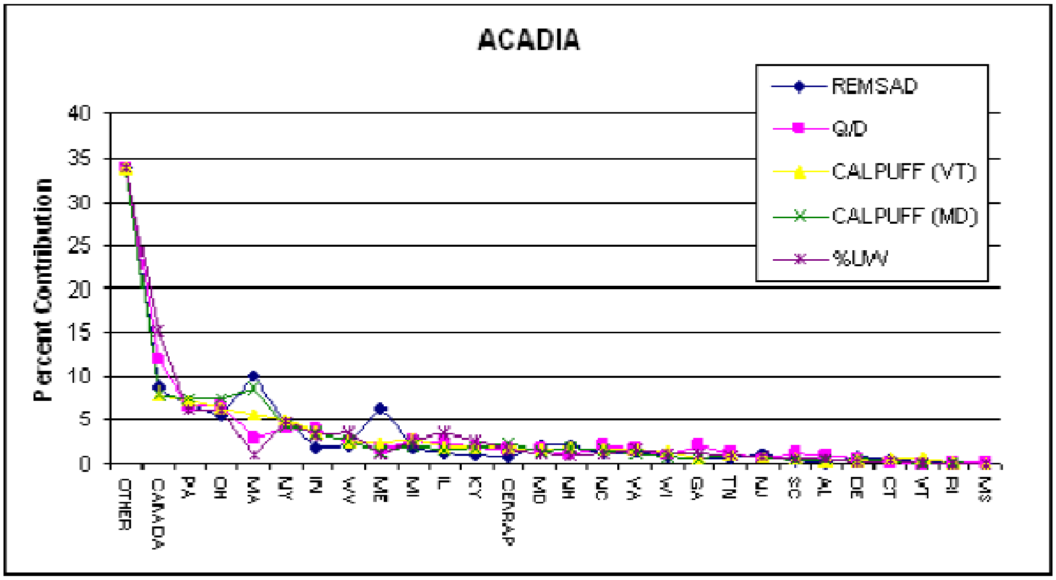
Notes:

(a) Only sources in that portion of the state within the RPO modeling domain were modeled.
(b) 52 Canadian point sources > 250 tons/yr SO_2 emissions during 2002 (from Canadian NPRI).

From: *Table 7-2a of Contributions to Regional Haze in the Northeast and Mid-Atlantic United States, NESCAUM, 2006.*

An alternative means of displaying the above results is in Table 7-7, which shows the individual state rankings produced by different assessment techniques for Acadia National Park, Maine. In the left-side column of Table 7-7, states are colored according to their average ranking across the different assessment methods. Those states that are ranked in the top five on average, across all techniques are colored red, while states ranked in the top six through ten are colored magenta, and so on for each group of five going down the left-side column. Through this color scheme, one can see how the states' average ranking compares to their rankings under each individual assessment method given in the other columns of the table. The fact that all techniques tend to come to consistent conclusions about which states are top contributors provides confidence that the source regions with the most influence on sulfate levels at MANE-VU Class I sites can be correctly identified. Note that the CENRAP states and several other states along the border of the analysis domain represent only partial state contributions.

Figure 7-2
Ranked Contribution to Sulfate Concentrations at Acadia National Park



The ranking of emissions contributions to visibility impairment in the MANE-VU Class I Areas by methods such as these has direct relevance to the consultation process described previously in Section 3, Regional Planning and Consultation. Using results from the results from the Contribution Assessment, Maine utilized the following criteria to identify states and regions for the purposes of consultation on regional haze:

1. Any state/region that contributed 0.1 $\mu g/m^3$ sulfate or greater on the 20 percent worst visibility days in the base year (2002),

2. Any state/region that contributed at least 2 percent of total sulfate observed on the 20 percent worst visibility days in 2002, and

3. Any state/region among the top ten contributors on the 20 percent worst visibility days in 2002.

Table 7-7
Individual State Rankings Produced by Different Assessment Techniques for Acadia National Park

Average	REMSAD	Q/d	CALPUFF (VT)	CALPUFF (MD)	E x RTP
CANADA	MA	CANADA	CANADA	MA	CANADA
PA	CANADA	PA	PA	CANADA	PA
OH	PA	OH	OH	OH	OH
MA	ME	NY	MA	PA	NY
NY	OH	IN	NY	NY	IL
IN	NY	MA	IN	IN	WV
WV	WV	MI	MI	WV	IN
ME	NH	WV	WV	CENRAP	MI
MI	MD	IL	ME	MI	KY
IL	IN	GA	IL	NH	CENRAP
KY	MI	NC	CENRAP	KY	VA
CENRAP	VA	KY	KY	IL	ME
MD	NC	VA	NH	NC	GA
NH	NJ	MD	MD	MD	WI
NC	IL	CENRAP	NC	ME	MD
VA	KY	ME	VA	VA	NC
WI	DE	TN	WI	TN	NH
GA	CENRAP	SC	TN	WI	MA
TN	WI	AL	NJ	NJ	TN
NJ	CT	WI	VT	GA	NJ
SC	GA	NH	GA	DE	AL
AL	TN	NJ	SC	SC	SC
DE	SC	DE	CT	AL	CT
CT	AL	CT	DE	CT	DE
VT	RI	MS	AL	RI	VT
RI	VT	RI	RI	VT	DC
MS	MS	VT	DC	DC	RI
DC	DC	DC	MS	MS	MS

8. Emissions Inventory

8.1 Sources of Visibility Impairing Pollutants in MANE-VU

This section explores the origin and quantity of haze-forming pollutants emitted in the Eastern and the mid-Atlantic United States.

Section 51.308(d)(4)(v) of EPA's Regional Haze Rule requires a statewide emission inventory of pollutants that are reasonably anticipated to cause or contribute to visibility impairment in any mandatory Class I area. The pollutants inventoried by Maine that affect fine particle formation, and thus contribute to regional haze, are sulfur oxides (SO_X), nitrogen oxides (NO_X), volatile organic compounds (VOC), ammonia (NH_3), and particles with an aerodynamic diameter less than or equal to 10 and 2.5 µm (i.e., primary PM_{10} and $PM_{2.5}$).

The emissions dataset illustrated below is the 2002 MANE-VU Version 3 regional haze emissions inventory. The emission inventories include carbon monoxide (CO), but it is not considered here as it does not contribute to regional haze. The MANE-VU regional haze emissions inventory version 3.0, released in April 2006, has superseded version 2.0 for modeling purposes. This inventory update was developed through the Mid-Atlantic Regional Air Management Association (MARAMA) for the MANE-VU RPO. This section describes emission characteristics by pollutant and source type (e.g., point, area, and mobile).

8.1.1 Sulfur Dioxide (SO_2)

SO_2 is the primary precursor pollutant for sulfate particles. Sulfate particles commonly account for more than 50 percent of particle-related light extinction at northeastern Class I areas on the clearest days and for as much as or more than 80 percent on the haziest days. Hence, SO_2 emissions are an obvious target of opportunity for reducing regional haze in the eastern United States. Combustion of coal and, to a lesser extent, of certain petroleum products accounts for most anthropogenic SO_2 emissions. In fact, in 1998 a single source category, coal-burning power plants, was responsible for two-thirds of total SO_2 emissions nationwide (NESCAUM, 2001a).

Figure 8-1 shows SO_2 emissions trends in the MANE-VU states as extracted from the 2002 MANE-VU inventory (EPA, 2005). Most states in the region showed declines in annual SO_2 emissions through 2002 compared with those in previous inventories. This decline can be attributed in part to implementation of Phase 2 of the Acid Rain Program, which in 2000 further reduced allowable emissions below Phase I levels and extended emission limits to a greater number of power plants.

The bar graph in Figure 8-2 shows the percent contribution from different source categories to overall, annual 2002 SO_2 emissions in the MANE-VU states. The graph shows that point sources dominate SO_2 emissions, which primarily consist of stationary

Figure 8-1
State Level Sulfur Dioxide Emissions

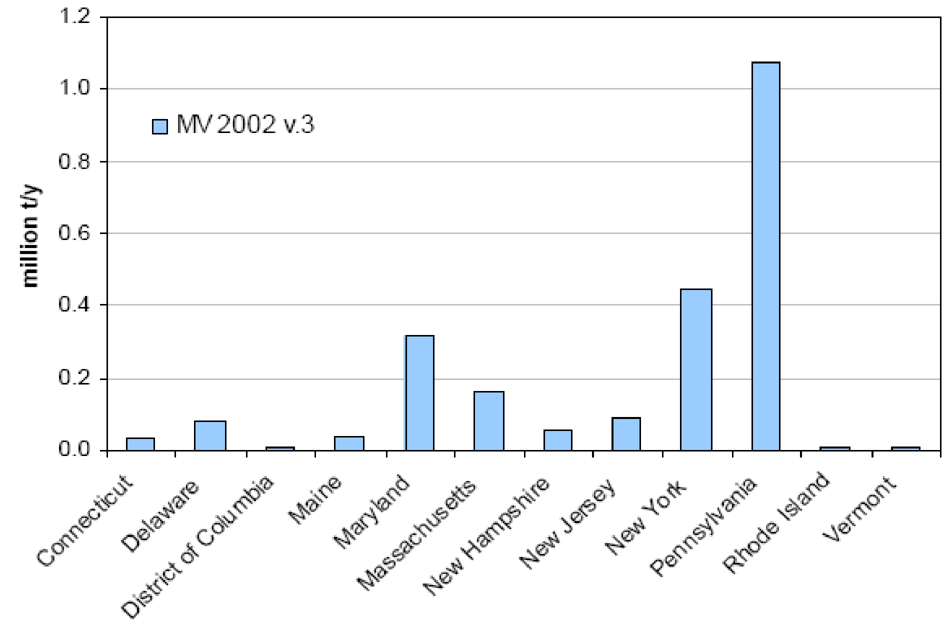
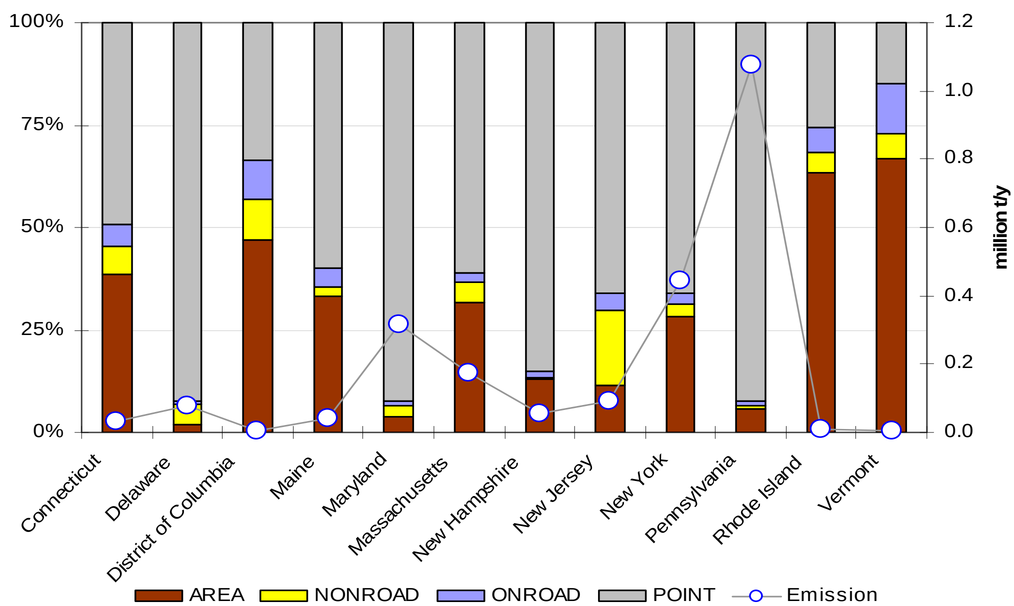


Figure 8-2
2002 SO_2
(Bar graph: Percentage fraction of four source categories, Circle: Annual emissions amount in 10^6 tons per year)



combustion sources for generating electricity, industrial energy, and heat. Smaller stationary combustion sources called "area sources" (primarily commercial and residential heating, and smaller industrial facilities) are another important source category in the MANE-VU states. By contrast, on-road and non-road mobile sources make only a relatively small contribution to overall SO_2 emissions in the region (NESCAUM, 2001a).

8.1.2 Volatile Organic Compounds (VOC)

Existing emission inventories generally refer to "volatile organic compounds" (VOCs) for hydrocarbons whose volatility in the atmosphere makes them particularly important from the standpoint of ozone formation. From a regional haze perspective, there is less concern with the volatile organic gases emitted directly to the atmosphere and more with the secondary organic aerosol (SOA) that the VOCs form after condensation and oxidation processes. Thus the VOC inventory category is of interest primarily from the organic carbon perspective of PM2.5.

After sulfate, organic carbon generally accounts for the next largest share of fine particle mass and particle-related light extinction at northeastern Class I sites. The term organic carbon encompasses a large number and variety of chemical compounds that may come directly from emission sources as a part of primary PM or may form in the atmosphere as secondary pollutants. The organic carbon present at Class I sites includes a mix of species, including pollutants originating from anthropogenic (i.e., manmade) sources as well as biogenic hydrocarbons emitted by vegetation. Recent efforts to reduce manmade organic carbon emissions have been undertaken primarily to address summertime ozone formation in urban centers. Future efforts to further reduce organic carbon emissions may be driven by programs that address fine particles and visibility.

Understanding the transport dynamics and source regions for organic carbon in northeastern Class I areas is likely to be more complex than for sulfate. This is partly because of the large number and variety of OC species, the fact that their transport characteristics vary widely, and the fact that a given species may undergo numerous complex chemical reactions in the atmosphere. Thus, the organic carbon contribution to visibility impairment at most Class I sites in the East is likely to include manmade pollution transported from a distance, manmade pollution from nearby sources, and biogenic emissions, especially terpenes from coniferous forests.

Organic carbon emissions in the form of smoke from both natural (wildfire) and anthropogenic (prescribed and agricultural burning activities) have been shown to have a significant impact on visibility in Class I areas. In the western United States, organic carbon is responsible for a significant portion of visibility impacts at Class I areas, with wildfire and prescribed burning the principal emissions sources. In the eastern United States, organic carbon emissions play a lesser, but still important role in visibility degradation, with fire (both wildfire and anthropogenic) responsible for a smaller proportion of organic carbon emissions.

The National Park Service investigated the impact of fire on regional air quality using several modeling and air quality analysis techniques[21]. One of the more interesting

[21] "Fire Effects on Regional Air Quality Including Visibility," Draft Report, National Park Service, Air Resources Division, August 1, 2006.

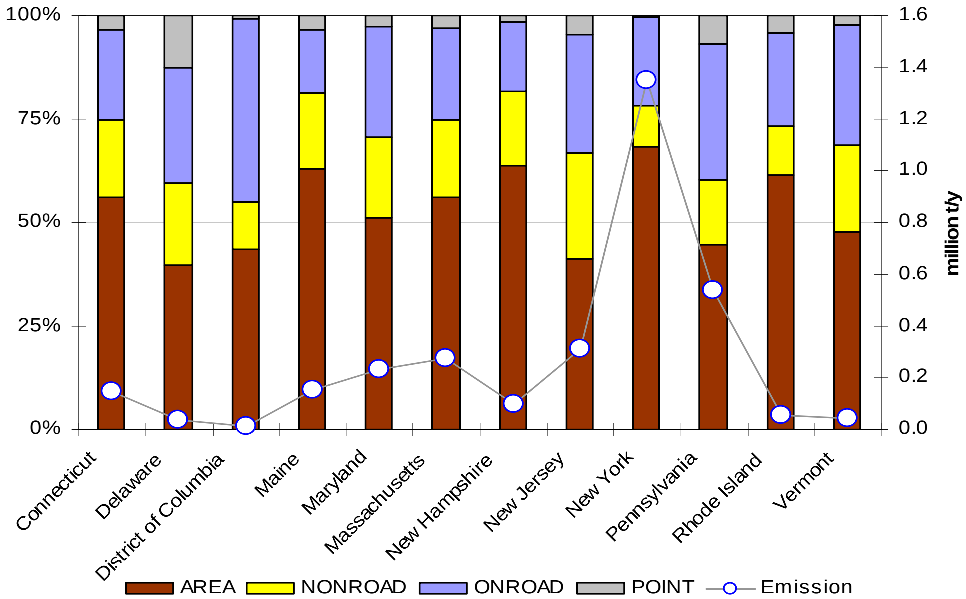
approaches analyzed the ratio of organic carbon to black (or elemental) carbon at IMPROVE monitor sites. The ratio of organic to elemental carbon (OC/EC) can be used to identify the likely source of organic carbon emissions, since this ratio displays significant variability, depending on the source of combustion. For example, internal combustion engines, which burn relatively efficiently, typically have a ratio of about 3, while less efficient combustion, which is characteristic of open fires, result in OC/EC ratios on the order of 10 or more. Using this approach, researchers estimated that fire was responsible for approximately 55% of all organic carbon monitored in the eastern United States.[22] An alternative apportionment method utilizing a fire occurrence database and back trajectories was also utilized to estimate fire impacts on observed organic carbon measurements. This approach estimated that approximately 20% of organic carbon observed at eastern United States IMPRIOVE sites was due to wildland fires, but likely is an underestimation of the impact of fire on visibility, since the fire activity datasets and back trajectory databases are incomplete.

Although organic carbon is responsible for approximately 13 percent of the baseline worst visibility (throughout the MANE-VU region), sulfates account for approximately 75 percent of baseline visibility degradation.[23] Conversely, for natural background visibility conditions, organic carbon is estimated to be responsible for approximately 50 percent of visibility degradation, while sulfates are responsible for only about 20 percent of the visibility degradation on the worst visibility days. This result arises from the fact that organic carbon concentrations under worst day baseline conditions differ relatively little from estimated worst day concentrations under natural background conditions. Sulfate concentrations, however, are approximately 90 percent higher under worst day baseline conditions. With sulfates being responsible for the preponderance of visibility degradation, and many organic carbon emissions being biogenic in nature (as confirmed by the minimal difference between baseline and natural background estimated concentrations), it makes sense to target sulfate levels for the first (and perhaps subsequent rounds) of regional haze controls. As noted above, organic carbon could be the subject of future control measures to mitigate regional haze, but is not the focus of initial planning efforts.

As shown in Figure 8-3, the VOC inventory is dominated by mobile and area sources. On-road mobile sources of VOCs include exhaust emissions from gasoline passenger vehicles and diesel-powered heavy-duty vehicles as well as evaporative emissions from transportation fuels. VOC emissions may also originate from a variety of area sources (including solvents, architectural coatings, and dry cleaners) as well as from some point sources (e.g., industrial facilities and petroleum refineries).

[22] This technique tends to overestimate the OC/EC ratio due to the presence of secondary organic aerosols, that are not associated with elemental carbon.
[23] Nitrate and elemental carbon at 8% and 4%, respectively, account for most of the rest of the visibility degradation on the 20 percent worst days.

Figure 8-3
2002 VOC
(Bar graph: Percentage fraction of four source categories, Circle: Annual emissions in million tons per year)



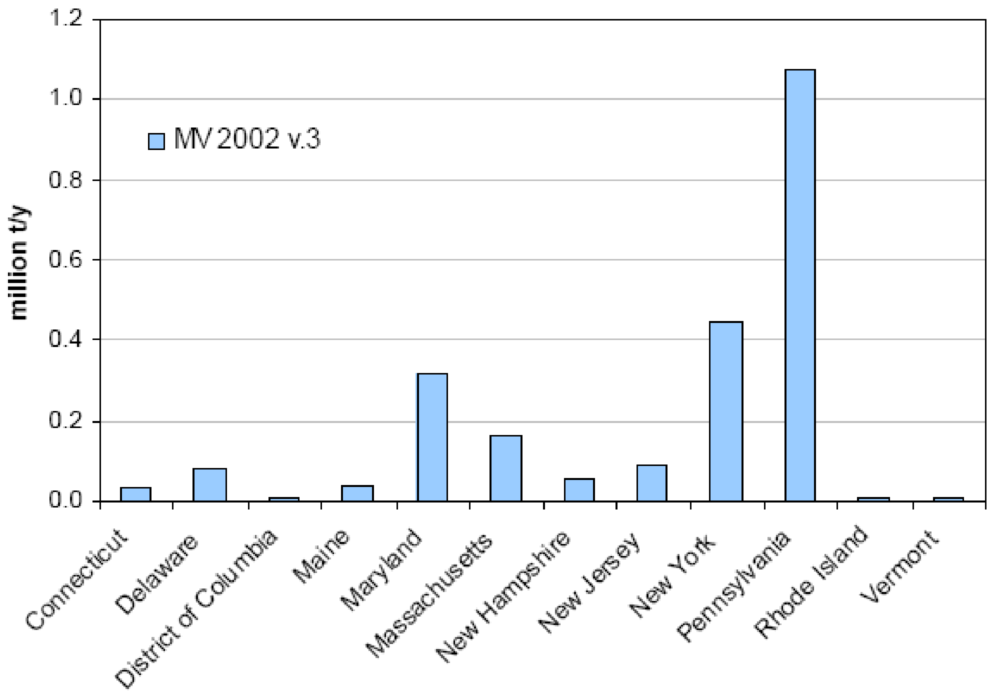
Biogenic VOCs may play an important role within the rural settings typical of Class I sites. The oxidation of hydrocarbon molecules containing seven or more carbon atoms is generally the most significant pathway for the formation of light-scattering organic aerosol particles (Odum et al., 1997). Smaller reactive hydrocarbons that may contribute significantly to urban smog (ozone) are less likely to play a role in organic aerosol formation, though it was noted that high ozone levels can have an indirect effect on visibility by promoting the oxidation of other available hydrocarbons, including biogenic emissions (NESCAUM, January 2001). In short, further work is needed to characterize the organic carbon contribution to regional haze in the Northeast and Mid-Atlantic states and to develop emissions inventories that will be of greater value for visibility planning purposes.

8.1.3 Oxides of Nitrogen (NO_X)

NO_X emissions contribute to visibility impairment in the eastern U.S. by forming light-scattering nitrate particles. Nitrate generally accounts for a substantially smaller fraction of fine particle mass and related light extinction than sulfate and organic carbon at northeastern Class I sites. Notably, nitrate may play a more important role at urban sites and in the wintertime. In addition, NO_X may have an indirect effect on summertime visibility by virtue of its role in the formation of ozone, which in turn promotes the formation of secondary organic aerosols (NESCAUM 2001a).

Since 1980, nationwide emissions of NO_X from all sources have shown little change. To a large extent, increases from the industrial and power plant combustion sectors have been offset by emission reductions from mobile source controls implemented during the same time period. Figure 8-4 shows NO_X emissions in the MANE-VU region at the state level. In the several years just prior to 2002, most MANE-VU states experienced declining NO_x emissions.

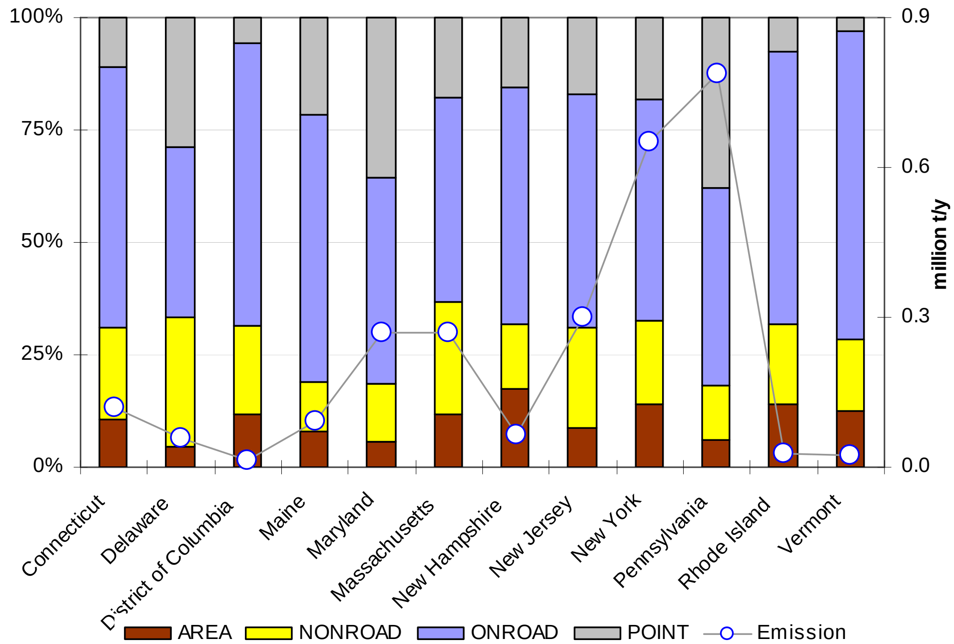
Figure 8-4
State Level Nitrogen Oxides Emissions



Power plants and mobile sources generally dominate state and national NO_x emissions inventories. Nationally, power plants account for more than one-quarter of all NO_x emissions, amounting to over six million tons. The electric sector plays an even larger role, however, in parts of the industrial Midwest where high NO_x emissions have a particularly significant power plant contribution. By contrast, mobile sources dominate the NO_x inventories for more urbanized Mid-Atlantic and New England states to a far greater extent, as shown in Figure 8-5. In these states, on-road mobile sources - a category that mainly includes highway vehicles - represent the most significant NO_x source category. Emissions from non-road (i.e., off-highway) mobile sources, primarily diesel-fired engines, also represent a substantial fraction of the inventory. While there are fewer uncertainties associated with available NO_x estimates than in the case of other key haze-related pollutants - including primary fine particle and ammonia emissions - further efforts could improve current inventories in a number of areas (NESCAUM, 2001a).

In particular, better information on the contribution of area and non-highway mobile sources may be of most interest in the context of regional haze planning. First, available emission estimation methodologies are weaker for these types of sources than for the large stationary combustion sources. Moreover, because SO_2 and NO_X emissions must mix with ammonia to participate in secondary particle formation, emissions that occur over large areas at the surface may be more efficient in secondary fine particulate formation than concentrated emissions from isolated tall stacks (Duyzer, 1994).

Figure 8-5
NO_X
(Bar graph: Percentage fraction of four source categories, Circle: Annual emissions amount in 10^6 tons per year)



8.1.4 Primary Particle Matter (PM_{10} and $PM_{2.5}$)

Directly-emitted or "primary" particles (as distinct from secondary particles that form in the atmosphere through chemical reactions involving precursor pollutants like SO_2 and NO_X) can also contribute to regional haze. For regulatory purposes, a distinction is made between particles with an aerodynamic diameter less than or equal to 10 micrometers and smaller particles with an aerodynamic diameter less than or equal to 2.5 micrometers (i.e., primary PM_{10} and $PM_{2.5}$, respectively).

Figure 8-6 and Figure 8-7 show PM_{10} and $PM_{2.5}$ emissions, respectively, for the MANE-VU states as reported for the 2002 base year. Most states showed a steady decline in annual PM_{10} emissions over this time period. By contrast, emission trends for primary $PM_{2.5}$ are more variable.

Crustal sources are significant contributors of primary PM emissions. This category includes fugitive dust emissions from construction activities, paved and unpaved roads, and agricultural tilling. Typically, monitors estimate PM_{10} emissions from these types of sources by measuring the horizontal flux of particulate mass at a fixed downwind sampling location within perhaps 10 meters of a road or field. Comparisons between estimated emission rates for fine particles using these types of measurement techniques and observed concentrations of crustal matter in the ambient air at downwind receptor sites suggest that physical or chemical processes remove a significant fraction of crustal

Figure 8-6
State Level Primary PM_{10} Emissions

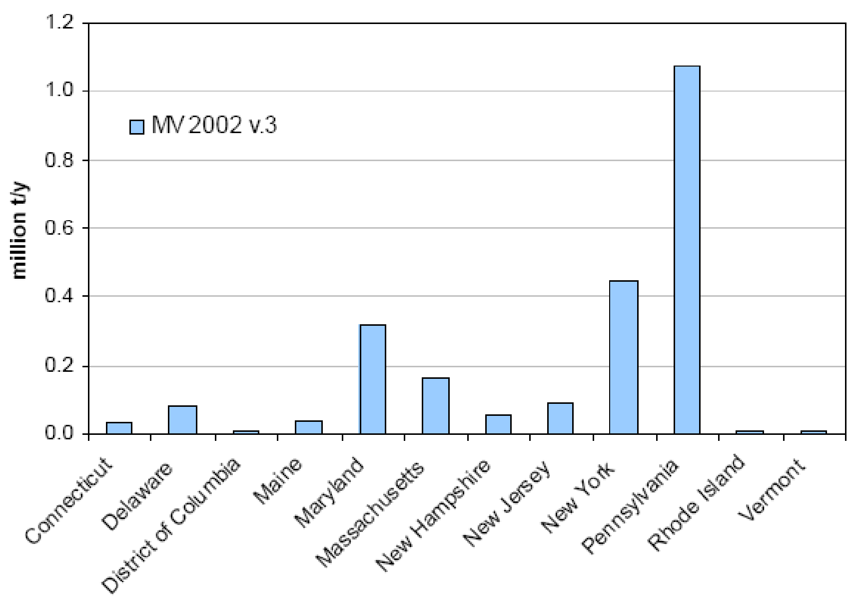
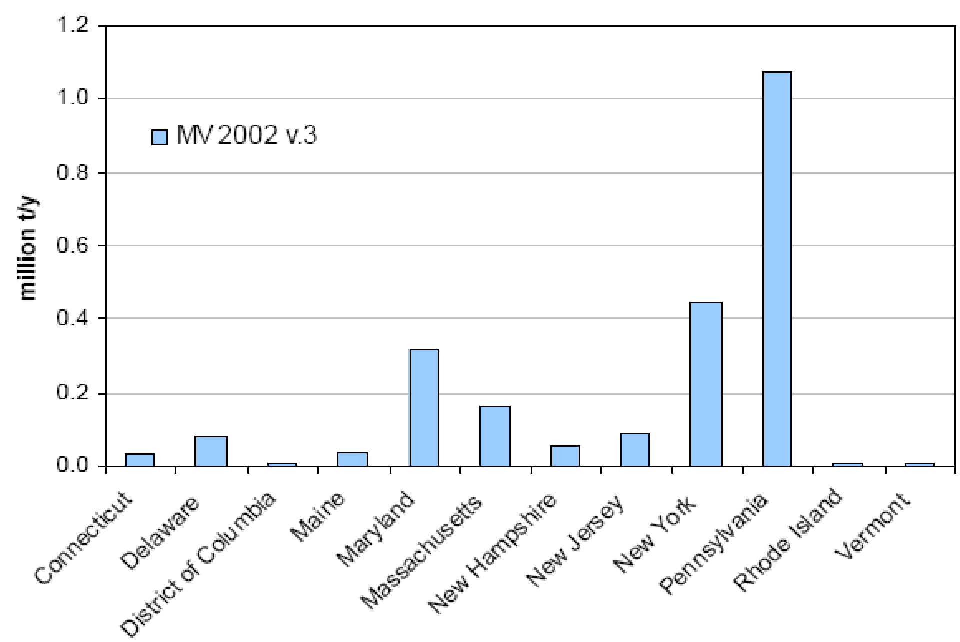


Figure 8-7
State Level Primary $PM_{2.5}$ Emissions*



* 1996 and 1999 Maine PM2.5 data augmented.

material relatively quickly. As a result, it rarely entrains into layers of the atmosphere where it can transport to downwind receptor locations. Because of this discrepancy between estimated emissions and observed ambient concentrations, modelers typically reduce estimates of total $PM_{2.5}$ emissions from all crustal sources by applying a factor of 0.15 to 0.25 to the total $PM_{2.5}$ emissions before including it in modeling analyses.

From a regional haze perspective, crustal material generally does not play a major role. On the 20 percent best-visibility days during the baseline period (2000-2004), it accounted for six to eleven percent of particle-related light extinction at MANE-VU Class 1 sites. On the 20 percent worst-visibility days, however, crustal material generally plays a much smaller role relative to other haze-forming pollutants, ranging from two to three percent. Moreover, the crustal fraction includes material of natural origin (such as soil or sea salt) that is not targeted under the Haze Rule. Of course, the crustal fraction can be influenced by certain human activities, such as construction, agricultural practices, and road maintenance (including wintertime salting). Thus, to the extent that these types of activities are found to affect visibility at northeastern Class I sites, control measures targeted at crustal material may prove beneficial and are within the purview of EPA and state agencies.

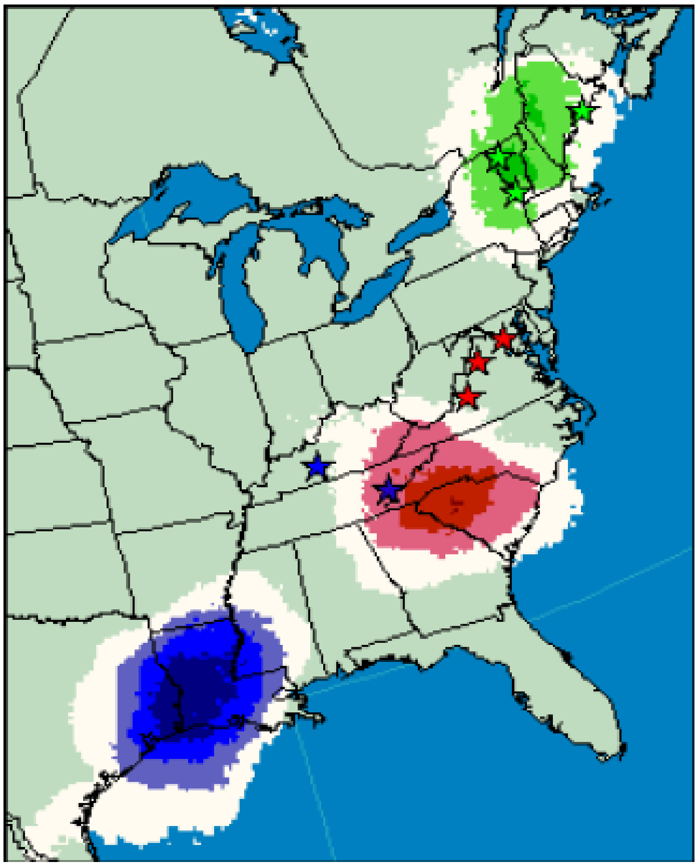
Experience from the western United States, where the crustal component has generally played a more significant role in driving overall particulate levels, may be helpful to the extent that it is relevant in the eastern context. In addition, a few areas in the Northeast, such as New Haven, Connecticut and Presque Isle, Maine, have some experience with the control of dust and road-salt as a result of regulatory obligations stemming from their past non-attainment status with respect to the NAAQS for PM_{10}.

Current emissions inventories for the entire MANE-VU area indicate residential wood combustion represents 25 percent of primary fine particulate emissions in the region. This finding implies that rural sources can play an important role in addition to the contribution from the region's many highly populated urban areas. An important consideration in this regard is that residential wood combustion occurs primarily in the winter months, while managed or prescribed burning activities occur largely in other seasons. The latter category includes agricultural field-burning activities, prescribed burning of forested areas and other burning activities such as construction waste burning. Particulate emissions from many of these sources can be managed by limiting allowed burning activities to times when favorable meteorological conditions can efficiently disperse the emissions.

Although the data are currently limited, Maine and the other MANE-VU states are concerned about the growing use of residential woodstoves and outdoor wood boilers by homeowners seeking alternatives to petroleum-based fuels for home heating. Over the next several years, Maine will continue to evaluate monitored particulate mater levels in the state and in particular, assess the smoke component of the monitored particulate matter to determine if there is any trend in smoke levels in Maine. If smoke levels increase significantly, that might be cause for evaluating whether additional control measures for this source category may be necessary.

Figure 8-8, taken from Appendix B of the MANE-VU Contribution Assessment (Attachment A), represents the results of source apportionment and trajectory analyses on wood smoke in the region extending form the Gulf States to the Northeast. The green-highlighted portion of the map depicts the wood smoke source region in the northeast states. The stars on the map represent air monitoring sites (including those at several Class I areas) whose data sets were determined to be useful to the modeling analysis.

Figure 8-8
Wood Smoke Source Regional Aggregation



Northeast: ACAD, PMRC, LYBR
Mid-Atlantic: WASH, SHEN, JARI
Southeast: GRSM, MACA

MANE-VU's "Technical Support Document on Agricultural and Forestry Smoke Management in the MANE-VU Region, September 1, 2006 (Attachment Y), concluded that fire from land management activities was not a major contributor top regional haze in the MANE-VU Class I areas, and that the majority of emissions from fires were from residential wood combustion.

Figures 8-9 and Figure 8-10 show that area and mobile sources dominate primary PM emissions. (The NEI inventory categorizes residential wood combustion and some other combustion sources as area sources.) The relative contribution of point sources is larger in the primary $PM_{2.5}$ inventory than in the primary PM_{10} inventory since the crustal component (which consists mainly of larger or "coarse-mode" particles) contributes mostly to overall PM_{10} levels. At the same time, pollution control equipment commonly installed at large point sources is usually more efficient at capturing coarse-mode particles.Figure 8-9

Primary PM_{10}

(Bar graph: Percentage fraction of four source categories, Circle: Annual emissions amount in 106 tons per year)

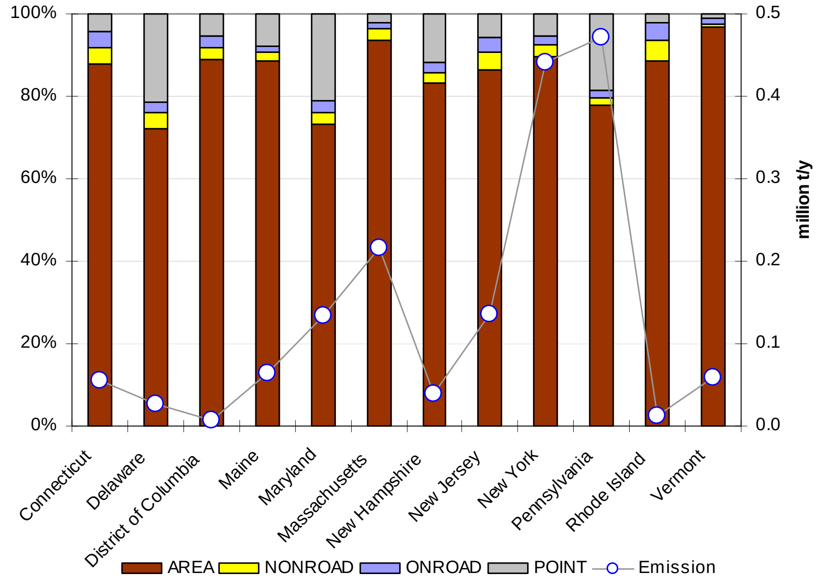
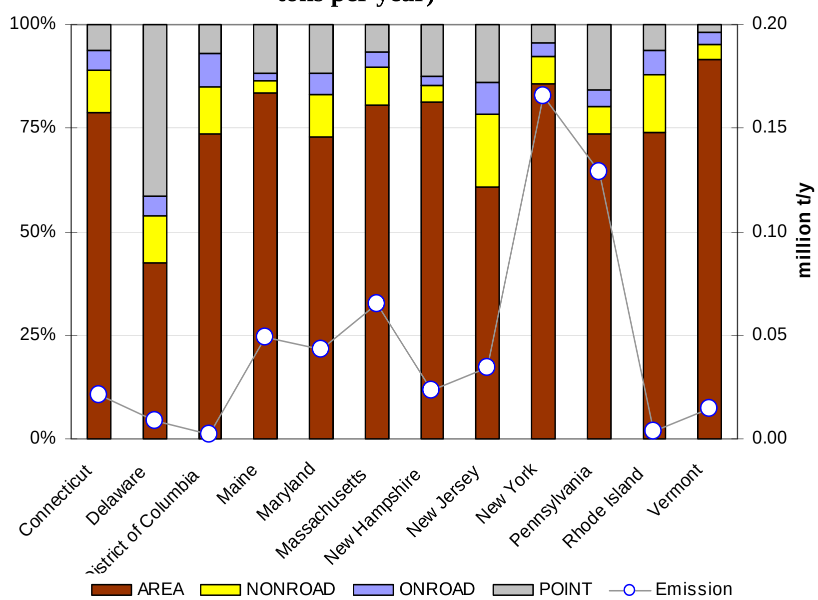


Figure 8-10

Primary $PM_{2.5}$

(Bar graph: Percentage fraction of four source categories, Circle: Annual emissions amount in 106 tons per year)



8.1.5 Ammonia Emissions (NH_3)

Knowledge of ammonia emission sources will be necessary in developing effective regional haze reduction strategies because of the importance of ammonium sulfate and ammonium nitrate in determining overall fine particle mass and light scattering. According to 1998 estimates, livestock agriculture and fertilizer use accounted for approximately 86 percent of all ammonia emissions to the atmosphere (EPA, 2000b). However, improved ammonia inventory data are needed as inputs to the photochemical models used to simulate fine particle formation and transport in the eastern United States. States were not required to include ammonia in their emissions data collection efforts until fairly recently (See Consolidated Emissions reporting rule, 67 CFR 39602, June 10, 2002). Therefore, emissions data for ammonia do not exist at the same level of detail or reliability as exist for other pollutants.

Ammonium ion (formed from ammonia emissions to the atmosphere) is an important constituent of airborne particulate matter, typically accounting for 10–20 percent of total fine particle mass. Reductions in ammonium ion concentrations can be extremely beneficial because a more-than-proportional reduction in fine particle mass can result. Ansari and Pandis (1998) showed that a one $\mu g/m^3$ reduction in ammonium ion could result in up to a four $\mu g/m^3$ reduction in fine particulate matter. Decision makers, however, must weigh the benefits of ammonia reduction against the significant role it plays in neutralizing acidic aerosol.[24]

To address the need for improved ammonia inventories, MARAMA, NESCAUM and EPA funded researchers at Carnegie Mellon University (CMU) in Pittsburgh to develop a regional ammonia inventory (Davidson et al., 1999). This study focused on three issues with respect to current emissions estimates: (1) a wide range of ammonia emission factor values, (2) inadequate temporal and spatial resolution of ammonia emissions estimates, and (3) a lack of standardized ammonia source categories.

The CMU project established an inventory framework with source categories, emissions factors, and activity data that are readily accessible to the user. With this framework, users can obtain data in a variety of formats[25] and can make updates easily, allowing additional ammonia sources to be added or emissions factors to be replaced as better information becomes available (Strader et al., 2000; NESCAUM, 2001b).

Figure 8-11 shows that estimated ammonia emissions for the MANE-VU states in 2002. Area and on-road mobile sources dominate according to Figure 8-12. Specifically, emissions from agricultural sources and livestock production account for the largest share of estimated ammonia emissions in the MANE-VU region, except in the District of

[24] SO_2 reacts in the atmosphere to form sulfuric acid (H_2SO_4). Ammonia can partially or fully neutralize this strong acid to form ammonium bisulfate or ammonium sulfate. If planners focus future control strategies on ammonia and do not achieve corresponding SO_2 reductions, fine particles formed in the atmosphere will be substantially more acidic than those presently observed.
[25] For example, the user will have the flexibility to choose the temporal resolution of the output emissions data or to spatially attribute emissions based on land-use data.

Figure 8-11
State Level Ammonia Emissions

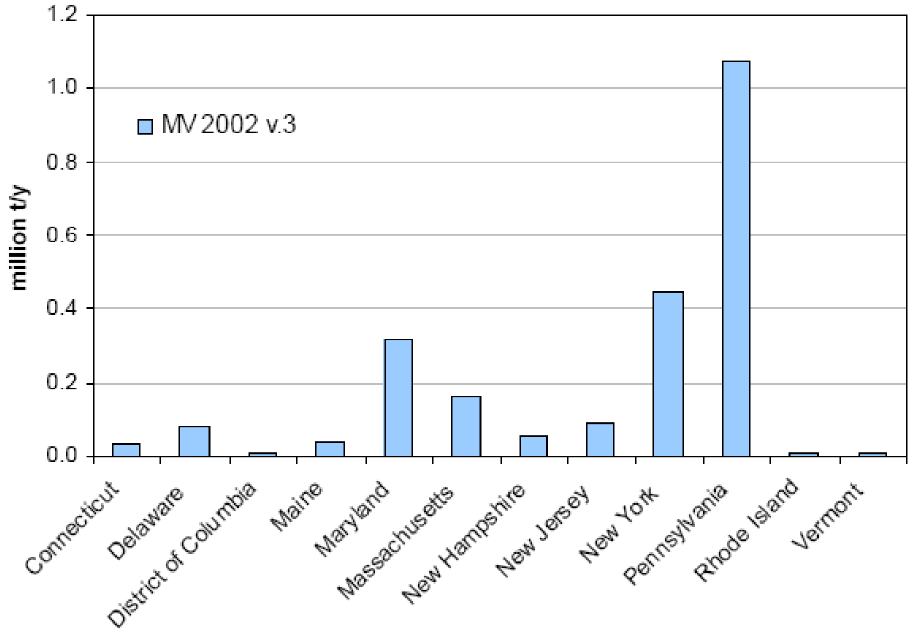
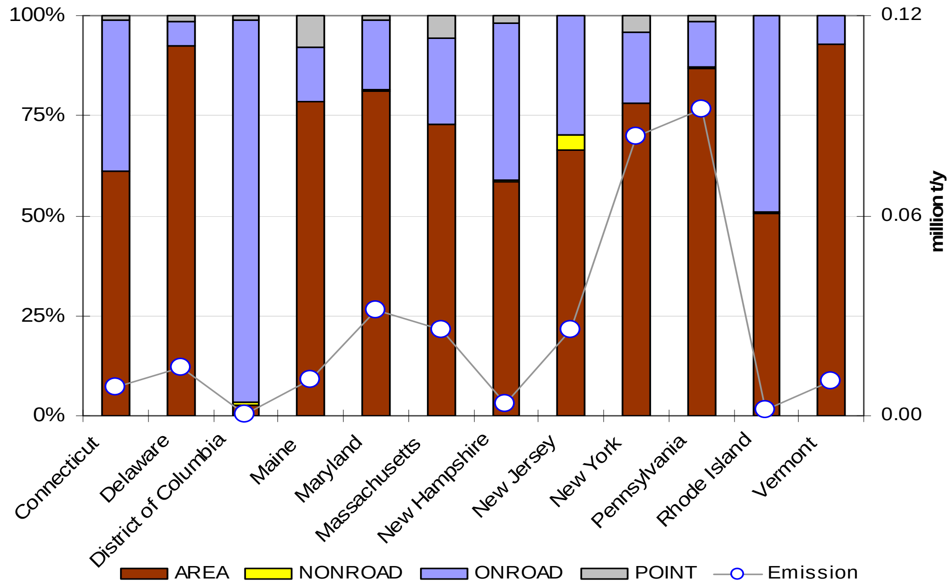


Figure 8-12
State Ammonia Emissions by Source Category
(Bar graph: Percentage fraction of four source categories)
(Circle: Annual emissions amount in 10^6 tons per year)



Columbia. The two remaining sources with a significant emissions contribution are wastewater treatment systems and gasoline exhaust from highway vehicles.

8.2 Baseline and Future Year Emission Inventories for Modeling

40 CFR Section 51.308(d) (3) (iii) requires the State of Maine to identify the baseline emission inventory on which strategies are based. The baseline inventory is intended to be used to assess progress in making emission reductions. Based on EPA guidance entitled, "2002 Base Year Emission Inventory SIP Planning: 8-hour Ozone, $PM_{2.5}$, and Regional Haze Programs" which identifies 2002 as the anticipated baseline emission inventory year for regional haze, all of the MANE-VU states are using 2002 as the baseline year for regional haze inventories

With contractor assistance, MARAMA developed a 2002 baseline modeling inventory using the inventories that Maine and other states submitted to EPA to meet their SIP obligations and the requirements of the Consolidated Emissions Reporting Rule (CERR). To create the 2002 baseline inventory for modeling, MARAMA and its contractor quality-assured and augmented states' inventories and generated the necessary input files for the emissions processing model.

Future-year inventories for 2009, 2012, and 2018 were projected from the 2002 base year. These future-year emissions inventories include emissions growth due to projected increases in economic activity as well as emissions reductions expected from the implementation of control measures. While the 2009 and 2012 emissions projections were originally developed in support of participating state's ozone attainment demonstrations, the inventory for 2018 (the year targeted by the Regional Haze Rule) was developed for the specific purposes of regional haze SIP planning. Therefore, although the 2009 and 2012 projected inventories are mentioned in subsequent sections, only the 2002 baseline inventory and 2018 projected inventory are described below in Section 7.5, Summary of Emissions Inventories.

Accurate baseline and future-year emissions inventories are crucial to the analyses required for the regional haze SIP process. These emissions inventories were used to drive the air quality modeling simulations undertaken to assess the visibility improvements that would result from possible control measures. Air quality modeling was also used to perform a pollution apportionment, which evaluates the contribution to visibility impairment by geographic region and emission source sector.

To be compatible with the air quality modeling simulations, the baseline and future-year emissions inventories were processed with the Sparse Matrix Operator Kernel Emissions (SMOKE) emissions pre-processor for subsequent input into the CMAQ and REMSAD air quality models. Further description of the base and future-year emissions inventories is provided below.

8.2.1 Baseline Inventory

The starting point for the 2002 baseline emissions inventory was the 2002 inventory submittals that were made to EPA by state and local agencies as part of the Consolidated Emissions Reporting Rule (CERR). With contractor assistance (E.H. Pechan &

Associates), MANE-VU then coordinated and quality-assured the 2002 inventory data, and prepared it for input into the SMOKE emissions model. The 2002 emissions from non-MANE-VU areas within the modeling domain were obtained from other Regional Planning Organizations for their corresponding areas. These Regional Planning Organizations included the Visibility Improvement State and Tribal Association of the Southeast (VISTAS), the Midwest Regional Planning Organization (MRPO), and the Central Regional Air Planning Association (CENRAP).

The 2002 baseline inventory went through several iterations. Work on Version 1 of the 2002 MANE-VU inventory began in April 2004, and the final inventory and SMOKE input files were completed during January 2005. Work on Version 2 (covering the period of April through September 2005) involved incorporating revisions requested by some MANE-VU state/local agencies on the point, area, and on-road categories. Work on Version 3 (covering the period from December 2005 through April 2006) included additional revisions to the point, area, and on-road categories as requested by some states. Thus, the Version 3 inventory for point, area, and on-road sources was built upon Versions 1 and 2. This work also included development of the biogenic inventory. In Version 3, the non-road inventory was completely redone because of changes that EPA made to the NONROAD2005 non-road mobile emissions model.

Version 3 of the MANE-VU 2002 baseline emissions inventory was used in the regional air quality modeling simulations, including performance testing of the air quality models used in the development of this SIP. Further description of the data sources, methods, and results for this version of the 2002 baseline inventory is presented in E.H. Pechan & Associates, Inc. "Technical Support Document for 2002 MANE-VU SIP Modeling Inventories, Version 3, November 20, 2006" (Attachment H). Emissions inventory data files are available on the MARAMA website at: http://www.marama.org/visibility/EI_Projects/index.html.

8.2.2 Future Year Emission Control Inventories

Future-year emissions inventories are provided in MACTEC's technical support document "Development of Emissions Projections for 2009, 2012, and 2018 for NonEGU Point, Area, and Nonroad Sources in the MANE-VU Region," Final Report, February 28, 2007, (Attachment I). This document describes the data sources, methods, and modeling results for three future years, five emission source sectors, two emission control scenarios, seven pollutants, and eleven states plus the District of Columbia. The following summarizes the basic framework of the future-year inventories that were developed:

- ***Projection years***: 2009, 2012, and 2018;
- ***Emission source sectors***: point-source electric generating units (EGUs), point-source non-electric generating units (non-EGUs), area sources, non-road mobile sources, and on-road mobile sources.
- ***Emission control scenarios***:
    - A combined on-the-books/on-the-way (OTB/OTW) control strategy

accounting for emission control regulations already in place as of June 15, 2005, as well as some emission control regulations that are not yet finalized but are expected to achieve additional emission reductions by 2009.

- A beyond-on-the-way (BOTW) scenario to account for controls from potential new regulations that may be necessary to meet attainment and other regional air quality goals, mainly for ozone.
- An updated scenario (referred to as the "final modeling inventory") to account for additional potentially reasonable control measures. For the MANE-VU region, these include: SO2 reductions at a set of 167 EGUs which were identified as contributing to visibility impairment at northeast Class I areas; implementation of a low-sulfur fuel strategy for non-EGU sources; and implementation of a BART strategy for BART-eligible sources not controlled under other programs. The final modeling inventory was used to develop the reasonable progress goals in this SIP.
- Pollutants: ammonia, carbon monoxide (CO), oxides of nitrogen (NOx), sulfur dioxide (SO2), volatile organic compounds (VOCs), fine particulate matter (PM2.5, sum of filterable and condensable components), and coarse particulate matter (PM10, sum of filterable and condensable components).

- **States:** The states are those that comprise the MANE-VU region. In addition to the District of Columbia, the 11 MANE-VU states are Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.

8.3 Emission Processor Selection and Configuration

The Sparse Matrix Operator Kernel Emissions (SMOKE) model (Version 2.1) was used by the New York State Department of Environmental Conservation (NYSDEC) to format the emissions inventories for use with the air quality models that are discussed in Chapter 9. SMOKE is principally an emissions processing system, as opposed to a true emissions inventory preparation system, in which emissions estimates are simulated from "first principles." This means that, with the exception of mobile and biogenic sources, its purpose is to provide an efficient, modern tool for converting emissions inventory data into the formatted emissions files required for a photochemical air quality model. A detailed description of all SMOKE input files such as area, mobile, fire, point and biogenic emissions files and the SMOKE model configuration are provided in Attachment I.

As discussed in detail in Chapter 11, the MANE-VU member states selected several control strategies for inclusion in the modeling. Emission reduction requirements mandated by the Clean Air Act were also included in projecting future year emissions. In addition, 40 CFR Section 51.308(d)(3)(v)(D) requires the State of Maine to consider source retirement and replacement schedules in developing the future inventories and long-term strategy.

8.4 Inventories for Specific Source Types

There are five emission source classifications in the emissions inventory as follows:

1) Stationary point,
2) Stationary area,
3) Off-road mobile,
4) On-road mobile, and
5) Biogenic.

Stationary point sources are large sources that emit greater than a specified tonnage per year. **Stationary area sources** are those sources whose emissions are relatively small but due to the large number of these sources, the collective emissions could be significant, i.e., dry cleaners, service stations, agricultural sources, fire emissions, etc. **Off-road mobile sources** are equipment that can move but do not use the roadways, i.e., lawn mowers, construction equipment, railroad locomotives, aircraft, etc. **On-road mobile sources** are automobiles, trucks, and motorcycles that use the roadway system. The emissions from these sources are estimated by vehicle type and road type. **Biogenic sources** are natural sources like trees, crops, grasses and natural decay of plants. **Stationary point sources** emission data is tracked at the facility level. For all other source types emissions are summed on the county level.

The subsections below provide an overview of each of the source categories and the methods that were used to develop their corresponding baseline and future-year emissions estimates. All emissions data were prepared for modeling in accordance with EPA guidance.

8.4.1 Stationary Point Sources

Point source emissions are emissions from large individual sources. Generally, point sources have permits to operate and their emissions are individually calculated based on source specific factors on a regular schedule. Emissions estimates for point sources are usually made on a regular basis, with the largest point sources inventoried annually. Sources with emissions greater than or equal to 100 tons per year (tpy) of a criteria pollutant, 10 tpy of a single hazardous air pollutant (HAP), or 25 tpy total HAP are considered to be major sources. Emissions from smaller sources are also calculated individually but less frequently. Point sources are grouped into EGU sources and other industrial point sources, termed as non-EGU point sources.

8.4.1.1 Electric Generating Units

The base-year inventory for EGU sources were based on 2002 continuous emissions monitoring (CEM) data reported to EPA in compliance with the Acid Rain Program or 2002 state emissions inventory data. The CEM data provided actual hourly emission values used in the modeling of SO_2 and NO_x emissions from these large sources. Emissions of other pollutants (e.g., VOCs, CO, NH_3, and $PM_{2.5}$) were provided by the states in most instances.

Future-year inventories of EGU emissions for 2009, 2012 and 2018 were developed using ICF International's Integrated Planning Model (IPM) to forecast growth in electric demand and replacement of older, less efficient and more polluting power plants with newer, more efficient and cleaner units. This effort was undertaken by an inter-RPO workgroup. While the output of the IPM model predicts that a certain number of older plants will be replaced by newer units to meet future electric growth and state-specific NOx and SO2 caps, the MANE-VU/Maine inventory did not directly rely on the closure of any particular plant in establishing the 2018 inventory upon which the reasonable progress goals were set.

The IPM model results do not provide a reliable basis upon which to predict EGU closures. Specific plant closures in the Maine inventory are addressed in Chapter 12, Reasonable Progress Goals. Preliminary modeling was performed with unchanged IPM 2.1.9 model results. However, prior to the most recent modeling, future-year EGU inventories were adjusted as follows:

• First, IPM predictions were reviewed by permitting and enforcement staff of the MANE-VU states. In many cases, staff believed that the IPM shutdown predictions were unlikely to occur. In particular, many oil-fired EGUs in urban areas were predicted to be shut down by IPM. Similar source information was solicited from states in both VISTAS and MRPO. As a result of this model validation, the IPM modeling output was adjusted before the most recent modeling to reflect staff knowledge of specific plant status in MANE-VU, VISTAS, and MRPO states. Where expected EGU operating status was contrary to what was predicted by IPM modeling, the future-year emissions inventory was adjusted to reflect the expected operation of those plants.

• Second, as a result of inter- and intra-RPO consultations, MANE-VU agreed to pursue certain emission control measures (see Section 3.0, Regional Planning). For EGUs, the agreed-upon approach was to pursue emission reductions from each of the top 167 stacks located in MANE-VU, MRPO, and VISTAS that contributed the most to visibility impairment at any Class I area in the MANE-VU region. This approach, known as the targeted EGU strategy, is further described in Section 11.0 of this SIP.

8.4.1.2 Non-EGU Point Sources

The non-EGU category used annual emissions as reported by state and local agencies pursuant to the Consolidated Emission Reporting Rule (CERR) for the base year 2002 (or MANE-VU Version 3). As described in section 8.2 , MANE-VU's contractor, E.H. Pechan & Associates (Pechan), coordinated the quality assurance of the inventory and prepared the necessary files for input into the SMOKE emissions model. Further information on the preparation of the MANE-VU 2002 baseline point source modeling emissions inventory can be found in Chapter II of the Baseline Emissions Report (Attachment I). Projected non-EGU point source emissions were developed for the MANE-VU region by MACTEC Federal Programs, Inc. under contract to the Mid-Atlantic Regional Air Management Association (MARAMA).

The specific methodologies that were employed are described in Section 2 of the Emissions Projections Report (Attachment I). MACTEC used state-supplied growth factor data, where available, to project future-year emissions. Where state-supplied data were not available, MACTEC used EPA's Economic Growth and Analysis System, Version 5.0 (EGAS 5.0) to develop applicable growth factors for the non-EGU component. MACTEC also incorporated the applicable federal and state emissions control program s to account for the expected emissions reductions that will take place under the OTB/OTW and BOTW scenarios.

8.4.2 Stationary Area Sources

Stationary area sources include sources whose individual emissions are relatively small, but due to the large number of these sources, the collective emissions are significant. Some examples include solvent cleaning, service stations and residential heating. Area source emissions are estimated by multiplying an emission factor by some known indicator of collective activity, such as fuel usage, or number of households or population.

The area source emissions inventory submittals made for the CERR became the basis for the area source portion of the 2002 baseline inventory. MANE-VU's consultant, Pechan, prepared the area source modeling inventory using the CERR submittals as a starting point. Pechan quality-assured the inventory and augmented it with additional data, including MANE-VU sponsored inventories for categories such as residential wood combustion and open burning. Details on the preparation of MANE-VU's 2002 baseline area source emissions inventory can be found in Chapter III of the Baseline Emissions report (Attachment H).

In a similar fashion, MACTEC prepared future-year area source emission projections for the MANE-VU region. The specific methodologies employed are described in Section 3 of the Emissions Projection Report (Attachment I). MACTEC applied growth factors to the 2002 baseline area source inventory using state-Supplied data, where available, or using the EGAS 5.0 growth factor model. MACTEC also accounted for the appropriate control strategies in the future year projections.

8.4.2.2 Non-Road Mobile Sources

Non-road mobile sources are equipment that can move but do not use the roadways, such as construction equipment, aircraft, railroad locomotives, lawn and garden equipment. For the majority of the non-road mobile sources, the emissions for base year 2002 were estimated using the EPA's NONROAD Model contained within the Mobile6 model. Aircraft, railroad locomotives, and commercial marine vessels are not included in the NONROAD model; their emissions are estimated using applicable references and methodologies. Again, Pechan prepared the 2002 baseline modeling inventory using the state and local CERR submittals as a starting point. Details on the preparation of the 2002 baseline non-road inventory are described in Chapter IV of the Baseline Emissions Report (Attachment H).

Future-year non-road mobile source emissions were projected for the MANE-VU region by MACTEC. The methodologies employed are discussed in Section 4 of the Emission Projections Report (Attachment I). MACTEC used EPA's NONROASD2005 non-road vehicle emissions model as contained in EPA's National Mobile Inventory Model (NMIM). Since the calendar year is an explicit input into the NONROAD model, future-year emissions for non-road vehicles could be calculated directly for the applicable projection years. For the non-road vehicle types that are not included in the NONROAD model (i.e., aircraft, locomotives and commercial marine vessels), MACTEC used the 2002 baseline inventory and the projected inventories that EPA developed for these categories for the Clean Air Interstate Rule (CAIR) to develop emission ratios and subsequent combined growth and control factors. Since the future years for the CAIR projections did not precisely match those required for the purposes of ozone, particulate mater and the regional haze analyses (i.e., 2009, 2012, and 2018), MACTEC used linear interpolation to develop factors for the required future years.

8.4.3 On-Road Mobile Sources

The on-road emissions source category consists of vehicles that are meant to travel on public roadways, including cars, trucks, buses and motorcycles. The basic methodology used for on-road mobile source calculations is to multiply vehicle-miles-travelled (VMT) by emission factors developed using EPA's MOBILE6.2 motor vehicle emission factors model. The on-road mobile category requires that SMOKE model inputs be prepared instead of the SMOKE/IDA emissions data format that is required by the other emission source categories. Therefore, for the 2002 baseline inventory, Pechan prepared the necessary VMT and MOBILE6 inputs in SMOKE format.

Projected on-road mobile source inventories were developed by NESCAUM for the MANE-VU region for ozone, particulate matter, and regional haze SIP purposes. As with other emission source categories, projected on-road mobile inventories were developed for calendar years 2009, 2012, and 2018. As part of this effort, MANE-VU member states were asked to provide VMT data and MOBILE6 emissions model inputs for the applicable calendar years. Using the inputs supplied by the MANE-VU member states, NESCAUM compiled and generated the required SMOKLE/MOBILE6 emission model inputs. Further details regarding the on-road mobile source projections can be found in NESCAUM's "Technical Memorandum, Development of MANE-VU Mobile Source Projection Inventories for SMOKE/MOBILE6 Application," June 2006 (Attachment J).

8.4.4 Biogenic Emission Sources

Biogenic emissions for the 2002 baseline modeling emissions inventory were calculated for the modeling domain by the New York State Department of Environmental Conservation (NYSDEC). NYSDEC used the Biogenic Emissions Inventory System (BEIS) Version 3.12 as contained within the SMOKE emissions processing model. Biogenic emissions estimates were made for CO, nitrous oxide (NO) and VOCs. Further details about the biogenic emissions processing can be found in NYSDEC's technical support document TSD-1c, "Emission Processing for the Revised 2002 OTC Regional and Urban 12 km Base Case Simulations," September 19, 2006, and in Chapter VI: Biogenic Sources, of the "Technical Support Document for 2002 MANE-VU SIP Modeling Inventories," Version 3, November 20, 2006 (Attachment H) . Biogenic emissions were assumed to remain constant for the future-years analysis, a reasonable approximation reflecting the expectation that most of the region will remain heavily forested for the duration of the planning period.

8.5 Summary of Maine's 2002 and 2018 Emissions Inventory

Tables 8-1 through 8-4, below, summarize the Maine baseline and future-year emission inventories. As previously discussed in section 8.2.2, there are three projected control scenarios for the 2018 inventory. The on-the-books/on-the-way (OTB/OTW) control strategy scenario accounts for emission control regulations that were already in place as of June 15, 2005, as well as some regulations that are not yet finalized, but are expected to achieve additional emission reductions by 2009. The beyond-on–the- way (BOTW) scenario includes emission controls that may be necessary to for attainment of the ozone and PM NAAQS, along with meeting other regional air quality goals. The final modeling emission inventory accounts for additional potentially reasonable control measures for reducing regional haze as discussed in Section 11 and 12 of this SIP, and was used to generate Maine's reasonable progress goals.

Table 8-1
2002 Emissions Inventory for Maine
(tons per year)

	CO	NH_3	NO_x	PM_{10}	PM_{25}	SO_2	VOC
Mobile	410,958	1,468	54,687	1,239	934	1,804	23,037
Nonroad	153,424	11	9,820	1,437	1,329	917	31,144
EGU Point	7,962	145	7,831	1,169	888	9,299	842
Non-EGU Point	9,043	700	12,108	6,120	4,899	14,412	4,477
Area	109,223	8,747	7,360	168,953	32,774	13,149	100,621
Biogenics	64,936		2,018				600,205
Total	755,545	11,071	93,824	178,919	40,825	39,581	760,327

Table 8-2
2018 OTB/OTW Emissions Inventory for Maine
(tons per year)

	CO	NH_3	NOx	PM_{10}	PM_{25}	SO_2	VOC
Mobile	237,170	1,715	12,828	272	266	894	10,414
Nonroad	166,679	15	6,543	1,086	978	82	21,988
EGU Point	4,057	139	1,827	296	279	5,436	53
Non-EGU Point	11,433	859	15,753	7,496	5,935	18,794	5,709
Area	94,181	12,312	7,424	189,619	33,820	13,901	92,410
Biogenics	64,936		2,018				600,205
Total	578,456	15,041	46,393	198,768	41,278	39,107	730,779

Table 8-3
2018 BOTW Emissions Inventory for Maine
(tons per year)

	CO	NH_3	NOx	PM_{10}	PM_{25}	SO_2	VOC
Mobile	237,170	1,715	12,828	272	266	894	10,414
Nonroad	166,679	15	6,543	1,086	978	82	21,988
EGU Point	4,057	139	1,827	296	279	5,436	53
Non-EGU Point	11,433	859	14,137	7,477	5,922	18,692	5,708
Area	94,181	12,312	7,036	188,928	33,201	4,940	90,866
Biogenics	64,936		2,018				600,205
Total	578,456	15,041	44,389	198,058	40,646	30,044	729,234

Table 8-4
2018 Final Modeling Emissions Inventory for Maine
(tons per year)

	CO	NH_3	NOx	PM_{10}	PM_{25}	SO_2	VOC
Mobile	237,170	1,715	12,828	272	266	894	10,414
Nonroad	166,679	15	6,543	1,086	978	82	21,988
EGU Point	4,057	139	1,827	296	279	6,806	53
Non-EGU Point	11,433	859	14,137	7,477	5,922	13,082	5,708
Area	94,181	12,312	7,036	57,411	18,877	1,127	90,866
Biogenics	64,936		2,018				600,205
Total	578,456	15,041	44,390	66,542[26]	26,321	21,991	729,235

[26] An adjustment factor was applied during the processing of emissions data to restate fugitive particulate matter emissions. Grid models have been found to overestimate fugitive dust impacts when compared with ambient samples; therefore, an adjustment is typically applied to account for the removal of particles by vegetation and other terrain features. The summary emissions for PM_{10} in Table 8.4 reflect this adjustment. Comparable adjustments were not made to PM_{10} values listed in Tables 8.1 through 8.3.

9. Modeling

Air quality modeling to assess regional haze has been done cooperatively by the MANE-VU member states, with major modeling efforts being conducted by NESCAUM[27] and screening modeling being conducted by the New Hampshire Department of Environmental Services (NHDES)[28]. These modeling efforts include emissions processing, meteorological input analysis, and chemical transport modeling to conduct regional air quality simulations for calendar year 2002 and several future periods, including the 2018 primary target period for this SIP. Modeling was conducted in order to assess contribution from upwind areas, as well as Maine's contribution to its own Class I areas. Further, the modeling evaluated visibility benefits of control measures being considered for achieving reasonable progress goals and establishing a long-term emissions management strategy for MANE-VU Class I areas. The modeling tools utilized for these analyses include the following:

- The Fifth-Generation Pennsylvania State University/National Center for Atmospheric Research (NCAR) Mesoscale Model (MM5) was used to derive the required meteorological inputs for the air quality simulations.
- The Sparse Matrix Operator Kernel Emissions (SMOKE) emissions modeling system was used to process and format the emissions inventories for input into the air quality models.
- The Community Mesoscale Air Quality model (CMAQ) was used for the primary SIP modeling.
- The Regional Model for Aerosols and Deposition (REMSAD) was used during contribution apportionment.
- The California Grid Model (CALGRID) and its associated EMSPROC6 emissions processor was used to screen specific control strategies.

Each of these tools has been evaluated and found to perform adequately, and the SIP pertinent modeling underwent full performance testing and the results were found to meet the specifications of EPA modeling guidance.

For more details on the regional haze modeling, refer to the NESCAUM report "MANE-VU Modeling for Reasonable Progress Goals, Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits," February 7, 2008 (Attachment P). The detailed modeling approach for the most recent 2018 projected scenario can be found in the NESCAUM report "2018 Visibility Projections," May 13, 2008 (Attachment Q).

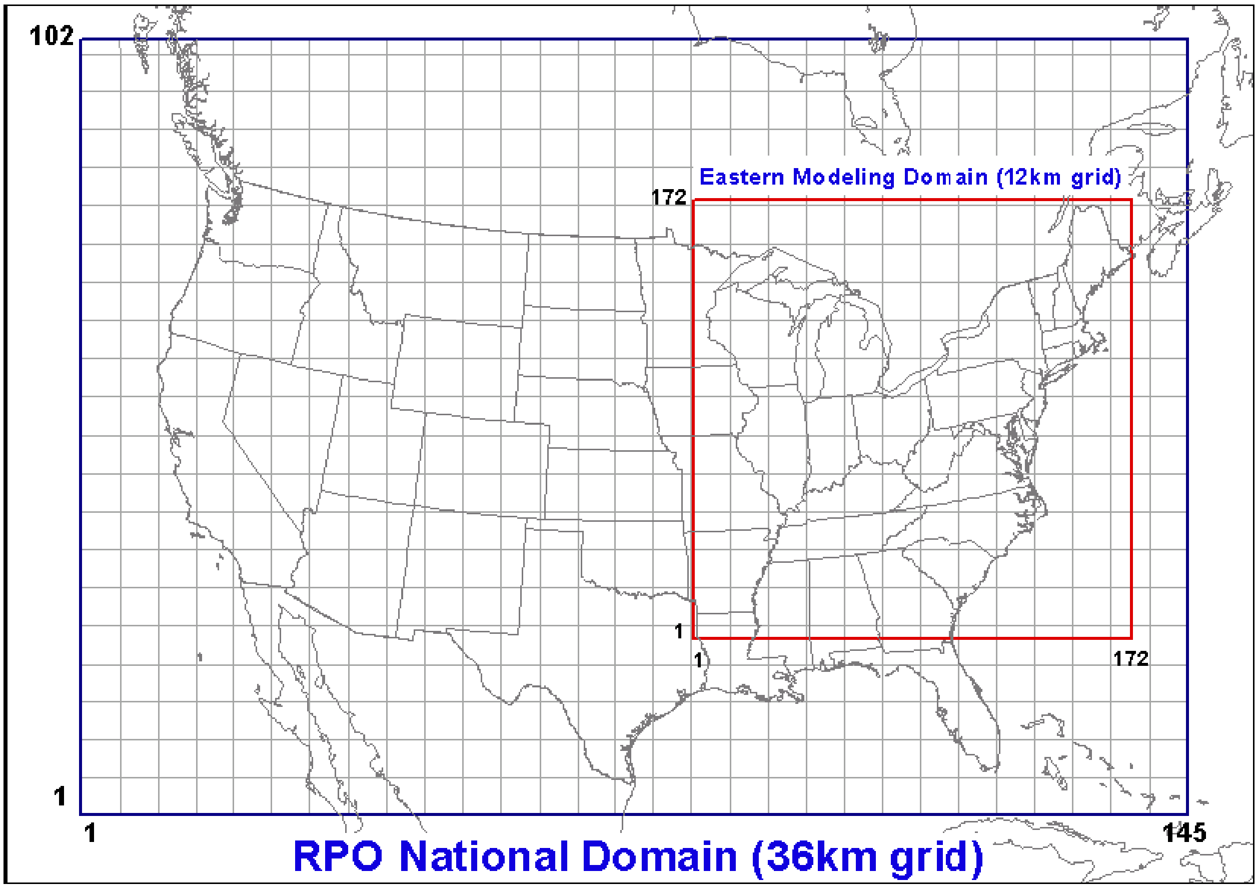
9.1 Meteorology

The meteorological inputs for the air quality simulations were developed by the University of Maryland (UMD) using the MM5 meteorological modeling system. Meteorological inputs were generated for 2002 to correspond with the baseline emissions inventory and analysis year. The MM5 simulations were performed on a nested grid as

[27] Along with the NYSDEC, NJDEP/Rutgers, VADEQ, and UMD.
[28] Along with the VTDEP and MDEQ.

illustrated in Figure 9-1. As shown in the figure, the modeling domain is comprised of a 36-km, 145 x 102 continental grid and a nested 12-km, 172 x 172 grid encompassing the

Figure 9-1
Modeling domains used in MANE-VU air quality modeling studies with CMAQ.
Outer (blue) domain grid is 36 km and inner (red) domain is 12 km grid
The gridlines are shown at 180 km intervals (5 × 5 36 km cells/15 × 15 12 km cells)



Eastern United States and parts of Canada. In cooperation with the New York State Department of Conservation (NYSDEC), an assessment was made to compare the MM5 predictions with observations from a variety of data sources, including:

- Surface observations from the National Weather Service and the Clean Air Status and Trends Network (CASTNet);
- Wind-profiler measurements from the Cooperative Agency Profilers (CAP) network;
- Satellite cloud image data from the UMD Department of Atmospheric and Oceanic Science; and
- Precipitation data from the Earth Observing Laboratory at NCAR. This assessment was performed for the period covering May through September 2002.

Further details regarding the MM5 meteorological processing and the modeling domain can be found in NYSDEC's technical support document TSD-1a, "Meteorological Modeling Using Penn State/NCAR 5th Generation Mesoscale Model (MM5)," February 1, 2006 (Attachment K), and in the NESCAUM report "MANE-VU Modeling for Reasonable Progress Goals, Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits," November 27, 2007 (Attachment P).

9.2 Emissions Data Preparation

Emissions were prepared for input into the CMAQ and REMSAD air quality models using the SMOKE emissions modeling system. SMOKE supports point, area, mobile (both on-road and non-road), and biogenic emissions. The SMOKE emissions modeling system uses flexible processing to apply chemical speciation as well as temporal and spatial allocation to the emissions inventories. SMOKE incorporates the Biogenic Emission Inventory System (BEIS) and EPA's MOBILE6 motor vehicle emission factor model to process biogenic and on-road mobile emissions, respectively. Vector-matrix multiplication is used during the final processing step to merge the various emissions components into a single model-ready emissions file. Examples of processed emissions outputs are shown below in Figure 9-2.

Further details on the SMOKE processing conducted in support of the air quality simulations is provided in NYSDEC's technical support document TSD-1c, "Emission Processing for the Revised 2002 OTC Regional and Urban 12 km Base Case Simulations," September 19, 2006 (Attachment I), and in NESCAUM's report, "MANE-VU Modeling for Reasonable Progress Goals, Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits," February 7, 2008 (Attachment P). Additional details on the emissions inventory preparation can be found in Section 8.0 of this report.

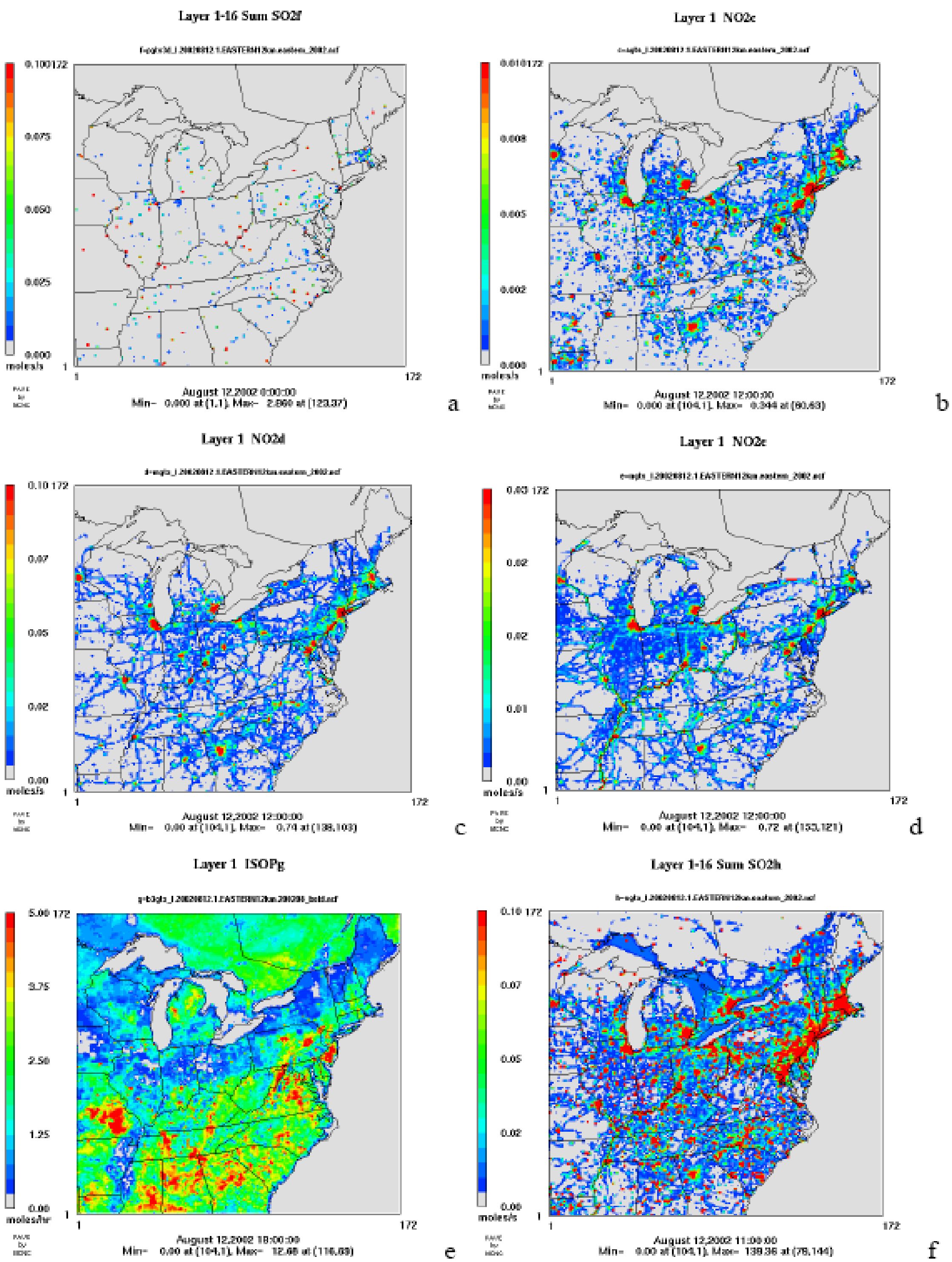
9.3 Primary Regional Haze Modeling Platforms

MANE-VU used two regional-scale air quality models to perform its primary air quality simulations. These are the Community Multi-scale Air Quality modeling system (CMAQ; Byun and Ching, 1999) and the Regional Modeling System for Aerosols and Deposition (REMSAD; SAI, 2002). CMAQ was developed by USEPA, while REMSAD was developed by ICF Consulting/Systems Applications International (ICF/SAI) with USEPA support. CMAQ has undergone extensive community development and peer review (Amar et al., 2005) and has been successfully used in a number of regional air quality studies (Bell and Ellis, 2003; Hogrefe et al., 2004; Jimenez and Baldasano, 2004; Mao and Talbot, 2003; Mebust et al., 2003). REMSAD has also has been peer reviewed (Seigneur et al., 1999) and used by USEPA for regulatory applications) to study ambient concentrations and deposition of sulfate and other PM species[29].

[29] www.epa.gov/otaq/regs/hd2007/frm/r00028.pdf and www.epa.gov/clearskies/air_quality_tech.html

Figure 9-2
Examples of Processed Model-Ready Emissions

(a) SO_2 from Point; (b) NO_2 from Area; (c) NO_2 from On-road; (d) NO_2 from Non-road; (e) ISOP from Biogenic; (f) SO_2 from all source categories



9.3.1 CMAQ

The CMAQ air quality simulations were performed cooperatively between five modeling centers, including NYSDEC, the New Jersey Department of Environmental Protection (NJDEP) in association with Rutgers University, the Virginia Department of Environmental Quality (VADEQ), UMD, and NESCAUM. NYSDEC also performed an annual 2002 CMAQ simulation on the 36-km domain shown in Figure 9-1; this simulation was used to derive the boundary conditions for the inner 12-km eastern modeling domain. Boundary conditions for the 36-km simulations were obtained from a run of the GEOS-Chem (Goddard Earth Observing System) global chemistry transport model that was performed by researchers at Harvard University.

The CMAQ modeling system is a three-dimensional Eulerian model that incorporates output fields from emissions and meteorological modeling systems and several other data sources through special interface processors into the CMAQ Chemical Transport Model (CCTM). The CCTM then performs chemical transport modeling for multiple pollutants on multiple scales. With this structure, CMAQ retains the flexibility to substitute other emissions processing systems and meteorological models. CMAQ is designed to provide an air quality modeling system with a "one atmosphere" capability containing state-of-science parameterizations of atmospheric processes affecting transport, transformation, and deposition of such pollutants as ozone, particulate matter, airborne toxics, and acidic and nutrient pollutant species (Byun and Ching, 1999).

MANE-VU SIP modeling on both 36 km and 12 km domains used CMAQv4.5.1, IOAPI V2.2 and NETCDF V3.5 libraries. The CMAQ model is configured with the Carbon Bond IV mechanism (Gery et al., 1989) using the EBI solver for gas phase chemistry rather than the SAPRC-99 mechanism due to better computing efficiency with no significant model performance differences for ozone and PM as compared to observations. NY DEC completed annual 2002 CMAQ modeling on the 36 km domain to provide dynamic boundary conditions for all simulations performed on the 12 km domain. Three-hourly boundary conditions for the outer domain were derived from an annual model run performed by researchers at Harvard University using the GEOSCHEM global chemistry transport model (Park et al., 2004). Model resolution was species dependent at either 4° latitude by 5° longitude or 2° by 2.5°.

Annual CMAQ modeling on the 12 km domain is divided into five periods. UMD was responsible for the period from January 1 to February 28; NJ DEP/Rutgers were responsible for the period from March 1 to May 14; NYSDEC was responsible for the period from May 15 to September 30; VADEQ was responsible for the period from October 1 to October 31; and NESCAUM was responsible for the period from November 1 to December 31. Each period uses a 15-day spin-up run to minimize the impact of the default initial concentration fields. Each modeling group performed CMAQ simulations on its period for a series of scenarios including 2002 Base Case, 2009 Base Case, 2018 Base Case, 2009 Control Case, and 2018 Control Case. All scenarios adopt the same meteorological field (2002) and boundary conditions, varying only emission inputs. To ensure consistency, a benchmark test was conducted by each modeling group.

In addition to the annual simulations conducted with CMAQ by the five modeling centers, NESCAUM conducted limited sensitivity analysis of several control measures using the beta version of CMAQ with the particle and precursor tagging methodology (CMAQ-PPTM) (ICF, 2006). The technical options that were used in performing the CMAQ simulations are described in detail in NYSDEC's technical support document TSD-1d, "8hr Ozone Modeling using the SMOKE/CMAQ system," February 1, 2006 (Attachment K). Further technical details regarding the CMAQ model and its execution are also provided in NESCAUM's report, "MANE-VU Modeling for Reasonable Progress Goals, Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits," February 7, 2008 (Attachment P).

9.3.2 REMSAD

The REMSAD modeling simulations were used to satisfy the haze rule requirement that a pollution apportionment be performed to assess contribution to visibility improvement by geographic region or source sector. REMSAD's species tagging capability makes it an important tool for this purpose. The Regional Modeling System for Aerosols and Deposition (REMSAD) is a three-dimensional Eulerian model designed to support a better understanding of the distributions, sources, and removal processes relevant to fine particles and other airborne pollutants. It calculates the concentrations of both inert and chemically reactive pollutants by simulating the physical and chemical processes in the atmosphere that affect pollutant concentrations. The basis for the model is the atmospheric diffusion equation representing a mass balance in which all of the relevant emissions, transport, diffusion, chemical reactions, and removal processes are expressed in mathematical terms. The REMSAD model performs a four-step solution procedure: emissions, horizontal advection/diffusion, vertical advection/diffusion and deposition, and chemical transformations during one-half of each advective time step, and then reverses the order for the following half-time step. The maximum advective time step for stability is a function of the grid size and the maximum wind velocity or horizontal diffusion coefficient. Vertical diffusion is solved on fractions of the advective time step to keep their individual numerical schemes stable.

REMSAD uses a flexible horizontal and vertical coordinate system with nested grid capabilities and user-defined vertical layers. It accepts a geodetic (latitude/longitude) horizontal coordinate system or a Cartesian horizontal coordinate system measured in kilometers. REMSAD uses a simplified version of CB-IV chemistry mechanism that is based on a reduction in the number of different organic compound species and also includes radical-radical termination reactions. The organic portion of the chemistry is based on three primary organic compound species and one carbonyl species.

The model parameterizes aerosol chemistry and dynamics for PM and calculates secondary organic aerosol (SOA) yields from emitted hydrocarbons. REMSAD V7.12 and newer versions have capabilities that allow model tags of sulfur species (up to 11 tags), nitrogen (4 tags), mercury (up to 24 tags), and cadmium (up to 10 tags) to identify the impact of specific tagged species. Unlike CMAQ, REMSAD provides no choice of chemical and physical mechanisms. Due to the simplified chemistry mechanism, REMSAD may not simulate atmospheric processes as well as CMAQ. However, advantages such as the tagging feature for sulfur, more efficient modeling, and reasonable correspondence with measurements for many species, make REMSAD an important source apportionment tool for MANE-VU. The MANE-VU REMSAD modeling utilized the same 12 km eastern modeling domain shown in Figure 9-1, above. Multiple runs are necessary to permit tagging of sulfur emissions for all of the states in the domain, Canada, and the boundary conditions. NESCAUM's report, "MANE-VU Modeling for Reasonable Progress Goals, Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits," February 7, 2008, further describes the REMSAD model and its application to the regional haze SIP efforts (See Attachment P).

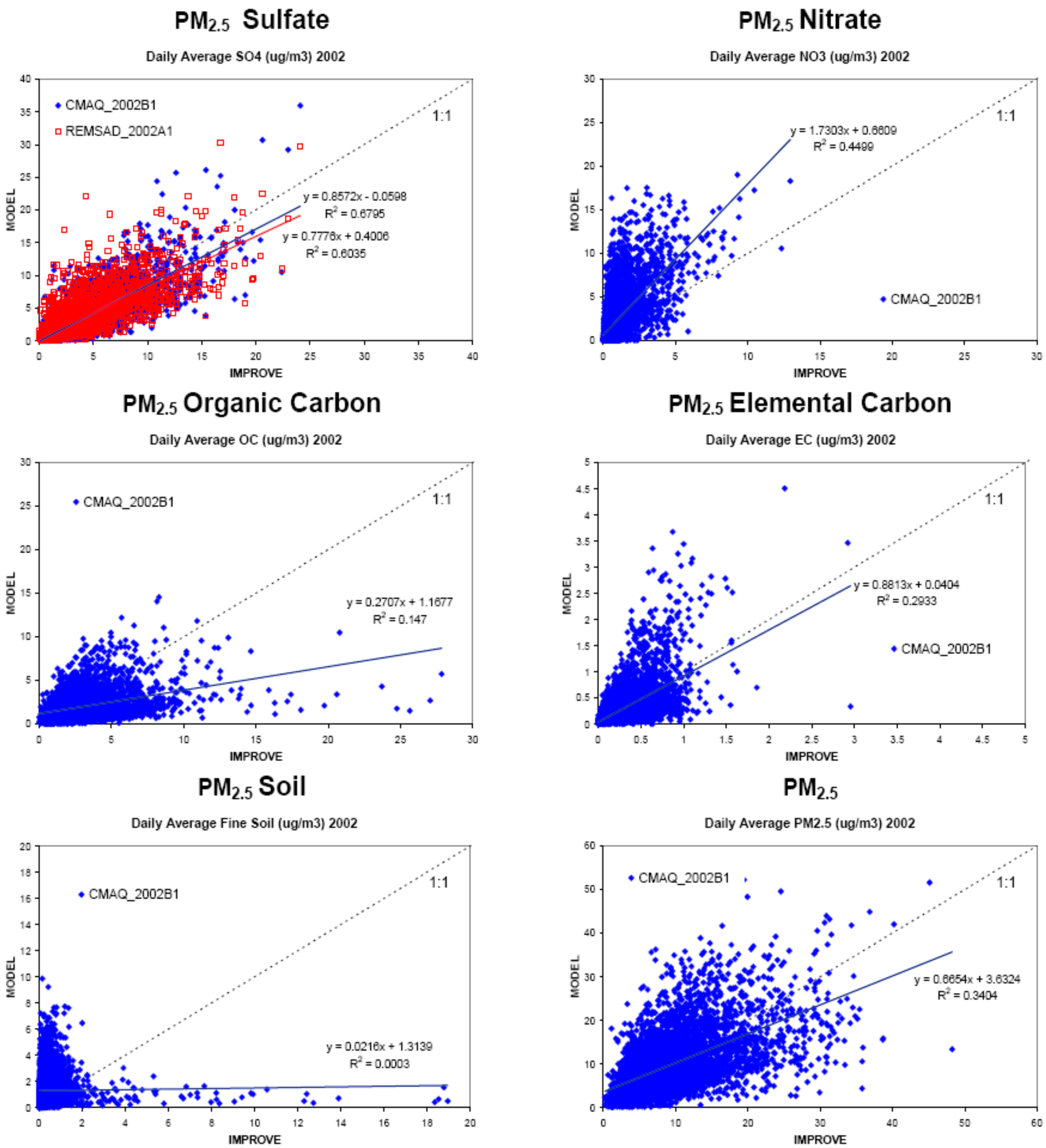
9.4 Primary Model Evaluation

9.4.1 CMAQ

NYSDEC extensively analyzed the CMAQ model performance to evaluate model predictions against observations of ozone, $PM_{2.5}$, and other chemical species. To do this, model predictions for the base year simulation are compared to the actual ambient data observed in the historical episode. This verification is a combination of statistical and graphical evaluations. If the model appears to be predicting fine particles and other airborne pollutants in the right locations for the right reasons, then the model can be used as a predictive tool to evaluate various control strategies and their effects on regional haze. CMAQ modeling was conducted for the year 2002 (completed by cooperative modeling efforts from NYDEC, UMD, NJDEP, Rutgers, VADEP, and NESCAUM) under the Base B4 emission scenario (See Attachment P). CMAQ performance for $PM_{2.5}$ species and visibility is examined based on this CMAQ run on a 12 km resolution domain. Measurements from IMPROVE and STN networks are paired with model predictions by location and time for evaluation. Figure 9-3 presents the domain-wide paired comparison for sulfate and other PM2.5 species including nitrate, OC, EC, fine soil, and $PM_{2.5}$ daily average concentration from the CMAQ simulation and two sets of observations (STN and IMPROVE). It shows that predicted $PM_{2.5}$ sulfate and measured sulfate are in a good 1:1 linear relationship with varying from 0.6 to 0.7. $PM_{2.5}$ nitrate (top row right panel) also has close to a 1:1 linear relationship between the model and observations, although the values are much lower (from ~0.2 to ~0.5) than for sulfate. Paired OC (middle row left panel) concentrations have a scattered distribution with over- and under-estimation and a very weak linear relationship (r^2 of ~0.1). CMAQ tends to overestimate EC (middle row right panel) and fine soil (bottom row left panel) concentrations.[30]

[30] EC and soil are inert species not involved in chemical transformation. Poor emission inventory data may be the main cause for the weak linear relationships between prediction and measurement. In addition, there are no fire emissions considered in CMAQ modeling. The wild fire in Quebec, Canada in early July of 2002 led to high concentrations of observed OC, EC, and fine soil that are not predicted by CMAQ.

Figure 9-3
Domain-Wide Paired Comparison For Sulfate And Other $PM_{2.5}$ Species
CMAQ vs IMPROVE/STN



Because sulfate is the dominant $PM_{2.5}$ species, modeled $PM_{2.5}$ (bottom row right panel) shows a relatively strong near 1:1 linear relationship.

Additional model performance evaluations include assessing the ability of the CMAQ model to correctly model PM2.5 species across the modeling domain (spatial distribution of the correlation coefficient between CMAQ predictions and Improve observations), mean fractional error of CMAQ predictions, mean fraction bias of CMAQ predictions, and paired comparisons of the haze index between CMAQ predictions and Improve measurements at selected Class I sites were undertaken. In summary, the CMAQ model was demonstrated to perform best for daily average SO_4 mass and $PM_{2.5.}$ Many other species vary significantly over the course of a day, or from day to day, and small model over- or underprediction at low concentrations can lead to large biases on a composite basis. These model performance evaluations are described in detail in NYSDEC's technical support document TSD-1e, "CMAQ Model Performance and Assessment, 8-Hr OTC Ozone Modeling," February 23, 2006 (Attachment K) and in NESCAUM's report , "MANE-VU Modeling for Reasonable Progress Goals, Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits," February 7, 2008 (Attachment P).

9.4.2 REMSAD

The Regional Modeling System for Aerosols and Deposition (REMSAD) model was utilized by MANE-VU for its contribution assessment. REMSAD model performance has been evaluated as part of several previous national and regional modeling exercises. EPA evaluated REMSAD performance as for their Clear Skies Act base case study using 1996 meteorology and 1996 NET inventory.[31] Modeling results were compared with IMPROVE measurement, with REMSAD found to perform better in the Eastern US than in the Western US on PM sulfate and $PM_{2.5}$, although it underestimates ambient levels countrywide and performs relatively poorly on soil, carbonaceous aerosols and PM nitrate.[32]

A spatial performance evaluation of REMASAD simulations for sulfate on the 12km northeast US domain for the year 2002 was conducted through comparison with IMPROVE/STN measurements, as illustrated in Figure 9-4. These comparisons are inexact, because the discrete measurements represent a uniform gridded concentration field. This approach, however, does provide a first order examination of measurement and modeling results, which is appropriate for an annual averaged analysis.

In general, the REMSAD simulation field is well-matched with measurement data. Figure 9-5 shows the comparison of paired 24-hour surface sulfate concentrations between five different air quality model results (including REMSAD) and IMPROVE measurements during the year 2002 for Lye Brook Wilderness Area (Vermont) and

[31] See Clear Skies Act Air Quality Modeling Technical Support Document at http://www.epa.gov/air/clearskies/aq_modeling_tsd_csa2003.pdf

[32] NESCAUM also performed REMSAD modeling using the 1996 meteorology, but with the 2001 Proxy emission inventory, therefore a direct comparison to the EPA CSA modeling results could not be completed. To evaluate REMSAD for this exercise, NESCAUM first compared its own modeling results with EPA's CSA 2001 case modeling results, which also used the 1996 meteorology. NESCAUM's results were an exact match with EPA's REMSAD modeling on $PM_{2.5}$ and PM sulfate distributions. In addition, NESCAUM also compared the long term modeling average (annual mean) of PM species to IMPROVE annual means for three sites. These comparisons show good agreement for REMSAD modeling of PM sulfate, NH4, OC and EC.

Shenandoah National Park (Virginia). The comparison illustrates that the two CMAQ model runs show the best performance in terms of slope, intercept and coefficient of correlation (r2), with the REMSAD results showing the 2nd best performance. Along with EPA's previous evaluation (Timin B. et al., 2002) the NESCAUM performance evaluation confirms that REMSAD performs reasonably well for longer-term (annual averaged) sulfate simulation.

Figure 9-4
Sulfate Concentrations From the IMPROVE/STN Measurements and the REMSAD Model

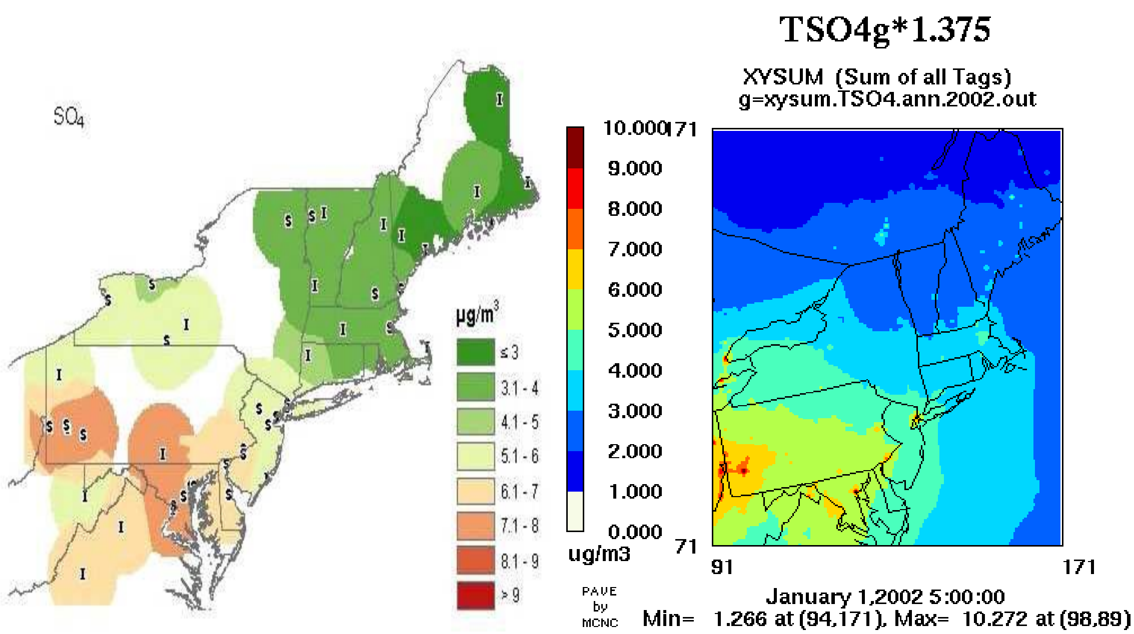
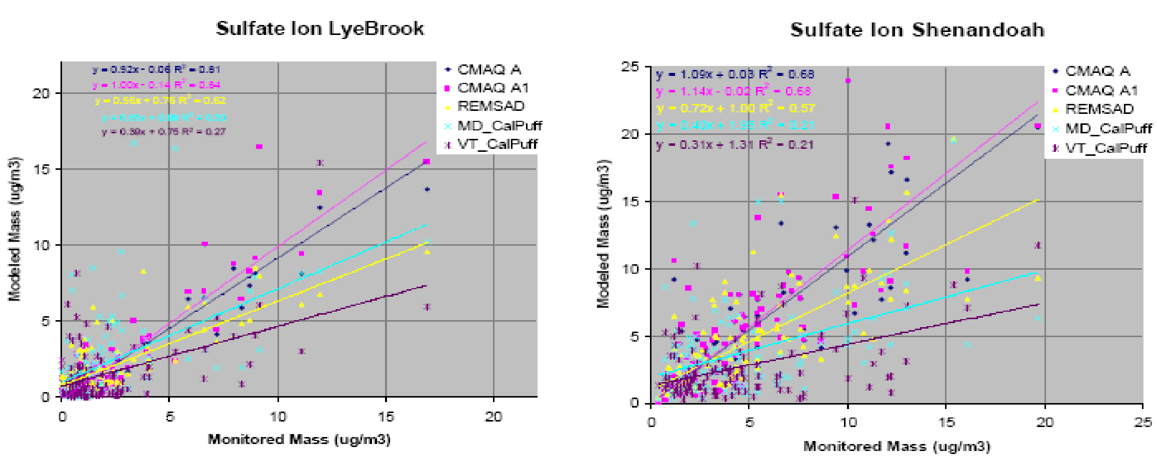


Figure 9-5
Comparison of Measurement and Modeled Data for Alternative Annual Model Simulations



9.5 Additional Modeling Platforms

9.5.1 CALGRID

In addition to the SIP-quality modeling platforms that were described above, an additional modeling platform was developed for use as a screening tool to evaluate additional control strategies or to perform sensitivity analyses. The CALGRID model was selected as the basis for this platform. CALGRID is a grid-based photochemical air quality model that is designed to be run in a Windows environment. In order to make the CALGRID model the best possible tool to supplement the SIP-quality CMAQ and REMSAD modeling, the current version of the CALGRID platform was set up to be run with the same set of inputs as the SIP-quality models. The CALGRID air quality simulations were run on the same 12-km eastern modeling domain that was used for CMAQ and REMSAD. This model's performance was relative to the performance of the already evaluated CMAQ and REMSAD models and was thus determined to perform adequately.

Conversion utilities were developed to re-format the meteorological inputs, the boundary conditions, and the emissions for use with the CALGRID modeling platform. Pre-merged SMOKE emissions files were obtained from the modeling centers and re-formatted for input into EMSPROC6, the emissions pre-processor for the CALGRID modeling system. EMSPROC6 allows the CALGRID user to adjust emissions temporally, geographically, and by emissions category for control strategy analysis. The pre-merged SMOKE files that were obtained from the modeling centers were broken down into the biogenic, point, area, non-road, and on-road emissions categories. These files by component were then converted for use with EMSPROC6, thus giving CALGRID users the flexibility to analyze a wide variety of emissions control strategies. The MANE-VU CALGRID modeling is described in greater detail in Attachment P.

9.5.2 CALPUFF

CALPUFF is a non-steady-state Lagrangian puff model that simulates the dispersion, transport, and chemical transformation of atmospheric pollutants. Two parallel CALPUFF modeling platforms were developed by the Vermont Department of Environmental Conservation (VTDEC) and the Maryland Department of the Environment (MDE). The VTDEC CALPUFF modeling platform utilized meteorological observation data from the National Weather Service (NWS) to drive the CALMET meteorological model. The MDE platform utilized the same MM5 meteorological inputs that were used in the modeling done in support of the ozone and regional haze SIPs. These two platforms were run in parallel to evaluate individual states' contributions to sulfate levels at Northeast and Mid-Atlantic Class I areas. The CALPUFF modeling effort is described in detail in NESCAUM's report, "Contributions to Regional Haze in the Northeast and Mid-Atlantic United States," August 2006 (Attachment A).

10. Best Available Retrofit Technology

The Best Available Retrofit Technology (BART) requirement of Section 169A of the Clean Air Act (42 U.S.C.§7491(b)(2)(A)) and implementing rules (40 C.F.R. Part 51, Attachment Y) are intended to reduce visibility impairing pollutants[33] emitted from existing stationary sources which were grandfathered from the New Source Review (NSR) requirements of the Clean Air Act. The federal definition of BART in 40 CFR Part 51.301 is as follows:

> "**Best Available Retrofit Technology (BART**) means an emission limitation based on the degree of reduction achievable through the application of the best system of continuous emission reduction for each pollutant which is emitted by an existing stationary source facility. The emission limitation must be established, on a case-by-case basis, taking into consideration the technology available, the costs of compliance, the energy and nonair quality environmental impacts of compliance, any pollution control equipment in use or in existence at the source, the remaining useful life of the source, and the degree of improvement in visibility which may reasonably be anticipated to result from the use of such technology."

The BART requirements apply to certain older industrial sources that began operating before the federal Prevention of Significant Deterioration (PSD) rules were adopted in 1977 to protect visibility in Class I areas. PSD and BART represent the two primary regulatory tools for protecting visibility and addressing regional haze from industrial sources. The PSD rules apply to new sources and major modifications of existing sources[34], while BART applies to 26 types of stationary sources which began operation between August 7, 1962 and August 7, 1977 with the potential to emit more than 250 tons per year of a visibility impairing pollutant. Once the Regional Haze SIP is approved by the EPA, the BART facility has up to five years to install the appropriate controls and comply with the established emission standards. Maine is requiring sources subject to BART to install, operate and maintain BART rather than implement an emissions trading program or other alternative measure.

10.1 The Federal BART Rule

In June 2005, EPA adopted the final BART rule. The BART rule requires states/tribes to develop an inventory of sources within each state or tribal jurisdiction that would be eligible for controls. The rule contains the following elements that:

[33] The visibility impairing pollutants are defined by the EPA as sulfur dioxide (SO_2), oxides of nitrogen (NO_x) and particles with an aerodynamic diameter less than or equal to 10 and 2.5 μm (i.e., PM_{10} and $PM_{2.5}$, respectively).

[34] The PSD rules are part of the New Source Review rules, which apply to major new sources and major modifications of existing sources, to protect both visibility and air quality in general. See further description in Section 12. Since BART addresses existing sources, the evaluation of controls considers the effectiveness and the remaining life of the existing controls, and the cost of replacing them. While PSD and BART may end up evaluating similar types of controls, the criteria and selection of controls for BART is different due to the retrofit factors and visibility improvement that would result.

- Outline methods to determine if a source is "reasonably anticipated to cause or contribute to haze"
- Defines the methodology for conducting a BART control analysis
- Provides presumptive limits for electricity generating units (EGUs) larger than 750 Megawatts
- Provides a justification for the use of the Clean Air Interstate Rule (CAIR) as BART for CAIR affected EGUs

Beyond the specific elements listed above, EPA provided the states with a great deal of flexibility in implementing the BART program.

10.1.1 Federal BART Requirements for Electric Generating Units (EGUs)

According to 40 CFR Section 51.308(e)(4) of the Regional Haze Rule, a State that opts to participate in the Clean Air Interstate Rule (CAIR) Cap and Trade program under 40 CFR Part 96AAA-EEE need not require affected BART eligible EGUs to install, operate, and maintain BART. Since Maine and Maine sources were not included in the CAIR Cap and Trade Program, EGUs in Maine that are subject to BART must install, operate and maintain emission controls.

Section V of the Regional Haze Regulations and Guidelines for Best Available Retrofit Technology (BART) Determinations Preamble sets forth presumptive requirements for States to require EGUs to reduce SO_2 and NO_x emissions for units greater than 200 MW in capacity at plants greater than 750 MW in capacity that significantly contribute to visibility impairment in Federal Class I areas. The analysis conducted presents alternative control scenarios of possible additional controls for EGUs located at plants less than 750 MW in capacity.

Under 40 CFR Section 51.308(e)(1)(i)(B) of the Regional Haze Rule, the determination of BART for fossil fuel fired power plants having a total generating capacity of greater than 750 megawatts must be made pursuant to the guidelines of Attachment Y of this part of the CFR (Guidelines for BART Determinations under the Regional Haze Rule). EPA adopted those guidelines on July 6, 2005. The guidelines provide a process for making BART determinations that States can use in implementing the regional haze BART requirements on a source-by-source basis, as provided in 40 CFR 51.308(e)(1). States must follow the guidelines in making BART determinations on a source-by-source basis for power plants of greater than 750 megawatts (MW), but are not required to use the process in the guidelines when making BART determinations for other types of sources. For oil-fired EGUs, the presumptive level of BART control for SO_2 is the use of oil containing 1 percent or less sulfur by weight. Combustion controls constitute the presumptive BART control for NO_x at these units.

10.2 Maine State BART Requirements

In 2007, the Maine Legislature enacted enabling legislation establishing deadlines and control requirements/limitations for BART eligible units in Maine[35]. 38 MRSA §603-A, sub-§8 states:

> "8. Best available retrofit technology or BART requirements. For those BART eligible units determined by the department to need additional sulfur air pollution controls to improve visibility, the controls must:
>
> A. Be installed and operational no later than January 1, 2013; and
>
> B. Either:
>
> (1) Require the use of sulfur oil having 1% or less of sulfur by weight; or
>
> (2) Be equivalent to a 50% reduction in sulfur emissions from a BART eligible unit based on a BART eligible unit source emission baseline determined by the department under 40 Code of Federal Regulations, Section 51.308 (d)(3)(iii)(2006) and 40 Code of Federal Regulations, Section 51 Attachment Y (2006)."

10.3 BART-Eligible Sources in Maine

Determining BART-eligible sources is the first step in the BART process. The Maine BART-eligible sources were identified in accordance with the methodology in Appendix Y of the Regional Haze Rule, Guidelines for BART Determinations Under the Regional Haze Rule, Part II, How to Identify BART-Eligible Sources (70 FR 39158). This guidance consists of the following criteria:

1. The facility contains emission units[36] which fall into one or more of 26 source categories:

    - Fossil-fuel fired steam electric plants of more than 250 million British thermal units (BTU) per hour heat input
    - Coal cleaning plants (thermal dryers)
    - Kraft pulp mills
    - Portland cement plants
    - Primary zinc smelters
    - Iron and steel mill plants
    - Primary copper smelters
    - Municipal incinerators capable of charging more than 250 tons of refuse per day
    - Hydrofluoric, sulfuric, and nitric acid plants

[35] Sources may also cap their emissions below the 250 ton BART eligibility threshold.
[36] EPA rules (40 CFR Part 51.166) define *emission unit* as "any part of a stationary source that emits or has the potential to emit any pollutant".

- Petroleum refineries
- Lime plants
- Phosphate rock processing plants
- Coke oven batteries
- Sulfur recovery plants
- Carbon black plants (furnace process)
- Primary lead smelters
- Fuel conversion plants
- Sintering plants
- Secondary metal production facilities
- Chemical process plants
- Fossil-fuel boilers of more than 250 million BTUs per hour heat input
- Petroleum storage and transfer facilities with a capacity exceeding 300,000 barrels
- Taconite ore processing facilities
- Glass fiber processing plants
- Charcoal production facilities

2. The units "began operation" after August 7, 1962 (defined as "engaged in activity related to the primary design function of the facility"), and were the units "in existence on August 7, 1977 (defined as "the owner or operator has obtained all the necessary pre-construction approvals or permits required by Federal, State or local air pollution emissions and air quality laws or regulations and either has (1) begun, or caused to begin, a continuous program of physical on-site construction of the facility or (2) entered into a binding agreements or contractual obligation, which cannot be canceled or modified without substantial loss to the owner or operator, to undertake a program of construction of the facility to be completed in a reasonable time").

   [Note: Sources that were in operation before August 7, 1962, but were reconstructed during the August 7, 1962 to August 7, 1977 time period are also subject to BART if "the fixed capital cost of the new component exceeds 50 percent of the fixed capital cost of a comparable entirely new source"]

3. The potential emissions from these units 250 tons per year or more for sulfur dioxide (SO_2), nitrogen oxides (NO_x), particulate matter (PM), volatile organic compounds (VOC), or ammonia (NH4). The BART Guidelines recommend addressing SO_2, NO_x, and particulate matter. The State of Maine addressed these three pollutants, and used particulate matter less than 10 microns in diameter (PM_{10}) as an indicator for particulate matter to identify BART eligible units, as the Guidelines suggest. Consistent with the Guidelines, the State of Maine did not evaluate emissions of VOCs and ammonia in BART determinations for these reasons:

   - The majority of VOC emissions in Maine are biogenic in nature, with the areas near Maine Class I areas especially so (the ability to further reduce total ambient VOC concentrations at Class I areas is limited);
   - Point, area and mobile sources of VOCs in Maine are already comprehensively controlled as part of our ozone attainment and maintenance strategy;

- The overall ammonia inventory is very uncertain, and the amount of anthropogenic emissions at sources that were BART-eligible was relatively small, and
- No additional sources were identified that had greater than 250 tons per year ammonia and required a BART analysis.

The identification of BART sources in Maine was undertaken as part of a multi-state analysis conducted by the Northeast States for Coordinated Air Use Management (NESCAUM). NESCAUM worked with Maine DEP licensing engineers to review all sources and determine their BART eligibility. Maine DEP identified 10 sources as BART-eligible. These sources are listed below in Table 10-1.

10.4 Sources Subject to BART

Maine, working with MANE-VU, found that every MANE-VU state with BART-eligible sources contributes to visibility impairment at one or more Class I areas to a significant degree (See the MANE-VU Contribution Assessment in Attachment A). As a result, Maine has found that all eligible sources within Maine are subject to BART. The State of Maine is utilizing this option for demonstrating its sources are reasonably anticipated to cause or contribute to visibility impairment at Class I areas for three reasons: (1) the BART sources represent an opportunity to achieve greater reasonable progress; (2) additional public health and welfare benefits will accrue for the resulting decreases in fine particulate matter; and (3) to demonstrate its commitment to federal land managers (FLMs) and other RPOs as it seeks the implementation of reasonable measures in other states.[37]

According to Section III of the 2005 Regional Haze Rule, once the state has compiled its list of BART-eligible sources, it needs to determine whether to make BART determinations for all of the sources or to consider exempting some of them from BART because they may not reasonably be anticipated to cause or contribute to any visibility impairment in a Class I area.

Based on the collective importance of BART sources, Maine has decided that no exemptions would be given for sources; a BART determination will be made for each BART-eligible source.

10.5 MANE-VU BART Modeling

MANE-VU conducted modeling analyses of BART-eligible sources using CALPUFF in order to provide a regionally-consistent foundation for assessing the degree of visibility improvement which could result from installation of BART controls (See Attachment L).

[37] Maine's decision that all BART eligible sources are subject to BART should not be misconstrued to mean that all BART-eligible sources must install BART. Maine's approach simply requires the consideration of each of the five statutory factors before determining whether or not controls are warranted.

Table 10-1
BART-Eligible Sources in Maine

Source and Unit	Location	I.D	BART Source Category
FPLE Wyman Station Boiler #3 Boiler #4	Yarmouth, ME	2300500135 -004 -005	SC 1- Fossil fuel fired electric plants
Domtar Power Boiler #9 Lime Kiln	Woodland, ME	2302900020 -001 -002	SC 3 - Kraft pulp mills
Dragon Products Kiln	Thomaston, ME	2301300028 -005	SC 4 – Portland cement plants
Red Shield Acquisition, LLC #4 Recovery Boiler Lime Kiln	Old Town, ME	2301900034 -002 -004	SC 3 - Kraft pulp mills
Verso Bucksport #5 Boiler	Bucksport, ME	2300900004 -001	SC 22 – Fossil fuel fired boilers
SAPPI Somerset Recovery Boiler Smelt Tanks #1, #2 Lime Kiln	Hinckley, ME	2302500027 -003 -007 -004	SC 3 - Kraft pulp mills
Verso Androscoggin Power Boiler #1 Power Boiler #2 Waste Fuel Incinerator Recovery Boilers #1 and #2 Smelt Tank #1 Smelt Tank #2 Lime Kiln A Lime Kiln B Flash Dryer	Jay, ME	2300700021 -001 -002 -003 -004/005 -009 -010 -007 -008 -018	SC 3 - Kraft pulp mills
Katahdin Paper Power Boiler #4	Millinocket, ME	2301900056 -004	SC 22 – Fossil fuel fired boilers
Lincoln Paper and Tissue Recovery Boiler #2	Lincoln, ME	2301900023 -002	SC 3 - Kraft pulp mills
Rumford Paper Power Boiler #5	Rumford, ME	2301700045 -003	SC 3 – Kraft pulp mills

While this modeling analysis differed slightly from the statutory language, it was intended to provide a first-order estimate of the maximum visibility benefit that could be achieved by eliminating all emissions from a BART source, and provides a useful metric for determining which sources are unlikely to warrant (additional) controls to satisfy BART.

The MANE-VU modeling effort analyzed 136 BART-eligible sources in the MANE-VU region using the CALPUFF modeling platform and two meteorological data sets: 1) a wind field based on National Weather Service (NWS) observations; and 2) a wind field based on the MM5 meteorological model (MM5 2006). Modeling results from both the NWS and MM5 platforms include each BART eligible unit's maximum 24-hr, 8^{th} highest 24-hr, and annual average impact at the Class I area. These visibility impacts were modeled relative to the 20 percent best, 20 percent worst, and average annual natural background conditions. In accordance with EPA guidance, which allows the use of either estimates of the 20 percent best or annual average natural background visibility conditions as the basis for calculating the deciview difference that individual sources would contribute for BART modeling purposes, MANE-VU opted to utilize the more conservative best conditions estimates approach because it is more protective of the region.

The 2002 baseline modeling provides an estimate of the maximum improvement in visibility at Class I Areas in the region that could result from the installation of BART controls (the maximum improvement is equivalent to a "zero-out" of emissions). In virtually all cases, the installation of BART controls would result in less visibility improvement than what is represented by a source's 2002 impact, but this approach does provide a consistent means of identifying those sources with the greatest contribution to visibility impairment.

In addition to modeling the maximum potential improvement from BART, MANE-VU also determined that 98 percent of the cumulative visibility impact from all MANE-VU BART eligible sources corresponds to a maximum 24-hr impact of .22 dv from the NWS-driven data and 0.29 dv from the MM5 data. As a result, MANE-VU concluded that, on the average, a range of 0.2 to 0.3 dv would represent a significant impact at MANE-VU Class I areas, and sources having less than 0.1 dv impact are unlikely to warrant additional controls under BART.[38]

Table 10-2 illustrates the modeled impacts (maximum) of Maine BART-Eligible sources on selected Class I areas in Maine and New Hampshire. For this table, SO_4, NO_3 and PM_{10} modeled impacts at these Class I areas were totaled to provide an estimate of the maximum 24-hr impact at these nearby Class I areas. It should be noted that a number of BART-eligible sources (highlighted) have less than a 0.1 deciview impact on Class I areas.

[38] As an additional demonstration that sources whose impacts were below the 0.1 dv level were too small to warrant BART controls, the entire MANE-VU population of these units was modeled together to examine their cumulative impacts at each Class I suite. The results of this modeling demonstrated that the maximum 24-hour impact at any Class I area of all modeled sources with individual impacts below 0.1 dv was only a 0.35 dv change relative to the estimated best days natural conditions at Acadia National Park. This value is well below the 0.5 dv impact recommended by EPA for exemption modeling and used by most other RPOs.

10.6 The Maine BART Analysis Protocol

40 CFR 51.308(e)(1)(ii)(A) requires that, for each BART-eligible source within the state, any BART determination must be based on an analysis of the best system of continuous emission control technology available and the associated emission reductions achievable. In addition to considering available technologies, this analysis must evaluate five specific factors for each source:

1. The costs of compliance,
2. The energy and non-air quality environmental impacts of compliance,
3. Any existing pollution control technology in use at the source,
4. The remaining useful life of the source, and
5. The degree of visibility improvement which may reasonably be anticipated from the use of BART.

Although Maine did not exempt any BART-eligible sources from a BART determination, it did utilize the MANE-VU zero-out modeling (described in the previous section) as a surrogate for estimating the visibility improvement reasonably expected from the application of controls. As previously highlighted in Table 10-2, there are ten BART-eligible sources with less than 0.1 deciview impact at any Class I area, with these impacts ranging from a low of 0.0018 deciviews to a higher (but still insignificant) 0.0822 deciviews. Since zero-out modeling shows that the elimination of all emissions from these sources would provide only insignificant visibility benefits at nearby Class I areas, and recognizing that the majority of these units already have controls fully satisfying BART requirements, the Department used the "anticipated visibility improvement from BART" factor to determine the scope of the BART analysis and whether visibility impact modeling need be performed by specific sources. The Maine approach is consistent with that used by other MANE-VU states that are not allowing sources to utilize exemption modeling. With the Maine approach, all BART-eligible sources were required to undertake an engineering analysis of their existing and possible future controls. If an emissions unit was found to be well-controlled (in comparison with possible future controls), and the visibility impacts of the unit relatively small[39] as determined by the MANE-VU zero-out modeling, BART was determined by existing controls, and additional visibility impact modeling was not necessary (for a more detailed look at Maine's BART process, see Attachment M-1).

10.7 Summary of Maine BART Determinations

The following section details the BART determinations for all BART-eligible sources in Maine. All BART requirements are incorporated in a Title V air emissions license (operating permit) for each source; draft Title V licensee are included in Attachment M.

[39] Sources with less than 0.1 deciview impact on Class I areas are presumed to have a small impact.

Table 10-2
Modeled Impacts (Deciviews) of Maine BART-Eligible Sources at Selected MANE-VU Class I Areas
(Sources with < 0.1 deciview total impact highlighted)

Facility Name	Stack Name	NWS CALPUFF				MM5 CALPUFF			
		Total	SO4	NO3	PM10	Total	SO4	NO3	PM10
		24-hr dv impact				24-hr dv impact			
FPLE Wyman Station	Boiler_4	0.1423	0.1276	0.0334	0.0010	0.4749	0.3846	0.1072	0.0005
FPLE Wyman Station	Boiler_3	0.2212	0.1715	0.0704	0.0004	0.3049	0.2545	0.0508	0.0014
Domtar Ind.	#9_Power_Boiler	1.3630	0.2828	0.7988	1.3134	1.6506	0.1815	0.7279	1.3717
Domtar Ind.	Lime_Kiln	0.5296	0.0559	0.4309	0.1207	0.4589	0.0427	0.3820	0.1048
Dragon Products	Kiln	2.0155	0.2434	1.7614	0.0604	1.8626	0.3208	1.7234	0.0413
Red Shield Acquisition, Old Town	#4_Recovery_Boiler	0.2425	0.0634	0.1633	0.0173	0.2631	0.0424	0.2070	0.0391
Red Shield Acquisition, Old Town	Lime_Kiln	0.0851	0.0171	0.0433	0.0278	0.1338	0.0138	0.0855	0.0463
Verso, Bucksport	Boiler_#5	0.0543	0.0260	0.0267	0.0021	0.1591	0.0817	0.0721	0.0098
SAPPI Somerset	Recovery_Boiler	0.2159	0.0151	0.1971	0.0087	0.4421	0.0179	0.4168	0.0158
SAPPI Somerset	Smelt_Tanks_#1_and_#2	0.0108	0.0034	0.0000	0.0095	0.0000	0.0000	0.0000	0.0000
SAPPI Somerset	Lime_Kiln	0.0380	0.0270	0.0105	0.0012	0.0651	0.0455	0.0187	0.0010
Verso, Androscoggin	Power_Boiler_#1	0.6948	0.5720	0.1235	0.0094	1.7631	1.2176	0.5867	0.0290
Verso, Androscoggin	Power_Boiler_#2	0.7223	0.5948	0.1287	0.0095	1.8289	1.2646	0.6105	0.0293
Verso, Androscoggin	Waste_Fuel_Incinerator Boiler_	0.4256	0.0036	0.3651	0.0591	0.4956	0.0064	0.4544	0.0367
Verso, Androscoggin	Recovery_Boiler_#1_and_#2	0.1101	0.0454	0.0598	0.0078	0.3856	0.0952	0.2723	0.0215
Verso, Androscoggin	Smelt_Tank_#1	0.0139	0.0002	0.0000	0.0137	0.0122	0.0002	0.0000	0.0120
Verso, Androscoggin	Smelt_Tank_#2	0.0129	0.0004	0.0000	0.0125	0.0135	0.0006	0.0000	0.0129
Verso, Androscoggin	Lime_Kiln_A	0.0441	0.0001	0.0273	0.0167	0.0457	0.0004	0.0337	0.0123
Verso, Androscoggin	Lime_Kiln_B	0.0296	0.0001	0.0197	0.0098	0.0293	0.0004	0.0228	0.0062
Verso, Androscoggin	Flash_Dryer	0.0222	0.0044	0.0173	0.0005	0.0252	0.0097	0.0175	0.0003
Katahdin Paper Millinocket	PB_#4	0.8293	0.6630	0.1569	0.0210	0.4458	0.3832	0.1164	0.0216
Lincoln Paper and Tissue	Recovery_Boiler_#2	0.1151	0.0141	0.0806	0.0224	0.1200	0.0073	0.0882	0.0322
Rumford Paper	PB_#5	0.0369	0.0039	0.0327	0.0026	0.1025	0.0108	0.0897	0.0020
		> 0.1 dv TOTAL and a pollutant				> 0.1 dv TOTAL only			

10.7.1 Cap-Outs and Shutdowns

EPA guidance allows BART-eligible sources to adopt a federally enforceable permit limit to permanently limit emissions of visibility impairing pollutants to less than 250 tons per year, thereby "capping-out" of BART. Four Maine sources capped out of BART:

1. Katahdin Paper Company, LLC
2. Red Shield Acquisition, LLC
3. Rumford Paper Company
4. Verso Bucksport, LLC

These sources have actual emissions of visibility impairing pollutants of fewer than 250 tons per year, and are BART-eligible only because their potential emissions (PTE) exceed the statutory threshold of 250 tons per year. Pursuant to their requests, the Maine DEP has established federally enforceable permit conditions that limit the PTE of these units to less than the statutory threshold of 250 tons per year for all visibility impairing pollutants, which makes these units not subject to BART requirements.

Federally enforceable terms and conditions were established for each source that limit the PTE for SO_2, PM_{10} and NO_x to less than 250 TPY. Note that
if, in the future, the source requests an increase in PTE greater than 250 tons per year per visibility impairing pollutant, then they shall be subject to the Best Available Retrofit Technology (BART) provisions of the Environmental Protection Agency's (EPA) Regional Haze Program Requirements (40 Code of Federal Regulations, Part 51, Section 308).

10.7.2 Maine BART Determinations

In general, the following determinations summarize the controls and limits that are currently required under existing air emission licenses (as noted), or will be required specifically due to BART.

1. Domtar Maine, LLC

The Domtar Woodland Pulp facility is a pulp mill, which utilizes the Kraft Pulping process and produces market pulp. The Mill also operates support facilities including woodyards, wastewater treatment plant, sludge press, pulp production labs, environmental labs, finishing, shipping, and receiving operations, storage areas, a landfill, and a power boiler. There are two BART eligible units at the facility; the #9 Power Boiler, and the Lime Kiln.

#9 Power Boiler is rated at 625 MMBtu/hr and was placed into operation in 1971. #9 Power Boiler is fueled primarily by biomass but is also licensed to burn #6 fuel oil, sludge, TDF, specification waste oil, HVLC, LVHC, mill yard waste, oily rags, stripper off-gas, and propane. Emissions are controlled using a variable-throat wet venturi scrubber and low-NO_x burners. The Lime Kiln is rated at 75 MMBtu/hr and was placed into operation in 1966. Emissions are controlled using a variable-throat wet venturi scrubber and a Ceilcote cross-flow scrubber. The Lime Kiln is fueled by #6 fuel oil.

BART Analysis Summary

#9 Power Boiler

PM: Domtar evaluated the use of Fabric Filters, Wet Electrostatic Precipitator (WESP), Dry Electrostatic Precipitator (DESP), and Wet Scrubbers to control PM at the #9 Power Boiler. Fabric filters were found not technically feasible due to fire risk from combustible fly-ash, while WESP is not technically feasible due to operational difficulties with multi-fuel boilers. A DESP could not be installed post-scrubber due to excess moisture levels, but could be installed upstream. A DESP was evaluated and found to provide a 98-99% control efficiency for biomass a 90% efficiency for oil (for comparison, a wet scrubber provides an 85-98% control efficiency) . Domtar estimated the cost for DESP installation at $4,640 per ton of PM removed, and found that DESP is not a cost-effective option.

SO_2: Power Boiler #9 is currently controlled through the use of a wet scrubber and low sulfur fuel (biomass). Domtar did not investigate other control technologies because the combination of low sulfur fuel and wet scrubber provides maximum emission reductions from this unit.

NO_x: Domtar identified a number of potential NO_x control strategies for use on Power Boiler #9, including: NOx tempering, flue gas recirculation (FGR), selective non-catalytic reduction (SNCR), selective catalytic reduction (SCR), low NOx burners and good combustion practices. Several potential NOx controls were found to be technically infeasible, and did not warrant further investigation. NOx tempering is not technically feasible due to reduced thermal efficiency and increased fuel usage, SCR is not technically feasible due to the increased frequency of catalyst fouling from multi-fuel boilers, and FGR is not technically feasible based on previous failed FGR trials conducted on the #9 Power Boiler. SNCR, with a 30-40% control efficiency, and low NOx Burners, with 10% control efficiency, were identified as technically feasible control strategies. Domtar's analysis estimated the cost-effectiveness of SNCR at $7,360 per ton, and noted that SNCR has a reduced effectiveness on boilers with significant load swings (such as Power Boiler #9). Given the low cost-effectiveness of SNCR, Domtar identified the continued use of low NO_x burners as BART.

Lime Kiln

*PM: T*he Lime Kiln is subject to the MACT standard for PM found in 40 CFR, Part 63, Subpart MM. According to 40 CFR, Part 51, Appendix Y, According to 40 CFR Part 51, Appendix Y, Section IV (C), an exemption is made that states "We believe that, in many cases, it will be unlikely that States will identify emission control standards more stringent than the Maximum Achievable Control Technology (MACT) standards without identifying control options that would cost many thousands of dollars per ton. Unless there are new technologies subsequent to the MACT standards which would lead to cost-effective increases in the level of control, you may rely on the MACT standards for the purposes of BART." Since this current MACT requirement satisfies the requirements of BART, no further analysis was undertaken.

SO_2: Domtar identified the use of a wet scrubber and in-process capture as feasible technologies for the control of SO_2 from the lime kiln. Since both technologies are currently employed by Domtar (including two wet scrubbers), no further analysis was necessary.

NO_x: A number of potential NO_x control strategies were identified for the lime kiln, including: SNCR, SCR, non-selective catalytic reduction (NSCR), FGR, low NOx burners and good combustion practices. The impracticality of installing chemical injection nozzles inside a rotating Kiln drum makes SNCR technically infeasible. SCR and NSCR are not feasible due to the known presence of catalyst fouling substances in the Lime Kiln. FGR is not feasible as it reduces the temperature in the flame zone, thus hindering the chemical reaction taking place in the Lime Kiln. Low NO_x burners are a non-demonstrated technology and are not listed in the EPA BACT/RACT/LEAR Clearinghouse for Lime Kiln emissions control. Good combustion practices are the only feasible option, which is already employed at the Lime Kiln. No further analysis is necessary.

BART Determination for Domtar

Unit	**PM**		**SO_2**		**NO_x**	
	Control Type	Emission Limit and Reference	Control Type	Emission Limit and Reference	Control Type	Emission Limit and Reference
#9 Power Boiler	Wet scrubber	0.15 lb/MMBtu (Existing Title V license)	Wet scrubber	0.3 lbs/MMBtu on a 24-hour basis (BART order)	Low-NO_x burners	0.4 lb/MMBtu on a 24-hour basis (Existing Title V license)
Lime Kiln	Wet scubber	Compliance with 40 CFR Part 63 Subpart MM	Wet scrubber/Process control	8.3 lbs/hr. (Existing Title V license)	Good combustion practices	120 ppmvd @10% O_2 (Existing Title V license)

2. Dragon Products Company

Dragon operates a cement manufacturing facility in Thomaston. The facility, built in 1971, was initially a wet process cement kiln that was converted to the more efficient dry cement manufacturing process beginning in 2003. The modernization project converted the existing wet process cement kiln to a dry process (preheater/precalciner type), converted the existing (wet) raw mill to a pregrinding finish cement mill, and improved other ancillary operations within the facility. The planned annual production rate of the new facility is approximately 766,500 tons of clinker.

The BART eligible kiln system is a single dry process rotary kiln and inline raw mill equipped with a preheater/precalciner. Various allowable fuels, including petcoke, #2 fuel oil, #4 fuel oil, specification waste oil, non-specification waste oil, whole tires, and tire chips provide thermal energy necessary to convert raw materials (limestone, silica, iron ore, fly ash, and/or other raw material additives) into calcium silicates or 'clinker'. Hot flue gases from the kiln flow counter-current to the feed material up the length of the kiln. Heat is transferred to the fed material from the direct contact of the flue gases in the kiln and preheater/precaliner tower.

BART Analysis Summary

Dragon submitted a 5-step BART analysis of the technical feasibility and cost of compliance, the energy and non-air quality impacts of compliance, any existing air pollution control technology in use at the source, the remaining useful life of the source, and the degree of visibility improvement anticipated from the use of BART (a CALPUFF version 5.8 analysis was performed by Dragon).

PM: Emissions of PM from the kiln system are generated as a function of the clinker production process. The kiln system is subject to 40 CFR Part 63, Subpart LLL, *National Emission Standards for Hazardous Air Pollutants from the Portland Cement Manufacturing Industry*. Since the MACT is current and Dragon complies with the particulate matter limits in §63.1343 and uses a fabric filter dust collector for PM_{10} control, no further BART analysis was performed.

SO_2: Emissions of SO_2 from cement kilns are generally related to the inherent SO_2 removal efficiency present in the kiln system operation itself, the pyritic sulfur concentration of the raw feed materials, the sulfur to alkali ratio of the raw feed materials, and whether the prevailing condition of the system is oxidizing or reducing. Dragon identified wet scrubbing, semi-dry scrubbing, dry scrubbing, fuel switching, and process alterations as possible retrofit control technologies for reducing SO_2 emissions.

Wet caustic scrubbing, where one or more soluble components of an acid gas are dissolved in a liquid with a low volatility, semi-dry scrubbing, based on atomizing a reagent slurry stream containing lime and contacting the flue gases in a spray dryer type vessel, and dry scrubbing, consisting of injecting a dry reagent into the gas stream prior to the particulate matter control device, were considered technically feasible for the kiln system and were further evaluated[40]. The three scrubbing options were reviewed further, and the results are in the following table:

[40] A dry scrubbing system is currently installed on the kiln system but is not operated.

Control Technology	Expected SO_2 Emission Rate (tons/yr)	Emissions Performance Level	Expected SO_2 Emissions Reductions (tons/yr)	Cost of Compliance
Wet Scrubbing	49.0	95%	46.6	Total Cap. Investment: $9,419,115 Total Annualized Cost:$2,238,950 Ave Cost Effectiveness:$48,098/ton Ave Cost Effectiveness per deciview: $12,508,101/dv
Semi-Dry Scrubbing	49.0	90%	44.1	Total Cap. Investment: $2,359,464 Total Annualized Cost:$675,978 Ave Cost Effectiveness:$15,328/ton Ave Cost Effectiveness per deciview: $3,907,387/dv
Dry Scrubbing	49.0	50%	24.5	Total Cap. Investment: $0 Total Annualized Cost:$245,737 Ave Cost Effectiveness:$10,030/ton Ave Cost Effectiveness per deciview: $2,254,468/dv

Based on capital costs associated with the additional retrofit controls, the resultant SO_2 control cost effectiveness values, and the predicted visibility at the nearest Class I area, it was determined that these are not viable BART options.

Fuel switching and process alterations were also evaluated, but were not found to be viable control options.

<u>NO_X</u>: Emissions of NO_X from cement kilns are generally related to thermal NO_X, fuel NO_X, and raw feed material NO_X. Dragon identified fuel switching, process optimization, flue gas recirculation (FGR), indirect fuel firing, staged air combustion/mid-kiln firing, low NO_X burners, selective Non-Catalytic Reduction (SNCR), and Selective Catalytic Reduction (SCR) as available NO_x control retrofit technologies.

Fuel switching was not considered technically feasible since the nitrogen content of the fuel used in the kiln burning zone has little or no effect on NO_X generation in a portland cement kiln. Flue gas recirculation was not considered technically feasible since the effectiveness of FGR relies on cooling the flame and generating a reducing combustion atmosphere to reduce thermal NO_X emissions, which is not compatible with the high flame temperature and an oxidizing combustion zone atmosphere in the kiln system required to produce quality clinker. SCR was not considered technically feasible since there are no full scale SCR systems (ammonia injection upstream of a catalyst bed) in operation at cement kilns in the United States due to various concerns including exhaust temperature and plugging.

Process optimization is currently being used on the kiln system, with advanced computer controls and instrumentation to improve overall facility operation and fuel efficiency.

Indirect fuel firing is currently the kiln system's method of operation, whereby pulverized solid fuel from a solid fuel mill is captured in a cyclone or fabric filter and is stored before being conveyed to the kiln. This separates the mill conveyance air from the fuel and the fuel is introduced in a controlled manner from storage, reducing primary kiln combustion air to less than 10% of the total combustion air (in a direct-fired cement kiln, the primary combustion air can make up to 20% of the total combustion air). Staged air combustion/mid-kiln firing is currently being used in the kiln system to reduce kiln stratification and improve combustion of the fuel, which aids in reducing emissions. Low NO_X burners are currently being used on the kiln system. SNCR is currently being used on the kiln system, with ammonia injection at a location in the correct temperature range for proper reaction to reduce NO_X emissions.

Dragon initially proposed the use of the existing NO_X controls as they are currently operated as BART. However, the Department requested additional information on the use of the SNCR technology at the facility relating to further NO_X control. Dragon supplied possible operational changes to the existing SNCR control unit including: increasing the operating time of the SNCR control unit, relocating the reagent injection nozzles, changing the reagent used in the SNCR control unit, and increasing the injection rate of the SNCR control unit reagent. The unit is already operated whenever the kiln is in operation so changing the operating time is not feasible. Relocating the injection nozzles or changing the reagent (19% aqueous ammonia) is not feasible, since the SNCR unit operates at the optimum injection point and reagent type based on the original trial test. Increasing the injection rate is a feasible option.

Records show that from April 2005 through December 2008, the SNCR operated at an average control efficiency of approximately 22%, and in 2008, the efficiency was slightly lower at 18%. Since the June 18, 2008 comments of the MACT standards for the Portland Cement amendments, EPA has stated that that 'for an SNCR (control unit) with optimal injection configuration and reagent injection rate, a 50% NO_X emission reduction represents a reasonable level of performance of SNCR over the long term,." The Department requested that Dragon assess the operation of the SNCR at 50% efficiency. Dragon performed an operational change impact analysis with the following results:

Control Technology	Expected NO_X Emission Rate (tons/yr)	Emissions Performance Level	Expected NO_X Emissions Reductions (tons/yr)	Cost of Compliance
SNCR operating at 50%	1130.6	927.1	565.3	Total Cap. Investment: $0 Total Annualized Cost:$1,483,877 Ave Cost Effectiveness:$4101/ton Ave Cost Effectiveness per deciview: $7,419,385/dv

Dragon proposed no increased reagent reaction rate due to additional cost, additional ammonia slip, and no perceptible change in visibility at the nearest class I area (Acadia

National Park). However, the Department is setting a 45% removal efficiency requirement to further reduce NO_X.

BART Determination

The Department determined BART for Dragon as follows:

BART Determination for Dragon Products Company

Unit	PM		SO_2		NO_x	
	Control Type	Emission Limit and Reference	Control Type	Emission Limit and Reference	Control Type	Emission Limit and Reference
Kiln	baghouse	9.3 lb/hr and 0.3 lb/ton dry kiln feed (Existing Title V license; 40 CFR Part 63)	N/A	70.00 lb/hr. on a 90-day rolling average (Existing Title V license) and 200 tons/year on a 12-month rolling average (BART order)	SNCR 45% control efficiency on a 24-hour basis (BART order)	350.0 lb/hr on a 90-day rolling average and 1533.0 tons per year on a 12-month rolling total basis (Existing Title V license)

3. FPL Energy Wyman, LLC.

FPLE Wyman is an 850-megawatt electric generating facility located on Cousins Island in Yarmouth, Maine. The plant consists of four generation units, all of which fire #6 residual fuel oil. A fifth unit is a smaller oil-fired auxiliary boiler which provides building heat and auxiliary steam and a sixth unit is an emergency backup diesel generator that provides electricity for use on-site. There are two BART eligible units at the facility- Unit 3 and Unit 4.

Boiler #3 is a Combustion Engineering boiler, installed in 1963, with a maximum design heat input capacity of 1190 MMBtu/hr firing #6 fuel oil (2% sulfur). The boiler is equipped with multiple centrifugal cyclones for control of particulate matter and optimization and combustion controls for NO_X. Boiler #4 is a Foster Wheeler boiler, installed in 1975, with a maximum design heat input capacity of 6290 MMBtu/hr firing #2 or #6 fuel oil (0.7 % sulfur). The boiler is equipped with an electrostatic precipitator for control of particulate matter and optimization and combustion controls for NO_X.

BART Analysis Summary

PM: Emissions of PM from oil fired boilers are a function of fuel firing.[41] Both boilers #3 and #4 have high efficiency combustion systems in conjunction with PM control devices; boiler #3 having multiclones and boiler #4 having an ESP. The cost analysis of installing an ESP on boiler #3 resulted in pollutant removal cost effectiveness of $19,000/ton of PM removed and visibility improvement cost effectiveness of $143 million per deciview of visibility improvement. This was determined to be excessive and not cost-effective.

SO_2: Emissions of SO_2 from oil fired boilers are related to the sulfur in the fuel. FPLE Wyman identified the following available retrofit control technologies for reducing SO_2 emissions from the oil fired boilers: low sulfur #2 fuel oil, reduced sulfur #6 fuel oil, and wet or dry scrubbers. Low sulfur #2 fuel oil (0.05% down to 0.0015%) and the use of reduced sulfur #6 fuel oil (1% or less) were considered technically feasible options. Post combustion controls of wet or dry scrubbers on large boilers were researched and generally only typically applied to coal fired boilers. The use of scrubbing systems on oil fired boilers is considered cost prohibitive and was not considered as a BART option.

FPLE Wyman performed a cost analysis on lowering the sulfur content in both boilers. Boiler #3 currently fires 2% sulfur oil and boiler #4 currently fires 0.7% sulfur oil. The annual costs were calculated to be the following (based on the differential fuel costs):

Boiler #3		Boiler #4	
% sulfur	Annual Costs	% sulfur	Annual Costs
1.0	$0.68 million	-	-
0.7	$0.80 million	-	-
0.5	$3.2 million	0.5	$9.2 million
0.3	$5.7 million	0.3	$18.3 million

The visibility cost effectiveness, incremental visibility improvement, and incremental visibility cost effectiveness from switching from 2% sulfur to reduced sulfur content fuel oil for boiler #3 was the following:

% Sulfur	Ranked Visibility Impact	Visibility Cost Effectiveness ($/deciview)	Incremental Visibility Improvement	Incremental Visibility Cost Effectiveness ($/deciview)
1.0	1st 8th	$0.69 million $1.95 million	- -	- -
0.7	1st 8th	$0.56 million $1.67 million	0.44 dv 0.13 dv	$0.27 million $1.92 million

[41] It is estimated from the MANE-VU August 2006 document *Contributions to Regional Haze in the Northeast and Mid-Atlantic United States, Tools and Techniques for Apportioning Fine Particle/Visibility Impairment in MANE-VU* (pages 3-2, 4-7, 4-8) that course particulate matter has typically less than 4% of the contribution to visibility impairment at the MANE-VU Class I areas.

0.5	1st 8th	$1.82 million $5.41 million	0.35 dv 0.12 dv	$6.97 million $20.3 million
0.3	1st 8th	$2.64 million $8.12 million	0.37 dv 0.10 dv	$6.59 million $24.4 million

The visibility cost effectiveness, incremental visibility improvement, and incremental visibility cost effectiveness from switching from 0.7% sulfur to reduced sulfur content fuel oil for boiler #4 was the following:

% Sulfur	Ranked Visibility Impact	Visibility Cost Effectiveness ($/deciview)	Incremental Visibility Improvement	Incremental Visibility Cost Effectiveness ($/deciview)
0.5	1st 8th	$22.3 million $39.8 million	- -	- -
0.3	1st 8th	$19.5 million $35.2 million	0.53 dv 0.29 dv	$17.3 million $31.6 million

Based on the sulfur contributions in the Northeast and the information above, FPLE Wyman proposed 1% sulfur fuel oil for boiler #3 beginning in 2013, and the current sulfur limit of 0.7% for boiler #4 as BART.

NO_X: Emissions of NO_X from oil fired boilers are from thermal and fuel NO_X. In order to minimize NO_X emissions, FPLE Wyman installed combustion control technologies pursuant to 06-096 CMR 145, *NO_X Control Program Regulation*. FPLE Wyman installed combustion control technology upgrades including low NO_X fuel atomizers, improved swirler design, and overfire and interstage air ports. The burners were optimized and fuel/air flows were balanced to the burners on each unit. The combustion control technology upgrades were completed in April 2003 and reductions of 29-35% have been documented with boiler #3 and reductions of 24-47% have been documented with boiler #4 depending on each unit's load. These reductions are equivalent to the use of SNCR (Selective Non-Catalytic Reduction) technology on the boilers.

The cost analysis of installing additional NO_X controls of regenerative selective catalytic reduction (RSCR) on the boilers in addition to the current combustion controls resulted in a pollutant removal cost effectiveness of $125,000/ton and $83,000/ton of NO_X removed for boiler #3 and boiler #4, respectively. This was determined to be excessive and not cost effective.

BART Determination

The Department determined BART for FPLE Wyman as follows:

BART Determination for FPLE Wyman

Unit	PM		SO_2		NO_x	
	Control Type	Emission Limit and Reference	Control Type	Emission Limit and Reference	Control Type	Emission Limit and Reference
Boiler #3	multiclones	0.15lb/MMBtu (BART order)	Low-sulfur oil	1% sulfur by weight oil (BART order)	Combustion engineering	0.175 lb/MMBtu on a 90-day rolling average* (Existing Title V license; 06-096 CMR Chapter 145)
Boiler #4	ESP	0.1 lb/MMBtu (Existing Title V license; 40 CFR Part 60)	Low-sulfur oil	0.7% sulfur by weight oil (Existing Title V license, 40 CFR Part 60)	Combustion engineering	0.170 lb/MMBtu on a 90-day rolling average*(Existing Title V license; 06-096 CMR Chapter 145)

Alternatively, the NO_x limit from boilers #3 and #4 averaged shall be limited to 0.165 lbs/MMBtu on a 90—day operating rolling average

4. Lincoln Paper and Tissue, LLC

Lincoln Paper & Tissue (LPT) is an integrated kraft pulp and paper mill. Currently, LPT operates a hardwood digester and a softwood sawdust digester to produce pulp with approximately 50% recycled content. LPT uses one recovery boiler and a lime kiln in the recaust process for reclamation of the pulping chemicals. Also, LPT has three oil-fired boilers and one multi-fuel boiler to supply the mill with steam. The two paper machines produce specialty paper and the two tissue machines produce multi-ply dyed tissue. The pulp dryer machine produces bailed pulp which is either used by LPT or sold to other paper manufacturers.

At LPT, the only BART-eligible source is the Recovery Boiler #2, which is used to recover chemicals and produce steam. Emissions exit through two identical 175 foot stacks. The recovery boiler is a straight fire unit burning black liquor, typically without combustion support from fossil fuel. Normally, oil is used only during start-ups, shutdowns and to stabilize operation of the boiler.

The Recovery Boiler is exhausted to a wet bottom electrostatic precipitator (ESP) to control particulate emissions. This unit also serves to re-introduce salt cake into the black liquor which further concentrates the solids content.

<u>BART Analysis Summary</u>

The LPT BART analysis evaluated the best system of continuous emissions control technology available for each of the visibility-impairing pollutants (SO_2, PM, and NO_x). LPT's BART analysis submittal demonstrated that additional emission controls are neither feasible nor necessary for Recovery Boiler #2. PM emissions are controlled with the ESP to levels meeting compliance with MACT standards and therefore meet BART. SO_2 emissions are controlled by proper operation of the recovery boiler, including a three-level staged combustion air control system, and limitations on fuel oil use and sulfur content. NO_x emissions are minimized through staged combustion (having independently operating primary, secondary, and tertiary air dampers) and by the low nitrogen content of black liquor solids along with proper operation of the Recovery Boiler. Existing SO_2 and NO_x controls on the #2 Recovery Boiler were determined by the Department and EPA to meet BACT in the PSD/NSR licensing of the facility. As no new control technologies are available for further control of these pollutants from a recovery boiler the BACT determination constitutes BART compliance. Maine did not require additional visibility impact modeling because of the limited visibility impacts from this source.[42]

BART Determination

The Department determined BART for Lincoln Paper and Tissue as follows:

BART Determination for Lincoln Paper and Tissue

Unit	**PM**		**SO_2**		**NO_x**	
	Control Type	Emission Limit and Reference	Control Type	Emission Limit and Reference	Control Type	Emission Limit and Reference
Recovery Boiler	ESP	0.044 grains per dry standard cubic foot (0.044 gr/dscf) (Existing Title v license; 40 CFR Part 63)	Low-sulfur oil	141 ppmv (dry basis) @8% O_2 on a 24-hour block average basis (Existing Title v license)	Combustion engineering	233 ppmv (dry basis) @ 8% O_2 on a 24-hour block average basis (Existing Title v license)

5. SD Warren Company, Somerset

SD Warren Company (SDW) is an integrated kraft pulp and paper mill. Whole logs, chips, and biomass, are delivered to the mill by truck and/or train. The logs are sawn, debarked, chipped and stored in the mill's woodyard. The biomass is stored in piles and then conveyed to the boilers. The chips are stored in piles and then conveyed to the chip bin, chip steaming vessel, and then the digester. SDW operates one Kamyr continuous digester to produce pulp (hardwood, softwood, or any combination thereof), one recovery boiler and one lime kiln in the recaust process for reclamation of the pulping chemicals. There are two multi-fuel boilers and an oil fired package boiler to supply the mill with steam. SDW has three paper machines which produce paper. There are also two pulp machines. One pulp machine has a steam operated dryer and both machines produce

[42] Modeled visibility impacts attributable to Recovery Boiler #2 as 0.0073 deciviews (dv) for SO2, 0.0882 dv for NOx, 0.0322 dv for PM, and 0.12 dv total impacts.

bailed pulp. The mill also operates support facilities, including the wood yard, wastewater treatment plant, sludge presses, pulp and paper production labs, environmental labs, roll wrapping, shipping and receiving operations, and a landfill.

There are four emissions units that were determined to be BART eligible at this facility; the Recovery Boiler, Smelt Tanks #1 and #2, and the Lime Kiln. The Recovery Boiler was installed in 1975-1976. It is used to recover chemicals from spent pulping liquors and to produce steam for mill operations. The Recovery Boiler is licensed to fire black liquor (spent pulping liquor), residual (#6) fuel oil, distillate (#2) fuel oil, and used oil. The Recovery Boiler is also licensed to combust low volume-high concentration (LVHC) and high volume-low concentration (HVLC) gases produced at various points in the pulping process. The current black liquor firing rate is 5.1 million pounds per day of black liquor solids (BLS). The licensed maximum black liquor firing rate will become 5.5 million pounds per day of BLS after the boiler upgrade project is completed (scheduled for October 2010). The Recovery Boiler is subject to MACT standards for Chemical Recovery Combustion Sources at Kraft Soda, Sulfite, and Stand-Alone Semichemical Pulp Mills (40 CFR 63, Subpart MM).

SDW operates two smelt tanks which were installed in 1975-1976. The Smelt Tanks operate in conjunction with the Recovery Boiler. Recovered sodium-based pulping chemicals, in the form of molten salts, are discharged from the bottom of the Recovery Boiler into the Smelt Tanks, where they are mixed with a water/caustic solution to form green liquor. The Smelt Tanks are subject to MACT standards for Chemical Recovery Combustion Sources at Kraft Soda, Sulfite, and Stand-Alone Semichemical Pulp Mills (40 CFR 63, Subpart MM).

The Lime Kiln was installed in 1975-1976. It is used to convert lime mud (principally calcium carbonate) to lime (calcium oxide). Fuel is fired in the Lime Kiln to generate the heat that is needed to convert lime mud to lime. The Lime Kiln is licensed to fire residual (#6) fuel oil, distillate (#2) fuel oil, used oil, and propane. The Lime Kiln is also licensed to combust LVHC gases and foul condensate streams.

BART Analysis Summary

Recovery Boiler

PM: SDW currently operates a three-chamber electrostatic precipitator (ESP) on the Recovery Boiler. SDW identified the following available retrofit technologies for control of PM from Kraft mill recovery boilers: electrostatic precipitators, wet scrubbers, and fabric filters. Wet scrubbers were eliminated as a feasible control strategy because the ESP currently installed is capable of a greater degree of emissions control at a lower operating cost. Fabric filters are generally considered to be equivalent to ESPs in regards to pollution control. However, fabric filters have not been applied to recovery boilers at Kraft mills and have been eliminated as a feasible control alternative. Since the controls already in place are considered the most stringent available, and these controls are already required by a federally enforceable condition, SDW was not required to perform the remaining steps of the control analysis.

SO_2: SDW's Recovery Boiler is currently equipped with a three-level staged combustion air control system and, after the upgrade project, will be equipped with a four-level staged combustion air system. SDW identified staged combustion systems and wet scrubbers as available retrofit technologies for control of SO_2 from Kraft mill recovery boilers. SO_2 emissions from recovery boilers occur due to the volatilization and subsequent oxidation of sulfur compounds that are present in the black liquor. Proper operation of the recovery boiler maximizes the conversion of sulfur compounds in the liquor to the principal constituents of the pulping chemicals. This occurs through capture of these sulfur compounds in the combustion zone of the boiler by sodium fume released from the smelt bed. Consequently, proper combustion control achieved through the use of staged combustion air systems results in effective control of SO_2 emissions. The only available alternative for SO_2 emission control is a wet scrubber. However, recovery boilers with a properly operated staged air combustion system operate at much lower concentrations of SO_2 in the flue gas than emission units to which wet scrubbers are routinely applied. Since the controls already in place are considered the most stringent available, and these controls are already required by a federally enforceable condition, SDW was not required to perform the remaining steps of the control analysis.

NO_x: SDW's Recovery Boiler is currently equipped with a three-level staged combustion air control system and is in the process of upgrading with a four-level staged combustion air system. SDW identified the following available retrofit technologies for control of NO_x from Kraft mill recovery boilers: staged combustion systems, Selective Non-Catalytic Reduction (SNCR), Selective Catalytic Reduction (SCR), Low NO_x Burners, Flue Gas Recirculation, and Low-Temperature Oxidation. Emission controls which have been demonstrated on conventional steam boilers, including SNCR, SCR, flue gas recirculation, and low NO_x burners, cannot be applied to, or have not been demonstrated to be feasible on, Kraft mill recovery boilers. There has been some small-scale work done on "low-temperature oxidation" where pure oxygen is injected into the evaporation process to drive ammonia from the black liquor. However, the company currently looking into this technology has advised SDW that they are not aware of any commercial size case where this technology has been used. Therefore, this technology is not considered technically-feasible. There are no technically-feasible alternatives for control of NO_x emissions from recovery boilers other than proper operation of the boiler and the staged combustion control system. Since the controls already in place are considered the most stringent available, and these controls are already required by a federally enforceable condition, SDW was not required to perform the remaining steps of the control analysis.

Smelt Tanks

PM: SDW currently operates a wetted fan scrubber on each of the smelt tanks for control of particulate emissions. The scrubbing media for the scrubbers is either water or weak wash from the white liquor clarification system. SDW identified the following available retrofit technologies for control of PM from smelt tanks: electrostatic precipitators, wet scrubbers, fabric filters, and mist eliminators. The most common PM emission control system employed on smelt tanks is wet scrubbers. The use of wet scrubbers also provides a secondary environmental benefit by controlling reduced sulfur compound emissions. The high moisture content of the smelt tank exhaust gases makes dry PM control systems, including fabric filters and dry ESPs, technically infeasible on this type of emission unit. The only remaining control technology, mist eliminators, provide a lower degree of PM emission control than the use of wet scrubbers. Since the controls already in place are considered the most stringent available, and these controls are already required by a federally enforceable condition, SDW was not required to perform the remaining steps of the control analysis.

SO_2: Since no combustion takes place within smelt tanks, SO_2 is not generated within the emission unit. SDW was not able to identify any retrofit control technologies applicable to the control of SO_2 emissions from smelt tanks.

NO_x: Since no combustion takes place within smelt tanks, NO_x is not generated within the emission unit. SDW was not able to identify any retrofit control technologies applicable to the control of NO_x emissions from smelt tanks.

Lime Kiln

PM: Particulate emissions from the Lime Kiln are currently controlled by a variable throat venturi scrubber system followed by a cyclone separator. SDW identified the following available retrofit technologies for control of PM from lime kilns: electrostatic precipitators, wet scrubbers, and fabric filters. Fabric filters have never been applied to kraft pulp mill lime kilns. They are generally deemed to be technically infeasible on lime kilns. ESPs provide a greater degree of particulate matter control than venturi scrubbers. However, the possible annual reduction in emissions to be gained by replacing the existing scrubber with an ESP is relatively small (estimated at under 40 ton/year). Additionally, the scrubber also helps control emissions of SO_2 and reduced sulfur compounds. This beneficial removal of other pollutants is not available to lime kilns equipped with ESPs. Consequently, replacement of the existing scrubber with an ESP would be expected to result in higher TRS and SO_2 emissions from the Lime Kiln. With respect to any possible improvement in visibility impacts associated with retrofitting an ESP on the Lime Kiln, the modeling result for current PM emissions from the Lime Kiln was 0.0463 dv; well below the State's de minimis level of 0.1 dv. Therefore, any additional emission reductions that might be achieved by retrofitting the Lime Kiln with an ESP could only result in visibility impacts that would similarly be de minimis.

SO_2: SO_2 forms in the Lime Kiln from either the combustion of sulfur in the fuel or combustion of TRS compounds in the LVHC gases. Currently emissions of SO_2 are controlled by using a combination of the inherent sulfur removal provided by operation of the kiln itself (i.e. extensive contact between burner exhaust gases and the calcium compounds in the kiln) enhanced through the use of a venturi wet scrubber (post-combustion). SDW also uses a caustic scrubber (pre-combustion) on the LVHC gases fired in the boiler. Firing of LVHC gases in the Lime Kiln without pre-treatment with the caustic scrubber causes formation of rings within the Lime Kiln leading to excessive down-time of the equipment. Emissions of SO_2 from the Lime Kiln can vary significantly based on the amount of LVHC gases being fired and whether or not the

caustic scrubber is in operation. SDW identified the following available retrofit technologies for control of SO_2 from lime kilns: lime kiln operation and wet scrubbers. Since the controls already in place are considered the most stringent available, and these controls are already required by a federally enforceable condition, SDW was not required to perform the remaining steps of the control analysis.

NO_x: NO_x emissions from the Lime Kiln are currently controlled by good combustion controls and operation of the unit's combustion air system. SDW identified the following available retrofit technologies for control of NO_x from lime kilns: Combustion Air Systems controls, SNCR, SCR, Low NO_x Burners, Flue Gas Recirculation. There are no technically feasible alternatives for control of NO_x from lime kilns beyond the measures currently employed. Low NO_x burner systems, which seek to reduce thermal NO_x formation through either combustion air or fuel staging, are not possible on the lime kilns because such systems negatively impact the efficiency, energy use, and calcining capacity of a lime kiln. Post combustion controls, such as SCR and SNCR, are not feasible for lime kilns. The temperature window necessary for the SNCR process (1500 – 2000 °F) is unavailable in a Kraft lime kiln. The high PM load at the exit of the kiln precludes the placement of the catalyst grid needed for the SCR process upstream of the PM control device, and the requisite temperature window required for this process (550 – 750 °F) is not available downstream of the PM control system. Since the controls already in place are considered the most stringent available, and these controls are already required by a federally enforceable condition, SDW was not required to perform the remaining steps of the control analysis.

BART Determination

BART Determination for SD Warren

Unit	**PM**		**SO_2**		**NO_x**	
	Control Type	Emission Limit and Reference	Control Type	Emission Limit and Reference	Control Type	Emission Limit and Reference
Recovery Boiler	ESP	0.030 gr/dry standard cubic foot (dscf) when all three ESP chambers are online and 0.038 gr/dscf when less than three chambers are online; 207 lb/hr (NSR License #A-19-77-2-A, 40 CFR Part 63, subpart MM)	Low-sulfur oil	100 ppmv (dry basis) @8% O_2 on a 24-hour block average basis (BART order) 1975lbs/hr (NSR License #A-19-77-2-A)	Combustion engineering	120 ppmv (dry basis) @ 8% O_2 on a 24-hour block average basis; 750 lb/hr (NSR License #A-19-77-2-A)

Smelt Tanks #1 and #2	Wet scrubber	26lb/hr; 0.2 lbs/ton BLS 40 CFR Part 63, subpart MM (Existing Title V license)	N/A	26lb/hr (Existing Title V license)	N/A	N/A
Lime Kiln	Wet scrubber	0.10 gr/dscf @10% O_2; 58 lb/hr (Existing Title V license; 40 CFR Part 63)	Wet scrubber	1.92 lb/MMBtu; 100 tons/year limit on a 12-month rolling average (Existing Title V license)	Staged Combustion	120 ppmvw @ @10% O_2 (Existing Title V license)

6. Verso Androscoggin

The Verso Androscoggin pulp mill produces bleached Kraft pulp and groundwood pulp. The bleached pulp is produced in two separate process lines, designated “A” and “B”. Groundwood pulp is produced in another separate process line. Logs and wood chips are received in the Woodyard area, where they are stored and processed for eventual use in the Pulp Mill or Groundwood Mill. The Pulp Mill consists of two separate, parallel Kraft chemical pulping process lines. Pulp produced at the Verso Jay Mill is either used in the paper mill area or dried in the Flash Dryer for storage and/or sale.

The Paper Mill consists of all the equipment and operations used to convert pulp to paper, including stock preparation, additive preparation, coating preparation, starch handling, finishing, storage and paper machines. Non-condensable gases (NCGs) collected throughout the process from certain units in the Pulp Mill are sent to the Lime Kilns for combustion. The high-volume, low-concentration (HVLC) emission streams from certain other units are collected and sent to the Regenerative Thermal Oxidizer where they are incinerated. The Mill produces steam and electric power for mill operations with Power Boilers #1 and #2 and the Waste Fuel Incinerator (WFI).

There are ten BART-eligible units at Verso Jay: (1) Power Boiler #1; (2) Power Boiler #2; (3) Waste Fuel Incinerator; (4) Recovery Boilers # 1; (5) Recovery Boiler #2; (6) Smelt Tank #1; (7) Smelt Tank #2; (8) Lime Kiln A; (9) Lime Kiln B; and (10) Flash Dryer. Power Boilers #1 and #2 are each rated at 680 MMBtu/hr and began operation in 1965 and 1967, respectively. Power Boilers #1 and #2 are licensed to fire #6 fuel oil, #2 fuel oil, and used oil. The license currently limits the sulfur content of the fuel oil to no more than 1.8%, by weight. In addition, each boiler is equipped with low NO_x burners. The operation of the two boilers is related to whether or not and how the cogeneration plant (three natural gas fired turbines) at the Mill is operating. Typically when the cogeneration plant is operating, Power Boilers #1 and #2 do not operate. When the cogeneration plant is not operating, both boilers are operated, however, one boiler will typically carry the bulk of the load and the other boiler is idled or run at low load. There are occasions when both boilers operate at high load, but this is not a routine operating mode.

The Waste Fuel Incinerator (WFI) is rated at 480 MMBtu/hr on biomass and 240 MMBtu/hr on oil and began operation in 1976. While the WFI primarily fires biomass, fuel oils (#6 and #2 fuel oils, waste oil, and oily rags) can also be fired in the boiler. Sulfur dioxide and particulate matter emissions are controlled using a variable throat venturi scrubber and demister arrangement. When #6 fuel oil is fired in significant amounts, caustic is used in the wet scrubber to meet the applicable SO_2 emission limit. In addition, the WFI is equipped with a combustion system designed to ensure the optimal balance between control of NO_x and limitation of CO and VOC.

Recovery Boilers #1 and #2 generate steam while regenerating chemicals used in the wood pulping process, and began operation in 1965 and 1976, respectively. Recovery Boilers (#1 and #2) have rated processing capacities of 2.50 and 3.44 million pounds per day of dry black liquor solids (MMlb/day of BLS), respectively. Inorganic material (smelt) from the bottoms of the recovery boilers is used to produce green liquor, which is a solution of sodium sulfide and sodium carbonate salts, when it is dissolved in water or weak wash in the Smelt Dissolving Tanks (#1 and #2). Although the recovery boilers primarily fire black liquor, they also fire small quantities of #2 and #6 fuel oils during startup, shutdown, and load stabilization conditions. The license currently limits the sulfur content of the fuel oils to no more than 0.5%, by weight. Particulate matter emissions from both recovery boilers are currently controlled using an electrostatic precipitator (ESP).

Smelt Dissolving Tank #1 is rated at 2.50 MMlb/day of dry BLS and began operation in 1965. Smelt Dissolving Tank #2 is rated at 3.44 MMlb/day of dry BLS and began operation in 1975. Inorganic materials from the recovery boiler floors drain into Smelt Dissolving Tanks #1 and #2 as molten smelt. In the smelt dissolving tanks, the smelt is mixed with weak wash to form green liquor which is pumped to the causticizing area. Sulfur dioxide (SO_2) and particulate matter (PM_{10}) emissions from Smelt Dissolving Tank #1 are controlled with a dual-nozzle wet cyclonic scrubber which utilizes an alkaline scrubbing solution and was installed in 1983. Sulfur dioxide (SO_2) and particulate matter (PM_{10}) emissions from Smelt Dissolving Tank #2 are controlled with a triple-nozzle wet cyclonic scrubber which utilizes an alkaline scrubbing solution and was installed in 1976.

The "A" and "B" Lime Kilns process lime mud (calcium carbonate) from the causticizing area to regenerate calcium oxide (CaO). Inside the lime kilns, the lime mud is dried and heated to a high temperature where the lime mud is converted to lime (calcium oxide or CaO). "A" and "B" Lime Kilns are each rated at an operating rate of 248 tons of calcium oxide (CaO) per day and a heat input of 72 MMBtu/hr and began operation in 1965 and 1975, respectively. The lime kilns are licensed to fire #6 fuel oil, #2 fuel oil, propane, and used/waste oil. The license currently limits the sulfur content of the fuel oil to no more than 1.8%, by weight. The A and B Lime Kilns also serve as an incineration device (control device) for select sources of low volume high concentration (LVHC) non-condensable gases (NCG) from pulping operations at the mill. Particulate matter (PM_{10})

emissions are controlled from the “A” and “B” Lime Kilns using a fixed throat venturi scrubber.

The Flash Dryer is used to dry pulp for resale or for storage and future use on one of Verso Androscoggin’s paper machines. The Flash Dryer has a rated heat input capacity of 84 MMBtu/hr and began operation in 1964. The flash dryer is licensed to fire #2 fuel oil, which contains a maximum sulfur content of 0.5% as defined by ASTM D396 standards. Particulate matter emissions are controlled using a wet shower system and SO_2 emissions are limited through the firing of #2 fuel oil.

<u>BART Analysis Summary</u>

Power Boilers #1 and #2:

PM: Verso did not identify or evaluate potential control technologies for the reduction of PM_{10} emissions from Power Boilers #1 and #2 because these units are subject to MACT Standards under section 112 of the CAA. In addition, Verso stated in their application that PM_{10} emissions are low based on the firing of fuel oil and that PM_{10} emissions from Power Boilers #1 and #2 have a minimal impact on visibility and a reduction in these emissions would have no impact on the contribution of either boiler to overall visibility impacts. Verso Androscoggin proposed that the final “Boiler MACT” standards (40 CFR Part 63, Subpart DDDDD) that the boilers are subject to will also represent BART for Power Boilers #1 and #2.

SO_2: Verso Androscoggin identified and evaluated low sulfur fuels, wet scrubbing, dry scrubbing, and semi-dry scrubbing as potential control technologies in the reduction of SO_2 emissions from Power Boilers #1 and #2. Low sulfur fuels and wet scrubbing control technologies were found to be technically feasible by Verso Androscoggin and so were evaluated further.[43] A summary of Verso Androscoggin’s evaluation of the remaining viable SO_2 control technologies (low sulfur fuels and wet scrubbing) is provided in the table below.

SO_2 BART Analysis Summary for Power Boilers #1 and #2

Control Technology	Control Effectiveness	Cost Effectiveness ($/ton removed)	Energy and Other Impacts	Greatest Visibility Improvement
Natural Gas	99%	$3,334	Negligible	1.5
#2 Fuel Oil	97%	$3,341	Negligible	1.5
0.7%	60%	$631	Negligible	0.9

[43] Dry and semi-dry scrubbing control technologies were evaluated, however Verso Androscoggin found that control effectiveness levels would be low (<25%), downstream particulate matter control devices such as an ESP and/or fabric filter would need to be installed to collect and re-circulate the scrubbing material, and no applications of these technologies on fuel oil fired boilers like Power Boilers #1 and #2 were identified during Verso Androscoggin’s research of potential control technologies.

Sulfur #6 Fuel Oil				
0.7% Sulfur #6 Fuel Oil	60%	$631	Negligible	0.9
Wet Scrubbing	99%	$2,278	Disposal Impacts	1.5

The cost effectiveness numbers in the table above are based on controlling SO_2 emissions from Power Boilers #1 and #2 at the control effectiveness rates indicated in the table from the highest estimated two year average annual emissions between 2002 and 2008. In recent years (2008 and 2009) these boilers have been operating close to only 20% of the time, which for example, would result in an actual cost effectiveness of between $4,920 and $7,133 per ton of SO_2 removed with the installation of a wet scrubber. The use of low sulfur fuels or a wet scrubber has the potential to reduce visibility impacts from Power Boilers #1 and #2 by a perceptible amount; however there are significant cost differences among the three low sulfur containing fuels evaluated by Verso Androscoggin and the wet scrubber. Based on Verso Androscoggin's identification and evaluation of control technology options, they propose that the use of 0.7% sulfur #6 fuel oil is a feasible and justifiable cost at $631 per ton of SO_2 reduced, but that the other low sulfur fuel options and the wet scrubbing option are not economically justifiable and do not represent BART. Therefore, Verso Androscoggin proposes that the use of lower sulfur (0.7%) #6 fuel oil in place of the higher sulfur (1.8%) #6 fuel oil currently fired, represents BART for control of SO_2 emissions from Power Boilers #1 and #2.

NO_x: Verso Androscoggin identified and evaluated selective catalytic reduction (SCR), low NO_x burners (LNBs), selective non-catalytic reduction (SNCR), and combustion control methods (including an overfire air (OFA) system and a flue gas recirculation (FGR) system) as potential control technologies in the reduction of NO_x emissions from Power Boilers #1 and #2. SCR and SNCR control technologies were found to be technically feasible and so were evaluated further. LNBs are currently installed and used on Power Boilers #1 and #2, and are estimated to provide a 15% reduction in NO_x emissions, so were not evaluated further. Combustion control methods were evaluated, however none were found to be viable control options for Power Boilers #1 and #2. Verso Androscoggin found that the size and design of Power Boilers #1 and #2 would provide little room for the installation of an overfire air system and that the application of a flue gas recirculation system would result in minimal reductions (7% to 15%) in NO_x emissions. A summary of Verso Androscoggin's evaluation of the remaining viable NO_x control technologies (SCR and SNCR) is provided in the table below.

Control Technology	Control Effectiveness	Cost Effectiveness ($/ton removed)	Energy and Other Impacts	Greatest Visibility Improvement
SCR	90%	$5,271	Minor Impacts	1.7
SNCR	35%	$5,973	Minor Impacts	1.4

The cost effectiveness numbers in the table above are based on controlling NO_x emissions from Power Boilers #1 and #2 at the control effectiveness rates indicated in the table from the highest estimated two year average annual emissions between 2002 and 2008. In recent years (2008 and 2009) these boilers have been operating close to only 20% of the time, which for example, would result in an actual cost effectiveness of $16,313 per ton of NO_x removed with the installation of SCR. Although the use of SCR or SNCR has the potential to reduce visibility impacts by a perceptible amount, Verso Androscoggin proposes that the cost effectiveness levels are not economically justifiable based on the limited use of Power Boilers #1 and #2. Based on Verso Androscoggin's identification and evaluation of control technology options, they propose that the current use of LNBs represents BART for control of NO_x emissions from Power Boilers #1 and #2 and that no additional level of control is justifiable as BART.

Waste Fuel Incinerator Boiler:

PM: Verso Androscoggin did not identify or evaluate potential control technologies for the reduction of PM_{10} emissions from the Waste Fuel Incinerator Boiler (WFI) because this unit is subject to MACT Standards under section 112 of the CAA. Verso Androscoggin proposed that the final "Boiler MACT" standards (40 CFR Part 63, Subpart DDDDD) that the WFI is subject to will also represent BART for the WFI.

SO_2: Verso Androscoggin identified and evaluated low sulfur fuels, wet scrubbing, dry scrubbing, and semi-dry scrubbing as potential control technologies in the reduction of SO_2 emissions from the WFI. While using low sulfur fuels is technically feasible, Verso Androscoggin believes that it is not a practically feasible option for the WFI based on the limited amount of fuel oil typically used in the boiler (less than 10% of the annual fuel oil heat input capacity). The WFI currently uses a water based wet scrubbing system for PM control with the addition of caustic to meet SO_2 emission limits when firing #6 fuel oil in significant amounts. Dry and semi-dry scrubbing control technologies were not considered by Verso Androscoggin to be either practical or technically feasible for the WFI due to the fact that they could not find any applications of these technologies on any other biomass-fired grate type boilers like the WFI. Verso Androscoggin also believes that the cost of removing the existing wet scrubber and replacing it with a dry or semi-dry scrubbing system and a new ESP and/or fabric filter would be costly. A summary of Verso Androscoggin's evaluation of the only remaining viable SO_2 control technology (adding caustic to the existing wet scrubbing system) is provided in the table below.

SO_2 BART Analysis Summary for the Waste Fuel Incinerator

Control Technology	Control Effectiveness	Cost Effectiveness ($/ton removed)	Energy and Other Impacts	Greatest Visibility Improvement
Addition of Caustic to Existing Wet Scrubber	50%	$21,800	Disposal Impacts	<0.1

The WFI has very low baseline SO_2 emissions (~50 tons per year) due to the inherent low sulfur content and alkalinity of the primary fuel (biomass) and the small amount of fuel oil used in the WFI. In addition, during the limited amount of time that #6 fuel oil is used to provide a significant portion of the heat input to the WFI, caustic is added to the wet scrubber to control SO_2 emissions. Based on Verso Androscoggin's identification and evaluation of control technology options, they propose that additional control of SO_2 emissions from the WFI cannot be justified as BART due to the imperceptible effect it would have on visibility.

NO_x: Verso Androscoggin identified and evaluated selective catalytic reduction (SCR), low NO_x burners (LNB), selective non-catalytic reduction (SNCR), and combustion control methods (including an overfire air system and a flue gas recirculation system) as potential control technologies in the reduction of NO_x emissions from the WFI. SCR and SNCR control technologies were found to be technically feasible and so were evaluated further. Since the WFI primarily fires biomass on the grate, LNBs would not be effective for the majority of the time that the WFI operates, thus Verso Androscoggin felt LNBs did not warrant further evaluation. Combustion control methods were evaluated, however none were found to be viable control options for the WFI due to the limited NO_x removal potential (<15%), potential impacts to other pollutants and boiler equipment, and the limited amount of room available for the installation of control equipment. A summary of Verso Androscoggin's evaluation of technically feasible NO_x control technologies (SCR, SNCR, and FGR) is provided in the table below.

Control Technology	Control Effectiveness	Cost Effectiveness ($/ton removed)	Energy and Other Impacts	Greatest Visibility Improvement
SCR	90%	$4,676	Minor Impacts	0.3
SNCR	30%	$5,944	Minor Impacts	0.1
FGR	15%	$17,010	Minor Energy Impacts	<0.1

Although the use of SCR has the potential to reduce visibility impacts by a perceptible amount, Verso Androscoggin proposes that the cost effectiveness levels are not economically justifiable for any of the control technologies evaluated, including SCR. Based on Verso Androscoggin's identification and evaluation of control technology options, they propose that additional control of NO_x emissions from the WFI cannot be justified as BART due to the capital costs ($3 million to more than $7.6 million) and cost effectiveness levels ($4,700 to more than $17,000 per ton of NO_x removed).

Recovery Boilers #1 and #2

PM: Particulate matter (PM) emissions from Recovery Boilers #1 and #2 are currently controlled by an existing shared/common electrostatic precipitator (ESP). Verso Androscoggin did not identify or evaluate potential control technologies for the reduction of PM_{10} emissions from Recovery Boilers #1 and #2 because these units are subject to MACT Standards under section 112 of the CAA. Recovery Boilers #1 and #2 are subject to MACT standards pursuant to 40 CFR Part 63, Subpart MM (MACT II). Verso Androscoggin reviewed the RACT/BACT/LAER Clearinghouse (RBLC) and believes that the current control configuration is the most current control technology in use on recovery boilers and that there are no new technologies subsequent to the MACT standard that should be considered. Based on this information, Verso Androscoggin proposed in its BART analysis that it was not necessary to expand the BART analysis for PM_{10} and therefore did not identify or evaluate potential control technologies for the additional reduction of PM_{10} emissions from Recovery Boilers #1 and #2. Verso Androscoggin proposes that "MACT II" standards (40 CFR Part 63, Subpart MM) that the boilers are currently subject to represent BART for PM_{10} emissions from Recovery Boilers #1 and #2.

SO_2: Verso Androscoggin has found that sulfur dioxide (SO_2) emissions from Recovery Boilers #1 and #2 are variable due to several factors including black liquor properties (e.g., sulfidity, sulfur to sodium ratio, heat value, and solids content), combustion air, liquor firing patterns, furnace design features, and type of startup fuel used. Both recovery boilers are low-odor design. Although each recovery boiler has the ability to utilize #2 fuel oil, #6 fuel oil, and used/waste oil for startup, shutdown, and load stabilizing conditions, fuel oil firing is not a typical operating scenario for the recovery boilers. SO_2 emission levels during fuel oil firing conditions are directly related to the sulfur content of the fuel oils. Black liquor solids (BLS) firing produces sodium fume, which effectively scrubs SO_2 emissions. Verso Androscoggin identified and evaluated wet scrubbing, dry scrubbing, and semi-dry scrubbing as potential control technologies in the reduction of SO_2 emissions from Recovery Boilers #1 and #2, however none of these technologies were found to have been applied to recovery boilers and Verso Androscoggin believes that operation of these technologies could negatively affect the operation of Recovery Boilers #1 and #2. Based on Verso Androscoggin's identification and evaluation of control technology options, they propose that each of the control technologies evaluated are not technically feasible and therefore were not evaluated further. Verso Androscoggin proposes that existing combustion controls represent BART for the control of SO_2 emissions from Recovery Boilers #1 and #2.

NO_x: Kraft recovery boilers are a unique type of combustion source that inherently produce low levels of NO_x emissions. Most of the NO_x emissions produced by recovery boilers can be attributed to fuel based NO_x resulting from the partial oxidation of the nitrogen contained in the black liquor. Both Recovery Boilers (#1 and #2) operate with a reducing zone in the lower part of the boiler and an oxidizing zone in the region of the liquor spray guns designed to provide secondary and tertiary staged combustion zones to complete combustion of the black liquor and minimize NO_x emissions.

Verso Androscoggin identified and evaluated selective catalytic reduction (SCR), low NO_x burners (LNB), selective non-catalytic reduction (SNCR), and combustion control methods (including the addition of a fourth level or quaternary air system and a flue gas recirculation system) as potential control technologies in the reduction of NO_x emissions from Recovery Boilers #1 and #2. SCR has not been applied or demonstrated successfully on any recovery boilers according to Verso Androscoggin and they do not know how the unique characteristics of recovery boiler exhaust gas constituents would react with a SCR catalyst, so they did not further evaluate this control technology. Verso Androscoggin's evaluation of LNB technology is that it is not feasible to use this technology in the firing of black liquor given its tar-like qualities and the method by which it is injected into the boiler and that it would have minimal results in the firing of fuel oils given the small amounts of fuel oils that are fired in the recovery boilers. Verso Androscoggin's evaluation of SNCR control technologies resulted in a finding that there have been no applications of this technology on recovery boilers in the United States for a variety of reasons, including safety concerns associated with the risk of a smelt/water explosion should boiler tube walls corrode and leak near urea injection points and risks associated with an ammonia handling system for the SNCR. Operational concerns associated with SNCR were found to include the potential formation of acidic sulfates that could result in corrosion and a catastrophic boiler tube failure. As a result of Verso Androscoggin's initial evaluation of SNCR, no further evaluation was conducted. Recovery Boilers #1 and #2 are currently designed and operated using low excess air combined with three levels of staged combustion to minimize NO_x emissions. Additional combustion control methods were evaluated by Verso Androscoggin, however none were found to be viable control options for Recovery Boilers #1 and #2 due to the limited amount of space in the boilers to install a fourth or quaternary air system and due to the technical challenges re-circulating recovery boiler exhaust gases in a FGR system due to the unique characteristics of the exhaust gases. Based on Verso Androscoggin's identification and evaluation of control technology options, they proposed that the existing combustion control methods represent BART and that additional control of NO_x emissions from Recovery Boilers #1 and #2 are not technically feasible and warrant no further evaluation.

Smelt Tanks #1 and #2

PM: Particulate matter (PM) emissions from Smelt Dissolving Tanks #1 and #2 are currently controlled by existing wet cyclonic scrubbers. Verso Androscoggin did not identify or evaluate other potential control technologies for the reduction of PM_{10} emissions from Smelt Dissolving Tanks #1 and #2 because these units are subject to MACT Standards under section 112 of the CAA. Smelt Dissolving Tanks #1 and #2 are subject to MACT standards under 40 CFR Part 63, Subpart MM (MACT II). Verso Androscoggin reviewed the RACT/BACT/LAER Clearinghouse (RBLC) and believes that the current control configuration is the most current control technology in use on smelt dissolving tanks and that there are no new technologies subsequent to the MACT standard that should be considered. Verso Androscoggin proposes that "MACT II" standards (40 CFR Part 63, Subpart MM) that the smelt dissolving tanks are currently subject to represent BART for PM_{10} emissions from Smelt Dissolving Tanks #1 and #2.

SO_2: Verso Androscoggin has found that sulfur dioxide (SO_2) emissions from Smelt Dissolving Tanks #1 and #2 are dependent on how much sulfur carries over from the respective recovery boilers with the smelt. Controlled smelt-water explosions in the smelt dissolving tanks can create SO_2 as a result of the oxidation of the sulfur in the smelt. SO_2 emissions from both smelt dissolving tanks combined are very low at approximately 5 tons per year. Verso Androscoggin proposes that BART for SO_2 emissions from Smelt Dissolving Tanks #1 and #2 is no additional control based on the

following: (1) SO_2 emissions from the smelt dissolving tanks during the BART baseline period were and are expected to continue to be extremely low (~5 TPY, combined); (2) the smelt dissolving tanks and associated scrubbers are designed and operated to minimize SO_2 emissions; (3) SO_2 emissions from the smelt dissolving tanks have a minimal impact on visibility (<0.1 deciviews); and (4)additional control of SO_2 emissions from the smelt dissolving tanks would have a minimal impact on overall visibility.

NO_x: Smelt Tanks #1 and #2 do not emit NO_x.

Lime Kilns A and B

PM: Particulate matter (PM_{10}) emissions from the “A” and “B” Lime Kilns consist primarily of dust entrained from the combustion section of the kilns. This dust consists of sodium salts, calcium carbonate, and calcium oxide. PM_{10} emissions are currently controlled by existing venturi scrubbers. These units are also subject to MACT Standards under section 112 of the CAA, and 40 CFR Part 63, Subpart MM (MACT II). Verso Androscoggin reviewed the RACT/BACT/LAER Clearinghouse (RBLC) and believes that there are two control technologies that represent the most stringent PM control (ESPs and venturi scrubbers). Both ESPs and venturi scrubbers have been used to control PM emissions from lime kilns and both are capable of a high level of control. Verso Androscoggin proposes that use of the existing venturi scrubbers to control PM_{10} emissions from the “A” and “B” represents BART for the following reasons: (1) the existing venturi scrubbers maintain compliance with the MACT II PM emission limits; (2) the replacement of the existing venturi scrubbers with dry ESPs could increase SO_2 emissions from the lime kilns when compared to use of the venturi scrubbers; (3) the replacement of the existing venturi scrubbers with wet ESPs would result in high capital costs ($1.5 million per kiln); and (4)visibility impacts from the lime kilns are minimal and installation of additional control would result in inconsequential improvement in visibility.

SO_2: Verso Androscoggin has found that a significant portion of the sulfur dioxide (SO_2) formed during the combustion process in the lime kilns is removed as the regenerated quicklime in the kilns functions as a scrubbing agent. In addition, the NCG collection system is equipped with a scrubber that uses white liquor (sodium hydroxide or NaOH) and thus the sulfur loading from the NCGs is minimized. SO_2 emissions from both lime kilns combined are very low at less than 4 tons per year primarily due to the alkalinity of the lime. Verso Androscoggin proposes that BART for SO_2 emissions from the “A” and “B” Lime Kilns is no additional control based on the following: (1) SO_2 emissions from the lime kilns during the BART baseline period were and are expected to continue to be extremely low (<4 TPY, combined); (2) there are no control technologies available for lime kilns that are more cost effective than the inherent scrubbing that occurs for SO_2 due to the alkalinity of the lime in the process; (3) SO_2 emissions from the smelt dissolving tanks have a minimal impact on visibility (<0.1 deciviews); and (4)additional control of SO_2 emissions from the lime kilns would have a minimal impact on overall visibility.

*NO*x: Verso Androscoggin identified and evaluated selective catalytic reduction (SCR), low NO_x burners (LNB), and selective non-catalytic reduction (SNCR) as potential NOx control technologies. Verso Androscoggin's evaluation of SCR and SNCR as potential NO_x control technologies revealed that they have not been installed on any lime kilns in the pulp and paper industry, and were also found to be technically infeasible, so were not evaluated further. Verso Androscoggin's research with respect to lime kilns and LNB technology revealed that the technology is actually a combination of passive combustion control measures used to minimize NO_x formation primarily from thermal NO_x and to a lesser extent fuel NO_x. These combustion control measures include careful design of the fuel feed system in order to ensure proper mixing of the fuel with air and burner "tuning" or optimization which impacts fuel burning efficiency and overall flame length. Verso Androscoggin already incorporates burner "tuning" in the operation and maintenance of the "A" and "B" Lime Kilns to optimize the relationship between NO_x emissions and operating efficiency. Based on Verso Androscoggin's identification and evaluation of control technology options, they propose that the current use of LNB (referred to as combustion control measures on lime kilns) represents BART for control of NO_x emissions from "A" and "B" Lime Kilns and that no additional level of control is technically feasible. Verso Androscoggin also notes in their BART analysis that existing NO_x emissions from the "A" and "B" Lime Kilns have a minimal impact on visibility (<0.1 deciviews) and that additional control of NO_x emissions would have a minimal impact on the overall improvement to visibility.

Flash Dryer

PM: Particulate matter (PM_{10}) emissions from the Flash Dryer are currently controlled by the use of a wet shower system. Verso Androscoggin proposes that the application of add-on controls and the use of cleaner fuels are not practical considerations for controlling PM emissions from the Flash Dryers and that with potential visibility impacts from the Flash Dryer being extremely low, any emission reductions would have an inconsequential impact on visibility improvement.

SO_2: The Flash Dryer is limited to firing #2 fuel oil with a maximum sulfur content of 0.5%, by weight and so has relatively low SO_2 emissions. Although Verso Androscoggin could replace the use of #2 fuel oil with lower sulfur containing fuels such as low sulfur (0.05%) diesel fuel or natural gas, the Flash Dryer is predicted to have peak visibility impacts of 0.1 deciviews or less. Based on Verso Androscoggin's identification and evaluation of SO_2 control technology options for the Flash Dryer, they propose that no additional level of control is representative of BART.

NO_x: The Flash Dryer is not equipped with any NO_x control equipment. NO_x emissions from the Flash Dryer are primarily generated from the nitrogen component in the fuel oil. Verso Androscoggin currently uses good maintenance practices to minimize NO_x emissions from the Flash Dryer. Verso Androscoggin's investigation of conventional NO_x combustion controls (e.g., LNB, OFA, and FGR) lead to findings that they are either unavailable for installation on the Flash Dryer or are not feasible for a combustion source as small as the Flash Dryer.

BART Determinations:

BART Determination for VERSO Androscoggin

Unit	PM		SO_2		NO_x	
	Control Type	Emission Limit and Reference	Control Type	Emission Limit and Reference	Control Type	Emission Limit and Reference
Power Boilers #1 and #2	Low sulfur oil/ combustion control	Compliance with 40 CFR Part 63 Subpart DDDD	Low sulfur fuel	Low sulfur fuel oil containing no more than 0.7 % sulfur, by weight. (BART order)	Low NO_x burners	0.447 lbs/MMBtu on a 24-hour block average basis (Existing Title V license)
Waste Fuel Incinerator	Combustion controls, wet scrubber	Compliance with 40 CFR Part 63 Subpart DDDD	Wet scrubber	0.8 lbs/MMBtu on a 3-hour average (Existing Title V license)	Combustion controls	0.4 lbs/ MMBtu on a 24-hour block average basis (Existing Title V license)
Recovery Boiler #1	ESP	Compliance with 40 CFR Part 63 Subpart MM	Staged air combustion	120 ppmdv @8% O_2 on a 30-day rolling average basis when operating at a black liquor recover rate of 50% or higher. SO2 emissions shall not exceed 140 ppmdv @8% O_2 on a 30-day rolling average basis when operating at a black liquor recover rate of less than 50% (BART order)	Combustion controls (NSR)	150 ppmdv, when corrected to 8% % O_2 on a 24-hour block average basis (BART order)
Recovery Boiler #2	ESP	Compliance with 40 CFR Part 63 Subpart MM (Existing Title V license)	Staged air combustion	120 ppmdv @8% O_2 on a 30-day rolling average basis (Existing Title V license)	Combustion controls (RACT)	206 ppm corrected to 8% % O_2 on a 24-hour block average basis (Existing Title V license)

Smelt Tanks #1 and #2	Wet cyclonic scrubber	Compliance with 40 CFR Part 63 Subpart MM (Existing Title V license)	Wet cyclonic scrubber	Smelt Tank #1- 2.7 lbs/hr Smelt Tank #2- 3.9 lbs/hr (Existing Title V license)	N/A	N/A
Lime Kilns A and B	Venturi scrubber	Compliance with 40 CFR Part 63 Subpart MM	Venturi scubber	6.7 Lbs/hr, 74.6 tpy (Existing Title V license)	Combustion controls (RACT)	120 ppm @ 10% O_2 (stack test) (Existing Title V license)
Flash Dryer	Wet shower	5 lbs/hr (Existing Title V license)	Low sulfur fuel (#2 oil)	Low sulfur fuel oil containing no more than 0.5 % sulfur, by weight (Existing Title V license)	Good combustion practices (Existing Title V license)	11.8 lbs/hr

10.8 Schedule for BART Implementation

As provided in 40 CFR Section 51.308(e)(1)(iv) BART must be in operation for each applicable source no later than five years after SIP/TIP approval. Pursuant to 38 M.R.S.A. §603-A, sub-§8 (b), the State of Maine is requiring that each source subject to BART shall install and operate BART as expeditiously as practicable but in no event later than January 1, 2013.

As provided in 40 CFR Section 51.308(e)(1)(v) the Title V operating permits for BART sources must include a requirement that each source maintain the control equipment and establish procedures to ensure such equipment is properly operated and maintained. This requirement will be included in the Title V operating permit for each source subject to BART. The BART requirements for Maine Bart eligible sources will be federally enforceable through the Title V operating permit program and through incorporation in the Maine Regional Haze SIP.

Copies of the draft Title V operating permits for each source are included in Attachment M

11. Reasonable Progress Goals

The Regional Haze Rule (40 CFR Section 51.308 (d)(1)) requires each state with Class I areas to establish reasonable progress goals providing for reasonable progress towards achieving natural visibility in each Class I area. In addition, EPA released guidance on June 7, 2007 to use in setting reasonable progress goals. The goals must provide improvement in visibility for the most impaired days, and ensure no degradation in visibility for the least impaired days over the State Implementation Plan (SIP) period. The State of Maine must also provide an assessment of the number of years it would take to attain natural visibility conditions if improvement continues at the rate represented by the reasonable progress goal.

Under 40 CFR Section 51.308 (d)(1)(iv), consultation is required in developing reasonable progress goals. The rule states:

> *In developing each reasonable progress goal, the State must consult with those States which may reasonably be anticipated to cause or contribute to visibility impairment in the mandatory Class I Federal area. In any situation in which the State cannot agree with another such State or group of States that a goal provides for reasonable progress, the State must describe in its submittal the actions taken to resolve the disagreement. In reviewing the State's implementation plan submittal, the Administrator will take this information into account in determining whether the State's goal for visibility improvement provides for reasonable progress towards natural visibility conditions.*

As discussed in Section 3, Maine consulted with states that contribute to visibility impairment at its Class I areas and with states that requested consultation with Maine regarding their Class I areas (New Hampshire, Vermont and New Jersey). Maine worked closely with these states during the consultation process and agrees with the reasonable progress goals established by New Hampshire, Vermont and New Jersey.

In developing the reasonable progress goals the Class I state must also consider four factors (cost, time needed, energy & non-air quality environmental impacts, and remaining useful life). The state also must show that it considered the uniform rate of improvement and the emission reduction measures needed to achieve it for the period covered by the implementation plan, and if the state proposes a rate of progress slower than the uniform rate of progress, assess the number of years it would take to attain natural conditions if visibility improvement continues at the rate proposed.

11.1 Calculation of Uniform Rate of Progress

As a benchmark to aid in developing reasonable progress goals, MANE-VU compared the baseline visibility conditions to natural visibility condition at each Class I area. The difference between baseline and natural visibility conditions at each MANE-VU Class I area was used to determine the uniform rate of progress that would be needed during each implementation period in order to attain natural visibility. Table 11-1 presents baseline visibility, natural visibility and required uniform rate of progress for each MANE-VU Class I area. Visibility values are expressed in deciviews (dv) where a single-unit decrease would represent a barely perceptible improvement in visibility.

Table 11-1
Uniform Rate of Progress Calculation
(all values in deciviews)

Class I Area	(2000-2004) Baseline Visibility (deciviews) (20% Worst Days)	Natural Visibility Conditions (20% Worst Days)	Deciview Improvement Needed by 2018	Total Deciview Improvement Needed by 2064	Uniform Rate of Improvement Annually
Acadia National Park	22.9	12.4	2.4	10.5	0.174
Roosevelt/Campobello International Park	21.7	12.0	2.3	9.7	0.162
Moosehorn Wilderness Area	21.7	12.0	2.3	9.7	0.162
Presidential Range/Dry River Wilderness Area	22.8	12.0	2.5	10.8	0.180
Great Gulf Wilderness Area	22.8	12.0	2.5	10.8	0.180
Lye Brook Wilderness	24.5	11.7	3.0	12.8	0.212
Brigantine Wilderness	29.0	12.2	3.9	16.8	0.280

Note: Both natural conditions and baseline visibility for the 5-year period from 2000 through 2004 were calculated in conformance with an alternative method recommended by the IMPROVE Steering Committee.[44]

The reasonable progress goals established for the Maine Class I areas are expected to provide greater visibility improvements than the uniform rate of progress shown in Table 11-1, above.

11.2 Reasonable Progress Goals for Class I Areas in Maine

In accordance with the requirements of 40 CFR Section 51.308 (d)(1), this Regional Haze SIP establishes reasonable progress goals (RPG) for each Class I area in Maine for the period of the implementation plan.

40 CFR Section 51.308(d)(1)(vi) requires that reasonable progress goals represent at least the visibility improvement expected from implementation of other Clean Air Act programs during the applicable planning period. As documented in Section 8 Emissions

[44] "Baseline and Natural Visibility Conditions, Considerations and Proposed Approach to the Calculation of Baseline and Natural Visibility Conditions at MANE-VU Class I Areas," NESCAUM, December 2006.

Inventory, and Section 12 Long-Term Strategy, the modeling that formed the basis for reasonable progress goals in MANE-VU Class I areas included estimation of the effects of all other programs required by the Clean Air Act. Further information may be found in those sections of this SIP and in the documentation for the MANE-VU modeling.

Both natural conditions and baseline visibility for the 5-year period from 2000 through 2004 were calculated in conformance with an alternative method recommended by the IMPROVE Steering Committee. Progress toward the 2018 target will be calculated based on 5-year averages calculated in a nationally consistent manner consistent with EPA's "Guidance for Tracking Progress Under the Regional Haze Rule" (EPA-454/B-03-004, September 2003) as updated by the alternative method for calculating regional haze recommended by the IMPROVE Steering Committee.

To determine the RPG in deciviews, MANE-VU conducted modeling with certain control measure assumptions. The control measures reflected in these reasonable progress goals are summarized below. In establishing its reasonable progress goals for 2018, Maine recognizes that contributing states have the flexibility to submit SIP revisions between now and 2018 as they are able to adopt control measures to implement these goals. This long-term strategy to reduce and prevent regional haze will allow each state up to 10 years to pursue adoption and implementation of reasonable and cost-effective SO_2, NO_x and PM control measures.

Tables 11-2 and 11-3 below, provide a summary of the Reasonable Progress Goals for Maine Class I areas.

Table 11-2
Reasonable Progress Goals—20% Worst Days
(all values in deciviews)

Class I Area	**Baseline Visibility (deciviews) (20% Worst Days 2000-2004)**	**Reasonable Progress Goals, 20% Worst Days (expected deciview level by 2018)**	**Deciview Improvement Expected by 2018**	**Natural Visibility Conditions (20% Worst Days)**
Acadia National Park	22.9	19.4	3.5	12.4
Moosehorn Wilderness Area/ Roosevelt Campobello International Park	21.7	19.0	2.7	12.0

Table 11-3
Reasonable Progress Goals—20% Best Days
(all values in deciviews)

Class I Area	Baseline Visibility (deciviews) (20% Best Days)	Reasonable Progress Goals, 20% Best Days (expected deciview level by 2018)	Deciview Improvement Expected by 2018	Natural Visibility (20% Best Days) (deciviews)
Acadia National Park	8.8	8.3	0.5	4.7
Moosehorn Wilderness Area/ Roosevelt Campobello International Park	9.2	8.6	0.6	5.0

11.3 Identification of Additional Reasonable Controls

Maine and the other MANE-VU states have identified specific emission control measures- beyond those which individual states or RPOs have already made commitments to implement- that would be reasonable to undertake as part of a concerted strategy to mitigate regional haze. The proposed additional control measures were incorporated into the regional strategy adopted by MANE-VU on June 20, 2007, to meet the reasonable progress goals established in this SIP. The basic elements of this strategy are described in the MANE-VU "Ask" (see Subsection 3.4). States targeted for coordinated actions toward achieving these goals include all of the MANE-VU states plus Georgia, Illinois, Indiana, Kentucky, Michigan, North Carolina, Ohio, South Carolina, Tennessee, Virginia and West Virginia[45] .

In addition to proposed emission controls in the U.S., the MANE-VU Class I states determined that it was reasonable to include anticipated emission reductions in Canada in the modeling used to set reasonable progress goals. This determination was based on evaluations conducted before and during the consultation process (see description of relevant consultations in Subsection 3.3). Specifically, the modeling accounts for six coal-burning EGUs in Canada having a combined output of 6,500 MW that are scheduled to be shut down and replaced by nine natural gas turbine units with selective catalytic reduction (SCR) by 2018.

The process of identifying reasonable progress measures and setting reasonable progress goals is described in the subsections which follow. Further elaboration on the reasonable progress measures which make up the Maine/MANE-VU long-term strategy is provided

[45] In addition, the State of Vermont identified at least one source in the State of Wisconsin as a significant contributor to visibility impairment at the Lye Brook Wilderness Class I Area.

in Section 12 of this SIP. Under this plan, the affected states will have a maximum of 10 years to implement reasonable and cost-effective control measures to reduce primarily SO_2 and NO_x emissions. For a description of how proposed emission control measures were modeled to estimate resulting visibility improvements, see Subsection 11.5, Visibility Effects of Additional Control Measures.

10.4 The Foundations for Determining Reasonable Controls

40 CFR Section (d)(1)(i)(A) of EPA's Clean Air Visibility Rule requires that, in establishing reasonable progress goals for each Class I area, the State must consider the costs of compliance, the time necessary for compliance, the energy and non-air quality environmental impacts of compliance, and the remaining useful life of any potentially affected sources. The SIP must include a demonstration showing how these factors were taken into consideration in setting the reasonable progress goals. These factors are sometimes termed the "four statutory factors," since their consideration is required by the Clean Air Act.

Focus on SO_2: MANE-VU conducted a Contribution Assessment (Attachment A) and developed a conceptual model that indicated particulate sulfate formed from emissions of SO_2 was the dominant contributor to visibility impairment at all sites and during all seasons in the base year. While other pollutants, including organic carbon and NOx, will need to be addressed in order to achieve the national visibility goals, MANE-VU's contribution assessment suggested that an early emphasis on SO_2 will yield the greatest near-term benefit. Therefore, it is reasonable to conclude that the additional measures considered in establishing reasonable progress goals require reductions in SO2 emissions.

Contributing Sources: The MANE-VU Contribution Assessment indicates that emissions in 2002 from within the MANE-VU region were responsible for about 25 to 30 percent of the sulfate at MANE-VU Class I areas. Sources in the Midwest and Southeast regions were responsible for about 15 to 25 percent each, respectively. Point sources dominated the inventory of SO_2 emissions. Therefore, the MANE-VU's long-term strategy, includes additional measures to control sources of SO_2 both within the MANE-VU region and in other states that were determined to contribute to regional haze at MANE-VU Class I areas.

The Contribution Assessment documented the source categories most responsible for visibility degradation at MANE-VU Class I areas. As described in the Section 12, Long Term Strategy, there was a collaborative effort between the Ozone Transport Commission and MANE-VU to evaluate a large number of potential control measures. Several measures that would reduce SO_2 emissions were identified for further study.

These efforts led MANE-VU to prepare the report entitled, "Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas" MACTEC, July 9, 2007 otherwise known as the Reasonable Progress Report (Attachment T), which documented an analysis of the four statutory factors for five major source categories. Table 11-4 summarizes the results of MANE-VU's Reasonable Progress Report, which considered EGUs, ICI boilers, cement kilns, heating oil and residential wood combustion.

Table 11-4
Summary of Results from the Four Factor Analysis

Source Category	Primary Regional Haze Pollutant	Control Measure(s)	Average Cost in 2006 dollars (per ton of pollutant reduction)	Compliance Timeframe	Energy and Non-Air Quality Environmental Impacts	Remaining Useful Life
Electric Generating Units	SO_2	Switch to a low sulfur coal (generally <1% sulfur), switch to natural gas (virtually 0% sulfur), coal cleaning, Flue Gas Desulfurization (FGD)-Wet, -Spray Dry, or -Dry.	IPM®* v.2.1.9 predicts $775-$1,690 $170-$5,700 based on available literature	2-3 years following SIP submittal	Fuel supply issues, potential permitting issues, reduction in electricity production capacity, wastewater issues	50 years or more
Industrial, Commercial, Institutional Boilers	SO_2	Switch to a low sulfur coal (generally <1% sulfur), switch to natural gas (virtually 0% sulfur), switch to a lower sulfur oil, coal cleaning, combustion control, Flue Gas Desulfurization (FGD) - Wet, -Spray Dry, or -Dry.	$130-$11,000 based on available literature. Depends on size.	2-3 years following SIP submittal	Fuel supply issues, potential permitting issues, control device energy requirements, wastewater issues	10-30 years
Cement and Lime Kilns	SO_2	Fuel switching, Dry Flue Gas Desulfurization-Spray Dryer Absorption (FGD), Wet Flue Gas Desulfurization (FGD), Advanced Flue Gas Desulfurization (FGD).	$1,900-$73,000 based on available literature. Depends on size.	2-3 years following SIP submittal	Control device energy requirements, wastewater issues	10-30 years
Heating Oil	SO_2	Lower the sulfur content in the fuel. Depends on the state.	$550-$750 based on available literature. There is a high uncertainty associated with this cost estimate.	Currently feasible. Capacity issues may influence timeframe for implementation of new fuel standards	Increases in furnace/boiler efficiency, Decreased furnace/boiler maintenance requirements	18-25 years
Residential Wood Combustion	PM	State implementation of NSPS, Ban on resale of uncertified devices, installer training certification or inspection program, pellet stoves, EPA Phase II certified RWC devices, retrofit requirement, accelerated changeover requirement, and accelerated changeover inducement.	$0-$10,000 based on available literature	Several years - dependent on mechanism for emission reduction	Reduce greenhouse gas emissions, increase efficiency of combustion device	10-15 years

* Integrated Planning Model® CAIR versus CAIR plus analysis conducted for MARAMA/MANE-VU by ICF.

The MANE-VU states reviewed the four-factor analysis presented in the Reasonable Progress Report, consulted with each other about the measures, and concluded by adopting the statements known as the MANE-VU Ask on June 20, 2007. These statements identify the control measures that would be pursued toward improving visibility in the region.. The following discussion focuses on the four basic control strategies chosen by MANE-VU and included in the modeling used to establish reasonable progress goals: BART, emissions reductions from specific EGUs, low sulfur fuel oil requirements, and additional measures determined to be reasonable.

11.4.1 Best Available Retrofit Technology (BART) Controls

The MANE-VU states have identified approximately 100 BART-eligible sources in the region. Most of these facilities are already controlling emissions in response to other federal or state air programs, or are likely to install emission controls under new programs. Previously, EPA determined that CAIR fulfilled the BART requirement for all EGUs in CAIR-affected states. Although CAIR has been remanded to EPA, the determination that CAIR is equivalent to BART is still in place. Maine anticipates that those same units will be covered by successor legislation or new rulemaking undertaken in response to the CAIR remand. A complete compilation of BART-eligible sources in the MANE-VU region is available in Attachment A of MANE-VU's "Assessment of Control Technology Options for BART-Eligible Sources," March 2005 (Attachment R).

To assess the benefits of implementing BART in the MANE-VU region, NESCAUM estimated reductions for twelve BART-eligible units in the MANE-VU states that would probably be controlled as a result of BART requirements alone. These sources include one EGU and eleven non-EGUs. The affected units were identified by staff members in each MANE-VU state, who then furnished data on potential control technologies and expected emission levels for these units under BART implementation. The twelve sources are listed in Table 11-5, along with their 2002 baseline and 2018 projected emissions. Information on these units was incorporated into the 2018 emissions inventory projections that were used to establish reasonable progress goals.

Best Available Retrofit Technology is Reasonable: BART controls are part of the strategy for improving visibility at MANE-VU Class I areas. MANE-VU prepared reports to provide states with information about available control technologies (e.g., MANE-VU's "Assessment of Control Technology Options for BART-Eligible Sources," March 2005), estimated cost ranges and other factors associated with those controls. The reasonable progress goals established in this Regional Haze SIP assume that states whose emissions affect MANE-VU Class I areas will make determinations demonstrating the reasonableness of BART controls for sources in their states.

Table 11-5
Estimated Emissions from BART-Eligible Facilities MANE-VU States

State	Facility Name	Unit Name	SCC Code	Plant ID *	Point ID *	Facility Type	Fuel	2002 SO_2 Emissions (tons)	2018 SO_2 Emissions (tons)
MD	EASTALCO ALUMINUM	28	30300101	021-0005	28	Metal Production		1506	1356
MD	EASTALCO ALUMINUM	29	30300101	021-0005	29	Metal Production		1506	1356
MD	LEHIGH PORTLAND CEMENT	39	30500606	013-0012	39	Portland Cement		9	8
MD	LEHIGH PORTLAND CEMENT	16	30500915	021-0003	16	Portland Cement		1321	1,189
MD	LEHIGH PORTLAND CEMENT	17	30500915	021-0003	17	Portland Cement		976	878
MD	WESTVACO FINE PAPERS	2	10200212	001-0011	2	Paper and Pulp		8923	1338
ME	Wyman Station	Boiler 3	10100401	2300500135	004	EGU	Oil	616	308
ME	SAPPI Somerset	Power Boiler #1	10200799	2302500027	001	Paper and Pulp	Oil/Wood Bark/Process Gas	2884	1442
ME	IP Jay	Power Boiler #2	10200401	2300700021	002	Paper and Pulp	Oil	3086+	1543
ME	IP Jay	Power Boiler #1	10200401	2300700021	001	Paper and Pulp	Oil	2964+	1482
NY	KODAK PARK DIVISION	U00015	10200203	8261400205	U00015	Chemical Manufacturer		23798	14216
NY	LAFARGE BUILDING MATERIALS INC	41000	30500706	4012400001	041000	Portland Cement		14800	4440

*(from the MANE-VU Inventory)
+1999 emissions

11.4.2 The MANE-VU Low Sulfur Fuel Strategy

The MANE-VU region, especially the northeast, is heavily reliant on distillate oil for home space heating, with more than with more than 4 million gallons used, according to 2006 estimates from the Energy Information Administration[46]. Likewise, the heavier residual oils are widely used by non-EGU sources, and to a lesser extent the EGU sector. The sulfur content of distillate fuels currently averages above 2000 ppm (0.2percent). Although the sulfur content of residual oils varies by source and across the region, it can exceed 2.0 percent. In 2002, combustion of distillate and residual fuel in the MANE-VU region resulted in SO_2 emissions totaling approximately 380,000 tons.

As the second component of MANE-VU's long term strategy, the member states agreed to pursue measures that would require the sale and use of fuel oils having reduced sulfur content. This strategy would be implemented in two phases:

1. Phase 1 would require reducing the sulfur content in distillate (#1 and #2) fuel oils from current levels of 2,000 to 2,3000 ppm (0.20 to .23 percent) to a maximum of 500 ppm (0.05 percent) by weight. It would also restrict the sale of heavier blends of residual (#4 and # 5 and #6) fuel oils that have a sulfur content greater than 2,500 ppm (0.25 percent) and 5, ppm (0.5 percent) by weight, respectively.
2. Phase 2 would require further reducing the sulfur content of the distillate fraction from 500 ppm (0.05 percent) to 15 ppm (0.0015 percent) while keeping the sulfur limits on residual oils at first-phase levels.

The two phases are to be introduced in sequence with slightly different timing for an inner zone of the MANE-VU states[47] and the remainder of the MANE-VU states. While all MANE-VU states have agreed to pursue implementation of both phases to full effect by the end of 2018, it is possible that not every state can make a firm commitment to these measures today. States are expected to review the situation by the time of the first five-year regional haze progress report.

Reductions in sulfur dioxide emissions will occur as a direct consequence of the low-sulfur fuel strategy. For both phases combined, it is estimated that SO_2 emissions in the MANE-VU region will decline from 2002 levels by 168,222 tons per year for combustion of light distillates, and by 42,875 tons per year for combustion of the heavier fuels. Together, these reductions represent a 35 percent decrease in the projected 2018 SO_2 emissions inventory for non-EGU sources in the region.

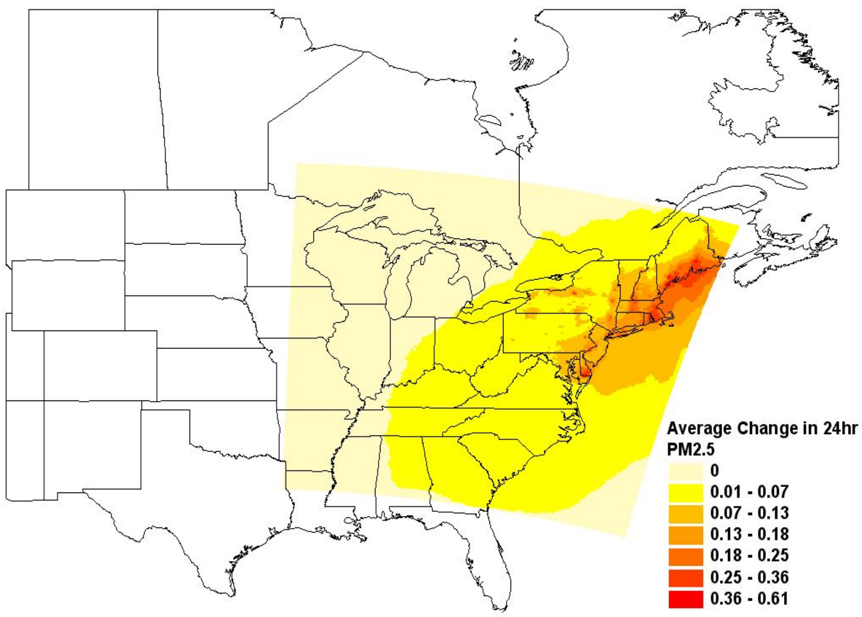
NESCAUM analyzed both steps of the program separately, but it is the combined benefit of implementing the program that is relevant to the question of visibility improvement by 2018. To estimate the total 2018 emissions reductions from this strategy, MANE-VU applied the expected sulfur dioxide emission reductions to all non-EGU sources burning #1, #2, #4, #5, or #6 fuel oil. These emission reductions would result directly from the

[46] U.S. Department of Energy, EIA, Table F3a, at http://www.eia.doe.gov/emeu/states/sep_fuel/html/fuel_use_df.html.
[47] The inner zone includes Delaware, Maryland, New Jersey, New York, and possibly portions of eastern Pennsylvania.

lowering of fuel sulfur content from original levels to 0.0015 percent for #1 and #2 oil, to 0.25 percent for #4 oil and to 0.5 percent for #5 and #6 oil.

The reduction in SO_2 emissions by 2018 will yield corresponding reductions in sulfate aerosol, the main culprit in fine particle pollution and regional haze. The full benefits of MANE-VU's low-sulfur fuel strategy is represented in Figure 11-1, which displays the estimated average change in 24-hr average $PM_{2.5}$ for the combined first and second phases of the low-sulfur fuel strategy as calculated by the CMAQ model.

Figure 11-1
Average Change in 24-hr $PM_{2.5}$ Due to Low Sulfur Fuel Strategies Relative to OTB/OTW
($\mu g/m^3$)



Low Sulfur Fuel Oil Requirements are Reasonable: The MANE-VU Contribution Assessment documented source apportionment analyses that linked visibility impairment in MANE-VU Class I areas with SO_2 emissions from sources burning fuel oil. The reasonable assumption underlying the low-sulfur fuel oil strategy is that refiners can, by 2018, produce home heating and fuel oils that contain 50 percent less sulfur for the heavier grades (#4 and #6 residual oil), and a minimum of 75 percent and maximum of 99.25 percent less sulfur in #2 fuel oil (also known as home heating oil, distillate, or diesel fuel) at an acceptably small increase in price to the consumer.

Four-Factor Analysis- Low sulfur Fuel Oil Strategy

The MANE-VU Reasonable Progress Report discussed the four factors as they apply to low sulfur fuel use for industrial, commercial, and institutional boilers and residential heating systems. MANE-VU's Reasonable Progress Report identified switching to lower sulfur oil as an available SO_2 control option that would achieve 50 to 90 percent reductions in SO_2 emissions from ICI Boilers. The report also noted that home heating oil use generates an estimated 100,000 tons of SO_2 emissions in the Northeast each year, and that SO_2 emissions would decline in proportion to reductions in fuel sulfur content. The following discussion summarizes information concerning the four factors for the low-sulfur fuel strategy.

Costs of Compliance

The MANE-VU Reasonable Progress Report noted that because of requirements for motor vehicle fuels, refineries have already performed the capital investments required for the production of low sulfur diesel (LSD) and ultra-low sulfur diesel (ULSD). The report estimated a cost per ton of SO_2 removed by switching to lower sulfur fuel would range from $554 to $734 per ton (Converted from 2001 to 2006 dollars using a conversion factor of 1.1383). In some seasons and some locations, low sulfur diesel is actually cheaper than regular diesel fuel. (See Chapter 8 of the Reasonable Progress Report.)

The sulfur content of #4 and #6 fuels can also be cost-effectively reduced. Residual oil is essentially a by-product of the refining process, and is produced in several grades that can be blended to meet a specified fuel sulfur content limit. New York Harbor residual fuel prices for the week ended March 21, 2008 ranged from a low of $71.38 a barrel for 2.00 and 2.2 percent sulfur fuel; to a high of $91.38 per barrel for 0.3 percent sulfur fuel. Low pour[48] fuel oil with 0.5 percent sulfur sold for $80.83 per barrel in this same period[49].

While the costs for achieving the projected emissions reductions with the low-sulfur fuel strategy are somewhat dependent on market conditions, they are believed to be reasonable in comparison to costs of controlling other sectors. Some MANE-VU states are proceeding with low-sulfur oil requirements much sooner than 2018; however, all of the MANE-VU states concur that a low-sulfur oil strategy is both reasonable and achievable by 2018. MANE-VU has concluded that the cost of requiring lower sulfur fuel is reasonable.

Time Necessary for Compliance

MANE-VU's Reasonable Progress Report indicated that furnaces and boilers would not have to be retrofit and would not require expensive control technology to burn ULSD distillate fuel oil. Therefore, the time necessary for compliance would be determined by the availability of the fuel.

[48] Low pour refers to a low-temperature pour point (or reduced viscosity at low temperature) for the fuel.
[49] During this same period, residual oil with a fuel sulfur content limit of 0.7 percent and 1.0 percent traded at $75.13 and $72.63, respectively.

The MANE-VU Reasonable Progress Report notes that, on a national scale, more ULSD is produced than both LSD and high sulfur fuel, and concludes that there is sufficient domestic infrastructure to produce adequate stocks of LSD and ULSD. The NESCAUM Low Sulfur Heating Oil Report[50] also observes that the federal rules for heavy-duty highway diesel fuel are flexible, so that if there is a shortage of 15 ppm fuel, the 15 to 500 ppm fuel could be used to relieve the shortage. With this flexibility, the report concludes that the likelihood of a fuel shortage in the short term due to use of ULSD for heating oil is diminished. The volatile nature of heating supply and demand presents unique challenges to the fuel oil industry. The success of a low sulfur fuel oil program is predicated on meeting these challenges. The Northeast states are assessing a variety of business strategies and regulatory approaches that could be used to minimize any potential adverse supply and price impacts that could result from a regional 500 ppm sulfur standard for heating oil. Suppliers can increase pre-season reserves and look to increase imports from offshore refiners producing low sulfur product. Blending domestically produced biodiesel into heating oil offers opportunity to reduce imports, stabilize supplies and minimize supply-related price spikes.

Potential supply disruptions and price spikes for residual fuels were a particular concern for several northern MANE-VU states. While the potential for disruptions in the supply of residual fuels is greater than that for distillate oil, these disruptions would affect only a limited number of states during extreme weather events.

MANE-VU has identified several mechanisms that could be implemented to address disruptions, including seasonal averaging and emergency waivers. A seasonal averaging approach would reduce potential supply constraints by allowing the use of higher sulfur fuel during periods of peak demand (and limited supply), and then requiring the increased sulfur content of these fuels to be offset through the use of a lower sulfur fuel at other times. This approach would provide regulatory certainty and greater flexibility during the winter months when fuel supplies may be subject to weather-related disruptions, but at a cost of increased recordkeeping and compliance monitoring. Since many states already have statutory authority to waive fuel sulfur limits for an emergency waiver, states could also utilize their discretionary powers to address short-term supply disruptions.

The strategy adopted by Maine and the other MANE-VU states proposes to phase in the required use of lower-sulfur fuels over the next 8 years, providing adequate time for full implementation.

Energy and Non-Air Quality Environmental Impacts of Compliance

According to MANE-VU's Reasonable Progress Report, reducing the sulfur content of fuel oil would have a variety of beneficial consequences for boilers and furnaces using this fuel. Low-sulfur distillate fuel is cleaner burning and emits less particulate matter, thereby substantially reducing the rate of fouling of heating units and allowing longer time intervals between cleanings. The MANE-VU report cites a study by the New York

[50] "Low Sulfur Heating Oil in the Northeast States: An Overview of Benefits, Costs and Implementation Issues", December 31, 2005 by NESCAUM.

State Energy Research and Development Authority (NYSERDA) showing that boiler deposits are reduced by a factor of two by lowering the fuel sulfur content from 1,400 ppm to 500 ppm. The use low-sulfur oil could extend the useful life of a source by reducing the maintenance required because low-sulfur oil is less damaging to the combustion equipment. The report also notes that decreasing sulfur levels in fuel would enable manufacturers to develop more efficient furnaces and boilers by using more advanced condensing equipment that recovers energy normally lost to the heating of water vapor in the exhaust gases.

Furthermore, SO_2 controls would also have beneficial environmental impacts by reducing acid deposition and helping to decrease concentrations of $PM_{2.5}$. Reductions in $PM_{2.5}$ would potentially help nonattainment areas meet health-based National Ambient Air Quality Standards.

Remaining Useful Life of Any Potentially Affected Sources

Residential furnaces and boilers have finite life spans, but they do not need to be replaced to burn low- or ultra-low-sulfur fuel. The Energy Research Center estimates that the average life expectancy of a residential heating oil boiler is 20-25 years. As noted above, use of low-sulfur fuel is less damaging to equipment and could therefore extend the useful life of an oil-fired residential furnace or boiler.

Available information on the remaining useful life of ICI boilers indicates a wide range of life expectancies, depending on unit size, capacity factor[51], and level of maintenance performed. The typical life expectancy of an ICI boiler ranges from 10 years to more than 30 years. As in the case of residential units, use of lower-sulfur fuels could extend the lifespan of an ICI boiler.

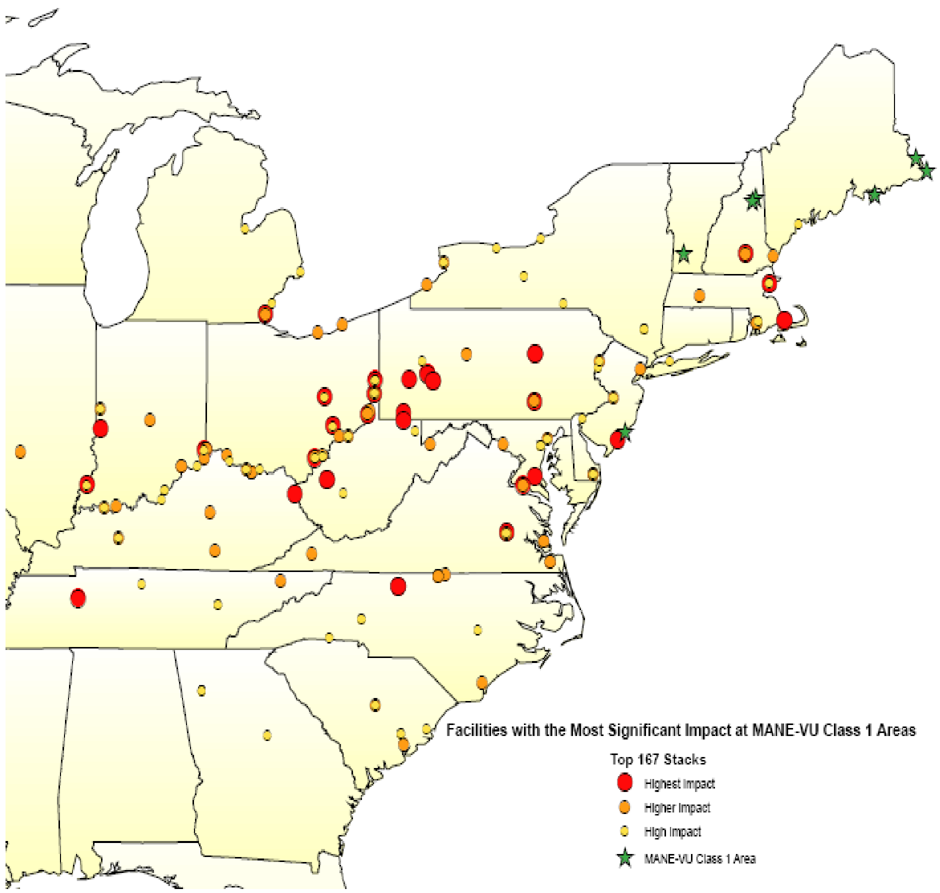
11.4.3 Targeted Strategy for Reducing SO_2Emissions from EGU Stacks

EGUs are the single largest sector contributing to visibility impairment at MANE-VU Class I areas. SO_2 emissions from power plants continue to dominate the emissions inventory. Sulfate formed through atmospheric processes from SO_2 emissions are responsible for over half the mass and approximately 70-80 percent of the extinction on the days of worst visibility (NESCAUM’s Contribution Assessment and Conceptual Model, Attachment A).

To ensure that EGU controls are targeted at those EGUs with the greatest impact on visibility at MANE-VU Class I areas, a modeling analysis was conducted to identify the individual sources responsible for the greatest contributions to visibility impairment. Accordingly, MANE-VU developed a list of the 100 EGUs having the greatest impacts at each MANE-VU Class I area during 2002 The combined list for all seven MANE-VU Class I areas identified a total of 167 distinct emission points, with these stacks located throughout the Northeast, Midwest and Southeast (Figure 11-2)

[51] Capacity factor is defined as the actual amount of energy a boiler generates in one year divided by the total amount it could generate if it ran full time at full capacity.

Figure 11-2
Location of 167 EGU Stacks Contributing the Most to Visibility Impairment at MANE-VU Class I Areas

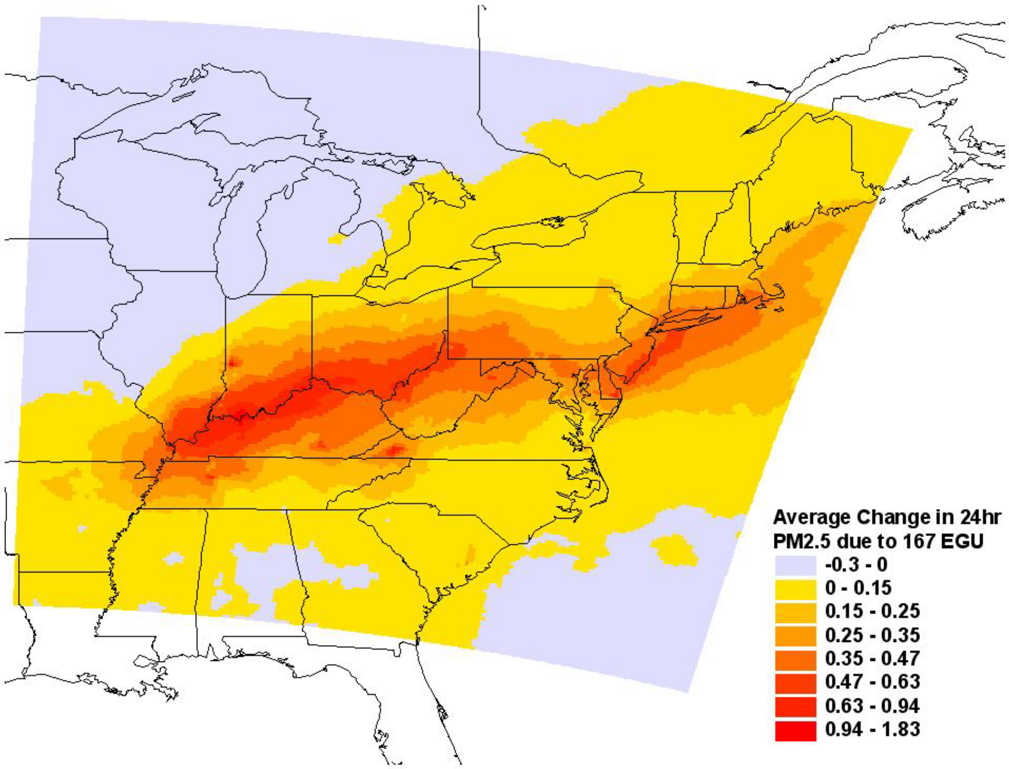


After consultations with its member states and other RPOs MANE-VU requested a 90-percent reduction in SO_2 emissions from the top 167 stacks no later than 2018 (See the MANE-VU "Ask," described in Section 3.4 of this SIP). NESCAUM's preliminary modeling for MANE-VU showed that reducing SO_2 emissions from the targeted facilities by 90 percent would also produce measurable improvements in ambient 24-hour $PM_{2.5}$ concentrations. Assuming a control level equal to 10 percent of the 2002 baseline emissions (i.e., 90 percent emission reduction), NESCAUM used CMAQ to model sulfate concentrations in 2018 after implementation of controls. The modeled sulfate values were then converted to estimates of $PM_{2.5}$ concentrations.

Figure 11-3 illustrates the reduction in fine particle pollution in the Eastern U.S. that would result from implementing the targeted EGU SO_2 strategy. Improvements in $PM_{2.5}$

concentrations would occur throughout the MANE-VU region as well as for portions of the VISTAS and Midwest RPO regions, especially the Ohio River Valley.

Figure 11-3
Preliminary Estimate of Average Change in 24-hr $PM_{2.5}$ Due to 90 Percent Reduction in SO_2 Emissions from 167 EGU Stacks Affecting MANE-VU



Although the reductions are potentially large, MANE-VU determined, after consultation with affected states, that it was unreasonable to expect that the full 90-percent reduction in SO_2 emissions would be achieved by 2018. Therefore, additional modeling was conducted to assess the more realistic scenario in which emissions would be controlled by the individual facilities and/or states to levels already projected to take place by that date. At some facilities, the actual emission reductions are anticipated to be greater or less than the 90 percent benchmark. For a detailed description of this analysis, see Alpine Geophysics' report for MARAMA entitled "Documentation of 2018 Emissions from Electric Generating Units in the Eastern United States for MANE-VU's Regional Haze Modeling, Revised Final Draft, April 21, 2008 (Attachment S).

Targeted EGU SO_2 Emissions Reductions are Reasonable: MANE-VU identified specific EGU stacks that were significant contributors to visibility degradation at MANE-VU Class I areas in 2002 based on CALPUFF modeling analyses documented in the Contribution Assessment. MANE-VU obtained information about existing and planned controls on emissions from those stacks. These analyses and the information on proposed EGU controls are presented in the MANE-VU Reasonable Progress Report, and the

Contribution Assessment (specifically Attachment D),as well as in Section 8.0 (Emissions Inventory), and Section 12.0 (Long Term Strategy) of this SIP.

Based on information gathered from the states and RPOs, MANE-VU anticipates that emissions from many of the specific EGU stacks will be controlled as a result of EPA's Clean Air Interstate Rule (CAIR). Since CAIR is a cap and trade program, it is not possible to predict with certainty which of the 167 stacks will in fact be controlled under CAIR in 2018.

Four-Factor Analysis – Targeted EGU SO_2 Reduction Strategy

Costs of Compliance

Technologies to control the precursors of regional haze are commercially available.[52] Because EGUs are the most significant stationary source of SO_2, NO_x, and PM, they have been subject to extensive federal and state regulations to control all three pollutants. The technical feasibility of control technologies has been successfully proven for a large number of small (@100MW) to very large boilers (over 1,000 MW) using different types of coal used. Over the last few years, the cost data clearly indicate that many technologies provide substantial and cost-effective reductions.

Both wet and dry flue gas desulfurization ("scrubbers") are in wide commercial use in the U.S. for controlling SO_2 emissions from coal-fired power plants. The capital costs for new or retrofit wet or dry scrubbers are higher than the capital costs for NO_x and PM controls. Capital costs ranged from $180/kW for large units (larger than 600 MW) to as high as $350/kW for small units (200 to 300 MW). (See pages 2-22 of the NESCAUM report "Assessment of Control Technologies for BART Eligible Sources," March 2005, Attachment R). However, the last few years have seen a general trend of declining capital costs due to vendor competition and technology maturation. Also, the cost-effectiveness (in dollars per ton of emissions removed) is very attractive because the high sulfur content of the coal burned by these units results in a very large amount of SO_2 removed by the control devices. The typical cost-effectiveness is in the range of 200 to 500 dollars per ton of SO_2 removed, although the cost rises steeply for small units burning low-sulfur coals and operating at low capacity factors. For any unit, the overall cost effectiveness is determined mostly by the baseline pre-controlled SO_2 emission rate (or fuel sulfur content), size and capacity factor of the unit, as well as the capital cost of flue gas desulfurization (generally ranges from $150 to $200/Kw).

The MANE-VU Reasonable Progress Report reviewed options for controlling coal-fired EGU boilers, including switching to lower-sulfur coal, switching to natural gas, coal cleaning, and flue gas desulfurization (FGD). The most effective control option (but not necessarily appropriate for all installations) is FGD, which can achieve up to a 95 percent reduction in SO_2 emissions. The cost varies considerably among units and was estimated

[52] The information in this and the next paragraph comes from the "Assessment of Control Technology Options for BART-Eligible Sources: Steam Electric Boilers, Industrial Boilers, Cement Plants and Paper and Pulp Facilities," March 2005, prepared by NESCAUM, in partnership with MANE-VU.

to range from as low as $170/ton to as high as $5,700/ton. Table 11-6 summarizes the estimated SO_2 control costs on a dollar per ton of SO_2 removed basis.

Table 11-6
Estimated Cost Ranges for SO_2 Control Options for Coal-Fired EGU Boilers
(2006 dollars per ton of SO_2 removed)

Technology	Description	Performance	Cost Range (2006 dollars/ton of SO_2 Reduced)
Switch to a Low Sulfur Coal (generally <1% sulfur)	Replace high-sulfur bituminous coal combustion with lower-sulfur coal	50-80% reduction in SO_2 emissions by switching to a lower-sulfur coal	Potential reduction in coal costs, but possibly offset by expensive retrofits and loss of boiler efficiency
Switch to natural gas (virtually 0% sulfur)	Replace coal combustion with natural gas	Virtually eliminate SO_2 emissions by switching to natural gas	Unknown – cost of switch is currently uneconomical due to price of natural gas
Coal Cleaning	Coal is washed to remove some of the sulfur and ash prior to combustion	20-25% reduction in SO_2 emissions	2-15% increase in fuel costs based on current prices of coal
Flue Gas Desulfurization (FGD) – Wet	SO_2 is removed from flue gas by dissolving it in a lime or limestone slurry. (Other alkaline chemicals are sometimes used)	30-95%+ reduction in SO_2 emissions	$570-$5,700 for EGUs <1,200 MW $330-$570 for EGUs >1,200 MW
Flue Gas Desulfurization (FGD) – Spray Dry	A fine mist containing lime or other suitable sorbent is injected directly into flue gas	60-95%+ reduction in SO_2 emissions	$570-$4,550 for EGUs <600 MW $170-$340 for EGUs >600 MW
Flue Gas Desulfurization (FGD) –Dry	Powdered lime or other suitable sorbent is injected directly into flue gas	40-60% reduction in SO_2 emissions	$250-$850 for EGUs ~300 MW

Table references:
1. EIA website accessed on 2/20/07: http://www.eia.doe.gov/cneaf/coal/page/coalnews/coalmar.html
2. EIA website accessed on 2/20/07: http://www.eia.doe.gov/cneaf/coal/page/acr/table31.html
3. STAPPA-ALAPCO. *Controlling Fine Particulate Matter Under the Clean Air Act: A Menu of Options*; March 2006.

To predict future emissions and further evaluate the costs of emission controls for electric generating units, MANE-VU and other RPOs have followed the example of EPA in using the Integrated Planning Model (IPM®), an integrated economic and emissions model for EGUs. This model projects electricity supplies based on various assumptions while at the same time developing least-cost solutions to electrical generating needs within the specified emissions targets. IPM also provides estimates of the costs of complying with various policy requirements.

EPA developed IPM version 2.1.9 and used this model to evaluate the impacts of CAIR and the Clean Air Mercury Rule (CAMR)[53]. Recently, EPA updated their input data and

[53] CAMR was also vacated by the federal courts and is no longer in effect.

developed IPM v3.0. However, because of time constraints, all MANE-VU modeling runs were based on EPA IPM v2.1.9 with changes made to the input assumptions. As stated previously, CAIR has recently been remanded to EPA and it is unknown at this time when EPA will propose a revised or new rule in accordance with the court's July 11, 2008 decision.

The RPOs collaborated with each other to update EPA Base Case v.2.1.9 using more current data about EGUs with more realistic fuel prices, creating an IPM run called VISTAS PC_1f. The VISTAS IPM run is the basis for regional air quality modeling for regional haze SIPs in MANE-VU.

MANE-VU, through MARAMA, contracted with the consulting firm ICF International to prepare two new IPM runs[54]. The first modeling run, known as the MARAMA CAIR Base Case run, was based on the VISTAS PC_1f run and underlying EPA IPM v.2.1.9 with some updated information on fuel prices, control constraints, etc. This run also goes by the name MARAMA_5c. The second run, called the MARAMA CAIR Plus run (also known as MARAMA_4c), was similarly based on VISTAS PC_1f run and the underlying EPA IPM v.2.1.9, and included updated information used in the VISTAS run, but assumed lower NO_X emission caps and higher SO_2 retirement ratios.

Based on modeling results, MANE-VU estimates that the marginal cost of SO_2 reductions (the cost of reducing an additional ton of emissions) ranges from $640/ton in 2008 to $1,392 ton in 2018.[55]

Costs will vary for individual plants to reduce emissions by 90 percent, as recommended in the MANE-VU Ask. However, this strategy provides states with the flexibility to pursue controls on specific sources as appropriate and to control emissions from alternative sources, if necessary, to meet the 90 percent target established in the Ask.

Given the significance of SO_2 emissions from specific EGU's to visibility impairment in MANE-VU Class I areas, the MANE-VU Commissioners, after weighing all factors- the availability of technology to reduce emissions, the estimated cost of controls, the costs of alternative measures, the flexibility to achieve alternative reductions if necessary, etc. - concluded that the costs of reducing emissions from the identified key stacks was reasonable. Maine agrees with this conclusion for base-load coal-fired units, but recognizes add-on controls may not be cost-effective for oil-fired peaking units.

Time Necessary for Compliance

MANE-VU's Reasonable Progress Report indicates that, generally, sources are given a 2- to 4-year phase-in period to comply with new rules. Under Phase I of the NO_x SIP call, EPA provided a compliance date of about 3.5 years from the SIP submittal date. Most MACT standards allow a 3-year compliance period. Under Phase II of the NO_x SIP Call,

[54] See the report, *Comparison of CAIR and CAIR+ Proposal using the Integrated Planning Model (IPM®),* ICF Resources LLC, May 2007, Attachment U.
[55] See Table 6, "Allowance Prices (Marginal Costs) of Emissions Reductions…" p. 9, ICF, May 2007, Attachment U.

EPA provided a 2-year compliance period from the SIP submittal date. The MANE-VU states concluded that there is more than sufficient time between 2008 and 2018 for affected states to adopt requirements and for affected sources to install necessary controls. Maine agrees with this conclusion

Energy and Non-Air Quality Environmental Impacts of Compliance

The MANE-VU Reasonable Progress Report identified several energy and non-air quality impacts as a result of additional EGU controls. These included potential adverse impacts on fuel supplies if there were large-scale fuel switching, the triggering of NSR requirements, and the generation of wastewater and sludge from flue gas desulfurization systems. Conversely, additional controls for SO_2, NOx, and ammonia would have beneficial environmental impacts by reducing mercury emissions, acid deposition and nitrogen deposition to water bodies and natural landscapes. Reductions would also result in decreases in ambient levels of $PM_{2.5}$ with corresponding health benefits. The MANE-VU states concluded that the energy and non-air quality impacts of additional EGU controls are reasonable. Maine agrees with this conclusion

Remaining Useful Life of Any Potentially Affected Sources

As noted in the MANE-VU Reasonable Progress Report, remaining useful life estimates of EGU boilers indicate a wide range of operating lifetimes, depending on unit size, capacity factor, and level of maintenance performed. Typical life expectancies range to 50 years or more. Additionally, implementation of air pollution regulations over the years has necessitated emission control retrofits that have increased the expected life spans of many EGUs. The lifetime of an EGU may be extended through repair, re-powering, or other strategies if the unit is more economical to run than to replace with power from other sources. Extending facility lifetime may be particularly likely for a unit serving an area with limited transmission to bring in other power. The remaining useful life of a unit should not be confused with the economic decision of whether or not to continue operating a unit or to re-power or replace it. The cost of environmental compliance is only one of many factors involved in such a decision.

11.4.4 Non-EGU SO_2 Emissions Reduction Strategy Outside the MANE-VU Region

In addition to the measures described above, (i.e., BART, low sulfur fuel within MANE-VU, and targeted controls on specific EGUs), MANE-VU asked states in neighboring regional planning organizations to consider further non-EGU emissions reductions comparable to those achieved by states located within the MANE-VU region through the application of MANE-VU's low sulfur fuel strategy. Previous modeling indicated that the MANE-VU low sulfur fuel strategy would achieve a greater than 28 percent reduction in non-EGU SO_2 emissions by 2018. After consultation with other states and consideration of comments received, the MANE-VU Class I States decided to include, in the latest modeling for the VISTAS and MRPO regions, implementation of measures capable of achieving SO_2 emission reductions equivalent to MANE-VU's 28 percent reduction in non-EGU SO_2 emissions in 2018.

To model the impact of this strategy on visibility at MANE-VU Class I areas, MANE-VU had to make reasonable assumptions about where the requested emissions reductions would occur in the VISTAS and MRPO states without knowing precisely how those reductions would be realized. As a means to approximate a 28 percent reduction in non-EGU SO_2 emissions, the following reductions were modeled:

- For control measures in VISTAS and MRPO states:
    - Coal-Fired ICI Boilers: SO_2 emissions were reduced by 60 percent
    - Oil-Fired ICI boilers: SO_2 emissions were reduced by 75 percent
    - ICI Boilers lacking fuel specification: SO_2 emissions were reduced by 50 percent

- For additional controls only in the VISTAS states: SO_2 emissions from other area oil-combustion sources were reduced by 75 percent (based on the same SCCs identified in MANE-VU's oil strategies list)

This modeling scenario represents just one example of realistic strategies that states outside of MANE-VU could employ to meet the non-EGU SO_2 emissions reductions requested by MANE-VU.

A number of non-MANE-VU states have not included, or may not include, the requested 28 ercent reduction in non-EGU SO_2 emissions in their initial SIPs. The MANE-VU states encourage EPA to hold these states responsible for satisfying the MANE-VU Ask in the course of preparing their first five-year progress reports in order to meet the CAA national goal of remedying any existing visibility impairment in Class I areas.

Non-EGU SO_2 Emission Reductions Measures Outside the MANE-VU Region are Reasonable: After EGUs, ICI boilers and heaters are the next largest class of SO_2 emitters. ICI boilers are thus a logical choice among non-EGU sources for consideration of additional SO_2 control measures.

ICI Boiler Control Options

Air pollution reduction and control technologies for ICI boilers have advanced substantially over the past 25 years. However, according to the 1998 survey of industrial boilers by EPA (2004), only 2 percent of gas-fired boilers and 3 percent of oil-fired boilers had installed any kind of air pollution control device. A larger percentage of coal-fired boilers had installed air pollution control devices: specifically, 47 percent had installed some type of control device, mainly to control particulate matter (PM). Post-combustion SO_2 controls were used by less than one percent of industrial boilers in 1998, with the exception of boilers firing petroleum coke (2 percent of boilers firing petroleum coke had acid scrubbers). A small percentage of industrial boilers had combustion controls in place in 1998, although since 1998, additional low-NO_x firing systems may have been installed since that date.

Almost all SO_2 emission control technologies fall in the category of reducing SO_2 after its formation, as opposed to minimizing its formation during combustion. The method of SO_2 control appropriate for any individual ICI boiler is dependent upon the type of boiler, type of fuel, capacity utilization, and the types and staging of other air pollution control devices. However, cost-effective emissions reduction technologies for SO_2 are available and are effective in reducing emissions from the exhaust gas stream of ICI boilers. Post-combustion SO_2 control is accomplished by reacting the SO_2 in the gas with a reagent (usually calcium- or sodium-based) and removing the resulting product (a sulfate/sulfite) for disposal or commercial use, depending on the technology used. SO_2 reduction technologies are commonly referred to as Flue Gas Desulfurization (FGD) and are usually described in terms of the process conditions (wet versus dry), byproduct utilization (throwaway versus saleable) and reagent utilization (once-through versus regenerable).

The exceptions to the nearly universal use of post-combustion controls are found in fuel switching, coal cleaning, and fluidized bed boilers, in which limestone is added to the fuel in the combustion chamber. SO_2 control options for ICI boilers are outlined in Table 11-7. Further descriptions of these SO_2 control technology options are available in Chapter 4 of the MANE-VU Reasonable Progress Report (Attachment T).

The SO_2 removal efficiency of these controls varies from 20 to 99+ percent, depending upon the fuel type and control strategy. For coal-fired boilers, options include switching to low-sulfur coal, coal cleaning, wet FGD, dry FGD, and spray dryers. The overall SO_2 reductions vary from a low of 20 to 25 percent for switching to low-sulfur fuel(s) to a high of 60 to 95 percent for wet FGD and spray dry FGD. The majority of control strategies, however, are capable of achieving a 60 percent or greater reduction. Thus, assuming that coal-fired ICI boilers adopt varying levels of controls, with most choosing a 50 to 70 percent reduction strategy and fewer choosing either the 20 percent or the 90 percent reduction strategy, the region-wide average is likely to be in the range of a 60 percent reduction in SO_2 emissions. This assumption is validated by the data which documents that wet FGD systems represent 85 percent of the FGD systems in use in the United States and that FGD systems have an average SO_2 removal efficiency of 78 percent. MANE-VU's modeling of a 60 percent reduction in SO_2 emission from coal-fired ICI boilers is therefore reasonable.

For oil-fired boilers, options include switching to a lower sulfur fuel (e.g., oil or natural gas), dry FGD, and spray dryers. The overall SO_2 reductions vary from a low of 40 to 60 percent for dry FGD, to a high of 60 to 95 percent for spray dry FGD. For comparison, the MANE-VU low sulfur fuel strategy assumes a 50 to 90 percent reduction in SO_2 emissions from oil-fired ICI boilers. Assuming a typical distribution of control strategies chosen by the sources, MANE-VU's modeling of an average 75 percent reduction in SO_2 emission from oil-fired ICI boilers is reasonable.

For ICI boilers in which a fuel was not specified, a 50 percent reduction in SO_2 emissions was assumed. ICI boilers in this category include those outside the MANE-VU region for which the current inventory did not specify the type of fuel burned. Because a response was not received from the MRPO, this assumption also encompasses some of the uncertainty regarding the implementation of MANE-VU's non-EGU Ask. Given the paucity of data, a lower reduction in SO_2 emissions (50 percent) was assumed in this category than for coal- or oil-fired ICI boilers. Implementation of one or more of the suggested SO_2 control options capable of achieving an average 50 percent SO_2 reduction at these sources is a reasonable assumption.

Table 11-7
Available SO_2 Control Options for ICI Boilers

Technology	Description	Applicability	Performance
Switch to a Low Sulfur Coal (generally <1% sulfur)	Replace high-sulfur bituminous coal combustion with lower-sulfur coal	Potential control measure for all coal-fired ICIs currently using coal with high sulfur content	50-80% reduction in SO_2 emissions by switching to a lower-sulfur coal
Switch to Natural Gas (virtually 0% sulfur)	Replace coal combustion with natural gas	Potential control measure for all coal-fired ICIs	Virtually eliminate SO_2 emissions by switching to natural gas
Switch to a Lower Sulfur Oil	Replace higher-sulfur residual oil with lower-sulfur distillate oil. Alternatively, replace medium sulfur distillate oil with ultra-low sulfur distillate oil	Potential control measure for all oil-fired ICIs currently using higher sulfur content residual or distillate oils	50-80% reduction in SO_2 emissions by switching to a lower-sulfur oil
Coal Cleaning	Coal is washed to remove some of the sulfur and ash prior to combustion	Potential control measure for all coal-fired ICI boilers	20-25% reduction in SO_2 emissions
Combustion Control	A reactive material, such as limestone or bi-carbonate, is introduced into the combustion chamber along with the fuel	Applicable to pulverized coal-fired boilers and circulating fluidized bed boilers	40%-85% reductions in SO_2 emissions
Flue Gas Desulfurization (FGD) - Wet	SO_2 is removed from flue gas by dissolving it in a lime or limestone slurry. (Other alkaline chemical are sometimes used)	Applicable to all coal-fired ICI boilers	30-95%+ reduction in SO_2 emissions
Flue Gas Desulfurization (FGD) - Spray Dry	A fine mist containing lime or other suitable sorbent is injected directly into flue gas	Applicable primarily for boilers currently firing low to medium sulfur fuels	60-95%+ reduction in SO_2 emissions
Flue Gas Desulfurization (FGD) - Dry	Powdered lime or other suitable sorbent is injected directly into flue gas	Applicable primarily for boilers currently firing low to medium sulfur fuels	40-60% reduction in SO_2 emissions

For emissions from other area oil-combustion sources in the VISTAS region, an SO_2 reduction of 75 percent was assumed. This is equivalent to the MANE-VU low sulfur fuel strategy. The four factor analysis of this strategy was presented in Section 11.3.2.

Four-Factor Analysis – Non-EGU SO_2 Emission Reduction Measures Outside MANE-VU

Based on the survey of available technologies outlined above and the four-factor analysis summarized below, MANE-VU concludes that each of the strategies assumed for modeling purposes to meet the MANE-VU Ask of a 28 percent reduction in non-EGU SO_2 emissions is reasonable. States should have no difficulty in meeting this benchmark in light of the control efficiencies that are attainable at reasonable costs with retrofit technologies that are available for ICI boilers today.

Costs of Compliance

Industrial boilers have a wider range of sizes than EGUs and often operate over a wider range of capacities. Thus, cost estimates for the same technologies will generally span a relatively larger range, and costs for individual boilers will depend on the capacity of the boiler and typical operating conditions. In general, cost-effectiveness increases as boiler size and capacity factor (a measure of boiler utilization) increases.

MANE-VU's Reasonable Progress Report (Attachment T) provides emission control cost estimates for ICI boilers in the range of $130 per ton to $11,000 per ton, a very wide range due to the variability of sources and control options in this category.[56] All costs presented below for emission controls on ICI boilers are borrowed from this report. Dollar amounts originated from EPA publications cited in the report and have been converted to 2006 dollars using a conversion factor from www.inflationdata.com.

- *Cost of Fuel Switching:*

Although fuel switching can be a very effective means of reducing SO_2 emissions (reductions of 50 to 99.9 percent are possible), burning low-sulfur fuel may not be a technically feasible or economically practical SO_2 control alternative for every ICI coal-fired boiler. Factors impacting applicability include the characteristics of the plant and the particular type of fuel change being considered. Additionally, switching to a lower sulfur coal can affect fuel handling systems, boiler performance, PM control effectiveness, and ash handling systems. Oil-fired boilers switching to a lower sulfur fuel of the same grade (e.g., switching from #6 fuel oil at 2.0%S to #6 fuel oil at 0.5% S) do not typically encounter these issues; please see Section 11.4.2 for a discussion of the costs and issues associated with switching to low sulfur fuel oil.

The costs of coal fuel switching, including substitution or blending with a low-sulfur coal, can be attributed to two main reasons: the cost of low-sulfur coal compared to higher sulfur coal (including coal's heating value), and the cost of any necessary boiler or coal handling equipment modifications. Many plants will be able to switch from high-sulfur to low-sulfur bituminous coal without serious difficulty, but switching from bituminous to sub-bituminous coal may require potentially significant investments and modifications to an existing plant. Even if a lower sulfur fuel is available, it may not be cost competitive if it must be transported long distances from the supplier or supplied in small quantities. It also may be more cost-effective to burn a higher sulfur fuel supplied by nearby suppliers and to use a post-combustion control device.

Switching from coal combustion to natural gas combustion virtually eliminates SO_2 emissions. It is technically feasible to switch from coal to natural gas, but the wide variation in natural gas process means that it may be uneconomical to consider this option for large ICIs due to the fuel quantity necessary and the price of natural gas. Natural gas

[56] MANE-VU's Reasonable Progress Report is entitled "Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas" prepared by MACTEC for MARAMA, dated July 9, 2007.

is currently about twice times the price of coal in terms of heating value, but has been as high as seven times the price of coal in recent years.

- Cost of Coal Cleaning

The World Bank, an organization which assists with economic and technological needs in developing countries, reports that the cost of physically cleaning coal varies from $1 to $10 per ton of coal cleaned, depending on the coal quality, the cleaning process used, and the degree of cleaning desired. In most cases the costs were found to be between $1 and $5 per ton of coal cleaned. The effectiveness of coal cleaning is typically a 20 to 25 percent reduction in SO_2 emissions. Coal cleaning also increases the heating value of the fuel by a small amount.

- Cost of Combustion Controls

Dry sorbent injection (DSI) systems have lower capital and operation costs than post-combustion FGD systems because of the simplicity of the DSI design, lower water use requirements, and smaller land area requirements. Table 11-8 presents the estimated costs of adding DSI-based SO_2 controls to ICI boilers based for different boiler sizes, fuel types, and capacity factors.

- Cost of FGD

Installation of post-combustion SO_2 controls in the form of FGD has several impacts on facility operations, maintenance, and waste handling procedures. FGD systems generally require substantial land area for construction of the absorber towers, sorbent tanks, and waste handling equipment. The facility costs therefore depend on the cost and availability of space for construction of the FGD system. Solid waste handling is another factor that influences the cost of FGD control systems. Significant waste material may be generated that requires disposal. These costs may be mitigated, however, by utilization of a forced oxidation FGD process that produces commercial-grade gypsum, which may be sold as a raw material for other commercial processes.

Table 11-8
Estimated Dry Sorbent Injection (DSI) Costs for ICI Boilers
(2006 dollars)

Fuel	SO_2 Reduction (%)	Capacity Factor (%)	Cost Effectiveness ($/Ton of SO_2)		
			100 MMBTU/hr	250 MMBTU/hr	1,000 MMBTU/hr
2%-sulfur coal	40	14	4,686	3,793	2,979
		50	1,312	1,062	834
		83	772	624	490
3.43%-sulfur coal	40	14	2,732	2,212	1,737
		50	765	619	486
		83	450	364	286
2%-sulfur coal	85	14	2,205	1,786	1,402
		50	617	500	392
		83	363	294	231
3.43%-sulfur coal	85	14	1,286	1,040	818
		50	360	291	229
		83	212	171	134

Table11-9 presents the total estimated cost effectiveness of adding FGD-based SO_2 controls for different boiler sizes, fuel types, and capacity factors. There is no indication that these cost data include revenue from gypsum sales, which would partially offset the costs of FGD controls.

Carbon dioxide is also emitted as a by-product of FGD, therefore impacts of increased carbon emissions would need to be considered. CO_2 emissions will become more of an issue in the future if they are limited under climate change mitigation strategies. Given the uncertainty of such future strategies, costs related to increased carbon emissions from FGD cannot yet be assessed.

MANE-VU's request for a 28 percent reduction in non-EGU SO_2 emissions allows states flexibility in determining which sources to control, so that the most cost-effective control measures can be adopted and implemented over the next 10 years. Given the wide range of control options and costs available for this purpose, MANE-VU has concluded that its request for a 28 percent reduction in non-EGU SO_2 emissions is reasonable. Maine concurs with this conclusion.

Time Necessary for Compliance

For pre- and post-combustion SO_2 emission controls, engineering and construction lead times will vary between 2 and 5 years, depending on the size of the facility and specific control technology selected. Generally, sources are given a 2-4 year phase-in period to comply with new rules, as previously described, and states generally have a 2-year period for compliance with RACT rules.

Table 11-9
Estimated FGD Costs For ICI Boilers
(2006 dollars)

Fuel	Technology	SO_2 Reduction (%)	Capacity Factor (%)	Cost Effectiveness ($/Ton of SO_2)		
				100 MMBTU/hr	250 MMBTU/hr	1,000 MMBTU/hr
High-sulfur coal	FGD (Dry)	40	14	3,781	2,637	1,817
			50	1,379	1,059	828
			83	1,006	814	676
Lower-sulfur coal	FGD (Dry)	40	14	4,571	3,150	2,119
			50	1,605	1,207	928
			83	1,147	906	744
Coal	FGD (Spray dry)	85	14	4,183	2,786	1,601
			50	1,290	899	567
			83	843	607	407
High-sulfur coal	FGD (Spray dry)	85	14	3,642	2,890	1,909
			50	1,116	875	601
			83	709	563	398
Lower-sulfur coal	FGD (Wet)	40	14	4,797	3,693	2,426
			50	1,415	1,106	751
			83	892	705	492
Oil	FGD (Wet)	40	14	10,843	8,325	5,424
			50	2,269	1,765	1,184
			83	1,371	1,079	740

For the purposes of this review, it is assumed that a 2-year period after SIP submittal is adequate for the installation of pre-combustion controls (fuel switching or cleaning) and a 3-year period for the installation of post-combustion controls. MANE-VU has therefore concluded that there is sufficient time between 2008 and 2018 for the affected states to adopt emission control requirements and for affected sources to install controls necessary to meet MANE-VU's requested SO_2 emission reductions from non-EGU sources. Maine concurs with this conclusion.

Energy and Non-Air Quality Environmental Impacts of Compliance

The primary energy impact of pre- or post-combustion control alternatives is a potential increase in electricity usage. Fuel switching and cleaning do not significantly affect the efficiency of the boiler itself, but require additional energy to clean or blend coal. FGD systems typically operate with high-pressure drops across the control equipment, and therefore consume significant amounts of electricity to operate blowers and circulation pumps. In addition, some combinations of FGD technology and plant configuration may require flue gas reheating to prevent physical damage to equipment, resulting in higher fuel usage.

The primary non-air environmental impacts of fuel switching derive from transportation of the fuel. Secondary environmental impacts derive from waste disposal and material handling operations (e.g. fugitive dust). For FGD systems, the generation of wastewater and sludge from the SO_2 removal process is a consideration. Wastewater from the FGD systems will increase sulfate, metals, and solids loading at the receiving wastewater treatment facility, resulting in potential impacts to operating cost, energy requirements, and effluent water quality. Processing of the wastewater sludge can require energy for stabilization and/or dewatering, and transporting the sludge to the landfill has additional environmental impacts.

Fuel switching to a low-sulfur distillate fuel oil has a variety of beneficial consequences for ICI boilers. Low-sulfur distillate fuel is cleaner burning and emits less particulate matter, which reduces the rate of fouling of heating units substantially and permits longer time intervals between cleanings. According to a study conducted by the New York State Energy Research and Development Authority, (NYSERDA)[57], lowering the fuel sulfur content from 1,400 ppm to 500 ppm will reduce boiler deposits by a factor of two. These reductions in buildup of deposits result in longer service intervals between cleanings.

Reducing SO_2 emissions from ICI boilers would have positive environmental and health impacts. SO_2 controls would reduce acid deposition, helping to preserve aquatic life, forests, crops, and buildings and sculptures made of acid-sensitive materials. These emission reductions would also help to decrease ambient concentrations of $PM_{2.5}$, a significant contributor to premature morbidity and illness in individuals with heart or lung conditions.

[57] Reference 10 in Attachment T.

MANE-VU has concluded that the energy and non-air environmental impacts of controlling SO_2 emissions from ICI boilers are justified in light of the beneficial impacts on regional haze, fine particulate air pollution, acid rain, and equipment operation, as described above. Maine concurs with this conclusion.

Remaining Useful Life of Any Potentially Affected Sources

Available information for remaining useful life estimates of ICI boilers indicates a wide range of operating time, depending on size of the unit, capacity factor, and level of maintenance performed. Typical life spans range from about 10 years up to over 30 years. However, the remaining useful life of a source is highly variable; and older units are not likely to be retrofitted with expensive emission controls. Given the typical range of life expectancies of ICI boilers, the technical options available, and the flexibility that non-MANE-VU states would have to meet the Ask, MANE has concluded that its request for a 28 percent reduction in non-EGU SO_2 emissions is reasonable. Maine concurs with this conclusion.

11.5 Visibility Impacts of Additional Reasonable Controls

MANE-VU's evaluations included modeling to estimate the visibility effects of various elements of the Maine/MANE-VU Ask. This modeling is described in NESCAUM's report entitled "MANE-VU Modeling for Reasonable Progress Goals," February 2008, (Attachment P). NESCAUM also conducted more recent, revised modeling to assess the effects of all haze reduction strategies combined. The latter modeling is described in NESCAUM's report entitled "2018 Visibility Projections," March 2008, (Attachment Q). The following information about the effects of specific strategies is taken from these reports.

The NESCAUM modeling demonstrates that significant visibility benefits will accrue from implementation of the additional reasonable control measures described in Subsection 11.4, above. Figures 11.3 and 11.4 describe the results of this modeling. In the first of the two figures, the light yellow bars represent expected visibility at MANE-VU Class I areas in 2018. Comparison of these values with the 2018 "glide slope" values (the plum-colored second bars from the left) shows that all areas are expected to experience visibility improvements that meet or exceed the uniform rate of progress calculated for each area. The second figure shows that, for the 20 percent of days having the best visibility, expected visibility in 2018 will be better than it is today at all locations.

In conclusion, the reasonable progress goals for Class I areas proposed by the MANE-VU states are found to be consistent with the stated national goals of preventing further visibility degradation while making timely progress toward achieving natural visibility conditions in Class I areas by 2064.

Figure 11-3
Demonstration of Required and Reasonable Visibility Progress for 20% Worst Visibility Days

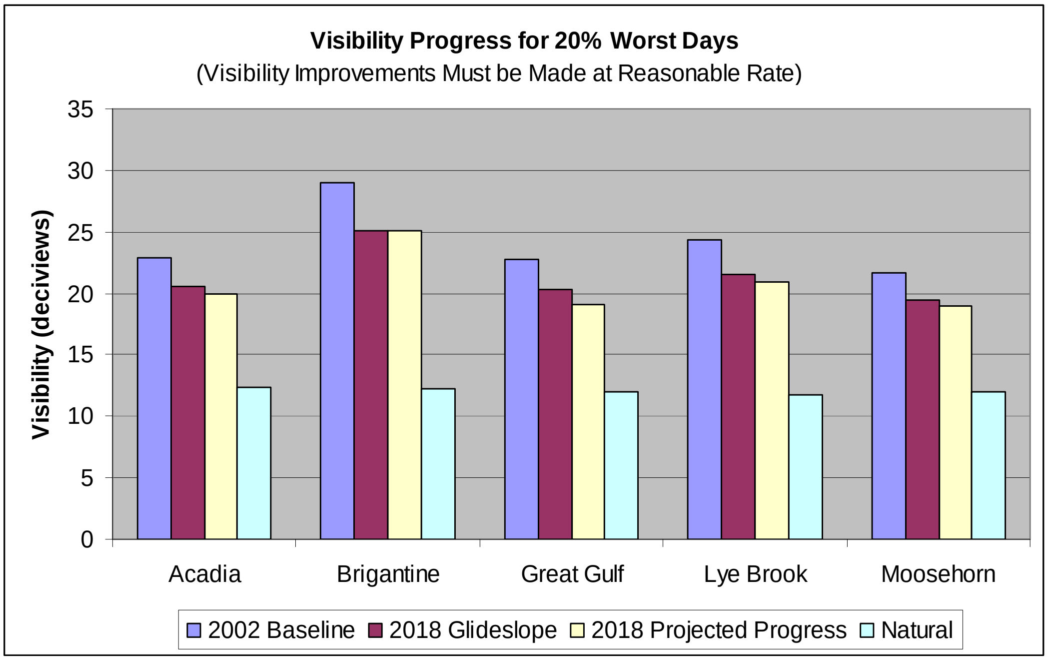
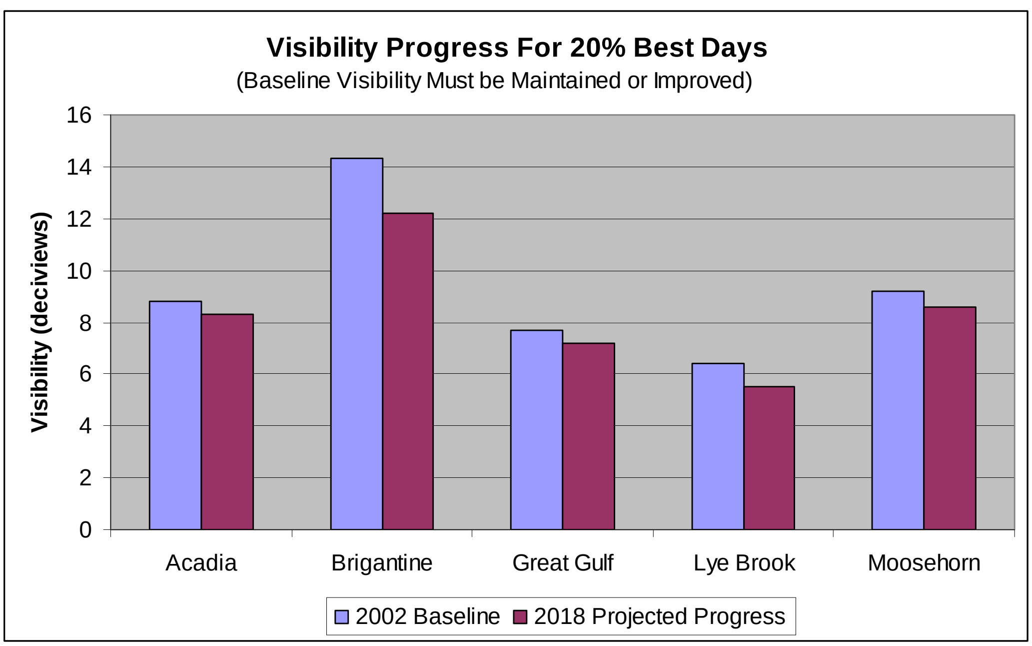


Figure 11-4
Demonstration of Required and Visibility Maintenance for 20% Best Visibility Days



12. Long Term Strategy

40 CFR Section 51.308(d)(3) requires the State of Maine to submit a long-term strategy that addresses regional haze visibility impairment for each mandatory Class I Federal area within and outside the State which may be affected by emissions from within Maine. These Class I areas include: Acadia National Park; Great Gulf Wilderness Area; Presidential Range-Dry River Wilderness; Moosehorn Wilderness and Roosevelt Campobello International Park. The long-term strategy must include enforceable emissions limitations, compliance schedules, and other measures necessary to achieve the reasonable progress goals established by States/Tribes where the Class I areas are located. As described in Section 3.0, Regional Planning and Consultation, Maine consulted with states and tribes both within and outside MANE-VU when developing the emission management strategies in this SIP. The following describes how Maine meets the long-term strategy requirements of the Regional Haze Rule.

Maine's long term strategy includes enforceable emissions limitations, compliance schedules, and other measures necessary to achieve the reasonable progress goals established in Section 11. Additional measures may be reasonable to adopt at a later date after further consideration and review. In developing this long-term strategy, Maine also considered the requirements of the Clean Air Act, Section 110(a)(2)9D)(i)(ii), pertaining to interstate and international transport of pollutants. Maine has previously addressed this issue in its "Transport SIP Revision," submitted to EPA on April 24, 2008. As that document observed, states must include provisions in their implementation plans to prohibit any source or activity from emitting air pollutants in amounts that would interfere with another state's ability to prevent significant deterioration of air quality and visibility. The long-term strategy presented herein is designed to protect visibility in Maine as well as in areas outside of Maine that are affected by Maine emissions.

12.1 Overview of the Long Term Strategy Development Process

The regional strategy development process identified reasonable measures that would reduce emissions contributing to visibility impairment at MANE-VU Class I areas by 2018 or earlier. The process for identifying potential emission reduction measures and the technical basis for the long term strategy is discussed in the following sections.

As a MANE-VU member and participant, Maine supported a number of technical analyses that were developed to assist the MANE-VU states in deciding which regional haze control measures to pursue. These analyses are documented in the following reports:

- "Contributions to Regional Haze in the Northeast and Mid-Atlantic United States" (also known as the Contribution Assessment), August 3, 2006, NESCAUM (Attachment A).

- "Comparison of CAIR and CAIR Plus Proposal using the Integrated Planning Model®" (also known as the CAIR+ Report), May 30. 2007, ICF/MARAMA (Attachment U).
- "Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas" (also known as the Reasonable Progress Report), July 9, 2007, MACTEC/MARAMA (Attachment T).
- "Five-Factor Analysis of BART-Eligible Sources: Survey of Options for Conducting BART Determinations," June 1, 2007, NESCAUM (Attachment N).
- "Assessment of Control Technology Options for BART-Eligible Sources: Steam Electric Boilers, Industrial Boilers, Cement Plants and Paper and Pulp Facilities," March 7, 2005, NESCAUM (Attachment R).

12.2 The Regional Process for Identifying Potential Strategies

MANE-VU reviewed a wide range of potential control measures to reduce regional haze at the affected Class I areas by the 2018 milestone. The process of choosing a set of proposed regional haze control measures started in late 2005. The Ozone Transport Commission (OTC) selected a contracting firm to assist with the analysis of ozone and regional haze control measure options, and provided the contractor with a "master list" of some 900 potential control measures, based on experience and previous state implementation plan work. With the help of an internal OTC control measure workgroup, the contractor narrowed the list of available regional haze control measures for further consideration by MANE-VU.

MANE-VU then developed an interim list of control measures for regional haze. The identified control measures can be divided into three general categories:

- Beyond-CAIR sulfate reductions from electricity generating units (EGUs) and related control measures targeted at specific EGUs in the eastern United States;
- Low-sulfur heating oil (residential and commercial);
- Controls on ICI boilers (both coal and oil-fired);
- Controls on lime and cement kilns; and
- Controls on residential wood combustion, and outdoor burning (including outdoor wood boilers).

The next step was to further refine this list, with the aid of several of the reports named above. The CAIR Plus Report (Attachment U) documents MANE-VU's assessment of the costs of CAIR and provides a cost analysis for additional SO_2 and NO_x controls at EGUs in the eastern United States. The Reasonable Progress Report documents the assessment of control measures for EGUs and the other source categories selected for analysis. Further analysis is provided in the NESCAUM document entitled, "Assessment of Control Technology Options for BART-Eligible Sources: Steam Electric Boilers, Industrial Boilers, Cement Plants and Paper and Pulp Facilities."

The beyond-CAIR EGU strategy quickly became central to the MANE-VU long term strategy planning efforts, since EGU sulfate emissions are the largest contributor to visibility impairment at MANE-VU Class I areas. Similarly, a low-sulfur oil strategy gained traction after a NESCAUM-initiated conference with refiners and fuel-oil suppliers concluded that such a strategy could fully implemented by 2018. Thus the low-sulfur heating oil and the oil-fired ICI boiler sector control measures merged into an overall strategy requiring the use of low-sulfur oil. Under this strategy, low-sulfur oil would be required for all residential and commercial heating units and all ICI boilers burning #2, #4, or #6 fuel oils.

During MANE-VU's internal consultation meeting in March 2007, member states reviewed the interim list of control measures to make additional refinements. States determined, for example, that there may be too few coal-fired ICI boilers in the MANE-VU states for that to be considered as a "regional" strategy, but those sources could be controlled on a state-by-state basis. The MANE-VU members also decided that lime and cement kilns, of which there are few in the MANE-VU region, would best be handled via the BART determination process. Residential wood burning and outdoor wood boilers remained on the list for those states where localized visibility impacts are a consideration, even though emissions from these sources are primarily organic carbon and direct particulate mater. Finally, the MANE-VU membership decided that the issue of outdoor wood burning should be examined further by individual states, because of concerns related to enforcement and penetration of existing state regulations[58].

12. 3 The Technical Basis for Strategy Development

40 CFR Section 51.308(d)(3)(iii) requires Maine to document the technical basis for the State's apportionment of emission reductions necessary to meet reasonable progress goals in each Class I area affected by its emissions. Maine relied on the technical analyses developed by MANE-VU to demonstrate that the Maine emission reductions, when coordinated with those of other States and Tribes, are sufficient to achieve reasonable progress goals in Class I areas affected by emissions originating in Maine.

The emission reductions necessary to meet reasonable progress goals in the Class I areas affected by Maine are described in the following documents:

- "Baseline and Natural Background Visibility Conditions—Considerations and Proposed Approach to the Calculation of Baseline and Natural Background Visibility Conditions at MANE-VU Class I Areas," December 31, 2006, NESCAUM (Attachment G).
- "The Nature of the Fine Particle and Regional Haze Air Quality Problems in the MANE-VU Region: A Conceptual Description," November 2, 2006, NESCAUM (Attachment V).

[58] Maine regulates outdoor burning activities through statute at 12 MRSA §9321 et seq. and through its 06-096 CMR Chapter 102 Open Burning and 06-096 CMR Chapter 150 Control of Emissions From Outdoor Wood Boilers rule.

- "Contributions to Regional Haze in the Northeast and Mid-Atlantic United States (also known as the Contribution Assessment)," August 31, 2006, NESCAUM (Attachment A).
- "Comparison of CAIR and CAIR Plus Proposal using the Integrated Planning Model® (also known as the CAIR+ Report) May 30, 2007, ICF/MARAMA (Attachment U).
- "Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas" (called the Reasonable Progress Report), July 9, 2007, MACTEC/MARAMA) (Attachment T).
- "Five-Factor Analysis of BART-Eligible Sources: Survey of Options for Conducting BART Determinations," June 1, 2007, NESCAUM (Attachment N).
- "Assessment of Control Technology Options for BART-Eligible Sources: Steam Electric Boilers, Industrial Boilers, Cement Plants and Paper and Pulp Facilities," March 7, 2005, NESCAUM (Attachment R).
- "MANE-VU Modeling for Reasonable Progress Goals: Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits," February 7, 2008, NESCAUM (Attachment P).
- "2018 Visibility Projections," March 31, 2008, NESCAUM (Attachment Q).

In addition, Maine relied on analyses conducted by neighboring RPOs, including the following documents, which are available upon request but are not incorporated into this SIP:

- VISTAS Reasonable Progress Analysis Plan by VISTAS, dated September 18, 2006.
- Reasonable Progress for Class I Areas in the Northern Midwest-Factor Analysis, by EC/R, dated July 18. 2007..

As described in Subsection 12.2, above, Maine worked with the other members of MANE-VU and with the Ozone Transport Commission to evaluate a large number of potential emission reduction strategies covering a wide range of sources of SO_2 and other pollutants contributing to regional haze. 40 CFR 51.308(d)(3)(v) requires states to consider several factors in developing their long-term strategies. Operating within this framework and using the available information about emissions and potential impacts, the MANE-VU Reasonable Progress Workgroup selected the following source categories for detailed analysis:

- Coal and oil-fired electric generating units, (EGUs);
- Point and area source industrial, commercial and institutional (ICI) boilers;
- Cement and lime kilns;
- Sources capable of using low-sulfur heating oil; and
- Residential wood combustion and open burning.

These efforts led to the selection of the emission reductions strategies presented in this SIP.

12.4 Emission Reductions Due to Ongoing Air Pollution Reduction Programs

40 CFR Section 51.308(d)(3)(v)(A) requires Maine to consider emission reductions from ongoing pollution control programs. In developing its Long Term Strategy, Maine considered emission control programs being implemented between the 2002 baseline period and 2018. The emission reduction programs described in Subsection 12.4.1, 12.4.2 and 12.4.3 below represent commitments already made by Maine and other states to implement air pollution control measures for EGU point sources, non-EGU point sources, and area sources, respectively. These control measures are the very same measures that were included in the 2018 emissions inventory and used in the modeling. While these control measures were not designed expressly for the purpose of improving visibility, the pollutants they control include those that contribute to visibility impairment in MANE-VU Class I Areas.

MANE-VU's 2018 "beyond on the way" (BOTW) emissions inventory accounts for emission controls already in place as well as emission controls that are not yet finalized but are likely to achieve additional reductions by 2018. The BOTW inventory was developed based on the MANE-VU 2002 Version 3.0 inventory and the MANE-VU 2018 on the books/on the way (OTB/OTW) inventory. Inventories used for other RPOs reflect anticipated emissions controls that will be in place by 2018. The inventory is termed "beyond on the way" because it includes control measures that were developed for ozone SIPs that were not yet on the books in some states. For some states it also included controls that were under consideration for Regional Haze SIPs that have not yet been adopted. More information may be found in the following documents:

- "Development of Emissions Projections for 2009, 2012, and 2018 for Non-EGU Point, Area, and Non-road Sources in the MANE-VU Region," February 2007, MACTEC/MARAMA (Attachment J)
- "Documentation of 2018 Emissions from Electric Generating Units in Eastern U.S. for MANE-VU Regional Haze Modeling," April 28, 2008, Alpine Geophysics/MARAMA (Attachment S)
- "MANE-VU Modeling for Reasonable Progress Goals: Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits," February 7, 2008, NESCAUM (Attachment P)
- "2018 Visibility Projections," March 31, 2008, NESCAUM (Attachment Q)

12.4.1 EGU Emissions Controls Expected by 2018

The following EGU emission reduction programs were included in the modeling used to develop the reasonable progress goals. These programs represent the greatest opportunities for reducing SO_2 emissions at Class I areas in the MANE-VU region and serve as the starting point for MANE-VU's long-term strategy to mitigate regional haze.

Clean Air Interstate Rule (CAIR). This major federal rule has been remanded to EPA to correct deficiencies. The original CAIR imposed permanent caps on sulfur dioxide (SO_2) and nitrogen oxides (NO_x) in the eastern United States by 2015. When fully effective, this program was expected to reduce SO_2 emissions in the CAIR region by up to 70 percent. The first phase of CAIR was implemented on an interim basis in 2009, and EPA is expected to issue a revised CAIR rule in response to the remand in 2010 or 2011. To predict future emissions from EGUs after implementation of CAIR, MANE-VU used the Integrated Planning Model (IPM).[59] Adjustments to the IPM output were made to provide a more accurate representation of anticipated controls at specific EGU sources as documented in the Alpine Geophysics report listed above. In making these adjustments, emission controls originating from the following states and regional programs were considered.

Connecticut EGU Regulations: Connecticut adopted the following regulations governing EGU emissions:

- *Regulations of Connecticut State Agencies (RCSA) section 22a-174- 19a*, limiting the SO_2 emission rate to 0.33 lb SO_2/MMBtu for fossil fuel-fired EGUs greater than 15 MW that are also Title IV sources. (Implementation status - 2007).
- *RCSA section 22a-174-22*, limiting the non-ozone seasonal NO_X emission rate to 0.15 lb NO_X/MMBtu for fossil fuel-fired EGUs greater than 15 MW. (Implementation status - 2007).
- *Connecticut General Statutes section 22a-199*, limiting the mercury (Hg) emission rate to 0.0000006 lb Hg/MMBtu for all coal-fired EGUs or alternatively coal-fired EGUs can meet a 90% Hg emission reduction. (Implementation status - 2008).

Delaware EGU Regulations: Delaware adopted the following regulations governing EGU emissions:

1. *Reg. 1144, Control of Stationary Generator Emissions*, SO_2, PM, VOC and NO_x emission control, state-wide, effective January 2006.

2. *Reg. 1146, EGUs, Electric Generating Unit (EGU) Multi-Pollutant Regulation*, SO_2 and NO_x emission control, state-wide, effective December 2007. SO_2 reductions will be more than regulation specifies.

[59] The IPM model runs also anticipated the implementation of EPA's Clean Air Mercury Rule (CAMR), which was recently vacated by the courts. However, MANE-VU believes that the adjustments made to the predicted SO_2 emissions from EGUs will have a larger effect on the air quality modeling analysis conducted for this SIP than will the vacatur of the CAMR rule. The emission adjustments were based on state's comments on the actual levels of SO_2 controls expected to be installed in response to state-specific regulations and EPA's CAIR rule. MANE-VU believes these adjustments improve the reliability of both the emission inventory and modeling results.

3. *Regulation No. 1148, Control of Stationary Combustion Turbine Electric Generating Unit Emissions*, requiring SO2, NO_x and $PM_{2.5}$ emission controls, state-wide, effective January 2007.

Delaware estimates that these regulations will result in the following emission reductions for affected units: SO_2 emissions of 32,630 tons in 2002 will decline to 8,137 tons in 2018 (a 75 percent reduction); NO_x emissions of 8,735 tons in 2002 will decline to 3,740 tons in 2018 (a 57 percent reduction).

Also, Delaware anticipates the following reductions resulting from the consent decree with the Valero Refinery Delaware City, DE (formerly Motiva, Valero Enterprises). 2002 SO_2 levels of 29,747 tons will drop to 608 tons in 2018 (a 98 percent reduction). NO_x 2002 levels of 1,022 tons will fall to 102 tons in 2018 (a 90 percent reduction).

Maine EGU Regulations: *Chapter 145 NO_X Control Program,* limits the NO_X emission rate to 0.22 lb NO_X /MMBtu for fossil fuel-fired units greater than 25 MW built before 1995 with a heat input capacity between 250 and 750 MMBtu/hr, and which also limits the NO_X emission rate to 0.17 lb NO_X /MMBtu for fossil fuel-fired units greater than 25 MW built before 1995 with a heat input capacity greater than 750 MMBtu/hr. (effective 2007)

Massachusetts EGU Regulations: Based on the Massachusetts Department of Environmental Protection's *310 CMR 7.29, Emissions Standards for Power Plants,* adopted in 2001, six of the largest fossil fuel-fired power plants in Massachusetts must comply with emissions limitations for NO_x, SO_2, mercury, and CO_2. These regulations will achieve an approximately 50 percent reduction in NO_x emissions and a 50 - 75 percent reduction in SO_2 emissions compared to previous emissions. Depending upon the compliance path selected by the affected facilities, the facilities will comply with the output-based NO_x and SO_2 standards between 2004 and 2008. This regulation also limits the six grandfathered EGUs to a CO_2 emisison rate of 1,800 lb/MWh.

New Hampshire EGU Regulations: New Hampshire adopted the following regulations governing EGU emissions:

- *Chapter Env-A 2900* capping NOx emissions at 3,644 tons NO_X per year, SO_2 emissions at 7,289 tons SO_2 per year, and CO_2 emissions at 5,425,866 tons CO_2 per year for all existing fossil steam units by December 31, 2006.

- *Chapter Env-A 3200 NOx Budget Trading Program* limiting ozone season NO_X emissions on all fossil fuel-fired EGUs greater than 15 MW to 0.15 lb/MMBtu, effective November 2, 2007.

New Jersey New Source Review Settlement Agreements: The New Jersey settlement agreement with PSEG required the following actions for specific EGUs:

- *Bergen Unit #2*: Repower to combined cycle by December 31, 2002.
- *Hudson Unit #2*: install Dry FGD or approved alternative technology by Dec. 31,

2006 to control SO_2 emissions, and operate the control technology at all times the unit operates to limit SO_2 emissions to 0.15 lb SO_2/MMBtu; install SCR or approved alternative technology by May 1, 2007 to control NO_X emissions and operate the control technology year-round to limit NO_X emissions to 0.1 lb NO_x/MMBtu; and install a baghouse or approved alternative technology by May 1, 2007 to control PM emissions and limit PM emissions to 0.015 lb PM/MMBtu.

- *Mercer Unit #1*: install Dry FGD or approved alternative technology by Dec. 31, 2010 to control SO_2 emissions and operate the control technology at all times the unit operates to limit SO_2 emissions to 0.15 lb SO_2/MMBtu, and install SCR or approved alternative technology by 2005 to control NO_X emissions, and operate the control technology ozone season only in 2005 and year-round by May 1, 2006 to limit NO_X emissions to 0.13 lb NO_X/MMBtu.
- *For Mercer Unit #2*: install Dry FGD or approved alternative technology by Dec. 31, 2012 to control SO_2 emissions, and operate the control technology at all times the unit operates to limit SO_2 emissions to 0.15 lb SO_2/MMBtu, and install SCR or approved alternative technology by 2004 to control NO_X emissions, and operate the control technology ozone season only in 2004 and year-round by May 1, 2006 to limit NO_X emissions to 0.13 lb NO_X /MMBtu.

The New Jersey settlement also requires coal with monthly average sulfur content no greater than 2% at units operating an FGD.

New York EGU Regulations: New York adopted the following regulations governing EGUs:

Title 6 NYCRR Parts 237, Acid Deposition Reduction NO_x Budget Trading Program, limits NO_X emissions on all fossil fuel-fired EGUs greater than 25 MW to a non-ozone season cap of 39,908 tons in 2007.

Title 6 NYCRR Parts 238, Acid Deposition Reduction SO_2 Budget Trading Program limits annual SO_2 emissions from all fossil fuel-fired EGUs greater than 25 MW to an annual SO_2 cap of 197,046 tons SO_2/year, starting in 2007 and an annual SO_2 cap of 131,364 tons SO_2/year starting in 2008.

North Carolina Clean Smokestacks Act: Enacted in 2002, this legislation requires that coal-fired EGUs achieve a 77 percent cut in nitrogen oxide (NO_x) emissions by 2009 and a 73 percent cut in sulfur dioxide (SO_2) emissions by 2013. This legislation also establishes annual caps on both SO_2 and NO_x emissions for the two primary utility companies in North Carolina, Duke Energy and Progress Energy. These reductions must be made in North Carolina, and allowances are not saleable.

Consent Agreements in the VISTAS region: The effects of the following consent agreements in the VISTAS states were reflected in the emissions inventories used for those states:

- *Santee Cooper*: A 2004 consent agreement calls for Santee Cooper in South Carolina to install and commence operation of continuous emission control equipment for PM/SO_2/NO_x emissions; comply with system-wide annual PM/SO_2/NO_x emissions limits; agree not to buy, sell or trade SO_2/NO_x allowances allocated to Santee Cooper System as a result of said agreement; and to comply with emission unit limits of said agreement.
- *TECO*: Under a settlement agreement, by 2008, Tampa Electric in Florida will install permanent emissions-control equipment to meet stringent pollution limits; implement a series of interim pollution reduction measures to reduce emissions while the permanent controls are designed and installed; and retire pollution emission allowances that Tampa Electric or others could use, or sell to others, to emit additional NO_x, SO_2 and PM.
- *VEPCO*: Virginia Electric and Power Co. agreed to spend $1.2 billion between by 2013 to eliminate 237,000 tons of SO_2 and NO_x emissions each year from eight coal-fired electricity generating plants in Virginia and West Virginia.
- *Gulf Power 7*: A 2002 agreement calls for Gulf Power to upgrade its operation to cut NO_x emission rates by 61 percent at its Crist 7 generating plant by 2007 with major reductions beginning in early 2005. The Crist plant is a significant source of nitrogen oxide emissions in the Pensacola Florida, area.

12.4.2 Non-EGU Point Point Source Controls Expected by 2018

For non-EGU sources within MANE-VU, Maine relied on MANE-VU's Version 3.0 Emission Inventory for 2002. MACTEC conducted an analysis of various control measures as documented in "Development of Emission Projections for 2009, 2012, and 2018 for Non-EGU, Area, and Nonroad sources in the MANE-VU Region" (Attachment I). Control factors were applied to the 2018 MANE-VU inventory for non-EGUs to represent the following national, regional, or state control measures:

- NO_x SIP Call Phase I (NO_x Budget Trading Program) (except ME, NH and VT)
- NO_x SIP Call Phase II (except ME, NH and VT)
- NO_x RACT in 1-hour Ozone SIPs (already included in the 2002 inventory)
- NO_x OTC 2001 Model Rule for ICI Boilers
- 2-, 4-, 7-, and 10-year MACT Standards
- Combustion Turbine and RICE MACT (NO_x co-benefits not included- assumed to be minimal)
- Industrial Boiler/Process Heater MACT[60]

[60] The inventory was prepared before the MACT for Industrial Boilers and Process Heaters was vacated. Control efficiency was assumed to be at 4 percent for SO_2 and 40 percent for PM.

- EPA's Refinery Enforcement Initiative (Fluid catalytic cracking units and fluid coking units; process heaters and boilers; flare gas recovery; leak detection and repair; and benzene (wastewater))

In addition, states provided specific control measure information about specific non-EGU sources or regulatory programs in their state. For example, several states developed additional control measures in the course of their planning efforts to reduce ozone within the Ozone Transport Region (OTR). These control measures were included by MANE-VU in their inventories used for regional haze modeling. (The affected states may or may not have committed to adopting these measures in their ozone SIPs). For specific states, the ozone reduction strategies included in the modeling would reduce NO_x emissions from the following non-EGU point sources:

- Asphalt production plants in Connecticut, New Jersey, New York, and the District of Columbia;
- Cement kilns in Maine, Maryland, New York, and Pennsylvania; and
- Glass and fiberglass furnaces in Maryland, Massachusetts, New Jersey, New York and Pennsylvania.

For other regions, MANE-VU used emission inventory data developed by the RPOs for those regions, including VISTAS Base G2, MRPO's Base K, and CenRAP's emissions inventory. Non-EGU source controls incorporated into the modeling include the following consent agreements reflected in the VISTAS inventory:

- Dupont: A 2007 agreement calls for E. I. Dupont Nemours & Company's James River plant to install dual absorption pollution control equipment by September 1, 2009, resulting in emission reductions of approximately 1,000 tons SO_2 annually. The James River plant is a non-EGU located in the state of Virginia.
- Stone Container: A 2004 agreement calls for the West Point Paper Mill in Virginia owned by Smurfit/Stone Container to control with a wet scrubber the SO_2 emissions of the #8 Power Boiler. This control device should result in reductions of over 3,500 tons of SO_2 in 2018.

12.4.3 Area Source Controls Expected by 2018

For area sources within MANE-VU, Maine utilized MANE-VU's Version 3.0 Emissions Inventory for the 2002 base year. In general, MANE-VU developed the 2018 inventory for area sources by applying growth and control factors to the 2002 Version 3.0 inventory. Area source control factors were developed and incorporated in the modeling for the following national or regional control measures:

- OTC VOC Model Rules (Consumer Products, Architectural and Industrial Maintenance Coatings, Portable Fuel Containers, Mobile Equipment Repair and Refinishing and Solvent Cleaning);

- Residential Woodstove NSPS; and
- State-specific control strategies implemented since 2002.

The following additional control measures were included in the 2018 analysis to reduce VOC and NO_x emissions for the following area source categories for some states (as identified below):

- VOC control measures for adhesives and sealants (controls added in all MANE-VU states except VT);
- VOC control measures for emulsified and cutback asphalt paving (controls added in all MANE-VU states except ME, and VT);
- VOC control measures for consumer products (controls added in all MANE-VU states except VT);
- VOC control measures for portable fuel containers (controls added in all MANE-VU states except VT); and;
- NO_x control measures for the combustion of natural gas, no. 2, 4 and 6 fuel oil, and coal (CT, NJ, NY).

As noted above, inventory data for other regions were obtained from those Region's RPOs. Some of the area source control measures listed above may have been developed by states for the primary purpose of reducing ozone within the Ozone Transport Region (OTR)- see Subsection 12.4.2 for information on other measures included in state's ozone SIPs.

12.4.4 Mobile Sources Controls Expected by 2018

For the on-road mobile source emission inventory, Maine relied on MANE-VU's version 3.0 emission inventory, which included the following post-2002 emission control measures:

On-Board Refueling Vapor Recovery (ORVR) Rule: The 1990 Clean Air Act (CAA) Amendments contain provisions that require passenger cars to capture refueling emissions. In 1994, EPA published the ORVR rule establishing standards for refueling emissions controls for passenger cars and light trucks. The onboard controls were required to be phased in for all new car production by 2000 and for all light trucks by 2006. The rule established a refueling emission standard of 0.20 grams per gallon of dispensed fuel, which was expected to yield a 95 percent reduction of VOC emissions over uncontrolled levels. The CAA authorizes EPA to allow state and local agencies to phase out Stage II programs, even in the worst nonattainment areas, once EPA has determined that onboard systems are in "widespread use".

***Heavy Duty Diesel (2007) Engine Emission Standards for Trucks and Buses*:** EPA set a PM emissions standard for new heavy-duty engines of 0.01 grams per brake-horsepower-hour (g/bhp-hr), to take full effect for diesel engines in the 2007 model year. This rule also includes standards for NO_x and non-methane hydrocarbons (NMHC) of 0.20 g/bhp-hr and 0.14 g/bhp-hr, respectively. These NO_x and NMHC standards will be phased-in together between 2007 and 2010 for diesel engines. Sulfur in diesel fuel must be lowered to enable modern pollution-control technology to be effective on these trucks and buses. EPA began requiring the use of 500 ppm low sulfur diesel fuel in 1993. In 2006, the highway diesel sulfur content was lowered to 15ppm (ultra low sulfur diesel).

Tier 2 Motor Vehicle Standards: Tier 2 is a fleet averaging program, modeled after the California LEV II standards. Manufacturers can produce vehicles with emissions ranging from relatively dirty to zero, but the mix of vehicles a manufacturer sells each year must have average NO_x emissions below a specified value. Tier 2 standards became effective in the 2005 model year and are included in the assumptions used for calculating mobile source emissions inventories used for 2018.

12.4.5 Controls on Non-Road Sources Expected by 2018

For non-road emission sources, Maine used Version 3.0 of the MANE-VU 2002 Emissions Inventory. Because the NONROAD Model used to develop the nonroad source emissions did not include aircraft, commercial marine, and locomotives, MANE-VU's contractor, MACTEC, developed the inventory for these source categories. Nonroad mobile source emissions for the 2018 emission inventory were calculated with EPA's NONROAD2005 emissions model as incorporated in the NMIM2005 (National Mobile Inventory Model) database. The NONROAD model accounts for the emissions benefits associated with Federal non-road equipment emissions control measures such as the following:

- "Control of Air Pollution; Determination of Significance for Nonroad Sources and Emissions Standards for New Nonroad Compression Ignition Engines At or Above 37 Kilowatts," 59 FR 31306, June 17, 1994.
- "Control of Emissions of Air Pollution From Nonroad Diesel Engines," 63 FR 56967, October 23, 1998.
- "Control of Emissions From Nonroad Large Spark-Ignition Engines and Recreational Engines (Marine and Land-Based); Final Rule," 67 FR 68241, November 8, 2002.
- "Control of Emissions of Air Pollution From Nonroad Diesel Engines and Fuel; Final Rule," 69 FR 38958, June 29, 2004.

As noted above, the inventory information used for other regions was obtained from those regions' RPOs.

12.5 Additional Reasonable Strategies

As required under 40 CFR Section 51.308(d)(3)(v), Maine and the other MANE-VU states applied a four-factor analysis to potential control measures for the purpose of establishing reasonable progress goals (See Subsection 11.4 for a detailed description). Reasonable measures include those that the affected states have already committed themselves to implementing, as described in Subsection 12.4, above. In addition, the MANE-VU states have identified other control measures that were found to be reasonable and were included in the modeling that was used to set reasonable progress goals. (These additional measures surpass the "beyond-on-the-way" emission controls and inventories). All of the control measures- those embodied in the states' commitments to existing or planned programs and the additional reasonable control measures described below- comprise the long-term strategy for improving visibility at MANE-VU Class I Areas.

Specifically, the MANE-VU long-term strategy includes the following additional measures to reduce pollutants that cause regional haze:

- Timely implementation of BART requirements;

- A low sulfur fuel oil strategy in the inner zone states (New Jersey, New York, Delaware, and Pennsylvania, or portions thereof) to reduce the sulfur content of:
  - Distillate oil to 0.05 percent sulfur by weight (500 ppm) by no later than 2012,
  - #4 residual oil to 0.25 percent sulfur by weight by no later than 2012,
  - #6 residual oil to 0.3 – 0.5 percent sulfur by weight by no later than 2012, and
  - Further reduce the sulfur content of distillate oil to 15 ppm by 2016;

- A low sulfur fuel oil strategy in the outer zone states (the remainder of the MANE-VU region) to reduce the sulfur content of:
  - Distillate oil to 0.05 percent sulfur by weight (500 ppm) by no later than 2014,
  - #4 residual oil to 0.25 percent-0.50 percent sulfur by weight by no later than 2018,
  - #6 residual oil to no greater than 0.5 percent sulfur by weight by no later than 2018, and
  - Further reduce the sulfur content of distillate oil to 15 ppm by 2018 depending on supply and availability;

- A 90 percent or greater reduction in sulfur dioxide (SO_2) emissions from each of the electric generating unit (EGU) stacks identified by MANE-VU (Attachment W) comprising a total of 167 stacks, dated June 20, 2007) as reasonably anticipated to cause or contribute to impairment of visibility in each mandatory Class I Federal area in the MANE-VU region. If it is infeasible to achieve that level of reduction from a unit, alternative measures will be pursued in such State; and

- Continued evaluation of other control measures including energy efficiency, alternative clean fuels, and other measures to reduce SO_2 and nitrogen oxide (NO_x) emissions from all coal-burning facilities by 2018 and new source performance standards for wood combustion.

This suite of additional control measures are those that the MANE-VU states have agreed to pursue for the purpose of mitigating regional haze. The corollary is that the MANE-VU Class I states (Maine, New Hampshire, Vermont, and New Jersey) are asking states outside the MANE-VU region that contribute to visibility impairment inside the region to pursue similar measures. The control measures that non-MANE-VU states choose to pursue may be directed toward the same emission source sectors identified by MANE-VU for its own emission reductions, or they may be equivalent measures targeting other source sectors. Under the MANE-VU long-term strategy, states will be allowed until 2018 to pursue adoption and implementation of proposed control measures.

12.5.1 BART

Implementation of the BART provisions of the Regional Haze Rule (40 CFR 51.308(e)) is one of the reasonable strategies included in this SIP[61]. BART controls in Maine are identified in Section 10 of this SIP.

To assess the benefits of implementing the BART provisions of the Regional Haze Rule for non-EGU facilities, NESCAUM included estimated reductions anticipated for BART-eligible facilities in the MANE-VU region in the final 2018 CMAQ modeling analysis, as described previously in Subsection 11.5 of this SIP. The modeling assumed that 12 units at seven BART-eligible sources in MANE-VU would be controlled as a result of BART requirements alone. (see Table 12.1

Note that additional emission reductions will occur at many other BART-eligible facilities within MANE-VU as a result of controls achieved by either programs that serve as BART but are not specifically identified as such (e.g., RACT). While not specifically identified as being attributable to BART, these additional emission reductions were accounted for in the 2018 CMAQ modeling.

Additional visibility benefits are likely to result from the installation of new emissions controls at BART-eligible facilities that are located in neighboring RPOs. However, the MANE-VU modeling did not account for BART controls in other RPOs, and consequently, did not include the visibility improvements at MANE-VU Class I Areas that would likely result from such measures.

[61] For EGU's , EPA determined that CAIR would fulfill the BART requirement for his sector.

12.5.2 Low-Sulfur Oil Strategy

The important assumption underlying MANE-VU's low-sulfur fuel oil strategy is based on the production and use of home heating and fuel oils that contain 50% less sulfur for the heavier grades (#4 and #6 residual), and a minimum of 75% and maximum of 99.25% less sulfur in #2 fuel oil (also known as home heating oil, distillate, or diesel fuel) at an acceptably small increase in price to the end user. As much as three-fourths of the total sulfur reductions achieved by this strategy come from using the low-sulfur #2 distillate for space heating in the residential and commercial sectors. The costs of these emission reductions are estimated at $550 to $750 per ton, as documented in the MANE-VU Reasonable Progress Report. While the costs of the low-sulfur fuel oil strategy vary depending on market conditions, they appear to be reasonable when measured against the costs of controlling other sectors.

Maine has already adopted a low sulfur fuel strategy. The 124th Second Regular Session of the Maine Legislature (2010) adopted LD 1662, "An Act To Improve Maine's Air Quality and Reduce Regional Haze at Acadia National Park and Other Federally Designated Class I Areas," which implements the MANE-VU low sulfur fuel strategy in Maine. This legislation establishes a statewide sulfur limit for distillate fuels of 50 ppm in 2016, and 15 ppm in 2018. For residual (#6) fuel oil, the statewide sulfur limit will be reduced to 0.5% in 2018. The legislation also directs the Department to undertake rulemaking (to be completed by 2014) to adopt rules that provide an opportunity for a licensed air contamination source that holds a license on the effective date of the statute to apply for an equivalent alternative sulfur reduction strategy to the residual fuel oil and distillate fuel requirements. The rules must provide for the achievement of equivalent sulfur emission reductions through other means, including, but not limited to, reductions in consumption of residual fuel oil and distillate fuel, early sulfur emission reductions from a baseline emissions inventory year of 2002, and conversions. LD 1662, as adopted by the Maine Legislature and signed by Governor Baldacci on April 5, 2010, is attached in Attachment Z.

12.5.3 Targeted EGU Strategy

MANE-VU has identified emissions from the top 167 EGU emission points that contribute most to visibility impairment at MANE-VU Class I Areas (see Figure 12-1). Controlling emissions from these contributing facilities is crucial to mitigating haze pollution in wilderness areas and national parks of the northeast states.

MANE-VU's agreed regional approach for the EGU source sector is to pursue a 90 percent control level on SO_2 emissions from the 167 identified stacks by 2018. MANE-VU has concluded that pursuing this level of sulfur reduction is both reasonable and cost-effective. Even though current wet scrubber technology can achieve sulfur reductions greater than 95 percent, and overall 90-percent sulfur reduction level would include the effects of lower average reduction rates from dry scrubbing technology, consistent with historic experience. The costs of SO_2 reductions will vary by unit. The MANE-VU Reasonable Progress Report (Attachment T) summarizes the various control methods and costs, which range from $170 to $5,700 per ton, depending on site-specific factors such as the size and type of unit, combustion technology, and type of fuel used. Maine has one EGU identified in the MANE-VU analysis, Wyman Station Unit #4, which is located in located in Yarmouth, Maine. As a signatory to the MANE-VU statement of principles (Attachment D), Maine is committed to pursue additional emission reductions at this facility through its low sulfur fuel oil program. Maine DEP believes that the use of low-sulfur fuel at this facility (in lieu of add-on controls) will provide the most cost-effective sulfur reductions, and that additional controls at this unit should be subsumed under the low-sulfur fuel strategy. For more detail on Maine's implementation of the Targeted EGU Strategy, see Section 12.9, below.

Several states have implemented state-specific EGU emission reduction programs. These commitments, identified below, are included in the long-term strategy as reasonable measures to meet MANE-VU's reasonable progress goals.

Maryland Healthy Air Act: Maryland adopted the following requirements governing EGUs:

- For NO_x:
  - Phase I (2009) sets unit specific annual caps (totaling 20,216 tons) and ozone season caps (totaling 8,900 tons).
  - Phase II (2012) sets unit specific annual caps (totaling 16,667 tons) and ozone season caps (totaling 7,337 tons).
- For SO_2:
  - Phase I (2010) sets unit specific annual caps (totaling 48,818 tons).
  - Phase II (2013) sets unit specific annual caps (totaling 37,235 tons).
- For mercury:
  - Phase I (2010) requires a 12-month rolling average of a minimum of 80% removal efficiency.
  - Phase II (2013) requires a: 12-month rolling average of a minimum of 90% removal efficiency.

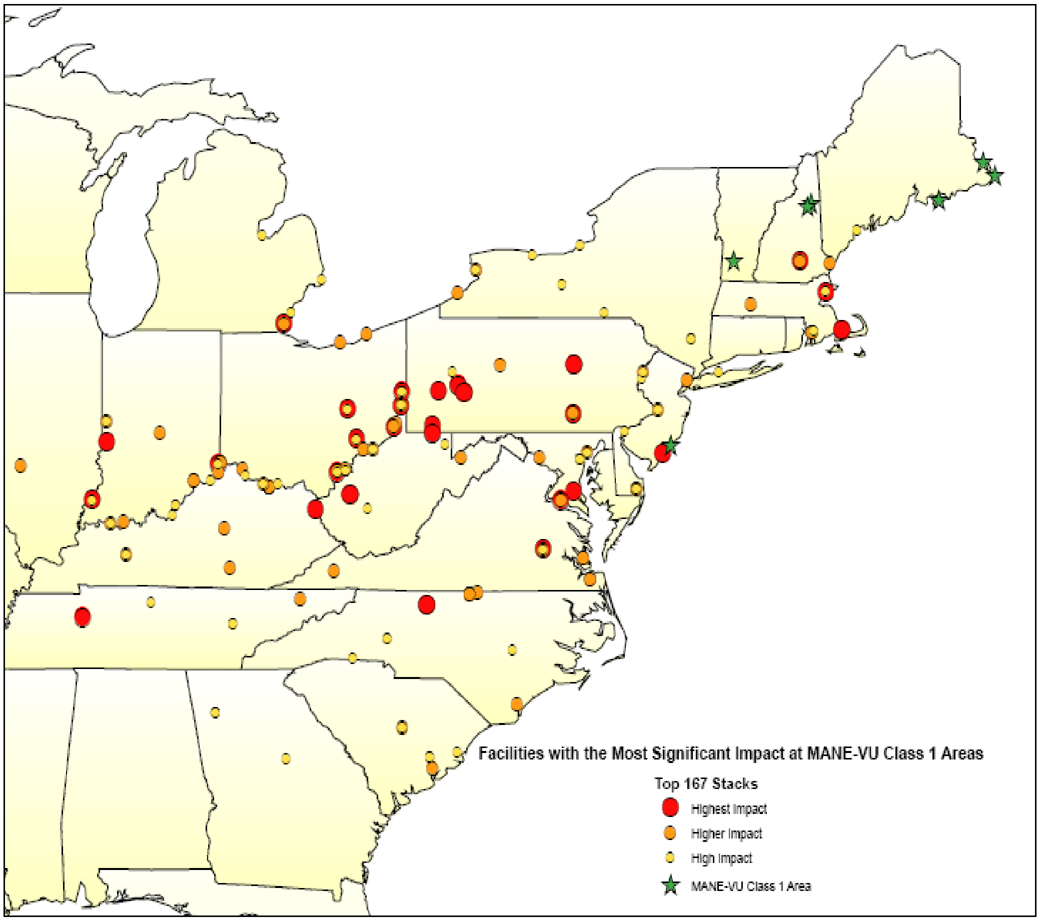
The specific EGUs included are: Brandon Shores (Units 1 and 2), C.P.Crane (Units 1 and 2), Chalk Point (Units 1, and 2), Dickerson (Units 1, 2, and 3), H.A. Wagner (Units 2 and 3) Morgantown (Units 1 and 2) and R. Paul Smith (Units 3 and 4). No out-of-state trading of emission allowances, no inter-company trading and no banking from year-to-year were included in this analysis

Table 12-1
Estimated Emissions from Non-CAIR Unit BART-Eligible Facilities Located in MANE-VU Used in Final Modeling

	Facility Name	Unit Name	SCC Code	Plant ID (from the MANE-VU Inventory)	Point ID (from the MANE-VU Inventory)	Facility Type	Fuel	2002 Emissions (tons)	2018 Emissions (tons)
MD	EASTALCO ALUMINUM	28	30300101	021-0005	28	Metal Production		1506	1356
MD	EASTALCO ALUMINUM	29	30300101	021-0005	29	Metal Production		1506	1356
MD	LEHIGH PORTLAND CEMENT	39	30500606	013-0012	39	Portland Cement		9	8
MD	LEHIGH PORTLAND CEMENT	16	30500915	021-0003	16	Portland Cement		1321	1,189
MD	LEHIGH PORTLAND CEMENT	17	30500915	021-0003	17	Portland Cement		976	878
MD	WESTVACO FINE PAPERS	2	10200212	001-0011	2	Paper and Pulp		8923	1338
ME	Wyman Station	Boiler 3	10100401	2300500135	004	EGU	Oil	616	308
ME	SAPPI Somerset	Power Boiler #1	10200799	2302500027	001	Paper and Pulp	Oil/Wood Bark/Process Gas	2884	1442
ME	IP Jay	Power Boiler #2	10200401	2300700021	002	Paper and Pulp	Oil	3086°	1543
ME	IP Jay	Power Boiler #1	10200401	2300700021	001	Paper and Pulp	Oil	2964°	1482
NY	KODAK PARK DIVISION	U00015	10200203	8261400205	U00015	Chemical Manufacturer		23798	14216
NY	LAFARGE BUILDING MATERIALS INC	41000	30500706	4012400001	041000	Portland Cement		14800	4440

° 1999 emissions

Figure 12-1
167 EGU Stacks Affecting MANE-VU Class I area(s)



Massachusetts EGU Regulations: Based on the Massachusetts Department of Environmental Protection's 310 CMR 7.29, Emissions Standards for Power Plants, adopted in 2001, six of the largest fossil fuel-fired power plants in Massachusetts must comply with emissions limitations. For mercury (Hg), 6 facilities must comply with: 85% Hg reduction or 0.0075 lbs Hg/GWh in 2008 and 90% Hg reduction or 0.0025 lbs Hg/GWh in 2012. The specific EGUs included are: Brayton Point (Units 1, 2, 3, 4, IC1, IC2, IC3, and IC4), Mystic (Units 4, 5, 6, 7, 307, 308, 309 and 310), NRG Somerset (Units 8, J1, and J2), Mount Tom (Unit 1), Canal (Units 1 and 2), and Salem Harbor (Units 1, 2, 3 and 4).

New Hampshire EGU Laws and Regulations: New Hampshire amended the following laws and regulations governing EGU emissions:

- RSA 125-O requires the installation of scrubbers on Merrimack Station (Units 1 and 2) by July 1, 2013 to control SO_2 and mercury emissions. This law allows State-level SO_2 credits for over- or early- compliance.

- Env-A 2900 sets limits for NO_x, SO_2, and CO_2 emissions by December 31, 2006 for all existing fossil EGUs.

New Jersey Hg MACT Rule: Under this rule, all coal-fired EGUs will have a mercury removal efficiency of 90%. (Some SO_2 reductions may occur as a result of this mercury rule.)

Consent Agreements in the VISTAS Region: The following consent agreements in the VISTAS states were reflected in the emissions inventories used for those states:

- *East Kentucky Power Cooperative*: A July 2, 2007 consent agreement between the EPA and East Kentucky Power Cooperative requires the utility to reduce its emissions of SO_2 by 54,000 tons per year and its emissions of NO_x by 8,000 tons per year, by installing and operating selective catalytic reduction (SCR) technology; low-NO_x burners, and PM and mercury Continuous Emissions Monitors at the utility's Spurlock, Dale and Cooper Plants. According to the EPA, total emissions from the plants will decrease between 50 and 75 percent from 2005 levels. As with all federal consent decrees, EKPC is precluded from using reductions required under other programs, such as CAIR, to meet the reduction requirements of the consent decree. EKPC is expected to spend $654 million to install pollution controls.
- American Electric Power: Under this agreement, American Electric Power will spend $4.6 billion dollars for emission controls at sixteen plants located in Indiana, Kentucky, Ohio, Virginia and West Virginia. These control measures will eliminate 72,000 tons of NO_x emissions each year by 2016 and 174,000 tons of SO_2 emissions each year by 2018.

12.6 Source Retirement and Replacement Schedules

40 CFR Section 51.308(d)(3)(v)(D) requires Maine to consider source retirement and replacement schedules in developing reasonable progress goals. Source retirement and replacement were considered in developing the 2018 emission inventory described previously in Subsection 11.2, Reasonable Progress Goals for Class I Areas in Maine. See also Table b-5 in the Emission Projections Report (Attachment N).

12.7 Additional Measures Considered

12.7.1 Measures to Mitigate the Impacts of Construction Activities

40 CFR Section 51.308(d)(3)(v)(B) requires Maine to consider measures to mitigate the impacts of construction activities on regional haze. MANE-VU's consideration of measures to mitigate the impacts of construction activities is documented in "Technical Support Document on Measures to Mitigate the Visibility Impacts of Construction Activities in the MANE-VU Region," Draft, October 20, 2006, MARAMA (Attachment X).

The construction industry is already subject to requirements for controlling pollutants that contribute to visibility impairment. For example, EPA's off-road engine standards and low sulfur fuel requirements result in reductions of PM and precursor emissions (SO_2 and NO_x) from construction vehicles.

At the state level, Maine currently regulates emissions of fugitive dust through its 06-096 CMR Chapter 101, Visible Emissions rules, which establishes opacity limits for emissions from several categories of air contaminant sources, including fugitive emissions from construction activities. Maine also regulates emissions from both on-road vehicles and construction activities through its 06-096 CMR Chapter 127 New Motor Vehicle Emission Standards rules (new motor vehicle emission standards), the 06-096 CMR Chapter 147 Diesel-Powered Motor Vehicle Emission Standards rules (opacity standards), and the 06-096 CMR General Permit Regulations for Nonmetallic Mineral Processing Plants rules. Non-road vehicles are subject to federal regulations.

MANE-VU's Contribution Assessment (Attachment B) found that, from a regional haze perspective, crustal material generally does not play a major role at MANE-VU Class I Areas. On the 20 percent best visibility days during the 2000-2004 baseline period, crustal material accounted for 6 to 11 percent of the particle-related light extinction at MANE-VU Class I Areas. On the 20 percent worst visibility days, however, the ratio was reduced to between 2 and 3 percent. Furthermore, the crustal fraction is largely made up of pollutants of natural origin (e.g., soil or sea salt) that are not targeted under the Regional Haze Rule. Nevertheless, the crustal fraction at any given location can be heavily influenced by the proximity of construction activities; and construction activities occurring in the immediate vicinity of MANE-VU Class I Areas could have a noticeable effect on visibility. The need for additional control measures for construction activities and their possible implementation will be evaluated in the first regional haze progress report.

12.7.2 Agricultural and Forestry Smoke Management

40 CFR Section 51.308(d)(3)(v)(E) requires Maine to consider smoke management techniques related to agricultural and forestry management in developing its long-term strategy. MANE-VU's analysis of smoke management in the context of regional haze SIPs is documented in "Technical Support Document on Agricultural and Forestry Smoke Management in the MANE-VU Region," September 1, 2006, MARAMA (Attachment Y).

As noted in this report, fires used for resource management are of far less significance to the total inventory of fine-particle pollutant emissions than other sources of wood smoke in the region. The largest wood smoke source categories, with respect to PM2.5 emissions, are residential wood combustion (73 percent); open burning (15 percent); and industrial, commercial and institutional wood combustion (9 percent). Unwanted fires involving buildings and wild lands make up only a minor fraction of wood burning emissions and cannot be reasonably addressed in this SIP. Fires that are covered under smoke management plans, including agricultural and prescribed forest burning, constitute less than one percent of total wood smoke emissions in MANE-VU[62].

Moreover, smoke emissions from all sources represent only a minor fraction of fine-particle mass that is the cause of regional haze. MANE-VU's Contribution Assessment (Attachment A) found that elemental carbon, the main ingredient of smoke, contributed only 3 to 4 percent of fine particle mass on days of worst and best visibility. Additionally, elemental carbon absorbs light more readily than it scatters light. It is therefore reasonable to conclude that smoke emissions from controlled agricultural and forestry burning contribute, on average, only a small fraction of one percent of total light extinction on days of both good and poor visibility. Maine has no information to indicate that this situation would change significantly over the next decade.

12.7.3 Control of Residential and Commercial Wood Combustion Emissions

As noted in Section 8, residential wood combustion is responsible for 25 percent of primary fine particulate emissions in the MANE-VU region, and is a significant contributor to regional haze. Maine has adopted regulations to address emissions from outdoor wood and pellet boilers, an outdoor wood boiler replacement and buy-back program, and a woodstove replacement buy-back program.

The Chapter 150 Control of Emissions from Outdoor Wood Boilers Rule

In June 2007, the Maine Legislature adopted the EPA Phase I particulate emission limit of 0.60 lbs/MMBtu/hr heat input as the standard for new outdoor wood-fired hydronic heaters (OWHH), also known as outdoor wood boilers, sold in Maine beginning April 1, 2008. Beginning April 1, 2010 new OWHH sold in Maine are required to meet a more stringent particulate emission standard of 0.32 lbs/MMBTU heat output (Phase II).

06-096 CMR Chapter 150 Control of Emissions from Outdoor Wood Boilers, which incorporated the OWHH particulate emission standards adopted by the Legislature, became effective November 1, 2007, and also established setback, stack height, particulate emission limits, and fuel requirements for outdoor wood boilers (See Attachment BB). Chapter 150 was subsequently amended[63] to control the sale, installation, use, and siting of outdoor wood boilers that combust biomass pellets as fuel. Maine is submitting this rule to EPA for incorporation into the Regional Haze SIP.

The Chapter 160, Outdoor Wood Boiler Replacement and Buy Back Program:

In April 2008, the Maine Legislature also enacted Public Law, Chapter 680, An Act Establishing an Outdoor Wood Boiler Fund. This Public Law established a nonlapsing fund administered by commissioner to be used by the Department to upgrade, purchase and replace outdoor wood boilers that create a nuisance condition as defined in the

[62] For example, PM2.5 and PM10 emissions from agricultural burning and forestry management activities account for only 0.139% and 0.157% of total wood smoke emissions (Source: 2002 MANE-VU Modeling Inventory Version 3.0).

Department's rules or threat to public health or safety, and directed the Department to develop a rule that includes, but not limited to, criteria for determining whether an outdoor wood boiler constitutes a nuisance condition or threat to public health or safety and is eligible for use of the fund, compensation criteria and amounts and procedures for certification and verification of removal and possible replacement of eligible outdoor wood boilers.

Pursuant to this legislation, the Department adopted the 06-096 CMR Chapter 160, Outdoor Wood Boiler Replacement and Buy Back Program rules, which establish a replacement and buy back program to remove nuisance outdoor wood boilers that were installed prior to February 1, 2008 and replace them with approved heating appliances. The Department will maintain a list of nuisance outdoor wood boilers and prioritize them for the program based on the threat to public health and safety and proximity to neighbors and sensitive populations. To receive compensation, the owner of the outdoor wood boiler must have explored all possible remedies, including increasing the stack height and setback distances to neighbors and potential retrofits to eliminate the nuisance conditions. Compensation may include the cost of installation and disposal and shall not exceed $15,000.

<u>The Residential Wood Stove Replacement Fund</u>

On April 8, 2010, the Maine Legislature enacted 38 MRSA §610-D, which established a residential woodstove replacement program in the Maine Department of Environmental Protection. Under this program, eligible participants will be able to receive funding toward the purchase of new cleaner-burning residential heating appliances to replace older wood stoves that are not certified by the EPA lower emitting residential heating appliances, such as EPA certified wood, pellet or vented gas stoves. The Department will be establishing eligibility criteria for program participation, benefits, and approved methods for replacement and disposal of non-certified wood stoves.

12.8 Estimated Effects of the Long-Term Strategy on Visibility

40 CFR 51.308(d)(3)(v)(G) requires Maine to consider, in developing its long-term strategy, the anticipated net effect on visibility due to projected changes in point, area and mobile source emissions over the period addressed by the long-term strategy. NESCAUM conducted modeling to evaluate the expected improvements to visibility at affected Class I Areas by 2018 as a consequence of implementing MANE-VU's long-term strategy. Those visibility improvements will result, in part, from the efforts identified in this SIP to reduce emissions that originate in Maine.

All Class I states affected by emissions originating in Maine have (or will have) established reasonable progress goals for 2018 for each of their Class I Areas. The control measures included in this SIP represent the reasonable efforts of Maine, in conjunction with the efforts of other MANE-VU states, toward achieving the reasonable progress goals established by the affected states.

Based on the most recent MANE-VU modeling, the proposed control measures will reduce sulfate levels at affected Class I Areas by about one-third on the worst visibility days and by 6 to 31 percent on the best visibility days by 2018. Nitrate and elemental carbon levels will also show substantial reductions across all areas for both bets and worst days, while smaller reductions in organic carbon will occur. Small increases are predicted for the fine soil component of regional haze. There is the possibility that the predicted increases in this component are not real but, rather, related to structural differences in the data sets used in the modeling for the baseline and future years[64]. No changes were predicted for sea salt because the model does not track this component.

The 2000-2004 visibility readings at affected Class I areas provide the baseline against which future visibility readings will be measured to assess progress deriving from implementation of Maine's Regional Haze SIP and those of the other MANE-VU states. To determine baseline visibility for affected Class I areas, the 2000-2004 IMPROVE monitoring data was used to calculate the average deciview values for the 20 percent best visibility days and the 20 percent worst visibility days over that period. Thus, the 20 percent best day and 20 percent worst day values represent average visibility conditions for the top and bottom quintiles.

To create the series of visibility graphs which follow, 2018 visibility estimates were made in accordance with EPA modeling guidance. First, 2002 daily average baseline concentrations were multiplied by their corresponding relative reduction factors to obtain 2018 projected concentrations for each day. The 2018 projected concentrations were then used to derive daily visibility in deciviews. As a final step, the deciview values for the 20 percent of days having best visibility were averaged, and the process repeated for the 20 percent of days having worst visibility. The resulting averages represent the projected upper and lower quintiles of visibility in 2018.

The following is provided to assist with interpretation of the line graphs in Figures 12.2 through 12.7. Note that lower deciview values indicate better visibility.

- The irregular blue line (~) represents the 20 percent best visibility average value as determined from monitoring data for each year of the period 2001-2005.
- The irregular red line (~) represents the 20 percent worst visibility average value as determined from monitoring data for each year of the period 2001-2005.
- The straight orange line (—) represents the 20 percent best visibility average value as determined from monitoring data for the 5-year period of 2000-2004. (This line represents the *20 percent best visibility baseline condition*.)
- The straight blue line (—) represents the 20 percent worst visibility average value as determined from monitoring data for the 5-year period of 2000-2004. (This line represents the *20 percent worst visibility baseline condition*.)

[64] Specifically, the fire emissions inventory used in VISTAS for the base year relied on an earlier version of fire emissions data than the one used for the 2018 inventory.

- The straight broken line (····) is a continuation of the 20 percent best visibility baseline, representing the 20 percent best visibility condition as it would be with no further degradation or improvement.

- The straight green line (—) represents the 20 percent worst visibility values that establish the uniform rate of progress for the period 2004-2064. (This line is sometimes referred to as the *uniform progress line*, or *"glide slope."* It was created by linear interpolation between the 20 percent worst visibility baseline value in 2004 and the 20 percent worst visibility value under natural conditions in 2064. If visibility improvements match this rate of progress, actual visibility will return to natural conditions in 2064).

- The light-green dash (---) shown at 2064 represents the theoretical 20 percent best visibility value under natural conditions (i.e., no anthropogenic emissions).

- The purple star (*) represents the 20 percent best visibility value in 2018 after implementation of MANE-VU's long-term strategy, as predicted by the CMAQ model. (This value is a *reasonable progress goal*.)

- The blue star (*) represents the 20 percent worst visibility value in 2018 after implementation of MANE-VU's long-term strategy, as predicted by the CMAQ model. (This value is a *reasonable progress goal*.)

Figures 12-2 through 12-4 are line graphs showing anticipated visibility improvements for the MANE-VU Class I Areas affected by emissions originating in Maine. Figures 12-2 and 12-3 illustrate the predicted visibility improvement at Acadia National Park and Moosehorn National Wildlife Refuge/Roosevelt Campobello International Park by 2018 resulting from the implementation of the long-term strategy (See the blue cross mark). This improvement is compared to the Uniform Rate of Progress for affected Class I areas (see green sloping line). Note that the blue cross mark is below than the green line as it passes over the 2018 date marked at the bottom of the chart. This indicates that the control measures identified in this SIP provide visibility improvements exceeding the uniform rate of progress for reaching natural visibility in 2064. The lower number of deciviews means better visibility.) Figure 12-4 demonstrates that Great Gulf Wilderness Class I area in New Hampshire, which is significantly affected by Maine emissions, is also projected to meet or exceed the uniform rate of progress goal for 2018. All Class I areas affected by Maine emissions are also projected to have no degradation from current baseline best visibility.

12.9 Implementation of the Regional Haze Strategies in Maine

40 CFR Section 51.308(d)(3)(ii) of the Regional Haze Rule requires Maine to demonstrate that its implementation plan includes all measures necessary to obtain the emission reductions needed to meet the reasonable progress goals. The modeling analysis referenced in Subsection 12.8 (Figures 12-2 through 12-4) above, which demonstrates that Maine's long-term strategy is sufficient to meet reasonable progress

goals, is predicated on Maine (and other MANE-VU) states reducing their SO_2 emissions as a result of a number of emission control programs.

Figure 12-2
Projected Visibility Improvement at Acadia National Park Based On 2018 Best and Final Projections

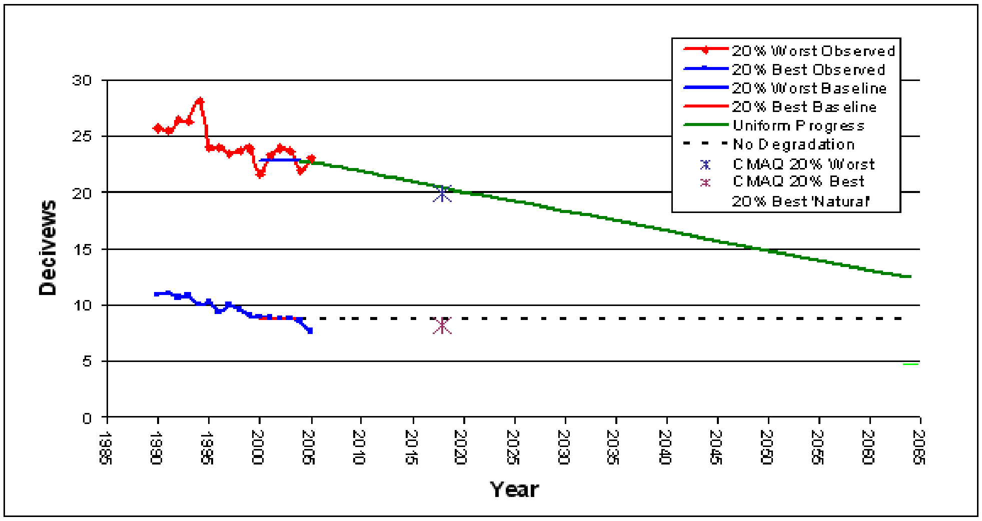


Figure 12-3
Projected Improvement in Visibility at Moosehorn National Wildlife Refuge and Roosevelt Campobello International Park based on 2018 Best and Final Projections

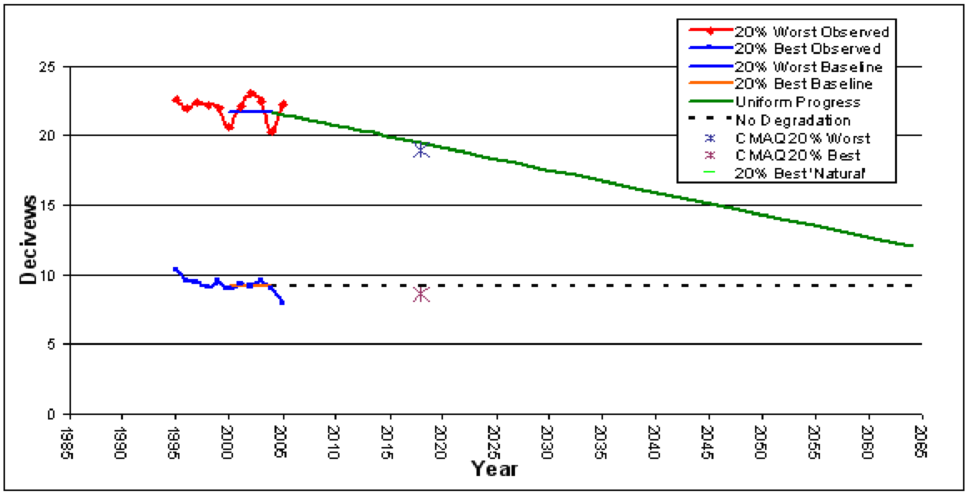
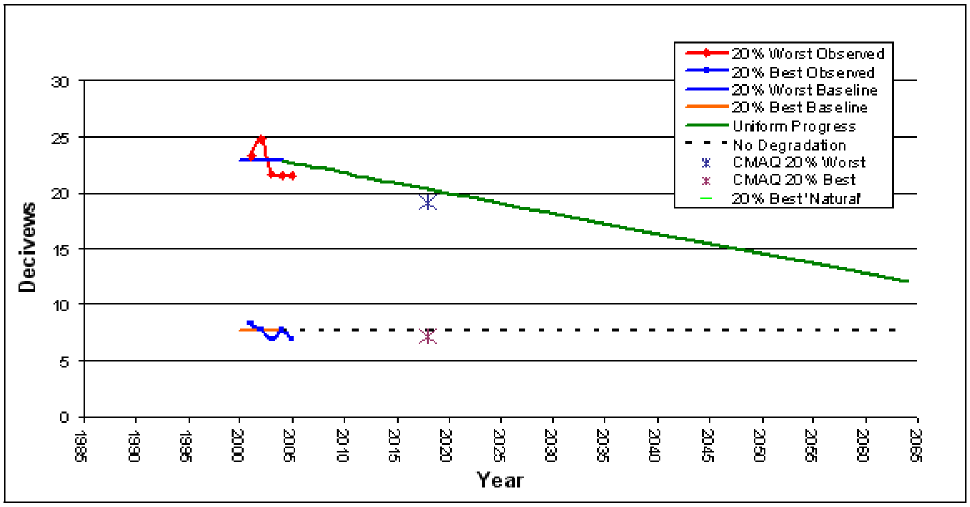


Figure 12-4
Projected Visibility Improvement at Great Gulf Wilderness
Based on Most Recent Projections for 2018



As previously noted, Maine has adopted, and will implement, the following measures as part of its long-term strategy to meet the reasonable progress goals:

1. A low sulfur fuel oil strategy in accordance with the MANE-VU statement providing SO_2 reductions for Wyman Station, ICI boilers, and residential heating units;
2. Timely implementation of BART requirements yielding a 50 percent or greater reduction in SO_2 emissions from Maine sources subject to BART;
3. A program to reduce SO_2 emissions at the Wyman Station #4 boiler by at least 84 percent from uncontrolled levels; and
4. A comprehensive program to reduce wood smoke emissions from outdoor wood and pellet boilers, woodstoves and other wood-burning devices.

12.9.1 The Maine Low Sulfur Oil Program

The Maine Low Sulfur Oil Program, as enacted by Public Law Chapter 604, (See Attachment Z), instituted the following restrictions on fuel sulfur content for residual (#4, #5, and #6) and distillate oil:

(1) Beginning January 1, 2018; a person may not use residual oil with a sulfur content greater than 0.5% by weight;

(2) Beginning January 1, 2016, a person may not use distillate oil with a sulfur content greater than 0.005 % by weight; and

(3) Beginning January 1, 2018, a person may not use distillate oil with a sulfur content greater than 0.0015 % by weight.

In addition to the low sulfur requirements for distillate and residual oil, the program contains two elements not included in the MANE-VU Low Sulfur Oil Strategy. These elements include:

1) An exemption from the low sulfur content limits for sources using distillate fuel for manufacturing purposes; and

2) Equivalent alternative sulfur reduction application. The Department of Environmental Protection is required to adopt major substantive rules[65] that provide an opportunity for a licensed air contamination source that holds a license on the effective date of this subsection to apply for an equivalent alternative sulfur reduction strategy to the residual fuel oil and distillate fuel requirements. The rules must provide for the achievement of equivalent sulfur emission reductions through other means, including, but not limited to, reductions in consumption of residual fuel oil and distillate fuel, early sulfur emission reductions from a baseline emissions inventory year of 2002 and conversions to alternative fuels. Approved alternate sulfur reduction strategies must be in effect by January 1, 2018.

The Distillate Fuel Exemption

The Department does not believe that the low sulfur content limit exemption for manufacturing purposes will have a significant impact on the emission reductions afforded by this strategy for 2018 and beyond. While the exemption allows the continued use of high-sulfur[66] distillate oil at several manufacturing facilities, there are structural impediments to the actual use of these fuels. First, since there is only a limited potential market for high-sulfur distillate[67] the Department believes that this fuel will not be readily available, and will likely be more expensive than the more widely-used 15 ppm distillate. Distributors and wholesalers of distillate fuels have noted that supplying high-sulfur distillate to a limited market introduces additional costs to their industry in the form of segregated storage and transportation/delivery systems, since even incidental contamination (co-mingling) can lead to non-compliance issues.

Very small amounts of higher sulfur product can contaminate ultra low sulfur distillate, as illustrated in Figure 12-5, below. Since less than 7 gallons of high sulfur distillate can contaminate an entire truck load of ultra-low sulfur distillate fuel, segregated storage and transportation/delivery systems are probably the only mechanism that can assure compliance with federal and state ULSD requirements for the petroleum marketing industry. Given the low demand, and additional storage, transportation and delivery costs, the Department does not believe that high sulfur distillate fuel will be widely used by the manufacturing sector in 2018 and later.

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[65] Rules must be adopted and submitted to the Maine Legislature for approval by January 1, 2014.
[66] Containing 2,000-5,000 ppm sulfur.
[67] All other users of distillate (diesel) fuel in Maine will be subject to the 15 ppm sulfur limits (including general use and space heating at manufacturing facilities).

Figure 12-5
Contamination of Ultra Low Sulfur Distillate (Diesel) Fuel

Fuel Type	Amount of non-ULSD added to 7,500 gallons of ULSD		
	7 gallons (0.1%)	37 gallons (0.5%)	75 gallons (1%)
500-ppm Fuel	+0.5 ppm	+2.5 ppm	+ 5.0 ppm
2,000 ppm Fuel	+2.0 ppm	+10.0 ppm	+ 20.0 ppm
5,000 ppm Fuel	+5.0 ppm	+ 25.0 ppm	+50.0 ppm

As noted above, Maine believes that future (2018) use of distillate fuel by the manufacturing sector will be limited due to cost and compliance concerns. Nevertheless, projected 2018 SO_2 emissions for Maine have been adjusted to address this exemption, and its impact on non-EGU point source emissions, as discussed in Section 12.10, below.

The Equivalent Alternative Sulfur Reduction Application
Under this provision of the Maine low sulfur oil program, the Department of Environmental Protection is required to adopt rules providing an opportunity for a licensed source that holds an air emission license to apply for an equivalent alternative sulfur reduction strategy to the residual fuel oil and distillate fuel requirements. Since these rules will require sulfur emission reductions that are equivalent to the use of 0.5% sulfur residual or 0.0015% sulfur distillate fuel, there will be no net change to the predicted SO_2 emission reductions provided by this strategy. The Department will be working with EPA to develop these rules, and will submit them for inclusion into the SIP.

12.9.2 BART in Maine

As required by 40 CFR §51.308(e), the Maine Regional Haze SIP includes emission limitations representing Best Available Retrofit Technology (BART) and schedules for compliance with BART for each BART-eligible source that may reasonably be anticipated to cause or contribute to any impairment of visibility in any mandatory Class I Federal area. Maine's implementation of the BART requirements is fully discussed in Section 10.

12.9.3 The Targeted EGU Strategy in Maine

As noted in section 12.5.3, above, MANE-VU's agreed regional approach for the EGU source sector is to pursue a 90 percent control level on SO_2 emissions from the 167 identified stacks by 2018. Maine has one EGU identified in the MANE-VU analysis; FPL Energy (FPLE) Wyman Station Unit #4.

FPLE Wyman Station is an 850-megawatt electric generating facility located on Cousins Island in Yarmouth, Maine. The facility consists of four generation units, all of which fire #6 residual fuel oil. The fifth unit is a smaller oil-fired auxiliary boiler which provides building heat and auxiliary steam, and the sixth unit is an emergency backup diesel generator that provides electricity for use on-site.

Unit #4 is powered by a Foster Wheeler boiler with a maximum design heat input of 6290 MMBtu/hr, firing #6 and #2 fuel oil. This unit is equipped with 30 front wall fired burners capable of firing up to 41,333 gal/hr. Boiler #4 was manufactured in 1974 and installed in 1975, and therefore is subject to the New Source Performance Standards (NSPS) Subpart D, but not Subpart Da. Unit #4 is a peaking unit, and operated at an average annual capacity factor of less than 10 percent between 2002 and 2009[68], with annual SO_2 emissions of 1,170 tpy in 2002.

Although flue gas desulfurization (FGD) through the use of a wet, semi-dry or dry scrubber is technically feasible, this technology is cost prohibitive due to the low-capacity factor of this unit and site-specific restrictions. In lieu of requiring add-on controls, Maine will be utilizing its low-sulfur fuels program to implement the MANE-VU Targeting EGU Strategy at this unit. The Maine Low Sulfur Fuel Program will require the use of low-sulfur fuel containing no more than 0.5% sulfur beginning January 1, 2018, providing an 84 percent reduction from baseline (3.0% sulfur) fuel.

Maine is also committing to further analyze the visibility benefits that would be provided by the use of 0.3% sulfur fuel, and to require the use of this fuel (or an equivalent emissions rate) no later than January 1, 2018, if necessary to meet the reasonable progress goals at Class I areas in Maine or any other Class I area significantly affected by Maine emissions. Maine is committing to undertake this analysis no later than January 1, 2013 as part of its 5-year periodic implementation plan revision.

12.9.4 Wood Smoke Emission Reductions Strategies in Maine

Strategies to reduce wood smoke emissions in Maine will also provide significant reductions in regional haze. As detailed in Section 12.7.3, Maine has adopted a comprehensive suite of programs designed to reduce wood smoke emissions from outdoor wood and pellet boilers and residential wood stoves. Since the visibility improvements provided by these programs were not modeled as part of the MANE-VU process, Maine has included these programs in its Regional Haze SIP as SIP enhancements, or strengthening measures. The 06-096 CMR Chapter 150 Control of Emissions from Outdoor Wood Boilers (Attachment BB), is included for incorporation in the Maine Regional Haze SIP.

12.10 Maine's Share of Emission Reductions

Implementation of the long-term strategy will produce significant reductions in Maine's emissions inventory by the end of the first planning period, or 2018. Changes to the emissions inventory will also occur as a result of population growth; changes in land use and transportation; development of industrial, energy, and natural resources; and other air pollution measures not directly relate to regional haze. However, it is the expected reductions in SO_2 emissions that will have the greatest effect on visibility improvement at MANE-VU Class I Areas; and those reductions will be largely due to the implementation of the control measures developed in this SIP.

[68] For comparison, the nationwide capacity factor for coal-fired generation in 2008 was 72.2 percent.

As noted in Subsection 12.9 (above) the emission controls included in the Maine Regional Haze SIP are generally consistent with those modeled in MANE-VU's development of reasonable progress goals for Maine and the other MANE-VU Class 1 states (see Section 11.2, above). However, since the Maine Low Sulfur Oil Program and efforts to reduce emissions at Wyman Station Unit #4 differ slightly from the programs and emission reductions modeled as reasonable progress goals, Maine must demonstrate that its long-term strategy will achieve the reasonable progress goals established by the Regional Haze SIP.

In an effort to demonstrate that the long-term strategy established by this SIP will achieve the modeled reasonable progress goals, Maine undertook a more refined analysis of its projected 2018 SO_2 emissions that is based on the 2008 Maine DEP Point Source Inventory.[69] The Maine analysis updated projected SO_2 emissions for point sources that included only the reductions provided by the use of 0.5% sulfur residual oil as implemented by the Maine Low Sulfur Fuel Program.[70] While this approach is necessarily very conservative, and does not capture all of the reductions provided by the use of low sulfur residual and ultra-low sulfur distillate fuel in Maine, it is more than sufficient to demonstrate that projected future emissions in Maine will be well below the level used to establish reasonable progress goals. The documentation for this effort and the updated Maine 2018 Projected Point Source Inventory are contained in Attachment AA.

After accounting for all facilities that ceased operation and/or surrendered their air emission licenses between 2001 and 2009 (25 sources) and accounting for the reductions provided by the use of 0.5% residual fuel, Maine's updated 2018 projected point source emissions were 8,445 tpy for all point sources (EGU and non-EGU combined); well below the 19,888 tpy utilized in the MANE-VU reasonable progress modeling.

Table 12-3, below, illustrates the MANE-VU 2002 (baseline) and MANE-VU 2018 (modeling) inventories for Maine, along with the Maine updated 2018 [projected inventories. The emission inventory for Maine projects changes to point, area and mobile source inventories by the end of the first implementation period resulting from population growth; industrial, energy and natural resources development; land management; and air pollution control. Table 12-4 compares the percentage reductions (SO_2) for the MANE-VU region and Maine for each source category. The implementation of the Long Term Strategy will reduce Maine's SO_2 emissions by 73.4 percent, as compared to the compared to the projected reduction of 67.5 percent in the MANE-VU region. Further information on Maine's emissions inventory, including other pollutants that contribute to visibility impairment, is available in Section 8.0, Emissions Inventory, and in Attachments I and AA.

[69] Since the Maine long-term strategies for non-point sources do not differ from those modeled, it is not necessary to update other source categories at this point in time.
[70] The Department's analysis did not include any reductions from the use of ULSD (15 ppm) at point sources.

Table 12-3
SO_2 Emissions from Point, Area and Mobile Sources in Maine
(tpy)

Source Category	MANE-VU 2002 Baseline	MANE-VU 2018 Modeling	Maine (Updated) 2018 Projected
On-Road Mobile	1,804	894	894
Non-Road Mobile	917	82	82
EGU Point	9,299	6,806	8,445
Non-EGU Point	14,412	13,082	
Area	13,149	1,127	1,127
TOTAL	39,581	21,991	10,548

Table 12-4
SO_2 Emissions from Point, Area and Mobile Sources in the MANE-VU Region and in Maine
(tpy)

Source Category	MANE-VU Region Percent Reduction 2002-2018	Maine Percent Reduction 2002-2018
On-Road Mobile	78.2	50.5
Non-Road Mobile	84.9	91.1
EGU Point	77.6	64.4
Non-EGU point	65.4	
Area	54.8	91.4
TOTAL	67.5	73.4

12.10 Emission Limitations and Compliance Schedules

40 CFR 51.308(d)(v)(C) requires Maine to establish emission limitations and compliance schedules to meet reasonable progress goals. Emission limitations and compliance schedules are in place for the Maine programs outlined in Subsection 12.9. Final BART determinations and control requirements for all Maine BART-eligible sources are included in the Regional Haze SIP, and include emission limitations and compliance schedules for all BART-eligible sources. The Maine Low Sulfur Fuel Program, implementing the MANE-VU low sulfur fuel strategy and the targeted EGU strategy in Maine was enacted by the Maine Legislature on March 25, 2010, and signed into law by

Governor John Baldacci on April 5, 2010. As noted in Section 12.9.3, Maine is committing to further analyze the visibility benefits that would be provided by the use of 0.3% sulfur fuel, and to require the use of this fuel (or an equivalent emissions rate) no later than January 1, 2018, if necessary to meet the reasonable progress goals at Class I areas in Maine or any other Class I area significantly affected by Maine emissions. Maine is committing to undertake this analysis no later than January 1, 2013 as part of its 5-year periodic implementation plan revision.

12.11 Enforceability of Emission Limitations and Control Measures

40 CFR 51.308(d)(3)(v)(F) requires Maine to ensure that emission limitations and control measures used to meet reasonable progress goals are enforceable. All control measures incorporated into law or codified in administrative rules will be enforceable. Any facility subject to state or federal permit requirements, including BART-eligible and V facilities, will be required to comply with the specific permit conditions that reference the applicable provisions of those laws and rules.

In Maine, the authority to create rules, issue permits and enforce laws related to regional haze is established in Title 38 Maine Revised Statutes Annotated (MRSA), Chapter 2, Department of Environmental Protection, Subchapter 1, Organization and Powers and in Title 38 MRSA, Chapter 4, Protection and Improvement of Air. Under 38 MRSA Chapter 2 and Chapter 4, the Department is authorized to enforce the state's air laws and regulations, establish a permit program, accept and administer grants, and exercise all incidental powers necessary to carry out the its statutory obligations.

Sections of Maine law of particular relevance to the regional haze SIP are:

- Title 38 Maine Revised Statutes Annotated (MRSA) section 581, Declaration of findings and intent, which declares the Legislature's intent to:

  "exercise the police power of the State in a coordinated state-wide program to control present and future sources of emission of air contaminants to the end that air polluting activities of every type shall be regulated in a manner that reasonably insures the continued health, safety and general welfare of all of the citizens of the State"

- 38 MRSA section 585. Establishment of emission standards, which states:

  "The board may establish and may amend standards, herein called "emission standards", limiting and regulating in a just and equitable manner the amount and type of air contaminants which may be emitted to the ambient air within a region. Such emission standards shall be designed to prevent air pollution and to achieve and maintain the ambient air quality standards within the region in which applicable"

- 38 MRSA section585, Establishment of emission standards, which states:

"The board may establish and amend regulations to implement ambient air quality standards and emission standards. These regulations shall be designed to achieve and maintain ambient air quality standards and emission standards within any region and prevent air pollution"

- 38 MRSA section 590, Licensing, which states, in relevant part:

  "1. License required. After ambient air quality standards and emission standards have been established within a region, the board may by rule provide that a person may not operate, maintain or modify in that region any air contamination source or emit any air contaminants in that region without an air emission license from the department"

- 38 MRSA sections 347-A, 347-C, and 349, which provide for the enforcement of all SIP measures; and

- 38 MRSA section 353-A, which establishes annual air emission license fees and 38 MRSA section 353A (1) A, which establishes an annual fee surcharge for emissions of hazardous air pollutants.

The Maine regulations also provide for enforceable emission control measures and compliance schedules to meet the applicable requirements of the Clean Air Act and rules promulgated by EPA. The following regulations are of particular relevance to the Maine Regional Haze SIP:

06-096 CMR Chapter 100 Definitions Regulation
06-096 CMR Chapter 101 Visible Emissions Regulation
06-096 CMR Chapter 102 Open Burning Regulation
06-096 CMR Chapter 103 Fuel Burning Equipment Particulate Emission Standard
06-096 CMR Chapter 104 Incinerator Particulate Emission Standard
06-096 CMR Chapter 105 General Process Source Particulate Emission Standard
06-096 CMR Chapter 106 Low Sulfur Fuel
06-096 CMR Chapter 109 Emergency Episode Regulation
06-096 CMR Chapter 110 Ambient Air Quality Standards
06-096 CMR Chapter 114 Classification of Air Quality Control Regions
06-096 CMR Chapter 115 Major and Minor Source Air Emission License Regulations
06-096 CMR Chapter 116 Prohibited Dispersion Techniques
06-096 CMR Chapter 117 Source Surveillance
06-096 CMR Chapter 121 Emission Testing of Resource Recovery Facilities
06-096 CMR Chapter 126 Capture Efficiency Test Procedures
06-096 CMR Chapter 127 New Motor Vehicle Emission Standards
06-096 CMR Chapter 138 Reasonably Available Control Technology for Facilities that Emit Nitrogen Oxides
06-096 CMR Chapter 140 Part 70 Air Emission License Regulations
06-096 CMR Chapter 145 NOx Control Program
06-096 CMR Chapter 146 Diesel-Powered Motor Vehicle Emission Standards

06-096 CMR Chapter 148	Emissions from Smaller-Scale Electric Generating Resources
06-096 CMR Chapter 149	General Permit Regulation for Nonmetallic Mineral Processing Plants
06-096 CMR Chapter 150	Control of Emissions from Outdoor Wood Boilers
06-096 CMR Chapter 160	Outdoor Wood Boiler Replacement and Buy Back Program

The Maine regulations provide for enforceable emission control measures and compliance schedules to meet the applicable requirements of the clean Air Act and rules promulgated by EPA. The Maine rules also define the State's air emission licensing (permit) program for stationary sources to ensure that national ambient air quality standards are achieved.

12.12 Prevention of Significant Deterioration

Prevention of Significant Deterioration (PSD) requirements for new major stationary sources and major modifications (emitting > 50 tons of any air contaminant) are implemented in Maine through the 06-096 CMR Chapter 100 Definitions Regulation which was approved into the SIP on October 15, 1996[71], the 06-096 CMR Chapter 113 Growth Offset Regulation which was approved into the SIP on February 14, 1996[72], and the 06-096 CMR Chapter 115 Major and Minor Source Air Emission License Regulations which were approved into the SIP by EPA on February 14, 1996.[73,74] PSD is applicable to all major sources (or existing sources making a major modification), triggering significance thresholds, located in an area that is in attainment with the National Ambient Air Quality Standards or unclassified. One of the intentions of the PSD program is to protect air quality in national parks, wilderness areas, and other areas of special natural, scenic, or historic value. The PSD permitting process requires a technical air quality analysis and additional analyses to assess the potential impacts on soils, vegetation and visibility.

The required procedures for evaluating the impacts of a proposed PSD source on air quality and visibility are provided in Section 7 of Maine's 06-096 CMR Chapter 115 Major and Minor Source Air Emission License Regulations. The Ambient Air Quality Impact Analysis must demonstrate that the new allowable emissions will not result in an exceedence of the remaining increments for SO_2, NO_2 or PM_{10} in any Class I area. The applicant must also demonstrate "that the increase in allowable emissions will not cause an adverse impact on visibility in any sensitive area or in any Class I area, and will not interfere with reasonable progress toward the remedying of existing man-made visibility impairment in a sensitive area. The analysis must be submitted to the Department and the

[71] 61 FR 53639
[72] 61 FR 5694
[73] 61 FR 5694
[74] Although these rules have been amended several times since being incorporated into the SIP, these revisions did not change any of the major source permitting requirements relevant to PSD, and the current state regulations are consistent with the SIP-approved versions for the purposes of implementing the PSD requirements.

appropriate Federal land Manager at least 60 days prior to the close of the public comment period on the source or modification. In this manner, new major sources and existing sources making major modifications will be constructed in a manner that will not degrade air quality or visibility. The PSD permitting program is an integral part of Maine's long-term strategy for meeting its regional haze goals.

12.13 Reasonably Attributable Visibility Impairment

40 CFR Section 51.302 (c) provides for general plan requirements in cases where the affected FLM has notified the State that Reasonably Attributable Visibility Impairment (RAVI) exists in a Class I Area in the state. There are no RAVI sources in the MANE-VU region.

13. Comprehensive Periodic Implementation Plan Revisions

40 CFR Section 51.308(f) requires a State/Tribe to revise its regional haze implementation plan and submit a plan revision to EPA by July 31, 2018 and every ten years thereafter. In accordance with the requirements listed in 40 CFR Section 51.308(f) of the federal rule for regional haze, Maine commits to revising and submitting this regional haze implementation plan by July 31, 2018 and every ten years thereafter.

In addition, 40 CFR Section 51.308(g) requires periodic reports evaluating progress towards the reasonable progress goals established for each mandatory Class I area. In accordance with the requirements listed in 40 CFR Section 51.308(g) of the federal rule for regional haze, Maine commits to submitting a report on reasonable progress to EPA every five years following the initial submittal of the SIP. The report will be in the form of a SIP revision submitted by no later than December 17, 2012**.** The reasonable progress report will evaluate the progress made towards the reasonable progress goal for each mandatory Class I area located within Maine and in each mandatory Class I area located outside Maine, which may be affected by emissions from within Maine**.** All requirements listed in 51.308(g) shall be addressed in the SIP revision for reasonable progress.

Section (d)(4)(v) requires periodic updates of the emission inventory. Maine commits to update the inventory by no later than December 17, 2012**.**

13. Determination of the Adequacy of the Existing Plan

As required by 40 CFR Section 51.308(h), depending on the findings of the five-year progress report, required under 40 CFR Section 51.308 (g), Maine commits to taking one of the following actions at the same time the State submits the 5-year progress report:

(1) If the State determines that the existing implementation plan requires no further substantive revision in order to achieve established goals for visibility improvement and emissions reductions, the State will provide to the Administrator a negative declaration that further revision of the existing implementation plan is not needed.

(2) If the State determines that the implementation plan is or may be inadequate to ensure reasonable progress due to emissions from sources in another State(s) which participated in a regional planning process, the State will provide notification to the Administrator and to the other State(s) which participated in the regional planning process with the States. The State will also collaborate with the other State(s) through the regional planning process for the purpose of developing additional strategies to address the plan's deficiencies.

(3) If the State determines that the implementation plan is or may be inadequate to ensure reasonable progress due to emissions from sources in another country, the State will provide notification, along with available information, to the Administrator.

(4) If the State determines that the implementation plan is or may be inadequate to ensure reasonable progress due to emissions from sources within the State, the State will revise its implementation plan to address the plan's deficiencies within one year.

The findings of the five-year progress report will determine which action is appropriate and necessary.

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