Office of the Registrar of Regulations,
Legislative Council,
State of Delaware

Delaware's Visibility State Implementation Plan (SIP)

September 24, 2008

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Acknowledgments

The Delaware Department of Natural Resources and Environmental Control (DNREC) acknowledges the efforts and assistance of the many agencies and individuals whose contributions were instrumental in the preparation of this State Implementation Plan Revision. Specifically, DNREC acknowledge the United States Department of the Interior, Fish and Wildlife Service; the United States Environmental Protection Agency, Region 3; the Mid-Atlantic/Northeast Visibility Union (MANE-VU); the Northeast States for Coordinated Air Use Management (NESCAUM); and the Mid-Atlantic Regional Air Management Association (MARAMA) for assistance and guidance in developing analysis, technical support and templates used in developing this State Implementation Plan.

EXECUTIVE SUMMARY

Regional haze is defined as visibility impairment that is produced by a multitude of sources and activities which emit fine particles and their precursors, and which are located across a broad geographic area. These emissions are transported over large regions, and impact areas that include the entire State of Delaware, and national parks, forests and wilderness areas ("Class I" federal areas). The Clean Air Act mandates protection of visibility, especially in Class I areas. In 1999, and in various revisions that extend through 2006, the U.S. Environmental Protection Agency (EPA) finalized the Regional Haze Rule. The rule calls for state, tribal and federal agencies to work together to improve visibility in 156 national parks and wilderness areas.

Under the Regional Haze Rule, states are required to develop a series of state implementation plans (SIPs) to reduce visibility impairment with the express intent that by 2064, the visibility in all Class I areas will be returned to natural conditions. The first such SIP must establish interim goals and emissions reduction strategies for 2018, based on trends from various sources including point, area, and mobile (both on-road and non-road) source emissions, biogenic, and wildfire and agricultural emissions.

This SIP was developed based on consultations and work-products of the Mid-Atlantic/Northeast Visibility Union (MANE-VU) Regional Planning Organization (RPO). It encompasses 1) monitoring strategies for evaluating visibility impacts, 2) baselines and trends, 3) long-term strategies (LTS), 4) how Delaware meets its fair share of the "reasonable progress goals" (RPG) towards reducing visibility impairment in Class I areas, and 5) Best Available Retrofit Technology (BART). [1] This SIP also demonstrates that Delaware has met its BART, RPG and LTS obligations for 2018 visibility impairment through existing Delaware/Federal regulations and on-the-books/on-the-way federal emission controls. In addition to extensive consultation with the MANE-VU states, Delaware has consulted with Federal Land Managers (FLMs) responsible for the Class I areas, and the EPA in the development of this SIP.

The Delaware Department of Natural Resources and Environmental Control (Department) will submit this SIP to the EPA to fulfill its obligation under EPA's Regional Haze Rule. A public hearing will be held for this plan on September 23, 2008, and the proposed plan may be adopted for submittal to EPA on or before October 3, 2008.

This is a first step in a process scheduled to extend through 2064. Delaware will continue to coordinate with other states, FLMs, EPA, MANE-VU, and other RPOs to maintain/improve the visibility in Class I areas. This coordination will include five year progress reports, necessary SIP revisions, and face-to-face consultation meetings, as necessary.

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1 MANE-VU states agreed upon a ≥ 2 percent sulfate attribution to a Class I area in order for an upwind state to meet the definition of "significantly contributing" to visibility impairment for that Class I area. Studies showed that Delaware "contributes" only to the Brigantine National Wildlife Refuge Class I area in Brigantine, New Jersey (See Section 9.3 of this SIP). Therefore, this SIP focuses on how Delaware control measures will improve visibility at Brigantine.

Section 1 - Background and Overview

1.1 Introduction

When most people think of air pollution, a mental image of the brown smog or haze hovering over Los Angeles or other metropolitan areas may come to mind. We can't see clean air but we can see dirty air and we know that it limits our ability to see across a broad geographic area, to include popular scenic areas that many enjoy visiting, such as our National Parks and Wilderness areas. Today, when you visit a national park or wilderness area you may notice a brown or smoky haze on the horizon that limits your ability to clearly see a natural resource or a majestic vista. And, while Delaware is not the home to any national park or wilderness area, this same type of visibility degradation is experienced throughout our State.

Particles and gases in the air cause visibility impairment by scattering and absorbing light in the atmosphere (i.e., light traveling from a particular scene is unable to reach you). On a day without pollution the National Park Service estimates that the visual range is approximately 140 miles in the West and 90 miles in the East. Unfortunately, air pollution impairs visibility to some degree in every national park.

The United States Environmental Protection Agency (EPA) has defined visibility as the clarity with which scenic vistas and landscape features are perceived at great distances. Visibility can be impaired by natural sources such as rain, wildfires, volcanic activity, sea mists, and wind blown dust from undisturbed desert areas. Visibility also can be impaired by human-caused sources of air pollution such as industrial processes, (e.g., power plants, smelters, refineries, etc.), mobile sources (e.g., cars, trucks, trains, etc.) and area sources (e.g., the burning of wood and agricultural debris, wind blown dust from disturbed soils, etc.).

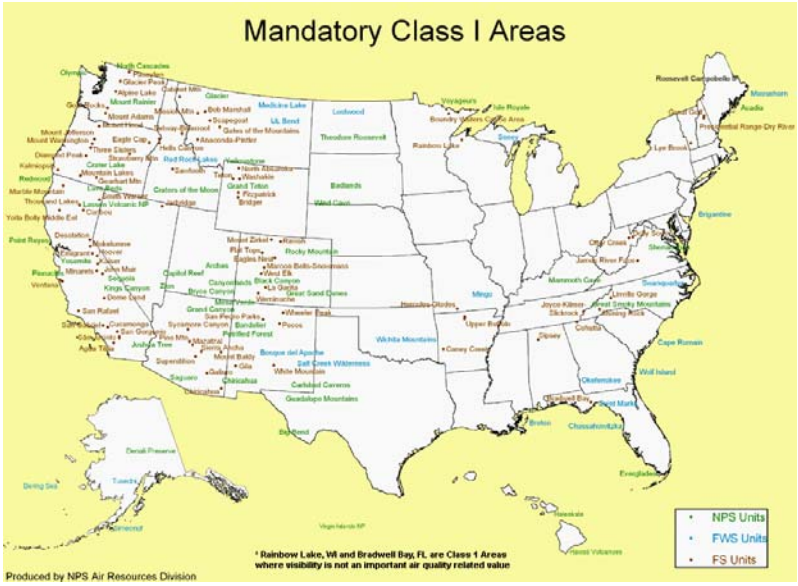
These pollutants that limit visibility – sulfates, nitrates, organic matter, smoke and soil dust – are the same particles to comprise fine particulate matter ($PM_{2.5}$). $PM_{2.5}$ causes significant health effects in humans as well as other environmental harm such as acid deposition and eutrophication of our lakes, rivers and streams. Delaware has been designated by the EPA as being in non-attainment for $PM_{2.5}$, and has submitted a state implementation plan to the EPA that demonstrates attainment by 2009. Because of this relationship between visibility and $PM_{2.5}$, there is significant overlap between the emission reduction strategies in this SIP and Delaware's $PM_{2.5}$ SIP.

The primary end point or goal of the Clean Air Act (CAA) Regional Haze Program is to return the visibility condition in our national parks and wilderness areas to their "natural" conditions. Because visibility impairment occurs, and is caused by emissions generated, across wide geographic areas which incorporate numerous state and local boundaries, the solution to our visibility problem must be developed on a regional scale and national scale (See Section 1.3 of this SIP).

1.2 Regulatory Background

In 1977, Congress recognized that our ability to see should be protected, and they adopted provisions in the Clean Air Act (CAA) to improve the visibility "in areas of great scenic importance." These areas have become known as the mandatory Class I Federal Areas (Class I areas) and are located in 35 states and one territory. [40 CFR 81.401-437] The Class I designation applies to national parks exceeding 6,000 acres, wilderness areas and national memorial parks exceeding 5,000 acres and all international parks that were in existence prior to 1977. Class I areas include 156 national parks and wilderness areas such as the Grand Canyon, Yosemite, Yellowstone, Mount Rainier, Shenandoah, the Great Smokies, Acadia and the everglades. The Brigantine National Wildlife Refuge in New Jersey is the only Class I area that emissions from Delaware significantly impact (see Section 9.3 of this SIP).

Congress amended the Clean Air Act to include the Visibility Protection Program, and established it under section 169A (42 U.S.C. 7491) with a visibility goal that calls for "*the prevention of any future and the remedying of any existing, impairment of visibility in Class I areas which impairment results from manmade air pollution*." Congress directed the Department of the Interior along with the EPA to develop rules and regulations to address these concerns from manmade sources of pollution attributed to causing haze.



EPA began by developing a two phase approach for addressing visibility impairment. Phase I addressed haze forming pollution from major stationary sources such as large industrial complexes and the electric power plants. In 1980 EPA published regulations [40 CFR 51.300 – 51.307] requiring states with Class I areas within their borders to develop and implement State Implementation Plans (SIP) to address reasonable progress toward the national visibility goal. These plans would include monitoring strategies, address existing impairment from major stationary sources, prevent future impairment from proposed facilities, consult with Federal Land Managers in the developing or revising the SIP, develop a long-term strategy to address issues facing the state and review the SIP every three years. Delaware was not included in Phase I, as no Class I areas are located in Delaware.

The second phase of the approach required EPA to address visibility impairment on a broader regional scale. The 1980 regulations only addressed visibility impairment from specific sources and did not adequately address the emission transport carried over long distances. EPA determined that before moving forward with Phase II, there was a need to close the gap on the lack of information in a number of technological and scientific areas before they could address the broader regional haze problem. Identifying, quantifying and modeling the emissions that

reduced visibility were the initial focus for EPA, as well as studying the transport phenomenon of haze pollutants.

In 1985, the Interagency Monitoring of Protected Visual Environments (IMPROVE) program was established to coordinate the monitoring of air quality in national parks and wilderness areas, and to ensure sound and consistent scientific methods were being used. Monitoring protocols were established for visibility measurement, particulate matter measurement, and scientific photography of the Class I areas. IMPROVE monitoring was designed to establish reference information on visibility conditions and trends to aid in the development of visibility protection programs. Monitoring from the IMPROVE network demonstrated that visibility in all the Class I areas was impaired to some degree by regional haze. [2] Note that there are no IMPROVE monitoring sites located in Delaware (See Section 6 of this SIP).

By 1990 Congress, who was not completely satisfied with EPA's efforts on visibility, took the bull by the horns and added Section 169B (42 U.S.C. 7492) to the CAA. This required EPA to address the regional visibility problem. As a result EPA was able to fund the program more fully with the newly provided monies for research, and to provide the required assessment reports to Congress. This action formally brought Delaware into the program.

EPA was authorized to establish visibility transport commissions who would conduct research and policy development and report on their findings. These commissions were to represent the governors and their air quality management administrators from a region along with tribal leaders and representatives from Federal Land Management agencies. The only commission that was specifically spelled out and required by the CAAA was the Grand Canyon Visibility Transport Commission (GCVTC) which was established in 1991. The GCVTC represented the Grand Canyon region and Plateau covering 16 Class I areas in eight states (Oregon, California, Nevada, Utah, Arizona, Wyoming, Colorado and New Mexico). In 1996 the GCVTC issued its first report to EPA recommending additional study and research necessary for filling information gaps and for resolving certain policy issues - Report *of the Grand Canyon Visibility Transport Commission to the United States Environmental Protection Agency*. [3]

In 1998, Congress provided clarification on the Regional Haze SIP deadline and responded to comments from the States on the need for synchronizing regional haze and the recently established (62 FR 28652, July 17, 1997) national ambient air quality standard (NAAQS) for fine particulate matter ($PM_{2.5}$) in the Transportation Equity Act for the 21st Century (TEA-21 and 42 U.S.C. § 7407). The TEA-21 legislation addressed the timing requirements for implementation of the regional haze rule by linking the deadline for SIP submittal to the date the area within each State is designated as attainment, non-attainment, or unclassifiable for the NAAQS for $PM_{2.5}$.. The 1998 legislation also directed EPA to provide Federal funding to States to establish,

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2 Interagency Monitoring of Protected Visual Environments. IMPROVE Home Page. Retrieved on October 15, 2005 from http://vista.cira.colostate.edu/improve.

3 Report of the Grand Canyon Visibility Transport Commission to the United States Environmental Protection Agency. June 1996. Retrieved on November 28, 2005 from http://www.wrapair.org/WRAP/reports/GCVTCFinal.PDF.

purchase, operate and maintain a $PM_{2.5}$ fine particle monitoring network to gather data used in designating whether areas meet national standards for $PM_{2.5}$.

The designation process to determine whether a State has areas that fail to meet the $PM_{2.5}$ NAAQS involved a cooperative effort between states and EPA. An extended amount of time was necessary to establish the monitoring networks for a pollutant such as $PM_{2.5}$ and to collect sufficient data to make a scientific basis for the designation. [4]

In 1999, EPA carried out its regulatory responsibilities under Section 169A by publishing the Regional Haze Rule (64 FR 35714, July 1, 1999) to improve air quality in the Nation's national parks and wilderness areas. The Rule required States with Class I areas within its borders and States with sources that may reasonably cause or contribute to impaired visibility to a Class I area, in coordination with EPA, the National Park Service, U.S. Fish and Wildlife Service, the U.S. Forest Service, and other interested parties, to develop and implement air quality protection plans to reduce the pollution that cause visibility impairments found in the 156 Class I areas. The first State plans for regional haze were due in the 2003 and 2008. [5]

However, the implementation of the 1999 regional haze rule was further delayed by action in the courts. In 2002, the D.C. Circuit court (*American Corn Growers et al. v. EPA)* vacated certain provisions of the rule and remanded them back to EPA to further address and clarify the provisions on determining the control technology on a source-by-source basis. These provisions addressed the development of technologies to control emissions from stationary sources known to contribute to impaired visibility.

Other areas of the Haze rule were challenged by *Center for Energy and Economic Development* governing the optional emissions trading program for certain western States and Tribes known as the "WRAP Annex Rule." [6] (*Center for Energy and Economic Development v. EPA).* In September 2000, the Western Regional Air Partnership (WRAP) submitted a plan to EPA containing recommendations for implementing the regional haze rule in the Western United States.

Specifically, the plan contained a set of recommended regional emissions reduction milestones for sulfur dioxide, a key compound in the formation of fine particles and regional haze. The plan, also known as the Annex to the 1996 Report of the Grand Canyon Visibility Transport Commission (GCVTC), included a description of an emissions trading program for nine Western States and eligible Indian Tribes within that geographic area. The trading program would act as

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4 USEPA Fine Particle (2.5) Designations. December 2005. Retrieved on December 7, 2005 from http://www.epa.gov/pmdesignations/index.htm.

5 EPA's Regional Haze Program. Retrieved from http://www.epa.gov/oar/visibility/program.html. June 2005.

6 *Center for Energy and Economic Development v. EPA*,398___F.3d ___653, Case No. 03-1222 (D.C. Cir. February 18, 2005) ("CEED"). Retrieved on December 7, 2005 from http://www.ceednet.org/docs/western_annex_win.pdf .

a backstop to ensure that emission milestones would be met. EPA approved the WRAP Annex in May 2003, and codified it as amendments to the regional haze rule.

Five western States submitted implementation plans under these provisions in 2003. The D.C. Circuit vacated EPA's approval of the WRAP Annex in a decision issued on February 18, 2005. In addition to invalidating the WRAP Annex, the Court's decision also affects similar programs developed in the future." [7]

In response the court's ruling, EPA revised the Rule on June 15, 2005, which provided the following changes to the Regional Haze Regulations:

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

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

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

The latest revision to the Rule was finalized on October 5, 2006. Among other things, this revision clarified the requirements associated with demonstrating how emissions trading or alternative programs may be used as an alternative to applying Best Available Retrofit Technology (BART) Requirements (See Section 8 of this SIP).

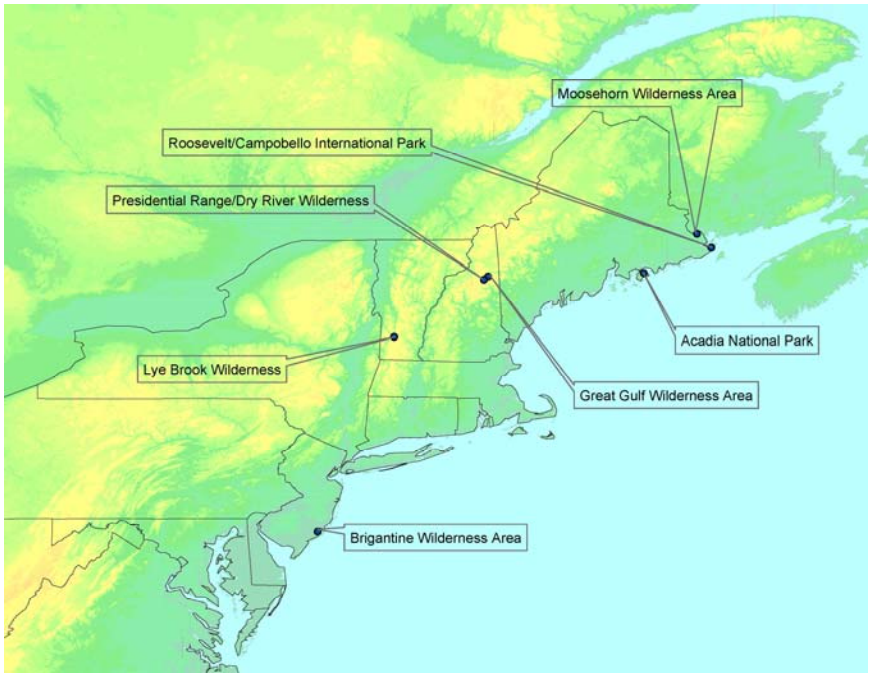
1.3 Regional Planning Organizations

To aide states in their efforts to develop the technical basis for the state's implementation plans, EPA provided funding to five multi-state regional planning organizations – Western Regional Air Partnership (WRAP), Central Regional Air Planning Association (CENRAP), Mid-West Regional Planning Organization (Mid-West RPO), Mid-Atlantic/Northeast Visibility Union (MANE-

7 USEPA Fact Sheet - Requirements for an Emissions Trading Program that Could Satisfy Best Available Retrofit Technology Requirements under EPA's Regional Haze Program. July 25, 2005. Retrieved on October 27, 2005 from http://www.epa.gov/oar/visibility/fs_2005_07_20.html.

VU) and Visibility Improvement State and Tribal Association of the Southeast (VISTAS).

These organizations provide a forum for state air control administrators to develop regional strategies to address regional haze and to coordinate with other regions. They also provide a means by which states can work together to coordinate efforts on other key issues impacting regional haze – ozone, NOx SIP Call, Acid Rain, $PM_{2.5}$ NAAQS, etc. The five RPOs worked with their member states to develop SIP guidance and templates. Delaware is a member of the Mid-Atlantic/Northeast Visibility Union. Section 3 of this SIP provides additional information on how Delaware fits into the regional planning process.



The Mid-Atlantic Region Air Management Association (MARAMA), the Northeast States for Coordinated Air Use Management (NESCAUM) and the Ozone Transport Commission (OTC) established the Mid-Atlantic/Northeast Visibility Union (MANE-VU) [8] regional planning organization to coordinate efforts to address visibility impairment at seven Class I areas located in the Mid-Atlantic and Northeast corridor: Acadia National Park, ME; Brigantine Wilderness, NJ; Great Gulf Wilderness, NH; Lye Brook Wilderness, VT; Moosehorn Wilderness, ME; Presidential Range – Dry River Wilderness, NH; and Roosevelt Campobello International Park, New Brunswick.

1.4 Required Elements for State Implementation Plans

The Regional Haze Rule (Rule) requires each State that contributes to visibility impairment of any Class I area to develop an implementation plan (SIP) for reducing regional haze. The plan must include goals aimed at improving visibility, and a long-term plan for reducing pollutant emissions that contribute to visibility degradation.

The deadline for the Regional Haze SIP was linked to $PM_{2.5}$ when the Delaware $PM_{2.5}$ designations were established – it was to be submitted three years from the date of designation. EPA approved the $PM_{2.5}$ designations on December 17, 2004. Therefore, the Regional Haze SIPs were due to EPA no later than December 17, 2007.

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

Delaware's New Castle County was designated as non-attainment for $PM_{2.5}$ by EPA on December 17, 2004. It should be noted that Delaware had expected to submit its initial implementation plan for regional haze to EPA three years from the $PM_{2.5}$ designation date, but delays in the development of the regional inventories, regional modeling and the consultation process were not completed at that time. Control measures, reasonable progress goals and long term strategy discussions were contingent upon those multi-state modeling results and interstate consultation.

The Regional Haze Rule gives States the flexibility to develop cost-effective strategies for pollution reductions, and encourages States to coordinate with each other through regional planning efforts. The core areas to be addressed in the SIP are codified at 40 CFR 51.308, (1) Best Available Retrofit Technology; (2) calculation of Baseline and Natural Visibility Conditions – Class I States only; (3) Reasonable Progress Goals; (4) Long-term Strategy – control measures needed to achieve reasonable progress goals; and (5) Monitoring Strategy and Other Implementation Plan Requirements. These core elements are addressed in this SIP as follows:

Regional Haze Implementation Plan Elements 40 CFR 51.308		
Source:	**Required Element:**	**Location in this SIP:**
(d)(1)	*Reasonable progress goals.*	Sections 10 and 11
(d)(2)	*Calculations of baseline and natural visibility conditions.*	Section 5
(d)(3)	*Long-term strategy for regional haze.*	Section 9
(d)(4)	*Monitoring strategy and other implementation plan requirements.*	Sections 6 and 7
(e)	*Best Available Retrofit Technology (BART) requirements for regional haze visibility impairment.*	Section 8
(f)	*Requirements for comprehensive periodic revisions of implementation plans for regional haze.*	Section 12
(g)	*Requirements for periodic reports describing progress towards the reasonable progress goals.*	Section 12
(h)	*Determination of the adequacy of existing implementation plan.*	Section 13
(i)	*State and Federal Land Manager coordination*	Section 4

1.5 Area of Influence for MANE-VU Class I Areas

The key difference between SIPs from States with Class I areas and States without Class I areas is the calculation of the baseline and natural visibility for their Class I areas, and the determination of reasonable progress goals. Class I States calculate baseline visibility conditions for the period between 2002 and 2004. The average impairment for the most and least impaired days are determined for each calendar year and compiled into the average of three annual averages (40 CFR 51.308 (d)(2)(i)). The natural visibility conditions are determined for the same baseline period with the most and least impaired days determined by available monitoring data or an appropriate data analysis technique (40 CFR 51.308 (d)(iii-iv)). In contrast, States without Class I areas are responsible for doing their fair share to help meet the reasonable progress goals established by the impacted Class I States, and for maintaining their emissions monitoring network.

There are seven Class I areas located in the Mid-Atlantic and Northeast. Delaware does not have a Class I area located within its borders. As a result, the Rule requires Delaware, in consultation with MANE-VU and others, to identify where its emissions are most likely to influence visibility in Class I areas. In order to identify states whose emissions are most likely to influence visibility in MANE-VU Class I areas, MANE-VU prepared the *Contributions to Regional Haze in the Northeast and Mid-Atlantic United States* (Contribution Assessment). The full report can be found in Appendix 1-1.

Based on that work, MANE-VU concluded that it was appropriate to define an "Area of Influence" (AoI) including all of the states participating in MANE-VU plus other states outside MANE-VU for which modeling indicated they contributed at least two percent (2%) of the sulfate ion in MANE-VU Class I areas in 2002. The Visibility Improvement State and Tribal Association of the Southeast (VISTAS)[9] also conducted an AoI analysis, which used a level of one percent (1%) to assess whether an upwind state significantly contributed. The VISTAS AoI did not show Delaware to be a contributor to any VISTAS Class I area.

Through participation in the MANE-VU regional planning process, Delaware has been identified as impacting the visibility impairment in only the Brigantine National Wildlife Refuge (Brigantine) Class I area (see Section 9.3 of this SIP). Brigantine's location is shown in Figure 1-1. Other Class I areas in MANE-VU are also shown in Figure 1-1 for information purposes. This technical work is discussed further in Sections 6 and 7 of this SIP. A full discussion of the process and outcome of consultations between Delaware and other states is contained in Section 3 of this SIP.

Additional information about the monitoring procedures and analyses used by Delaware to determine how Delaware emission sources contribute to visibility impairment at Brigantine National Wildlife area is provided in Appendix 1.1 - *Contribution Assessment*.

The reasonable progress goals (RPGs) for the only Class I area that Delaware impacts – Brigantine National Wildlife area – are discussed in Section 10, and the details for how Delaware has met each RPG is provided in Section 11.

9 VISTAS is comprised of the following states: Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, West Virginia, the Eastern Band of Cherokee Indians, and Knox County, TN

1.6 What is Reasonable Progress?

Reasonable Progress Goals must consider certain statutory factors established by Congress that include - the costs of compliance, time needed for compliance, energy and non-air quality environmental impacts along with the remaining useful life of any potentially affected sources. For each Class I area located within a State, the Class I State must establish goals (expressed in deciviews) that provide for reasonable progress towards achieving natural visibility conditions by 2064. The Class I State must compare the baseline visibility to natural visibility conditions in their Class I areas and determine a uniform rate of visibility improvement toward their 2064 goal. The Class I State must also consult with those States, which may reasonably be anticipated to cause or contribute to visibility impairment in their Class I areas (40 CFR 51.308 (d)(1)(i-vi)).

1.6 What are Long-term Strategies?

Another core component of the SIP is to develop a Long-term Strategy that includes enforceable emissions limitations, compliance schedules, and other measures necessary to achieve the reasonable progress goals established by States having Class I areas. States without Class I areas but with sources identified to cause or contribute to another State's Class I area must consult with that State in order to develop coordinated emission management strategies, and to demonstrate in its SIP that it has included all measures necessary to obtain its share of emission reductions to support the progress goal of the impacted State.

The State must consider, at a minimum, the following factors in developing its long-term strategy: (1) Emission reductions due to ongoing air pollution control programs, including measures to address reasonably attributable visibility impairment; (2) Measures to mitigate the impacts of construction activities; (3) Emissions limitations and schedules for compliance to achieve the reasonable progress goal; (4) Source retirement and replacement schedules; (5) Smoke management techniques for agricultural and forestry management purposes including plans as currently purposes; (6) Enforceability of emissions limitations and control measures; and (7) 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.

1.7 Best Available Retrofit Technology (BART)

On July 6, 2005 (70 FR 39104) EPA finalized 40 CFR 51 – Regional Haze Regulations and Guidelines for Best Available Retrofit Technology (BART) Determinations addressing the issues from the Circuit Court decisions. The BART requirements were most recently updated on October 5, 2006. BART is defined as an emission limitation based on the degree of reduction achievable through the application of the best system of continuous emission reduction for each pollutant, which is emitted by a BART-eligible source. The changes to the rule included how the States would identify the best system of continuous emission control technology and by which States can consider an individual facility's contribution to regional haze when determining to require controls, and what the level of control should be met. The rule changes also clarified the requirements associated with demonstrating how emissions trading or alternative programs may be used as an alternative to applying Best Available Retrofit Technology (BART) Requirements.

Congress defined sources potentially subject to BART - as major stationary sources, including reconstructed sources; from one of 26 identified source categories which included utility and industrial boilers, and large industrial plants such as pulp mills, refineries and smelters; which have the potential to emit 250 tons per year or more of any air pollutant, and which were placed in operation between August 1962 and August 1977. [CAA 169A (b)(2)(A) & (g)(7)].

Delaware's BART sources and information pertaining to Delaware's BART analysis are discussed in Section 8.

1.8 Periodic Updates and Revisions to SIPs

Other details to be discussed in the SIP include the process to submit periodic plan revisions to EPA every ten years, with the first revision due by 2018. In addition to the submitting plan revisions every ten years, the State will discuss how they intend to evaluate and report their progress towards the reasonable progress goals established for each Class I area within the State and each Class I area located outside the State, which may be affected by emissions from within the State. These progress reports are to be submitted every five years to EPA. Depending on the findings of the five-year progress report, the State commits to taking one of the actions listed in 40 CFR 51.308(h) (see Section 13 of this SIP).

Delaware is also required to coordinate with the Federal Land Managers (FLM) during the development and revision process of the SIP with an opportunity to address the assessment of the impairment of the visibility in any Class I area, recommendations on the development of reasonable progress goals, and recommendations on the development and implementation of strategies to address visibility impairment. Delaware's coordination with FLMs is discussed in Section 4.

Section 2 - General Planning Provisions & Future Submissions

The Regional Haze Rule gives the States the flexibility to develop cost-effective strategies for pollution reductions, and encourages States to coordinate with each other through regional planning efforts. The core areas to be addressed in the SIP other than the Best Available Retrofit Technology determination (40 CFR 51.308) are (1) calculation of Baseline and Natural Visibility Conditions – Class I States only; (2) Reasonable Progress Goals; (3) Long-term Strategy – control measures needed to achieve reasonable progress goals; and (4) Monitoring Strategy and Other Implementation Plan Requirements.

- Pursuant to the requirements of 51.308(a) and (b), Delaware submits this SIP to meet the requirements of EPA's Regional Haze rules that were adopted to comply with requirements set forth in the Clean Air Act. Elements of this Plan address the Core Requirements pursuant to 40 CFR 51.308(d) and the Best Available Retrofit Technology (BART) components of 40 CFR 50.308(e). In addition, this SIP addresses Regional Planning, State and Federal Land Manager coordination, and contains a commitment to provide Plan revisions and adequacy determinations.

- Section 51.308(f) requires the States to submit their SIP revision by July 31, 2018 and every ten years thereafter. Delaware will submit this SIP revision as required.

- Section 51.308(g) requires states to submit a report to EPA every 5 years evaluating progress towards the reasonable progress goal for each Class I Federal area located within the State and in each Class I Federal area located outside the State that may be affected by emission from within the State. The first progress report is due 5 years from submittal of the initial implementation plan and must be in the form of implementation plan revisions. Delaware will submit this progress report by the scheduled provided. The SIP reasonable progress goals for Delaware are outlined in Section 10.

- In accordance with Section 51.308(h), at the time the progress report is submitted, the State of Delaware will also submit a determination of the adequacy of its existing SIP revision.

- Administrative Requirements from Appendix V to CFR Part 51 require Delaware to demonstrate it has legal authority to adopt and implement this Plan. Legislative authority for the Delaware air quality program relating to the responsibilities in the CAA is codified in Title 7 "Conservation" of the Delaware Code, Chapter 60 – Delaware's comprehensive water and air resources conservation law, which gives the Delaware Department of Natural Resources and Environmental Control (DNREC) the power and duty to implement the provisions of the CAA in the State of Delaware.

  For example, §110(a)(2)(J) (PSD) requires Delaware to meet the applicable requirements of part C (relating to prevention of significant deterioration of air quality and visibility protection). Delaware's Prevention of Significant Deterioration (PSD) requirements are promulgated in Regulation No. 1125, Preconstruction Review, of the State of Delaware Regulations Governing the Control of Air Pollution. Section 3.15 (Source Obligation), Subsection 3.16.2 requires AQMS to determine that the source or modification of a unit at

that source may employ a system of innovative control technology if the source causes or contributes to a violation of an applicable national ambient air quality standard; or impacts any Class I area (3.16.2.4.2). PSD is discussed in more detail in Section 9-8.

- Finally, Delaware addresses those requirements of Section 110(a)(2)(A)-(M) of the CAA which have not been specifically addressed in other SIP revisions in our *Implementation, Maintenance, And Enforcement of National Ambient Air Quality Standards State Implementation Plan Revision For Ozone, Fine Particulate Matter ($PM_{2.5}$), and Visibility* (December 13, 2007).

Section 3 - Regional Planning

Because visibility impairment occurs across wide geographic areas which incorporate numerous state and local boundaries, the solution to visibility impairment is to address it on a regional scale with the primary end point or goal being to return the visibility condition in our national parks and wilderness areas to their "natural" conditions. As mentioned previously, in 1999, EPA and affected States/Tribes established five Regional Planning Organizations (RPOs) to facilitate interstate coordination on their SIPs.

The State of Delaware is a member of the Mid-Atlantic / Northeast Visibility Union (MANE-VU) RPO. Members of MANE –VU are listed in Table 3-1.

Table 3-1 MANE-VU Members

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

*Non-voting members

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 the Northeast States for Coordinated Air Quality Management (NESCAUM). The states along with federal agencies and professional staff from OTC, MARAMA and NESCAUM are members of the various committees and workgroups.

Since its inception on July 24, 2001, MANE-VU established an active committee structure to address both technical and non-technical issues related to regional haze. The primary committees are the Technical Support Committee (TSC) charged with assessing the nature and magnitude of the regional haze problem within MANE-VU, interpreting the results of technical work, and report on such work to the MANE-VU Board. In addition to the formal working committees, there are also three standing working groups of the TSC. They are broken down by topic area: Emissions Inventory, Modeling, and Monitoring/Data Analysis Workgroups.

The TSC has evolved to function as a valuable sounding board for all the technical projects and processes of 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.

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

The Communications Committee oversaw the development of MANE-VU's newsletter and outreach tools both for stakeholders and the public regarding regional issues within MANE-VU's members.

MANE-VU established a Policy Advisory Group (PAG) to provide advice to decision-makers on policy questions. FLMs, EPA, states, and tribes are represented on the PAG. It meets on an as needed basis.

The following points highlight many of the ways MANE-VU member states and tribes have cooperatively addressed visibility:

- Budget 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 discuss pertinent issues.
- SIP Policy and Planning: MANE-VU states/tribes collaborated on the development of a SIP Template.
- Capacity Building: To educate its staff and members MANE-VU included technical presentations on conference calls and organized workshops with nationally recognized experts. Presentations on data analysis, BART work, inventory topics, modeling, control measures etc. were an effective education, and coordination tool.
- Routine Operations: MANE-VU staff at OTC, MARAMA, and NESCAUM established a coordinated approach to: budget, grant deliverables/due-dates, workgroup meetings, inter-RPO feedback, etc.

This proposed SIP utilizes data analysis, modeling results and other technical support documents prepared for and by MANE-VU technical support committee members. By coordinating with MANE-VU and other RPOs, Delaware has worked to ensure that Best Available Retrofit Technology (BART) [Section 8 of this SIP], long term strategies and reasonable progress goals [Section 9 of this SIP] provide sufficient reductions to mitigate impacts of sources in Delaware on affected Class I areas (i.e., Brigantine, NJ). Further details on MANE-VU's background, purpose, roles and responsibilities, as well as organizational structure can be found in MANE-VU's *Final Interim Principles for Regional Planning* (Appendix 3-1).

Information and a description of the processes used to consult regarding baseline determinations, natural background levels, and reasonable progress goal development is available in sections 7 through 11 of this SIP

Section 4 Federal Land Manager Coordination

The regional haze rule requires the states, in coordination with EPA, the National Park Service, U.S. Fish and Wildlife Service, the U.S. Forest Service, and other interested parties, to develop and implement air quality protection plans to reduce the pollution that causes visibility impairment.

Section 51.308(i) requires coordination between States/Tribes and the Federal Land Managers (FLMs). Opportunities have been provided by MANE-VU for FLMs to review and comment on each of the technical documents developed by MANE-VU and included in this SIP Delaware has provided agency contacts to the FLMs as required. In the development of this Plan, the FLMs were consulted in accordance with the provisions of 51.308(i)(2). The State of Delaware has provided the FLMs an opportunity for consultation, in person at least 60 days prior to holding any public hearing on the SIP. This draft SIP was received by FLMs on April 29, 2008 for their review and comment.

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

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

The consultation will be coordinated with the designated visibility protection program coordinators for the National Park Service, U. S. Fish and Wildlife Service and the U.S. Forest Service.

In accordance with 40 CFR 51.308(i)(3) the State of Delaware has received comments regarding the SIP from FLMs. Comments received from the Federal Land Managers on the Plan were addressed. The comments and responses are included in Appendix 4-1 of this plan.

Delaware will provide FLMs with an opportunity to provide comments on future SIP revisions as required by Section 51.308(f). 51.308(f) requires States to submit a SIP revision by July 31, 2018 and every ten years thereafter.

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

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

Section 5 - Assessment of Baseline, Natural and Current Conditions

The requirement for this Section applies only to states containing Class I areas. Therefore, Delaware will not address these requirements in this SIP.

Section 6 - Monitoring Strategy

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

6.1 IMPROVE Program Objectives

Data collected at Class I area IMPROVE sites[10] are used by land managers, industry planners, scientists, public interest groups, and air quality regulators to understand and protect the visual air quality resource in Class I areas. Most importantly, the IMPROVE program scientifically documents for American citizens the visual air quality of their wilderness areas and national parks. A Quality Assurance Project Plan (QAPP) for the IMPROVE program, dated March 2002, can be found at:

http://vista.cira.colostate.edu/improve/Publications/QA_QC/IMPROVE_QAPP_R0.pdf

Program objectives include:

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

Section 51.308(d)(4)(iii) of EPA's Regional Haze Rule requires the inclusion of procedures by which monitoring data and other information are used in determining the contribution of emissions from within the State to visibility impairment at mandatory Class I Federal areas.

Delaware has been in nonattainment for ozone since 1990, and continues to be nonattainment based on the new standard. Furthermore, New Castle County is nonattainment for the $PM_{2.5}$ annual standard, and more recently, Delaware submitted a recommendation that New Castle be designated nonattainment for the new daily $PM_{2.5}$ standard. Accordingly, Delaware is required to maintain its current monitoring network, and to develop emission inventories once a year for major sources, and every three (3) years for all sources.

10 Delaware does not contain any Class I areas, and therefore does not have IMPROVE monitors. Much of this SIP is based on MANE-VU/New Jersey's assessment of their IMPROVE data from Brigantine, i.e. assessment of Baseline, Natural Background and Current Conditions.

As mentioned above, the Regional Haze Rule requires procedures by which other information is used in determining the contribution of emissions from within the State to visibility impairment at mandatory Class I Federal areas. Delaware has conducted receptor modeling and emissions inventory analysis to determine source contributions to within the state, and the proportional impacts of those sources to areas outside the state.

Delaware provides the following information on its monitoring network:

- Delaware's original $PM_{2.5}$ monitoring network design and monitor siting were completed in accordance with EPA requirements and guidance as stated in 40 CFR Part 58 Appendices D and E, and the EPA OAQPS document "Guidance for Network Design and Optimum Site Exposure for $PM_{2.5}$ and PM_{10}" (U.S. EPA 1997a). Final network documents were submitted to EPA Region 3 in June 1998, and EPA approved Delaware's $PM_{2.5}$ monitoring network.

- Annual Ambient Air Monitoring Network Reviews, including $PM_{2.5}$, have been completed each year in accordance with 40 CFR Part 58 Appendix D and subsequently submitted to EPA Region 3 for approval.

- In fulfillment of the federal 103 Grant Requirements, Delaware submits annual Data Quality Assessments for $PM_{2.5}$ speciation data and $PM_{2.5}$ FRM data to EPA Region 3. All data comply with appropriate federal and state requirements, including 40 CFR Part 50 Appendices L and N, and 40 CFR Part 58 Appendix A.

- In fulfillment of the federal 103 Grant Requirements, Delaware also submits annual $PM_{2.5}$ Speciation Monitoring Network Review and Monitoring Strategy reports to EPA Region 3. The $PM_{2.5}$ speciation network design and monitor siting follows EPA requirements and guidance as stated in 40 CFR Part 58 Appendices D and E, and the documents "Guidance for Network Design and Optimum Site Exposure for $PM_{2.5}$ and PM_{10}" (U.S. EPA 1997a), "Particulate Matter ($PM_{2.5}$) Speciation Guidance" (U.S. EPA 1999), and "Guideline on Speciated Particulate Monitoring" (U.S. EPA 1999a).

Delaware accepts the contribution assessment analysis completed by NESCAUM entitled, *Contributions to Regional Haze in the Northeast and Mid-Atlantic States*. See appendix 1-1. Methods of visibility and emissions data analysis used in preparing the Contribution Assessment include source apportionment analysis, trajectory analysis, emissions divided by distance, emissions times upwind probability, chemical transport models, and Lagrangian dispersion modeling. The many techniques used provided a stronger weight of evidence for the assessment of contribution by source types and regions.

Delaware agrees that NESCAUM is providing quality technical information by using the IMPROVE program data and the VIEWS site.

Section 7 - Emissions Inventory

40 CFR Section 51.308(d)(3)(iv) requires each state to identify all anthropogenic sources of visibility impairment considered by the state in developing its long-term strategy. EPA's *Guidance for Setting Reasonable Progress Goals Under the Regional Haze Program* (June, 2007) notes that this process begins with the identification of key pollutants and source categories that contribute to visibility impairment at the Class I area(s) affected by emissions from the state.

Section 51.308(d)(4)(v) of EPA's Regional Haze Rule requires a statewide emission inventory of pollutants that are reasonably anticipated to cause or contribute to visibility impairment in any mandatory Class I area. The pollutants inventoried by Delaware include volatile organic compounds, nitrogen oxides, fine particles ($PM_{2.5}$), coarse particles (PM_{10}), ammonia, and sulfur dioxides.

This section explores the characteristics, origin and quantity of visibility-impairing pollutants emitted in Delaware and the eastern/mid-Atlantic United States.

The pollutants that affect fine particle formation, and thus contribute to visibility impairment, are sulfur oxides (SO_X), nitrogen oxides (NO_X), volatile organic compounds (VOC), ammonia (NH_3), and particles with an aerodynamic diameter less than or equal to 10 and 2.5 µm (i.e., primary PM_{10} and $PM_{2.5}$). The emissions dataset illustrated below is the 2002 MANE-VU Version 3 emissions inventory. The emission inventories include carbon monoxide (CO), but it is not considered in this SIP as it does not contribute to visibility impairment. The MANE-VU regional haze emissions inventory version 3.0, released in April 2006, was used for modeling purposes. This inventory was developed through the Mid-Atlantic Regional Air Management Association (MARAMA) for the MANE-VU RPO. The trends among recent emission inventories presented here use the 1996 EPA NET and 1999 NEI and Version 3 of the MANE-VU inventory.[11]

[11] EPA's Emission Factor and Inventory Group (EFIG) (EPA/OAR (Office of Air and Radiation)/OAQPS (Office of Air Quality Planning and Standards)/EMAD (Emissions, Monitoring and Analysis Division) prepares a national database of air emissions information with input from numerous state and local air agencies, from tribes, and from industry. This database contains information on stationary and mobile sources that emit criteria air pollutants and their precursors, as well as hazardous air pollutants (HAPs). The database includes estimates of annual emissions, by source, of air pollutants in each area of the country on an annual basis. The NEI includes emission estimates for all 50 states, the District of Columbia, Puerto Rico, and the Virgin Islands. Emission estimates for individual point or major sources (facilities), as well as county level estimates for area, mobile and other sources, are available currently for years 1985 through 1999 for criteria pollutants, and for years 1996 and 1999 for HAPs. Data from the NEI help support air dispersion modeling, regional strategy development, setting regulation, air toxics risk assessment, and tracking trends in emissions over time. For emission inventories prior to 1999, the National Emission Trends (NET) database maintained criteria pollutant emission estimates and the National Toxics Inventory (NTI) database maintained HAP emission estimates. Beginning with 1999, the NEI began preparing criteria and HAP emissions data in a more integrated fashion to take the place of the NET and the NTI.

7.1 Baseline and Future Year Emission Inventories for Modeling

Section 51.308(d)(3)(iii) of EPA's Regional Haze Rule requires the State of Delaware to identify the baseline emission inventory on which strategies are based. The baseline inventory is intended to be used to assess progress in making emission reductions. Based on EPA guidance entitled, *2002 Base Year Emission Inventory SIP Planning: 8-hour Ozone, PM $_{2.5}$, and Regional Haze Programs,* which identifies 2002 as the anticipated baseline emission inventory year for regional haze, MANE-VU and the State of Delaware are using 2002 as the baseline year. Future year inventories were developed for the years 2009, 2012 and 2018 based on the 2002 base year. These future year emission inventories include emissions growth due to projected increases in economic activity as well as the emissions reductions due to the implementation of control measures.

The 2002 emissions were first generated by the individual states in the MANE-VU area. MARAMA then coordinated and quality assured the 2002 inventory data. 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 and the Central Regional Air Planning Association.

Version 3 of the 2002 base year emission inventory was used in the regional modeling exercise. Technical support documentation for the MANE-VU 2002 base inventory is presented in Appendix 7-1. This document explains the data sources, methods, and results for preparing this version of the 2002 base year criteria air pollutant and ammonia emissions inventory. Documentation for the future year estimations of EGUs is presented in Appendix 7-3. Documentation for the future year estimations of the remaining source sectors (non-EGU sectors) is presented in Appendix 7-4.

The inventory and supporting data prepared includes the following:

1) Comprehensive, county-level, mass emissions and modeling inventories for 2002 emissions for criteria air pollutants and ammonia for the State and Local agencies included in the MANE-VU region.
2) The temporal, speciation, and spatial allocation profiles for the MANE-VU region inventories.
3) Inventories for wildfires, prescribed burning and agricultural field burning for the southeastern provinces of Canada;
4) Inventories for other Regional Planning Organizations, Canada, and Mexico.

The mass emissions Inventory files were converted to the National Emissions Inventory Input Format Version 3.0. As discussed in greater detail in Chapter 7, the modeling inventory files were processed in Sparse Matrix Operator Kernel Emissions/Inventory Data Analyzer (SMOKE).

The inventories include annual emissions for oxides of nitrogen (NOx), volatile organic compounds (VOC), ammonia, particles with an aerodynamic diameter less than or equal to a

nominal 10 micrometers (PM10) and $PM_{2.5}$. The inventories also included summer day, winter day, and average day emissions. However, not all states included daily emissions in their inventories. In these instances, temporal profiles prepared for MANE-VU were used to calculate daily emissions.

Work on Version 1 of the 2002 MANE-VU inventory began in April 2004. The consolidated inventory for point, area, onroad, and nonroad sources was prepared starting with the inventories that MANE-VU state/local agencies submitted to the EPA from May through July of 2004 as a requirement of the Consolidated Emissions Reporting rule. The EPA's format and content quality assurance (QA) programs (and other QA checks not included in EPA's QA software) were run on each inventory to identify format and/or data content issues.[12] A contractor, E.H. Pechan & Associates, Inc. (Pechan), worked with the MANE-VU state/local agencies and the MARAMA staff to resolve QA issues and augment the inventories to fill data gaps in accordance with the Quality Assurance Project Plan prepared for MANE-VU.[13] The final inventory, SMOKE and input files were finalized during January 2005.

Work on Version 2 (covering the period form April through September 2005) involved incorporating revisions requested by some MANE-VU state/local agencies on the point, area, and inroad inventories. Work on Version 3 (covering the period from December 2007 through April 2005) included additional revisions to the point, area, and onroad inventories as requested by some states. Thus, the Version 3 inventory for point, area, and onroad sources was built upon Versions 1 and 2. This work also included development of the biogenics inventory. In Version 3, the nonroad inventory was completely redone because of changes that the EPA made to the NONROAD2005 model. Detailed county and statewide 2002 emissions inventory data are provided in appendix 7-2, which gives point sources down to the unit level, ten digit source category code area/nonroad, and mobile sources by vehicle, fuel and roadway type.

7.2 Visibility-Impairing Pollutant Characteristics

7.2.1 Sulfur Dioxide

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

12 EPA. Basic Format& Content Checker 3.0 (Formerly known as the Quality Assurance / Quality Control Software 3.0) – March 2004. Extended Quality Control Tool – Updated May 18, 2004. United States Environmental Protection Agency. 2004.
13 MANE-VU. Quality Assurance Project Plan (QAPP) for Area and Point Source Emissions Modeling Inventory Project, Final. Prepared for the Mid-Atlantic/Northeast Visibility Union by E.H. Pechan & Associates, Inc. and Carolina Environmental Program, August 3, 2004.

Figure 7-1 shows SO_2 emissions trends in the MANE-VU states extracted from the NEI for the years 1996, 1999, and the 2002 MANE-VU inventory (EPA 2005 and MARAMA, 2004). Most of the states (with the exception of Maryland) show declines in year 2002 annual SO_2 emissions as compared to 1996 emissions. Some of the states show an increase in 1999 followed by a decline in 2002 and others show consistent declines throughout the entire period. The upward trend in emissions after 1996 probably reflects electricity demand growth during the late 1990s combined with the availability of banked emissions allowances from initial over-compliance with control requirements in Phase 1 of the EPA Acid Rain Program. This led to relatively low market prices for allowances later in the decade, which encouraged utilities to purchase allowances rather than implement new controls as electricity output expanded. The observed decline in the 2002 SO_2 emissions inventory reflects implementation of the second phase of the EPA Acid Rain Program, which in 2000 further reduced allowable emissions and extended emissions limits to more power plants.

Figure 7-2 shows the percent contribution from different source categories to overall, annual 2002 SO_2 emissions in the MANE-VU states. The chart shows that point sources dominate SO_2 emissions, which primarily consist of stationary combustion sources for generating electricity, industrial energy, and heat. Smaller stationary combustion sources called "area sources" (primarily commercial and residential heating, and smaller industrial facilities) are another important source category in the MANE-VU states. By contrast, on-road and non-road mobile sources make only a relatively small contribution to overall SO_2 emissions in the region (NESCAUM, 2001a).

Figure 7-1. State Level Sulfur Dioxide Emissions

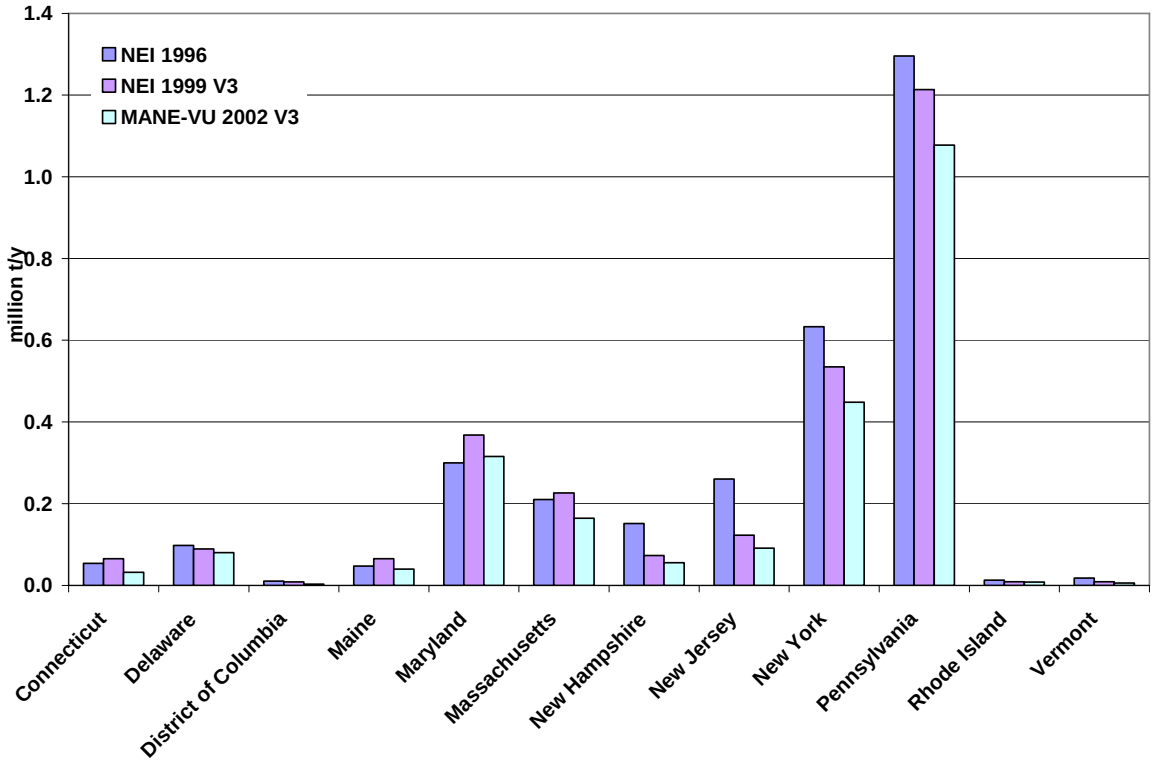
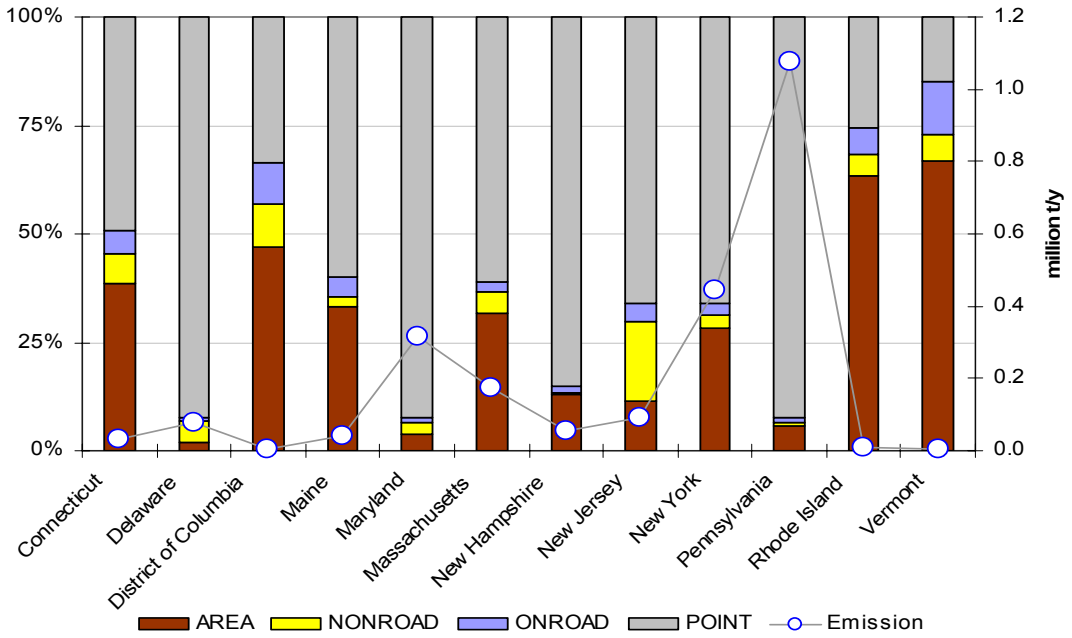


Figure 7-2. 2002 SO_2 (Bar graph: Percentage fraction of four source categories, Circle: Annual emissions amount in 10^6 tons per year)



For the reasons described above, the emphasis in developing this SIP revision was placed on sources of SO_2. Emissions inventory analysis shows that point sources dominated the 2002 inventory of SO_2 emissions. The largest source category of sulfur dioxide in the region is electric generating units (EGUs). Additional SO_2 source categories analyzed include oil-fired installations at residential, commercial, institutional, or industrial facilities; industrial, commercial, and institutional (ICI) boilers; and cement and lime kilns.

Roughly 70 percent of the 2.3 million tons of SO_2 emission in the 2002 MANE-VU emissions inventory Version 3.0 were from EGUs, making them the largest SO_2 source category in terms of visibility impairing emissions. MANE-VU found through modeling analysis documented in the Contribution Assessment that emissions from specific EGUs were important contributors to visibility impairment in MANE-VU Class I areas in 2002. Figure 11-1 shows the locations of 167 EGU stacks that impair visibility at one or more MANE-VU Class I area. Some of the stacks identified as important were outside the states identified as contributing at least 2 percent of the sulfate at MANE-VU Class I areas, these were dropped from the list. The list of these sources is found in Appendix 9-10.

7.2.2 Volatile Organic Compounds (VOC)

Existing emission inventories generally refer to "volatile organic compounds" (VOCs) for hydrocarbons whose volatility in the atmosphere makes them particularly important from the standpoint of ozone formation. From a regional haze perspective, there is less concern with the volatile organic gases emitted directly to the atmosphere and more with the secondary organic aerosol (SOA) that the VOCs form after condensation and oxidation processes. Thus the VOC inventory category is of interest primarily from the organic carbon perspective of $PM_{2.5}$. 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 come directly from emission sources as a part of primary PM or may form in the atmosphere as secondary pollutants. The organic carbon present at Class I sites is a mix of species, including pollutants originating from anthropogenic (i.e., manmade) sources as well as biogenic hydrocarbons emitted by vegetation. Recent efforts to reduce manmade organic carbon emissions have been undertaken primarily to address summertime ozone formation in urban centers. Delaware has enacted numerous regulations to further reduce organic carbon emissions (treated as volatile organic compounds in our ozone SIPs).[14]

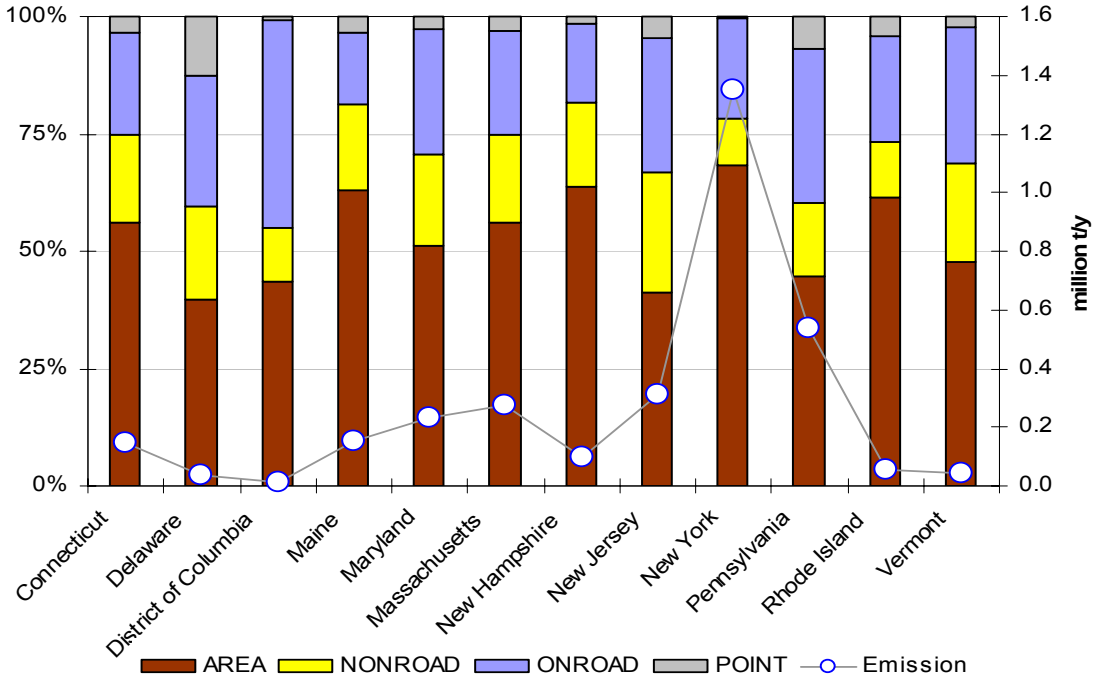
Understanding the transport dynamics and source regions for organic carbon in northeastern Class I areas is likely to be more complex than for sulfate. This is partly because of the large number and variety of OC species, the fact that their transport characteristics vary widely, and the fact that a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

As shown in Figure 7-3, the VOC inventory is dominated by mobile and area sources. On-road mobile sources of VOCs include exhaust emissions from gasoline passenger vehicles and diesel-powered heavy-duty vehicles as well as evaporative emissions from transportation fuels. VOC emissions may also originate from a variety of area sources (including solvents, architectural coatings, and dry cleaners) as well as from some point sources (e.g., industrial facilities and petroleum refineries).

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

14 A listing of those regulations can be found in Appendix 7-6

Figure 7-3. 2002 VOC (Bar graph: Percentage fraction of four source categories, Circle: Annual emissions in million tons per year)



7.2.3 Oxides of Nitrogen (NO_x)

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

Figure 7-4 shows NO_x emissions in the MANE-VU region at the state level. Since 1980, nationwide emissions of NO_x from all sources have shown little change. In fact, emissions increased by 2 percent between 1989 and 1998 (EPA, 2000a). This increase is most likely due to industrial sources and the transportation sector, as power plant combustion sources have implemented modest emissions reductions during the same time period. Most states in the MANE-VU region experienced declining NO_x emissions from 1996 through 2002, except Massachusetts, Maryland, New York, and Rhode Island, which show an increase in NO_x emissions in 1999 before declining to levels below 1996 emissions in 2002.

Power plants and mobile sources generally dominate state and national NO_x emissions inventories. Nationally, power plants account for more than one-quarter of all NO_x emissions, amounting to over six million tons. The electric sector plays an even larger role, however, in parts of the industrial Midwest where high NO_x emissions have a particularly significant power plant contribution. By contrast, mobile sources dominate the NO_x inventories for more urbanized Mid-Atlantic and New England states to a far greater extent, as shown in Figure 7-5. In these states, on-road mobile sources - a category that mainly includes highway vehicles - represent the most significant NO_x source category. Emissions from non-road (i.e., off-highway)

mobile sources, primarily diesel-fired engines, also represent a substantial fraction of the inventory. While there are fewer uncertainties associated with available NO_x estimates than in the case of other key haze-related pollutants - including primary fine particle and ammonia emissions - further efforts could improve current inventories in a number of areas (NESCAUM, 2001a).

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

Figure 7-4. State Level Nitrogen Oxides Emissions

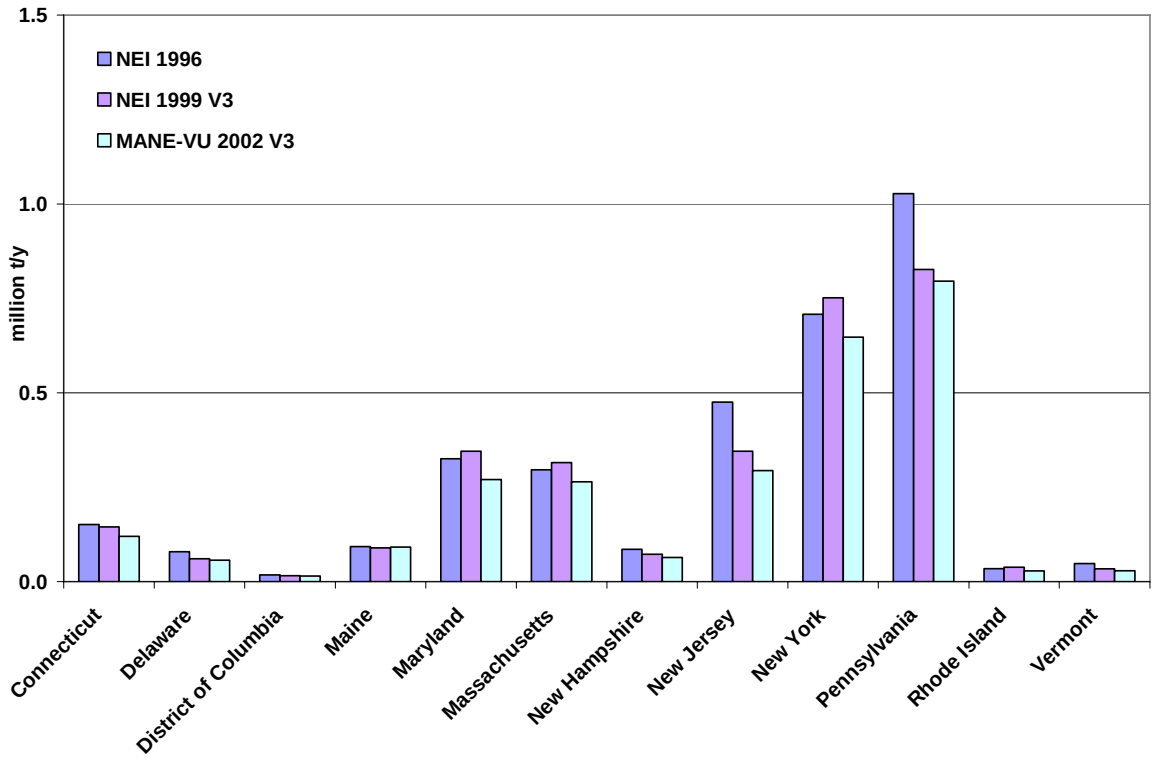
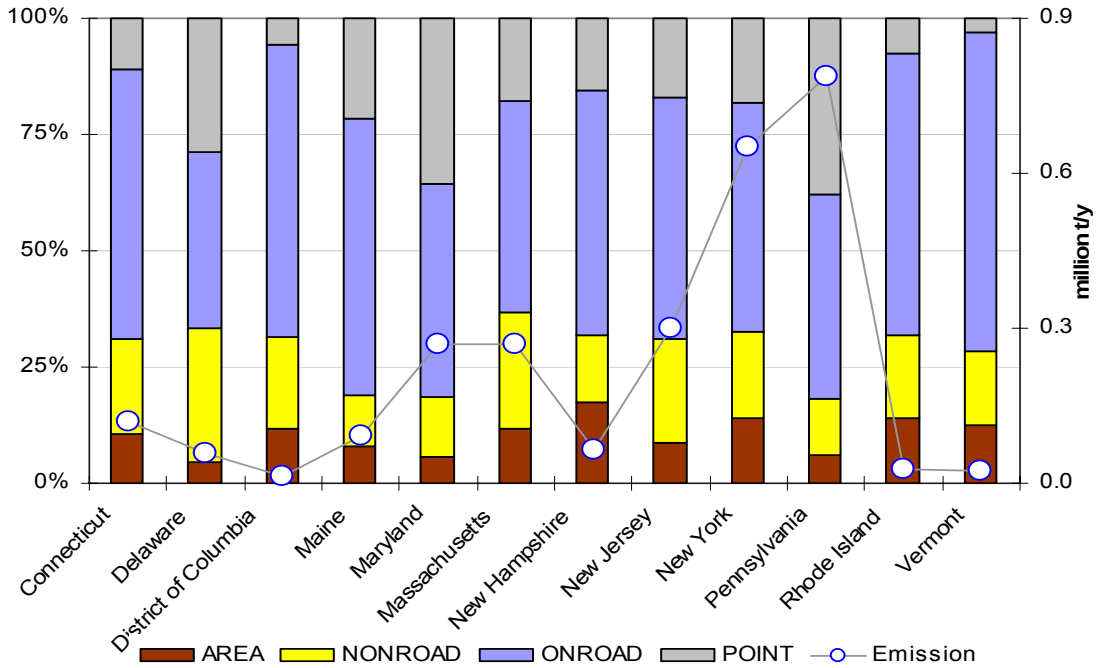


Figure 7-5. NO_x (Bar graph: Percentage fraction of four source categories, Circle: Annual emissions amount in 10^6 TPY



7.2.4 Directly-Emitted or "Primary" Particles

Particles suspended in the ambient air are categorized in a variety of ways depending on their composition and genesis. Directly-emitted or "primary" particles are those that are emitted in non-gaseous form directly from the source. Secondary particles form in the atmosphere through chemical reactions involving precursor pollutants like SO_2 and NO_X)

A further distinction is made between particles with an aerodynamic diameter less than or equal to 10 micrometers and smaller particles with an aerodynamic diameter less than or equal to 2.5 micrometers (i.e., primary PM_{10} and $PM_{2.5}$, respectively).

Figure 7-6 shows PM_{10} and $PM_{2.5}$ emissions for the MANE-VU states for the years 1996, 1999, and 2002. Note that for PM_{10} the inventory values are drawn from the 2002 NEI. Most states show a steady decline in annual PM_{10} emissions over this time period. By contrast, emission trends for primary $PM_{2.5}$ are more variable.

Figure 7-6. State Level Primary PM_{10} Emissions

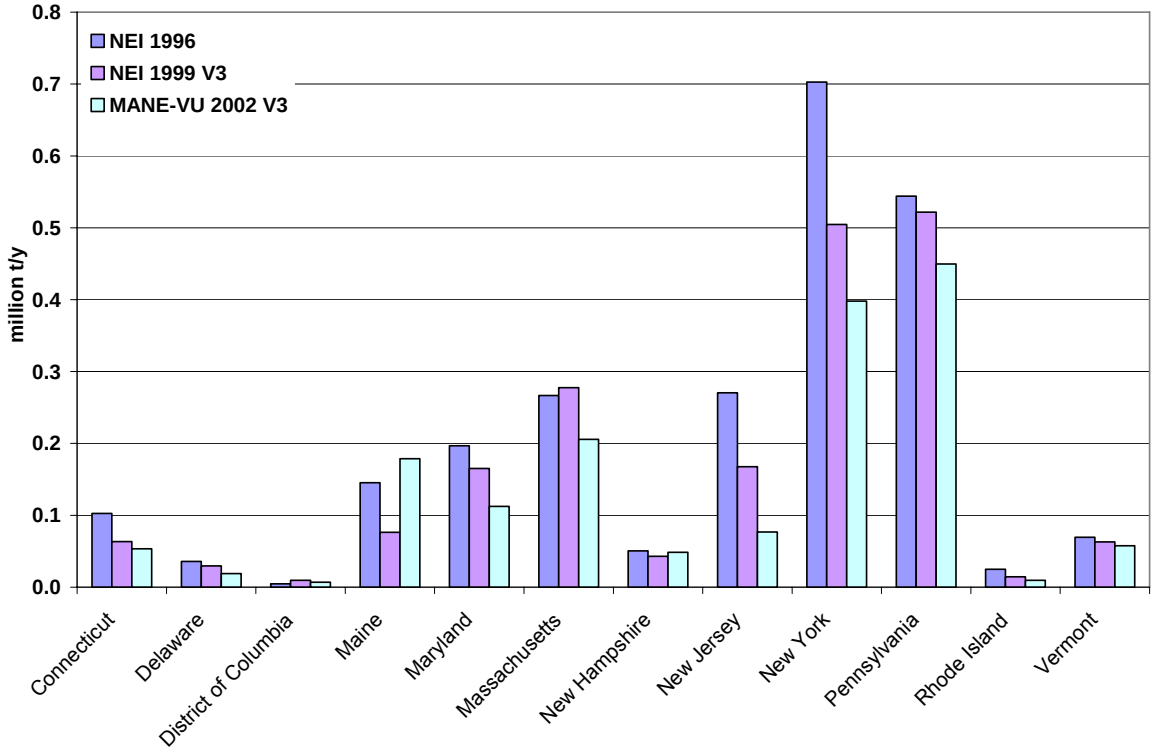
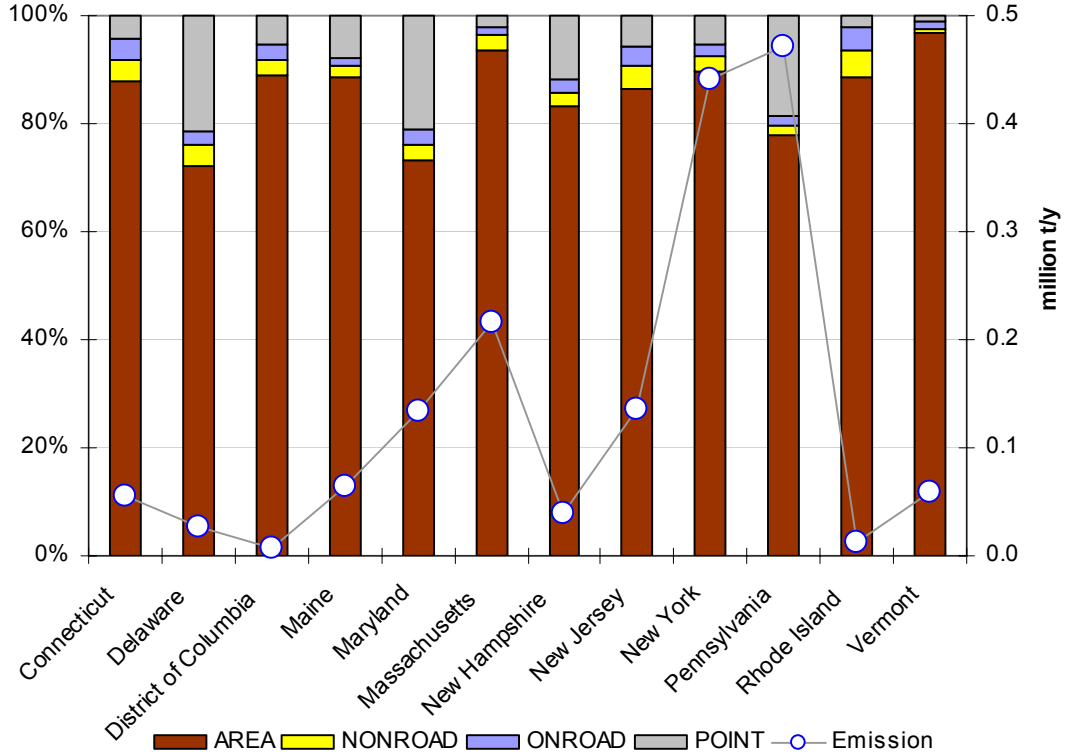


Figure 7-7 shows that area and mobile sources dominate primary PM emissions. The NEI inventory categorizes residential wood combustion and some other combustion sources as area sources. The relative contribution of point sources is larger in the primary $PM_{2.5}$ inventory than in the primary PM_{10} inventory since the crustal component (which consists mainly of larger or "coarse-mode" particles) contributes mostly to overall PM_{10} levels. At the same time, pollution control equipment commonly installed at large point sources is usually more efficient at capturing coarse-mode particles.

Figure 7-7 Primary PM_{10} (Bar graph: Percentage fraction of four source categories, Circle: Annual emissions amount in 10^6 tons per year)



7.2.4.1 Crustal PM

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 transport to downwind receptor locations. Because of this discrepancy between estimated emissions and observed ambient concentrations, modelers typically reduce estimates of total $PM_{2.5}$ emissions from all crustal sources by applying a factor of 0.15 to 0.25 to the total $PM_{2.5}$ emissions before including it in modeling analyses

From a regional haze perspective, crustal material generally does not play a major role. On the 20 percent best-visibility days during the baseline period (2000-2004), it accounted for six to eleven percent of particle-related light extinction at MANE-VU Class 1 sites. On the 20 percent worst-visibility days, however, crustal material generally plays a much smaller role relative to other haze-forming pollutants, ranging from two to three percent. Moreover, the crustal fraction includes material of natural origin (such as soil or sea salt) that is not targeted under the Haze Rule. Of course, the crustal fraction can be influenced by certain human activities, such as

construction, agricultural practices, and road maintenance (including wintertime salting) — thus, to the extent that these types of activities are found to affect visibility at northeastern Class I sites, control measures targeted at crustal material may prove beneficial.

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

7.2.4.2. Woodsmoke PM

The MANE VU 2002 Version 3 emissions inventory indicates residential wood combustion represents 25 percent (annual average) of primary fine particulate emissions in the MANE VU region. In Delaware residential wood combustion represents 25 percent of the inventory. The residential wood combustion component of the inventory is shown in Tables 7-1 and 7-2. Residential wood combustion is represented as SCC 2104008 in the MANE VU 2002 Version 3 inventory.

Table 7-1 MANE-VU Version 3 Residential Wood Emissions

State	CO	NH3	NOx	PM10-PRI	PM25-PRI	SO2	VOC
Connecticut	65,253	470	821	8,521	8,521	120	41,068
Delaware	9,109	66	120	1,228	1,228	16	5,952
District of Columbia	1,142	4	13	158	158	2	733
Maine	99,653	719	1,265	12,570	12,570	184	59,816
Maryland	61,175	441	751	8,194	8,194	107	39,434
Massachusetts	104,462	753	1,332	13,689	13,689	194	66,217
New Hampshire	63,714	460	815	8,019	8,019	119	38,652
New Jersey	74,311	535	943	9,901	9,901	132	49,989
New York	313,180	2,242	3,647	41,980	36,703	615	226,182
Pennsylvania	74,915	0	930	10,286	10,286	142	25,537
Rhode Island	3,667	7	44	509	509	7	1,982
Vermont	31,539	8	396	4,093	3,818	58	10,970
MANE-VU Res Wood Total	902,118	5,704	11,078	119,148	113,595	1,696	566,532
MANE-VU Total	17,986,440	309,260	2,676,002	1,616,136	446,366	2,321,338	2,987,753
% of Total	**5%**	**2%**	**0%**	**7%**	**25%**	**0%**	**19%**

Table 7-2 MANE-VU Version 3 State Level Residential Wood Emissions

State	Res. Wood $PM_{2.5}$	Total $PM_{2.5}$	% of Total $PM_{2.5}$ In State
Connecticut	8,521	18,366	46%
Delaware	**1,228**	**8,210**	**15%**
District of Columbia	158	1,613	10%
Maine	12,570	40,825	31%
Maryland	8,194	38,930	21%
Massachusetts	13,689	51,864	26%
New Hampshire	8,019	21,997	36%
New Jersey	9,901	31,595	31%
New York	36,703	108,953	34%
Pennsylvania	10,286	108,812	9%
Rhode Island	509	2,901	18%
Vermont	3,818	12,300	31%

Receptor-based source attribution found wood smoke to be a small to moderate contributor to $PM_{2.5}$, with contributions typically higher in rural areas than urban areas, winter peaks in northern areas from residential wood burning, and occasional large summer impacts at all sites from wildfires. Source apportionment and inventory evidence implies that rural sources can play an important role in addition to the contribution from the region's many highly populated urban areas particularly in the winter months. Typically managed or prescribed burning activities occur largely in non-winter seasons. The latter category includes agricultural field-burning activities, prescribed burning of forested areas and other burning activities such as construction waste burning. Limiting burning to times when favorable meteorological conditions can efficiently disperse resulting emissions can manage many of these types of sources. Note that these conclusions are based on seasonal averages, not 20 percent best or worst days.

7.2.5 Ammonia Emissions (NH_3)

Knowledge of ammonia emission sources will be necessary in developing effective regional haze reduction strategies because of the importance of ammonium sulfate and ammonium nitrate in determining overall fine particle mass and light scattering. According to 1998 estimates, livestock, agriculture and fertilizer use accounted for approximately 86 percent of all ammonia emissions to the atmosphere (EPA, 2000b). However, better ammonia inventory data is needed for the photochemical models used to simulate fine particle formation and transport in the eastern United States. Because the EPA does not regulate ammonia as a criteria pollutant or as a criteria pollutant precursor, these data do not presently exist at the same level of detail or certainty as for NO_x and SO_2.

Ammonium ion (formed from ammonia emissions to the atmosphere) is an important constituent of airborne particulate matter, typically accounting for 10–20 percent of total fine particle mass. Reductions in ammonium ion concentrations can be extremely beneficial because a more-than-proportional reduction in fine particle mass can result. Ansari and Pandis (1998) showed that a one $\mu g/m^3$ reduction in ammonium ion could result in up to a four $\mu g/m^3$ reduction in fine particulate matter. Decision makers, however, must weigh the benefits of ammonia reduction against the significant role it plays in neutralizing acidic aerosol.[15]

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

The CMU project established an inventory framework with source categories, emissions factors, and activity data that are readily accessible to the user. With this framework, users can obtain data in a variety of formats[16] and can make updates easily, allowing additional ammonia sources to be added or emissions factors to be replaced as better information becomes available (Strader et al., 2000; NESCAUM, 2001b).

Figure 7-8 shows that estimated ammonia emissions were fairly stable in the 1996, 1999, and 2002 NEI for MANE-VU states, with some increases observed for Massachusetts, New Jersey and New York. Area and on-road mobile sources dominate according to Figure 7-9. 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. The two remaining sources with a significant emissions contribution are wastewater treatment systems and gasoline exhaust from highway vehicles.

[15] 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.

[16] For example, the user will have the flexibility to choose the temporal resolution of the output emissions data or to spatially attribute emissions based on land-use data.

Figure 7-8 State Level Ammonia Emissions

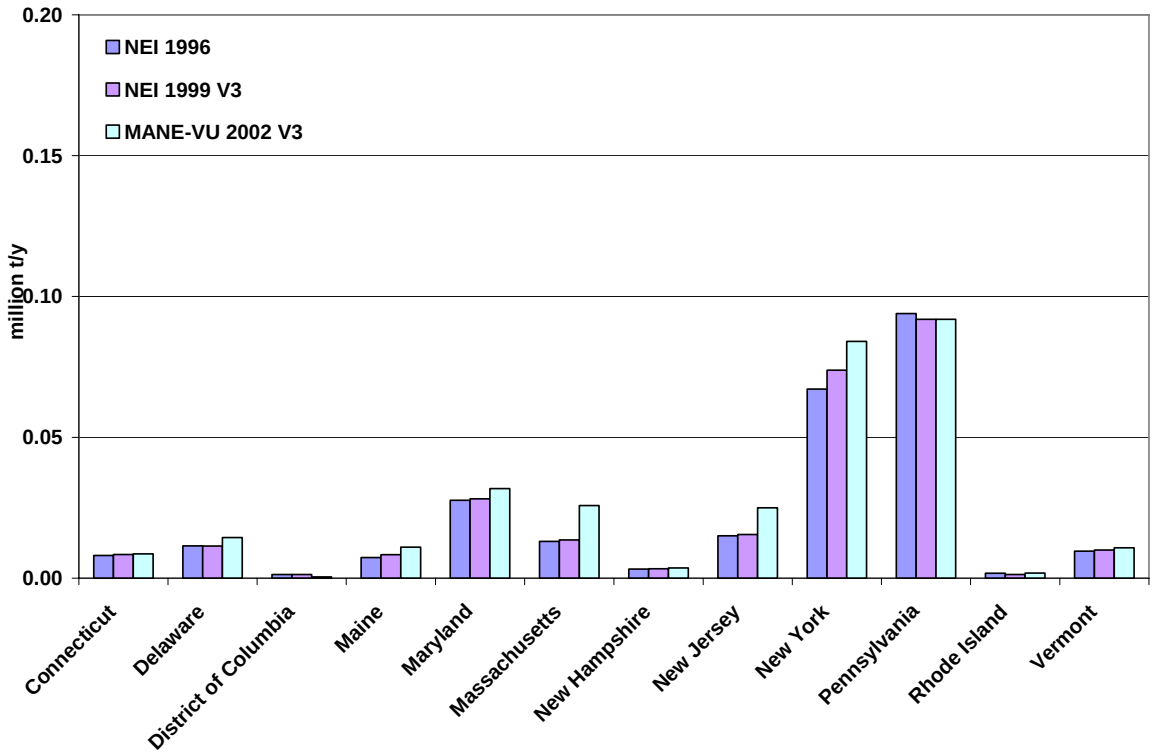
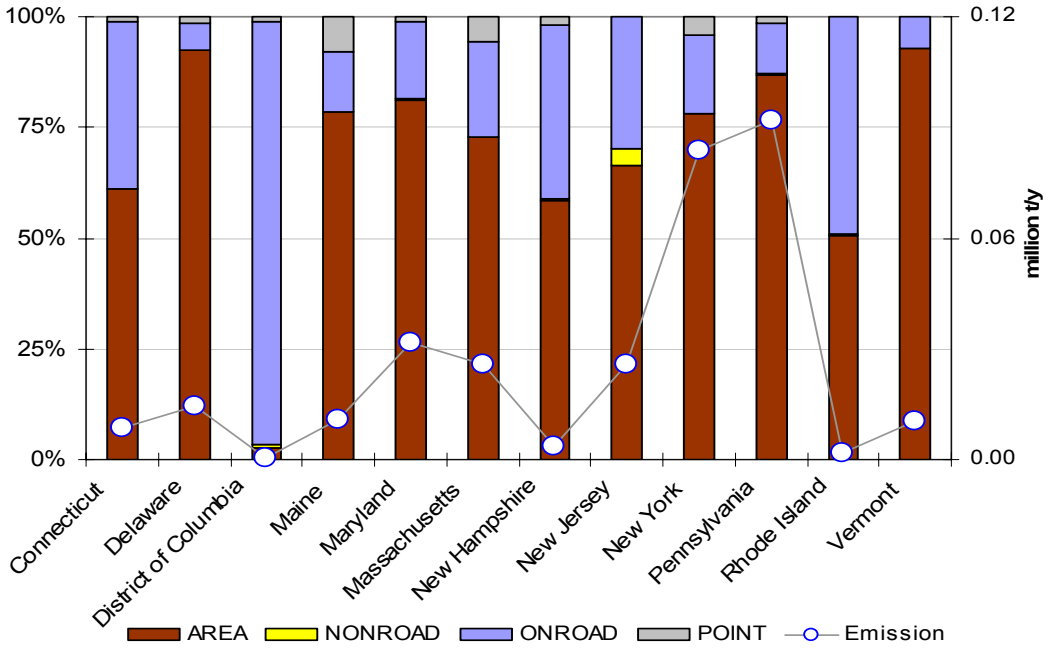


Figure 7-9. NH_3 (Bar graph: Percentage fraction of four source categories, Circle: Annual emissions amount in 10^6 tons per year)



7.3 Sources of Other Pollutants

Source apportionment documented in Appendix B of the MANE-VU Contribution Assessment also identified biomass combustion as a local source contributing to visibility impairment. According to Appendix B of the MANE-VU Contribution Assessment, woodsmoke also contributes to visibility impairment, with contributions typically higher in rural areas than urban areas, winter peaks in northern areas from residential wood burning, and occasional large summer impacts at all sites from wildfires.

Wood smoke impacting MANE-VU Class I areas is more local in origin than sources of SO_2, except for major transport events. Appendix B of the MANE-VU Contribution Assessment represents the results of source apportionment and trajectory analyses. It illustrates that the impacts of woodsmoke on MANE-VU Class I areas are more likely due to emissions from within MANE-VU and Canada.

The MANE-VU *Technical Support Document on Agricultural and Forestry Smoke Management in the MANE-VU Region* 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.

7.4 Future Year Emission Control Inventories

Technical support documents for these future inventories is included in Appendices 7-4 and 7-5 and explains the data sources, methods, and results for future year emission forecasts for three years; four emission sectors; two emission control scenarios; seven pollutants; and eleven states plus the District of Columbia. The following is a summary of the future year inventories that were developed:

1) The three projection years are 2009, 2012, and 2018[17];
2) The four source sectors are Electric Generating Units (EGUs), non-electrical generating units (non EGUs) point sources, area sources, and nonroad mobile sources. MANE-VU prepared EGU projections using the Integrated Planning Model (IPM) and onroad mobile source projections using the SMOKE emission modeling system.
3) The two emission control scenarios are:
    i. A combined "on-the-books/on-the-way" (OTB/W) control strategy accounting for post- 2002 state and federal emission control regulation already in place, as well as some emission control regulation that are final, but with an effective date between the date of this SIP submittal and 2013, and other states' adoption of

17 Only the 2018 projection year was considered in this SIP, since 2018 is the target year of interest. 2009 and 2012 were developed for concurrent PM and Ozone SIPs purposes. There is obvious uncertainty in promising future regulations as modeled in the B&F Modeling, and thus uncertainty in enforcing control measures is high as well. However, Delaware has clearly shown that OTB/OTW Delaware/federal rules and regulations demonstrate Delaware meets its fair share of the reasonable progress goals. Section 11 discusses these measures in detail, presents a point-by-point discussion of each goal, and even demonstrates that Delaware has a "surplus" of SO_2 emissions beyond what was modeled using 2018 Best and Final control measures. Therefore there is no uncertainty or lack of enforceability associated with reasonable progress goals and visibility progress for this SIP.

OTC VOC shortfall measures by states outside Delaware and MANE-VU states); and

ii. A beyond on the way (termed "Best and Final" modeling run) scenario to account for controls from potential new regulations that may be necessary to meet reasonable progress goals[18] for Class I areas (i.e. Brigantine for this SIP.[19]

4) The inventories were developed for seven pollutants, which are SO_2, NO_X, VOCs, carbon monoxide, PM_{10} – Primary (sum of the filterable and condensable components), $PM_{2.5}$ – Primary (sum of the filterable and condensable components), and ammonia.

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

7.5 Emission Processor Selection and Configuration

The mass emissions Inventory files were converted to the National Emissions Inventory Input Format Version 3.0. As discussed in greater detail in Chapter 10, the modeling inventory files were processed in Sparse Matrix Operator Kernel Emissions/Inventory Data Analyzer (SMOKE).

The SMOKE Processing System was selected for the modeling analysis. SMOKE is principally an emissions processing system, as opposed to a true emissions inventory preparation system, in which emissions estimates are simulated from "first principles." This means that, with the exception of mobile and biogenic sources, its purpose is to provide an efficient, modern tool for converting emissions inventory data into the formatted emissions files required for a photochemical air quality model.

Inside the MANE-VU region, the modeling inventories were processed by the New York Department of Environmental Conservation (NYSDEC) using the SMOKE (Version 2.1) processor to provide inputs for the CMAQ model.

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18 There are two primary measures considered for future control measures. They are 1) SO_2 reductions from the top 167 EGUs in the modeling domain (includes four units in DE), and 2) lower sulfur fuels. These measures are discussed in detail in Section 11.

19 The 2018 "Best & Final" modeling relied up emission projections including if-then scenarios of various control measures adopted. It is important to point out that emission projections refers to extrapolating baseline emission estimates to predict future emissions based upon expected future activity levels and emissions controls. However, because sources and their associated air emissions are not static over time, baseline emissions may not accurately represent emissions for a future year. Emission projections are an attempt to account for the effects of future growth and emissions controls. Because projections attempt to quantify the unknown future, there will always be some uncertainty associated with any estimate of projected emissions. MANE-VU and Delaware have attempted to minimize uncertainty by using source-specific growth factors and control factors that most nearly approximate future year emissions.

A detailed description of all SMOKE input files (i.e. projection years) such as area, mobile, fire, point and biogenic emissions files and the SMOKE model configuration are provided in Appendix 7-5.

As discussed in detail in Chapter 10, the MANE-VU member states selected several control strategies for inclusion in the 2018 Best & Final modeling. Emission reduction requirements mandated by the Clean Air Act were also included in projecting future year emissions. In addition, Section 51.308(d)(3)(v)(D) requires States to consider source retirement and replacement schedules in developing the future inventories and long-term strategy.

7.6 Inventories for Specific Source Types

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

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

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

7.6.1 Stationary Point Sources

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

7.6.1.1 Electric Generating Units

The base year inventory for EGU sources used 2002 continuous emissions monitoring (CEM) data reported to the EPA in compliance with the Acid Rain program or 2002 hourly emission data provided by stakeholders. These data provide hourly emissions profiles that can be used in the modeling of emissions of SO_2 and NO_x from these large sources. Emission profiles are used to estimate emissions of other pollutants (volatile organic compounds, carbon monoxide, ammonia, fine particles, soil) based on measured emissions of SO_2 and NO_x.

Future year inventories of EGU emissions for 2009 and 2018 were developed using the IPM model to forecast growth in electric demand and replacement of older, less efficient and more polluting power plants with newer, more efficient and cleaner units. 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-by-State NO_x and SO_2 caps, the State of Delaware did not directly rely upon the closure of any particular plant in establishing the 2018 inventory upon which the reasonable progress goals were set. This is because, the IPM model results are not the basis upon which to reliably predict plant closures and the issues of specific plant closures in the State of Delaware.

For example, IPM predicted all of Delaware's oil-burning EGUs would have no emissions in 2009. Contrary to this, Delaware's oil-burning EGUs have indicted to the Department that that the oil-burning units will be operating for the foreseeable future. Therefore, Delaware determined that the IPM method was not an accurate method of projected future emissions from EGUs in Delaware, and re-projected EGU emissions using Department of Energy growth factors. Afterwards, Delaware-specific controls from post-2002 regulations were applied and the estimates sent to MARAMA for inclusion in future year modeling. The source of data for determining growth was: Energy Information Administration (EIA), Annual Energy Review 2004 (mid-Atlantic), DOE/EIA-0384 (2004) (Washington, DC, August 2005). Using 2002 as the baseline, 2009 growth factors were derived by taking 2009 projected energy consumption by sector (Energy Consumption) and source (fuel type-quadrillion Btu), and then dividing that by 2003 growth rates. Delaware provided MANE-VU modelers with 2018 projections.

7.6.2 Non-EGU Point Sources

The non-EGU category used annual emissions as reported for the base year 2002 MANE-VU Version 3. These emissions were temporally allocated to month, day, and our using source category code (SCC) based allocation factors. The general approach for estimating future year emissions was to use growth and control data consistent with EPA's Clean Air Interstate Rule (CAIR) analyses. This data was supplemented with site specific growth factors as appropriate.

7.6.3 Stationary Area Sources

Stationary area sources include sources whose individual emissions are relatively small but due to the large number of these sources, the collective emissions are significant. Some examples include the combustion of fuels for heating, dry cleaners, and service stations. Emissions are estimated by multiplying an emission factor by some known indicator of collective activity, such

as fuel usage, or number of households or population. The general approach for estimating future year emissions was to use growth and control data consistent with EPA's CAIR analyses.[20] This data was supplemented with state specific growth factors as appropriate.

7.6.4 Off-Road Mobile Sources

Non-road mobile sources are equipment that can move but do not use the roadways, such as construction equipment, aircraft, railroad locomotives, lawn and garden equipment. For the majority of the non-road mobile sources, the emissions for base year 2002 were estimated using the EPA's Non-Road model. The Non-Road model considers that a certain number of non-road sources will be replaced every year by newer, less polluting vehicles that meet the new EPA standards for off-road sources.

These lower emissions have been built into the 2018 inventory as well as the benefits received from lower sulfur gasoline in off-road vehicles. Aircraft engine, railroad locomotives and commercial marine are not included in the Non-Road model. For these sources growth and control data consistent with EPA's CAIR analyses were used. This data was supplemented with state specific growth factors as appropriate.

7.6.5 Highway Mobile Sources

For on-road vehicles, MOBILE6.2 was used to estimate emissions. For future year emissions the Mobile6 model considers that a certain number of the vehicle fleet in each State will be replaced every year by newer, less polluting vehicles that meet the EPA Tier II motor vehicle standards. These lower emissions have been built into the 2018 inventory as well as the benefits received from lower sulfur gasoline in on-road diesel and gasoline vehicles and the 2007 heavy-duty diesel standards. All new mobile source measures and standards, as well as any benefits from implementation of individual State Inspection and Maintenance programs, were used in developing the 2018 inventory.

7.6.6 Biogenic Emission Sources

Biogenic emissions were estimated using SMOKE-BEIS3 (Biogenic Emission Inventory System 3 version 0.9) preprocessor. Further information on Biogenic emissions estimation is contained in the modeling section of this document.

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20 On July 11, 2008, the U.S. Court of Appeals for the District of Columbia Circuit vacated the Clean Air Interstate Rule (CAIR). In considering petitions for review challenging various aspects of CAIR, the Court concluded, "because we find more than several fatal flaws in the rule and the Environmental Protection Agency adopted the rule as one, integral action, we vacate the rule in its entirety and remand to EPA to promulgate a rule that is consistent with this opinion." However, the Court did not question the integrity of technical analysis which supported CAIR.

7.7 Summary of MANE-VU 2002 and 2018 OTB/W Emissions Inventory

Tables 7-3 through 7-8 represent the final 2002, 2018 OTB/W and 2018 RPG (Best and Final modeling) inventories for MANE-VU and Delaware. Detailed emissions by source sectors and source category codes can be found in Appendices 7-2 and 7-5.

Table 7-3 MANE-VU 2002 Emissions Inventory Summary

	VOC	NO_x	$PM_{2.5}$	PM_{10}	NH_3	SO_2
Point	97,300	673,660	55,447	89,150	6,194	1,907,634
Area	1,528,141	262,477	332,729	1,455,311	249,795	316,357
Onroad	789,560	1,308,233	22,107	31,561	52,984	40,091
Nonroad	572,751	431,631	36,084	40,114	287	57,257
Biogenics	2,575,232	28,396	-	-	-	-
TOTAL	5,562,984	2,704,397	446,367	1,616,136	309,260	2,321,339

Source: Pechan, 2006. "Technical Support Document for 2002 MANE-VU SIP Modeling Inventories, Version 3." November 20, 2006. Available online:
http://www.marama.org/visibility/Inventory%20Summary/2002EmissionsInventory.htm

Table 7-4 MANE-VU 2018 OTB/W Emissions Inventory Summary

	VOC	NO_x	$PM_{2.5}$	PM_{10}	NH_3	SO_2
EGU	4528	175,219	52,360	65,558	6,148	320,651
Non-EGU	110,524	237,802	41,220	63,757	4,986	270,433
Area	1,387,882	284,535	345,419	1,614,476	341,746	305,437
Onroad	269,981	303,955	9,189	9,852	66,476	8,757
Nonroad	380,080	271,185	23,938	27,059	369	8,643
Biogenics	2,575,232	28,396	-	-	-	-
TOTAL	4,728,227	1,301,092	472,126	1,780,702	419,725	913,921

Source: MACTEC, 2007. "Development of Emission Projections for 2009, 2012, and 2018 for non-EGU Point, Area, and Nonroad Sources in the MANE-VU Region." February 28, 2007
Available online: http://www.marama.org/visibility/Inventory%20Summary/FutureEmissionsInventory.htm

TABLE 7-5 MANE-VU 2018 BEST AND FINAL

	VOC	NO_x	$PM_{2.5}$	PM_{10}	NH_3	SO_2
EGU	4528	175219	52360	65558	6148	386584
Non-EGU	109762	199733	40907	62925	4988	211320
Area	1334038	263031	243321	720462	341747	129656
Onroad	269,981	303,955	9,189	9,852	66,476	8,757
Nonroad	380,076	271,181	23,933	27,055	360	8,643
Biogenics	2,575,232	28,396	0	0	0	0
TOTAL	4,673,617	1,241,515	369,710	885,852	419,719	744,960

Table 7-6 MANE-VU 2002 Emissions Inventory Summary - Delaware

	VOC	NO_x	$PM_{2.5}$	PM_{10}	NH_3	SO_2
EGUs	110	11,973	2,060	2,397	43	38,038
Non-EGUs	4,645	4,372	1,606	1,820	153	35,706
Area	15,519	2,608	3,204	13,039	13,279	1,588
Onroad	10,564	21,341	415	581	903	584
Nonroad	8,010	16,227	926	1,021	5	3,983
TOTAL	**38,848**	**56,521**	**8,211**	**18,858**	**14,383**	**79,899**

Table 7-7 Delaware 2018 OTB/W Emissions Summary

	VOC	NO_x	$PM_{2.5}$	PM_{10}	NH_3	SO_2
EGUs	117	12,341	2,438	2,950	76	35,442
Non-EGUs	1,993	4,246	1,254	1,487	134	7,610
Area	13,742	3,014	3,426	14,844	13,342	1,545
Onroad	5,037	5,917	191	202	1,328	128
Nonroad	5,653	14,631	808	897	7	3,296
TOTAL	**26,542**	**40,149**	**8,117**	**20,380**	**14,887**	**48,021**

Table 7-8 Delaware 2018 RPG (Best & Final) Emissions Summary

	VOC	NO_x	$PM_{2.5}$	PM_{10}	NH_3	SO_2
EGUs	117	12,341	2,438	2,950	76	10,941
Non-EGUs	1,987	4,246	1,254	1,487	134	5,766
Area	13,066	3,014	3,073	10,500	13,342	380
Onroad	5,037	5,917	191	202	1,328	128
Nonroad	5,652	14,631	808	896	6	3,296
TOTAL	**25,859**	**40,149**	**7,764**	**16,035**	**14,886**	**20,511**

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Section 8 - Best Available Retrofit Technology

40 CFR Part 51.308(e) states; "*The State must submit an implementation plan containing emissions limitations representing BART and schedules for compliance for BART for each BART-eligible source that may reasonably be anticipated to cause or contribute to any impairment of visibility in any mandatory Class I Federal area, unless the State demonstrates that an emissions trading program or other alternative will achieve greater reasonable progress toward natural visibility conditions*."

BART requirements pertain to large facilities in each of 26 source categories that meet certain criteria, including industrial boilers, paper and pulp plants, cement kilns, and other large stationary sources. The BART program applies to units installed and operated between 1962 and 1977 with the potential to emit more than 250 tons per year of a visibility impairing pollutant. Each BART eligible unit must undergo an analysis to determine if new emission limits are appropriate to limit its impact on Class I areas. The BART requirements are intended to reduce emissions specifically from large sources that, due to age, were exempted from new source performance standards (NSPS) requirements of the Clean Air Act.

In June 2005, EPA adopted the final BART rule. The most recent revision to the BART rule became effective on October 5, 2006. The BART program requires states/tribes to develop an inventory of sources within each state or tribal jurisdiction that would be eligible for controls. The rule includes the following elements that:

- Outline methods to determine if a source is "reasonably anticipated to cause or contribute to haze"
- Defines the methodology for conducting BART control analysis
- Provides presumptive limits for electricity generating units (EGUs) larger than 750 Megawatts

Beyond the specific elements listed above, EPA provided the states with a great deal of flexibility in implementing the BART program. This section identifies the pollutants covered by BART, the Delaware sources that are BART-eligible, and describes how BART requirements are satisfied relative to each pollutant emitted by each of these sources.

8.1 Pollutants Covered by BART

Delaware has regulated sulfur dioxide (SO_2), nitrogen oxides (NOx) and primary particle emissions under BART. Delaware did not include either VOCs or ammonia as part of the BART determinations for the following reasons:

- "EPA's Draft PART 51—**Requirements For Preparation, Adoption, And Submittal of Implementation Plans** 1., Subpart I—Review of New Sources and Modifications , 51.166 Prevention of significant deterioration of air quality [states], "*Volatile organic compounds are presumed not to be precursors to $PM_{2.5}$ in any attainment or unclassifiable area, unless the State demonstrates to the Administrator's satisfaction that emissions of volatile organic*

compounds from stationary sources in a specific area are a significant contributor to that area's ambient $PM_{2.5}$ concentrations".

- Page 80 of the preamble, *"…In regard to ammonia, however, we believe there is sufficient uncertainty about emissions inventories and about the potential efficacy of control measures from location to location such that the most appropriate approach for proposal is a case-by-case approach…*"

- Page 83 of the Preamble, "*However, while significant progress has been made in understanding the role of gaseous organic material in the formation of organic PM, this relationship remains complex. We recognize that further research and technical tools are needed to better characterize emissions inventories for specific VOC compounds, and to determine the extent of the contribution of specific VOC compounds to organic PM mass. In light of the factors discussed above, EPA proposes that States are not required to address VOCs as $PM_{2.5}$ nonattainment plan precursors, unless the State or EPA makes a finding that VOCs significantly contribute to a $PM_{2.5}$ nonattainment problem in the State or to other downwind air quality concerns. In proposing this policy, we are mindful of the fact that a majority of areas that have been designated as nonattainment for $PM_{2.5}$ are already designated as nonattainment for the 8-hour ozone standard. Thus, these areas will already be required to evaluate VOC control measures for ozone purposes. (The inventory of VOC as defined here, including gaseous organic compounds, is essentially identical to the inventory of VOC for ozone control purposes.)"*

Delaware agrees with EPA's rationale above. Because of the lack of tools to estimate emissions and subsequently model VOC and ammonia, and because Delaware is aggressively addressing VOCs through our ozone SIPs, Delaware has determined that SO2, NOx and $PM_{10/2.5}$ are the only reasonable contributing visibility impairing pollutants to target under BART. This conclusion is consistent with discussions in the consultation process.

8.2 BART-Eligible Sources in Delaware

Delaware's BART-eligible sources were identified using the methodology in the Guidelines for Best Available Retrofit Technology (BART) Determinations under the Regional Haze Rule, 40 CFR Part 51.308. Delaware's BART-eligible sources are four (4) electric generating units (EGUs) and one (1) steel mill (Claymont Steel), and are described in Table 8-1. .

Table 8-1 BART-Eligible Sources in Delaware

Facility and Unit	MW	Pollutant	Location	I.D
NRG Indian River – Unit 3	177	SO_2, NO_x, PM	Millsboro	1000500001
City of Dover, McKee Run – Unit 3	114	SO_2, NO_x, PM	Dover	1000100002
Conectiv Edge Moor – Units 4 and 5	177, 446	SO_2, NO_x, PM	Wilmington	1000300007

Facility and Unit	MW	Pollutant	Location	I.D
Claymont Steel - EAF and Reheater	N/A	SO_2, NO_x, PM	Claymont	1000300063

8.3 Evraz Claymont Steel Cap-Out

One BART-eligible unit in Delaware, the Electric Arc Furnace (EAF) and Reheater at Evraz Claymont Steel, has actual emissions of visibility impairing pollutants of under 250 tons per year, and is BART-eligible only because their potential emissions (PTE) exceeds the statutory threshold of 250 tons per year. Pursuant to their request, DNREC has established federally enforceable permit conditions that limit these units PTE to less than the statutory threshold of 250 tons per year for all visibility impairing pollutants, which makes this unit not subject to BART requirements.

Federally enforceable terms and conditions were established in the Title V permit for the Reheat Furnace (RF) and Electric Arc Furnace (EAF) that limit the PTE for SO2, PM_{10} and NOx to less than 250 TPY. The regulatory authority for issuing Title V limits is provided in Delaware Regulation Nos. 1101 (Sections 3.1 & 3.2), 1102 (Sections 2 & 11), and 1130. The effective date of the permit is July 2, 2008. Copies of Delaware Regulation No. 1130 (i.e., Delaware's Title V Regulation) and Regulation 1102 are included at Appendices 8-3 and 8-4 of this SIP, respectively. Claymont Steel's Regulation No. 1130 (Title V permit) is included at Appendix 8-5 of this SIP.

Note that there is a provision in the permit which states: If, in the future, Claymont Steel requests an increase in PTE greater than 250 tons per year per visibility impairing pollutant, then they shall be subject to the Best Available Retrofit Technology (BART) provisions of the Environmental Protection Agency's (EPA) Regional Haze Program Requirements (40 Code of Federal Regulations, Part 51, Section 308).

8.4 BART Analysis

In accordance with 40 CFR 51.308(e)(2)(i)(A), Delaware has identified that there are four electric generating units (EGUs) in Delaware that are BART eligible sources (See Section 8.2 above). Each of these units has the potential to contribute to impairment of visibility in a Class I area. Each of these units are also EGUs regulated under Delaware Regulation 1146, EGU Multi-pollutant Regulation.

Regulation 1146 is a non-trading program/regulation that was established primarily as a measure to aid in the attainment of the ozone and fine particulate matter ambient air quality standards, and to reduce emissions of the neurotoxin mercury. Because Regulation No. 1146 provides for stringent regulation of NOX and SO_2, and because it is demonstrated as clearly superior to a unit-by-unit BART analysis, it is being included in this SIP as an alternative measure to BART for SO_2 and NOx under 40 CFR 51.308(e)(2)(i). How Regulation No. 1146 achieves greater reasonable progress than would have resulted from the installation and operation of BART at all

sources subject to BART in Delaware and covered by the alternative program is detailed in Section 8.4.1 below.

Particulate matter is not directly covered by Regulation No. 1146. Unit-by-unit BART determinations were conducted by the BART-eligible units for particulate matter, which is discussed in Section 8.4.2 below.

8.4.1. SO2 and NOx Alternative Measures to BART.

In early 2003, Delaware's Department of Natural Resources and Environmental Control (DNREC) began discussions with Delaware's large electric generating companies toward achieving significant reductions in power plant stack emissions. Those discussions included NOx, SO_2 and mercury reductions. It was DNREC's goal for this effort to evaluate a range of emission reduction options, assess the feasibility of the options, and develop a plan to implement feasible emissions reduction technologies. A number of meetings were held and considerable information was exchanged. However, a consensus regarding site-specific, technologically feasible, and cost effective emission reductions capabilities could not be reached. DNREC continued to evaluate industry development of cost effective, retrofit capable emission reduction controls applicable to electric generating unit (EGU) sources similar to those in Delaware, and in 2006 DNREC renewed its effort develop appropriate EGU emission control regulation.

In December 2006, Delaware promulgated Regulation 1146, Electric Generating Unit (EGU) Multi-Pollutant Regulation. Regulation 1146, in part, established nitrogen oxides (NOx) and sulfur dioxide (SO_2) emission limits for Delaware's coal-fired and residual oil-fired electric generating units (EGUs) with a nameplate rating of 25 MW or greater. Regulation 1146 was promulgated to assist Delaware in a number of environmental endeavors, including the attainment and maintenance of the National Ambient Air Quality Standards (NAAQS) for ozone and fine particulate matter ($PM_{2.5}$) and to assist Delaware in achieving the emissions reductions needed to support Delaware's 8-hour ozone Reasonable Further Progress Plan (RFP).

The population of Delaware's EGUs affected by Regulation 1146 is in Table 8-2

Table 8-2 Delaware's EGUs affected by Regulation 1146

Facility	Unit	Nameplate (MW)	Initial Year of Operation	Primary Fuel	Firing Configuration	Heat Input Rating (MMBTU/hr)
Edge Moor	3	75	1954	Bit. Coal	Tangential - DB	1117
Edge Moor	4	177	1966	Bit. Coal	Tangential - DB	1867
Edge Moor	5	446	1973	Oil/Gas	Opposed Wall	4695
Indian River	1	82	1957	Bit. Coal	Wall - DB	1090
Indian River	2	82	1959	Bit. Coal	Wall - DB	1186
Indian River	3	177	1970	Bit. Coal	Wall - DB	1904
Indian River	4	442	1980	Bit. Coal	Turbo - DB	5091
McKee Run	3	114	1975	Oil/Gas	Wall	1180

None of the above EGU's can be viewed as base load units. The oil-fired units tend to operate as peaking units with annual capacity factors (on a heat input basis) typically in the range of 8% to 15%. The coal fired units typically operate in a load following mode, increasing output with increasing daily demand and operating at minimum load or hot-shutdown during daily times of low demand. Weekend shutdowns of these units are routine. Typical annual capacity factors for these units range from 40% to 65% (on a heat input basis).

In order to determine appropriate NOx and SO_2 emission rates for inclusion in Regulation 1146, DNREC collected guidance and information from a number of sources to assist in its evaluation of appropriate emissions limits to incorporate in Regulation 1146. DNREC held public workshops to solicit input from the general public, industry trade organizations, vendor inputs, environmental groups, and the potentially regulated sources. DNREC reviewed actual operating emission rate data for controlled units in the EPA's Acid Rain Database and operating and environmental data from the Energy Information Administration databases. DNREC reviewed reports and control capability information from the EPA, the Institute for Clean Air Companies, emission control vendors, industry publications and other publicly available information sources. Further, DNREC reviewed site-specific analysis performed and submitted by the facilities that would be affected by Regulation 1146, including control technology applicability, installation feasibility, operational impact, productivity impact, and estimated capital and operating costs. (See "Technical Support Document for Proposed Regulation No. 1146 Electric Generating Unit (EGU) Multi-Pollutant Regulation" for additional discussion in Appendix 8-6)

In its evaluation, DNREC concluded that it was technically feasible to incorporate emission rates into Regulation 1146 that would reflect the emission control capabilities of flue gas desulfurization (FGD) and selective catalytic reduction (SCR) for the affected coal-fired units and 0.5% sulfur fuel oil (for SO_2 control) and SCR for the residual oil-fired units. Because of the complexity of the retrofits at the sites, DNREC estimated a range of capital cost for installation at the facilities to total from $520,000,000 to $755,000,000 (1999 dollars). However, DNREC also evaluated emission rates attainable with alternative technologies that have been proven effective in industry, were commercially available, and offered significant reduction in capital requirements for the emissions sources. DNREC determined that the best available, cost effective emissions control retrofit technologies for this fleet of units was installation of duct sorbent injection for SO_2 at the coal fired units, low sulfur fuel oil (0.5% sulfur in fuel) for the SO_2 control at the residual oil-fired units, and SNCR with low-NOx burners and overfire air (where technologically feasible) for the coal and residual oil-fired units. DNREC estimated a range of capital costs for such installations as $100,000,000 to $175,000,000 (1999 dollars).

Of significant impact to DNREC's evaluation was the fact that the affected units were relatively small EGUs, had small and complex footprints complicating large retrofit installation of SCRs and FGDs, and had long histories of cyclic operation and low capacity factors which would adversely affect the operational effectiveness of SCR and FGD. DNREC's analysis indicated that for SO_2 control, the more costly technologies (FGD) would only increase the SO_2 removal to 85% (from baseline year, 2002) from the 79% (from baseline year, 2002) estimated for the selected suite (which included duct sorbent injection) of emission control technologies. This value represents an estimated additional annual SO_2 reduction of only 2,557 tons. Likewise for comparing the NOx control technologies, the more expensive controls (including SCR) resulted

in a reduction of 71% (from baseline year, 2002) while the chosen suite of technologies (including layered combustion controls and/or SNCR) was estimated to achieve a 63% reduction from baseline year (2002). This value represented an estimated additional annual NOx reduction of only 799 tons.

The above emissions estimates translate to relatively high estimated incremental costs of pollutant reductions between the emissions control suite strategies; approximately $11,000 per incremental ton of SO_2 removed and $10,000 per incremental ton of NOx removed. The relatively small improvements in emissions reductions (2,557 annual tons of SO_2 and 799 annual tons of NOX) combined with the relatively high incremental cost to achieve the pollutant reductions were not judged to be highly cost effective at this time based on the significantly higher estimated capital cost required to meet the more stringent emission rates represented by SCR and FGD.

It should be kept in mind that prior to the development of Regulation 1146, these Delaware EGU's were already subject to regulations that served to require SO_2 and NOx emissions reductions. All of the subject units had federally enforceable operating permit restrictions for sulfur in fuel limits (1.0% sulfur for the oil fired units, 1.0% sulfur in coal for the Edge Moor coal-fired units, and Indian River unit's sulfur in coal limits ranging from 1.0% to 1.6% depending upon the unit). All of the units had also previously installed NOx controls (LNB's on all units and overfire air on most) and incorporated proper operation of the controls in their operating permits in accordance with Delaware's NOx RACT regulations and to assist in compliance with the NOx SIP Call.

Based upon this information, and factoring in the size, age, site configuration, fuel burning capabilities, current and historic operating scenarios, and other site-specific information, DNREC promulgated the following emission rate limitations in Regulation 1146:

	2009	**2012**
NOx - Coal & Residual Oil Fired EGU's > 25 MW	0.15 lb/MMBTU	0.125 b/MMBTU
SO_2 – Coal Fired EGU's > 25 MW	0.37 lb/MMBTU	0.26 lb/MMBTU
SO_2 – Residual Oil Fired EGU's > 25 MW	0.5% Sulfur Fuel Oil	0.5% Sulfur Fuel Oil

For the above rate limits, all lb/MMBTU limits are continuous and based on a rolling 24-hour averaging period, beginning on May 1, 2009. For the sulfur in fuel oil limits, facilities are not permitted to accept fuel oil with a sulfur content greater than 0.5% by weight on or after January 1, 2009. Emission rates are required by Regulation 1146 to be monitored and reported in accordance with the requirements of 40 CFR Part 75. Sulfur-in-fuel-oil compliance is monitored through sampling and analysis of delivered fuel. These limits and monitoring requirements are federally enforceable in the facilities' Regulation No. 1130 (Title V) operating permits. These regulatory emissions limitations of Regulation 1146 meet the requirements of 40 CFR 51.308(e)(2)(i)(B). The compliance date requirements of Regulation 1146 ensure that reductions take place much earlier to the period of the first long term strategy for regional haze, meeting the requirements of 40 CFR 51.308(e)(2)(iii).

Delaware's Regulation 1146 incorporated the above emissions rate limitations based on a suite of emissions reduction technology capabilities, but did not specify or require the installation of

any particular emission reduction technology or suite of technologies. Affected sources were free to select among available emission control technologies, fuel-switching, operational practices, or any combination of these or other methodologies to meet the regulatory emissions reduction requirements for the particular source in a fashion that best fits the needs of the particular source. Appropriate provisions will be included as federally enforceable provisions in each subject facility's operating permit.

Delaware considers the above SO_2 and NOx emissions rate limits/controls as representative of an alternative program to the best available retrofit technology for the coal-fired and residual oil-fired EGU's affected by Regulation1146, which includes all of Delaware's BART eligible units. As described above, this position is based on control technology's effectiveness, capital costs, complexity with regards to application on cycling units, changes in plant auxiliary loads (and therefore plant efficiency), impact on plant operations and flexibility, O&M costs, size of the affected units, and expected remaining operating life of the affected units. The development of the emissions limitation requirements of Regulation 1146 meets the requirements of 40 CFR 51.308(e)(2)(i)(C).

Because of the evaluation process DNREC utilized in developing the NOx and SO_2 emission rate limits in the development of Regulation 1146, it is Delaware's position that those limits also represent alternative to BART for the purposes of 40 CFR Part 51.308(e)(2) for Delaware's BART eligible sources. 40 CFR Part 51.308(e)(2) provides that, a State may opt to implement or require participation in an emissions trading program or other alternative measure rather than to require sources subject to BART to install, operate, and maintain BART. Such an emissions trading program or other alternative measure must achieve greater reasonable progress than would be achieved through the installation and operation of BART.

Of the eight units subject to Delaware's Regulation 1146, four of those units have also been identified as BART eligible units. The Delaware BART eligible EGU sources are identified in table 8-3. This fulfills the requirements of 40 CFR Part 51.308(e)(2)(i)(A) and (B), as it includes a list of all all BART-eligible sources and all BART source categories covered by the alternative program.

Table 8-3 Delaware BART eligible sources - EGUs

Facility	BART Eligible Unit	Nameplate (MW)	Initial Year of Operation	Primary Fuel	Heat Input Rating (MMBTU/hr)
Edge Moor	4	177	1966	Bit. Coal	1867
Edge Moor	5	446	1973	Oil/Gas	4695
Indian River	3	177	1970	Bit. Coal	1904
McKee Run	3	114	1975	Oil/Gas	1180

As discussed earlier, the Delaware Regulation 1146 requires significant NOx and SO_2 emissions reductions from a total of eight large coal and residual oil-fired EGU's. Delaware's BART eligible units are a subset of four of the eight units. A comparison of the Regulation 1146 emission rate limits and the BART "presumptive" limits (as discussed in Appendix Y of 40 CFR Part 51 – Guidelines for BART Determinations Under the Regional Haze Rule) for Delaware's

BART eligible units is provided in Table 8-4. Note that 40 CFR Part 51.308(e)(2)(i)(C) provides that continuous emission control technology and associated emission reductions for similar types of sources within a source category based on both source-specific and category-wide information, as appropriate may be used in this analysis.

Table 8-4 Emission Rate Limits and the BART "Presumptive" Limits

Facility	Unit	2012 Reg 1146 SO2 Rate Limit	2015 BART Presumptive SO2 Rate	2012 Reg 1146 NOx Rate Limit	2015 BART Presumtive NOx Rate
Edge Moor	4	0.26 lb/MMBTU	0.15 lb/MMBTU	0.125 lb/MMBTU	0.28 lb/MMBTU
Edge Moor	5	0.5% Sulfur F.O	1.0% Sulfur F.O.	0.125 lb/MMBTU	Exist (0.29 lb/MMBTU)
Indian River	3	0.26 lb/MBTU	0.15 lb/MMBTU	0.125 lb/MMBTU	0.39 lb/MMBTU
McKee Run	4	0.5% Sulfur F.O.	1.0% Sulfur F.O.	0.125 lb/MMBTU	Exist (0.32 lb/MMBTU)

From the above table it would appear that, on a unit specific basis, there are some instances where Delaware's Regulation 1146 provides more stringent emission rate requirements than the presumptive BART limits, and there are some instances where the BART presumptive limits are more stringent than the Regulation 1146 limits. However, from this fleet of Delaware BART eligible units, and based on unit specific baseline year (2002) heat input levels, the Regulation 1146 emission limits result in significantly reduced annual SO_2 and NOx mass emissions relative to application of the BART presumptive limits, as shown in Table 8-5.

Table 8-5 Annual SO_2 and NOx Mass Emissions Relative to Application of the BART Presumptive Limits

Facility	Unit	2012 Reg 1146 SO2 (tons)	2012 Reg 1146 NOx (tons)	Presumptive BART Only SO2 (tons)	Presumptive BART Only NOx (NOx)
Edge Moor	4	1262	607	728	1359
Edge Moor	5	1774	443	3547	1289
Indian River	3	561	270	324	841
McKee Run	3	480	120	960	345
	Total	4076	1440	5558	3834

Additionally, Delaware's Regulation 1146 provides emission rate limits for four coal-fired units in addition to the above Delaware BART eligible units. Because the Regulation 1146 emissions rate limits are applicable to a fleet of units larger than the Delaware BART eligible units, the total emissions reductions achieved by Regulation 1146 greatly exceed that which would be achieved through application of presumptive BART emission rate limits on BART eligible units only. Table 8-6 provides a comparison of SO_2 and NOx emissions from the fleet of units subject to Regulation 1146 for actual baseline year (2002), estimated emissions using the actual baseline year (2002) heat inputs and Regulation 1146 emission rate limits, and estimated emissions using the actual baseline year (2002) heat inputs and presumptive BART limits where applicable:

Table 8-6 Comparison of SO_2 and NOx Emissions - Regulation 1146 vs. BART Presumptive Limits

FACILITY	UNIT	Actual 2002 SO2 MASS	Actual 2002 NOX MASS	2012 Reg 1146 SO2	2012 Reg 1146 NOx	Presumptive BART Only SO2	Presumptive BART Only NOx
Edge Moor	3	3344	922	860	414	3344	922
Edge Moor	4	5051	1096	1262	607	728	1359
Edge Moor	5	2132	1289	1774	443	3547	1289
Indian River	1	3950	707	462	222	3950	707
Indian River	2	3833	641	464	223	3833	641
Indian River	3	4682	664	561	270	324	841
Indian River	4	7491	2479	1930	928	7491	2479
McKee Run	3	700	345	480	120	960	345
	Total	31183	8143	7792	3226	24176	8583

Table 8-6 demonstrates the NOx and SO_2 emissions reductions associated with Regulation 1146, meeting the requirements of 40 CFR 51.308(e)(2)(i)(D), and also demonstrates, meeting the requirements of 40 CFR 51.308(e)(2)(i)(E) that Regulation 1146 achieves greater emissions reductions than achieved strictly by BART implementation at Delaware's BART eligible sources. As the emission reductions achieved by Regulation 1146 are relative to Delaware's baseline year (2002), the data in the above table meets the requirements of 40 CFR 51.308(e)(2)(iv).

If the data in Table 8-6 is revised to reflect the emissions on a facility basis, rather than on a unit basis, it can be seen that Delaware's Regulation 1146 also results in facility emissions that are far less than the emissions from that facility under a presumptive BART only scenario. Table 8-7 reflects this per facility emissions scenario.

Table 8-7 Facility Emissions Scenario

FACILITY	2002 SO2 MASS	2002 NOX MASS	2002 HEAT INPUT	2012 Reg 1146 SO2	2012 Reg 1146 NOx	Presumptive BART Only SO2	Presumptive BART Only NOx
Edge Moor	10527	3307	23417336	3896	1464	7619	3570
Indian River	19956	4491	26280546	3416	1643	15598	4668
McKee Run	700	345	1919684	480	120	960	345

Based upon comparison with actual baseline year (2002) emissions and unit capacities, it is clear that the emission rate limits of Delaware's Regulation 1146 achieves greater annual SO2 and NOx emissions than would be achieved only through application of presumptive BART emissions limits on Delaware's BART eligible EGU sources. Further, application of the Delaware Regulation 1146 SO2 and NOx emission rate limits to the larger fleet of EGUs subject to Regulation 1146 (but not BART eligible) results in total emissions reduction significantly greater than those that would be achieved by presumptive BART alone. The requirements of Regulation 1146 do not result in a substantial difference in distribution of emissions relative to BART only for Delaware's BART-eligible EGU sources, meeting the requirements of 40 CFR 51.308(e)(3). In fact, there is no difference in the distribution of emissions as, like BART, the

requirements of Regulation 1146 apply on a unit-by-unit basis (i.e., no trading). Regulation 1146 also requires the more stringent emissions limitation three years earlier than emissions limitations determined by BART.

The analysis, development, and implementation of Delaware's Regulation 1146, in conjunction with the above emissions calculations, provide a demonstration that the requirements of Regulation 1146 achieve greater reasonable progress than would have resulted from the installation and operation of BART at all EGU sources subject to BART in Delaware, as discussed in 40 CFR 51.308(e)(2). As demonstrated above, the requirements of Regulation 1146 also fulfill the requirements of 40 CFR 51.308.(e)(3); "*A state which opts under 40 CFR 51.*308(e)(2) to implement an emissions trading program or other alternative measure rather than to require sources subject to BART to install, operate, and maintain BART may satisfy the final step of the demonstration required by that section as follows: If the distribution of emissions is not substantially different than under BART, and the alternative measure results in greater emissions reductions, then the alternative measure may be deemed to achieve greater reasonable progress."

Delaware's BART-eligible sources will be subject to the requirements of paragraph 40 CFR Part 51.308(d) in the same manner as other sources.

8.4.2 BART Requirements for Particulate Matter (PM)

Section 8.4.1 of this SIP demonstrated that the Multi-Pollution Regulation 1146 meets the requirements of an alternative BART measure for SO_2 and NOx. This section discusses BART for PM. Delaware's BART-eligible sources conducted a 5-factor analysis in accordance with 40 CFR Part 51 308 (e)(1)(ii). Copies of the letters requesting those facilities to conduct the Determinations are included in Appendix 8-1. A detailed description of each unit, modeling protocol and their BART engineering determinations are in Appendix 8-2. As a result of Federal Land Manager (FLM) comments, addendums were sent to DNREC which updated the analysis. They are also in Appendix 8-2.

8.4.2.1 Primary Particulate Control Technology

Primary particulate matter (PM) emissions from coal-fired and oil-fired electric utility boilers consists primarily of fly ash. Fly ash from coal-fired boilers is the unburned carbon char and the mineral portion of combusted coal. Fly ash from oil-fired boilers also typically consists of unburned carbon char and the mineral portion of the fuel oil. The amount of ash in the fuel, which ultimately exits the boiler unit as fly ash, is a complex function of the fuel properties, furnace-firing configuration, and boiler operation.

For the dry-bottom, pulverized coal-fired boilers, approximately 80 percent of the total ash exits as fly ash. Wet-bottom, pulverized-coal-fired boilers emit significantly less fly ash. On the order of 50 percent of the total ash exits the boiler as fly ash. In a cyclone furnace boiler, most of the ash is retained as liquid slag; thus, the quantity of fly ash exiting the boiler is typically 20 to 30 percent of the total ash. However, the high operating temperatures unique to these designs

may also promote ash vaporization and larger fractions of submicron fly ash compared to dry bottom designs. Fluidized-bed combustors emit high levels of fly ash since the coal is fired in suspension and the ash is present in dry form. Spreader-stoker-fired boilers can also emit high levels of fly ash. However, overfeed and underfeed stokers emit less fly ash than spreader stokers, since combustion takes place in a relatively quiescent fuel bed.

In addition to the fly ash, PM emissions from coal-fired and oil-fired EGUs result from reactions of the SO_2 and NO_x compounds as well as unburned carbon particles carried in the flue gas from the boiler. The SO_2 and NO_x compounds are initially in the vapor phase following coal combustion in the furnace chamber but can partially chemically transform in the stack, or near plume, to form fine PM in the form of nitrates, sulfur trioxide (SO_3), and sulfates. Firing configuration and boiler operation can affect the fraction of carbon (from unburned fuel) contained in the fly ash.

In general, the high combustion efficiencies achieved by pulverized coal-fired boilers and cyclone-fired boilers result in relatively small amounts of unburned carbon particles in the exiting combustion gases. Those pulverized-coal-fired electric utility boilers that use special burners for NO_x control tend to burn coal less completely; consequently, these furnaces tend to emit a higher fraction of unburned carbon in the combustion gases exiting the furnace. Similar issues exist for residual oil-fired boilers.

PM control technologies include electrostatic precipitators (ESPs), fabric filters (FFs) (also called baghouses.), and particulate scrubbers (PS). These technologies typically achieve greater than 95 percent removal of total particulate mass with over 80 percent removal of PM smaller than 0.3 um (with the exception of particulate scrubbers which achieve only 30-85 percent removal for this smaller size fraction). Mechanical collectors have even lower trapping efficiencies. PM controls are in place on virtually all EGUs already, including all of the Delaware BART EGU units; hence the issue that will be faced in conducting BART determinations is how these existing controls will interface with proposed controls for other pollutants.

Nationally, electrostatic precipitators are the predominant control type used on coal-fired electric utility boilers both in terms of number of units (84 percent) and total generating capacity (87 percent). Some oil-fired boilers also utilized ESPs. The second most common control device type used is a fabric filter. Fabric filters are used on about 14 percent of the coal-fired electric utility boilers. Particle scrubbers are used on approximately three percent of the boilers. The least used control device type is a mechanical collector. Less than one percent of the coal-fired electric utility boilers use this type of control device as the sole PM control. Other boilers equipped with a mechanical collector use this control device in combination with one of the other PM control device types.

Electrostatic Precipitators

Electrostatic precipitator (ESP) control devices have been used to control PM emissions from power plants since the early 1920's. These devices can be designed to achieve high PM collection efficiencies (greater than 99 percent). An ESP operates by imparting an electrical

charge to incoming particles, and then attracting the particles to oppositely charged metal plates for collection. Periodically, the particles collected on the plates are dislodged in sheets or agglomerates (by rapping the plates) and fall into a collection hopper. The dust collected in the ESP hopper must be removed and may be treated as a solid waste or, in some instances, used for beneficial purposed such as use in cement manufacture.

The effectiveness of particle capture in an ESP depends largely on the electrical resistance of the particles being collected. An optimum value exists for a given ash. Above and below this value, particles become less effectively charged and collected. Coal that contains a moderate to high amount of sulfur (more than approximately three percent) produces an easily collected fly ash. Low-sulfur coal produces a high-resistivity fly ash that is more difficult to collect. Resistivity of the fly ash can be changed by operating the boiler at a different temperature or by conditioning the particles upstream of the ESP with sulfur trioxide, sulfuric acid, water, sodium, or ammonia. In addition, collection efficiency is not uniform for all particle sizes. For coal fly ash, particles larger than about 1 to 8 µm and smaller than about 0.3 µm (as opposed to total PM) are typically collected with efficiencies from 95 to 99.9 percent. Particles near the 0.3 µm size are in a poor charging region that reduces collection efficiency to 80 to 95 percent.

An ESP can be used at one of two locations in a coal-fired electric utility boiler system. For many years, every ESP was installed downstream of the air heater where the temperature of the flue gas is between 130 and 180 °C (270 and 350 °F). An ESP installed at this location is referred is as a "cold-side" ESP. However, to meet SO2 emission requirements, many electric utilities switched to burning low-sulfur coal. These coals have higher electrical ash resistivity, making the fly ash more difficult to capture in an ESP downstream of the air heater. Therefore, to take advantage of the lower fly-ash resistivity at higher temperatures, some ESPs are installed upstream of the air heater, where the temperature of the flue gas is in the range of 315 to 400 °C (600 to 750 °F). An ESP installed upstream of the air heater is referred to as a "hot-side" ESP.

Fabric Filters

Fabric filters (FF) have been used for fly ash control from coal-fired electric utility boilers since the 1970s. This type of control device collects fly ash in the combustion gas stream by passing the gases through a porous fabric material. The buildup of solid particles on the fabric surface forms a thin, porous layer of solids or a filter cake, which further acts as a filtration medium. Gases pass through this cake/fabric filter, but the fly ash is trapped on the cake surface. The fabric material used is typically fabricated in the shape of long, cylindrical bags. Hence, fabric filters also are frequently referred to as "baghouses."

Gas flow through a FF becomes excessively restricted if the filter cake on the bags becomes too thick. Therefore, the dust collected on the bags must be removed periodically. The type of mechanism used to remove the filter cake classifies FF design types. Depending on the FF design type, the dust particles will be collected either on the inside or outside of the bag. For designs in which the dust is collected on the inside of the bags, the dust is removed by either mechanically shaking the bag (called a "shaker type" FF) or by blowing air through the bag from the opposite side (called a "reverse-air" FF). An alternate design mounts the bags over internal frame structures, called "cages" to allow collection of the dust on the outside of the bags. A

pulsed jet of compressed air is used to cause a sudden stretching, then contraction, of the bag fabric dislodging the filter cake from the bag. This design is referred to as a "pulse-jet" FF. The dislodged dust particles fall into a hopper at the bottom of the baghouse. The dust collected in the hopper is a solid waste that must be must be removed and may be treated as a solid waste or, in some instances, used for beneficial purposed such as use in cement manufacture.

An FF must be designed and operated carefully to ensure that the bags inside the collector are not damaged or destroyed by adverse operating conditions. The fabric material must be compatible with the gas stream temperatures and chemical composition. Because of the temperature limitations of the available bag fabrics, location of an FF for use in a coal-fired electric utility boiler is restricted to downstream of the air heater. In general, fabric filtration is the best commercially available PM control technology for high-efficiency collection of small particles.

Electrostatic stimulation of fabric filtration (ESFF) involves a modified fabric filter that uses electrostatic charging of incoming dust particles to increase collection efficiency and reduce pressure drop compared to fabric filters without charging. Filter bags are specially made to include wires or conductive threads, which produce an electrical field parallel to the fabric surface. Conductors can also be placed as a single wire in the center of the bag. When the bags are mounted in the baghouse, the conductors are attached to a wiring harness that supplies electricity. As particles enter the field and are charged, they form a porous mass or cake of agglomerates at the fabric surface. Greater porosity of the cake reduces pressure drop, while the agglomeration increases efficiency of small particle collection. Cleaning is required less frequently, resulting in longer bag life. For felted or nonwoven bags, the field promotes collection on the outer surface of the fabric, which also promotes longer bag life. Filtration velocity can be increased so that less fabric area is required in the baghouse. The amount of reduction is based on an economic balance among desired performance, capital cost, and operating costs. A number of variations exist on the ESFF idea of combining particle charging with fabric filtration.

Particle Scrubbers and Mechanical Collectors

Particle scrubbers are generally much less efficient than ESPs and baghouses (especially in collecting finer fraction of PM). To achieve high collection efficiencies these devices will typically require relatively large amounts of water consumption and fan energy in the form of high pressure drops across the device. These devices are not largely used for particulate collection on EGUs.

Mechanical collectors have the least collection efficiency and are hardly used in the industry for modern coal-fired EGUs. However, mechanical collectors are frequently found on residual oil-fired EGUs. These devices remove particulate from the flue gas by centrifugal, inertial, and gravitational forces developed in a vortex separator, or grouping of vortex separators, sometimes referred to as cyclone separators or multi-cyclone separators. Because these collectors primarily rely on differential inertia, collection efficiencies vary with particle size, density, gas temperature, and pressure drop through the apparatus. Efficiencies are very high on material greater than 20 microns in size, but drop off rapidly as the particle sizes drop.

8.4.2.2 Five Factor Analysis for Each BART Source

States are required to determine BART for each BART-eligible source. According to 40 CFR 51.308(e)(1)(ii)(A) the determination of BART must be based on an analysis of the best system of continuous emission control technology available and associated emission reductions achievable. 40 CFR 51.308(e)(1)(ii)(A) requires the analysis to take into consideration the following five factors for the technology available :

1) The costs of compliance,
2) The energy and non-air quality environmental impacts of compliance, any
3) Pollution control equipment in use at the source,
4) The remaining useful life of the source, and
5) The degree of improvement in visibility which may reasonably be anticipated to result from use of the technology.

The facilities subject to BART were asked by DNREC to conduct BART determinations using the 5-Factor Analysis, for PM only. Consistent with the MANE-VU Board (June, 2004) decision, this analysis would include consideration of potential visibility impacts as a result of installing various controls for primary particulate matter.

The remainder of this Section provides a brief description of each unit, a summary of each facility's engineering analysis, and DNRECs determination of BART. Further details can be found in facility reports, in Appendix 8-2.

8.4.2.3 City of Dover McKee Run

McKee Run Unit 3 is a 102 MW Riley Stoker boiler fired on No. 6 fuel oil with natural gas used as a back-up fuel. The boiler is equipped with a mechanical multi-cyclone which is used as a control device for particulate matter. Flue gas is directed through the cyclone where particulate is removed from the gas stream and collected in a hopper. The waste ash that is collected is then injected back into the boiler to complete combustion of the unburned char portion of the fly ash. The boiler is equipped with low NOx burners and fan boost over-fire air to control NOx emissions. The sulfur content of the No. 6 fuel oil is limited to no greater 1.0 percent, which restricts SO_2 and particulate matter emissions. The boiler exhausts through a stack 200 feet tall. The boiler produces steam to power a 102 MW electric generator.

The City of Dover provided a "five factor analysis" pursuant to the requirements of 40 CFR 51.308(e)(1)(ii)(A). In summary:

> Cost. Table 8-8 is a summary table from City of Dover showing their cost analysis of available control technologies. More details are provided in their report.

Energy and non-air environmental impacts. McKee Run did not include energy and non-air environmental impacts, as no control technology was ruled out based on this criteria.

Existing controls at source. Mechanical Cyclone and 1.0% limit on sulfur in the fuel burned.

Remaining useful life of source. An emission unit's "remaining useful life" may be considered a part of the overall cost analysis if the remaining useful life is less than the time period used for amortizing costs. In such a case, the shorter time period should be used in the cost calculations. McKee Run did not use remaining useful life to adjust the amortization period for any of the cost calculations.

Visibility improvement reasonably expected from the technology. Table 8-9 is a summary table showing the visibility improvement on the highest impact day that would occur for each of the potential BART control technologies.

Table 8-8 Summary of Economic Impact Analysis for PM_{10} Controls at Boiler 3

Control Technology	***Projected Emission Rate (tons/yr)***	***Emissions Performance Level***	***Expected Emissions Reductions (tons/yr)***	***Costs of Compliance***
Switch from 1% S No. 6 Fuel Oil to Natural Gas	328.2	89%	292.8	Total Annualized Cost: $19,027,596 Average Cost Effectiveness: $64,986/ton Cost Effectiveness per dV: $243,943,538/dV Incremental Cost: Not calculated due to the high annual cost of the fuel switching option to No. 2 FO.
Switch from 1% S No. 6 Fuel Oil to 0.3% S No. 2 Fuel Oil	328.2	66%	216.1	Total Annualized Cost: $57,082,788 Average Cost Effectiveness: $264,137/ton Cost Effectiveness per dV: $1,001,452,421/dV Incremental Cost: $190,906/incremental ton (No. 6 FO to No. 2 FO vs. No. 6 FO to No. 4 FO)
Use Add-On Control of a Wet ESP	328.2	43%	141.1	Total Annualized Cost: $1,915,511 Average Cost Effectiveness: $13,573/ton Cost Effectiveness per dV: $47,887,775/dV Incremental Cost: Lowest annualized cost therefore no incremental cost analysis conducted.

Control Technology	*Projected Emission Rate (tons/yr)*	*Emissions Performance Level*	*Expected Emissions Reductions (tons/yr)*	*Costs of Compliance*
Switch from 1% S No. 6 Fuel Oil to 0.3% S No. 4 Fuel Oil	328.2	35%	116.4	Total Annualized Cost: $38,055,192 Average Cost Effectiveness: $326,821/ton Cost Effectiveness per dV: $731,830,615/dV Incremental Cost: $2,918,484/incremental ton (No. 6 FO to No. 4 FO vs. No. 6 FO 1% to No. 6 FO 0.5%)
Switch from 1% S No. 6 Fuel Oil to 0.5% S No. 6 Fuel Oil	328.2	32%	106.7	Total Annualized Cost: $9,513,798 Average Cost Effectiveness: $89,197/ton Cost Effectiveness per dV: $221,251,116/dV

Table 8-9 Summary of BART Analysis City of Dover Unit 3

VIP	***Step 1 – Identify Control Technologies***	***Step 2 – Identify Technically Feasible Control Technologies***	***Step 3 – Evaluate Control Effectiveness for Technically Feasible Control Technologies***	***Step 4.1 – Calculate Cost Effectiveness for Control Technologies***	***Steps 4.2 and 4.3 – Determine Energy, Other Non-Air Quality Environmental Impacts, and Remaining Useful Life***	***Step 5 – Evaluate Visibility Impacts of Control Technologies***	***Identify BART Control***
Boiler 3 (Emission Unit 3)							
PM_{10}							
	Switch from 1% S No. 6 Fuel Oil to Natural Gas	Yes	89%	Total Annualized Cost: $19,027,596 Average Cost Effectiveness: $64,986/ton Cost Effectiveness per dV: $243,943,538/dV Incremental Cost: Not calculated due to the high annual cost of the fuel switching option to No. 2 FO.	N/A	Highest Average 98th Percentile Impact Improvement of only 0.08 dV in Brigantine.	Fuel switching is not a cost effective BART control option for PM_{10}. BART not justified as visibility improvement of only 0.08 dV occurs.
	Switch from 1% S No. 6 Fuel Oil to 0.3% S No. 2 Fuel Oil	Yes	66%	Total Annualized Cost: $57,082,788 Average Cost Effectiveness: $264,137/ton Cost Effectiveness per dV: $1,001,452,421/dV Incremental Cost: $190,906/incremental ton (No. 6 FO to No. 2 FO vs. No. 6 FO to No. 4 FO)	N/A	Highest Average 98th Percentile Impact Improvement of only 0.06 dV in Brigantine.	Fuel switching is not a cost effective BART control option for PM_{10}. BART not justified as visibility improvement of only 0.06 dV occurs.
	Use Add-On Control of a Wet ESP	Yes	43%	Total Annualized Cost: $1,915,511 Average Cost Effectiveness: $13,573/ton Cost Effectiveness per dV: $47,887,775/dV Incremental Cost: Lowest annualized cost therefore no incremental cost analysis conducted.	1) Energy demand due to ESP and 2) Disposal and handling of collected slurry from wet ESP.	Highest Average 98th Percentile Impact Improvement of only 0.04 dV in Brigantine.	The use of add-on control of a wet ESP is not a cost effective BART control option for PM_{10}. BART not justified as visibility improvement of only 0.04 dV occurs.

Table 8-9 Summary of BART Analysis City of Dover Unit 3

VIP	***Step 1 – Identify Control Technologies***	***Step 2 – Identify Technically Feasible Control Technologies***	***Step 3 – Evaluate Control Effectiveness for Technically Feasible Control Technologies***	***Step 4.1 – Calculate Cost Effectiveness for Control Technologies***	***Steps 4.2 and 4.3 – Determine Energy, Other Non-Air Quality Environmental Impacts, and Remaining Useful Life***	***Step 5 – Evaluate Visibility Impacts of Control Technologies***	***Identify BART Control***
	Switch from 1% S No. 6 Fuel Oil to 0.3% S No. 4 Fuel Oil	Yes	35%	Total Annualized Cost: $38,055,192 Average Cost Effectiveness: $326,821/ton Cost Effectiveness per dV: $731,830,615/dV Incremental Cost: $2,918,484/incremental ton (No. 6 FO to No. 4 FO vs. No. 6 FO 1% to No. 6 FO 0.5%)	N/A	Highest Average 98th Percentile Impact Improvement of only 0.05 dV in Brigantine.	Fuel switching is not a cost effective BART control option for PM_{10}. BART not justified as visibility improvement of only 0.05 dV occurs.
	Switch from 1% S No. 6 Fuel Oil to 0.5% S No. 6 Fuel Oil	Yes	32%	Total Annualized Cost: $9,513,798 Average Cost Effectiveness: $89,197/ton Cost Effectiveness per dV: $221,251,116/dV	N/A	Highest Average 98th Percentile Impact Improvement of only 0.04 dV in Brigantine.	Fuel switching is not a cost effective BART control option for PM_{10}. BART not justified as visibility improvement of only 0.04 dV occurs. However, this improvement will occur as a result of Delaware's Multi-Pollutant regulation.
	Use Add-On Control of Dry ESP	Yes – However, not analyzed since fuel switching options alone resulted in greater control of PM_{10}.	N/A	N/A	High energy demand due to multiple field ESP.	N/A	Not analyzed since fuel switching options alone resulted in greater control of PM_{10}.

Table 8-9 Summary of BART Analysis City of Dover Unit 3

VIP	*Step 1 – Identify Control Technologies*	*Step 2 – Identify Technically Feasible Control Technologies*	*Step 3 – Evaluate Control Effectiveness for Technically Feasible Control Technologies*	*Step 4.1 – Calculate Cost Effectiveness for Control Technologies*	*Steps 4.2 and 4.3 – Determine Energy, Other Non-Air Quality Environmental Impacts, and Remaining Useful Life*	*Step 5 – Evaluate Visibility Impacts of Control Technologies*	*Identify BART Control*
	Use Add-On Control of Baghouse	No	N/A	N/A	N/A	N/A	Not analyzed due to technical difficulty expressed by control technology vendors.

The Department has reviewed the BART analysis performed by the City of Dover. Based on this review, DNREC is establishing 0.5 % sulfur as BART for City of Dover – Unit 3. AP-42 states that sulfur content in residual fuel is directly proportional to particle emissions. [21] Therefore, reducing sulfur content by half reduces PM by half. Evaluation of all of the five (5) factors shows that a sulfur limit of 0.5 % is BART for the following reasons:

- Residual fuel with a sulfur content of 0.5 percent is cost-effective for purposes of improving visibility at Class I areas.[22]
- No significant energy or non-air quality environmental benefits or dis-benefits associated with using lower sulfur fuel were identified.
- 0.5% sulfur fuel will reduce PM emissions by approximately 50%
- Since the remaining useful life of the unit is expected to be greater than the life of the control options, no weight was given to the remaining useful life parameter.
- Although there are small visibility incremental benefits that could be reasonably anticipated as a result of installation of other control options (<0.1 dv on the worst day impact), DNREC believes that the increased costs associated with higher cost options are not justified by the minimal visibility improvement.

8.4.2.4 Conectiv Edge Moor Units 4 and 5

Edge Moor Unit 4 is a nominal 175 MW dry-bottom, pulverized coal (primary fuel), tangentially-fired boiler equipped with low-NOx coal burners (LNB) and overfire air (OFA) for

21 EPA Technology Transfer Network Clearinghouse for Inventories & Emissions Factors, Chapter 1 Volume 3 http://www.epa.gov/ttn/chief/ap42/ch01/final/c01s03.pdf

22 This applies only to this BART analysis, and that it does not imply that we have determined that additional PM controls are not cost effective for any other future purpose or analysis.

the control of NO_x emissions and an electrostatic precipitator (ESP) for the control of filterable particulate emissions. Unit 4 is currently permitted to burn coal with a sulfur content of up to 1.0% wt.

Edge Moor Unit 5 is a nominal 445 MW residual oil-fired (primary fuel) boiler with oil LNB and OFA for the control of NO_x emissions and a multicylone for the control of filterable particulates. Unit 5 is currently permitted to burn oil with a sulfur content of up to 1.0% wt.

Conectiv provided an analysis of the available control technologies, and a "five factor analysis" pursuant to the requirements of 40 CFR 51.308(e)(1)(ii)(A) for the technologically feasible options. The technologically feasible options for Unit 4 include the existing ESP and a Dry Sorbent Injection (DSI) system, and an ESP/DSI followed by a baghouse. For Unit 5 no technologically feasible options were identified other than the use of lower, 0.05%, sulfur fuel oil (see the Departments analysis below).

In summary:

> Cost. Control Option 1 (i.e., ESP/DSI) was used as a baseline, and the addition of a fabric filter was estimated to have a Total Annualized Cost of $4,331,450 and an incremental visibility improvement cost at Brigantine ($/dv) of $16,518,074/dV.
>
> Energy and non-air environmental impacts. No significant energy or non-air environmental impacts were identified.
>
> Existing controls at source. For Unit 4, and ESP; For Unit 5 a Multi-Cyclone and 1.0% limit on sulfur in the fuel burned.
>
> Remaining useful life of source. An emission unit's "remaining useful life" may be considered a part of the overall cost analysis if the remaining useful life is less than the time period used for amortizing costs. In such a case, the shorter time period should be used in the cost calculations. Conectiv did not use remaining useful life to adjust the amortization period for any of the cost calculations (i.e., they used a 30-year amortization period).
>
> Visibility improvement reasonably expected from the technology. The results of Conectiv's modeling study using peak daily baseline PM_{10} emissions demonstrated that visibility impacts due to primary PM_{10} emissions from Edge Moor Units 4 and 5 are below the established significance level of 0.1 delta-dv (8th highest or 98th percentile day in each of the three modeled years 2001, 2002 and 2003). The visibility impacts for Brigantine Wilderness are just above the MANE-VU established significance level of 0.1 delta-dv (a maximum value of 0.13 delta-dv, 8th highest or 98th percentile day in each of the three modeled years 2001, 2002 and 2003) when sulfates are included in the modeling. The modeling shows that the visibility impacts from non-sulfate PM_{10} are below 0.1 delta-dv for both Class I areas (a maximum value of 0.06 delta-dv, 8th highest or 98th percentile day in each of the three modeled years 2001, 2002 and 2003).

The Department has reviewed Conectiv's BART analysis for Unit 4. Based on this review DNREC is establishing that existing PM controls (i.e., ESP) and a DSI system at Edge Moor Unit 4 are BART. Evaluation of all of the five (5) factors shows that ESP/DSI is BART for Unit 4 for the following reasons:

- The addition of a fabric filter was not cost-effective for purposes of improving visibility at Class I areas.

- Energy or non-air quality environmental benefits or dis-benefits were not considered in ruling out any control technology.

- The existing ESP is effective at reducing particulate matter emissions, and the addition of the DSI system will reduce condensable emissions.

- Since the remaining useful life of the unit is expected to be greater than the life of the control options, no weight was given to the remaining useful life parameter.

- The incremental benefit in visibility that would result from the installation of a fabric filter was small (comparable to 0.1 dv on the 8th highest day impact).

The Department has reviewed Conectiv's BART analysis for Unit 5. Based on this review DNREC is establishing 0.5 % sulfur as BART for PM at Edge Moor Unit 5. AP-42 states that sulfur in fuel is a one-to-one ratio with particle emissions. Therefore, by reducing sulfur content by half reduces PM by half. Evaluation of all of the five (5) factors shows that a sulfur limit of 0.5 % is BART for the following reasons:

- Residual fuel with a sulfur content of 0.5 percent is cost-effective for purposes of improving visibility at Class I areas.

0.5% sulfur would reduce PM emissions by 50%.

- There are no significant energy or non-air quality environmental benefits or dis-benefits associated with using lower sulfur fuel.

- Since the remaining useful life of the unit is expected to be greater than the life of the control options, no weight was given to the remaining useful life parameter.

- This option will provide a small visibility incremental benefit.

8.4.2.5 NRG - Indian River

Unit 3 is a coal-fired, 165 MW EGU equipped with cold-side ESP. The permitted limit for PM for Unit 3 as per the existing Title V operating permit is 0.3 lb/MMBtu (2-hour average). This emission limit was used for estimating maximum hourly PM10 emission rates.

NRG provided an analysis of the available control technologies, and a "five factor analysis" pursuant to the requirements of 40 CFR 51.308(e)(1)(ii)(A) for the technologically feasible options. Table 8-10 summarizes the cost effectiveness.

Table 8-10 Cost Effectiveness for Visibility Improvement for Alternative Control Technologies Brigantine NWA

Control Technology	Emission Rate (lb/ MMBtu)	Visibility Impact (dv)	Expected Change in Visibility Impact from Baseline	Capital Cost $	Direct Cost $	Indirect Cost $	Total Annualized Cost $	Average Cost Effectiveness ($ per change in dv)
Baseline (existing Cold side ESP): Emission Scenario 1	0.3	0.173	-	-	-	-	-	-
Pulse Jet Fabric Filter: Emission Scenario 1	0.015	0.01	0.163	$43,419,200	$20,330,504	$15,621,995	$35,952,499	**$220,567,479**
Wet ESP after FGD: Emission Scenario 1	0.01	0.007	0.166	$88,270,292	$39,882,776	$31,759,177	$71,641,952	**$431,578,024**
Baseline (existing Cold side ESP): Emission Scenario 2	0.3	0.466	-	-	-	-	-	-
Pulse Jet Fabric Filter: Emission Scenario 2	0.015	0.404	0.062	$43,419,200	$20,330,504	$15,621,995	$35,952,499	**$579,879,016**
Wet ESP after FGD: Emission Scenario 2	0.01	0.367	0.099	$88,270,292	$39,882,776	$31,759,177	$71,641,952	**$723,656,081**

Energy and non-air environmental impacts There are no significant energy or non-environmental impacts for either the Pulse Jet Fabric Filter (PJFF) or the wet ESP. The higher pressure drop in the PJFF will result in some increase in power requirement. The PJFF will generate dry ash in the hopper which will be transported to the landfill on the site as is currently done with the ash from existing ESP.

The Wet ESP consumes electric power similar to dry ESP and thus there will be no significant change in power demand. The additional condensable acid mist generated by wet FGD up stream is effectively captured in the Wet ESP. The small quantity of wastewater stream from the wet ESP would be connected to the plant's existing discharge system and thus will have no significant water quality impact.

Existing controls at source. The existing control at Unit 3 for particulate matter is a cold side ESP.

Remaining useful life of source. Since the remaining useful life for Unit 3 is expected to be greater than the life of the control options, no further consideration of this parameter is needed in the analysis.

Visibility improvement reasonably expected from the technology.
Table 8-11 summarizes the visibility impacts for the Unit 3 for particulates. As shown in this table, the changes in visibility impact for both alternative control technologies are minimal over the baseline for both emission scenarios. The changes are less than 0.1 dv, which is considered the threshold for a significant impact.

Table 8-11 Change in Delta Deciview from Baseline Scenario (ESP) Emission Scenario 1: PM10 Emissions Only

Class I Area	Parameter	Baseline	Pulse Jet Fabric Filter	Wet ESP after FGD
Brigantine NWA	1st Highest Delta Deciview	0.173	0.01	0.007
	Difference from Baseline	-	0.163	0.166

The Department has reviewed NRG Indian River's BART analysis. Based on this review DNREC is establishing that existing PM controls for Indian River - Unit 3 (i.e., ESP) are BART. Evaluation of all of the five (5) factors shows that further control is not required for BART for the following reasons:

- Additional PM control options for NRG Indian River, were not cost-effective for purposes of improving visibility at Class I areas. The lowest cost technology was shown to be $220,567,479 per change in dv.

- The existing ESP is effective at reducing particulate matter emissions.[22]

- There are no significant energy or non-air quality environmental benefits or dis-benefits to be considered.

- Since the remaining useful life of the unit is expected to be greater than the life of the control options, no weight was given to the remaining useful life parameter.

- There are exceedingly small visibility incremental benefits that could be reasonably anticipated as a result of installation of the higher cost control options (<0.2 dv on the worst day impact).

8.4.2.6 Particulate Matter BART Summary

40 CFR Part 51, 308(e)(1)(iii) states, "if the State determines in establishing BART that technological or economic limitations on the applicability of measurement methodology to a

particular source would make the imposition of an emission standard infeasible, it may instead prescribe a design, equipment, work practice, or other operational standard, or combination thereof, to require the application of BART. Such standard, to the degree possible, is to set forth the emission reduction to be achieved by implementation of such design, equipment, work practice or operation, and must provide for compliance by means which achieve equivalent results." DNREC has determined that because Continuous Emission Monitors (CEMS) technology for PM is not yet on the market to determine emission limits (after current controls), BART should be prescribed as a combination of equipment and operational standards, as set forth in Table 8-12.

Table 8-12 Summary of BART control measures for PM

Source and Unit	Controls (BART)	Operational Standard	Monitoring, Testing and Recordkeeping Requirements	Compliance Schedule
NRG Indian River – Unit 3 (coal)	Existing Electrostatic Precipitator (ESP)	BART shall be proper operation of the existing ESP.	Reporting, monitoring, and recordkeeping requirements to make the BART equipment and operational standard (i.e., proper operation of the existing ESP) practically enforceable shall be imposed pursuant to Regulation No. 30 Section 6(a)(3)(i)(B), Regulation 1102, Section 11.2.9 and shall be incorporated into Regulation 30 operating permit.	BART will be effective on and after the date NRG Indian River's Regulation 1102 permit is changed to reflect BART limits, but no later than 01/01/2013.
City of Dover, McKee Run – Unit 3 (#6 residual oil)	Low Sulfur Oil	BART shall be the use of oil with ≤ 0.5% sulfur.	Reporting, monitoring, and recordkeeping requirements to make the BART operational standard (i.e., burning of low sulfur oil) practically enforceable shall be imposed pursuant to Regulation No. 30 Section 6(a)(3)(i)(B), Regulation 1102, Section 11.2.9 and shall be incorporated into Regulation 30 operating permit.	BART will be effective on and after the date City of Dover – McKee Run's Regulation 1102 permit is changed to reflect BART limits, but no later than 01/01/2013
Conectiv Edge Moor – Unit 4 (coal)	Existing Electrostatic Precipitator (ESP) and installation of Dry Sorbent Injection (DSI).	BART shall be proper operation of the existing ESP and DSI..	Reporting, monitoring, and recordkeeping requirements to make the BART equipment and operational standard (i.e., proper operation of the existing ESP and DSI) practically enforceable shall be imposed pursuant to Regulation No. 30 Section 6(a)(3)(i)(B), Regulation 1102, Section 11.2.9 and shall be incorporated into Regulation 30 operating permit.	BART will be effective on and after the date Conectiv Edge Moor 's regulation 1102 permit is changed to reflect BART limits, but no later than 01/01/2013
Conectiv Edge Moor Unit 5 (#6 residual oil)	Low Sulfur Oil	BART shall be the use of oil with ≤ 0.5% sulfur.	Reporting, monitoring, and recordkeeping requirements to make the BART operational standard (i.e., burning of low sulfur oil) practically enforceable shall be imposed pursuant to Regulation No. 30 Section 6(a)(3)(i)(B), Regulation 1102, Section 11.2.9 and shall be incorporated into Regulation 30 operating permit.	BART will be effective on and after the date Conectiv Edge Moor's Regulation 1102 permit is changed to reflect BART limits, but no later than 01/01/2013

Section 9 - Long Term Strategy

40 CFR Section 51.308(d)(3) requires States to submit a long-term strategy that addresses regional haze visibility impairment for each mandatory Class I Federal area within and outside the State/Tribe which may be affected by emissions from within the State/Tribe. Since Delaware impacts only the Brigantine Class I area, its long-term strategy must include enforceable emissions limitations, compliance schedules, and other measures necessary to achieve the reasonable progress goals established by New Jersey. Delaware must consult with other states affecting the Class I area to develop coordinated emission management strategies and must demonstrate that it has included all measures necessary to obtain its share of the emission reductions needed to meet the progress goal for the area. Delaware consulted with New Jersey, and this SIP includes measures needed to achieve its obligations agreed upon through that process.

This long term strategy addresses visibility impairment for Brigantine, and how Delaware meets the long-term strategy requirements.

The long term strategy described below includes enforceable emissions limitations, compliance schedules, and other measures necessary to achieve the reasonable progress goals established for the above Class I area. Additional measures may be reasonable to adopt at a later date after further consideration and review.

9.1 Overview of the Long Term Strategy Development Process

As a member of MANE-VU, Delaware has supported a regional approach towards deciding which control measures to pursue for reducing visibility-impairing pollutants. This regional strategy development process was based on technical analyses documented in the following reports:

- Contributions to Regional Haze in the Northeast and Mid-Atlantic United States (called the Contribution Assessment),
- Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas (called the Reasonable Progress Report),
- Five-Factor Analysis of BART-Eligible Sources: Survey of Options for Conducting BART Determinations, and
- Assessment of Control Technology Options for BART-Eligible Sources: Steam Electric Boilers, Industrial Boilers, Cement Plants and Paper and Pulp Facilities.

The regional strategy development process identified reasonable measures that would reduce emissions contributing to visibility impairment at Class I areas affected by emissions from within the MANE-VU region by 2018 or earlier. This section describes the process of identifying potential emission reduction strategies.

9.1.1 Regional Process of Identifying Potential Strategies

MANE-VU reviewed a wide range of potential control measures to reduce emissions from sources contributing to visibility impairment in affected Class I areas. The process by which MANE-VU arrived at a set of proposed control measures to pursue for the 2018 milestone started in late 2005 in conjunction with efforts to identify measures to reduce ozone pollution. The Ozone Transport Commission (OTC) selected a contracting firm to assist with the analysis of ozone and control measure options. OTC 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 OTC control measure workgroup, the contractor also identified available control measures for MANE-VU's further consideration.

MANE-VU then developed an interim list of control measures, which included: sulfate reductions from electricity generating units (EGUs), low-sulfur heating oil (residential and commercial), and controls on ICI boilers (both coal and oil-fired), lime and cement kilns, residential wood combustion, and outdoor burning (including outdoor wood boilers).

The next step in the control measure selection process was to further refine the interim list. The CAIR+ Report documents the analysis of the cost of additional SO_2 and NO_x controls at EGUs in the Eastern U.S. The Reasonable Progress Report documents the assessment of control measures for EGUs and the other source categories selected for analysis. Further analysis is provided in the NESCAUM document entitled, "Assessment of Control Technology Options for BART-Eligible Sources: Steam Electric Boilers, Industrial Boilers, Cement Plants and Paper and Pulp Facilities."

The EGU strategy continued to stay on the list since EGU sulfate emissions have, by far, the largest impact on visibility in the MANE-VU Class I areas. Likewise, 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 in the 2014 timeframe. Thus the low-sulfur heating oil and the oil-fired ICI boiler sector control measures merged into an overall low-sulfur oil strategy for #2, #4, and #6 residual oils for both the residential and commercial heating and oil-fired ICI boiler source sectors.

During a March 2007 MANE-VU consultation meeting member states reviewed the interim list of control measures to make further refinements. States determined, for example, that there may be too few coal-fired ICI boilers in the MANE-VU states for that to be considered as a "regional" strategy, but could be a sector pursued by individual states. They also determined that lime and cement kilns, of which there are few in the MANE-VU region, would likely be handled via the BART determination process. Residential wood burning[23] and outdoor wood boilers (OWB) remained on the list for those states where localized visibility impacts may be of concern, even though emissions from these sources are primarily organic carbon and direct particulate matter.

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23 Delaware relies on the federal rule for controlling residential wood combustion, i.e. *40 C.F.R. Part 60 Subpart AAA New Source Performance Standards ("NSPS") for PM, VOC and NOx emission control.* This is adequate, as receptor modeling for the Wilmington and Dover monitors shows this source to be insignificant.

Finally, outdoor wood burning was determined to also be better left as a sector to be examined further by individual states, due to issues of enforceability and penetration of existing state regulations.[24]

9.2 Technical Basis for Emission Reduction Obligations

40 CFR Section 51.308(d)(3)(iii) requires states/tribes to document the technical basis for the state's/tribe's apportionment of emission reductions necessary to meet reasonable progress goals in each Class I area affected by the state's/tribe's emissions.

The State of Delaware relied on technical analyses developed by MANE-VU to demonstrate that Delaware's emission reductions, when coordinated with those of other States and Tribes are sufficient to achieve reasonable progress goals in the Class I area affected by Delaware sources.

MANE-VU's technical documentation of the emission reductions necessary to meet reasonable progress goals in the Class I area affected by the State of Delaware is summarized in the following sections of this SIP, and in additional documentation referenced in those sections:

- 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 (NESCAUM, December 2006) (Appendix 9-1)
- The Nature of the Fine Particle and Regional Haze Air Quality Problems in the MANE-VU Region: A Conceptual Description (NESCAUM, November 2006)(Appendix 9-2)
- Contributions to Regional Haze in the Northeast and Mid-Atlantic United States (NESCAUM, August 2006)(called the Contribution Assessment) (Appendix 1-1)
- Assessment of Reasonable Progress for Regional haze in MANE-VU Class I Areas (MACTEC, July 2007)(called the Reasonable Progress Report) (Appendix 9-3)
- Five-Factor Analysis of BART-Eligible Sources: Survey of Options for Conducting BART Determinations (June, 2007)(Appendix 9-4)
- Assessment of Control Technology Options for BART-Eligible Sources: Steam Electric Boilers, Industrial Boilers, Cement Plants and Paper and Pulp Facilities (NESCAUM, March 2005)(Appendix 9-5)
- MANE-VU Modeling for Reasonable Progress Goals: Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits (NESCAUM, February 2008)(Appendix 9-6)
- 2018 Visibility Projections (NESCAUM, March 2008)(Appendix 9-7)

The following sections discuss the pollutants, source regions, and types of sources considered in developing this long term strategy.

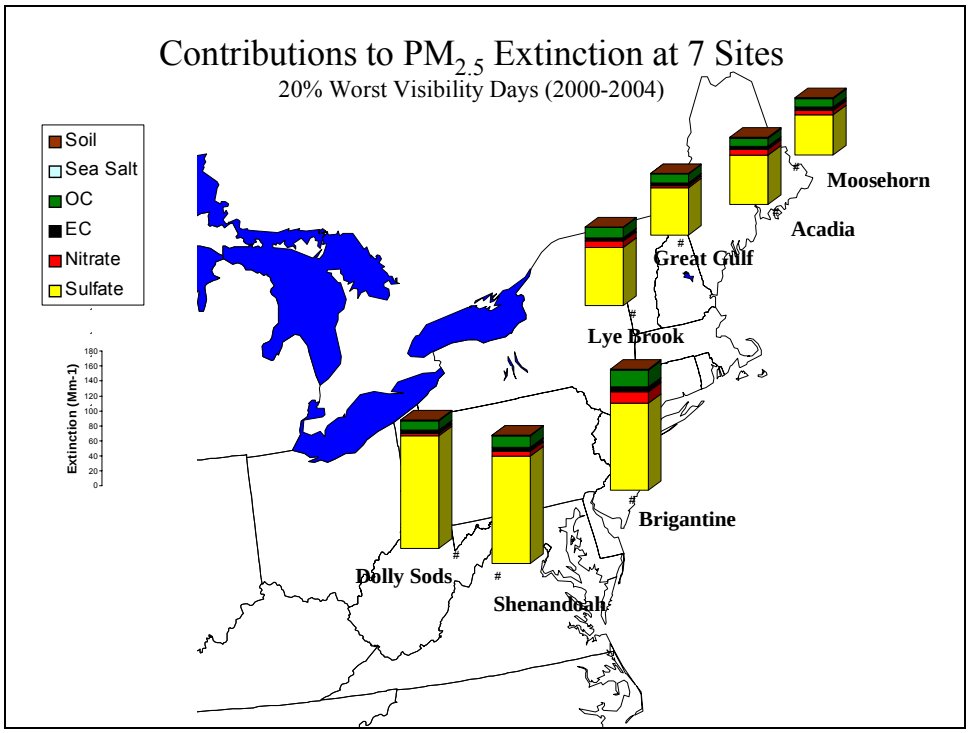
Finalized in August 2006, the MANE-VU Contribution Assessment reflects a conceptual model in which sulfate emerges as the most important single constituent of fine particle pollution and

24 Delaware reviewed the $PM_{2.5}$ emissions, which includes OC, from OWB and determined them to be insignificant (less than one percent of Delaware's total $PM_{2.5}$ inventory)

the principle cause of visibility impairment across the region. Sulfate alone accounts for anywhere from one-half to two-thirds of total fine particle mass on the 20 percent haziest days at MANE-VU Class I sites. As a result of the dominant role of sulfate in the formation of regional haze in the Northeast and Mid-Atlantic region, MANE-VU concluded that an effective emissions management approach would rely heavily on broad-based regional SO_2 control efforts in the eastern United States.

Figure 9-1 shows the dominance of sulfate in the extinction calculated from the 2000-2004 baseline data.

Figure 9-1 Contributions to $PM_{2.5}$ Extinction at Seven Class I Sites



9.3 Modeling and Source Attribution Studies

9.3.1 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 Class I areas. With respect to sulfate, based on estimates from four different techniques, the Contribution Assessment estimated emissions from within MANE-VU in 2002 were responsible for about 25-30 percent of the sulfate at Class I areas located within and nearby to the MANE-VU region (see Chapter 8 of the Contribution Assessment). The contribution of sulfate at these Class I areas from other regions, Canada, and outside the modeling domain were also significant.

Table 9-1 shows the results of one of the four methods of assessing state-by-state contributions to sulfate impacts (the REMSAD model). This table highlights the importance of emissions from outside the MANE-VU region.

Table 9-1 Percent of Modeled Sulfate Due to Emissions from Listed States[25]

Contributing States or Areas	Acadia, Maine (%)	Brigantine, New Jersey (%)	Dolly Sods, West Virginia (%)	Great Gulf and Presidential Range Dry River, New Hampshire (%)	Lye Brook, Vermont (%)	Moosehorn and Roosevelt Campobello, Maine (%)	Shenandoah, Virginia (%)
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
Midwest RPO	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
Other	43.36	25.02	18.18	40.03	33.09	52.83	18.71

MANE-VU Class I states considered the modeling results documented in the Contribution Assessment to determine which states should be consulted in developing the long term strategy for improving visibility in MANE-VU Class I areas. Because sulfate was the primary pollutant of concern and the REMSAD model results quantified sulfate impacts, three methods of evaluating states' impacts using REMSAD results were considered:

1. States/regions that contributed 0.1 ug/m^3 sulfate or greater on the 20 percent worst visibility days in the base year (2002)

[25] Percentages based on 2002 annual average sulfate impact estimated with REMSAD model as described in MANE-VU Contribution Assessment Chapter 4 and summarized on page 8-2 of the Contribution Assessment.

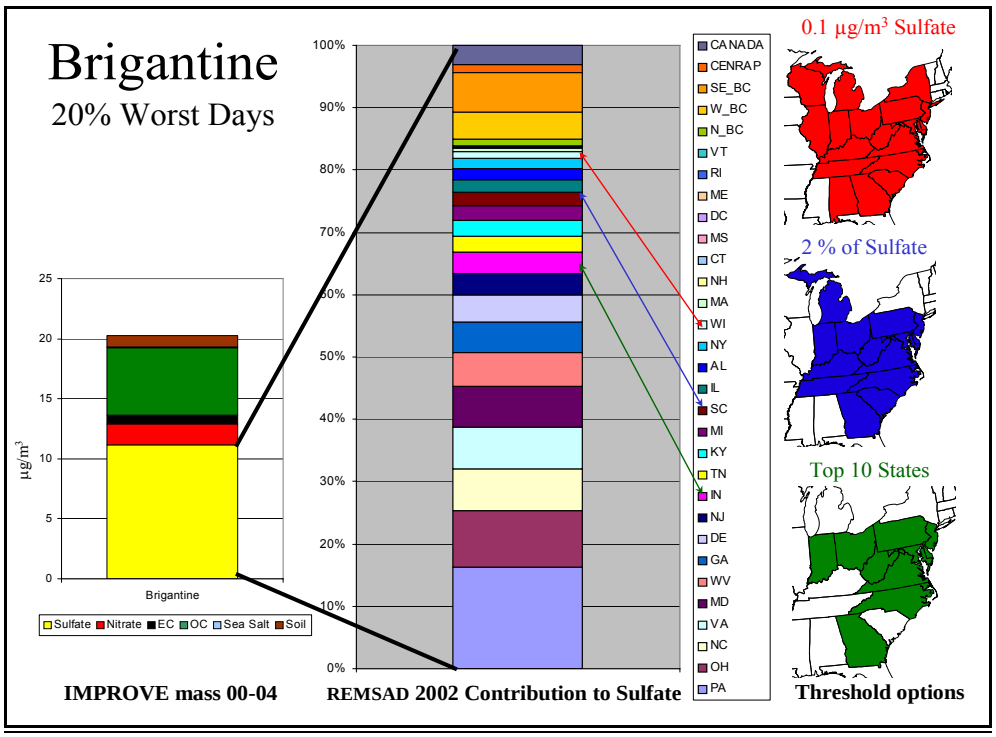
2. States/regions that contributed at least 2 percent of total sulfate observed on 20 percent worst visibility days in 2002
3. The top ten contributing states on the 20 percent worst visibility days in 2002.

Figure 9-2 shows modeled sulfate contributions to Brigantine, the only Class I areas that Delaware significantly contributes to. On the left side is the IMPROVE monitored $PM_{2.5}$ mass data by species for 2000-2004 (the baseline years). The yellow, bottom portion of the bar chart is the measured sulfate concentration.

The second part of Figure 9-2, in the center, shows the REMSAD sulfate modeling results for 2002. This middle bar chart indicates contributions of states and regions to the total modeled sulfate concentrations.

Finally, on the right side of Figure 9-2 are three maps which correspond to the three potential methods for evaluating states impacts that are identified above. The top map shows states contributing at least 0.1 ug/m^3 of sulfate; the middle map shows states contributing at least 2 percent of total sulfate; and the bottom map highlights the ten states contributing the greatest amount of the sulfate to Brigantine in 2002.

Figure 9-2 Modeled 2002 Contributions to Sulfate by State at Brigantine



For purposes of deciding how broadly to consult, the MANE-VU States decided to use method 2, which identified states that contributed at least 2 percent of total sulfate observed on the 20 percent worst visibility days in 2002. Based on the MANE-VU Contribution Assessment and the

application of the "≥ 2% SO_2 rule," emissions from Delaware were determined to contribute to visibility degradation exclusively to the Brigantine Wilderness Class I area.

9.4 Baseline Emissions

40 CFR Section 51.308(d)(3)(iii) requires Delaware to identify the baseline emissions information on which the long-term strategy is based.

- Delaware used the 2002 MANE-VU Emissions Inventory Version 3.0 as its baseline inventory. The inventory is documented in Section 7 of this SIP.

- For purposes of modeling other regions, MANE-VU used emissions inventories developed by the RPOs for those regions, including VISTAS Base G2, MRPO's Base K, and CenRAP's emissions inventory.

More specific information about the baseline emissions inventory data used may be found in Section 7 of this SIP.

9.5 Modeling Techniques Used

The following documents describe preliminary and final modeling runs conducted by MANE-VU and used in developing this long term strategy:

- Contributions to Regional Haze in the Northeast and Mid-Atlantic United States (NESCAUM, August 2006)(called the Contribution Assessment) (Appendix 1-1)
- MANE-VU Modeling for Reasonable Progress Goals: Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits (NESCAUM, February 2008)(Appendix 9-6)
- 2018 Visibility Projections (NESCAUM, March 2008)(Appendix 9-7)

As documented in the MANE-VU Contribution Assessment, two regional-scale air quality models were used to perform air quality simulations for MANE-VU. These are the Community Multi-scale Air Quality modeling system (CMAQ; Byun and Ching, 1999) and the Regional Modeling System for Aerosols and Deposition (REMSAD; SAI, 2002). CMAQ was developed by EPA, while REMSAD was developed by ICF Consulting/Systems Applications International (ICF/SAI) with EPA support. CMAQ provides one-atmosphere results for multiple pollutants while the REMSAD model was used primarily for attribution of sulfate species in the Eastern US via the species-tagging scheme included in Version 7.10 and newer versions of the model.

Three rounds of modeling were conducted:

- CMAQ was run for a complete set of baseline simulations including 2002, 2009 and 2018. Preliminary runs are described in greater detail in Appendix C of the MANE-VU *Contribution Assessment*.
- Runs assessing impacts of potential control measures are described in the *Modeling for Reasonable Progress Goals* report (NESCAUM, 2008).

- Final modeling to help develop reasonable progress goals is described in the *2018 Visibility Projections* report (NESCAUM, 2008).

The modeling tools utilized for these analyses include MM5, SMOKE, CMAQ and REMSAD, and incorporate tagging features that allow for the tracking of individual source regions or measures.

A significant feature of the REMSAD work used to evaluate regional contributions is that NESCAUM reprocessed the SO_2 emission data from each state to take advantage of REMSAD's tagging capabilities. Thus, all SO_2 emissions included in the model for the eastern half of the country were tagged according to state of origin, and emissions from Canada and the boundary conditions were also tagged. This allowed for a rough estimation of the total contribution from elevated point sources in each state to simulated sulfate concentrations at eastern receptor sites. Using identical emission and meteorological inputs to those prepared for the Integrated SIP (CMAQ) platform, REMSAD was used to simulate the annual average impact of each state's SO_2 emission sources on the sulfate fraction of $PM_{2.5}$ over the northeastern United States. For more information see Appendix C of the MANE-VU Contribution Assessment.

In addition to the REMSAD run with tagging, NESCAUM and its modeling partners at the University of Maryland and Rutgers University performed a sensitivity run with the CMAQ Particle and Precursor Tagging Methodology (CMAQ-PPTM) system. This run was used to assess the impacts of potential control measures under consideration. This work is described in the *Modeling for Reasonable Progress* report.

The modeling platform is further described in the reports *Modeling for Reasonable Progress* and *2018 Visibility Protections*. MANE-VU used the Inter-RPO modeling domain. The 36-km gridded domain covers the continental US, southern Canada, and northern Mexico. The 12-km gridded inner domain covers the northeastern, central, and southeastern U.S. as well as southeastern Canada.

Meteorological inputs for CMAQ, provided by Dalin Zhang's group at the University of Maryland, were derived from the Fifth-Generation Pennsylvania State University/National Center for Atmospheric Research (NCAR) Mesoscale Model (MM5). A detailed description of the meteorological inputs can be found in the *Modeling for Reasonable Progress* report in appendix 9-6.

9.6 Model Evaluation

The evaluation of model performance is also described in the report on *Modeling for Reasonable Progress*. As summarized below, the modeling tools were evaluated and found to perform adequately relative to USEPA modeling guidance.

NESCAUM evaluated the 2002 annual 12 km resolution meteorological fields generated by MM5 using ENVIRON's METSTAT program. Model results of surface wind speed, wind direction, temperature, and humidity were paired with measurements from EPA's Clean Air Status and Trends Network (CASTNET) and National Center for Atmospheric Research's

Techniques Data Laboratory (TDL) network by hour and by location and then statistically compared. Based on this statistical comparison between model prediction and data from the two networks for wind speed, wind direction, temperature, and humidity, MM5 performs well. An acceptable small bias, high index of agreement and strong correlation with CASTNET and TDL data are shown. Since MM5 uses TDL data for nudging, the model predictions are in better agreement with TDL data than with CASTNET data. MM5 performs better in Midwest and Northeast than Southeastern US.

CMAQ modeling was conducted for the year 2002 by cooperative modeling efforts from NYDEC, UMD, NJDEP, Rutgers, VADEP, and NESCAUM. CMAQ performance for $PM_{2.5}$ species and visibility was examined based on this CMAQ run on a 12 km resolution domain. Measurements from IMPROVE and STN networks were paired with model predictions by location and time for evaluation. The goal and the criteria for $PM_{2.5}$ evaluation suggested by Boylan and Baker (2004) were adopted by every RPO for SIP modeling. The performance goals are: Mean Fractional Error (MFE) $\leq +50\%$, and Mean Fraction Bias (MFB) $\leq \pm 30\%$; while the criteria are proposed as: MFE $\leq +75\%$, and MFB $\leq \pm 60\%$.

CMAQ prediction of $PM_{2.5}$ species from 40 STN sites and 17 IMPROVE sites within MANE-VU region were paired with measurements and statistically analyzed to generate MFE and MFB values. Considering CMAQ performance in terms of MFE and MFB goals, sulfate, nitrate, OC, EC, and $PM_{2.5}$ all had the majority of data points within the goal curve, some were between the goal and acceptable criteria, and only a few were outside the criteria curve. Only fine soil has the majority of points outside the criteria curve, but there were some sites still within the goal. For the MANE-VU region, CMAQ performs best for $PM_{2.5}$ sulfate, followed by $PM_{2.5}$, EC, nitrate, OC, and then fine soil.

Regional haze modeling also requires a CMAQ performance evaluation for aerosol extinction coefficient (B_{ext}) and the haze index. Modeled daily aerosol extinction at each IMPROVE site was calculated following the IMPROVE formula with modeled daily $PM_{2.5}$ species concentration and relative humidity factors from IMPROVE. The approach used natural background visibility estimates and the haze index following EPA Guidance. The modeled B_{ext} showed a near 1:1 linear relationship (slope of 0.78 and r_2 of 0.46) with IMPROVE observed B_{ext}. The regression excluded three points from July 7, 2002; the monitors were directly impacted by Canadian fires whose emissions were not modeled.

9.7 Emission Reductions Due to Ongoing Air Pollution Programs

40 CFR Section 51.308(d)(3)(v)(A) requires State/Tribes to consider emission reductions from ongoing pollution control programs. In developing its Long Term Strategy, Delaware considered federal and Delaware emission control programs being implemented between the baseline period (i.e., 2002) and 2018.

Significant emissions control programs are being implemented between the baseline period and 2018. These programs are described in more detail below.

Delaware's 2018 "on the books" and "on the way" (OTB/W) emissions inventory accounts for emission controls in place since 2002, as well as emission controls that will achieve additional reductions by 2009. A MANE-VU "beyond on the way" (BOTW) regional inventory was also developed for purposes of modeling SO_2 control measures which would determine Class I areas meeting uniform rate of progress through reasonable control measures (see Section 10) through modeling 2018 scenarios (called the "Best & Final"). Inventories used for other RPOs also reflect anticipated emissions controls that will be in place by 2018. The inventory is termed "beyond on the way" because it includes control measures which were not yet on the books in some states. For some states it also included controls that were under consideration.[26] However, Delaware 2018 emission estimates used in the Best and Final modeling were strictly OTB/OTW (i.e., all estimates of Delaware 2018 emissions are based on adopted and enforceable requirements). More information may be found in the following documents:

- *Documentation of 2018 Emissions from Electric Generation Units in the Eastern U.S. for MANE-VU's Regional Haze Modeling* (Alpine Geophysics, March 2008)(Appendix 7-3)

- *Development of Emissions Projections for 2009, 2012, and 2018 for Non-EGU Point, Area, and Non-road Sources in the MANE-VU Region* (MACTEC, February 2007)(Appendix 7-4)

- Appendix 7-5 MANE-VU 2009, 2012, 2009 and 2018 Inventory Spreadsheets

- *MANE-VU Modeling for Reasonable Progress Goals: Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits*, (NESCAUM, February 2008)(Appendix 9-6)

- 2018 Visibility Projections, NESCAUM (March 2008) (Appendix 9-7)

9.7.1 Delaware EGU Emissions Controls that will Reduce Emissions by 2018

Delaware adopted the following regulations governing EGU emissions:

1. *Reg. 1144, Control of Stationary Generator Emissions*, SO_2, PM, VOC and NO_x emission control, State-wide, Effective January 2006.
2. *Reg. 1146, EGUs, Electric Generating Unit (EGU) Multi-Pollutant Regulation,* SO_2 and NO_x emission control, State-wide, effective December 2007.

26 The 2018 "Best & Final" modeling relied up emission projections including if-then scenarios of various control measures adopted. It is important to point out that emission projections refers to extrapolating baseline emission estimates to predict future emissions based upon expected future activity levels and emissions controls. However, because sources and their associated air emissions are not static over time, baseline emissions may not accurately represent emissions for a future year. Emission projections are an attempt to account for the effects of future growth and emissions controls. Because projections attempt to quantify the unknown future, there will always be some uncertainty associated with any estimate of projected emissions. MANE-VU and Delaware have attempted to minimize uncertainty by using source-specific growth factors and control factors that most nearly approximate future year emissions.

3. *Regulation No. 1148, Control of Stationary Combustion Turbine Electric Generating Unit Emissions*, NO_x emission control, State-wide, effective July 2007.

9.7.2 Other Point Source Controls Expected by 2018 Due to Ongoing Air Pollution Control Programs

Control factors were applied to the 2018 MANE-VU inventory to represent the following national, regional, or state control measures:

- NO_x SIP Call Phase I (NO_x Budget Trading Program)
- NO_x SIP Call Phase II
- NO_x RACT in 1-hour Ozone SIPs
- NO_x OTC 2001 Model Rule for ICI Boilers
- 2-, 4-, 7-, and 10-year MACT Standards
- Combustion Turbine and RICE MACT
- Industrial Boiler/Process Heater MACT[27]
- EPA Refinery Consent Decrees
- Clean Air Interstate Rule (CAIR) [28]

In addition, states provided specific control measure information about specific sources or regulatory programs in their state. MANE-VU used the state-specific data to the extent it was available.

Delaware-specific measures for Point Sources that will reduce emissions by 2018 are:

- Consent Decree. Valero Refinery, Delaware City (formerly Premcor and Motiva Enterprises) New Castle County. Control of SO_2, and NO_x Emission from Boilers and Heaters. 2002 SO_2 levels of 29,747 will drop to 608 in 2018 (98 percent). NO_x 2002 levels of 1,022 will fall to 102 in 2018 (90 percent).

- Regulation 1142, Section 1, Control of NO_x Emissions from Industrial Boilers, NOx Emission Control

- Regulation 1142, Section 2, Control of NO_x Emissions from Industrial Boilers and Process Heaters at Petroleum Refineries, NO_x emission control, New Castle County

- Regulation 1124 Sec. 46, Crude Oil Lightering Operations, VOC emission control,

- Facility and Unit shutdowns (see Appendix 9-8)

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[27] The inventory was prepared before the MACT for Industrial Boilers and Process Heaters was vacated. Control efficiency was assumed to be at 4 percent for SO_2 and 40 percent for PM.
28 CAIR was vacated on July 11, 2008. However, Delaware did not rely on CAIR reductions for BART, long term strategies or its obligations for meeting reasonable progress goals established by Class I states, i.e. New Jersey

9.7.3 Area Sources Controls Expected by 2018 Due to Ongoing Air Pollution Control Programs

For area sources within MANE-VU, Delaware relied on MANE-VU's Version 3.0 Emissions Inventory for 2002. In general, the 2018 inventory for area sources was developed by MANE-VU applying growth and control factors to the 2002 Version 3.0 inventory. Area source control factors were developed for the following Delaware control measures:

Delaware-specific measures for Area Sources that will reduce emissions by 2018 are::

- Regulation 1124 Sec. 33, Solvent Cleaning and Drying, VOC emission control
- Regulation 1124 Sec. 11, Mobile Equipment Repair and Refinishing, VOC emission control
- Regulation 1141 Sec. 3, Portable Fuel Containers, VOC emission control
- Regulation 1141 Sec. 2, Consumer Products, VOC emission control
- Regulation 1141 Sec 1, Architectural and Industrial Maintenance Coatings, VOC emission control
- Regulation 1124 Sec. 36, Stage II Vapor Recovery, VOC Emission control
- Residential Woodstoves 40 C.F.R. Part 60 Subpart AAA New Source Performance Standards ("NSPS") for PM, VOC and NOx emission control.
- Regulation 1113, Open Burning, PM, VOC and NOx emission control

9.7.4 Controls on Non-road Sources Expected by 2018 due to Ongoing Air Pollution Control Programs

Delaware used Version 3.0 of the MANE-VU 2002 Emissions Inventory. Non-road source controls incorporated into the modeling include the following:

- Phase I and Phase II Emissions Standards for Gasoline-Powered Non-Road Utility Engines, Federal Rule
- Emissions Standards for Diesel-Powered Non-Road Utility Engines of 50 or More Horsepower, Federal Rule
- Emissions Standards for Spark Ignition (SI) Marine Engines, Federal Rule
- Emissions Standards for Large Spark Ignition Engines, Federal Rule

- Reformulated Gasoline Use in Non-Road Motor Vehicles and Equipment, Federal Rule, "Control of Emissions from New Marine Compression-Ignition Engines at or above 30 liters per Cylinder; Final Rule," 68 Fed. Reg. 9746 (February 28, 2003), at pp.9755-56 (hereinafter "EPA C3 Rule")

9.7.5 Mobile Source Controls Expected by 2018 due to Ongoing Air Pollution Control Programs

- Regulation No. 31, Low Enhanced Inspection and Maintenance Program

- Regulation No. 1132, Transportation Conformity Regulation

- 40 CFR Parts 80, 85, and 86 Control of Air Pollution from New Motor Vehicles: Tier 2 Motor Vehicle Emissions Standards and Gasoline Sulfur Control Requirements; Final Rule

- 40 CFR Parts 69, 80, and 86 Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements; Final Rule.

- Regulation 1145, Excessive Idling of Heavy Duty Vehicles

- Regulation No. 40, NLEV Program

9.7.6 Source Retirement and Replacement Schedules

40 CFR Section 51.308(d)(3)(v)(D) requires States to consider source retirement and replacement schedules in developing reasonable progress goals.

Source retirement and replacement were considered in developing the 2018 emissions inventory described in *Development of Emissions Projections for 2009, 2012, and 2018 for Non-EGU Point, Area, and Non-road Sources in the MANE-VU Region* (MACTEC, February 2007)(Appendix 7-4).

Delaware sources that retired or shutdown can be in Appendix 9-8.

9.8 PSD and New Source Review

Delaware will continue carrying out the required review of proposed sources impact on visibility under 40 C.F.R. § 52.26 and 52.28, by implementing the Prevention of Significant Deterioration (PSD) permit requirements for new or modified major sources of air pollutants located within 100 kilometers of the Class I area, or within a larger radius on a case-by-case basis, in accordance with all applicable Federal rules for review of the impacts on Class I areas.

> Section 3 of Delaware's Regulation 1125 addresses the PSD program, and requires Delaware to review PSD actions with consideration of visibility impacts.

> It is designed to prevent adding new (or modified) source emissions increases without determining if they will impact air quality or Class I areas adversely.

In addition, Section 3.15 (Source Obligation), Subsection 3.16.2 requires AQMS to determine that the source or modification of a unit at that source may employ a system of innovative control technology if the source causes or contributes to a violation of an applicable national ambient air quality standard; or impacts any Class I area (3.16.2.4.2).

9.9 Estimated Impacts of Long Term Strategy on Visibility

40 CFR Section 51.308(d)(3)(v)(G) requires Delaware to address the net effect on visibility resulting from changes projected in point, area and mobile source emissions by 2018. NESCAUM has conducted modeling for MANE-VU to document the impacts of the long term strategy on visibility at affected Class I areas.

The starting point for judging the progress achieved by measures included in this SIP is the 2000-2004 baseline visibility at affected Class I areas, as assessed by NESCAUM. To calculate the baseline visibility NESCAUM, using 2000-2004 IMPROVE monitoring data, averaged together the deciview value for the 20 percent best days in each year, producing a single average deciview value for the best days. Similarly, NESCAUM averaged the deciview values for the 20 percent worst days in each year, producing a single average deciview value for the worst days.

Initial modeling to assess the impact of potential control measures is documented in *MANE-VU Modeling for Reasonable Progress Goals: Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits*, (Appendix 9-6). Results of the reasonable progress modeling showed that sulfate aerosol – the dominant contributor to visibility impairment in the Northeast's Class I areas on the 20 percent worst visibility days – has significant contributions from states throughout the eastern U.S. that are projected to continue in future years from all three of the eastern regional planning organizations (RPOs). An assessment of potential control measures identified a number of promising strategies that would yield significant visibility benefits beyond the uniform rate of progress and, in fact, significantly beyond the projected visibility conditions that would result from "on the books/on the way" air quality protection programs. These additional measures include the adoption of low sulfur heating oil, implementation of Best Available Retrofit Technology (BART) requirements, and additional electric generating unit (EGU) controls on select sources.

Final modeling was conducted after consultation with states in and outside of MANE-VU. Final modeling is documented in *2018 Visibility Projections* (Appendix 9-7). In summary, emissions inventory adjustments were made for this modeling in order to better represent the likely outcome of efforts to pursue the BART, low sulfur fuel, and EGU control measures included in the MANE-VU June 20, 2007 statements and described below in Section 10.4.1.

All results were developed using the CMAQ modeling platform described previously (NESCAUM, 2008). Species-specific relative reduction factors (RRFs) were used at each Class I area for the 20 percent worst and 20 percent best days. See Table 9-2.

Table 9-2 2018 20% Worst and Best Days relative reduction factors at Brigantine

	20% Worst	**20% Best**
SO_4	0.63	0.69
NO_3	0.93	0.62
EC	0.62	0.64
OC	0.98	0.97
Sea Salt*	1.00	1.00
Soil	1.26	1.17

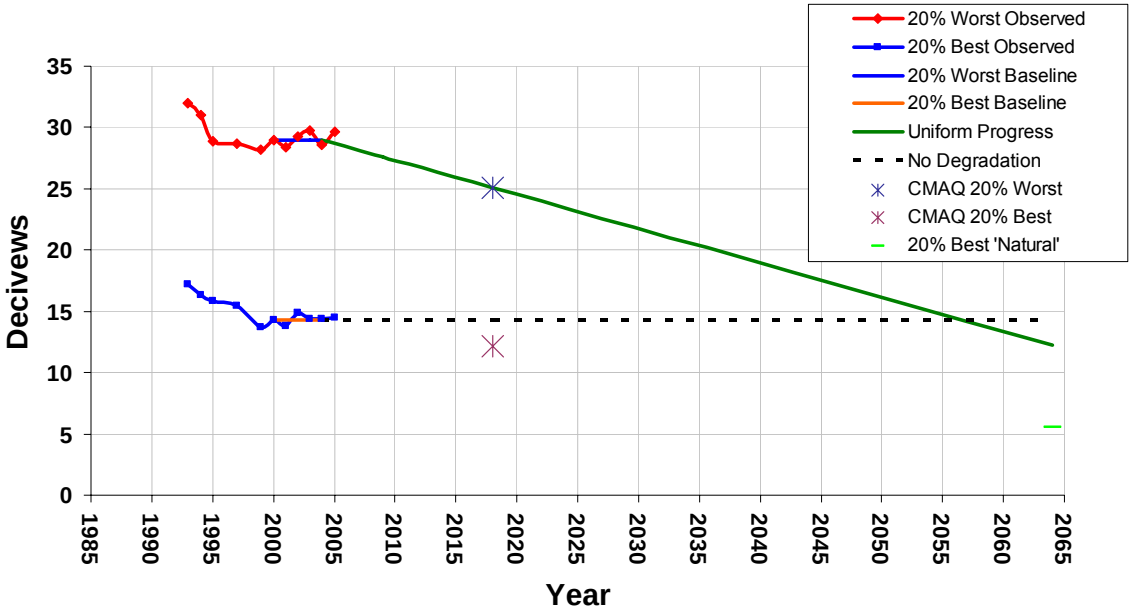
RRFs for Sea Salt are not calculated from CMAQ. We assume no changes in observed values between 2002 and future time periods.

The factors are developed from the 2002 baseline modeling and 2018 Best and Final modeling results, including 167 EGUs and low-sulfur fuels strategies. Ambient measurements identified which days to use in the calculations. The model concentrations for these days were averaged to create the RRF, which is the ratio of the future year to base year average concentration.

To determine visibility levels in 2018, the measured baseline average concentrations were multiplied by their corresponding RRF for each worst and best day. The projected concentrations were then used to derive daily visibility in deciviews, which were averaged across all best and worst days to create the projected future visibility. The results of this procedure are plotted along with the uniform progress glide slope in Figure 3-2 of the Contribution Assessment (Appendix 1- 1) for Brigantine. In addition, annual observed 20 percent best and 20 percent worst visibility are plotted as well as a line representing no degradation from current baseline best 20 percent visibility.

As illustrated in Figure 9.3, Brigantine is projected to meet or exceed the uniform rate of progress (URP) goal for 2018 on the 20 percent worst days. Delaware has met its fair share as "asked" by New Jersey in their Reasonable Progress Goals, to help Brigantine meet its URP. In addition, Brigantine Class I area does not anticipate increases in 20 percent best day visibility impairment relative to the baseline.

Figure 9.3 Projected Visibility Improvement at Brigantine National Wildlife Refuge Based On Best and Final Modeling



9.10 Measures to Mitigate the Impacts of Construction Activities

40 CFR Section 51.308(d)(3)(v)(B) requires Delaware to consider measures to mitigate the impacts of construction activities.

A description of MANE-VU's consideration of measures to mitigate the impacts of construction can be found in the MANE-VU Construction TSD entitled, *Technical Support Document on Measures to Mitigate the Visibility Impacts of Construction Activities in the MANE-VU Region*" in Appendix 9-10. The following statements summarize the main points of this technical support document:

- Although a temporary source, fugitive dust and diesel emissions from construction activities can have an affect on local air quality.

- While construction activities are responsible for a relatively large fraction of direct $PM_{2.5}$ and PM_{10} emissions in the Region, the impact on visibility is less because dust settles out of the air relatively close to the sources.

- Ambient air quality data shows that soil dust makes up only a minor fraction of the $PM_{2.5}$ measured in MANE-VU Class I areas, and impacts of diesel emissions in these rural areas are also a small part of total $PM_{2.5}$.

- The use of measures such as clean fuels, retrofit technology, best available technology, specialized permits, and truck staging areas (to limit the adverse impacts of idling) can help decrease the effects of diesel emissions on local air quality.

Delaware has regulations in place to mitigate potential impacts of construction on visibility in Class I Areas, specifically: Regulation No. 6 - Particulate Emissions from Construction and Materials Handling.[29] In summary, Regulation No. 6 states that any persons doing demolition, land clearing, land grading (including grading for roads), excavation, material transport, or the use of non-paved roads on private property are required to employ control dust control measures, when the Department determines that such activities could emit dust in quantities sufficient to cause air pollution.

29 http://www.dnrec.state.de.us/air/aqm_page/docs/pdf/reg_6.pdf

9.11 Agricultural and Forestry Smoke Management

40 CFR Section 51.308(d)(3)(v)(E) requires States to consider [wood]smoke management plans (SMP) and/or techniques for the purposes of agricultural and forestry management in developing reasonable progress goals.

Based upon receptor modeling for Delaware's rural and urban Speciated Trends Network monitors, woodsmoke is not a significant source of PM for Delaware (see Appendix 9-11, Hopke Report; Tables 6 and 7). Therefore, since woodsmoke PM is insignificant in Delaware, it is unlikely that fires for agricultural or forestry management cause impacts of any significance on visibility in the MANE-VU Class I Areas, including Brigantine Class I area in New Jersey.

Furthermore, the Delaware 2002 $PM_{2.5}$ Emissions Inventory SIP shows that emissions from agricultural and prescribed burning for forestry smoke management are insignificant. Statewide emissions from agricultural and prescribed forestry burns were 11 tons in 2002 - only 0.13 percent of Delaware's overall $PM_{2.5}$ emissions inventory. One of the reasons for these low emission rates is that agricultural burning for crop management is limited in Delaware due to widespread use of no-till practices. Also, agricultural burning tends to increase pH levels to levels that are detrimental to new crops. The Department does not expect these emissions to change significantly, and believes that smoke management for visibility purposes is a low priority for this 10 year period (2008-2018).

A SMP is a required element of a SIP only when the smoke impacts from fires can be managed for improved visibility at Class I areas. Since both the Hopke Report and Delaware's emissions inventory data show that agricultural and forestry management woodsmoke is insignificant, a SMP is not required. [30] Consequently, visibility impacts from agricultural and forestry burns will not be considered when issuing burn authorizations.

9.12 Enforceability of Emission Limitations and Control Measures

40 CFR Section 51.308(d)(3)(v)(F) requires Delaware to ensure that emission limitations and control measures used to meet reasonable progress goals are enforceable. Delaware EGU control measures alone were demonstrated to achieve the reasonable progress goal; in terms of total SO_2 emissions reductions (see Section 11). These EGU measures are already on the books and are enforceable at both the state and federal levels.

However, Delaware will continue to evaluate as appropriate and necessary the other measures included in the reasonable progress goals, i.e. low-sulfur fuels, to determine whether they are reasonable to adopt and implement by 2018. Delaware expects to make that determination in the SIP revision due in five years.

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30 The Department notes that Delaware's Regulation 1113 (Open Burning), prohibits prescribed and agricultural burning from May through September. Although the Department does not consider the Open Burning regulation a "Smoke Management Plan" (SMP), May through September is the season typically associated with the worst 20% visibility-impairing days at Brigantine, so this regulation may benefit the Brigantine Class I area to a small degree.

9.13 Consultation on the Long Term Strategy

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

Delaware consulted with other States and tribes by participation in the MANE-VU and inter-RPO processes that developed technical information necessary for development of coordinated strategies.

On May 10, 2006, MANE-VU adopted the Inter-RPO State/Tribal and FLM Consultation Framework Appendix 9-12. That document set forth the following principles:

1) All State, Tribal, RPO, and Federal participants are committed to continuing dialogue and information sharing in order to create understanding of the respective concerns and needs of the parties.
2) Continuous documentation of all communications is necessary to develop a record for inclusion in the SIP submittal to EPA.
3) States alone have the authority to undertake specific measures under their SIP. This inter-RPO framework is designed solely to facilitate needed communication, coordination and cooperation among jurisdictions but does not establish binding obligation on the part of participating agencies.
4) There are two areas which require State-to-State and/or State-to-Tribal consultations ("formal" consultations): (i) development of the reasonable progress goal for a Class I area, and (ii) development of long-term strategies. While it is anticipated that the formal consultation will cover the technical components that make up each of these policy decision areas, there may be a need for the RPOs, in coordination with their State and Tribal members, to have informal consultations on these technical considerations.
5) During both the formal and informal inter-RPO consultations, it is anticipated that the States and Tribes will work collectively to facilitate the consultation process through their respective RPOs, when feasible.
6) Technical analyses will be transparent, when possible, and will reflect the most up-to-date information and best scientific methods for the decision needed within the resources available.
7) The State with the Class I area retains the responsibility to establish reasonable progress goals. The RPOs will make reasonable efforts to facilitate the development of a consensus between the State with a Class I area and other States affecting that area. In instances where the State with the Class I area can not agree with such other States that the goal provides for reasonable progress, actions taken to resolve the disagreement must be included in the State's regional haze implementation plan (or plan revisions) submitted to the EPA Administrator as required under 40 CFR Section 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 Section 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 Section 51.308(i) and other consultation procedures developed by consensus.

10) The consultation process is designed to share information, define and document issues, develop a range of options, solicit feedback on options, develop consensus advice if possible, and facilitate informed decisions by the Class I States.

11) The collaborators, including States, Tribes and affected FLMs, will promptly respond to other RPO/State/Tribe requests for comments.

The document also describes a process primarily applicable to formal consultation with states in other RPOs concerning regional haze SIP elements. Although other RPOs did not formally adopt the same process, in general, the process was followed and provided significant opportunities for consultation with other states concerning the long term strategy as well as reasonable progress goals.

MANE-VU consultation meetings and conference calls included those held on the following dates:

- MANE-VU Intra-Regional Consultation, March 1, 2007
  - At this meeting, MANE-VU members reviewed the requirements for regional haze plans, preliminary modeling results, and work being done to prepare the MANE-VU report on reasonable progress factors, and control strategy options under review.
- MANE-VU Intra-State Consultation, June 7, 2007
  - At this meeting the MANE-VU Class I states adopted a statement of principles, and all MANE-VU members discussed draft statements concerning reasonable controls within and outside of MANE-VU. Federal Land Managers also attended the meeting, which was open to stakeholders.
- MANE-VU Conference Call, June 20, 2007
  - On this call, the MANE-VU states concluded discussions of statements concerning reasonable controls within and outside MANE-VU and agreed on the statements called the MANE-VU "Ask," including a statement concerning controls within MANE-VU, a statement concerning controls outside MANE-VU, and a statement requesting a course of action by the U.S. EPA. Federal Land Managers also participated in the call. Upon approval, all statements as well as

the statement of principles adopted on June 7 were posted and publicly available on the MANE-VU web site.

- MANE-VU Class I States' Consultation Open Technical Call, July 19, 2007
  - On this call, 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 was held at LADCO offices in Chicago, Illinois and was attended by representatives of both MANE-VU and MRPO states as well as staff. The meeting provided an opportunity to formally present the MANE-VU "Ask" to MRPO states and to consult with them regarding the reasonableness of the requested controls. Federal Land Manager agencies also attended the meeting.
- MANE-VU Consultation Meeting with VISTAS, August 20, 2007
  - This meeting was held at State of Georgia offices in Atlanta and was attended by representatives of both MANE-VU and VISTAS states as well as staff. The meeting provided an opportunity to formally present the MANE-VU "Ask" to VISTAS states and to consult with them regarding the reasonableness of the requested controls. Federal Land Manager agencies also attended the meeting.
- MANE-VU – Midwest RPO Consultation Conference Call, September 13, 2007
  - This call was a follow-up to the meeting held on August 6 in Chicago and provided an opportunity to further clarify what was being asked of the MRPO states. The flexibility in the "Ask" was explained. Both MRPO and MANE-VU staff agreed to work together to facilitate discussion of further controls on ICI boilers and EGUs.
- MANE-VU Air Directors' Consultation Conference Call, September 26, 2007
  - This call allowed MANE-VU members to clarify their understanding of the "Ask" and to provide direction to modeling staff as to how to interpret the "Ask" for purposes of estimating visibility impacts of the requested controls.
- MANE-VU Air Directors' Conference Call, February 28, 2008
  - On this call, NESCAUM presented the results of the final 2018 modeling and described the methods used to represent the impacts of the measures agreed to by the Class I States. Federal Land Manager agencies also attended this call.
- MANE-VU Air Directors' Conference Call, March 21, 2008
  - On this call, MANE-VU states discussed the process for establishing Reasonable Progress Goals for MANE-VU Class I areas

The State/Tribe's coordination with FLMs on long-term strategy development is described in Section 4 of this SIP.

References

Byun D.W., and J.K.S. Ching. *Science Algorithms of the EPA Models-3 Community Multiscale Air Quality (CMAQ) Modeling System*. EPA/600/R-99/030. March 1999.

SAI. *User's Guide to the Regional Modeling System for Aerosols and Deposition (REMSAD), Version 7.* ICF Consulting/SAI, San Francisco, CA. 2002

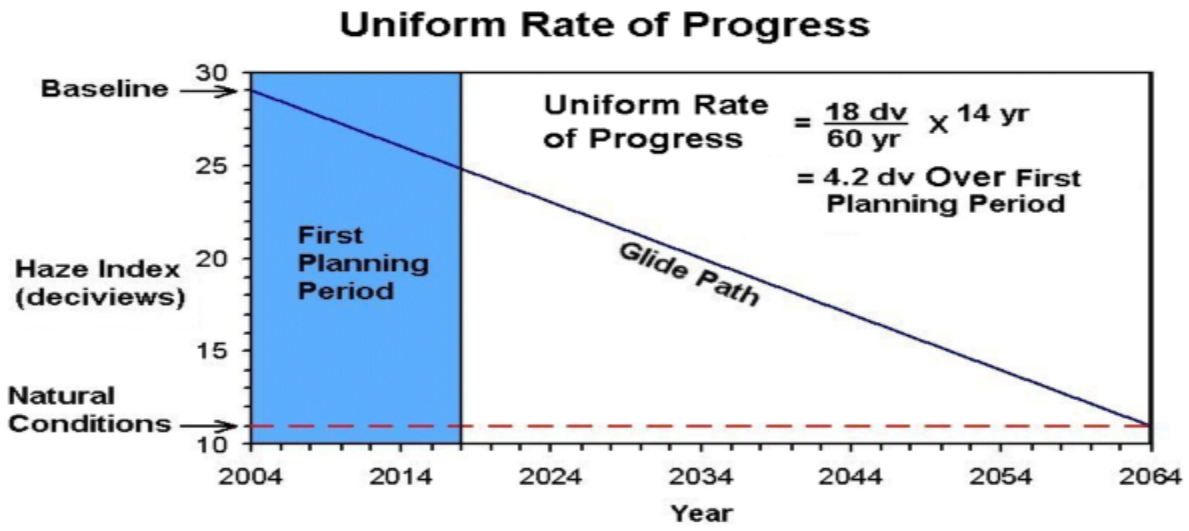
Section 10 - Reasonable Progress Goals

The key difference between SIPs from States with Class I areas and those States without Class I areas but may have sources that impact visibility on Class I areas is the calculation of the baseline and natural visibility for their Class I areas and the determination of reasonable progress goals - expressed in deciviews - that provide for reasonable progress towards achieving natural visibility by 2064. It is the Class I states responsibility assess these calculations. The Class I States must also consult with those States, which may reasonably be anticipated to cause or contribute to visibility impairment in their Class I areas (40 CFR 51.308 (d)(1)(i-vi)).

The baseline visibility conditions are calculated for the baseline period between 2002 and 2004. The average impairment for the most and least impaired days are determined for each calendar year and compiled into the average of three annual averages (40 CFR 51.308 (d)(2)(i)). The natural visibility conditions are determined for the same baseline period with the most and least impaired days determined by available monitoring data or an appropriate data analysis technique (40 CFR 51.308 (d)(iii-iv)).

U.S. Environmental Protection Agency (EPA) released guidance on June 7, 2007 to use in setting reasonable progress goals. The goals must provide improvement in visibility for the most impaired days, and ensure no degradation in visibility for the least impaired days over the State Implementation Plan (SIP) period. The State must also provide an assessment of the number of years it would take to attain natural visibility condition if improvement continues at the rate represented by the reasonable progress goal. Figure 10.1 illustrates an example of how Uniform Rate of Progress is calculated [31]

Figure 10.1 Example calculation of Uniform Rate of Progress



31 Draft Guidance for Setting Reasonable Progress Goals Under the Regional Haze Program, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. November 28, 2005

10.1 Consultation and Agreement with Other States' Goals

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

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

Through the RPO "*Consultation Framework*" (Appendix 9-12), Delaware consulted with the following states having Class I areas, as those states established reasonable progress goals for their Class I areas:

- Maine
- New Hampshire
- Vermont
- New Jersey
- West Virginia
- Virginia
- North Carolina

Delaware learned through this consultation process that its emissions significantly contribute (≥ 2% annual average sulfate) to only the Brigantine Class I area in New Jersey. Delaware DNREC has reviewed New Jersey's draft SIP, and agrees with their reasonable progress goals. More discussions of their RPG follow in Section 11.

10.2 Analysis of the Four Statutory Factors

40 CFR Section 51.308(d)(1), was promulgated under the authority of section 169A(b)(2) of the federal Clean Air Act and requires Class I states to consider the following four factors to determine which additional emission control measures are needed to make reasonable progress in improving visibility: 1) costs of compliance, 2) time necessary for compliance, 3) energy and non-air quality environmental impacts of compliance, and 4) remaining useful life of any existing source subject to such requirements. These are known as the four statutory factors. The plan must include reasonable measures and identify the visibility improvement that will result from those measures. Class I states also must show that it considered the uniform rate of improvement and the emission reduction measures needed to achieve it for the period covered by the implementation plan. If the state proposes a rate of progress slower than the uniform rate of progress, assess the number of years it would take to attain natural conditions if visibility improvement continues at the rate proposed.

10.3 Identification of Key Source Categories

Based on available information about emissions and potential impacts, the MANE-VU Reasonable Progress Workgroup, which included New Jersey, selected the following source categories for detailed analysis of the four factors the Clean Air Act establishes as the basis for determining how much progress in visibility improvement is reasonable:

- Coal and oil-fired Electric Generating Units, (EGUs);
- Point and area source industrial, commercial and institutional boilers;
- Cement kilns;
- Lime kilns;
- The use of heating oil; and
- Residential wood combustion and open burning.

This analysis is described in detail in the *Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas* (MACTEC) (Appendix 9-3). The *Reasonable Progress Report* summarizes MANE-VU's assessment of pollutants and associated source categories affecting visibility in Class I areas in and near MANE-VU, lists possible control measures for those pollutants and source categories, and develops the requisite four factor analysis. Table 10-1 presents a summary of the four factor analysis for the source categories analyzed in the Reasonable Progress Report.

Table 10-1: Summary of Results from the Four Factor Analysis

Source Category	Primary Regional Haze Pollutant	Control Measure(s)	Average Cost in 2006 dollars (per ton of pollutant reduction)	Compliance Timeframe	Energy and Non-Air Quality Environmental Impacts	Remaining Useful Life
Electric Generating Units	SO_2	Switch to a low sulfur coal (generally <1% sulfur), switch to natural gas (virtually 0% sulfur), coal cleaning, Flue Gas Desulfurization (FGD)- Wet, -Spray Dry, or -Dry.	IPM®* v.2.1.9 predicts $775-$1,690. $170-$5,700 based on available literature	2-3 years following SIP submittal	Fuel supply issues, potential permitting issues, reduction in electricity production capacity, wastewater issues	50 years or more
Industrial, Commercial, Institutional Boilers	SO_2	Switch to a low sulfur coal (generally <1% sulfur), switch to natural gas (virtually 0% sulfur), switch to a lower sulfur oil, coal cleaning, combustion control, Flue Gas Desulfurization (FGD)- Wet, -Spray Dry, or -Dry.	$130-$11,000 based on available literature. Depends on size.	2-3 years following SIP submittal	Fuel supply issues, potential permitting issues, control device energy requirements, wastewater issues	10-30 years

*Integrated Planning Model®

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
Cement and Lime Kilns	SO_2	Fuel switching, Dry Flue Gas Desulfurization-Spray Dryer Absorption (FGD), Wet Flue Gas Desulfurization (FGD), Advanced Flue Gas Desulfurization (FGD).	$1,900-$73,000 based on available literature. Depends on size.	2-3 years following SIP submittal	Control device energy requirements, wastewater issues	10-30 years
Heating Oil	SO_2	Lower the sulfur content in the fuel. Depends on the state.	$550-$750 based on available literature. There is a high uncertainty associated with this cost estimate.	Currently feasible. Capacity issues may influence timeframe for implementation of new fuel standards	Increases in furnace/boiler efficiency, Decreased furnace/boiler maintenance requirements	18-25 years
Residential Wood Combustion	PM	State implementation of NSPS, Ban on resale of uncertified devices, installer training certification or inspection program, pellet stoves, EPA Phase II certified RWC devices, retrofit requirement, accelerated changeover requirement, accelerated changeover inducement.	$0-$10,000 based on available literature	Several years - dependent on mechanism for emission reduction	Reduce greenhouse gas emissions, increase efficiency of combustion device	10-15 years

10.4 The Four Reasonable Progress Goals

The reasonable progress goals adopted by the New Jersey/MANE-VU Class I States represent implementation of the regional course of action set forth by MANE-VU on June 20, 2007 in two Resolutions: "*Statement of the Mid-Atlantic/Northeast Visibility union (MANE-VU) Concerning a Course of Action within MANE-VU toward Assuring Reasonable Progress,*" and *The Resolution of the Commissioners of States with Mandatory Class I Federal Areas within the Mid-Atlantic Northeast Visibility Union (MANE-VU) Regarding Principles for Implementing the Regional Haze Rule* (Resolution). See Appendix 10-1.

New Jersey's consultation letter to Delaware said that reasonable progress goals agreed upon by way of MANE-VU consultation process are intended to reflect the pursuit by New Jersey of a course of action including pursuing the adoption and implementation of the "emission management" strategies, as appropriate and necessary. The New Jersey (and other MANE-VU Class I states) RPGs are summarized as follows:

1. Timely implementation of BART requirements;

2. A 90 percent or greater reduction in sulfur dioxide (SO_2) emissions from each of the electric generating unit (EGU) stacks identified by MANE-VU (Appendix 9-9) comprising a total of 167 stacks, dated June 20, 2007) as reasonably anticipated to cause or contribute to impairment of visibility in each mandatory Class I Federal area in the MANE-VU region. If it is infeasible to achieve that level of reduction from a unit, alternative measures will be pursued in such State; and

3. A low sulfur fuel oil strategy[32] to reduce the sulfur content of:

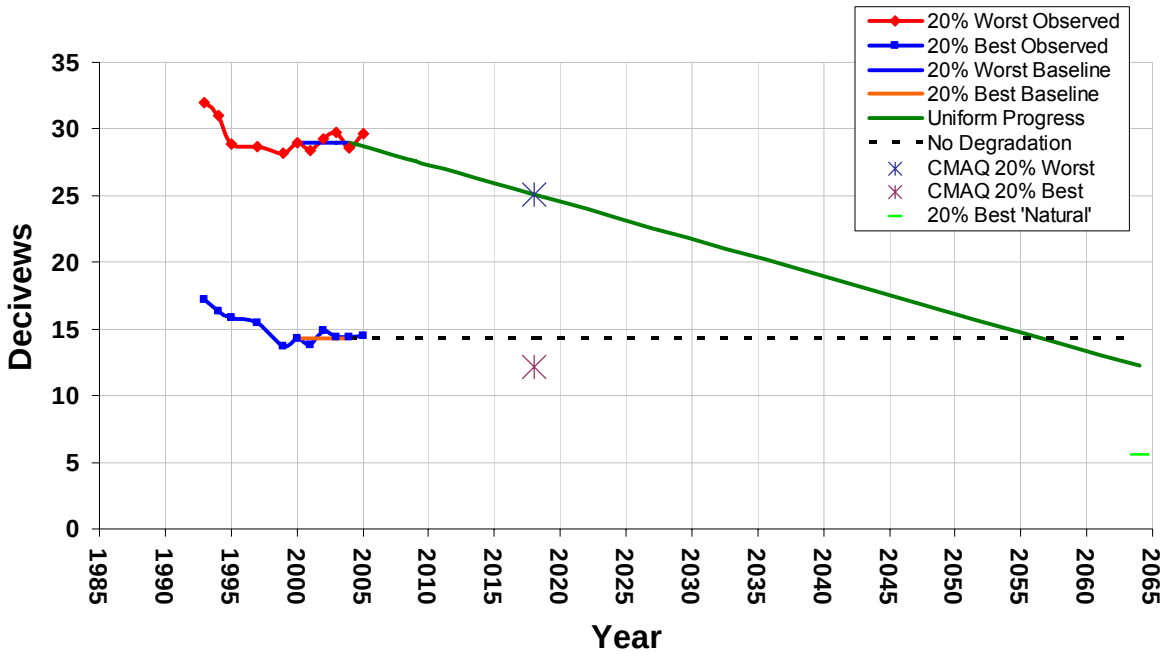
    a. Distillate oil to 0.05 percent sulfur by weight (500 ppm) by no later than 2012,
    b. #4 residual oil to 0.25 percent sulfur by weight by no later than 2012,
    c. #6 residual oil to 0.3 – 0.5 percent sulfur by weight by no later than 2012, and
    d. Further reduce the sulfur content of distillate oil to 15 ppm by 2016; and

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

Figure 10.2 illustrates that Brigantine Class I area will meet Uniform Rate of Progress if the Four reasonable progress goals described above are adopted.

32 MANE-VU established different timelines for the low-sulfur fuel strategy for "inner" and "outer" MANE-VU states. This SIP is limited to those low-sulfur fuel strategies specific to Delaware.

Figure 10.2 Brigantine Glide Path from Best and Final Modeling



Section 11 - How Delaware Achieves the Reasonable Progress Goals

Section 10 of this SIP discussed the reasonable progress goals agreed upon MANE-VU Class I states, to include New Jersey. This section addresses the four (4) reasonable progress goals, and demonstrates how Delaware has met each of them. Additional measures adopted by Delaware are also discussed.

11.1 Best Available Retrofit Technology (BART)

BART requirements are discussed in detail in Section 8 of this SIP. In Section 8 of this SIP Delaware has demonstrated that BART for PM has been met at each BART eligible source. Section 8 of this SIP also demonstrates that Delaware Regulation No. 1146, EGU Multi-Pollutant Regulation, is an alternative program that is clearly superior to a unit-by-unit BART determination for SO2 and NOX, and that this alternative program will result in greater reasonable progress than BART.

This demonstrates that Delaware has met the reasonable progress "ask" for BART.

11.2 90 Percent Reductions of SO_2 from Delaware EGU Units within the "Top 167"

MANE-VU identified 167 stacks at EGU facilities which had the highest emissions in the eastern U.S. These had highest visibility impacts on MANE-VU Class I areas, including Brigantine. Thus, controlling emissions from those stacks is crucial to improving visibility in the Brigantine Class I area. Delaware's Conectiv Edge Moor Unit 5 and NRG Indian River Units 1-4 are five of the "167 units." For Delaware to do its fair share towards meeting the reasonable progress goals, SO_2 emission reductions from those units (or those units plus other sources[33]) must be reduced by at least 90% from a 2002 baseline.

Table 11-1 shows the SO_2 emission reductions needed from these five Delaware units to meet the 90% RPG.

Table 11-1 SO_2 Emission Reduction scenario "asked" by New Jersey of Delaware to meet 2018 Brigantine reasonable progress goals

Units	SO_2 Reduction (TPY)
Edge Moor Unit 5 & Indian River Units 1-4	**19,909**

Table 11-2 shows the SO_2 emission reductions that will occur by 2018, from a 2002 baseline, from these five Delaware units, and from all units subject to DE Reg. 1146.

33 The MANE-VU Resolution states, "If it is infeasible to achieve that level of reduction from a 167 unit, alternative measures will be pursued in such State, which could include other point sources."

Table 11-2 2018 SO_2 reductions from Delaware EGU regulations already in place

Units	SO_2 Reductions (TPY)
Edge Moor Unit 5 & Indian River Units 1-4	*16,662*
Remaining EGUs in Delaware covered by DE Reg. 1146	7,164
Total Delaware Reductions under Reg. 1146	**23,826**
"Surplus" *(Delaware reductions minus RPG [23,826 – 19,909])*	**3,917**

It is apparent from Tables 11-1 and 11-2 that the 16,662 TPY reductions from *Edge Moor Unit 5 & Indian River Units 1-4* will not be enough to satisfy New Jersey's RPG of 19,909 TPY. However, when SO_2 reductions under Reg. 1146 are summed from all Delaware EGUs that are subject to Reg. 1146, the total amount of reductions is 23,826 TPY, which is 3,917 TPY more reductions than those "asked" for by New Jersey.

This demonstrates that Delaware have met the RPG "ask" for EGUs. Also, note that under Reg. 1146 these significant reductions will be made by 2012, which is well before the time frame requested by New Jersey.

11.3 Low Sulfur Fuel Oil Strategy

The assumption underlying the MANE-VU 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), and a minimum of 75 percent and maximum of 99.25 percent less sulfur in #2 fuel oil (also known as home heating oil, distillate, or diesel fuel); at an acceptably small increase in price to the end user. As much as 75 percent of the total sulfur reductions achieved by this strategy come from using the low-sulfur #2 distillate for space heating in the residential and commercial sectors. The MANE-VU Class I states agreed that a low-sulfur oil strategy is reasonable to pursue by 2018 *as appropriate and necessary*.

Tables 11-3 shows the reductions by fuel type that would occur in Delaware by 2018, from a 2002 baseyear, assuming the low sulfur fuel oil strategy is adopted by 2018.

Table 11-3 2018 SO_2 reductions that would result from implementing a low sulfur fuel strategy (RPG) in Delaware

RPG Reductions asked for	SO_2 (TPY)
Residual and # 4 Fuel Oils (assumes 0.5 % sulfur)	1,445
Distillate (15 ppm sulfur)	1,205
Total	**2,650**

Table 11.4 shows the increase/reduction by fuel type that would occur in Delaware by 2018, from a 2002 baseyear, assuming current SO2 control measures are maintained.

Table 11-4 2018 SO_2 emissions reduction/increase with existing Delaware regulations

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Delaware 2018 emissions based on Regulations already in place	**SO_2 (TPY)**
Residual Fuel (1.0 % sulfur)	-1,271
Distillate (2000 ppm)	95
Total	**- 1,176**

Comparing Table 11-3 with 11-4 shows that Delaware projected SO_2 emissions fall 3,826 TPY short of the RPG "asks" (2,650 minus [negative] 1,176 TPY). Delaware has not yet adopted the low sulfur oil strategy, and has a "deficit" of 3,826 TPY SO_2.

However, note from above that Delaware has made 3,917 TPY reductions beyond the "Top 167 EGU ask" (Section 11.2). This 3,917 "surplus" is greater than the low-sulfur fuel "deficit" of 3,826 TPY SO_2.

This demonstrates that Delaware has met New Jersey's RPG "ask" for low-sulfur fuels by implementing expanded regulations on EGUs[34], and thus achieved its fair share of SO_2 emission reductions. Despite this, as agreed upon the Resolutions, Delaware will continue to pursue adoption of this low sulfur fuel strategy along with other states in the region.

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

Delaware is evaluating a number of other measures. For instance, in accordance with Executive Order 31 issued by Delaware Governor Ruth Minner, the Energy Task Force addressed the following goals:

- The expansion of the diversity of fuels used to meet Delaware's current and future energy needs.
- The development of conservation programs to reduce the need to build more electricity generation facilities.
- Ensuring that energy infrastructure will meet Delaware's future needs for efficiently transporting energy resources.
- Encouraging producers of clean energy technologies and producers of energy efficient products to locate their business operations in Delaware.

34 The reasonable progress goals established in the Class I states Resolution includes an option of flexibility which provided that Delaware could obtain its share of the emission reductions needed to meet the progress goals for New Jersey through implementation of other new or expanded rules or programs that will achieve a commensurate or equal level of emission reduction in their State and visibility benefit in the Class I areas.

Delaware also continues to promote renewable energy and address climate change. For example, The Delaware Solid Waste Authority (DSWA) signed contracts to develop landfill gas from the Jones Crossing and Sandtown landfills, for a total generation of 10MW of power, which is an important contribution to renewable energy production in the state. And, Governor Minner joined with nine other Northeastern and Mid-Atlantic states in May 2003 to develop a regional program to reduce carbon dioxide emissions from power plants.

This demonstrates that Delaware has met New Jersey's RPG "ask" for continued evaluation of other control measures.

11.5 Delaware Reductions vs. Regional Reductions Further Demonstrating Fair Share

Table 11-5 shows the average SO_2 percent reduction that will be obtained by 2018, from a 2002 baseyear, for all MANE-VU states (including Delaware) is 68 percent.

Table 11-5 SO_2 Emission Reductions from Point, Area and Mobile Sources in MANE-VU

Emissions Sector	Baseline 2002 TPY	2018 (with additional measures for RPG) TPY	Percent Reduction
Area	316,357	129,656	**59%**
Non-EGU	264,377	211,320	**20%**
EGU	1,643,257	386,584	**76%**
On-Road Mobile	40,091	8,757	**78%**
Non-Road Mobile	57,257	8,643	**85%**
Total	**2,321,339**	**744,960**	**68%**

Table 11-6 shows the average SO_2 percent reduction that will be obtained by 2018, from a 2002 baseyear, for Delaware is 74 percent.

Table 11-6 SO_2 Emission Reductions from Point, Area and Mobile Sources in Delaware

Emissions Sector	Baseline 2002 TPY	2018 (with additional measures for RPG) TPY	Percent Reduction
Area	1,588	380	**76%**
Non-EGU	35,706	5,766	**84%**
EGU	38,038	10,941	**71%**
On-Road Mobile	584	128	**78%**
Non-Road Mobile	3,983	3,296	**17%**
Total	**79,899**	**20,511**	**74%**

A comparison of Tables 11-5 and 11-6 shoes that Delaware has achieved more than the average SO_2 percentage reductions of all MANE-VU states. This is an indicator that Delaware has achieved its "fair share" of emissions reductions needed to satisfy Class I states reasonable progress goals.

Section 12 Comprehensive Periodic Implementation Plan Revisions

40 CFR 51.308(f) requires Delaware to revise its visibility implementation plan and submit a plan revision to EPA by July 31, 2018 and every ten years thereafter. In accordance with the requirements listed in 40 CFR 51.308(f), Delaware will revise and submit this SIP to the EPA by July 31, 2018 and every ten years thereafter.

In addition, 40 CFR 51.308(g) requires periodic reports evaluating progress towards the reasonable progress goals established for each mandatory Class I area. In accordance with the requirements listed in 40 CFR 51.308(g), Delaware will submit a report on reasonable progress to EPA every five years following the initial submittal of this SIP. The report will be in the form of a SIP revision, submitted by October, 2013 and will evaluate the progress made towards the reasonable progress goals for Brigantine. All requirements listed in 51.308(g) shall be addressed in the SIP revision for reasonable progress.

Section (d)(4)(v) requires periodic updates of the emission inventory. Delaware will update the emissions inventory by 2012.

Section 13 Determination of the Adequacy of the Existing Plan

As required by 40 CFR 51.308(h), depending on the findings of the five-year progress report, required under 40 CFR 51.308 (g), Delaware will consider taking one of the following actions at the same time it submits the 5-year progress report:

(1) If the State determines that the existing implementation plan requires no further substantive revision in order to achieve established goals for visibility improvement and emissions reductions, the State will provide to the Administrator a negative declaration that further revision of the existing implementation plan is not needed.

(2) If the State determines that the implementation plan is or may be inadequate to ensure reasonable progress due to emissions from sources in another State(s) which participated in a regional planning process, the State will provide notification to the Administrator and to the other State(s) which participated in the regional planning process with the States. The State will also collaborate with the other State(s) through the regional planning process for the purpose of developing additional strategies to address the plan's deficiencies.

(3) If the State determines that the implementation plan is or may be inadequate to ensure reasonable progress due to emissions from sources in another country, the State will provide notification, along with available information, to the Administrator.

(4) If the State determines that the implementation plan is or may be inadequate to ensure reasonable progress due to emissions from sources within the State, the State will revise its implementation plan to address the plan's deficiencies within one year.

The findings of the five-year progress report will determine which action is appropriate and necessary.

The criteria that Delaware plans to use in evaluating the options above include emissions inventories, monitoring data, future MANE-VU projects and on-going consultation with New Jersey.