Connecticut
Regional Haze SIP Revision

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Mid-Atlantic/Northeast Visibility Union (MANE-VU)

Prepared by

The Connecticut
Department of Environmental Protection

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Introduction

State and federal air quality regulators have been challenged with developing multi-pollutant control programs due to the synergistic impacts of pollutants such as nitrogen oxides (NO_x), sulfur dioxide (SO_2), particulate matter (PM) and volatile organic compounds (VOC) on attainment of the ozone and $PM_{2.5}$ national ambient air quality standards (NAAQS) as well as on human health. In addition to requirements to maintain and meet NAAQS, states are also charged with reducing exposure to air toxics, eliminating a type of visibility impairment known as regional haze by 2064, and mitigating greenhouse gas emissions that contribute to global climate change.

In order to accomplish such diverse tasks, many emission sectors including energy, transportation, industrial, residential, commercial and agricultural must engage in control strategies. Within these sectors, areas which are likely to achieve emissions reductions in Connecticut include electric generating units (EGUs), diesel trucks, stationary diesel engines, outdoor wood boilers, industrial/commercial/institutional (ICI) boilers, residential heating, and light duty vehicles. Emission reductions achieved by lowering fuel sulfur content, instituting energy efficiency measures, implementing a high electric demand day program and moving towards reductions beyond the federal NO_x cap-and-trade programs are other possible areas for emission reductions.

While the context of this document specifically addresses regional haze state implementation plan (SIP) requirements, improving overall air quality and meeting numerous goals with limited resources will require a multi-pollutant approach. Indeed, regional haze is impacted by multiple visibility impairing pollutants, including SO_2, NO_x and PM. Multi-pollutant actions taken to reach regional haze reduction goals will positively influence on several air quality initiatives. In addition, the January 2008 Benefits Mapping and Analysis Program (BENMAP) study prepared by Northeast States for Coordinated Air Use Management (NESCAUM) shows that programs designed to reduce regional haze will result in billions of dollars in public health benefits (Attachment EE).

What is Regional Haze?

Regional haze is visibility-impairing pollution produced across a broad geographic area by sources and activities emitting fine particles and their precursors. Such fine particles are comprised mainly of sulfates, nitrates, organic carbon, elemental carbon and soil dust. Congress adopted the visibility provisions in the Clean Air Act (CAA) in order to protect areas of scenic significance at 156 mandatory Class I Federal areas (Class I areas), which include certain national parks, wilderness areas and national memorial parks, and international parks.

General SIP Requirements

The Environmental Protection Agency (EPA) requires states to submit regional haze SIPs that describe the states' measures for meeting the national goal of a return to natural visibility conditions at Class I areas by 2064. States with Class I areas must set reasonable progress goals for achieving and maintaining natural visibility conditions in their SIPs. Connecticut does not contain any Class I areas. States impacting Class I areas must submit SIPs detailing anticipated actions taken in order to meet reasonable progress goals, as well as explaining the long-term strategy, including enforceable emissions limitations, compliance schedules, and other measures for meeting this long-term return to natural visibility goal. Regional haze SIPs are also required to include calculations of baseline and natural visibility conditions as well as monitoring strategies for tracking reasonable progress. Finally, regional haze SIPs must include a determination of Best Available Retrofit Technology (BART) for sources of a certain size or emissions profile that began operating during a specific timeframe. In the future, states must submit revisions to the regional haze SIP every 5 years evaluating progress toward meeting reasonable progress goals and also updating the long-term strategy in 2018 as well as every 10 years thereafter.

1.0 THE REGIONAL HAZE ISSUE

In 1999, the Environmental Protection Agency (EPA) issued regulations to improve visibility in 156 national parks and wilderness areas across the United States. The affected areas include many of our best known natural places, including the Grand Canyon, Yosemite, Yellowstone, Mount Rainier, Shenandoah, the Great Smokies, Acadia, and the Everglades. These regulations address visibility impairment in the form of regional haze.

Haze is an atmospheric phenomenon that obscures the clarity, color, texture, and form of what we see. It is caused primarily by anthropogenic (manmade) pollutants but can also be caused by a number of natural phenomena, including forest fires, dust storms, and sea spray. Some haze-causing pollutants are emitted directly to the atmosphere by anthropogenic emission sources such as electric power plants, factories, automobiles, construction activities, and agricultural burning. Others occur when gases emitted to the air (haze precursors) interact to form new particles that are carried downwind of the original source.

Emissions from these activities generally span broad geographic areas and can be transported hundreds or thousands of miles. Consequently, regional haze occurs in every part of the nation. Because of the regional nature of haze, EPA's regulations require the states to consult with one another toward the national goal of improving visibility – specifically, at the 156 parks and wilderness areas designated under the Clean Air Act (CAA) as mandatory Class I Federal Areas.

The Regional Haze Rule calls for each state to formulate a *long-term strategy* for meeting this goal. These requirements apply to any state having a Class I area as well as any state that contributes to visibility impairment at any (downwind) Class I area. The visibility goal must be designed both to improve visibility on the haziest days and to ensure that no degradation occurs on the clearest days.

A state's long-term strategy must include enforceable emission reduction measures designed to meet reasonable progress goals. The first long-term strategy covers the 10-15-year period ending in 2018, and subsequent revisions are to be issued every 10 years thereafter. In identifying the emission reduction measures to be included in the long-term strategy, states should address all types of manmade emissions contributing to visibility degradation in Class I areas, including those from mobile sources; stationary sources (such as factories); smaller, so-called "area" sources (such as residential wood stoves and small boilers); and prescribed fires to reduce wildland fuel loads.

In developing their plans, states can take into account emission reductions attributable to ongoing air pollution control programs at the state, regional, or national levels. For most states and regions of the country, however, additional emission control measures beyond those already on the books will be necessary if national visibility goals are to be achieved. In addition, the Regional Haze Rule mandates that control measures be implemented for certain existing sources placed into operation between 1962 and 1977. This portion of the rule is known as *Best Available Retrofit Technology (BART).*

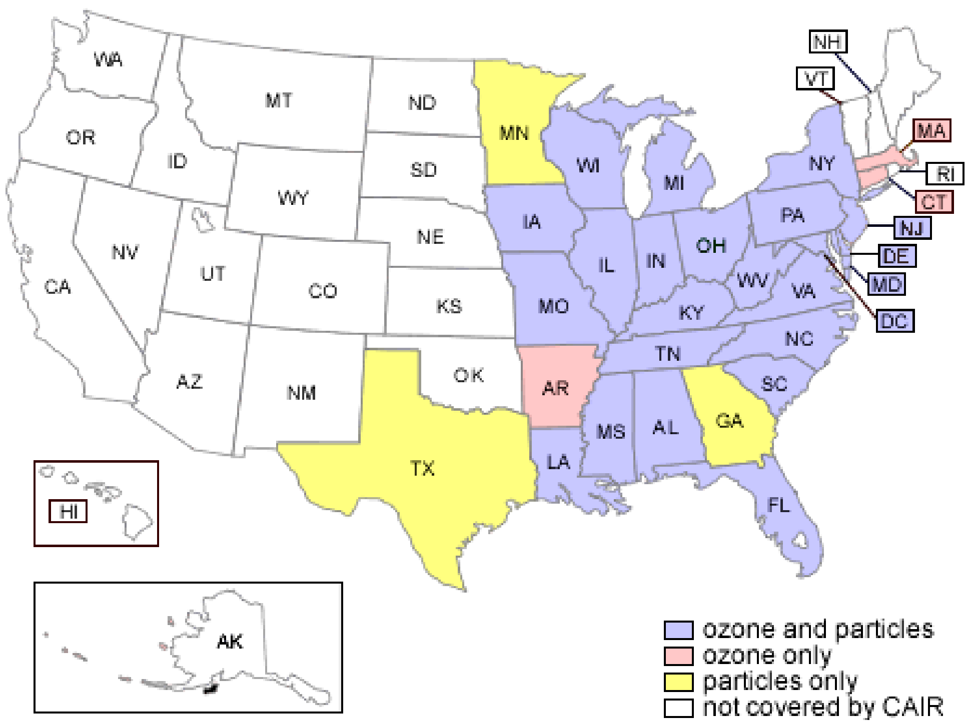
Each state's plan for addressing regional haze will take the form of a State Implementation Plan (SIP) or SIP revision. Connecticut's SIP, presented here, was developed after extensive consultations with other states and regional planning organizations. Connecticut also consulted with states outside the Northeast.

The regulatory, organizational, and technical basis for Connecticut's regional haze plan will be found in Sections 1.0 through 8.0 of this SIP document. The prescriptive elements of Connecticut's plan – BART provisions, reasonable progress goals, and long-term strategy – are described in detail in Sections 9.0 through 11.0.

1.1 Regional Haze Planning after Remand of CAIR

On March 10, 2005, EPA issued the Clean Air Interstate Rule (CAIR). This federal rule was designed to achieve 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. CAIR would permanently cap emissions originating in 28 eastern states and the District of Columbia (Figure 1.1).

Figure 1.1: Map of CAIR States



http://www.epa.gov/cair/

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.

On July 11, 2008, the U.S. Court of Appeals for the District of Columbia Circuit found that CAIR violated the CAA. The court vacated CAIR in its entirety and remanded to EPA to promulgate a new rule consistent with the court's opinion. EPA appealed the decision amid widespread concern that, despite its flaws, some form of CAIR was preferable to the sudden regulatory void created by the court's decision. Upon reconsideration, on December 23, 2008 the U.S. Court of Appeals for the District of Columbia Circuit stayed the vacatur of CAIR but maintained the remand to EPA to promulgate a new rule consistent with the court's July 11, 2008 opinion. The court did not impose a definitive deadline by which EPA must correct CAIR's flaws, but the court stated that it does "not intend to grant an indefinite stay of the effectiveness" of its decision.

Because CAIR formed the regulatory underpinnings for most of the emission reductions that were to produce visibility improvements in mandatory Class I areas, the vacatur of CAIR would have represented a major difficulty for the individual states in attempting to comply with the Regional Haze Rule. 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 rule. As a major ramification, the vacatur would have immediately invalidated EPA's determination that CAIR satisfied the requirements of BART.

The U.S. Congress and EPA are considering a number of possible short- and long-term regulatory or legislative fixes to improve CAIR. It is too early to know when this process will reach a conclusion and what the outcome will dictate for regional haze planning. Over the longer term, Connecticut anticipates that future emission control requirements meeting the provisions of a reauthorized CAA, or its successor, will be at least as stringent as CAIR originally would have obtained. As to the validity of the already-completed planning components, a number of mitigating circumstances apply:

- Some states may apply BART provisions where CAIR would previously have sufficed and this is likely to yield even greater emission reductions from BART-eligible facilities.
- Many states have instituted their own emission reduction programs through multi-pollutant legislation and other means. Connecticut applauds the efforts of other states and encourages them to follow through with the implementation of laws, consent decrees, and other measures that would complement emissions reductions from CAIR.
- Strict adherence to the spirit of the CAA in future national initiatives will probably result in emission reductions exceeding those previously projected for CAIR. A major limitation of the original CAIR was that it relied on interstate emissions trading and did not respond to the specific language of the CAA, Section 110 a (2)(D), which prohibits *any* source or activity within a state from impairing the ability of another state to meet national air quality standards or visibility requirements. CAIR was only one tool, not an all-purpose remedy, for addressing the problem of interstate transport of pollutants.

For these reasons, the Connecticut Department of Environmental Protection (CTDEP) believes that future emissions and air quality levels under CAIR remand scenarios are not likely to be vastly different from values predicted by MANE-VU's completed modeling, even though that modeling was based on implementation of CAIR as originally finalized. Consequently, the reasonable progress goals and long-term strategy developed for Connecticut's regional haze SIP still represent a defensible position from which to go forward with measures to improve visibility at MANE-VU's Class I Areas.

Connecticut 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, Connecticut and the rest of MANE-VU stand apart from some other states in asserting that additional measures beyond CAIR are essential to meeting established visibility goals at MANE-VU's Class I Areas.

In describing Connecticut's present situation, it may be helpful to note that the remand of CAIR is a complicating factor but not an absolute impediment to making visibility progress in the near term. The salient points to consider are as follows:

- Connecticut will meet its "fair share" of emissions in comparison with other MANE-VU states and the CAIR states, as Connecticut's long-term strategy demonstrates (see Section 11.0).
- By the time of the first regional haze SIP five-year progress report, the regulatory framework should be clearer; and new modeling results may be available. It will then be possible to fine-tune regional haze plans to meet the CAIR replacement rule. CTDEP is committed to reviewing and updating its regional haze SIP at that time.

It should be noted that Connecticut's Regional Haze SIP includes many references to the original CAIR program. These references serve two purposes: 1) The included references provide historical context, and 2) they help to maintain continuity with the large body of completed work – much of it based on the original CAIR – that serves as the foundation for regional haze planning in the MANE-VU states to date.

1.2 The Basics of Haze

Small particles and certain gaseous molecules in the atmosphere cause poor visibility by scattering and absorbing light, thereby reducing the amount of visual information about distant objects that reaches an observer. Some light scattering by air molecules and naturally occurring aerosols occurs even under natural conditions.[1]

The distribution of particles in the atmosphere depends on meteorological conditions and leads to various forms of visibility impairment. When high concentrations of pollutants are well mixed in the atmosphere, they form a uniform haze. When temperature inversions trap pollutants near the surface, the result can be a sharply demarcated layer of haze. Plume blight – a distinct, frequently brownish plume of pollution from a particular emissions source – occurs under stable atmospheric conditions, where pollutants take a long time to disperse.

Visibility impairment can be quantified using three different, but mathematically related measures: light extinction per unit distance (e.g., Mm^{-1})[2]; 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

1 The fact that air molecules scatter more short-wavelength (blue) light accounts for the blue color of the sky. The term "aerosol" is defined as a suspension of particles in a gas. In this report, the term refers to particles suspended in the atmosphere.

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

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 21.4 to 29 dv (a visual range of about 30 to 14 miles).

The small particles that commonly cause hazy conditions in the East are primarily composed of sulfate, nitrate, organic carbon, elemental carbon (soot), and crustal material (e.g., soil dust, sea salt, etc.). Of these constituents, only elemental carbon impairs visibility by absorbing visible light; the others scatter light. Sulfate, nitrate, and organic carbon[3] are secondary pollutants that form in the atmosphere from precursor pollutants, primarily SO_2, NO_X, and volatile organic compounds (VOCs), respectively. By contrast, soot, crustal material and some organic carbon particles are released directly to the atmosphere. Particle constituents also differ in their relative effectiveness at reducing visibility. Sulfates and nitrates, for example, contribute disproportionately to haze because of their chemical affinity for water. This property allows them to grow rapidly, in the presence of moisture, to the optimal particle size for scattering light (i.e., 0.1 to 1 micrometer).

1.3 Anatomy of Regional Haze

Monitoring data collected over the last decade show that fine particle[4] concentrations, and hence visibility impairment, are generally highest near industrial and highly populated areas of the Northeast and Mid-Atlantic. Particle concentrations are lower, and visibility conditions are better, at the more northerly Class I sites (such as the Great Gulf and Presidential Range - Dry River Wildernesses in New Hampshire), where visibility on the 20 percent best days[5] is close to natural, unpolluted conditions. By contrast, visibility at the more southerly Brigantine site in New Jersey is substantially impaired even on the 20 percent clearest days. On the 20 percent haziest days, visibility impairment is substantial throughout the region.

Sulfate is the dominant contributor to fine particle pollution throughout the eastern U.S. On the haziest 20 percent of days, it accounts for one-half to two-thirds of total fine particle mass and is responsible for about three-quarters of total light extinction at Class I sites in the Northeast and Mid-Atlantic. Even on the clearest 20 percent of days, sulfate typically constitutes 40 percent or more of total fine particle mass in the region. Moreover, sulfate accounts for 60 to 80 percent of the difference in fine particle mass concentrations on hazy versus clear days.

Organic carbon consistently accounts for the next largest fraction of total fine particle mass;

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[3] The term "organic carbon" encompasses a large number of hydrogen and carbon containing molecules. Light scattering secondary organic aerosols result from the oxidation of hydrocarbons that are emitted from many different sources, ranging from automobiles to solvents, to natural vegetation. Organic carbon can be emitted as a primary particle from sources such as wood burning, meat cooking, automobiles, and paved road dust.

[4] "Fine particles" refers throughout this study to particles less than or equal to 2.5 micrometers in diameter, consistent with US EPA's fine particle National Ambient Air Quality Standard (NAAQS).

[5] "20 percent best visibility conditions" are defined throughout this report as the simple average of the lower 20th percentile of a cumulative frequency distribution of available data (expressed in deciviews). Similarly, "20 percent worst visibility conditions" represent the upper 20th percentile of the same distribution of available data.

its contribution typically ranges from 20 to 30 percent on the haziest days. Notably, organic carbon accounts for as much as 40 to 50 percent of total mass on the clearest days, indicating that biogenic hydrocarbon sources (i.e. vegetation) are important at Class I areas in the region.

The relative contributions of nitrate, elemental carbon, and fine soil are smaller than those of sulfate and organic carbon – typically less than 10 percent of total mass and varying with location. However, in some settings such as a monitoring site in Washington, DC,[6] nitrate plays a considerably larger role, pointing to the importance of local NO_X sources to fine-particle pollution in urban environments.

In the Northeast, the worst visibility tends to occur during the summer. New Hampshire's Department of Environmental Services found that about half of the worst visibility days in the New Hampshire Class I Areas occur in the summer when meteorological conditions are more conducive to the formation of sulfate from SO_2 and to the oxidation of organic aerosols. The remaining worst visibility days are divided nearly equally among spring, winter, and fall. In addition, winter and summer transport patterns are different, possibly leading to different contributions from upwind source regions. In contrast to sulfate and organic carbon, the nitrate contribution is typically higher in the winter months[7]. The crustal and elemental carbon fractions do not show a clear pattern of seasonal variation.

The basis for EPA's regional haze regulations is recognition that visibility impairment is fundamentally a regional phenomenon. Emissions from numerous sources over a broad geographic area commonly create hazy conditions across large portions of the eastern U.S. as a result of the long-range transport of airborne particles and precursor pollutants in the atmosphere. The key sulfate precursor, SO_2, for example, has an atmospheric lifetime of several days and is known to be subject to transport distances of hundreds of miles. NO_X and some organic carbon species are also subject to long-range transport, as are small particles of soot and crustal material.

The importance of transport dynamics is well illustrated by a particularly severe haze episode that occurred in mid-July of 1999. During this episode, unusually hot and humid conditions coincided with the development of a high-pressure system over the Mid-Atlantic States that produced atmospheric stagnation over the heavily urbanized, southern portion of the northeastern Regional Planning Organization region (i.e., Philadelphia - DC - southern New Jersey). At the same time, wind patterns above the area of stagnation brought a steady flow of air from the Midwest into the New England states. This set of conditions resulted in several days of unusually high concentrations of fine-particle pollution throughout the region. On July 17, 1999, ambient sulfate concentrations at Acadia National Park were 40 percent higher than any previous measurement at that site since the late 1980s. On the same day, visibility at the Burlington, Vermont, airport was limited to just 3 miles. As is often the case, high concentrations of ground-level ozone accompanied these severe haze conditions. These coinciding conditions occurred because haze and ground-level ozone – although they are fundamentally different phenomena – tend to form and accumulate under similar

[6] The Washington, DC, site is part of the IMPROVE nationwide monitoring network and is mentioned here for the purposes of comparison.

[7] This is largely due to the fact that the ammonium nitrate bond is more stable at lower temperatures. The role of ammonia in combination with both sulfate and nitrate is discussed further in later sections.

meteorological conditions.

1.4 Regulatory Framework

In amendments to the CAA in 1977, Congress added Section 169A (42 U.S.C. 7491), setting 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 manmade 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

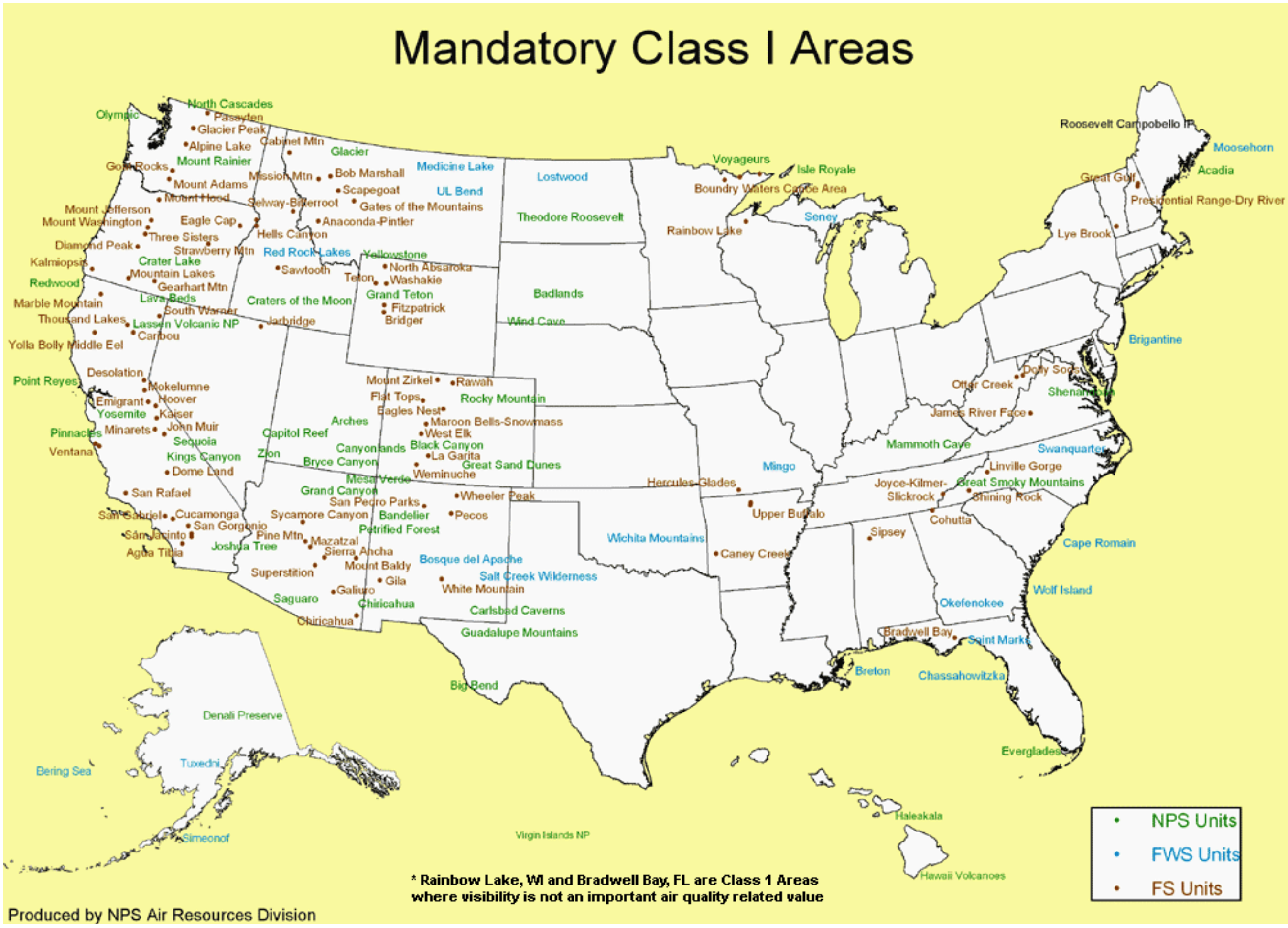
In 1980, Bradwell Bay, Florida, and Rainbow Lake, Wisconsin, were excluded for purposes of visibility protection as federal Class I areas. Today, 156 national park and wilderness areas remain as Class I visibility protection areas (Figure 1.2).

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, a localized phenomenon, and did little to address regional haze issues in the Eastern United States.

When the CAA was amended, again, in 1990, Congress added Section 169B (42 U.S.C. 7492), authorizing further research and regular assessments of progress made. 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. GCVTC submitted its report to EPA in June 1996, following four years of research and policy development. This report, as well as the many research reports prepared by the GCVTC, contributed invaluable information to EPA in its development of regulations for visibility improvement.

Figure 1.2: Locations of Federally Protected Mandatory Class I Areas



1.4.1 The Regional Haze Rule

The federal requirements that states must meet to achieve national visibility goals are contained in the Code of Federal Regulations (CFR), 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). 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 large geographic region. This wide-reaching pollution net means that many states – even those without Class I Areas – are required to participate in haze reduction efforts. The specific requirements for States' regional haze SIPs are set forth in 40 CFR 51.308, Regional Haze Program Requirements.

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 regional haze issue. The Mid-Atlantic and Northeast states, joined by the District of Columbia and tribes in the Northeast, formed the Mid-Atlantic / Northeast Visibility Union

(MANE-VU).[8]

EPA's adoption of the Regional Haze Rule faced several legal challenges. 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 the Regional Haze Rule. The Court remanded the BART provisions of the rule to EPA and denied industry's challenge to the haze rule goals of achieving natural visibility levels and zero degradation. 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 D.C. 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).

In the aftermath of these decisions, EPA's final rulemaking incorporated the following changes to the Regional Haze Rule:

- Revised the regulatory text in 40 CFR 51.308(e)(2)(i) in response to the *CEED* court's remand, to
  - Remove the requirement that the determination of BART be based on cumulative visibility analyses, and
  - Clarify the process for making such determinations, including the application of BART presumptions for electric generating units (EGUs) as contained in 40 CFR 51, Appendix Y;
- Added new regulatory text in 40 CFR 51.308(e)(2)(vi) to provide minimum elements for cap-and-trade programs in lieu of BART; and
- Revised regulatory text in 40 CFR 51.309 to reconcile the optional framework for certain Western states and tribes to implement the recommendations of the GCVTC with the *CEED* decision.

1.4.2 State Implementation Plan

EPA prepared a checklist summarizing the requirements of the final Regional Haze Rule to be addressed in Regional Haze SIPs. Attachment A contains a copy of that checklist with cross-references to sections of Connecticut's Regional Haze SIP showing how the requirements have been met.

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

[8] MANE-VU includes the following member states: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and the District of Columbia. A more complete description of MANE-VU appears in Section 3.0 of this SIP.

40 CFR 51.308(f) requires the CTDEP to submit periodic revisions to its Regional Haze SIP by July 31, 2018, and every ten years thereafter. **CTDEP acknowledges and will comply with this schedule.**

40 CFR 51.308(g) requires CTDEP to submit a report to EPA every 5 years that evaluates progress toward the reasonable progress goal for each mandatory Class I area located outside the state that may be affected by emissions from within the state. **CTDEP will submit the first progress report, in the form of a SIP revision, within 5 years from the date of final submittal of this initial State Implementation Plan.**

As required by 40 CFR 51.308(d)(4)(v), **CTDEP will also make periodic updates to Connecticut's emissions inventory** (see Section 6.0, Emissions Inventory). CTDEP proposes to use the most updated inventory to coincide with the progress reports.

Finally, as required by 40 CFR 51.308(h), **CTDEP 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, CTDEP will take one or more of the following actions at that time, whichever actions are appropriate or necessary:

- If CTDEP determines that the existing State Implementation Plan requires no further substantive revision in order to achieve established goals for visibility improvement and emissions reductions, CTDEP will provide to the EPA Administrator a negative declaration stating that further revision of the existing plan is not needed.
- If CTDEP 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, Connecticut will provide notification to the EPA Administrator and to those other state(s). Connecticut 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 Connecticut's plan.
- If CTDEP determines that its implementation plan is or may be inadequate to ensure reasonable progress as a result of emissions from sources in another country, CTDEP will provide notification, along with available information, to the EPA Administrator.
- If CTDEP determines that the implementation plan is or may be inadequate to ensure reasonable progress as a result of emissions from sources within the state, CTDEP will revise its implementation plan to address the plan's deficiencies within one year from this determination.

2.0 AREAS CONTRIBUTING TO REGIONAL HAZE

40 CFR 51.308(3)(iii) of the Regional Haze Rule requires states to determine their contributions to visibility impairment at mandatory Class I areas. Through source apportionment modeling (more fully described in Section 8.0, Understanding the Sources of Visibility-Impairing Pollutants), MANE-VU has 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 complete findings are contained 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, otherwise known as the Contribution Assessment (Attachment B).

The regional modeling performed by MANE-VU used a pollutant tagging scheme to produce a comprehensive assessment of the individual contributions from 28 nearby states to visibility impairment at the northeastern Class I areas and two other Class I areas. The modeling also provided a partial accounting of the contributions from several states along the western and southern edges of the modeling domain (i.e., boundary conditions) where only a portion of the states’ emissions were tracked. Modeling was conducted for the base year 2002 and then projected to year 2018, when currently anticipated emission control programs would be in place.

Modeling results indicate that the relative contributions of states within the modeling domain will decrease significantly by 2018 as a result of anticipated SO_2 emission reductions from implementation of existing state programs, revision of the federal Clean Air Interstate Rule (CAIR), and additional state and federal control measures described in following sections of this document. At the same time, there will be large *increases* in the *relative* contributions from Canada and the boundary areas. These predicted increases are due simply to the fact that contributions from outside the modeling domain will represent a larger share of the total after the various emission control programs have reduced contributions from within the domain.

2.1 Class I Areas Affected by Connecticut’s Emission Sources

Connecticut does not contain any Class I areas. Emission sources within Connecticut have had measurable impacts on visibility at Class I areas at downwind locations. The magnitude of these impacts is described in detail in MANE-VU’s Contribution Assessment (Attachment B). Table 2.1 briefly lists the affected Class I areas and Connecticut’s percent contribution to total annual sulfate at each area in the 2002 baseline year, as determined from the modeling.

Table 2.1: Connecticut's Contributions to Total Annual Average Sulfate Impact (Percent, Mass Basis) at Eastern Class I Areas in 2002

Mandatory Class I Area(s)	Percent Contribution
Great Gulf Wilderness* & Presidential Range–Dry River Wilderness*	0.48
Acadia National Park*	0.76
Moosehorn Wilderness* & Roosevelt Campobello International Park*	0.56
Lye Brook Wilderness*	0.55
Brigantine Wilderness*	0.53
Shenandoah National Park	0.08
Dolly Sods Wilderness	0.04

*MANE-VU Class I Area

Connecticut's emissions account for less than 1 percent of visibility-impairing sulfate in the downwind Class I areas of Great Gulf Wilderness & Presidential Range-Dry River Wilderness, Acadia National Park, Moosehorn Wilderness & Roosevelt Campobello International Park, and Lye Brook Wilderness. Also, Connecticut's emissions account for less than 1 percent of visibility-impairing sulfate in the more southerly Class I areas of Brigantine Wilderness, Shenandoah National Park, and Dolly Sods Wilderness.

Table 2.2 shows Connecticut's SO_2 annual impacts at northeast Class I Areas as compared with other MANE-VU states. Connecticut consistently has one of the smallest impacts on all northeast Class I Areas when considering all MANE-VU states.

Table 2.2: Percent Contributions (Mass Basis) of Individual States and Regions to Total Annual Sulfate Impacts at Northeast Class I Areas (REMSAD)

Contributing State or Region	Mandatory Class I Area						
	Acadia ME	Brigantine NJ	Dolly Sods WV	Great Gulf & Presidential Range – Dry River, NH	Lye Brook VT	Moosehorn & Roosevelt Campobello ME	Shenandoah VA
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
MANE-VU	36.17	34.83	14.81	27.83	31.78	30.08	20.59
MRPO	11.98	18.16	30.26	20.10	21.48	10.40	26.84
VISTAS	8.49	21.99	36.75	12.04	13.65	6.69	33.86
CenRAP	0.88	1.12	1.58	1.65	1.67	0.82	1.48
Canada	8.69	7.11	3.90	14.84	12.43	7.85	4.75
Other	33.79	16.78	12.70	23.54	18.99	44.17	12.48

Source: Table 8-1 of the MANE-VU Contribution Assessment

Note: Indicated percent contributions from VISTAS, CenRAP and Canada apply only to those portions lying within the modeling domain (see Figure 7.1). Actual contributions, especially from CenRAP, would be higher than stated.

The ranking of emission contributions to visibility impairment in the MANE-VU Class I Areas has direct relevance to the consultation process described in Section 3.0, Regional Planning and Consultation. Using results from the REMSAD model, MANE-VU applied the following three criteria to identify states and regions for the purposes of consultation on regional haze:

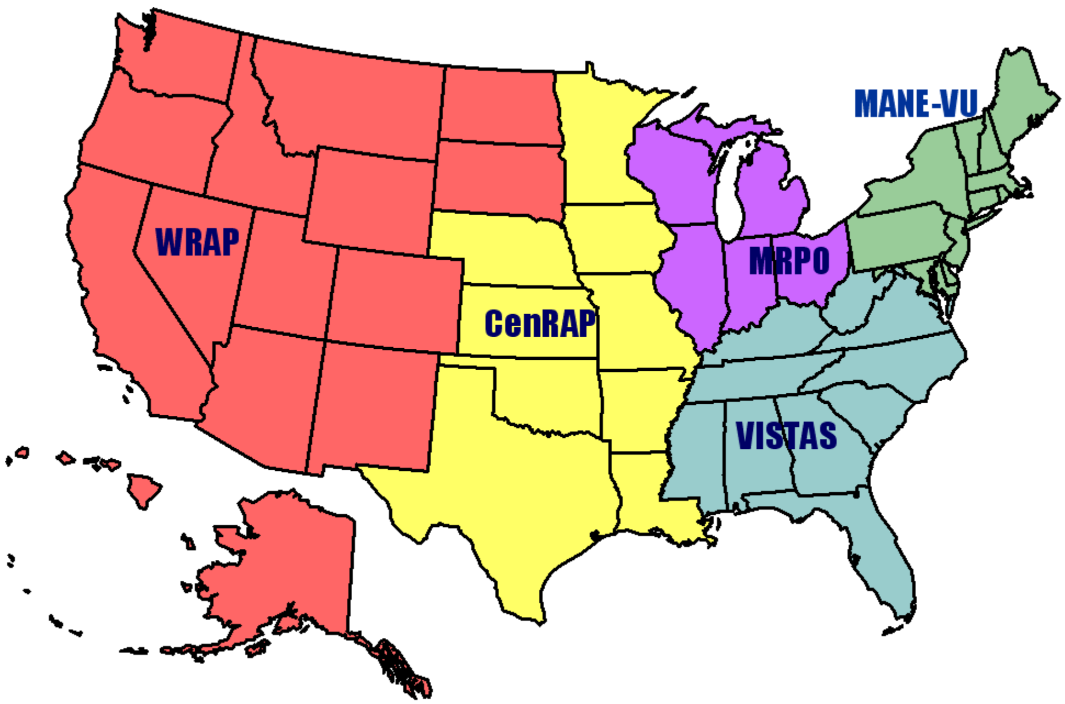
1. Any state/region that contributed 0.1 $\mu g/m^3$ sulfate or greater on the 20 percent worst visibility days in the base year (2002),
2. Any state/region that contributed at least 2 percent of total sulfate observed on the 20 percent worst visibility days in 2002, and
3. Any state/region among the top ten contributors on the 20 percent worst visibility days in 2002.

For the purposes of deciding how broadly to consult, the MANE-VU States settled on the second of the three criteria: any state/region that contributed at least 2 percent of total sulfate observed on the 20 percent worst visibility days in 2002. Connecticut, Rhode Island, Vermont, and the District of Columbia were not identified as being among the political or regional units contributing at least 2 percent of sulfate at any of the seven Class I areas. However, as participants in MANE-VU, those entities have agreed to pursue adoption of regional control measures aimed at visibility improvement on the haziest days and prevention of visibility degradation on the clearest days. Section 8.2 includes additional discussion regarding individual state contributions to regional haze at Class I areas.

3.0 REGIONAL PLANNING AND CONSULTATION

In 1999, EPA and affected states/tribes agreed to create five Regional Planning Organizations (RPOs) to facilitate interstate coordination on State Implementation Plans (SIPs) addressing regional haze. The RPOs, and states/tribes within each RPO, are required to consult on emission management strategies toward visibility improvement in affected Class I areas. As shown in the accompanying map (Figure 3.1), the five RPOs are 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). Connecticut is a member of MANE-VU.

Figure 3.1: EPA-Designated Regional Planning Organizations (RPOs).



3.1 Mid-Atlantic / Northeast Visibility Union (MANE-VU)

MANE-VU's work is managed by the Ozone Transport Commission (OTC) and carried out by OTC, the Mid-Atlantic Regional Air Management Association (MARAMA), and NESCAUM. The states, tribes, and federal agencies comprising MANE-VU are listed in Table 3.1. Individuals from the member states, tribes, and agencies, along with professional staff from OTC, MARAMA, and NESCAUM, make up the various committees and workgroups. MANE-VU also established a Policy Advisory Group (PAG) to provide advice to decision-makers on policy questions. EPA, Federal Land Managers, states, and tribes are represented on the PAG, which meets on an as-needed basis.

Table 3.1: MANE-VU Members

Connecticut	Rhode Island
Delaware	Vermont
Maine	District of Columbia
Maryland	Penobscot Nation
Massachusetts	St. Regis Mohawk Tribe
New Hampshire	U.S. Environmental Protection Agency*
New Jersey	U.S. Fish and Wildlife Service*
New York	U.S. Forest Service*
Pennsylvania	U.S. National Park Service*

*Non-voting member

Since its inception on July 24, 2001, MANE-VU has created 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) and the Communications Committee. While the work of these committees is instrumental to policies and programs, all policy decisions reside with and are made by the MANE-VU Board.

The TSC is 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. This committee has evolved to function as a valuable resource on all technical projects and issues for MANE-VU. The TSC has established a process to ensure that important regional-haze-related projects are completed in a timely fashion, and members are kept informed of all MANE-VU tasks and duties. In addition to the formal working committees, there are three standing workgroups of the TSC assigned by topic area: the Emissions Inventory Workgroup, the Modeling Workgroup, and the Monitoring/Data Analysis Workgroup.

The Communications Committee is charged with developing approaches to inform the public about the regional haze problem and making recommendations to the MANE-VU Board to facilitate that goal. This committee oversees the production of MANE-VU's newsletter and outreach tools, both for stakeholders and the public, regarding regional issues affecting MANE-VU's members.

3.2 Regional Consultation and the "Ask"

On May 10, 2006, MANE-VU adopted the Inter-RPO State/Tribal and FLM Consultation Framework (Attachment C). That document set forth the principles presented in Table 3.2. The MANE-VU states and tribes applied these principles to the regional haze consultation and SIP development process. Issues addressed included regional haze baseline assessments, natural background levels, and development of reasonable progress goals – described at length in later sections of this SIP.

Formal inter-regional consultation meetings took place on August 6, 2007, in Rosemont, Illinois, (for Midwestern states) and on August 20, 2007, in Atlanta, Georgia, (for Southern states). Consultation continues with the Midwestern states, seeking common approaches for reducing power plant emissions beyond the levels defined under the now-remanded federal CAIR rule, controls on industrial boilers, and cleaner-burning fuels for mobile sources. Ongoing consultation with MRPO focuses mainly on the health benefits of reducing ozone and small particulate emissions; however, the control measures being considered would also result in visibility improvements.

Throughout the consultation process, MANE-VU states were guided by the principals contained in a resolution adopted by the MANE-VU Class I states on June 7, 2007. In the resolution, the Class I states agreed to set reasonable progress goals for 2018 that would provide visibility improvement at least as great as that which would be achieved under a uniform rate of progress to reach natural visibility conditions by 2064. The goals would be set by the Class I states at levels reflecting implementation of measures determined to be reasonable after consultation with the contributing states. At the same time, the Class I states recognized that each state should be given the flexibility to choose other measures that achieve the same or greater benefits.

The final results of consultation efforts will ultimately rest with the individual states as they develop and implement their own regional haze SIPs. The other MANE-VU states have agreed to incorporate certain control measures into their SIPs, but most of these plans are still under development. For the non-MANE-VU states, the expectation is that the same or equivalent control measures will be included in those states plans. However, some states – particularly those within the VISTAS region – have already submitted draft SIPs that do not go as far in controlling emissions as MANE-VU would like. See Subsection 3.2.2.3 and Subsection 3.2.4, below, for further discussion related to the non-MANE-VU states.

Table 3.2: MANE-VU Consultation 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 among 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 RPOs'/States'/Tribes' requests for comments.

The following points identify several important ways in which MANE-VU member states and tribes have cooperatively addressed regional haze:

- *Prioritization*: MANE-VU developed a process to coordinate MARAMA, OTC, and NESCAUM staff in developing budget priorities, project rankings, and the eventual federal grant requests.
- *Issue Coordination*: MANE-VU established a conference call and meeting schedule for each of its committees and workgroups. In addition, its MANE-VU directors regularly discussed pertinent issues.
- *SIP Policy and Planning*: MANE-VU states/tribes collaborated on the development of a regional haze 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, Best Available Retrofit Technology (BART) applicability, inventory topics, modeling, and control measures were effective education and coordination tools.
- *Routine Operations*: MANE-VU staff at OTC, MARAMA, and NESCAUM established a coordinated approach to budget tracking, project deliverables and due dates, workgroup meetings, inter-RPO consultations, etc.

Both formal and informal consultations within MANE-VU have been ongoing since the organization's establishment in 2001; but the bulk of formal consultation took place in 2007, as outlined in Table 3.3. Further documentation of consultation meetings and calls is included in Attachment D.

Table 3.3: Summary of MANE-VU's Consultations on Regional Haze Planning

MANE-VU Intra-Regional Consultation Meeting, March 1, 2007:

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:

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:

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" (see Subsection 3.2.2 of this SIP), 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 EPA. Federal Land Managers also participated in the call. Upon approval, all three statements as well as the statement of principles adopted on June 7 were posted and publicly available on the MANE-VU website. The MANE-VU "Ask" was determined to represent the needs of all Class I areas both within the MANE-VU region and beyond, and was thus adopted as a goal for Connecticut.

MANE-VU Class I States' Consultation Open Technical Call, July 19, 2007:

The MANE-VU "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, held at LADCO offices in Chicago, was attended by representatives of MANE-VU and MRPO states as well as staff. The meeting provided an opportunity to formally present the MANE-VU "Ask" to MRPO states and to consult with them on 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, held at State of Georgia offices in Atlanta, was attended by representatives of MANE-VU and VISTAS states. The meeting provided an opportunity to formally present the MANE-VU "Ask" to VISTAS states and to consult with them on the reasonableness of the requested controls. Federal Land Manager agencies also attended the meeting.

MANE-VU / MRPO Consultation Conference Call, September 13, 2007:

As a follow-up to the meeting held on August 6 in Chicago, this call provided an opportunity for MANE-VU to clarify further what was being asked of the MRPO states. The flexibility in the "Ask" was explained. 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:

MANE-VU members clarified their understanding of the "Ask" and provided direction to modeling staff regarding interpretation of the "Ask" for purposes of estimating visibility impacts of the requested controls.

3.2.1 Connecticut-Specific Consultations

40 CFR 51.308(d)(3)(i) of the Regional Haze Rule requires the State of Connecticut to consult with other states/tribes to develop coordinated emission management strategies. This requirement applies both when emissions from a 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 at mandatory Class I areas within a state/tribe. Connecticut does not have any Class I areas.

Connecticut consulted with other states/tribes by participating in the MANE-VU and inter-RPO processes leading to the creation of coordinated strategies on regional haze. This coordinated effort considered the individual and aggregated impacts of states'/tribes' emissions on Class I areas within and outside the states/tribes.

As described in Section 2.0, Areas Contributing to Regional Haze, emissions originating in Connecticut have had, and will continue to have, impacts on other Class I areas in the region. Accordingly, Connecticut has entered into consultations with the states in which the affected Class I areas are located (Table 3.4).

Table 3.4: Class I Area States Requesting Consultation with Connecticut

Class I Federal Area	State / Province
Great Gulf Wilderness	New Hampshire
Presidential Range - Dry River Wilderness	New Hampshire
Acadia National Park	Maine
Moosehorn Wilderness	Maine
Roosevelt Campobello International Park	Maine
Lye Brook Wilderness	Vermont
Brigantine Wilderness	New Jersey

3.2.2 The MANE-VU "Ask"

In addition to having a set of guiding principles for consultation (as described in Table 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 the following pair of documents (available in Attachment E), 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 U.S.:

- "Statement of the Mid-Atlantic / Northeast Visibility Union (MANE-VU) Concerning a Course of Action within MANE-VU toward Assuring Reasonable Progress," and
- "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."

Together, these documents are known as the MANE-VU "**Ask**." Connecticut agrees to the language and substance of these documents, and is therefore pursuing emission reductions consistent with them. The particular emission management strategies that comprise the "Ask" are described in Subparts 3.2.2.1 through 3.2.2.3, below.

3.2.2.1 Meeting the "Ask" – MANE-VU States

The member states of MANE-VU have stated their intention to meet the terms of the "Ask" in their individual State Implementation Plans. The "Ask" for member states promises that each state will 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 reduce the sulfur content of distillate oil further 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 reduce the sulfur content of distillate oil further to 15 ppm by 2018, depending on supply availability;
- ***A targeted EGU strategy*** for 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; and
- ***Continued evaluation of other control measures***, including improvements in energy efficiency, use of alternative (clean) fuels, further control measures to reduce SO_2 and NO_X emissions from all coal-burning facilities by 2018, and new source performance standards for wood combustion. These and other measures will be evaluated during the consultation process to determine whether they are reasonable strategies to pursue.

⇨ **CTDEP supports the SIPs of each of its fellow MANE-VU states, provided that these commitments are incorporated into approvable State Implementation Plans.**

3.2.2.2 Meeting the "Ask" – Connecticut

Connecticut, being a MANE-VU member state, participated in the development of the MANE-VU "Ask" which was approved by the MANE-VU Board on June 20, 2007. Connecticut intends to meet the terms of this agreement as follows:

- By demonstrating BART equivalency through its existing regulations (for additional details, refer to Section 9.0, Best Available Retrofit Technology (BART)).

- All of Connecticut's BART-eligible sources, as well as all NO_x Budget Program/CAIR sources, meet the recommended residual oil content or use lower sulfur content residual oil than specified in MANE-VU's low-sulfur fuel oil strategy as a result of Regulations of Connecticut State Agencies section 22a-174-19a. In terms of a state-wide limitation of #4 residual oil to 0.25-0.5% 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, CTDEP has done a preliminary analysis of the potential number of sources impacted. Given regional fuel supply issues, such a limitation in Connecticut is dependent on multi-state implementation. CTDEP continues to participate in consultations with other MANE-VU states to develop a low sulfur heating strategy consistent with the MANE-VU "Ask".

- Section 16a-21a of the Connecticut General Statutes limits fuel sulfur content of heating distillate oil and off-road diesel oil to 500 ppm as of the date on which the last of the States New York, Massachusetts and Rhode Island limit the sulfur content of such fuels. Therefore, implementation of the 500 ppm limitation in Connecticut is contingent upon New York, Massachusetts and Rhode Island adopting a 500 ppm limitation for heating distillate oil and off-road diesel oil. Regarding the reduction of sulfur content of distillate oil to 15 ppm by 2018 component of the MANE-VU "Ask", Connecticut continues to work with other states in the region and the fuel industry to take steps to implement reductions consistent with the MANE-VU "Ask" in the most efficient and reasonable manner.

- None of Connecticut's EGUs fall on the list of the top 167 contributing EGU emission points.

- CTDEP is currently evaluating other control measures including energy efficiency, alternative clean fuels, and other measures to reduce SO_2 and NO_x emissions from all coal-burning facilities by 2018. CTDEP will evaluate new source performance standards for wood combustion.

CTDEP will provide an update of the progress towards meeting the MANE-VU "Ask" in its first progress report in support of this Regional Haze SIP, to be submitted five years from the date of final submittal of this SIP.

3.2.2.3 Meeting the "Ask" – States outside MANE-VU

Connecticut agrees with the MANE-VU "Ask" for consulting states outside the MANE-VU region. This "Ask" requests the affected states to pursue 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 strategy***, as described for the MANE-VU states, for the top 167 EGU stacks contributing the most to visibility impairment at mandatory Class I areas in the MANE-VU region, or an equivalent SO_2 emission reduction within each state;

- ***Installation of reasonable control measures on non-EGU sources*** by 2018 to achieve an additional 28 percent 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-VU's low-sulfur fuel oil strategy (see Section 11.0, Long-Term Strategy);
- ***Continued evaluation of other control measures***, including additional reductions in SO_2 and NO_X emissions from all coal-burning facilities by 2018 and promulgation of new source performance standards for wood combustion. These and other measures will be evaluated during the consultation process to determine whether they are reasonable strategies to pursue.

⇨ **CTDEP looks for each consulting state to address specifically, in its Regional Haze SIP, each element of the MANE-VU "Ask".**

CTDEP is concerned that non-MANE-VU states may be inclined not to adopt MANE-VU's "Ask" because of the associated costs, potential conflicts, and relative lack of perceived benefits within their jurisdictions. On the basis of consultations held, MANE-VU members believe that some non-MANE-VU states will choose not to pursue reductions beyond CAIR-equivalent controls and other measures pertaining to BART requirements. Connecticut understands that, among non-MANE-VU states that have already submitted their regional haze SIPs to EPA, a number of the affected states have decided not to address major elements of the MANE-VU "Ask" in their plans.

There are some positive developments, however. Many states of the MRPO are working with MANE-VU states to investigate the potential for widespread use of low-sulfur fuel oil and installation of emission controls on ICI boilers within their region. The Midwest states would be more likely than Southeast states to adopt a low-sulfur oil strategy because the VISTAS states do not have the same extent of fuel oil usage and lack the inventory infrastructure found in more northerly states. Both MRPO and VISTAS claim 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-equivalent requirements and not looking beyond this level of emission controls for additional emission reductions. Further discussion of these issues is provided in Subsection 3.2.4, below.

3.2.3 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 even a single update to one RPO's emissions required each of the other RPOs 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. Because each rendition put previous modeling efforts out of date, and a single modeling run could take more than a month to complete, inventory updates have contributed to SIP delays. Most states missed the required Regional Haze SIP filing date of December 17, 2007. The RPOs also took differing perspectives on which version of the EGU dispatching model to use. At the beginning of the process, ICF International's Integrated Planning Model (IPM) version 2.1.9 was available, and EPA agreed to its use for emissions preparation. Subsequently, IPM version 3.0 became available and was preferred by some users 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 also to remain with IPM v2.1.9. Therefore, for the three eastern RPOs, differing emissions assumptions eventually worked their way into the final set of modeling assumptions.

MANE-VU's most recent visibility projections take into account on-the-books/on-the-way (OTB/OTW) emissions control programs for 2018, and go further by including additional reasonable controls in the region, as developed through the 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 Connecticut's. Where that is the case, those states' modeling results will be inconsistent with meeting the terms of the "Ask" – a situation that may not be adequately addressed in their individual SIPs.

3.2.4 Consultation Issues

40 CFR 51.308(d)(1)(iv) of the Regional Haze Rule describes another consultation requirement for Class I states. 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 the states to 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 what actions were taken to resolve the disagreement. 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 visibility and health benefits. In particular, reductions in SO_2 emissions, because they would yield lower ambient concentrations of fine particle ($PM_{2.5}$) pollution, would help all MANE-VU states in meeting the NAAQS and would have direct benefits to public health and welfare.

A few non-MANE-VU states did not respond to MANE-VU Class I state's consultation requests or responded by downplaying the magnitude of their states' contributions to visibility impairment at MANE-VU's Class I areas. 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 needed to be considered. Also a concern for Connecticut is the possibility that some states may have performed modeling for establishment of reasonable progress goals without including the effects of a rigorous BART determination for the non-EGU sector. 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 F), VISTAS indicated that for its member states, most actions exceeding CAIR requirements would not be reasonable. MANE-VU has taken 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 a 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. Also, MANE-VU believes that low sulfur fuels – even though they are less widely available in the Southeast 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 10.0, Reasonable Progress Goals.

During the consultation process, disagreements such as these were worked through to the maximum extent possible, and the results of these consultations are summarized below:

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

  → *Outcome*: 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.

- *Situation*: The low-sulfur fuel oil strategy adopted by MANE-VU elicited concerns from MRPO and VISTAS as not being reasonable because of the limited availability of low-sulfur fuel oil and the historically lower usage of this fuel within their regions.

  → *Outcome*: MANE-VU agreed to modify the "Ask" to reflect greater flexibility in providing 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.

- *Situation*: MANE-VU received no response from other RPOs concerning non-EGU control measures that they did consider reasonable.

  → O*utcome*: As a default position, MANE-VU's modeling included emission adjustments for those regions based on MANE-VU's own analyses of what constituted reasonable control measures from non-EGU sources (see Section 10.0, Reasonable Progress Goals).

- *Situation*: 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.

→ *Outcome*: For the top contributing EGU stacks located within the MANE-VU, MRPO, and VISTAS 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 the now-remanded CAIR would have been the primary determinant of which EGUs among the top 167 stacks would have been fitted with emission controls, MANE-VU recognized that these units are the primary sources affecting visibility in the MANE-VU states. For the initial planning, MANE-VU has allowed flexibility as to how other RPOs meet the "Ask". However, 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 the levels of control that CAIR would have provided. MANE-VU therefore maintains that additional federal action is needed to achieve the visibility benefits shown to be feasible through sensitivity modeling (see Attachment G, "MANE-VU Modeling for Reasonable Progress Goals: Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits," February 7, 2008) and demonstrated to be available at reasonable cost (see Attachment H, 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 E.

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. Connecticut 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.

3.2.5 State/Tribe and Federal Land Manager Coordination

CTDEP will continue to coordinate and consult with the Federal Land Managers (FLMs) during the development of future progress reports and plan revisions, as well as during the implementation of programs having the potential to contribute to visibility impairment in the mandatory Class I areas.

40 CFR 51.308(i) of the Regional Haze Rule requires coordination between states/tribes and the 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. Connecticut has identified agency contacts to the FLMs as required under 40 CFR 51.308(i)(1). Connecticut has consulted with the FLMs in the development of this plan and, in accordance with 40 CFR 51.308(i)(2), has provided the FLMs an opportunity for consultation, in person, at least 60 days prior to holding any public hearing on the SIP. This SIP was submitted to the FLMs on February 4, 2009 for review and comment.

Pursuant to 40 CFR 51.308(i)(3), Connecticut has requested and received comments on this SIP from the Federal Land Managers. CTDEP received written preliminary comments from the U.S. Department of the Interior (DOI), National Park Service (NPS) and U.S. Fish and Wildlife Service (USFWS) on March 16, 2009. A conference call to discuss the agencies' comments was held on March 18, 2009, with representatives from NPS, the U.S. Forest Service (USFS), USFWS, EPA, and CTDEP. Final comments from DOI – NPS and USFWS were received in a letter dated April 3, 2009 and final comments from the USFS were received in a letter dated April 8, 2009 (both sets of comments were received prior to the public hearing). The comments received from the FLMs and responses by CTDEP and a summary of the conference call are included in Attachment I of this plan. All of these documents were made available for public review during the comment period for this SIP (Note: The MANE-VU states also received comments from other stakeholders during the planning process; their comments can be found in Attachment J. *[Both attachments will be available after the comment period.]*

The comments submitted by the FLMs were both general and specific; CTDEP appreciates the effort put forth by the FLMs. The comments were very helpful and will greatly assist CTDEP in developing an effective and approvable Regional Haze SIP. The NPS and USFWS were concerned that the draft SIP did not include an analysis for the full adoption of the MANE-VU Ask and they also recommended that additional demonstrations of the adequacy of the alternative BART approach be provided. The USFS stated that overall, Connecticut has done a commendable job compiling the Regional Haze SIP and addressing the requirements of the Regional Haze Rule. Comments of a specific nature from the FLMs were relatively minor for the most part. CTDEP's responses to the agencies' comments are addressed point-by-point in the response document contained in Attachment I.

40 CFR 51.308(i)(4) requires procedures for continuing consultation between the states/tribes and FLMs on the implementation of the visibility protection program. In particular, CTDEP will consult with the designated visibility protection program coordinators for the National Park Service, U. S. Fish and Wildlife Service, and the U.S. Forest Services periodically and as circumstances require, on the following implementation items.

1. Status of emissions strategies identified in the SIP as contributing to improvements in the worst-day visibility;
2. Summary of major new source permits issued;
3. Status of CTDEP's actions toward completing any future assessments or rulemakings on sources identified as probable contributors to visibility impairment, but not directly addressed in the most recent SIP revision;
4. Work underway for preparing the 5-year SIP review and/or 10-year SIP revision, including any items where the FLMs' consideration or support is requested; and

5. Summary of topics discussed in ongoing communications (e.g., meetings, emails, etc.) between CTDEP and the FLMs regarding implementation of the visibility improvement program.

3.2.6 EPA Consultation and Review

Connecticut has consulted with EPA in the course of regional haze modeling and plan development, and EPA has provided specific input regarding completion of the draft SIP. On May 22, 2008, CTDEP received written comments from EPA on a draft of the BART section of the regional haze SIP that was submitted for preliminary review. On April 3, 2009, CTDEP received additional written comments from EPA on a version of CTDEP's draft regional haze SIP, identical to the draft SIP reviewed by the FLMs. Connecticut has addressed EPA's comments by making appropriate amendments to the draft SIP, all of which are incorporated into the present document. EPA's specific comments and CTDEP's responses are included in Attachment I.

4.0 ASSESSMENT OF BASELINE AND NATURAL VISIBILITY CONDITIONS

Pursuant to 40 CFR 51.308(d)(2) of the Regional Haze Rule, states must determine baseline and natural visibility conditions for each Class I area within their jurisdictions. This information allows states to assess current levels of visibility degradation and provides a basis for setting reasonable progress goals toward restoration of natural visibility conditions in Class I areas.

The effectiveness of any plan to reduce regional haze in Class I areas is dependent on the availability of reliable data. The Interagency Monitoring of Protected Visual Environments (IMPROVE) program was established in 1985 to provide the data necessary to support the creation of Federal and State implementation plans for the protection of visibility in Class I areas. IMPROVE has made it possible to assess current visibility conditions, track changes in visibility, and identify the chemical species and emission sources responsible for visibility impairment. In particular, IMPROVE data were used to calculate baseline and natural conditions for MANE-VU Class I Areas.

The IMPROVE monitors listed in Table 4.1 provide data representative of Class I Areas in the MANE-VU region.

Table 4.1: IMPROVE Monitors for MANE-VU Class I Areas

IMPROVE Site / Location	Class I Area(s) Served	Latitude, Longitude	State
ACAD1 Acadia National Park	Acadia National Park	44.38, -68.26	Maine
MOOS1 Moosehorn Wilderness	Moosehorn Wilderness Roosevelt Campobello International Park	45.13, -67.27	Maine
GRGU1 Great Gulf Wilderness	Great Gulf Wilderness Presidential Range – Dry River Wilderness	44.31, -71.22	New Hampshire
LYBR1 Lye Brook Wilderness	Lye Brook Wilderness	43.15, -73.13	Vermont
BRIG1 Brigantine National Wildlife Refuge	Brigantine National Wildlife Refuge	39.47, -74.45	New Jersey

http://www.vista.circa.colostate.edu/views/; http://vista.cira.colostate.edu/improve/

4.1 Calculation Methodology

In September 2003, EPA issued guidance for the calculation of natural background and baseline visibility conditions. The guidance provided a default method and described certain refinements that states might consider in order to tailor their estimates to any Class I areas not adequately represented by the default method. At that time, MANE-VU calculated natural visibility for each of the MANE-VU Class I Areas using the default method for the 20 percent best and 20 percent worst visibility days. MANE-VU also evaluated ways to refine the estimates. Potential refinements included 1) increasing the multiplier used to calculate impairment attributed to carbon, 2) adjusting the formula used to calculate the 20 percent best and worst visibility days, and 3) accounting for visibility impairment caused by 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 to visibility assessment. Therefore, default estimates were used with the understanding that this methodology would be reconsidered upon demonstrated improvements in the science.

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

Several comments supported the proposed approach in general; other comments were divided among four main topics: 1) the equation used to calculate visibility, 2) the statistical technique used to estimate the 20 percent best and worst visibility days, 3) the inclusion of transboundary effects and fires, and 4) the timing as to when new information should be included. All comments were reviewed and summarized by MANE-VU; and air directors were briefed on comments, proposed response options, and implications. Attachment J provides a compilation of comments received and a summary of stakeholders' comments.

MANE-VU's position on natural background conditions was presented in a report issued in June 2004 (see Attachment K, "Natural Background Visibility Conditions: Considerations and Proposed Approach to the Calculation of Natural Background Visibility Conditions at MANE-VU Class I Areas," June 10, 2004). The report stated, "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 scientific basis for these revisions was well understood, and the Committee determined that the revisions improved the performance of the equation at reproducing observed visibility at Class I sites.

In 2006, MANE-VU conducted an assessment of the default and alternative approaches for calculation of baseline and natural background conditions at MANE-VU Class I Areas. Based on that assessment, in December 2006, MANE-VU recommended adoption of the alternative reconstructed extinction equation for use in the regional haze SIPs. (See Attachment L, "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 2006.) MANE-VU will continue to participate in further research efforts on this topic and will reconsider the calculation methodology as scientific understanding evolves.

4.2 MANE-VU Baseline Visibility

The IMPROVE program has calculated the 20 percent best and 20 percent worst baseline (2000-2004) and natural visibility conditions using the EPA-approved alternative method described above for each MANE-VU Class I Area. The data are posted on the Visibility Information Exchange Web System (VIEWS) operated by the regional planning organizations. The information can be accessed at http://vista.cira.colostate.edu/views/) and is summarized in Table 4.2 below. Displayed are the five-year average baseline visibility values for the period 2000-2004, natural visibility levels, and the difference between baseline and natural visibility values for each of the MANE-VU Class I Areas. The difference columns (best and worst) are of particular interest because they describe the magnitude of visibility impairment attributable to manmade emissions, which are the focus of the Regional Haze Rule.

The five-year averages for 20 percent best and worst visibility were calculated in accordance with 40 CFR 51.308(d)(2), as detailed in NESCAUM's Baseline and Natural Background document found in Attachment L.

Table 4.2: Summary of Baseline Visibility and Natural Visibility Conditions for the 20 Percent Best and 20 Percent Worst Visibility Days at MANE-VU Class I Areas

Class I Area(s)	2000-2004 Baseline (deciviews)		Natural Conditions (deciviews)		Difference (deciviews)	
	Best 20%	Worst 20%	Best 20%	Worst 20%	Best 20%	Worst 20%
Acadia National Park	8.8	22.9	4.7	12.4	4.1	10.5
Moosehorn Wilderness and Roosevelt Campobello International Park	9.2	21.7	5.0	12.0	4.1	9.7
Great Gulf Wilderness and Presidential Range – Dry River Wilderness [9]	7.7	22.8	3.7	12.0	3.9	10.8
Lye Brook Wilderness	6.4	24.5	2.8	11.7	3.6	12.7
Brigantine Wilderness	14.3	29.0	5.5	12.2	8.8	16.8

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

[9] Based on 4-year average for 2001-2004 (data collection in 2000 was for summer only).

5.0 AIR MONITORING STRATEGY

In the mid-1980's, the Interagency Monitoring of Protected Visual Environments (IMPROVE) program 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 have since merged under the name 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.

5.1 IMPROVE Program Objectives

The IMPROVE program provides scientific documentation of the visual air quality of America's wilderness areas and national parks. Many individuals and organizations – land managers; industry planners; scientists, including university researchers; public interest groups; and air quality regulators – use the data collected at IMPROVE sites to understand and protect the visual air quality resource in Class I areas. Major objectives of the IMPROVE program include the following:

- 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, and
- Provide regional haze monitoring for all visibility-protected federal Class I areas where practical, as required by EPA's Regional Haze Rule.

5.2 Monitoring Requirements

EPA's Regional Haze Rule establishes air monitoring requirements that affected states must meet to assess visibility impairment caused by regional haze in Class I areas. The following describes how Connecticut is complying with specific sections of the rule:

- 40 CFR 51.308(d)(4) 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. Connecticut does not have any Class I areas, so this requirement is not applicable. This monitoring strategy must be coordinated with the additional requirements of 40 CFR 51.305 (reasonably attributable visibility impairment (RAVI)), which are not applicable to Connecticut either.
- 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. Connecticut does not have any Class I areas, so this requirement is not applicable.
- 40 CFR 51.308(d)(4)(iii) requires, for a state with no mandatory Class I areas, procedures by which monitoring data and other information are used to determine the

state's contribution of emissions to visibility impairment at mandatory Class I areas outside the state. Connecticut's contributions are summarized in Subsection 2.1 of this SIP and are documented in a detailed technical analysis prepared by NESCAUM entitled, "Contributions to Regional Haze in the Northeast and Mid-Atlantic United States," August 2006 (Attachment B). The NESCAUM study used various tools and techniques to assess the contributions of individual states and regions to visibility degradation in Class I areas within and outside MANE-VU.

- 40 CFR 51.308(d)(4)(iv) requires a state to submit visibility monitoring data annually for each Class I area in the state and, if possible, to provide the data in electronic format. Connecticut does not have any Class I areas, so this requirement is not applicable.
- 40 CFR 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 areas. Section 6.0, Emissions Inventory, addresses this requirement.
- 40 CFR 51.308(d)(4)(vi) requires that SIPs provide other elements, including reporting, recordkeeping, and other measures necessary to assess and report on visibility. While Connecticut believes the current IMPROVE network is sufficient to adequately measure and report progress toward the regional haze goals set for MANE-VU's Class I areas, CTDEP in the past has found additional monitoring information to be useful in assessing patterns of regional visibility and fine particle pollution. Examples of these data sources include:

  - The MANE-VU RAIN network, which provides continuous, speciated information on rural aerosol characteristics and visibility parameters;
  - The EPA CASTNET program, 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 Speciation Trends Network (STN) methods (the latter program comprising 54 monitoring stations located mainly in or near larger metropolitan areas); and
  - The Supersites program, which has undertaken special studies to expand knowledge of the processes that control fine particle formation and transport in the region.

Assuming adequate resources, CTDEP will continue using these and other data sources for the purposes of understanding visibility impairment and documenting progress toward national visibility goals for Class I areas under the Regional Haze Rule. CTDEP agrees that the IMPROVE network is an appropriate monitoring network to track regional haze progress and encourages EPA to continue funding the IMPROVE network. CTDEP will work with other states and the FLMs to maintain the IMPROVE network to the extent resources are available.

5.3 Monitoring Sites for MANE-VU Class I Areas

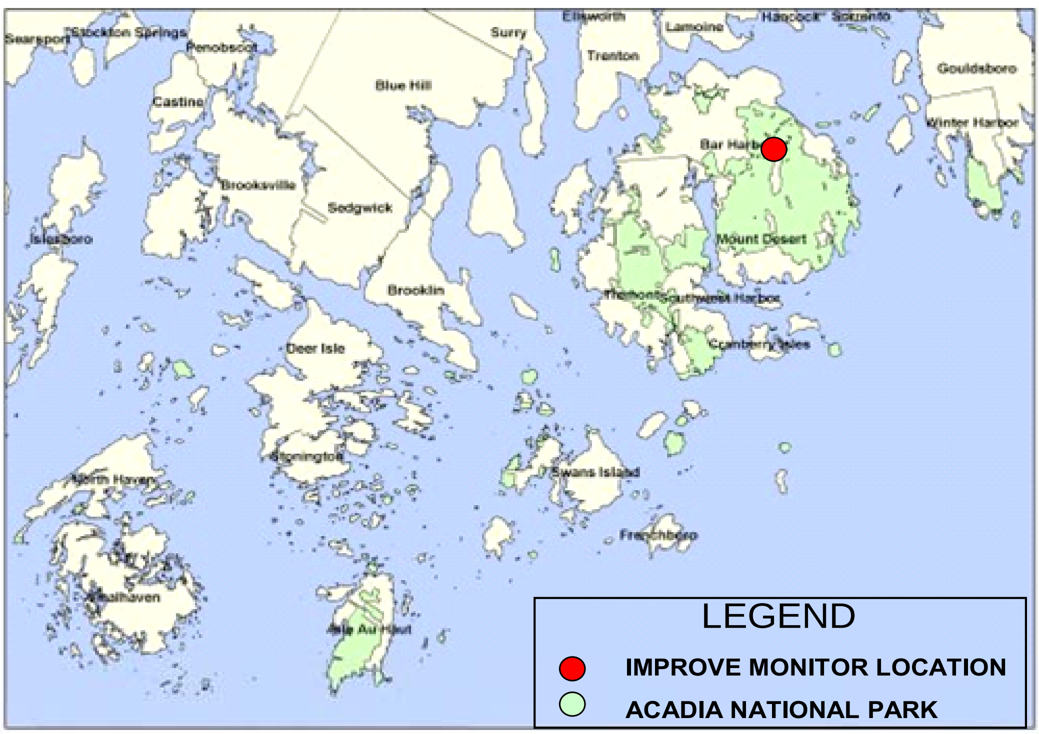
IMPROVE monitoring sites have been established for each of the Class I areas in the region.

The Great Gulf Wilderness and Presidential Range-Dry River Wilderness share a single monitoring site. Moosehorn Wilderness and Roosevelt Campobello International Park also share a monitoring site. Each of the other MANE-VU Class I Areas has its own monitoring site.

5.3.1 Acadia National Park, Maine

The IMPROVE monitor for Acadia National Park (ACAD1) is located at park headquarters, near Bar Harbor, Maine, at elevation 157 meters, latitude 44.38˚, and longitude -68.26˚. This monitor is operated and maintained by the National Park Service. Connecticut considers the ACAD1 site as adequate for assessing reasonable progress toward visibility goals at Acadia National Park, and no additional monitoring sites or equipment are necessary at this time.

Figure 5.1: Map of Acadia National Park Showing Location of IMPROVE Monitor



Created by Tom Downs, MEDEP 4/17/07

http://www.maine.gov/dep/air/meteorology/images/Acadia.jpg

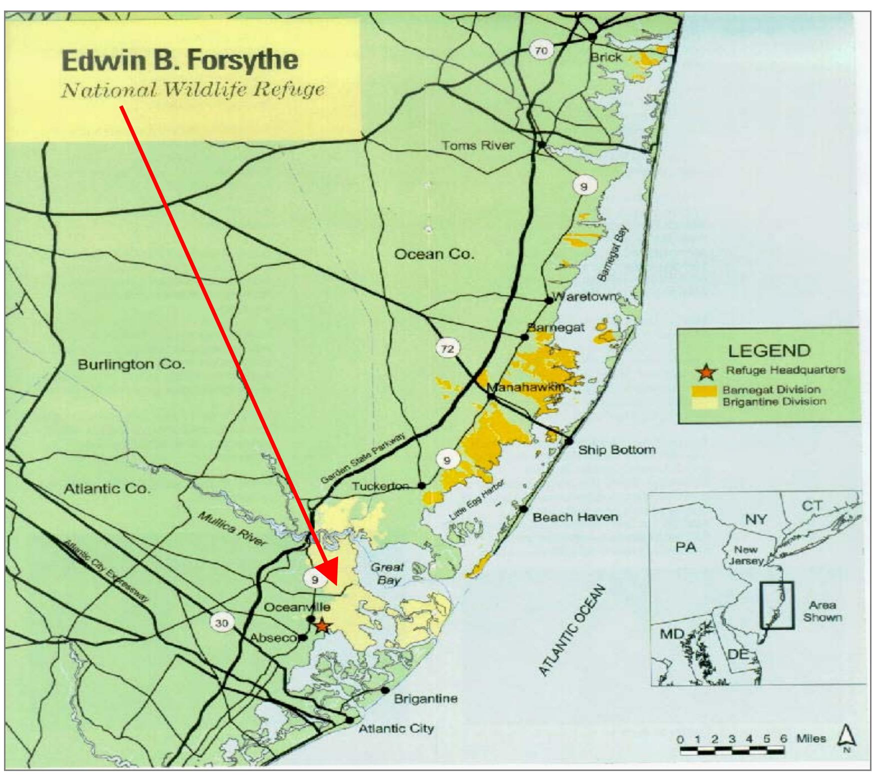
Figure 5.2: Acadia National Park on Clear and Hazy Days

http://www.hazecam.net/class1/acadia.html

5.3.2 Brigantine Wilderness, New Jersey

The IMPROVE monitor for the Brigantine Wilderness (BRIG1) is located at the Edwin B. Forsythe National Wildlife Refuge Headquarters in Oceanville, New Jersey, at elevation 5 meters, latitude 39.47˚, and longitude -74.45˚. This monitor is operated and maintained by the U.S. Fish & Wildlife Service. Connecticut considers the BRIG1 site as adequate for assessing reasonable progress toward visibility goals at the Brigantine Wilderness, and no additional monitoring sites or equipment are necessary at this time.

Figure 5.3: Map of Edwin B. Forsythe National Wildlife Refuge



http://www.fws.gov/northeast/forsythe/MAP.htm

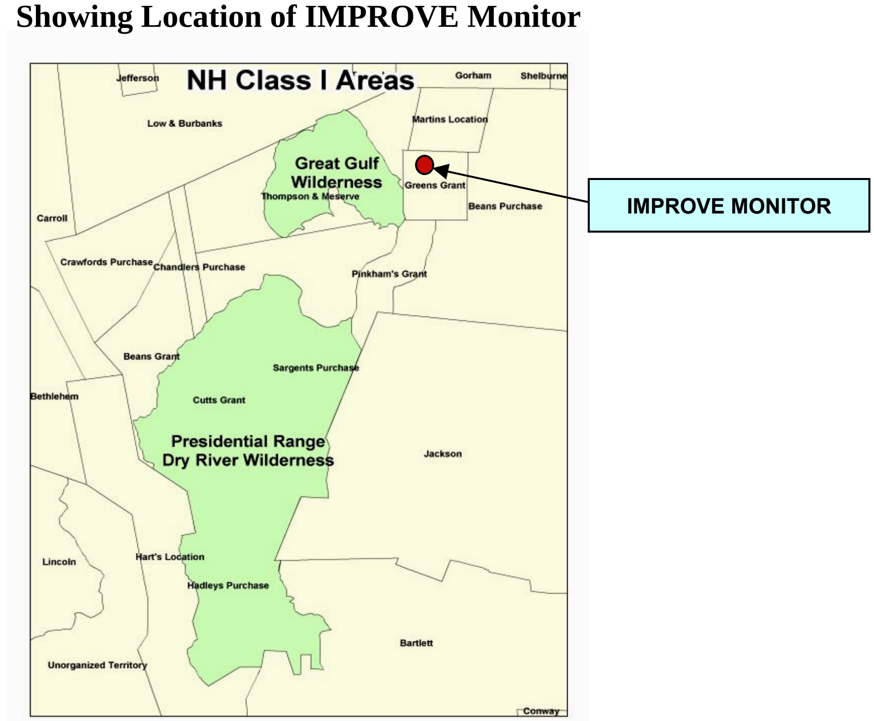
Figure 5.4: Brigantine Wilderness on Clear and Hazy Days

http://www.hazecam.net/class1/brigantine.html

5.3.3 Great Gulf Wilderness, New Hampshire

The IMPROVE monitor for the Great Gulf Wilderness (GRGU1) is located at Camp Dodge, in the mid-northern area of Greens Grant in the White Mountain National Forest. The monitor site lies just east and south of where Route 16 crosses the Greens Grant / Martins Location boundary, south of Gorham, New Hampshire, at elevation 454 meters, latitude 44.31˚, and longitude of -71.22˚. This monitor, which also represents the Presidential Range – Dry River Wilderness (see 5.3.4 below), is operated and maintained by the U.S. Forest Service. Connecticut considers the GRGU1 site as adequate for assessing reasonable progress toward visibility goals at the Great Gulf Wilderness, and no additional monitoring sites or equipment are necessary at this time.

Figure 5.5: Map of Great Gulf and Presidential Range – Dry River Wilderness Areas Showing Location of IMPROVE Monitor



http://www.maine.gov/dep/air/meteorology/images/NHclass1.jpg

Figure 5.6: Great Gulf Wilderness on Clear and Hazy Days

http://www.wilderness.net

5.3.4 Presidential Range – Dry River Wilderness, New Hampshire

The IMPROVE monitor for the Presidential Range – Dry River Wilderness is also the monitor for Great Gulf Wilderness (GRGU1), as described above. Connecticut considers the GRGU1 site as adequate for assessing reasonable progress toward visibility goals at the Presidential Range – Dry River Wilderness, and no additional monitoring sites or equipment are necessary at this time.

Figure 5.7: Presidential Range – Dry River Wilderness in Autumn

http://www.wilderness.net

5.3.5 Lye Brook Wilderness, Vermont

The IMPROVE monitor for the Lye Brook Wilderness (LYBR1) is located on Mount Equinox at the windmills in Manchester, Vermont, at elevation 1015 meters, latitude 43.15˚, and longitude of -73.13˚. The monitor does not lie within the wilderness area but is situated on a mountain peak across the valley to the west of the wilderness area. The IMPROVE site and the Lye Brook Wilderness are at similar elevations. The monitor is operated and maintained by the U.S. Forest Service. Connecticut considers the LYBR1 site as adequate for assessing reasonable progress toward visibility goals at the Lye Brook Wilderness, and no additional monitoring sites or equipment are necessary at this time.

Figure 5.8: Location of Lye Brook Wilderness IMPROVE Monitor

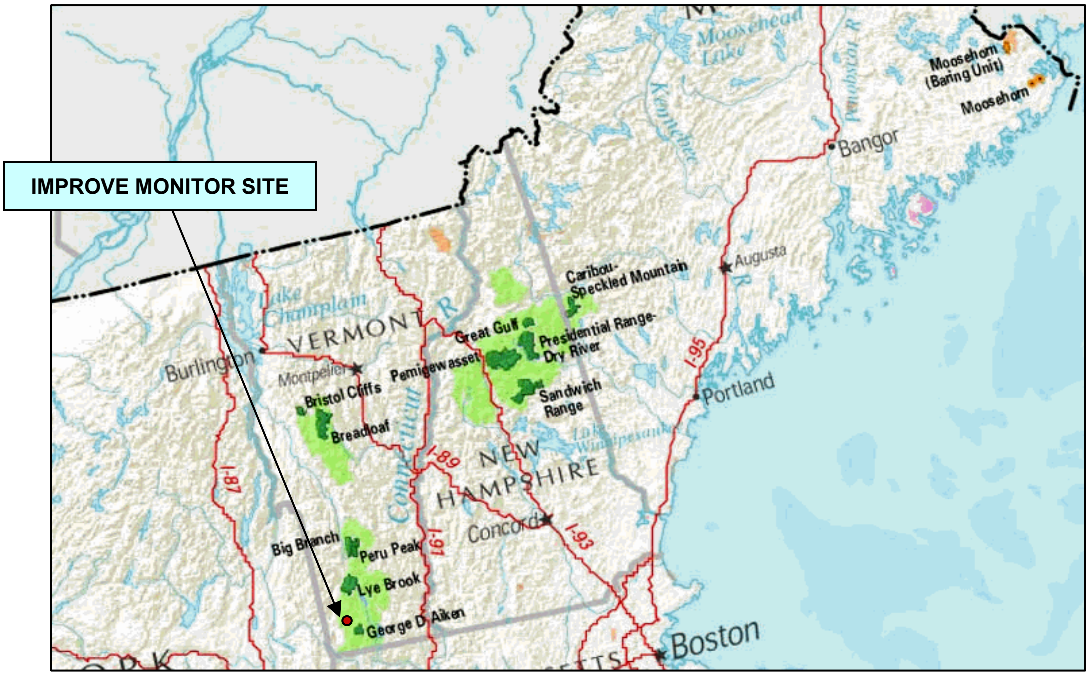
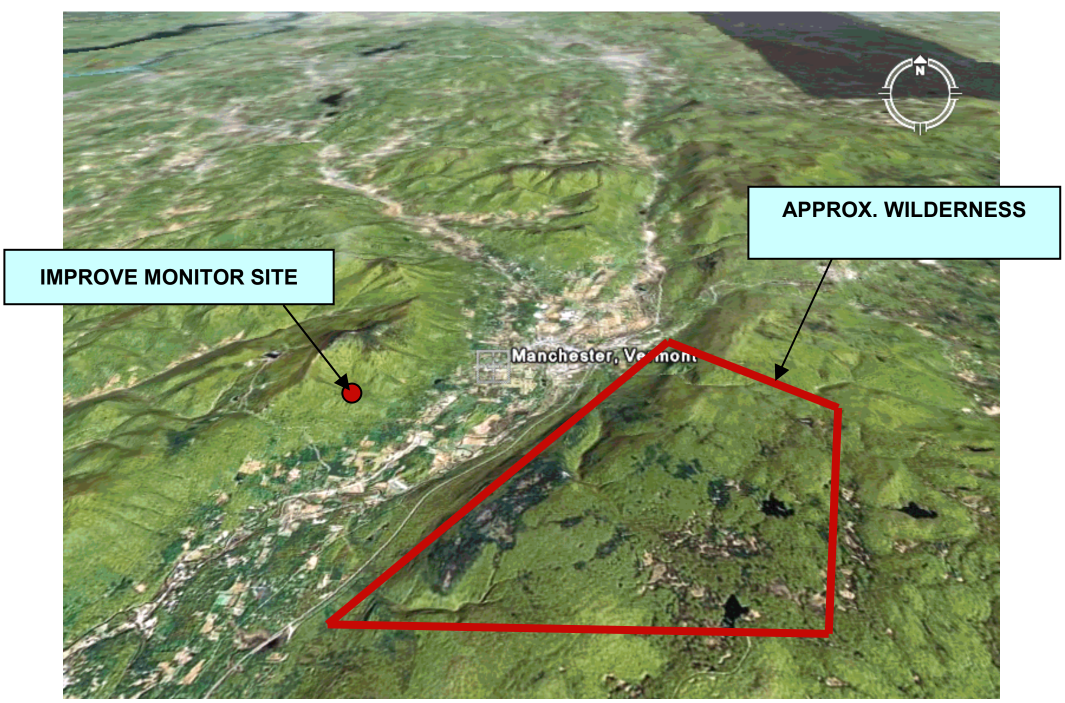
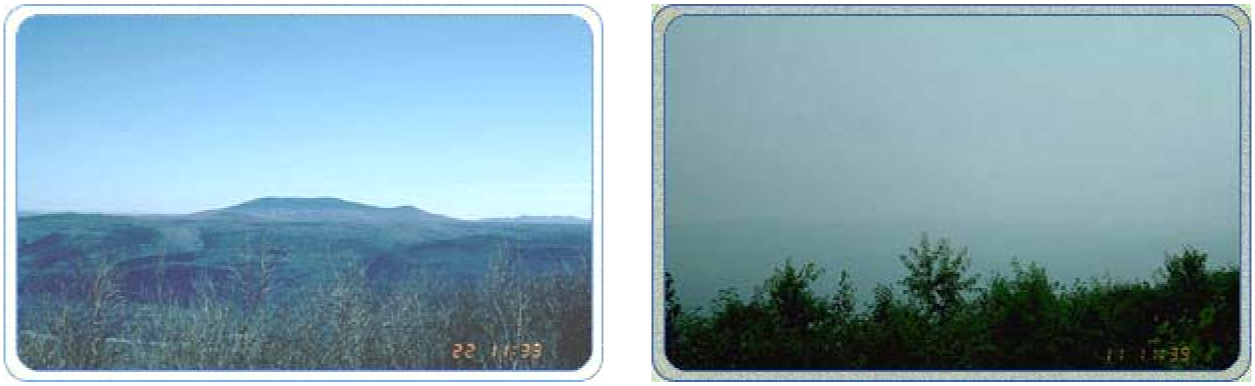


Figure 5.9: Aerial View of Lye Brook Wilderness IMPROVE Monitoring Site



sources: GoogleEarth: and Paul Wishinski Vermont DEC, Air Pollution Control Division

Figure 5.10: Lye Brook Wilderness on Clear and Hazy Days



http://www.hazecam.net/class1/lye.html

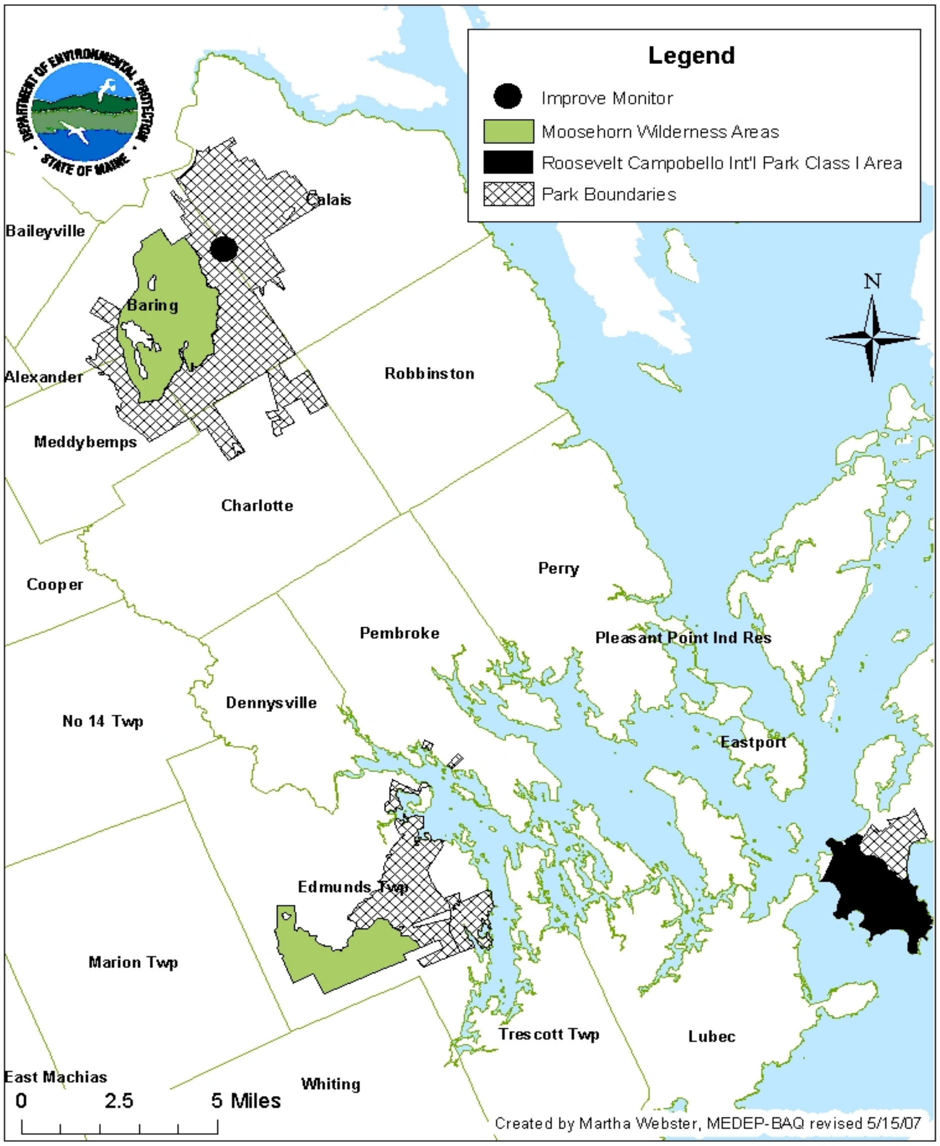
5.3.6 Moosehorn Wilderness, Maine

The IMPROVE monitor for the Moosehorn Wilderness (MOOS1) is located near McConvey Road, about one mile northeast of the National Wildlife Refuge Baring (ME) Unit Headquarters, at elevation 78 meters, latitude 45.13˚, and longitude -67.27˚. This monitor also represents the Roosevelt Campobello International Park in New Brunswick, Canada. The monitor is operated and maintained by the U.S. Fish & Wildlife Service. Connecticut considers the MOOS1 site as adequate for assessing reasonable progress toward visibility goals at the Moosehorn Wilderness, and no additional monitoring sites or equipment are necessary at this time.

Figure 5.11: Moosehorn Wilderness on Clear and Hazy Days

http: //www.hazecam.net/moosehorn.html

Figure 5.12: Map of the Baring and Edmunds Divisions of the Moosehorn National Wildlife Refuge Showing Location of IMPROVE Monitor



5.3.7 Roosevelt Campobello International Park, New Brunswick, Canada

The IMPROVE monitor for Roosevelt Campobello International Park is also the monitor for the Moosehorn Wilderness (MOOS1), as described above. Connecticut considers the MOOS1 site as adequate for assessing reasonable progress toward visibility goals at Roosevelt Campobello International Park, and no additional monitoring sites or equipment are necessary at this time.

Figure 5.13: Map of Roosevelt Campobello International Park

http://www.maine.gov/dep/air/meteorology/images/rcip.jpg

Figure 5.14: Roosevelt Campobello International Park on Clear and Hazy Days

source: Chessie Johnson

6.0 EMISSIONS INVENTORY

40 CFR 51.308(d)(4)(v) of EPA's Regional Haze Rule requires a statewide emissions inventory of pollutants that are reasonably anticipated to cause or contribute to visibility impairment in any mandatory Class I area. The inventory must include emissions for a baseline year, future (projected) year, and the most recent year for which data are available. Connecticut's baseline year, 2002, is also the most recent year for which data are available. The pollutants inventoried include nitrogen oxides (NO_X), sulfur dioxides (SO_2), volatile organic compounds (VOCs), fine particles (particulate matter less than 2.5 micrometers in diameter, or $PM_{2.5}$), coarse particles (particulate matter less than 10 micrometers in diameter, or PM_{10}), and ammonia (NH_3). The following source categories were included in the emissions inventory: stationary point sources, stationary area sources, on-road mobile sources, non-road mobile sources, and biogenic sources. These emissions categories are discussed further in Subsection 7.3, Model Platforms.

6.1 Baseline and Future-Year Emissions Inventories for Modeling

40 CFR 51.308(d) (3) (iii) of EPA's Regional Haze Rule requires the State of Connecticut to identify the baseline emissions inventory on which emission control strategies are founded. The baseline inventory is intended to be used for assessing progress in making emission reductions. In accordance with EPA's guidance memorandum "2002 Base Year Emission Inventory SIP Planning: 8-hour Ozone, $PM_{2.5}$, and Regional Haze Programs," November 18, 2002, all of the MANE-VU states are using 2002 as the baseline year for regional haze.

Previously, on February 1, 2008, Connecticut submitted its 2002 baseline inventory to EPA to meet its implementation planning obligations under the 8-hour ozone program. It should be noted, however, that emissions inventories are not static documents, but are constantly revised and updated to reflect the input of better emissions estimates as they become available. With contractor assistance, MARAMA developed a 2002 baseline modeling inventory using the inventories that Connecticut 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. As described in Subsection 6.1.1 below, work on this effort underwent several versions. Therefore, the 2002 baseline emissions summarized in this document may differ slightly from Connecticut's original 2002 baseline inventory submittal.

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 Connecticut's and other states' 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 Subsection 6.4, 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 Community Mesoscale Air Quality (CMAQ) and Regional Model for Aerosols and Deposition (REMSAD) air quality models described in Subsection 7.3. Further description of the base and future-year emissions inventories is provided below.

6.1.1 Baseline Inventory (2002)

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 CERR. With contractor assistance (E.H. Pechan & Associates, Inc.,), 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. 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, also known as the Baseline Emissions Report (Attachment M). Emissions inventory data files are available on the MARAMA website at: http://www.marama.org/visibility/EI_Projects/index.html.

6.1.2 Future-Year Emissions 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, also known as the Emission Projections Report (Attachment N). 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; and
  - 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 (sometimes referred to as "best-and-final") to account for additional potentially reasonable control measures. For the MANE-VU region, these include: SO_2 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 Best Available Retrofit Technology (BART) strategy for BART-eligible sources not controlled under other programs.

  (Note: Refer to Section 11.0, Long-Term Strategy, for detailed descriptions of specific control strategies.)
- ***Pollutants*:** ammonia, carbon monoxide (CO), oxides of nitrogen (NO_X), sulfur dioxide (SO_2), volatile organic compounds (VOCs), fine particulate matter ($PM_{2.5}$, sum of filterable and condensable components), and coarse particulate matter (PM_{10}, sum of filterable and condensable components).
- ***States*:** Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont, plus the District of Columbia (all members of the MANE-VU region).

6.2 Emission Processor Selection and Configuration

The Sparse Matrix Operator Kernel Emissions (SMOKE) model was used to format the emissions inventories for use with the air quality models that are discussed in Subsection 7.3. SMOKE is primarily 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, SMOKE's 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. The SMOKE emissions processing that was performed in support of the air quality modeling for regional haze is described further in Subsection 7.2.

6.3 Inventories for Specific Source Categories

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

- Stationary point,
- Stationary area,
- Non-road mobile,
- On-road mobile, and
- Biogenic.

Stationary point sources are large sources that emit greater than a specified tonnage per year, as described below. ***Stationary area sources*** are those sources whose individual emissions are relatively small (i.e., dry cleaners, service stations, agricultural areas, fires, etc.), but because of the large number of these sources, their collective emissions are significant. ***Non-road mobile sources*** are equipment that can move but do not use the roadways (i.e., lawn mowers, construction equipment, railroad locomotives, marine vessels, aircraft, etc.). ***On-road mobile sources*** include automobiles, trucks, buses, and motorcycles that use the roadway system. ***Biogenic sources*** include natural sources such as trees, crops, grasses, and natural decay of plants.

The subsections below give 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.

6.3.1 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 parameters. Emissions estimates for point sources are usually made on a regular basis, and the largest point sources are inventoried annually. Sources with emissions greater than or equal to 100 tons per year (tpy) of a criteria pollutant (Connecticut threshold is 25/50 tpy for NO_x and VOC, depending on the non-attainment area), 10 tpy of a single hazardous air pollutant (HAP), or 25 tpy for total HAPs are considered to be major sources. Emissions from smaller point sources are also calculated individually but less frequently. Point sources are further subdivided into EGUs and non-EGUs.

6.3.1.1 Electric Generating Units (EGUs)

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. See Chapter II, Section A.2.a.i of the "Technical Support Document for 2002 MANE-VU SIP Modeling Inventories", Version 3 (Attachment M) for a discussion of the quality assurance steps performed on the CEM data that were included in the 2002 baseline modeling inventory. 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 (see Attachment H for emission summaries) 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 NO_X and SO_2 caps, Connecticut 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. 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. No operating status adjustments were made to Connecticut sources.

- 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 (none are located in Connecticut). This approach, known as the targeted EGU strategy, is further described in Section 11.0 of this SIP.

6.3.1.2 Non-EGU Point Sources

The primary basis for the 2002 baseline non-EGU emissions inventory was data reported by state and local agencies for the CERR. As described in Subsection 6.1.1, 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 M).

Projected non-EGU point source emissions were developed for the MANE-VU region by MACTEC Federal Programs, Inc. under contract to Mid-Atlantic Regional Air Management Association (MARAMA). The specific methodologies that were employed are described in Section 2 of the Emission Projections Report (Attachment N). 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 programs to account for the expected emissions reductions that will take place under the OTB/OTW and BOTW scenarios.

6.3.2 Stationary Area Sources

Stationary area sources include sources whose individual emissions are relatively small but, because the number of sources is large, their collective emissions are significant. Some examples include dry cleaners, service stations, and residential heating. For each area source, emissions are estimated by multiplying an appropriate emission factor by some known indicator of collective activity, such as fuel usage, 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 M).

In 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 Emission Projections Report (Attachment N). 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.

6.3.3 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, and lawn & garden equipment. For the majority of non-road mobile sources, emissions are estimated using the EPA's NONROAD model. Aircraft, railroad locomotives, and commercial marine vessels are not included in the NONROAD model; and 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 M).

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 N). MACTEC used EPA's NONROAD2005 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 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 matter, and regional haze analyses (i.e. 2009, 2012, and 2018), MACTEC used linear interpolation to develop factors for the required future years.

6.3.4 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-traveled (VMT) by emission factors developed using the EPA's MOBILE6 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 the other emissions 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 model inputs for the applicable calendar years. Using the inputs supplied by the MANE-VU member states, NESCAUM compiled and generated the required SMOKE/MOBILE6 emissions 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 O).

6.3.5 Biogenic Emission Sources

For the purposes of the 2002 baseline modeling emissions inventory, biogenic emissions 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 (Attachment P), and in Chapter VI of Pechan's "Technical Support Document for 2002 MANE-VU SIP Modeling Inventories," Version 3, November 20, 2006 (Attachment M). 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.

6.4 Summary of Emissions Inventories

Connecticut's baseline and future-year emissions inventories are summarized in Tables 6.1 and 6.2, below. All values are reported in tons per year (tpy).

Table 6.1: Connecticut 2002 Emissions Inventory Summary (tpy)

Emission Sector	VOC	NO_X	$PM_{2.5}$	PM_{10}	NH_3	SO_2
EGU Point	303	6,150	461	627	--	13,550
Non-EGU Point	4,604	6,773	822	990	--	2,438
Area	87,302	12,689	14,247	48,281	5,318	12,418
Mobile	31,755	68,816	1,042	1,580	3,294	1,667
Non-Road Mobile	33,880	25,460	1,794	1,952	16.6	2,087
Biogenic	64,017	560	--	--	--	--
TOTAL	221,861	120,448	18,366	53,430	8,629	32,160

Descriptions of how the Connecticut 2002 specific emissions were generated can be found in Attachment M (EGU Point, Non-EGU Point – pages 20, 43; Area – pages 58-59; Mobile – pages 97-99; Non-Road Mobile – pages 77, 84; and Biogenic – page 117).

Table 6.2: Connecticut 2018 RPG (Best and Final) Emissions Inventory Summary (tpy)

Emission Sector	VOC	NO_X	$PM_{2.5}$	PM_{10}	NH_3	SO_2
EGU Point	145	3,418	927	959	341	6,697
Non-EGU Point	4,227	7,501	937	1,104	--	2,068
Area	68,395	11,795	9,635	20,511	5,061	534
Mobile	10,768	14,787	500	567	3,872	366
Non-Road Mobile	20,694	16,233	1,135	1,236	20	815
Biogenic	64,017	560	--	--	--	--
TOTAL	168,246	54,294	13,134	24,377	9,294	10,480

Note: Emission estimates for all MANE-VU states are archived at ftp.marama.org (User Name: mane-vu; Password: exchange).

Descriptions of Connecticut-specific adjustments to the 2018 RPG (Best and Final) Emissions Inventory can be found in Attachment N (Non-EGU Point source growth factors – page 2-5, control measures – pages 5-3 through 5-6; and Area growth factors – page 3-4, control measures - pages 3-9, 5-20 through 5-22) and Attachment O (Mobile source activity input data and scenario input files – page 3, SMOKE-related files – page 4). No Connecticut-specific adjustments were made to the EGU Point, Non-Road Mobile and Biogenic inventories.

Note that total ammonia emissions in 2018 are projected to increase slightly from total ammonia emissions in 2002. This can likely be attributed to a projected increase in vehicle miles traveled and projected increase in EGU Point NH_3 emissions (possibly from projected installation of SCR controls on one or more units).

CTDEP will be preparing a periodic emission inventory on a three year schedule as required by EPA and these emissions will be used to track how the projected emissions compare to actual emissions in the first five-year regional haze SIP progress report and required SIP revision due in 2018.

7.0 AIR QUALITY MODELING

Air quality modeling to assess regional haze has been performed within MANE-VU, with major modeling being conducted by NESCAUM and screening modeling being conducted by NHDES. These modeling efforts include emissions processing, meteorological input analysis, and chemical transport modeling to perform regional air quality simulations for calendar year 2002 and several future periods, including the primary target date, 2018, for this SIP. Modeling was conducted in order to assess contributions from upwind areas as well as Connecticut's contribution to Class I areas in downwind states. Further, the modeling evaluated visibility benefits of specific control measures being considered to achieve reasonable progress goals and establish a long-term emissions management strategy for MANE-VU Class I Areas.

Several modeling tools were utilized for these analyses:

- 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 Puff Model (CALPUFF) was used to assess the contribution of individual states' emissions to sulfate levels at selected Class I receptor sites.

Each of these tools has been evaluated and found to perform adequately. 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 G). The detailed modeling approach for the most recent 2018 projections can be found in NESCAUM's "2018 Visibility Projections," May 13, 2008 (Attachment Q).

7.1 Meteorology

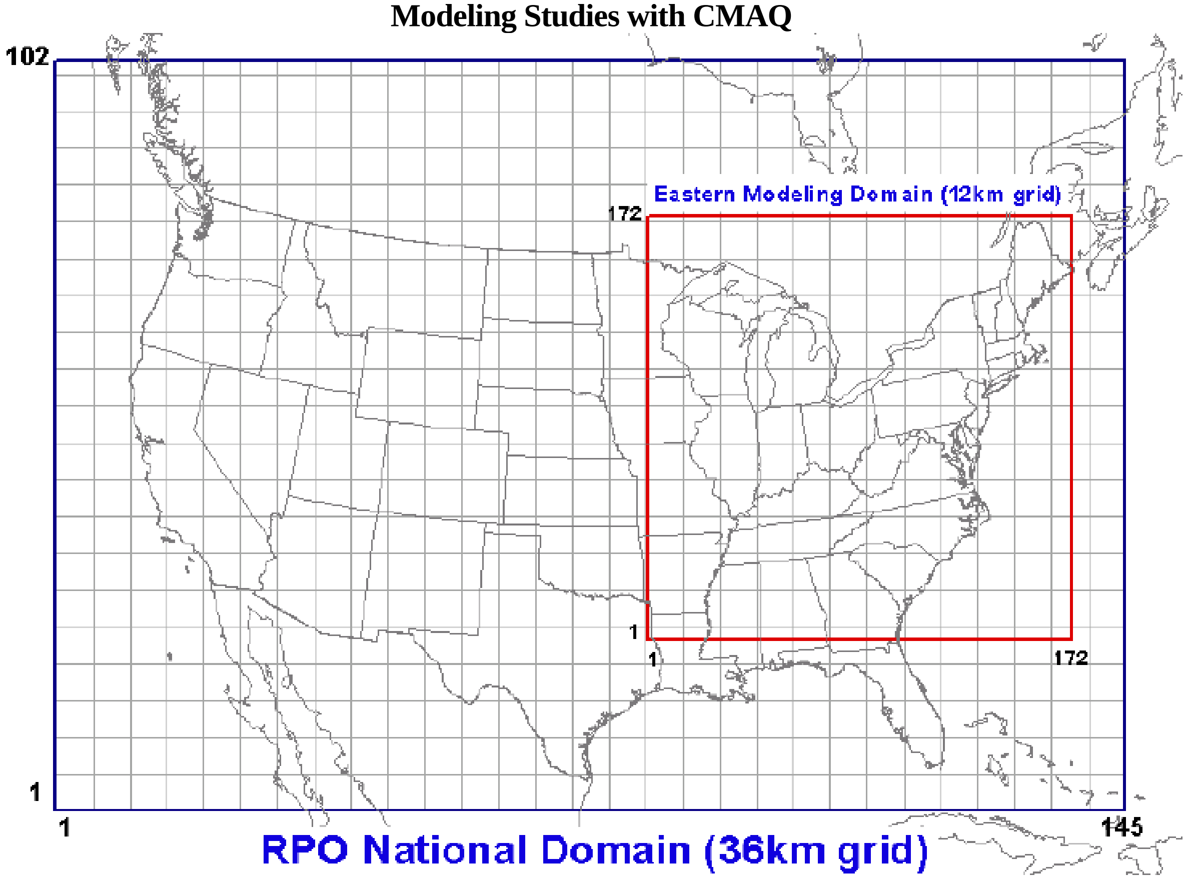
The meteorological inputs for the air quality simulations were developed by the University of Maryland (UMD) using the MM5 meteorological modeling system. Meteorological inputs were generated for 2002 to correspond with the baseline emissions inventory and analysis year. The MM5 simulations were performed on a nested grid (Figure 7.1). The modeling domain is composed of a 36-km, 145 x 102 continental grid and a nested 12-km, 172 x 172 grid encompassing the eastern United States and parts of Canada. In cooperation with the New York State Department of Conservation (NYSDEC), an assessment was made for the period of May-September 2002 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.

The analyses shows that in general, the performance of the MM5 is reasonable both at the surface and in the vertical, thereby providing confidence in the use of these data in the CMAQ simulations.

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 R), 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 G).

Figure 7.1: Modeling Domains Used in MANE-VU Air Quality Modeling Studies with CMAQ



Note: Outer (blue) domain is 36-km grid. Inner (red) domain is 12-km grid. Gridlines are shown at 180-km intervals (5×5 36-km cells and 15×5 12-km cells).

7.2 Data Preparations

Emissions data 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 in Figure 7.2.

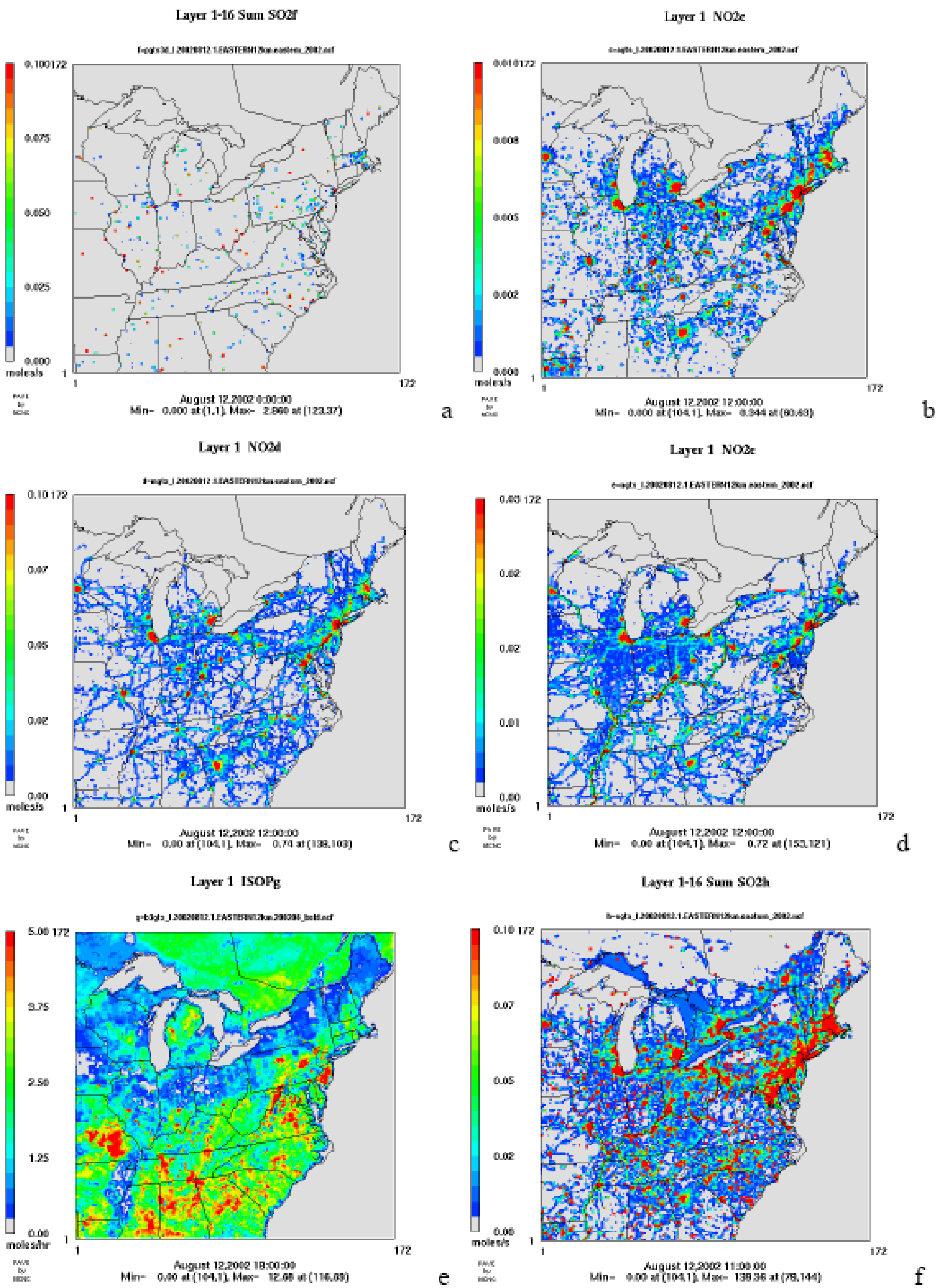
Further details on the SMOKE processing conducted in support of the air quality simulations is provided in NYSDEC's technical support document TSD-1c, "Emission Processing for the Revised 2002 OTC Regional and Urban 12 km Base Case Simulations," September 19, 2006 (Attachment P), and in NESCAUM's report, "MANE-VU Modeling for Reasonable Progress Goals, Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits," February 7, 2008 (Attachment G). Additional details on the emissions inventory preparation can be found in Section 6.0 of this report.

7.3 Model Platforms

Two regional-scale air quality models, CMAQ and REMSAD, were used for the air quality simulations that directly supported the regional haze SIP effort. CMAQ was developed by EPA and was used to perform the primary SIP-related modeling. The CMAQ modeling simulations were also an important tool for the 8-hour ozone SIP process. REMSAD was developed by ICF Consulting/Systems Applications International with support from EPA. REMSAD was used by NESCAUM to perform a source apportionment (contribution assessment) analysis. All of the air quality simulations that were used in the SIP efforts were performed on the 12-km eastern modeling domain shown in Figure 7.1 above.

NYSDEC performed an extensive model performance analysis to evaluate CMAQ model predictions against observations of ozone, $PM_{2.5}$, and other pollutant species. In general, the CMAQ results were best for daily maximum O3 and daily average PM2.5 and SO4 mass. Many other species vary tremendously 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. It is important to demonstrate that the model performs reasonably over the diurnal cycle, not just in terms of daily maximum or average values. Also, it is important to demonstrate that the model can reproduce concentrations above the ground level. This model performance evaluation is 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 S). 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. A model performance evaluation for $PM_{2.5}$ species, aerosol extinction coefficient, and the haze index is 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 G).

Figure 7.2: 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, and (f) SO_2 from all Source Categories



7.3.1 CMAQ

The CMAQ air quality simulations were performed cooperatively among five modeling centers: 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 7.1; 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 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 T). 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 G).

7.3.2 REMSAD

The REMSAD modeling simulations were used to produce the contribution assessment required by the Regional Haze Rule. REMSAD's species tagging capability makes it an important tool for this purpose. The REMSAD model simulations were performed on the same 12-km eastern modeling domain as shown in Figure 7.1. NESCAUM's report, "MANE-VU Modeling for Reasonable Progress Goals, Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits," February 7, 2008 (Attachment G), further describes the REMSAD model and its application to the regional haze SIP efforts.

7.3.3 CALGRID

In addition to the SIP-quality modeling platforms described above, another 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 comparable to the performance of the already evaluated CMAQ and REMSAD models and was thus determined to perform adequately.

Conversion utilities were developed to reformat the meteorological inputs, the boundary conditions, and the emissions data for use with the CALGRID modeling platform. Pre-merged SMOKE emissions files were obtained from the modeling centers and reformatted 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. Additional information on the CALGRID modeling platform can be found in NHDES' "Modeling Protocol for the OTC CALGRID Screening-Level Modeling Platform for the Evaluation of Ozone," May 23, 2007 (Attachment U).

7.3.4 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 B).

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8.0 UNDERSTANDING THE SOURCES OF HAZE-CAUSING POLLUTANTS

This section explores the origins, quantities, and roles of visibility-impairing pollutants emitted in the eastern United States and Canada that contribute significantly to regional haze at MANE-VU's mandatory Class I areas.

8.1 Fine-Particle Pollutants

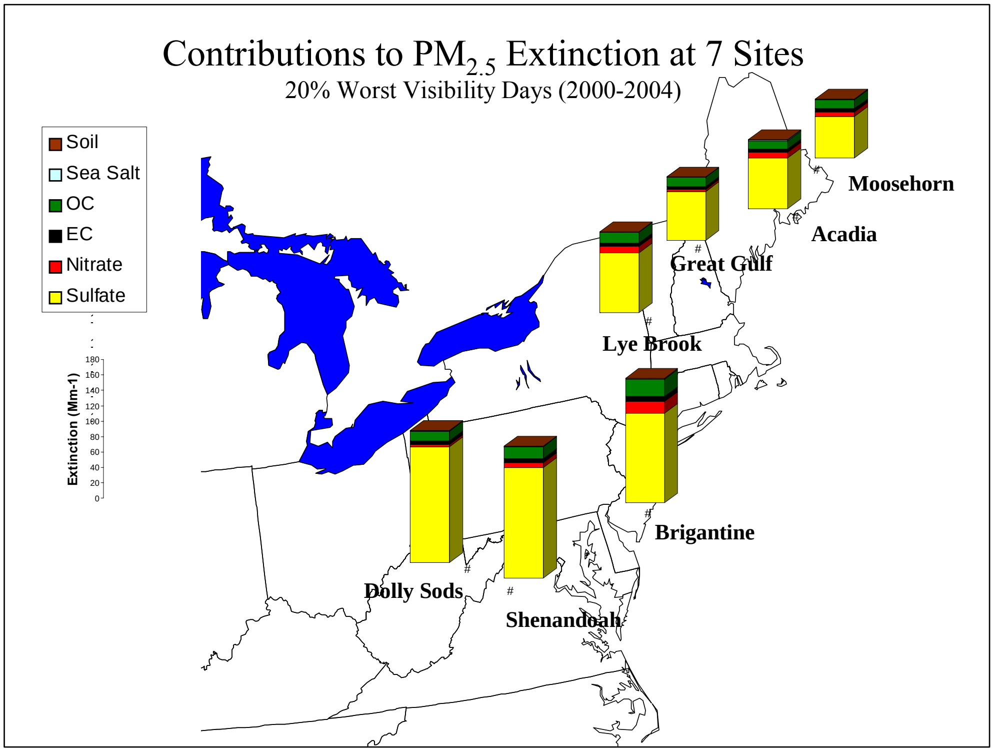
The pollutants primarily responsible for fine particle formation, and thus contributing to regional haze, include SO_2, NO_X, VOCs, NH_3, PM_{10}, and $PM_{2.5}$. The MANE-VU Contribution Assessment (Attachment B), finalized in August 2006, reflects a conceptual model in which sulfate emerges as the most important single constituent of haze-forming fine particle pollution and the principle cause of visibility impairment across the Northeast region. Sulfate alone accounts for anywhere from ½ to ⅔ of total fine particle mass on the 20 percent haziest days at MANE-VU Class I Areas. This translates to about ⅔ to ¾ of visibility extinction on those days.

Visibility extinction is a measure of the ability of particles to scatter and absorb light. Extinction is expressed in units of inverse mega-meters (Mm^{-1}). Figure 8.1 shows the dominance of sulfate in visibility extinction calculated from 2000-2004 baseline data for seven Northeast 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 SO2 emission reductions are readily available, cost-effective, and could be implemented quickly. On the basis of 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. In comparison with sulfate, the emission sources of organic carbon are diverse, variable, more diffuse, and less well understood; and the problem of controlling organic carbon emissions is exceedingly complex. 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.

Figure 8.1: Contributions to $PM_{2.5}$ Extinction at Seven Class I Areas



8.2 Contributing States and Regions

The MANE-VU Contribution Assessment used various modeling techniques, air quality data analysis, and emissions inventory analysis to identify source categories and states that contribute to visibility impairment in MANE-VU and nearby Class I areas. These analyses highlight the importance of emissions from outside MANE-VU to visibility impairment inside the region. Note that, although there is some variation in the contribution estimates among the different assessment methods employed, there is a general consistency of results from one method to another.

Table 8.1 displays the results of just one of the methods used (the REMSAD model) to assess state-by-state and regional contributions to annual sulfate impacts in nine Class I areas.

Table 8.1: Percent Contributions (Mass Basis) of Individual States and Regions to Total Annual Sulfate Impacts at Northeast Class I Areas (REMSAD)

Contributing State or Region	Mandatory Class I Area						
	Acadia ME	Brigantine NJ	Dolly Sods WV	Great Gulf & Presidential Range – Dry River, NH	Lye Brook VT	Moosehorn & Roosevelt Campobello ME	Shenandoah VA
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
MANE-VU	36.17	34.83	14.81	27.83	31.78	30.08	20.59
MRPO	11.98	18.16	30.26	20.10	21.48	10.40	26.84
VISTAS	8.49	21.99	36.75	12.04	13.65	6.69	33.86
CenRAP	0.88	1.12	1.58	1.65	1.67	0.82	1.48
Canada	8.69	7.11	3.90	14.84	12.43	7.85	4.75
Other	33.79	16.78	12.70	23.54	18.99	44.17	12.48

Source: Table 8-1 of the MANE-VU Contribution Assessment

Note: Indicated percent contributions from VISTAS, CenRAP and Canada apply only to those portions lying within the modeling domain (see Figure 7.1). Actual contributions, especially from CenRAP, would be higher than stated.

Figures 8.2 and 8.3, also borrowed from the Contribution Assessment, illustrate another method for identifying and ranking states' contributions to sulfate at Class I areas using the 2002 data. This simple technique for deducing the relative impact of emissions from specific point sources on specific receptor sites involves calculating the ratio of annual emissions (Q) to source-receptor distance (d). The ratio (Q/d) is then multiplied by a factor to account for the frequency effect of prevailing winds. The use of this technique is explained in the Contribution Assessment (see pages 4-12 to 4-17 of Attachment B).

Figure 8.2: Ranked Sulfate Contributions to Northeast Class I Receptors Based on Q/d Method (Mass Basis), by Location of Origin

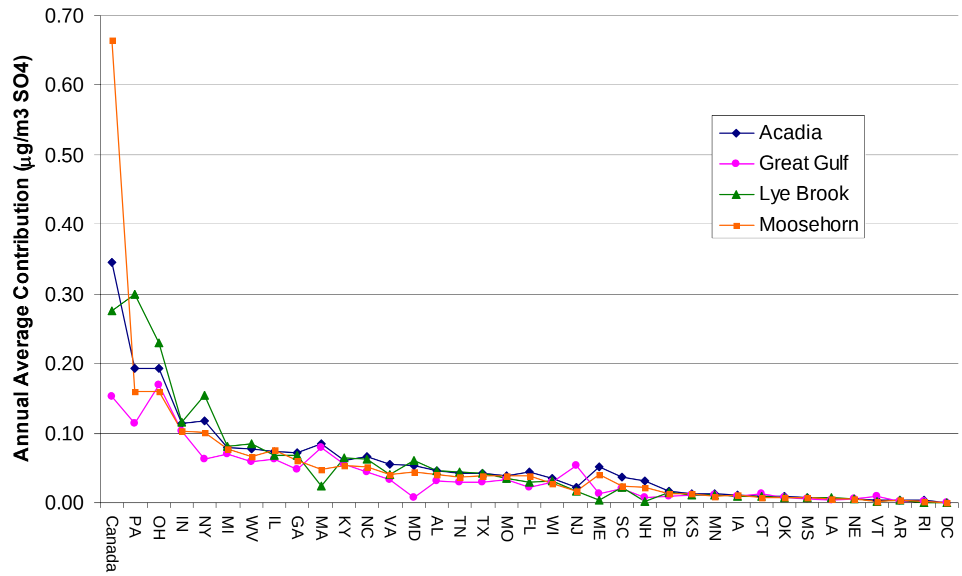
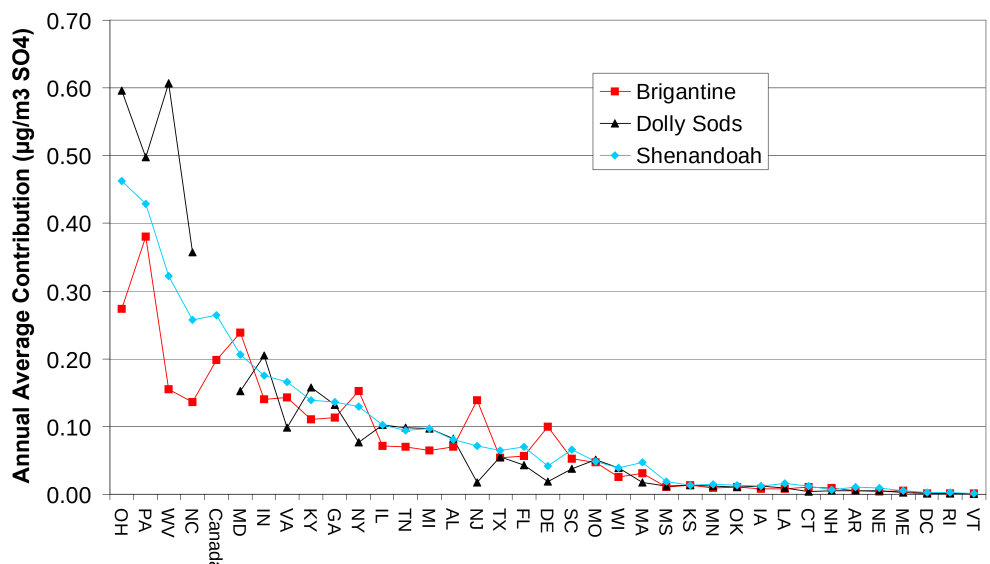


Figure 8.3: Ranked Sulfate Contributions to Mid-Atlantic Class I Receptors Based on Q/d Method (Mass Basis), by Location of Origin



The first of the Q/d plots covers the four northern Class I areas in MANE-VU. The second covers one Class I area in the southern part of MANE-VU and two neighboring Class I areas in the VISTAS region. Observe, again, the comparative importance of emissions from Canada and from states outside the MANE-VU region.

The ranking of emission 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 3.0, Regional Planning and Consultation. Using results from the REMSAD model, MANE-VU applied the following three criteria to identify states and regions for the purposes of consultation on regional haze:

4. 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),
5. Any state/region that contributed at least 2 percent of total sulfate observed on the 20 percent worst visibility days in 2002, and
6. Any state/region among the top ten contributors on the 20 percent worst visibility days in 2002.

For the purposes of deciding how broadly to consult, the MANE-VU States settled on the second of the three criteria: any state/region that contributed at least 2 percent of total sulfate observed on the 20 percent worst visibility days in 2002.

In Figures 8.4 through 8.10, below, states and regions meeting the three listed criteria are identified graphically for seven Class I areas: Shenandoah and Dolly Sods are Class I areas in the VISTAS region that are impacted by emissions from MANE-VU states; the other five Class I areas are in MANE-VU. Note that the IMPROVE monitor at Great Gulf also represents the Presidential Range – Dry River Wilderness, and the IMPROVE monitor at Moosehorn also represents Roosevelt Campobello International Park.

Each figure has the following components:

- On the left is a single bar graph of the IMPROVE-monitored $PM_{2.5}$ mass concentration ($\mu g/m^3$) by constituent species for the baseline years 2000-2004. The yellow, bottom portion of the bar represents the measured sulfate concentration.
- The middle component of each figure provides a bar graph of the 2002 total sulfate contribution of each state or region as estimated by REMSAD.
- Finally, the right segment contains three maps showing which states meet the criteria described above.

Connecticut, Rhode Island, Vermont, and the District of Columbia were not identified as being among the political or regional units contributing at least 2 percent of sulfate at any of the seven Class I areas. However, as participants in MANE-VU, those entities have agreed to pursue adoption of regional control measures aimed at visibility improvement on the haziest days and prevention of visibility degradation on the clearest days.

Figure 8.4: Modeled 2002 Contributions to Sulfate at Great Gulf, by State

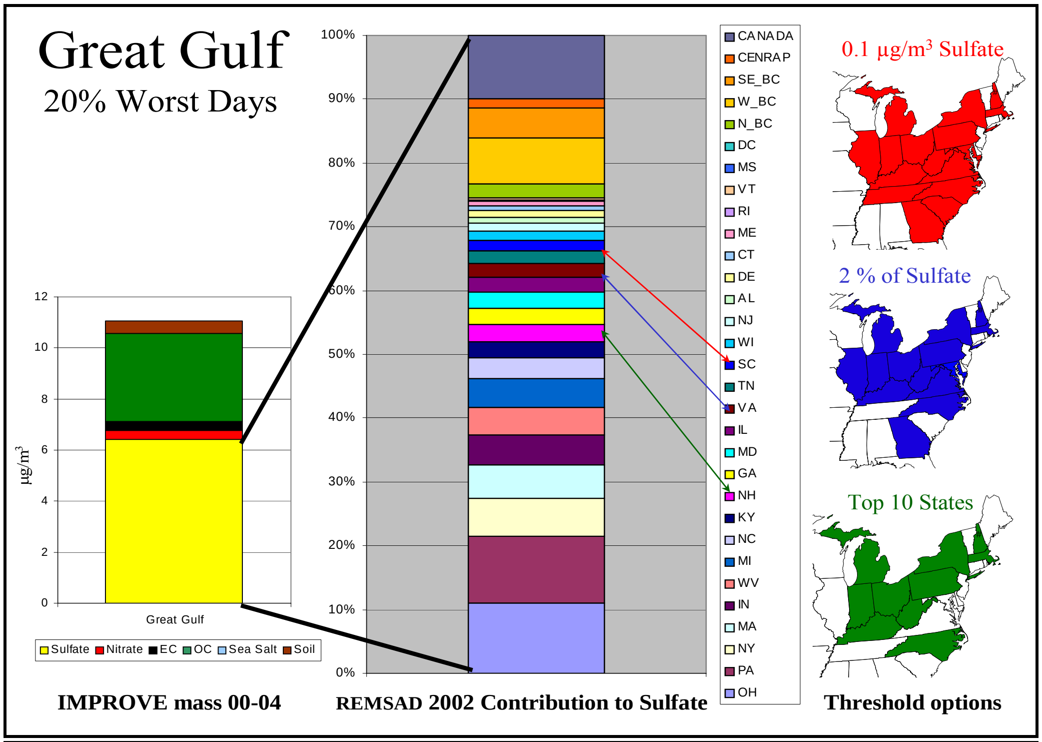


Figure 8.5: Modeled 2002 Contributions to Sulfate at Brigantine, by State

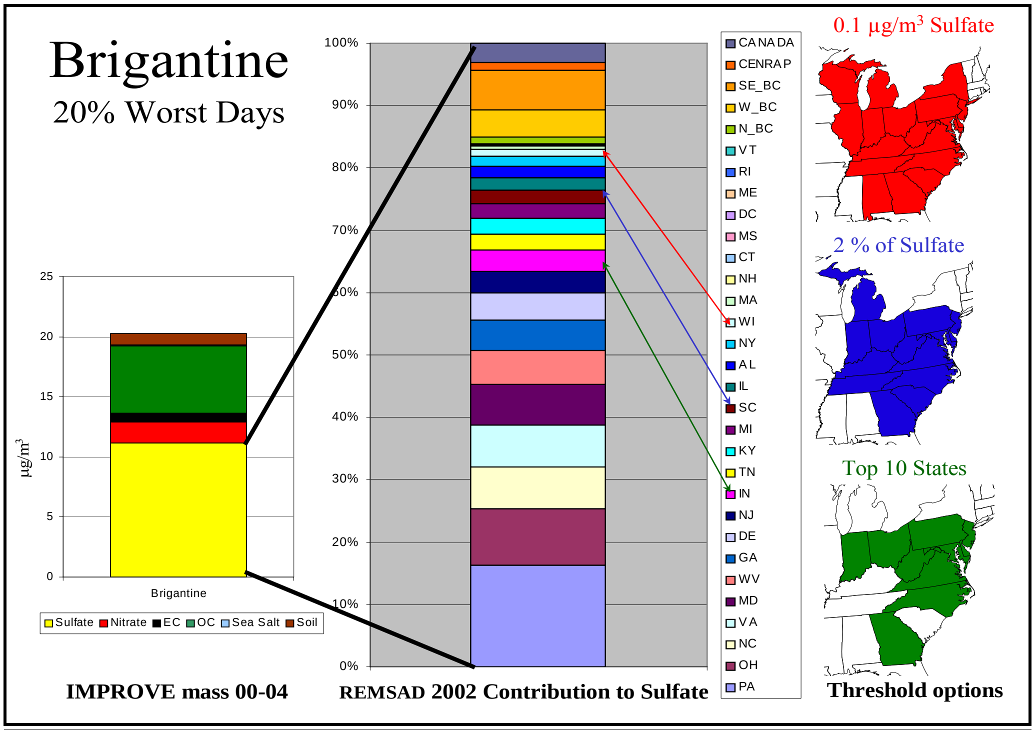


Figure 8.6: Modeled 2002 Contributions to Sulfate at Lye Brook, by State

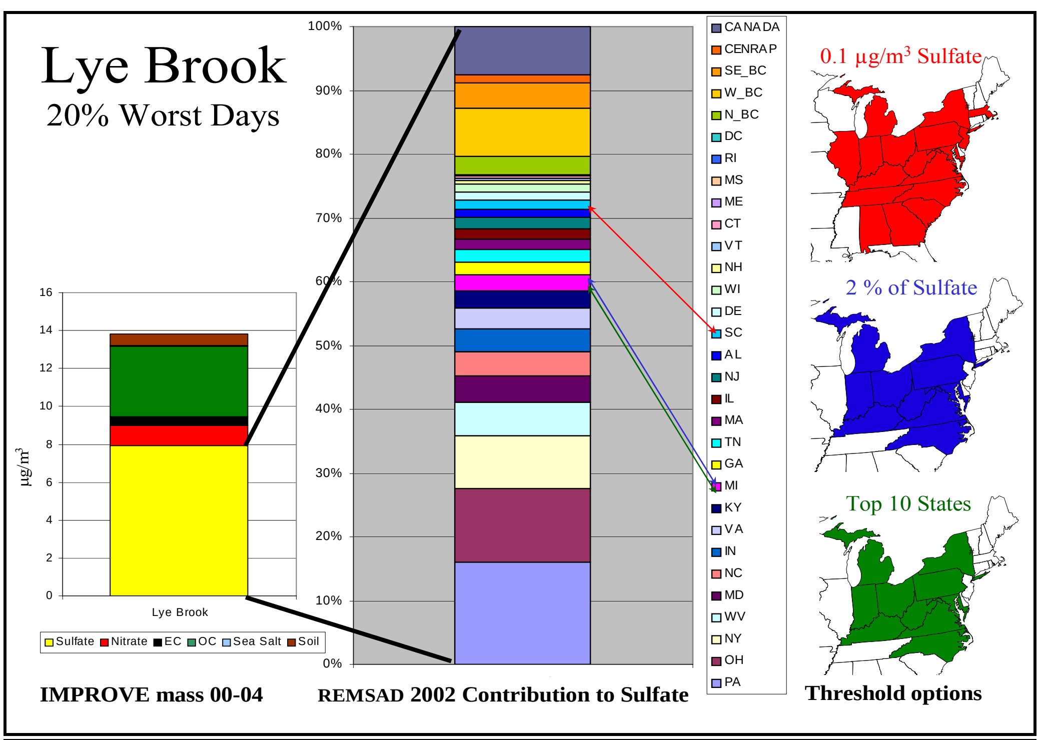


Figure 8.7: Modeled 2002 Contributions to Sulfate at Acadia, by State

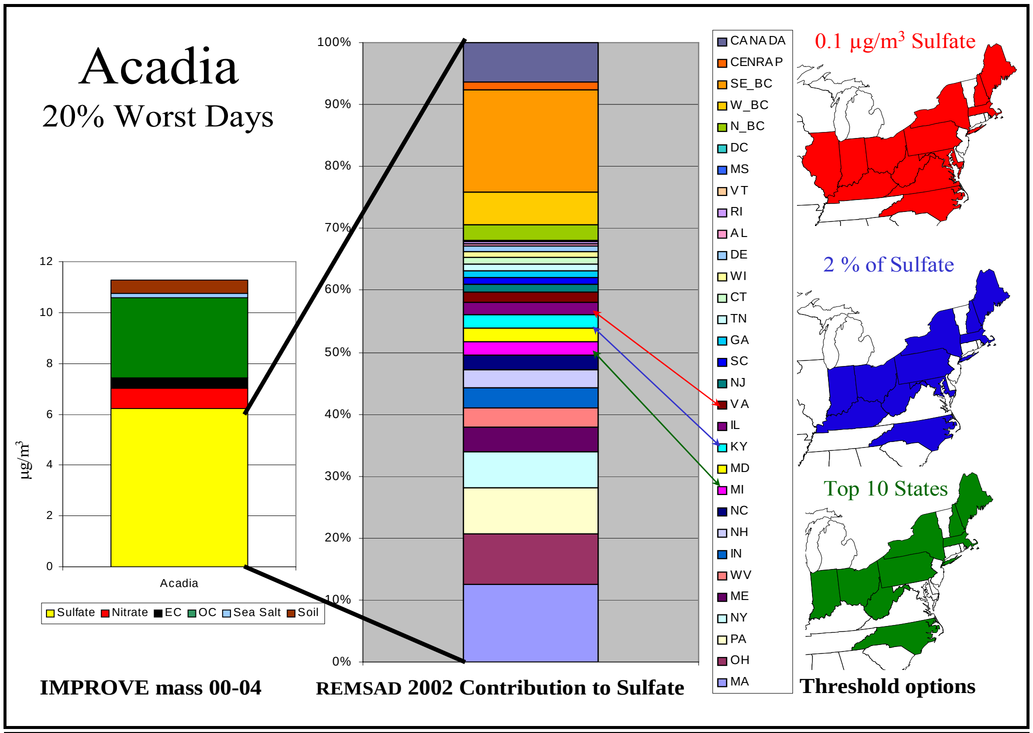


Figure 8.8: Modeled 2002 Contributions to Sulfate at Moosehorn, by State

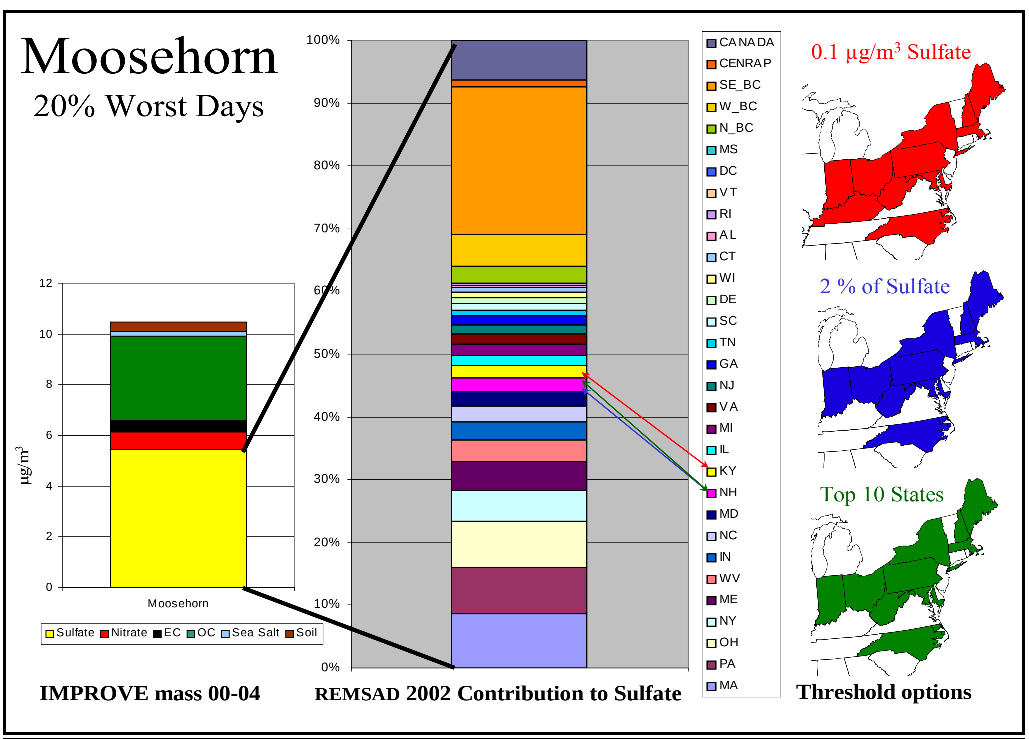


Figure 8.9: Modeled 2002 Contributions to Sulfate at Shenandoah, by State

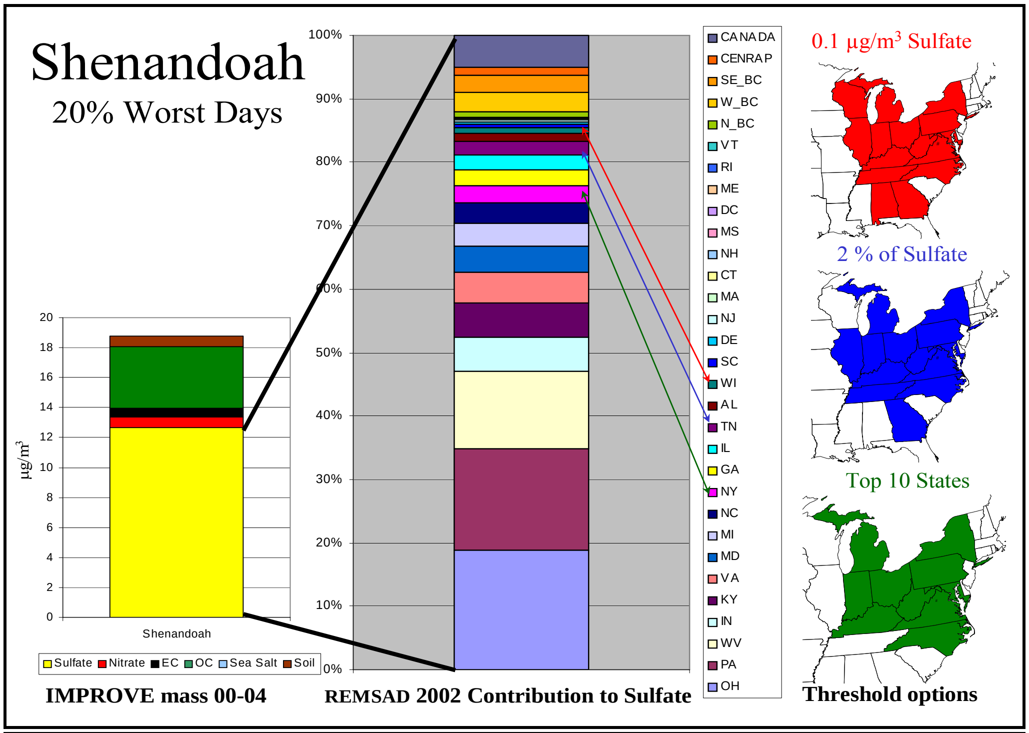
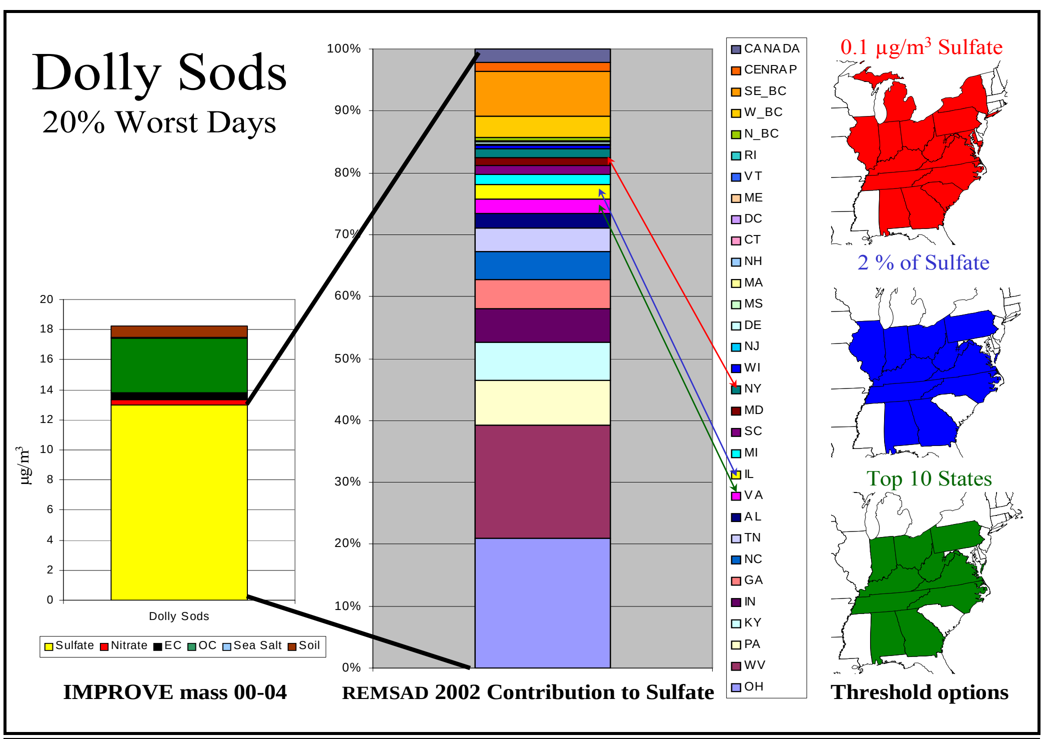


Figure 8.10: Modeled 2002 Contributions to Sulfate at Dolly Sods, by State



8.3 Emission Sources and Characteristics

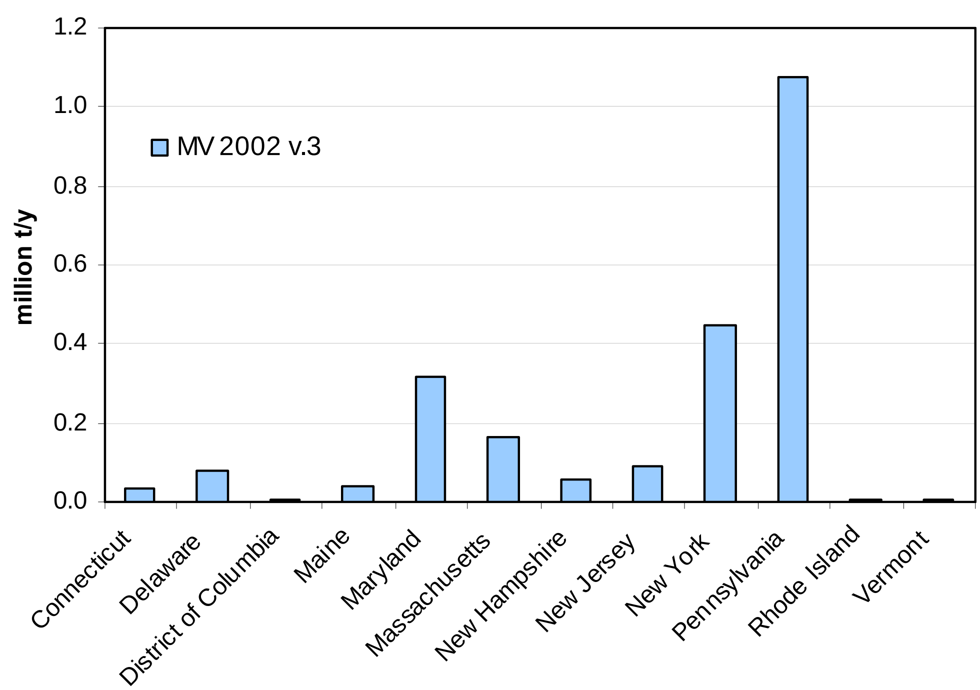
As previously mentioned, the major pollutants responsible for regional haze are SO_2, NO_X, VOCs, NH_3, PM_{10}, and $PM_{2.5}$. The following is a description of the sources (e.g., point, area, and mobile) and characteristics of pollutant emissions contributing to haze in the eastern United States. Emissions data and graphics presented for the purposes of this section are taken from the MANE-VU 2002 Baseline Emissions Inventory, Version 2.0 (note that the more recent MANE-VU 2002 Baseline Emissions Inventory, Version 3.0, released in April 2006, has superseded Version 2.0 for modeling purposes). Although the emissions inventory database also includes carbon monoxide (CO), this primary pollutant is not considered here because it does not contribute to regional haze.

8.3.1 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 80 percent or more 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).

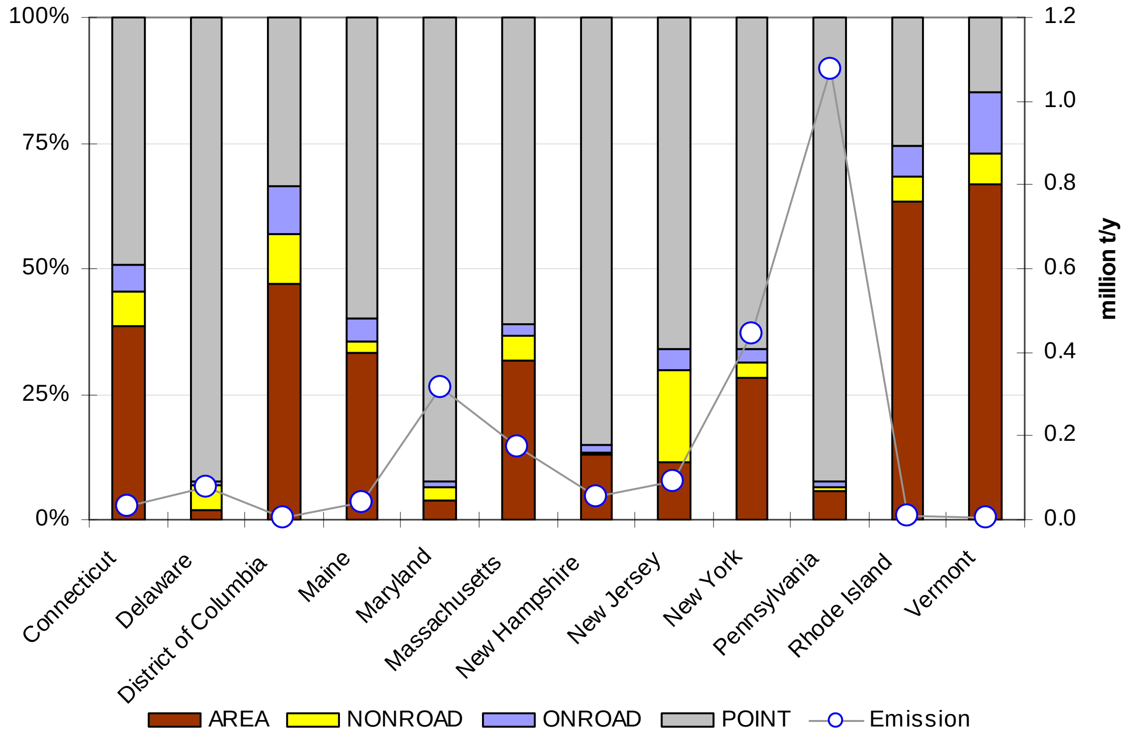
Figure 8.11 shows SO_2 emissions in the MANE-VU states as extracted from the 2002 MANE-VU inventory (MARAMA, 2005).

Figure 8.11: Annual Sulfur Dioxide (SO_2) Emissions, by State



The bar graph in Figure 8.12 displays the percentage contributions from different emission source categories to annual SO_2 emissions in the MANE-VU states in 2002. The chart shows that point sources – consisting mainly of stationary combustion sources for generating electricity, industrial power, and heat – dominate SO_2 emissions in the region.

Figure 8.12: 2002 Sulfur Dioxide (SO_2) Emissions, by State
Bar Graph = Percentage Fractions of Four Source Categories
Line Graph = Total Annual Emissions (10^6 tpy)



As can be seen in Table 8.2 (EPA NEI database, 2008), most states in the region showed declines in annual SO_2 emissions through 2002 compared with those from previous inventories.

Table 8.2 MANE-VU 1990, 1996 and 2002 SO_2 Point Source Emissions (tpy)

	CT	DC	DE	ME	MD	MA	NH	NJ	NY	PA	RI	VT
1990	70,845	5,123	88,450	70,086	314,157	256,593	76,597	155,021	654,256	1,377,470	3,899	1,050
1996	44,055	1,717	83,836	28,128	275,360	121,119	58,605	133,862	404,465	1,156,280	2,664	2,117
2002	16,027	2,057	74,447	22,915	291,009	105,966	46,579	61,229	297,113	995,869	2,653	911

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.

Smaller stationary combustion sources, referred to collectively as area sources, are another important source category in the MANE-VU states. These include smaller industrial, commercial, and institutional boilers as well as residential heating sources. By contrast, on-road and non-road mobile sources make a relatively minor contribution to overall SO_2 emissions in the region (NESCAUM, 2001a).

8.3.2 Volatile Organic Compounds (VOC)

Existing emissions inventories generally refer to volatile organic compounds (VOCs) as hydrocarbons whose volatility in the atmosphere makes them particularly important to ozone formation. From a regional haze perspective, there is less concern with the volatile organic gases emitted directly to the atmosphere than with the secondary organic aerosols (SOAs) that VOCs form after undergoing condensation and oxidation. Thus the VOC inventory category is of interest primarily because of the organic carbon component of $PM_{2.5}$.

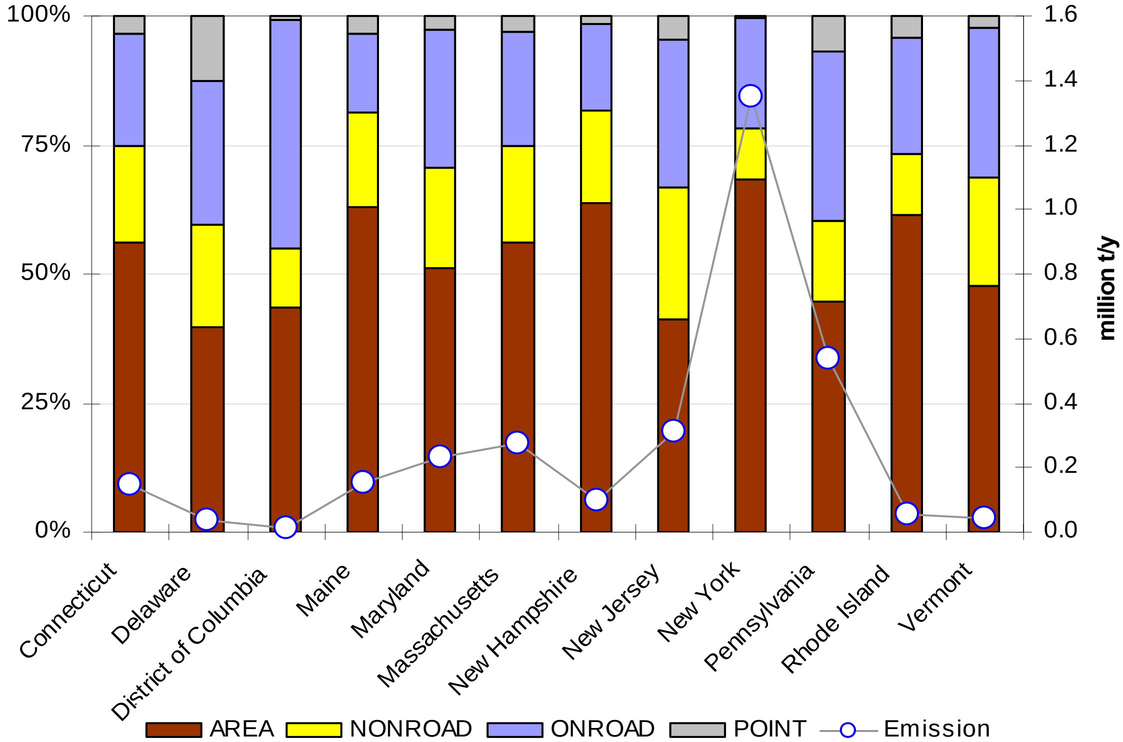
After sulfate, organic carbon generally accounts for the next largest share of fine particle mass and particle-related light extinction at northeastern Class I sites. The term organic carbon encompasses a large number and variety of chemical compounds that may be emitted directly from emission sources as components of primary PM or that may form in the atmosphere as secondary pollutants. The organic carbon present at Class I areas 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 cut back on manmade organic carbon emissions have been undertaken mainly for the purpose of reducing summertime ozone formation in urban centers. Future efforts to make further reductions in organic carbon emissions may be driven by programs that address fine particles and visibility.

Understanding the source regions and transport dynamics for organic carbon in MANE-VU and nearby Class I areas is likely to be more complex than for sulfate. This complexity derives from the large number and diversity of organic carbon species, the wide variation in their transport characteristics, 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 areas in the region is likely to include manmade pollution from nearby sources, manmade pollution transported from a distance, and biogenic emissions – especially terpenes from coniferous forests.

As shown in Figure 8.13, the VOC inventory is dominated by mobile and area sources. On-road mobile sources of VOCs include evaporative emissions from transportation fuels and exhaust emissions from gasoline passenger vehicles and diesel-powered, heavy-duty vehicles. VOC emissions may also originate from a variety of area sources (including those that use organic solvents, architectural coatings, and dry cleaning fluids) as well as from some point sources (e.g., industrial facilities and petroleum refineries).

Biogenic VOCs (not included in Figure 8.13) may play an important role within the rural settings typical of Class I areas. 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, although it is noted that high ozone levels can have an indirect effect on visibility by promoting the oxidation of other available hydrocarbons, including biogenic emissions (NESCAUM, 2001a). In short, further work is needed to characterize the organic carbon contribution to regional haze in the MANE-VU states and to develop emissions inventories that will be of greater value for visibility planning purposes. As pointed out in Subsection 8.1 above, organic carbon could be the subject of future control measures to mitigate regional haze but is not the focus of initial planning.

Figure 8.13: 2002 Volatile Organic Compound (VOC) Emissions, by State
Bar Graph = Percentage Fractions of Four Source Categories
Line Graph = Total Annual Emissions (10^6 tpy)



8.3.3 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 areas. Notably, nitrate may play a more important role in urban settings 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. Emissions increased by 2 percent between 1989 and 1998 (EPA, 2000a). To a large extent, increases from the industrial and power plant combustion sectors have been offset by emission reductions from transportation source controls implemented during the same time period. Figure 8.14 shows NO_X emissions in 2002 for each state in the MANE-VU region. In the several years just prior to 2002, most MANE-VU states experienced declining NO_X 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 annually. The electric sector plays an even larger role in parts of the industrial Midwest, where power plants contribute significantly to

NO_X emissions. By contrast, mobile sources dominate the NO_X inventories for more urbanized MANE-VU states, as shown in Figure 8.15. In these states, on-road mobile sources (i.e., highway vehicles) represent the largest NO_X source category. Emissions from non-road (i.e., off-highway) mobile sources, primarily diesel-powered engines, also make up a substantial fraction of the inventory.

Figure 8.14: Annual Nitrogen Oxide (NO_X) Emissions, by State

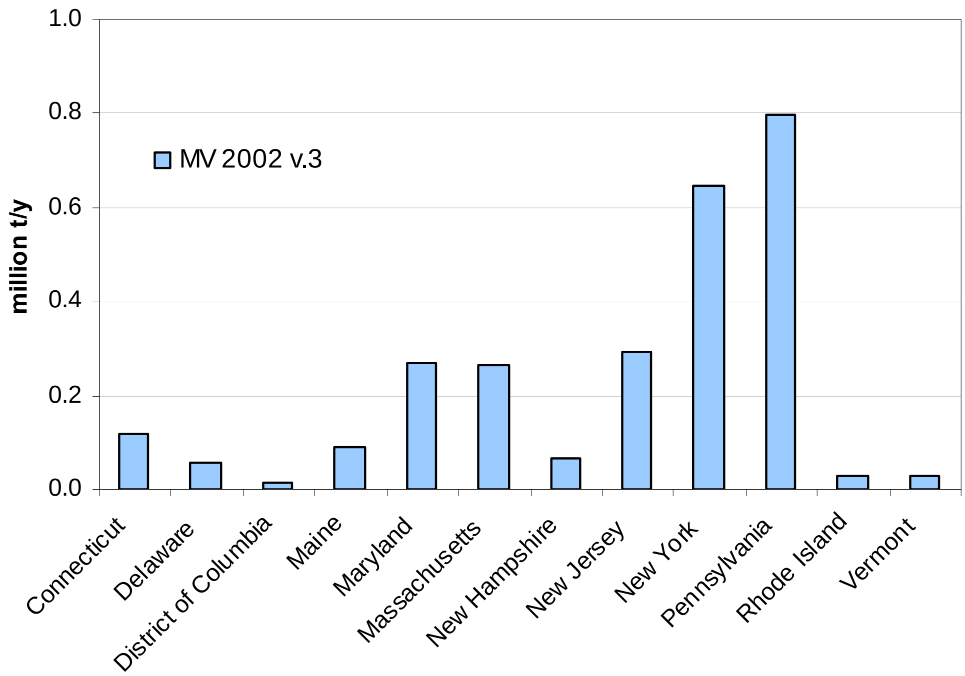
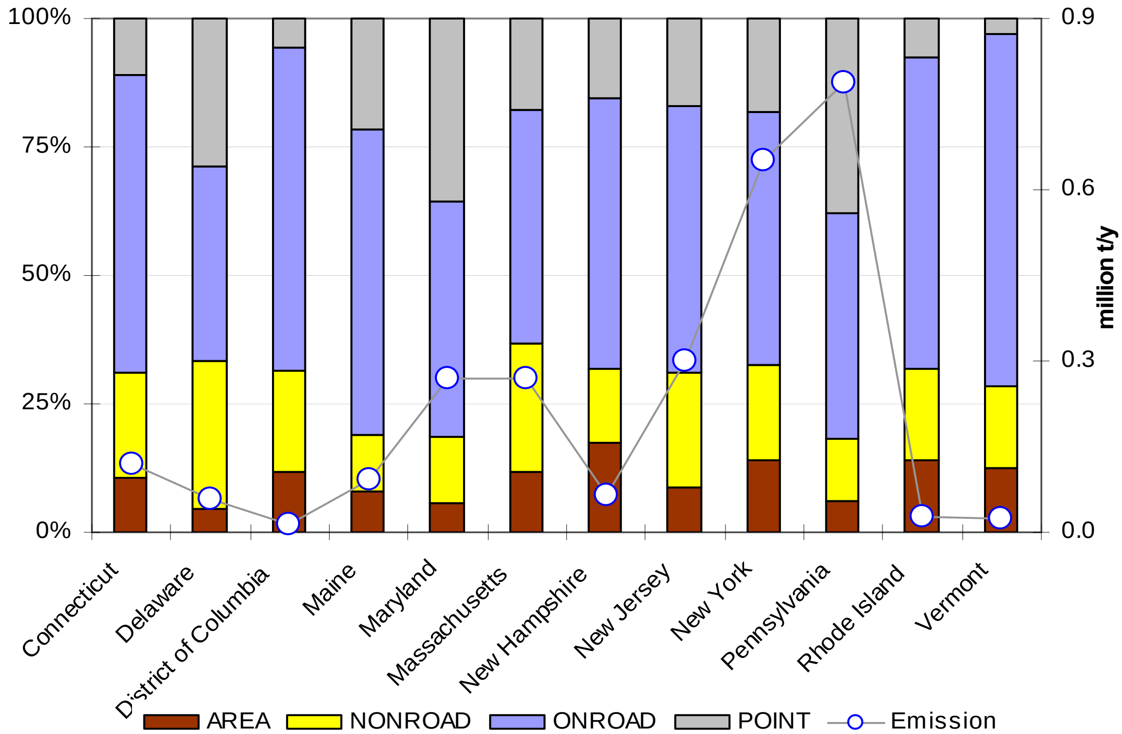


Figure 8.15: 2002 Nitrogen Oxide (NO_X) Emissions, by State
Bar Graph = Percentage Fractions of Four Source Categories
Line Graph = Total Annual Emissions (10^6 tpy)



8.3.4 Primary Particulate 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 such as SO_2 and NO_X) can also contribute to regional haze. For regulatory purposes, a distinction is made between particulate matter (PM) with an aerodynamic diameter less than or equal to 10 micrometers (PM_{10}) and smaller particles with an aerodynamic diameter less than or equal to 2.5 micrometers ($PM_{2.5}$).

Figures 8.16 and 8.17 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 in the years leading up to the 2002 inventory. By contrast, emission trends for primary $PM_{2.5}$ were 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 material relatively quickly. As a result, it rarely entrains into layers of the atmosphere where it can be transported 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 them in modeling analyses.

Figure 8.16: Primary Coarse Particle (PM_{10}) Emissions, by State

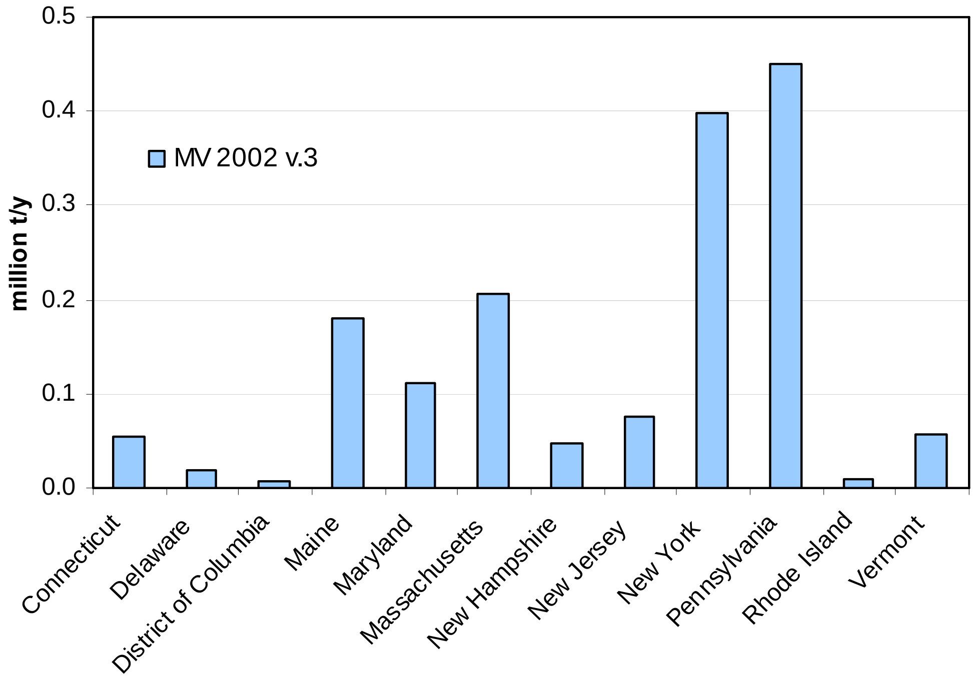
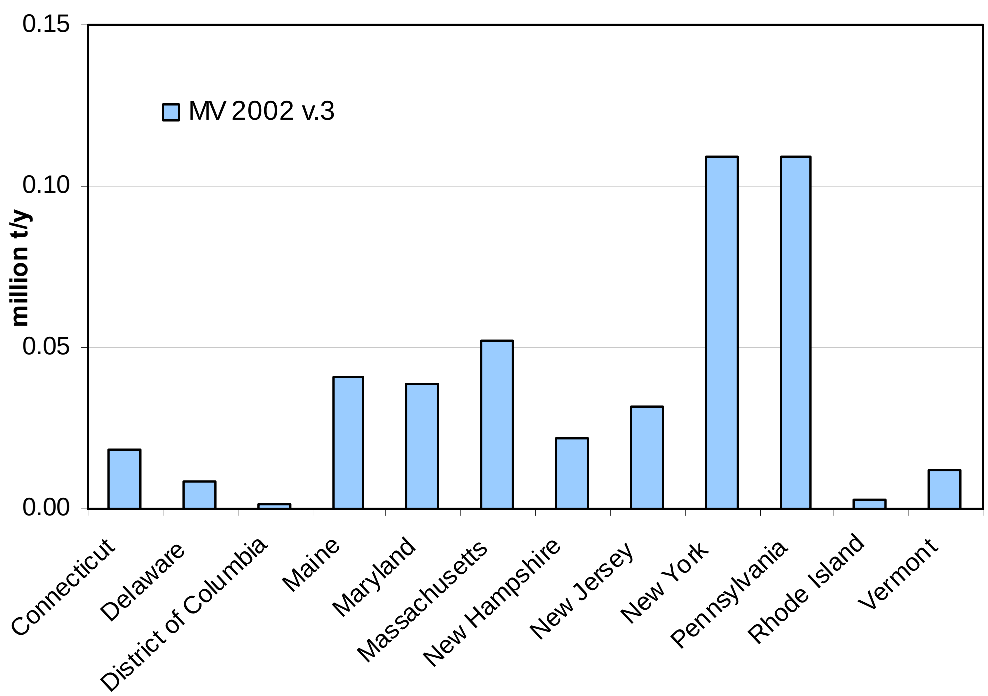


Figure 8.17: Primary Fine Particle ($PM_{2.5}$) Emissions, by State



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), crustal PM accounted for six to eleven percent of particle-related light extinction at MANE-VU Class I sites. On the 20 percent worst visibility days, however, crustal material generally plays a much smaller role, ranging from two to three percent visibility extinction, than other haze-forming pollutants. Moreover, the crustal fraction includes materials of natural origin, such as soil or sea salt, that is not targeted under the Regional Haze Rule. Of course, the crustal fraction can be influenced by 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 areas, control measures to reduce coarse and fine particulate matter deriving from crustal material may prove beneficial and are within the purview of EPA or state agencies.

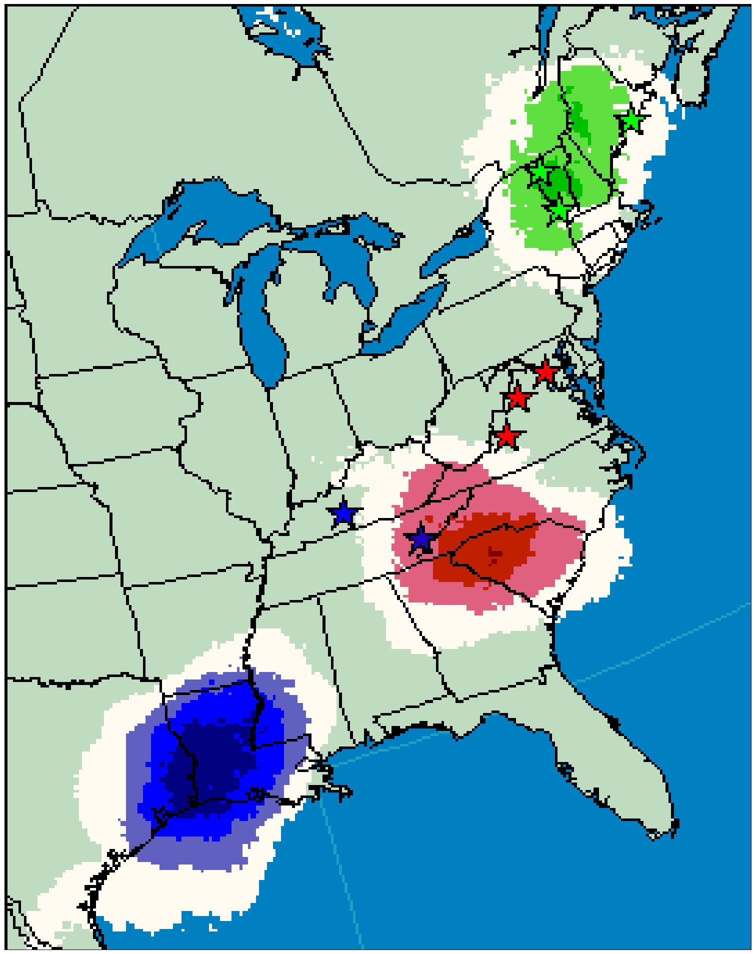
Experience from the western United States, where the crustal component has played a more significant role in overall particulate levels, may be applicable to the extent that it is relevant to the situation in the eastern states. In addition, a few areas in the Northeast, such as New Haven, Connecticut,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

Current emissions inventories for the entire MANE-VU area indicate that residential wood combustion represents 25 percent of primary fine particle emissions in the region. This finding implies that rural sources can play an important role as well as contributions from the region's many populous urban areas. An important consideration in this regard is that residential wood combustion occurs mainly in the winter months, while managed or prescribed burning activities occur largely in other seasons. The latter category includes agricultural field-burning, prescribed burning of forested areas, and miscellaneous 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 data are currently limited, Connecticut and other MANE-VU states are concerned about the growing use of residential wood stoves by homeowners seeking alternatives to petroleum-based fuels for home heating. Over the next several years, CTDEP will continue to evaluate monitored particulate matter 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 Connecticut. If smoke levels increase significantly, that might be cause for evaluating whether additional control measures for this source category might be necessary.

Figure 8.18, taken from Appendix B of the MANE-VU Contribution Assessment, represents the results of source apportionment and trajectory analyses on wood smoke in the area extending from 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 monitor sites (including those at several Class I areas) whose data sets were determined to be useful to the modeling analysis.

Figure 8.18: Wood Smoke Source Regional Aggregations



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 V), concluded that fire from land management activities was not a major contributor to regional haze in MANE-VU Class I Areas, and that the majority of emissions from fires were from residential wood combustion.

Figures 8.19 and 8.20 show that area sources dominate primary PM emissions. (EPA's National Emissions 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 because the crustal component of particulate emissions (consisting mainly of larger, or coarse, particles) contributes more to overall PM_{10} levels than to $PM_{2.5}$ levels. At the same time, pollution control equipment commonly installed at large point sources is usually more efficient at capturing coarse particle emissions.

Figure 8.19: 2002 Primary Coarse Particle (PM_{10}) Emissions, by State
Bar Graph = Percentage Fractions of Four Source Categories
Line Graph = Total Annual Emissions (10^6 tpy)

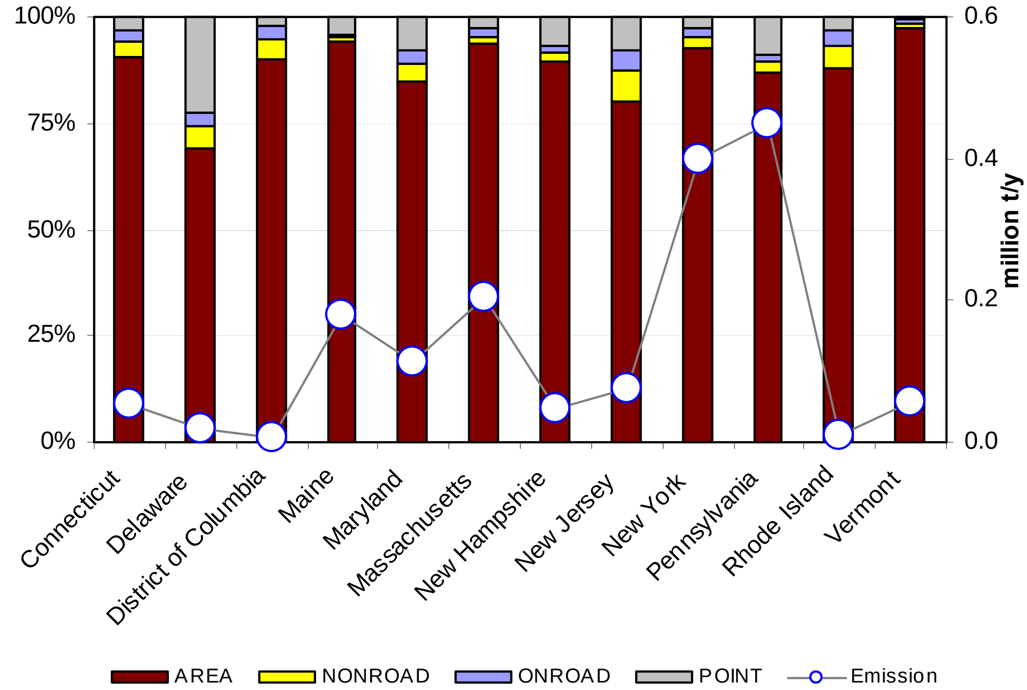
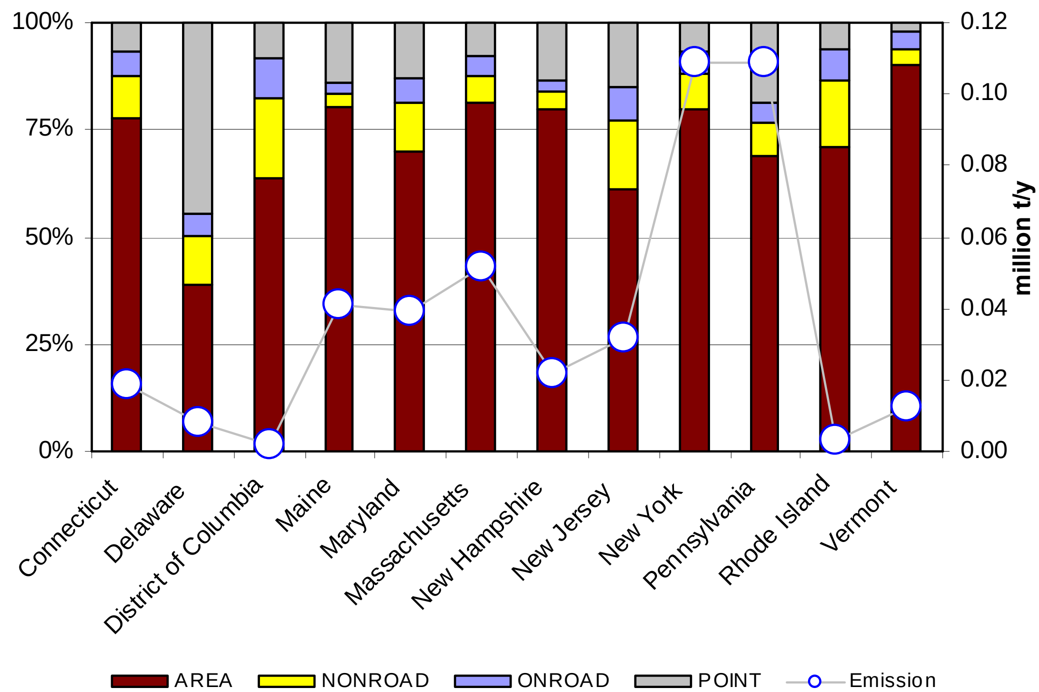


Figure 8.20: 2002 Primary Fine Particle ($PM_{2.5}$) Emissions, by State
Bar Graph = Percentage Fractions of Four Source Categories
Line Graph = Total Annual Emissions (10^6 tpy)



8.3.5 Ammonia Emissions (NH_3)

Because ammonium sulfate ($(NH_3)_2SO_4$) and ammonium nitrate (NH_3NO_3) are significant contributors to atmospheric light scattering and fine particle mass, knowledge of ammonia emission sources is important to the development of effective regional haze reduction strategies. 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 the 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 exists 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 instrumental to controlling regional haze because such reductions yield proportionately greater reductions in fine particle mass. 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.[10]

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 emission estimates: 1) a wide range of ammonia emission factors, 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, emission factors, and activity data that are readily accessible to the user. With this framework, users can obtain data in a variety of formats[11] and can make updates easily, allowing additional ammonia sources to be added or emission factors to be replaced as better information becomes available (Strader et al., 2000; NESCAUM, 2001b).

Figures 8.21 and 8.22 show estimated ammonia emissions for the MANE-VU states in 2002. Area and on-road mobile sources dominate the ammonia inventory data. 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 Columbia.

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[10] 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.

[11] 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.

The two other sources contributing significant emissions are wastewater treatment systems and gasoline exhaust from highway vehicles.

Figure 8.21: Ammonia (NH_3) Emissions, by State

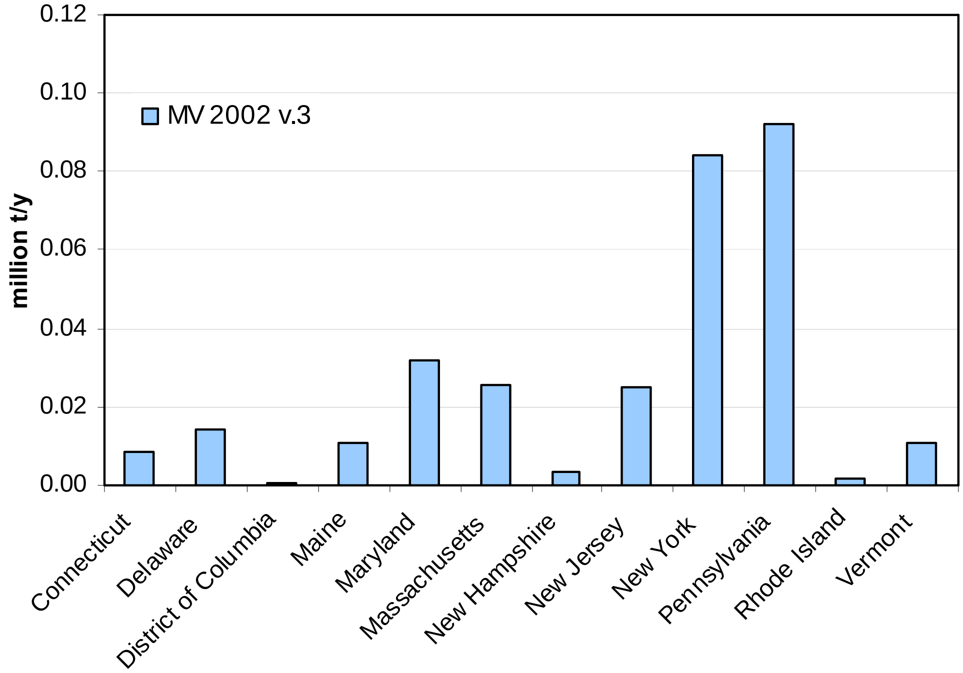
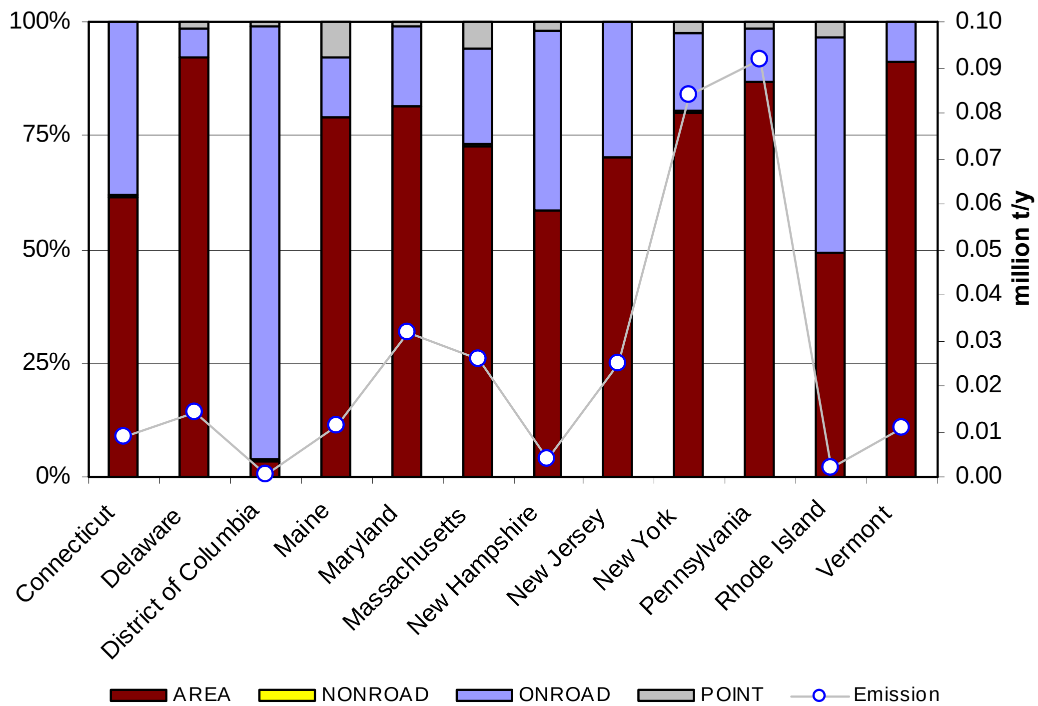


Figure 8.22: 2002 Ammonia (NH_3) Emissions, by State
Bar Graph = Percentage Fractions of Four Source Categories
Line Graph = Total Annual Emissions (10^6 tpy)



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EPA 2005, http://www.epa.gov/ttn/chief/eiinformation.html.

9.0 Best Available Retrofit Technology (BART)

Section 169A(b)(2)(A) of the Clean Air Act (CAA), as amended August 7, 1977, requires states with emissions that are reasonably anticipated to cause or contribute to visibility impairment in a Class I area to adopt a plan requiring best available retrofit technology (BART) of certain sources. The SIP must include a requirement that each major stationary source which was in existence but which had not been in operation for greater than fifteen years as of the date of enactment of section 169A(b)(2)(A) and which may reasonably be anticipated to cause or contribute to impairment of visibility shall procure, install and operate BART for controlling emissions from such source for the purpose of eliminating or reducing visibility impairment. On July 6, 2005, EPA issued final Regional Haze Regulations and Guidelines for BART Determinations (40 CFR 51) and on October 13, 2006 EPA issued final Regional Haze Regulations; Revisions to Provisions Governing Alternative to BART Determinations (40 CFR 51). The requirements and implementation of the BART program as they apply to air pollution sources in Connecticut are described in this section.

9.1 BART Overview

The BART program is intended to reduce visibility-impairing emissions of the pollutants sulfur dioxide (SO_2), nitrogen oxides (NO_x) and particulate matter (PM) from large stationary sources that were not required to meet certain emission control requirements at the time the CAA was amended in 1977. Any SO_2, NO_x and PM emission reductions will assist states in achieving the reasonable progress goals of the Regional Haze program. The BART requirement applies to facilities in any of 26 source categories that have units installed and operated between 1962 and 1977 with the potential to emit more than 250 tons per year of a visibility impairing pollutant (see 64 Federal Register (FR) 35737-35738). States must consider five statutory factors when determining BART control requirements for BART-eligible units:

- Cost of controls,
- Energy and non-air quality environmental impacts,
- Existing controls at the source,
- Remaining useful life of the source, and
- Visibility improvement reasonably expected from application of controls.

As set forth in 40 CFR 51.308(e)(2), states may opt to implement or require participation by BART sources in an emissions trading program or an alternative measure that will achieve greater reasonable progress than BART implementation at all sources subject to BART. In addition, if such alternative measure has been designed primarily to meet a Federal or State requirement other than BART, a more simplified approach can be used to demonstrate that the alternative measure will make greater reasonable progress than implementing BART alone. CTDEP has determined that the alternative measure, described below, is sufficient for BART eligible sources in Connecticut to meet their obligations under EPA's BART guidance.

The approach, as employed here by CTDEP, entails establishing a BART benchmark through the following measures:

- Identification of BART-eligible sources,
- A determination of which BART-eligible sources are subject to BART,
- A determination of what BART is for each source subject to BART, and
- A determination of the overall visibility improvement anticipated from the application of BART to all sources subject to BART.

According to the EPA regulations, once the BART benchmark has been established, the state can compare the reductions achieved from the alternative measure with the reductions achieved from the BART benchmark. If the reductions from the alternative measure are greater than the BART benchmark, the state can assume that the alternative measure results in greater reasonable progress than BART.

The CTDEP demonstrates here that its existing regulatory programs meet EPA's alternative measure requirements resulting in greater reasonable progress than would be achieved by implementing BART. Connecticut's programs identified to meet the alternative BART requirements include the following:

- For SO_2: Regulations of Connecticut State Agencies (RCSA) section 22a-174-19a (Control of Sulfur Dioxide Emissions from Power Plants and Other Large Stationary Sources of Air Pollution);
- For NO_x: RCSA Section 22a-174-22 (Control of Nitrogen Oxides Emissions), and RCSA Section 22a-174-22c (CAIR NO_x Ozone Season Trading Program starting in May 2009); and
- For PM: RCSA Section 22a-174-18 (Control of Particulate Matter and Visible Emissions). In addition, CTDEP concludes that the requirement for additional PM control measures is not reasonably justified from the BART assessment.

The following sections establish a BART benchmark, provide estimated emission reductions achieved from Connecticut's existing regulatory programs, and show that reductions from Connecticut's existing regulatory programs exceed reductions from the application of BART alone.

9.2 Establishing a BART benchmark

As indicated above, the simplified alternative approach to meeting EPA's BART requirements entails establishing a BART benchmark. This includes i) identification of BART-eligible sources, ii) a determination of which BART-eligible sources are subject to BART, iii) a determination of what BART is for each source subject to BART, and iv) a determination of the overall visibility improvement anticipated from the application of BART to all sources subject to BART.

9.2.1 Identification of BART-Eligible Sources

BART-eligible sources in Connecticut were identified in accordance with the description of sources potentially subject to BART in Appendix Y of 40 CFR Part 51 (Guidelines for BART Determinations Under the Regional Haze Rule). BART-eligible sources must meet the following criteria:

- Major stationary sources which have the potential to emit 250 tons per year or more of any visibility impairing air pollutant;
- From one of 26 identified source categories; and
- Were built between August 1962 and August 1977.

The BART-eligible sources initially identified in Connecticut are listed in Table 9-1:

Table 9-1: Initial list of BART-eligible sources in Connecticut
Middletown Power LLC, Unit 3, Middletown
Middletown Power LLC, Unit 4, Middletown
Montville Power LLC, Unit 6, Montville
Norwalk Power LLC, Unit 2, Norwalk
PSEG Power Connecticut LLC, Bridgeport Harbor Station, Unit 3, Bridgeport
PSEG Power Connecticut LLC, New Haven Harbor Station, Unit 1, New Haven
Pfizer Inc., Boiler No. 5, Groton
Pfizer Inc., Boiler No. 8, Groton
Pfizer Inc., OSP2, Groton
Cascades Boxboard Group – CT LLC (formerly known as Sprague Paperboard Inc.), PFI Boiler, Versailles

On March 10, 2006, the CTDEP issued Consent Order No. 8262 to Pfizer Inc. This Consent Order capped actual aggregated emissions from the boilers and the Organic Synthesis Plant 2 (OSP2) to less than 250 tpy for each of the air pollutants NO_x, SO_2 and PM. Therefore, Pfizer's facility is no longer considered BART-eligible. The final list of BART-eligible sources in Connecticut along with type of fuel burned, existing controls, and unit and plant capacity is shown in Table 9-2. Figures 9-1 and 9-2 display the locations of these BART-eligible sources as well as 2006 potential and actual annual emissions of SO_2 and NO_x, respectively.

Table 9-2: Final list of BART-eligible sources in Connecticut

Unit/Fuel	Unit/Plant Capacity	Existing Controls/Sulfur limits
Middletown Power LLC, Unit 3, Residual Oil, Natural Gas	245 MW/>750 MW	ESP, boiler excess air control, SNCR/0.3% fuel sulfur content*
Middletown Power LLC, Unit 4, Residual Oil	400 MW/>750 MW	Boiler excess air control/0.3% fuel sulfur content*
Montville Power LLC, Unit 6, Residual/Distillate Oil	410 MW/<750 MW	None/0.3% fuel sulfur content*
Norwalk Power LLC, Unit 2, Residual Oil	172 MW/<750 MW	ESP, SNCR/0.3% fuel sulfur content*
PSEG Power Connecticut LLC, Bridgeport Harbor Station, Unit 3, Coal, Residual Oil	410 MW/<750 MW	ESP, low-NOx concentric firing system/0.33 lb/MMBtu*
PSEG Power Connecticut LLC, New Haven Harbor Station, Unit 1, Residual/Distillate Oil, Natural Gas	465 MW/<750 MW	ESP, overfire air, FGR, waterwall lances, low-NOx burners/0.3% fuel sulfur content*
Cascades Boxboard Group – CT LLC, PFI Boiler, Residual Oil, Natural Gas	275 MMBtu/hr/NA	Low-NOx burners/0.5% fuel sulfur content or quarterly emission rate of 0.55 lb/MMBtu

*Or meet an average emission rate of equal to or less than 0.33 lb/MMBtu for each calendar quarter from a single unit or 0.3 lb/MMBtu for each calendar quarter from two or more units.

Figure 9.1: Connecticut BART Eligible Sources SO_2 Emissions

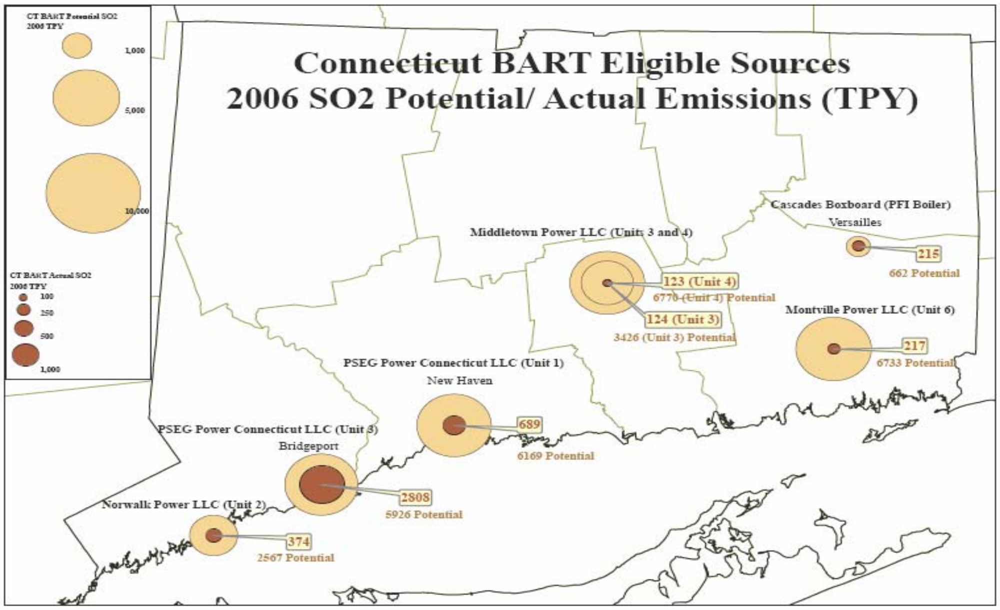
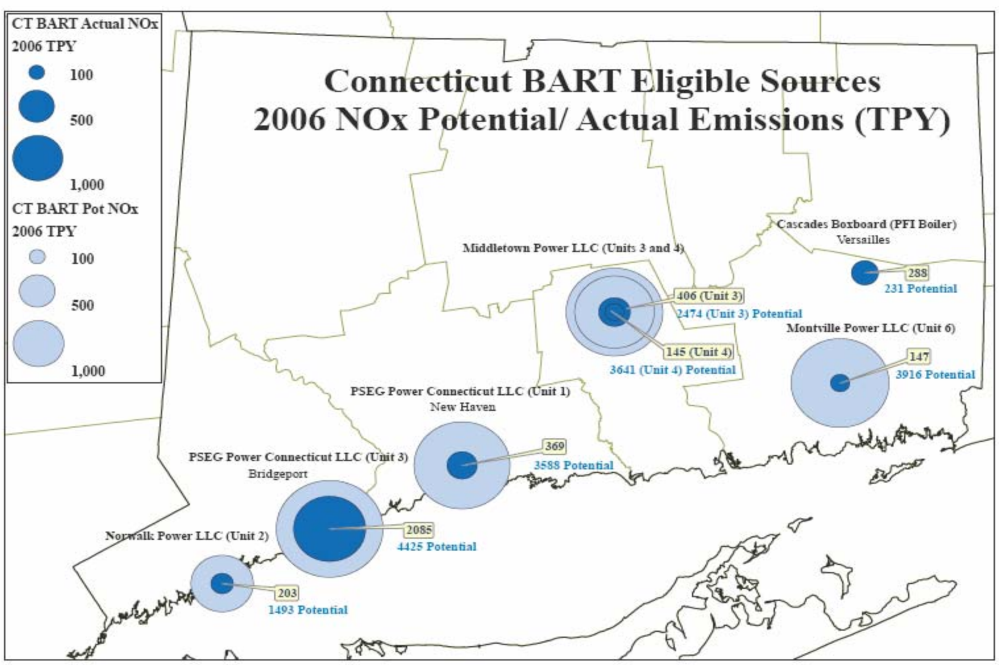


Figure 9.2: Connecticut BART Eligible Sources NO_x Emissions



With the exception of Cascades Boxboard Group's industrial boiler (PFI), all of the BART-eligible sources in Connecticut are electric generating units (EGUs).

9.2.2 Determination of which BART-eligible sources are subject to BART

The State of Connecticut is a member of the Mid-Atlantic/Northeast Visibility Union (MANE-VU). As part of the consultation process amongst MANE-VU states a policy decision was made by the MANE-VU Board in June 2004 that all BART-eligible sources are subject to BART. As such, no BART exemptions will be given, meaning all BART-eligible sources are included in the full BART review process.

9.2.3 Determination of what BART is for each source subject to BART

The following discussions describe the currently available NOx, SO_2 and PM control technologies for EGUs and Industrial Boilers, the EPA Guideline for BART Determinations, and the MANE-VU BART Workgroup recommended emission limits for NOx, SO_2 and PM.

Currently available control technologies for EGUs and Industrial Boilers

NOx

Firing Configurations and Firing Practices

Firing configuration and firing practices can result in a 5 to 60% reduction in NOx formation. Firing configuration is a design characteristic of the boiler. Firing practices include such things as low excess air, flue-gas recirculation, staged combustion, reduced air preheat, low NOx burners, and fuel substitution/alteration.

Operating at low excess air involves reducing the amount of combustion air to the lowest possible level while maintaining efficient and environmentally compliant boiler operation. NOx formation is inhibited because less oxygen is available in the combustion zone. These methods may change the normal operation of the boiler and the effectiveness is boiler-specific. Implementation of these techniques may also reduce operational flexibility; however, they may reduce NOx by 10 to 20% from uncontrolled levels.

Flue-gas recirculation involves reinserting a portion of the flue-gas into the combustion chamber. The reduced oxygen content of the reused air will inhibit the production of NOx.

Staged combustion involves a fuel-rich combustion zone, followed by a secondary combustion zone in which excess air is introduced.

Reduced air preheat involves bypassing the combustion air preheater and thus lowering the combustion temperature and reducing the formation of thermal NOx.

Low NOx burners are designed to control fuel/air mixing and increase heat dissipation. These alternative burners can be installed on new boilers or retrofitted on older units. Low NOx burners have been shown to reduce NOx formation by 35-55%.

Fuel substitution requires burning fuel with a lower nitrogen content to inhibit the production of fuel NOx. The lower the content of nitrogen in a fuel, the lower the resultant NOx emissions will be.

Overfire Air
Overfire air involves injecting a portion of the total combustion air above the burners. Overfire air limits NOx by (1) suppressing thermal NOx by partially delaying an extending the combustion process resulting in less intense combustion and cooler flame temperatures; (2) a reduced flame temperature that limits thermal NOx formation, and/or (3) a reduced residence time at peak temperature which also limits thermal NOx formation. Overfire air can reduce NOx emissions by 20-30%.

Water/Steam Injection
Water or steam can be injected into the boiler combustion zone to reduce the peak flame temperature. The lower temperature results in a lower rate of formation of thermal NOx.

Selective Non-Catalytic Reduction (SNCR)
SNCR is a post-combustion technique that involves injecting ammonia or urea into specific temperature zones in the upper furnace or convective pass. The ammonia or urea reacts with NOx in the flue gas to produce nitrogen and water. The effectiveness of SNCR depends on the temperature where reagents are injected; mixing of the reagent in the flue gas; residence time of the reagent within the required temperature window; ratio of reagent to NOx; and the sulfur content of the fuel that may create sulfur compounds that deposit in downstream equipment. There is not as much commercial experience to base effectiveness on a wide range of boiler types; however, in limited applications, NOx reductions of 35 to 60% have been achieved.

Selective Catalytic Reduction (SCR)
SCR is another post-combustion technique that involves injecting ammonia into the flue gas in the presence of a catalyst to reduce NOx to nitrogen and water. The SCR reactor can be located at various positions in the process including before an air heater and particulate control device, or downstream of the air heater, particulate control device, and flue gas desulfurization systems. The performance of SCR is influenced by flue gas temperature, fuel sulfur content, ammonia-to-NOx ratio, inlet NOx concentration, space velocity, and catalyst condition. NOx emission reductions of 75 to 90% have been achieved through the use of SCR on oil-fired boilers operating in the U.S.

<u>SO_2</u>
Wet Flue Gas Desulphurization (FGD)
FGD processes use an alkaline reagent to absorb SO_2 in the flue gas and produce a sodium or a calcium sulfate compound. These solid sulfate compounds are then removed in downstream equipment. Wet regenerable, meaning the reagent material can be treated and reused, FGD processes are attractive because they have the potential for better than 95% sulfur removal efficiency, have minimal waste water discharges, and produce a saleable sulfur product. Some of the current nonregenerable calcium-based processes can, however, produce a saleable gypsum product.

To date, wet systems are the most commonly applied. Wet systems generally use alkali slurries as the SO_2 absorbent medium and can be designed to remove greater than 95% of the incoming SO_2. Lime/limestone scrubbers, sodium scrubbers, and dual alkali scrubbing are among the commercially proven wet FGD systems.

Low-Sulfur Fuels
SO_2 emissions are directly related to the sulfur content of the fuel burned. Reducing the amount of sulfur in the fuel will reduce SO_2 emissions. The low-sulfur coal may be naturally occurring or the result of coal cleaning.

PM
Mechanical Collectors
Mechanical collectors, such as cyclones, are typically effective at collecting large particles. Smaller particles typically escape the cyclone along with the gases. Cyclones are best used in conjunction with other pollution control equipment. The collection efficiency for larger particulate matter (PM greater than 10 microns) typically runs around 85%.

Electrostatic Precipitators (ESPs)
When particle-laden gases pass through an ESP, the particles become charged. An electric field then acts on the particles and forces them to the sides of the precipitator. The particles can then be collected by washing the sides of the precipitator or knocking it so that the particles fall down into a collector. Existing ESPs are typically 40 to 60% efficient. New or rebuilt ESPs can achieve collection efficiencies of more than 99%.

Fabric Filters
Fabric filtration, or baghouses, incorporates multiple fabric bags/filters inside a structure. The particulate removal efficiency of the fabric filter system is dependent on a variety of particle and operational characteristics including particle size distribution, particle cohesion characteristics, and particle electrical resistivity. Operational parameters that affect collection efficiency include air-to-cloth ratio, operating pressure loss, cleaning sequence, interval between cleaning, and cleaning intensity. The structure of the fabric filter, filter composition, and bag properties also affect collection efficiency. Collection efficiencies of baghouses may be more than 99%.

Fuel Substitution
Cleaner fuels will result in less PM emissions.

Scrubbing Systems
Scrubbing systems involve the injection of chemicals and/or water into the flue gas to inhibit the physical or chemical absorption of particles or gaseous pollutants. Scrubbing systems have been shown to reduce PM emissions by 50-60%.

EPA Guideline for BART Determinations/MANE-VU BART Workgroup recommended emission limits
EPA's Guideline for BART Determinations (40 CFR 51, Appendix Y) establishes presumptive SO_2 and NO_x emission limits for 750 megawatt (MW) and greater power plants. Middletown Power LLC is the only Connecticut BART-eligible facility that is greater than 750 MW. All of Connecticut's BART-eligible units are oil-fired, with the exception of Bridgeport Harbor Station Unit 3, which is coal-fired.

For each oil-fired EGU at a 750 MW power plant, regardless of size, EPA recommends that, for SO_2 control purposes, states evaluate limiting the sulfur content of the fuel oil burned to 1 percent or less by weight. For NO_x control purposes at power plants with a generating capacity in excess of 750 MW currently using selective non-catalytic reduction (SNCR) for part of the year (Middletown Unit 3), EPA suggests that use of such controls year round is BART.

States are not required to follow EPA's guidelines when doing BART determinations for other types of sources. However, for a currently uncontrolled coal-fired EGU at a power plant smaller than 750 MW, EPA claims that SO_2 control levels of either 95% or 0.15 lbs/MMBtu are generally cost-effective and could be considered in BART determinations considering the five factors specified in CAA section 169A(g)(2). For NOx, EPA recommends that for other sources currently using SNCR to reduce NO_x emissions during part of the year (i.e., Norwalk Unit 2), states consider requiring the use of such controls year round. For coal-fired EGUs greater than 200 MW located at power plants of 750 MW capacity or less and operating without post-combustion controls, EPA provides a NO_x emission rate of 0.62 lb/MMBtu as a cost-effective level to meet for wet-bottom tangential-fired units burning bituminous coal (i.e., PSEG Bridgeport Harbor Unit 3). For oil-fired and gas-fired EGUs larger than 200 MW at plants smaller than 750 MW (Montville 6, New Haven Harbor 1), EPA believes that installation of combustion control technology to control NO_x is generally highly cost-effective and should be considered in the determination of BART.

Additionally, as part of the regional consultation process, the MANE-VU BART Workgroup established recommended BART emission limits for various types of sources (NESCAUM Five-Factor Analysis of BART-Eligible Sources (6/1/07) (Attachment W)). Table 9-3 includes the MANE-VU BART Workgroup recommended BART emission limits for non-CAIR EGUs and industrial boilers; such units are the only types of BART-eligible units in Connecticut. Since Connecticut is only subject to the CAIR NO_x ozone season program, the BART-eligible EGUs in Connecticut are considered to be non-CAIR EGUs.

Table 9-3: MANE-VU BART workgroup recommended BART emission limits for non-CAIR EGUs and industrial boilers

	SO_2	NO_x	PM
Non-CAIR EGUs	Coal – 95% control or 0.15 lb/MMBtu Oil – 95% control or 0.33 lb/MMBtu (0.3% fuel sulfur limit)	o In NO_x SIP call area, extend use of controls to year-round o 0.1 – 0.25 lb/MMBtu, depending on coal and boiler type	0.02 – 0.04 lb/MMBtu
Industrial Boilers	90% control, MACT acid gas control level, ICI-RACT, or 0.5% fuel sulfur limit (0.55 lb/MMBtu)	0.1 – 0.4 lb/MMBtu, depending on boiler and fuel type	0.02 – 0.04 lb/MMBtu

9.2.4 Determination of the overall visibility improvement anticipated from the application of BART to all MANE-VU sources subject to BART

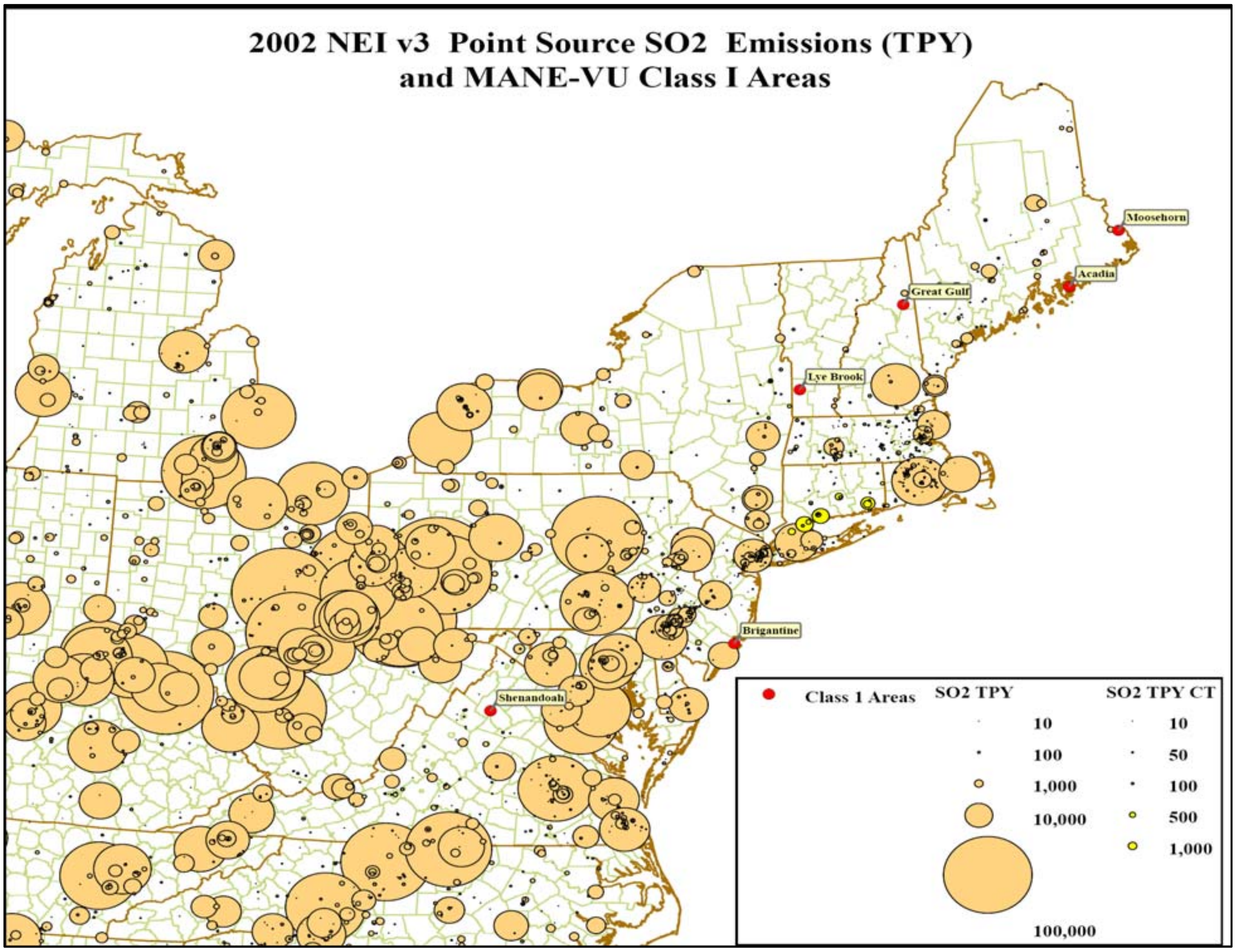
MANE-VU has conducted modeling to assess the visibility improvement from controlling all MANE-VU BART-eligible sources. In one assessment, they modeled the collective visibility improvement from controlling all BART-eligible sources (SO_2, NO_x and PM) with individual impacts, as determined from screening modeling, of less than 0.1 deciviews (dv). This modeling predicted a maximum collective improvement of only 0.3 dv at MANE-VU Class I areas. Both Norwalk Harbor Unit 2 and the Cascades Boxboard Group PFI boiler have individual impacts of less than 0.1 dv at MANE-VU Class I areas.

MANE-VU also modeled the individual impacts on visibility at MANE-VU Class I areas from each BART-eligible source on two CALPUFF Model platforms using two different meteorological data sets, NWS and MM5 (see modeling results in Attachment X). The two platforms modeled three different natural background visibility conditions (best, average, worst) for three pollutants (SO_2, NO_x and PM) in order to determine where the maximum Class I impacts would occur for each BART-eligible source in the MANE-VU region. According to the 2002 individual impact modeling, Bridgeport Harbor Unit 3, New Haven Harbor Unit 1, Middletown Unit 3 and Montville Unit 6 had visibility impacts greater than 0.1 dv on at least one Class I area.

MANE-VU has concluded that a visibility impact in the range of 0.2 to 0.3 dv or greater from an individual source would represent a "significant" impact at MANE-VU Class I areas on an average basis. This significant impact threshold is more stringent than the 0.5 dv BART applicability contribution threshold in EPA's BART Guidelines. Based on MANE-VU's modeling of 2002 emissions, only two of Connecticut's BART-eligible units, Bridgeport Harbor Station Unit 3 and New Haven Harbor Station Unit 1, had annual average visibility impacts greater than 0.2 dv on a Class I area in 2002. For Bridgeport Harbor Station, maximum visibility impacts occurred at Brigantine with total extinction from all pollutants ranging from 0.40 to as high as 0.84 dv with corresponding sulfate contribution ranging from 0.32 to 0.67 dv. For New Haven Harbor Station, maximum visibility impacts were also at Brigantine and ranged from 0.35 to 0.74 dv of combined extinction from all pollutants with corresponding sulfate contribution ranging from 0.29 to 0.61 dv. The visibility impacts from these facilities would now be significantly lower due to implementation of Connecticut's SO_2 emissions reduction program, instituted in 2002 and 2003, that greatly reduced the SO_2 emissions and, hence, the visibility impacts from these sources. This is because Connecticut's SO_2 limits from these sources were reduced to 0.55 lb SO_2/MMBtu in 2002 and to 0.33 lb SO_2/MMBtu in 2003 (see summary of RCSA section 22a-174-19a in Subsection 9.3.1). Prior to 2002 SO_2 limits for these sources ranged as high as 1.1 lb SO_2/MMBtu, with the exception of Middletown Unit 3, which has been limited by order to a 0.55 lb SO_2/MMBtu emission rate since 1981. None of Connecticut's BART-eligible EGUs appear on the list of top 167 electric generating emission points contributing to visibility impairment in MANE-VU (Attachment E).

Another indication of the relative importance of Connecticut's point source emissions as a potential for impacting regional haze at Class I areas is shown in Figure 9.3. Clearly, SO_2 emissions from point sources in Connecticut are relatively small compared with point source emissions in other states.

Figure 9.3:



9.3 Connecticut's Alternative Measures

During the last few years Connecticut has developed additional regulatory measures aimed at reducing emissions of SO_2 and NO_x from a large universe of in-state sources. As demonstrated below, such measures achieve greater emissions reductions than would be achieved through the installation and operation of BART. Table 9-4 lists the Connecticut sources, including Connecticut's seven BART-eligible sources (highlighted), that are addressed in the following discussions on Connecticut's SO_2 and NOx Programs for Alternative BART.

Table 9-4: Universe of Sources Addressed in Connecticut's SO_2 and NOx Programs for Alternative BART (Post-2002 NOx Budget Program Source, Unit ID, Location, Size) (BART-eligible units are highlighted; Acid Rain Program units are boldfaced)

AES Thames, Unit A, Montville, 200 MW	**Milford Power Company LLC 1, Milford, 272 MW**
AES Thames, Unit B, Montville, 200 MW	**Milford Power Company LLC 2, Milford, 272 MW**
Algonquin Power Windsor Locks, 38 MW	**Montville Power LLC, Unit 5, Montville, 81 MW**
Connecticut Jet Power, Branford, 20 MW	**Montville Power LLC, Unit 6, Montville, 410 MW**
Bridgeport Energy 1, Bridgeport, 170 MW	**PSEG Power Connecticut LLC, Unit 1, New Haven, 465 MW**
Bridgeport Energy 2, Bridgeport, 170 MW	**Norwalk Power LLC, Unit 1, Norwalk, 172 MW**
PSEG Power Connecticut LLC, Unit 2, Bridgeport, 170 MW	**Norwalk Power LLC, Unit 2, Norwalk, 172 MW**
PSEG Power Connecticut LLC, Unit 3, Bridgeport, 410 MW	Norwalk Power LLC, Unit 10, Norwalk, 20 MW
PSEG Power Connecticut LLC, Unit 4, Bridgeport, 22 MW	Norwich DPUC, Norwich, 20 MW
Capitol District Energy Center, Hartford, 55 MW	Pfizer Inc, Boiler 5, Groton, 399 MMBtu/hr
Cascades Boxboard Group - Connecticut LLC, Versailles, 275 MMBtu/hr	Pfizer Inc, Boiler 8, Groton, 267 MMBtu/hr
Connecticut Jet Power, Cos Cob 10, Greenwich, 20 MW	Pratt & Whitney Cogen, East Hartford, 32 MW
Connecticut Jet Power, Cos Cob 11, Greenwich, 20 MW	CRRA, South Meadow 11A, Hartford, 20 MW
Connecticut Jet Power, Cos Cob 12, Greenwich, 20 MW	CRRA, South Meadow 11B, Hartford, 20 MW
Devon Power LLC, Unit 7, Milford, 109 MW	CRRA, South Meadow 12A, Hartford, 20 MW
Devon Power LLC, Unit 8, Milford, 109 MW	CRRA, South Meadow 12B, Hartford, 20 MW
Devon Power LLC, Unit 10, Milford, 20 MW	CRRA, South Meadow 13A, Hartford, 20 MW
Devon Power LLC, Unit 11, Milford, 40 MW	CRRA, South Meadow 13B, Hartford, 20 MW
Devon Power LLC, Unit 12, Milford, 40 MW	CRRA, South Meadow 14A, Hartford, 20 MW
Devon Power LLC, Unit 13, Milford, 40 MW	CRRA, South Meadow 14B, Hartford, 20 MW
Devon Power LLC, Unit 14, Milford, 40 MW	Connecticut Jet Power, Torrington Terminal, Torrington, 20 MW
Connecticut Jet Power, Franklin Drive, Torrington, 20 MW	FirstLight Power Resources Services, Tunnel, Preston, 20 MW
Lake Road Generating Company 1, Killingly, 264 MW	**Wallingford Energy 1, Wallingford, 50 MW**
Lake Road Generating Company 2, Killingly, 264 MW	**Wallingford Energy 2, Wallingford, 50 MW**
Lake Road Generating Company 3, Killingly, 264 MW	**Wallingford Energy 3, Wallingford, 50 MW**
Middletown Power LLC, Unit 2, Middletown, 117 MW	**Wallingford Energy 4, Wallingford, 50 MW**
Middletown Power LLC, Unit 3, Middletown, 245 MW	**Wallingford Energy 5, Wallingford, 50 MW**
Middletown Power LLC, Unit 4, Middletown, 400 MW	Waterside Power 4, Stamford, 23.2 MW
Middletown Power LLC, Unit 10, Middletown, 20 MW	Waterside Power 5, Stamford, 23.2 MW
	Waterside Power 7, Stamford, 23.2 MW

9.3.1 Connecticut's SO_2 Program for Alternative BART

RCSA section 22a-174-19a became effective on December 28, 2000 and included a two-tiered timeframe for reducing SO_2 emissions from large EGUs and industrial sources (the approximately 59 sources referenced in Table 9-4). All of the BART-eligible sources in Connecticut are now subject to these regulations.

Summary of RCSA Section 22a-174-19a

Tier One. Starting on January 1, 2002, all sources subject to Connecticut's Post-2002 NOx Budget Program (all sources listed in Table 9-4) were required to:

- Combust liquid fuel, gaseous fuel or a combination of each, provided that each fuel possesses a fuel sulfur limit of equal to or less than 0.5% sulfur, by weight;
- Meet an average emission rate of equal to or less than 0.55 pounds of SO_2 per MMBtu for each calendar quarter for an affected unit at the premises; or
- Meet an average emission rate of equal to or less than 0.5 pounds of SO_2 per MMBtu calculated for each calendar quarter, if such owner or operator averages the emissions from two or more affected units at the premises.

Tier Two. Starting on January 1, 2003, all sources in Connecticut that are Acid Rain Sources under Title IV of the Clean Air Act and are subject to Connecticut's Post-2002 NOx Budget Program (30 boldfaced sources in Table 9-4) shall:

- Combust liquid fuel, gaseous fuel or a combination of each, provided that each fuel possesses a fuel sulfur limit of equal to or less than 0.3% sulfur, by weight;
- Meet an average emission rate of equal to or less than 0.33 pounds of SO_2 per MMBtu for each calendar quarter for an affected unit at a premises; or
- Meet an average emission rate of equal to or less than 0.3 pounds SO_2 per MMBtu calculated for each calendar quarter, if such owner or operator averages the emissions from two or more affected units at a premises.

Prior to January 1, 2005 CTDEP allowed sources subject to the January 1, 2003 emission rates to meet such emission rates by using SO_2 discrete emission reduction credits certified by CTDEP or EPA's SO_2 Acid Rain Program allowances; also known as emissions credit trading. Connecticut General Statute 22a-198 suspended SO_2 emissions credit trading starting on January 1, 2005. As part of its $PM_{2.5}$ SIP revision on November 18, 2008, CTDEP submitted parts of RCSA section 22a-174-19a to EPA in order to make the fuel sulfur limits of Connecticut's alternative BART program federally enforceable. The approval request is pending. CTDEP will be making revisions to RCSA section 22a-174-19a to ensure consistency with state statute provisions and will submit the revisions to EPA as a SIP revision once they become finalized.

Additionally (but with no need for it being made a federally enforceable part of this SIP), starting on January 1, 2002, each Post-2002 NO_x Budget Program source that is also a Title

IV source was required to retire one ton of SO_2 allowances, rounded up to the next whole ton, for each ton of SO_2 emitted in the state of Connecticut. This provision has resulted in 37,462 tons of SO_2 allowances retired between 2002-2006.

All of Connecticut's BART-eligible sources are included in the Post-2002 NO_x Budget Program (subject sources are listed in Table 9-4), which has now been rolled into the CAIR NO_x Ozone Season Trading Program. All of CT's BART-eligible EGUs are also Title IV sources. Therefore**,** in accordance with Tier 2 of RCSA section 22a-174-19a described above, all of Connecticut's BART-eligible EGUs are subject to requirements that are equivalent to the MANE-VU BART workgroup's recommended SO_2 BART limit for oil-fired non-CAIR EGUs (0.33 lb/MMBtu or 0.3% fuel sulfur limit).

The BART-eligible industrial boiler at Cascades Boxboard Group-CT LLC is subject to the January 1, 2002 SO_2 emission rate in RCSA section 22a-174-19a, which is the same as the MANE-VU BART workgroup's recommended SO_2 BART limit for industrial boilers (0.55 lb/MMBtu or 0.5% fuel sulfur limit). EPA's BART guidelines for oil-fired units recommend evaluation of limiting the sulfur content of the fuel oil burned to 1 percent or less by weight. Therefore all of the oil fired BART eligible units are meeting the more stringent MANE-VU BART workgroup's SO_2 BART recommendations. Bridgeport Harbor 3, with a SO_2 emission limit of 0.3 or 0.33 lb SO_2/MMBtu (depending on the regulatory option selected), is the only coal-fired BART eligible source in Connecticut. The MANE-VU BART workgroup's recommended BART limit for coal-fired non-CAIR EGUs is 0.15 lb/MMBtu. EPA's suggested, but not required, emission rate is the same. While Bridgeport Harbor Unit 3's SO_2 limit does exceed the recommendations of the MANE-VU BART workgroup and EPA, as described below, the net effect of Connecticut's SO_2 program is to produce greater emission reductions from all BART-eligible units than would be achieved through the installation and operation of BART alone. Furthermore, Connecticut's only 750 MW BART-eligible power plant, Middletown Power LLC, is subject to a more stringent fuel sulfur limit (0.33 lb/MMBtu) than EPA's presumptive BART guideline limit for oil-fired units of 1 percent or less by weight fuel oil sulfur content. All of Connecticut's BART-eligible EGUs measure SO_2 emissions with continuous emission monitoring systems (CEMS) pursuant to 40 CFR 75.

Analysis of CT's Alternative BART Program for SO_2

Attachment X contains a spreadsheet with the 2001, 2002 and 2006 SO_2 actual and potential (ton per year and ton per day) emissions for all units in the Post-2002 NO_x Budget Program. Where 2006 potential emissions did not decrease from 2002 potential emission levels, the unit's allowable or permitted level did not decrease. Tables 9-5 and 9-6 show the 2001, 2002, 2006 SO_2 potential emissions (both tons per year and tons per day) from the BART-eligible units. For comparison purposes, the presumptive 2012 MANE-VU BART workgroup and EPA BART potential emissions are provided. Table 9-7 shows the 2001, 2002 and 2006 SO_2 actual emissions from the BART-eligible units.

Table 9-5: SO_2 Annual Potential (Allowable) Emissions @ 8760 Hours (tpy)

BART-eligible Unit/Location	2001*	2002*	2006*	MANE-VU BART workgroup presumptive BART 2012	EPA presumptive BART 2012
Middletown Unit 3, Middletown	5709**	5709	3426	3426	11419
Middletown Unit 4, Middletown	11284**	11284	6770	6770	22568
Montville Unit 6, Montville	22442	11221	6733	6733	22442
Norwalk Unit 2, Norwalk	8557	4278	2567	2567	8557
Bridgeport Harbor Unit 3, Bridgeport	18212	9877	5926	2694	2694***
New Haven Harbor Unit 1, New Haven	20508	10282	6169	6169	20508
Cascades Boxboard Group PFI Boiler, Versailles	1325	662	662	662	1325
Total	88037	53313	32253	29021	89513

*Based on the lower of RCSA section 22a-174-19a regulatory limits or federally enforceable permit conditions.

**Fuel sulfur limited to 0.5% in Consent Order no. 7024.

***While this level of control is not required by EPA guidelines, it is recommended that such level of control be considered.

Table 9-6: SO_2 Daily Potential (Allowable) Emissions @ 24 Hours (tpd)

BART-eligible Unit/Location	2001*	2002*	2006*	MANE-VU BART workgroup presumptive BART 2012	EPA presumptive BART 2012
Middletown Unit 3, Middletown	15.6	15.6	9.4	9.4	31.3**
Middletown Unit 4, Middletown	30.9	30.9	18.5	18.5	61.8**
Montville Unit 6, Montville	61.5	30.7	18.4	18.4	61.5
Norwalk Unit 2, Norwalk	23.4	11.7	7.0	7.0	23.4
Bridgeport Harbor Unit 3, Bridgeport	49.9	27.1	16.2	7.4	7.4***
New Haven Harbor Unit 1, New Haven	56.2	28.2	16.9	16.9	56.2
Cascades Boxboard Group PFI Boiler, Versailles	3.6	1.8	1.8	1.8	3.6
Total	241.1	146	88.2	79.4	245.2

*Based on the lower of RCSA section 22a-174-19a regulatory limits or New Source Review permit conditions.

**Fuel sulfur limited to 0.5% in Consent Order no. 7024.

***While this level of control is not required by EPA guidelines, it is recommended that such level of control be considered.

Table 9-7: SO_2 Actual Annual Emissions (tpy)

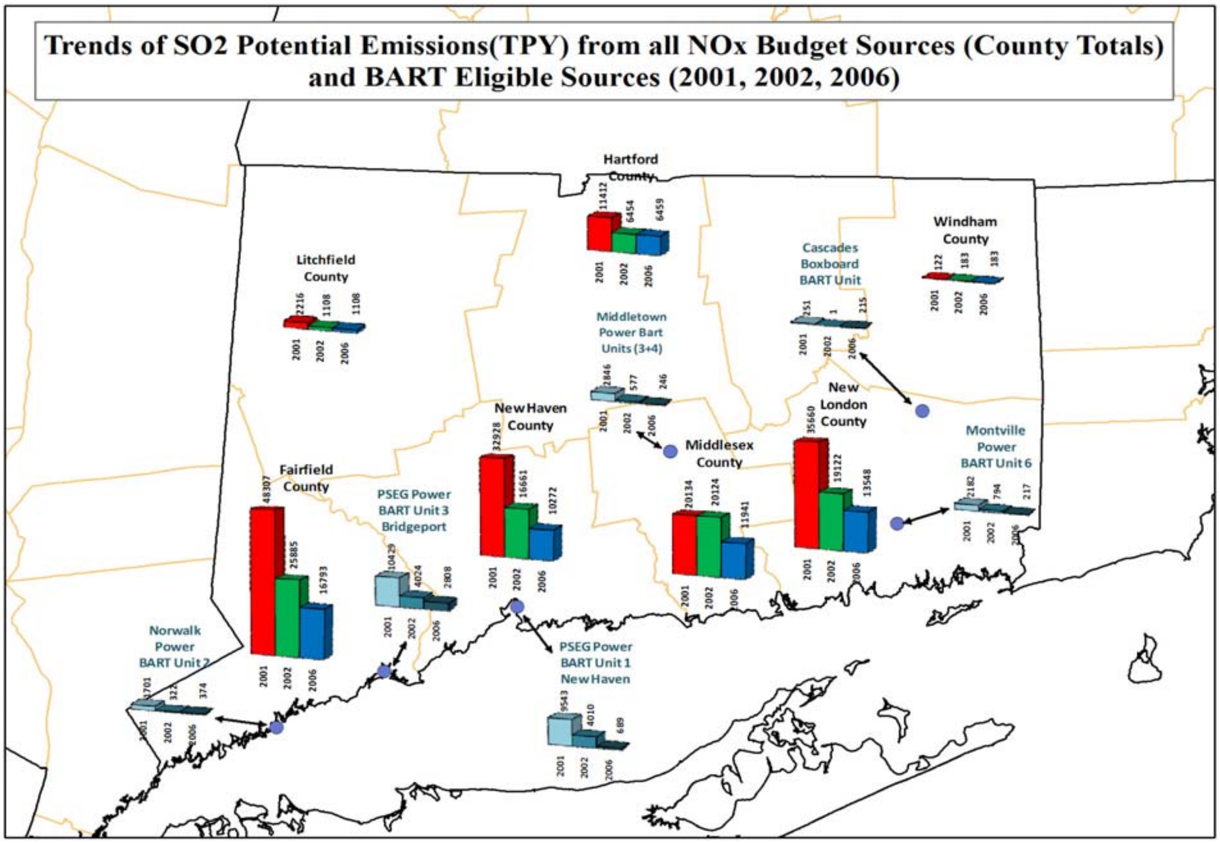
Source/Unit/Location	2001	2002	2006
Middletown Unit 3, Middletown	1830	269	124
Middletown Unit 4, Middletown	1015	308	123
Montville Unit 6, Montville	2182	794	217
Norwalk Unit 2, Norwalk	1701	322	374
Bridgeport Harbor Unit 3, Bridgeport	10429	4024	2808
New Haven Harbor Unit 1, New Haven	9543	4010	689
Cascades Boxboard Group, PFI Boiler, Versailles	251	0.5	215
Total	26,951	9727	4550

Presumptive BART potential emission levels for 2012 (tpy) in Table 9-5 were calculated by multiplying the MANE-VU BART workgroup and EPA recommended BART emission rates in lb/MMBtu by the design capacity of the unit in MMBtu/hr by 8760 hrs/year as follows:

- For Bridgeport Harbor 3, the sole coal-burning unit, 0.15 lb/MMBtu, the MANE-VU BART workgroup's and EPA's recommended SO_2 emission rate for coal-burning units, was used.
- For the five oil-burning EGUs, the MANE-VU BART workgroup's and EPA's recommended BART emission rates of 0.33 lb/MMBtu and 1.1 lb/MMBtu respectively, were used in the calculations.
- MANE-VU BART workgroup post-BART SO_2 potential emissions for Cascades Boxboard Group – Connecticut LLC were assumed not to change after 2002 because the source became subject to RCSA section 22a-174-19a in 2002 (0.55 lb/MMBtu) and the allowable SO_2 limit did not change after that date so the 2006 potential emissions remain the same.

Figure 9.4 is a map of Connecticut designating 2001, 2002 and 2006 SO_2 potential emissions from all Post-2002 NO_x Budget Program sources and 2001, 2002 and 2006 SO_2 potential emissions from BART-eligible sources.

Figure 9.4:



As shown in Table 9-8, by comparing SO_2 potential emission reductions since 2002 from all Post-2002 NO_x Budget Program sources subject to RCSA section 22a-174-19a (89,537 tons minus 60,304 tons equals 29,233 tons) with SO_2 potential post-BART emission reductions from BART-eligible sources since 2002 (53,313 tons minus 29,021 tons equals 24292), it is apparent that Connecticut's existing SO_2 regulatory requirements achieve approximately 4,841 tons of greater reductions than estimated reductions from BART alone.

Table 9-8: Comparison of SO_2 Potential Emission Reductions since 2002 from all Post-2002 NO_x Budget Program sources vs. BART-eligible sources alone (tpy)			
SO_2 potential emissions from all Post-2002 NOx Budget Program sources	**Year=2002**	**Year=2006**	**Reduction in potential emissions**
	89,537	**60,304**	**29,233**
SO_2 potential emissions from BART-eligible sources alone		**Year=2012**	
	53,313	**29,021**	**24,292**
Additional reductions beyond BART alone			**4,841**

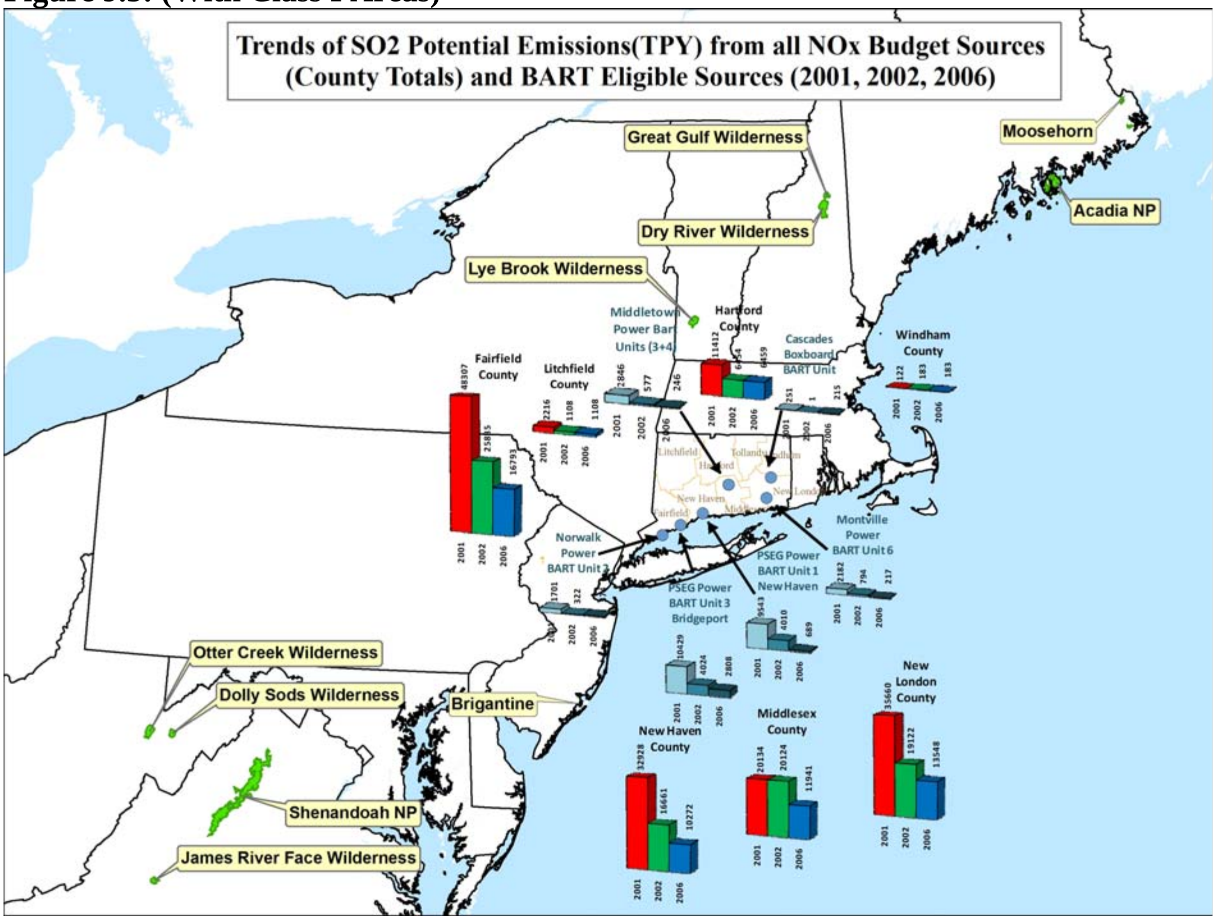
Table 9-9 shows the reductions in actual SO_2 emissions from all Post-2002 NO_x Budget Program sources and all BART-eligible sources since 2001. Note the significant reduction in actual SO_2 emissions starting in 2002 (effective year of Tier 1 of RCSA section 22a-174-19a) and continuing in 2006 (Tier 2 of RCSA section 22a-174-19a was effective in 2003). Attachment X contains maps of reductions in actual SO_2 emissions since 2001 from all Post-2002 NO_x Budget Program sources as well as all BART-eligible sources (both Connecticut-specific and as related to Class I areas).

Table 9-9: Comparison of SO_2 Actual Emission Reductions since 2001 from all Post-2002 NO_x Budget Program sources vs. BART-eligible sources alone (tpy)				
SO_2 actual emissions from all Post-2002 NO_x Budget Program sources	**Year=2001**	**Year=2002**	**Year=2006**	**Reduction in actual emissions since 2001**
	35,625	**13,056**	**7,146**	**28,479**
SO_2 actual emissions from BART-eligible sources alone	**26,951**	**9,727**	**4,549**	**22,402**
Additional reductions beyond BART-eligible sources alone				**6,077**

40 CFR 51.308(e)(3) provides a process for determining whether an alternative measure makes greater reasonable progress than would be achieved through the installation and operation of BART. If the geographic distribution of emissions reductions is similar between

an alternative measure and BART, the comparison of the two measures may be made on the basis of emissions alone. The alternative measure may be deemed to make greater reasonable progress than BART if it results in greater emissions reductions than requiring sources subject to BART to install, operate and maintain BART. In this case, the geographic distribution of emissions reductions is similar (see map in Figure 9.4) and greater emissions reductions than BART are achieved by the alternative measure. Figure 9.5 shows 2001, 2002 and 2006 SO_2 potential emissions from all Post-2002 NO_x Budget Program sources and 2001, 2002 and 2006 SO_2 potential emissions from BART-eligible sources as related to nearby Class I areas.

Figure 9.5: (With Class I Areas)



Timing.

Because CTDEP's SO_2 regulatory requirements were effective in 2002/2003, greater air quality benefit has been realized than from the BART timing requirements. EPA requires compliance with BART emission limitations no later than 5 years after EPA approves the state's regional haze SIP (70 FR 39172); such SIPs were due to EPA in December of 2007. Therefore, Connecticut and its neighboring states will have benefited from reduced SO_2 emissions for many years compared with when such reductions are required by EPA's BART rule. As can be seen in Tables 9-8 and 9-9, emissions reductions from Connecticut's Alternative BART Program for SO_2 occurred during the first implementation period of the regional haze rule, 2000 through 2018.

9.3.2 Connecticut's NOx Program for Alternative BART

Most of the BART-eligible units in Connecticut installed NO_x reduction technology during the early to mid 1990's in response to Connecticut's ozone reduction strategies, whereby lower NO_x emission limits were promulgated. As described below, CTDEP has concluded that the NO_x emission limits contained in the existing regulations are at least as stringent as BART.

Summary of Revisions to RCSA Sections 22a-174-22, 22a, 22b and 22c

Pursuant to the ozone reasonably available control technology (RACT) provisions of the 1990 Clean Air Act Amendments, in 1995, CTDEP adopted NO_x control regulations (RCSA section 22a-174-22) achieving substantial reductions in 24-hour NO_x emission rates from a variety of sources, including the BART-eligible units. The maximum allowable 24-hour NO_x emission rate for cyclone furnaces (including Middletown Unit 3) was reduced by 52%, the maximum allowable 24-hour NO_x emission rate for existing coal-fired boilers (Bridgeport Unit 3) was reduced by 58% and the maximum allowable 24-hour NO_x emission rate for no. 6 oil-fired boilers (including Middletown Unit 4, Montville Unit 6, Norwalk Unit 2, New Haven Harbor Unit 1 and Cascades Boxboard's PFI boiler) was reduced by 17% when compared to previously adopted NO_x limits.

Since 1999, CTDEP has adopted several NO_x budget trading programs which progressively reduced allowances allocated to Connecticut's NO_x budget sources during the summer ozone season. RCSA section 22a-174-22a limited the summer NO_x emissions budget to 5866 tons beginning in 1999 and RCSA section 22a-174-22b reduced the summer NO_x budget further to 4466 tons beginning in 2003. All of Connecticut's BART-eligible units are currently subject to the Post-2002 NO_x Budget Program (RCSA section 22a-174-22b sources listed in Table 9-4) and are also included in the CAIR NO_x Ozone Season Trading Program starting in 2009 pursuant to RCSA section 22a-174-22c. The CAIR NO_x Ozone Season Trading Program includes a NO_x budget for Connecticut sources of 2691 tons that is not to be exceeded during the ozone season (May 1st through September 30th each year). Implementation of the CAIR Program (2691 tons of summer season NO_x) will result in a 76% reduction from the estimated 11203 tons of ozone season NO_x emissions from NO_x Budget Program sources in 1990.

In addition to these ozone season requirements for EGUs 15 MW and greater and large industrial sources, RCSA section 22a-174-22(e)(3) (adopted in 2000) required that, starting in October 2003, sources subject to RCSA section 22a-174-22 that are also NO_x Budget Program sources meet a non-ozone seasonal NO_x emission rate of 0.15 lb/MMBtu. Therefore, all of Connecticut's NO_x Budget Program sources (listed in Table 9-4), including all of Connecticut's BART-eligible sources, are subject to year-round NO_x emission restrictions. Pursuant to RCSA section 22a-174-22, CTDEP allows sources subject to the 24-hour and non-ozone season NO_x emission limits to use NO_x discrete emission reduction credits or NO_x Budget Program allowances to comply with the subject emission limits. Table 9-10 shows applicable NO_x limits for the BART-eligible units and Table 9-11 shows NO_x allowances allocated to these sources under the various emissions trading programs.

Table 9-10: Historical NO_x limits for BART-eligible Units (lb/MMBtu)[1, 2, 3, 4]

BART-eligible Unit	Pre-1995 24-hr NO_x limit	24-hr NO_x limits as of 5/31/95
Middletown Unit 3	0.9 (oil)	0.25 (no. 6 oil)/0.20 (no. 2 oil, gas)
Middletown Unit 4	0.3 (oil)	0.25 (no. 6 oil)/0.20 (no. 2 oil)
Montville Unit 6	0.3 (oil)	0.25 (no. 6 oil)/0.20 (no. 2 oil)
Norwalk Unit 2	0.3 (oil)	0.25 (no. 6 oil)/0.20 (no. 2 oil)
Bridgeport Harbor Unit 3	0.9 (coal)/0.3 (oil)	0.38 (coal)/0.25 (no. 6 oil)/0.20 (no. 2 oil)
New Haven Harbor Unit 1	0.3 (oil)/0.9 (gas)	0.25 (no. 6 oil)/0.20 (no. 2 oil, gas)
Cascades PFI Boiler	0.3 (oil)/0.9 (gas)	0.25 (no. 6 oil)/0.20 (gas)

[1]Starting in May 1999 all of the BART-eligible units were in Phase I of the NO_x Budget Program (see Table 9-11) with the additional ozone-season budget constraint (5866 tons) equating to an approximate 0.20 lb/MMBtu NO_x emission rate.

[2]Starting in May 2003 all of the BART-eligible units were in Phase II of the NO_x Budget Program (NO_x SIP Call) with the additional ozone-season budget constraint (4477 tons, later revised to 4466 tons) equating to an approximate 0.15 lb/MMBtu NO_x emission rate.

[3]Starting in October 2003 all of the BART-eligible units were also required to meet a non-ozone seasonal NO_x limit of 0.15 lb/MMBtu, with a credit trading compliance option.

[4]Starting in 2009 all of the BART-eligible units are subject to the CAIR NO_x Ozone Season Trading Program with an additional ozone-season budget constraint (2691 tons) equating to an approximate 0.14 lb/MMBtu NO_x emission rate.

Table 9-11: NO_x Ozone Season Allowances Allocated to BART-eligible Units

BART-eligible Unit	1999 NO_x Budget Program (5866 tons)	2005 NO_x SIP Call (4466 tons)	2009 CAIR (2691 tons)
Middletown Unit 3	379	188	124
Middletown Unit 4	122	24	60
Montville Unit 6	320	86	59
Norwalk Unit 2	375	186	88
PSEG Bridgeport Unit 3	1111	2568	741
PSEG New Haven Unit 1	965	399	154
Cascades PFI Boiler	85	71	81
Total	3357	3522	1307

For oil-fired EGUs at 750 MW or larger power plants, EPA's BART Guideline recommends states should consider requiring the use of controls year-round for units currently using SNCR for part of the year. The only BART-eligible units at a 750 MW power plant in Connecticut, Middletown Units 3 and 4, both have boiler excess air control for NO_x and Middletown Unit 3 also has SNCR for NOx control purposes. For oil-fired and gas-fired EGUs larger than 200 MW, EPA believes that installation of current combustion control technology is generally highly cost-effective and should be considered in BART determinations.

The MANE-VU BART workgroup's recommended NO_x BART emission limits for non-CAIR EGUs are to extend the use of controls to year-round in the NO_x SIP Call area and operate in an emission limit range of 0.1 – 0.25 lb/MMBtu of heat input, depending on coal and boiler type. For industrial boilers, the MANE-VU BART workgroup's recommended NO_x BART emission limit range is 0.1 – 0.4 lb/MMBtu, depending on boiler and fuel type (consistent with OTC control strategies and NO_x SIP Call emission limits). Pursuant to the CAIR NO_x Ozone Season Trading Program and RCSA section 22a-174-22(e)(3), all of Connecticut's BART-eligible sources are subject to year-round NO_x emission rates of 0.14 lb/MMBtu (ozone season) and 0.15 lb/MMBtu (non-ozone season). All of Connecticut's BART-eligible sources monitor NO_x emissions with CEMS pursuant to 40 CFR 75.

Analysis of CT's Alternative BART Program for NO_x

EPA states "participation in either the annual or seasonal CAIR NO_x cap-and-trade program is a necessary condition for relying on EPA's determination that states can substitute CAIR for BART for NO_x." (71 FR 60623) Connecticut finalized its CAIR regulation for participation in the CAIR NO_x Ozone Season Trading Program (CAIR Program) in 2009 and submitted its CAIR SIP Revision to EPA. This SIP revision was approved by EPA on January 24, 2008 (73 FR 4105). While it is unknown at this time how EPA will resolve the remand of CAIR, it is assumed that whatever changes EPA makes will result in reduction levels at least as stringent as CAIR. As part of its $PM_{2.5}$ SIP revision on November 18, 2008, CTDEP submitted RCSA section 22a-174-22(e)(3) to EPA in order to make the 0.15 lb/MMBtu non-ozone seasonal limit for NO_x Budget Program sources federally enforceable. The approval request is pending.

As weight of evidence that Connecticut's NO_x control programs achieve better than BART reductions, there are three elements that should be considered:

- DERC Trading. Sources using NO_x discrete emission reduction credits (DERCs) in order to comply with the 24-hour and non-ozone seasonal limits in RCSA section 22a-174-22 are required to retire an additional 5% of DERCs beyond the regulatory limit as a design margin in order to simulate real-world controlled conditions. Sources generating NO_x DERCs through over control are required to retire 10% of DERCs generated for the benefit of the environment.

- CAIR Budget Reduction. EPA required that an additional source (Exeter Energy), not previously in CTDEP's NO_x Budget Programs, be added to CTDEP's CAIR Program without increasing the budget of NO_x allowances available to the State. Exeter Energy typically emits approximately 50 tons of NO_x per ozone season. The addition of another source to the CAIR universe reduced allocations available for other CAIR Program sources, including all of the BART-eligible EGUs. In addition, Connecticut is the only state with a CAIR budget that does not decrease in 2015 (however, this may change as a result of the CAIR remand). Connecticut's CAIR budget was obtained by using overly conservative NO_x SIP Call calculated budget levels prior to the February 1999 memorandum of understanding between Massachusetts, Rhode Island and Connecticut (64FR49987, September 15, 1999) and subsequent revised NO_x SIP Call budget levels, so in essence, Connecticut is required to meet a 2015 equivalent CAIR budget in 2009.

- CAIR Allocations. CTDEP is changing the allocation methodology that was previously used in its NO_x Budget Programs for the CAIR Program. Starting in 2012, unless the CAIR remand necessitates a change, all megawatt hours of electricity generated by CAIR Program sources will be treated equally for the purpose of allocating allowances, and the less efficient EGUs, including all of the BART-eligible EGUs, will receive substantially fewer allowances than they received under the NO_x Budget Programs, thereby encouraging further NO_x reducing measures such as controls and/or repowering.

Attachment X contains a spreadsheet that lists all of the Post-2002 NO_x Budget Program units that are also subject to the non-ozone seasonal emission limit of 0.15 lb/MMBtu and shows the NO_x potential emissions from 1994, 2002 and 2006. Where 2006 potential emissions did not decrease from 2002 potential emission levels, the unit's allowable or permitted level did not decrease. As can be seen in Table 9-12, NO_x potential and actual emissions have decreased since 1994 as a result of revised RCSA section 22a-174-22 (Control of NO_x) requirements and additional reductions since 2002 have been achieved as a result of the RCSA section 22a-174-22(e)(3) non-ozone seasonal emission limit.

Table 9-12: Potential and Actual NO_x Emissions from all Post-2002 NO_x Budget Program Units (tpy)

	1994	**2002**	**2006**
Potential Emissions	89812	46188	34833
Actual Emissions	13411	6150	5346

Figure 9.6 contains a map of Connecticut designating NO_x potential emissions in 1994, 2002 and 2006 from all Post-2002 NO_x Budget Program units by county as well as all BART-eligible units. As with SO_2, the geographic distribution of emissions is similar when comparing NO_x reductions between the alternative measure and requiring sources subject to BART to install, operate, and maintain BART.

Figure 9.6:

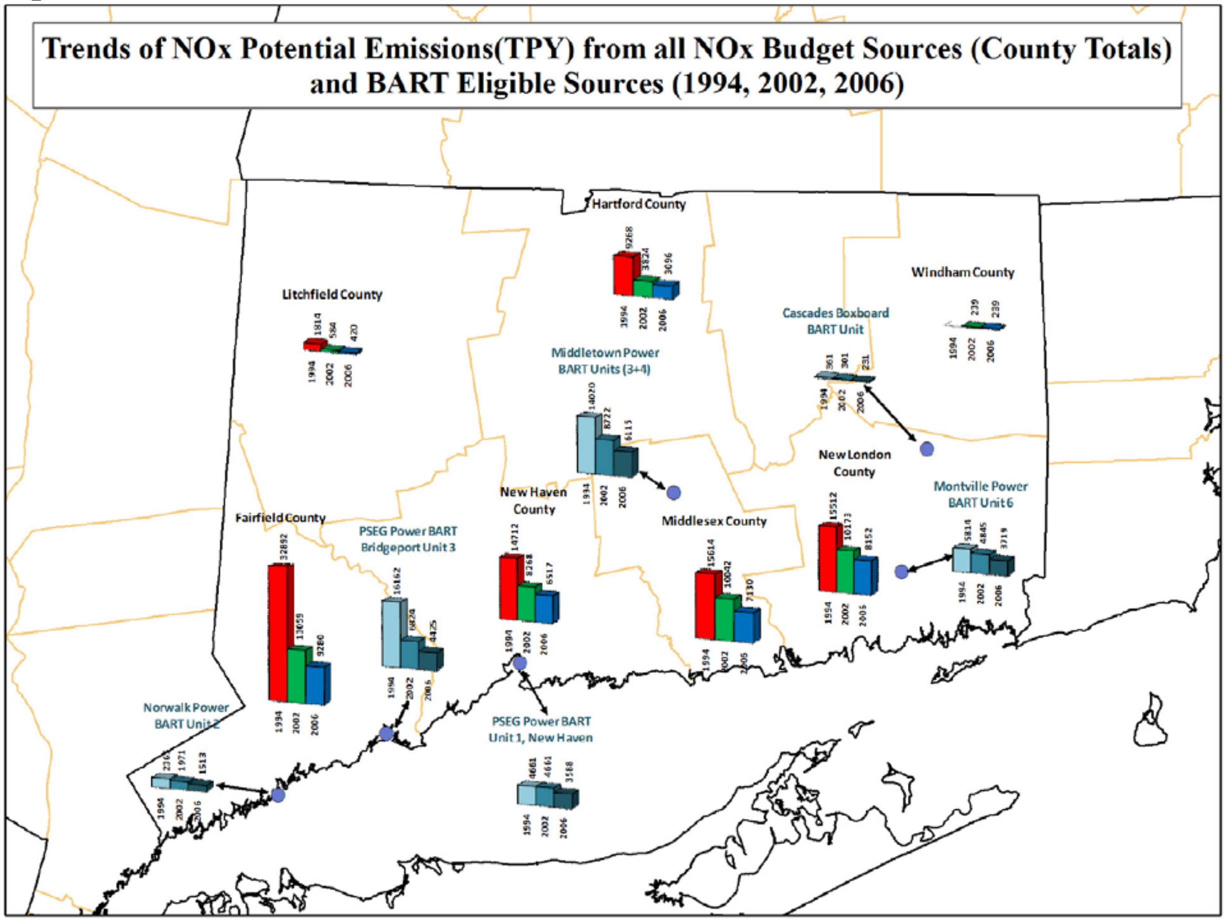
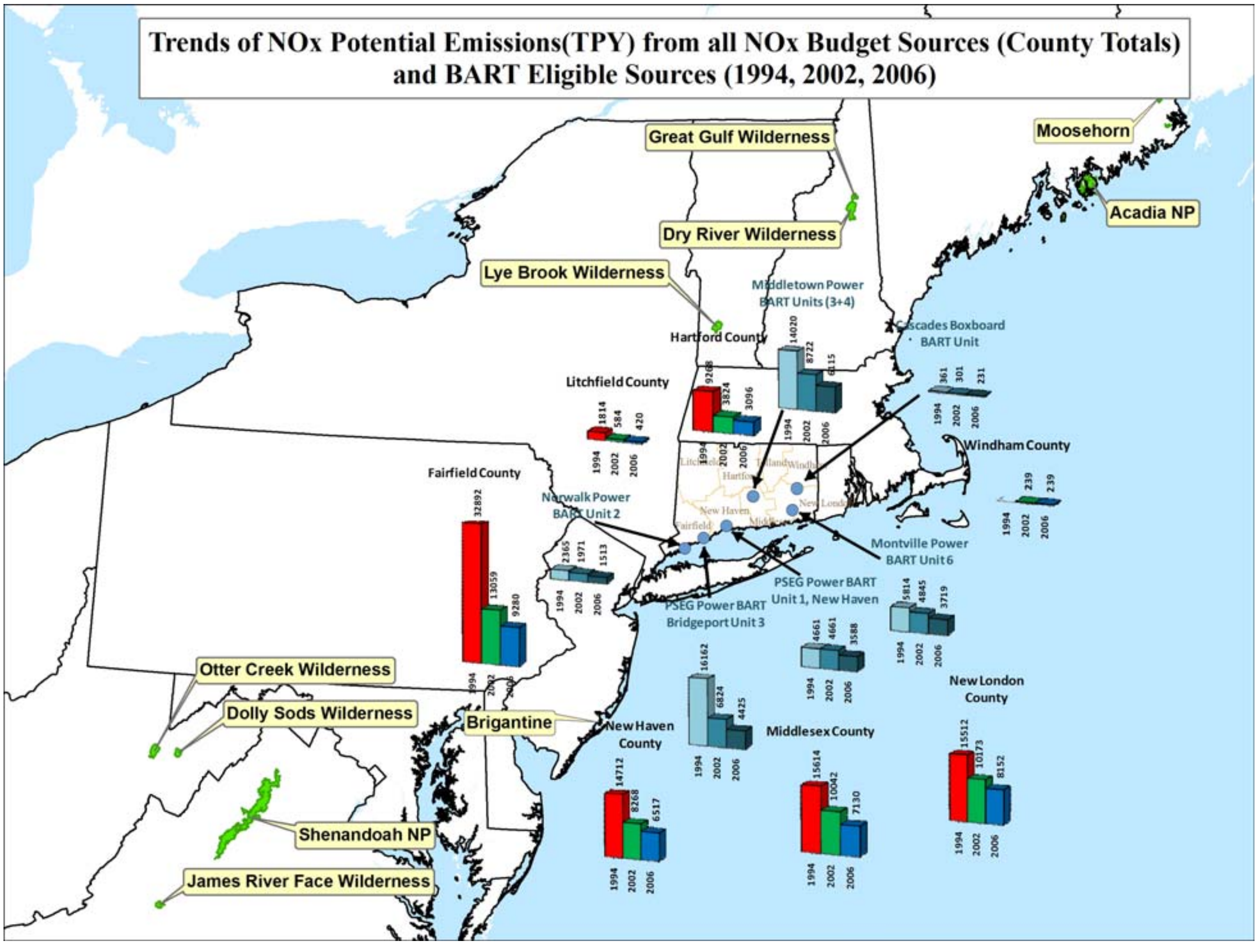


Figure 9.7 shows 1994, 2002 and 2006 NO_x potential emissions from all Post-2002 NO_x Budget Program sources and 1994, 2002 and 2006 NO_x potential emissions from BART-eligible sources as related to nearby Class I areas.

Figure 9.7: (With Class I Areas)



Attachment X contains maps of reductions in actual NO_x emissions since 1994 from all Post-2002 NO_x Budget Program sources as well as all BART-eligible sources (both Connecticut-specific and as related to Class I areas).

Tables 9-13 and 9-14 show the 1994 (pre-RCSA section 22a-174-22 revisions), 2002 and 2006 NO_x potential emissions (both tons per year and tons per day) from BART-eligible units. In order to show reductions achieved as a result of the 2003 non-ozone seasonal limit, both ozone season and non-ozone season numbers are provided for 2006. Table 9-15 shows the 1994, 2002 and 2006 NO_x actual emissions from the BART-eligible units. By comparing NO_x potential emissions reductions since 1994 from all Post-2002 NO_x Budget Program sources with NO_x potential emissions reductions since 1994 from BART-eligible units, it is evident that Connecticut's existing NO_x regulatory requirements achieve greater NO_x reductions than from BART alone (see Figure 9.6).

Table 9-13: NO_x Potential Emissions* (tpy)

BART-eligible Unit/Fuel	1994 (tpy)	2002 (tpy)	2006 tons per ozone season	2006 tons per non-ozone season	2006 total tons
Middletown Unit 3/No. 6 oil	8329	3980	1668	806	2474
Middletown Unit 4/No. 6 oil	5691	4742	1988	1653	3641
Montville Unit 6/No. 6 oil	6121	5101	2138	1778	3916
Norwalk Unit 2/No. 6 oil	2334	1945	815	678	1493
Bridgeport Harbor Unit 3/coal	16162	6824	2860	1565	4425
New Haven Harbor Unit 1/No. 6 oil	4661	4661	1959	1629	3588
Cascades Boxboard PFI Boiler/No. 6 oil	361	301	126	105	231
Total	43659	27554	11554	8214	19768

*Based on the lower of RCSA section 22a-174-22 regulatory limits or federally enforceable permit conditions.

Table 9-14: NO_x Potential Emissions (tons per day)*

BART-eligible Unit/Fuel	1994	2002	2006 Ozone Season	2006 Non-ozone Season
Middletown Unit 3/No. 6 oil	22.8	10.9	10.9	3.80
Middletown Unit 4/No. 6 oil	15.6	13.0	13.0	7.80
Montville Unit 6/No. 6 oil	15.9	13.3	13.3	7.97
Norwalk Unit 2/No. 6 oil	6.48	5.40	5.40	3.24
PSEG Bridgeport Unit 3/coal	44.3	18.7	18.7	7.38
PSEG New Haven Unit 1/No. 6 oil	12.8	12.8	12.8	7.68
Cascades PFI Boiler/No. 6 oil	0.989	0.84	0.84	0.495
Total	119.7	75.2	75.2	38.6

*Based on the lower of RCSA section 22a-174-22 regulatory limits or federally enforceable permit conditions.

Table 9-15: NO_x Actual Emissions (tpy)

BART-eligible Unit	Pre-RACT (1994)	2002	2006
Middletown Unit 3	1293	468	406
Middletown Unit 4	274	145	145
Montville Unit 6	307	312	147
Norwalk Unit 2	802	82	203
PSEG Bridgeport Unit 3	3654	1689	2085
PSEG New Haven Unit 1	1802	1143	369
Cascades PFI Boiler	462	215	288
Total	8594	4054	3643

Timing

Greater air quality benefits for the citizens of Connecticut and neighboring states have been realized from the early implementation of CTDEP's NO_x regulatory requirements than would have occurred under EPA's BART implementation requirements (five years after EPA approval of CTDEP's regional haze SIP). As can be seen in Tables 9-13, 9-14 and 9-15, emissions reductions from Connecticut's Alternative BART Program for NO_x occurred during the first implementation period of the regional haze rule, 2000 through 2018.

9.3.3 BART Requirements for PM

Sections 9.3.1. and 9.3.2. of this SIP demonstrated that Connecticut's existing SO2 and NO_x regulations meet the requirements of alternative BART for SO2 and NO_x. This section describes BART for primary PM through a qualitative analysis of the five factors: i) existing controls, ii) visibility improvement reasonably expected from implementation of controls, iii) cost of controls, iv) remaining useful life of the source, and v) energy and non air quality impacts from controls.

EPA's BART guidelines for 750 MW and greater power plants do not contain presumptive emission limits for PM. The MANE-VU BART workgroup's recommended BART emission limits for PM (measured as particles less than 2.5 microns in diameter, or $PM_{2.5}$) are emission rate ranges of 0.02-0.04 lb/MMBtu for non-CAIR EGUs and 0.02-0.07 lb/MMBtu for industrial boilers.

Existing controls at sources

Table 9-16 shows the registration/permit status and existing PM controls at BART-eligible units in Connecticut.

Table 9-16: Registration/Permit Status and Existing PM Controls at BART-Eligible Units

BART-eligible Unit	Registration/Permit Status	Existing PM Controls
Middletown Unit 3	Registration, Title V	ESP
Middletown Unit 4	NSR*, Title V	None
Montville Unit 6	Registration, Title V	None
Norwalk Unit 2	Registration, Title V	ESP
PSEG Bridgeport Unit 3	NSR*, Title V	ESP
PSEG New Haven Unit 1	NSR*, Title V	ESP
Cascades PFI Boiler	Registration, Title V	None

*Federally enforceable New Source Review permit

Upon renewal or revision of the Title V permits for Middletown Unit 3, Norwalk Power Unit 2, PSEG Power Bridgeport Unit 3 and PSEG Power New Haven Harbor Unit 1, existing ESP controls will be included as an applicable requirement pursuant to 40 CFR Part 51 (BART). PSEG Bridgeport Unit 3 also installed a baghouse for mercury control by July 2008, thereby achieving concomitant PM reduction benefits.

RCSA section 22a-174-18 includes PM emission limits of 0.10 lb/MMBtu for natural gas and 0.14 lb/MMBtu for no. 6 oil for registered sources (Middletown Unit 3, Montville Unit 6, Norwalk Unit 2, Cascades PFI boiler). For permitted sources (Middletown Unit 4, PSEG Bridgeport Unit 3 and PSEG New Haven Unit 1), RCSA section 22a-174-18 includes a PM emission limit of 0.10 lb/MMBtu. However, the PSEG Bridgeport and New Haven units have more stringent PM permit emission limits than are specified by RCSA section 22a-174-18 for some fuels. The specific permitted PM emission rate for PSEG Bridgeport Unit 3 operating on coal is 0.06 lb/MMBtu and the specific permitted PM emission rates for PSEG New Haven Unit 1 are 0.061 lb/MMBtu operating on residual oil and 0.003 lb/MMBtu operating on natural gas. CTDEP submitted the current version of RCSA section 22a-174-18 to EPA for SIP approval on December 1, 2004. The approval request is pending.

Visibility improvement reasonably expected from application of controls
MANE-VU's 2002 individual unit modeling shows that none of Connecticut's PM emissions from BART-eligible sources have a significant visibility impact on any Class I area.

Cost of controls
Table 9-17 shows the cost of PM controls per year for those BART-eligible units without PM controls as well as actual PM emissions for 2005. Numbers were calculated by using the range of control technologies and cost per actual cubic feet per minute (ACFM) of gas flow values provided in NESCAUM's Assessment of Control Technology Options for BART-Eligible Sources (March 7, 2005) (Attachment Z) and ACFM values provided in the 2005 emission statements.

Table 9-17: Cost of PM Controls and 2005 Actual PM Emissions			
	Capital Cost Ranges ($)	**Fixed & Variable O&M Cost Ranges ($/year)**	**2005 Actual PM Emissions (tons)**
Middletown Unit 4	20,496,000-68,320,000	683,200-3,416,000	46
Montville Unit 6	20,220,000-67,400,000	674,000-3,370,000	18
Cascades PFI Boiler	120,000-4,800,000	48,000-324,000	42

Given the very high cost per ton reduced for the remaining BART-eligible units without PM controls (the EGUs (Middletown Power Unit 4 and Montville Power Unit 6) are load-following units that operate infrequently), along with the lack of PM contribution evidence from MANE-VU's modeling, the existing conditions in Connecticut with respect to PM control are deemed to be equivalent to BART.

Remaining useful life of the source

The MANE-VU BART workgroup's recommendation on the remaining useful life factor is that BART-eligible sources with reasonable control options available should either control emissions from the BART-eligible sources prior to 2013 or accept a federally enforceable permit limitation or retirement date prior to each state's public notice and hearing processes and FLM review of BART SIP elements. The weight of this factor was not taken into consideration for this analysis.

Energy and non-air quality environmental impacts

No significant energy or non-air quality environmental benefits or dis-benefits associated with PM controls were identified.

In conclusion, further primary PM control beyond the controls already implemented by Connecticut's BART-eligible units is deemed not warranted at this time as such measures are not cost-effective and the visibility contribution from Connecticut's BART-eligible units with respect to PM is insignificant.

9.4 Reasonably Attributable Visibility Impairment

40 CFR 51.302(c) provides for general plan requirements in cases where the affected Federal Land Manager has notified the state that Reasonably Attributable Visibility Impairment (RAVI) exists in a Class I Area in the state. Based on the modeling conducted by MANE-VU and consultations with Federal Land Managers, there are no RAVI sources in Connecticut or the other MANE-VU states.

9.5 Conclusion

CTDEP's existing regulatory programs for SO_2, NO_x and PM reductions achieve a greater visibility improvement than BART alone because the recommended MANE-VU BART workgroup or EPA presumptive BART emission rate levels have been applied to a larger universe of sources (that includes the BART-eligible units) than the seven BART-eligible units in Connecticut. In addition, CTDEP's current regulatory levels were effective many years earlier than would be required by BART. The geographic distribution of sources limited by existing emission reduction requirements in Connecticut is equivalent to the geographic distribution of BART-eligible units.

From a regional haze perspective, SO_2 is the pollutant with the most impact on visibility, and CTDEP has substantially reduced SO_2 emissions with the implementation of RCSA section 22a-174-19a. From 2002-2006, Connecticut SO_2 emissions from sources subject to RCSA section 22a-174-19a reduced by approximately 45%.

Connecticut's BART-eligible units are all subject to year-round NO_x emission limitations. In terms of primary PM, further control beyond the controls already implemented by Connecticut's BART-eligible units is deemed not warranted at this time as such measures are not cost-effective and the visibility contribution from Connecticut's BART-eligible units with respect to primary PM is insignificant (see NWS and MM5 modeling results in Attachment X).

CTDEP has submitted to EPA the non-ozone seasonal NO_x limit provisions of RCSA section 22a-174-22, the fuel sulfur content provisions of RCSA section 22a-174-19a and the primary PM emission limits of RCSA section 22a-174-18 in order to make such provisions federally enforceable. In addition, CTDEP commits to incorporating as applicable requirements existing PM controls into Title V permit renewals for BART purposes.

10.0 REASONABLE PROGRESS GOALS

40 CFR 51.308(d)(1) of the Regional Haze Rule requires states with Class I areas to establish, for each Class I area within the state, reasonable progress goals (RPG) toward achieving natural visibility conditions. On June 1, 2007, the U.S. Environmental Protection Agency (EPA) released final guidance to be used by states in setting reasonable progress goals. The goals must provide for visibility improvement on the days of greatest visibility impairment and ensure no visibility degradation on the days of least visibility impairment for the duration of the State Implementation Plan (SIP) period.

As provided in 40 CFR 51.308(d)(1)(iv), the state must consult with other states in the setting of 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 condition."

Connecticut does not have any Class I areas, but because Connecticut may reasonably be anticipated to cause or contribute to visibility impairment in MANE-VU Class I areas, it consulted with MANE-VU states with Class I areas: New Hampshire, Maine, Vermont and New Jersey. A description of the consultation process is found in Section 3.0, Regional Planning and Consultation. Connecticut agrees with the reasonable progress goals established by New Hampshire, Maine, Vermont and New Jersey (see Subsection 10.2). As referred to in Subsection 2.1, emissions from Connecticut sources also impact Class I areas in West Virginia and Virginia, albeit to a much lesser extent than impacts on MANE-VU Class I areas.

The Regional Haze Rule also requires each Class I state to consider four factors in setting reasonable progress goals: cost, time needed for compliance, energy and non-air quality environmental impacts, and remaining useful life. In addition, the state 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. If the state proposes a rate of progress slower than the uniform rate of progress, the state must assess the number of years it would take to attain natural conditions if visibility improvement continues at the rate proposed.

10.1 Calculation of Uniform Rate of Progress

As a benchmark to aid in developing reasonable progress goals, MANE-VU compared baseline visibility conditions to natural visibility conditions at each MANE-VU Class I area. The difference between baseline and natural visibility conditions for the 20 percent worst days was used to determine the uniform rate of progress that would be needed during each implementation period in order to attain natural visibility conditions by 2064. Table 10.1 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 each single-unit deciview decrease would represent a barely perceptible improvement in visibility.

Table 10.1: Uniform Rate of Progress Calculation (all values in deciviews)

Class I Area	2000-2004 Baseline Visibility (20% Worst Days)	Natural Visibility (20% Worst Days)	Total Improvement Needed by 2018	Total Improvement Needed by 2064	Uniform Annual Rate of Improvement
Acadia National Park	22.9	12.4	2.4	10.5	0.174
Moosehorn Wilderness and Roosevelt Campobello International Park	21.7	12.0	2.3	9.7	0.162
Great Gulf Wilderness and Presidential Range – Dry River Wilderness	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.[12]

The reasonable progress goals established for MANE-VU's Class I Areas, described later in Subsection 10.2, are expected to provide visibility improvements in excess of the uniform rates of progress shown above.

10.2 Identification of (Additional) Reasonable Control Measures

Connecticut and the other MANE-VU states have identified specific emission control measures – beyond those which individual states or RPOs had 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 3.2.2, Regional Planning and Consultation). 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.[13]

In addition to including proposed emission controls in the eastern United States, MANE-VU 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

[12] "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.

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

consultations in Subsection 3.2.1). 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 be replaced by nine natural gas turbine units equipped with selective catalytic reduction (SCR) by 2018.

The process of identifying reasonable measures and setting reasonable progress goals is described in the subsections which follow. Further elaboration on the reasonable measures which make up the Connecticut/MANE-VU long-term strategy is provided in Section 11.0 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 10.3, Visibility Affects of (Additional) Reasonable Control Measures.

10.2.1 Rationale for Determining Reasonable Controls

40 CFR 51.308(d)(1)(i)(A) of EPA's Regional Haze 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 RPGs. These factors are sometimes termed the "four statutory factors," since their consideration is required by the Clean Air Act.

Focus on SO₂: MANE-VU conducted a Contribution Assessment (Attachment B) and developed a conceptual model that showed the dominant contributor to visibility impairment at all MANE-VU Class I areas during all seasons in the base year was particulate sulfate formed from emissions of SO_2. While other pollutants, including organic carbon, 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 would yield the greatest near-term benefit. Therefore, it is reasonable to conclude that the additional measures considered in setting reasonable progress goals require reductions in SO_2 emissions.

***Contributing Source*s**: The MANE-VU Contribution Assessment indicates that emissions from within MANE-VU in 2002 were responsible for approximately 25 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. Point sources dominated the inventory of SO_2 emissions. Therefore, 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 Section 11.0, 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 to production of the MANE-VU report by MACTEC Federal Programs, Inc., "Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas," Final, July 9, 2007, otherwise known as the Reasonable Progress Report (Attachment Y).

This report provides an analysis of the four statutory factors for five major source categories: EGUs; ICI boilers; cement and lime kilns; heating oil combustion; and residential wood combustion. Table 10.2 summarizes the results of MANE-VU's four-factor analysis for the source categories considered.

Table 10.2: Summary of Results from Four-Factor Analysis of Different Source Categories

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), including wet, spray-dry, or dry.	$775-$1,690 based on IPM® v.2.1.9 * $170-$5,700 based on available literature	2-3 years following SIP submittal	Fuel supply issues, possible permitting issues, reduced 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 controls; flue gas desulfurization (FGD), including wet, spray-dry, or dry.	$130-$11,000 based on available literature; dependent 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; flue gas desulfurization (FGD), including wet, spray-dry, or dry; advanced flue gas desulfurization (FGD).	$1,900-$73,000 based on available literature; dependent on size.	2-3 years following SIP submittal	Control device energy requirements, wastewater issues	10-30 years
Heating Oil	SO_2	Switch to lower-sulfur fuel (varies by state)	$550-$750 based on available literature; high degree of uncertainty with this cost estimate	Currently feasible; capacity issues may influence timeframe for implementation of new fuel standards	Increased furnace/boiler efficiency, reduced 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 or inducement	$0-$10,000 based on available literature	Several years, depending on mechanism for emission reductions	Increased efficiency of combustion device, reduced greenhouse gas emissions	10-15 years

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

The MANE-VU states reviewed the four-factor analyses presented in the Reasonable Progress Report, consulted with one another about possible control measures, and concluded by adopting the statements known as the MANE-VU Ask. These statements identify the control measures that would be pursued toward improving visibility in the region. The following discussions focus on the four basic control strategies chosen by MANE-VU and included in the modeling to establish the reasonable progress goals:

1.) BART,
2.) Low-sulfur fuel oil requirements,
3.) Emission reductions from specific EGUs, and
4.) Additional measures determined to be reasonable.

10.2.2 Best Available Retrofit Technology 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 participating CAIR states. Although CAIR has been remanded to EPA, the determination that CAIR=BART is still in place. Connecticut anticipates that those same units will be covered by successor legislation or new rulemaking in the redesign of CAIR. A complete compilation of BART-eligible sources in the MANE-VU region is available in Appendix A of MANE-VU's "Assessment of Control Technology Options for BART-Eligible Sources," March 2005, also known as the BART Report (Attachment Z).

To assess the benefits of implementing BART in the MANE-VU region, NESCAUM estimated emission reductions for twelve BART-eligible sources in 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 sources were identified by a survey of states' staff members, who furnished data on the potential control technologies and expected control levels for these sources under BART implementation. The twelve sources are listed in Table 10.3 along with their 2002 baseline and 2018 estimated emissions. Information on these sources was incorporated into the 2018 emissions inventory projections that were used in the modeling to set reasonable progress goals.

Table 10.3: Estimated Emissions from BART-Eligible Facilities in MANE-VU States (Facilities Likely to be Controlled as a Result of BART Alone)

State	Facility Name	Unit Name	SCC Code	Plant ID (MANE-VU Inventory)	Point ID (MANE-VU Inventory)	Facility Type	2002 SO_2 Emissions (tons)	2018 SO_2 Emissions (tons)
MD	EastAlco Aluminum	28	30300101	021-0005	28	Metal Production	1,506	1,356
MD	Eastalco Aluminum	29	30300101	021-0005	29	Metal Production	1,506	1,356
MD	Lehigh Portland Cement	39	30500606	013-0012	39	Portland Cement	9	8
MD	Lehigh Portland Cement	16	30500915	021-0003	16	Portland Cement	1,321	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	8,923	1,338
ME	Wyman Station	Boiler 3	10100401	2300500135	004	EGU	616	308
ME	SAPPI Somerset	Power Boiler 1	10200799	2302500027	001	Paper and Pulp	2,884	1,442
ME	Verso Androscoggin LLC	Power Boiler 1	10200401	2300700021	001	Paper and Pulp	2,964*	1,482
ME	Verso Androscoggin LLC	Power Boiler 2	10200401	2300700021	002	Paper and Pulp	3,086*	1,543
NY	Kodak Park Division	U00015	10200203	8261400205	U00015	Chemical Manufacturer	23,798	14,216
NY	Lafarge Building Materials, Inc	41000	30500706	4012400001	041000	Portland Cement	14800	4440

Note: Many additional sources in MANE-VU are BART-eligible but are expected to be controlled as a result of other emission reduction programs (e.g., state-specific multi-pollutant programs, a redesigned CAIR, etc.).
*Data for 1999 baseline year.

***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 BART Report referenced above), 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 Class I areas in MANE-VU will make determinations demonstrating the reasonableness of BART controls for sources in their states.

10.2.3 Low-Sulfur Fuel Strategy

The MANE-VU region, especially the Northeast, is heavily reliant on distillate oil for home space heating, with more than 4 billion gallons used, according to 2006 estimates from the Energy Information Administration[14]. 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 2,000 ppm (0.2 percent). Although the sulfur content of residual oils varies by source and region, it can exceed 2.0 percent in the Northeast. Combustion of distillate and residual fuel in the MANE-VU states resulted in SO_2 emissions totaling approximately 380,000 tons in 2002.

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:

- Phase 1 would require reducing the sulfur content in distillate (#1 and # 2) fuel oils from current levels of 2,000 to 2,300 ppm (0.20 to 0.23 percent) to a maximum of 500 ppm (0.05 percent) by weight. It would also restrict the sale of heavier blends of residual (# 4, #5, and # 6) fuel oils that have sulfur content greater than 2,500 ppm (0.25 percent) and 5,000 ppm (0.5 percent) by weight, respectively.
- 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 MANE-VU states[15] and the remainder of 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 SIP 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

[14] U.S. Department of Energy, EIA, Table F3a, at http://www.eia.doe.gov/emeu/states/sep_fuel/html/fuel_use_df.html.

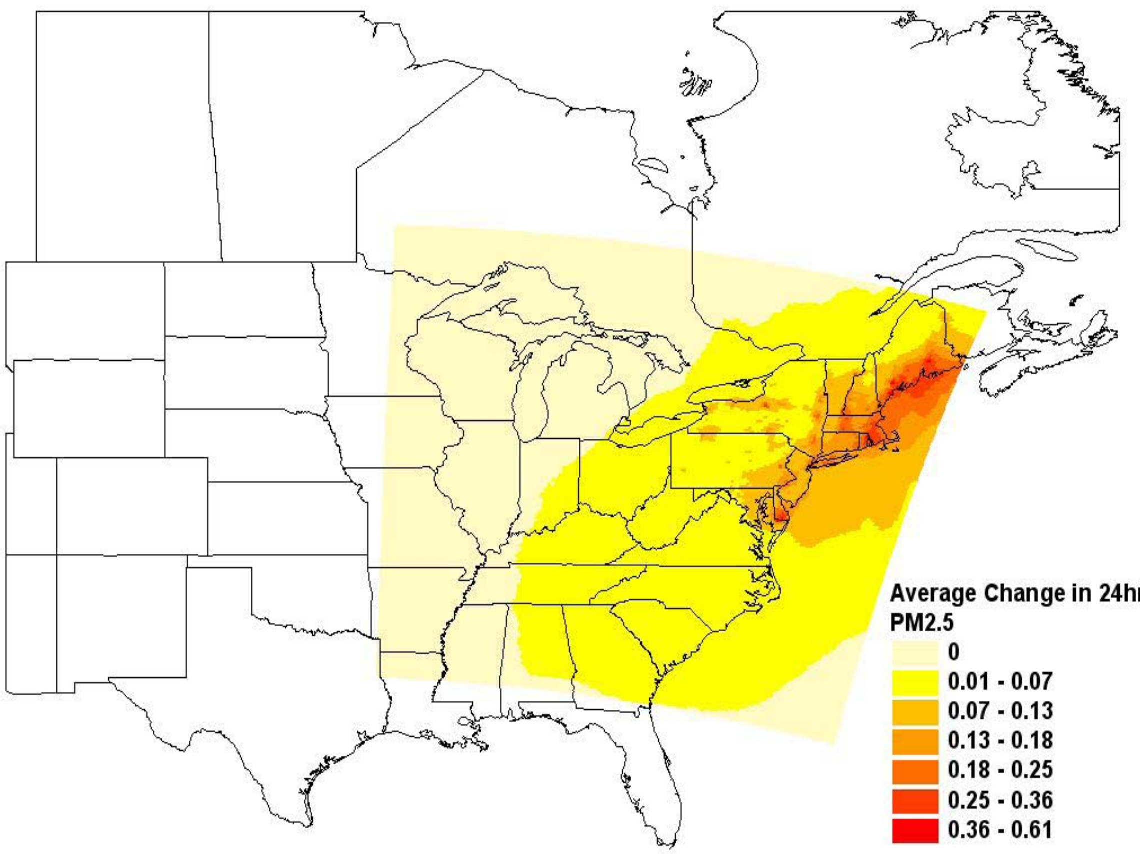
[15] The inner zone includes New Jersey, Delaware, New York, and possibly portions of eastern Pennsylvania.

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 the two program phases separately for MANE-VU, but it is the combined benefit of implementing both phases that is relevant to the question of visibility improvement by 2018. To estimate the effects of the low-sulfur fuel 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 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 benefit of MANE-VU's low-sulfur fuel strategy is represented in Figure 10.1, which displays the estimated average reductions in 24-hr $PM_{2.5}$ concentration as calculated by the CMAQ model for the combined first and second phases of the program.

Figure 10.1: Average Change in 24-hr $PM_{2.5}$ Due to Low-Sulfur Fuel Strategy (Phases I and 2 Combined) Relative to OTB/OTW (values in $\mu g/m^3$)



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 75 to 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 ICI boilers and residential heating systems. MANE-VU's Reasonable Progress Report identified switching to a lower-sulfur fuel 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.

1) Low-Sulfur Fuel Oil 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 less expensive than higher-sulfur 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 byproduct 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 ending March 21, 2008, ranged from a low of $71.38 a barrel for 2.0 and 2.2 percent sulfur fuel to a high of $91.38 per barrel for 0.3 percent sulfur fuel[16].

While the costs of achieving the projected emissions reductions with the low-sulfur fuel strategy are somewhat uncertain, they are believed to be reasonable in comparison with the 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 within the MANE-VU region by no later than 2018. MANE-VU has concluded that the cost of requiring the use of lower-sulfur fuels is reasonable.

2) Low-Sulfur Fuel Oil Strategy – 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 technologies to burn ULSD distillate fuel oil. Therefore, the time necessary for compliance would be determined by the availability of the fuel.

[16] During this same period, low-pour (low-temperature, reduced viscosity) residual fuel oil with a 0.5 percent sulfur content sold for $80.83 per barrel. 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 the United States has the infrastructure to produce adequate stocks of these fuels. NESCAUM's report, "Low Sulfur Heating Oil in the Northeast States: An Overview of Benefits, Costs, and Implementation Issues," December 2005 (Attachment AA) 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 of 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 are a particular concern for several northern MANE-VU states. Maine, New Hampshire, and Massachusetts receive a significant percentage of their residual fuel supplies from offshore sources during the winter months, when barge traffic from New York Harbor is interrupted because of severe weather. At these times, residual oil is often imported directly from foreign sources (e.g., Venezuela and Russia), and stakeholders have expressed concerns that the supply of low-sulfur residual fuels may be insufficient to satisfy demand during these periods. 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 in an emergency, states could also utilize their discretionary powers to address short-term supply disruptions.

The strategy adopted by Connecticut and the other MANE-VU states proposes to phase in the required use of lower-sulfur fuels over the next 10 years, providing adequate time for full implementation.

3) Low-Sulfur Fuel Oil Strategy – 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 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 State Energy

Research and Development Authority (NYSERDA) that showed 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 of 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 have beneficial environmental impacts by reducing acid deposition and helping to decrease ambient concentrations of $PM_{2.5}$. Reductions in $PM_{2.5}$ resulting from use of low-sulfur fuels could help nonattainment areas meet health-based National Ambient Air Quality Standards.

4) Low-Sulfur Fuel Oil Strategy – 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 oil. 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.

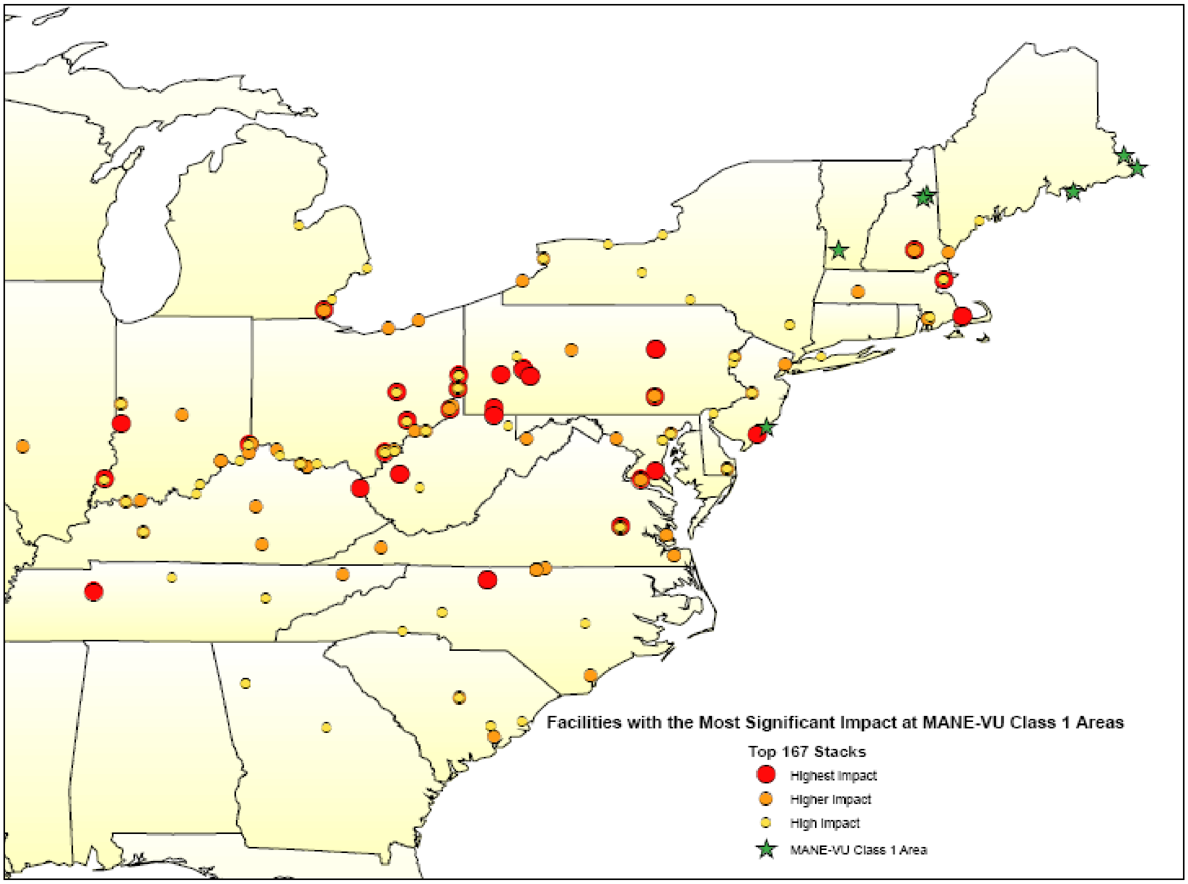
Available information on the remaining useful life of ICI boilers indicates a wide range of life expectancies, depending on unit size, capacity factor, and level of maintenance performed. (Capacity factor is defined as the actual amount of energy a boiler generates in one year divided by the total amount it could generate if it ran full time at full capacity.) 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 life span of an ICI boiler.

10.2.4 Targeted EGU Strategy for SO_2 Reduction

EGUs are the single largest sector contributing to visibility impairment at MANE-VU's 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 visibility extinction on the days of worst visibility (see MANE-VU's Contribution Assessment, Attachment B).

To ensure that EGU control measures are targeted at those units having the greatest impact on visibility at MANE-VU Class I Areas, a modeling analysis was conducted to identify the individual sources responsible for the highest contributions to visibility degradation. Accordingly, MANE-VU developed lists of the 100 EGU emission points (stacks) having the largest 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. These 167 stacks are spread across the Northeast, Southeast, and Midwest (Figure 10.2).

Figure 10.2: Location of 167 EGU Stacks Contributing the Most to Visibility Impairment at MANE-VU Class I Areas

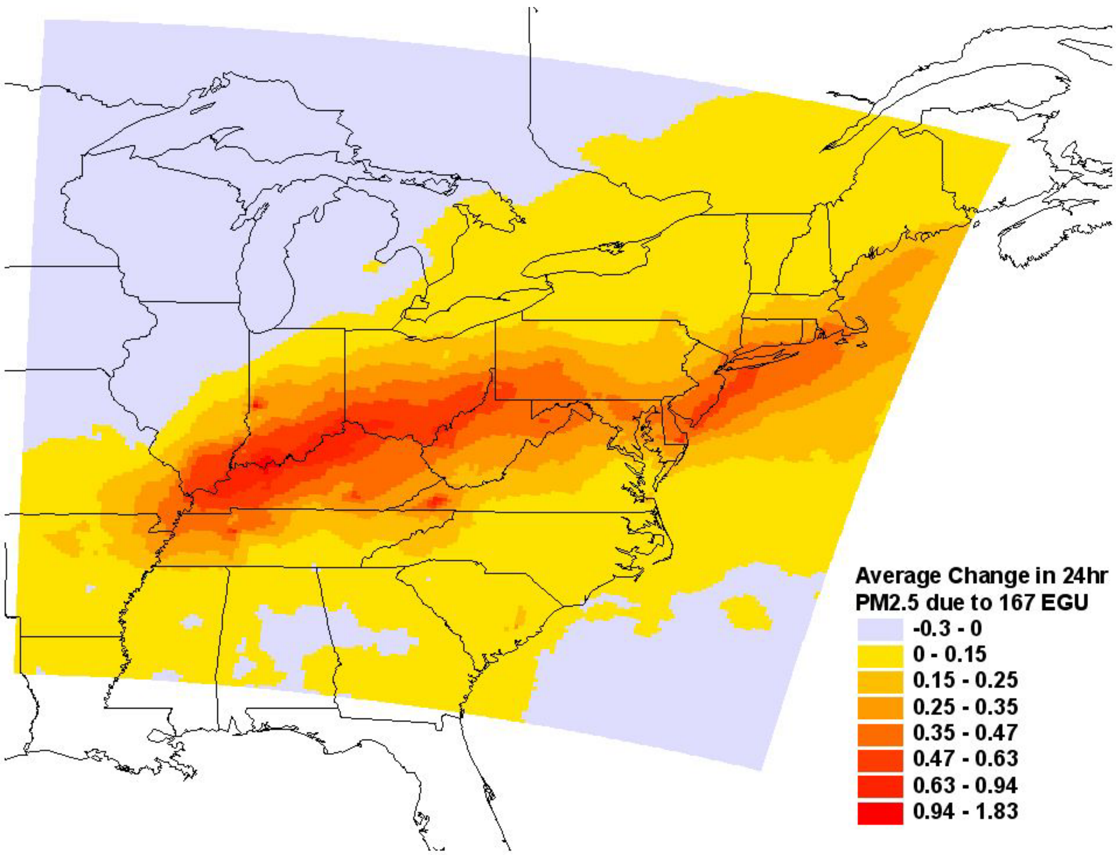


Note: Some facilities have more than one stack.

After consultations with its member states and with other RPOs, MANE-VU requested a 90-percent reduction in SO_2 emissions from the top 167 stacks by no later than 2018 (see the MANE-VU "Ask"). NESCAUM's preliminary modeling for MANE-VU showed that SO_2 emission reductions of this magnitude from the targeted facilities would produce substantial 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 $PM_{2.5}$ concentration. Figure 10.3 displays the predicted average change in 24-hr $PM_{2.5}$.

The map in Figure 10.3 illustrates the reductions in fine-particle pollution in the Eastern U.S. that would result from implementation of the targeted EGU strategy for SO_2. Improvements in $PM_{2.5}$ levels would occur throughout the MANE-VU region and portions of the VISTAS and MRPO regions, especially along the Ohio River Valley.

Figure 10.3: Preliminary Estimate of Average Change in 24-hr $PM_{2.5}$ Resulting from a 90-Percent Reduction in SO_2 Emissions from the Top 167 EGU Stacks Affecting MANE-VU Class I Areas



Although the reductions would be both advantageous and potentially large, MANE-VU determined, after further 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 details, 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 28, 2008 (Attachment H).

***Targeted EGU SO_2 Reduction Strategy Controls 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 information on proposed EGU controls are presented in MANE-VU's Reasonable Progress Report and the Contribution Assessment as well as in Section 6.0, Emissions Inventory, and Section 11.0, Long-Term Strategy section of this SIP.

Based on information gathered from the states and regional planning organizations, MANE-VU anticipated that emissions from many of the targeted EGU stacks would be subject to EPA's Clean Air Interstate Rule (CAIR). However, because CAIR is a cap-and-trade program, it was not possible to predict with certainty which of the 167 stacks would be controlled under CAIR in 2018. Given the remand of CAIR, it is less possible to predict with certainty what controls will be in place in 2018.

Four-Factor Analysis – Targeted EGU SO_2 Reduction Strategy: The following discussion addresses each of the four factors with respect to the strategy of controlling specific EGUs. Information is taken primarily from the MANE-VU Reasonable Progress Report (Attachment Y) and MANE-VU BART Report (Attachment Z).

1) Targeted EGU SO_2 Reduction Strategy – Costs of Compliance: Technologies to control the precursors of regional haze are commercially available today. 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 substantial number of small (e.g., 100 MW) to very large (over 1,000 MW) boilers burning different types of coal. Over the last few years, the cost data clearly indicate that many technologies provide substantial and cost-effective emission reductions.

Both wet and dry 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 for scrubbers ranged from $180/kW for large units (greater than 600 MW) to as high as $350/kW for small units (200 to 300 MW). (See pages 2-22 through 2-25 of the BART Report, Attachment Z). However, the last few years have seen a general trend of declining capital costs attributable 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 results in very large amounts of SO_2 removed by the control devices. The typical cost is in the range of 200 to 500 dollars per ton of SO_2 removed, although the cost rises steeply for small units burning lower-sulfur coal and operating at low capacity factors. For any plant, overall cost-effectiveness depends mainly on the baseline pre-controlled SO_2 emission rate (or fuel sulfur content), size and capacity factor of the unit, and capital costs of flue gas desulfurization (generally ranging 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 95 percent reduction in SO_2 emissions. The costs of different technologies vary considerably among units and were estimated to range from as low as $170/ton to as high as $5,700/ton. Table 10.4 summarizes the estimated costs of controlling SO_2 emissions, expressed in dollars per ton of SO_2 removed.

Table 10.4: 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 the US Environmental Protection Agency (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 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). CAMR was also vacated by the federal courts and is no longer in effect. Recently, EPA updated their input data and developed IPM v.3.0. However, because of time constraints, all MANE-VU runs were based on EPA IPM v.2.1.9 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 one another to update the inputs to IPM v.2.1.9 using more current data on the EGUs and more realistic fuel prices. The resulting IPM run is called

VISTAS PC_1f. This IPM run serves as the basis for regional air quality modeling for ozone and haze SIPs in MANE-VU and the OTC.

MANE-VU, through MARAMA, contracted with the consulting firm ICF Resources, L.L.C. to prepare two new IPM runs, as documented in "Comparison of CAIR and CAIR Plus Proposal using the Integrated Planning Model (IPM®)," Final Draft Report, May 30, 2007 (Attachment BB). The first run, known as the MARAMA CAIR Base Case run (also known as MARAMA_5c), 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. 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. The MARAMA CAIR Plus run included updated information used in the VISTAS run but assumed lower NO_X emission caps and higher SO_2 retirement ratios.

Based on the modeling results, MANE-VU estimates that the marginal cost of SO_2 emission reductions (the cost of reducing one additional ton of emissions) ranges from $640/ton in 2008 to $1,392/ton in 2018 (see Table 6, "Allowance Prices (Marginal Costs) of Emissions Reductions…," in Attachment BB).

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 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 importance of SO_2 emissions from specific EGUs 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 costs of controls, the costs of alternative measures, the flexibility to achieve alternative reductions if necessary, etc. – concluded that the costs of the targeted EGU strategy are reasonable. Connecticut agrees with this conclusion.

2) Targeted EGU SO_2 Reduction Strategy – 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 3½ years from the SIP submittal date. Most MACT standards allow a 3-year compliance period. Under Phase II of the NO_X SIP Call, EPA provided for 2-year compliance period from the SIP submittal date. MANE-VU Class I states conclude 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. Connecticut agrees with this conclusion.

3) Targeted EGU SO_2 Reduction Strategy – Energy and Non-Air Quality Environmental Impacts of Compliance: The MANE-VU Reasonable Progress Report identified several energy and non-air quality impacts from additional EGU controls. Large-scale fuel switching could potentially impact fuel supplies. Flue gas desulfurization systems may generate wastewater and sludge (which is sometimes recycled as a useful byproduct). On the other hand, SO_2, NO_X, and ammonia controls would have beneficial environmental impacts by reducing acid deposition and nitrogen deposition to water bodies and natural land areas. Emission reductions for these pollutants would also produce decreases in ambient levels of

$PM_{2.5}$ and result in corresponding health benefits. Similarly, mercury emissions may be reduced by the addition of controls for other pollutants. MANE-VU Class I states conclude that the energy and non-air quality impacts of additional EGU controls are reasonable. Connecticut agrees with this conclusion.

4) Targeted EGU SO_2 Reduction Strategy – 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 capacity to bring in other power.

10.2.5 Non-EGU SO_2 Emissions Reduction Strategy for Non-MANE-VU States

In addition to the measures described above (i.e., BART, low-sulfur fuel, and targeted EGU controls), MANE-VU asked states in neighboring regional planning organizations to consider further non-EGU emission reductions comparable to those achieved by MANE-VU states through 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, MANE-VU decided to include, in the latest modeling for the VISTAS and MRPO regions, implementation of control 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 effects of this strategy on visibility at MANE-VU Class I Areas, MANE-VU had to make reasonable assumptions about where the requested emission reductions would occur in the VISTAS and MRPO states without knowing precisely how those reductions would be realized. As a way to represent approximately 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 oil-fired area 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-percent reduction in non-EGU SO2 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 Reduction Measures Outside MANE-VU are Reasonable*:** After EGUs, ICI boilers 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.

<u>ICI Boiler Control Options</u>: Air pollution reduction and control technologies for ICI boilers have advanced substantially over the past 25 years. However, according to a 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 controls: 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 using this fuel had acid scrubbers). A small percentage of industrial boilers had combustion controls in place in 1998, although additional low-NO_X firing systems may have been installed since that date.

Almost all SO_2 emission control technologies fall into 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 emission 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 particular technology. 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. Both pre- and post-combustion SO_2 emission control alternatives for ICI boilers are outlined in Table 10.5. Further description of these technology options is available in Chapter 4 of the MANE-VU Reasonable Progress Report (Attachment Y).

The SO_2 removal efficiency of these controls varies from 20 to 99+ percent depending on the fuel type and control technology. 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 fuel switching 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 would be likely to fall in the vicinity of a 60- percent reduction in SO_2 emissions.

This assumption is validated by data showing that wet FGD systems represent 85 percent of the FGD systems in use in the United States and that these 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.

Table 10.5: 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 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 normal 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 from the MRPO was not received, 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 for this category than for coal- or oil-fired ICI boilers. Implementation of one or more of the suggested SO_2 control options to achieve, on average, a 50-percent reduction in SO_2 emissions at these sources is a reasonable assumption.

For emissions from other area oil-combustion sources in the VISTAS region, an SO_2 reduction of 75 percent was assumed. This reduction is equal to the reduction that would result from implementing the MANE-VU low-sulfur fuel strategy for this sector. The four-factor analysis for the low-sulfur fuel strategy was described in Subsection 10.2.3.

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 analyses 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.

1) Non-EGU SO_2 Emission Reduction Measures outside MANE-VU – 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 an individual boiler 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 Y) provides emission control cost estimates for ICI boilers in the range of \$130 to \$11,000 per ton of SO_2 removed, a very wide spread due to the variability of sources and control options in this category. 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 are restated in 2006 dollars using appropriate adjustment factors found at www.inflationdata.com.

◊ *Cost of Fuel Switching*: Although fuel switching can be a very effective means of controlling SO_2 emissions (reductions of 50 to 99.9 percent are possible), burning low-sulfur fuel may not be technically feasible or economically practical as an SO_2 control option 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. (See Subsection 10.2.3 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 factors: the cost of low-sulfur coal compared to higher-sulfur coal (including consideration of the coal's heating value), and the cost of 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 subbituminous 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 supplied in small quantities or transported long distances from the supplier. 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 it is currently uneconomical to consider this option for large ICI boilers because of the fuel quantity necessary and the price of natural gas. Natural gas is roughly seven times the price of coal in terms of heating value (price per million Btus).

◊ *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. Coal cleaning typically results in a 20- to 25-percent reduction in SO_2 emissions and 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 needs, and smaller land area requirements. Table 10.6 presents the estimated costs of adding DSI-based SO_2 emission controls to ICI boilers for different boiler sizes, fuel types, and capacity factors.

Table 10.6: Estimated Costs of Dry Sorbent Injection (DSI) for ICI Boilers (2006 dollars)

Fuel	SO_2 Reduction (%)	Capacity Factor (%)	Cost-Effectiveness ($/ton of SO_2 removed)		
			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	40	14	1,286	1,040	818
		50	360	291	229
		83	212	171	134

◊ *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. In addition, significant quantities of waste material may be generated that require disposal. The 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 10.7 presents the total estimated cost-per-ton of adding FGD-based SO_2 emission controls to ICI boilers for different boiler sizes, fuel types, and capacity factors. There is no indication that these cost data include possible revenues from gypsum sales, which would partially offset the costs of FGD controls.

Carbon dioxide is also emitted as a byproduct of FGD; therefore, the impacts of increased carbon emissions associated with this technology 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 the request for a 28-percent reduction in non-EGU SO_2 emissions is reasonable. Connecticut concurs with this conclusion.

Table 10.7: Estimated Costs of Flue Gas Desulfurization for ICI Boilers (2006 dollars)

Fuel	Technology	SO_2 Reduction (%)	Capacity Factor (%)	Cost-Effectiveness ($/ton of SO_2 removed)		
				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

2) Non-EGU SO_2 Emission Reduction Measures outside MANE-VU – 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- to 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.

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

3) Non-EGU SO_2 Emission Reduction Measures Outside MANE-VU – 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 dewatered sludge to a landfill has additional environmental implications.

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 NYSERDA (reference 10 in Attachment AA), boiler deposits are reduced by a factor of two by lowering the fuel sulfur content from 1,400 ppm to 500 ppm. 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, and crops as well as buildings and sculptures made of acid-sensitive materials. These emission reductions would also help to decrease ambient levels of $PM_{2.5}$, a significant contributor to premature morbidity and illness in individuals with heart or lung conditions.

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. Connecticut concurs with this conclusion.

4) Non-EGU SO_2 Emission Reduction Measures Outside MANE-VU – Remaining Useful Life of Any Potentially Affected Sources: Available information for remaining useful life estimates of ICI boilers indicates a wide range of life expectancies, depending on unit size, capacity factor, and level of maintenance performed. Typical life spans range from about 10 years to over 30 years. However, the remaining useful life of a specific 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-VU has concluded that a 28-percent reduction in non-EGU SO_2 emissions is reasonable. Connecticut concurs with this conclusion.

10.3 Visibility Effects of (Additional) Reasonable Control Measures

MANE-VU's evaluations included modeling to estimate the effects on visibility of the MANE-VU Ask. The results of this work are summarized below.

NESCAUM performed preliminary modeling as described in the report entitled "MANE-VU Modeling for Reasonable Progress Goals, Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits," February 7, 2008 (Attachment G). 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 "2018 Visibility Projections," May 13, 2008 (Attachment Q).

The NESCAUM modeling demonstrates that significant visibility benefits will accrue from implementation of the additional reasonable control measures described in Subsection 10.2, above. Figures 10.4 and 10.5 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 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 10.4: Demonstration of Required and Reasonable Visibility Progress for 20 Percent Worst Visibility Days

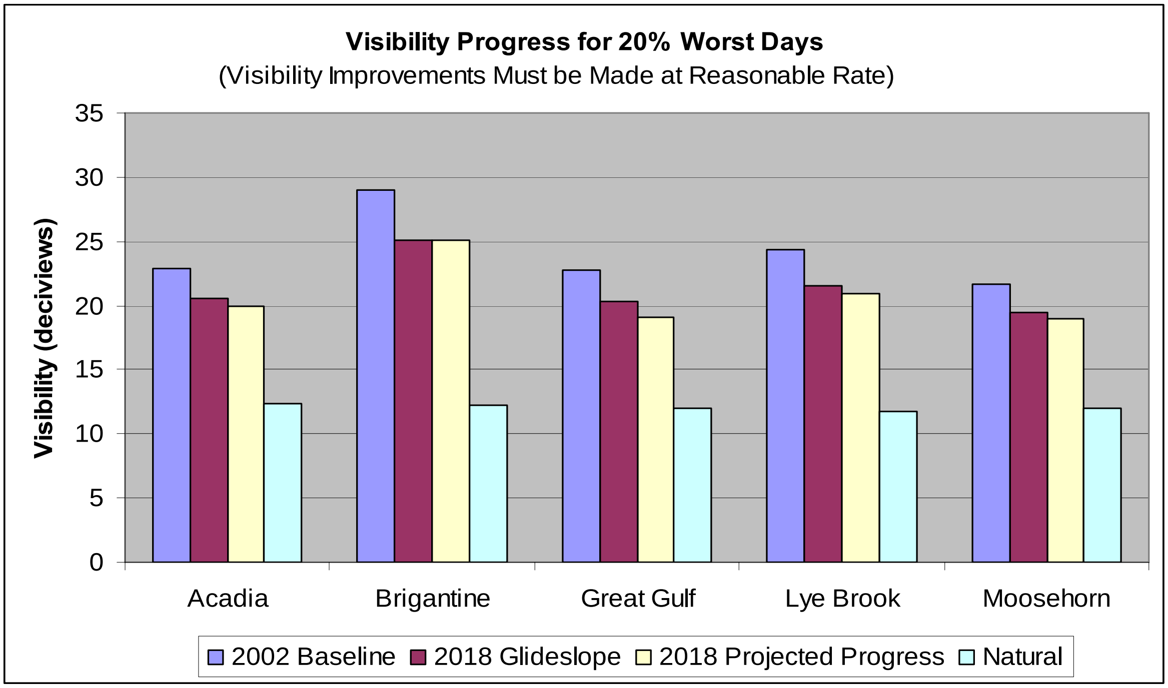
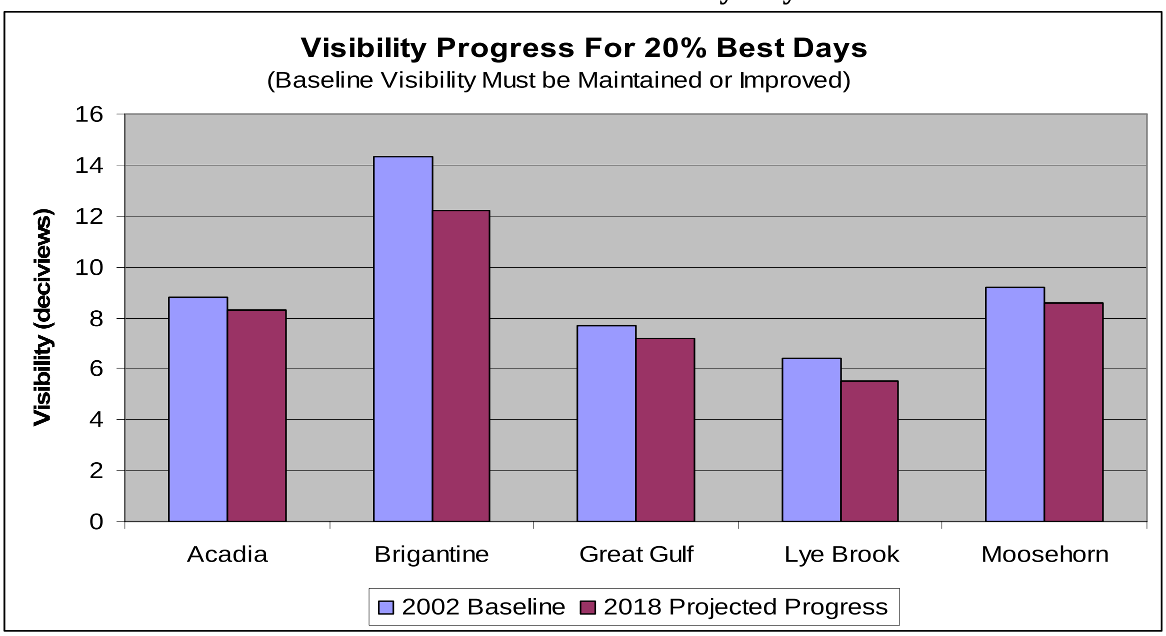


Figure 10.5: Demonstration of Required Maintenance or Improvement of Visibility for 20 Percent Best Visibility Days



References

U.S. Environmental Protection Agency, *National Emission Standards for Hazardous Air Pollutants for Industrial/ Commercial/Institutional Boilers and Process Heaters*, http://cascade.epa.gov/RightSite/dk_public_collection_detail.htm?ObjectType=dk_docket_collection&cid=OAR-2002-0058&ShowList=items&Action=view (Accessed Feb. 25, 2004)

11.0 LONG-TERM STRATEGY

40 CFR 51.308(d)(3) of the Regional Haze Rule requires the State of Connecticut to submit a long-term strategy that addresses regional haze visibility impairment for all mandatory Class I federal areas outside the state that may be affected by emissions from within the state. Affected areas include the seven designated Class 1 areas within the MANE-VU region: Great Gulf Wilderness, Presidential Range - Dry River Wilderness, Acadia National Park, Moosehorn Wilderness, Roosevelt Campobello International Park, Lye Brook Wilderness, and Brigantine Wilderness. As presented in Section 3.0, Regional Planning and Consultation, Connecticut consulted with other states to develop the coordinated emission management strategies contained in this SIP. The following describes how Connecticut meets the long-term strategy requirements of the Regional Haze Rule.

Connecticut's long-term strategy includes enforceable emission limitations, compliance schedules, and other measures necessary to achieve the reasonable progress goals described in Section 10.0. Additional measures may be reasonable to adopt at a later date after further consideration and review. In developing this long-term strategy, Connecticut also considered the requirements of the Clean Air Act, Section 110 (a)(2)(D)(i)(II), pertaining to interstate and international transport of pollutants. CTDEP has previously addressed this issue in Connecticut's "Transport SIP Revision," submitted to EPA on March 13, 2007. 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 Connecticut as well as areas downwind from Connecticut.

11.1 Overview of Strategy Development Process

The regional strategy development process identified reasonable measures that would reduce emissions contributing to visibility impairment at Class I areas by 2018 or earlier. The process of identifying potential emission reduction measures and the technical basis for the long-term strategy are discussed in this section. As a MANE-VU member and participant, Connecticut supported several technical analyses undertaken to assist the MANE-VU states in deciding which regional haze control measures to pursue. These analyses are documented in the following reports:

- NESCAUM, "Contributions to Regional Haze in the Northeast and Mid-Atlantic United States," August 2006, otherwise known as the Contribution Assessment (Attachment B).
- ICF Resources, L.L.C., "Comparison of CAIR and CAIR Plus Proposal Using the Integrated Planning Model®," Final Draft Report, May 30, 2007, otherwise known as the CAIR Plus Report (Attachment BB);
- MACTEC Federal Programs, Inc., "Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas," Final, July 9, 2007, otherwise known as the Reasonable Progress Report (Attachment Y);

- NESCAUM, "Five-Factor Analysis of BART-Eligible Sources: Survey of Options for Conducting BART Determinations," June 1, 2007 (Attachment W); and
- NESCAUM, "Assessment of Control Technology Options for BART-Eligible Sources: Steam Electric Boilers, Industrial Boilers, Cement Plants and Paper and Pulp Facilities," March 2005, otherwise known as the BART Report (Attachment Z).

MANE-VU reviewed a wide range of potential control measures aimed at reducing regional haze by the 2018 milestone. The process of choosing a set of control measures started in late 2005. 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 Measures Workgroup, the contractor narrowed the list of regional haze control measures for further consideration by MANE-VU.

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

- Beyond-CAIR sulfate reductions and related control measures targeted at specific EGUs in the eastern United States,
- Low-sulfur heating oil for ICI boilers and residential sources (i.e., boilers and furnaces), and
- Emission controls on ICI boilers (both coal- and oil-fired); lime and cement kilns; residential wood stoves; 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 documents MANE-VU's assessment of the costs of CAIR and provides a cost analysis for additional SO_2 and NO_X controls at sources 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 second of the two NESCAUM documents referenced above pertaining to BART controls.

The beyond-CAIR strategy for EGUs rose to the top of the list because the Contribution Assessment showed that EGU sulfate emissions have, by far, the largest impact on visibility in the 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 realistically be implemented within the next 10 years. Thus, the low-sulfur heating oil option for the residential and commercial sectors and the control measures option for the oil-fired ICI boiler sector 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 MANE-VU for these sources to be included in a regional strategy, but that they could be covered in programs adopted by individual states. The member states also decided that lime and cement kilns, of which there are few in the MANE-VU region, are most likely to 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 matter. Finally, it was decided that the issue of outdoor wood burning should be examined further on a state-by-state basis because of concerns related to enforcement and penetration of existing state regulations. Connecticut currently regulates outdoor word burning through statute at CGS 22a-174(f) and regulation at RCSA 22a-174-17.

11.2 Technical Basis for Strategy Development

40 CFR 51.308(d)(3)(iii) requires Connecticut 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 Connecticut's emissions. Connecticut relied on technical analyses developed by MANE-VU to demonstrate that Connecticut's 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 Connecticut.

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

- NESCAUM, "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 2006 (Attachment L);
- NESCAUM, "The Nature of the Fine Particle and Regional Haze Air Quality Problems in the MANE-VU Region: A Conceptual Description," Final, November 2, 2006 (Attachment CC);
- NESCAUM, "Contributions to Regional Haze in the Northeast and Mid-Atlantic United States," August 2006, otherwise known as the Contribution Assessment (Attachment B).
- ICF Resources, L.L.C., "Comparison of CAIR and CAIR Plus Proposal Using the Integrated Planning Model®," Final Draft Report, May 30, 2007, otherwise known as the CAIR Plus Report (Attachment BB);
- MACTEC Federal Programs, Inc., "Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas," Final, July 9, 2007, otherwise known as the Reasonable Progress Report (Attachment Y);
- NESCAUM, "Five-Factor Analysis of BART-Eligible Sources: Survey of Options for Conducting BART Determinations," June 1, 2007 (Attachment W);
- NESCAUM, "Assessment of Control Technology Options for BART-Eligible Sources: Steam Electric Boilers, Industrial Boilers, Cement Plants and Paper and Pulp Facilities," March 2005, otherwise known as the BART Report (Attachment Z);
- NESCAUM, "MANE-VU Modeling for Reasonable Progress Goals: Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits," February 7, 2008 (Attachment G); and
- NESCAUM, "2018 Visibility Projections," May 13, 2008 (Attachment Q).

As described in Attachment G, the "beyond on the way" scenario – defined by CAIR with other "on the books" measures and the limitation of fuel sulfur content to 500 ppm for all No. 2 "distillate" fuel oil sold in the MANE-VU region – is sufficient to achieve visibility improvement beyond the so-called "uniform rate of progress" defined by uniform visibility improvement between now and 2064, the planning horizon for the regional haze program. However, it should be noted that USEPA guidance for setting reasonable progress goals asks states to consider reviewing all measures identified through the four factor analysis process (see Section 10.2.1) and to adopt each measure that is determined to be reasonable.

As described in Subsection 11.1, above, Connecticut worked with other members of the Ozone Transport Commission and MANE-VU 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 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 EGUs)
- Point and area source ICI boilers;
- Cement kilns 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 reduction strategies presented in this SIP.

11.3 Existing Commitments to Reduce Emissions

40 CFR Section 51.308(d)(3)(v)(A) requires Connecticut to consider emission reductions from ongoing pollution control programs. In developing its long-term strategy, Connecticut considered air pollution programs being implemented between the 2002 baseline year and 2018. The emission reduction programs described in Subsections 11.3.1, 11.3.2, and 11.3.3 below represent commitments already made by Connecticut 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 emission 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 BOTW because it includes control measures that were developed for ozone SIPs that were not yet on the books in some states. For some states, BOTW 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:

- MACTEC Federal Programs, Inc., "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, otherwise known as the Emission Projections Report (Attachment N);
- 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 (Attachment H);
- NESCAUM, "MANE-VU Modeling for Reasonable Progress Goals: Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits," February 7, 2008 (Attachment G); and
- NESCAUM, "2018 Visibility Projections," May 13, 2008 (Attachment Q).

11.3.1 Controls on EGUs 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. While the first phase of CAIR begins in 2009, it is unknown when EPA will issue a revised CAIR rule in response to the remand and what level of reductions will be required. To predict future emissions from EGUs after implementation of CAIR, MANE-VU used the Integrated Planning Model (IPM)[17]. 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 state 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/MMBtu for fossil-fuel-fired EGUs 15 MW and greater that are also Title IV sources (effective, 2003).

[17] 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 states' 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 emissions inventory and modeling results.

- *RCSA, section 22a-174-22*, limiting the non-ozone seasonal NO_X emission rate to 0.15 lb/MMBtu for fossil-fuel-fired EGUs 15 MW and greater that are also NO_x Budget Program sources (effective, October 2003).
- *Connecticut General Statutes, section 22a-199*, limiting the mercury (Hg) emission rate to 0.0000006 lb/MMBtu for all coal-fired EGUs or alternatively coal-fired EGUs can meet a 90% Hg emission reduction (effective, July 2008).

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

- *Reg. 1144, Control of Stationary Generator Emissions*, requiring emission controls for SO_2, PM, VOC, and NO_X state-wide, effective January 2006.
- *Reg. 1146, Electric Generating Unit (EGU) Multi-Pollutant Regulation,* requiring SO_2 and NO_X emission controls state-wide, effective December 2007. SO_2 reductions will be more than regulation specifies.
- *Reg. 1148, Control of Stationary Combustion Turbine Electric Generating Unit Emissions*, requiring SO_2, 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 8,735tons 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 Valero Refinery Delaware City, DE (formerly Motiva, Valero Enterprises): SO_2 emissions of 29,747 tons in 2002 will decline to 608 tons in 2018 (a 98-percent reduction); NO_X emissions in 1,022 in 2002 will decline 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/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 also limits the NO_X emission rate to 0.15 lb/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, Hg, and CO_2. These regulations will achieve an approximately 50-percent reduction in NO_X emissions and a 50- to 75-percent reduction in SO_2 emissions. Depending on the compliance paths selected, the affected facilities will meet 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 emission rate of 1,800 lb/MWh.

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

- *Chapter Env-A 2900, Multiple Pollutant Annual Budget Trading and Banking Program*, capping NO_X emissions at 3,644 tons per year, SO_2 emissions at 7,289 tons per year, and CO_2 emissions at 5,425,866 tons CO_2 per year for all existing fossil-fuel fired steam units by December 31, 2006.
- *Chapter Env-A 3200, NO_X 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/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/MMBtu; and install a baghouse or approved alternative technology by May 1, 2007, to control 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/MMBtu; and install SCR or approved alternative technology by 2005 to control NO_X emissions and operate the control technology during ozone season only in 2005 and year-round by May 1, 2006, to limit NO_X emissions to 0.13 lb/MMBtu.
- *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/MMBtu; and install SCR or approved alternative technology by 2004 to control NO_X emissions and operate the control technology during ozone season only in 2004 and year-round by May 1, 2006, to limit NO_X emissions to 0.13 lb/MMBtu.

The New Jersey settlement also requires that units operating an FGD use coal having a monthly average sulfur content no greater than 2 percent.

***New York EGU Regulations*:** New York adopted the following regulations governing EGU emissions:

- *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 SO_2 emissions from all fossil-fuel-fired EGUs greater than 25 MW to an annual cap of 197,046 tons per year starting in 2007 and an annual cap of 131,364 tons per 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 NO_X emissions by 2009 and a 73-percent cut in sulfur dioxide SO_2 emissions by 2013. This act also established 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 this agreement; and to comply with emission unit limits of this agreement.
- *TECO*: Under a settlement agreement, by 2008, Tampa Electric in the state of Florida will install permanent emission 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 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 NO_X emissions in the Pensacola, Florida, area.

11.3.2 Controls on Non-EGU Point Sources Expected by 2018

For non-EGU sources within MANE-VU, Connecticut relied on MANE-VU's Version 3.0 Emission Inventory for 2002. MACTEC conducted an analysis of various control measures as documented in the Emission Projections Report (Attachment N). 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, VT);
- NO_X SIP Call Phase II (except ME, NH, 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 were not included and assumed to be small);

- Industrial Boiler/Process Heater MACT[18]; and
- 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 control measure information about specific non-EGU sources or regulatory programs in their states. MANE-VU used the state-specific data to the extent it was available. 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 the 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's Base G2, MRPO's Base K, and CenRAP's emissions inventory. Non-EGU source controls incorporated into the modeling include those required under the following consent agreements as reflected in the VISTAS inventory:

- *Dupont*: A 2007 agreement calls for E. I. Dupont Nemours & Co.'s James River plant to install dual absorption pollution control equipment by September 1, 2009, resulting in SO_2 emission reductions of approximately 1,000 tons 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 SO_2 emissions from its #8 Power Boiler by using a wet scrubber. This control device should result in reductions of over 3,500 tons of SO_2 in 2018.

11.3.3 Controls on Area Sources Expected by 2018

For area sources within MANE-VU, Connecticut relied on 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:

[18] The inventory was prepared before the MACT for Industrial Boilers and Process Heaters was vacated. Control efficiency was assumed to be 4 percent for SO_2 and 40 percent for PM. The overall effects of including these reductions in the inventory are estimated to be minimal.

- The Ozone Transport Commission's VOC Model Rules (for 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 NO_X and VOC emissions for the following area source categories for some (identified) states:

- NO_X control measures for combustion of coal; natural gas; and #2, #4, and #6 fuel oils (CT, NJ, and NY only);
- VOC control measures for adhesives and sealants (all MANE-VU states except New Jersey[19] and VT);
- VOC control measures for emulsified and cutback asphalt paving (all MANE-VU states except ME and VT);
- VOC control measures for consumer products (all MANE-VU states except VT); and
- VOC control measures for portable fuel containers (all MANE-VU states except VT).

As noted above, inventory data for other regions were obtained from those regions' 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 11.3.2 for information on other measures included in states' ozone SIPs.

11.3.4 Controls on Mobile Sources Expected by 2018

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

- Use of reformulated gasoline in the four New Hampshire southern counties classified as ozone nonattainment areas: Rockingham, Strafford, Hillsborough, and Merrimack;
- An enhanced safety inspection program in New Hampshire, including an anti-tampering inspection for motor vehicles less than 20 years old;
- On-board diagnostics testing for 1996 and newer vehicles in New Hampshire in lieu of the anti-tampering inspection;
- Federal On-Board Refueling Vapor Recovery (ORVR) Rule;
- Federal Tier 2 Motor Vehicle Emissions Standards and Gasoline Sulfur Requirements; and
- Federal Heavy-Duty Diesel Engine Emission Standards for Trucks and Buses

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[19] New Jersey's emission reductions from control measures for adhesives and sealants apply only to area sources. No reductions for point sources (SCC 4-02-0007-xx) were included to avoid inventory double-counting.

Similar programs in other MANE-VU states were included in the on-road mobile source emission inventory, where applicable. The last four items listed above are federal programs, briefly described here:

***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.

Tier 2 Motor Vehicle Emissions Standard*s*: 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. The Tier 2 regulations also require reduced gasoline sulfur levels. The reduction in sulfur levels contributes directly to cleaner air and has additional beneficial effects on vehicle emission control systems. The 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.

***Heavy-Duty Diesel Engine Emission Standards for Trucks and Buses*:** EPA set a PM emissions standard of 0.01 grams per brake-horsepower-hour (g/bhp-hr) for new heavy-duty diesel engines in trucks and buses, to take full effect 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. Sulfur in diesel fuel must be lowered to enable modern pollution-control technology to be effective on the trucks and buses that use this fuel. EPA will require a 97-percent reduction in the sulfur content of highway diesel fuel from its current level of 500 parts per million (low-sulfur diesel) to 15 parts per million (ultra-low sulfur diesel).

11.3.5 Controls on Non-Road Sources Expected by 2018

For non-road emission sources, Connecticut used Version 3.0 of the MANE-VU 2002 Emissions Inventory. Because the NONROAD Model used to develop the non-road source emissions did not include aircraft, commercial marine vessels, and locomotives, MANE-VU's contractor, MACTEC, developed the inventory for these sources. Non-road mobile source emissions for the 2018 emission inventory were calculated with EPA's NONROAD2005 emissions model as incorporated into the NMIM2005 (National Mobile Inventory Model) database. The NONROAD model accounts for emissions benefits associated with federal non-road emission control requirements 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, inventory data for other regions were obtained from those regions' RPOs.

11.4 Additional Reasonable Measures

As required under 40 CFR 51.308(d)(1)(i)(A), Connecticut and the other MANE-VU states applied four-factor analysis to potential control measures for the purpose of establishing reasonable progress goals (see Subsection 10.2 for detailed description). Reasonable measures include those that the affected states have already committed themselves to implementing, as described in Subsection 11.3, 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:
  - #2 distillate oil to 0.05 percent (500 ppm) sulfur, by weight, 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;
  - Further reduction of 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:
  - #2 distillate oil to 0.05 percent (500 ppm) sulfur, by weight, by no later than 2014;
  - #4 residual oil to 0.25-0.5 percent sulfur, by weight, by no later than 2018;
  - #6 residual oil to 0.5 percent sulfur or less, by weight, by no later than 2018;
  - Further reduction of the sulfur content of distillate oil to 15 ppm by 2018, contingent on supply and availability.
- A 90-percent or greater reduction in SO_2 emissions from each of the EGUs identified by MANE-VU as reasonably anticipated to cause or contribute to impairment of

visibility in each mandatory Class I area in the MANE-VU region. (This requirement affects 167 point sources, or stacks, at EGU facilities in the eastern United States.) If it is infeasible to achieve this level of SO_2 reductions from specific EGUs, equivalent alternative measures will be pursued in the affected states.

- Continued evaluation of other control measures, including energy efficiency, alternative clean fuels, 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 MANE-VU's long-term strategy, states will be allowed up to ten years to pursue adoption and implementation of proposed control measures. While some measures that states pursue may not represent enforceable commitments immediately, they may become enforceable in the future as new laws are passed, rules are written, and facility permits are issued.

11.4.1 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. For EGUs, EPA determined that CAIR would fulfill the BART requirement for this sector. Connecticut's approach demonstrates BART equivalency and is described in Section 9.0 of this SIP.

To assess the benefits of implementing BART controls for MANE-VU's non-EGU sectors, NESCAUM included in the final 2018 CMAQ modeling analysis anticipated emission reductions for the region's BART-eligible facilities, as described previously in Subsection 10.2.2 of this SIP. It is anticipated that twelve units at eight BART-eligible sources in MANE-VU would be controlled as a result of BART requirements alone (see Table 10.3).

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

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

11.4.2 Low-Sulfur Oil Strategy

The important assumption underlying MANE-VU's low-sulfur fuel oil strategy is that refiners can, by 2018, produce sufficient quantities of home heating and other fuel oils with lower sulfur content than current fuel supplies at only a small increase in price to the end user. The expected reductions in sulfur content range from 50 percent for the heavier grades (#4 and #6 residual) to a minimum of 75 percent and maximum of 99.25 percent for #2 fuel oil (also known as home heating oil, distillate, or diesel fuel). As much as three-fourths of the total sulfur reductions achieved by this strategy will come from using low-sulfur #2 distillate for space heating in the residential and commercial sectors. The costs of these emissions 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 remain somewhat uncertain, they appear to be reasonable when measured against the costs of controlling other sectors.

The MANE-VU states agree that a fuel sulfur content limit on residual oil and distillate oil is reasonable to pursue over the next ten years. CTDEP will review the details of this strategy in five years, coincident with Connecticut's first regional haze SIP progress report. Section 16a-21a of the Connecticut General Statutes limits fuel sulfur content of heating distillate oil and off-road diesel oil to 500 ppm as of the date on which the last of the States New York, Massachusetts and Rhode Island limit the sulfur content of such fuels. Therefore, implementation of this strategy in Connecticut is dependent upon adjacent states' implementation. CTDEP continues to participate in consultations with other MANE-VU states to develop a low sulfur heating strategy consistent with the MANE-VU "Ask".

11.4.3 Targeted EGU Strategy

MANE-VU has identified emissions from the top 167 EGU emission points that contribute the most to visibility impairment at MANE-VU Class I Areas (see Figure 10.2). 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, an overall 90-percent sulfur reduction level would include the effects of lower average reduction rates from dry scrubbing technology, consistent with historical experience. The costs of SO_2 emission reductions will vary by unit. MANE-VU's Reasonable Progress Report (Attachment Y) summarizes the available control methods and costs, which range from $170 to $5,700 per ton (2006 dollars), depending on site-specific factors such as size of unit, combustion technology used, and type of fuel burned. Connecticut is not home to any of the top 167 EGU emission points that contribute the most to visibility impairment at MANE-VU Class I Areas.

As of 2003, EGUs in Connecticut reduced their SO_2 emissions by 72 percent since 1999.

These benefits to regional visibility occurred as a consequence of Connecticut's Control of Sulfur Dioxide Emissions from Power Plants and Other Large Stationary Sources of Air Pollution regulation, which was established by law in RCSA section 22a-174-19a. Under this regulation, Acid Rain Program EGUs 15 MW and greater are required to limit fuel sulfur content combusted to equal to or less than 0.3% sulfur, or to meet an average emission rate of equal to or less than 0.33 lbs SO2/MMBtu for each calendar quarter for an affected unit, or to meet an average emission rate of equal to or less than 0.3 lbs SO_2/MMBtu for each calendar quarter if the owner or operator averages the emissions from two or more affected units at a premises. CTDEP will continue to evaluate other control measures for EGUs and will provide an update on its evaluation in Connecticut's first five-year regional haze SIP progress report.

Several other states within and outside the MANE-VU region have implemented state-specific EGU emission reduction programs that will help MANE-VU meet visibility improvement goals. Many of the state programs that will contribute to meeting the targeted EGU strategy are identified in Subsection 11.3.1. Listed below are other state programs not previously identified that will also contribute to meeting this strategy. These other programs may yield additional benefits by controlling emissions at certain EGUs not listed among the top 167 EGU stacks. The listed programs represent existing commitments by the states and, as such, were included in MANE-VU's most recent modeling.

***Maryland Healthy Air Act*:** Maryland adopted the following requirements governing EGU emissions:

- 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 minimum removal efficiency of 80 percent.
  - Phase II (2013) requires a 12-month-rolling-average minimum removal efficiency of 90 percent.

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 of allowances, and no banking of allowances from year to year were included in the analyses.

***New Jersey Mercury MACT Rule*:** Under this rule all coal-fired EGUs in New Jersey will have a mercury removal efficiency of 90 percent. (Some SO_2 reductions may occur as a co-benefit of mercury emission controls.)

***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 EPA and East Kentucky Power Cooperative (EKPC) requires the utility to reduce its SO_2 emissions by 54,000 tons per year and its NO_X emissions 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 (AEP) 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 from the affected facilities.

11.5 Source Retirement and Replacement Schedules

40 CFR Section 51.308(d)(3)(v)(D) of the Regional Haze Rule requires Connecticut to consider source retirement and replacement schedules in developing its long-term strategy. Source retirement and replacement were considered in developing the 2018 emissions inventory described previously in Subsection 10.3, Reasonable Progress Goals for Class I Areas in the State. While the output of the IPM model predicts that a certain number of older power plants will be replaced by newer units to meet future electric growth and state-specific NO_X and SO_2 caps, Connecticut 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 modeling used to develop the 2018 emissions inventory appears to predict that several large EGUs in Connecticut, including five of the six BART-eligible EGUs (Middletown Power 3 & 4, Montville Power 6, Norwalk Power 2 and PSEG Power Connecticut New Haven Harbor 1) will retire by 2018. Table 11.1 shows two non BART-eligible EGUs in Connecticut that have retired since 2002.

Table 11.1 Retired EGUs

Unit	Capacity (MW)	Retirement Date
Devon 7	109	11/28/07
Devon 8	109	11/28/07

11.6 Measures to Mitigate the Impacts of Construction Activities

40 CFR 51.308(d)(3)(v)(B) of the Regional Haze Rule requires Connecticut to consider measures to mitigate the impacts of construction activities on regional haze. MANE-VU's consideration of control measures for 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," (Attachment DD).

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, Connecticut's RCSA section 22a-174-18, "Control of particulate matter and visible emissions", addresses the control of airborne particulate matter and fugitive particulate matter in subsections (c) and (d). These regulations, which include dust control measures and visible emissions from diesel powered mobile sources, apply to road building and construction activities. Regulations are available online at http://www.dep.state.ct.us/air2/regs/mainregs.htm.

Two additional emissions control programs related to construction activities are currently underway in Connecticut. First, the Connecticut Clean Air Construction Initiative is a 10-year pilot project designed to reduce idling and operational emissions from construction equipment used to complete the I-95 New Haven Harbor Crossing Improvement Project also called the Q Bridge Project. Retrofits and idling restrictions for this project are required as part of contract specifications with the Connecticut Department of Transportation (CTDOT). Diesel retrofits and idling restrictions for construction vehicles were also written into a special act called the Connecticut Clean Diesel Plan by the Connecticut Department of Environmental Protection (CTDEP). The CTDEP hopes to work with CTDOT to expand this program to all state road construction projects. Currently, 150 diesel powered construction machines have been retrofitted with oxidation catalysts and by the projects' completion 200 machines will be retrofitted.

The CTDOT has implemented diesel vehicle emission controls that Contractors and Sub-contractors are obligated to follow. Any non-road construction equipment with engine horsepower (HP) rating of 60 HP and above that are assigned to a contract for a period in excess of 30 consecutive calendar days must be retrofitted with Emission Control Devices and/or use Clean Fuels in order to reduce diesel emissions. Contractors must submit a certified list of non-road diesel powered construction equipment that will be retrofitted with emission control devices and/or use Clean Fuel and include the addition or deletion of non-road diesel equipment. The list has three parts and a monthly report must also be submitted by the contractor updating the above stated information. If these rules are not followed the contractor will be issued a Non-Compliance and given 24 hours to bring the equipment into compliance or have it removed from the project. If the contractor still does not comply further and more extreme actions will be taken. For further information on this project contact the CTDOT, regarding the I-95 New Haven Harbor Crossing Corridor Improvement Program.

Second, a PM_{10} limited maintenance plan for the City of New Haven was approved by EPA. The plan includes some contingency measures that apply to New Haven under a state order. The measures focus on street paving and sweeping.

MANE-VU's Contribution Assessment (Attachment B) found that, from a regional haze perspective, crustal material generally does not play a major role. On the 20 percent best-visibility days during the 2000-2004 baseline period, crustal material accounted for 6 to 11 percent of particle-related light extinction at MANE-VU Class I Areas. On the 20 percent worst-visibility days, however, the ratio was reduced to 2 to 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.

Connecticut has adopted an indirect source permitting program to minimize particulate matter emissions from highway construction activities (RCSA section 22a-174-100 – not part of Connecticut's SIP). The need for additional control measures for construction activities and their possible implementation will be evaluated in the first five-year regional haze SIP progress report.

11.7 Agricultural and Forestry Smoke Management

40 CFR 51.308(d)(3)(v)(E) requires Connecticut to consider smoke management techniques related to agricultural and forestry management in developing the long-term strategy. MANE-VU's analysis of smoke management in the context of regional haze is documented in "Technical Support Document on Agricultural and Forestry Smoke Management in the MANE-VU Region, September 1, 2006," (Attachment V).

As that report notes, fires used for resource benefits 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 $PM_{2.5}$ emissions, are residential wood combustion (73 percent); open burning (15 percent); and industrial, commercial, and institutional wood combustion (9 percent) (see Figure 2 in Subsection 4.1 of Attachment V). Unwanted fires involving buildings and wild lands make up only a minor fraction of wood burning emissions and cannot be reasonably addressed in a 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 (see Figure 2 in Subsection 4.1 of Attachment V).

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 B) 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. CTDEP has no information to indicate that this situation would change significantly over the next decade.

Connecticut currently regulates outdoor word burning through a statute at CGS 22a-174(f) and a regulation at RCSA 22a-174-17. The open burning requirements limit the locations and times when open burning can take place. These requirements were originally adopted to protect public health but also act to reduce smoke and regional haze. Although CTDEP does not have a formal smoke management program, as a smoke management policy, CTDEP's Division of Forestry can only initiate prescribed burns when such activity has less significant impacts on air quality (see Attachment FF).

CTDEP's Bureau of Air Management currently obtains wildfire and prescribed burning data, including number of acres burned, when the wildfire or prescribed burn occurred and the location of the wildfire or prescribed burn, from CTDEP's Forestry Division. The wildfire and prescribed burning data will be included in CTDEP's periodic inventory every three years. CTDEP will track smoke emissions from wildfires and prescribed fires and will assess if emissions from such activities are increasing in the first five-year regional haze SIP progress report and required SIP revision due in 2018.

11.8 Estimated Effects of Long-Term Strategy on Visibility

40 CFR 51.308(d)(3)(v)(G) requires Connecticut 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 Connecticut.

All Class I states affected by emissions originating in Connecticut 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 Connecticut, 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 best and worst days, while smaller reductions in organic carbon levels will occur. Small increases are predicted for the fine soil component of regional haze. There is a 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. (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.) No changes are 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 Connecticut'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 11.1 through 11.5. 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*.)
- 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 11.1 through 11.5 are line graphs showing anticipated visibility improvements for the MANE-VU Class I Areas. All locations are projected to meet or exceed their uniform-rate-of-progress goals for 2018. In addition, all areas are expected to see improvements in best-day visibility relative to baseline values.

Figure 11.1: Expected Visibility Improvement at Great Gulf Wilderness Based on Most Recent Projections [20]

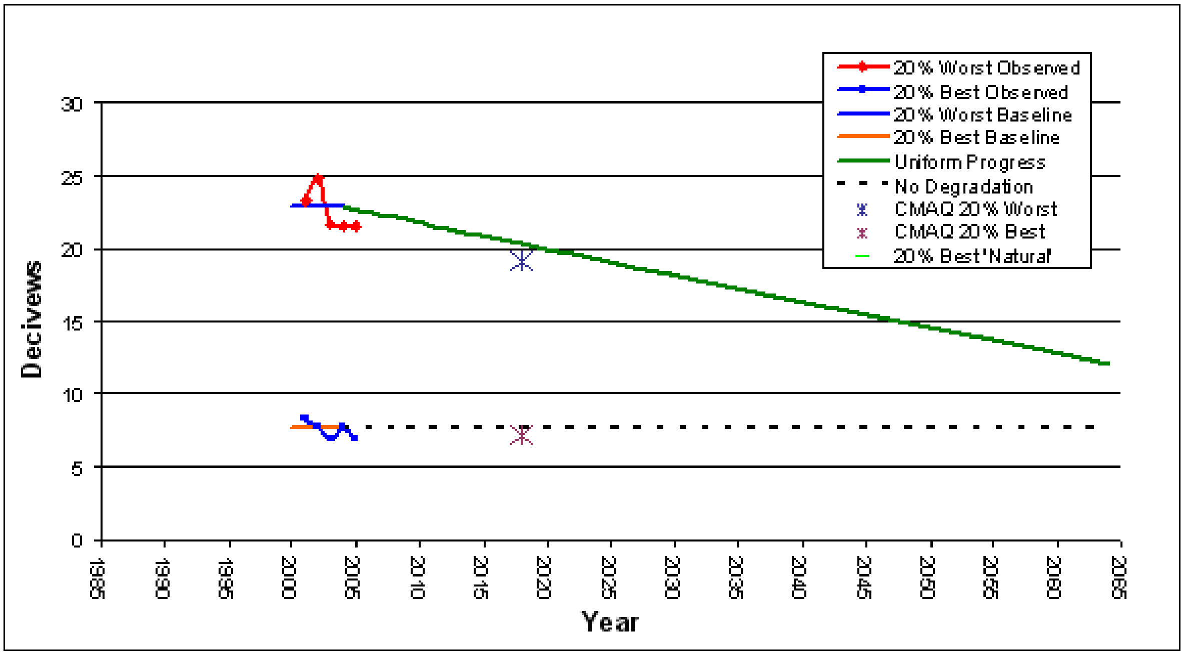
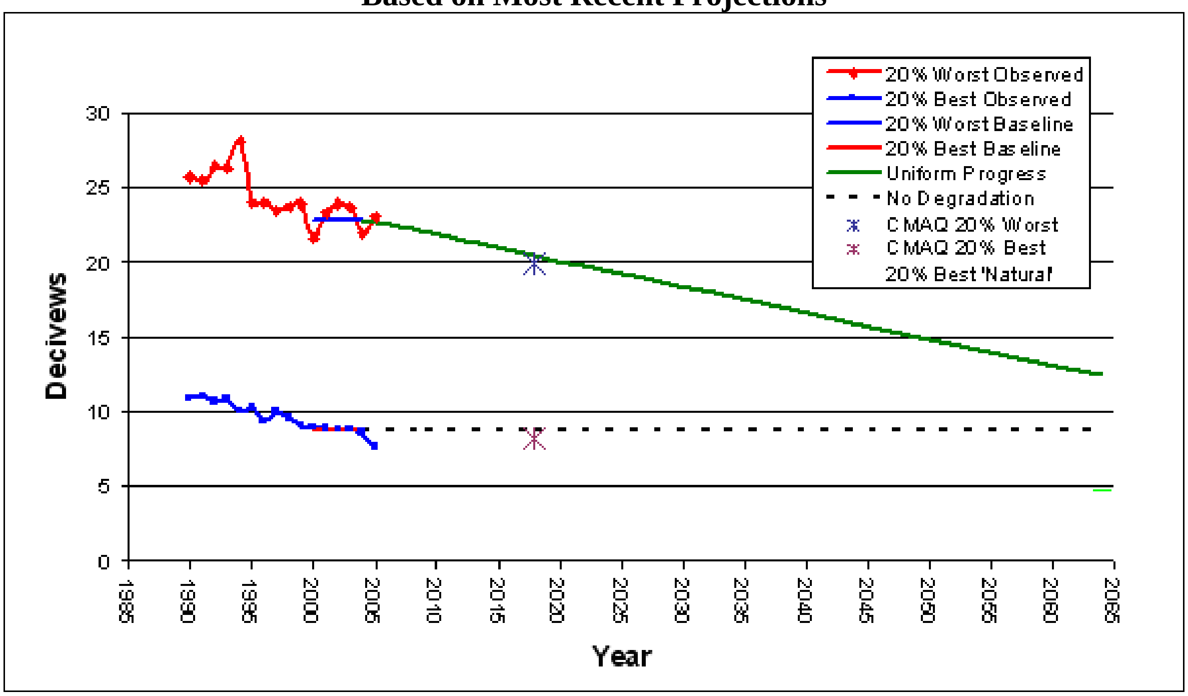


Figure 11.2: Expected Visibility Improvement at Acadia National Park Based on Most Recent Projections



[20] The visibility improvement estimate for Great Gulf Wilderness also serves as an estimate for Presidential Range - Dry River Wilderness.

Figure 11.3: Expected Visibility Improvement at Brigantine National Wildlife Refuge Based on Most Recent Projections

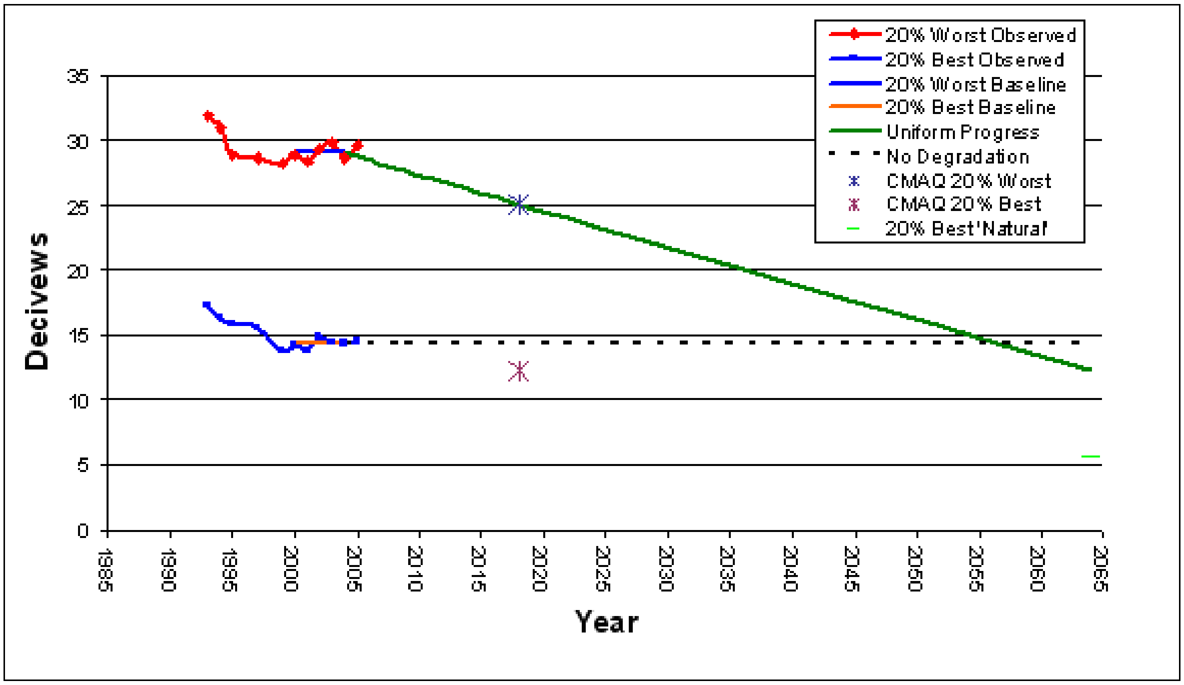


Figure 11.4: Expected Visibility Improvement at Lye Brook Wilderness Based on Most Recent Projections

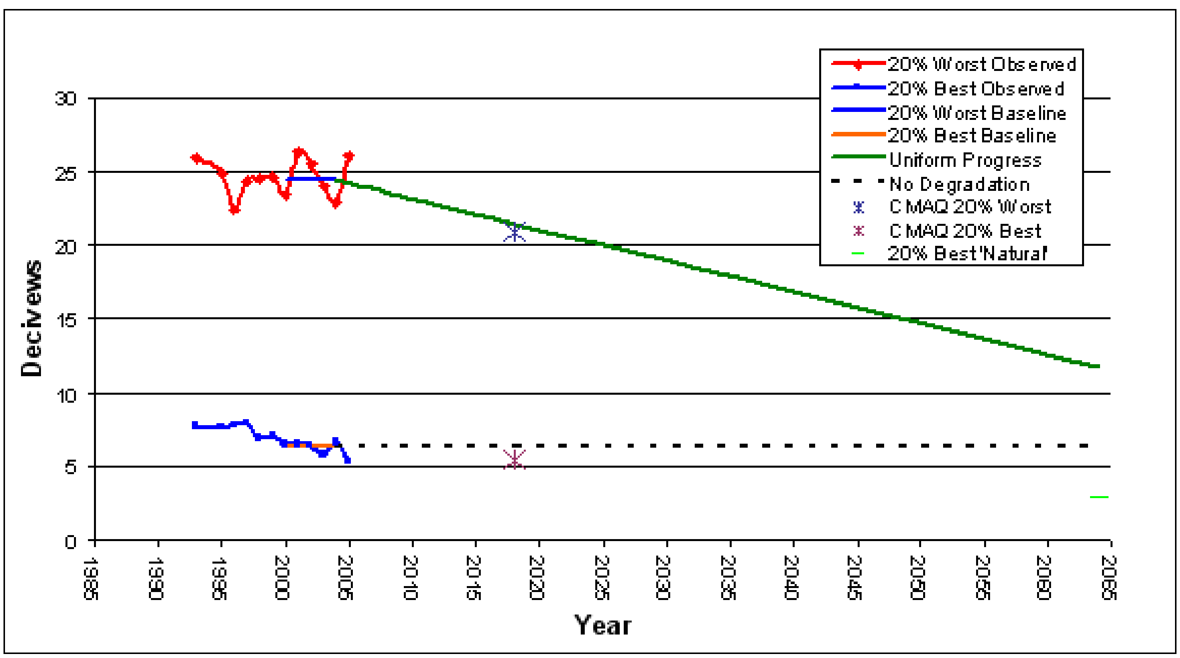
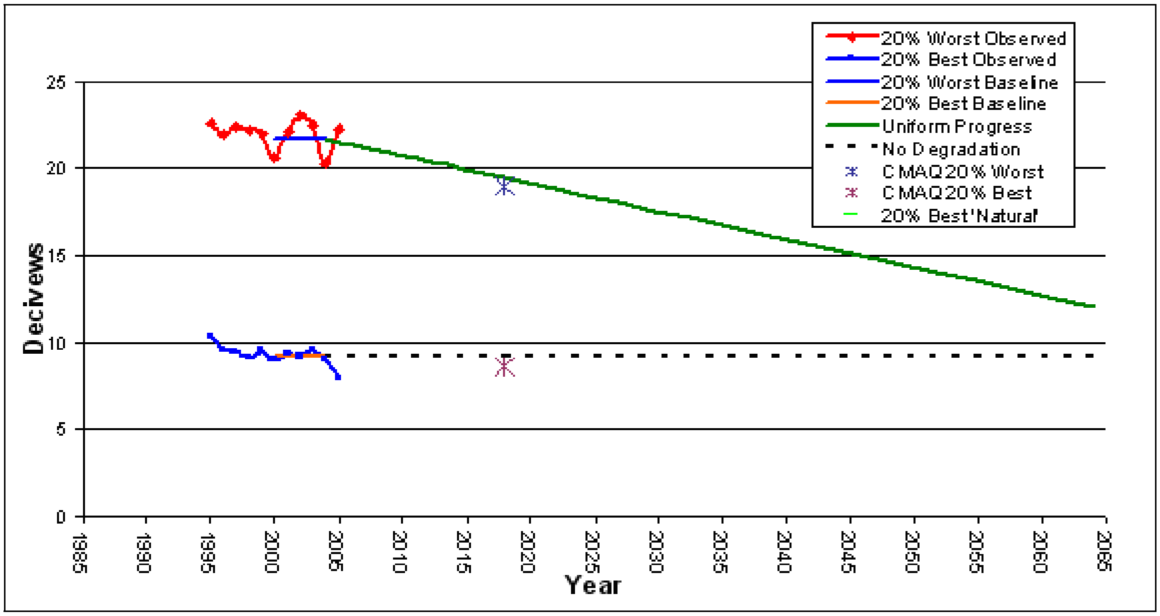


Figure 11.5: Expected Visibility Improvement at Moosehorn National Wildlife Refuge Based on Most Recent Projections[21]



11.9 Connecticut's Share of Emission Reductions

40 CFR 51.308(d)(3)(ii) of the Regional Haze Rule requires Connecticut to demonstrate that its implementation plan includes all measures necessary to obtain its share of emission reductions needed to meet the reasonable progress goals. The modeling analyses referenced in Subsection 11.8, above, demonstrate that the MANE-VU long-term strategy is sufficient to meet these visibility goals.

The basis for the long-term strategy is a statement adopted by MANE-VU on June 20, 2007 (see Subsection 3.2.2, The MANE-VU "Ask"). The MANE-VU "Ask" provides that each state will have up to 10 years to pursue adoption and implementation of reasonable control measures for NO_X and SO_2 emission reductions. Connecticut's regional haze SIP is wholly consistent with this long-term strategy. To further meet its obligation beyond those controls already adopted, CTDEP has agreed to pursue the following measures, consistent with the provisions of the MANE-VU "Ask":

- Participation in a regional low-sulfur fuel oil strategy that will result in SO_2 emission reductions from residential heating units across the state; and
- Continued evaluation of other possible control measures for haze-causing emissions.

Implementation of the long-term strategy will produce significant reductions in Connecticut's emissions inventory by the end of the first planning period, 2018. Changes to the emissions inventory will also occur as a result of population growth; changes in land use and

[21] The visibility improvement estimate for Moosehorn Wilderness also serves as an estimate for Roosevelt/Campobello International Park.

transportation; development of industrial, energy, and natural resources; and other air pollution control measures not directly related 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 implementation of the control measures developed for this SIP. (As a precursor to sulfate, SO_2 emissions are responsible for most of the fine-particle mass on the haziest days at MANE-VU Class I Areas. See Section 8.0, Understanding the Sources of Haze-Causing Pollutants.)

As referred to in Section 11.2, the "beyond on the way" scenario described in Attachment G (defined by CAIR with other "on the books" measures and the limitation of fuel sulfur content to 500 ppm for all No. 2 "distillate" fuel oil sold in the MANE-VU region) is sufficient to achieve visibility improvement beyond the so-called "uniform rate of progress" defined by uniform visibility improvement between now and 2064, the planning horizon for the regional haze program. Section 16a-21a of the Connecticut General Statutes limits fuel sulfur content of heating distillate oil and off-road diesel oil to 500 ppm as of the date on which the last of the States New York, Massachusetts and Rhode Island limit the sulfur content of such fuels.

Current and projected SO_2 emissions for the various source categories in Connecticut and, for comparison, all of MANE-VU are summarized in Tables 11.2 and 11.3. These emissions represent the majority of all haze-causing pollutants originating within the state and region. Further information on Connecticut's emissions inventory, including other pollutants that contribute to visibility impairment, is available in Section 6.0, Emissions Inventory.

Table 11.2: SO_2 Emissions from Point, Area, and Mobile Sources in Connecticut (tpy)[22]

Source Category	Baseline 2002	Projected 2018	% Reduction 2002-2018
Area	12,418	534	95.6
Non-EGU Point	2,438	2,068	15.1
EGU Point	13,550	6,697	50.6
On-Road Mobile	1,667	366	78
Non-Road Mobile	2,087	815	60.9
TOTAL	**32,160**	**10,480**	**67.4**

[22] It should be noted that due to Connecticut's early SO_2 emission reduction strategy, SO_2 emissions from EGUs and large point sources were reduced from 35,625 tons per year in 2001 to 13,055 tons per year in 2002 (see Attachment X).

Table 11.3: SO_2 Emissions from Point, Area, and Mobile Sources in all of MANE-VU (tpy)

Source Category	Baseline 2002	Projected 2018	% Reduction 2002-2018
Area	286,921	129,656	54.8
Non-EGU Point	264,377	211,320	65.4
EGU Point	1,643,257	386,584	77.6
On-Road Mobile	40,090	8,757	78.2
Non-Road Mobile	57,257	8,643	84.9
TOTAL	**2,291,902**	**744,960**	**67.5**

Note: Emission estimates for all MANE-VU states are archived at ftp.marama.org (User Name: mane-vu; Password: exchange).

The projected overall reduction of 67.4 percent for SO_2 emissions originating in Connecticut is comparable to the projected reduction of 67.5 percent in the MANE-VU region. In addition, SO_2 emissions from EGUs and large point sources in Connecticut decreased by 63% from 2001 to 2002 as a result of Connecticut's early SO_2 emission reduction strategy. This comparison indicates that Connecticut will meet its share of anticipated SO_2 emission reductions within the region by 2018.

In terms of additional programs leading to visibility improvements, CTDEP recognizes the increased use of wood burning devices, as fuel prices rise and more people turn to wood as a primary or secondary fuel source. In 2005, the Connecticut General Assembly took initial steps to address some of the public health and environmental concerns, including visibility issues, caused by outdoor wood burning furnaces (OWBFs) through the adoption of minimum siting and operational restrictions.[23] While actively enforcing the statute, CTDEP continues to gather and evaluate information concerning OWBF emissions and to learn from the success of surrounding states with more stringent regulatory programs for OWBFs. Adoption of performance standards for new OWBFs would be most effectively pursued by EPA since the sales market includes the entire northern United States.

In addition, in 2005 CTDEP adopted RCSA section 22a-174-36b, Low Emission Vehicles II Program, which implements the California LEV II program beginning with model year 2008. The California LEV II program is more stringent than the federal Tier 2 motor vehicle emissions standards. An analysis provided by Cambridge Systemics for NESCAUM finds that the California LEV II program provides an additional emissions reduction benefit in light duty vehicle emissions (17 tons per day of NOx and VOC in CT, NJ and RI) over and above what the federal Tier 2 program is expected to achieve. Reduced formation of secondary organic aerosol is likely another benefit of the California LEV II program.

[23] Section 22a-174k of the Connecticut General Statutes prohibits the construction and use of an OWBF unless the OWBF is located more than 200 feet from any residence, meets certain stack height criteria and the owner complies with certain operating practices, including a requirement to burn only clean wood.

11.10 Emission Limitations and Compliance Schedules

40 CFR 51.308(d)(3)(v)(C) requires Connecticut to establish emission limitations and compliance schedules to meet reasonable progress goals. Emission limitations and compliance schedules are already in place for the Connecticut programs outlined in Subsection 11.3 of this section. There are two additional reasonable control measures described in Subsection 11.4; these additional measures include:

1. Additional low-sulfur fuel oil requirements, and
2. Continued evaluation of other control measures for coal burning facilities by 2018 and NSPS for wood combustion.

CTDEP will continue to pursue these measures, consistent with the provisions of the MANE-VU "Ask", and will provide a status update in the first five-year regional haze SIP progress report. **Connecticut intends to adopt all reasonable control measures as expeditiously as practicable, in a manner consistent with state law, so that they may be in place by the end of the ten-year planning period.**

11.11 Enforceability of Emission Limitations and Control Measures

40 CFR 51.308(d)(3)(v)(F) requires Connecticut 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 Title V facilities, will be required to comply with the specific permit conditions that reference the applicable provisions of those laws and rules.

In Connecticut, the authority to create rules, issue permits, and enforce laws related to regional haze are established in Connecticut General Statutes (CGS) Chapter 446c, Air Pollution Control. Under CGS sections 22a-171 and 22a-174, Duties of Commissioner of Environmental Protection and Powers of the Commissioner, respectively, the CTDEP Commissioner is authorized to enforce the state's air laws, establish a permit program, accept and administer grants, and exercise all incidental powers necessary to carry out the statutory obligations.

Sections of Connecticut law of particular relevance to the regional haze SIP are:

- Connecticut General Statutes (CGS) section 22a-174(c) , which authorizes the issuance of permits;
- CGS section 22a-174(g), which authorizes the Commissioner to collect fees to recover the costs of reviewing and acting upon permit applications and monitoring compliance with the terms and conditions of permits issued; and
- CGS section 22a-177, which establishes the legal authority for enforcement of the RCSA (sections 22a-174-1 – 22a-174-200) and CGS section 22a-178, which authorizes CTDEP to issue orders to correct violations of any regulation, order or permit adopted or issued under Chapter 446c (Air Pollution Control).

The Connecticut 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 Connecticut regulations also define the permit program and fee structure for stationary sources, to ensure that national ambient air quality standards are achieved. Specifically:

- RCSA section 22a-174-3a (formerly RCSA section 22a-174-3), Permits to Construct and Operate Stationary Sources (RCSA section 22a-174-3 originally effective 6/1/72, amended fifteen times or more and replaced by RCSA section 22a-174-3a on 3/15/02 and amended on 5-29-07), provides for the issuance of state permits to operate. RCSA subsection 22a-174-3a(k) addresses the prevention of significant deterioration of air quality and visibility protection, in accordance with the requirements of 40 CFR 51.166 and 40 CFR 52.21.

- RCSA section 22a-174-33 Title V, provides for the issuance of Title V operating permits.

- RCSA section 22a-174-26, Fees (originally effective 9/24/82, amended subsequently five times, most recently on 5-26-04), provides for the payment of fees to cover the reasonable costs of administering the permit program.

With respect to control measures for visibility improvement under the Regional Haze Rule, the following enforceable provisions will apply to affected in-state BART-eligible units:

- Low-sulfur fuel limits in RCSA section 22a-174-19a have applied to all of the BART eligible units since 2002/2003 (0.5% fuel sulfur content or 0.55 lb/MMBtu quarterly SO_2 emission limit for non-EGUs; 0.5%/0.3% fuel sulfur content or 0.55 lb/MMBtu/0.33 lb/MMBtu quarterly SO_2 emission limits for EGUs). CTDEP has submitted the emission limits of RCSA section 22a-174-19a to EPA on November 18, 2008 in order to make such provisions federally enforceable. The approval request is pending.

- CTDEP has submitted RCSA section 22a-174-22(e)(3) to EPA on November 18, 2008 in order to make the 0.15 lb/MMBtu non-ozone seasonal NO_x emission limit (effective October 2003) federally enforceable. The approval request is pending.

- CTDEP will incorporate existing PM controls at the BART-eligible units into Title V permit renewals for BART purposes. Two of Connecticut's BART-eligible units with PM controls have federally enforceable New Source Review permits (see Table 9-16). In addition, CTDEP submitted the current version of RCSA section 22a-174-18 to EPA for SIP approval on December 1, 2004. The approval request is pending.

Also, Section 16a-21a of the Connecticut General Statutes limits fuel sulfur content of heating distillate oil and off-road diesel oil to 500 ppm as of the date on which the last of the States New York, Massachusetts and Rhode Island limit the sulfur content of such fuels.

Ultimately, Connecticut's Regional Haze SIP is dependent on the implementation of enforceable emission limitations and control measures, both within the state and in other states identified as contributing to visibility impairment at Class I Areas. Because Connecticut has no jurisdiction over other states, the attainment of regional progress goals will, to a large extent, be predicated on the good-faith efforts of contributing upwind states to meet their fair share of emission reductions through implementation of their own enforceable control measures. While Connecticut can provide assurances regarding the implementation of in-state emission controls, the bulk of regional-haze-causing pollutants at Class I Areas will continue to come from non-Connecticut sources.

11.12 Prevention of Significant Deterioration

RCSA section 22a-174-3a(k) spells out the Prevention of Significant Deterioration (PSD) requirements of Permits to Construct and Operate Stationary Sources. 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.

Recommended procedures for evaluating the impacts of a proposed PSD source on air quality and visibility are provided in CTDEP's "Ambient Impact Analysis Guidelines", 1989. Since 1989, there have been regulatory changes and developments that leave some information in the document outdated, so CTDEP recommends on its website that sources contact the Attainment Planning Stationary Source group for additional information. In this manner, new major sources and existing sources making major modifications will be constructed and operated in a manner that will not degrade air quality or visibility. The PSD permitting program, as set forth under RCSA section 22a-174-3a(k), is an integral part of Connecticut's long-term strategy for meeting its regional haze goals.

Attachment A through FF are available on the CT DEP website at:

http://www.ct.gov/dep/cwp/view.asp?a=2684&Q=432658&depNav_GID=1619