ATTACHMENT A

EPA Regional Haze Checklist

EPA Checklist for Regional Haze SIPs Submitted Under 40 CFR 51.308 (8/04/06)

Purpose:

This checklist has been prepared by EPA staff to use in reviewing regional haze SIPs to ensure that the SIPs have the necessary components. The checklist represents our best efforts to summarize the requirements of the regional haze rule but it is not a regulation and does not change or substitute for any legal requirements in the Clean Air Act (CAA) or the regional haze rule. Any decisions regarding the completeness of a particular SIP will be made based on the CAA and the relevant regulations. Therefore, interested parties are free to raise questions and objections to the checklist and its use in a particular situation.

Acronyms and Terms:

BART is Best Available Retrofit Technology
CAA is the Clean Air Act
CAIR is Clean Air Interstate Rule
EI is Emissions Inventory
FLM is Federal Land Manager
Glidepath is the linear rate of improvement sufficient to attain natural conditions by 2064
LTS is Long Term Strategy
RAVI is Reasonably Attributable Visibility Impairment
RHR is the Regional Haze Rule
RPO is Regional Planning Organization
RPG is Reasonable Progress Goal

Notes:

1. This checklist is based on Appendix V to 40 CFR Part 51, and 40 CFR 51.308, as updated by the BART Rule (70 FR 39104, July 6, 2005), and the trading rule, as proposed in 70 FR 44154, August 1, 2005. This checklist will be revised if necessary, should that be necessitated by the final version of the trading rule.
2. All boxes should either be "Y" or "N/A" or the SIP may be deficient.
3. This checklist assumes the State will not be participating in a trading program, or other alternative measure to BART. If this is not the case, then additional/alternative regulations that appear in 51.308(e)(2) and (3) apply.
4. Only the requirements from 51.308 pertaining to the *current* RH SIP submission, and not those pertaining to future revisions and/or reports required under 51.308(f), (g), and (h) (except for a SIP commitment to do them), were included.
5. The "1999 RHR" is 64 FR 35714, July 1, 1999.
6. The "2005 BART Rule" is 70 FR 39104, July 6, 2005.
7. The "BART Guidelines" is *Appendix Y to Part 51—Guidelines for BART Determinations Under the Regional Haze Rule*, 70 FR 39104, July 6, 2005.
8. The "Tracking Guidance" is the *Guidance for Tracking Progress Under the Regional Haze Rule*, EPA-454/B-03-004, September, 2003.
9. The "Attainment Guidance" is the *Draft Guidance for Demonstrating Attainment of Air Quality Goals for PM2.5 and Regional Haze*, January 2, 2001.

10. The "Natural Visibility Guidance" is the *Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule*, EPA-454/B-03-005, September 2003.
11. The "Baseline Memo" is a memo, *2002 Base Year Emission Inventory SIP Planning: 8-Hour Ozone, PM2.5 and Regional Haze Programs*, dated 11/18/2002, from Lydia Wegman to the Regional Air Directors.
12. The "draft RPG Guidance" is the *Draft Guidance for Setting Reasonable Progress Goals Under the Regional Haze Program*, dated November 28, 2005.
13. The "Visibility Monitoring Guidance" is Visibility Monitoring Guidance, EPA-454/R-99-003, June 1999.
14. The "EI Guidance" is the *Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations*, EPA-454/R-05-001, dated August, 2005.
15. The "Interim Fire Policy" is the *Interim Air Quality Policy on Wildland and Prescribed Fires*, April 23, 1998.

* Requirements that do not apply to States without Class I areas are denoted by an asterisk.

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Y/N or NA	Regulation Citation	Regulation Summary (*not verbatim*)	Location in SIP	References
	Administrative Requirements from Appendix V to Part 51			
Y	2.1(a)	Has a letter of submittal from the governor/ designee, requesting EPA approval of the SIP been received?	Cover letter	
Y	2.1(b)	Has the State provided evidence it has adopted the legally enforceable portions of the plan in the State code or body of regulations; or issued the necessary permits, orders, consent agreements in final form?	Subsections 11.10 and 11.11	
Y	2.1(c)	Has the State provided evidence it has the necessary legal authority under State law to adopt and implement the plan?	Subsection 11.11	
	2.1(d)	Has the official State regulation /document been signed/stamped/dated by the appropriate State official indicating that it is fully enforceable by the State?	To be provided upon SIP approval	
Y	2.1(e)	Has the State provided evidence it followed all of the procedural requirements of the State's laws and constitution in the adoption/issuance of the plan?	Section 12 and Attachments JJ and KK; draft rules prepared (Attachments FF and GG)	
Y	2.1(f)	Has the State provided evidence that public notice was given of the proposed change consistent with procedures approved by EPA, including the date of publication of such notice?	Attachments JJ	
Y	2.1(g)	Has the State provided a certification that public hearings(s) were held in accordance with the information provided in the public notice and the State's laws and constitution, if applicable?	Attachments KK	
Y	2.1(h)	Has the State provided a compilation of public comments and the State's response thereto?	Attachments I and J	
	Technical Requirements from 40 CFR 51.308			
N	(b)	Was the SIP submitted no later than December 17, 2007?	SIP was submitted on May 26, 2009, and resubmitted after revision on January 29, 2010.	

Y/N or NA		Regulation Citation	Regulation Summary (*not verbatim*)	Location in SIP	References
Y		(d)	Did the State provide a table identifying each mandatory Class I Federal area located within the State and in each mandatory Class I Federal area located outside the State affected by emissions from within the State?	Subsection 2.1, Table 2.1	Visibility Monitoring Guidance
Y	*	(d)(1)	Did the State establish RPGs for each Class I area that provide for an improvement in visibility for the most impaired days over the period of the SIP, and ensure no degradation in visibility for the least impaired days over the same period?	Subsection 10.3, Table 10-8	• p. 35730 of the 1999 RHR • p. 1-6 of the Tracking Guidance • Attainment Guidance • draft RPG Guidance
Y	*	(d)(1)(i)(A)	In establishing RPGs for each Class I area, did the State consider the costs of compliance, the time necessary for compliance, the energy and non-air quality environmental impacts of compliance, and the remaining useful life of any potentially affected sources, and include a demonstration showing how these factors were taken into consideration in selecting the goal?	Subsections 10.2 thru 10.4	• p. 35731-33 of the 1999 RHR • draft RPG Guidance
Y	*	(d)(1)(i)(B)	Did the State submit the glidepath (i.e., rate of progress needed to attain natural visibility conditions by 2064) for each Class I area?	• Subsection 10.1, Table 10-1 • Subsection 11.8, Figures 11-1 and 11-3 thru 11-7	• p. 35727-33, 35 of the 1999 RHR • Natural Visibility Guidance • p. 39124, 39143 of the 2005 BART rule • The Baseline Memo
Y	*	(d)(1)(i)(B)	In establishing the RPG for each Class I area, did the State calculate the uniform rate of improvement in visibility and the emission reduction measures needed to achieve it for the period covered by the SIP?	• Subsection 10.1, Table 10-1 • Section 11 • Subsection 11.8, Figures 11-1 and 11-3 thru 11-7	• p. 35732 of the 1999 RHR • draft RPG Guidance
NA	*	(d)(1)(ii)	If the State establishes a RPG < the glidepath, has it demonstrated, based on the factors in (d)(1)(i)(A), the rate of progress for the SIP to attain natural conditions by 2064 is not reasonable, and its RPG is reasonable?		p. 35732 of the 1999 RHR
NA	*	(d)(1)(ii)	If the State establishes a RPG < the glidepath, did it provide to the public for review as part of its SIP, an assessment of the number of years it would take to attain natural conditions using its RPG?		p. 35732 of the 1999 RHR

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Y/N or NA		Regulation Citation	Regulation Summary (*not verbatim*)	Location in SIP	References
Y		(d)(1)(iv)	In developing its RPG, has the State consulted with those States that may reasonably be anticipated to cause or contribute to visibility impairment in the Class I areas?	Section 3	p. 35735 of the 1999 RHR
Y		(d)(1)(iv)	If the State cannot agree with another State(s) that a goal provides for reasonable progress, has the State described in its submittal the actions taken to resolve the disagreement?	Subsection 3.2, Parts 3.2.3 and 3.2.4	p. 35732 of the 1999 RHR
Y	*	(d)(1)(vi)	Has the State adopted RPGs that represent at least the visibility improvement expected from implementation of other CAA programs during the applicable planning period?	Section 10	p. 35733 of the 1999 RHR
Y	*	(d)(2)(i)	Has the State calculated baseline visibility conditions for each Class I area for the most impaired and least impaired days using 2000 to 2004 monitoring data?	Section 4.2, Tables 4.2 and 4.3	• p. 35728-30 of the 1999 RHR • Natural Visibility Guidance • Attainment Guidance • Tracking Guidance
Y	*	(d)(2)(i)	In calculating the baseline visibility conditions, did the State estimate the average degree of visibility impairment for the most and least impaired days for each calendar year from 2000 to 2004, and then determine the average of these annual values?	Section 4.2, Tables 4.2 and 4.3	
Y	*	(d)(2)(i)	If the State has Class I areas without onsite monitoring data for 2000 - 2004, did the State use the most representative available monitoring data for 2000 - 2004 to establish baseline values, in consultation with the EPA Regional Office?	Subsection 5.3, Parts 5.3.3 and 5.3.4	• p. 35728-29 of the 1999 RHR • Visibility Monitoring Guidance
Y	*	(d)(2)(iii)	Did the State calculate natural visibility conditions for the most impaired and least impaired days by estimating the degree of impairment based on available monitoring information and appropriate data analysis techniques?	Subsection 5.2	• p. 35764, 35729-30 of the 1999 RHR • Natural Visibility Guidance
Y	*	(d)(2)(iv)A	Did the State calculate the number of deciviews by which baseline conditions exceed natural visibility conditions for the most impaired and least impaired days for the first planning period?	Subsection 4.2, Table 4-2	p. 35732 of the 1999 RHR

Y/N or NA	Regulation Citation	Regulation Summary (*not verbatim*)	Location in SIP	References
Y	(d)(3)	Did the State submit a LTS that addresses visibility impairment for each Class I area, inside and outside the State, which may be affected by the State's emissions?	Section 11	p. 35734-35 of the 1999 RHR
Y	(d)(3)	Does the LTS include enforceable emissions limitations, compliance schedules, and other measures as necessary to achieve the RPGs established by States having Class I areas?	Subsections 11.10 and 11.11	p. 35734-35 of the 1999 RHR
Y	(d)(3)(i)	In establishing its LTS, did the State consult with other State(s) to develop coordinated emission management strategies for cases in which it has emissions that are reasonably anticipated to contribute to visibility impairment in any Class I area located in those State(s)?	Section 3	p. 35735 of the 1999 RHR
Y	(d)(3)(i)	In establishing its LTS, did the State consult with other State(s) to develop coordinated emission management strategies for cases in which those State(s) have emissions that are reasonably anticipated to contribute to visibility impairment in any Class I area located within the State?	Section 3	
Y	(d)(3)(ii)	In establishing its LTS, where multiple State(s) cause or contribute to impairment of the same Class I area, did the State include all measures necessary to obtain its share of the emission reductions needed to meet the RPG for the area?	Subsection 11.9	p. 35735 of the 1999 RHR
Y	(d)(3)(ii)	In addressing (d)(3)(ii), above, if the State participated in a RPO, did it ensure it included all measures needed to achieve its apportionment of emission reduction obligations agreed upon through that process?	Subsection 11.9	p. 35735 of the 1999 RHR
Y	(d)(3)(iii)	In establishing its LTS, did the State document the technical basis, including modeling, monitoring and emissions information, on which it is relying to determine its apportionment of emission reduction obligations necessary for achieving reasonable progress in each Class I area it affects?	Subsections 11.1 and 11.2	• p. 35735 of the 1999 RHR • EI Guidance
Y	(d)(3)(iii)	In addressing (d)(3)(iii), above, did the State identify the baseline emissions inventory on which its strategies are based?	Subsection 6.1, Part 6.1.1	• p. 35728 of the 1999 RHR • Baseline Memo • EI Guidance

Y/N or NA		Regulation Citation	Regulation Summary (*not verbatim*)	Location in SIP	References
Y		(d)(3)(iv)	Did the State identify all anthropogenic sources of visibility impairment considered by it in developing its LTS, including consideration of major and minor stationary sources, mobile sources, and area sources?	Section 8	• p. 35735 of the 1999 RHR • EI Guidance
Y		(d)(3)(v)(A)	In developing its LTS, did the State consider the emission reductions due to ongoing air pollution control programs, including measures to address RAVI?	Subsection 11.3	p. 35737 of the 1999 RHR
Y		(d)(3)(v)(B)	In developing its LTS, did the State consider measures to mitigate the impacts of construction activities?	Subsection 11.6	p. 35737 of the 1999 RHR
Y		(d)(3)(v)(C)	In developing its LTS, did the State consider emissions limitations and schedules for compliance to achieve the reasonable progress goal?	Subsection 11.10	p. 35737 of the 1999 RHR
Y		(d)(3)(v)(D)	In developing its LTS, did the State consider source retirement and replacement schedules?	Subsection 11.5	p. 35737 of the 1999 RHR
Y		(d)(3)(v)(E)	In developing its LTS, did the State consider smoke management techniques for agricultural and forestry management purposes, including plans as currently exist within the State for these purposes?	Subsection 11.7	• p. 35736 of the 1999 RHR • Interim Fire Policy
Y		(d)(3)(v)(F)	In developing its LTS, did the State consider enforceability of emissions limitations and control measures?	Subsection 11.11	p. 35737 of the 1999 RHR
Y		(d)(3)(v)(G)	In developing its LTS, did the State consider the anticipated net effect on visibility due to projected changes in point, area, and mobile source emissions over the period addressed by the LTS?	Subsection 11.8	p. 35737 of the 1999 RHR
Y	*	(d)(4)	Did the State submit with the SIP a monitoring strategy for measuring, characterizing, and reporting of regional haze visibility impairment representative of all Class I areas within the State?	Section 5	• p. 35744 of the 1999 RHR • Attainment Guidance • Tracking Guidance • Visibility Monitoring Guidance
NA	*	(d)(4)	Did the State coordinate the above monitoring strategy with the RAVI monitoring strategy in 51.305?		p. 35717, 37, of the 1999 RHR

Y/N or NA		Regulation Citation	Regulation Summary (*not verbatim*)	Location in SIP	References
N	*	(d)(4)(i)	Did the SIP provide for the establishment of any additional monitoring sites or equipment needed to assess whether RPGs to address regional haze for all Class I areas within the State are being achieved?	Subsection 5.2 (Current system is sufficient.)	• p. 35744 of the 1999 RHR • Attainment Guidance • Tracking Guidance • Visibility Monitoring Guidance
Y	*	(d)(4)(ii)	Did the SIP establish procedures by which monitoring data and other information are used in determining the contribution of emissions from within the State to regional haze visibility impairment at Class I areas both within and outside the State?	Subsection 5.2 and Contribution Assessment (Attachment B)	• p. 35744 of the 1999 RHR • Attainment Guidance • Tracking Guidance • Visibility Monitoring Guidance
NA		(d)(4)(iii)	For a State with no Class I areas, did the SIP establish procedures by which monitoring data and other information are used in determining the contribution of emissions from within the State to regional haze visibility impairment at Class I areas in other States?		• p. 35744 of the 1999 RHR • Attainment Guidance • Tracking Guidance • Visibility Monitoring Guidance
Y	*	(d)(4)(iv)	Did the SIP provide for the reporting of all visibility monitoring data to EPA at least annually for each Class I area in the State?	Subsection 5.2	• p. 35744-45 of the 1999 RHR • Visibility Monitoring Guidance
Y		(d)(4)(v)	Did the SIP include a statewide EI of pollutants that are reasonably anticipated to cause or contribute to visibility impairment in any Class I area?	Section 6	Attainment Guidance
Y		(d)(4)(v)	Did the EI include emissions for a baseline year, emissions for the most recent year for which data are available, and estimates of future projected emissions?	Section 6 (The 2002 EI data represent both the baseline year and the most recent year for which reliable data are available.)	• p. 35728-29 of the 1999 RHR • Visibility Monitoring Guidance • Attainment Guidance
Y		(d)(4)(v)	Did the SIP include a commitment to update the EI periodically?	Subsection 1.4, Part 1.4.2	EI Guidance
Y		(d)(4)(vi)	Did the SIP include other elements necessary to assess and report on visibility (e.g., reporting, recordkeeping, etc.)?	Subsection 5.2	

Y/N or NA	Regulation Citation	Regulation Summary (*not verbatim*)	Location in SIP	References
Y	(e)	Did the State submit a SIP containing emission limitations representing BART, and schedules for compliance with BART, for each BART eligible source that may reasonably be anticipated to cause or contribute to any impairment of visibility in any Class I area?	Section 9	BART Guidelines
Y	(e)(1)(i)	Did the SIP include a list of all BART-eligible sources within the State with supporting documentation?	Subsection 9.2 and Attachment X	BART Guidelines
Y	(e)(1)(ii)	Did the SIP include a determination of BART for each BART-eligible source in the State that emits any air pollutant which may reasonably be anticipated to cause or contribute to any impairment of visibility in any Class I area?	Subsection 9.3 and Attachment X	BART Guidelines
Y	(e)(1)(ii)(A)	Did the SIP include a determination of BART based on an analysis of the best system of continuous emission control technology available, and associated emission reductions achievable for each source subject to BART within the State?	Subsection 9.3 and Attachment X	BART Guidelines
Y	(e)(1)(ii)(A)	In the BART analysis, did the State take into consideration the technology available, the costs of compliance, the energy and nonair quality environmental impacts of compliance, any pollution control equipment in use at the source, the remaining useful life of the source, and the degree of improvement in visibility which may reasonably be anticipated to result from the use of such technology?	Subsection 9.3 and Attachment X	• BART Guidelines • p. 39107, 127 of the 2005 BART Rule
NA	(e)(1)(ii)(B)	Did the State determine BART for fossil-fuel fired power plants > 750 megawatts pursuant to the BART guidelines?	BART facilities < 750 MW, but guidelines used	• BART Guidelines • p. 39108 of the 2005 BART Rule
NA	(e)(1)(iii)	If the State has determined that technological or economic limitations on the applicability of measurement methodology to a particular source would make the imposition of an emission standard infeasible, has the State prescribed a design, equipment, work practice, or other operational standard, to require the application of BART, as an alternative to a BART emission standard?		BART Guidelines

Y/N or NA	Regulation Citation	Regulation Summary *(not verbatim)*	Location in SIP	References
NA	(e)(1)(iii)	If the State adopted a design, equipment, work practice, or other operational standard alternative to BART, did the State, to the degree possible, set forth the emission reduction to be achieved, and provide for compliance by means which achieve equivalent results?		• BART Guidelines • p. 39172 of the 2005 BART Rule
Y	(e)(1)(iv)	Has the State required each source subject to BART to install and operate BART as expeditiously as practicable, but no later than 5 years after approval of the SIP?	Subsection 9.5	p. 39158, 70, 72 of the 2005 BART Rule
Y	(e)(1)(v)	Has the State required each BART source to maintain the required control equipment and establish procedures to ensure such equipment is properly operated and maintained?	Subsection 9.5	p. 39172 of the 2005 BART Rule
NA	(e)(4)	If the State is using its participation in CAIR to exempt BART-eligible EGU's from BART, has it included supporting documentation?		p. 39136-42 of the 2005 BART Rule
NA	(e)(4)	If the State is using its participation in CAIR to exempt BART-eligible EGU's from BART, did it include provisions for a geographic enhancement to the program to address RAVI BART under 51.302(c)?		p. 39143, 57 of the 2005 BART Rule
NA	(e)(6)	If a facility is seeking an exemption under 51.303(a)(2)–(h) for any of its BART-eligible emission units, has the appropriate documentation been included in the SIP?		40 CFR 51.303(a)(2)–(h)
Y	(f)	Has the State included a commitment it will submit its SIP revision, as specified in 51.308(f), *by July 31, 2018,* and every ten years thereafter?	Subsection 1.4, Part 1.4.2	• p. 35745 of the 1999 RHR • Section 110(a)(2)(H) of the CAA
Y	(g)	Has the State included a commitment it will submit its SIP report, as specified in 51.308(g), *by an exact date named*, that is within 5 years from submittal of the initial SIP?	Subsection 1.4, Part 1.4.2	• p. 35745 of the 1999 RHR • Section 110(a)(2)(F) of the CAA
Y	(h)	Has the State included a commitment it will, at the time of the submission of the SIP report, also submit a determination of the adequacy of its existing Regional Haze SIP revision, as specified in 51.308(h)?	Subsection 1.4, Part 1.4.2	• p. 35745 of the 1999 RHR • Section 110(a)(2)(F) of the CAA

EPA Checklist for Regional Haze SIPs Submitted Under 40 CFR 51.308 (8/04/06)

Y/N or NA	Regulation Citation	Regulation Summary (*not verbatim*)	Location in SIP	References
Y	(i)(1)(i)-(ii)	Did the State, by November 29, 1999, identify in writing to the FLMs the title of the official to which any FLM can submit recommendations on the implementation of 51.308 including, (i) identification of impairment of visibility in any Class I area(s); and (ii) identification of elements for inclusion in the visibility monitoring strategy required by 51.305 and 51.308?	Subsection 3.2, Part 3.2.5	p. 35747-48 of the 1999 RHR
Y	(i)(2)	Did the State provide the FLM an opportunity for consultation, in person and at least 60 days prior to holding any public hearing on the SIP (or its revision)?	Subsection 3.2, Part 3.2.5	p. 35747-48 of the 1999 RHR
Y	(i)(2)(i)-(ii)	Did the above consultation include the opportunity for the FLMs to discuss their: (i) assessment of impairment of visibility in any Class I area; and, (ii) recommendations on the development of the RPG and on the development and implementation of strategies to address visibility impairment?	Subsection 3.2, Part 3.2.5	p. 35747-48 of the 1999 RHR
Y	(i)(3)	Did the State include in the SIP a description of how it addressed any comments provided by the FLMs?	Subsection 3.2, Part 3.2.5, and Attachment I	p. 35747-48 of the 1999 RHR
Y	(i)(4)	Does the SIP provide procedures for continuing consultation between the State and FLMs on the implementation of 51.308, including development and review of SIP revisions and 5-year progress reports, and on the implementation of other programs having the potential to contribute to impairment of visibility in Class I areas?	Subsection 3.2, Part 3.2.5	p. 35747-48 of the 1999 RHR

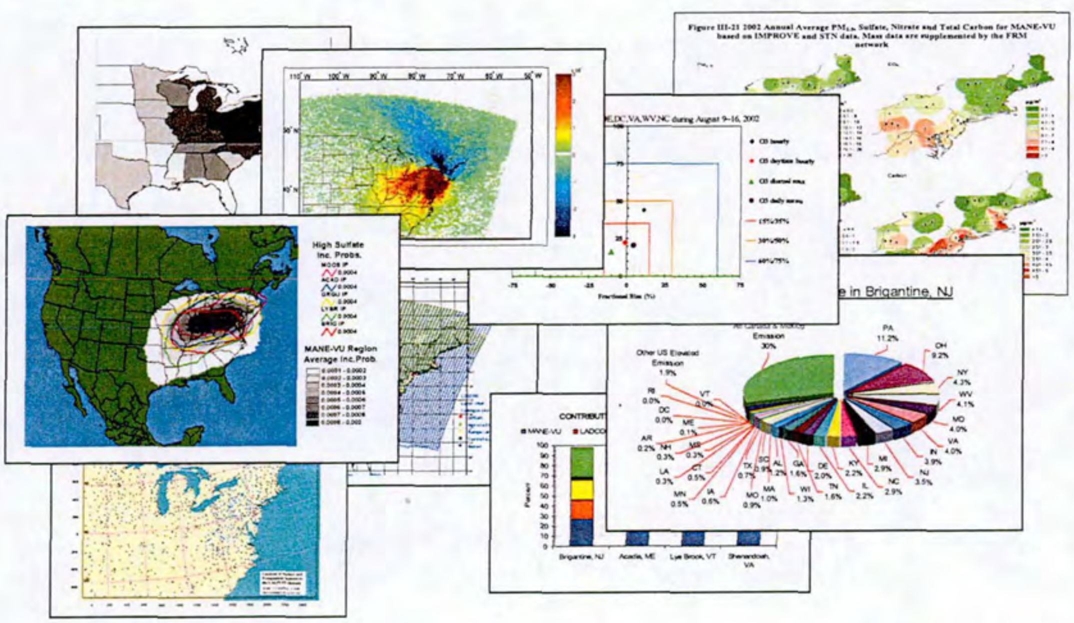
ATTACHMENT B

MANE-VU Contribution Assessment

Contributions to Regional Haze in the Northeast and Mid-Atlantic United States

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

Prepared by NESCAUM
For the Mid-Atlantic/Northeast Visibility Union (MANE-VU)



August 2006

Members of NESCAUM Board

Contributions to Regional Haze in the Northeast and Mid-Atlantic United States

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

Prepared by
NESCAUM

August 2006

Contributions to Regional Haze in the Northeast and Mid-Atlantic United States

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

Project Director

Gary Kleiman, NESCAUM

Program Officer

Marcia Spink, U.S. EPA

Editors

John Graham, NESCAUM
Gary Kleiman, NESCAUM
Marika Tatsutani, NESCAUM
Paul Miller, NESCAUM

Principle Contributors (listed alphabetically by chapter)

Chapter 1:	Gary Kleiman, NESCAUM
Chapter 2:	Gary Kleiman, NESCAUM
Chapter 3:	George Allen, John Graham, Alan Leston, NESCAUM
Chapter 4:	Michael Borucke, John Graham, NESCAUM, Serpil Kayin, MARAMA, Jung-Hun Woo, NESCAUM
Chapter 5:	Serpil Kayin, MARAMA Iyad Kheirbek, Gary Kleiman, NESCAUM, Rich Poirot, VT DEC.
Chapter 6:	John Graham, Shan He, Emily Savelli, Jung-Hun Woo, NESCAUM
Chapter 7:	Mark Garrison, ERM, Dan Riley, Paul Wishinski, VT DEC
Chapter 8:	All of the above
Chapter 9:	Gary Kleiman, NESCAUM

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Tom Downs, Maine Department of Environmental Protection
VISTAS
MOG
Dominion Power
AMC
Ann McWilliams, EPA Region 1

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TABLES

Units, Symbols, Acronyms

Acronyms

AGL – Above Ground Level
ATAD – Atmospheric Transport and Diffusion Model
ARL – Air Resources Laboratory (NOAA)
BART – Best Available Retrofit Technology
BEIS – Biogenic Emission Inventory System
BRAVO - Big Bend Regional Aerosol and Visibility Observational study
CAIR – Clean Air Interstate Rule
CALMET – Meteorological model for developing input data for CALPUFF
CALPUFF – Lagrangian dispersion model developed by EarthTech, Inc.
CAMNET – Northeast Visibility Camera Network
CASTNet – Clean Air States and Trends Network
CEMS – Continuous Emissions Monitoring System
CENRAP – Central Regional Air Planning Association
CFR – Code of Federal Regulations
CMAQ – Community Multi-scale Air Quality Model
CMB – Chemical Mass Balance
CMU – Carnegie Mellon University
CTM – Chemical Transport Model
CWP – Clustered Weighted Probability
EDAS – Eta Data Assimilation System
EFIG – USEPA Emission Factor and Inventory Group
EGU – Electricity Generating Unit
EMAD – Emissions, Monitoring and Analysis Division
ERM – Environmental Resources Management, Inc.
FASTNET – Fast Aerosol Sensing and Tools for Natural aErosol Tracking
FNL – FiNaL run of the Global Data Assimilation System
FRM – Federal Reference Method
GIS – Geographic Information System
IMPROVE – Interagency Monitoring of Protected Visual Environments
IP – Incremental Probability
HAPS – Hazardous Air Pollutants
HYSPLIT – Hybrid Single-Particle Langrangian Integrated Trajectory model
MANE-VU – Mid-Atlantic/Northeast Visibility Union
MARAMA – Mid Atlantic Region Air Management Association
MDE – Maryland Department of the Environment
MDNR – Maryland Department of Natural Resources
MM5 – Fifth Generation Mesoscale Model
MOBILE – Mobile Source Emission Factor Model (USEPA)
MWRPO – Midwest Regional Planning Organization
NAAQS – National Ambient Air Quality Standards
NARSTO – North American Research Strategy for Tropospheric Ozone
NCAR – National Center for Atmospheric Research
NEI – National Emissions Inventory
NESCAUM – Northeast States for Coordinated Air Use Management
NET – National Emissions Trends (EPA)
NOAA – National Oceanic and Atmospheric Administration
NRC – National Research Council
NTI – National Toxics Inventory
NWS – National Weather Service
OAQPS – USEPA Office of Air Quality Planning and Standards

OAR – USEPA Office of Air and Radiation
OTC – Ozone Transport Commission
PCA – Principle Component Analysis
PM – Particulate Matter
PMF – Positive Matrix Factorization
PSCF – Potential Source Contribution Function
RAIN – Real Time Aerosol Intensive Network
REMSAD – Regulatory Modeling System for Aerosols and Deposition
RH – Relative Humidity
RPO – Regional Planning Organization
RTA – Residence Time Analysis
SIP – State Implementation Plan
SMOKE – Sparse Matrix Operator Kernel Emissions model
STN – Speciation Trends Network
TLD – Transport Layer Depth
TSC – Technical Support Committee
UMD – University of Maryland
UNMIX – Mathematical receptor model used for source attribution studies
USEPA – United States Environmental Protection Agency
USFS – United States Forest Service
USFWS – United States Fish and Wildlife Service
USNPS – United States National Park Service
VISTAS - Visibility Improvement State and Tribal Association of the Southeast
VT DEC – Vermont Department of Environmental Conservation
WRAP-Western Regional Air Partnership

Chemical Species

BC – Black Carbon
CM – coarse mass
CO – carbon monoxide
EC – elemental carbon
HC – hydrocarbons
H_2SO_4 – sulfuric acid
HNO_3 – nitric acid
NO_X – oxides of nitrogen (NO_2 and NO)
NO – nitric oxide
NO_2 – nitrogen dioxide
NO_3^- – nitrate
NH_3 – ammonia
NH_4 – ammonium
NH_4HSO_4 – ammonium bisulfate
$(NH_4)_2SO_4$ – ammonium sulfate
(NH_4NO_3) – ammonium nitrate
O_3 – ozone
OC – organic carbon
OMC – organic mass from carbon
$PM_{2.5}$ – particle matter up to 2.5 μm in size
PM_{10} – particle matter up to 10 μm in size
Se – selenium
SOA – secondary organic aerosol
SO_2 – sulfur dioxide
SO_4^{2-} – sulfate
VOC – volatile organic compounds

Symbols

b_{ext} – light extinction coefficient (Mm^{-1})
C_i – constant for wind sector i
d – distance
E x UP – emissions times upwind probability
f(RH) – relative humidity adjustment factor
I – impact
Q – annual emissions
R^2 – correlation coefficient

Units

Length

m – meter
μm – micrometer (0.000001m; 10^{-6}m)
km – kilometer (1,000 x m; 10^3 m)
Mm – Megameter (1,000,000 x m; 10^6 m)

Area

m^2 – square meter
km^2 – square kilometer

Volume

L – liter
m^3 – cubic meter

Concentration

$\mu g/m^3$ – micrograms per cubic meter
ng/m^3 – nanograms per cubic meter
ppb – parts per billion
ppm – parts per million

Scattering Efficiency

m^2/g – square meters per gram

Visibility

dv – deciview

Executive Summary

Regional haze State Implementation Plans (SIPs) due in December 2007 must include a contribution assessment and pollution apportionment analysis as part of the long-term emissions management strategy for meeting visibility improvement objectives in Class I areas subject to USEPA's 1999 Regional Haze Rule. The Mid-Atlantic/Northeast Visibility Union (MANE-VU) Technical Support Committee (TSC) has adopted a weight-of-evidence approach as a first step toward meeting these obligations and in an effort to better understand the causes of visibility impairment at Class I areas within the MANE-VU region. The weight-of-evidence approach relies on several independent methods for assessing the contribution of different emissions sources and geographic source regions to regional haze in the northeastern and mid-Atlantic portions of the United States.

The preliminary findings described in this report draw from the considerable body of work that has already been developed concerning the nature and extent of visibility impairment in the MANE-VU region. This work has produced a conceptual model of regional haze in which sulfate emerges as the most important single constituent of haze-forming fine particle pollution and the principle cause of visibility impairment across the 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. Even on the 20 percent clearest days, sulfate generally accounts for the largest fraction (40 percent or more) of total fine particle mass in the region. Sulfate has an even larger effect when one considers the differential visibility impacts of different particle constituents. It typically accounts for 70–82 percent of estimated particle-induced light extinction at northeastern and mid-Atlantic Class I sites.

While substantial visibility impairment is common across the region, it is most severe in the southern and western portions of MANE-VU that are closest to large power plant sources of sulfur dioxide (SO_2) emissions located in the Ohio River and Tennessee Valleys. Summertime visibility is driven almost exclusively by the presence or absence of regional sulfate, whereas wintertime visibility depends on a combination of regional *and* local influences coupled with local meteorological conditions (inversions) that can lead to the concentrated build-up of emissions from local sources.

These findings suggest that an effective emissions management approach would rely heavily on broad-based regional SO_2 control efforts in the eastern United States aimed at reducing summertime fine particulate matter ($PM_{2.5}$) concentrations. MANE-VU is investigating additional measures to reduce in-region emissions of SO_2 and organic carbon (OC), which is typically the next most important contributor to overall fine particle mass throughout the region. Nearby SO_2 reductions can help reduce wintertime PM concentrations, while OC reductions can help reduce total PM concentrations year-round. For areas with high wintertime PM levels, strategies aimed at reducing ambient levels of nitrogen oxides (NO_X) may also be effective.

Available monitoring data provide strong evidence that regional SO_2 reductions have yielded, and will continue to yield, reductions in ambient secondary sulfate levels with subsequent reductions in regional haze and associated light extinction. They indicate that reductions in anthropogenic primary particle emissions will also result in visibility improvements, but that these will not have a zone of influence as large as those of the secondary aerosols.

Given the dominant role of sulfate in the formation of regional haze in the Northeast and Mid-Atlantic region — and the likelihood that SO_2 reductions will therefore need to play a central role in achieving near-term visibility improvements — this report focuses on early efforts to assess the regional sulfate contribution to ambient fine particle levels experienced at the (primarily rural) MANE-VU Class I areas. The primary objective of this report is to identify and describe the suite of analytical tools and techniques that are presently available for: (1) understanding the causes of sulfate-driven visibility impairment at Class I areas in MANE-VU and nearby regions, as well as the relative contribution of various emissions sources and geographic source regions; and (2) describe how these tools and techniques will be applied in future MANE-VU SIP work.

The analytical and assessment tools discussed in this report include Eulerian (grid-based) source models, Lagrangian (air parcel-based) source dispersion models, as well as a variety of data analysis techniques that include source apportionment models, back trajectory calculations, and the use of monitoring and inventory data. A range of methodological approaches characterize these tools, which Table ES-1 summarizes. The tools rely on different data sources and entail varying degrees of sophistication and uncertainty. Thus, it is important to emphasize that these methods have been extensively reviewed, updated, and refined over the past year to ensure that the highest quality results are now available for the SIP development process. The overall coherence and consistency of results that emerges from application of these tools and techniques suggest that what is known about the causes of sulfate pollution in the MANE-VU region is sufficiently robust to provide a useful and appropriate basis for design of future control programs and for consultations between different regional organizations charged with planning for compliance with the Regional Haze Rule.

Figure ES-1 provides one illustration of the high degree of correspondence in the results. The figure shows rankings of state contributions to sulfate mass at Brigantine Wilderness Area in New Jersey derived from several of the techniques listed in Table ES-1.[1] There is substantial consistency across a variety of analysis methods using techniques based on disparate chemical, meteorological and physical principles. Taken together, these findings create a strong weight-of-evidence case for the preliminary identification of the most significant contributors to visibility impairment in the MANE-VU Class I areas.

Similar results for other sites demonstrate that highly simplified, empirical approaches for identifying source contributions are consistent with more sophisticated approaches. Therefore, a firm basis exists for addressing contributions to regional transport of sulfate, and the range of variability between these techniques suggests the precision of these estimates.

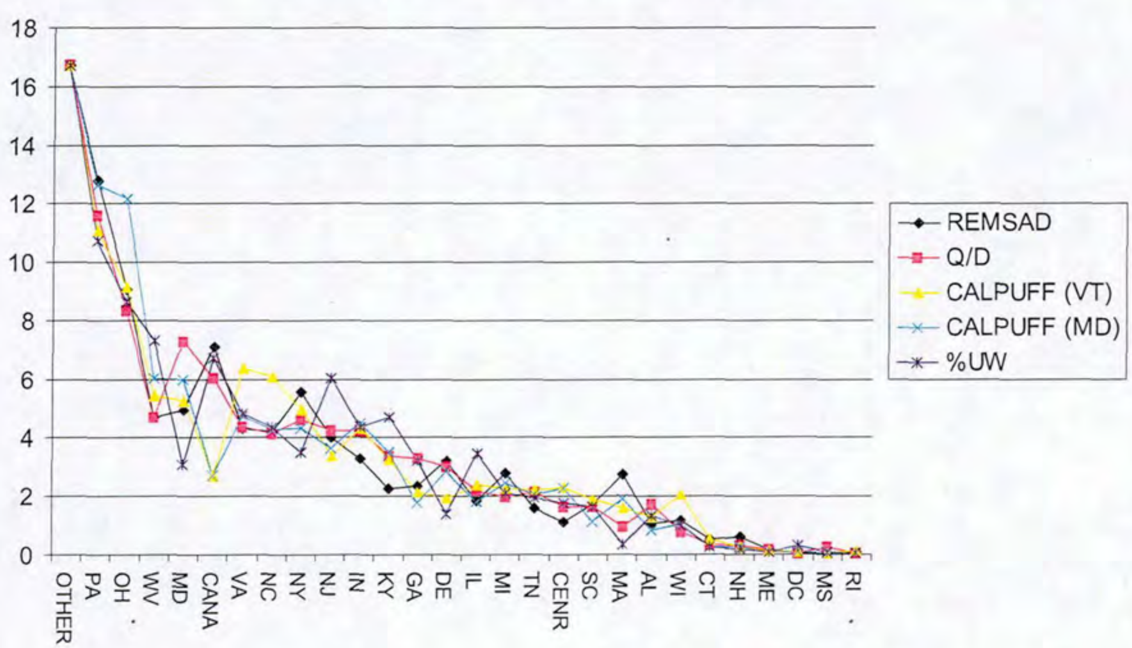
[1] As described in Chapter 8, REMSAD is the only analysis platform used to quantify "out of domain" contributions to sulfate. Thus, the REMSAD calculated contribution for the "out of domain" sources (17% at Brigantine, NJ) was used to calculate the percent contribution shown in Figure ES-1 for all other methods.

We have further aggregated these results by regional planning organization (RPO) using state-by-state sulfate mass contributions (in $\mu g/m^3$) derived by the REMSAD, CALPUFF, emissions/distance, and emissions times (×) upwind probability methods.[2] Figure ES-2 shows these results in terms of their absolute contribution (displayed within the bars shown in the graphic) and in terms of their proportional contribution relative to other RPOs.[1]

Table ES-1. Summary of technical approaches for attributing state contributions to observed sulfate in MANE-VU Class I areas.

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

Figure ES-1. Comparison results using different techniques for ranking state contributions (in units of percent of in-domain contribution) to sulfate levels at Brigantine Wilderness Area, New Jersey.



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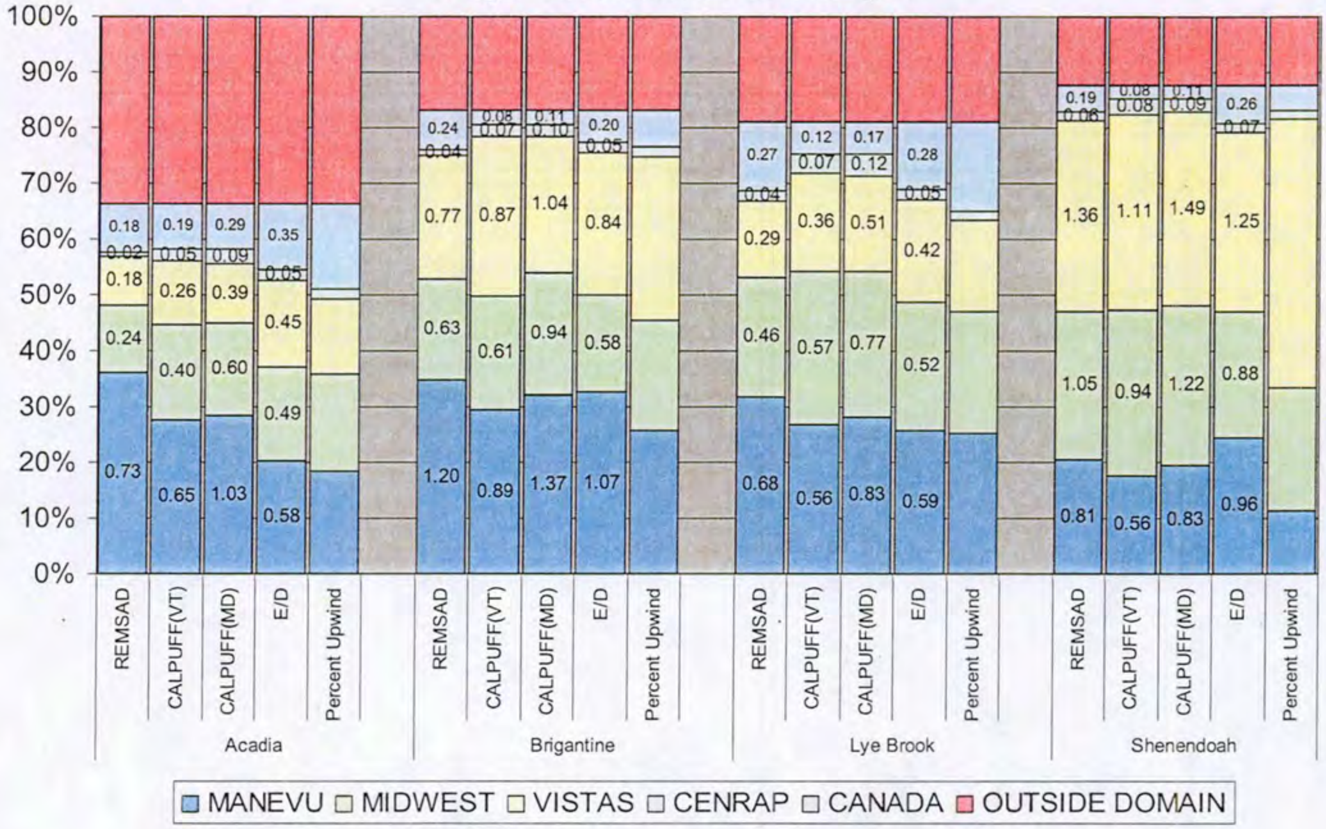
[2] See Chapter 4 for an explanation of how the emissions divided by distance technique is expressed as a sulfate mass concentration and the associated assumptions for the emissions × upwind probability method.

Notwithstanding small differences in precisely which states were included within each assessment technique, estimates obtained from averaging over the five quantitative assessment techniques indicate that MANE-VU states account for about 25-30 percent of the sulfate in the Acadia, Brigantine, and Lye Brook Class I areas. The Midwest RPO (MWRPO) and Visibility Improvement State and Tribal Association of the Southeast (VISTAS) states each account for about 15 percent of the total sulfate contribution at Acadia and about 25 percent each at Brigantine and Lye Brook. The Central states Regional Air Partnership (CENRAP) states, Canada, and an "out of domain" contribution add the remainder.[3] Although variation exists across estimates of contributions for different sites and using different techniques, the overall pattern is generally consistent.

Figure ES-2. Estimated RPO contributions to sulfate concentrations at Class I areas using different assessment techniques



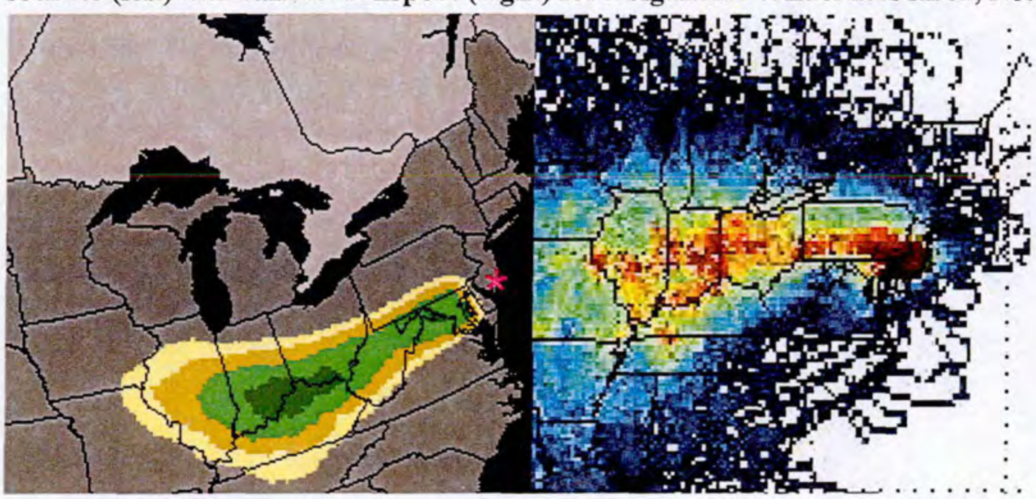
Shenandoah National Park, Virginia, which is a VISTAS Class I area, has a somewhat reversed order of relative contributions. There, VISTAS and MWRPO states account for roughly 30 percent of overall sulfate each, with MANE-VU states contributing roughly 15-20 percent and CENRAP states, Canada and "out of domain" accounting for the remainder.

[3] Note here that the contribution representing out of domain sources was – in all cases – derived solely by the REMSAD platform and that this value has been applied to the other analysis techniques to provide a consistent estimate of the total contributions to sulfate pollution at each site.

Other qualitative analysis methods have been developed that reinforce the findings shown above. These include trajectory methods and source apportionment techniques. These receptor-based methods provide compelling support for the more quantitative attribution methods discussed previously. Figure ES-3 (left panel) shows the source region associated with a "coal combustion/secondary sulfate" source profile observed at Brigantine Wilderness in New Jersey and (right panel) the predominant meteorological pathways associated with the highest sulfate observations at Brigantine. The meteorological transport regime most common during high sulfate observations (shown on the right) directly connects the most likely source region with the receptor site (shown on the left), which reinforces the large quantitative contributions of source states determined for the Brigantine receptor in Chapter 8.

Finally, we note that while sulfate is the most important particle constituent for designing near-term control strategies, reductions in other local and distant pollutant emissions are important. Additional measures will be necessary in the long term to address public health impacts of ambient fine particle concentrations and to achieve long-term regional haze goals to restore pristine visibility conditions year-round in the nation's Class I wilderness areas. This is especially true during winter months, when planners need to give particular consideration to reducing urban and mobile sources of NO_X and OC as well as sources of SO_2.

Figure ES-3. Geographic regions associated with "coal combustion/secondary sulfate" sources (left) and sulfate transport (right) for Brigantine Wilderness Area, NJ.



Note: This figure is the consistency of interpretation between the "coal-combustion/secondary sulfate" source region and receptor site shown in the left hand panel being directly connected by the predominant meteorological transport pathway on high observed sulfate days at Brigantine, shown in the right hand panel.

1. INTRODUCTION

The 1999 Regional Haze Rule (hereafter, the Haze Rule) requires States and Tribes to submit State Implementation Plans (SIPs) to the U.S. Environmental Protection Agency (USEPA) for approval by January 2008 at the latest. The haze SIPs must include a "contribution assessment" to identify those states or regions that may be influencing specially protected federal lands known as Federal Class I areas.[4] These states or regions would then be subject to the consultation provisions of the Haze Rule. The Haze Rule also requires a "pollution apportionment" analysis as part of the long-term emissions management strategy for each site.

In 2004, Congress harmonized the timeline for SIP submissions, including SIPs for meeting federal fine particulate matter ($PM_{2.5}$) and regional haze requirements.[5] One effect of this change is that the "regional planning SIP" or "committal SIP" — originally due one year after PM designations — will now be due along with all other SIP products in late 2007 or early 2008.

The Haze Rule originally would have applied a very low threshold test to determine whether a state would be part of a regional planning process, As a result of the congressional harmonization, however, the requirement for a contribution assessment is now, in effect, part of the "pollution apportionment" analysis used to determine which sources must be included in a long-term emissions management strategy. This is subject to a somewhat higher threshold of evidence since it forms the basis for judging whether long-term strategies are adequately addressing the causes of haze in protected areas.

To adequately determine the degree to which specific geographic regions or areas are contributing to visibility impairment at MANE-VU Class I areas, the MANE-VU Technical Support Committee (TSC) has adopted a weight-of-evidence approach that relies on several independent methods of attribution. These include Eulerian (grid-based) source models, Lagrangian (air pollution-based) source dispersion models, and a variety of data analysis techniques that include source apportionment models, back trajectory calculations, and the use of monitoring and inventory data.

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[4] 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. In the MANE-VU area, this includes: Acadia National Park, Maine; Brigantine Wilderness (within the Edwin B. Forsythe National Wildlife Refuge), New Jersey; Great Gulf Wilderness, New Hampshire; Lye Brook Wilderness, Vermont; Moosehorn Wilderness (within the Moosehorn National Wildlife Refuge), Maine; Presidential Range – Dry River Wilderness, New Hampshire; and Roosevelt Campobello International Park, New Brunswick.

[5] In the Omnibus Appropriations Act of 2004 [Consolidated Appropriations Act for Fiscal Year 2004, Pub. L. 108–199, January 23, 2004], Congress harmonized both designations and regional haze SIP deadlines. EPA promulgated $PM_{2.5}$ designations for all areas of each state on December 17, 2004. The Omnibus Appropriations Act provides that regional haze SIPs for each state as a whole are then due not later than three years after promulgation of the $PM_{2.5}$ designations. Thus, all components of the regional haze SIPs are now due no later than December 17, 2007 (three years after the USEPA issued the official designations). The USEPA has suggested informally that they will accept Regional Haze SIPs in April 2008 when $PM_{2.5}$ SIPs are due.

While we already know much about visibility impairment and its causes in the MANE-VU region (see NESCAUM, 2001; NESCAUM, 2002), significant gaps in understanding remain with respect to the organic component of fine particulate pollution. While we expect continuing research activities to substantially benefit future SIP efforts, the MANE-VU members have determined that sufficient information exists to design effective emission control strategies to meet visibility goals through 2018.

Reducing sulfur emissions offers particular leverage for achieving near-term visibility goals. It is the sulfate fraction of airborne fine particle matter that dominates light extinction on the 20 percent worst visibility days in the Northeast and Mid-Atlantic region. This is important because improving visibility on the 20 percent worst days is a near-term regulatory objective under the Regional Haze rule. In addition, many tools are available for assessing sulfate contributions. Therefore, this document focuses to a large extent on assessing sources and source regions for the sulfate fraction of haze-causing particles.

To lay a foundation for the analyses described in later chapters of this report, Chapter 2 provides a conceptual model of visibility impairment in the eastern United States. Chapter 3 presents a summary of available monitoring data and observations that we use to support the conceptual model and to validate models and data analyses. In fact, measured data — far from being used merely to support modeling analyses — serve as the primary basis for several of the receptor techniques presented in later chapters. There is thus no substitute for a robust monitoring network to understand the causes of fine particle pollution and visibility impairment.

Later chapters reinforce the notions introduced in Chapters 2 and 3 in using emission inventories (Chapter 4), receptor-based approaches including the use of back trajectories, trajectory clustering techniques and source apportionment models (Chapter 5), Eulerian chemical transport models (Chapter 6), and Lagrangian dispersion models (Chapter 7). We synthesize and interpret these various techniques in Chapter 8 and present conclusions in Chapter 9. We discuss technical aspects of the analyses in several of these later chapters in greater detail in a series of appendices.

As a general matter throughout this report, the focus is on assessing the contribution of all sources within broad geographical areas (i.e., whole states) whose combined emissions are likely to contribute to regional haze. As cited in Watson (2002), the National Research Council (NRC) has concluded that:

> (1) "…a program that focuses solely on determining the contribution of individual emission sources to visibility impairment is doomed to failure. Instead, strategies should be adopted that consider many sources simultaneously on a regional basis, although assessment of the effect of individual sources will remain important in some situations;" (2) "…there are (and will probably continue to be) considerable uncertainties in ascertaining a precise relationship between individual sources and the spatial pattern of regional haze;" and (3) "…the best approach for evaluating emission sources is a nested progression from simpler and more direct models to more complex and detailed methods" (Watson, 2002).

Watson (2002) goes on to point out that, "Part of the modeling conundrum is the focus of modeling efforts on demonstrating attainment rather than gaining a better understanding of the situation. Although USEPA emphasizes the construction of a conceptual model and evaluation of the weight of evidence in its introduction, the modeling details contained in the guidance are business as usual: seeking a quantitative comparison of present and future design values with a numerical goal."

Consistent with the NRC's admonition and USEPA's stated desire to incorporate weight-of-evidence approaches to improve conceptual models, MANE-VU has attempted wherever possible to incorporate qualitative analyses in sensible ways so as to increase confidence in its quantitative estimates of the contribution of various emissions sources and source regions to regional haze.

References

NESCAUM, *Regional Haze and Visibility Impairment in the Northeast and Mid-Atlantic United States*, Northeast States for Coordinated Air Use Management, Boston, MA, January, 2001.

NESCAUM, *Updated Visibility Statistics for the MANE-VU Region Technical Memorandum #1,* Northeast States for Coordinated Air Use Management, Boston, MA February, 2002.

Watson, J., "Visibility: Science and Regulation," *JAWMA* 52:628-713, 2002.

2. CONCEPTUAL MODEL OF REGIONAL HAZE IN THE MANE-VU REGION

Developing a conceptual model of regional haze requires combining experience and atmospheric-science expertise with multiple data sources and analysis techniques. This includes measured data on ambient pollutant concentrations as well as emission inventory and meteorological data, chemical transport modeling, and observationally based models (NARSTO, 2003). Here, we begin with a conceptual model based on the existing scientific literature concerning fine particles and their effect on visibility. This includes numerous review articles and reports on the subject. Most past assessments of fine particle pollution and visibility impairment have tended to be national in scope. For purposes of this discussion, we have selectively reviewed the literature in order to present a distinctly Eastern focus.

Because the uncertainties involved in any particular method of analysis are usually large or ill-defined, it is preferable to develop visibility and fine particle management strategies with inputs from multiple analyses using multiple approaches. The MANE-VU TSC has adopted this approach, which leads to the diversity of data analyses and model results that follow. Later chapters of this report use original contributions and analyses developed by MANE-VU researchers to bolster and support the concepts presented in these introductory chapters. MANE-VU has combined the outputs and integrated them into a final conceptual model that explains the formation and transport mechanisms for fine particulate matter in the eastern United States.

2.1. Visibility Effects of Particulate Matter (PM)

Visibility impairment in the eastern United States is largely due to the presence of light-absorbing and light-scattering fine particles in the atmosphere. The USEPA has identified visibility impairment as the best understood of all environmental effects of air pollution (Watson, 2002). A long-established physical and chemical theory relates the interaction of particles and gases in the atmosphere with the transmission of visual information along a sight path from object to observer.

Visibility-impairing particle-light interactions are sensitive to the chemical composition of the particles involved, and also depend strongly on ambient relative humidity. Secondary particles, which form in the atmosphere through chemical reactions, tend to fall within a size range that is most effective at scattering visible light (NARSTO, 2003). These particles are generally smaller than one micrometer (μm) or one one-millionth of a meter. The particles that contribute most to visibility impairment also are a concern under the health-based National Ambient Air Quality Standard (NAAQS) for fine particulate matter, defined as including all particles with an aerodynamic diameter less than 2.5 μm ($PM_{2.5}$).

2.2. Chemical Composition of Particulate Matter in MANE-VU

Sulfate alone accounts for anywhere from one-half to two-thirds of total fine particle mass on the 20 percent haziest days at all MANE-VU Class I sites. Even on the 20 percent clearest days, sulfate generally accounts for the largest fraction (40 percent or more) of total fine particle mass in the region (NESCAUM, 2001). Sulfate accounts for a major fraction of $PM_{2.5}$, not only in the Northeast but across the eastern United States (NARSTO, 2003).

After sulfate, organic carbon (OC) consistently accounts for the next largest fraction of total fine particle mass. Its contribution typically ranges from 20 to 30 percent of total fine particle mass on the haziest days. The fact that the contribution from organic carbon can be as high as 40 percent at the more rural sites on the 20 percent clearest days is likely indicative of the role played by organic emissions from vegetation (so-called "biogenic hydrocarbons" (HC)). Relative contributions to overall fine particle mass from nitrate (NO_3), elemental carbon, and fine soil are all smaller (typically under 10 percent), but the relative ordering among the three species varies with location. Nitrate plays a noticeably more important role at urban sites compared to northeastern and mid-Atlantic Class I locations, perhaps reflecting a greater contribution from vehicles and other urban pollution sources (NESCAUM, 2001).

Almost all particle sulfate originates from sulfur dioxide (SO_2) oxidation and typically associates with ammonium (NH_4) in the form of ammonium sulfate ($(NH_4)_2SO_4$), 95 percent of SO_2 emissions are from anthropogenic sources (primarily from fossil fuel combustion), while the majority of ammonium comes from agricultural activities and, to a lesser extent, from transportation sources in some areas (NARSTO, 2003).

Two major chemical pathways produce sulfate from SO_2 in the atmosphere. In the gas phase, production of sulfate involves the oxidation of SO_2 to sulfuric acid (H_2SO_4), ammonium bisulfate (NH_4HSO_4), or ammonium sulfate, depending on the availability of ammonia (NH_3). In the presence of small wet particles (typically much, much smaller than rain drops or even fog), a highly efficient aqueous phase process can oxidize SO_2 to sulfate extremely quickly (~10 percent per hour).

Not only is sulfate the dominant contributor to fine particle mass in the region, it accounts for anywhere from 60 percent to almost 80 percent of the difference between fine particle concentrations on the clearest and haziest days at northeastern and mid-Atlantic Class I sites. Notably, at urban locations such as Washington, DC, sulfate accounts for only about 40 percent of the difference in average fine particle concentrations for the 20 percent most versus least visibility impaired days (NESCAUM, 2001). We discuss this further in the next section of this chapter.

Some of the dominant components of total fine particle mass have an even larger effect when considering the differential visibility impacts of different particle species. Sulfate typically accounts for over 70 percent of estimated particle-induced light extinction at northeastern and mid-Atlantic Class I sites. Organic carbon continues to be the second most important contributor to particle-induced light extinction at rural sites on the most impaired days, but slips to third behind nitrate in Washington, DC (NESCAUM, 2001).

2.3. Geographic Considerations and Attribution of PM/Haze Contributors

In the East, an accumulation of particle pollution often results in hazy conditions extending over thousands of square kilometers (km^2) (NARSTO, 2003). Substantial visibility impairment is a frequent occurrence in even the most remote and pristine areas of the Northeast and Mid-Atlantic region (NESCAUM, 2001).

Both annual average and maximum daily fine particle concentrations are highest near heavily industrialized areas and population centers. Not surprisingly, given the direct connection between fine particle pollution and haze, the same pattern emerges when one compares measures of light extinction on the most and least visibility impaired days at parks and wilderness areas subject to the Haze Rule in the Northeast and Mid-Atlantic region (NESCAUM, 2001).

Contributions to fine particle mass concentrations at rural locations include long-range pollutant transport as well as non-anthropogenic background contributions. Urban areas generally show mean $PM_{2.5}$ levels exceeding those at nearby rural sites. In the Northeast, this difference implies that local urban contributions are roughly 25 percent of the annual mean urban concentrations, with regional aerosol contributing the remaining, and larger, portion (NARSTO, 2003).

This rural versus urban difference in typical concentrations also emerges in a source apportionment analysis of fine particle pollution in Philadelphia (Chapter 10, NARSTO, 2003) using two different mathematical models, UNMIX and Positive Matrix Factorization (PMF). (We describe these models in greater detail in Chapter 5 and Appendix B.) This analysis provides additional insight concerning sources of fine particle pollution in urban areas of the densely populated coastal corridor between Washington D.C. and New England. Specifically, this analysis found the following apportionment of $PM_{2.5}$ mass in the study area:

- Local SO_2 and sulfate: ~ 10 percent
- Regional sulfate: ~ 50 percent
- Residual oil: 4-8 percent
- Soil: 6–7 percent
- Motor vehicles: 25–30 percent

The analysis does not account for biogenic sources, which most likely are embedded in the motor vehicle fraction (NARSTO, 2003). The Philadelphia study suggests that both local pollution from near-by sources and transported "regional" pollution from distant sources contribute to the high sulfate concentrations observed in urban locations along the East Coast on an annual average basis. Summertime sulfate and organic carbon are strongly regional in eastern North America. Typically 75–95 percent of the urban sulfate concentrations and 60–75 percent of the urban OC concentrations arise from cumulative region-wide contributions (NARSTO, 2003).

While these statistics provide some preliminary context for attributing responsibility for the region's particulate matter and visibility problems, they say nothing about the relative efficiency of a state's or region's emissions in causing or contributing to the problem. It is clear that distance from the emissions source matters. Local, near-by sources are exceedingly important and sources within about 200 kilometers (km) are much more efficient (on a per ton emitted basis) at producing pollution impacts at eastern Class I sites such as Shenandoah National Park than emissions sources farther away (USNPS, 2003). In general, the "reach" of sulfate air pollution resulting from SO_2

emissions is longest (650-950 km). The reach of ammonia emissions or reduced nitrogen relative to nutrient deposition is the shortest (around 400 km), while oxides of nitrogen and sulfur — in terms of their impacts with respect to acidic deposition — have a reach between 550–650 km and 600–700 km, respectively (USNPS, 2003).

Monitoring evidence indicates that non-urban visibility impairment in eastern North America is predominantly due to sulfate particles, with organic particles generally second in importance (NARSTO, 2003). This makes sense, given the "long reach" of SO_2 emissions once they are chemically transformed into sulfate and given the ubiquitous nature of OC sources in the East.

The poorest visibility conditions occur in highly industrialized areas encompassing and adjacent to the Ohio and Tennessee River Valleys. These areas feature large coal-burning power stations, steel mills, and other large emissions sources. Average visibility conditions are also poor in the highly populated and industrialized mid-Atlantic seaboard but improve gradually northeast of New York City (Watson, 2002).

A review of source apportionment and ensemble trajectory analyses conducted by USEPA (2003) found that all back trajectory analyses for Eastern sites associated sulfate with the Ohio River Valley area. Studies also frequently associated other types of industrial pollutants with known source areas. Several studies in the USEPA review noted transport across the Canadian border, specifically sulfates from the midwestern United States into Canada, and smelter emissions from Canada into the northeastern United States.

A recent, comprehensive analysis of air quality problems at Shenandoah National Park conducted by the U.S. National Park Service (USNPS, 2003) focused on contributions to particulate pollution and visibility impairment south of the MANE-VU region. In descending order of importance, the National Park Service analysis determined that Ohio, Virginia, West Virginia, Pennsylvania, and Kentucky comprise the top five of thirteen key states contributing to ambient sulfate concentrations and haze impacts at the park. West Virginia, Ohio, Virginia, Pennsylvania, and Kentucky comprise the top five contributing states with respect to sulfur deposition impacts at the park. Finally, Virginia, West Virginia, Ohio, Pennsylvania, and North Carolina were found to be the top five states contributing to deposition impacts from oxidized nitrogen at the park (USNPS, 2003).

In summary, the National Park Service found that emission sources located within a 200 kilometer (125 mile) radius of Shenandoah cause greater visibility and acidic deposition impacts at the park, on a per ton basis, than do more distant emissions sources (USNPS, 2003). When mapping deposition and concentration patterns for all three pollutants using contour lines, the resulting geographic pattern shows a definite eastward tilt in the area of highest impact. This is the result of prevailing wind patterns, which tend to transport most airborne pollutants in an arc from the north-northeast to the east.[6] The Park Service found, for example, that emissions originating in the Ohio River Valley end up three times farther to the east than to the west (USNPS, 2003).

[6] The prevailing winds are eastward to northeast. This leads to greater pollution transport to the east-northeast relative to other directions.

We note that several MANE-VU states may themselves be contributing to fine particle mass concentrations observed at Shenandoah. According to the Park Service analysis, sources in Pennsylvania contribute on the order of 10 percent of observed ambient sulfate mass at the park, while sources in Maryland, New York and Delaware contribute 3.5, 1.7 and 0.5 percent respectively (USNPS, 2003).

2.4. Seasonal differences

Eastern and western coastal regions of the United States and Canada show marked seasonality in the concentration and composition of fine particle pollution, while central interior regions do not (NARSTO, 2003). While the MANE-VU domain extends inland as far as the Pennsylvania and Ohio border, the majority of Class I areas in MANE-VU cluster along the East Coast and thus typically show strong seasonal influences. Maximum $PM_{2.5}$ concentrations occur during the summer over most of the Northeast, with observed summer values for rural areas in the region, on average, twice those of winter. Winter nitrate concentrations, however, are generally higher than those observed in summer and, as mentioned above, urban concentrations typically exceed rural concentrations year-round. In addition, local mobile source carbon grows in importance during wintertime. Hence, in some large urban areas such as Philadelphia and New York City, peak concentrations of $PM_{2.5}$ can occur in winter.

The conceptual models that explain elevated regional $PM_{2.5}$ peak concentrations in the summer differ significantly from models that explain the largely urban peaks observed during winter. On average, summertime concentrations of sulfate in the northeastern United States are more than twice that of the next most important fine particle constituent, OC, and more than four times the combined concentration of nitrate and black carbon (BC) constituents (NARSTO, 2003). Episodes of high summertime sulfate concentrations are consistent with stagnant meteorological flow conditions and the accumulation of airborne sulfate (via atmospheric oxidation of SO_2) through long-range transport of sulfur emissions from industrialized areas within and outside the region.

National assessments (NARSTO, 2003) have indicated that in the winter, sulfate levels in urban areas are almost twice as high as background sulfate levels across the eastern U.S., indicating that the local urban contribution to wintertime sulfate levels is comparable in magnitude to the regional sulfate contribution from long-range transport. MANE-VU's network analysis for the winter of 2002 suggests that the local enhancement of sulfate in urban areas of the OTR is somewhat less with ranges from 25 to 40% and that the long range transport component of PM sulfate is still the dominant contributor in most eastern cities.

In the winter, urban OC and sulfate each account for about a third of the overall $PM_{2.5}$ mass concentration observed in Philadelphia and New York City. Nitrate also makes a significant contribution to urban $PM_{2.5}$ levels observed in the northeastern United States during the winter months. Wintertime concentrations of OC, sulfate, and NO_3 in urban areas can be twice the average regional concentrations of these pollutants, indicating the importance of local source contributions (NARSTO, 2003). This is likely because winter conditions are more conducive to the formation of local inversion layers that prevent vertical mixing. Under these conditions, emissions from tailpipe, industrial and other local sources become concentrated near the Earth's surface, adding to background pollution levels associated with regionally transported emissions.

It is worth noting that while sulfate plays a significant role in episodes of elevated particle pollution during summer and winter months, the processes by which sulfate forms may vary seasonally. Nearly every source apportionment study reviewed by USEPA (2003) identified secondary sulfate originating from coal combustion sources as the largest or one of the largest contributors to overall fine particle mass in the region. It often accounted for more than 50 percent of $PM_{2.5}$ mass at some locations during some seasons. In a few cases, source apportionment studies identified a known local source of sulfate, but most assessments (in conjunction with back trajectory analysis) have pointed to coal-fired power plants in the Midwest as an important source for regional sulfate. Studies with multiple years of data have also tended to identify a distinguishable chemical "signature" for winter versus summer sources of sulfate, with the summer version typically accounting for a greater share of overall fine particle mass. Researchers have speculated that the two profiles represent two extremes in the chemical transformation processes that occur in the atmosphere between the source regions where emissions are released and downwind receptor sites. We note that while coal combustion is often referred to as the "sulfate source" because of the dominance of its sulfate contribution, coal combustion is usually the single largest source of selenium (Se) and other heavy metal trace elements (USEPA, 2003).

Visually, hazy summer days in the Northeast can appear quite different from hazy winter days. The milky, uniform visibility impairment shown in Figure 2-1 is typical of summertime regional haze events in the Northeast. During the winter, by comparison, reduced convection and the frequent occurrence of shallow inversion layers often creates a layered haze with a brownish tinge, as shown in Figure 2-2. This visual difference suggests seasonal variation in the relative contribution of different gaseous and particle constituents during the summer versus winter months (NESCAUM, 2001). Rural and inland areas tend not to experience these layered haze episodes as frequently due to the lack of local emission sources in most rural areas (valleys with high wood smoke contributions are an exception).

Overall (regional) differences in summer versus winter particle mass concentrations and corresponding visibility impairment (as measured by light extinction) are largely driven by seasonal variation in sulfate mass concentrations. This is because winter meteorological conditions are less conducive to the oxidation of sulfate from SO_2 (as borne out by the previously cited source apportionment studies). In addition, seasonal differences in long-range transport patterns from upwind SO_2 source regions may be a factor.

The greater presence of nitrate during the cold season is a consequence of the chemical properties of ammonium nitrate. Ammonia bonds more weakly to nitrate than it does to sulfate, and ammonium nitrate tends to dissociate at higher temperatures. Consequently, ammonium nitrate becomes more stable at lower temperatures and hence contributes more to overall light extinction during the winter months (NESCAUM, 2001).

Figure 2-1. Summer time at Mt Washington

Clean Day **Typical Haze Event**

Figure 2-2. Wintertime in Boston

Clean Day **Typical Haze Event**

2.5. Implications for control strategies

A 2003 assessment of fine particulate matter by NARSTO[7] notes that, "[c]urrent air-quality management approaches focusing on reductions of emissions of SO_2, NO_X, and VOCs are anticipated to be effective first steps towards reducing $PM_{2.5}$ across North America, noting that in parts of California and some eastern urban areas VOC (volatile organic compounds) emissions could be important to nitrate formation."

This conclusion seems to be well supported by the historical record, which documents a pronounced decline in particulate sulfate concentrations across the eastern United States during the 1990s. The timing of this observed decline suggests that this is linked to reductions in SO_2 emissions resulting from controls implemented under the federal Acid Rain Program beginning in the early to mid 1990s. From 1989 to 1998, SO_2

[7] NARSTO was formerly an acronym for the "North American Research Strategy for Tropospheric Ozone." More recently, the term NARSTO became simply a wordmark signifying a tri-national, public-private partnership for dealing with multiple features of tropospheric pollution, including ozone and suspended particulate matter. For more information on NARSTO see http://www.cgenv.com/Narsto/.

emissions in the eastern half of the country — that is, including all states within a region defined by the western borders of Minnesota and Louisiana — declined by about 25 percent. This decline in SO_2 emissions correlated with a decline of about 40 percent in average SO_2 and sulfate concentrations, as measured at Clean Air States and Trend Networks (CASTNet) monitoring sites in the same region over the same time period. In fact, at prevailing levels of atmospheric SO_2 loading, the magnitudes of the emissions and concentration changes were not statistically different. This finding suggests that regional reductions in SO_2 emissions have produced near-proportional reductions of particulate sulfate in the eastern United States (NARSTO, 2003). Reductions since 1990 in precursor SO_2 emissions are likely also responsible for a continued decline in median sulfate concentrations in the northeastern United States. Nevertheless, the fact that episodes of high ambient sulfate concentrations (with peak levels well above the regional median or average) continue to occur, especially during the summertime when regional transport from the Ohio River Valley is also at its peak, suggests that further reductions in regional and local SO_2 emissions would provide significant further air quality and visibility benefits (NARSTO, 2003).

For urban areas of the northeastern and southeastern United States, an effective emissions management approach may be to combine regional SO_2 control efforts aimed at reducing summertime $PM_{2.5}$ concentrations with local SO_2 and OC control efforts. Local SO_2 reductions would help reduce wintertime PM concentrations, while OC reductions can help reduce overall PM concentrations year-round. For areas with high wintertime PM levels, strategies that involve NO_X reductions may also be effective (NARSTO, 2003).

Further support for this general approach may be found in a review of several studies by Watson (2002) that concluded SO_2 emission reductions have in most cases been accompanied by statistically significant reductions in ambient sulfate concentrations. One study (Husar and Wilson, 1993) shows that regionally averaged light extinction closely tracks regionally averaged SO_2 emissions for the eastern United States from 1940 through the mid-1980s. Another study by Malm et al. (2002) shows that regionally averaged emissions and ambient concentrations decreased together from 1988 through 1999 over a broad region encompassing the states of Connecticut, Delaware, Illinois, Indiana, Kentucky, Maine, Massachusetts, Maryland, Michigan, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, Virginia, Wisconsin, and West Virginia (Watson, 2002).

These studies and available data from the IMPROVE (Interagency Monitoring of Protected Visual Environment) monitoring network provide strong evidence that regional SO_2 reductions have yielded, and will continue to yield, reductions in ambient secondary sulfate levels with subsequent reductions in regional haze and associated light extinction. They indicate that reductions in anthropogenic primary particle emissions will also result in visibility improvements, but that these will not have a zone of influence as large as those of the secondary aerosols (Watson, 2002).

Watson (2002) notes that during the 65 years in which the regional haze program aims to reach its final visibility goals, several opportunities to revise this basic control approach will arise through the decadal SIP cycle. This enables new scientific results to continue to exert a positive influence as states implement new regulatory control programs for SO_2, NO_X and VOCs, and as ambient concentrations of these pollutants change relative to each other and relative to ambient ammonia levels. As these relationships between species change, atmospheric chemistry may dictate a revised control approach to those previously described. Further research on these issues should be a priority for supporting 2018 SIP submissions. They include the possibility that:

- Reduction of sulfate in a fully neutralized atmosphere (excess ammonia) could encourage ammonium nitrate formation.
- Ever greater emissions reductions could be required to produce a given level of improvement in ambient pollutant concentrations because of non-linearities in the atmospheric formation of sulfate.
- Changes in ambient conditions favoring the aqueous oxidation of sulfate (this pathway largely accounts for the non-linearity noted above) may have implications for future emissions control programs. Causes of changing ambient conditions could include, for example, climate change.

West et al. (1999) examine a scenario for the eastern United States where $PM_{2.5}$ mass decreases linearly with ammonium sulfate until the latter is fully neutralized by ammonia. Further reductions would free ammonia for combination with gaseous nitric acid that, in turn, would slightly increase $PM_{2.5}$ until all of the nitric acid is neutralized. At that point, further sulfate reductions would once again be reflected in lower $PM_{2.5}$ mass. This is an extreme case that is more relevant to source areas (e.g., Ohio) where nitric acid (HNO_3) is more abundant than in areas with lower emissions (e.g., Vermont) (Watson, 2002).

In most situations with non-neutralized sulfate (typical of the eastern United States), ammonia is a limiting agent for the formation of nitrate but will not make any difference until sulfate is reduced to the point where it is completely neutralized. At that point, identifying large sources of ammonia emissions will be important. This point is likely to be many years in the future, however (Watson, 2002).

Based on analyses using the Community Multi-Scale Air Quality (CMAQ) model, the aqueous phase production of sulfate in the Northeast appears to be very oxidant limited and hence non-linear. Thus, conditions that are conducive to a dominance of the gas-phase production pathway drive the summer peaks in ambient sulfate levels. Nonetheless, the expected reduction in ambient sulfate levels resulting from a given reduction in SO_2 emissions is less than proportional overall due to the non-linearity introduced by the aqueous pathway for sulfate formation (NARSTO, 2003). These non-linearity effects are more pronounced for haze than for sulfate deposition, especially at higher sulfate air concentrations (USNPS, 2003).

Finally, we note that because visibility in the clearest areas is sensitive to even minute increases in particle concentrations, strategies to preserve visibility on the clearest days may require stringent limits on emissions growth. In this context, even the dilute emissions from distant sources can be important (NARSTO, 2003).

2.6. Summary

The presence of fine particulate matter in ambient air significantly obscures visibility during most parts of the year at sites across the MANE-VU region. Particle pollution generally, and its sulfate component specifically, constitute the principle driver for regional visibility impacts. While the broad region experiences visibility impairment, it is most severe in the southern and western portions of MANE-VU that are closest to large power plant SO_2 sources in the Ohio River and Tennessee Valleys.

The presence or absence of regional sulfate almost exclusively drives summer visibility impairment, whereas winter visibility depends on a combination of regional and local influences coupled with local meteorological conditions (inversions) that lead to the concentrated build-up of pollution.

Sulfate is the key particle constituent from the standpoint of designing control strategies to improve visibility conditions in the northeastern United States. Significant further reductions in ambient sulfate levels are achievable, though they will require more than proportional reductions in SO_2 emissions.

Long-range pollutant transport and local pollutant emissions are important, especially along the eastern seaboard, so one must also look beyond the achievement of further sulfate reductions. During the winter months, in particular, consideration also needs to be given to reducing urban sources of SO_2, as well as NO_X and OC (NARSTO, 2003).

References

Husar, R.B. and Wilson, W.E., "Haze and Sulfur Emission Trends in the Eastern United States," *Environ. Sci. Technol. 27* (1), 12-16, 1993.

NARSTO, *Particulate Matter Science for Policy Makers: A NARSTO Assessment*, EPRI 1007735, February, 2003.

NESCAUM, *Regional Haze and Visibility Impairment in the Northeast and Mid-Atlantic United States*, Northeast States for Coordinated Air Use Management, Boston, MA, January, 2001.

Malm, W. C., Schichtel, B. A., Ames, R.B., and Gebhart, K.A., "A 10-year spatial and temporal trend of sulfate across the United States," *J. Geophys. Res. 107(D22):4627*, doi:10.1029/2002JD002107, 2002.

USEPA, *COMPILATION OF EXISTING STUDIES ON SOURCE APPORTIONMENT FOR $PM_{2.5}$, Second Draft*, Emissions, Monitoring, and Analysis Division, Office of Air Quality Planning and Standards, Research Triangle Park, NC, August, 2003.

USNPS, *Assessment of Air Quality and Related Values in Shenandoah National Park*, Technical Report NPS/NERCHAL/NRTR-03/090, U.S. Department of the Interior, National Park Service, Northeast Region, Philadelphia, Pennsylvania, May, 2003.

Watson, J., "Visibility: Science and Regulation," *JAWMA* 52:628-713, 2002.

West, J.J., Ansari, A.S., and Pandis, S.N., "Marginal $PM_{2.5}$: Nonlinear Aerosol Mass Response to Sulfate Reductions in the Eastern United States," *JAWMA* 49:1415-1424, 1999.

3. OVERVIEW OF MONITORING RESULTS

SIP developers use monitoring data in three important ways to support regional haze SIP activities. Section 3.1 presents measurements from the IMPROVE network needed in establishing SIP requirements. Following USEPA guidance (USEPA, 2003a; USEPA, 2003b), we use these data to preview the uniform progress goals that SIP developers must consider for each Class I area.

Section 3.2 reviews a recent NESCAUM report (NESCAUM, 2004b) to demonstrate how available monitoring data support and validate the conceptual model presented in Chapter 2.

Section 3.3 presents early results from the MANE-VU Real-Time Aerosol Intensive Network (RAIN). These suggest some of the ways MANE-VU is preparing to extend and improve understanding of visibility issues across the region. We anticipate this aspect of the MANE-VU monitoring strategy to be critical for future status reports and SIP updates.

3.1. Baseline Conditions

The Haze Rule requires states and tribes to submit plans that include calculations of current and estimated baseline and natural visibility conditions. They will use monitoring data from the IMPROVE program as the basis for these calculations. Table 3-1 presents the five-year average[8] of the 20 percent worst day mass concentrations in six Class I areas. Five of these areas are in MANE-VU and one (Shenandoah) is nearby but located in a neighboring regional planning organization (RPO) region.[9] Table 3-2 gives the corresponding worst day contributions to particle extinction for the six Class I areas. Each of these tables show the relative percent contribution for all six Class I sites. Sulfate and organic carbon dominate the fine mass, with sulfate even more important to particle extinction.

To guide the states in calculating baseline values of reconstructed extinction and for estimating natural visibility conditions, USEPA released two documents in the fall of 2003 outlining recommended procedures (USEPA 2003a; USEPA 2003b). These proposed methods were used, along with the data in Table 3-1 and Table 3-2 to create Table 3-3, which provides detail on the 20 percent worst conditions for the six Class 1 areas.

The first column of data in the Table 3-3 gives the default natural background levels for the worst visibility days at these six sites. Although debate continues with regard to some assumptions underlying the USEPA default approach for estimating natural background visibility conditions, MANE-VU has decided to use this approach, at least initially, for 2008 SIP planning purposes (NESCAUM, 2004a). The second column shows the baseline visibility conditions on the 20 percent worst visibility days. These values are based on IMPROVE data from the official five-year baseline period (2000-

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[8] Great Gulf calculations are based on four years of data (2001-2004).

[9] Note that values presented for Shenandoah, a Class I area in the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) region, are for comparative purposes only. VISTAS will determine uniform rates of progress for areas within its region.

2004). Using these baseline and natural background estimates, we derive the uniform rate of progress shown in the third column.[10] The final column displays the interim 2018 progress goal based on 14 years of improvement at the uniform rate.

Table 3-1. Fine mass and percent contribution for 20% worst days

20% Worst-day fine mass (μg/m³) / % contribution to fine mass					
Site	SO_4	NO_3	OC	EC	Soil
Acadia	6.3 / 60%	0.8 / 8%	2.5 / 23%	0.4 / 4%	0.5 / 5%
Brigantine	11.5 / 59%	1.8 / 9%	4.5 / 23%	0.7 / 4%	1.0 / 5%
Great Gulf	7.3 / 63%	0.3 / 3%	2.9 / 25%	0.4 / 3%	0.6 / 5%
Lye Brook	8.5 / 62%	1.1 / 8%	3.0 / 22%	0.5 / 3%	0.6 / 5%
Moosehorn	5.7 / 58%	0.7 / 7%	2.6 / 27%	0.4 / 4%	0.4 / 4%
Shenandoah	13.2 / 72%	0.7 / 4%	3.3 / 18%	0.6 / 3%	0.7 / 4%

Table 3-2. Particle extinction and percent contribution for 20% worst days

20% Worst-day particle extinction (Mm^{-1}) / % contribution to extinction						
Site	SO_4	NO_3	OC	EC	Soil	CM
Acadia	66.0 / 73%	8.1 / 9%	10.1 / 11%	4.4 / 5%	0.5 / 1%	1.8 / 2%
Brigantine	106.2 / 69%	16.1 / 10%	18.3 / 12%	7.1 / 5%	1.0 / 1%	5.2 / 4%
Great Gulf	66.5 / 76%	3.0 / 3%	10.6 / 13%	3.8 / 4%	0.5 / 1%	2.9 / 3%
Lye Brook	76.7 / 73%	9.3 / 9%	12.1 / 11%	4.7 / 5%	0.7 / 1%	1.8 / 2%
Moosehorn	56.1 / 70%	6.3 / 8%	10.5/ 13%	4.4 / 5%	0.4 / 0%	2.1 / 3%
Shenandoah	132.5 / 82%	5.8 / 4%	13.2 / 8%	5.7 / 4%	0.8 / 0%	2.6 / 2%

Table 3-3. Natural background and baseline calculations for select Class I areas

Site	Natural Background (dv)	Baseline 2000-04 (dv)	Uniform Rate (dv/year)	Interim Progress Goal 2018 (dv)
Acadia	11.45	22.34	0.18	19.80
Brigantine	11.28	27.60	0.27	23.97
Great Gulf	11.30	22.25	0.18	19.69
Lye Brook	11.25	23.70	0.21	20.80
Moosehorn	11.36	21.18	0.16	18.89
Shenandoah	11.27	27.88	0.28	24.00

The regional haze rule calls for steady improvement of visibility on the 20 percent worst visibility days. States are to consider this uniform rate of progress, and if reasonable measures can be identified to meet or exceed this rate while ensuring no degradation of visibility on the best days, then it should be adopted as a Federal Class I

[10] We calculate the rate of progress as (baseline – natural background)/60 to yield the annual deciview (dv) improvement needed to reach natural background conditions in 2064, starting from the 2004 baseline.

area's *reasonable* progress goal. A number of instructive analyses are presented below using each area's uniform progress goal as an example, but these should not be interpreted as constituting MANE-VU recommendations on reasonable progress goals.

As a practical means of analyzing uniform progress goals, we have examined the components of observed fine particle pollution that substantially contribute to visibility degradation. This analysis shows that certain species dominate the extinction budget while others play virtually no role on the worst haze days.

As demonstrated in Table 3-2, the inorganic constituents of fine particles (sulfates and nitrates) are the dominant contributors to visibility impairment, accounting for about 80 percent of total particle extinction. Within the MANE-VU sites, the relative split between these two components is about eight to one sulfate to nitrate (at Shenandoah, the average 20 percent worst day contribution of sulfates is even more dominant). Carbonaceous components account for the bulk of the remaining particle extinction, ranging from 12 to nearly 20 percent, mostly in the form of organic carbon. The remaining components add little to the extinction budget on the worst days, with a few percent attributable to coarse mass and around a half percent from fine soil.

One approach to designing control strategies for achieving reasonable progress goals is to reduce all components of $PM_{2.5}$ in equal proportion. Achieving the 2018 uniform progress goals (expressed in Mm^{-1} in the second column of Table 3-4) requires between a 29 and 36 percent reduction in each component of the six haze components of fine particle extinction if their relative percent contributions to the current worst baseline conditions are kept constant (see the third column of Table 3-4). Given the dominant role of sulfate and nitrate, however, and the difficulty in obtaining 29 to 36 percent reductions in some of the other categories such as soil or course mass, sulfate- and nitrate-based control programs are likely to offer more reasonable emission reduction opportunities.

Table 3-4. Percent particle B_{ext} reduction needed to meet uniform progress[11]

Site	Particle Extinction Decrease (Mm^{-1})	Uniform Reduction (%)	Sulfate/Nitrate Reduction (%)	OC/EC Reduction (%)
Acadia	27.7	31	38	194
Brigantine	55.3	36	46	218
Great Gulf	30.6	33	42	195
Lye Brook	35.4	34	41	210
Moosehorn	23.4	29	38	158
Shenandoah	57.1	36	42	303

[11] We derive the information in this table from the results of Table 3-3. First, we converted the baseline and interim goal levels from dv to Mm^{-1} units, thus avoiding the logarithmic nature embedded into the deciview calculations. The first column of the table gives the difference between baseline and interim goal. The ratio of this difference to the baseline yields the uniform rate of reduction tabulated in the second column. We generate the paired species reduction percentages by using the wet and dry aerosol extinction coefficients. We determine f(RH) values by dividing the five-year B_{ext} average by the dry extinction coefficient, giving a weighted average value of the f(RH) during the worst 20% of days. Similarly, in Table 3-5, we calculate mass values using the relative contributions of the species to be reduced and their wet and dry efficiencies.

The fourth column of Table 3-4 displays the results if a sulfate and nitrate focused control approach were taken to meet uniform progress goals. For these two inorganic species, a greater reduction would be necessary on the 20 percent worst days if the other four components showed no change relative to baseline levels. The last column shows that the contribution of the carbonaceous species is too small to meet the entire required 2018 progress goal on its own (i.e. the percent reduction is greater than 100) if a carbon-only control approach were attempted.

Since it is easier to understand the implications of requisite mass reductions, rather than extinction, Table 3-5 tabulates the corresponding mass changes required for meeting uniform progress goals on the 20 percent worst days. On an absolute mass basis, the changes across sites are more varied than they are when viewed from a percentage change perspective. That in part is a function of the relative pollution levels at each site, in addition to the logarithmic nature of the deciview (dv). This table (along with Table 3-6) can aid planners to gauge the potential impact that meeting uniform progress goals under the Regional Haze program will have on regional fine particle mass levels.

Table 3-5. Mass reductions required on 20% worst days based on extinction estimates in Table 3-4

	20% Worst Day Mass Reduction ($\mu g/m^3$)							
	Uniform Percent Change All Species				Only Inorganic		Only Carbonaceous	
Site	SO_4	NO_3	OC	EC	SO_4	NO_3	OC	EC
Acadia	1.95	0.25	0.76	0.13	2.38	0.31	4.80	0.85
Brigantine	4.14	0.65	1.64	0.26	5.22	0.82	9.92	1.56
Great Gulf	2.42	0.11	0.97	0.13	3.06	0.14	5.74	0.76
Lye Brook	2.85	0.36	1.02	0.16	3.49	0.44	6.36	1.00
Moosehorn	1.68	0.20	0.77	0.13	2.14	0.26	4.12	0.69
Shenandoah	4.78	0.24	1.19	0.21	5.57	0.28	9.94	1.74

Table 3-6 provides an estimate of mass decreases that might be expected on an average day. It assumes using either a uniform rate of change in *all* species, or a uniform rate of change in the *sulfate and nitrate* component of fine particulate, to achieve the progress toward the 2018 goals, respectively. These values are likely a lower bound to the annual average change at Class I areas anticipated from current conditions to 2018 as they are based on the assumption that on the best days, no change occurs and the percent reduction on the middle days is half of what is predicted on the worst.[12]

[12] We derived the values tabulated in Figure 3-6 as follows: We multiplied half of the percentage change expected on the worst 20% of days by the average mass concentration of each species for the middle 20% of days. Note that if we apply a 25% reduction on the cleaner remaining quintile and 75% reduction on the dirtier remaining quintile, the annual average reduction would presumably be greater than that on the middle days given the skew in the distribution of all days. For example, in the inorganic-only case at Acadia, the average of the worst 20% change and best 20% is (2.69 + 0)/2 or 1.35 $\mu g/m^3$, which is nearly four times greater than the middle day. Further, given the large reduction on the worst days, it is reasonable to expect some small improvement on the best days.

Table 3-6. Estimated Mass Reduction on an Average Day

	Estimated Average Day Mass Reduction ($\mu g/m^3$)					
	Uniform Percent Change All Species				Only Inorganic	
Site	SO_4	NO_3	OC	EC	SO_4	NO_3
Acadia	0.25	0.05	0.16	0.02	0.31	0.06
Brigantine	0.80	0.19	0.38	0.08	1.01	0.25
Great Gulf	0.28	0.04	0.19	0.03	0.36	0.05
Lye Brook	0.29	0.07	0.17	0.03	0.36	0.09
Moosehorn	0.25	0.05	0.19	0.03	0.32	0.06
Shenandoah	0.79	0.24	0.28	0.05	0.92	0.28

3.1.1. Preview of revised IMPROVE Algorithm for aerosol extinction

Recently, the IMPROVE Steering Committee accepted an alternative approach for calculating visibility metrics based on measured aerosol concentrations. The new algorithm improves the correspondence between the reconstructed extinction and directly measured light scattering at the extremes of the visibility range. These extremes form the basis for determining the uniform progress "glide path."

The new equation revises or adds to the original version. The most significant changes include:

- revision of the dry aerosol extinction coefficients for sulfate, nitrate and organic carbon,
- splitting sulfate, nitrate and organic mass into small and large size fractions based on total species mass,
- revised f(RH) curves for inorganic species,
- inclusion of sea salt mass and associated f(RH) growth factor,
- use of a *site-specific* Rayleigh scattering term, and
- revision of the organic mass multiplier.

The VIEWS website provides the revised dataset for all IMPROVE data, allowing the calculation of the baseline period with the new algorithm. Natural background calculation methods that mirror many of the changes adopted as an alternative for baseline calculations have been suggested; however, none have been formally adopted by the IMPROVE Steering Committee at this time.

As a first step toward assessing the implications of the algorithm revisions, we compare the baseline visibility levels from the old and new approaches. The new calculation approach results in between one and two deciview increase in the 20 percent worst visibility conditions during the baseline period for the six sites considered. Extinction changes are observed for all components, with increases ranging from 6 to 42 percent depending on species. The greatest overall percentage change occurs for organic carbon and the least for fine soil. Changes in the baseline 20 percent best days were much less with the absolute contribution of a component to visibility degradation increasing in some cases and decreasing in others. On average, the values decrease by 0.1 deciview. Table 3-7 and Table 3-8 summarize the species-specific changes for worst and best days' aerosol extinction.

Table 3-7. Aerosol extinction by specie for 20% worst days

20% worst-day particle extinction (Mm^{-1}) New Algorithm / Old Algorithm							
Site	SO_4	NO_3	OC	EC	Soil	Coarse	Salt
Acadia	76.4 / 66	8.6 / 8.1	12.5 / 10.1	4.8 / 4.4	0.6 / 0.5	2.1 / 1.8	1.4 / 0
Brigantine	134.2 / 106.2	18.1 / 16.1	25.9 / 18.3	7.9 / 7.1	1.0 / 1.0	6.5 / 5.2	0.7 / 0
Great Gulf	79.6 / 66.5	3.4 / 3.0	14.8 / 10.6	4.3 / 3.8	0.6 / 0.5	3.1 / 2.9	0.1 / 0
Lye Brook	94.4 / 76.7	10 / 9.3	17.1 / 12.1	5.3 / 4.7	0.7 / 0.7	2.1 / 1.8	0.1 / 0
Moosehorn	64 / 56.1	7 / 6.3	13.4 / 10.5	5.1 / 4.4	0.4 / 0.4	2.5 / 2.1	1.1 / 0
Shenandoah	169.6 / 132.5	7.9 / 5.8	18.2 / 13.2	6.5 / 5.7	0.8 / 0.8	3.0 / 2.6	0.1 / 0

Table 3-8. Aerosol extinction by specie for 20% best days

20% best-day particle extinction (Mm^{-1}) New Algorithm / Old Algorithm							
Site	SO_4	NO_3	OC	EC	Soil	Coarse	Salt
Acadia	6.8 / 7.4	1.1 / 1.2	2.3 / 2.4	0.9 / 0.9	0.1 / 0.1	0.7 / 0.7	0.4 / 0
Brigantine	5.7 / 6.2	1.0 / 1.1	2.0 / 2.1	0.9 / 0.9	0.1 / 0.1	0.9 / 0.7	0.2 / 0
Great Gulf	5.7 / 6.2	1.0 / 1.1	2.0 / 2.1	0.9 / 0.9	0.1 / 0.1	0.9 / 0.7	0.2 / 0
Lye Brook	4.5 / 5.0	1.2 / 1.2	1.3 / 1.4	0.6 / 0.6	0.1 / 0.1	0.5 / 0.5	0.0 / 0
Moosehorn	6.8 / 7.3	1.0 / 1.2	3.1 / 3.1	1.0 / 1.0	0.1 / 0.1	1.1 / 1.1	0.3 / 0
Shenandoah	11.4 / 12.8	4.2 / 4.4	2.9 / 3.0	1.6 / 1.6	0.2 / 0.2	1.1 / 1.1	0.1 / 0

Figure 3-1and Figure 3-2 graphically compare the old and new algorithm for six sites. The left-hand side of the figures presents the old contribution of aerosol extinction while the right-hand side shows the new calculations. Relatively small differences are apparent, with slight relative decreases in sulfate contribution offset by small increases in nitrate, organic carbon and the addition of sea salt.

The potential impact of these changes on the uniform rate of progress slope cannot be determined at this time, since revisions in natural background calculations remain incomplete. A preliminary assessment, however, suggests that natural background estimates for MANE-VU may increase by about 10 percent. This translates to a change of just over one deciview. This estimate combined with the average increase of 1.5 deciview in baseline conditions would not likely change the slope of.the uniform progress curve in any significant way. Nonetheless, the actual mass reductions required could change given the logarithmic nature of the haze index, where marginal mass changes are larger at higher deciview levels. It is not a straightforward exercise to estimate the potential effect of such changes given the increased complexity of the new algorithm relative to the old equation.

Figure 3-1. Comparison of Old and New Algorithms for Baseline Worst Days

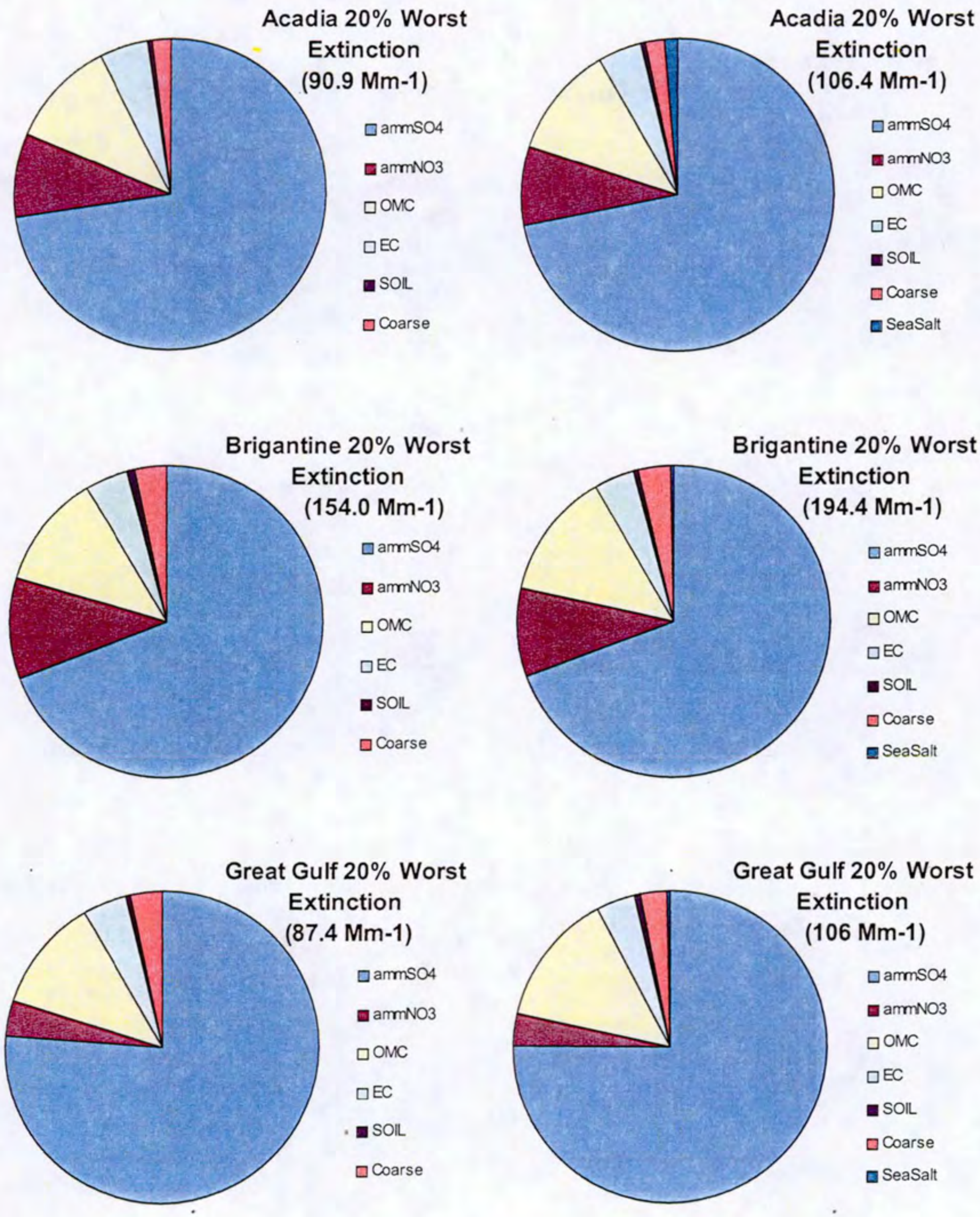
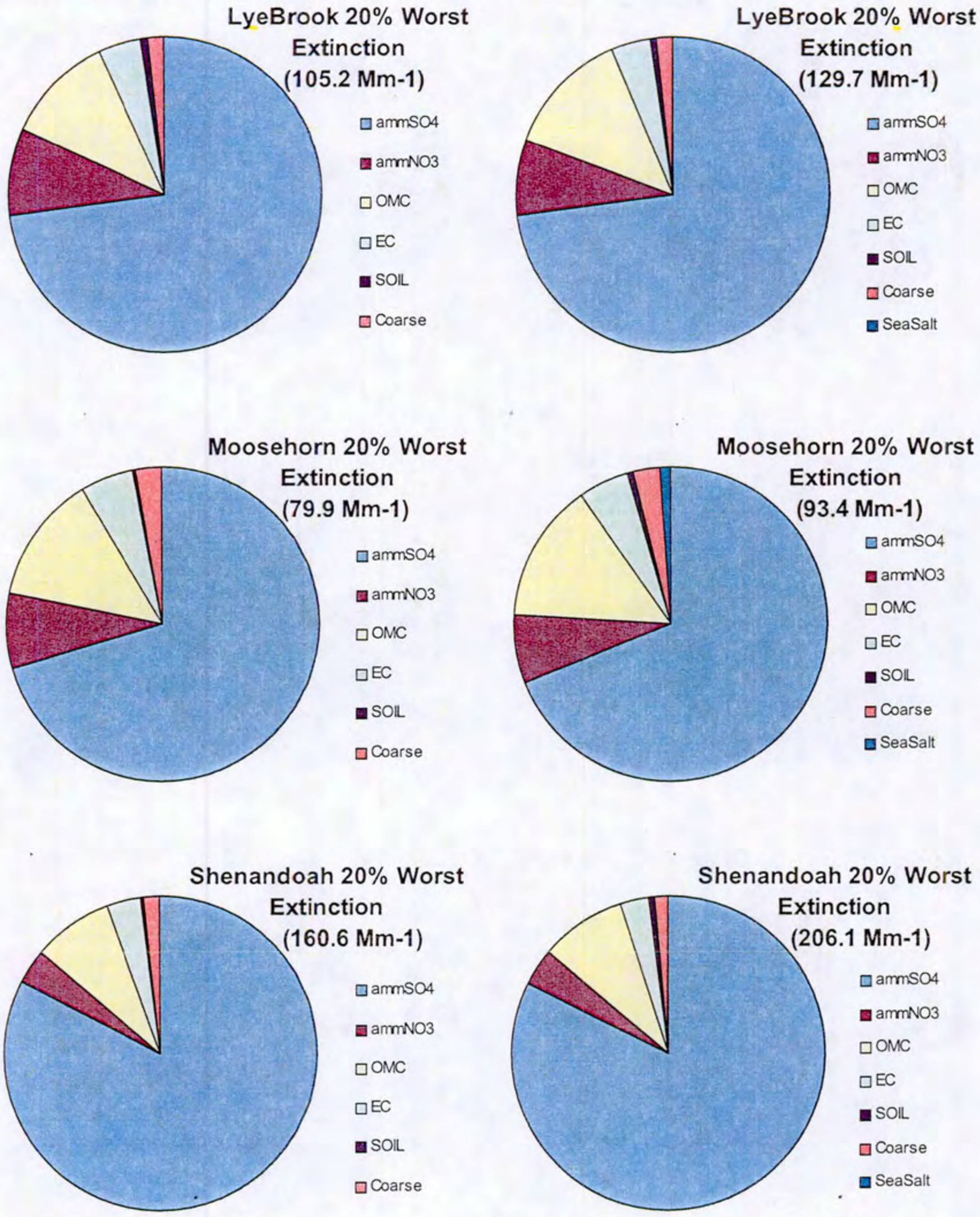


Figure 3-2. Comparison of Old and New Algorithms for Baseline Worst Days



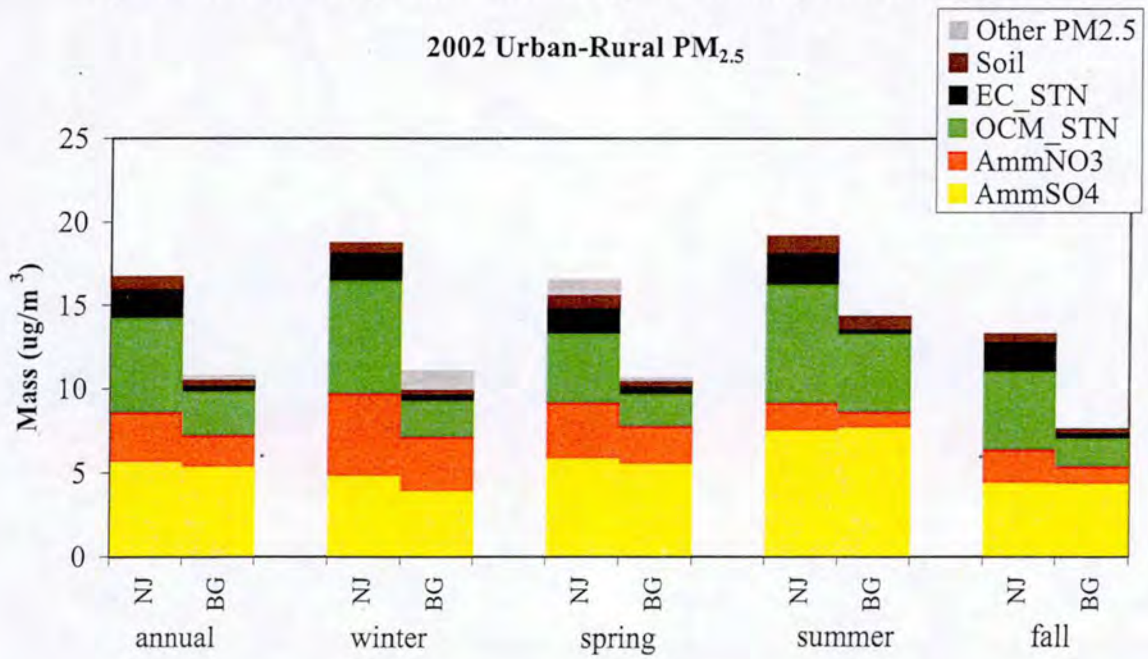
3.2. 2002 Monitoring Data

The recent MANE-VU report "2002 Year in Review" (NESCAUM, 2004b) provides a comprehensive review of monitoring data available to support SIP development in the MANE-VU region, including data on fine particle composition, as well as temporal and spatial distributions. The data in this study support the conceptual model in several important ways. They show that: (1) the single largest component of fine particle mass is sulfate; (2) the largest sulfate-generating emissions sources that affect the MANE-VU region lie to the south and west of the region; (3) fine particle concentrations are bi-modal with peaks in the summer and winter; and (4) summer and winter peak concentrations are generally caused by different chemical and physical processes in the atmosphere (i.e., summer peaks are strongly related to regional sulfate transport whereas winter peaks result from the sum of regionally-generated sulfate and locally generated sulfate, as well as organics and nitrate that build up during local stagnation events).

3.2.1. Sulfate

Data from several monitoring programs indicate that sulfate (on an annual basis) is the single largest component of fine particle mass in the MANE-VU region. Figure 3-3 displays sample data from two Speciation Trends Network (STN) sites in New Jersey. This shows that sulfate accounts for roughly half of fine particle mass on an annual average basis at background sites and about a third at the urban site. During summer, sulfate comprises over half the fine particle mass at rural background sites and two-fifths of fine particle mass at the urban site. When considering the different light-extinguishing properties of various fine particle constituents, sulfate is responsible for an even greater fraction of visibility impairment. It accounts for between three-quarters and four-fifths of overall light extinction on the 20 percent worst- visibility days (Table 3-2).

Figure 3-3. New Jersey Urban Area Compared to an Upwind Background Site



3.2.2. Southwest-Northeast Gradient

Figure 3-4 shows that $PM_{2.5}$ mass declines fairly steadily along a southwest to northeast transect of MANE-VU. This decline is consistent with the existence of large fine particle emissions sources (both primary and secondary) to the south and west of the MANE-VU region.

This trend in $PM_{2.5}$ mass is primarily due to a marked southwest-to-northeast gradient in ambient sulfate concentrations during three seasons of the year as illustrated in Figure 3-5. Wintertime concentrations, by contrast, are far more uniform across the entire region. Figure 3-6 shows that on an annual basis, both total PM and sulfate mass are highest in the southwestern portions of MANE-VU (note the different scales for each pollutant). High concentrations of nitrate and organic particle constituents, which play a role in localized wintertime PM episodes, tend to be clustered along the northeastern urban corridor and in other large urban centers.

Sulfate is a secondary pollutant, meaning that it forms in the atmosphere from precursor emissions. The formation of sulfate from SO_2 emissions requires time in an oxidizing environment. Therefore, it is likely that a substantial portion of the sulfate observed in the MANE-VU region is from sulfur emitted from south and west of the region. Modeled meteorological (trajectory) data presented in Chapter 5 support this conclusion by showing that the dominant wind direction over the MANE-VU region during periods of high sulfate concentrations is from the southwest.

Figure 3-4. MANE-VU FRM $PM_{2.5}$ statistics along a southwest to northeast axis

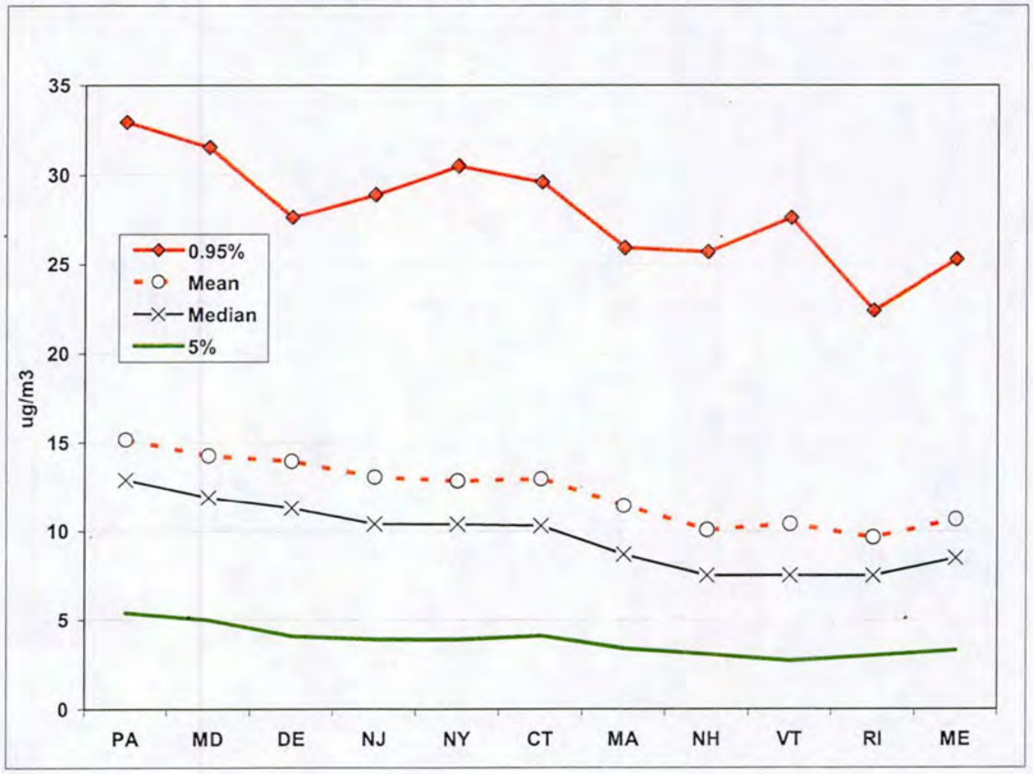


Figure 3-5. 2002 Seasonal average SO4 based on IMPROVE and STN data

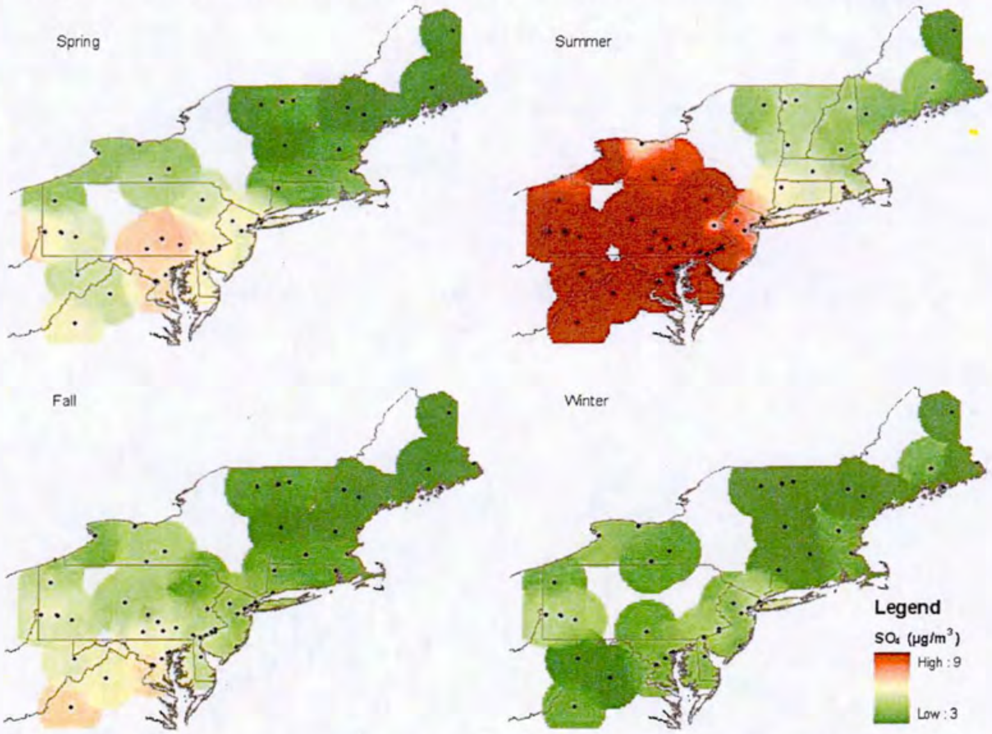
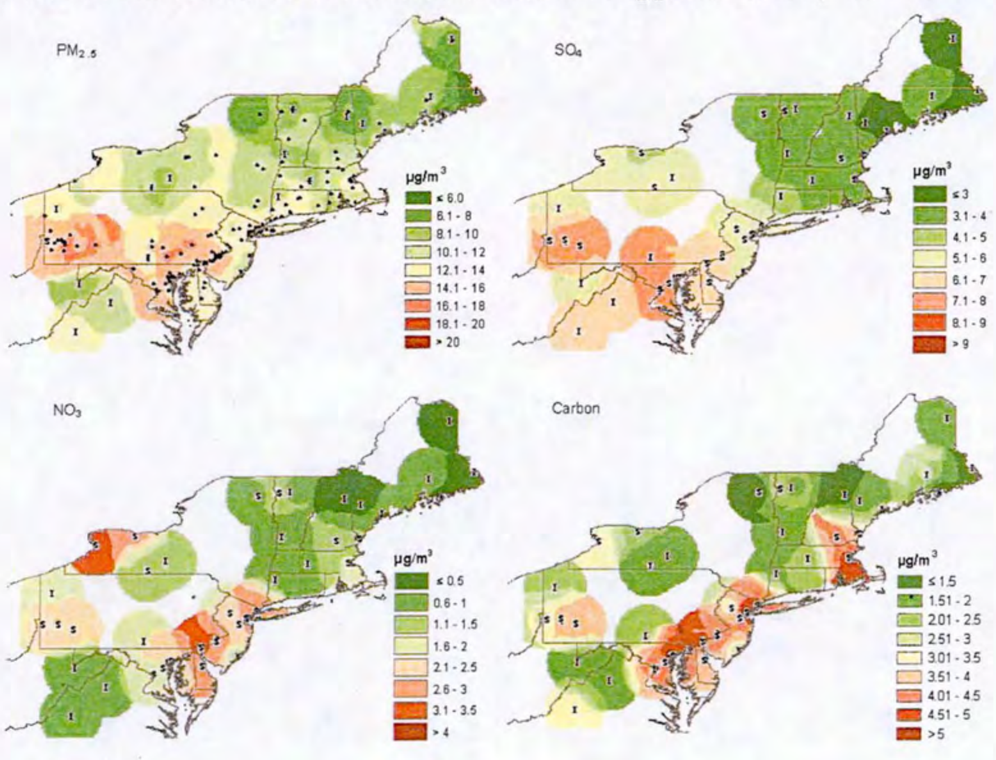


Figure 3-6. 2002 Annual average $PM_{2.5}$, sulfate, nitrate and total carbon for MANE-VU based on IMPROVE and STN data. Mass data are supplemented by the FRM network.



3.2.3. Seasonality

In general, fine particle concentrations in MANE-VU are highest during the warmest (summer) months but also exhibit a secondary peak during the coldest (winter) months. This bimodal seasonal distribution of peak values is readily apparent in Figure 3-7. The figure shows the smoothed 60-day running average of fine particle mass concentrations using continuous monitoring data from two northeastern cities over a period of several years.

Figure 3-7. Moving 60-day average of fine aerosol mass concentrations based on long-term data from two northeastern cities

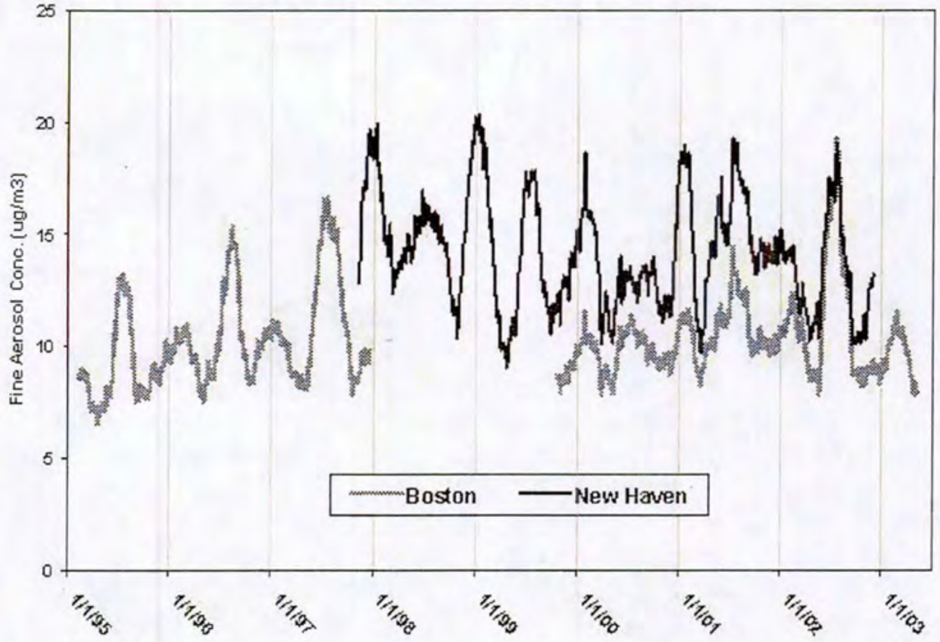


Figure 3-8. 30-day average fine aerosol mass concentrations from eight northeastern cities

Although the patterns exhibited by these monitoring data include occasional anomalies (as in the summer of 2000), summer peak concentrations in both cities of Figure 3-7 are generally much higher than the surrounding winter peaks. Figure 3-8 also demonstrates this bimodal pattern. Though slightly more difficult to discern in just a single year's worth of data, a "W" pattern does emerge at almost all sites across the region during 2002 with the winter peak somewhat lower than the summer peak at most sites. Urban monitors in Wilmington, Delaware and New Haven, Connecticut have wintertime peak values approaching those of summer.

3.2.4. Seasonal Mechanisms

In the summertime, MANE-VU sites repeatedly experience sulfate events due to transport from regions to the south and west. During such events, rural and urban sites throughout the MANE-VU region record high (i.e., >15 $\mu g/m^3$) daily average $PM_{2.5}$ concentrations. Meteorological conditions during the summer frequently allow for summer "stagnation" events when very low wind speeds and warm temperatures allow pollution levels to build in an air mass as it is slowly transported across the continent. During these events, atmospheric ventilation is poor and local emission sources add to the burden of transported pollution with the result that concentrations throughout the region (both rural and urban) are relatively uniform. Generally there are enough of these events to drive the difference between urban and rural sites down to less than 1 $\mu g/m^3$ during the warm or hot months of the year. As a result, concentrations of fine particles aloft will often be higher than at ground-level during the summertime, especially at rural monitoring sites. Thus, when atmospheric "mixing" occurs during summer[13] mornings (primarily 7 to 11 a.m.), fine particle concentrations at ground-level can actually increase (see Hartford, CT or Camden, NJ in Figure 3-9).

During the wintertime, strong inversions frequently trap local emissions overnight and during the early morning, resulting in elevated urban concentrations. These inversions occur when the earth's surface loses thermal energy by radiating it into the atmosphere (especially on clear nights). The result is a cold, stable layer of air near the ground. At sunrise, local emissions (both mobile and stationary) begin increasing in strength and build-up in the stable ground layer (which may extend only 100 meters or less above-ground). Increasing solar radiation during the period between 10 a.m. and noon typically breaks this cycle by warming the ground layer so that it can rise and mix with air aloft. Because the air aloft during wintertime is typically less polluted than the surface layer, this mixing tends to reduce ground-level particle concentrations (see Figure 3-10). This diurnal cycle generally drives wintertime particle concentrations, although the occasional persistent temperature inversion can have the effect of trapping and concentrating local emissions over a period of several days, thereby producing a significant wintertime pollution episode.

[13] Here we define summer as May, June, July and August.

Figure 3-9. Mean hourly fine aerosol concentrations during the summer season

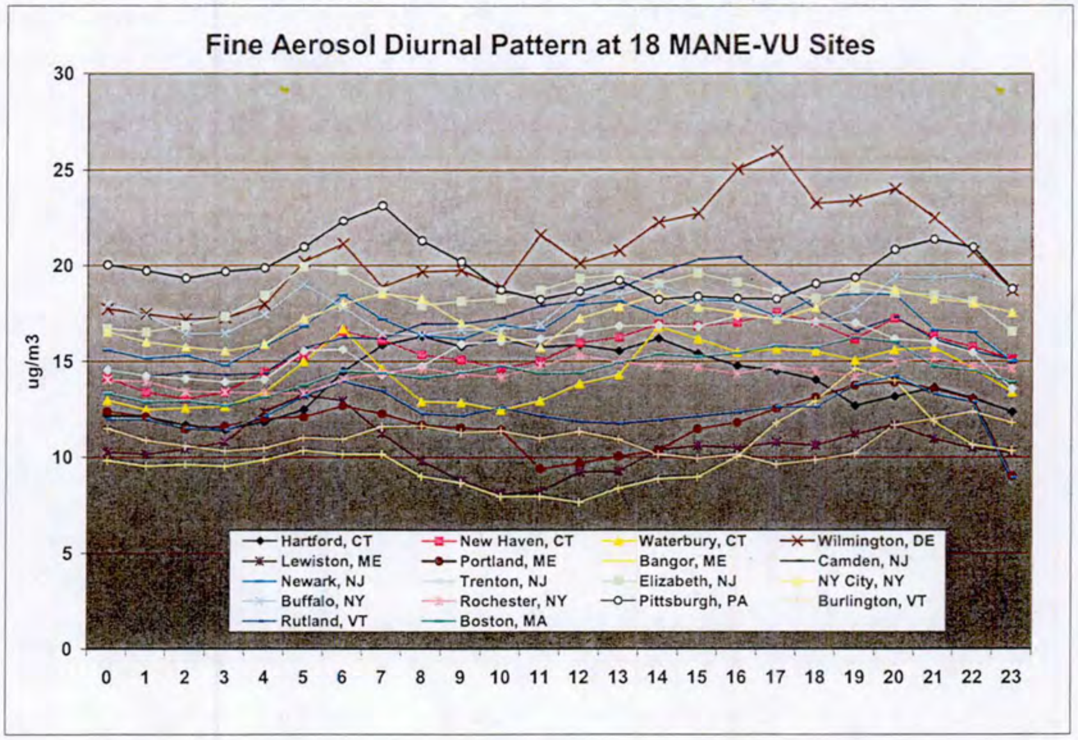
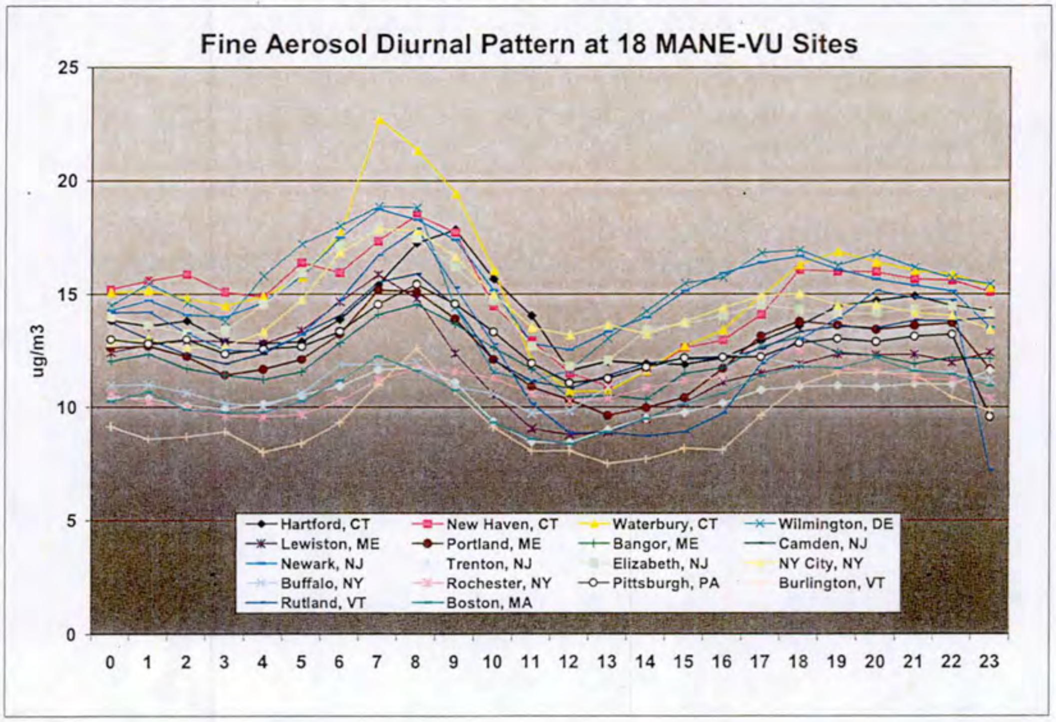


Figure 3-10. Mean hourly fine aerosol concentrations during the winter season



Rural areas experience the same temperature inversions but have relatively fewer local emissions sources so that wintertime concentrations in rural locations tend to be lower than those in nearby urban areas. Medium and long-range fine particle transport events do occur during the winter but to a far lesser extent than in the summertime. In sum, it is the interplay between local and distant sources together with seasonal meteorological conditions that drives the observed 3–4 $\mu g/m^3$ wintertime rural versus urban difference in PM concentrations.

3.3. RAIN data

Routine monitoring networks operated by USEPA, the National Park Service or state monitoring agencies collected much of the monitoring data shown so far. We anticipate that these data will continue to provide crucial information on the nature and extent of visibility impairment across the region. In addition, MANE-VU is also developing a network of enhanced monitoring sites capable of providing continuous data on the concentration, composition, and visibility impacts of fine particles. These data will be critical for understanding the more complex issues associated with organic carbon as well as any tradeoffs between sulfate and nitrate control. This Rural Aerosol Intensive Network (RAIN), which was first deployed in 2004, is therefore likely to play a prominent role in future visibility control programs and in the development of regional haze SIPs due in 2018.

NESCAUM coordinates the RAIN effort as a cooperative effort of the MANE-VU member state air agencies. The network covers the region from western Maryland (near large sulfur sources in the Ohio River Valley) through northwestern Connecticut to Acadia National Park in Maine. The initial network consists of these three rural, moderate elevation (700 to 2,500 feet) sites in a southwest to northeast line, all with detailed PM and visibility related measurements. The network design includes highly time resolved (1-2 hour) aerosol mass, composition, and optical property measurements. These provide enhanced insight into regional aerosol generation and source characterization, which are factors that drive short term visibility, and aerosol model performance and evaluation. In addition to these three sites, as of 2006 the NY-DEC/SUNY-Albany intensive measurement site at Pinnacle State Park (Addison, NY, seven miles southwest of Corning, NY, and seven miles north of the Pennsylvania border) has most of the RAIN parameters and methods other than visibility; efforts are underway to bring that site into the RAIN program (to ensure consistent method operation) and to add visibility measurements.

The RAIN sites use the Sunset Laboratory Model 3 field carbon analyzer and the new Thermo Environmental Model 5020 sulfate analyzer. This is the first use of these methods in routine, ongoing state-run networks. Combined with other more routine measurements such as IMPROVE aerosol, NGN-2 (wet) nephelometers, continuous $PM_{2.5}$, trace SO_2, ozone, meteorology, and automated digital visibility cameras (CAMNET), these methods make up the core RAIN monitoring lineup. Some of the RAIN sites will have additional related measurements, including "true" trace CO, NO_X, dry scattering (NGN-3a nephelometer), and other measurements. An Air and Waste

Management Association conference proceedings paper provides more information on the design of the network and examples of data from the summer of 2004.[14]

A longer term goal of RAIN is to enhance the network with other measurements and sites in future years. A National Weather Service ASOS visibility sensor at a RAIN site would allow the large network of existing ASOS data to be "tethered" to visibility measurements we understand well. Strong aerosol acidity, nitric acid, and ammonia are measurements that would be desirable on either an integrated or real-time basis. There are no continuous nitrate measurements in RAIN at this time because available methods suitable for routine deployment in state networks are not yet sufficiently robust.[15] Lack of continuous nitrate data is not a significant issue for this analysis since nitrate is not (yet) a major visibility factor at these rural sites. We expect that most of the continuous method data from RAIN to be available in real-time to web data resources like VIEWS, FASTNET and AIRNowTech by the end of 2006.

Measurements similar to those in RAIN done towards the west and south borders of the MANE-VU domain (Ohio and Virginia for example) would greatly enhance our understanding of the impact of the large sulfur source region in and around the Ohio River Valley on regional visibility. We encourage agencies and RPOs in those areas to develop intensive sites to complement the RAIN data.

As an initial test of the RAIN network, we examined visibility and related particle information for the third quarter of 2004 to determine how well the data from one (or both) of two recently installed semi-continuous monitors could reproduce the visibility data reported by existing NGN-2a nephelometers. The relevant data came from two monitors of interest: the Thermo Model 5020 (for sulfate) and the Sunset Labs (Model 3) semi-continuous analyzer for elemental and organic carbon. In addition, a Rotronic sensor (Model MP-101A, with active aspiration) measured relative humidity (RH) data on-site in order to supply a correction factor - f(RH) - for estimating the light scattering associated with various fine particle constituents.

Because ammonium sulfate is the major component of haze-producing particulate pollution in the northeastern United States, we examined sulfate data first. The Thermo Model 5020 reports sulfate and the IMPROVE algorithm for calculating visibility parameters assumes that all sulfate is in the form of ammonium sulfate. During high sulfate events in the rural Northeast this is not always the case, although it is still a reasonable first assumption.

The Thermo sulfate method has been shown to consistently under-report sulfate relative to IMPROVE sulfate measurements at the RAIN sites, but not at some other sites. Since the correlation with IMPROVE sulfate is high at all RAIN sites, the hourly RAIN sulfate data can be corrected to be "IMPROVE"-like with reasonable confidence. A RAIN technical memorandum describes this issue in more detail.[16] For the Acadia sulfate data used here, the daily correlation coefficient (R^2) between IMPROVE and

[14] http://www.nescaum.org/documents/allen-awma_haze-rain-paper-oct-2004_proceedings.pdf/

[15] See the EPA method evaluation report at http://www.epa.gov/ttn/amtic/semicontin.html for more information.

[16] "Rural Aerosol Intensive Network (RAIN) Preliminary Data Analysis," available at: http://www.nescaum.org/documents/2006-05-memo8-rain.pdf/

Thermo sulfate is 0.95 (based on third and fourth quarter 2004 data). A correction factor of 1.30 is applied to the Thermo sulfate data based on the linear regression of IMPROVE and Thermo sulfate 24-hour samples for the third and fourth quarters of 2004 data; this correction makes the Thermo sulfate data consistent with the IMPROVE sulfate data.

We need three types of data to relate direct measures of atmospheric light scattering to a re-constructed or calculated estimate of light scattering based on observed sulfate levels: (1) direct measurements of light scattering (via nephelometer); (2) sulfate measurements; and (3) relative humidity measurements. The three RAIN sites in the northeastern United States measure each of these variables. Of these sites, however, only the McFarland Hill site at Acadia National Park in Maine is within a Class I area. Therefore, we selected data from the McFarland Hill site for the preliminary analysis we describe below.

Given the highly non-linear relationship between relative humidity and ammonium sulfate particle size and the limitations of relative humidity (RH) sensor accuracy at very high values of RH, we excluded from this analysis data collected when relative humidity was equal to or greater than 95 percent. Of the 2,208 hourly observations recorded from June 1 through September 30, this relative humidity 'exclusion' removed 525 hours. Data for an additional 92 hours were not available due to missing measurements from either the sulfate monitor or the nephelometer. We excluded a further 35 hours due to flagged nephelometer performance (such flags could be triggered by excess noise or rate-of-change in the signal). This left 1,556 hourly observation pairs for the third quarter, equivalent to a data capture rate of 70 percent - still a substantial sample given the nature of the emerging technology employed at the RAIN sites.

We multiplied sulfate concentrations from the Thermo 5020 by 1.37 to convert them to a mass equivalent for ammonium sulfate (this is the same factor IMPROVE uses). This new variable (SULFATE) is the strongest driver of light extinction in the Northeast because of the extreme size-dependent nature of ammonium sulfate light scattering, which in turn is highly (and very non-linearly) dependent on atmospheric relative humidity. Next, we converted the hourly RH values to a relative humidity function "f(RH)" by using a conversion table adopted by IMPROVE.[17] Then we applied a "dry specific scattering" coefficient of "3"[18] to the hourly SULFATE values. The final equation is shown below:

Reconstructed Sulfate Scattering = 3 * f(RH) * (SULFATE)

When we compared this reconstructed estimate of hourly light scattering to the IMPROVE NGN-2a nephelometer data (via a least-squares linear regression), we obtained an R^2 of 0.888. When two apparent outlier hours are removed (both of which occurred during periods when relative humidity was over 87 percent and changing rapidly) the regression slope is 0.846, the intercept is -5, and R^2 increases to 0.942. This

[17] See: http://vista.cira.colostate.edu/improve/Tools/humidity_correction.htm; this is the original f(RH) table, not the new one.

[18] Described at http://vista.cira.colostate.edu/improve/Tools/ReconBext/reconBext.htm

implies that sulfate alone is responsible for approximately 85 percent of the light scattering (and visibility degradation) for this period of measurement.

Because elemental carbon absorbs light much more strongly than it scatters light, we added only the "light-scattering carbon" (OC) detected by the Sunset Model 3 to this reconstruction. The IMPROVE program uses the following equation to describe the impact of light-scattering carbon:

$$\textbf{\textit{Reconstructed Carbon Scattering}} = 4 * f_{org}(RH) * [OMC]$$

where the dry scattering coefficient of this carbon fraction is set at "4," the relative humidity factor is set at unity (due to the weak hygroscopicity of organic carbon), and OMC represents "organic mass by carbon." The IMPROVE Steering Committee has recently adopted 1.8 as an alternative organic mass multiplier (rather than 1.4) for calculating OMC values for use in reconstructed extinction as described in section 3.1. We have also used 1.8 for the analysis presented below.

Because the RAIN sites collect carbon data over two-hour periods, we averaged the McFarland Hill sulfate (Thermo-5020), scattering (NGN-2) and RH (Rotronic) hourly data into two-hour, whole number blocks in order to bring the data from Sunset Labs into the reconstruction equation. In addition, we subtracted a "filter blank" value for the Sunset OC data of 0.5 $\mu g/m^3$ (empirically derived from user experience of the Model 3) from the OC data prior to their use in the reconstruction calculation (OMC = (Sunset OC – 0.5) x 1.8). See Figure 3-11 for results of these reconstructed estimates of visibility using both sulfate and carbon measurements.

As indicated by Figure 3-11, adding the organic carbon data to the sulfate data significantly improves the agreement between reconstructed estimates of aerosol scattering and direct visibility measurements at the McFarland Hill site. Specifically, it appears that these two components of the ambient aerosol generally explain about 94 percent of the observed scattering at Acadia during the summer, with a very high correlation coefficient even at 2-hour intervals. This is excellent agreement considering that scattering from nitrate and crustal aerosol components is not included in this reconstruction.

These data demonstrate that the highly time-resolved nature of RAIN data is invaluable in examining short-term variations (i.e., on the order of days to weeks) in haze production and transport. The sulfate, carbon and other monitoring capabilities emerging from the RAIN project will provide another valuable tool to state and tribal authorities in seeking to understand the sources of regional haze and to craft effective control strategies. A more detailed analysis of RAIN data is available in a recently released MANE-VU technical memorandum.[19]

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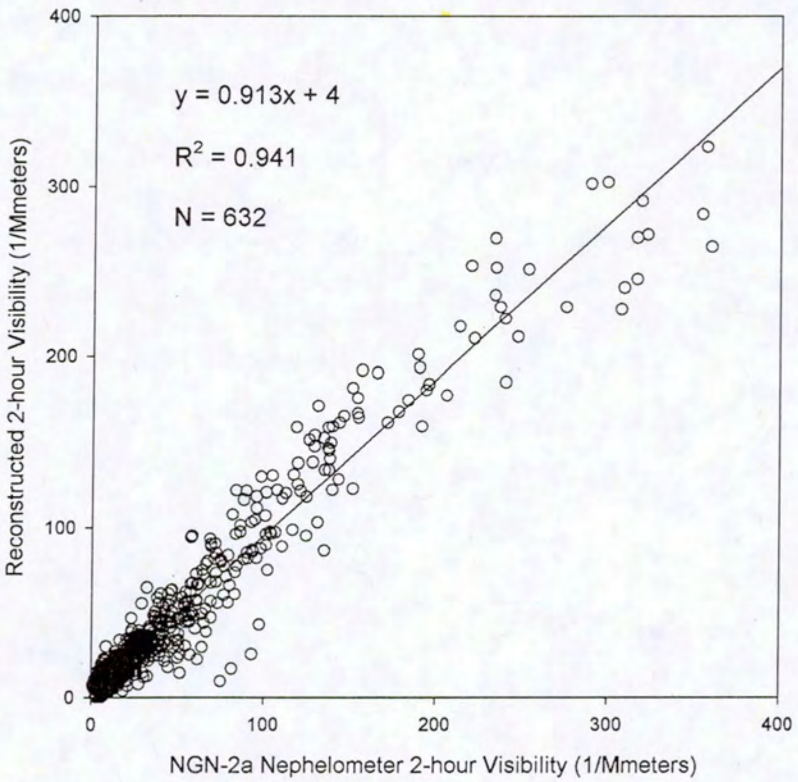
[19] "Rural Aerosol Intensive Network (RAIN) Preliminary Data Analysis," available at: http://www.nescaum.org/documents/2006-05-memo8-rain.pdf/

Figure 3-11. 2-Hour Reconstructed scattering at Acadia, Maine using semi-continuous SO_4 and OC data for the third quarter of 2004



References

NESCAUM, "Natural Background Visibility Conditions: Considerations and Proposed Approach to the Calculation of Natural Background Visibility Conditions at MANE-VU Class I Areas," Northeast States for Coordinated Air Use Management, Boston, MA, June 2004a.

NESCAUM, "2002: A Year in Review," Northeast States for Coordinated Air Use Management, Boston, MA, December, 2004b.

USEPA, "Guidance for Tracking Progress under the Regional Haze Rule," EPA-454/B-03-004 September 2003a.

USEPA, "Guidance for Estimating Natural Visibility Conditions under the Regional Haze Program," EPA-454/B-03-005 September 2003b.

4. HAZE-ASSOCIATED POLLUTANT EMISSIONS

This chapter explores the origin and quantity of haze-forming pollutants emitted in the eastern and the mid-Atlantic United States. It also describes the procedures used to prepare emissions inventory data for use in chemical transport models (Chapter 6 describes in greater detail the models themselves).

The pollutants that affect fine particle formation, and thus contribute to regional haze, are sulfur oxides (SO_X), nitrogen oxides (NO_X), volatile organic compounds (VOC), ammonia (NH_3), and particles with an aerodynamic diameter less than or equal to 10 and 2.5 μm (i.e., primary PM_{10} and $PM_{2.5}$). The emissions dataset illustrated below is the 2002 MANE-VU Version 2 regional haze emissions inventory. The emission inventories include carbon monoxide (CO), but we do not consider that pollutant here as it does not contribute to regional haze. The MANE-VU regional haze emissions inventory version 3.0, released in April 2006, has superseded version 2 for modeling purposes. This inventory update was developed through the Mid-Atlantic Regional Air Management Association (MARAMA) for the MANE-VU RPO. The comparative observations among recent emission inventories presented here (the 1996 USEPA NET and 1999 NEI) would hold true were version 3.0 substituted for version 2.0. [20]

The first section of this chapter describes emission characteristics by pollutant and source type (e.g., point, area, and mobile). The second section describes on-going efforts to process emissions inventory data in support of air quality modeling. The final section provides source apportionment estimates for several MANE-VU Class 1 areas based on 2002 SO_2 inventory data.

4.1. Emissions Inventory Characteristics

4.1.1. Sulfur Dioxide (SO_2)

SO_2 is the primary precursor pollutant for sulfate particles. Sulfate particles commonly account for more than 50 percent of particle-related light extinction at northeastern Class I areas on the clearest days and for as much as or more than 80 percent

[20] EPA's Emission Factor and Inventory Group (EFIG) (USEPA/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.

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 substantially lesser extent, of certain petroleum products accounts for most anthropogenic SO_2 emissions. In fact, in 1998 a single source category — coal-burning power plants — was responsible for two-thirds of total SO_2 emissions nationwide (NESCAUM, 2001a).

Figure 4-1 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 (USEPA, 2005; 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 USEPA 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 USEPA Acid Rain Program, which in 2000 further reduced allowable emissions and extended emissions limits to more power plants. Figure 4-2 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) 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).

4.1.2. Volatile Organic Compounds (VOC)

Existing emission inventories generally refer to "volatile organic compounds" (VOCs) for hydrocarbons whose volatility in the atmosphere makes them particularly important from the standpoint of ozone formation. From a regional haze perspective, we are concerned less 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 almost certainly includes a mix of species, including pollutants originating from anthropogenic (i.e., manmade) sources as well as biogenic hydrocarbons emitted by vegetation. Recent efforts to reduce manmade organic carbon emissions have been undertaken primarily to address summertime ozone formation in urban centers. Future efforts to further reduce organic carbon emissions may be driven by programs that address fine particles and visibility.

Figure 4-1. State Level Sulfur Dioxide Emissions

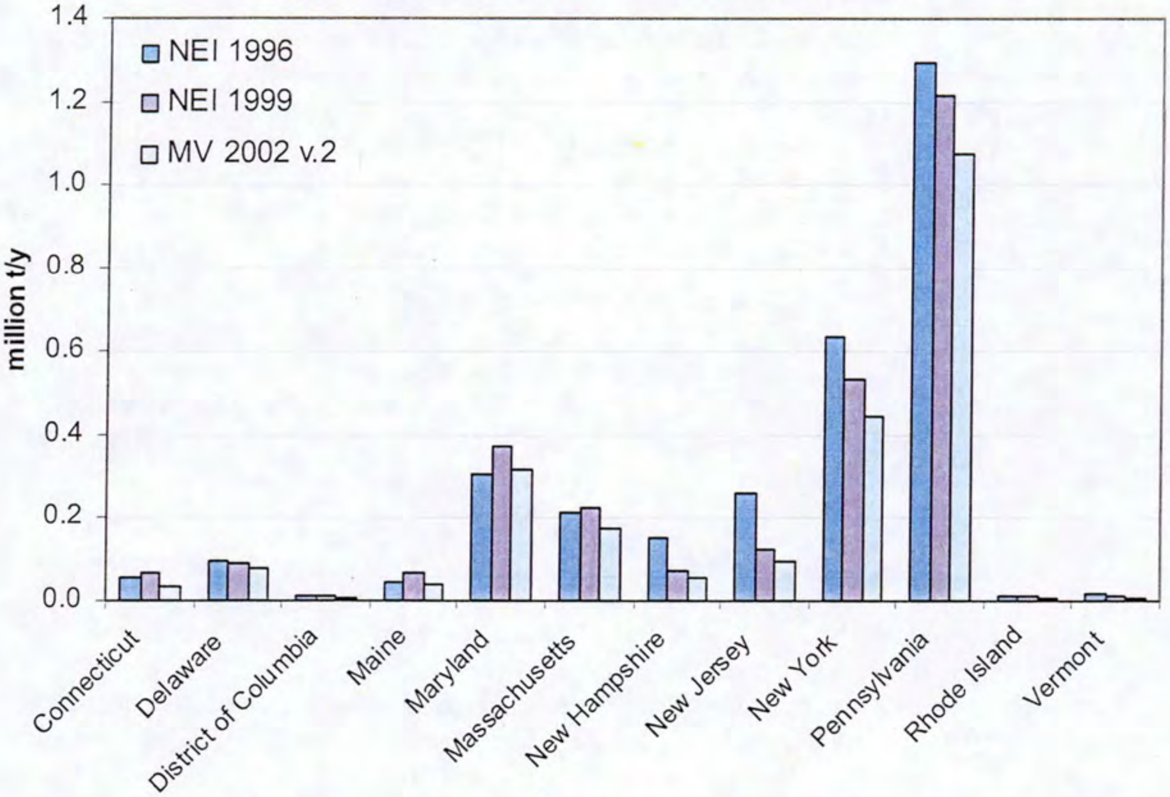
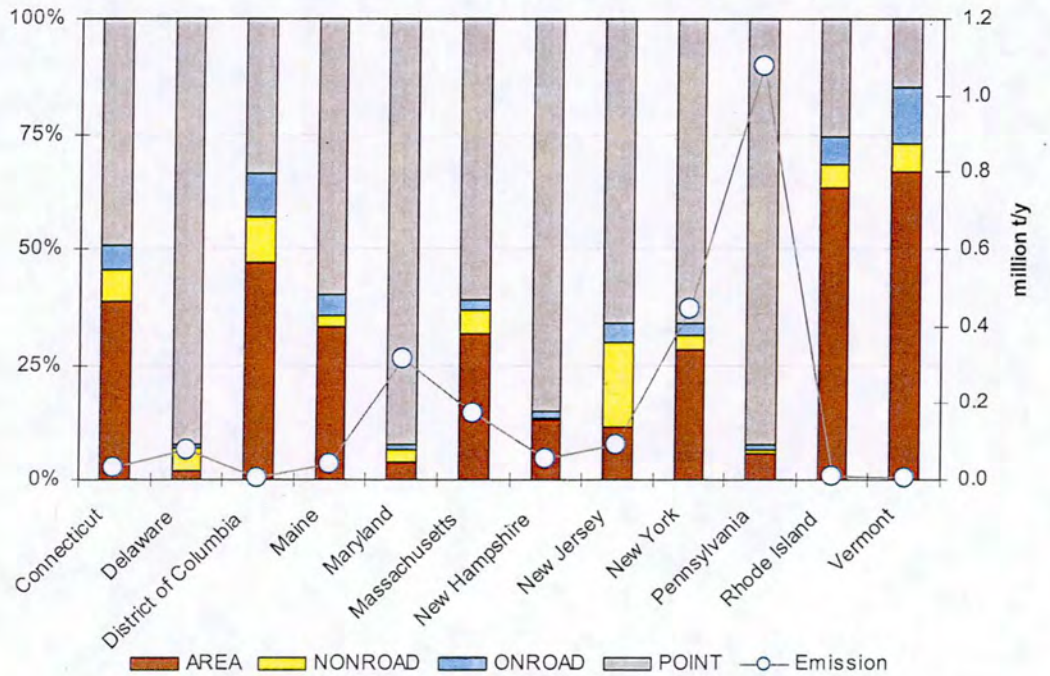


Figure 4-2. SO_2 (Bar graph: Percentage fraction of four source categories, Circle: Annual emissions amount in 10^6 tons per year)

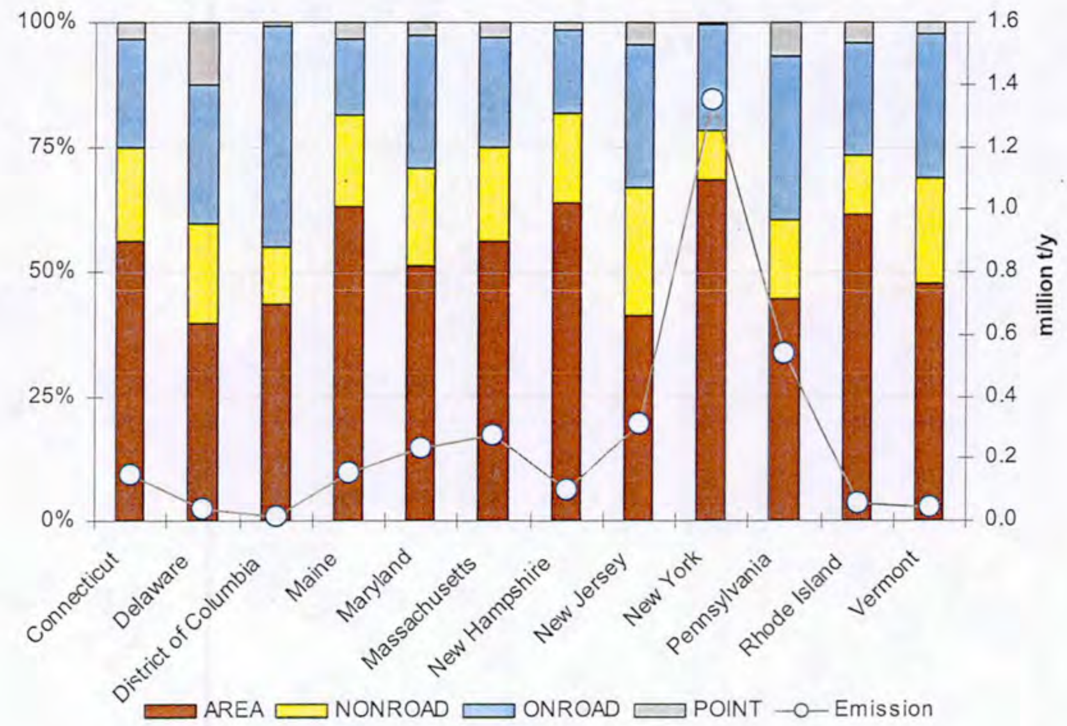


Understanding the transport dynamics and source regions for organic carbon in northeastern Class I areas is likely to be more complex than for sulfate. This is partly because of the large number and variety of OC species, the fact that their transport characteristics vary widely, and the fact that a 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 4-3, 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 we note that high ozone levels can have an indirect effect on visibility by promoting the oxidation of other available hydrocarbons, including biogenic

Figure 4-3. VOC (Bar graph: Percentage fraction of four source categories, Circle: Annual emissions amount in 10^6 tons per year)



emissions (NESCAUM, January 2001). In short, we need further work 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.

4.1.3. Oxides of Nitrogen (NO_X)

NO_X emissions contribute directly 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 4-4 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 (USEPA, 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 4-5. 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 4-4. State Level Nitrogen Oxides Emissions

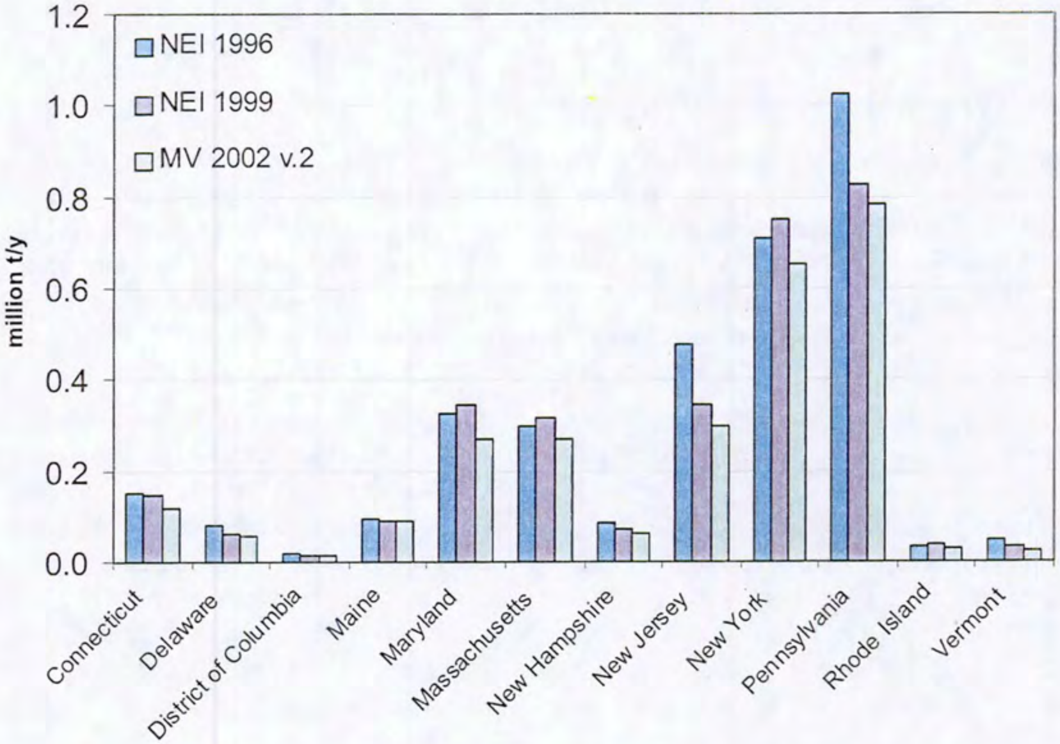
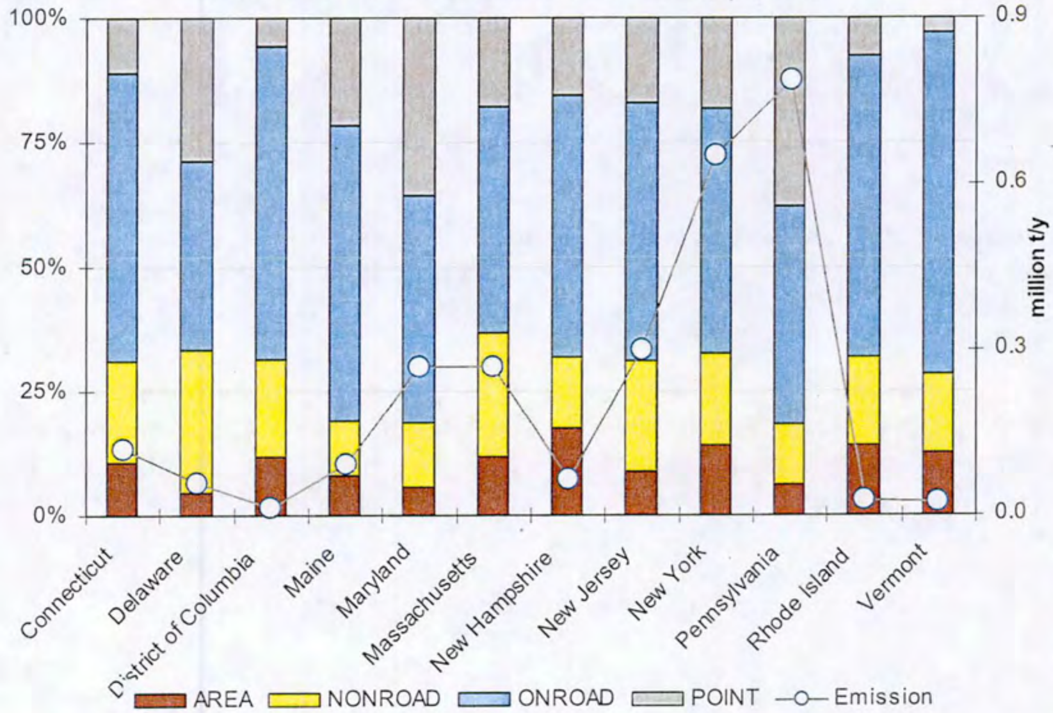


Figure 4-5. NO_X (Bar graph: Percentage fraction of four source categories, Circle: Annual emissions amount in 10^6 tons per year)



4.1.4. Primary Particulate Matter (PM_{10} and $PM_{2.5}$)

Directly-emitted or "primary" particles (as distinct from secondary particles that form in the atmosphere through chemical reactions involving precursor pollutants like SO_2 and NO_X) can also contribute to regional haze. For regulatory purposes, we make a distinction 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 4-6 and Figure 4-7 show 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.

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 before including 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}.

Figure 4-6. State Level Primary PM_{10} Emissions

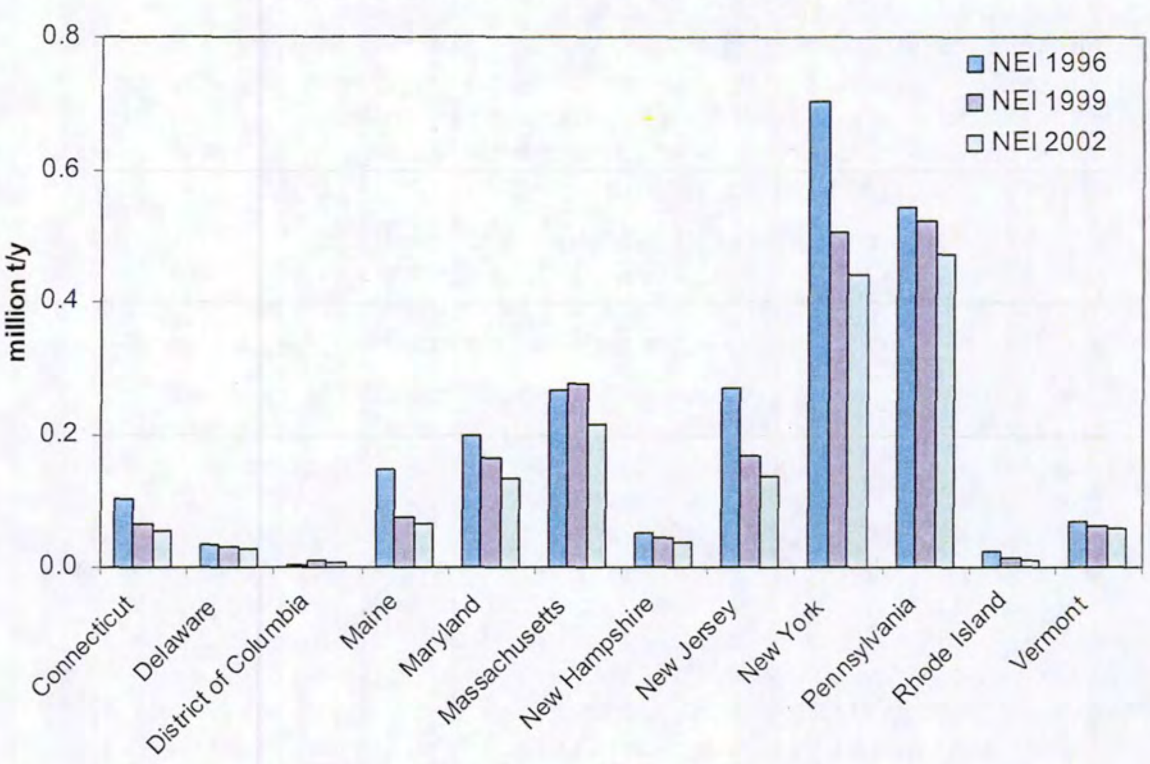
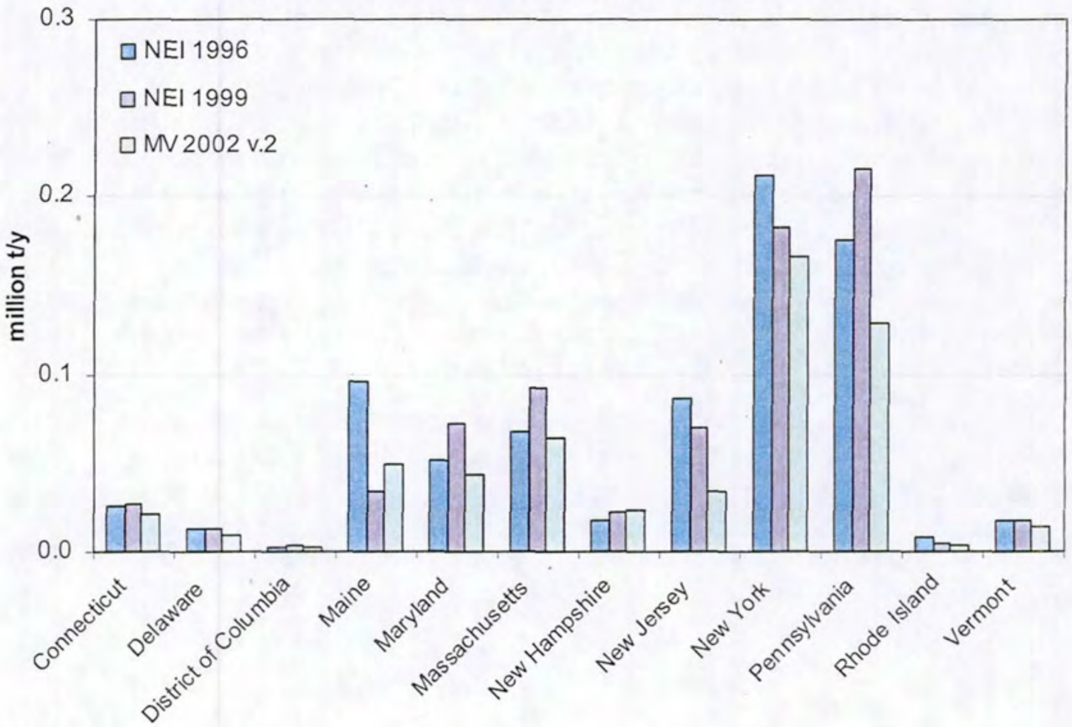


Figure 4-7. State Level Primary $PM_{2.5}$ Emissions



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

Figure 4-8 and Figure 4-9 show that area and mobile sources dominate primary PM emissions. (The NEI inventory categorizes residential wood combustion and some other combustion sources as area sources.) The relative contribution of point sources is larger in the primary $PM_{2.5}$ inventory than in the primary PM_{10} inventory since the crustal component (which consists mainly of larger or "coarse-mode" particles) contributes mostly to overall PM_{10} levels. At the same time, pollution control equipment commonly installed at large point sources is usually more efficient at capturing coarse-mode particles.

4.1.5. Ammonia Emissions (NH_3)

Knowledge of ammonia emission sources will be necessary in developing effective regional haze reduction strategies because of the importance of ammonium sulfate and ammonium nitrate in determining overall fine particle mass and light scattering. According to 1998 estimates, livestock agriculture and fertilizer use accounted for approximately 86 percent of all ammonia emissions to the atmosphere (USEPA, 2000b). We need, however, better ammonia inventory data for the photochemical models used to simulate fine particle formation and transport in the eastern United States. Because the USEPA 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.[21]

[21] 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.

Figure 4-8. Primary PM_{10} (Bar graph: Percentage fraction of four source categories, Circle: Annual emissions amount in 10^6 tons per year)

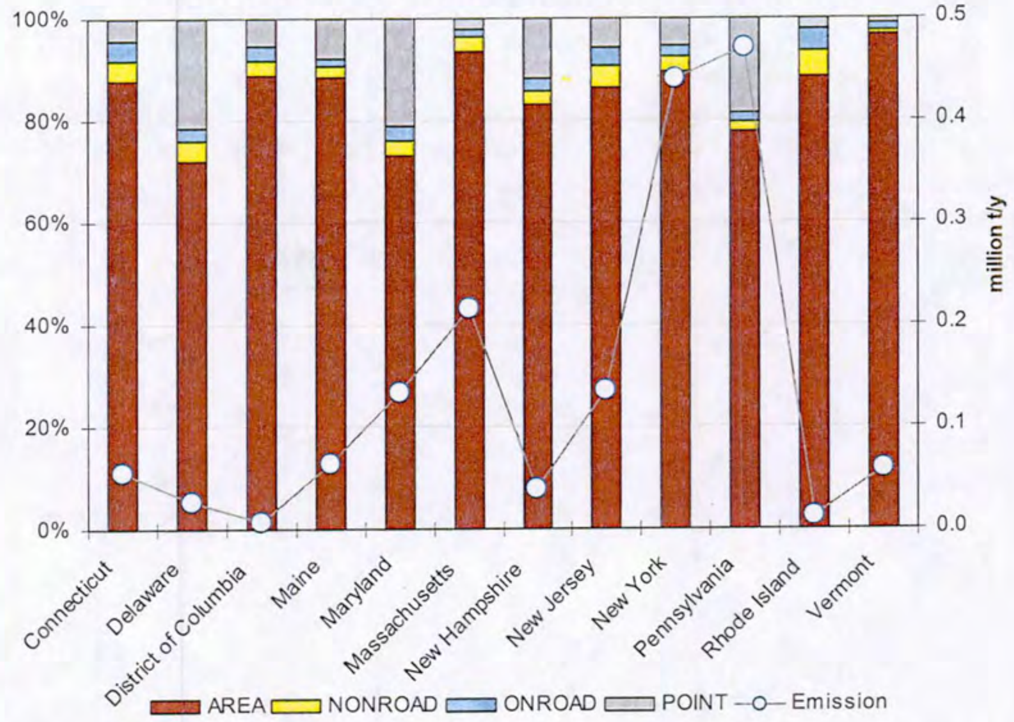
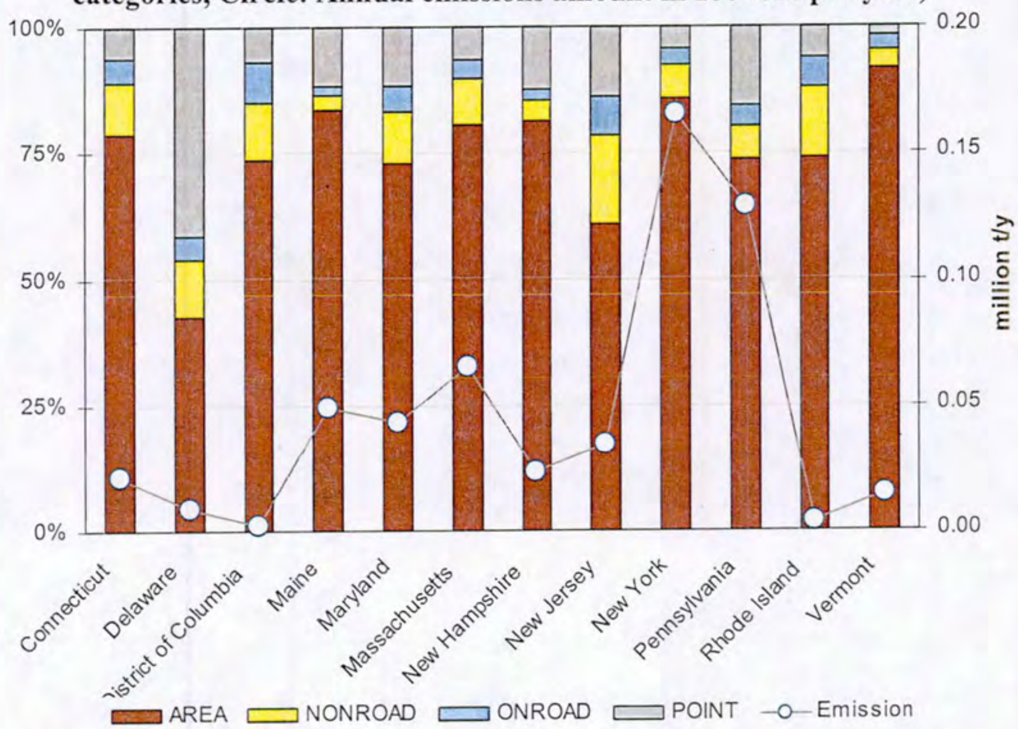


Figure 4-9. Primary $PM_{2.5}$ (Bar graph: Percentage fraction of four source categories, Circle: Annual emissions amount in 106 tons per year)

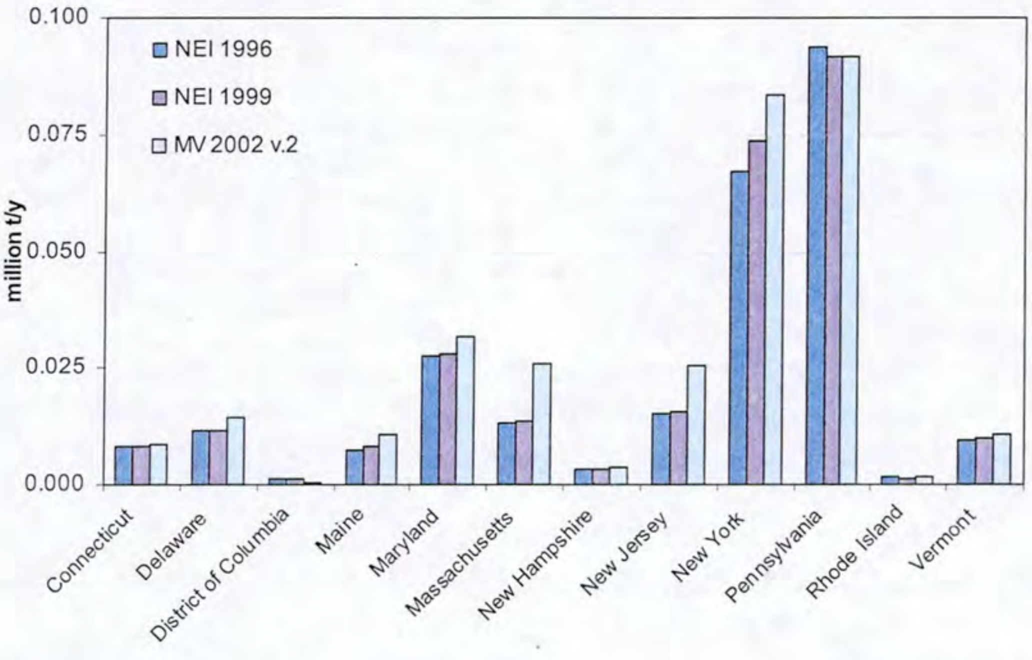


To address the need for improved ammonia inventories, MARAMA, NESCAUM and USEPA funded researchers at Carnegie Mellon University (CMU) in Pittsburgh to develop a regional ammonia inventory (Davidson et al., 1999). This study focused on three issues with respect to current emissions estimates: (1) a wide 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[22] 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).

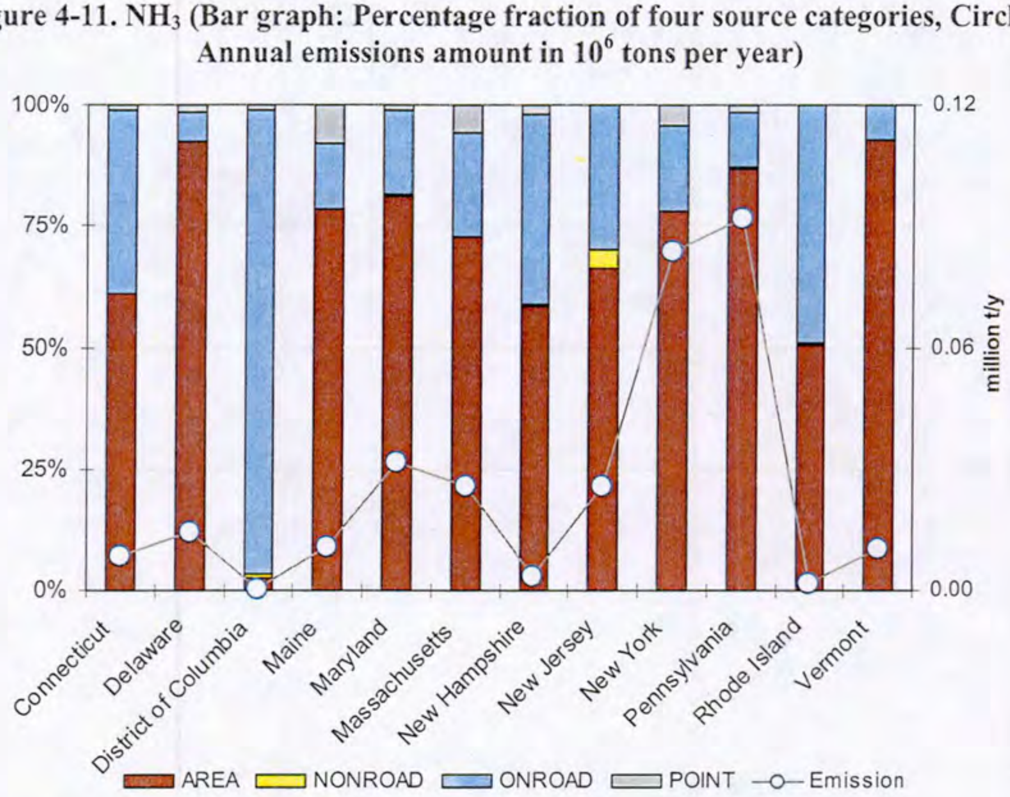
Figure 4-10 shows that estimated ammonia emissions were fairly stable in the 1996, 1999, and 2002 NEI for MANE-VU states, with some increases observed for Massachusetts, New Jersey and New York. Area and on-road mobile sources dominate the ammonia inventory, according to Figure 4-11. Specifically, emissions 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.

Figure 4-10. State Level Ammonia Emissions



[22] 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 4-11. NH_3 (Bar graph: Percentage fraction of four source categories, Circle: Annual emissions amount in 10^6 tons per year)



4.2. Contribution Assessments Based on Emissions Inventories

Two data analysis methods have been developed that directly combine emission inventory data with meteorological data in order to provide first-order contributions to observed sulfate from individual states. The first approach, known as "Q/d," evaluates the state contribution as a proportion of the ratio of the total SO_2 emissions from that state and the distance from the state to the receptor. States and sources are assigned wind sectors to account for prevailing wind patterns in establishing contributions. The second approach, known as "Emissions times Upwind Probability," evaluates the state contribution through the use of ensemble back trajectories (See Appendix A for a more detailed description of trajectory methods). The back trajectory-derived residence times of air parcels have been mapped onto a grid to create a "residence time probability field," which is then multiplied by an SO_2 emissions field to obtain estimated source contributions. The results of the two approaches are compared for receptor sites in and around the MANE-VU region.

4.2.1. Sulfur Dioxide Emissions Divided by Distance

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

One simple technique for deducing the relative impact of emissions from specific point sources on a specific receptor site involves calculating the ratio of annual emissions (Q) to source-receptor distance (d).[23] This empirical relationship is reasonable based on simple dispersion assumptions. Results from SO_2 modeling using the CALPUFF (California Puff) model (EarthTech, 2004) further bolster its validity by showing a strong relationship between emissions and distance. In fact, this extremely simple method of estimating impact can be significantly improved to account for some aspects of meteorology by scaling results according to the extremely linear relationships between CALPUFF and Q/d values within specific wind sectors.

The geographic domain of the sources included in the Q/d study consisted of U.S. states in the CENRAP, MANE-VU, VISTAS, and MIDWEST RPO regions. Canadian provinces in the lower eastern region were also included. The categories of SO_2 emission sources included in this analysis were area sources (e.g., residential boilers and heaters), non-road mobile sources (e.g., tractors and construction vehicles), and point sources (e.g., industrial smokestacks and power generation facilities).[24] Results were calculated for seven receptors including: Acadia National Park, Brigantine Wilderness in the Forsythe Wildlife Preserve, Dolly Sods Wilderness, Lye Brook Wilderness, Moosehorn Wilderness, Presidential Range-Dry River Wilderness, and Shenandoah National Park.

The empirical formula that relates emission source strength and estimated impact can be expressed through the equation $I=C_i*Q/d$. In this equation, the strength of an emission source, Q, is linearly related to the impact, I, that it will have on a receptor located a distance, d, away. The effect of meteorological prevailing winds can be factored into this approach by establishing the constant, C_i, as a function of the sectors relative to the receptor site. This relationship can be established by comparing Q/d values to modeled impacts, which are also dependent on prevailing wind patterns at the site of impact. By establishing a different constant for each sector, based on prior modeling results – in this case, CALPUFF results – we are in effect "scaling" Q/d results

[23] We calculated distances using the Haversine formula, which uses spherical geometry to calculate the distance between two points on the surface of a sphere. Because the Earth is not an exact sphere, use of this formula introduces a small amount of error — on the order of 0.5% — in the distance calculations for any two locations on the Earth's surface (see http://mathforum.org/library/drmath for further details).

[24] On-road mobile sources contribute about 2% of the SO_2 inventory nationally (See Figure 4-2 for regional breakdown) and were not considered significant enough to include in this analysis, which does not provide results to that level of precision.

by CALPUFF-calculated source impacts. The absolute impacts produced are then dependent on the CALPUFF results, however the relative contributions of each source within a wind sector is established completely independent of the CALPUFF calculation, yielding a quasi-independent method of apportionment to add to our weight-of-evidence approach.

To determine the appropriate constant for each wind sector relative to a given receptor, a linear regression analysis was performed on 778 sources in the eastern U.S. with emissions data available from the continuous emissions monitoring system (CEMS) for 2002. The Q/d values were calculated for these sources and compared with their modeled source impacts from the CALPUFF model (see Phase I modeling discussed in Appendix D). The sites were grouped by angle into "wind sectors" such that each wind sector had a best-fit line with as high a correlation coefficient (R^2) value as possible. Most sectors had an R^2 above or near 0.90. The slopes of the resulting best-fit lines were used as the constants in the above equation.[25]

To calculate the impact that each state had on a given receptor, the area and non-road SO_2 emission sources were summed across the entire state, and the distance to the receptor site for those emission sources was calculated based on that state's geographic center, adjusted for population density.[26] In this way, the area and non-road emissions were treated as a single point source located at the population-weighted center of each state. These impacts were then added to the impact of the point sources that were calculated individually. The sum of area, non-road, and point source impacts for each state was used to compare the contributions relative to other states in the eastern U.S. and parts of Canada.

The principal contributors to the MANE-VU receptors, according to this method, include the midwestern states of Indiana and Ohio, as well as Pennsylvania and New York. This is due not only to the large emissions from these states, but also to the predominantly westerly winds that carry Midwest pollution eastward (the Midwest was located in the wind sector with the highest C_i-value, five times that of the lowest Ci-value). Table 4-1 shows the relative contribution of eastern states and Canadian provinces on several receptor sites in the region. Figure 4-12 and Figure 4-13 show the corresponding Q/d rankings across a set of northern and southern Class I areas in or near MANE-VU.

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[25] The analysis resulted in best-fit lines that did not always go through the origin. By forcing the regression lines through the origin, we ensure that a source with zero emissions would correspond to zero impact at the receptor. After having forced the best-fit lines through the origin, R^2 values remained greater than 0.77 and changed less than 0.01 from the original regression. The changes to the slope were considered insignificant, with an average change of 4%, ranging from -11% to 16%; the extremes occurred for plots with relatively few points and on the low end of R-squared correlations. Some angle ranges were not associated with a wind sector because of insufficient data for that angle range. For example, there was a lack of data for Lye Brook Wilderness receptor in the 0-144° angle range. This angle sector and similar sectors lacking adequate data were assigned the lowest C_i-value amongst the other wind sectors of the same receptor site. The impact of this decision should be small given the relatively few sources in these directions and their tendency to be downwind of the receptor.

[26] Calculations using county-level emissions and distance to county centroid to receptor were compared to the approach used here. This added complexity, however, did not substantially change the predicted impacts nor the relative rankings among states.

Table 4-1. 2002 SO_2 CALPUFF-scaled Emissions over Distance Impact ($\mu g/m^3$)

STATE	ACADIA	LYE BROOK	BRIGANTINE	SHENANDOAH	EMISSIONS
Pennsylvania	0.19	0.30	0.38	0.43	1,090,562
Ohio	0.19	0.23	0.27	0.46	1,273,755
West Virginia	0.08	0.09	0.16	0.32	573,136
Maryland	0.05	0.06	0.24	0.21	292,970
New York	0.12	0.15	0.15	0.13	341,493
Indiana	0.11	0.11	0.14	0.18	914,039
North Carolina	0.07	0.06	0.14	0.26	510,452
Virginia	0.06	0.04	0.14	0.17	309,709
Georgia	0.07	0.07	0.11	0.14	605,040
Kentucky	0.06	0.06	0.11	0.14	521,583
Michigan	0.08	0.08	0.06	0.10	432,166
Illinois	0.07	0.07	0.07	0.10	642,264
Tennessee	0.04	0.04	0.07	0.09	423,705
New Jersey	0.02	0.02	0.14	0.07	64,437
Alabama	0.05	0.05	0.07	0.08	548,054
Texas	0.04	0.04	0.05	0.06	849,831
Florida	0.04	0.03	0.06	0.07	537,327
Massachusetts	0.08	0.02	0.03	0.05	123,754
South Carolina	0.04	0.02	0.05	0.07	262,867
Delaware	0.02	0.02	0.10	0.04	83,549
Missouri	0.04	0.04	0.05	0.05	361,911
Wisconsin	0.03	0.03	0.03	0.04	263,040
Maine	0.05	<0.01	<0.01	0.01	39,423
Kansas	0.01	0.01	0.01	0.01	136,104
New Hampshire	0.03	<0.01	0.01	0.01	53,772
Minnesota	0.01	0.01	0.01	0.01	124,151
Mississippi	0.01	0.01	0.01	0.02	126,456
Iowa	0.01	0.01	0.01	0.01	230,676
Connecticut	0.01	0.01	0.01	0.01	41,093
Oklahoma	0.01	0.01	0.01	0.01	139,327
Louisiana	0.01	0.01	0.01	0.02	346,170
Arkansas	<0.01	<0.01	0.01	0.01	140,096
Nebraska	0.01	<0.01	<0.01	0.01	46,074
Rhode Island	<0.01	<0.01	<0.01	<0.01	2,531
Vermont	<0.01	<0.01	<0.01	<0.01	1,575
Dist. of Columbia	<0.01	<0.01	<0.01	<0.01	1,715
Ontario	0.01	0.24	0.12	0.15	5,010
New Brunswick	0.15	0.01	0.02	0.02	1,261
Quebec	0.09	0.02	0.03	0.05	6,567
Nova Scotia	0.08	0.01	0.02	0.02	7,566
Newfoundland	0.01	<0.01	<0.01	0.01	15,287
Prince Edward Is.	<0.01	<0.01	<0.01	<0.01	10,157

Figure 4-12. Ranked state percent sulfate contributions to Northeast Class I receptors based on emissions divided by distance (Q/d) results

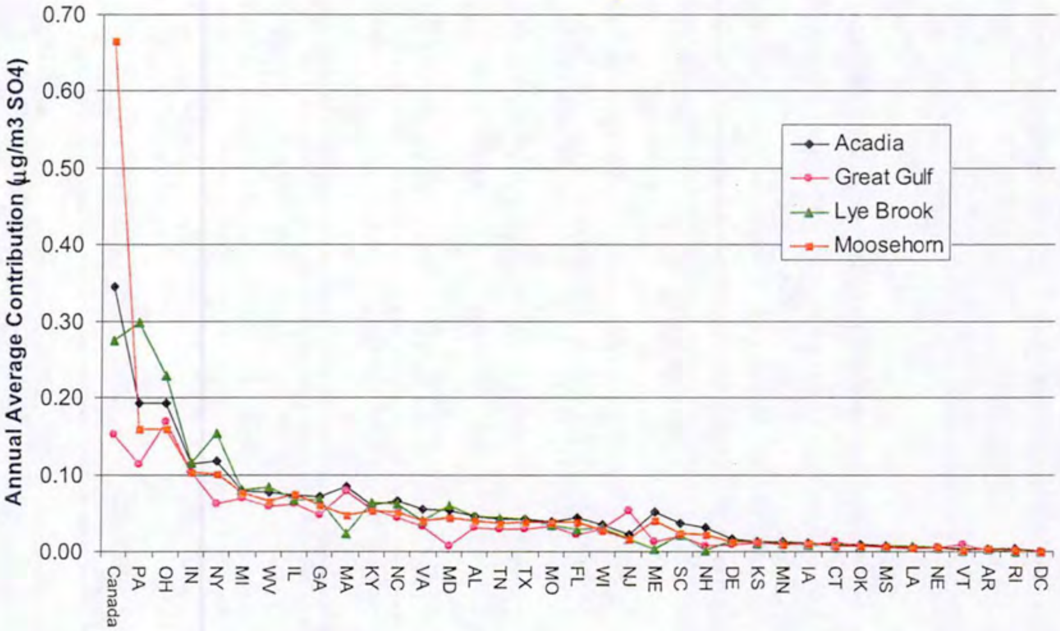
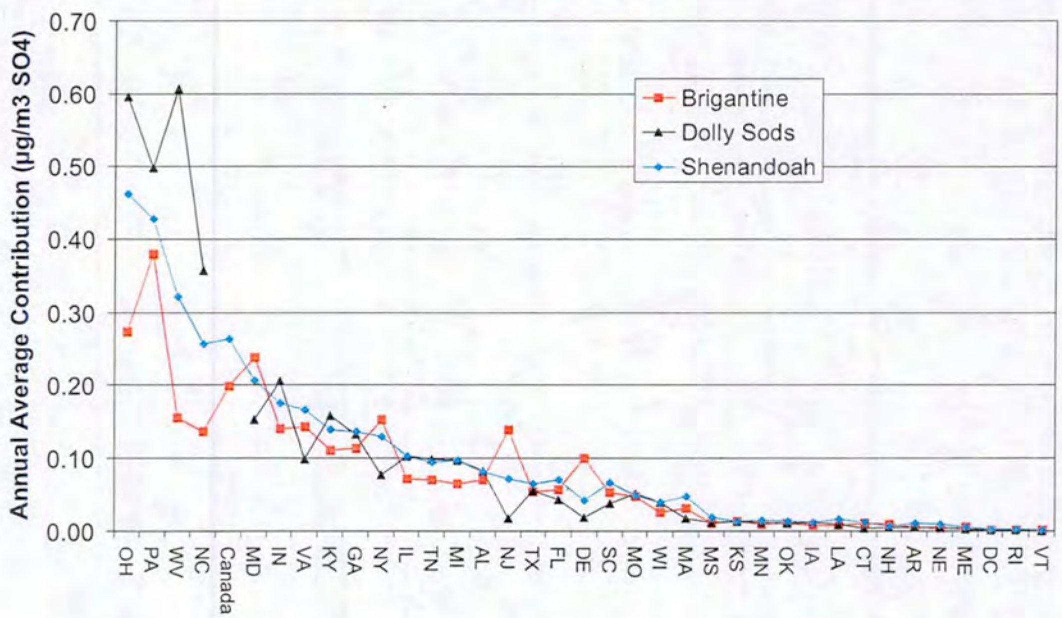


Figure 4-13. Ranked state percent sulfate contributions to Mid-Atlantic Class I receptors based on emissions divided by distance (Q/d) results



It is difficult to draw firm conclusions from what is essentially an empirical relationship between emission source strength, distance and observed impacts at receptor sites, but the addition of the CALPUFF-derived scale factors to this approach yields important insights as to the abilities of fairly simple screening techniques to accurately predict potential contributions to downwind receptors. This is borne out by the high degree of correspondence between the relative contributions of regions as identified by this and other techniques shown in Chapter 8.

4.2.2. Emissions times Upwind Probability

The Emissions times Upwind Probability method of assessing contribution to pollution involves multiplying the back-trajectory calculated residence time probability for a grid cell with the total emissions – over the same time period – from that grid cell. The product is an emissions-weighted probability field that can be integrated within state boundaries to calculate relative probabilities of each state contributing to pollution transport.

A back trajectory is the path that a parcel of air is calculated to have taken prior to its arrival at a given receptor (See Chapter 5). The back trajectories used in this study were calculated by the HYSPLIT system (Draxler, 1997 and 1998). Five years of back trajectories, calculated eight times per day results in 14,600 back trajectories. The back trajectories are 72-hours in length and have calculated endpoints, or locations, at hourly intervals that specify the air mass path. The endpoints from all trajectories are mapped into a matrix of residence times spent in individual grid cells over the five year period. The resulting sum expresses the likelihood that air spent time in a particular quarter degree longitude by quarter degree latitude grid cell over a domain between 25° and 57° latitude and -110° to -50° longitude. These residence times are then multiplied by the MANE-VU base year SO_2 emission inventory that has been allocated to a 12 km horizontal grid based on a Lambert Conformal projection.[27] The resulting product matrix contains the SO_2-weighted residence times that are then numerically integrated within the boundaries of each state to define a "contribution" for each state. This provides a relative ranking of contribution by state that can be used to compare with other methods of attribution.[28]

The area of analysis included states from Maine to Mississippi. Several states lie on the periphery of our available SO_2 emissions field and were used in the study despite an incomplete inventory of SO_2 emissions for the far edges of each state; these included

[27] Since the latitude-longitude projection of the residence time grid is different than the Lambert conformal projection of the emissions grid, there is not a one-to-one mapping. We therefore interpolated each residence time grid cell to increase the spatial resolution to 1/20° latitude by 1/20° longitude. Each residence time cell was then associated with the nearest SO_2 emission cell to ensure that each SO_2 emission component of the inventory was associated with the approximate residence time that was spent in nearest proximity to the emissions region. A distance of one-quarter degree between associated grid cells was used as a cutoff for the analysis. In other words, the product of a particular SO_2 cell and residence time cell would not be used if the geographical distance between them was greater than one-quarter degree (latitude or longitude).

[28] Note that the absolute units are expressed as nmole/hr, which represent a fractional contribution of a grid cell's emission rate that is likely to influence a downwind receptor. The physical meaning of this contribution is not clear, so this has been used in a relative sense only.

Missouri, Arkansas, Mississippi, Alabama, and Georgia.[29] Canada has significant SO_2 emissions in the domain of the SO_2 grid, hence contributions have been calculated for portions of Ontario, Quebec and New Brunswick that were within the SO_2 emission grid. Table 4-2 provides a ranking of state contributions and Figure 4-14 and Figure 4-15 show the ranked contribution for two groupings of Class I sites in or near MANE-VU.

Table 4-2. 2002 SO_2 Upwind Probability (percent contribution)

	ACADIA	LYEBROOK	BRIGANTINE	SHENANDOAH
West Virginia	0.06	0.07	0.09	0.19
Ohio	0.09	0.11	0.10	0.12
Pennsylvania	0.09	0.13	0.13	0.07
Kentucky	0.04	0.05	0.06	0.09
Indiana	0.05	0.05	0.05	0.06
New York	0.07	0.11	0.04	0.02
Virginia	0.03	0.02	0.06	0.06
North Carolina	0.02	0.01	0.05	0.07
Illinois	0.06	0.05	0.04	0.04
Georgia	0.02	0.02	0.04	0.05
Michigan	0.04	0.04	0.02	0.02
Tennessee	0.02	0.01	0.02	0.04
Maryland	0.02	0.02	0.04	0.03
New Jersey	0.02	0.02	0.07	0.01
Alabama	0.01	0.01	0.02	0.02
South Carolina	0.01	0.01	0.02	0.02
Wisconsin	0.02	0.02	0.01	0.01
Missouri	0.01	0.01	0.01	0.01
Delaware	<0.01	0.01	0.02	<0.01
Massachusetts	0.02	0.01	<0.01	<0.01
New Hampshire	0.02	0.01	<0.01	<0.01
Minnesota	0.01	0.01	<0.01	<0.01
Connecticut	0.01	0.01	<0.01	<0.01
Maine	0.02	<0.01	<0.01	<0.01
Iowa	0.01	<0.01	<0.01	<0.01
Dist. of Columbia	<0.01	<0.01	<0.01	<0.01
Arkansas	<0.01	<0.01	<0.01	<0.01
Mississippi	<0.01	<0.01	<0.01	<0.01
Vermont	<0.01	<0.01	<0.01	<0.01
Louisiana	<0.01	<0.01	<0.01	<0.01
Rhode Island	<0.01	<0.01	<0.01	<0.01
Texas	<0.01	<0.01	<0.01	<0.01
Canada	0.23	0.20	0.08	0.05

[29] These states still had significant areas that were not covered by the SO_2 grid. Thus only a fraction of these states' emissions were included in the total state contribution. The following are estimates of the area *not* covered by the SO_2 grid: MO-20%, AR-10%, MS-25%, AL-20%, GA-5%.

Figure 4-14. Ranked state percent sulfate contributions to Northeast Class I receptors based on emissions times upwind probability (E x UP) results

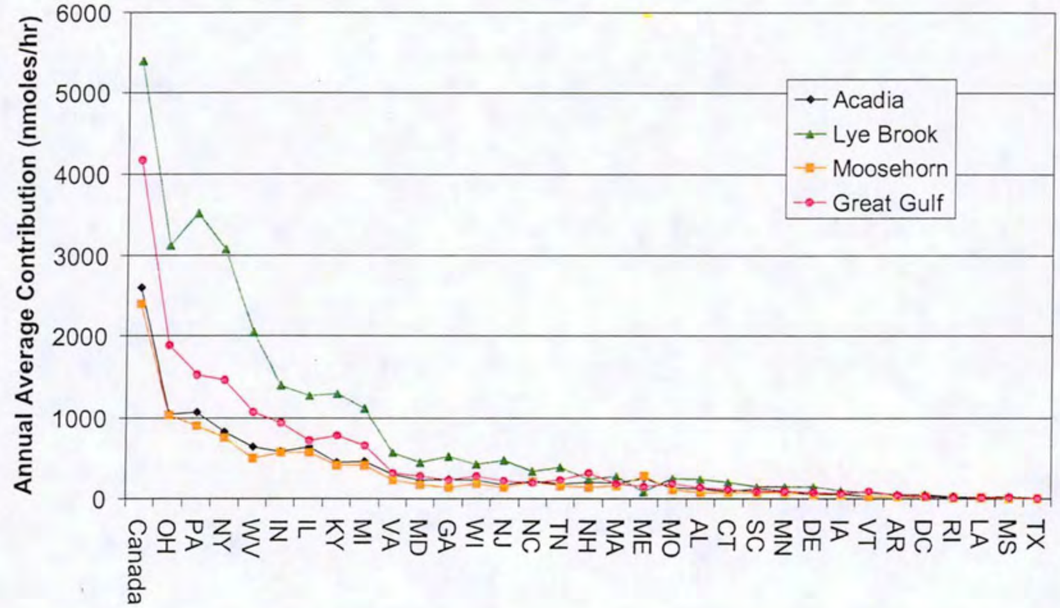
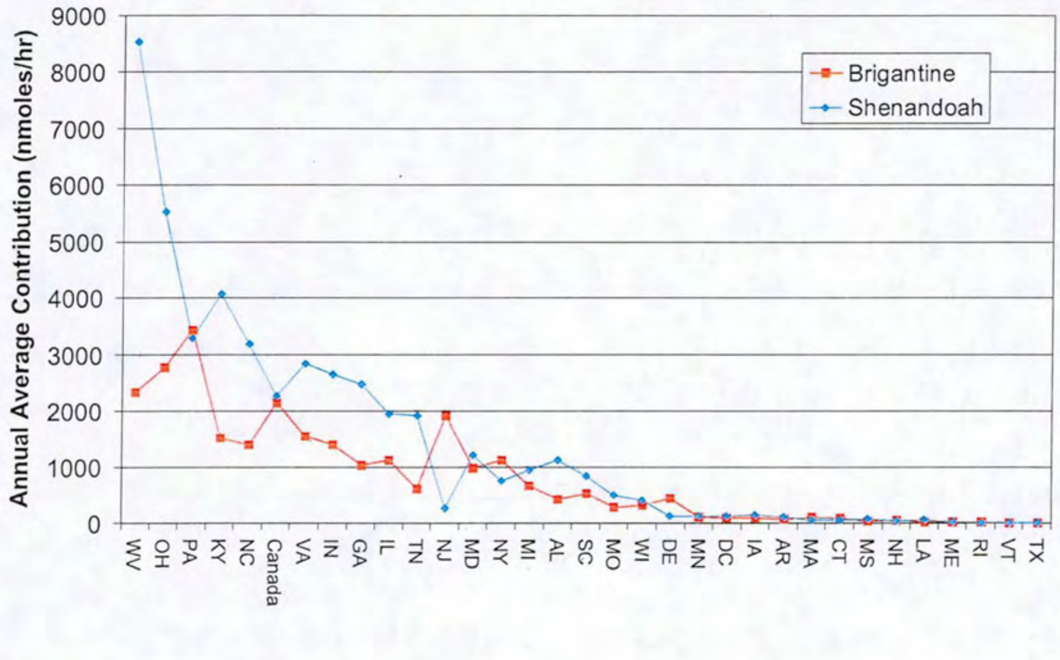


Figure 4-15. Ranked state percent sulfate contributions to Mid-Atlantic Class I receptors based on emissions times upwind probability (E x UP) results



References

Ansari, A. S., and Pandis, S.N., "Response of inorganic PM to precursor concentrations," *Environ. Sci. Technol.*, 32, 2706-2714, 1998.

Davidson, C., Strader, R., Pandis, S., and Robinson, A., *Preliminary Proposal to MARAMA and NESCAUM: Development of an Ammonia Emissions Inventory for the Mid-Atlantic States and New England.* Carnegie Mellon University, Pittsburgh, PA. 7-Jan. 1999.

Draxler, R.D. and Hess, G.D., "Description of the HYSPLIT-4 Modeling System," *NOAA Technical Memorandum ERL, ARL-224*, Air Resources Laboratory, Silver Springs, Maryland, 24 pgs., 1997.

Draxler, R.D. and Hess, G.D., "An Overview of the HYSPLIT-4 Modeling System for Trajectories, Dispersion, and Deposition," *Australian Meteorological Magazine*, 1998, 47, 295-308.

Duyzer, J., "Dry Deposition of Ammonia and Ammonium Aerosols over Heathland," *J. Geophys. Res.*, 99(D9):18,757 – 18,763, 1994.

EarthTech, 2004, http://src.com/calpuff/calpuff1.htm

MARAMA 2004, http://www.marama.org/visibility/2002%20NEI/index.html

NESCAUM, "Regional Haze and Visibility in the Northeast and Mid-Atlantic States," January 2001a.

NESCAUM, "Development of an Improved Ammonia Emissions Inventory for the United States," December 2001b.

NESCAUM, "2002: A Year in Review," December, 2004.

Odum, J.R., Jungkamp, T.P.W., Griffin, R.J., Flagan, R.C., and Seinfeld, J.H., "The Atmospheric Aerosol-forming Potential of Whole Gasoline Vapor," *Science*, 276, 96-99, 1997.

Strader, R., Anderson, N., and Davidson, C., *Development of an Ammonia Inventory for the Mid-Atlantic States and New England, Progress Report, October 18, 2000*, available online: http://marama.org/rt_center/MARAMAprogress10-18-00.pdf, 2000.

USEPA, *National Air Quality and Emission Trends Report, 1998*, EPA 454/R-00-003, available online: http://www.epa.gov/oar/aqtrnd98/, 2000a.

USEPA, *National Air Pollutant Trends, 1900 – 1998*, EPA 454/R-00-002, available online: http://www.epa.gov/ttn/chief/trends/trends98/trends98.pdf, 2000b.

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

5. DATA ANALYSIS TECHNIQUES

Trajectory analyses have historically been used to trace the path of polluted air masses prior to their arrival at a given receptor site. Such analyses, by linking downwind measurements of ambient air quality with specific geographic areas upwind, can be very helpful in exploring the relative contribution of transported emissions from potential source regions on high and low pollution days. As with all of the tools and modeling techniques discussed in this report, trajectory analysis is not without some uncertainties and limitations. One such limitation is the fact that these analyses are typically unable to distinguish emission contributions from one point along the length of the trajectory from a different point along the path. In addition, the accuracy of any individual back trajectory calculation for a single observation or episode may be compromised by inherent limitations in the underlying Lagrangian trajectory models, which tend to become less accurate as the calculation progresses further back in time. Fortunately, a variety of techniques are available to mitigate these uncertainties and enhance confidence in the results obtained using trajectory analysis. These include techniques for triangulating results across multiple sites, ensemble techniques that combine the results of large numbers of back trajectories, clustering algorithms that group similar trajectories based on their spatial characteristics, and techniques for combining trajectory analyses with source apportionment models. All of these strategies can be useful in improving and refining traditional trajectory analyses.

This chapter describes the results of back trajectory analyses that have been conducted to date for key pollutant species observed at MANE-VU and nearby receptor sites. In addition, we explore novel techniques for improving the accuracy of individual trajectories by grouping meteorologically similar back-trajectories into trajectory "clusters" and examining the relationship between the transport pathways defined by these clusters and downwind air quality observations. We then turn to source apportionment models which can be used to group available monitoring data for various components of $PM_{2.5}$ in logical combinations that best explain the variation in observed species concentrations in terms of specific "source profiles." These source profiles are used to distinguish the emissions from common pollution sources (e.g., mobile sources, coal combustion). The information obtained through source apportionment analysis can then be used in combination with back trajectory analysis to link specific geographic source regions with downwind air quality conditions and to establish the relative contribution of different source regions to visibility impacts at the receptor site.

This chapter provides further description of several trajectory analysis techniques, before proceeding to a review of the insights gained to date by applying these techniques to analyze source regions for particulate pollution in the MANE-VU region. Preliminary results and interpretation are presented and used to support and bolster the basic conceptual model of regional haze outlined in Chapter 2.

5.1. Trajectory Analysis

The Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) model (Draxler, 1997 and 1998) was used to calculate back trajectories for 13 sites in the northeastern United States. Most of these sites are located in Class I areas that are subject to the Haze Rule, but several others are located in areas where potential nonattainment with the $PM_{2.5}$ NAAQS warrant analysis. Back trajectories were calculated eight times per day for starting heights of 200, 500, and 1,000 meters above ground level using meteorological wind fields for the five-year period from 2000 through 2004. Meteorological data from the National Oceanic and Atmospheric Administration (NOAA) Air Resources Laboratory (ARL) archives were used. These include wind fields from the Eta Data Assimilation System (EDAS), which cover North America with an 80 km spatial resolution and are based on 3-hourly variational analyses (Rolph, 2003). For the analyses presented here, we exclusively used the 500 meter EDAS trajectories from the baseline period (2000-2004).

Each trajectory was matched with corresponding monitoring data collected as close in time as possible to the "start" time of the back trajectory calculation. The analysis included ambient measurements for $PM_{2.5}$ and ozone (O_3), as well as all particulate matter constituents that are routinely measured as part of the IMPROVE program.

The resulting database of air quality monitoring results and associated back trajectories was used to develop several statistical measures of the probability or likelihood that a given upwind source region is associated with good or poor air quality at the receptor sites analyzed. Appendix A provides a detailed description of the metrics that were developed for this purpose and how they were calculated using both traditional trajectory analysis and cluster analysis techniques. This appendix also provides site-specific results.

5.1.1. Incremental Probability

The incremental probability (IP) field represents a measure of the likelihood that a given source region contributes more than "average" to high concentrations of a particular pollutant at a downwind receptor site (see Appendix A for a more complete definition). This technique can also be used to identify locations that are *less* likely to contribute to poor air quality at a given receptor site, thus allowing for more robust conclusions to be drawn about likely source regions for individual fine particle constituents.

Calculating IP fields for a subset of back trajectories within a complete sample can help further illuminate the different roles of different source regions. For example, it is interesting to note distinct differences between the IP field for back trajectories corresponding to the 10 percent highest observed sulfate values in the Northeast (three sites are shown that bracket the MANE-VU region's Class I sites) and the IP field for trajectories corresponding to the lowest sulfate values in the Northeast (specifically, sulfate values in the lowest 10^{th} percentile). Figure 5-1 and Figure 5-2 illustrate the IP fields for each set of observations, respectively.

In Figure 5-1 and Figure 5-2, note that the red color indicates areas with greater probability of contributing to transport on the selected days. These show that the very highest observed sulfate values across the region are strongly associated with transport from a source region that encompasses the Ohio River Valley, western Pennsylvania, and the urban East Coast corridor. On the days with the lowest measured sulfate, transport is associated with northwesterly winds from Canada and weather patterns off the Atlantic.

Figure 5-1. Incremental Probability (Top 10% Sulfate) at Acadia, Brigantine and Lye Brook 2000-2004

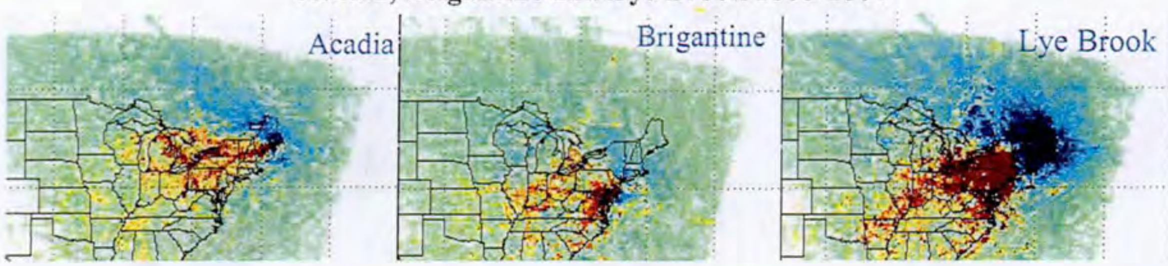
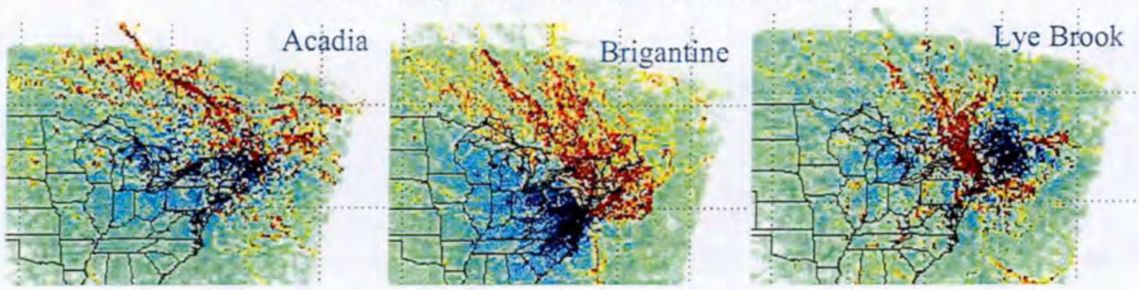


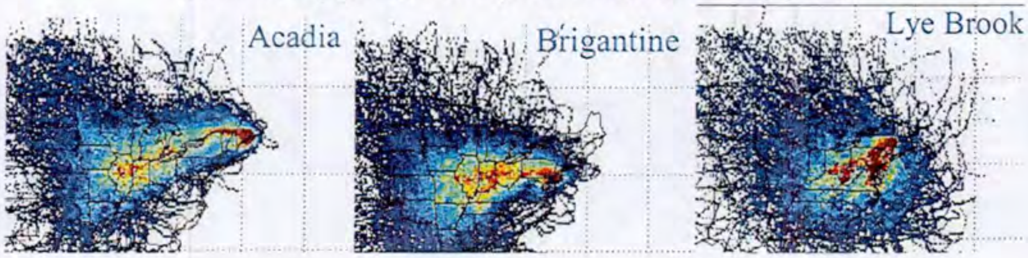
Figure 5-2. Incremental Probability (Bottom 10% Sulfate) at Acadia, Brigantine and Lye Brook 2000-2004



5.1.2. Clustered Back-Trajectories

Each of the IP fields shown in Figure 5-1 or Figure 5-2 incorporate results from over 14,000 back trajectories over the five-year period analyzed. In cases like these, where IP fields are calculated from a very large set of data points, the error in the calculation of any individual trajectory — which can be as high as 30 percent or more of the total transport distance involved in a given trajectory — is not likely to affect the overall result. Assuming that such errors are randomly distributed (i.e., no systematic bias exists in the calculations used by the trajectory model to calculate wind speed or direction), the use of large numbers of individual trajectories will effectively ensure that the random errors cancel out. To further minimize the effect of any errors with respect to individual trajectories, it is also possible to cluster large numbers of back trajectories according to their three-dimensional similarity (see Appendix A for a detailed description of several methodologies used). Figure 5-3 shows residence-time probability fields for clusters of similar back trajectories grouped according to their proximity to unique meteorological pathways. This metric yields probabilistic representations of the meteorological pathways which were most likely to be associated with the highest observed sulfate concentrations at the receptor site. Such probabilistic representations reduce the reliance on any one back trajectory and ensure that the general pattern used to associate a transport pathway with a downwind receptor site is more likely to be accurate.

Figure 5-3. Proximity based cluster with the highest associated sulfate value for three sites in the MANE-VU region, Acadia (sulf=3.19 $\mu g/m^3$), Brigantine (sulf=6.79 $\mu g/m^3$), and Lye Brook (sulf=3.92 $\mu g/m^3$)



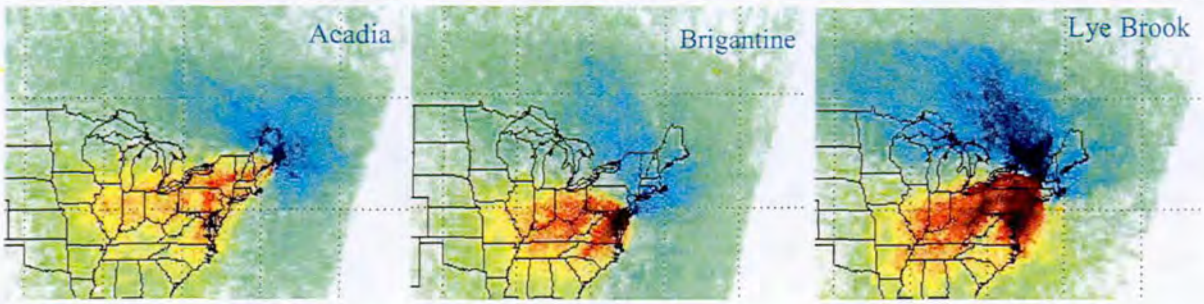
5.1.3. Cluster-Weighted Probability

The clusters derived above can be used individually or combined in an "ensemble cluster" approach similar to how individual trajectories are combined to develop the IP metric. This second method for associating transport patterns with downwind pollution measurements involves using all clusters generated by the clustering algorithms described in the preceding section (and in detail in Appendix A) and weighting them by their average observed sulfate value. Simply averaging the residence-time probability of all clusters would yield the "everyday" probabilities that are used in calculating IP fields. Instead, weighting each cluster *before* the averaging process serves to highlight transport patterns that are associated with high sulfate levels at the receptor site, while downplaying patterns that are associated with low values. Figure 5-4 shows the resulting cluster-weighted probability (CWP) field. Results are similar to those obtained using the incremental probability metric described previously, but they now include all clusters, not just the high-day values.

A noteworthy feature of the clustering process is that while it reduces uncertainty about prevailing transport patterns, it is not helpful in taking advantage of weather variations to identify specific source regions. Thus, results for a particular site should be interpreted as showing that observed air quality conditions have an increased probability of being associated with the transport of a specific pollutant, as opposed to being associated with a particular source region for a given pollutant. Put another way, it is difficult to make an association with a specific point along the pathway defined by a cluster. As with the IP approach described earlier, however, multi-site averaging can address this ambiguity by making it possible to triangulate on regions that are associated with the transport of pollution to multiple sites in different locations, as shown in Figure 5-4.

Both trajectory-based approaches (i.e., IP and CWP) have also been applied to Class I receptor sites in the nearby VISTAS region, which includes the Dolly Sods and Otter Creek Wilderness Areas in West Virginia as well as Shenandoah National Park and the James River Face Wilderness Area in Virginia. Results for the VISTAS Class I sites are presented at the conclusion of Appendix A.

Figure 5-4. Cluster Weighted Probability at Acadia, Brigantine and Lye Brook 2000-2004



5.2. Source Apportionment Models and Ensemble Trajectory Analysis of Source Apportionment Results

Previous sections of this chapter have discussed a category of receptor-based assessment techniques known more generally as ensemble trajectory analysis. The latter category includes residence time analysis (RTA) as well as potential source contribution function (PSCF) and cluster analysis (see also Appendix A). In this section we turn to multivariate mathematical models for analyzing source contributions, such as chemical mass balance (CMB) models, principal component analysis (PCA), positive matrix factorization (PMF), and UNMIX.

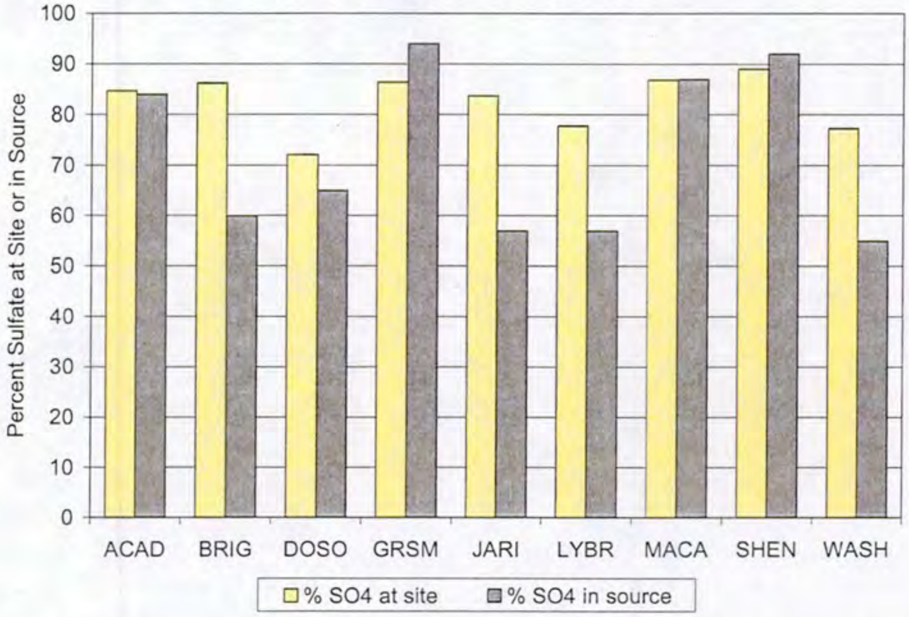
Receptor-based models begin with ambient air quality measurements at one or more receptor locations and work "backward" to identify logical combinations of pollutant species that best fit a "source profile." Sources matching that profile are assumed to have contributed to the ambient pollutant concentrations historically observed at the receptor locations. These models are typically driven by variations in PM constituent concentrations across multiple observations at one or more sites. An advantage of PCA, PMF, and UNMIX is that source profiles do not need to be known in advance; however, this does mean that the results must be subjectively interpreted to identify and distinguish likely sources.

Because of these complexities and because the multivariate models typically rely entirely on measurements of PM constituents without regard to meteorology, it can be extremely useful to consider results obtained through the ensemble trajectory techniques (which rely on meteorology only) when interpreting or evaluating the outputs from a multivariate modeling exercise.

Appendix B provides details of numerous source apportionment and associated ensemble back trajectory analyses. These details cover results obtained for many of the most significant components of fine particulate mass and resulting light extinction. Here we focus on the "secondary sulfate" or "coal" source profile that was identified at nearly every site in the eastern United States. Secondary sulfate typically accounts for 30–60 percent of overall fine particle mass and 60–80 percent of visibility impairment on the haziest days in the Northeast.

Figure 5-5 shows results from one of the broadest studies conducted to date of sulfate sources and characteristics at nine eastern IMPROVE sites. The bars on the left show the fraction of total sulfate measured at each site that is contributed by the "sulfate/coal" source profile as determined by the source apportionment models. The bars on the right show the fraction of each "sulfate/coal" source profile that is composed of sulfate. Figure 5-5 suggests that: (1) large sources contribute 70–90 percent of the total sulfate measured at these sites, and (2) that the contribution from these large sources consists of 50–90 percent sulfate.

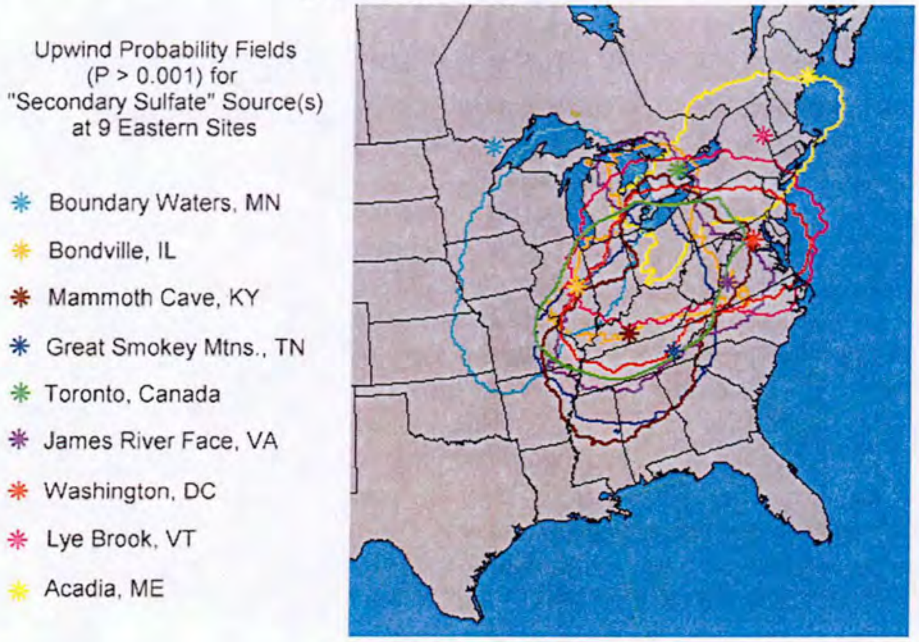
Figure 5-5. Sulfate characteristics of "secondary sulfate" (coal) sources identified at eastern sites



When large sulfate sources are associated with upwind states or regions through the use of back trajectories (Figure 5-6), it becomes clear that many Class I and urban sites in MANE-VU and adjoining areas are influenced by a common source region. These findings suggest that reductions in coal-related SO_2 emissions would have substantial benefits in terms of improved visibility and reduced PM concentrations over a large part of the eastern United States and eastern Canada.

This conclusion is further reinforced by comparing regions with significant emissions that match the "source profiles" generated by available mathematical modeling tools to regions identified through trajectory analysis as having a high probability of being upwind on days with high sulfate levels and high reconstructed extinction values. As shown in Figure 5-6, the degree of correspondence between these regions is substantial. This indicates that the "secondary sulfate/coal combustion" source profile prominent at several eastern sites is strongly linked to regions associated with the highest 10 percent of recorded sulfate and reconstructed extinction values. It is noteworthy that the upwind regions identified in Figure 5-7 are derived from measurements spanning the entire IMPROVE network, suggesting that the source region for "secondary sulfate/coal combustion," which is a dominant contributor to visibility impairment in parts of the eastern United States, is also a major contributor to observed sulfate and extinction outside the MANE-VU region.

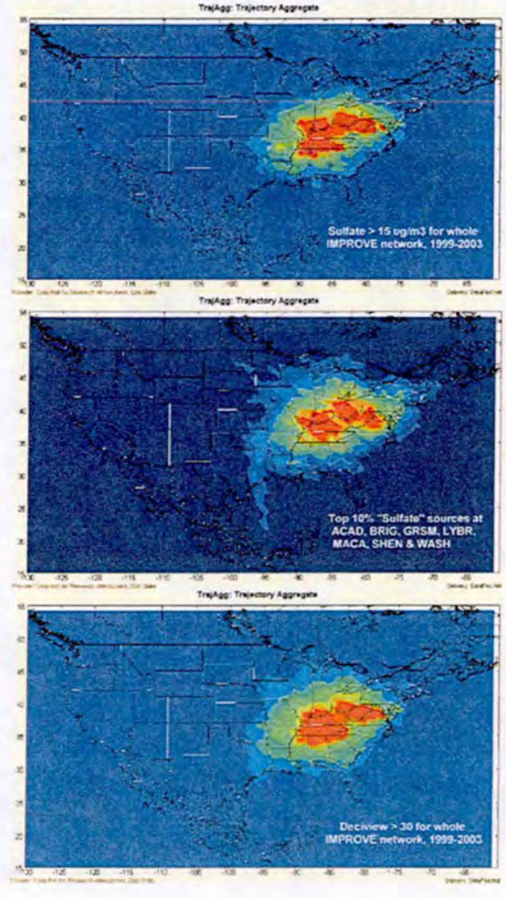
Figure 5-6. Incremental Probabilities for "Secondary Sulfate" (Coal) Sources in Eastern U.S.



5.3. Trajectory Model Evaluation and Future Work

The geographical correspondence exhibited in Figure 5-7 extends to the multi-site average IP fields calculated for the MANE-VU region and shown previously in Figure 5-1. It also extends to the multi-site average IP field calculated using the ATAD model and shown in Figure B-30 in Appendix B. Essentially, both figures are versions of the same thing, but they do exhibit some subtle differences. These differences are highlighted in Figure 5-8 which compares the results of ATAD and HYSPLIT IP calculations for the top 10 percent of sulfate, selenium, and nickel observations at Lye Brook, Vermont. Sulfate is a secondary pollutant that tends to peak in the summer, whereas nickel and selenium are primary pollutants that typically peak in the wintertime. Ni and Se serve as excellent markers for residual oil and coal combustion respectively. The figure indicates strong agreement between the two models in terms of

Figure 5-7. Comparison of probability fields for observed sulfate, "sulfate" source profiles for seven eastern sites and reconstructed deciviews



the IP fields they calculate for nickel, suggesting that — during wintertime — primary pollutants are tracked well by both techniques. There is less agreement between the IP fields for sulfate, suggesting either a southerly bias to the HYSPLIT calculations for this secondary pollutant, or a westerly bias to the ATAD results.

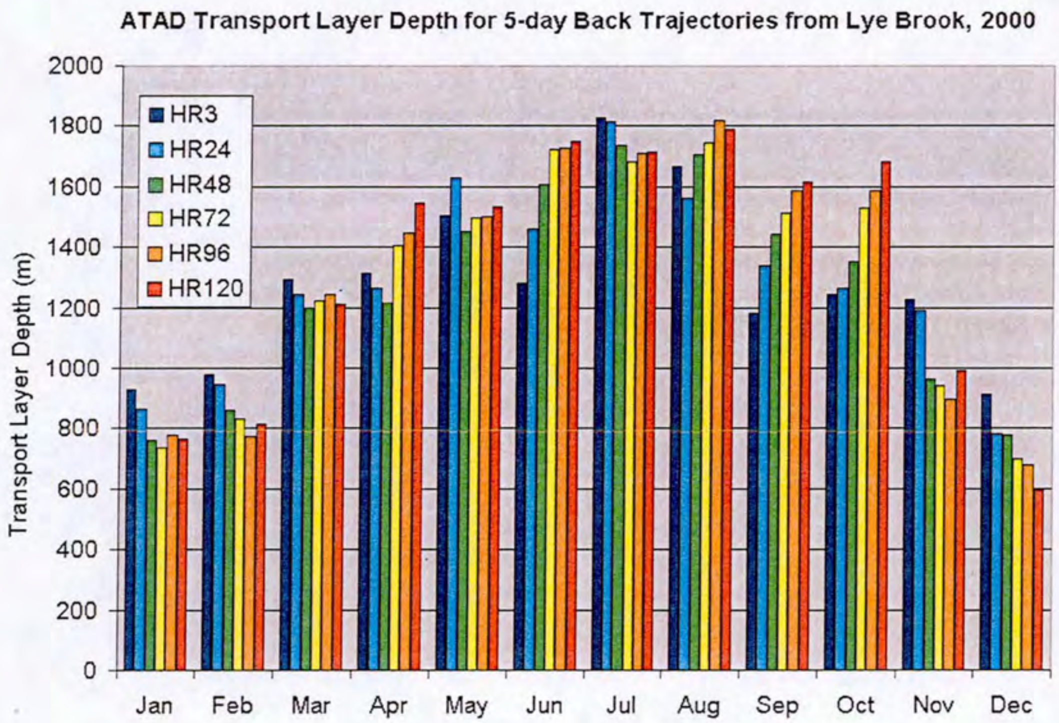
Seasonal differences in the meteorology that affects Lye Brook and other East Coast sites during the summer versus during the winter may help to explain these model discrepancies. Some of the largest absolute differences between the ATAD and HYSPLIT estimates occur for the highest sulfate days. While there are many differences between the models, one key difference is in their trajectory start heights. The HYSPLIT trajectories all start at 500 meters above ground level while the ATAD model first estimates a "transport layer depth" (TLD) and then initiates the trajectory (while constraining subsequent trajectory endpoints) at a point roughly half way between ground level and the TLD. During summer, when the largest sulfate events occur, the resulting ATAD start heights are roughly twice as high as the 500 m HYSPLIT start heights (see Figure 5-9). Hence the ATAD calculations tend to extend over a greater distance to the west, while the summer HYSPLIT trajectories may be more reflective of flows that are nearer the surface and more frequently east of the Appalachian Mountains. Both flow regimes are important. In fact, Blumenthal et al. (1997) have observed that the highest ozone concentrations in the Northeast (which often coincide with episodes of high sulfate concentrations) tend to occur when surface flows up the Northeast urban corridor combine with synoptic flows over the Appalachian Mountains from the west, a pattern that is often accompanied by lower level nocturnal jets along the Northeast corridor and through gaps in the Appalachians.

Figure 5-8. Comparison of IP contours generated by ATAD and HYSPLIT (both EDAS and FNL) for sulfate, nickel and selenium at Lye Brook

An extensive evaluation of the performance of HYSPLIT, ATAD, and Capita Monte Carlo trajectory models using a variety of different meteorological drivers, ensemble trajectory techniques, and performance tracers was recently conducted as part of the Big Bend Regional Aerosol and Visibility Observational (BRAVO) study (Pitchford et al., 2004). No one model consistently out-performed the others at that site, hence results from these and more sophisticated photochemical grid models (REMSAD and CMAQ) were merged to produce a best-estimate, "consensus" apportionment of sulfate in the BRAVO study.

MANE-VU is using all available trajectory models, trajectory-related metrics, and improved understanding of transport phenomena to further explore and support the development of emission control strategies for reducing regional haze.

Figure 5-9. ATAD Transport Layer Depth (TLD) by month. Color indicates the length of time prior to arriving at the receptor.



References

Blumenthal, D.L., Lurmann, F.W., Kumar, N., Ray, S.E, Korc, M.E., Londergan, R., Moore, G., Transport and mixing phenomena related to ozone exceedances in the Northeast U.S. Working Draft No. 1.1 prepared for Ozone Transport Assessment Group Air Quality Analysis Workgroup by Sonoma Technology, Inc., Santa Rosa, CA and Earth Tech, Concord, MA, STI-996133-1710-WD1.1, February 1997.

Draxler, R.D. and Hess, G.D., "Description of the HYSPLIT-4 Modeling System," *NOAA Technical Memorandum ERL, ARL-224*, Air Resources Laboratory, Silver Springs, Maryland, 24 pgs., 1997.

Draxler, R.D. and Hess, G.D., "An Overview of the HYSPLIT-4 Modelling System for Trajectories, Dispersion, and Deposition," *Australian Meteorological Magazine*, 47, 295-308, 1998.

Pitchford, M.L., Schichtel, B.A., Gebhart, K.A., Barna, M.G., Malm, W.C., Tombach, I.H., and Knipping, E.M., "Causes of Haze at Big Bend National Park – Results of the BRAVO Study and More" Regional and Global Perspectives on Haze: Causes, Consequences and Controversies – Visibility Specialty Conference, Air & Waste Management Association, Asheville, NC October 25-29, 2004.

Rolph, G.D., Real-time Environmental Applications and Display sYstem (READY) Website (http://www.arl.noaa.gov/ready/hysplit4.html). NOAA Air Resources Laboratory, Silver Spring, MD., 2003.

6. CHEMICAL TRANSPORT MODELS

Eulerian or "grid" models have traditionally served as the workhorse of air quality planning programs. These tools strive to be comprehensive in accounting for emissions, meteorological dynamics, chemical production, transformation, and destruction as well as wet and dry deposition and microphysical processes. With this degree of sophistication comes attendant uncertainty. Many of the more complex processes (e.g., cloud processes and boundary layer dynamics) are handled through parameterizations that attempt to approximate the real atmosphere at an appropriate level of detail. Chemical transport models for ozone and fine particles have improved markedly over the past several years as various groups have developed competing models and as the different strengths and weaknesses of these models help to shed light on various aspects of the underlying science.

Two regional-scale air quality models have been evaluated and used by NESCAUM to perform air quality simulations. These are the Community Multi-scale Air Quality modeling system (CMAQ)[30] and the Regional Modeling System for Aerosols and Deposition (REMSAD).[31] Appendix C provides detailed descriptions of these models and of their use by NESCAUM, together with performance evaluations and preliminary results. A brief overview of the two modeling platforms in terms of their relevance to future SIP work is provided here, along with highlights of the findings.

6.1. Chemical Transport Model (CTM) platforms – Overview

Both REMSAD and CMAQ are being used with a 12 km grid[32] in the eastern U.S. domain (see Figure 6-1(b)). Air quality is modeled on 22 vertical layers with hourly temporal resolution for the entire calendar year 2002. REMSAD has simplified chemistry but allows for emissions tracking of sulfate, nitrate, and mercury through a tagging feature that calculates the contribution of specific sources to ambient concentrations, visibility impacts, and wet or dry deposition. REMSAD has shown good performance when reproducing annual or seasonal statistics for sulfate and mercury chemistry, while CMAQ has shown good performance for multiple species. A new release of CMAQ (version 4.5) may improve performance for sulfate, nitrate and organics over what Appendix C presents and will be used with the quality-assured meteorology and emission inventory inputs described below for final SIP submissions in 2007 or 2008.

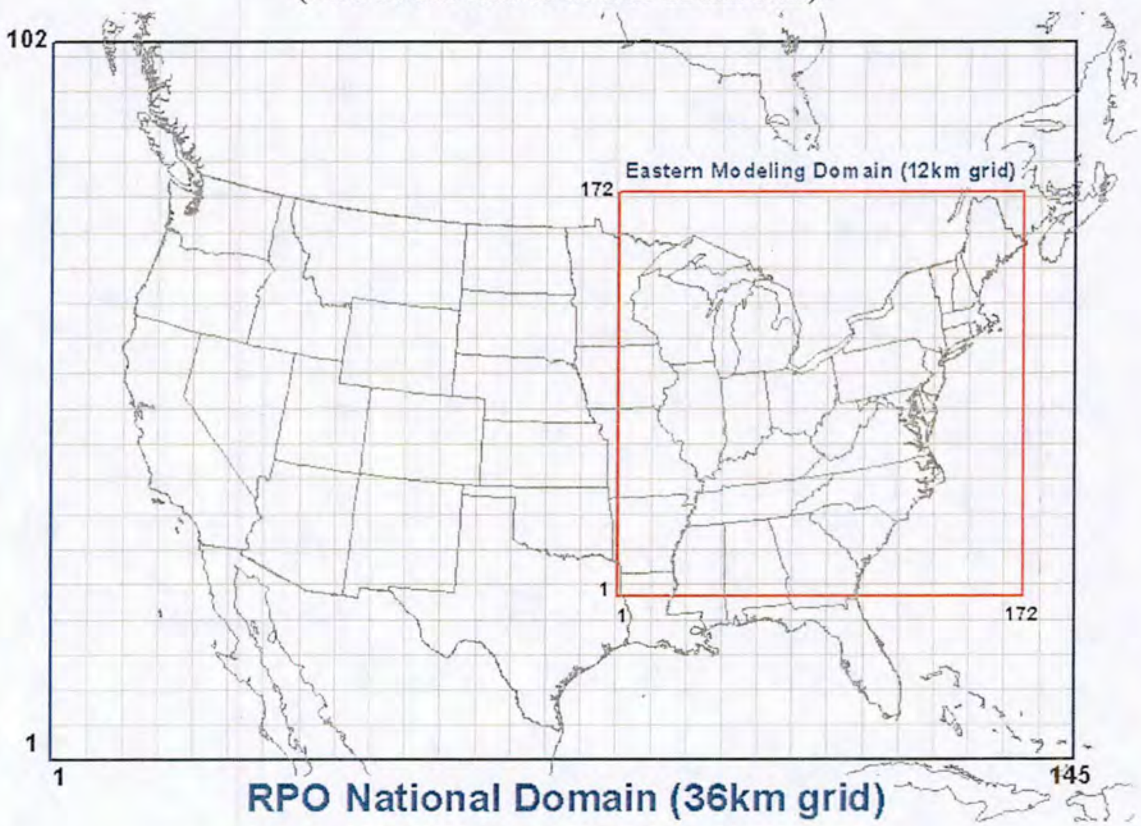
Meteorological inputs have been developed by the University of Maryland (UMD) using the Fifth-Generation Pennsylvania State University/National Center for Atmospheric Research (NCAR) Mesoscale Model (MM5) system.[33] A modified Blackadar boundary layer scheme is used as well as physics options including explicit representations of cloud physics with simple ice microphysics (no mixed-phase processes) and the Kain-Fritsch cumulus parameterization.

[30] See Byun and Ching, 1999.
[31] See ICF/SAI, 2002.
[32] 12 km grid describes a 12 by 12 km grid cell
[33] http://www.mmm.ucar.edu/mm5/

The New York Department of Environmental Conservation and NESCAUM are processing emissions inputs using the Sparse Matrix Operator Kernel Emissions (SMOKE) Modeling System. To model biogenic emissions, SMOKE uses the Biogenic Emission Inventory System, version 2.3 (BEIS2) and version 3.09 and 3.12 (BEIS3). SMOKE has also been integrated with the MOBILE6 model for on-road emissions. MANE-VU has developed a quality-assured 2002 emissions inventory which is being merged with the regional inventories for other RPOs in order to provide a comprehensive emissions inventory for the entire Northeast domain shown in Figure 6-1(b).

A dynamic 3-dimensional boundary condition feeds ambient concentration fields in at the domain boundaries which are representative of actual concentrations during 2002. This dynamic boundary condition was developed by applying the output of a global model run (Park et al., 2004) with 4 degree longitude by 5 degree latitude horizontal resolution at the boundaries of the 36 km grid domain shown in Figure 6-1(a). The results of this annual simulation are then applied at the boundary of our 12km grid domain, ensuring acceptable representation of the general trends and sulfate patterns that were present during the simulation period.

Figure 6-1. Modeling domains used in NESCAUM air quality modeling studies. (a) Domain 1: 36 km National US grid domain with location of 12 km grid domain highlighted; (b) Domain 2: 12km Northeast US grid domain. The gridlines are shown at 180 km intervals (5 x 5 36 km cells or 15 x 15 12 km cells).

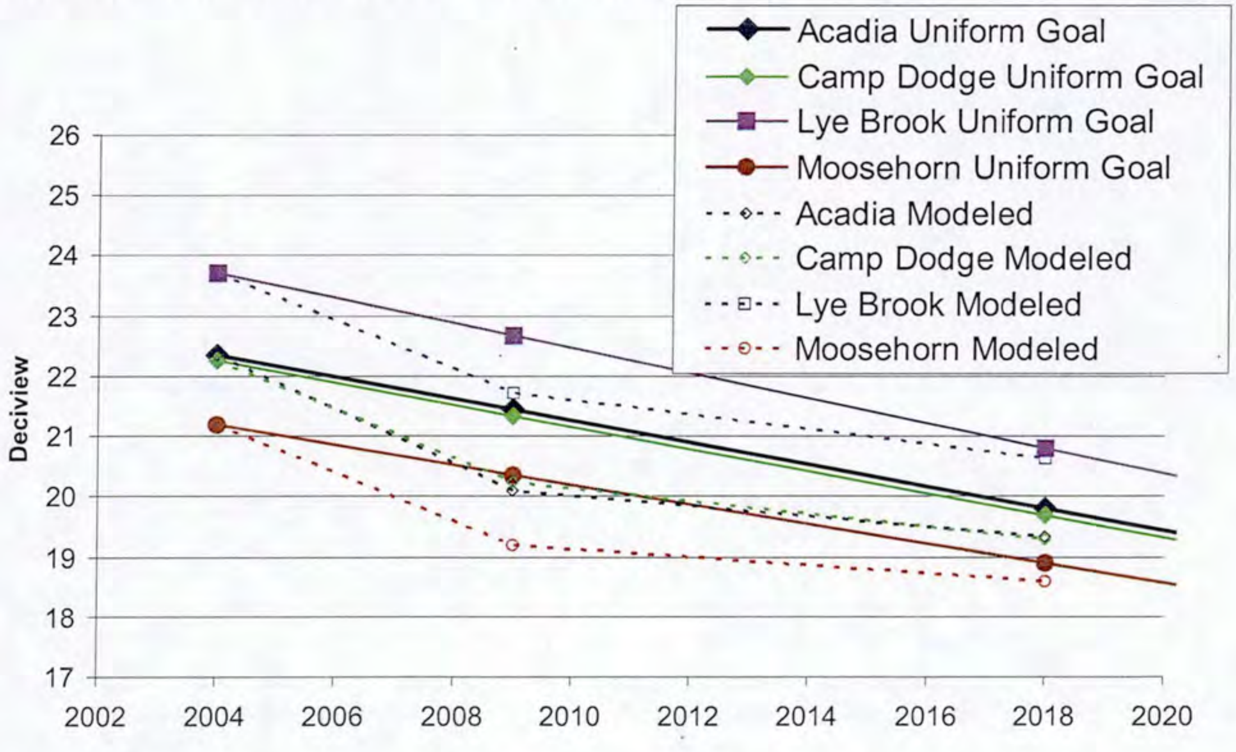


6.2. Preliminary Results

CMAQ has been run for a complete set of baseline simulations including 2002, 2009 and 2018. These preliminary runs are described in greater detail in Appendix C, but include inventory and meteorological drivers which will be updated for final SIP submissions. Nonetheless, these preliminary results suggest that implementation of existing regulations (including USEPA's Clean Air Interstate Rule, or CAIR) will continue to yield significant improvements in visibility over the next decade, primarily as a result of regional sulfate reductions (See Figure 6-2 a and b below for visibility improvement and see Figure C-27 in Appendix C for sulfate mass reductions). Despite these potential improvements, not all MANE-VU Class I areas are anticipated to achieve uniform progress goals as described by current USEPA guidance.[34] Brigantine Wilderness Area in New Jersey is projected to fall about a half deciview short of the uniform rate under existing emission reduction plans.

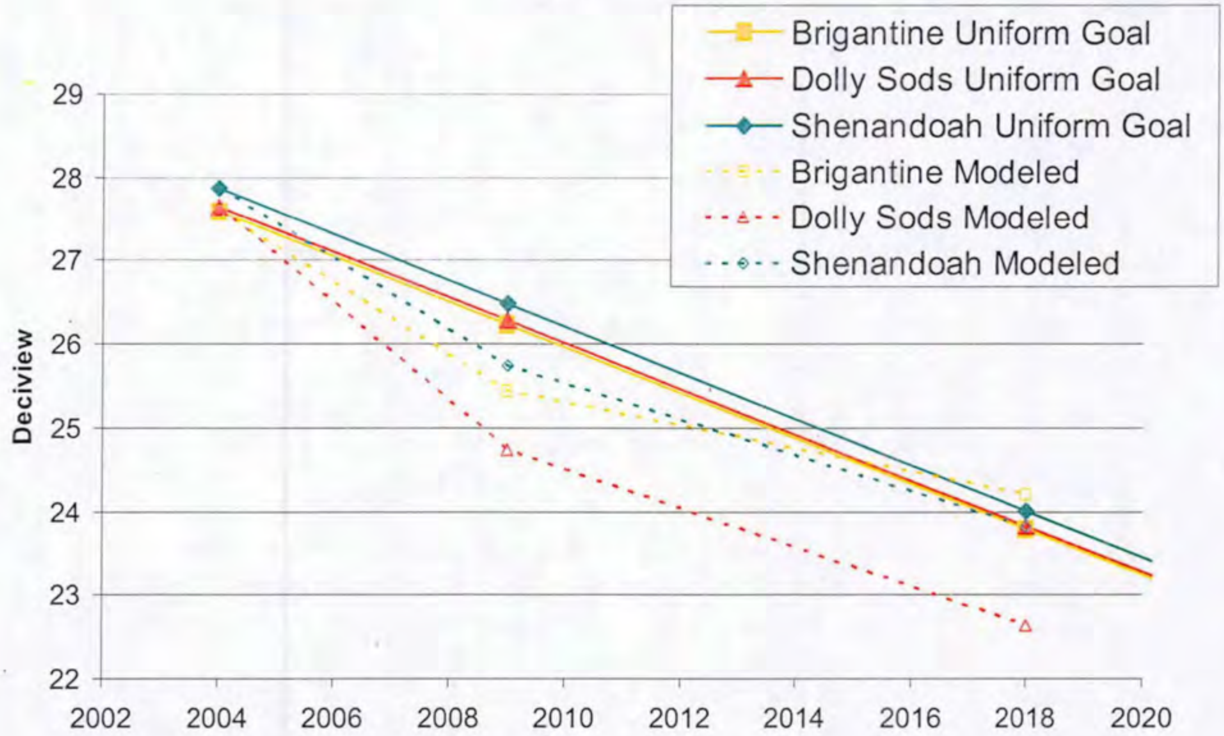
A significant difference between the CMAQ and the REMSAD results presented here is that NESCAUM has taken the additional step of reprocessing the SO_2 emission sources from each state such that these model inputs are formatted to take advantage of

Figure 6-2(a) and (b): CMAQ Integrated SIP Modeling Platform simulation results for 2002, 2009 and 2018 relative to Uniform Progress Goals calculated according to current USEPA guidance for (a) Northeast Class I sites in MANE-VU and (b) Mid-Atlantic Class I sites in or near MANE-VU.



[34] We note that uniform progress goals do not necessarily dictate visibility levels required by statute, but do represent a point of comparison for states when establishing *reasonable* progress goals toward our national visibility goal of no anthropogenic visibility impairment by 2064.

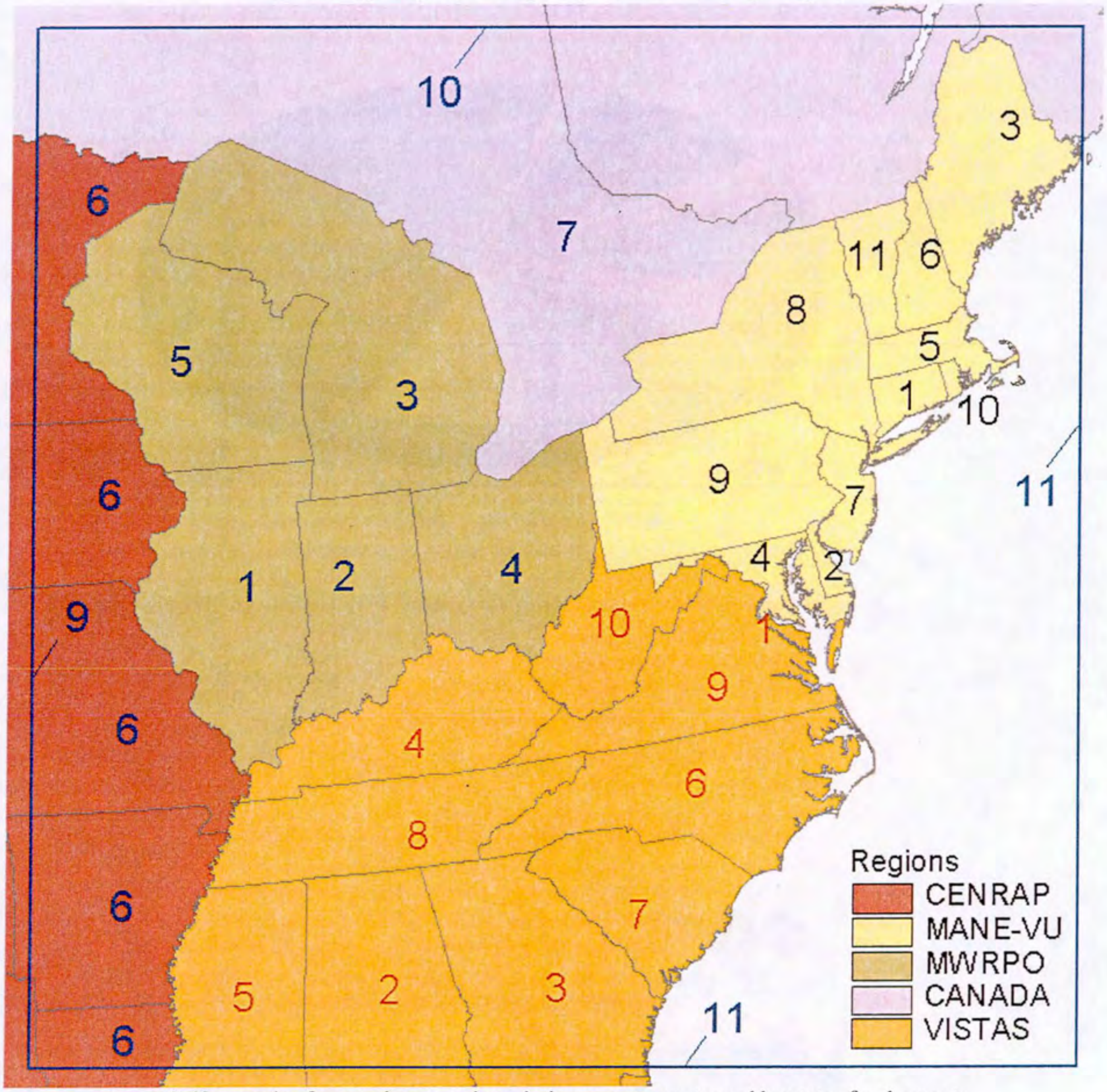
Figure 6-2(b).



REMSAD's tagging capabilities. Thus, all SO_2 emissions included in the model for the eastern half of the country, Canada and the boundary conditions have been tagged according to state of origin. This allows for a rough estimation of the total contribution from elevated point sources in each state to simulated sulfate concentrations at eastern receptor sites. The tagging scheme employed for this analysis is illustrated in Figure 6-3. 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.

Results of these tagged runs indicate that elevated point sources in Pennsylvania, Ohio, and New York contribute significantly, on an annual basis, to sulfate concentrations at all MANE-VU sites. Northern sites (e.g., Acadia) are more influenced by sources in upper midwestern states (e.g., Wisconsin and Michigan) whereas southern sites like Brigantine are more influenced by sources in more southerly states such as West Virginia, Maryland, and Virginia. Shenandoah, a VISTAS Class I site appears to be most strongly influenced by sources in Ohio, Pennsylvania, and West Virginia, followed by other nearby Southeast and Midwest states. Figure 6-4 through Figure 6-7 present these results showing the breakout of sulfate by individual tag. Note that the large "other" fraction of sulfate includes all sources outside the analysis domain, which includes some portions of the VISTAS and CENRAP RPO, Northern and Western Canada in addition to all other (i.e., inter-continental) sources of SO_2. Figure 6-8 shows similar results summarized by RPO for the 20% worst days.

Figure 6-3. REMSAD modeling tagging schemes.
(black: group 1, red: group 2, and blue: group 3)



Note: Sulfur species from anthropogenic emission sources are tagged by states for three sets of tags. Tag group 3 also includes boundary conditions. The color of the numbers represents tag groups (black: group 1, red: group 2, and blue: group 3)

Figure 6-4. 2002 Eastern states' contribution to annual PM sulfate in Acadia, ME

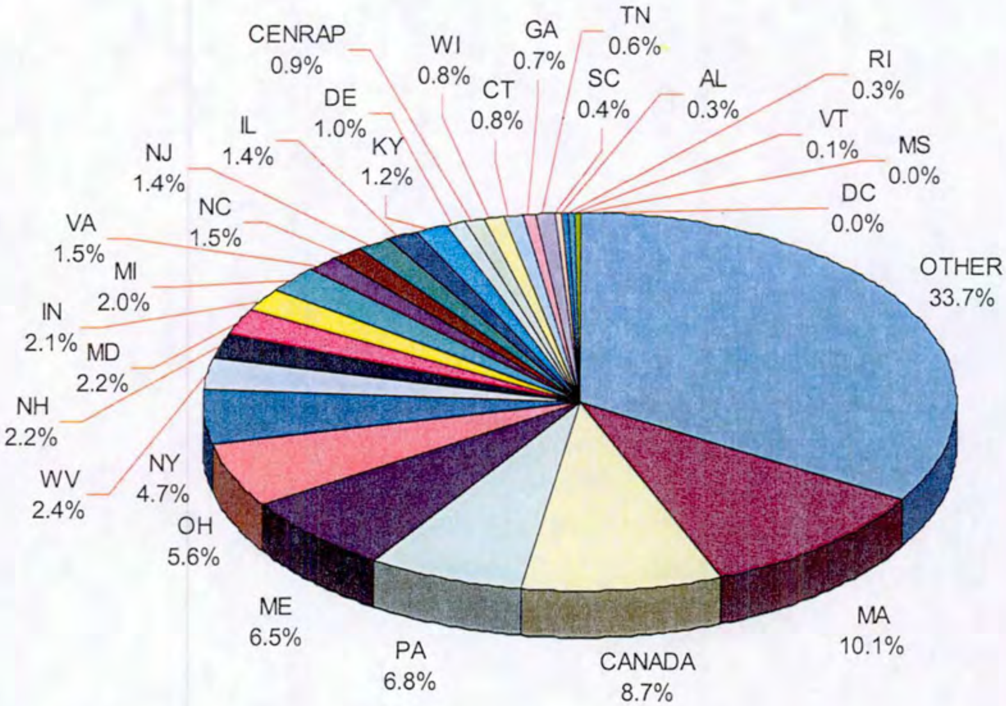


Figure 6-5. 2002 Eastern states' contribution to annual PM sulfate in Brigantine, NJ

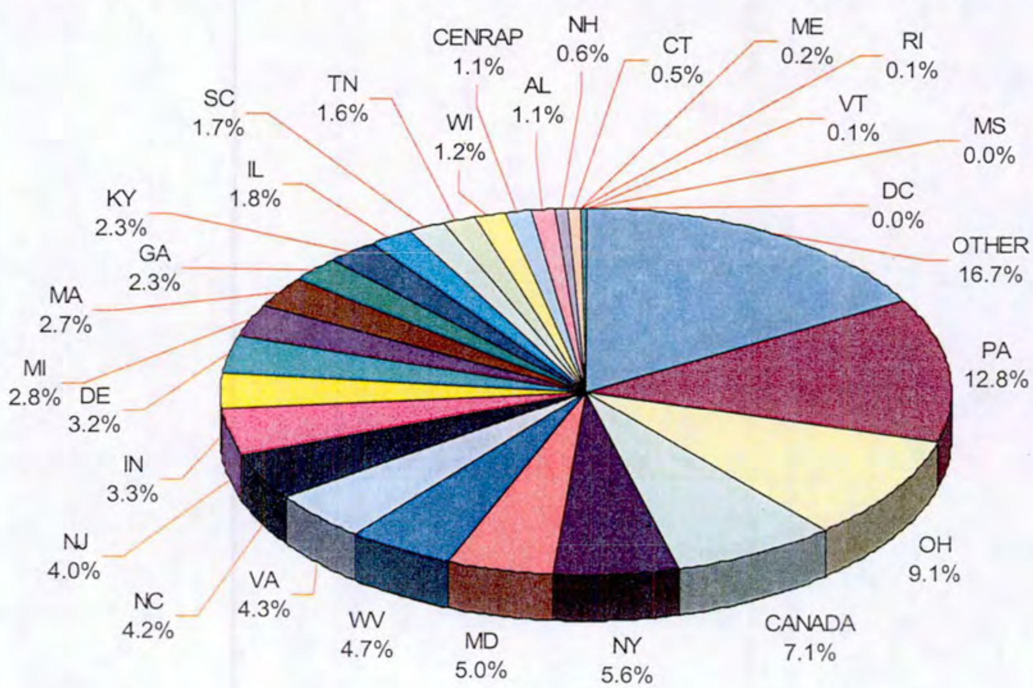


Figure 6-6. 2002 Eastern states' contribution to annual PM sulfate in Lye Brook, VT

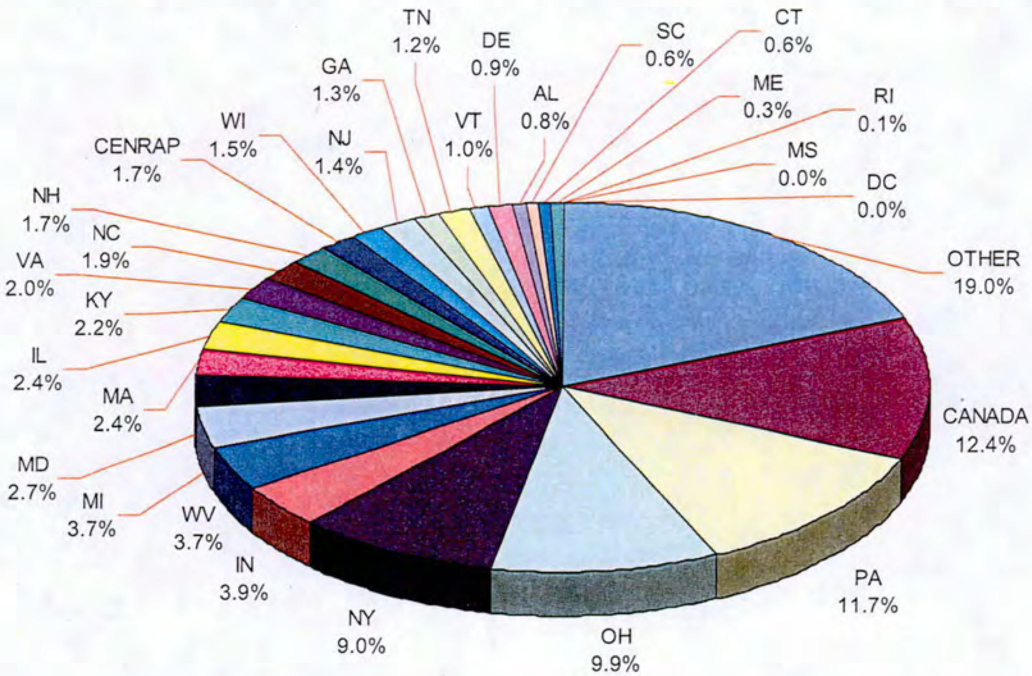


Figure 6-7. 2002 Eastern states' contribution to annual PM sulfate in Shenandoah, VA

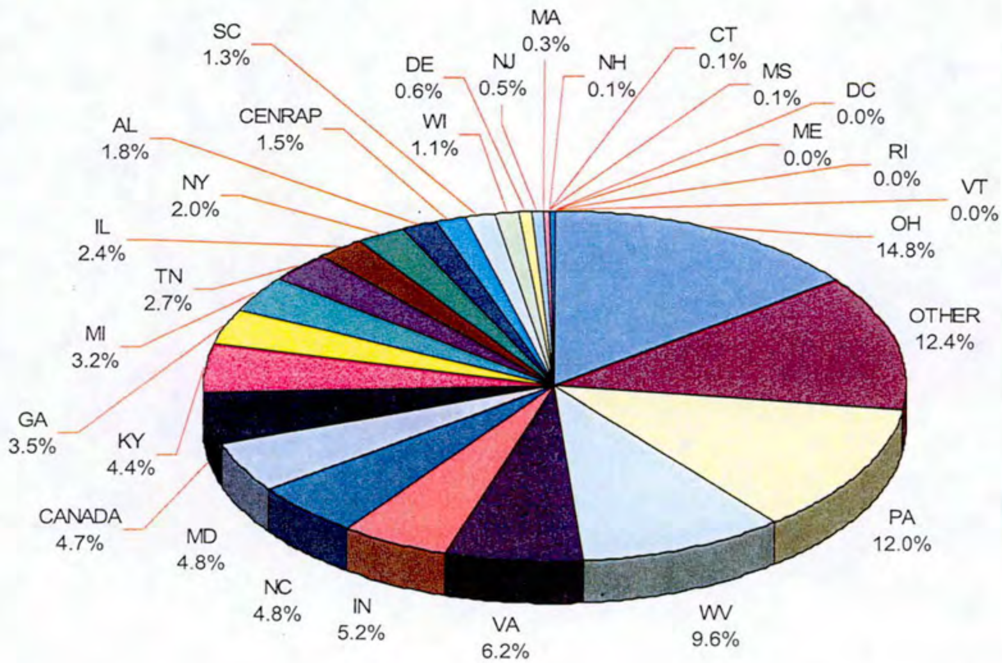
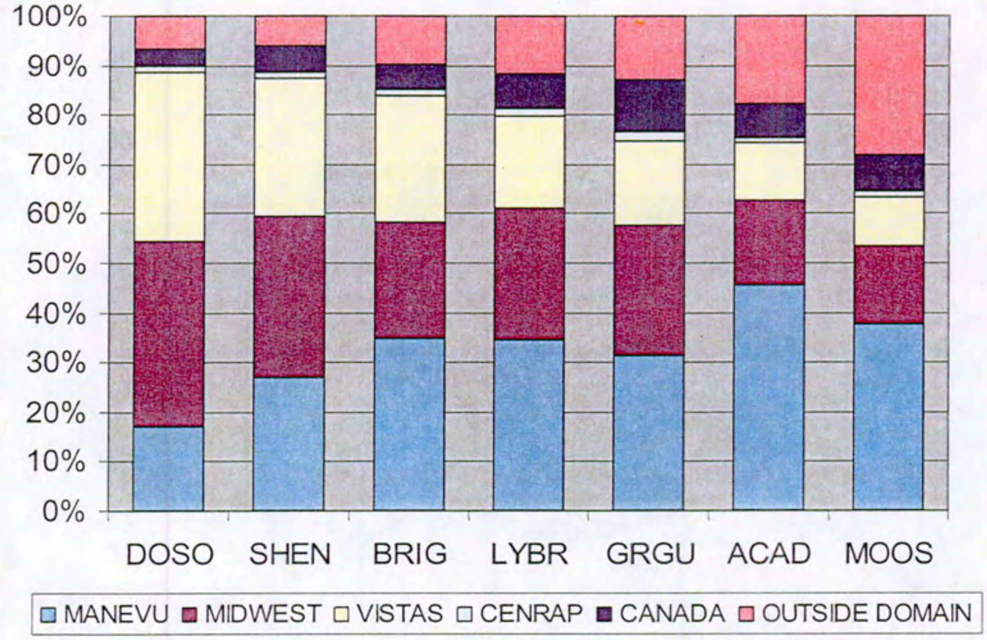


Figure 6-8. Comparison of Sulfate Extinctions on 20% Worst Visibility Days



References

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

Park, R. J., Jacob, D. J., Field, B. D., Yantosca, R. M., and Chin, M., *Natural and transboundary pollution influences on sulfate-nitrate-ammonium aerosols in the United States: implications for policy* , J. Geophys. Res., D15204, 10.1029/2003JD004473, 2004.

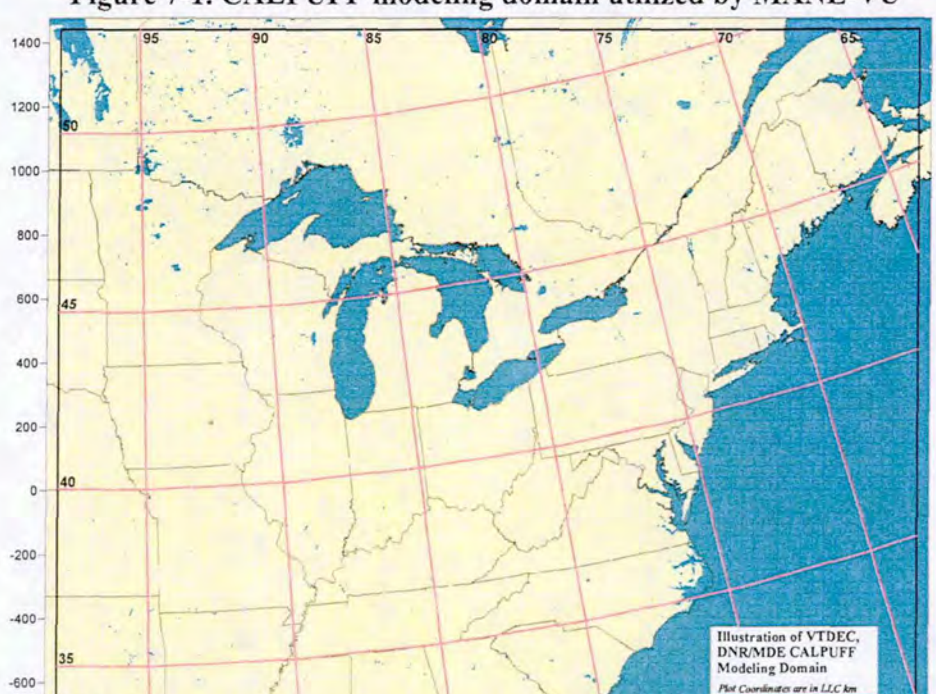
SAI, *User's Guide to the Regional Modeling System for Aerosols and Deposition (REMSAD), Version 7,* ICF Consulting/SAI, San Francisco, CA, 2002.

7. LAGRANGIAN DISPERSION MODELS

Dispersion models are commonly used to study the impacts of pollutant plumes or specific point source emissions on surrounding areas. The scale of these models has traditionally been limited to a few hundred kilometers because of a perceived lack of ability to accurately reproduce horizontal dispersion beyond these distances. Recent advances in the CALPUFF system (USEPA, 2006) — including enhancements to its horizontal diffusion and dispersion algorithms as well as the addition of chemical transformation parameterizations — have resulted in improved performance over much greater distances. In fact, the most recent proposed guidance for implementing the BART (Best Available Retrofit Technology) requirements of the Regional Haze Rule provide for the use of CALPUFF to analyze dispersion over distances exceeding 200 km as long as a detailed modeling protocol is included for approval by the appropriate reviewing authority (40 CFR Part 51, pg. 25194, May 5, 2004).

Appendix D provides specific information related to two CALPUFF platforms that have been developed for a large domain (see Figure 7-1) by the Vermont Department of Environmental Conservation (VT DEC) Air Pollution Control Branch and by the State of Maryland's Department of the Environment (MDE) and Department of Natural Resources (MDNR) with contract assistance provided by Environmental Resources Management (ERM). Appendix D contains detailed descriptions of the two platforms; the processing and evaluation of both MM5- and National Weather Service (NWS)-based meteorological data; the processing and evaluation of CEMS (Continuous Emissions Monitoring System)- and 2002 RPO-based emissions data; performance evaluations of

Figure 7-1. CALPUFF modeling domain utilized by MANE-VU



the overall modeling system; preliminary results of modeling to determine annual average and maximum 24-hour impact by individual unit and by state; and discussion of the future application of these platforms to the BART program. This chapter provides an overview of the two modeling platforms, a summary of initial results, and a brief analysis of the differences between the two platforms.

While CALPUFF will certainly play a role in helping MANE-VU assess potential visibility impacts for BART-eligible sources, the development of twin CALPUFF platforms utilizing both MM5-based and NWS-based meteorological drivers further expands the suite of analytical tools available for assessing contributions — at both the facility and state level — to downwind visibility impairment in the MANE-VU region.

7.1. Platform Overview

The VT DEC developed meteorological inputs for CALPUFF using observation-based inputs (i.e., rawinsonde and surface measurements) from the NWS and by applying CALMET. VT DEC also developed hourly emissions and exhaust flow data from the Acid Rain Program's CEMS data files for 869 large electric generating units (EGUs). These emissions data were utilized as inputs to CALPUFF, along with emissions data for four additional source sectors: non-EGU point sources, mobile (on-road), mobile (off-road), and general area sources. The emission inputs for these source sectors were derived from the 2002 RPO inventories.

The MDNR and MDE developed meteorological inputs for CALPUFF using MM5 data developed by the University of Maryland for the MANE-VU and Ozone Transport Commission SIP modeling work. The Maryland agencies utilized the CEMS data files developed by VT DEC, and independently developed emissions and source parameters for the other four source sectors based on the same inter-RPO 2002 inventories.

Both platforms were used to model the entire calendar year 2002. These simulations have been configured to provide estimates for both individual source impacts and cumulative state impacts and to allow for inter-platform comparisons. The modeling domain has been designed to be consistent with the other modeling systems described in this report (e.g., REMSAD, CMAQ), so that conclusions regarding the most significant sources of sulfate-related visibility impacts in MANE-VU can be compared. Consistency across a broad range of approaches will add credibility to the conclusions reached in the overall contribution assessment.

7.2. CALPUFF Modeling Results for Individual Sources

To explore differences between the two CALPUFF modeling platforms, each was used to create a ranked list of the 100 emissions sources that contribute most to ambient sulfate levels at each of several eastern Class I sites. Of the 100 top sources identified for the Brigantine Wilderness Area, 70 sources appeared on the lists generated by both platforms. At Acadia, Lye Brook, and Shenandoah, there was even more agreement between the model results, with both platforms identifying 78, 76, and 85 out of 100 of the same top sources for each of these sites, respectively. Figure 7-2 shows the correlation between estimated annual average impacts for the sources that were identified by both platforms as among the top 100 sulfate contributors. While the

NWS/rawindsonde-based meteorology consistently produced slightly lower estimates of impact than the MM5-based platform, the correlations are relatively robust, ranging from 0.89 at Brigantine to 0.93 at Lye Brook.

Overall, the CALPUFF modeling results to date demonstrate reasonably good comparability between the two platforms (as illustrated by Figure 7-2 and Table 7-1), but they also suggest a consistent pattern of under prediction for one platform relative to the other.

7.3. CALPUFF Modeling Results Overview

Table 7-1 provides further comparisons of the results of CALPUFF modeling utilizing the two different platforms described earlier in this chapter: VT DEC (NWS/rawinsonde-based meteorology) and Maryland (MM5-based meteorology).[35] The table summarizes annual average sulfate concentrations by source category for each of the two platforms relative to observed concentrations.

Table 7-1. CALPUFF Overall Modeling Summary

	Annual Average SO_4 Ion Concentration ($\mu g/m^3$)								
	NWS/Rawinsonde-based Meteorology				MM5-based Meteorology				Observed
	CEMS EGU	Non-CEMS Point	Area/Mobile	Total	CEMS EGU	Non-CEMS Point	Area/Mobile	Total	
Shenandoah	2.271	0.412	0.106	2.789	2.98	0.46	0.22	3.66	4.61
Brigantine	1.847	0.421	0.257	2.526	2.6	0.51	0.38	3.48	4.06
Acadia	0.965	0.385	0.218	1.569	1.42	0.42	0.28	2.13	1.86
Lye Brook	1.178	0.342	0.178	1.698	1.65	0.36	0.25	2.26	2.17

Generally, the NWS/rawinsonde platform predicts lower sulfate ion concentrations than the MM5 platform. On an annual average basis, the concentrations predicted using the MM5 platform are much closer to observed values than the concentrations predicted using the NWS/rawindsonde platform.

7.4. CALPUFF Results for Ranked State Sulfate Contributions

This section focuses on the ranked contribution of emissions from individual states to overall sulfate levels at specific receptor sites (additional results are summarized in a number of different ways in Appendix D). The rankings were calculated by summing impacts from EGUs included in the 2002 data base for each state. State contributions are then sorted by total annual impact. Predicted annual average sulfate ion concentrations from other source sectors were added to these data in Table 7-2(a-d) for both platforms. As in previous chapters, estimated contributions to receptor impact by state (using the results presented in Table 7-2) are depicted graphically in Figure 7-3 and Figure 7-4 for the observation-based and MM5-based platforms, respectively. States are ranked along the horizontal axis by averaging the individual results calculated for each state using the two CALPUFF platforms.

[35] The Maryland Department of the Environment is contributing toward this work through the Maryland Department of Natural Resources and their contractor ERM, Inc. who have developed the MM5-based meteorology and CALPUFF platform.

Figure 7-2. Correlation between MM5-based source contributions (Maryland/ERM) and NWS/rawindsonde-based source contributions (VT DEC) for common EGUs modeled at four receptor sites in or near MANE-VU

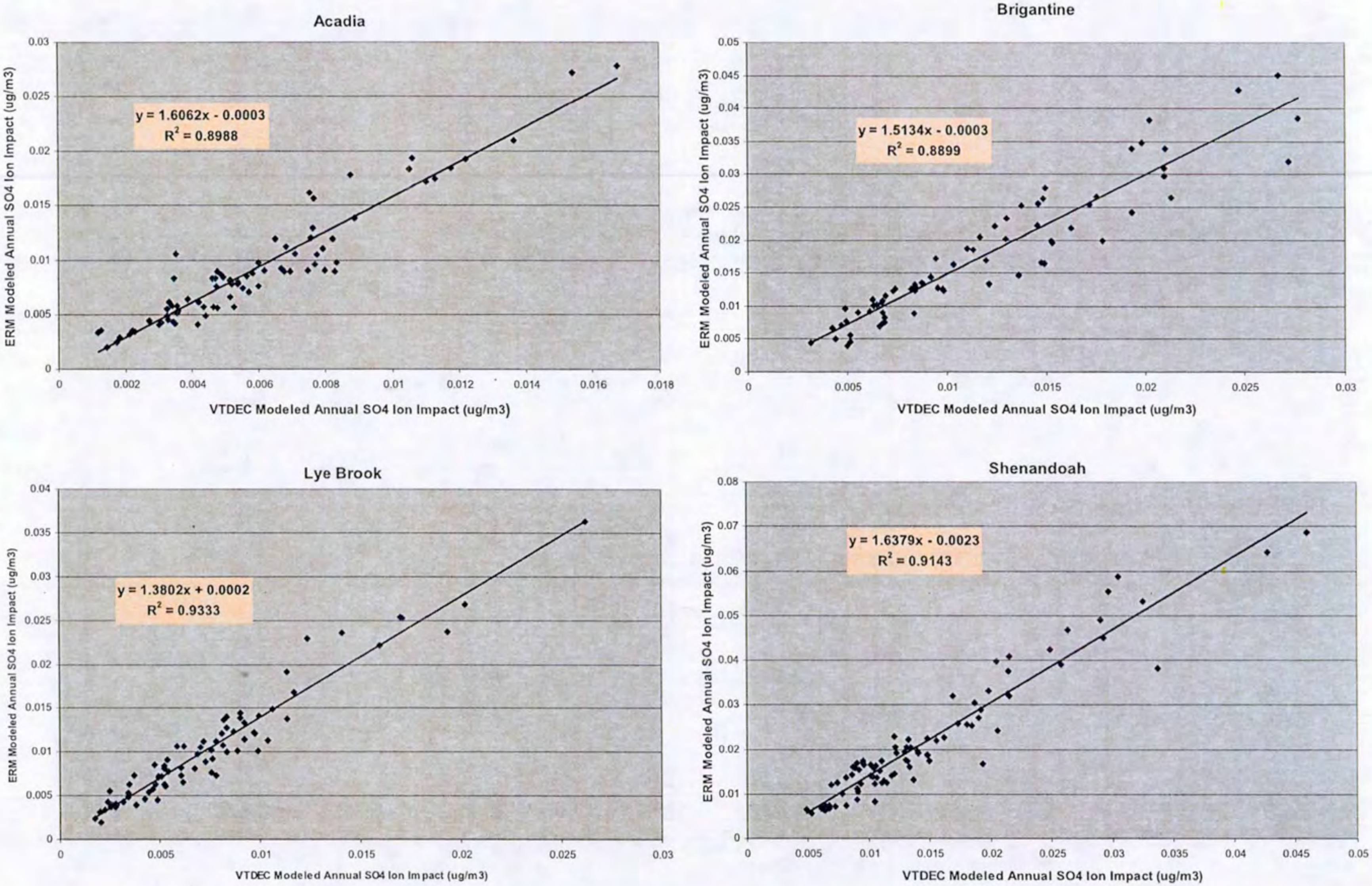


Table 7-2a. Sulfate Ion Impacts by State (Annual Average)
Acadia National Park

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

Notes:

(a) Only sources in that portion of the state within the RPO modeling domain were modeled.

(b) 52 Canadian point sources > 250 tons/yr SO_2 emissions during 2002 (from Canadian NPRI).

Table 7-2b. Sulfate Ion Impacts by State (Annual Average) Brigantine Wilderness Area

	NWS-based Meteorology (VT DEC) μg/m³				MM5-based Meteorology (MDE/MDNR) μg/m³			
STATE	**CEM PT**	**Non-CEM PT**	**Area/ Mobile**	**TOTAL PT**	**CEM PT**	**Non-CEM PT**	**Area/ Mobile**	**TOTAL**
AL(a)	0.0317	0.0055	0.0011	0.0383	0.0304	0.0017	0.0020	0.0341
AR(a)	0.0047	0	0	0.0047	0.0088	0.0032	0.0017	0.0137
CT	0.0041	0.0013	0.0099	0.0153	0.0044	0.0009	0.0063	0.0116
DC	0.0009	0.0004	0.0008	0.0021	0.0012	0.0005	0.0013	0.0030
DE	0.0395	0.0111	0.0073	0.0579	0.0524	0.0549	0.0138	0.1211
GA(a)	0.0576	0.0044	0.0030	0.0649	0.0672	0.0024	0.0057	0.0753
IA	0.0156	0.0176	0.0001	0.0333	0.0152	0.0137	0.0032	0.0321
IL	0.0521	0.0192	0.0005	0.0719	0.0535	0.0190	0.0043	0.0768
IN	0.1165	0.0125	0.0011	0.1302	0.1632	0.0162	0.0128	0.1921
KS(a)	0.0113	0	0	0.0113	0.0107	0.0009	0.0008	0.0124
KY	0.0846	0.0098	0.0039	0.0982	0.1285	0.0076	0.0135	0.1496
MA	0.0240	0.0049	0.0191	0.0480	0.0234	0.0406	0.0168	0.0808
MD	0.1351	0.0073	0.0165	0.1589	0.2191	0.0228	0.0210	0.2630
ME	0.0004	0.0017	0.0016	0.0037	0.0002	0.0017	0.0011	0.0030
MI	0.0579	0.0077	0.0028	0.0685	0.0810	0.0110	0.0120	0.1040
MN	0.0120	0.0056	0.0007	0.0183	0.0114	0.0025	0.0027	0.0166
MO	0.0179	0	0	0.0179	0.0202	0.0108	0.0036	0.0346
MS(a)	0	0.0006	0.0003	0.0009	0	0.0006	0.0005	0.0012
NC	0.1414	0.0360	0.0060	0.1835	0.1609	0.0160	0.0054	0.1823
ND(a)					0	0.0011	0.0015	0.0026
NE(a)	0.0031	0	0	0.0031	0.0025	0	0.0009	0.0035
NH	0.0064	0.0004	0.0012	0.0080	0.0100	0.0003	0.0010	0.0113
NJ	0.0426	0.0081	0.0518	0.1024	0.0625	0.0124	0.0805	0.1553
NY	0.0658	0.0120	0.0719	0.1497	0.0810	0.0307	0.0779	0.1896
OH	0.2611	0.0130	0.0017	0.2757	0.4297	0.0836	0.0088	0.5221
OK(a)	0.0068	0	0	0.0068	0.0077	0.0014	0.0007	0.0098
PA	0.2538	0.0460	0.0339	0.3336	0.4407	0.0553	0.0461	0.5421
RI	0	0	0.0042	0.0042	2.1E-06	0.0003	0.0016	0.0019
SC	0.0362	0.0139	0.0042	0.0542	0.0341	0.0101	0.0032	0.0475
SD(a)	0.0011	0	0	0.0011	0.0012	3.4E-05	0.0012	0.0024
TN	0.0477	0.0138	0.0049	0.0664	0.0630	0.0188	0.0061	0.0879
TX(a)	0	0	0	0	2.5E-07	0	2.9E-05	3.0E-05
VA	0.1442	0.0447	0.0035	0.1924	0.1577	0.0331	0.0119	0.2027
VT	0	0.0002	0.0033	0.0035	1.5E-06	0.0001	0.0006	0.0008
WI	0.0216	0.0312	0.0007	0.0535	0.0315	0.0106	0.0026	0.0447
WV	0.1499	0.0118	0.0016	0.1633	0.2340	0.0202	0.0046	0.2588
Canada(b)	0	0.0807	0	0.0807				
Totals	**1.84732**	**0.42121**	**0.25746**	**2.526**	**2.61**	**0.51**	**0.38**	**3.49**

Notes:

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

Table 7-2c. Sulfate Ion Impacts by State (Annual Average) Lye Brook Wilderness Area

	NWS-based Meteorology (VT DEC) µg/m³				MM5-based Meteorology (MDE/MDNR) µg/m³			
STATE	**CEM PT**	**Non-CEM PT**	**Area/ Mobile**	**TOTAL PT**	**CEM PT**	**Non-CEM PT**	**Area/ Mobile**	**TOTAL**
AL(a)	0.0151	0.0023	0.0005	0.0179	0.0209	0.0013	0.0015	0.0238
AR(a)	0.0053	0	0	0.0053	0.0072	0.0029	0.0015	0.0116
CT	0.0015	0.0004	0.0038	0.0057	0.0024	0.0006	0.0045	0.0075
DC	0.0001	0.0002	0.0003	0.0005	7.9E-05	0.0002	0.0004	0.0006
DE	0.0045	0.0017	0.0007	0.0068	0.0076	0.0123	0.0020	0.0219
GA(a)	0.0270	0.0016	0.0011	0.0296	0.0351	0.0012	0.0029	0.0392
IA	0.0151	0.0175	0.0001	0.0326	0.0184	0.0158	0.0041	0.0383
IL	0.0473	0.0173	0.0005	0.0651	0.0550	0.0208	0.0047	0.0805
IN	0.1039	0.0120	0.0011	0.1170	0.1369	0.0148	0.0128	0.1645
KS(a)	0.0115	0	0	0.0115	0.0167	0.0016	0.0013	0.0195
KY	0.0647	0.0075	0.0031	0.0753	0.0820	0.0047	0.0099	0.0967
MA	0.0106	0.0040	0.0125	0.0270	0.0161	0.0291	0.0203	0.0655
MD	0.0452	0.0025	0.0040	0.0518	0.0686	0.0088	0.0052	0.0826
ME	0.0001	0.0020	0.0017	0.0038	0.0003	0.0024	0.0018	0.0044
MI	0.0841	0.0113	0.0041	0.0995	0.0798	0.0121	0.0120	0.1039
MN	0.0130	0.0062	0.0007	0.0200	0.0147	0.0031	0.0035	0.0213
MO	0.0191	0	0	0.0191	0.0253	0.0140	0.0052	0.0445
MS(a)	0	0.0004	0.0002	0.0006	0	0.0006	0.0004	0.0011
NC	0.0424	0.0088	0.0016	0.0528	0.0680	0.0058	0.0022	0.0760
ND(a)					0	0.0014	0.0020	0.0035
NE(a)	0.0027	0	0	0.0027	0.0032	0	0.0012	0.0044
NH	0.0072	0.0007	0.0020	0.0098	0.0137	0.0008	0.0023	0.0167
NJ	0.0071	0.0017	0.0051	0.0139	0.0128	0.0029	0.0115	0.0272
NY	0.0637	0.0289	0.0586	0.1511	0.0985	0.0613	0.0842	0.2440
OH	0.2108	0.0112	0.0016	0.2237	0.2963	0.0649	0.0078	0.3690
OK(a)	0.0086	0	0	0.0086	0.0097	0.0020	0.0009	0.0127
PA	0.1918	0.0255	0.0169	0.2342	0.3050	0.0288	0.0219	0.3558
RI	0	0	0.0013	0.0013	1.4E-06	0.0002	0.0010	0.0012
SC	0.0088	0.0037	0.0013	0.0138	0.0133	0.0040	0.0014	0.0187
SD(a)	0.0014	0	0	0.0014	0.0017	4.3E-05	0.0014	0.0031
TN	0.0281	0.0065	0.0032	0.0378	0.0407	0.0098	0.0042	0.0546
TX(a)	0	0	0	0	8.4E-06	0	3.2E-05	4.0E-05
VA	0.0295	0.0088	0.0008	0.0391	0.0454	0.0104	0.0037	0.0596
VT	0	0.0006	0.0499	0.0505	4.0E-06	0.0017	0.0083	0.0100
WI	0.0229	0.0293	0.0007	0.0529	0.0351	0.0116	0.0028	0.0495
WV	0.0852	0.0079	0.0009	0.0939	0.1232	0.0121	0.0023	0.1375
Canada(b)	0	0.1211	0	0.1211				
Totals	**1.1780**	**0.3416**	**0.1781**	**1.6977**	**1.65**	**0.36**	**0.25**	**2.27**

Notes:

(a) Only sources in that portion of the state within the RPO modeling domain were modeled.

(b) 52 Canadian point sources > 250 tons/yr SO_2 emissions during 2002 (from Canadian NPRI).

Table 7-2d. Sulfate Ion Impacts by State (Annual Average)
Shenandoah National Park

	NWS-based Meteorology (VT DEC) μg/m^3				MM5-based Meteorology (MDE/MDNR) μg/m^3			
STATE	**CEM PT**	**Non-CEM PT**	**Area/ Mobile**	**TOTAL PT**	**CEM PT**	**Non-CEM PT**	**Area/ Mobile**	**TOTAL**
AL(a)	0.0521	0.0084	0.0018	0.0623	0.0504	0.0029	0.0034	0.0567
AR(a)	0.0074	0	0	0.0074	0.0087	0.0035	0.0019	0.0141
CT	0.0005	0.0002	0.0011	0.0018	0.0007	0.0001	0.0009	0.0017
DC	0.0004	0.0004	0.0008	0.0016	8.1E-05	0.0003	0.0009	0.0013
DE	0.0101	0.0029	0.0011	0.0141	0.0086	0.0136	0.0021	0.0243
GA(a)	0.0879	0.0056	0.0040	0.0975	0.0963	0.0032	0.0079	0.1073
IA	0.0192	0.0181	0.0001	0.0374	0.0152	0.0130	0.0036	0.0318
IL	0.0646	0.0222	0.0006	0.0874	0.0561	0.0189	0.0045	0.0794
IN	0.1782	0.0156	0.0015	0.1952	0.1907	0.0181	0.0155	0.2243
KS(a)	0.0137	0	0	0.0137	0.0091	0.0007	0.0006	0.0104
KY	0.1273	0.0135	0.0057	0.1465	0.1741	0.0106	0.0184	0.2031
MA	0.0036	0.0005	0.0020	0.0060	0.0029	0.0047	0.0023	0.0098
MD	0.1045	0.0116	0.0118	0.1280	0.1365	0.0373	0.0109	0.1847
ME	0	0.0004	0.0003	0.0007	2.8E-05	0.0003	0.0002	0.0006
MI	0.0830	0.0082	0.0036	0.0948	0.0860	0.0100	0.0125	0.1085
MN	0.0148	0.0055	0.0007	0.0210	0.0109	0.0023	0.0028	0.0160
MO	0.0255	0	0	0.0255	0.0180	0.0104	0.0034	0.0318
MS(a)	0	0.0009	0.0004	0.0013	0	0.0010	0.0007	0.0017
NC	0.1669	0.0251	0.0050	0.1970	0.2257	0.0148	0.0062	0.2467
ND(a)					0	0.0011	0.0016	0.0027
NE(a)	0.0038	0	0	0.0038	0.0023	0	0.0009	0.0032
NH	0.0010	0.0001	0.0002	0.0012	0.0013	5.3E-05	0.0002	0.0016
NJ	0.0102	0.0018	0.0046	0.0166	0.0119	0.0022	0.0071	0.0212
NY	0.0350	0.0027	0.0141	0.0519	0.0468	0.0141	0.0167	0.0776
OH	0.4678	0.0256	0.0027	0.4960	0.6483	0.1088	0.0114	0.7685
OK(a)	0.0080	0	0	0.0080	0.0081	0.0016	0.0009	0.0105
PA	0.2774	0.0354	0.0214	0.3342	0.4517	0.0318	0.0247	0.5082
RI	0	0	0.0004	0.0004	3.1E-07	2.9E-05	0.0002	0.0002
SC	0.0242	0.0117	0.0041	0.0401	0.0232	0.0093	0.0035	0.0359
SD(a)	0.0011	0	0	0.0011	0.0011	4.0E-05	0.0014	0.0025
TN	0.0781	0.0207	0.0073	0.1061	0.0929	0.0304	0.0086	0.1319
TX(a)	0	0	0	0	1.7E-07	0	3.2E-05	3.2E-05
VA	0.1102	0.0398	0.0047	0.1547	0.1124	0.0469	0.0263	0.1856
VT	0	0	0.0006	0.0007	3.6E-07	2.6E-05	0.0001	0.0002
WI	0.0259	0.0311	0.0007	0.0577	0.0289	0.0096	0.0026	0.0410
WV	0.2691	0.0259	0.0045	0.2995	0.4657	0.0402	0.0111	0.5170
Canada(b)	0	0.0781	0	0.0781				
Totals	**2.271**	**0.412**	**0.106**	**2.789**	**2.98**	**0.46**	**0.22**	**3.66**

Notes:

(a) Only sources in that portion of the state within the RPO modeling domain were modeled.

(b) 52 Canadian point sources > 250 tons/yr SO_2 emissions during 2002 (from Canadian NPRI).

Figure 7-3a. Ranked state percent sulfate contributions to Northeast Class I receptors based on observation-based (VT) CALPUFF results

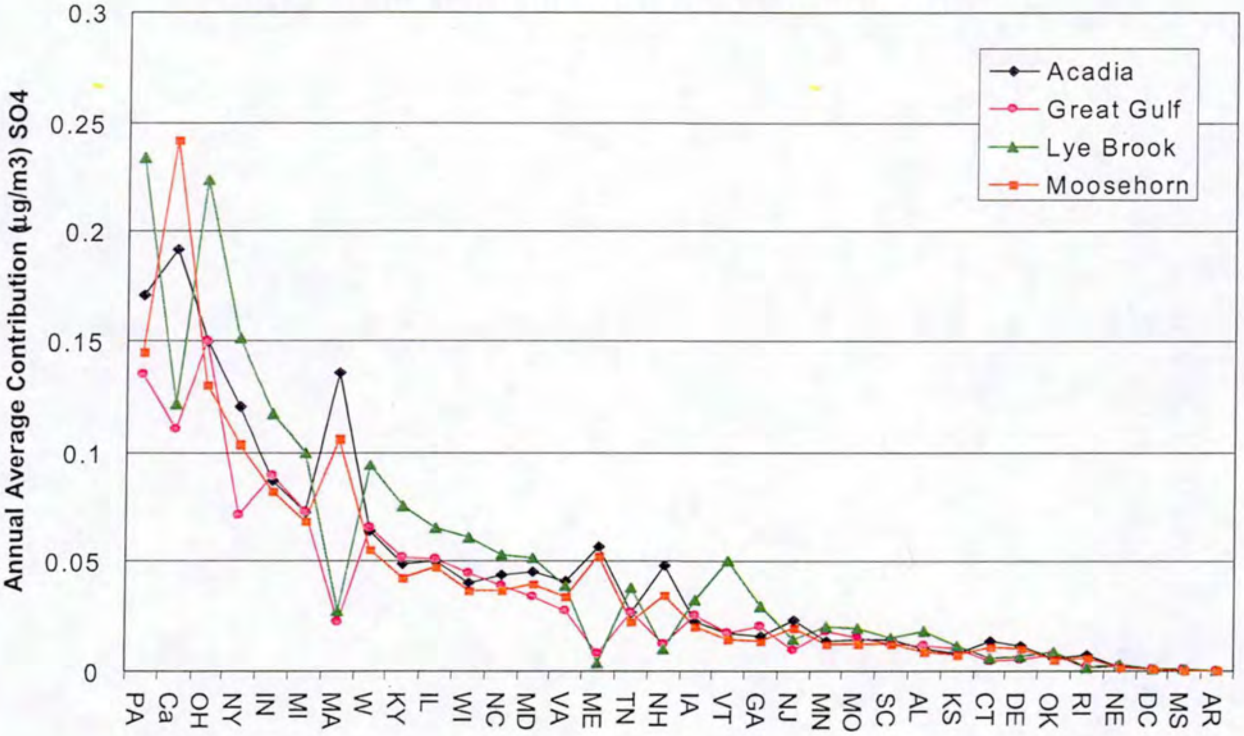


Figure 7-3b. Ranked state percent sulfate contributions to Mid-Atlantic Class I receptors based on observation-based (VT) CALPUFF results

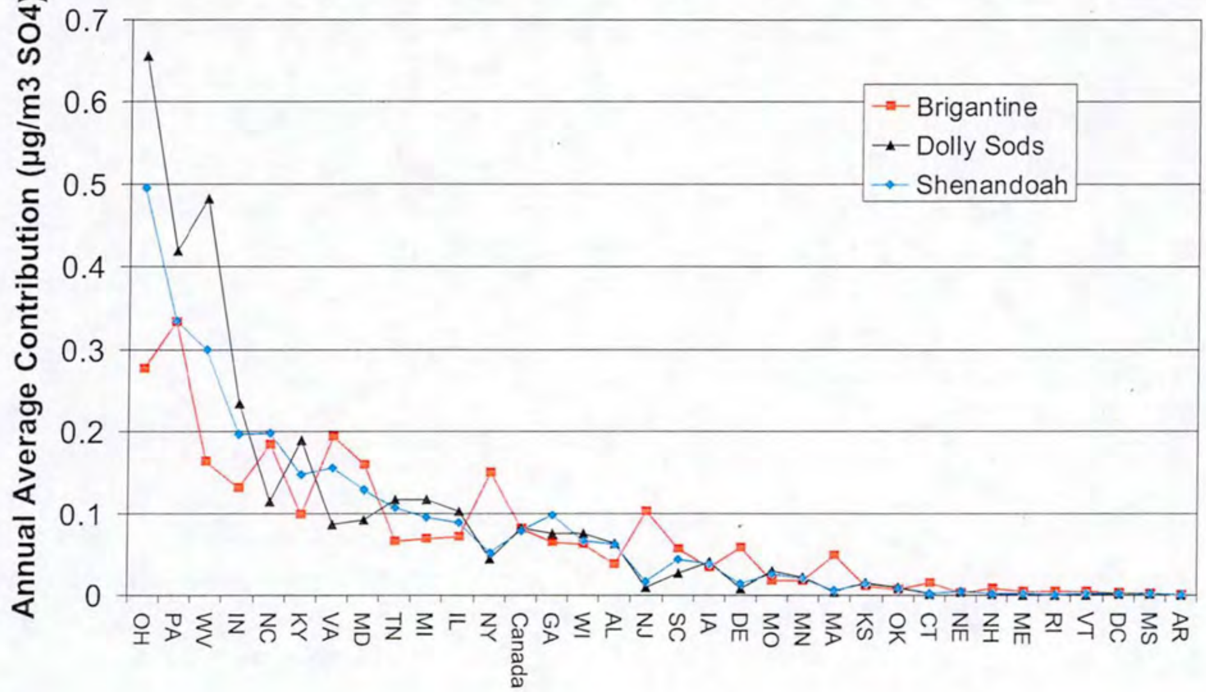
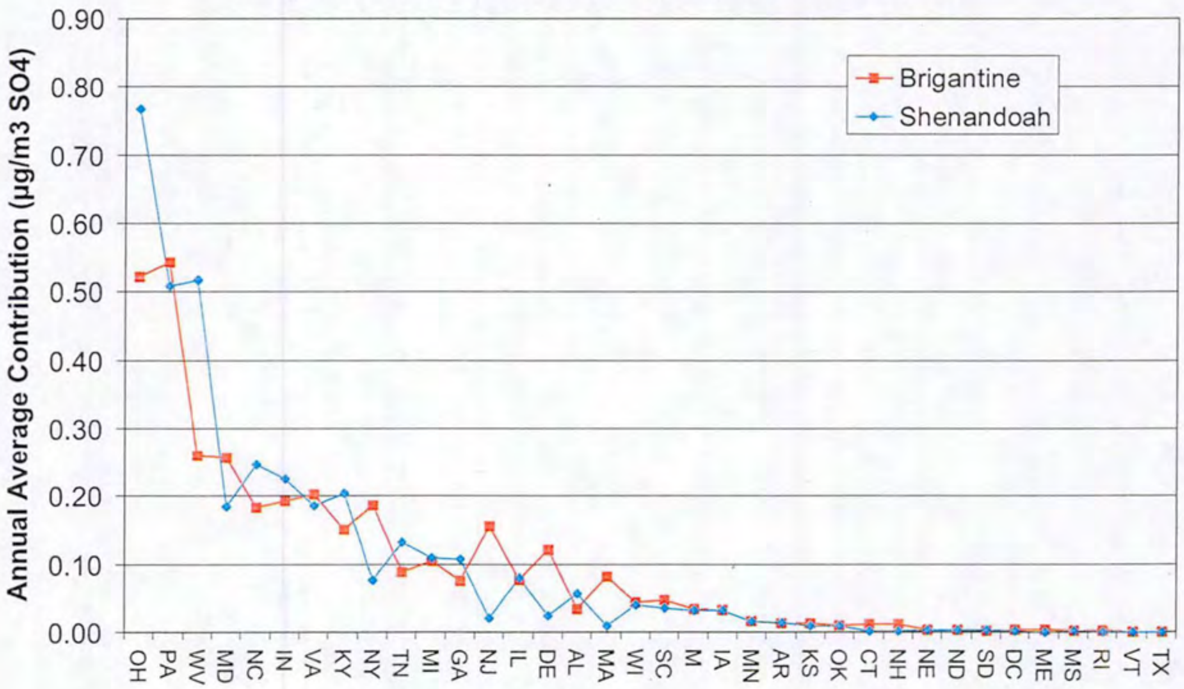


Figure 7-4a. Ranked state percent sulfate contributions to Northeast Class I receptors based on MM5-based (MD) CALPUFF results

Figure 7-4b. Ranked state percent sulfate contributions to Mid-Atlantic Class I receptors based on MM5-based (MD) CALPUFF results



7.5. Future work and potential uses of CALPUFF results for BART determinations

Modeling efforts to date have provided a solid basis for contributing to a weight-of-evidence assessment of state contributions. In addition, the two CALPUFF platforms can be used to evaluate the relative contributions to fine PM and visibility impacts of individual sources in the MANE-VU region. It is anticipated that MANE-VU will provide all states with a consistent set of modeling results from each of these platforms to serve as a preliminary basis for BART visibility determinations and states will have several options with regard to how these results are used:

- States may accept the MANE-VU modeling as an adequate basis for determining whether BART controls at a facility are justified by its contribution to visibility degradation.

- States may conduct additional modeling on their own to determine whether BART controls at a facility are justified by its contribution to visibility degradation.

- States may require a source to conduct additional modeling to determine whether BART controls at a facility are justified by its contribution to visibility degradation.

These options and the use of modeling results for BART determinations are discussed in more detail in the *MANE-VU BART Resource Book* (NESCAUM, 2006), and the reader is referred to that resource for additional information.

References

NESCAUM, *BART Resource Guide*, Northeast States for Coordinated Air Use Management, 2006.

USEPA, CALPUFF Modeling System, Available at: http://www.epa.gov/ttn/scram, 2006.

8. SYNTHESIS OF RESULTS USING DIFFERENT SOURCE ASSESSMENT TECHNIQUES

By synthesizing results from a variety of data sources and analysis techniques MANE-VU has taken a first step toward identifying sources of visibility impairment in the Northeast generally, and toward understanding the role of transported sulfate in particular. The variety of approach and complexity of analytical tools utilized for this purpose provides numerous metrics and means of comparison into how SO_2 emissions are chemically transformed, transported and combined with various local constituents of fine particle pollution in the MANE-VU region. Beyond reviewing these results, additional sections of this chapter describe opportunities for further synthesizing the available data to solidify a weight-of-evidence approach to implementing the contribution assessment and pollution apportionment requirements of the Haze Rule

8.1. Ranked Contribution

Chapter 4 of this report describes two crude methods of ranking state contributions based on the ratio of source emissions to source-receptor distance as well as the gridded product of emissions and upwind residence time probability. Chapter 5 describes the qualitative evidence available from several different trajectory-based techniques and source apportionment studies. These include source region comparisons, source profile examinations, and the development of other techniques and metrics to support the more quantitative ranking techniques. Chapter 6 describes results obtained using Eulerian grid models such as the Regulatory Modeling System for Aerosols and Deposition (REMSAD) and the Community Multi-scale Air Quality (CMAQ) model. Ultimately these types of models are likely to yield the most definitive assessments of contribution from different sources. Chapter 7 explores the use of lagrangian puff dispersion models such as CALPUFF for estimating source contributions and compares two related but distinct versions of the CALPUFF modeling system that demonstrate the sensitivity of this tool to emissions and meteorology inputs.

In Table 8-1 through Table 8-5 (and graphically in Figure 8-1), we have normalized the results obtained using five techniques for assessing state contribution by calculating the percentage contribution and plotted them on a common graph. The figure shows substantial consistency across a variety of independent analyses using techniques that are themselves based on the application of disparate chemical, meteorological and physical principles. Together, these findings create a strong weight-of-evidence case for identifying the most significant contributors to visibility impairment in MANE-VU Class I areas.

In Figure 8-1, several features of the normalized results bear notice. First, we note that the apparent perfect agreement among the techniques for the "other" contribution that represents all emissions from outside the domain of study is a result of having substituted the REMSAD calculated "other" contribution for all of the other methods. REMSAD is the only method that has a means of developing a comprehensive estimate of the total out-of-domain contribution because the boundary condition used was derived from a global model run using global SO_2 emissions estimates. It is also worth noting how high the "other," or out-of-domain, contribution is to observed sulfate at

Acadia National Park. This is not surprising given how close Acadia is to the domain boundaries on both the northern and eastern edge. There may be some recirculation of in-domain SO_2 emissions that leave the modeling domain and re-enter through the dynamic boundary condition, but lose their tag in the process.

It is also worth noting the differences between the methods for certain states and Canada, such as Massachusetts and Maine in the case of Acadia, Maryland and Canada for Brigantine, Canada for Lye Brook, and Ohio and West Virginia for Shenandoah. Those states and Canada that are directly upwind a large fraction of the time, either because they are very large geographically or because they are very nearby, are likely to be treated differently by the percent-time-upwind method relative to the other methods. In addition, the CALPUFF models appear to underestimate the contribution from Canada relative to other methods. This is likely to result from an incomplete characterization of the total SO_2 inventory for Canada relative to other methods that are based on the entire MANE-VU Canadian inventory.

Table 8-1. Annual Average Sulfate Impact from REMSAD (%)

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

Table 8-2. Annual Average Sulfate Impact from Q/D (%)

RPO	STATE	ACADIA	BRIGANTINE	DOLLY SODS	GREAT GULF	LYE BROOK	MOOSEHORN	SHENANDOAH
CANADA		**11.91**	**6.01**	**0.00**	**8.97**	**12.00**	**18.77**	**6.76**
CENRAP		**1.74**	**1.64**	**1.59**	**2.33**	**1.99**	**1.35**	**1.72**
CENRAP	Arkansas	0.13	0.15	0.13	0.08	0.17	0.09	0.26
	Iowa	0.29	0.19	0.24	0.40	0.32	0.24	0.24
	Louisiana	0.02	0.03	0.02	0.02	0.03	0.02	0.04
	Minnesota	0.22	0.13	0.16	0.30	0.24	0.13	0.19
	Missouri	1.08	1.15	1.03	1.53	1.23	0.87	1.00
MANE-VU		**20.13**	**32.53**	**20.10**	**21.48**	**25.69**	**12.84**	**24.50**
MANE-VU	Connecticut	0.34	0.33	0.11	0.74	0.38	0.21	0.31
	Delaware	0.59	3.01	0.46	0.51	0.67	0.36	1.07
	District of Columbia	0.01	0.05	0.02	0.01	0.02	0.01	0.09
	Maine	1.74	0.15	0.08	0.71	0.15	1.13	0.15
	Maryland	1.83	7.26	3.86	0.43	2.67	1.27	5.27
	Massachusetts	2.89	0.95	0.46	4.61	1.06	1.33	1.22
	New Hampshire	1.07	0.30	0.14	0.42	0.08	0.60	0.18
	New Jersey	0.76	4.22	0.43	3.11	0.75	0.48	1.82
	New York	4.02	4.61	1.93	3.67	6.71	2.83	3.30
	Pennsylvania	6.64	11.57	12.58	6.62	13.07	4.50	11.00
	Rhode Island	0.12	0.05	0.02	0.08	0.04	0.06	0.06
	Vermont	0.10	0.03	0.02	0.57	0.10	0.07	0.04
MIDWEST		**16.99**	**17.48**	**26.30**	**25.38**	**22.84**	**12.49**	**22.46**
MIDWEST	Illinois	2.53	2.16	2.60	3.64	2.98	2.11	2.61
	Indiana	3.94	4.24	5.17	6.01	5.01	2.91	4.50
	Michigan	2.69	1.95	2.46	4.08	3.50	2.16	2.49
	Ohio	6.63	8.34	15.06	9.94	9.98	4.51	11.85
	Wisconsin	1.19	0.79	1.00	1.71	1.38	0.80	1.01
VISTAS		**15.44**	**25.55**	**39.32**	**18.30**	**18.48**	**10.39**	**32.08**
VISTAS	Alabama	1.24	1.69	1.66	1.45	1.60	0.91	1.65
	Georgia	2.36	3.28	3.18	2.62	2.82	1.63	3.30
	Kentucky	2.07	3.36	3.99	3.18	2.79	1.50	3.54
	Mississippi	0.19	0.24	0.22	0.22	0.24	0.14	0.37
	North Carolina	2.27	4.16	9.03	2.59	2.69	1.44	6.60
	South Carolina	1.29	1.62	0.95	1.14	0.94	0.70	1.69
	Tennessee	1.45	2.14	2.49	1.74	1.92	1.06	2.40
	Virginia	1.93	4.36	2.49	1.97	1.78	1.12	4.25
	West Virginia	2.64	4.71	15.33	3.39	3.71	1.88	8.27
OTHER[36]		**33.79**	**16.78**	**12.70**	**23.54**	**18.99**	**44.17**	**12.48**
TOTAL (μg/m^3)		**1.920**	**2.740**	**3.455**	**1.305**	**1.858**	**1.977**	**3.417**

[36] OTHER is % from REMSAD result; Florida is considered within OTHER

Table 8-3. Annual Average Sulfate Impact from CALPUFF (NWS Observations) (%)

RPO	STATE	ACADIA	BRIGANTINE	DOLLY SODS	GREAT GULF	LYE BROOK	MOOSEHORN	SHENANDOAH
CANADA		**8.07**	**2.65**	**2.30**	**7.22**	**5.77**	**9.45**	**2.45**
CENRAP		**2.76**	**2.98**	**3.34**	**5.06**	**4.50**	**2.30**	**3.42**
CENRAP	Iowa	0.93	1.09	1.13	1.65	1.55	0.80	1.17
	Kansas	0.34	0.37	0.41	0.64	0.55	0.28	0.43
	Louisiana	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Minnesota	0.58	0.60	0.62	1.16	0.95	0.49	0.65
	Missouri	0.59	0.59	0.81	1.00	0.91	0.49	0.80
	Nebraska	0.07	0.10	0.11	0.14	0.13	0.06	0.12
	Oklahoma	0.25	0.22	0.26	0.47	0.41	0.20	0.25
MANE-VU		**27.41**	**29.17**	**16.21**	**20.91**	**26.52**	**21.11**	**17.47**
MANE-VU	Connecticut	0.58	0.50	0.03	0.26	0.27	0.41	0.06
	Delaware	0.48	1.90	0.21	0.31	0.32	0.38	0.44
	District of Columbia	0.02	0.07	0.02	0.03	0.02	0.02	0.05
	Maine	2.40	0.12	0.01	0.53	0.18	2.04	0.02
	Maryland	1.90	5.22	2.54	2.19	2.47	1.55	4.01
	Massachusetts	5.73	1.58	0.12	1.44	1.29	4.13	0.19
	New Hampshire	2.02	0.26	0.02	0.79	0.47	1.36	0.04
	New Jersey	0.98	3.37	0.28	0.63	0.67	0.75	0.52
	New York	5.06	4.92	1.24	4.67	7.20	4.03	1.63
	Pennsylvania	7.19	10.97	11.71	8.86	11.16	5.65	10.48
	Rhode Island	0.31	0.14	0.01	0.08	0.06	0.22	0.01
	Vermont	0.73	0.12	0.01	1.13	2.41	0.56	0.02
MIDWEST		**16.85**	**19.99**	**33.09**	**26.68**	**26.98**	**14.21**	**29.46**
MIDWEST	Illinois	2.12	2.37	2.86	3.36	3.11	1.84	2.74
	Indiana	3.67	4.28	6.52	5.83	5.57	3.19	6.11
	Michigan	3.06	2.25	3.28	4.74	4.74	2.67	2.97
	Ohio	6.31	9.07	18.33	9.82	10.66	5.07	15.55
	Wisconsin	1.69	2.03	2.10	2.93	2.90	1.44	2.09
VISTAS		**11.12**	**28.43**	**32.35**	**16.59**	**17.24**	**8.76**	**34.72**
VISTAS	Alabama	0.43	1.26	1.77	0.77	0.85	0.32	1.96
	Georgia	0.65	2.13	2.12	1.30	1.41	0.52	3.06
	Kentucky	2.05	3.23	5.29	3.39	3.59	1.64	4.59
	Mississippi	0.01	0.03	0.04	0.03	0.03	0.01	0.04
	North Carolina	1.84	6.03	3.20	2.52	2.51	1.42	6.18
	South Carolina	0.61	1.87	0.75	0.80	0.71	0.49	1.33
	Tennessee	1.10	2.19	3.27	1.72	1.80	0.86	3.33
	Virginia	1.72	6.33	2.42	1.80	1.86	1.32	4.85
	West Virginia	2.71	5.37	13.49	4.26	4.48	2.17	9.39
OTHER[36]		**33.79**	**16.78**	**12.70**	**23.54**	**18.99**	**44.17**	**12.48**
TOTAL ($\mu g/m^3$)		**1.571**	**2.533**	**3.125**	**1.167**	**1.701**	**1.429**	**2.793**

Table 8-4. Annual Average Sulfate Impact from CALPUFF (MM5) (%)

RPO	STATE	ACADIA	BRIGANTINE	DOLLY SODS	GREAT GULF	LYE BROOK	MOOSEHORN	SHENANDOAH
CANADA		**8.05**	**2.65**			**5.76**		**2.46**
CENRAP		**3.26**	**2.85**			**5.08**		**2.74**
CENRAP	Arkansas	0.23	0.32			0.39		0.33
CENRAP	Iowa	0.82	0.75			1.28		0.74
CENRAP	Kansas	0.43	0.29			0.65		0.24
CENRAP	Louisiana							
CENRAP	Minnesota	0.41	0.39			0.71		0.37
CENRAP	Missouri	1.01	0.80			1.48		0.74
CENRAP	Nebraska	0.10	0.08			0.15		0.07
CENRAP	Oklahoma	0.25	0.23			0.42		0.24
CENRAP	Texas	0.00	0.00			0.00		0.00
MANE-VU		**28.09**	**31.83**			**27.69**		**19.31**
MANE-VU	Connecticut	0.43	0.27			0.25		0.04
MANE-VU	Delaware	0.01	0.07			0.02		0.03
MANE-VU	District of Columbia	0.60	2.81			0.73		0.57
MANE-VU	Maine	1.62	0.06			0.14		0.01
MANE-VU	Maryland	1.68	5.95			2.59		4.27
MANE-VU	Massachusetts	8.67	1.87			2.18		0.23
MANE-VU	New Hampshire	2.05	0.26			0.56		0.04
MANE-VU	New Jersey	0.97	3.60			0.91		0.49
MANE-VU	New York	4.41	4.30			8.08		1.79
MANE-VU	Pennsylvania	7.44	12.57			11.86		11.83
MANE-VU	Rhode Island	0.14	0.04			0.04		0.00
MANE-VU	Vermont	0.08	0.02			0.33		0.00
MIDWEST		**16.28**	**21.79**			**25.58**		**28.43**
MIDWEST	Illinois	1.89	1.78			2.68		1.85
MIDWEST	Indiana	3.57	4.46			5.48		5.22
MIDWEST	Michigan	2.30	2.41			3.47		2.53
MIDWEST	Ohio	7.53	12.11			12.30		17.88
MIDWEST	Wisconsin	0.98	1.04			1.65		0.95
VISTAS		**10.53**	**24.10**			**16.90**		**34.57**
VISTAS	Alabama	0.43	0.79			0.79		1.32
VISTAS	Georgia	0.78	1.74			1.30		2.50
VISTAS	Kentucky	2.02	3.47			3.22		4.73
VISTAS	Mississippi	0.01	0.03			0.04		0.04
VISTAS	North Carolina	1.72	4.23			2.53		5.74
VISTAS	South Carolina	0.50	1.10			0.62		0.84
VISTAS	Tennessee	1.07	2.04			1.82		3.07
VISTAS	Virginia	1.36	4.70			1.99		4.32
VISTAS	West Virginia	2.64	6.00			4.58		12.03
OTHER[36]		**33.79**	**16.78**	**12.70**	**23.54**	**18.99**	**44.17**	**12.48**
TOTAL ($\mu g/m^3$)		**2.424**	**3.589**			**2.430**		**3.761**

Table 8-5. Annual Average Sulfate Impact from percent time upwind method (%)

RPO	State	Acadia	Brigantine	Dolly Sods	Great Gulf	Lye Brook	Moosehorn	Shenandoah
CANADA		**15.24**	**6.70**		**19.29**	**15.91**	**13.45**	**4.33**
CENRAP		**1.89**	**1.77**		**1.73**	**1.66**	**1.52**	**1.72**
CENRAP	Arkansas	0.12	0.24		0.15	0.15	0.15	0.20
	Iowa	0.38	0.27		0.27	0.28	0.28	0.25
	Kansas	0.00	0.00		0.00	0.00	0.00	0.00
	Louisiana	0.04	0.08		0.06	0.04	0.04	0.09
	Minnesota	0.56	0.33		0.38	0.44	0.44	0.22
	Missouri	0.80	0.85		0.87	0.75	0.62	0.95
	Texas	0.00	0.00		0.00	0.00	0.00	0.00
MANE-VU		**18.33**	**25.83**		**20.64**	**25.38**	**15.23**	**11.38**
MANE-VU	Connecticut	0.51	0.27		0.52	0.59	0.40	0.10
	Delaware	0.30	1.36		0.34	0.42	0.28	0.24
	District of Columbia	0.12	0.29		0.11	0.14	0.12	0.24
	Maine	1.49	0.08		0.68	0.26	1.53	0.05
	Maryland	1.32	3.06		1.31	1.31	0.96	2.29
	Massachusetts	1.10	0.33		0.86	0.81	0.90	0.12
	New Hampshire	1.21	0.17		1.48	0.72	0.77	0.06
	New Jersey	1.02	6.01		0.99	1.39	0.78	0.49
	New York	4.80	3.49		6.80	9.08	4.23	1.44
	Pennsylvania	6.21	10.71		7.10	10.36	5.07	6.33
	Rhode Island	0.11	0.05		0.08	0.08	0.09	0.02
	Vermont	0.14	0.03		0.37	0.23	0.10	0.01
MIDWEST		**17.35**	**19.55**		**20.67**	**21.63**	**15.56**	**22.03**
MIDWEST	Illinois	3.79	3.47		3.31	3.74	3.22	3.76
	Indiana	3.37	4.36		4.33	4.13	3.21	5.08
	Michigan	2.73	2.07		3.03	3.27	2.34	1.80
	Ohio	6.10	8.65		8.73	9.23	5.77	10.64
	Wisconsin	1.36	1.00		1.28	1.25	1.02	0.76
VISTAS		**13.40**	**29.37**		**14.14**	**16.43**	**10.07**	**48.06**
VISTAS	Alabama	0.72	1.32		0.63	0.71	0.39	2.14
	Georgia	1.40	3.21		1.06	1.54	0.72	4.73
	Kentucky	2.65	4.71		3.59	3.83	2.31	7.82
	Mississippi	0.04	0.10		0.06	0.06	0.03	0.12
	North Carolina	1.29	4.35		0.92	0.99	1.18	6.11
	South Carolina	0.72	1.64		0.42	0.41	0.44	1.62
	Tennessee	1.05	1.91		1.04	1.16	0.86	3.67
	Virginia	1.80	4.83		1.48	1.67	1.32	5.45
	West Virginia	3.74	7.31		4.94	6.05	2.81	16.39
OTHER[36]		**33.79**	**16.78**	**12.70**	**23.54**	**18.99**	**44.17**	**12.48**

MANE-VU will continue to explore these differences, but it remains encouraging that the use of different platforms and approaches results in more agreement across the various techniques than difference. With the few, specific exceptions mentioned above, it is relatively easy — using the normalized results from multiple techniques shown in Figure 8-1(a-d) — to identify those states that have the largest influence on sulfate levels at each Class I site. MANE-VU believes that this information can provide a solid basis for initiating consultation and planning efforts between upwind and downwind states and RPOs.

Figure 8-1(a-d). Comparison of normalized (percent contribution) results using different techniques for ranking state contributions to sulfate levels at the MANE-VU Class I sites (a) Acadia National Park, ME, (b) Brigantine Wilderness Area, NJ, (c)Lye Brook Wilderness Area, VT, and (d) Shenandoah National Park, VA.

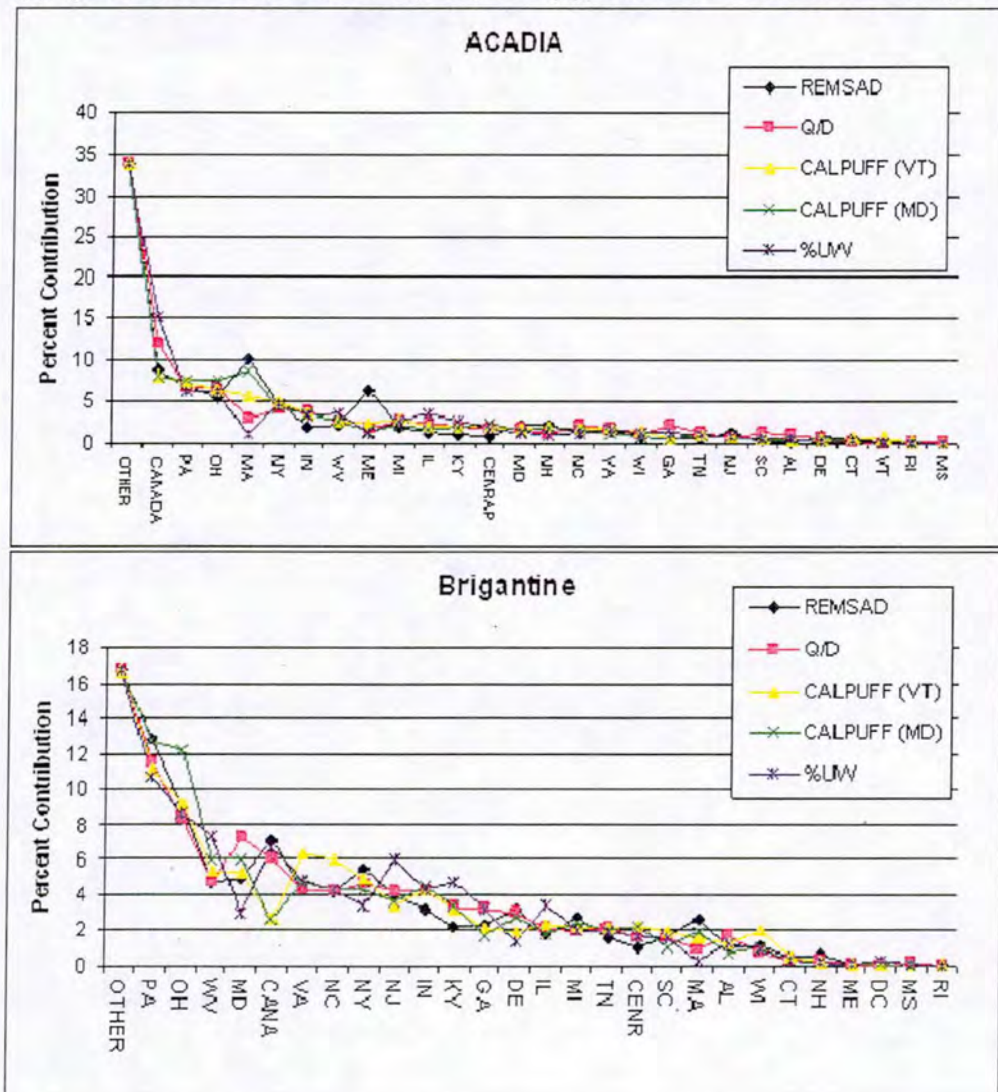
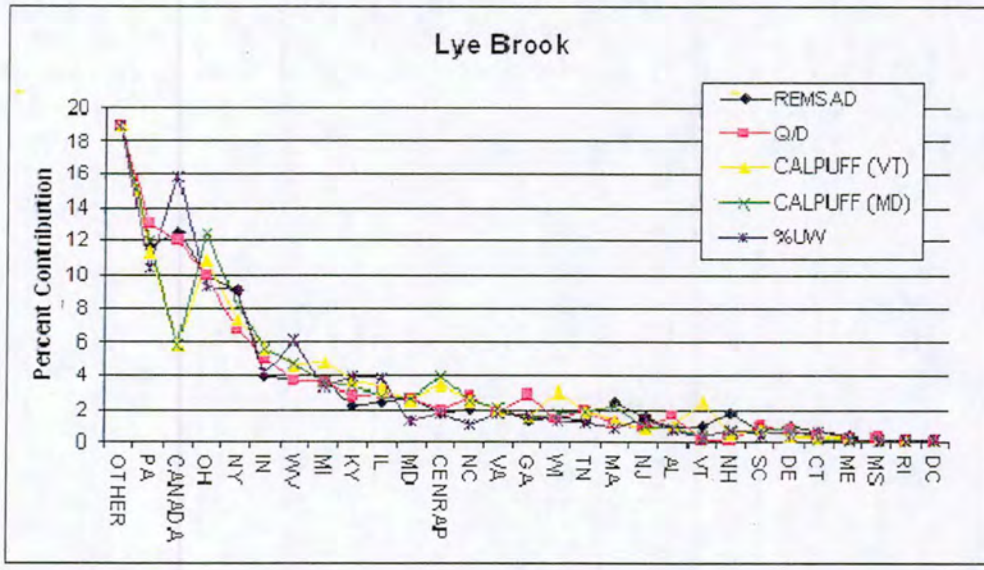
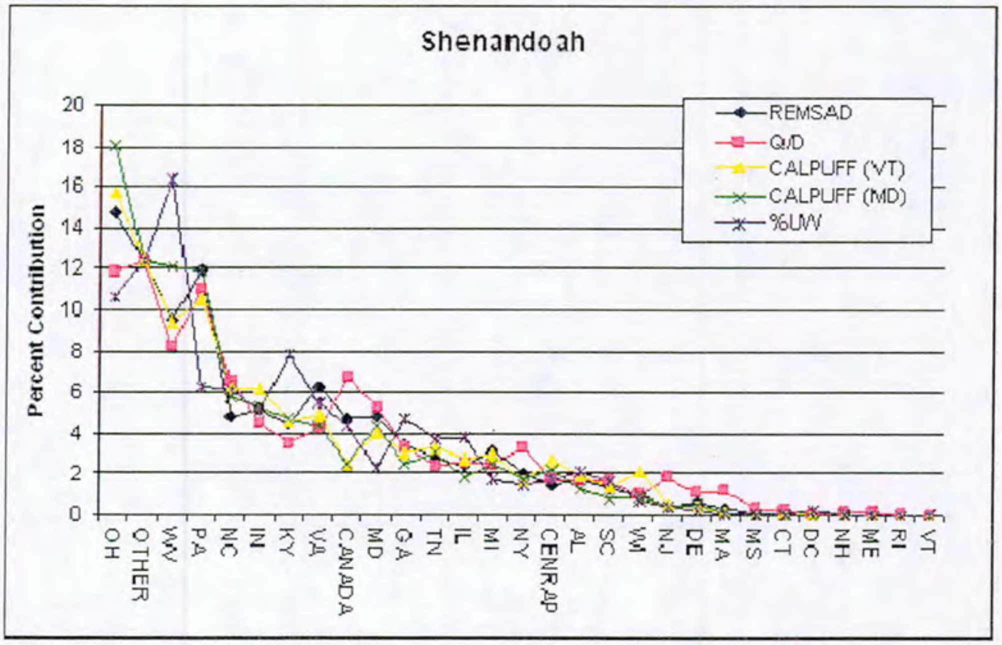


Figure 8-1(a-d). Continued





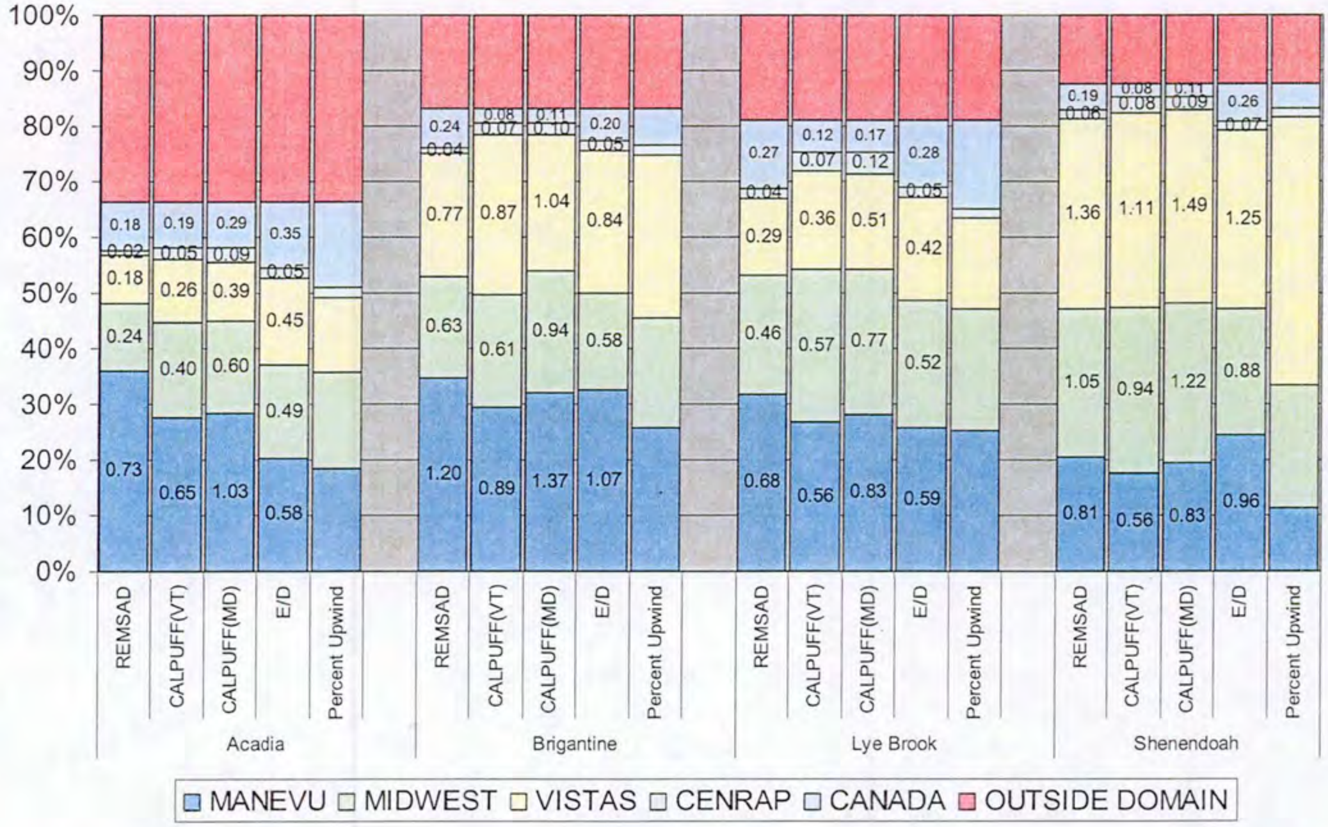
An alternative means of displaying the above results is in Table 8-6, which shows the individual state rankings produced by different assessment techniques for Acadia National Park, Maine. In the left-side column of Table 8-6, states are colored according to their average ranking across the different assessment methods. Those states that are ranked in the top five on average, across all techniques are colored red, while states ranked in the top six through ten are colored magenta, and so on for each group of five going down the left-side column. Through this color scheme, one can see how the states' average ranking compares to their rankings under each individual assessment method given in the other columns of the table. The fact that all techniques tend to come to consistent conclusions about which states are top contributors provides some confidence that the source regions with the most influence on sulfate levels at MANE-VU Class I sites can be correctly identified. Note that the CENRAP states and several other states along the border of the analysis domain represent only partial state contributions.

Table 8-6. Ranked Contributing States to Acadia Sulfate

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

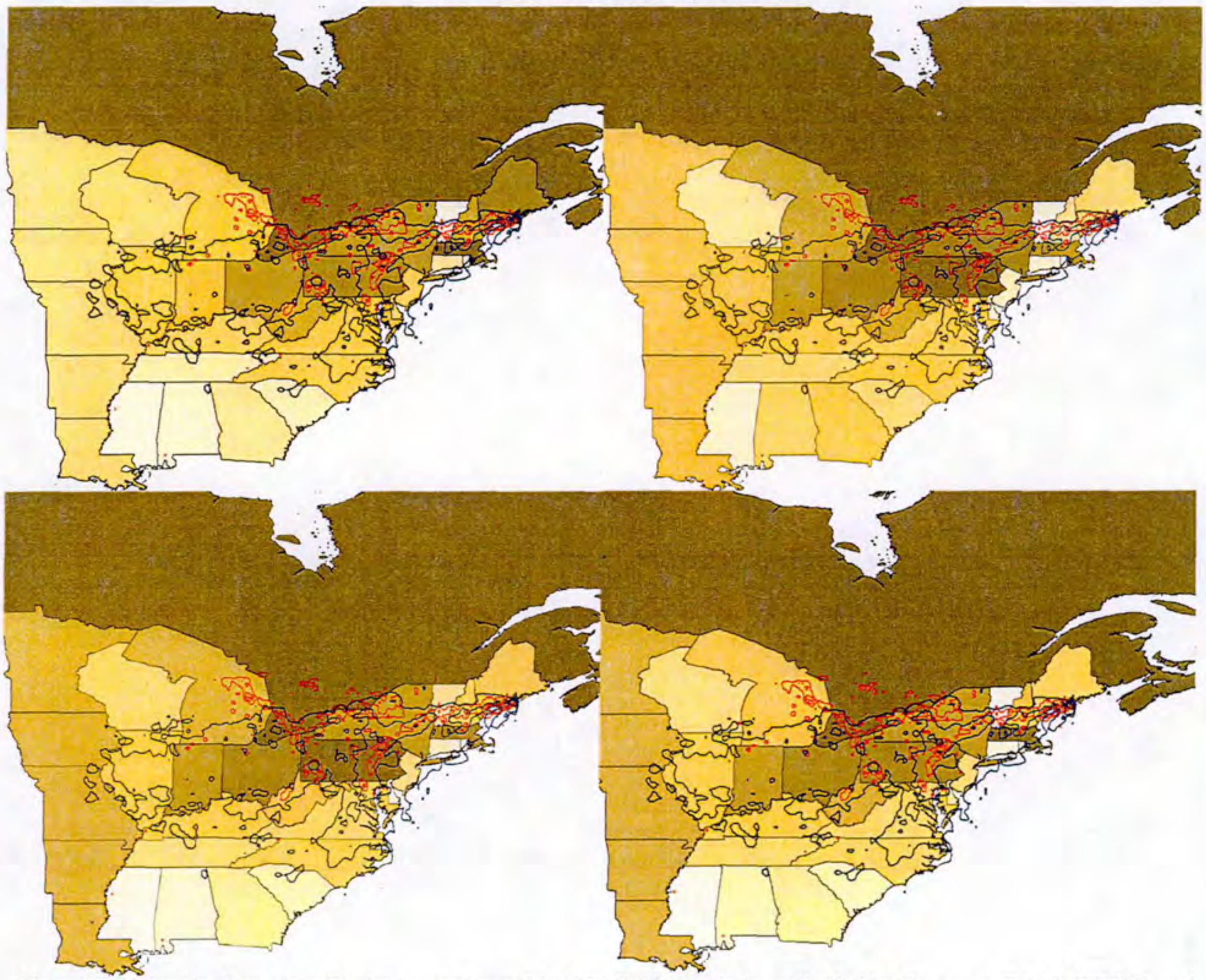
Yet one more way of combining the ranked contributions is shown in Figure 8-2, which summarizes the relative contributions of four RPOs, Canada, and "outside domain" regions to ambient sulfate concentrations at several Class I areas using four different assessment techniques. The techniques considered here include: tagged REMSAD modeling, two CALPUFF platforms (MM5-based meteorology used by MDE and NWS observation-based meteorology used by VT DEC), the empirical emissions divided by distance approach (Q/d), and emissions times residence time probability. The estimates of state-by-state sulfate mass contributions ($\mu g/m^3$) from each method have been aggregated by RPO, both in terms of their absolute contribution (these values are displayed within the bars shown in the graphic) and in terms of their proportional contribution relative to other RPOs. It should be noted that the "outside domain" contribution shown for each analysis method was derived exclusively from the REMSAD result. Averaging estimated impacts at the Acadia, Brigantine, and Lye Brook sites over the four assessment techniques utilized, MANE-VU states account for about 20 to 30 percent of sulfate impacts in these three MANE-VU Class I areas, while the Midwest RPO and VISTAS states each account for about 20 to 25 percent of the total sulfate contribution at Brigantine and Lye Brook and about 10 to 15 percent each at Acadia. The CENRAP states, Canada and "outside domain" add the remainder. Although variation exists across estimates of contribution for different sites and using different techniques, the overall pattern is generally consistent. Relative contributions are somewhat reversed at Shenandoah, which is a VISTAS Class I area. There, VISTAS states and Midwest RPO states account for roughly 20 to 30 percent of overall sulfate impacts, with MANE-VU states contributing roughly 15 to 20 percent.

Figure 8-2. Estimated RPO contributions to sulfate concentrations at Class I areas using different assessment techniques



While the foregoing discussion has focused on quantitative methods for comparing contributions from individual states and regions, additional analyses have been conducted to verify and support these results using more qualitative means of identifying "regions of influence" for each Class I area. One such qualitative approach to synthesizing and interpreting the results obtained through different assessment techniques is illustrated in Figure 8-3 and Figure 8-4 below, which show a series of maps shaded to indicate different levels of contribution from different states and regions as determined by the analysis platforms already discussed. In these maps, states are shaded darker the higher they rank in terms of percent contribution to sulfate at a Class I site. For example, in Figure 8-3, states in a line from Indiana through Massachusetts are calculated to have the greatest impact on sulfate at Acadia. Overlaid on top of these maps are contours of

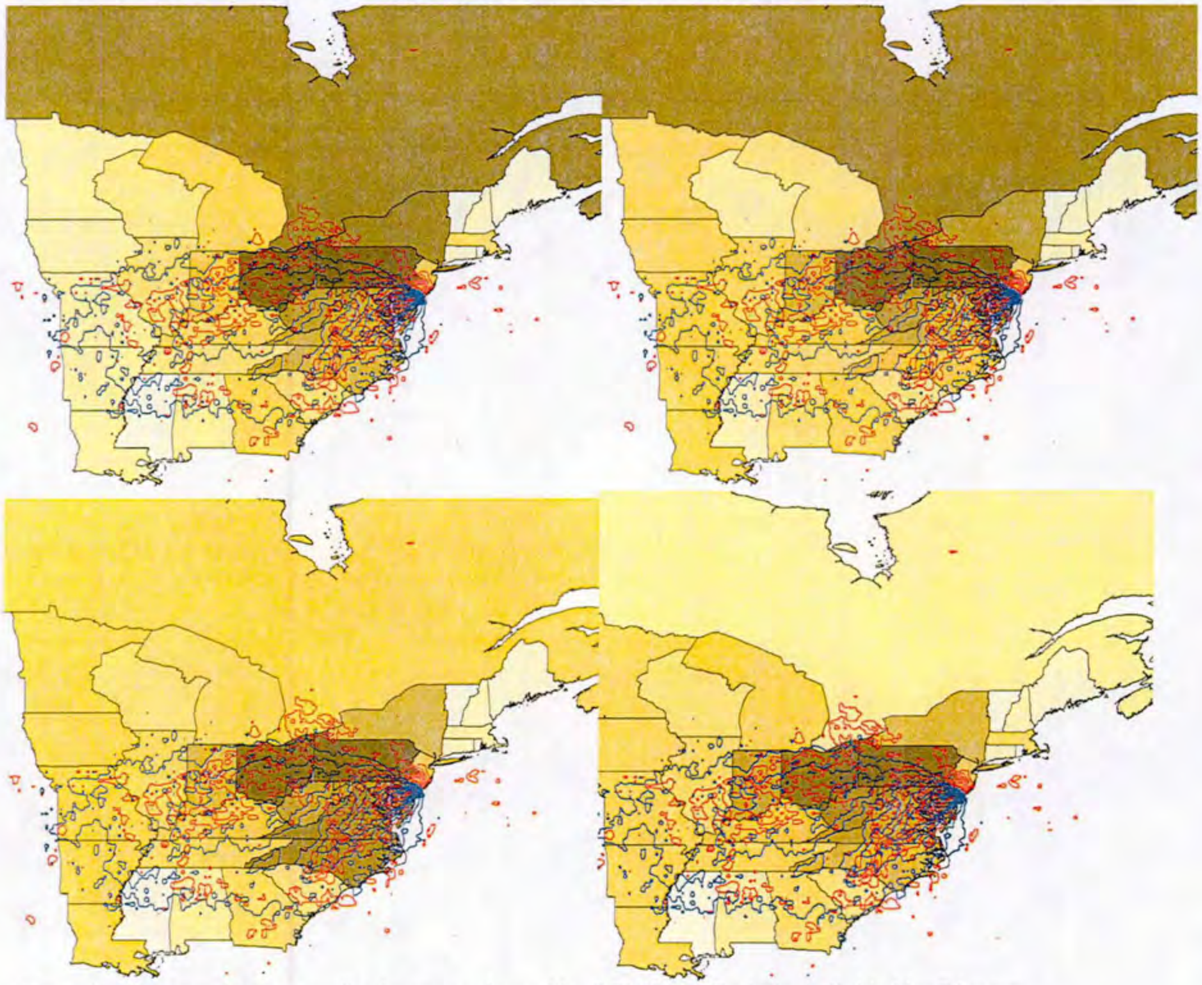
Figure 8-3. Ranked contributions of states to ambient sulfate concentrations at Acadia National Park, Maine.



Note: Shaded maps show contributions as estimated by REMSAD, Emissions divided by Distance, CALPUFF VT, and CALPUFF MD. Red and blue contours representing regions of high incremental probability (IP) and high cluster-weighted probability (CWP) are overlaid onto the shaded state maps to indicate similarity of regional contributions as calculated by these independent receptor-based methods.

Incremental Probability (red) and Cluster Weighted Probability (blue) of contributing to sulfate on the highest days. The substantial consistency in the patterns support and bolster the quantitative results. The importance of this finding is that the receptor-based results portrayed by the contours rely on methods that are completely independent of the source-based modeling approaches used to calculate the underlying ranks. This sort of internal consistency among approaches gives considerable strength to the weight-of-evidence approach that MANE-VU has adopted for identifying sulfate source regions.

Figure 8-4. Ranked contributions of states to ambient sulfate concentrations at Brigantine Wilderness Area, New Jersey.



Note: Shaded maps show contributions as estimated by REMSAD, Emissions divided by Distance, CALPUFF VT, and CALPUFF MD. Red and blue contours representing regions of high incremental probability (IP) and high cluster-weighted probability (CWP) are overlaid onto the shaded state maps to indicate similarity of regional contributions as calculated by these independent receptor-based methods.

9. CONCLUSION

As MANE-VU prepares to implement the requirements of the Regional Haze Rule, a significant technical effort has focused on developing multiple analysis tools for assessing contributions to fine particle pollution and thus visibility impairment at Class I areas in the eastern United States. These analysis tools span the discipline of atmospheric science and include traditional Eulerian "source" or "grid" models, Lagrangian dispersion models, back trajectory receptor techniques, source apportionment models, and simple approximations based on empirical relationships between emissions and geography.

A review of the literature and of recent monitoring data has yielded a conceptual model of visibility impairment in the MANE-VU region that attributes a dominant role, on the worst visibility days, to the sulfate component of fine particle matter. This model in turn suggests that the most effective near-term strategy for reducing fine particle pollution and visibility impairment in the East is to continue reducing anthropogenic emissions of SO_2. Reductions in both NO_X and VOCs should also be considered. Given that sulfate, in particular, plays a dominant role in causing visibility impairment throughout the East, MANE-VU has focused on multiple methods of apportioning the sulfate mass found in ambient air at Class I sites to contributing states and regions. This weight-of-evidence approach is intended to overcome large uncertainties that would otherwise undermine confidence in the results obtained using any one modeling or analysis technique in isolation.

The assessment techniques described in this report use numerous approaches to develop ranked lists of individual state contributions to sulfate levels in MANE-VU Class I areas. When these results are normalized and compared, we find broad general agreement concerning the top contributing states at each site as well as some differences that suggest the magnitude of uncertainty inherent in these results.

The conclusions that emerge from this report regarding the relative contributions of different upwind RPOs to downwind sulfate concentrations at MANE-VU Class I areas appear quite robust and the modest differences presented here relative to the preliminary results presented in Spring of 2005 are a further indication that the general patterns of contribution presented here are unlikely to change due to further refinements of the emissions and meteorological inputs. This suggests that the MANE-VU findings are sufficiently robust to serve as a basis for inter-RPO consultations and the regional haze planning process. Given that as much as 30 to 50 percent of the ambient sulfate found at northeastern Class I sites on hazy days appears to originate within neighboring RPOs, coordination and consultation is likely to be critical if MANE-VU is to achieve its visibility goals for 2018 and beyond.

Appendix A: Application of Trajectory Analysis Methods to Sulfate Source Attribution Studies in the Northeast U.S.

Appendix B: Source Attribution by Receptor-Based Methods

Appendix C: Chemical Transport Model Results for Sulfate Source Attribution Studies in the Northeast U.S.

Appendix D: Development of Parallel CALPUFF Dispersion Modeling Platforms for Sulfate Source Attribution Studies in the Northeast U.S.

ATTACHMENT C

Inter-RPO State/Tribal and FLM Consultation Framework

Inter-RPO State/Tribal and FLM Consultation Framework

I. Introduction

In the preamble for the Regional Haze Regulations ("Rule"), published in the Federal Register on July 1, 1999, the U.S. Environmental Protection Agency ("EPA") strongly encourages States and Tribes to participate in the regional planning process. (See, 64 FR 35714). The preamble also describes the role of regional planning organizations indicating that, "[t]he EPA expects that much of the consultation, apportionment demonstrations, and technical documentation will be facilitated and developed by regional planning organizations." (See, 64 FR 35735). The goals of instituting consultation procedures are mainly:

1. To help develop a common technical basis and apportionment for long-term strategies that could be approved by individual state participants and translated into regional haze SIPs for submission to EPA,
2. To demonstrate that states are working together to develop acceptable approaches for addressing regional visibility problems to which they jointly contribute, and
3. To provide information on areas of agreement and disagreement among States that the Administrator will take into account in the review of a State's implementation plan to determine whether the State's goal for visibility improvement provides for reasonable progress towards natural visibility conditions.

For the purposes of this Inter-Regional Planning Organization ("RPO") Consultation Framework, the term "consultation" refers solely to the consultation requirements, of the Regional Haze Rule, and is not intended to refer to or address theTribal government/Federal government consultation process.

II. Goal of Inter-RPO Consultation Framework

The primary goal of this Inter-RPO Consultation Framework is to delineate, by consensus, the basic consultation requirements for states, tribes, RPOs, and Federal Land Managers ("FLMs") required under 40 CFR Part 51, during the regional haze State Implementation Plan (SIP) development process. The consultation process is a documented process that must be included in the "core requirements" of the Regional Haze SIP submittal. In fact, the preamble of the Regional Haze Rule states that "[t]he EPA is requiring States to document their analyses, including **any** consultations with other States in support of their conclusions…." (64 FR 35721). (emphasis added). Formal consultation, as required by the Regional Haze Rules in 40 CFR Part 51, Subpart P, may be built upon prior, documented informal consultations.

The consultation process explicitly applies to the development of the first regional haze implementation plans due to EPA in 2008 as well as comprehensive periodic revisions every 10 years thereafter. The Consultation Framework may also be useful as states develop their required periodic reports describing progress towards the reasonable progress goals which are due every 5 years.

One of the key purposes of the consultation framework is to better define the consultation process within the context of regional haze planning, and to create greater certainty and understanding among RPOs. The process should be consistent across RPOs, and be well documented such that it positively contributes to improving visibility in mandatory Class 1 areas.

III. Consultation Requirements Specified in 40 CFR Part 51, Subpart P (relating to protection of visibility)

A. Development of the Reasonable Progress Goal:

Section 51.308(d) of the Regional Haze Rule specifies that "–[I]n 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 [EPA] 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." [40 CFR §51.308(d)(1)(iv)].

B. Development of Long-term Strategy:

The Regional Haze Rule provides that – "[w]here the State has emissions that are reasonably anticipated to contribute to visibility impairment in any mandatory Class I Federal area located in another State or States, the State must consult with the other State(s) in order to develop coordinated emission management strategies. The State must consult with any other State having emissions that are reasonably anticipated to contribute to visibility impairment in any mandatory Class I Federal area within the State." [40 CFR § 51.308(d)(3)(i)].

C. State and Federal Land Manager Coordination:

–According to Section 51.308(i)(2) of the Regional Haze Rule, " "[t]he State must provide the Federal Land Manager [FLM] with an opportunity for consultation, in person and at least 60 days prior to holding any public hearing on an implementation plan (or plan revision) for regional haze required by this [Subpart P]". The purpose of the consultation in person is to allow the affected FLM to discuss: (1) The FLM's "assessment of impairment of visibility in any mandatory Class I Federal area;" and (2) "Recommendations on the development of the reasonable progress goal and on the development and implementation of strategies to address visibility impairment." [40 CFR §51.308(i)(2)].

The Rule also provides that – "[t]he plan (or plan revision) must provide procedures for continuing consultation between the State and Federal Land Manager on the implementation of the visibility protection program required by[Subpart P], including development and review of implementation plan revisions and 5-year progress reports, and on the implementation of other programs having the potential to contribute to impairment of visibility in mandatory Class I Federal areas." [40 CFR §51.308(i)(4)].

IV. Types of Consultations

A.) State/Tribal-to-State/Tribal Inter-RPO Consultations.
B.) State/Tribal-to-Federal Land Manager (FLM) Consultations.

V. Suggested Discussion Topics during consultation process

A. State-to-State and State-Tribal regional haze consultations are required for the development of the reasonable progress goal and long-term strategies. Suggested discussion topics include the following:

1) Reasonable Progress Goal:
   a. Natural background
   b. Baseline conditions
   c. Uniform Rate of Visibility Improvement
   d. Contribution determination
   e. Other factors (regarding reasonable progress goals)

2) Long-term Strategies:
   a. Emissions inventory/smoke management plans
   b. Model performance
   c. Control measures
   d. Monitoring strategy

B. Thepreliminary listing of discussion topics is subject to change based on the recommendations of States/Tribes, RPOs and federal participants including EPA and the FMLs.

VI. Consultation 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 §51.308(d)(1)(iv).
8) All States whose emissions are reasonably anticipated to contribute to visibility impairment in a Class I area, must provide the Federal Land Manager ("FLM") agency for that Class I area with an opportunity for consultation, in person, on their regional haze implementation plans. The States/Tribes will pursue the development of a memorandum of understanding to expedite the submission and consideration of the FLM's comments on the reasonable progress goals and related implementation plans. As required under 40 CFR §51.308(i)(3), the plan or plan revision must include a description of how the State addressed any FLM comments.
9) States/Tribes will consult with the affected FLMs to protect the air resources of the State/Tribe and Class I areas in accordance with the FLM coordination requirements specified in 40 CFR §51.308(i) and other consultation procedures developed by consensus..
10) The consultation process is designed to share information, define and document issues, develop a range of options, solicit feedback on options, develop consensus advice if possible, and facilitate informed decisions by the Class I States.
11) The collaborators, including States, Tribes and affected FLMs, will promptly respond to other RPO's/States'/Tribes' requests for comments.

VII. Consultation Processes

A) Formal State/Tribal-to-State/Tribal Inter-RPO Consultations*:

1) Any State or group of States initiating a consultation with another State/States on visibility-related concerns needs to designate a contact person to handle expeditiously the administrative aspects of the consultation, including scheduling and notifying participants, and providing documentation.
2) The State initiating the consultation is responsible for coordination of all aspects of the consultation.
3) This process is designed chiefly to apply to consultations involving States consulting across RPO lines, whether the consultation is initiated by one or more Class I States or by a State or group of States without a Class I area. States consulting with other States within the same RPO are encouraged to follow this process to maintain consistency and achieve good documentation of outcomes.

4) It is assumed that most consultations will be initiated by States with Class I areas. All States (or their RPOs on their behalf) are responsible for initiating the required consultation with affected FLMs according to the procedures in 40 CFR §51.308(i) and this document. At the request of the State or group of States initiating the consultation, the RPO for the region in which the Class I area is located may serve as facilitator to help the Class I States consult with other states and participating tribes. The RPO will assist with all administrative, logistical and documentation aspects of the consultation process for the State or States that have requested facilitation by their RPO.
5) Consultations are a government-to-government transaction. Stakeholders are not participants in these consultations.
6) The consultation process will occur as part of the regional haze SIP development cycle. It may also be initiated as a part of a mid-course adjustment in the middle of a SIP cycle. This Framework does not apply to individual regulatory, enforcement or permitting activities and should not be understood to be of any relevance to those activities.
7) The consultation process as a whole may involve several types of meetings, conference calls, and information sharing. An initial consultation will usually occur in the form of a conference call among all parties, unless the parties agree to an alternative format.
8) The timing of consultations will be coordinated with the production of component work products and the process of offering opportunities for comments on those products. All parties will be sensitive to the time line of the Class I area State or Tribe.
9) For consultations on the regional haze reasonable progress goal and the long-term strategy, and on their component topics, the Class I States may request that an initial consultation be conducted via conference call. When feasible, web meeting tools or videoconferencing technology may be used to enable parties to share information more easily.
10) Preparation and notification:
    a. The State designates a contact (which may be the RPP Director/staff) that will have responsibility for scheduling and notifying all parties about the consultation, and making sure all necessary materials are promptly provided to the participants.
    b. Who gets notified: Those parties associated with what is indicated in the rule as "reasonably anticipated to contribute to a Class I area" – more specifically, the appropriate State Commissioners, State Air Directors, and RPO designated contacts. Affected FLM representative(s) and EPA representative(s) will also be invited to participate in such consultations. If appropriate, the State Commissioner or the State Air Director may wish to notify appropriate state or local government staff regarding any and all consultations.
    c. How scheduled: the State contact or RPO designee sends out an e-mail to the other State or States to arrange for available dates/times. Once arrangements are settled, the initiating State or its RPO designee then sends out formal notification via certified mail with an agenda, list of participants and call for additional materials. Thirty (30) calendar days will be allowed for all parties

to review the technical materials prior to the date of a formal consultation unless otherwise all parties mutually agree, in writing, to adhere to a longer or shorter time frame.

11) During consultation, the participants should:
    a. Explain the issue/proposal and supporting technical information
    b. Provide answers to clarifying questions
    c. Request that any issues that are not addressed or resolved be submitted in writing to the State contact and RPO designee.
    d. The State contact or RPO designee will takes notes and prepares a summary of the consultation.
12) Post-consultation and follow up:
    a. The summary will be distributed for review and comment, along with the consultation notification e-mail and letter, agenda, and list of participants. The finalized documentation will be provided to all participants and other interested stakeholders upon request. The summary notes for any consultation should indicate areas/items of agreement and disagreement.
    b. The State contact or RPO designee is responsible for compiling an ongoing record of the consultation, including any additional meetings/calls that occur on outstanding concerns. The State contact or RPO designee will distribute documentation on additional meetings/calls to all relevant parties.
    c. Issues that cannot be further discussed or resolved without additional information can be taken through pertinent committees involving stakeholders to get feedback.
13) Each RPO will develop a consultation page on their website where the documentation will be posted. Each RPO will post all documentation on behalf of the initiating State.

*Note: No specifics on Tribal consultations are referred to in this section at this time.

VIII. Formal State/Tribal-to-FLM Consultation Process:

A. As required under 40 CFR §51.308(i)(2), the state must provide the FLM with an opportunity for consultation, in person and at least 60 days prior to holding any public hearing on any regional haze implementation plan (or plan revision).
B. As previously described in VII(A) above, a State or group of States initiating a consultation with the FLM may request that their RPO serves as a facilitator for such consultations.
C. As noted in the process described in VII(A) above, the affected FLMs will be invited to participate in the formal State/Tribal to State/Tribal consultations that occur on reasonable progress goals and the long-term strategy. I
D. Unless required pursuant to applicable statute or regulation, nothing herein should be interpreted to require consultation with FLM with respect to any regulatory, enforcement or permitting actions.
E. FLM will be urged to respond in an efficient and timely fashion to the opportunity to consult on a regional haze plan and on the specifics of the plan.

ATTACHMENT D

Consultation Summaries and Other Documentation

MANE-VU Board Meeting
June 7, 2007

The Renaissance Providence Hotel
5 Avenue of the Arts
Providence, RI 02903 (401) 276-0010

DRAFT AGENDA

2:00 PM	**Welcome and Introductions**	***David Littell, Incoming Chair, Commissioner ME DEP***
2:15 AM	**What We Know About Regional Haze in MANE-VU** ○ Characterization of the Problem in the Region ○ Who's Contributing – Sources and Areas Affecting the MANE-VU Region	***Jeff Underhill, NH DEP***
2:30 PM	**What Can Be Done by 2018?** ○ Overview of MANE-VU BART Approach	***MANE-VU Representative (tbd)***
	○ What's Reasonable - Outcomes of the 4-Factor Analysis on Control Measures - Analysis of CAIR vs. CAIR+ on Additional SO2 Reductions	***Chris Salmi, NJ DEP***
3:00 PM	**Comments from Stakeholders**	
3:15 PM	**Overview of MANE-VU Approach on Regional Haze** ○ Next Steps for MANE-VU ○ Action Items	***David Littell, Incoming Chair, Commissioner ME DEP***
3:45 PM	**Summary and Close** ○ Action – Approval of Minutes from 5/06 Meeting ○ Announcement of Next Chair and Vice Chair	***David Littell, ME Incoming Chair, Commissioner ME DEP***
4:15 PM	**Adjourn**	

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

- **WHEREAS** the Clean Air Act and EPA's Regional Haze Rules require all States to identify key sources of haze-causing air pollution, develop plans to reduce emissions from those sources, and submit those plans to EPA by December 2007; and

- **WHEREAS** pollutants that impair visibility also cause unhealthy levels of ozone and fine particle pollution, and both the types of emission sources and major individual emission sources that contribute to visibility impairment in mandatory Class I Federal areas also contribute to unhealthy levels of ozone and fine particle pollution in urban and suburban areas; and,

- **WHEREAS** implementing controls to improve visibility in national parks and wilderness areas that are mandatory Class I Federal areas will also improve air quality in areas that are not currently attaining the health-based standards for ozone and fine particle pollution; and,

- **WHEREAS** the Clean Air Scientific Advisory Committee (CASAC) and USEPA staff have recently reviewed the health protection adequacy of the fine particulate and ozone standards and recommended these standards be lowered to more protective levels, and that additional emission controls would be required in order to meet more stringent ambient air quality standards; and,

- **WHEREAS** all States are required to develop and submit State Implementation Plans (SIPs) to control fine particulates, ozone and Regional Haze with varying dates for attaining a health or welfare standard; and,

- Allow the regulated community to better plan for the future with greater certainty with regard to air pollution control measures and programs; and

- **WHEREAS** technical analysis conducted for MANE-VU has identified sulfur dioxide emissions from sources in twenty-three States in the eastern United States as contributing to visibility impairment in the baseline year of 2002 within the MANE-VU mandatory Class I Federal areas (see attached list); and,

- **WHEREAS** further technical analysis conducted for MANE-VU has identified sulfur dioxide emissions from stacks at key Electric Generating Units (EGUs) as the most significant source of sulfate at MANE-VU mandatory Class I Federal areas in the baseline year of 2002, and

- **WHEREAS** it is in the best interest of human health and the environment to achieve these reductions as soon as practicable and as required by the Regional Haze rule and Clean Air Act to meet the 2018 planning goal for regional haze:

THEREFORE, be it resolved, that the Commissioners of the States with mandatory Class I Federal areas within MANE-VU will implement the regional haze rule in accordance with a set of principles that set forth a path for a) achieving reasonable progress toward preventing any future, and remedying any existing, impairment of visibility in mandatory Class I Federal areas, and b) leveraging the multi-pollutant benefits that such actions may provide for enhanced public health and environmental protection; and

FURTHERMORE, that the set of principles for implementing the regional haze rule includes the following:

1. We will establish reasonable progress goals for the mandatory Class I Federal areas within our borders based upon an identification of existing sources affecting visibility, considering new, existing and planned emissions control measures, and reflecting the requisite 4-Factor Analysis conducted to determine reasonable measures that can be implemented by 2018; and these goals will achieve as much or more visibility improvement as would be achieved by the uniform rate of progress, and

2. We invite all States identified as contributing to visibility impairment (listed below)in MANE-VU mandatory Class I Federal areas to review specific proposed measures identified as reasonable according to the 4-factor analysis required by the Regional Haze Rule, and

3. We will ask all States identified as contributing to visibility impairment in MANE-VU mandatory Class I Federal areas to make timely emissions reductions consistent with measures determined to be reasonable through the consultation process; and

4. In setting our reasonable progress goals, we are assuming all measures determined to be reasonable by the Class I states are implemented in contributing states; and

5. Our reasonable progress goals will assume implementation of measures already deemed "reasonable" to meet other requirements of the Clean Air Act within the MANE-VU or Ozone Transport Commission States, and we will seek agreement from other contributing States and areas outside the OTC or MANE-VU regions to implement these measures as well; and

6. The invitation to contributing States to review the proposed reasonable measures includes an option of flexibility such that each contributing State could obtain its share of the emission reductions needed to meet the progress goals for the MANE-VU mandatory Class I Federal areas 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 mandatory Class I Federal areas as would have been achieved through implementation of the reasonable measure in the same time frame requested by the MANE-VU States with mandatory Class I Federal areas, and

7. We call upon Federal Land Managers responsible for the air quality within our national parks and wilderness areas to identify any State's Regional Haze SIP submittal that is inconsistent with the reasonable progress goals set by Class I States, and to express concerns in writing to the affected States and to EPA during the 60-day SIP review period required by the Regional Haze rule, and

8. We call upon the US EPA to act on any inconsistencies between the reasonable progress goals set by the States with mandatory Class I Federal areas and the Regional Haze SIPs of contributing States and to resolve these discrepancies prior to approving the affected States' Regional Haze SIPs and to act on incomplete SIPs in the SIP review process, and

9. We will call upon the US EPA to implement any national or regional measures deemed "reasonable" through the consultation process through new or expanded federal rules, and

10. Through the consultation process, we will seek near-term commitments to implement new or expanded reasonable measures and long-term

resolve these discrepancies prior to approving the affected States' Regional Haze SIPs and to act on incomplete SIPs in the SIP review process, and

9. We will call upon the US EPA to implement any national or regional measures deemed "reasonable" through the consultation process through new or expanded federal rules, and

10. Through the consultation process, we will seek near-term commitments to implement new or expanded reasonable measures and long-term commitments in the 10 year or beyond time frame to reduce fine particle, nitrogen oxide, volatile organic compound and sulfur dioxide emissions, and

11. We commit to submitting the 5-year progress reports required by the Regional Haze rule as a revision to the initial SIP, and we will use these reports to review the status of measures committed to in initial SIPs, to address unresolved new control programs, to determine the availability and need for new reasonable measures and to adjust the Regional Haze SIP accordingly. The Class I states will rely on adequate Federal funding to comply with this Federal requirement.

Respectfully signed and committed,

The Commissioners of the States with mandatory Class I Federal areas in MANE-VU

New Hampshire

Maine

Vermont

New Jersey

States within MANE-VU and others Contributing at least 2% of Modeled Sulfate to 2002 Concentrations at MANE-VU mandatory Class I Federal areas

Maine
New Hampshire
Vermont
Massachusetts
Rhode Island
Connecticut
New York
New Jersey
Pennsylvania
Delaware
Maryland
District of Columbia
Michigan
Illinois
Indiana
Ohio
Wisconsin
Kentucky
West Virginia
Virginia
Tennessee
North Carolina
South Carolina
Georgia

DRAFT AGENDA
MANE-VU Class I States' Consultation with VISTAS States

1) **When:** **10:00 a.m., August 20, 2007**

2) **Where:** **Georgia Environmental Protection Division Training Room**
4244 International Parkway, Suite 116, Atlanta, Georgia

10:00 am	Welcome & Introductions - Goals for Meeting	David Littell, ME DEP Chair, MANE-VU
10:15 am	Overview of July 19 Technical Conference Call and MANE-VU Consultation Briefing Book	Anna Garcia, OTC
10:30 am	Summary of Reasonable Progress Work for MANE-VU Class I Areas - Proposed request from MANE-VU Class I States for controls in the VISTAS region and from EPA - Where the MANE-VU reasonable progress goal (RPG) is in 2018	MANE-VU Class I State Representative
10:50 am	Clarifying Questions	All Participants
11:00 am	Summary of Reasonable Progress Work for VISTAS Class I Areas - Proposed request from VISTAS states for controls in the MANE-VU region - Where the VISTAS RPGs are in 2018	VISTAS Class I State Representative
11:50 am	Clarifying Questions	All Participants
12:00 pm	Working Lunch	
12:30 pm	FLM Perspectives on RPGs and Reasonable Measures Work	EPA and FLM Representatives
12:45 pm	EPA Perspectives on RPGs and Reasonable Measures Work	EPA and FLM Representatives
1:00 pm	Roundtable Discussion on Reasonable Progress Goals and Reasonable Measures	All Participants
2:30 pm	Preliminary Summary of Consultation Discussions - Areas with agreement - Areas with no agreement	
2:45 pm	Next Steps	
3:00 pm	End of Consultation	

MANE-VU Consultation Appendix

Summary of MANE-VU Class I States' Consultations

In 2007, New Hampshire provided other states in the Mid-Atlantic/Northeast Visibility Union (MANE-VU), Midwest Regional Planning Organization (MRPO) and Visibility Improvement State and Tribal Association of the Southeast (VISTAS) regions with the results of technical analyses that illustrated which states in those regions have emissions that are reasonably anticipated to contribute to impairment in one or more of New Hampshire's Class I areas, including Great Gulf Wilderness and Presidential Range - Dry River Wilderness. The New Hampshire Department of Environmental Services (NHDES) sent a letter to these contributing states, inviting them to participate in consultations with New Hampshire and the other Class I states in MANE-VU to discuss ideas on the types and amounts of emissions reductions that are reasonable and, therefore, necessary to achieve reasonable progress in improving visibility at New Hampshire's Class I areas. The consultation calls and meetings that New Hampshire engaged in with our counterparts in the MANE-VU. MWRPO, and VISTAS regions served as a platform for comparing technical work and findings, discussing any adjustments that might be appropriate, and developing mutually beneficial solutions.

Representatives from the MANE-VU states have been having discussions with the other regional planning organizations (RPOs) periodically since 2000 on technical information and analyses. The MANE-VU states established a more formal consultation process in 2007, beginning with an in-person meeting of the members in Washington, DC on March 1, 2007. At this meeting the states received information on the requirements of the regional haze rule and how to define reasonable progress in Class I areas. The states also discussed potential control options which, if determined to be reasonable, would be considered as part of the Class I states' long term strategy for making reasonable progress toward achieving natural conditions by 2064. This was followed by a second in-person consultation in Providence, RI on June 7, 2007. This second meeting comprised a review of technical analyses completed to date, discussion of a resolution outlining the principles the Class I states would be following in their consultations with contributing states, and examination of a set of statements developed by the Class I states outlining their requests for control measures to be pursued by contributing states, both in the MANE-VU region and outside of it, for the purpose of achieving reasonable progress in the MANE-VU Class I areas .

The MANE-VU Class I states made revisions to the resolution and statements as a result of the discussions that occurred at the June 7th meeting. The MANE-VU states then engaged in another consultation via conference call on June20, 2007 to review the revised documents and vote on them. All member states on the consultation call voted to accept the resolution and statements, with the exception of New York and Vermont, who were unable to participate on the call. The MANE-VU executive staff followed up with both New York and Vermont by phone and email, and received their concurrence on the documents as well. Via the statement, the MANE-VU member states agreed to a course of action that includes pursuing the adoption and implementation of the following emission management strategies, as appropriate and necessary:

- timely implementation of BART requirements; and

- a low sulfur fuel oil strategy in the inner zone States (New Jersey, New York, Delaware and Pennsylvania, or portions thereof) to reduce the sulfur content of: distillate oil to 0.05% sulfur by weight (500 ppm) by no later than 2012, of #4 residual oil to 0.25% sulfur by weight by no later than

2012, of #6 residual oil to 0.3 – 0.5% sulfur by weight by no later than 2012, and to further reduce the sulfur content of distillate oil to 15 ppm by 2016; and

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

- a 90% or greater reduction in sulfur dioxide (SO_2) emissions from each of the electric generating unit (EGU) stacks identified by MANE-VU (Attachment 1- comprising a total of 167 stacks – dated June 20, 2007) as reasonably anticipated to cause or contribute to impairment of visibility in each mandatory Class I Federal area in the MANE-VU region. If it is infeasible to achieve that level of reduction from a unit, alternative measures will be pursued in such State; and

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

In addition, the long-term strategy accepted by the MANE-VU states to reduce and prevent regional haze allows each state up to 10 years to pursue adoption and implementation of reasonable and cost-effective NOx and SO_2 controls. Through the MANE-VU states' acceptance of the emission management strategies outlined in the statements on the June 20th call, they confirmed the set of actions the MANE-VU states will pursue in their state implementation plans (SIPs) to provide reasonable progress toward improved visibility by 2018, the first milestone in meeting the long-term regional haze goals for each Class I area.

Once the statements were accepted via the internal MANE-VU consultation process, the MANE-VU states initiated their consultation process with the MRPO and VISTAS states. The MANE-VU Class I states held an Open Technical Call on July 19, 2007 to provide the other regions with a review of the technical information and analyses performed by MANE-VU that were used in determining which states were contributing to impairment in the Class I areas and to discuss the approach the MANE-VU Class I areas planned to take on consultations. The MANE-VU Class I states then held in-person meetings with the contributing states from each of the other RPOs. The MANE-VU/MRPO consultation meeting occurred on August 6, 2007 in Chicago, IL, and the MANE-VU/VISTAS consultation meeting occurred on August 20, 2007 in Atlanta, GA. MANE-VU and the MRPO held an additional conference call on September 13, 2007, and the two RPOs continue to work on initiatives that came out of the consultation discussions through the MANE-VU/MRPO State Collaborative process. MANE-VU anticipates that some of the VISTAS states that participated in the consultations will also join in these collaborative initiatives in the near future.

The MANE-VU Air Directors also held additional intra-MANE-VU consultation discussions on issues concerning the emission management strategies outlined in the statements on three subsequent conference calls. During the September 26, 2007 call, participants discussed how to interpret the emission management strategies in the statements for purposes of estimating visibility impacts via air quality modeling. On February 28, 2008 the MANE-VU states received the results of the final 2018 modeling runs. Finally, on the March 21, 2008 call the states discussed the process for establishing reasonable progress goals for the MANE-VU Class I areas.

Summaries of the individual meetings and calls referenced above follow, with the intra-MANE-VU consultation documentation first, then the MRPO consultation documents and finally the VISTAS consultation summaries. Copies of the final MANE-VU Class I states' resolution and statements appear at the end of this appendix.

Listing of consultation summary documentation:

1. Intra-MANE-VU Consultation Meeting Summary, March, 1, 2007, Washington, DC
2. Intra-MANE-VU Consultation Meeting Summary, June 7, 2007, Washington, DC
3. Intra-MANE-VU Consultation Conference Call Summary, June20, 2007
4. Intra-MANE-VU Consultation Conference Call Summary, MANE-VU Air Directors, March 31, 2008
5. MANE-VU Class I States' Consultation Open Technical Call Summary, July 19, 2007
6. MANE-VU/MRPO Consultation Meeting Summary, August 6, 2007, Chicago, IL
7. MANE-VU/MRPO call
8. MANE-VU/VISTAS Consultation Meeting Summary, August 20, 2007, Atlanta, GA
9. 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, adopted June 20, 2007
10. Statement 1: Statement of the Mid-Atlantic/Northeast Visibility Union (MANE-VU) Concerning a Course of Action Within MANE-VU Toward Assuring Reasonable Progress, adopted June 20, 2007
11. Statement 2: Statement of the Mid-Atlantic/Northeast Visibility Union (MANE-VU) Concerning a Request for a Course of Action by States Outside of MANE-VU Toward Assuring Reasonable Progress, adopted June 20, 2007
12. Statement 3: Statement of the Mid-Atlantic/Northeast Visibility Union (MANE-VU) Concerning a Request for a Course of Action by the U.S. Environmental Protection Agency (EPA) Toward Assuring Reasonable Progress, adopted June 20, 2007
13. Attachment to Statements 1 and 2: List of 167 EGU stacks, dated June 20, 2007

Intra-MANE-VU Consultation Meeting Summary
March 1, 2007
Washington DC

Introduction

The Mid-Atlantic/Northeast Visibility Union (MANE-VU) held an in-person consultation meeting of the region's states on March 1, 2007 in Washington DC. The purpose of the consultation meeting was to fulfill the requirements of 40 CFR 51.308(d)(1)(B)(iv) and (3)(i) for Class I states to consult with contributing states on developing reasonable progress goals for the region's seven mandatory federal Class I areas, and for all contributing states to consult on the development of coordinated emission management strategies. All MANE-VU states were invited to participate along with the region's Federal Land Managers (FLMs) from the National Park Service, Fish & Wildlife Service, and Forest Service, and the Environmental Protection Agency (EPA) regional representatives from Regions I, II, and III.

Topics discussed included:

1) An overview of the regional haze program's goals and requirements;

2) A review of the uniform progress glidepaths and anticipated status of visibility impairment in 2018 in the seven MANE-VU mandatory federal Class I areas; and

3) A review of an analysis based on the Clean Air Act's statutory factors of what controls may be considered reasonable; and

4) Discussions of reasonable control options by source sector.

Key Outcomes of the Consultation

- As an overriding principle, MANE-VU looks for equivalent reductions, not equal reductions across source categories.
- A low-sulfur fuel oil strategy is viable as a MANE-VU 2018 control measure, at a 500 ppm sulfur limit in the near-term, and a 15 ppm goal for distillate in 2018.
- Sulfur limits on #4 and #6 fuel oil require more analysis, and oil-fired EGUs with scrubbers will need flexibility.
- The ICI boiler sector needs further analysis as to what controls may be reasonable, especially from small and medium-sized boilers.
- If it is reasonable for MANE-VU to achieve a 40% sulfur reduction in the non-EGU sector, it may also be reasonable that contributing states in other RPOs could find equivalent reasonable reductions.
- There was no real consensus on controls on residential wood / open burning as a regional strategy, as what can be achieved in these sectors varies widely from state to state.
- MANE-VU Class I states will conduct a series of separate phone calls to develop a proposal for moving forward on consultations and developing reasonable control options.
- The MANE-VU states agreed to keep working towards implementing reasonable regional controls, which would be discussed at the next MANE-VU consultation meeting in June 2007.

Attendees

States and Tribes:
Maine (Class I state) – David Littell, Jeff Crawford
New Hampshire (Class I state) – Jeff Underhill
New Jersey (Class I state) – Lisa Jackson, Nancy Wittenberg, Chris Salmi
Vermont (Class I state) – Justin Johnson, Dick Valentinetti, Paul Wishinski
Connecticut – Anne Gobin
Delaware – Ali Mirzakhalili
District of Columbia – Deidre Elvis-Peterson, Abraham Hagos
Maryland – Tad Aburn
Massachusetts – Arleen O'Donnell, Barbara Kwetz
Pennsylvania – Tom Fidler, Joyce Epps, Wick Havens
New York – Dave Shaw, Rob Sliwinski

Federal Land Management Agencies and EPA Regional Offices:
National Park Service – Bruce Polkowsky, John Bunyak
Forest Service – Anne Mebane, Anne Acheson, Andrea Stacey
Fish and Wildlife Service – Sandra Silva, Tim Allen
EPA Region I – Anne Arnold
EPA Region III – Makeba Morris, Neil Bigioni

Welcome and Introductory Remarks

David Littell, MANE-VU Vice-Chair and Commissioner of Maine's Department of Environmental Protection, opened the consultation with a welcome and introductions around the room. Mr. Littell followed with a presentation entitled "Bringing Clear Views to Acadia National Park and Other Class I Areas." Acadia National Park is one of three mandatory Class I areas in Maine while New Hampshire has two, and Vermont and New Jersey each have one. Mr. Littell noted that annual visitation at Acadia is over 2 million visits a year leading to visitor spending of more than $127 million in 2005, and surveys indicate that a clear vista is a strong factor in a visitor's positive experience at the park.

Mr. Littell then provided an overview of the goals for today's consultation, including:

- Review requirements, resources and critical timing issues to ensure all share a common understanding;
- Discuss options for control measures to identify what is reasonable in MANE-VU;
- Identify impediments to implementing control measures and discuss how to address them;
- Identify links between haze, PM, and ozone strategies that help define what's reasonable;
- Define reasonable progress for MANE-VU Class I Areas in terms of control measure options; and
- Summarize points of agreement and identify issues for follow-up consultation.

Overview of MANE-VU Consultation

Anna Garcia, MANE-VU Deputy Director, followed with a presentation entitled "Timing, Contribution, and Consultation." Noting that multiple methods show consistent conclusions about which states are top contributors and that a single MANE-VU consulting group offers the best opportunity to engage contributing states in a meaningful consultation process, Ms. Garcia emphasized that the MANE-VU states need to make sure we know what we are asking of the states within MANE-VU before consulting with contributing states outside of MANE-VU. Today's consultation is the first formal intra-MANE-VU consultation being held to develop MANE-VU's "clean hands" position and to start the process of determining reasonable control measures by MANE-VU states for the December 2007 Regional Haze State Implementation Plan (SIP) submissions.

MANE-VU Regional Haze Goals

Paul Wishinski from Vermont's Department of Environmental Conservation followed with a presentation entitled "Overview of Program Requirements for the Regional Haze Rule." Under the regional haze regulations, both the reasonable progress goals to be set by the Class I states and the long-term coordinated emissions strategies to meet the reasonable progress goals require consultations with contributing states and the Federal Land Managers (FLMs). Mr. Wishinski concluded, as did Ms. Garcia before, that the key next step is for the MANE-VU states to agree on what they believe are reasonable control measures for visibility improvement at the MANE-VU Class I areas.

Jeff Underhill from New Hampshire's Department of Environmental Services followed with a presentation entitled "Status of Visibility at MANE-VU Class I sites and Modeling for the Regional Haze Rule." Based on modeling results, Mr. Underhill concludes that all of MANE-VU's seven mandatory Class I areas will likely be below the uniform progress line in 2018 with "on-the-books" controls plus 500 ppm maximum sulfur limit for #2 distillate, except in Delaware and Vermont. However, more progress can be made through additional reasonable measures, and the Regional Haze Rule requires us to consider these measures via the consultation process with contributing states.

Developing Reasonable Progress for MANE-VU Class I Areas

Art Werner of MACTEC Federal Programs, Inc., MANE-VU's contractor for the four-factor reasonable progress project, followed with a presentation on the preliminary results of that project. Mr. Werner reviewed the four factors that need to be analyzed to determine which emission control measures are needed to make reasonable progress in improving visibility: 1) the costs of compliance, 2) the time necessary for compliance, 3) energy and non-air quality environmental impacts of compliance, and 4) the remaining useful life of any source subject to such requirements. Mr. Werner also presented a preliminary marginal cost figure of $1,390/ton (1999$) of SO2 in 2018 from a recent MANE-VU-sponsored IPM run for a "CAIR Plus" policy. The final report due in May will provide a methodology for addressing reasonable progress and inform the MANE-VU states on control measure costs for both priority source categories and selected individual sources for upcoming consultations on setting the reasonable progress goals for the MANE-VU mandatory Class I areas.

Assessing Control Options

The final presentation by Chris Salmi with New Jersey's Department of Environmental Protection entitled "Reasonable Measure Opportunities" emphasized that the MANE-VU Class I states intend to focus their reduction efforts for the 2018 milestone on sulfur dioxide reductions since they cause, on average, nearly 80% of the visibility impairment on the 20% worst days. Mr. Salmi presented recent control measure analyses showing that MANE-VU sources can reasonably achieve over 200,000 tons of

SO2 reductions in 2018 from non-EGU control measures, primarily from ICI coal and oil-fired sources, a low-sulfur distillate strategy, and controls on Best Available Retrofit Technology (BART) sources. Mr. Salmi concluded his presentation by posing two questions for the members:

1) What measures does MANE-VU consider reasonable for 2018?, and
2) What measures do we ask others to implement?

The questions began a roundtable discussion initiated by Ms. Garcia's intentionally broad question to the members asking what is reasonable.

Summary of Discussion

NESCAUM suggested, and New Hampshire agreed that as an overriding principle what MANE-VU is looking for is equivalent reductions, not equal reductions across source categories. The discussion segued to what MANE-VU can reasonably accomplish for a low-sulfur fuel oil strategy. The members agreed that this is a prime example of a source category where MANE-VU can make reasonable reductions due the widespread use of distillate for residential and commercial heating. Other states primarily outside of MANE-VU do not have a similar reliance on fuel oil for heating, so they could make equivalent reasonable reductions from other source categories to match MANE-VU's heating oil sulfur reductions.

Further discussion continued with respect to two potentially reasonable fuel-oil strategies for the MANE-VU region, dubbed S1 and S2:

- S1 is less stringent and envisions a 75% reduction in sulfur content to 500 ppm by 2018 for home heating / distillate, and 50% reductions in sulfur content for #4 and #6 fuel oils.
- S2 envisions a 99.25% reduction in sulfur content to 15 ppm by 2018 for home heating / distillate, and the same 50% reductions for #4 and #6 as in S1.

New Hampshire suggested the need to move carefully due to the concerns about price and supply issues. Vermont countered that there is a 10-year timeframe to accomplish a low-sulfur fuel oil strategy. Pennsylvania suggested that a 500 ppm strategy is reasonable, but timing is important. Vermont added that the Northeast states have been discussing low-sulfur fuel oil strategies for ten years already, and that two or three states such as New York, New Jersey, and Connecticut need to go first and pass regulations to catalyze regional negotiations with industry. New Jersey noted that New Jersey has started their rulemaking process on low-sulfur fuel oil; New York added that New York has started their rulemaking process for 500 ppm for distillate by 2018. Connecticut said that Connecticut's fuel standards are set by statute, and the statute precludes Connecticut from lowering its fuel-oil standards until neighboring states Massachusetts and Rhode Island do so as well, presumably for regional supply reasons.

Continuing the low-sulfur fuel oil discussion, Pennsylvania asked if EPA has been approached on a national low-sulfur fuel oil strategy. New Jersey replied that EPA is not focusing on this area, leaving it to the states. NESCAUM added that the industry believes that part of the deal with EPA for accomplishing the 15 ppm on-road ultra low-sulfur diesel (ULSD) standard is that there will be no more sulfur reductions expected. MANE-VU noted that in recent discussions, the industry suggested it was possible to achieve a 15 ppm sulfur level for distillate within a 2014 timeframe. Massachusetts said that it may be difficult for Massachusetts to commit to a 15 ppm sulfur level in distillate by 2018, noting, however, that the positive co-benefits of greater furnace efficiency and therefore lower GHG emissions might help in instituting a 15 ppm sulfur level in distillate regulation. New Jersey emphasized that we have a decade to accomplish a 15 ppm sulfur standard for distillate.

MANE-VU asked the group about what might work in terms of lower sulfur limits in #4 and #6 fuel oils. Pennsylvania said that Pennsylvania has various sulfur limits and they would need more time to analyze such limits. New Jersey noted that these low-sulfur fuels are already available as some New Jersey counties are already below 5000 ppm sulfur. Maine questioned what limits on #6 fuel oil would mean for those oil-fired EGUs that have scrubbers.

MANE-VU wrapped up the low-sulfur fuel-oil discussion asking the group if the S1 strategy was viable as a MANE-VU 2018 region haze control measure. The consensus was that a 500 ppm sulfur limit "near-term" and a 15 ppm "goal" for distillate in 2018 is viable. For #4 / #6 sulfur limits, the consensus was that more work needs to be done, and that flexibility should be provided to states that have scrubbers on their oil-fired EGUs.

The consultation moved on to sulfur reductions from the coal-fired ICI (Industrial, Institutional, and Commercial) sector and whether MANE-VU can include such reductions in a non-EGU strategy bundle at this time. Pennsylvania suggested that controls for small-to-medium size boilers (<100 MM Btu / hour heat input) may not be cost-effective, adding that a 50% reduction in sulfur emissions from coal-fired ICI sources may overestimate what can realistically be achieved. New Hampshire suggested that recent analysis by New Hampshire staff on installation costs should be considered. Maine added that this sector may be a viable source for other RPO states to achieve reasonable sulfur reductions from their non-EGU sectors that are equivalent to the 40% sulfur reductions expected from non-EGU sources within MANE-VU due to the low-sulfur fuel oil strategy.

The consensus concerning sulfur reductions from the coal-fired ICI sector was that there is a need for more analysis to determine what is reasonable to obtain sulfur reductions from small and medium-sized coal-fired boilers. There was also consensus that if MANE-VU achieves overall reasonable sulfur reductions in the 40% range from the non-EGU sector, then other RPOs could find equivalent reasonable reductions.

Discussions moved on to other potential regional haze control measures within MANE-VU. For lime and cement kilns, both Pennsylvania and New York agreed that there is wide variability in these sources. Pennsylvania suggested that lime kiln controls are not cost-effective, and that an EPA global settlement on cement kilns was coming soon anyway. New York added that they will be regulating its three cement kilns as BART sources.

For the residential wood combustion / open burning source category, there was general consensus on including outdoor wood boilers in this category. New Jersey encouraged greater use wood stove changeout programs. New Hampshire replied that what can be done on wood combustion varies from state to state, and, for example, in New Hampshire new wood stove standards would be acceptable, but not changeout programs. New York added that open burning bans are unenforceable, especially in rural areas. There was little consensus on control measures in this source category, considering that the primary pollutants of concern are organic carbon and direct particulate matter, and not sulfur which is the primary regional haze pollutant within MANE-VU for the first planning milestone in 2018.

The Intra-MANE-VU Consultation Meeting adjourned.

Intra-MANE-VU Consultation Meeting Summary
June 7, 2007
Providence, Rhode Island

Introduction

The Mid-Atlantic/Northeast Visibility Union (MANE-VU) held an in-person consultation meeting of the region's states on June 7, 2007 in Washington DC. The purpose of the consultation meeting was to fulfill the requirements of 40 CFR 51.308(d)(1)(B)(iv) and (3)(i) for Class I states to consult with contributing states on developing reasonable progress goals for the region's seven mandatory federal Class I areas, and for all contributing states to consult on the development of coordinated emission management strategies. All MANE-VU states were invited to participate along with the region's Federal Land Managers (FLMs) from the National Park Service, Fish & Wildlife Service, and Forest Service, and the Environmental Protection Agency (EPA) regional representatives from Regions I, II, and III.

Topics discussed included: 1) the process for setting reasonable progress goals by the MANE-VU Class I states; 2) an approach for intra-MANE-VU consultation including control strategy development within MANE-VU for setting the reasonable progress goals; 3) an approach for consulting with states outside of MANE-VU on the reasonable progress goals to be established by the MANE-VU Class I states; and 4) the next steps in the consultation process.

Key Outcomes of the Consultation

- All of the MANE-VU states agreed that a resolution setting out the principles by which the Class I states will implement the regional haze rule should go the MANE-VU Board for approval, although the document was to be signed only by the MANE-VU Class I states.

- Two separate draft statements on courses of action by states within and outside MANE-VU for assuring progress towards the MANE-VU Class I States' reasonable progress goals were tabled until a corrected list of 167 EGU stacks impacting visibility in the MANE-VU Class I areas could be generated. The MANE-VU states agreed that they would vote by conference call once the corrected 167 EGU stack list became available.

Attendees

States:
Maine (Class 1 state) – David Littell
New Hampshire (Class 1 state) – Bob Scott, Jeff Underhill
Vermont (Class 1 state) – Justin Johnson, Dick Valentinetti
New Jersey (Class 1 state) – Lisa Jackson, Nancy Wittenberg, Chris Salmi
Connecticut – Dave Wackter
Delaware – Ali Mirzakalili
District of Columbia – Cecily Beall
Massachusetts – Arleen O'Donnell, Barbara Kwetz
Maryland – Tad Aburn
New York – Dave Shaw
Pennsylvania – Tom Fidler, Joyce Epps, Wick Havens
Rhode Island – Michael Sullivan, Steve Majkut

Federal Land Management Agencies and EPA Regional Offices:
National Park Service – Bruce Polkowsky (in person), Holly Salazar (on phone)
Fish & Wildlife Service – Tim Allen (on phone)
Forest Service – Ann Mebane, Ann Acheson (on phone)
EPA Region III (on phone)

Welcome and Introductions

David Littell, MANE-VU Vice-Chair and Commissioner of Maine's Department of Environmental Protection, opened the consultation with a welcome and introductions around the room, including those on the phone. Anna Garcia, MANE-VU Deputy Director, followed with a brief outline of the goals for the consultation, including an update on recent technical work and discussions of the proposed MANE-VU Class I states resolution on consultation principles, a proposed statement on control measures within the MANE-VU region for achieving reasonable progress goals, and a proposed statement on controls outside of the MANE-VU region for achieving reasonable progress goals.

Status of Technical and Policy Work Issues

Gary Kleiman, NESCAUM, led this session with an update of the recent technical work, including preliminary modeling results. All seven of the MANE-VU Class I areas will be below the uniform rate of progress in 2018 according to preliminary modeling results. Tad Aburn, Maryland, asked the Federal land Managers (FLMs) if the MANE-VU technical approach is satisfactory. Bruce Polkowsky, National Park Service, replied that the other eastern RPOs are doing similar work and achieving better than uniform progress but have different approaches to reasonable progress. Tim Allen, Fish and Wildlife Service, commented that MANE-VU is not taking as much of a chemistry-intensive approach as other RPOs, and MANE-VU will likely need to address nitrates and organics in the next regional haze planning phase after 2018. Mr. Allen added that he is very supportive of obtaining as many reductions as possible now as they will only be more difficult to obtain later.

Chris Salmi, New Jersey Department of Environmental Protection, followed with a presentation on MANE-VU's approach to fulfilling the regional haze rule's reasonable progress requirement. The statutory four-factor analysis for control strategies for visibility-impairing source sectors provides the central focus for the Class I states' determination of what is reasonable. Finally, Anna Garcia ended the session with a brief presentation on the process by which MANE-VU chose the regional source sectors that were included in the four-factor analysis.

Roundtable Discussions

The MANE-VU states began their consultation with a roundtable discussion of the draft resolution by the MANE-VU Class I states on principles for implementing the regional haze rule, including the requirement for consulting with contributing states on reasonable progress. After minor wording changes, the states then agreed to seek Board approval although the resolution would be signed only by the MANE-VU Class I states.

Roundtable discussions ensued on the two proposed statements, one on control strategies within the MANE-VU states for assuring reasonable progress, and the other for states outside MANE-VU. When it became clear that more work needed to be done so all states were comfortable with the final list of 167

EGU stacks having the greatest visibility impact on the MANE-VU Class I areas, the states agreed to postpone voting on the statements until a later date by conference call.

A final discussion on a draft statement on requesting further action by the U.S. Environmental Protection Agency (EPA) on tightening the CAIR program for assuring reasonable progress also occurred. The states also agreed to table a vote on this statement until a conference call.

Consultation Next Steps

A brief discussion on next consultation steps, especially with the Regional Planning Organizations outside of MANE-VU also occurred. Those steps include:

- Consulting within and outside MANE-VU about which control strategies are reasonable;
- Deciding how to include the strategies in the final statements in modeling;
- Determining goals based on final modeling;
- Pursuing the adoption of enforceable emissions limits & compliance schedules; and
- Evaluating progress in 5 years.

Intra- MANE-VU Consultation Conference Call Summary
June 20, 2007

Introduction

On June 20, 2007 the MANE-VU Commissioners and Air Directors participated on a conference call to continue consultation discussions on emission management strategies for the region to pursue to achieve reasonable progress toward natural conditions in the region's Class I areas. The MANE-VU state Members completed their review of a resolution and three statements proposed by the Class I states to the larger MANE-VU membership, and voted to accept these documents and confirm the set of actions the MANE-VU states will pursue in their state implementation plans (SIPs) to provide reasonable progress toward improved visibility b 2018, the first milestone in meeting the Class I areas' long-term regional haze goals.

Attendees

States, Tribes and MSOs:
Maine (Class 1 state) – David Littell, Jeff Crawford
New Hampshire (Class 1 state) – Jeff Underhill, Andy Bodnarik
New Jersey (Class 1 state) – Chris Salmi
Connecticut – Anne Gobin
Delaware – Ali Mirzakalili
District of Columbia – Cecily Beall
Massachusetts – Barbara Kwetz
Maryland – Tad Aburn, Andy Hiltebridle
New York – Dave Shaw
Pennsylvania – Tom Fidler, Joyce Epps, Wick Havens
Penobscot Tribe – John Banks, Bill Thompson
Rhode Island – Steve Majkut
NESCAUM – Arthur Marin, Gary Kleiman

Consultation Discussions

The MANE-VU states voted on and passed three statements, which are attached to this summary, with some minor changes. The three statements are entitled as follows:

1. Statement of the Mid-Atlantic/Northeast Visibility Union (MANE-VU) Concerning a Course of Action Within MANE-VU Toward Assuring Reasonable Progress;

2. Statement of the mid-Atlantic/Northeast Visibility Union (MANE-VU) Concerning a Request for a Course of Action by States Outside of MANE-VU Toward Assuring Reasonable Progress; and

3. Statement of the Mid-Atlantic / Northeast Visibility Union (MANE-VU) Concerning a Request for a Course of Action by the U.S. Environmental Protection Agency (EPA) Toward Assuring Reasonable Progress.

The final versions of the statements which were accepted via the vote reflect the following changes:

- agreement on the list of EGU stacks, which is attached to both Statement 1 and 2, and revising the table to remove columns listing plant type, SO2 tons per year and rank, and changing the bottom notes accordingly (see explanation below);
- removal of the phrase "top 100" from the 4th action bullet on Statement 1 and the 2nd action bullet on Statement 2 (regarding 90% reduction from EGUs);
- correction of the date for 500 ppm low sulfur fuel oil to "by no later than 2012" (I made the error of changing that date to "2014" in translating the Consultation comments - it should be 2012 as for the other inner zone fuel requirements);
- revision of the last paragraph in Statement 3 to delete "beyond 2018 CAIR levels" and replace it with "by no later than 2018"; and
- a change in the signature line on all three statements to "Adopted by the MANE-VU States and Tribes on (date)."

In addition, the members agreed to keep the columns that were deleted from the abbreviated "167 stacks" table as part of the larger spreadsheet of the 167 stacks that MARAMA produced and t make that document part of a technical support document to Statements 1 and 2. The columns were deleted to keep the table simple and to reduce confusion about tons per year information used in the modeling vs. tons per year information in the Acid Rain Database, in which there are some differences. Attachment 1 to the Statements refers to the 2002 tons per year information from the MANE-VU Contribution Assessment at the bottom of the table.

The MANE-VU states also confirmed that, if it is infeasible for the oil/gas units that are in New Hampshire and Maine to meet the 90% reduction for EGUs, meeting the low sulfur fuel oil requirements would be sufficient. In addition, the MANE-VU states will also credit early state actions (within a few years prior to 2002) toward the 90% target of reducing emissions from EGUs on the "167 stack" list.

The group also decided that the technical support document for the statements and the consultation summaries would be circulated to the MANE-VU states for their review and comment, and to get any further corrections to the more comprehensive table of 167 stacks (some states had changes to the plant types on the list).

Voting on the Statements

At the end of the call the states voted on whether they would accept each of the statement. For Statement 1, New Jersey moved that the statement be put up for a vote and Pennsylvania seconded the motion. All MANE-VU states on the call voted to accept Statement 1. On Statement 2, the Penobscot Tribe moved that it be considered for a vote and Massachusetts seconded the motion. Once again, all MANE-VU states on the call voted to accept Statement 2. Finally, for Statement 3, the Penobscot Tribe moved that it be considered for a vote and New Jersey seconded the motion. All MANE-VU states on the call voted to accept Statement 3.

New York and Vermont were unable to participate on the consultation conference call, so to ensure that all the MANE-VU member states are in agreement on these actions, the MANE-VU executive staff proposed to contact each state individual by phone and email to get their response to the vote on the statements. Within one day of the consultation conference call, the MANE-VU executive staff briefed New York and Vermont by phone and email and received their confirmation that they accepted all three statements as revised on the call.

March 31, 2008
MANE-VU Air Directors

States:
Maine (Class I state) – Jeff Crawford
New Hampshire (Class I state) – Jeff Underhill, Andy Bodnarik
New Jersey (Class I state) – Chris Salmi, Stella Oluwasuen-Apo, Peg Gardner
Connecticut – Dave Wackter
Delaware – Jack Sipple
District of Columbia – Cecily Beall
Maryland – Roger Thunell, Brian Hug
Massachusetts – Glenn Keith
New York – Gopal Sistla, Rob Sliwinski
Pennsylvania – Joyce Epps

Representatives of MANE-VU member states met via conference call on March 31, 2008.

During the call, NESCAUM modeling assumptions and results were reviewed, and the three Class I states present (Maine, New Hampshire, and New Jersey) confirmed that they would be relying on the results of that modeling to set their reasonable progress targets. The targets based on the modeling were included in the MANE-VU SIP Template draft that is posted on the MARAMA web site and will be sent to EPA for review. (Note: sent on 4/2/08)

Ms. Garcia agreed to share the results of the MANE-VU modeling with Virginia and West Virginia before the Stakeholder meeting on Friday, April 4.

Maine, New Hampshire, Vermont, and Massachusetts had met with oil companies and distributors concerning the MANE-VU low sulfur oil strategy. Stakeholders had expressed some concern about the 0.5% limit for residual oil, but states wanted to gather more information before deciding whether to make any changes in the MANE-VU strategy.

Participating states reviewed choices concerning the Long Term Strategy section of the SIP Template, and it was agreed that a document describing those choices would be revised and discussed further with EPA and FLM agency representatives. Individual MANE-VU states might make different choices with respect to language in their SIPs, and some gave indications of their preferences.

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

Introduction & Purpose of Call (A. Garcia, MANE-VU)

Anna Garcia opened the call at 10 am (EDT) with a welcome and roll call by all 3 RPOs (see attached list of participants). She then reviewed the purpose of today's call, including:

After asking for general questions about the agenda and call purpose, the MANE- VU representatives began the substance of the call with an overview of the technical work to be discussed as organized in the MANE-VU briefing books provided for the call.

MANE-VU Contribution Assessment (G. Kleiman, NESCAUM)

Gary Kleiman provided a brief summary of the contribution assessment work that MANE-VU conducted to help them determine which states the Class I states would request be involved in consultation (see Tabs 4 & 5 of briefing book).

Discussion:

- M. Koerber (MRPO): Requested documentation of 2018 projections – MANE-VU work seems consistent with MRPO analyses. Also, it looks as if the Northeast states will be below the glide path for uniform progress by 2018.
- G. Kleiman (NESCAUM): There seems to be pretty good consistency across all the RPOs in terms of their modeling work. Also, VISTAS new emission inventory with GA reductions is not in the MANE-VU modeling. It also includes MANE-VU's 500 ppm low sulfur fuel strategy, but not the 15 ppm level.
- R. Papalski (NJ): So the modeling does take into account 500 ppm sulfur fuel oil?
- G. Kleiman (NESCAUM): Yes, and that is significant (not including VT or DE).
- M. Koerber (MRPO): I notice that in 2018 organic carbon is more significant, and may be as significant as sulfate. This issue is very complex, especially in urban areas. Where is MANE-VU's organic carbon coming from? MRPO will be interested in what our control measures analysis says for organic carbon.
- G. Kleiman (NESCAUM): There is some uncertainty with regard to what the modeling is indicating about organic carbon in 2018 – that is why MANE-VU is focusing on sulfate now.
- P. Wishinski (VT): Sulfate dominates extinction. Organic carbon does not contribute as much to extinction as sulfate in the MANE-VU region.
- P. Brewer (VISTAS): After discussion with Gary at MARAMA Science Meeting, our approach was more understandable.
- B. Lopez (WI): This work was based on IPM 2.1.9 – what is expected if put in context of EPA's IPM 3.0 runs?
- S. Wierman (MARAMA): IPM 3.0 results were not available at the time this analysis was done, so we used 2.1.9 with updated gas curves.
- L. Nixon (NH): On state by state basis sulfur levels from EPA 3.0 model runs. Liz, took a quick look at 3.0 and same SO_4 increases that look problematical.

MANE-VU Reasonable Progress Project Summary (S. Wierman, MARAMA)

Susan Wierman provided a brief summary of the reasonable progress work that MANE-VU conducted to help them develop long-term strategies and control measures for the 2018 state implementation plans(see Tab 7 – A, B and C - of briefing book).

Discussion:

- J. Hornback (SESARM): Are costs in 1999 dollars? If so, how do they compare in current dollars?
- S. Wierman (MARAMA): Yes, these are reflected in 1999 dollars. If converted to 2006 dollars the cost figures would be higher – multiply 1999 by 1.186 to go from 1999 $ to 2006 $.
- D. MacLeod (VA): Regarding the MANE-VU statement, how would disagreements between a Class I State and a non MANE-VU state be handled in the SIP?
- Garcia (MANE-VU): The statements that MANE-VU issued are the request for the kinds of measures that our Class I states believe are needed based on the technical work we have done. In the consultations these requests are a starting point for discussion, and provide a basis for looking at the work the other RPOs have done in comparison to our work to determine what may be needed and is reasonable. According to the rule, the consultations are not expected to result in agreement on everything, but the areas of agreement and disagreement that occur via consultation are to be documented in the SIP.
- J. Johnson (GA): Regarding EGUs, is there a relationship between what is on pages 68-78 and CAIR+? And does MANE-VU have any idea of what level of reductions would result from CAIR+?
- S. Wierman (MARAMA): We have not done an analysis of CAIR+ and its impact on visibility. Impact on visibility is not one of the 4 factors and so is not applicable.
- M. Koerber (MRPO): Isn't there a 5^{th} factor in guidance - $/deciview?
- S.Wierman (MARAMA) – EPA expects that we will look at visibility improvement, but still not a factor regarding reasonableness. MANE-VU is planning on looking at visibility improvement of the control measures we initially looked at as reasonable.
- S. Holman (NC): Modeling on visibility – are you doing CMAQ modeling for 2018? Or CALPUFF?
- G. Kleiman (NESCAUM): We are doing a CMAQ sensitivity run –not a full annual run, but for select periods, with tagging mechanism for different control measures.
- S. Holman (NC): In NC, 11 of 12 EGUs will have scrubbers - need to reflect units that have scrubbers on in VISTAS base G.

MANE-VU Long-Term Strategy/Statements

As discussions proceeded after the reasonable progress overview, participants began to ask questions about the MANE-VU resolution and statements (see Tab 3 of briefing book). These documents outline how MANE-VU is approaching the consultation process and a request that states pursue strategies in various sectors that MANE-VU believes are needed for its Class I areas, as a starting point for consultation discussions.

Discussion:

- F. Durham (WV): Regarding the low sulfur fuel strategy, will regulatory impact analyses for this measure be done on state or regional basis?
- G.Kleiman (NESCAUM), S.Wierman (MARAMA) & Ray Papalski (NJ): That will be done on state basis, but with coordination across the MANE-VU states. NJ will be doing an analysis, but there is also a federal role in terms of any national rulemakings that may happen on low sulfur fuel.

- J. Johnston (GA): What is the basis for saying that the low sulfur fuel strategy is reasonable for States outside MANE-VU?
- G. Kleiman (NESCAUM), S. Wierman (MARAMA), A.Garcia (MANE-VU): Actually the Class I states are looking for equivalent reductions to what they are doing in the low sulfur fuel strategy – not necessarily expecting that MRPO and VISTAS states will pursue a low sulfur fuel strategy. We are asking you to look at what is reasonable in terms of making equivalent reductions, which is the point of having the consultations. We know the MRPO and VISTAS states are looking at reasonable measures for your own Class I areas. During the consultation we anticipate comparing what you are looking at as reasonable with what we are requesting as a starting point for what is "potentially" reasonable.
- J. Johnston (GA): Is there flexibility to get more reductions from EGUs and fewer reductions from non-EGUs? What if, for example, we get more sulfate reductions from EGU sources equivalent to the amount of non-EGU MANE-VU reductions?
- P.Wishinski (VT), A. Garcia (MANE-VU): VT would support that kind of alternative. MANE-VU does envision that flexibility in our consultation discussions.
- M. Koerber (MRPO): An issue they have been looking at is actually setting a reasonable progress goal - what is MANE-VU's process for that?
- G. Kleiman (NESCAUM), A. Garcia (MANE-VU): A deciview number will come out of our CMAQ sensitivity runs, and agreed-to reductions after consultations, with full CMAC run. There may still be some overlap between what may and may not be agreed to and what the Class I states want to include as reasonable in CMAQ final run.
- M. Koerber (MRPO): There are very different EGU predictions between IPM 2.1.9, IPM 3.0, and what his states say will actually happen. Will it be possible to have further discussions after August 6th and August 20th consultations to refine and sync up EGU reductions and possible modeling run inputs?
- G. Kleiman (NESCAUM), A. Garcia (MANE-VU): It would be helpful for MRPO and VISTAS to share with us their information on their EGU inventory, so we can make sure our modeling for reasonable progress reflects their work and so that our states can understand what they will be doing. The in-person meetings are not the end of the consultation process. Our states are interested in having a continued dialogue, beyond the August in-person meetings.
- M. Koerber (MRPO): On page 61, is WI in or out? (in VT letter due to its CALPUFF runs)
- P. Wishinski (VT): VT CALPUFF modeling indicated that WI contributed >2% of emissions, so VT wants to include WI in consultation process, even though there are no WI EGUs on 167 list
- L. Bruss (WI): Please give him or Kevin Kessler a call (608) 266-0603
- D. Valentinetti (VT): We agree with Mike that this is an ongoing process for best science
- D. Andrews (KY): The two EGU modeling runs in the table of 167 stacks do not show much correlation – why?
- S. Wierman (MARAMA): Because the modeling for each of the different runs is based on different days, there were different meteorological inputs to each model and variability in wind fields (shows importance of meteorology).

MWRPO Overview (M. Koerber, LADCO)

- The MRPO states have moved ahead with some of their own state rules (consumer products, AIM, etc.). They also have PM SIPS to do.
- We updated our modeling to use 2005 as base year and made changes to IPM 3.0 based on what we know will actually happen – will be quite a bit different from 2.1.9 (not ready by Aug. 6th)
- Would hope modeling would form basis for a collaborative on future control strategies

- MRPO internal consultation process for the Northern Class I states has been ongoing for over a year – completed a great deal of technical work.
- Their reasonable progress project by EC/R is finished. It looked at the four factors, plus visibility improvement. Examined similar strategies as those that MACTEC did for MARAMA analysis. Now completing report - will send out later.
- Requirement to address regional haze Class I areas in state and outside state. Have done more work on who is contributing. Will provide MRPO states with a list of who they impact.

Discussion:

- A. Garcia (MANE-VU): Will MRPO states be looking for any national measures?
- M. Koerber (MRPO): Our Class I areas are still above the glidepath, so may need some regional/national reductions. We are looking at that – may have something as develop, but will not have it by Aug. 6th. Note that MANE-VU sites are at uniform progress with control measures but MRPO states are above uniform line.
- D. Littell (ME): How much of the contribution at their Class I sites is coming from Canada?
- M. Koerber (MRPO): On the 20% worst days, the contributions are mainly from the south.
- A. Garcia (MANE-VU): Would it be possible to include Canada (primarily Ontario) at the August 6th consultation? They have expressed an interest, and our northern Class I states would like to invite them to hear our discussions.
- M. Koerber (MRPO): That would be ok.

VISTAS Overview (Pat Brewer, VISTAS)

- In VISTAS we the focus is on sulfate as well.
- Started with IPM 2.1.9 – in Base G, took account of results supplied by utilities – created hybrid between 2.1.9 and ground – truthing in summer 2006 (somewhere between versions 2.1.9 and 3.0) – pretty close to MV CAIR+ results. Base G2 has some changes in GA & FL
- See improvements at Southwest and Appalachian sites – mountain sites below the uniform progress line; less improvement at coastal sites – very close to uniform progress. Smaller reductions in units affecting relative reductions over whole year. GA and FL are working closely together on those sites.
- Distributed reasonable progress approach to stakeholders - looked at areas of influence.
- Reasonable progress analysis based on area of influence approach shows sulfate from EGUs and other sources dominated – most responses from sulfate reductions. When looking at areas of influence, we looked at their sulfate sources
- In modeling we included Brigantine and other sites
- Look at cost of controls, what are sulfate emissions after implementing the on-the-way controls. After 2018, EGUs still contribute 40% of emissions. Coal burning ICI boilers are the next largest at 20-30% of emissions, also a small percent from glass, pulp and paper, etc. Know by SEC code what kind of sources and costs of typical measures (AirControl.net). Will be using MARAMA 4- Factor analysis to inform their process.
- Delivered lists of sources in areas of influence in November. VISTAS states consultation occurred in December 2006 - agreed on approach to take on 4- Factor analysis. Got back together in May and repeated our process. Some states sent letters asking them to look at certain kinds of sources -- "tell us what you decide when you do your analysis of these sources on your Class I areas." Provided schedules on next steps of SIP process.
- VISTAS has interstate consultations going on in southern states - May 2007 consultation, too, plus June FLM/EPA meeting, intrastate consultations . Now consultation has started with MANE-VU

- FLM/EPA feedback is commitment to good mid-course review in 2012 to see where EGU reductions are actually occurring .

Discussion:

- S. Wierman (MARAMA): Please elaborate on your comment that IPM run with Base G are "close to" MANE-VU CAIR+ run?
- P. Brewer (VISTAS): There are similarities with MACTEC top 30 for VISTAS EGUs
- A. Garcia (MANE-VU): We/ MANE-VU received similar look-back comments from our FLMs
- J. Hornback (SESARM): Everyone should look at emissions reductions that are already in place. Substantial reductions have occurred already, not just what's going to occur in 2018. Benefits from additional controls for upcoming NAAQS will help regional haze, too – substantial reductions in the southeast.
- T. Allen (FWS): CAIR uncertainly can be addressed by communicating with EGUs and can include in SIP instead of waiting for look-back
- G. Kleiman (NESCAUM): IPM projections a moving target, but info on controls on 167 stacks important to bring to consultation – we may not be very far apart. Any information that the RPOs and states can provide about controls on 167 Stacks would be very valuable. We also recognize that states are looking at their own measures. Any info on control measure decisions that you have made for your own sources may show we are closer - by August 6th and August 20th meeting.
- R. Papalski (NJ) Is the material from the VISTAS June meeting available?
- P. Brewer (VISTAS): Yes, all presentations from the June meeting are posted on VISTAS' website.
- J. Hornback (SESARM): More on 28% reduction – ICI sulfur goes up from 10% to 24% nationwide and could be possible national rule John H – 16% of sulfur from ICI boilers in 2002 up to 24% after CAIR. As we move into next round of fine particle work – ask whether we have enough info re ICI boilers. Impact, concern and what control options/cost are – talk to EPA? Uncontrolled/inadequately controlled sources
- A. Garcia (MANE-VU): Our states have done some work on ICI boilers and have some information developed already. We would be glad to work with MRPO and VISTAS on this issue.
- S. Wierman (MARAMA): It may be possible to include something on ICI boilers as a potential amendment to the MANE-VU National ask statement. Might be possible for it to come out of consultations.
- J. Hornback (SESARM): We should continue to collect data and be ready to move forward.
- S. Wierman (MARAMA): We would appreciate feedback at the consultation on joining MANE-VU on its request for a Phase 3 CAIR

Comments from FLMs

- Pay attention to mid course review – look at where you will be in 2012 compared to where you expected to be.
- Regarding the 2012 look back – discussions of source can be helpful and included in this SIP, with recognition of uncertainty.

EPA

- John Summerhays (EPA Region 5) and Michelle Notarianni (EPA/OAQPS), expressed their appreciation for being invited to participate on the call and on future consultations.

Outcomes & Next Steps

- R. Papalski (NJ): Asked that all RPOs bring a list of the 167 EGUs and any planned controls on those units to the August meeting.
- P. Wishinski (VT): To confirm, VT will be asking WI to participate in the August 6th meeting – will be calling WI to ask them to attend.
- A. Garcia (MANE-VU): Gave a brief overview of the upcoming consultation meetings on August 6th and 20th – asked for any further comments/changes to the agendas to be sent to her next week.
- T.Aburn (MD): Opportunity to work with EPA on CAIR "Phase 3" for 2018/2020 would be a great outcome of consultations – Ann, Strengthen numbers – Tad, can we talk about PM? Mike, very relevant and need to look ahead

Adjournment

Anna Garcia thanked everyone for their participation and promised to circulate a draft summary of the call for comment – asked that each RPO share their attendance lists for the open call all around via email. Information on this and other MANE-VU consultations will be posted on the consultation page of the MANE-VU website, www.manevu.org.

Attendees

MANE-VU:
Maine (Class I state) – Jeff Crawford, Tom Downs
New Hampshire (Class I state) – Bob Scott, Jeff Underhill
New Jersey (Class I state) – Chris Salmi, Ray Papalski, Sandy Krietzman
Vermont (Class I state) – Dick Valentinetti, Paul Wishinski
Connecticut – Wendy Jacobs
Delaware – Jack Sipple
Maryland – Tad Aburn, Andy Hiltebridle
Massachusetts – Eileen Hiney
New York – Matt Reis, Diana Rivenburgh
Penobscot Tribe – Bill Thompson
EPA Region I – Anne Arnold, Anne McWilliams
EPA Region II – Bob Kelly
EPA Region III – Ellen Wentworth, LaKeshia Robertson
FLM - Forest Service – Ann Mebane
FLM – Fish & Wildlife Service – Tim Allen
FLM – National Park Service – Bruce Polkowsky, Holly Salazer
MARAMA – Susan Wierman, Julie McDill
NESCAUM – Gary Kleiman
OTC – Anna Garcia, Doug Austin

MRPO:
Illinois – Rob Kaleel
Indiana – Chris Pederson, Ken Ritter
Michigan – Vince Helwig, Cynthia Hodges
Ohio – Bill Spires
Wisconsin – Larry Bruss, Bob Lopez
LADCO – Mike Koerber

VISTAS:

Georgia – Jimmy Johnston, Heather Abrams
Kentucky – John Lyons, Diana Andrews, Lona Brewer, Martin Luther
North Carolina – Keith Overcash, Sheila Holman, Laura Booth, George Bridgers
South Carolina – Renee Shealy, John Glass, Maeve Mason, Stacey Gardner
Tennessee – Barry Stephens, Quincy Styke, Julie Aslinger
Virginia – Tom Ballou, Doris MacLeod, Mike Kiss
West Virginia – Fred Durham, Bob Betterton, Laura Crowder
EPA Region IV – Brenda Johnson
EPA OAQPS – Michelle Notarianni
Metro 4/SESARM – John Hornback
VISTAS- Pat Brewer

MANE-VU/MRPO Consultation Meeting Summary
August 6, 2007
Rosemont, IL

On Monday, August 6, 2007, the Mid-Atlantic/Northeast Visibility Union (MANE-VU) Class I states (Maine, Vermont, New Hampshire, and New Jersey) held a consultation with several of the Midwest Regional Planning Organization (MRPO) states (Illinois, Indiana, Ohio, Michigan and Wisconsin). The following summary documents the discussions that took place during the consultation.

Summary of Today's Consultation Agreements

1. Define next steps for multi-pollutant approach to reduce regional haze, PM 2.5, and ozone
2. Discuss crafting a revised national ask among interested MANE-VU and MRPO states regarding needs for national action on EGUs, including potential multi-pollutant control levels for CAIR Phase III with emission rates and output-based options;
3. Pursue discussions on options for reducing SO2 (and NOx) emissions from ICI boilers, including:
    - Reconvening the MANE-VU/MRPO ICI boiler workgroup to re-examine the workgroup's January 2007 straw proposal;
    - Developing a process for sharing information on SO2 RACT for ICI boilers, and examining potential SO2 control measures;
    - Contacting NACAA regarding expansion of the Boiler MACT model rule work to address SO2 and NOx; and
    - Discuss crafting a national ask among interested MANE-VU and MRPO states regarding national action on ICI boilers.
4. Discuss crafting a national ask regarding low sulfur fuel for all off-road sources, and share information on biodiesel.
5. Continue to share modeling assumptions and analyses, and continue dialogue between MANE-VU and MRPO states regarding SIP submittals.
6. Define next steps to gather information on controls for locomotives and ocean-going vessels.
7. Develop list of controls for units that will be scrubbed, not just MANE-VU's list of 167 stacks.

Attendees

MANE-VU States:
Maine (Class I state) – David Littell, Jeff Crawford
New Hampshire (Class I state) – Tom Burack, Bob Scott
New Jersey (Class I state) – Chris Salmi
Vermont (Class I state) – Justin Johnson, Dick Valentinetti, Paul Wishinski

MRPO States:
Illinois – Laurel Kroack, Scott Leopold
Indiana – Tom Easterly, Ken Ritter
Michigan – Vince Hellwig, Cynthia Hodges, Bob Irvine
Ohio – Bob Hodanbosi
Wisconsin – Larry Bruss

Multi-State Organizations:
OTC/MANE-VU – Anna Garcia, Doug Austin
MARAMA/MANE-VU – Susan Wierman, Julie McDill
NESCAUM/MANE-VU – Gary Kleiman
LADCO/MRPO – Mike Koerber

Federal Land Managers:
National Park Service – Bruce Polkowsky
Forest Service – Anne Mebane, Chuck Sams, Rich Fisher
Fish & Wildlife Service – Tim Allen

Environmental Protection Agency:
Region I – Anne Arnold
Region II – Bob Kelly
Region III – Ellen Wentworth, Neil Bigioni (by phone)
Region V – John Summerhays
OAQPS – Todd Hawes, Michelle Notarianni (by phone)

Consultation Meeting Presentations and Discussions

Welcome and Introductions – Goals for Today's Meeting - David Littell, Maine DEP

- Presented goals for today's consultation:
    - Review requirements, resources and critical timing issues to ensure all share a common understanding;
    - Discuss options for control measures to identify what is reasonable for joint work between regions;
    - Identify impediments to implementing control measures and discuss how to address them;
    - Identify links between haze and PM that help define what is reasonable;
    - Examine reasonable progress for MRPO and MANE-VU Class I areas in terms of control measure options; and
    - Summarize points of agreement and identify issues for follow-up consultation
- Compare our request for what we need in terms of reductions to improve visibility at our Class I areas with what the MRPO states have done to address their own Class I areas and regional haze/PM issues
- Find out how close we are, what gaps may still remain, and discuss how we may address them together.

Overview of Open Technical Call & Consultation Briefing Book – Anna Garcia, MANE-VU

- Open Technical Call discussions provided a good technical basis for today's meeting.
- MANE-VU staff is developing draft documentation of the Open Call and of today's discussions, and will circulate the drafts for comment and make the final documentation available to all states for use in their state implementation plans (SIPs).

Summary of Reasonable Progress Work and Development of "Asks" for MANE-VU Class I Areas – Chris Salmi, New Jersey DEP

Presentation:

- Provided a review of MANE-VU Class I states' Resolution on Principles;
- Showed focus for MANE-VU is on sulfate reductions for the 2018 milestone;
- Gave an overview of MANE-VU's four factor analysis;
- Outlined how MANE-VU Class I states developed the "asks" for the MANE-VU and MPRO regions;
- Provided a comparative analysis of the MANE-VU region "ask" with that of the MRPO "ask";
- Outlined the specifics of each of the asks, including for MRPO:
    - Timely implementation of BART requirements;
    - A focused strategy for the electricity generating units (EGUs) comprising a 90% reduction of sulfate emissions from 2002 levels from 167 stacks that modeling indicates affect visibility impairment in MANE-VU Class I areas;
    - A 28% reduction from non-EGU sector emissions based on 2002 levels; and
    - Continued evaluation of other measures, including measures to reduce SO2 and nitrogen oxide (NOx) emissions from coal-burning facilities by 2018.
- Within MANE-VU, the Class I states have the following commitment:
    - Timely implementation of BART requirements;
    - A focused strategy for the electricity generating units (EGUs) comprising a 90% reduction of sulfate emissions from 2002 levels from 167 stacks that modeling indicates affect visibility impairment in MANE-VU Class I areas;
    - A low sulfur fuel oil strategy with different implementation timeframes for inner zone states versus outer zone states, that results in a 38% reduction from non-EGU sector emissions in the MANE-VU region; and
    - Continued evaluation of other measures, including measures including energy efficiency, alternative clean fuels and other measures to reduce SO2 and nitrogen oxide (NOx) emissions by 2018.
- Also outlined the national "ask" MANE-VU plans to make of the US EPA, for a Phase 3 of CAIR that reduces SO2 by at least an additional 18%.
- From presentation, next steps are:
    - Consult within and outside MANE-VU about which control strategies are reasonable;
    - Open a dialogue with the USEPA concerning a possible Phase 3 of CAIR;
    - Define strategies to include in the final modeling;
    - Determine goals based on the final modeling;
    - SIPs are due 12/17/07;
    - Adopt enforceable emissions limits & compliance schedules; and
    - Progress evaluation due in 5 years.

Discussion:

- *Question (Tom Easterly, Indiana)*: Are there emission rate targets instead of a flat 90% reduction?
    - *Answer (Chris Salmi, New Jersey)*: No, and no net reductions.
- *Question (Tom Easterly, Indiana)*: Where do the emissions go?
    - Answer (Gary Kleiman, NESCAUM): MANE-VU EGU reduction on the order of 68,000 TPY would be "rearranged." They are spread out between all EGUs proportionately, except for those in the 167 stacks, to maintain the cap.

- *Question (Tom Easterly, Indiana)*: Did MANE-VU use the 0.5dV exemption threshold for BART sources?
  - *Answer (Gary Kleiman, NESCAUM)*: MANE-VU did not exempt any BART sources from the BART determination process.
- *Question (Mike Koerber, MRPO)*: What is the source of the MANE-VU numbers?
  - *Answer (Gary Kleiman, NESCAUM)*: They are from MARAMA's inventory work. National ask for EGU sector based on IPM results and increasing the SO2 ratios.
- *Comment (Mike Koerber, MRPO)*: The MANE-VU numbers are close to his, but we need to sync them up.
- *Comment (Tom Easterly, Indiana)*: Companies make economic analyses for installation of controls and we keep changing the rules on them.
  - *Answer (Gary Kleiman, NESCAUM)*: They are spread out between all EGUs proportionately, except for those in the 167 stacks, to maintain the cap.

<u>Summary of Reasonable Progress Work for MRPO Class I Areas</u> – Mike Koerber, MRPO

<u>Presentation:</u>

- MRPO results consistent with MANE-VU analyses.
- MRPO states still looking at strategies for their 4 northern Class I areas, nitrates a bigger share of visibility impairment, visibility impacts mostly from southerly transport.
- With OTB measures, we are above glide path in 2018 for all 4 Class I areas.
- Review of MRPO 5-Factor Analysis (including degree of visibility improvement) for reasonable progress.
- Review of new visibility metric of $/dV improvement, additional control measures comparable in costs to existing OTB controls, most visibility improvement obtained from MRPO's EGU1 (0.3dV) and EGU2 (0.4dV) strategies.
- MRPO analysis regional in nature, not a focused EGU strategy like MANE-VU due to different source / receptor relationships.
- Review of projected visibility levels, Seney above glide path in 2018, a lot more SO2 will need to be "squeezed" out of the system to achieve 2064 natural conditions.
- Review of MRPO source apportionment analysis, MRPO contributes 10-15% of visibility impairment at Lye Brook in Vermont.
- Conclusions and key findings from MRPO analyses:
  - Many Class I areas in the eastern half of U.S. expected to be below the glide path in 2018 (with existing controls), including those in the Northeast;
  - Contribution analyses show closer states have larger impacts; and
  - Regional emission reductions (in 2013-2018 timeframe), such as those identified in MANE-VU's June 2007 resolutions, may be necessary to meet reasonable progress goals in the MRPO Class I areas and provide for attainment of new tighter PM2.5 and possibly tighter ozone standards in the MRPO states.

<u>Discussion:</u>

- *Question (Tom Easterly, Indiana)*: How do we deal with ammonia?
  - *Answer (Mike Koerber, MRPO)*: EPA won't touch it and ammonia is included in the analyses for completeness.
- *Question (Jeff Crawford, Maine)*: Are mobile measures included?

- - *Answer (Mike Koerber, MRPO)*: Only bundled measures including chip reflash and diesel retrofits where the states are not preempted from doing such measures.
- *Question (Tom Easterly, Indiana)*: Would a monthly electric bill of $150 be doubled?
  - *Answer (Mike Koerber, MRPO)*: Yes, at least doubled.
- *Question (Dave Littell, Maine)*: Are ammonia controls from the agricultural sector assumed?
  - *Answer (Mike Koerber, MRPO)*: Yes, assumes 10% ammonia reductions from best practices.
- *Question (Jeff Crawford, Maine)*: How much of the ammonia comes from CAFOs versus fertilizer application?

- *Answer (Mike Koerber, MRPO)*: Two-thirds to three-quarters comes from CAFOs, but urban ammonia sources are also important.

- *Question (Tim Allen, F&W Service)*: How much benefit is there from ammonia controls?
  - *Answer (Mike Koerber, MRPO)*: The analysis shows that a 10% ammonia decrease that may be cost-effective will result in greater than a 0.10dV improvement.
- *Comment (Bruce Polkowsky, NPS)*: 10% is a lot.
- *Comment (Larry Bruss, Wisconsin)*: There is a lot of uncertainty when it comes to the effects of ammonia reductions.
- *Question (Doug Austin, MANE-VU)*: Is the $/dV analysis based on three states or nine?
  - *Answer (Mike Koerber, MRPO)*: It is based on three states, and a nine-state analysis would be higher
- *Comment (Gary Kleiman, NESCAUM)*: MANE-VU saw almost identical MRPO contributions in the 10-15% range.
- *Comment (Chris Salmi, New Jersey)*: New Jersey is looking at performance standards for the 24-hour PM2.5 standard and a potentially tighter ozone standard.
- *Comment (Laurel Kroack, Illinois)*: Illinois would be interested if New Jersey could share that information.

EPA and FLM Perspectives on RPGs and Reasonable Measures Work – Bruce Polkowsky, NPS; Chuck Sams, Forest Service; John Summerhays, EPA Region V; Todd Hawes, EPA - OAQPS

Bruce Polkowsky, National Park Service

Tomorrow is the 30th anniversary of the passage of the 1977 Clean Air Act Amendments that enacted section 169A and established the regional haze program.

- The uniform progress line is "useful," but the 4-Factor analyses are most important from FLM perspective.
- Don't forget the 20% clean days reasonable progress goal (VISTAS getting 1 dv improvement).
- Are states being overly optimistic in their CAIR controls scenarios? Information coming in from states seems to be pointing to predicting a higher level of controls than what CAIR predicts.
- The location of controls is important for visibility as seen in the MANE-VU 167 stack analysis.
- The 2013 progress report is key, and it is important to know about new sources, too.
- PM 2.5, ozone and regional haze issues are all coming together in the 2013-2018 timeframe. The PM2.5 SIPs should take into account what the regional haze measures will achieve. Strategies should be coordinated to maximize their effectiveness for both regional haze, PM2.5, and ozone SIPs.
- The FLMs encourage states to be as detailed as possible in their regional haze SIPs, including dates, for control measure development. It is up to EPA through the approval and disapproval process as to how they will react to state promises to pursue control measures in the regional haze SIPs.

Chuck Sams, Forest Service

- There should be one hard copy of the regional haze SIP per FLM reviewer.
- The FLM goal is for comments back to the states 30 days before their public hearings.
- The FLMs need the SIPs as soon as possible for their 60-day review.
- The FLMs would appreciate a summary sheet that provides a cross-reference as to when the specific items on their checklist can be found in the SIP.
- There is an FLM expectation for ongoing consultation.

John Summerhays, EPA Region V

- There are three main requirements of the Regional Haze Rule:
    - (1) Reasonable Progress – lots of questions about what conclusions and questions about what EPA will have as a requirement to the different scenarios;
    - (2) BART – haven't seen much control taken on BART. EPA is thinking about how to ensure consistency in BART determinations by different states. EPA asks the RPOs to try to insure consistency across their states; and
    - (3) Consultations - RPOs have done valuable work in technical analyses and facilitating consultations.
- EPA appreciates being part of the current process and continuing that participation into the future.

Todd Hawes, EPA – OAQPS

- While EPA is not in a position to initiate consultations as required by the Regional Haze Rule, today's meeting is a good representation of what they envisioned the consultation process would be.
- EPA is getting lots of questions from states about the regional haze SIPs. Some states are saying they are not going to set reasonable progress goals, while some say they are only going to do BART, use it for their reasonable progress goal with no analysis.
- EPA is legally bound and expecting full SIPs on 12/17/2007 that include all of the required elements. It is not acceptable for states to say they do not have the time or resources, or that the SIP cannot be done by December 17.
- The EPA lawyers are working on "what if" scenarios.

Discussion:

- *Question to FLMs and EPA (Dick Valentinetti)*: Will the Federal agencies comment on the extent of agreement and disagreement on strategies?
    - *Answer (Bruce Polkowsky, NPS)*: Yes, they will.
- *Comment (Tim Allen, F&W Service)*: They will also be looking for regional consistency and that the various emission reductions for meeting the Class I reasonable progress goals are proportional between the states. They may comment more on any disagreements between RPOs.
- *Comment (Bruce Polkowsky, NPS)*: The continuing consultation requirement is in 308(i)(4). The MANE-VU states have provided input on format and frequency. The monitoring aspects are crucial and especially important to consult about.
- *Question to EPA (Bruce Polkowsky, NPS)*: The long-term strategy is a 10-year strategy from rule adoption, but are promises to look at reductions approvable?
    - *Answer (Todd Hawes, EPA)*: Realistically, we have to see what comes in December. They realize that they will not get 100% approvable SIPS in December 2007 and will have to see then what they will do about it.

- *Comment (Bruce Polkowsky, NPS)*: FLMs would rather have a SIP later that has all elements rather than one that is on time that does not.
- *Question to EPA (Susan Wierman, MARAMA)*: Can EPA process the BART SIPs first to start BART clock?
  - *Answer (Todd Hawes, EPA)*: Yes, they are discussing BART severability, and it would be easier to consider BART first if they get a complete SIP.
- *Comment (Susan Wierman, MARAMA)*: Holding up BART approvals due to incompleteness of the rest of SIP would be unfortunate. Glad to hear EPA discussing this issue.
- *Comment (Todd Hawes, EPA)*: They have 6 months to deem complete.
- *Question to MANE-VU (John Summerhays, EPA)*: How are BART compliance dates set in M-V?
  - *Answer (Susan Wierman, MARAMA)*: Some states are setting the date to be "as expeditiously as practicable." The states need to be doing their best to get BART controls in place as we do not want a repeat of the NOx SIP call delays. The BART requirement is one of the best ways in the Clean Air Act for getting old facilities controlled.
- *Question to MRPO (Todd Hawes, EPA)*: Can I get clarification on the $/dV metric developed by MRPO? Is there any cost-effectiveness breakpoint?
  - *Answer (Mike Koerber, MRPO)*: It is a reference point.
- *Question to EPA (Chris Salmi, New Jersey)*: How will EPA react to inconsistencies between state SIPs?
  - *Answer (Todd Hawes, EPA)*: The rule says EPA is the arbiter of any disagreement and there is little guidance beyond that. EPA would lean heavily on consultation documentation, but EPA will ultimately have to decide.
- *Comment to EPA and FLMs (Chris Salmi, New Jersey)*: It is one of the MANE-VU Class I States principles that the FLMs will help identify and EPA will act upon any inconsistencies.

<u>Roundtable Discussion on Reasonable Progress Goals and Reasonable Measures</u>

States continued the consultation with a roundtable discussion open on all issues raised during the Open Technical Call and this consultation meeting. Most of the discussion focused on the substance of the MANE-VU statements, or "asks" from the MRPO states and from the U.S. EPA.

<u>ICI Boilers, MACT and NOx/SO2 RACT</u>

During the Open Technical Call it was suggested that there may be an opportunity to examine the scope of the ICI boiler sector and potential emission reductions from that source category. Several states brought up the recent vacatur of the Boiler MACT in terms of the possibility for states to work together on this sector. NACAA is discussing with its members and the Ozone Transport Commission and Northeast States for Coordinated Air Use Management an effort to develop a Boiler MACT model rule. While for Boiler MACT this effort would focus on hazardous air pollutants (HAPs), including volatile organic compounds (VOCs), it may be possible to include in that project a parallel process to gather information on NOx and SO2 emissions from the boiler sector and develop options for control strategies, separate from the MACT levels.

MANE-VU states also inquired about what MRPO states are doing for PM 2.5 attainment. Many of the MRPO states are focusing on local sources for urban excess, and it appears that EPA is discouraging a focus on regional strategies. Illinois informed the group that it has a multi-pollutant agreement including scrubbers. Illinois also has a statewide NOx RACT proposal with stringent levels and is working on SO2 RACT, such as low sulfur diesel for non-road and refinery SO2 reductions. These RACT proposals are working their way through Illinois' regulatory processes, so they are not yet included in SIPs and are not reflected in MRPO's modeling. Michigan may also look at statewide RACT under the new PM2.5 standard.

In addition to the work done by the ICI boiler workgroup, OTC has completed some regional inventory work on its ICI boilers and NESCAUM is completing a study on ICI boilers that was sponsored by EPA. All of this work can be included in the review of this sector.

Follow up items from this discussion include:

- Reconvene MANE-VU/MRPO ICI Workgroup that was initiated under the State Collaborative to re-examine ICI boiler work and define next steps;
- Contact NACAA about possible addition to Boiler MACT model rule work to examine potential for NOx and SO2 reductions and identify strategies; and
- Look at pursuing SO2 RACT regionally, as well as asking EPA again for an ICI national rule.

Low Sulfur Fuels

In addition to the low sulfur fuel measures that MANE-VU is pursuing, the states discussed other areas of opportunity for low-sulfur fuels, including nonroad low-sulfur diesel. Illinois indicated that they will be talking to their four refineries about non-road low-sulfur diesel Michigan indicated that they are looking at a possible executive order mandating low-sulfur non-road diesel for state contracts. MRPO states also expressed interest in low-sulfur fuel for locomotives.

New Hampshire inquired as to whether the cost for biodiesel is similar to low-sulfur diesel, and suggested that we share information on biodiesel as an option. New Jersey expressed interest in ocean-going vessels as a source sector for low-sulfur fuel opportunities. The National Park Service folks indicated that there is a recent World Trade Organization agreement that could be of use in this regard, and that this is a sector that the VISTAS and WRAP states are also looking into.

Follow up items from this discussion include:

- Look at federal rules that are in the works for non-road, locomotive and marine engines to see if there are gaps or opportunities that MANE-VU and MRPO could explore together; and
- Share information on biodiesel as a low-sulfur fuel option.

State/Regional EGU Strategy

States discussed the EGU strategy proposed by the MANE-VU Class I areas, regarding a focus to pursue reductions of 90% or greater from the 167 stacks identified on the MANE-VU list. The MANE-VU states have agreed to pursue 90% EGU reductions and a low-sulfur fuel oil strategy. MRPO states will continue to examine what the potential for reductions are at these units, and provide information about which sources in their states are putting controls on, to better inform the process and our modeling. According to the information MRPO has at this time, over 70% of the emissions from the 167 stacks on the list will be scrubbed. The question remains whether that will be enough, or whether MRPO will still need to address the remaining 30% even if it has a very low impact. Another issue was raised regarding whether it would be acceptable for MRPO states to substitute reductions from the non-EGU sector that go beyond the 28% level for reductions that may not be obtainable in the EGU sector. MANE-VU states indicated that this would likely be acceptable, depending on the location and type of non-EGU source.

MANE-VU states raised the question as to whether the 70/30 split is the same for the rest of the EGUs, i.e. those in the MRPO region that are not part of the 167 stacks on the list. MRPO responded that they can get that information and provide it to MANE-VU. For example, IPM indicates that Rockport will be getting controls, while MRPO's information from the source is that they will not. There is also a concern that cumulatively, the controls that the EGU sources say are going on will be larger than what is required by CAIR, i.e., it will not reflect reductions that will be "sold" on the trading market, or what units they will be sold to, to keep emissions at the CAIR budget level.

Another concern was raised regarding the addition of controls to older EGUs and how they can be permitted given NSR issues for increases in other emissions. Some states responded that it has been possible to add scrubbers to older units and address increases in other emissions by fine-tuning the control systems.

Generally, while the concept is feasible, MRPO states anticipate needing more assistance and information from the MANE-VU Class I areas to understand the justification for controls on these units. In addition, it will be helpful to look at ways to incentivize the retirement/closing of old units and their replacement with cleaner technology, such as through output-based standards. We will also need to work together to craft language that will work in our SIPs to reflect the approach that MANE-VU is requesting that will be acceptable to EPA.

Follow up items from this discussion include:

- Continue to share specific information about what MANE-VU and MRPO sources are anticipating as controls on EGUs as compared to what is indicated in IPM modeling;
- Update our inventories and databases accordingly so that our information is "synched"; and
- Continue dialogue on approaches for addressing this sector to meet the 90% reduction target for the 167 stacks and on equivalent alternatives.

National "Ask" for CAIR Phase III

There is interest from some MRPO states in joining MANE-VU in its "ask" for a Phase III of CAIR. All of the MRPO states will review and consider the option as we continue our consultation process. For many MRPO states the real concern is obtaining PM 2.5 reductions; regional haze is not their primary concern. As we continue to discuss the national "ask" we need to develop control levels that will help all of our states with attainment for ozone, PM and regional haze. MANE-VU based its request on the recent IPM modeling work done on the levels that came out of the state collaborative work. Those levels are not as stringent as those that are in the original OTC multi-pollutant position, and we are in the process of reviewing them.

Follow up items from this discussion include:

- MANE-VU to revisit its multi-pollutant strategy;
- MRPO and MANE-VU to have discussions on potential multi-pollutant control levels for a CAIR Phase III; and
- Craft a revised national "ask" to reflect revised levels, as appropriate.

NEXT STEPS

In addition to the agreements reached during the discussions (listed at the beginning and in the roundtable discussion sections of this document) the MANE-VU Class I states and the MRPO states agreed to continue the consultation dialogue on the upcoming State Collaborative call, scheduled for 10:00 am CDT, 11:00 am EDT on Thursday, August 16th. The states will continue discussions from today's meeting, bring forth additional issues as necessary, and have a first opportunity to review and discuss the draft documentation of the consultation.

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

On Thursday, September 13, 2007, the Mid-Atlantic/Northeast Visibility Union (MANE-VU) Class I states (Maine, Vermont, New Hampshire, and New Jersey) held a consultation conference call with the Midwest Regional Planning Organization (MRPO) states (Illinois, Indiana, Ohio, Michigan and Wisconsin). The conference call came about as a result of the August 6, 2007 in-person consultation between the MANE-VU Class I states and the MRPO states who agreed to continue the consultation dialogue with respect to issues identified in the August 6th consultation. The following summary documents the discussions that took place during the consultation conference call.

Summary of Today's Consultation Conference Call Agreements

- Continue sharing necessary EGU emissions inventory and control equipment data.
- The individual MRPO states will respond by letter to the MANE-VU Ask.
- Reconvene the ICI Boiler Workgroup effort from earlier this year to provide technical direction. Invite interested VISTAS states. Start out by looking at the Workgroup's early 2007 straw proposal.
- Continue beyond-CAIR discussions on the state collaborative calls. Form a small EGU policy group to provide policy direction towards developing a federal EGU Ask.

Conference Call Attendees

MANE-VU States:
Maine (Class I state) – Jim Brooks, Jeff Crawford, Tom Downs
New Hampshire (Class I state) – Jeff Underhill, Andy Bodnarik, Liz Nixon
New Jersey (Class I state) – Chris Salmi, Ray Papalski
Vermont (Class I state) – Justin Johnson, Paul Wishinski
Connecticut – Wendy Jacobs
Delaware – Jack Sipple
Maryland – Tad Aburn
Massachusetts – Glenn Keith
New York – Rob Sliwinski, Matt Reis, Diana Rivenburgh, Scott Griffin

MRPO States:
Illinois – Rob Kaleel
Indiana – Dan Murray, Ken Ritter, Scott Deloney, Chris Pederson
Michigan – Bob Irvine, Cynthia Hodges
Ohio – Bob Hodanbosi, Bill Spires

Multi-State Organizations:
OTC/MANE-VU – Anna Garcia, Doug Austin
MARAMA/MANE-VU – Susan Wierman, Julie McDill
NESCAUM/MANE-VU – Arthur Marin, Gary Kleiman
LADCO/MRPO – Mike Koerber

Federal Land Managers:
National Park Service – Bruce Polkowsky
Forest Service – Anne Mebane

Consultation Conference Call Discussions

Clarification of the MANE-VU "Ask"

After the August 6, 2007 in-person consultation, the MRPO states had remaining questions relative to the MANE-VU Ask statements. One of the primary purposes of the consultation conference call was to address those questions.

One of the uncertainties expressed by MRPO was how to quantify the SO2 reductions from the EGU sector that MANE-VU requested. MRPO stated that they were working with MARAMA and NESCAUM to clarify the EGU SO2 inventories of the 50 MRPO stacks on the larger list of 167 stacks in the eastern U.S that were previously identified as locationally significant in terms of their visibility impacts on MANE-VU Class I areas.

MRPO also asked if MANE-VU meant that 90% SO2 reductions, on average, on all of the 50 stacks within the MRPO states was expected. MANE-VU replied affirmatively, while emphasizing the flexibility within the Ask statement wherein if the 90% average SO2 reductions from the 50 MRPO EGU stacks could not be realized then the shortfall could be made up by SO2 reductions from other in-state EGUs. Additional flexibility in the Ask statement is that the shortfall could be made up from SO2 reductions from the non-EGU sector that are in excess of the 28% reductions requested by MANE-VU from this sector. Vermont added that this flexibility is the least preferred since SO2 reductions from taller EGU stacks are more important to reducing visibility impairment than SO2 reductions from shorter non-EGU stacks. Finally, flipping the last flexibility scenario around, Wisconsin asked if they could substitute less expensive EGU SO2 reductions for more expensive non-EGU SO2 reductions, and Vermont replied that that would be most welcome for the same reason that tall stack reductions have a greater visibility benefit than short stack reductions.

Within this flexibility framework, a brief discussion followed on equivalent reductions versus equivalent impact. Vermont said it was of two minds on the topic in that although ideally they would like to see reductions from the flexibilities that have an equivalent impact on visibility as the 90% SO2 reductions from the 50 MRPO EGU stacks, they were willing to accept EGU reductions from EGUs outside the 50 as automatically equivalent, and they were also willing to accept EGU SO2 reductions in place of non-EGU SO2 reductions so long as the EGU emission reductions did not go somewhere else under CAIR. Maine agreed and emphasized that they were looking for additive reductions, not re-arranged emissions. Wisconsin stated that it would be difficult to make the case for equivalent visibility impact to management.

The discussion moved on to the MANE-VU Ask for a 28% reduction in SO2 emissions from the non-EGU sector. MRPO inquired whether BART reductions could be applied to the 28% non-EGU MANE-VU Ask. MANE-VU replied that they separated BART reductions out as additive to the other Asks. MRPO reiterated that that was not the understanding going in to this call. New Jersey replied that slide #16 of its presentation at the August 6th in-person consultation clearly shows BART reductions as separate. MANE-VU added that the 28% target came from the MANE-VU non-EGU low-sulfur fuel oil strategy. New Jersey clarified that if, after going through the BART determination process, the state determined that no controls were needed for regional haze purposes, but reductions were made for PM2.5 purposes, then those reductions could be applied to the 28% non-EGU Ask.

MRPO Response to the MANE-VU Ask

MRPO and MANE-VU jointly posed the question of how to respond to the Ask. MANE-VU added that they needed to perform its last modeling run based on either RPO feedback or the default Ask levels.

MRPO said that the July 30, 2007 letter from MANE-VU formalized the Ask, so it was up to the MRPO states to respond, probably individually and with the hope for regional consistency. MRPO added that some further technical discussions may be needed as well as drafting a federal EGU Ask and reconvening the ICI Boiler Workgroup. Ohio, Michigan, Indiana, and Wisconsin all agreed that they were not ready to make any formal commitments on reductions. Wisconsin added that a personnel change at the Commissioner level could result in a delayed response.

Maryland inquired whether the federal EGU Ask should somehow be included in the regional haze SIPs or should it arise out of a separate process. MRPO added that the air quality needs of all of the states on the call are much larger than regional haze, and that all states will need more EGU reductions for ozone and PM2.5 as long as they remain more cost-effective than reductions from other sectors. Most states agreed that they were unlikely to put such a federal EGU ask in their regional haze SIPs.

Next Steps

MANE-VU posed the question of how to keep moving the consultation process forward adding that the VISTAS states had showed some interest in joining a reconvened ICI Boiler Workgroup at the August 20th in-person consultation. MRPO replied that they were interested in reconvening the ICI Boiler Workgroup noting that West Virginia has interest as well. MRPO suggested having the Workgroup start out by looking at the OTC / MRPO straw proposal from earlier in 2007. Other potential sources of information include the National Association of Clean Air Agencies (NACAA) boiler Maximum Achievable Control technology (MACT) effort and a NESCAUM ICI boiler study sponsored by EPA.

As for the federal EGU ask, MANE-VU stated that there is a need to keep the policy discussions alive on the state collaborative calls. MANE-VU added that they are in the process of reviewing the 2004 multi-pollutant position, and will look at forming a small EGU policy group.

MANE-VU asked whether there should be another consultation conference call. MRPO replied that MANE-VU should wait for MRPO follow-up to the MANE-VU Asks via individual state letters to the MANE-VU Class I states.

MANE-VU/VISTAS Consultation Meeting
August 20, 2007
Atlanta, GA

On Monday, August 20, 2007, the Mid-Atlantic/Northeast Visibility Union (MANE-VU) Class I states (Maine, Vermont, New Hampshire, and New Jersey) held a consultation with several of the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) states (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, West Virginia, the Eastern Band of Cherokee Indians, and Knox County, Tennessee). The following summary documents the discussions that took place during the consultation.

Summary of Today's Consultation Agreements

1. Continue to share information and sync up our technical analyses.
2. Share information on biodiesel and biofuels, as well as what states are doing with respect to biomass boilers and outdoor wood boilers.
3. Continue dialogue on a potential CAIR Phase III policy position and the MANE-VU National "Ask."
4. Share information already developed on the ICI Boiler Sector, refine information on controls and costs, and engage in the upcoming National Association of Clean Air Agencies (NACAA) Boiler MACT work. Enlarge the non-EGU definition beyond boilers to include kilns.
5. Share information on locomotives and ocean-going vessels to see if there are more emission reduction opportunities.
6. Look at expanding the National "Ask" to include low-sulfur fuel oil.
7. John Hornback and Anna Garcia will discuss how to continue the dialogue, including conference calls and workgroup participation.

Attendees

<u>MANE-VU States</u>:
Maine (Class I state) – David Littell, Jeff Crawford
New Hampshire (Class I state) – Jeff Underhill
New Jersey (Class I state) – Ray Papalski
Vermont (Class I state) – Justin Johnson, Dick Valentinetti, Paul Wishinski
Pennsylvania - Tim Leon-Guerrero
Penobscot Nation – Bill Thompson

<u>VISTAS States</u>:
Georgia - Carol Couch, Heather Abrams, Jim Boylan, Chuck Mueller
Kentucky – Diana Andrews, Lona Brewer, John Lyons, Cheryl Taylor
North Carolina – Laura Boothe, Sheila Holman, Keith Overcash
South Carolina – Myra Reece, Renee Shealy
Tennessee – Julie Aslinger, Tracy Carter, Quincy Styke
Virginia – Jim Sydnor, Tom Ballou
West Virginia – John Benedict, Laura Crowder, Fred Durham

Multi-State Organizations:
OTC/MANE-VU – Anna Garcia, Doug Austin
MARAMA/MANE-VU – Susan Wierman
NESCAUM/MANE-VU – Gary Kleiman
VISTAS – John Hornback, Pat Brewer

Federal Land Managers:
National Park Service – Bruce Polkowsky
Forest Service – Cindy Huber, Chuck Sams, Andrea Stacy
Fish & Wildlife Service – Tim Allen

Environmental Protection Agency:
Region I – Anne McWilliams
Region II – Bob Kelly
Region III – LaKeshia Robertson, Ellen Wentworth
Region IV – Beverly Banister, Rick Gillam, Brenda Johnson, Kay Prince
OAQPS – Michelle Notarianni

Consultation Meeting Presentations and Discussions

Welcome and Introductions – Goals for Today's Meeting - David Littell, Maine DEP

- Presented goals for today's consultation:
    - Review requirements, resources and critical timing issues to ensure all share a common understanding;
    - Discuss options for control measures to identify what is reasonable for joint work between regions;
    - Identify impediments to implementing control measures and discuss how to address them;
    - Identify links between haze and PM that help define what is reasonable;
    - Examine reasonable progress for VISTAS and MANE-VU Class I areas in terms of control measure options; and
    - Summarize points of agreement and identify issues for follow-up consultation.
- Carol Crouch, Georgia, welcomed the attendees stating that today's dialogue seeking clarification and understanding on regional air quality issues by so many states is notable. The Georgia Resource Board just adopted a rule for multi-pollutant controls for their EGU sector that will see 22 of 32 units controlled including SO2 emissions reductions of 89% from 2002 base emissions. Ms. Crouch added that she hopes that today's discussions will highlight additional emission reduction opportunities.

Overview of Open Technical Call & Consultation Briefing Book – Anna Garcia, MANE-VU

- Open Technical Call discussions provided a good technical basis for today's meeting.
- Ms. Garcia noted that recent MANE-VU sensitivity modeling results form the basis for the various "ask" levels (within MANE-VU, outside of MANE-VU, and a national "ask") as reflected in the MANE-VU statements. The MANE-VU Class I states developed these statements to outline the reasonable measures that comprise a long term strategy for achieving reasonable progress at the MANE-VU Class I areas. These statements, also informally referred to as the "asks" that MANE-VU Class I states are making of the MANE-VU states, and states outside of MANE-VU that have been determined to

reasonably contribute to visibility impairment at MANE-VU Class I areas, and the US EPA for additional reductions from EGU sources on a national basis.

- MANE-VU staff will developing draft documentation of the Open Call and of today's discussions, and will circulate the drafts for comment and make the final documentation available to all states for use in their state implementation plans (SIPs).

Summary of Reasonable Progress Work and Development of "Asks" for MANE-VU Class I Areas – Paul Wishinski, Vermont DEC

Presentation:

- Provided a review of MANE-VU Class I states' Resolution on Principles;
- Showed focus for MANE-VU is on sulfate reductions for the 2018 milestone;
- Gave an overview of MANE-VU's four factor analysis;
- Outlined how MANE-VU Class I states developed the "asks" for the MANE-VU and VISTAS regions;
- Provided a comparative analysis of the MANE-VU region "ask" with that of the VISTAS "ask";
- Outlined the specifics of each of the "asks," including for VISTAS:
  - Timely implementation of BART requirements;
  - A focused strategy for the electricity generating units (EGUs) comprising a 90% reduction of sulfate emissions from 2002 levels from 167 stacks that modeling indicates affect visibility impairment in MANE-VU Class I areas;
  - A 28% reduction from non-EGU sector emissions based on 2002 levels; and
  - Continued evaluation of other measures, including measures to reduce SO2 and nitrogen oxide (NOx) emissions from coal-burning facilities by 2018.
- Within MANE-VU, the Class I states have the following commitment:
  - Timely implementation of BART requirements;
  - A focused strategy for the electricity generating units (EGUs) comprising a 90% reduction of sulfate emissions from 2002 levels from 167 stacks that modeling indicates affect visibility impairment in MANE-VU Class I areas;
  - A low sulfur fuel oil strategy with different implementation timeframes for inner zone states versus outer zone states, that results in a 38% reduction from non-EGU sector emissions in the MANE-VU region; and
  - Continued evaluation of other measures, including measures including energy efficiency, alternative clean fuels and other measures to reduce SO2 and nitrogen oxide (NOx) emissions by 2018.
- Also outlined the national "ask" MANE-VU plans to make of the US EPA, for a Phase 3 of CAIR that reduces SO2 by at least an additional 18%.
- From presentation, next steps are:
  - Consult within and outside MANE-VU about which control strategies are reasonable;
  - Open a dialogue with the USEPA concerning a possible Phase 3 of CAIR;
  - Define strategies to include in the final modeling;
  - Determine goals based on the final modeling;
  - SIPs are due 12/17/07;
  - Adopt enforceable emissions limits & compliance schedules; and
  - Progress evaluation due in 5 years.

Discussion:

- *Question (John Benedict, West Virginia)*: Is there geographical variability in MANE-VU's low-sulfur fuel oil strategy?

- *Answer (Gary Kleiman, NESCAUM)*: There are baseline levels for fuel oil usage within each state, but the fuel oil markets are regional in nature.
- *Comment (David Littell, Maine)*: The issue in Maine is peak oil usage by EGUs in the winter since they can get fuel oil from Venezuela and the USSR.

- *Question (John Benedict, West Virginia)*: What is the current distillate sulfur level?
  - *Answer (Paul Wishinski, Vermont)*: Between 220-2500 ppm.
- *Question (Tom Ballou, Virginia)*: Could you explain the rearrangement of the EGU emissions?
  - *Answer (Gary Kleiman, NESCAUM)*: They are spread out between all EGUs proportionately, except for those in the 167 stacks, to maintain the cap.
- *Question (Pat Brewer, VISTAS)*: Were adjustments made in the recent CMAQ sensitivity runs?
  - *Answer (Gary Kleiman, NESCAUM)*: Yes, for the tags. [Note: tagging is a modeling technique that identifies the benefits of individual control strategies].

<u>Summary of VISTAS Reasonable Progress Work</u> – Pat Brewer, VISTAS

<u>Presentation:</u>

- Provided both an overview and response to the MANE-VU "asks" including updates the VISTAS states received from their utilities last summer. The VISTAS Base G inventory may already satisfy the MANE-VU EGU "ask," and the 2018 Base G2 inventory includes the recent EGU controls enacted by Georgia. VISTAS' Base G2 and MANE-VU's CAIR+ runs look similar.
- VISTAS visibility problems and areas tend to overlay their PM2.5 nonattainment areas.
- VISTAS currently doing a 4-factor analysis for non-EGU sources.
- The SO2 focus for the 2018 SIPs are for both the 20% best and worst days. The coastal Class I sites have non-summer days in the 20% worst. Even on the 20% best days, VISTAS has a sulfur story.
- Organic carbon is 2^{nd} in importance regarding regional haze.
- VISTAS realizing 70% EGU reductions from EGU sector between 2002 and 2018. Eight scrubbers are now in operation in North Carolina. Even with scrubbers, the large EGUs still have SO2 emissions on the order of 5,000 tons per year.
- All of the VISTAS Class I mountain sites will have better than uniform progress. Mammoth cave and Sipsey see more wintertime nitrate than the others.
- The SO2 reductions will result in no degradation for the 20% best days.
- VISTAS' reasonable progress analysis was developed in fall 2006, and started with source sector sensitivity analyses confirming the need for SO2 reductions for the greatest visibility benefits.
- Large ammonia contributions seen at the coastal sites (Cape Romaine and Brigantine). Recirculation of these ammonia emissions out to the ocean and recirculation back characterized as boundary conditions.
- VISTAS consultations to date include a 12/2006 and 5/2007 Air Directors' meetings including letters to contributing states, a 6/2007 meeting with EPA and the FLMs, and North Carolina and South Carolina have submitted draft SIPs to the FLMs for their preliminary review.
- As for VISTAS states' contribution to MANE-VU Class I areas, VISTAS and MANE-VU have arrived at different conclusions of impacts on Brigantine, Lye Brook, and Acadia using different methodologies. [Note: MANE-VU used percent sulfate contribution methodology, whereas VISTAS used the Area of Influence (AOI) and residence time methodology.]
- As for responses to MANE-VU "asks," (1) BART satisfied within VISTAS, e.g, most BART sources meet exemption modeling criteria, some sources taking emission limits, most EGUs reducing SO2 and NOx under CAIR; (2) for 167 EGU list, VISTAS states will review EGU progress in 2012 to see where

emissions are versus the 90% target; and (3) for non-EGU, this is a ripe area for further discussion – VISTAS has lots of chemical plants and pulp and paper facilities.

- Wondering how the MANE-VU stakeholders have reacted to the low-sulfur fuel oil strategy since VISTAS analysis shows little visibility benefit from non-EGU sector and low-sulfur fuel oil strategies within VISTAS.
- There are large costs for SO2 emissions reductions from the coal-fired non-EGU sector.
- Conclusions and key findings from VISTAS analyses:
    - The greatest visibility benefits come from EGU and non-EGU SO2 reductions.
    - The VISTAS stakeholders asked "which sources?" To answer them, the AOI analyses looked at 100 km and 200 km radii with emissions weighted by residence time. AirControlNet used for all sources meeting both Q/d >5 and >10% residence time criteria to allow each state to prioritize for their 4-factor analysis.
    - Reasonable progress will be at least as stringent as the Base G2 controls.

Discussion:

- Comment *(Susan Wierman, MARAMA)*: If Base G2 inventory is correct and these SO2 reductions were not predicted by IPM, then it is essentially a beyond-CAIR strategy.
- *Question (Jeff Underhill, New Hampshire)*: Could upcoming modeling be clarified?
    - *Answer (Pat Brewer, VISTAS)*: There will be a full run this fall with Base G2 (it will also include any available controls for BART sources and other reductions identified by States through 4-factor reasonable progress analyses), and they have done sensitivity runs for BOTW reductions (30% beyond 2009).
- *Comment (Jeff Underhill, New Hampshire)*: Glad to see VISTAS is using Q/d, but not sure about depending on residence time. Also, after MRPO consultation, may be working together on non-EGU sector analysis, and VISTAS states join in if interested.
- *Question (Tad Aburn, Maryland)*: How have the new NAAQS standards impacted VISTAS?
    - *Answer (Pat Brewer, VISTAS)*: The PM2.5 problem areas are Birmingham, Atlanta, Kentucky, and West Virginia in 2009
- *Question (Ray Palpaski, New Jersey)*: Will the reductions for those PM2.5 areas also be in the regional haze SIPs?
    - *Answer (Pat Brewer, VISTAS)*: Yes, for North Carolina and Georgia, but not sure about the CAIR states.
- *Comment (Ray Palpaski, New Jersey)*: We need to get enforceable reductions for the CAIR states.

EPA and FLM Perspectives on RPGs and Reasonable Measures Work – Tim Allen, Fish and Wildlife Service; Bruce Polkowsky, National Park Service; Chuck Sams, Forest Service; Michelle Notarianni, EPA - OAQPS

Tim Allen, Fish and Wildlife Service

- The Fish and Wildlife and National Park Services are reviewing the regional haze SIPs as a team, and the Forest Service is conducting a separate review.
- In general, the FLMs are mainly concerned with content, and would like to see a SIP or long term strategy with a satisfactory conclusion. They are also concerned with the uncertainty of emissions growth, so they would also like the states to review the certainty level of identified emissions reductions.
- States should talk with EPA about the timing of regional haze SIP submissions. From the FLMs perspective, it would be better to have a more complete SIP, even if that means it would result in a

submittal that is slightly delayed beyond the deadline. The FLMs have seen three SIP submissions thus far – from NC, SC and CO.
- If a state would like expedited review, highlight key sections. Also, highlight any new technical information that they have not yet seen from consultations and that will require extra review time.
- For the 20% best days non-degradation goal, states should consider Prevention of Significant Deterioration (PSD) as part of their regional haze SIPs. The BART elimination test may be used for PSD.
- An observation from the MANE-VU/MRPO consultation is that the equivalent reductions process embodied in the MANE-VU "ask" works for reaching the visibility goals.

<u>Bruce Polkowsky, National Park Service</u>
- A reminder that thirteen days ago was the 30th anniversary of the passage of the 1977 Clean Air Act Amendments that enacted section 169A and established the regional haze program.
- The regional haze SIPs are the beginning of folding in protection of Class I areas to the nation's air quality effort.
- We may be getting to the point where a beyond-CAIR program is achievable. Given the additional 800,000 tons of emissions that are in the "ask", if states are getting them already, is this really that far from an additional phase of CAIR? If we can get SO2 reductions from EGUs, they should be permanent.

<u>Chuck Sams, Forest Service</u>
- He concurs with the perspectives presented by FWS and NPS.
- The Forest Service will be sending a document on SIP submissions to MANE-VU.
- Note that the 20% best days level will be a new baseline for the following 10-year period.
- Residual oil SO2 controls, especially marine, is an area ripe for more analysis and inter-RPO agreement.
- States should avoid the concept of the "committal SIP," but focus on "commitments." The FLMs would like to see as many emission reduction commitments as possible.

<u>Michelle Notarianni, EPA – OAQPS</u>
- Ms. Notarianni opened the floor for questions.
- *Question (Jeff Underhill, New Hampshire)*: Is EPA pushing to have regional convergence on regional haze SIP issues, i.e., how will EPA regional offices coordinate their review of these SIPs?
  - *Answer (Michelle Notarianni, EPA)*: There are ongoing discussions amongst the EPA Regions at a national level through the national workgroup, and it is anticipated that inter-regional discussions will occur on specific SIPs, similar to how the Regions handle multi-state ozone attainment SIPs.
  - *Question (Dick Valentinetti, Vermont)*: Is there an EPA SIP approval process for SIPs that are inter-related but come in at different times?

    - *Answer (Michelle Notarianni, EPA)*: EPA is looking at that issue right now, but they also must act within 18 months of receipt of each SIP submittal under the Clean Air Act.
- *Question (Tad Aburn, Maryland)*: Have there been any internal EPA discussions on the MANE-VU national "ask" or a next phase of CAIR?
  - *Answer (Michelle Notarianni, EPA)*: She is not aware of any but will follow-up. (Anna Garcia later provided the names of OAQPS representatives that MANE-VU has been in contact with on this topic.)

- *Comment (John Hornback, VISTAS)*: We need to show EPA enough information on costs and benefits, and the burden is on the states to make the case.
- *Comment (Bruce Polkowsky, NPS)*: The MANE-VU / MRPO agreement from the consultation two weeks ago is to accomplish exactly that, and he hopes the VISTAS states will join the effort.

- *Question (Bill Thompson, Penobscot Nation)*: How far along are other tribes with their regional haze SIPs? Is there any information available?
  - *Answer (Bruce Polkowsky, NPS)*: No activity from the Western tribes that he knows of.
- *Question (Bruce Polkowsky, NPS)*: Since state regulations will not be in place by SIP submittal and since these are 10-year SIPs, can EPA find a way to allow commitments?
  - *Answer (Michelle Notarianni, EPA)*: There are legal problems with that approach. In general, commitments in SIPs are allowed in a very narrow set of circumstances according to EPA's General Counsel. Exclusion of control measures due to lack of time, authority, or funding are not acceptable justifications for use of this approach.
  - *Comment (Anna Garcia, MANE-VU)*: MANE-VU will be trying to develop draft SIP language that will pass EPA muster on this issue, and would like EPA feedback.
  - *Comment (Rob Sliwinski, New York)*: The reality is that these are non-enforceable SIPs, and despite the requirements EPA will be getting committal SIPs from all states.
  - *Comment (Michelle Notarianni, EPA)*: EPA has no flexibility to change the regional haze SIP deadline due to statutory constraints, and they will have to see what is submitted and react accordingly. States should contact their Regional Office if they expect their SIP to be late.
  - *Comment (Beverly Banister, EPA)*: There is a meeting of the EPA Region III Air Directors in mid-September. These issues are foremost on the agenda, and she will share the discussion results afterwards if there is anything new to add to what was discussed today..
  - *Question (Rob Sliwinski, New York)*: Will EPA do regional haze FIPs?
    - *Answer (Michelle Notarianni, EPA)*: I have no answer on that at this time. The Agency has made no decision at this point as to how it will handle late regional haze SIPs. Again, States should contact their Regional Office if they expect their SIP to be late.
- *Comment (Susan Wierman, MARAMA)*: EPA should consider providing incentives outside of the SIP process like Early Action Compacts for ozone attainment. Also, EPA does not have the time to do regional haze FIPs.
- *Comment (Michelle Notariani, EPA)*: Thank you for your comment. We can share this with the national EPA workgroup. Note that Region 8 is presently working on a FIP for Montana.

Presentation by Susan Wierman, MARAMA

- Review of IPM emissions bar charts and future EGU strategies showing that it is feasible to do more than CAIR.

Roundtable Discussion on Reasonable Progress Goals and Reasonable Measures

States continued the consultation with a roundtable discussion on all issues raised during the Open Technical Call and this consultation meeting. Most of the discussion focused on the substance of the MANE-VU statements, or "asks" from the VISTAS states and from the U.S. EPA. Anna Garcia, MANE-VU, noted that MANE-VU will have health benefits information related to regional haze strategies in the fall.

Boiler MACT, ICI Boilers, and Pulp and Paper Sector

During the Open Technical Call it was suggested that there may be an opportunity to examine the scope of the ICI boiler sector and potential emission reductions from that source category. Several states brought up the recent vacatur of the Boiler MACT in providing the possibility for states to work together on this sector. The National Association of Clean Air Agencies (NACAA) is discussing with its members and the Ozone Transport Commission (OTC) and Northeast States for Coordinated Air Use Management (NESCAUM) an effort to develop a Boiler MACT model rule. While for Boiler MACT this effort would focus on hazardous air pollutants (HAPs), including volatile organic compounds (VOCs), it may be possible to include in that project a parallel process to gather information on NOx and SO2 emissions from the boiler sector and develop options for control strategies, separate from the MACT levels.

MANE-VU opened up the discussion on ICI boilers noting the recent agreement with the MRPO states to reconvene the ICI Boiler Workgroup for a collaborative effort in that sector and how VISTAS had indicated on the Open Technical Call was an area of interest to them. MANE-VU inquired whether VISTAS states would be interested in joining in such a collaborative effort. VISTAS expressed interest, inquiring as to whether policy or technical work would be needed and noting that it is very difficult to justify higher costs to the ICI sector when more cost-effective EGU reductions are still available. MANE-VU indicated that there will be a need for more cost and inventory work and possibly some health benefits analysis in order to build a case for ICI boiler reductions, and that there is an opportunity for coordination with NACAA on the upcoming Boiler MACT work. NESCAUM indicated that they will have a draft study on this sector out by the end of the year, and MANE-VU offered to share information and continue discussions to see what approaches states in both regions may be interested in taking.

VISTAS inquired whether MANE-VU had had any stakeholder feedback on the 4-factor analysis. MANE-VU replied that there had been no specific comments on the analysis; however, the Northeast states have been engaged in discussions with the oil industry on low-sulfur fuel oil. Maine added that it has had discussions with its sources that use residual oil. New Hampshire also noted that at a recent Council of Industrial Boilers meeting, most of the attendees accepted that it is only a matter of time before more reductions will be expected from this sector.

The ICI sector discussion moved to the pulp and paper industry. Georgia stated that they are getting comments from that industry questioning the level of control costs that is considered to be cost-effective, and noted that the state has not made any decisions on a bright line. New York commented that it does not make sense for states to pursue trying to define bright line costs individually, so we should keep the lines of communication open between our regions. VISTAS informed the group that EPA currently has a pulp and paper sectors strategy process with a multi-pollutant aspect, so it is a good time to get involved in that process. According to EPA, a draft preamble and model rule language for that process is due out towards the end of September. New York cautioned that states should understand what is contained in that pulp and paper model rule to see if any facilities are given a pass.

Follow up items from this discussion include:

- Identify VISTAS states interested in participating with MANE-VU and MRPO states on a boiler workgroup to examine potential sector controls, costs and health benefits;
- Review draft preamble and model rule language of EPA's pulp and paper sector strategy for discussion and comment; and
- Coordinate with NACAA's Boiler MACT effort.

Locomotive and Marine Sectors

MANE-VU then moved the discussion to focus on potential opportunities for emissions reductions from locomotives and ocean-going vessels. According to VISTAS, those emissions represent <1% of total SO2 emissions, so they are not important in the big picture, and that ,in fact, in the Gulf states those emissions may be blowing out of the domain. They noted, however, that it is also important to look at ozone and PM2.5 nonattainment issues in port cities, including inland Mississippi River ports, where reductions of those emissions may be more important but have ancillary benefits for regional haze. Maine added that an outcome from the MRPO consultation was that benefits from reductions from these sources are important to the MRPO states. MANE-VU suggested that a unified inter-RPO position for a national "ask" for this sector may be possible

Follow up items from this discussion include:

- Examine potential for ancillary benefits for regional haze from potential controls on port emission sources to reduce ozone and PM 2.5.

The National "Ask," and EGU and non-EGU Sectors

The group then turned to the EGU sector and a discussion of the potential for an inter-RPO dialogue on beyond-CAIR issues. The National Park Service noted that, given that the total EGU SO2 reductions identified by VISTAS states in correcting IPM output was less than the CAIR budget, that VISTAS states may want to consider supporting a national "ask" concept outlined by MANE-VU. EPA Region IV asked whether MANE-VU had discussed the national "ask" with anyone in EPA, and MANE-VU explained that the "ask" is based on a CAIR Plus analysis presented at an OTC meeting attended by Sam Napolitano, Bill Harnett, and Peter Tsirigotis, and that the OTC modeling analysis showed that a program that includes the entire CAIR domain is needed for an effective beyond-CAIR program. The OTC is currently re-examining its multi-pollutant position. Some VISTAS states did express interest in exploring the idea of a next phase of CAIR, and continuing discussions with MANE-VU on the national "ask," noting that additional reductions will be needed later for attainment of the new ozone and 24-hour PM standards.

Discussion followed on what information would be needed to help the VISTAS states in reviewing a national "ask" calling for a third phase of CAIR. One critical piece of information identified by VISTAS is a better understanding of the ozone benefits that a CAIR Plus strategy would yield since regional haze may provide insufficient leverage as a driver for a beyond-CAIR strategy. For those states ozone and/or the new 24-hour PM2.5 standard is a more significant driver. It was noted, however, by MANE-VU that regional haze can be the driver if supplemented by information on reductions in premature mortality that yield benefits of at least a factor of ten as compared to costs, and that the MRPO states interested in supporting the national "ask" are mainly looking at it for PM 2.5 benefits.

During the discussion about the MANE-VU "ask" for a 90% reduction from EGUs on the list of 167 stacks, MANE-VU states indicated that it would be helpful to also see an updated list of controls for the list of 167 units as well as any large non-EGUs not on the list.

As the focus of discussions turned to non-EGUs, VISTAS commented that at this time only two states have completed their BART determinations. MANE-VU added that their states are also still in the process of completing their BART determinations.

Follow up items from this discussion include:

- MANE-VU to revisit its multi-pollutant strategy;

- MANE-VU to provide benefits and other information on beyond-CAIR strategy to VISTAS;
- MANE-VU and interested VISTAS states to explore possibility of CAIR Phase III;
- Craft a revised national "ask" to reflect revised levels, as appropriate; and
  Exchange lists on updated controls anticipated on all EGUs.

Other Sectors

MANE-VU brought up the topic of alternative fuels, explaining that there was discussion with MRPO about biofuels and asking if there was interest in VISTAS in this area. Kentucky and Georgia expressed interest, and Tennessee informed the group that they are looking to become a leader in cellulosic ethanol production.

New Jersey raised a question about the possibility of developing a model rule for residential wood combustion that would be more stringent than EPA's rule for new fireplace units. VISTAS responded that residential wood combustion is not a big issue for them. The Forest Service noted that outdoor wood boilers are poorly controlled, with which Maine and New York agreed, commenting that larger commercial wood boilers are primarily a PM issue. However, it was pointed out by Vermont that particulate control is not cost-effective for smaller outdoor wood boilers.

Follow up items from this discussion include:

- Look at federal rules that are in the works for non-road, locomotive and marine engines to see if there are gaps or opportunities that MANE-VU and MRPO could explore together; and
  Share information on biodiesel as a low-sulfur fuel option.

Wrap-Up

As the consultation drew to a close MANE-VU asked whether the VISTAS states had any requests to make of MANE-VU states, as the intent of the meeting is for an exchange between the two RPOs. VISTAS requested that MANE-VU share any 2018 data that differs from the MANE-VU version 3 emission inventory. MANE-VU confirmed that they would provide information on the low-sulfur fuel oil strategy, the EGU strategy, and BART controls to VISTAS.

Follow up items from this discussion include:

- Continue to share specific information about what MANE-VU and VISTAS sources are anticipating as controls on EGUs as compared to what is indicated in IPM modeling;
- Update our inventories and databases accordingly so that our information is "synched"; and
- Continue dialogue on approaches for addressing this sector to meet the 90% reduction target for the 167 stacks and on equivalent alternatives.

Next Steps

In addition to the agreements reached during the discussions (listed at the beginning and in the roundtable discussion sections of this document) the MANE-VU Class I states and the VISTAS states agreed to continue the consultation dialogue over the next weeks and months. The states will continue discussions from today's meeting, bring forth additional issues as necessary, and have a first opportunity to review and discuss the draft documentation of the consultation.

MANE-VU Consultation Appendix

Summary of Consultation between the MANE-VU States

In early 2007, New Hampshire provided other states in the MANE-VU region with the results of technical analyses that illustrated which states in the region have emissions that are reasonably anticipated to contribute to impairment in one or more of New Hampshire's Class I areas, including Great Gulf Wilderness and Presidential Range - Dry River Wilderness. NHDES sent a letter to these contributing states, inviting them to participate in consultations with New Hampshire and the other Class I states in MANE-VU to discuss ideas on the types and amounts of emissions reductions that are reasonable and, therefore, necessary to achieve reasonable progress in improving visibility at New Hampshire's Class I areas. The consultation calls and meetings that New Hampshire engaged in with our counterparts in the MANE-VU region over this last year served as a platform for comparing technical work and findings, discussing any adjustments that might be appropriate, and developing mutually beneficial solutions.

Representatives from the MANE-VU states have been meeting periodically since 2000 to review technical information and provide their perspectives and direction on the subsequent iterations of the analyses. The MANE-VU states established a more formal consultation process in 2007, beginning with an in-person meeting of the members in Washington, DC on March 1, 2007. At this meeting the states received information on the requirements of the regional haze rule and how to define reasonable progress in Class I areas. The states also discussed potential control options which, if determined to be reasonable, would be considered as part of the Class I states' long term strategy for making reasonable progress toward achieving natural conditions by 2064. This was followed by a second in-person consultation in Providence, RI on June 7, 2007. This second meeting comprised a review of technical analyses completed to date, discussion of a resolution outlining the principles the Class I states would be following in their consultations with contributing states, and examination of a set of statements developed by the Class I states outlining their requests for control measures to be pursued by contributing states, both in the MANE-VU region and outside of it, for the purpose of achieving reasonable progress in the MANE-VU Class I areas .

The MANE-VU Class I states made revisions to the resolution and statements as a result of the discussions that occurred at the June 7th meeting. The MANE-VU states then engaged in another consultation via conference call on June20, 2007 to review the revised documents and vote on them. All member states on the consultation call voted to accept the resolution and statements, with the exception of New York and Vermont, who were unable to participate on the call. The MANE-VU executive staff followed up with both New York and Vermont by phone and email, and received their concurrence on the documents as well. Via the statement, the MANE-VU member states agreed to a course of action that includes pursuing the adoption and implementation of the following emission management strategies, as appropriate and necessary:

- timely implementation of BART requirements; and

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

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

- a 90% or greater reduction in sulfur dioxide (SO_2) emissions from each of the electric generating unit (EGU) stacks identified by MANE-VU (Attachment 1- comprising a total of 167 stacks – dated June 20, 2007) as reasonably anticipated to cause or contribute to impairment of visibility in each mandatory Class I Federal area in the MANE-VU region. If it is infeasible to achieve that level of reduction from a unit, alternative measures will be pursued in such State; and

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

In addition, the long-term strategy accepted by the MANE-VU states to reduce and prevent regional haze allows each state up to 10 years to pursue adoption and implementation of reasonable and cost-effective NOx and SO_2 controls.

Through the MANE-VU states' acceptance of the emission management strategies outlined in the statements on the June 20th call, they confirmed the set of actions the MANE-VU states will pursue in their state implementation plans (SIPs) to provide reasonable progress toward improved visibility by 2018, the first milestone in meeting the long-term regional haze goals for each Class I area. The MANE-VU Air Directors also consulted on issues concerning the emission management strategies outlined in the statements on three subsequent conference calls. During the September 26, 2007 call, participants discussed how to interpret the emission management strategies in the statements for purposes of estimating visibility impacts via air quality modeling. On February 28, 2008 the MANE-VU states received the results of the final 2018 modeling runs. Finally, on the March 21, 2008 call the states discussed the process for establishing reasonable progress goals for the MANE-VU Class I areas.

Summaries of the individual meetings and calls referenced above follow, along with copies of the final resolution and statements accepted by the MANE-VU member states.

Listing of consultation summary documentation:

1. Intra-MANE-VU Consultation Meeting Summary, March, 1, 2007, Washington, DC
2. Intra-MANE-VU Consultation Meeting Summary, June 7, 2007, Washington, DC
3. Intra-MANE-VU Consultation Conference Call Summary, June20, 2007
4. Intra-MANE-VU Consultation Conference Call Summary, MANE-VU Air Directors, March 31, 2008
5. 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, adopted June 20, 2007

6. Statement 1: Statement of the Mid-Atlantic/Northeast Visibility Union (MANE-VU) Concerning a Course of Action Within MANE-VU Toward Assuring Reasonable Progress, adopted June 20, 2007
7. Statement 2: Statement of the Mid-Atlantic/Northeast Visibility Union (MANE-VU) Concerning a Request for a Course of Action by States Outside of MANE-VU Toward Assuring Reasonable Progress, adopted June 20, 2007
8. Statement 3: Statement of the Mid-Atlantic/Northeast Visibility Union (MANE-VU) Concerning a Request for a Course of Action by the U.S. Environmental Protection Agency (EPA) Toward Assuring Reasonable Progress, adopted June 20, 2007
9. Attachment to Statements 1 and 2: List of 167 EGU stacks, dated June 20, 2007

Intra-MANE-VU Consultation Meeting Summary
March 1, 2007
Washington DC

Introduction

The Mid-Atlantic/Northeast Visibility Union (MANE-VU) held an in-person consultation meeting of the region's states on March 1, 2007 in Washington DC. The purpose of the consultation meeting was to fulfill the requirements of 40 CFR 51.308(d)(1)(B)(iv) and (3)(i) for Class I states to consult with contributing states on developing reasonable progress goals for the region's seven mandatory federal Class I areas, and for all contributing states to consult on the development of coordinated emission management strategies. All MANE-VU states were invited to participate along with the region's Federal Land Managers (FLMs) from the National Park Service, Fish & Wildlife Service, and Forest Service, and the Environmental Protection Agency (EPA) regional representatives from Regions I, II, and III.

Topics discussed included:

1) An overview of the regional haze program's goals and requirements;

2) A review of the uniform progress glidepaths and anticipated status of visibility impairment in 2018 in the seven MANE-VU mandatory federal Class I areas; and

3) A review of an analysis based on the Clean Air Act's statutory factors of what controls may be considered reasonable, and 4) Discussions of reasonable control options by source sector.

Key Outcomes of the Consultation

- As an overriding principle, MANE-VU looks for equivalent reductions, not equal reductions across source categories.
- A low-sulfur fuel oil strategy is viable as a MANE-VU 2018 control measure, at a 500 ppm sulfur limit in the near-term, and a 15 ppm goal for distillate in 2018.
- Sulfur limits on #4 and #6 fuel oil require more analysis, and oil-fired EGUs with scrubbers will need flexibility.
- The ICI boiler sector needs further analysis as to what controls may be reasonable, especially from small and medium-sized boilers.
- If it is reasonable for MANE-VU to achieve a 40% sulfur reduction in the non-EGU sector, it may also be reasonable that contributing states in other RPOs could find equivalent reasonable reductions.
- There was no real consensus on controls on residential wood / open burning as a regional strategy, as what can be achieved in these sectors varies widely from state to state.
- MANE-VU Class I states will conduct a series of separate phone calls to develop a proposal for moving forward on consultations and developing reasonable control options.
- The MANE-VU states agreed to keep working towards implementing reasonable regional controls, which would be discussed at the next MANE-VU consultation meeting in June 2007.

Attendees

States and Tribes:
Maine (Class I state) – David Littell, Jeff Crawford
New Hampshire (Class I state) – Jeff Underhill
New Jersey (Class I state) – Lisa Jackson, Nancy Wittenberg, Chris Salmi
Vermont (Class I state) – Justin Johnson, Dick Valentinetti, Paul Wishinski
Connecticut – Anne Gobin
Delaware – Ali Mirzakhalili
District of Columbia – Diedre Elvis-Peterson, Abraham Hagos
Maryland – Tad Aburn
Massachusetts – Arleen O'Donnell, Barbara Kwetz
Pennsylvania – Tom Fidler, Joyce Epps, Wick Havens
New York – Dave Shaw, Rob Sliwinski

Federal Land Management Agencies and EPA Regional Offices:
National Park Service – Bruce Polkowsky, John Bunyak
Forest Service – Anne Mebane, Anne Acheson, Andrea Stacey
Fish and Wildlife Service – Sandra Silva, Tim Allen
EPA Region I – Anne Arnold
EPA Region III – Makeba Morris, Neil Bigioni

Welcome and Introductory Remarks

David Littell, MANE-VU Vice-Chair and Commissioner of Maine's Department of Environmental Protection, opened the consultation with a welcome and introductions around the room. Mr. Littell followed with a presentation entitled "Bringing Clear Views to Acadia National Park and Other Class I Areas." Acadia National Park is one of three mandatory Class I areas in Maine while New Hampshire has two, and Vermont and New Jersey each have one. Mr. Littell noted that annual visitation at Acadia is over 2 million visits a year leading to visitor spending of more than $127 million in 2005, and surveys indicate that a clear vista is a strong factor in a visitor's positive experience at the park.

Mr. Littell then provided an overview of the goals for today's consultation, including:

- Review requirements, resources and critical timing issues to ensure all share a common understanding;
- Discuss options for control measures to identify what is reasonable in MANE-VU;
- Identify impediments to implementing control measures and discuss how to address them;
- Identify links between haze, PM, and ozone strategies that help define what's reasonable;
- Define reasonable progress for MANE-VU Class I Areas in terms of control measure options; and
- Summarize points of agreement and identify issues for follow-up consultation.

Overview of MANE-VU Consultation

Anna Garcia, MANE-VU Deputy Director, followed with a presentation entitled "Timing, Contribution, and Consultation." Noting that multiple methods show consistent conclusions about which states are top contributors and that a single MANE-VU consulting group offers the best opportunity to engage contributing states in a meaningful consultation process, Ms. Garcia emphasized that the MANE-VU states need to make sure we know what we are asking of the states within MANE-VU before consulting with contributing states outside of MANE-VU. Today's consultation is the first formal intra-MANE-VU consultation being held to develop MANE-VU's "clean hands" position and to start the process of determining reasonable control measures by MANE-VU states for the December 2007 Regional Haze State Implementation Plan (SIP) submissions.

MANE-VU Regional Haze Goals

Paul Wishinski from Vermont's Department of Environmental Conservation followed with a presentation entitled "Overview of Program Requirements for the Regional Haze Rule." Under the regional haze regulations, both the reasonable progress goals to be set by the Class I states and the long-term coordinated emissions strategies to meet the reasonable progress goals require consultations with contributing states and the Federal Land Managers (FLMs). Mr. Wishinski concluded, as did Ms. Garcia before, that the key next step is for the MANE-VU states to agree on what they believe are reasonable control measures for visibility improvement at the MANE-VU Class I areas.

Jeff Underhill from New Hampshire's Department of Environmental Services followed with a presentation entitled "Status of Visibility at MANE-VU Class I sites and Modeling for the Regional Haze Rule." Based on modeling results, Mr. Underhill concludes that all of MANE-VU's seven mandatory Class I areas will likely be below the uniform progress line in 2018 with "on-the-books" controls plus 500 ppm maximum sulfur limit for #2 distillate, except in Delaware and Vermont. However, more progress can be made through additional reasonable measures, and the Regional Haze Rule requires us to consider these measures via the consultation process with contributing states.

Developing Reasonable Progress for MANE-VU Class I Areas

Art Werner of MACTEC Federal Programs, Inc., MANE-VU's contractor for the four-factor reasonable progress project, followed with a presentation on the preliminary results of that project. Mr. Werner reviewed the four factors that need to be analyzed to determine which emission control measures are needed to make reasonable progress in improving visibility: 1) the costs of compliance, 2) the time necessary for compliance, 3) energy an nonair quality environmental impacts of compliance, and 4) the remaining useful life of any source subject to such requirements. Mr. Werner also presented a preliminary marginal cost figure of $1,390/ton (1999$) of SO2 in 2018 from a recent MANE-VU-sponsored IPM run for a "CAIR Plus" policy. The final report due in May will provide a methodology for addressing reasonable progress and inform the MANE-VU states on control measure costs for both priority source categories and selected individual sources for upcoming consultations on setting the reasonable progress goals for the MANE-VU mandatory Class I areas.

Assessing Control Options

The final presentation by Chris Salmi with New Jersey's Department of Environmental Protection entitled "Reasonable Measure Opportunities" emphasized that the MANE-VU Class I states intend to focus their reduction efforts for the 2018 milestone on sulfur dioxide reductions since they cause, on average, nearly 80% of the visibility impairment on the 20% worst days. Mr. Salmi presented recent control measure analyses showing that MANE-VU sources can reasonably achieve over 200,000 tons of SO2 reductions in 2018 from non-EGU control measures, primarily from ICI coal and oil-fired sources, a low-sulfur distillate strategy, and controls on Best Available Retrofit Technology (BART) sources. Mr. Salmi concluded his presentation by posing two questions for the members:

1) What measures does MANE-VU consider reasonable for 2018?, and
2) What measures do we ask others to implement?

The questions began a roundtable discussion initiated by Ms. Garcia's intentionally broad question to the members asking what is reasonable.

Summary of Discussion

NESCAUM suggested, and New Hampshire agreed that as an overriding principle what MANE-VU is looking for is equivalent reductions, not equal reductions across source categories. The discussion segued to what MANE-VU can reasonably accomplish for a low-sulfur fuel oil strategy. The members agreed that this is a prime example of a source category where MANE-VU can make reasonable reductions due the widespread use of distillate for residential and commercial heating. Other states primarily outside of MANE-VU do not have a similar reliance on fuel oil for heating, so they could make equivalent reasonable reductions from other source categories to match MANE-VU's heating oil sulfur reductions.

Further discussion continued with respect to two potentially reasonable fuel-oil strategies for the MANE-VU region, dubbed S1 and S2:

- S1 is less stringent and envisions a 75% reduction in sulfur content to 500 ppm by 2018 for home heating / distillate, and 50% reductions in sulfur content for #4 and #6 fuel oils.
- S2 envisions a 99.25% reduction in sulfur content to 15 ppm by 2018 for home heating / distillate, and the same 50% reductions for #4 and #6 as in S1.

New Hampshire suggested the need to move carefully due to the concerns about price and supply issues. Vermont countered that there is a 10-year timeframe to accomplish a low-sulfur fuel oil strategy. Pennsylvania suggested that a 500 ppm strategy is reasonable, but timing is important. Vermont added that the Northeast states have been discussing low-sulfur fuel oil strategies for ten years already, and that two or three states such as New York, New Jersey, and Connecticut need to go first and pass regulations to catalyze regional negotiations with industry. New Jersey noted that New Jersey has started their rulemaking process on low-sulfur fuel oil; New York added that New York has started their rulemaking process for 500 ppm for distillate by 2018. Connecticut said that Connecticut's fuel standards are set by statute, and the statute precludes Connecticut from lowering its fuel-oil standards until neighboring states Massachusetts and Rhode Island do so as well, presumably for regional supply reasons.

Continuing the low-sulfur fuel oil discussion, Pennsylvania asked if EPA has been approached on a national low-sulfur fuel oil strategy. New Jersey replied that EPA is not focusing on this area, leaving it to the states. NESCAUM added that the industry believes that part of the deal with EPA for accomplishing the 15 ppm on-road ultra low-sulfur diesel (ULSD) standard is that there will be no more sulfur reductions expected. MANE-VU noted that in recent discussions, the industry suggested it was possible to achieve a 15 ppm sulfur level for distillate within a 2014 timeframe. Massachusetts said that it may be difficult for Massachusetts to commit to a 15 ppm sulfur level in distillate by 2018, noting, however, that the positive co-benefits of greater furnace efficiency and therefore lower GHG emissions might help in instituting a 15 ppm sulfur level in distillate regulation. New Jersey emphasized that we have a decade to accomplish a 15 ppm sulfur standard for distillate.

MANE-VU asked the group about what might work in terms of lower sulfur limits in #4 and #6 fuel oils. Pennsylvania said that Pennsylvania has various sulfur limits and they would need more time to analyze such limits. New Jersey noted that these low-sulfur fuels are already available as some New Jersey counties are already below 5000 ppm sulfur. Maine questioned what limits on #6 fuel oil would mean for those oil-fired EGUs that have scrubbers.

MANE-VU wrapped up the low-sulfur fuel-oil discussion asking the group if the S1 strategy was viable as a MANE-VU 2018 region haze control measure. The consensus was that a 500 ppm sulfur limit "near-term" and a 15 ppm "goal" for distillate in 2018 is viable. For #4 / #6 sulfur limits, the consensus was that more work needs to be done, and that flexibility should be provided to states that have scrubbers on their oil-fired EGUs.

The consultation moved on to sulfur reductions from the coal-fired ICI (Industrial, Institutional, and Commercial) sector and whether MANE-VU can include such reductions in a non-EGU strategy bundle at this time. Pennsylvania suggested that controls for small-to-medium size boilers (<100 MM Btu / hour heat input) may not be cost-effective, adding that a 50% reduction in sulfur emissions from coal-fired ICI sources may overestimate what can realistically be achieved. New Hampshire suggested that recent analysis by New Hampshire staff on installation costs should be considered. Maine added that this sector may be a viable source for other RPO states to achieve reasonable sulfur reductions from their non-EGU sectors that are equivalent to the 40% sulfur reductions expected from non-EGU sources within MANE-VU due to the low-sulfur fuel oil strategy.

The consensus concerning sulfur reductions from the coal-fired ICI sector was that there is a need for more analysis to determine what is reasonable to obtain sulfur reductions from small and medium-sized coal-fired boilers. There was also consensus that if MANE-VU achieves overall reasonable sulfur reductions in the 40% range from the non-EGU sector, then other RPOs could find equivalent reasonable reductions.

Discussions moved on to other potential regional haze control measures within MANE-VU. For lime and cement kilns, both Pennsylvania and New York agreed that there is wide variability in these sources. Pennsylvania suggested that lime kiln controls are not cost-effective, and that an EPA global settlement on cement kilns was coming soon anyway. New York added that they will be regulating its three cement kilns as BART sources.

For the residential wood combustion / open burning source category, there was general consensus on including outdoor wood boilers in this category. New Jersey encouraged greater use wood stove changeout programs. New Hampshire replied that what can be done on wood combustion varies from state to state, and, for example, in New Hampshire new wood stove standards would be acceptable, but not changeout programs. New York added that open burning bans are unenforceable, especially in rural areas. There was little consensus on control measures in this source category, especially considering that the primary pollutants of concern are organic carbon and direct particulate matter, and not sulfur which is the primary regional haze pollutant within MANE-VU for the first planning milestone in 2018.

The Intra-MANE-VU Consultation Meeting adjourned.

Intra-MANE-VU Consultation Meeting
June 7, 2007
Providence, Rhode Island

Introduction

The Mid-Atlantic/Northeast Visibility Union (MANE-VU) held an in-person consultation meeting of the region's states on June 7, 2007 in Washington DC. The purpose of the consultation meeting was to fulfill the requirements of 40 CFR 51.308(d)(1)(B)(iv) and (3)(i) for Class I states to consult with contributing states on developing reasonable progress goals for the region's seven mandatory federal Class I areas, and for all contributing states to consult on the development of coordinated emission management strategies. All MANE-VU states were invited to participate along with the region's Federal Land Managers (FLMs) from the National Park Service, Fish & Wildlife Service, and Forest Service, and the Environmental Protection Agency (EPA) regional representatives from Regions I, II, and III.

Topics discussed included: 1) the process for setting reasonable progress goals by the MANE-VU Class I states; 2) an approach for intra-MANE-VU consultation including control strategy development within MANE-VU for setting the reasonable progress goals; 3) an approach for consulting with states outside of MANE-VU on the reasonable progress goals to be established by the MANE-VU Class I states; and 4) the next steps in the consultation process.

Key Outcomes of the Consultation

- All of the MANE-VU states agreed that a resolution setting out the principles by which the Class I states will implement the regional haze rule should go the MANE-VU Board for approval, although the document was to be signed only by the MANE-VU Class I states.

- Two separate draft statements on courses of action by states within and outside MANE-VU for assuring progress towards the MANE-VU Class I States' reasonable progress goals were tabled until a corrected list of 167 EGU stacks impacting visibility in the MANE-VU Class I areas could be generated. The MANE-VU states agreed that they would vote by conference call once the corrected 167 EGU stack list became available.

Attendees

States:
Maine (Class 1 state) – David Littell
New Hampshire (Class 1 state) – Bob Scott, Jeff Underhill
Vermont (Class 1 state) – Justin Johnson, Dick Valentinetti
New Jersey (Class 1 state) – Lisa Jackson, Nancy Wittenberg, Chris Salmi
Connecticut – Dave Wackter
Delaware – Ali Mirzakalili
District of Columbia – Cecily Beall
Massachusetts – Arleen O'Donnell, Barbara Kwetz
Maryland – Tad Aburn
New York – Dave Shaw
Pennsylvania – Tom Fidler, Joyce Epps, Wick Havens
Rhode Island – Michael Sullivan, Steve Majkut

Federal Land Management Agencies and EPA Regional Offices:
National Park Service – Bruce Polkowsky (in person), Holly Salazar (on phone)
Fish & Wildlife Service – Tim Allen (on phone)
Forest Service – Ann Mebane, Ann Acheson (on phone)
EPA Region III (on phone)

Welcome and Introductions

David Littell, MANE-VU Vice-Chair and Commissioner of Maine's Department of Environmental Protection, opened the consultation with a welcome and introductions around the room, including those on the phone. Anna Garcia, MANE-VU Deputy Director, followed with a brief outline of the goals for the consultation, including an update on recent technical work and discussions of the proposed MANE-VU Class I states resolution on consultation principles, a proposed statement on control measures within the MANE-VU region for achieving reasonable progress goals, and a proposed statement on controls outside of the MANE-VU region for achieving reasonable progress goals.

Status of Technical and Policy Work Issues

Gary Kleiman, NESCAUM, led this session with an update of the recent technical work, including preliminary modeling results. All seven of the MANE-VU Class I areas will be below the uniform rate of progress in 2018 according to preliminary modeling results. Tad Aburn, Maryland, asked the Federal land Managers (FLMs) if the MANE-VU technical approach is satisfactory. Bruce Polkowsky, National Park Service, replied that the other eastern RPOs are doing similar work and achieving better than uniform progress but have different approaches to reasonable progress. Tim Allen, Fish and Wildlife Service, commented that MANE-VU is not taking as much of a chemistry-intensive approach as other RPOs, and MANE-VU will likely need to address nitrates and organics in the next regional haze planning phase after 2018. Mr. Allen added that he is very supportive of obtaining as many reductions as possible now as they will only be more difficult to obtain later.

Chris Salmi, New Jersey Department of Environmental Protection, followed with a presentation on MANE-VU's approach to fulfilling the regional haze rule's reasonable progress requirement. The statutory four-factor analysis for control strategies for visibility-impairing source sectors provides the central focus for the Class I states' determination of what is reasonable. Finally, Anna Garcia ended the session with a brief presentation on the process by which MANE-VU chose the regional source sectors that were included in the four-factor analysis.

Roundtable Discussions

The MANE-VU states began their consultation with a roundtable discussion of the draft resolution by the MANE-VU Class I states on principles for implementing the regional haze rule, including the requirement for consulting with contributing states on reasonable progress. After minor wording changes, the states then agreed to seek Board approval although the resolution would be signed only by the MANE-VU Class I states.

Roundtable discussions ensued on the two proposed statements, one on control strategies within the MANE-VU states for assuring reasonable progress, and the other for states outside MANE-VU. When it became clear that more work needed to be done so all states were comfortable with the final list of 167

EGU stacks having the greatest visibility impact on the MANE-VU Class I areas, the states agreed to postpone voting on the statements until a later date by conference call.

A final discussion on a draft statement on requesting further action by the U.S. Environmental Protection Agency (EPA) on tightening the CAIR program for assuring reasonable progress also occurred. The states also agreed to table a vote on this statement until a conference call.

Consultation Next Steps

A brief discussion on next consultation steps, especially with the Regional Planning Organizations outside of MANE-VU also occurred. Those steps include:

- Consulting within and outside MANE-VU about which control strategies are reasonable;
- Deciding how to include the strategies in the final statements in modeling;
- Determining goals based on final modeling;
- Pursuing the adoption of enforceable emissions limits & compliance schedules; and
- Evaluating progress in 5 years.

Intra- MANE-VU Consultation Conference Call Summary
June 20, 2007

Introduction

On June 20, 2007 the MANE-VU Commissioners and Air Directors participated on a conference call to continue consultation discussions on emission management strategies for the region to pursue to achieve reasonable progress toward natural conditions in the region's Class I areas. The MANE-VU state Members completed their review of a resolution and three statements proposed by the Class I states to the larger MANE-VU membership, and voted to accept these documents and confirm the set of actions the MANE-VU states will pursue in their state implementation plans (SIPs) to provide reasonable progress toward improved visibility b 2018, the first milestone in meeting the Class I areas' long-term regional haze goals.

Attendees

States, Tribes and MSOs:
Maine (Class 1 state) – David Littell, Jeff Crawford
New Hampshire (Class 1 state) – Jeff Underhill, Andy Bodnarik
New Jersey (Class 1 state) – Chris Salmi
Connecticut – Anne Gobin
Delaware – Ali Mirzakalili
District of Columbia – Cecily Beall
Massachusetts – Barbara Kwetz
Maryland – Tad Aburn, Andy Hiltebridle
New York – Dave Shaw
Pennsylvania – Tom Fidler, Joyce Epps, Wick Havens
Penobscot Tribe – John Banks, Bill Thompson
Rhode Island – Steve Majkut
NESCAUM – Arthur Marin, Gary Kleiman

Consultation Discussions

The MANE-VU states voted on and passed three statements, which are attached to this summary, with some minor changes. The three statements are entitled as follows:

1. Statement of the Mid-Atlantic/Northeast Visibility Union (MANE-VU) Concerning a Course of Action Within MANE-VU Toward Assuring Reasonable Progress;

2. Statement of the mid-Atlantic/Northeast Visibility Union (MANE-VU) Concerning a Request for a Course of Action by States Outside of MANE-VU Toward Assuring Reasonable Progress; and

3. Statement of the Mid-Atlantic / Northeast Visibility Union (MANE-VU) Concerning a Request for a Course of Action by the U.S. Environmental Protection Agency (EPA) Toward Assuring Reasonable Progress.

The final versions of the statements which were accepted via the vote reflect the following changes:

- agreement on the list of EGU stacks, which is attached to both Statement 1 and 2, and revising the table to remove columns listing plant type, SO2 tons per year and rank, and changing the bottom notes accordingly (see explanation below);
- removal of the phrase "top 100" from the 4th action bullet on Statement 1 and the 2nd action bullet on Statement 2 (regarding 90% reduction from EGUs);
- correction of the date for 500 ppm low sulfur fuel oil to "by no later than 2012" (I made the error of changing that date to "2014" in translating the Consultation comments - it should be 2012 as for the other inner zone fuel requirements);
- revision of the last paragraph in Statement 3 to delete "beyond 2018 CAIR levels" and replace it with "by no later than 2018"; and
- a change in the signature line on all three statements to "Adopted by the MANE-VU States and Tribes on (date)."

In addition, the members agreed to keep the columns that were deleted from the abbreviated "167 stacks" table as part of the larger spreadsheet of the 167 stacks that MARAMA produced and t make that document part of a technical support document to Statements 1 and 2. The columns were deleted to keep the table simple and to reduce confusion about tons per year information used in the modeling vs. tons per year information in the Acid Rain Database, in which there are some differences. Attachment 1 to the Statements refers to the 2002 tons per year information from the MANE-VU Contribution Assessment at the bottom of the table.

The MANE-VU states also confirmed that, if it is infeasible for the oil/gas units that are in New Hampshire and Maine to meet the 90% reduction for EGUs, meeting the low sulfur fuel oil requirements would be sufficient. In addition, the MANE-VU states will also credit early state actions (within a few years prior to 2002) toward the 90% target of reducing emissions from EGUs on the "167 stack" list.

The group also decided that the technical support document for the statements and the consultation summaries would be circulated to the MANE-VU states for their review and comment, and to get any further corrections to the more comprehensive table of 167 stacks (some states had changes to the plant types on the list).

<u>Voting on the Statements</u>

At the end of the call the states voted on whether they would accept each of the statement. For Statement 1, New Jersey moved that the statement be put up for a vote and Pennsylvania seconded the motion. All MANE-VU states on the call voted to accept Statement 1. On Statement 2, the Penobscot Tribe moved that it be considered for a vote and Massachusetts seconded the motion. Once again, all MANE-VU states on the call voted to accept Statement 2. Finally, for Statement 3, the Penobscot Tribe moved that it be considered for a vote and New Jersey seconded the motion. All MANE-VU states on the call voted to accept Statement 3.

New York and Vermont were unable to participate on the consultation conference call, so to ensure that all the MANE-VU member states are in agreement on these actions, the MANE-VU executive staff proposed to contact each state individual by phone and email to get their response to the vote on the statements. Within one day of the consultation conference call, the MANE-VU executive staff briefed New York and Vermont by phone and email and received their confirmation that they accepted all three statements as revised on the call.

Intra-MANE-VU Consultation – March 31, 2008 – MANE-VU Air Directors' Call

States Attending the Consultation

Maine (Class I state) – Jeff Crawford
New Hampshire (Class I state) – Jeff Underhill, Andy Bodnarik
New Jersey (Class I state) – Chris Salmi, Stella Oluwasuen-Apo, Peg Gardner
Connecticut – Dave Wackter
Delaware – Jack Sipple
District of Columbia – Cecily Beall
Maryland – Roger Thunell, Brian Hug
Massachusetts – Glenn Keith
New York – Gopal Sistla, Rob Sliwinski
Pennsylvania – Joyce Epps

Representatives of MANE-VU member states met via conference call on March 31, 2008.

During the call, NESCAUM modeling assumptions and results were reviewed, and the three Class I states present (Maine, New Hampshire, and New Jersey) confirmed that they would be relying on the results of that modeling to set their reasonable progress targets. The targets based on the modeling were included in the MANE-VU SIP Template draft that is posted on the MARAMA web site and will be sent to EPA for review. (Note: sent on 4/2/08)

Ms. Garcia agreed to share the results of the MANE-VU modeling with Virginia and West Virginia before the Stakeholder meeting on Friday, April 4.

Maine, New Hampshire, Vermont, and Massachusetts had met with oil companies and distributors concerning the MANE-VU low sulfur oil strategy. Stakeholders had expressed some concern about the 0.5% limit for residual oil, but states wanted to gather more information before deciding whether to make any changes in the MANE-VU strategy.

Participating states reviewed choices concerning the Long Term Strategy section of the SIP Template, and it was agreed that a document describing those choices would be revised and discussed further with EPA and FLM agency representatives. Individual MANE-VU states might make different choices with respect to language in their SIPs, and some gave indications of their preferences.

MANE-VU Approach to the Development of "Consulting Groups"

On November 1, representatives from each RPO and the FLMs began a dialogue aimed at identifying groups of Class I areas that might serve to focus consultations for purposes of the regional haze rule. While it appears that consultations will be conducted state-to-state, the RPO representatives agreed that there may be a role for the RPO staff in identifying Class I areas with common visibility issues where a joint consultation process might be more efficient. At this point, the focus of the RPO efforts is to help identify common Class I "consulting groups" and leave it to the states involved in any future joint consultation process to discuss details regarding the nature and extent of state contributions to a common Class I group. Another role that the RPOs may play in the process is to assist with the scheduling of consultations so as to ensure that RPO-developed technical products would be ready and available to facilitate state discussions.

The Class I states within the MANE-VU RPO have considered the question of how best to group common Class I areas from the perspective of forming consulting groups. After reviewing monitoring and modeling data related to the sources of visibility impairment for each Class I site, they have proposed an approach that would create a single consulting group that encompasses all MANE-VU Class I sites. The "MANE-VU consulting group" would consist of the Acadia National Park, Maine; Brigantine Wilderness (within the Edwin B. Forsythe National Wildlife Refuge), New Jersey; Great Gulf Wilderness, New Hampshire; Lye Brook Wilderness, Vermont; Moosehorn Wilderness (within the Moosehorn National Wildlife Refuge), Maine; Presidential Range – Dry River Wilderness, New Hampshire; and Roosevelt Campobello International Park, New Brunswick.

The Class I states of MANE-VU recognize some differences between the Brigantine Wilderness and the northern tier of Class I sites in Vermont, New Hampshire and Maine. However, when viewed from the perspective of contributions to sulfate pollution – which is still the dominant form of visibility impairment experienced on the twenty percent worst visibility days at all MANE-VU sites – the group found more similarities than differences and felt that a single consulting group representing all MANE-VU sites offered the best opportunity to engage contributing states in a meaningful consultation process.

MANE-VU, therefore, proposes the addition of the MANE-VU consulting group to those already suggested by the Mid-West RPO in their October 19 memorandum. The revised "Table 1" on the next page reflects the proposed composition of the MANE-VU consulting group in a manner similar to that of the October 19 memo for three other proposed consulting groups. The MANE-VU Class I states are planning to contact those states listed in the proposed consulting group shortly to initiate the consultation process.

RPO	State	MI/MN (BOWA, VOYA, ISRO, SEN)	AR/MO/KY (UPBU, MINGO, HG, MACA)	VA/WV (DOSO, SHEN, JRIV)	MANE-VU (ACAD, MOOS, GRGU, LYBR, BRIG)
MANE-VU	Connecticut				x
	Delaware				x
	Maine				x
	Maryland			x	x
	Massachusetts				x
	New Hampshire				x
	New Jersey				x
	New York				x
	Pennsylvania			x	x
	Rhode Island				x
	Vermont				x
VISTAS	Alabama				
	Florida				
	Georgia				x
	Kentucky		x		x
	Mississippi				
	North Carolina				x
	South Carolina				x
	Tennessee		x		x
	Virginia			x	x
	West Virginia			x	x
MRPO	Illinois	x	x		x
	Indiana	?	x		x
	Michigan	x			x
	Ohio			x	x
	Wisconsin	x			
CENRAP	Arkansas		x		
	Iowa	x			
	Kansas				
	Louisiana				
	Minnesota	x			
	Missouri	?	x		
	Nebraska				
	Oklahoma				
	Texas				
WRAP	N. Dakota	x			
	S. Dakota				
	Other Western States				
Canada	Manitoba				
	New Brunswick				x
	Ontario	x			x
	Quebec				x
	Other Provinces				

MANE-VU Class I States' Consultation

1) **<u>When</u> – August 6, 2007**

2) **<u>Where</u> – MRPO Offices, Chicago, Illinois**

*****Draft Agenda*****

10:00 am	States Caucus	MANE-VU and MWRPO States & RPO staff
10:30 am	Welcome & Introductions - Goals for Today's Meeting	David Littell, ME DEP Chair, MANE-VU
10:45 am	Overview of June's Open Technical Call & MANE-VU Consultation Briefing Book	Anna Garcia, OTC
11:00 am	Summary of Reasonable Progress Work for MANE-VU Class I Areas - Proposed "ask" by the MANE-VU Class I States - Where the MANE-VU RPG is in 2018 based on the "ask"	MANE-VU Class I State Representative
11:20 am	Clarifying Questions	All Participants
11:30 am	Summary of Reasonable Progress Work for MWRPO Class I Areas - Proposed "ask" by MWRPO Class I States - Where the MWRPO RPGs are in 2018	MWRPO Class I State Representative
11:50 am	Clarifying Questions	All Participants
12:00 pm	Lunch	
1:00 pm	EPA and FLM Perspectives on RPGs and Reasonable Measures Work	EPA and FLM Representatives
1:30 pm	Roundtable Discussion on Reasonable Progress Goals and Reasonable Measures	All Participants
2:45 pm	Preliminary Summary of Consultation Discussions - Areas with agreement - Areas with no agreement	
3:00 pm	Next Steps	
3:15 pm	End of Consultation	

MANE-VU Class I States' Consultation

Open Technical Call

1) **<u>When</u> – July 19, 2007, 2 hours, 20 mins (10:00 AM – 12:20 PM)**
2) **<u>Call-in Number</u> – 1-866-537-1634, passcode 7545482#**

***** **Draft Agenda** *****

10:00 am	Introductions and Roll Call; Purpose of Today's Call	Anna Garcia
10:15 am	Review of MANE-VU's Contribution Assessment	Gary Kleiman
10:35 am	Q & A's on Contribution Assessment	All participants
10:45 am	Review of MANE-VU Reasonable Progress Project	Susan Wierman
11:00 am	Q & A's on Reasonable Progress Project	All participants
11:15 am	Reasonable Progress and Long-Term Strategy in MANE-VU Class I Areas: -- Resolution on Consultations -- Request for a course of action from contributing states (within MANE-VU region and outside it) -- Request for National action (from EPA)	MANE-VU Class I States
11:35 am	Reasonable Progress and Long-Term Strategy Needs from States Outside of MANE-VU -- Needs from MANE-VU region states -- Needs for National action (from EPA)	MWRPO and VISTAS Class I States
12:10 am	Discussion	All participants
12:20 am	Next Steps: In-Person Consultations - August 2007	Anna Garcia

ATTACHMENT E

The MANE-VU "Ask"

Mid-Atlantic/Northeast Visibility Union
MANE-VU

Reducing Regional Haze for Improved Visibility and Health

STATEMENT OF THE MID-ATLANTIC/NORTHEAST VISIBILITY UNION (MANE-VU) CONCERNING A COURSE OF ACTION WITHIN MANE-VU TOWARD ASSURING REASONABLE PROGRESS

The federal Clean Air Act and Regional Haze rule require States that are reasonably anticipated to cause or contribute to impairment of visibility in mandatory Class I Federal areas to implement reasonable measures to reduce visibility impairment within the national parks and wilderness areas designated as mandatory Class I Federal areas. Most pollutants that affect visibility also cause unhealthy concentrations of ozone and fine particles. In order to assure protection of public health and the environment, any additional air pollutant emission reduction measures necessary to meet the 2018 reasonable progress goal for regional haze should be implemented as soon as practicable .

To address the impact on mandatory Class I Federal areas within the MANE-VU region, the Mid-Atlantic and Northeast States will pursue a coordinated course of action designed to assure reasonable progress toward preventing any future, and remedying any existing impairment of visibility in mandatory Class I Federal areas and to leverage the multi-pollutant benefits that such measures may provide for the protection of public health and the environment. This course of action includes pursuing the adoption and implementation of the following "emission management" strategies, as appropriate and necessary:

- timely implementation of BART requirements; and

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

- a low sulfur fuel oil strategy in the outer zone States (the remainder of the MANE-VU region) to reduce the sulfur content of distillate oil to 0.05% sulfur by weight (500 ppm) by no later than 2014, of #4 residual oil to 0.25 – 0.5% sulfur by weight by no later than 2018, and of #6 residual oil to no greater than 0.5 % sulfur by weight by no later than

2018, and to further reduce the sulfur content of distillate oil to 15 ppm by 2018, depending on supply availability; and

- A 90% or greater reduction in sulfur dioxide (SO_2) emissions from each of the electric generating unit (EGU) stacks identified by MANE-VU (Attachment 1- comprising a total of 167 stacks – dated June 20, 2007) as reasonably anticipated to cause or contribute to impairment of visibility in each mandatory Class I Federal area in the MANE-VU region. If it is infeasible to achieve that level of reduction from a unit, alternative measures will be pursued in such State; and

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

This long-term strategy to reduce and prevent regional haze will allow each state up to 10 years to pursue adoption and implementation of reasonable and cost-effective NOx and SO_2 control measures.

Adopted by the MANE-VU States and Tribes on 20 June 2007

David Littell, Commissioner – Maine Dept. of Environmental Protection
Chair

Members
Connecticut
Delaware
District of Columbia
Maine
Maryland
Massachusetts
New Hampshire
New Jersey
New York
Pennsylvania
Penobscot Indian Nation
Rhode Island
St. Regis Mohawk Tribe
Vermont

Nonvoting Members
U.S. Environmental Protection Agency
National Park Service
U.S. Fish and Wildlife Service
U.S. Forest Service

MANE-VU Class I Areas
ACADIA NATIONAL PARK ME
BRIGANTINE WILDERNESS NJ
GREAT GULF WILDERNESS NH
LYE BROOK WILDERNESS VT
MOOSEHORN WILDERNESS ME
PRESIDENTIAL RANGE DRY RIVER WILDERNESS NH
ROOSEVELT CAMPOBELLO INTERNATIONAL PARK ME/NB, CANADA

Mid-Atlantic/Northeast Visibility Union
MANE-VU

Reducing Regional Haze for Improved Visibility and Health

STATEMENT OF THE MID-ATLANTIC/NORTHEAST VISIBILITY UNION (MANE-VU) CONCERNING A REQUEST FOR A COURSE OF ACTION BY STATES OUTSIDE OF MANE-VU TOWARD ASSURING REASONABLE PROGRESS

The federal Clean Air Act and the Regional Haze rule require States that are reasonably anticipated to cause or contribute to impairment of visibility in mandatory Class I Federal areas to implement reasonable measures to reduce visibility impairment within the national parks and wilderness areas designated as mandatory Class I Federal areas. Most pollutants that affect visibility also cause unhealthy concentrations of ozone and fine particles. In order to assure protection of public health and the environment, air pollutant emission reductions required to meet the 2018 reasonable progress goal for regional haze should be achieved as soon as practicable.

To address the impact on mandatory Class I Federal areas within the MANE-VU region, the Mid-Atlantic and Northeast States request that States outside of the MANE-VU region that are identified as contributing to visibility impairment in the MANE-VU mandatory Class I Federal areas pursue a course of action designed to assure reasonable progress toward preventing any future, and remedying any existing, impairment of visibility in mandatory Class I Federal areas and to leverage the multi-pollutant benefits that such actions may provide for the protection of public health and the environment. This request for a course of action includes pursuing the adoption and implementation of the following control strategies, as appropriate and necessary:

- timely implementation of BART requirements; and
- A 90% or greater reduction in sulfur dioxide (SO_2) emissions from each of the electric generating unit (EGU) stacks identified by MANE-VU (Attachment 1- 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

- the application of reasonable controls on non-EGU sources resulting in a 28% reduction in non-EGU SO_2 emissions, relative to on-the-books, on-the-way 2018 projections used in regional haze planning, by 2018, which is equivalent to the projected reductions MANE-VU will achieve through its low sulfur fuel oil strategy ; and

- continued evaluation of other measures including measures to reduce SO2 and nitrogen oxide (NOx) emissions from all coal-burning facilities by 2018 and promulgation of new source performance standards for wood combustion. These measures and other measures identified will be evaluated during the consultation process to determine if they are reasonable.

This long-term strategy to reduce and prevent regional haze will allow each state up to 10 years to pursue adoption and implementation, of reasonable NOx and SO_2 control measures.

Adopted by the MANE-VU States and Tribes on 20 June 2007

David Littell, Commissioner – Maine Dept. of Environmental Protection
Chair

Members
Connecticut
Delaware
District of Columbia
Maine
Maryland
Massachusetts
New Hampshire
New Jersey
New York
Pennsylvania
Penobscot Indian Nation
Rhode Island
St. Regis Mohawk Tribe
Vermont

Nonvoting Members
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U.S. Fish and Wildlife Service
U.S. Forest Service

MANE-VU Class I Areas
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BRIGANTINE WILDERNESS NJ
GREAT GULF WILDERNESS NH
LYE BROOK WILDERNESS VT
MOOSEHORN WILDERNESS ME
PRESIDENTIAL RANGE DRY RIVER WILDERNESS NH
ROOSEVELT CAMPOBELLO INTERNATIONAL PARK ME/NB, CANADA

Mid-Atlantic/Northeast Visibility Union
MANE-VU

Reducing Regional Haze for Improved Visibility and Health

STATEMENT OF THE MID-ATLANTIC / NORTHEAST VISIBILITY UNION (MANE-VU) CONCERNING A REQUEST FOR A COURSE OF ACTION BY THE U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA) TOWARD ASSURING REASONABLE PROGRESS

The US Clean Air Act and the EPA Regional Haze rule require States that are reasonably anticipated to cause or contribute to impairment of visibility in mandatory Class I Federal areas to implement reasonable measures to reduce visibility impairment within the national parks and wilderness areas designated as mandatory Class I Federal areas.

Most pollutants that affect visibility also cause unhealthy concentrations of ozone and fine particles, and contribute to other adverse environmental impacts. In order to assure protection of public health and the environment, air pollutant emission reductions required to meet the 2018 reasonable progress goal for regional haze should be achieved as soon as practicable.

MANE-VU assessments indicate that sulfur dioxide emissions from power plants in a broad region of the Eastern US are the most important contributor to regional haze at mandatory Class I Federal areas within MANE-VU.

By 2018, emissions from these plants will be substantially reduced under requirements of EPA's Clean Air Interstate Rule. This will result in improved visibility at MANE-VU Class I areas.

However, even after implementation of the CAIR rule, emissions from power plants will remain a substantial source of pollutants contributing to visibility impairment in MANE-VU Class I areas.

Furthermore, under more stringent national ambient air quality standards, these same pollutants will continue to contribute to ozone pollution and fine particle pollution in nonattainment areas within the region.

Therefore, it is an important responsibility of both EPA and the MANE-VU states to determine whether additional emissions reductions at power

444 North Capitol Street, NW ~ Suite 638 ~ Washington, DC 20001
202.508.3840 p ~ 202.508.3841 f
www.mane-vu.org

plants should be a part of a reasonably available strategy to improve visibility in the MANE-VU region.

MANE-VU sponsored additional modeling using the Integrated Planning Model (IPM®). Results of this modeling indicate that an additional 18% emissions reduction in SO2 emissions beyond CAIR levels could be achieved by 2018 at a reasonable cost.

The MANE-VU states and tribes request that EPA work with the eastern Regional Planning Organizations to develop a proposal for tightening the CAIR program to achieve an additional 18% reduction in SO2 by no later than 2018.

Adopted by the MANE-VU States and Tribes on June 20, 2007

David Littell, Commissioner – Maine Dept. of Environmental Protection
Chair

		TOP ELECTRIC GENERATING EMISSION POINTS CONTRIBUTING TO VISIBILITY IMPAIRMENT IN MANE-VU - MODELED BY BOTH VTDEC AND MM5													
Row number	CEMS Unit	ORIS ID	Acadia MM5	Acadia VTDEC	Brig MM5	Brig VTDEC	Lye MM5	Lye VTDEC	MM5 2002 SO2 TPY	VTDEC 2002 SO2 TPY		Plant Name	Plant Type	State Name	State Code
1	D005935	593			90	54			2,138	2,136	1	EDGE MOOR	O/G Steam	Delaware	10
2	D005941	594				95				3,742	2	INDIAN RIVER	Coal Steam	Delaware	10
3	D005942	594				74				3,760	2	INDIAN RIVER	Coal Steam	Delaware	10
4	D005943	594			84	44			4,686	4,682	2	INDIAN RIVER	Coal Steam	Delaware	10
5	D005944	594			69	21			7,390	7,384	2	INDIAN RIVER	Coal Steam	Delaware	10
6	D007031LR	703	79			86		75	38,520	38,486	3	BOWEN	Coal Steam	Georgia	13
7	D007032LR	703	72		89		61	68	37,289	37,256	3	BOWEN	Coal Steam	Georgia	13
8	D007033LR	703	71	99	74	64	63	94	43,067	43,029	3	BOWEN	Coal Steam	Georgia	13
9	D007034LR	703	69	95	86	58	60	89	41,010	40,974	3	BOWEN	Coal Steam	Georgia	13
10	D00709C02	709		84		75	89	71	47,591	47,549	4	HARLLEE BRANCH	Coal Steam	Georgia	13
11	D00861C01	861	28	96		65	46	62	42,355	42,318	5	COFFEEN	Coal Steam	Illinois	17
12	D010011	1001			53				28,876	28,851	6	CAYUGA	Coal Steam	Indiana	18
13	D010012	1001	95		46	68			26,016	25,992	6	CAYUGA	Coal Steam	Indiana	18
14	D00983C01	983					52		19,922		7	CLIFTY CREEK	Coal Steam	Indiana	18
15	D00983C02	983					54		18,131		7	CLIFTY CREEK	Coal Steam	Indiana	18
16	D0099070	990		55	100	70		37	29,801	29,774	8	ELMER W STOUT	O/G Steam	Indiana	18
17	D06113C03	6113	30	48	14	43	22	41	71,182	71,119	9	GIBSON	Coal Steam	Indiana	18
18	D06113C04	6113	44	70	97	83	73	83	27,848	27,823	9	GIBSON	Coal Steam	Indiana	18
19	D01008C01	1008			73		100	47	24,109	24,087	10	R GALLAGHER	Coal Steam	Indiana	18
20	D01008C02	1008			98			55	23,849	23,828	10	R GALLAGHER	Coal Steam	Indiana	18
21	D06166C02	6166	62	44	30	81	33	57	51,708	51,663	11	ROCKPORT	Coal Steam	Indiana	18
22	D00988C03	988						77		15,946	12	TANNERS CREEK	Coal Steam	Indiana	18
23	D00988U4	988	14	29	52	34	7	19	45,062	45,022	12	TANNERS CREEK	Coal Steam	Indiana	18
24	D01010C05	1010	43	32	12	28	31	17	60,747	60,693	13	WABASH RIVER	Coal Steam	Indiana	18
25	D067054	6705	34	60	34		44	73	40,118	40,082	14	WARRICK	Coal Steam	Indiana	18
26	D06705C02	6705	92		75		96		27,895		14	WARRICK	Coal Steam	Indiana	18
27	D01353C02	1353	38	30	15	26	85	29	41,545	41,508	15	BIG SANDY	Coal Steam	Kentucky	21
28	D01384CS1	1384	22				58		21,837	21,817	16	COOPER	Coal Steam	Kentucky	21
29	D01355C03	1355	21		51	99	68	52	38,104	38,070	17	E W BROWN	Coal Steam	Kentucky	21
30	D060182	6018	83				39		12,083		18	EAST BEND	Coal Steam	Kentucky	21
31	D01356C02	1356	93	71		88	50	59	25,646	25,623	19	GHENT	Coal Steam	Kentucky	21
32	D060411	6041	61						18,375		20	H L SPURLOCK	Coal Steam	Kentucky	21
33	D060412	6041	53		91			98	20,491	20,473	20	H L SPURLOCK	Coal Steam	Kentucky	21
34	D013644	1364			81				7,185		21	MILL CREEK	Coal Steam	Kentucky	21
35	D013782	1378					87		20,245		22	PARADISE	Coal Steam	Kentucky	21

Notes:
Plants in Red are added as a result of MM5 met modeling.
List does not include sources in states that do not contribute 2% of visibility impact to MANE VU Class I areas.
MM5 by ERM for Maryland

Printed : 7/27/2007 3:01 PM

Row number	CEMS Unit	ORIS ID	Acadia MM5	Acadia VTDEC	Brig MM5	Brig VTDEC	Lye MM5	Lye VTDEC	MM5 2002 S02 TPY	VTDEC 2002 S02 TPY		Plant Name	Plant Type	State Name	State Code
36	D013783	1378	76	100	11	84	55	42	46,701	46,660	22	PARADISE	Coal Steam	Kentucky	21
37	D015074	1507	78						1,170		23	WILLIAM F WYMAN	O/G Steam	Maine	23
38	D006021	602	90		38			100	20,014	19,996	24	BRANDON SHORES	Coal Steam	Maryland	24
39	D006022	602	99		29			99	19,280	19,263	24	BRANDON SHORES	Coal Steam	Maryland	24
40	D015521	1552			63				17,782	17,767	25	C P CRANE	Coal Steam	Maryland	24
41	D015522	1552			68				14,274	14,262	25	C P CRANE	Coal Steam	Maryland	24
42	D01571CE2	1571	42	47	1	4	20	28	48,566	48,522	26	CHALK POINT	Coal Steam	Maryland	24
43	D01572C23	1572	73	79	47	45	69	32	32,188	32,159	27	DICKERSON	Coal Steam	Maryland	24
44	D015543	1554			77				10,084	10,075	28	HERBERT A WAGNER	O/G Steam	Maryland	24
45	D015731	1573	67	50	16	12	56	38	36,823	36,790	29	MORGANTOWN	Coal Steam	Maryland	24
46	D015732	1573	59	53	10	13	51	39	30,788	30,761	29	MORGANTOWN	Coal Steam	Maryland	24
47	D016191	1619	37	80					9,252	9,244	30	BRAYTON POINT	Coal Steam	Massachusetts	25
48	D016192	1619	35	66					8,889	8,881	30	BRAYTON POINT	Coal Steam	Massachusetts	25
49	D016193	1619	4	14	65	56	79		19,325	19,308	30	BRAYTON POINT	Coal Steam	Massachusetts	25
50	D015991	1599	5	36			65		13,014	13,002	31	CANAL	O/G Steam	Massachusetts	25
51	D015992	1599	7	27			74		8,980	8,971	31	CANAL	O/G Steam	Massachusetts	25
52	D016061	1606						48		5,249	32	MOUNT TOM	Coal Steam	Massachusetts	25
53	D016261	1626	85						3,430		33	SALEM HARBOR	Coal Steam	Massachusetts	25
54	D016263	1626	91	78					4,971	4,966	33	SALEM HARBOR	Coal Steam	Massachusetts	25
55	D016264	1626	32	25					2,880	2,878	33	SALEM HARBOR	O/G Steam	Massachusetts	25
56	D016138	1613	94						4,376		34	SOMERSET	Coal Steam	Massachusetts	25
57	D01702C09	1702						96		4,565	35	DAN E KARN	Coal Steam	Michigan	26
58	D01733C12	1733	49	24	80	80	45	22	46,081	46,040	36	MONROE	Coal Steam	Michigan	26
59	D01733C34	1733	27	26		76	26	27	39,362	39,327	36	MONROE	Coal Steam	Michigan	26
60	D017437	1743		91						15,805	37	ST CLAIR	Coal Steam	Michigan	26
61	D017459A	1745					76	61	18,341	18,324	38	TRENTON CHANNEL	Coal Steam	Michigan	26
62	D023641	2364	2	57					9,356	9,348	39	MERRIMACK	Coal Steam	New Hampshire	33
63	D023642	2364	1	17	99		28	87	19,453	19,435	39	MERRIMACK	Coal Steam	New Hampshire	33
64	D080021	8002	45	74					5,033	5,028	40	NEWINGTON	O/G Steam	New Hampshire	33
65	D023781	2378		81	2	15			9,747	9,738	41	B L ENGLAND	Coal Steam	New Jersey	34
66	D024032	2403	63	97	25	50	40	44	18,785	18,768	42	HUDSON	O/G Steam	New Jersey	34
67	D024081	2408			95				8,076		43	MERCER	Coal Steam	New Jersey	34
68	D024082	2408			60				5,675		43	MERCER	Coal Steam	New Jersey	34
69	D02549C01	2549		64	41		42	72	25,343	25,320	44	C R HUNTLEY	Coal Steam	New York	36
70	D02549C02	2549					99		12,317		44	C R HUNTLEY	Coal Steam	New York	36
71	D024804	2480					71		7,720		45	DANSKAMMER	O/G Steam	New York	36

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MM5 by ERM for Maryland

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Row number	CEMS Unit	ORIS ID	Acadia MM5	Acadia VTDEC	Brig MM5	Brig VTDEC	Lye MM5	Lye VTDEC	MM5 2002 SO2 TPY	VTDEC 2002 SO2 TPY		Plant Name	Plant Type	State Name	State Code		
72	D02554C03	2554	33	51	62		27	51	30,151	30,125	46	DUNKIRK	Coal Steam	New York	36		
73	D02526C03	2526					78		14,929		47	WESTOVER	Coal Steam	New York	36		
74	D025276	2527					80		12,650		48	GREENIDGE	Coal Steam	New York	36		
75	D025163	2516			96				7,359		49	NORTHPORT	O/G Steam	New York	36		
76	D025945	2594		76						1,747	50	OSWEGO	O/G Steam	New York	36		
77	D02642CS2	2642					91		14,086		51	ROCHESTER 7	Coal Steam	New York	36		
78	D080061	8006						93		3,817	52	ROSETON	O/G Steam	New York	36		
79	D080062	8006						88		2,840	52	ROSETON	O/G Steam	New York	36		
80	D080421	8042	13	12	18	5	10	34	57,820	57,769	53	BELEWS CREEK	Coal Steam	North Carolina	37		
81	D080422	8042	23	15	32	10	15	49	45,296	45,256	53	BELEWS CREEK	Coal Steam	North Carolina	37		
82	D027215	2721	98	45	87	39	97	85	19,145	19,128	54	CLIFFSIDE	Coal Steam	North Carolina	37		
83	D027133	2713		61						14,460	55	L V SUTTON	Coal Steam	North Carolina	37		
84	D027093	2709				97				9,390	56	LEE	Coal Steam	North Carolina	37		
85	D027273	2727	100	40		48	75	84	26,329	26,305	57	MARSHALL	Coal Steam	North Carolina	37		
86	D027274	2727	89	39	83	51	66	82	27,308	27,284	57	MARSHALL	Coal Steam	North Carolina	37		
87	D06250C05	6250	60	59		35	37		27,395	27,371	58	MAYO	Coal Steam	North Carolina	37		
88	D027121	2712				59			12,031	12,020	59	ROXBORO	Coal Steam	North Carolina	37		
89	D027122	2712	82	41	54	23	94		29,337	29,310	59	ROXBORO	Coal Steam	North Carolina	37		
90	D02712C03	2712	56	37	57	24	21	78	30,776	30,749	59	ROXBORO	Coal Steam	North Carolina	37		
91	D02712C04	2712	88	72		47	47		22,962	22,941	59	ROXBORO	Coal Steam	North Carolina	37		
92	D0283612	2836	55	20	48	89	29	35	41,432	41,395	60	AVON LAKE	Coal Steam	Ohio	39		
93	D028281	2828	29	9	31	30	24	8	37,307	37,274	61	CARDINAL	Coal Steam	Ohio	39		
94	D028282	2828						56	20,598	20,580	61	CARDINAL	Coal Steam	Ohio	39		
95	D028283	2828						80		15,372	61	CARDINAL	Coal Steam	Ohio	39		
96	D028404	2840	3	1	6	2	2	3	87,801	87,724	62	CONESVILLE	Coal Steam	Ohio	39		
97	D02840C02	2840	84	73			81	63	22,791	22,771	62	CONESVILLE	Coal Steam	Ohio	39		
98	D028375	2837		86	56		35	70	35,970	35,938	63	EASTLAKE	Coal Steam	Ohio	39		
99	D081021	8102			23	71	59	95	18,207	18,191	64	GEN J M GAVIN	Coal Steam	Ohio	39		
100	D081022	8102				78			12,333	12,322	64	GEN J M GAVIN	Coal Steam	Ohio	39		
101	D028501	2850	36	67	39	53		45	30,798	30,771	65	J M STUART	Coal Steam	Ohio	39		
102	D028502	2850	24	65	40	49	98	46	28,698	28,673	65	J M STUART	Coal Steam	Ohio	39		
103	D028503	2850	26		72	62			27,968	27,944	65	J M STUART	Coal Steam	Ohio	39		
104	D028504	2850	20	77	45	52	88	54	27,343	27,319	65	J M STUART	Coal Steam	Ohio	39		
105	D060312	6031			67	77		90	19,517	19,500	66	KILLEN STATION	Coal Steam	Ohio	39		
106	D02876C01	2876	40	7	3	9	30	10	72,593	72,529	67	KYGER CREEK	Coal Steam	Ohio	39		
107	D028327	2832	65	28	59	22	48	20	46,991	46,950	68	MIAMI FORT	Coal Steam	Ohio	39		

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108	D02832C06	2832				60	43	64	23,694	23,673	68	MIAMI FORT	Coal Steam	Ohio	39
109	D028725	2872	74	92	78		90	36	30,079	30,052	69	MUSKINGUM RIVER	Coal Steam	Ohio	39
110	D02872C04	2872	6	19	13	6	19	15	83,134	83,060	69	MUSKINGUM RIVER	Coal Steam	Ohio	39
111	D02864C01	2864	70	56	61	63	49	24	35,193	35,162	70	R E BURGER	Coal Steam	Ohio	39
112	D07253C01	7253		89	58	57		33	30,977	30,949	71	RICHARD GORSUCH		Ohio	39
113	D028665	2866		82				53	19,796	19,779	72	W H SAMMIS	Coal Steam	Ohio	39
114	D028667	2866	57	16	42	41	41	16	33,601	33,572	72	W H SAMMIS	Coal Steam	Ohio	39
115	D02866C01	2866	97	54	93	96	92	30	24,649	24,627	72	W H SAMMIS	Coal Steam	Ohio	39
116	D02866C02	2866		69	92			50	26,022	25,999	72	W H SAMMIS	Coal Steam	Ohio	39
117	D02866M6A	2866		85				58	19,564	19,546	72	W H SAMMIS	Coal Steam	Ohio	39
118	D060191	6019		93		72		60		21,496	73	W H ZIMMER	Coal Steam	Ohio	39
119	D028306	2830	46	38	70	40	12	69	30,466	30,439	74	WALTER C BECKJORD	Coal Steam	Ohio	39
120	D031782	3178	77	63				81	16,484	16,469	75	ARMSTRONG	Coal Steam	Pennsylvania	42
121	D031403	3140	31	34	9	46	18	18	38,801	38,767	76	BRUNNER ISLAND	Coal Steam	Pennsylvania	42
122	D03140C12	3140	52	46	49	69	25	23	29,736	29,709	76	BRUNNER ISLAND	Coal Steam	Pennsylvania	42
123	D082261	8226	25	21	33	42	36	9	40,268	40,232	77	CHESWICK	Coal Steam	Pennsylvania	42
124	D03179C01	3179	16	10	5	8	5	4	79,635	79,565	78	HATFIELD'S FERRY	Coal Steam	Pennsylvania	42
125	D031221	3122	11	6	26	38	17	14	45,754	45,714	79	HOMER CITY	Coal Steam	Pennsylvania	42
126	D031222	3122	9	4	37	92	13	11	55,216	55,167	79	HOMER CITY	Coal Steam	Pennsylvania	42
127	D031361	3136	8	2	4	14	6	1	87,434	87,357	80	KEYSTONE	Coal Steam	Pennsylvania	42
128	D031362	3136	18	3	8	19	8	2	62,847	62,791	80	KEYSTONE	Coal Steam	Pennsylvania	42
129	D03148C12	3148			71		84		17,214		81	MARTINS CREEK	Coal Steam	Pennsylvania	42
130	D031491	3149	19	8	35	7	1	6	60,242	60,188	82	MONTOUR	Coal Steam	Pennsylvania	42
131	D031492	3149	15	5	21	20	3	5	50,276	50,232	82	MONTOUR	Coal Steam	Pennsylvania	42
132	D031131	3113			82				9,674		83	PORTLAND	Coal Steam	Pennsylvania	42
133	D031132	3113			36		93		14,294		83	PORTLAND	Coal Steam	Pennsylvania	42
134	D03131CS1	3131	54	31	79		32	65	22,344	22,324	84	SHAWVILLE	Coal Steam	Pennsylvania	42
135	D033193	3319				100				11,045	85	JEFFERIES	O/G Steam	South Carolina	45
136	D033194	3319		90		87				11,838	85	JEFFERIES	O/G Steam	South Carolina	45
137	D03297WT1	3297		68		61				17,671	86	WATEREE	Coal Steam	South Carolina	45
138	D03297WT2	3297		83		73				17,199	86	WATEREE	Coal Steam	South Carolina	45
139	D03298WL1	3298		35	94	37			25,170	25,148	87	WILLIAMS	Coal Steam	South Carolina	45
140	D062491	6249		58		82				17,920	88	WINYAH	Coal Steam	South Carolina	45
141	D03403C34	3403			85				20,314		89	GALLATIN	Coal Steam	Tennessee	47
142	D03405C34	3405	39						19,368		90	JOHN SEVIER	Coal Steam	Tennessee	47
143	D03406C10	3406	10	11	27	33	4	43	104,523	104,431	91	JOHNSONVILLE	Coal Steam	Tennessee	47

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144	D03407C15	3407	64	87		66	67	76	37,308	37,274	92	KINGSTON	Coal Steam	Tennessee	47
145	D03407C69	3407	48	98		91	82	91	38,645	38,611	92	KINGSTON	Coal Steam	Tennessee	47
146	D038033	3803				55				9,493	93	CHESAPEAKE	Coal Steam	Virginia	51
147	D038034	3803		94		16				10,806	93	CHESAPEAKE	Coal Steam	Virginia	51
148	D037974	3797				90				9,293	94	CHESTERFIELD	Coal Steam	Virginia	51
149	D037975	3797		88	44	27	86		19,620	19,602	94	CHESTERFIELD	Coal Steam	Virginia	51
150	D037976	3797	66	18	7	3	34	66	40,570	40,534	94	CHESTERFIELD	Coal Steam	Virginia	51
151	D03775C02	3775	47						16,674		95	CLINCH RIVER	Coal Steam	Virginia	51
152	D038093	3809		52	64	29			10,477	10,468	96	YORKTOWN	Coal Steam	Virginia	51
153	D03809CS0	3809	96	43	19	17	62		21,219	21,201	96	YORKTOWN	Coal Steam	Virginia	51
154	D039423	3942						79		10,126	97	ALBRIGHT	Coal Steam	West Virginia	54
155	D039431	3943	51	23	20	32	16	13	42,385	42,348	97	FORT MARTIN	Coal Steam	West Virginia	54
156	D039432	3943	50	22	22	31	14	12	45,850	45,809	97	FORT MARTIN	Coal Steam	West Virginia	54
157	D039353	3935	41	33	28	11	64	26	42,212	42,174	98	JOHN E AMOS	Coal Steam	West Virginia	54
158	D03935C02	3935	17	42	43	1	11	21	63,066	63,010	98	JOHN E AMOS	Coal Steam	West Virginia	54
159	D03947C03	3947	86	62	55		57	25	38,575	38,541	99	KAMMER	Coal Steam	West Virginia	54
160	D03936C02	3936				98			15,480	15,467	100	KANAWHA RIVER	Coal Steam	West Virginia	54
161	D03948C02	3948	58	13	17	36	9	7	55,405	55,356	101	MITCHELL	Coal Steam	West Virginia	54
162	D062641	6264	75	49	50	18	77	40	42,757	42,719	102	MOUNTAINEER	Coal Steam	West Virginia	54
163	D03954CS0	3954	68		24	25	23	67	20,130	20,112	103	MT STORM	Coal Steam	West Virginia	54
164	D0393851	3938				79		97	12,948	12,936	104	PHILIP SPORN	Coal Steam	West Virginia	54
165	D03938C04	3938				94			26,451	26,427	104	PHILIP SPORN	Coal Steam	West Virginia	54
166	D060041	6004			66		83	31	21,581	21,562	105	PLEASANTS	Coal Steam	West Virginia	54
167	D060042	6004			88			92	20,550	20,532	105	PLEASANTS	Coal Steam	West Virginia	54

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MM5 by ERM for Maryland

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ATTACHMENT F

Comments from VISTAS and West Virginia Department of Environmental Protection

VISIBILITY IMPROVEMENT –
STATE AND TRIBAL ASSOCIATION OF THE SOUTHEAST
526 FOREST PKWY STE F
FOREST PARK GA 30297-6140

(voice) 404-361-4000 (fax) 404-361-2411
www.vistas-sesarm.org

April 25, 2008

Anna Garcia
Executive Director
Mid Atlantic/Northeast Visibility Union
Hall of the States, 444 North Capitol St.
Suite 638
Washington, DC 20001

RE: VISTAS Comments
MANE-VU Best and Final Modeling

Dear Anna,

The states involved in the VISTAS regional haze planning organization appreciate the opportunity to provide the following comments to the MANE-VU states regarding the recent MANE-VU Best and Final modeling effort which evaluated visibility benefits in 2018 of possible future emissions control strategies. The MANE-VU Best and Final strategy appears to include controls in the VISTAS region, and perhaps elsewhere, for which no enforceable requirements are in place to implement the projected controls. The modeling effort utilized information that is inconsistent with what was provided to MANE-VU during interstate consultation with the VISTAS states. MANE-VU used emission control strategies and levels for the VISTAS states that are different from those used in the VISTAS assessment and included in the State Implementation Plans (SIPs) by the VISTAS states.

For Electric Generating Units, VISTAS states began with the 2018 emissions controls projected by the Integrated Planning Model (IPM) version 2.1.9 and adjusted these projections to reflect known controls on specific units. VISTAS states consulted with their utilities to adjust IPM projections for 2018. This included additional controls on EGUs in Georgia and North Carolina for which state regulations are in place that require specific controls to be installed by 2018. It also included controls on EGUs in Alabama, Kentucky, Virginia, and West Virginia consistent with requirements of federal consent decrees. Florida, South Carolina, and Virginia added back into the inventory emissions from oil-fired boilers that IPM assumed would be shut down by 2018 but utilities indicated would not be shut down. In contrast, MANE-VU added SO_2 emissions back into the 2018 eastern RPO inventory because as modeled for VISTAS, total SO_2 emissions in the areas of the MRPO, MANE-VU and VISTAS were below the CAIR caps and MANE-VU states do not believe that that is realistic. VISTAS states are confident of controls that will be installed in the Southeast by 2009 and are relying on state regulations as well as utility and IPM projections for 2018.

These MANE-VU assumptions provide an alternative worst case estimate of 2018 emissions that does not use the specific evaluation completed by the VISTAS states and used in the VISTAS states' SIPs. VISTAS states have documented the basis for the assumptions used in their SIPs and will re-evaluate progress in 2012 to determine if adjustments to these assumptions are needed.

MANE-VU states determined that reducing sulfur in fuel oil for residential, commercial, and industrial users and implementing BART controls could reduce SO_2 emissions from non-EGU sources in MANE-VU states by more than 28%. MANE-VU therefore asked VISTAS and MRPO to reduce SO_2 emissions from non-EGU by 28% and subsequently reduced the VISTAS and MRPO non-EGU 2018 SO_2 inventory by that percentage in the MANE-VU Best and Final modeling. *Fuel oil contributes 15-37% to SO_2 in areas of influence for MANE-VU Class I areas,* but in the VISTAS states, fuel oil contributions are less than 10% of the SO_2 emissions in the areas of influence for the VISTAS Class I areas. The VISTAS SO_2 contribution assessment for the VISTAS Class I areas demonstrated that the major sources of SO_2 in the VISTAS areas of influence are EGUs and coal-fired industrial boilers. To achieve a 28% reduction in non-EGU emissions in the VISTAS states, MANE-VU assumed that a 50-60% SO_2 reduction would be achieved for emissions from industrial boilers in the VISTAS states. These assumptions do not appear to take into account cost analyses conducted by VISTAS states as part of the evaluation of the four statutory factors for contributing sources in the areas of influence for VISTAS Class I areas. While most VISTAS states determined that there were no cost-effective controls for sources contributing to Class I areas in the VISTAS states, some VISTAS states are still completing their determinations. The ultimate collective conclusions of the VISTAS states will also apply for more distant Class I areas such as those in the MANE-VU region.

In summary, the MANE-VU Best and Final modeling has evaluated benefits of potential control strategies that do not reflect the emissions inventories provided to MANE-VU for the VISTAS states. Therefore the VISTAS states recommend that the MANE-VU states use the VISTAS inventories rather than the MANE-VU Best and Final inventory in their SIPs. States are given the authority to define reasonable measures for sources within their respective boundaries. Through the SIP approval process, EPA will determine if control assumptions included in VISTAS states' SIPs are appropriate to demonstrate reasonable progress toward visibility improvement. The VISTAS states believe that the MANE-VU state SIPs will be most readily approvable by EPA if the VISTAS inventories are used.

Thank you for your consideration. If you have questions, please direct them to John Hornback, executive director of SESARM, at 404-361-4000 or hornback@metro4-sesarm.org.

Sincerely,

Barry Stephens

Barry Stephens, Chair
VISTAS State and Tribal Air Directors

CC: John Hornback

Susan Wierman
Executive Director
Mid-Atlantic Regional Air Management Association, Inc.
8600 LaSalle Road, Suite 636
Towson, MD 21286

west virginia department of environmental protection

Division of Air Quality
601 57th Street SE
Charleston, WV 25304
Phone: 304.926.0475 ♦ Fax: 304.926.0479

Joe Manchin III, Governor
Stephanie R. Timmermeyer, Cabinet Secretary
www.wvdep.org

April 25, 2008

Ms. Angela King
MANE-VU c/o
MARAMA
via e-mail

RE: West Virginia Comments on the
MANE-VU 2018 Visibility Projections
Draft Report

Dear Ms. King:

The West Virginia Department of Environmental Protection, Division of Air Quality (DAQ) appreciates the opportunity to comment on the Mid-Atlantic/Northeast Visibility Union (MANE-VU) 2018 Visibility Projections Draft Report. These comments are being submitted via e-mail to the Mid-Atlantic Regional Air Management Association (MARAMA), which is assisting MANE-VU.

West Virginia is a member of the Visibility Improvement - State and Tribal Association of the Southeast (VISTAS) regional planning organization and concurs with the comments submitted by Barry Stephens, Chair of the VISTAS State and Tribal Air Directors, on behalf of the VISTAS members. VISTAS has expended a tremendous amount of resources to assist member states in developing their Regional Haze State Implementation Plans (SIPs) and has consistently delivered high-quality technical analyses. We strongly believe that the sophisticated professional work completed by VISTAS provides a more than adequate technical basis on which members can build their SIPs. Indeed, EPA and the Federal Land Managers have universally praised the VISTAS work products and initial SIPs for their technical accuracy and comprehensiveness. In addition to the VISTAS comments, DAQ would like to provide supplemental comments.

We would like to emphasize that we expressly notified several MANE-VU states at the start of the public comment period for our proposed Regional Haze SIP in October 2007. Further, though not required, the DAQ at that time provided electronic copies of the full SIP documentation, including the emission inventories developed by VISTAS, to the following MANE-VU states: Maryland, New Hampshire, New Jersey, Vermont, and Pennsylvania.

Although DAQ did receive several substantive comments from New Jersey on other matters, no comments received from New Jersey, or any other MANE-VU state, raised any issue regarding the emissions inventories used in the SIP modeling. Given subsequent developments, the DAQ believes that some of the potential commenters knew, or should have known, that significantly different emissions inventories were in process for MANE-VU's visibility evaluations. The emissions are clearly the fundamental basis for any such evaluations and should be one of the first elements examined upon review because the projected emission changes establish the expected rate of progress. Yet no one, including potential MANE-VU commenters, raised this issue during the formal comment period for our proposed Regional Haze SIP, despite proactive outreach efforts. Given the impact on evaluations for Class I areas such as Brigantine (NJ), Shenandoah (VA) and Dolly Sods (WV), the DAQ believes that it is inappropriate to arbitrarily revise the projected emissions inventory for a regulatory analysis. We believe that the approach taken by VISTAS is more suitable and supportable.

For electric generating units (EGUs), VISTAS states began with the 2018 emission controls projected by the Integrated Planning Model (IPM) version 2.1.9 and adjusted the projections to reflect known controls on specific units. West Virginia recommended that the IPM projections be used for our EGUs in 2018, since we did not have any more reliable information available to justify changes. West Virginia did, however, make adjustments to the 2009 IPM projections to remove controls that we knew were not scheduled for installation by that date. Ignoring the careful application of local knowledge, MANE-VU has inappropriately increased the SO_2 emissions of W.Va.'s EGU sources by 20%, without regard for existing/scheduled controls, and without consulting the DAQ.

MANE-VU also determined that their member states could achieve a 28% reduction in non-EGU SO_2 emissions by reducing sulfur in fuel oil. Therefore, MANE-VU asked VISTAS and the Mid-West Regional Planning Organization (MRPO) to reduce SO_2 emissions from their non-EGUs by 28%. DAQ evaluated potential controls for non-EGUs in our state and determined that there were no equivalent reasonably available controls. However, the W.Va. EGUs achieve excess emission reductions which more than offset the MANE-VU fuel oil "ask." DAQ documented this result in our proposed Regional Haze SIP as provided to the MANE-VU states identified above. MANE-VU, however, then assumed a 50-60% decrease in SO_2 emissions from industrial boilers in the VISTAS states, including W.Va. This reduction is neither realistic nor enforceable and was modeled without consulting DAQ.

The Regional Haze Rule gives states the authority to define reasonable measures for sources within their respective borders and the VISTAS states, including W.Va., provided MANE-VU with the projected 2018 VISTAS emission inventory during the interstate consultation process. MANE-VU chose not to accept the VISTAS inventory and instead evaluated the benefits of potential control strategies that do not reflect the information provided by the VISTAS states.

DAQ believes that MANE-VU has significantly changed emission control assumptions subsequent to the formal RPO consultation meeting, without a sound basis. West Virginia strongly recommends that the MANE-VU states use the VISTAS inventories supplied to them for our states, rather than the inventory that MANE-VU has adopted. DAQ notes that EPA will ultimately determine what control assumptions are appropriate for use in SIPs to demonstrate reasonable progress toward visibility improvement. DAQ believes that the MANE-VU state SIPs are more likely to be federally approvable if the VISTAS inventories are used.

Sincerely,

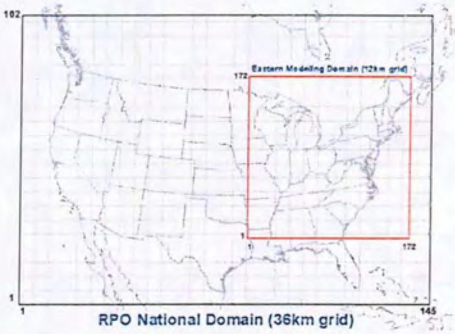
William Frederick Durham
Deputy Director
Assistant Director, Planning
Division of Air Quality

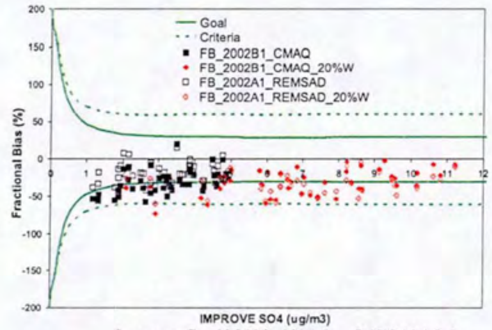
ATTACHMENT G

MANE-VU Modeling for Reasonable Progress Goals

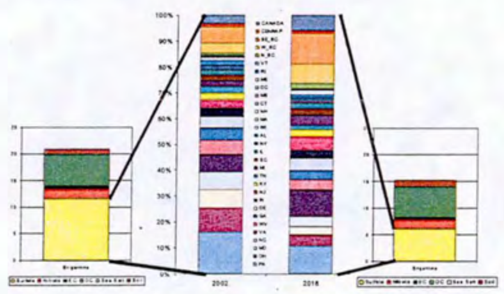
MANE-VU Modeling for Reasonable Progress Goals

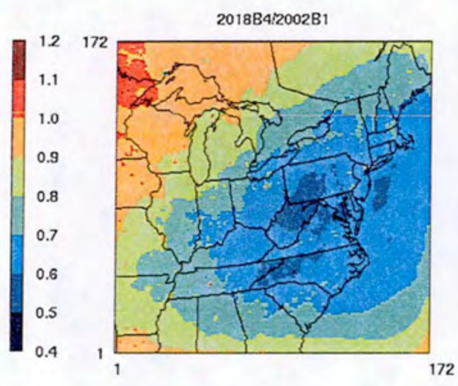
Model performance evaluation, pollution apportionment, and control measure benefits





Layer 1 RRF SO4 ANNUAL





Prepared by
NESCAUM
For the
Mid-Atlantic/Northeast Visibility Union Regional Planning Organization

February 7, 2008

Members of Northeast States for Coordinated Air Use Management

Arthur Marin, Executive Director
Northeast States for Coordinated Air Use Management

Anne Gobin, Bureau Chief
Connecticut Department of Environmental Protection, Bureau of Air Management

James P. Brooks, Bureau Director
Maine Department of Environmental Protection, Bureau of Air Quality

Barbara Kwetz, Director
Massachusetts Department of Environmental Protection, Bureau of Waste Prevention

Robert Scott, Director
New Hampshire Department of Environmental Services, Air Resources Division

William O'Sullivan, Director
New Jersey Department of Environmental Protection, Office of Air Quality Management

David Shaw, Director
New York Department of Environmental Conservation, Division of Air Recourses

Stephen Majkut, Chief
Rhode Island Department of Environmental Management, Office of Air Resources

Richard A. Valentinetti, Director
Vermont Department of Environmental Conservation, Air Pollution Control Division

MANE-VU Modeling for Reasonable Progress Goals

Model performance evaluation, pollution apportionment, and control measure benefits

Prepared by
NESCAUM
for the
Mid-Atlantic/Northeast Visibility Union Regional Planning Organization

February 7, 2008

MANE-VU MODELING FOR REASONABLE PROGRESS GOALS

MODEL PERFORMANCE EVALUATION, POLLUTION APPORTIONMENT, AND CONTROL MEASURE BENEFITS

Project Director

Gary Kleiman, NESCAUM

Editor

Paul Miller, NESCAUM

Administrative Support

Emily Savelli, Iyad Kheirbek, NESCAUM

Principal Contributors

Shan He, Emily Savelli, Jung-Hun Woo, John Graham, NESCAUM

Acknowledgments

NESCAUM could not have completed this work without the preparation of emission inventories by the Mid-Atlantic Regional Air Management Association (MARAMA) and the MANE-VU member states. NESCAUM also acknowledges the funding for this work through USEPA agreement number XA-97318101-0 to the Ozone Transport Commission in support of the MANE-VU Regional Planning Organization. NESCAUM is solely responsible for the content of this report and any errors it may contain.

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Executive Summary

The main purpose of this report is to assist states in developing effective solutions to regional visibility and fine particle problems and comply with requirements under the Regional Haze Rule. NESCAUM has utilized in-house air quality modeling capabilities that include emission processing, meteorological input analysis, and chemical transport modeling to conduct regional air quality simulations for calendar year 2002 and several future periods. This work has been directed at satisfying a number of compliance goals under the Haze State Implementation Plan (SIP), including a contribution assessment, a pollution apportionment for 2018, and the evaluation of visibility benefits of control measures being considered for achieving reasonable progress goals and establishing a long-term emissions management strategy for MANE-VU Class I areas.

The modeling tools utilized for these analyses include MM5, SMOKE, CMAQ and REMSAD, and incorporate tagging features that allow for the tracking of individual source regions or measures. These tools have been evaluated and found to perform adequately relative to USEPA modeling guidance.

Results show 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 that would address this future contribution has 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 "beyond on the way" 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. The combined benefits of adopting all of these programs could lead to an additional benefit of between 0.38 and 1.1 deciviews at MANE-VU Class I areas on the 20 percent worst visibility days by 2018.

1. INTRODUCTION

1.1. Background

This report presents information intended to assist states in developing effective solutions to regional visibility and fine particle problems and comply with requirements under the 1999 U.S. Environmental Protection Agency (USEPA) "Regional Haze Rule" [64 Fed. Reg. 35714 (July 1, 1999)]. NESCAUM has utilized in-house air quality modeling capabilities that include emission processing, meteorological input analysis, and chemical transport modeling to conduct regional air quality simulations for calendar year 2002 and several future periods.

This work has been directed at satisfying a number of compliance goals under the Haze State Implementation Plans (SIPs), including a contribution assessment (*see* NESCAUM, 2006a), a pollution apportionment for 2018, and the evaluation of benefits of control measures being considered for achieving reasonable progress establishing a long-term emissions management strategy for MANE-VU Class I areas.[1] NESCAUM has employed several tools to achieve all of these goals, but the primary tool described and detailed here consists of a regional air quality modeling platform using meteorological fields developed by the University of Maryland using the MM5 platform (Penn State, 2007), emission inventories developed by MANE-VU (MARAMA, 2007a) and processed through the SMOKE emissions processing tool (SMOKE, 2007), and air quality simulations conducted jointly by multiple modeling centers utilizing USEPA's Community Multi-scale Air Quality (CMAQ) model (Byun and Ching, 1999). Sulfate apportionment was also carried out using the REMSAD model (SAI, 2005) with SO_2 tagging capabilities and control strategy evaluation was conducted utilizing a beta version of CMAQ-PPTM (ICF, 2006).

This report describes these efforts that form the foundation upon which MANE-VU states will base their haze SIP submissions. After the MANE-VU RPO considers the results provided here and consults with neighboring states and federal land managers, we anticipate that a final model simulation will be conducted to serve as a basis for calculating final reasonable progress goals.

This introduction provides a basic description of the modeling platform and the input data that we used for regional air quality simulations. Chapter 2 provides a model performance evaluation for both the meteorological input data as well as the chemical transport model for the base year 2002. Chapters 3 through 5 present results from 2018 simulations with respect to the projected "beyond on the way" scenario that we take as a starting point for the haze program, pollution apportionment for 2018, and haze control strategy evaluation.

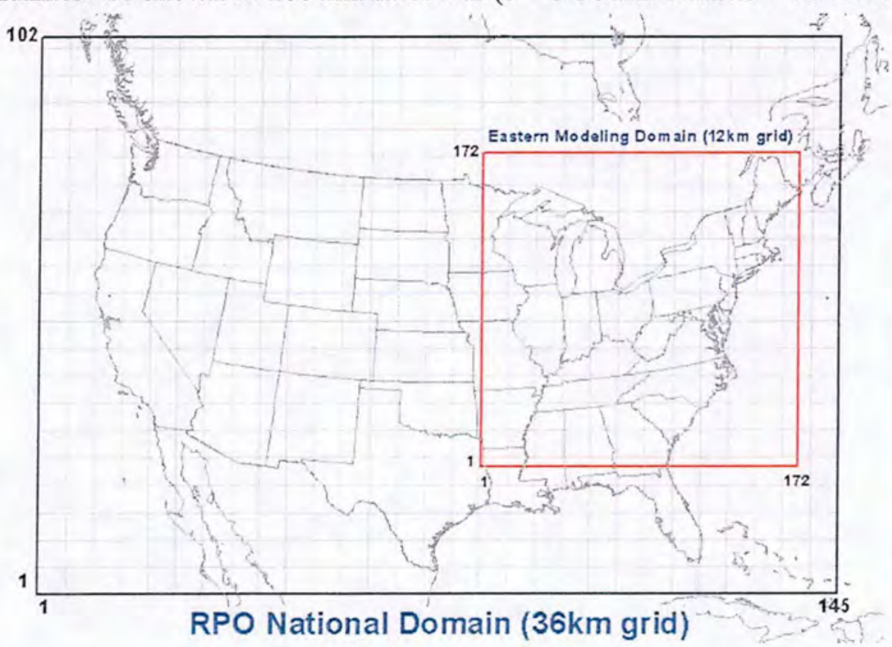
[1] There are seven designated Class I areas in the Northeast and Mid-Atlantic States. They include Acadia National Park and Moosehorn Wilderness Area in Maine; Roosevelt Campobello International Park in New Brunswick and Maine; the Lye Brook Wilderness Area in Vermont; the Great Gulf and Presidential Range-Dry River Wilderness Areas in New Hampshire; and the Brigantine Wilderness Area in New Jersey.

1.2. Meteorology

Professor Dalin Zhang's group from University of Maryland (UMD) provided the 2002 annual meteorological field for air quality modeling. Meteorological inputs for CMAQ are derived from the Fifth-Generation Pennsylvania State University/National Center for Atmospheric Research (NCAR) Mesoscale Model (MM5)[2] system meteorological fields. MM5 is a model with limited-area primitive equations of momentum, thermodynamics, and moisture with the option of hydrostatic and non-hydrostatic physics. It is designed to simulate mesoscale atmospheric circulation. Domains are uniform rectangular grids representing three-dimensional regions of the atmosphere.

MANE-VU has adopted the Inter-RPO domain description for its modeling runs.[3] This 36-km domain covers the continental United States, southern Canada and northern Mexico. The dimensions of this domain are 145 and 102 cells in the east-west and north-south directions, respectively. A 12-km inner domain was selected to better characterize air quality in MANE-VU and surrounding RPO regions. This domain covers the eastern region, which includes the northeastern, central, and southeastern U.S., as well as southeastern Canada. It extends from 66°W~94°W in longitude and 29°N~50°N in latitude with 172 × 172 grid cells (Figure 1-1).

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



[2] http://www.mmm.ucar.edu/mm5/

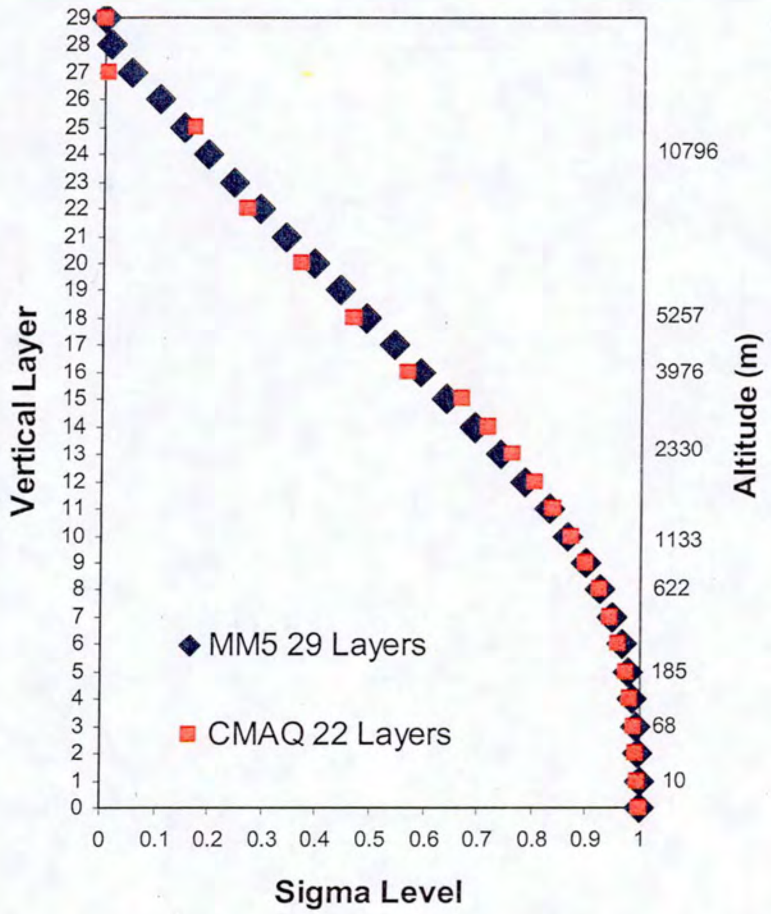
[3] The modeling system for 2002 annual simulation is applied with a Lambert Conformal Conic projection with parallels at 33N and 45N. A spherical earth radius of 6370km is used for all elements of the system (MM5/SMOKE/CMAQ).

The UMD MM5 model runs are made on these two nested domains with the inner (12 km) domain using finer resolution terrain data. Initially, we conducted a set of test runs for the period of August 6 to 16, 2002.

The horizontal coordinated system is equally spaced geographically and uses the Arakawa-B gridding scheme. The resolution can be as high as 1 km. Sigma (σ) is a terrain-following vertical coordinate that is a function of pressure at the point (for hydrostatic) or reference (non-hydrostatic) state pressure (P), the surface pressure (P_{s0}), and the pressure at the top (P_{top}) of the model; $\sigma = (P-P_{top}) / (P_{s0}-P_{top})$. The model utilizes a terrain-following sigma coordinate with 29 layers. The first level is at 10 m and a radiative upper-boundary condition is at 50 hPa (Figure 1-2).

Based on test run results, the boundary layer processes were determined using the Blackadar high-resolution planetary boundary layer parameterization. Physics options also included explicit representations of cloud physics with simple ice microphysics (no mixed-phase processes) and the Kain-Fritsch cumulus parameterization. UMD ran the non-hydrostatic MM5 v3.5.3 with three planetary boundary layer (PBL) schemes; (1) modified Blackadar [BL], (2) the Pleim-Xiu scheme with the soil module [P-X], and (3) modified Blackadar with soil module [SSIB].The model was initialized with the analyses of the National Center for Environmental Prediction (Eta Model). TDL data are used for MM5 nudging. A modeled wind field map (Figure 1-3) shows typical prevailing mesoscale flows from the midwest U.S. to the East Coast.

Figure 1-2. Vertical Structure of Meteorological and Air Quality Modeling Domains



The simulated meteorological fields were compared to the measurements from Techniques Development Laboratory of National Weather Service (TDL NWS) and Clean Air Status and Trends Network (CASTNET). The TDL data are reflective of urban/suburban settings, while the CASTNET sites are more representative of rural areas. There are 48 CASTNET sites and about 800 TDL sites within Domain 2 (as shown in Figure 1-4). Overall, the BL scheme shows a better correspondence to the measured data than the other two schemes, although it poorly captures the diurnal pattern of humidity. While the P-X scheme shows a better correspondence with the observed diurnal pattern for humidity, it fails to perform well for wind speed and temperature (Hao et al., 2004).

Figure 1-3. MM5 modeled wind field map at 12:00 UTC on August 8, 2002

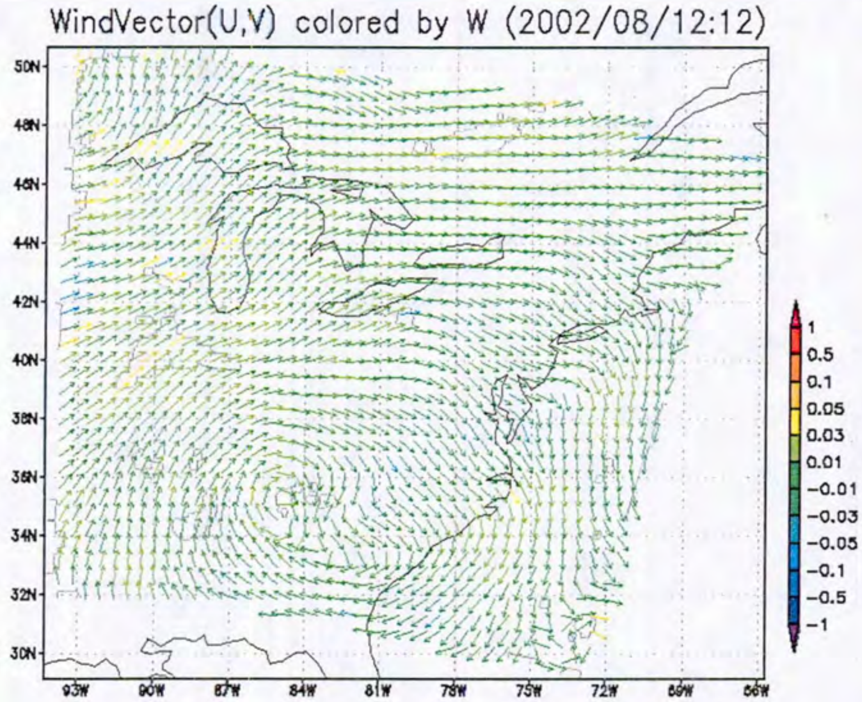
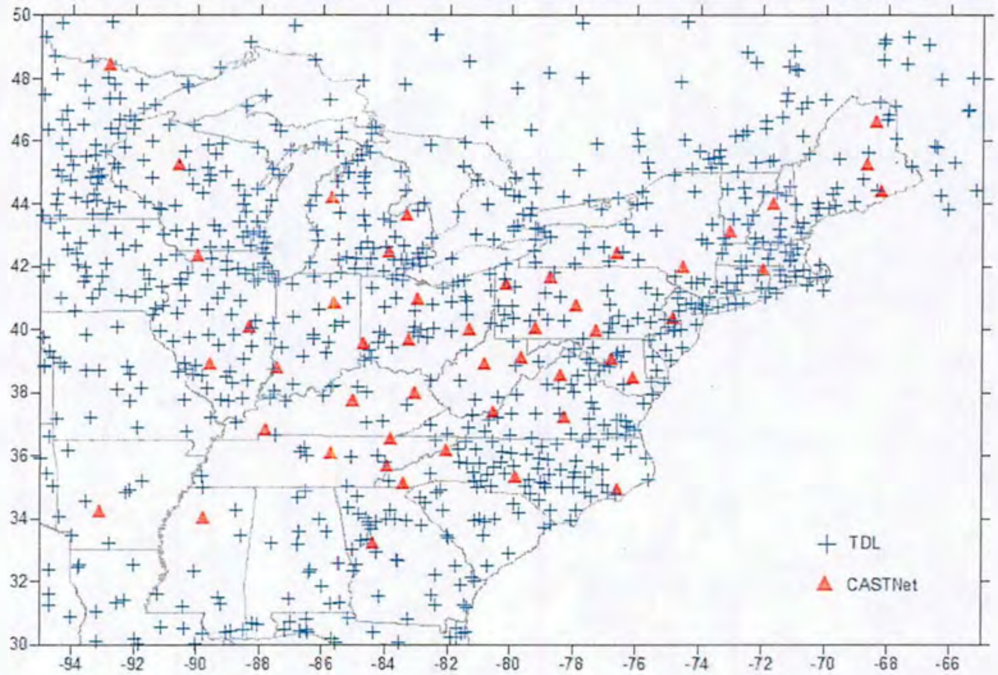


Figure 1-4. Observation Network sites within 12km resolution domain



1.3. Emissions Preparations

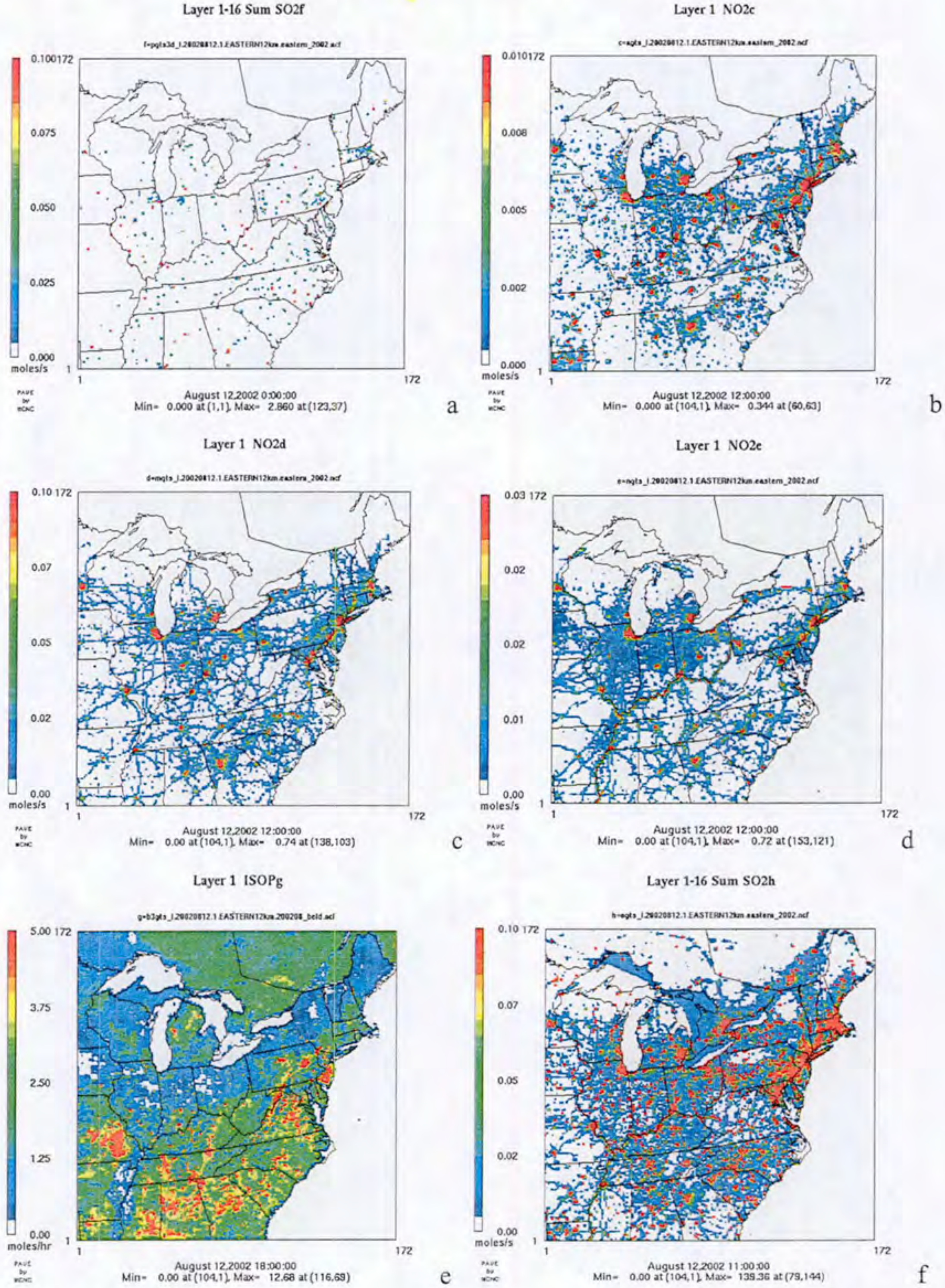
We simulated emission scenarios using the Sparse Matrix Operator Kernel Emissions (SMOKE) Modeling System. SMOKE is primarily an emissions processing system designed to create gridded, speciated, hourly emissions for input into a variety of air quality models, such as CMAQ and REMSAD. SMOKE supports area, biogenic, mobile (both onroad and nonroad), and point source emissions processing for criteria, particulate, and toxic pollutants. For biogenic emissions modeling, SMOKE uses the Biogenic Emission Inventory System, version 2.3 (BEIS2) and version 3.09 and 3.12 (BEIS3). SMOKE is also integrated with the onroad emissions model MOBILE6.

The sparse matrix approach used throughout SMOKE permits rapid and flexible processing of emissions data. Flexible processing comes from splitting the processing steps of inventory growth, controls, chemical speciation, temporal allocation, and spatial allocation into independent steps whenever possible. The results from these steps are merged together in the final stage of processing using vector-matrix multiplication. It allows individual steps (such as adding a new control strategy, or processing for a different grid) to be performed and merged without having to redo all of the other processing steps (http://cf.unc.edu/cep/empd/products/smoke/version2.1/html/).

The emission processing for CMAQ for the 36 km national domain and 12 km eastern domain (Domain 2) has been performed by the New York State Department of Environmental Conservation (NYS DEC) (for base year 2002 and future year 2009) and by NESCAUM (for future year 2018) using SMOKE v2.1 compiled on a Red Hat 9.0 Linux operating system with the Portland Group Fortran compiler version 5.1. They use the 2002 static emission inventory, CEM data, and surrogates data based on the 2002 RPO data. Biogenic emissions are calculated using BEIS3 with BELD3 data. Mobile source emissions are processed using MOBILE6. An updated 2000 inventory for Canada and a 1999 inventory for Mexico inventory were used for processing.

The emissions processing was performed on a month-by-month and RPO-by-RPO basis, i.e., SMOKE processing was performed for each of the RPOs (MANE-VU, VISTAS, CENRAP, MRPO, WRAP) individually as well as for Canada and Mexico. Note the processing of WRAP and Mexican emissions was necessary for use with the 36 km grid modeling only. For each month/RPO combination, a separate SMOKE ASSIGNS file was created, and the length of the episode in each of these ASSIGNS files was set to the entire month. Specific data sources for individual source categories are listed below and the examples of processed emissions outputs are shown in Figure 1-5.

Figure 1-5. Examples of processed model-ready emissions: (a) SO_2 from Point; (b) NO_2 from Area; (c) NO_2 from Onroad; (d) NO_2 from Nonroad; (e) ISOP from Biogenic; (f) SO_2 from all source categories



1.3.1. Emissions Processing Files

The profile and cross reference files listed below are held constant for all modeling years unless stated otherwise.

Temporal Allocation

MANE-VU:

Area and Nonroad sources:
amptpro.m3.us+can.manevu.030205.txt and amptref.m3.manevu.012405.txt
Mobile source: MANEVU_2002_mtpro_02022006_addCT.txt
MANEVU_2002_mtref_02022006_addCT.txt
Point sources: Based on the same files as for the MANE-VU area and nonroad temporal files listed above, but added the VISTAS-generated CEM-based 2002 state-specific temporal profiles and cross-references for EGU sources for the MANE-VU states. No CEM, hour-specific, EGU emissions were used.

CENRAP:

The following temporal profiles and cross-reference files were used for all source categories: amptpro.m3.us_can.cenrap.010605.txt,
amptref.m3.cenrap.010605.txt
These files were downloaded from the CENRAP website
www.cenrap.org/emission_document.asp
For point sources, the CEM-based hour-specific EGU emissions described in Section 2.2.4 were utilized to override the annual-total based emissions whenever a match could be established by SMOKE

VISTAS, WRAP and MRPO:

The following month-specific temporal profiles and cross-reference files were used for all source categories:
amptpro_typ_us_can_{MMM}_vistas_27nov04.txt where {MMM} is jan, feb, mar, etc., amptref_2002_us_can_vistas_17dec04.txt
These files were obtained from Greg Stella (Alpine Geophysics)
For point sources (EGU and fires), the hour-specific emission files described in Sections 2.3.4 and 2.5.4 were utilized for the VISTAS and WRAP states to override the annual-total based emissions whenever a match could be established by SMOKE

Canada and Mexico:

The SMOKE2.1 default temporal profiles and cross-reference files (amptpro.m3.us+can.txt and amptref.m3.us+can.txt) were utilized.

Chemical speciation

The same speciation profiles (gspro.cmaq.cb4p25.txt) and cross-references (gsref.cmaq.cb4p25.txt) were utilized for all regions and all source categories. Different versions of these files were obtained (SMOKE2.1 default, USEPA-CAIR modeling, VISTAS, CENRAP and MANE-VU) and compared. After comparing the creation dates and header lines of these files, it was determined that the USEPA-CAIR and MANE-VU files had the most recent updates, and consequently the final speciation profile and cross-reference files used for all regions and source categories was based on the USEPA-CAIR files with the addition of MANE-VU specific updates.

Spatial Allocation

U.S.

The spatial surrogates for the 12 km and 36 km domains were extracted from the national grid 12 km and 36 km U.S. gridding surrogates posted at USEPA's website at www.epa.gov/ttn/chief/emch/spatial/newsurrogate.html. The gridding cross-references were also obtained from this website, but for the processing of MANE-VU area source emissions, MANE-VU specific cross-reference entries posted on the MARAMA ftp site were added.

Canada

The spatial surrogates for Canadian emissions for the 12 km and 36 km domains were extracted from the national grid 12 km and 36 km Canadian gridding surrogates posted at USEPA's website at www.epa.gov/ttn/chief/emch/spatial/newsurrogate.html. The gridding cross-references were also obtained from this website.

Mexico

The spatial surrogates for Mexican emissions the 36 km domain were extracted from the national 36 km gridding surrogates used by USEPA in the CAIR modeling. These files were obtained from USEPA's CAIR NODA ftp site www.airmodelingftp.com. The gridding cross-references were also obtained from this ftp site.

1.3.2. 2002 Emission Inventory

A 2002 base year emission inventory was developed to assess model performance and to serve as a point of comparison for future year projections in terms of emissions reductions and air quality improvement. In order to assess model performance, actual 2002 emissions (to the extent possible) are incorporated into the inventory and simulated in CMAQ in order to compare with observations. In addition, 2002 simulated values are compared to 2009 or 2018 projections with various emission reductions incorporated to see what degree of air quality improvement can be expected as a result of those reductions.

CANADA:

All source categories except that of point sources where were obtained from USEPA's ftp site ftp.epa.gov/EmisInventory/canada_2000inventory.

No county/province-specific correction factors were available for Canada. Hence, a "divide-by-four" correction for Source Classification Codes (SCCs) listed at www.epa.gov/ttn/chief/emch/invent/index.html#dust were adjusted with FORTRAN prior to running SMOKE.

Area

AS2000_SMOKEready.txt

Nonroad

NONROAD2000_SMOKEready.txt

Onroad

MOBILE2000_SMOKEready.txt

Point

There has long been difficulty in obtaining an up-to-date Canadian criteria emissions inventory for point sources. This is due largely to confidentiality rights afforded to Canadian facilities. Thus far, the most recent inventory of Canadian point sources is rooted in the 1985 NAPAP data. Toward this end, an effort was made to obtain more recent Canadian point source data and incorporate it into an inventory database.

Perhaps the most accurate and publicly accessible source of Canadian pollutant data is now available from the National Pollutant Release Inventory (NPRI) database. The NPRI data are available at Environment Canada's website, www.ec.gc.ca/pdb/npri/npri_home_e.cfm. The page hosts a database available for download as an MS Access or Excel file. The database contains a rather comprehensive list of information. Detailed information is available about each facility, including location, activity and annual emissions. In addition, facilities having stacks with a height of 50 meters or more are required to report stack parameters.

Unfortunately, one of the limitations of the NPRI database for modeling purposes is that the data are only available at the facility level, so in order to use this data, a few generalizations had to be made. Each facility has a Standard Industrial Classification (SIC) code associated with it; however, emissions models require SCCs. While no direct relationship exists between these two codes, a general albeit subjective association can be made, since SCCs are needed for SMOKE. In most cases, only a SCC3 level code was assigned with confidence.

CENRAP:

All CENRAP BaseB files were downloaded from its ftp site ftp.cenrap.org.

County-specific correction factors were applied to take into account fugitive dust for SCCs listed at: www.epa.gov/ttn/chief/emch/invent/index.html#dust; the correction factor file gcntl.xportfrac.txt was obtained from USEPA's CAIR NODA ftp site http://www.airmodelingftp.com (password protected); this adjustment was performed using the SMOKE programs cntlmat and grwinven to generate an adjusted IDA inventory file used for subsequent SMOKE processing for "other area" and point sources.

Where data sets are month dependant, {MMM} represents JAN, FEB, MAR, etc. Note that for both area and nonroad sources, the annual and monthly inventories were processed in one step. Processed with SMK_AVEDAY_YN set to N such that seasonal profiles were used to apportion the inventories into monthly values.

Area

CENRAP_AREA_MISC_SMOKE_INPUT_ANN_STATE_071905.txt
CENRAP_AREA_BURNING_SMOKE_INPUT_ANN_TX_NELI_071905.txt
CENRAP_AREA_MISC_SMOKE_INPUT_NH3_MONTH_{MMM}_072805.txt
CENRAP_AREA_SMOKE_INPUT_NH3_MONTH_{MMM}_071905.txt
CENRAP_AREA_SMOKE_INPUT_ANN_STATE_081705_xfact.txt
- "_xfact" is the adjusted version for fugitive dust as described above

Nonroad

CENRAP_NONROAD_SMOKE_INPUT_ANN_071305.txt
CENRAP_NONROAD_SMOKE_INPUT_MONTH_{MMM}_071305.txt

Onroad

M6-Input files + VMT - MOBILSMOKE_Inputs.zip (Mar06)
VMT/Speed files: mbinv02_vmt_cenrap_ce.ida,
mbinv02_vmt_cenrap_no.ida, mbinv02_vmt_cenrap_so.ida, and
mbinv02_vmt_cenrap_we.ida

Point

CENRAP_POINT_SMOKE_INPUT_ANNUAL_DAILY_072505_xfact.txt
- "_xfact" is the adjusted version for fugitive dust as described above

MANE-VU:

PECHAN prepared all of the MANE-VUv3.0 inventories for SMOKEv2.1 located at ftp://ftp.marama.org/2002 Version 3/ (username: mane-vu, password: exchange).

County-specific correction factors were applied to take into account fugitive dust for SCCs listed at: www.epa.gov/ttn/chief/emch/invent/index.html#dust; the correction factor file gcntl.xportfrac.txt was obtained from USEPA's CAIR NODA ftp site http://www.airmodelingftp.com (password protected); this adjustment was performed using the SMOKE programs cntlmat and grwinven to generate an adjusted IDA inventory file used for subsequent SMOKE processing for area and point sources.

Area

MANEVU_AREA_SMOKE_INPUT_ANNUAL_SUMMERDAY_040606.txt
MANEVU_AREA_SMOKE_INPUT_ANNUAL_WINTERDAY_040606.txt

Nonroad

MANEVU_NRD2002_SMOKE_030306.ida

Onroad

VMT/Speed: MANEVU_2002_mbinv_02022006_addCT.txt was prepared by PECHAN and NESCAUM; MANEVU_V3_update.tar can be downloaded from http://bronze.nescaum.org/Private/junghun/MANE-VU/onroad_ver3_update/

Point

MANEVU_Point_SMOKE_INPUT_ANNUAL_SUMMERDAY_041006.txt
MANEVU_Point_SMOKE_INPUT_ANNUAL_WINTERDAY_041006.txt

MRPO:

MARAMA contracted Alpine Geophysics to convert MRPO BaseK NIF formatted inventory to IDA, a SMOKE ready inventory format. Files can be found at ftp.alpinegeophysics.com – username: marama or on MARAMA's ftp site ftp.marama.org – username: mane-vu, password: exchange. Obtained by NESCAUM between April and June 2006.

County-specific correction factors were applied to take into account fugitive dust for SCCs listed at: www.epa.gov/ttn/chief/emch/invent/index.html#dust; the correction factor file gcntl.xportfrac.txt was obtained from USEPA's CAIR NODA ftp site http://www.airmodelingftp.com (password protected); this adjustment was performed using the SMOKE programs cntlmat and grwinven to generate an adjusted IDA inventory file used for subsequent SMOKE processing for "other area" and point sources.

Where data sets are month dependant, {MMM} represents jan, feb, mar, etc. and {MM} is 01, 02, 03, etc.

Area

Agricultural Ammonia - arinv_nh3_2002_mrpok_{MMM}_3may2006.txt
Wind Erosion Fug-Dust - dustinv_2002_mrpok_{MMM}_23may2006.txt
- The month-specific files were processed separately from the annual runs and SMK_AVEDAY_YN was set to Y so that no seasonal profiles would be applied and the inventory numbers in the 'average day' column would be used.

Other Area Sources - arinv_other_mrpok_2002_20jun2006_xfact.txt

- Adjusted for fugitive dust as described above
- SMK_AVEDAY_YN was set to N, so seasonal profiles were used to apportion the annual inventory numbers by month.
- To save SMOKE processing, the annual "marine" inventory was processed together with other area sources.

Nonroad

NMIM Generated Sources - nrinv_2002_mrpok_{MMM}_3may2006.txt
MAR (Marine/Air/Rail) - arinv_mar_mrpok_2002_27apr2006.txt
- MAR inventory was SMOKE processed with annual other area sources.

Onroad

M6-Input files & VMT – mobile_inventory_mrpobasek.tar.gz
M6-Ancillary – mobile_m6files_mrpobasek.tar.gz
VMT/Speed file: mbinv_mrpo_02f_vmt_02may06.txt
- VMT is based on VISTAS Phase II modeling which was verified and updated for MRPOs BaseK May 2006 provided by Greg Stella (Alpine Geophysics)

Point

EGU - ptinv_egu_2002_mrpok_1may2006.txt
Non-EGU - ptinv_negu_2002_mrpok_1may2006.txt
- Christian Hogrefe (NYSDEC) merged the two inventories and adjusted for fugitive dust, ptinv_egu_negu_2002_mrpok_1may2006_xfact.txt

VISTAS:

All VISTAS emission files were obtained from Greg Stella (Alpine Geophysics) via ftp.alpinegeophysics.com – username: vistasei They reflect version BaseG of the VISTAS inventory with the exception of fire emissions, which reflect BaseF for Lo-Fires and BaseD for Hi-Fires. Files were obtained between February and August, 2006.

The header lines of these files indicate that the fugitive dust correction was already applied, so no further correction was performed. Where data sets are month dependant, {MMM} represents jan, feb, mar, etc. and {MM} is 01, 02, 03, etc.

Area

arinv_vistas_2002g_2453922_w_pmfac.txt – Base G
ida_ar_fire_2002_vistaonly_basef.ida – Base F low fires

Nonroad

NMIM Generated Sources - nrinv_vistas_2002g_2453908.txt
MAR (Marine/Air/Rail) - marinv_vistas_2002g_2453908.txt

Onroad

M6-Input files – vistas_baseg02_m6_inputs_20Jul06.tar
VMT/Speed – mbinv_vistas_02g_vmt_12jun06.txt Base G generated by C. Loomis (Alpine Geophysics) July 2006 for VISTAS states

Point

Annual EGU - egu_ptinv_vistas_2002typ_baseg_2453909.txt

Annual Non-EGU - negu_ptinv_vistas_2002typ_baseg_2453909.txt
Hour-specific - pthour_2002typ_baseg_{MMM}_28jun2006.ems
Month Dependant Hi-Fire - ptinv_fires_{MM}_typ.vistas.ida (vr.BaseD)
Hour-specific plume-rise - pthour_fires_{MM}_typ.vistas.ida (vr.Jan05)

1.3.3. 2018 "On the Books/On the Way" (OTB/OTW) Emission Inventory

The emissions processing was conducted in a very similar manner for future projection years relative to the 2002 base year, but with the projected inventories. The future years "on the books/on the way" (OTB/OTW) emissions inventories account for emission control regulations already in place as well as emission control regulations that are final but have not yet been fully implemented and are likely to achieve additional reductions by 2009. Processing occurred during January of 2007.

CANADA:

All source categories except that of point sources were obtained from USEPA's ftp site ftp.epa.gov/EmisInventory/canada_2000inventory.

No county/province-specific correction factors were available for Canada. Hence, for Area, Onroad, and Nonroad, a "divide-by-four" correction for SCCs listed at www.epa.gov/ttn/chief/emch/invent/index.html#dust were adjusted with FORTRAN prior to running SMOKE.

Area

AS2020_SMOKEready.txt

Nonroad

NONROAD2020_SMOKEready.txt

Onroad

MOBILE2020_SMOKEready.txt

Point

Non-EGUs -- ptinv_canada_2002_negu.ida same as 2002 BaseB4
EGUs -- egu062idasum_cp.txt and egu062idawin_cp.txt
- U.S.-Canada 2020 Canadian Base Case -- Scenario #062
- Original IPM parsed file (based on NEEDS 2.1.6)
- Annualized emissions were calculated by combining summer and winter with FORTRAN to create and use ptinv_canada_2020_egu.ida

CENRAP

County-specific correction factors were applied to take into account fugitive dust for SCCs listed at: www.epa.gov/ttn/chief/emch/invent/index.html#dust; the correction factor file gcntl.xportfrac.txt was obtained from USEPA's CAIR NODA ftp site http://www.airmodelingftp.com (password protected); this adjustment was performed using the SMOKE programs cntlmat and grwinven to generate an adjusted IDA inventory file used for subsequent SMOKE processing.

Area

arinv_nodust_ref_cenrap2002-2018_081705.ida
fdinv.cnrap2002_2018_wfac.ida
nh3inv.annual.cenrap2002_2018.ida
nh3inv.cenrap2002_2018.ann.ida
nh3inv.misc_annual.cenrap2002_2018.ida
nh3inv.misc.cenrap2002_2018.ann.ida
rdinv.cnrap2002_2018.wfac.ida

- To save SMOKE processing, all area source inventories were processed with area sources from the MWRPO and VISTAS.

Nonroad

cenrap_2018_fnl_nrd_emissions091506.txt
nrinv_cenrap_2018_mod_w_mrpok_15sep2006.txt
nrinv_cenrap_2018_mod_w_mrpok_14sep2006.txt

- To save SMOKE processing, all nonroad source inventories were processed with nonroad sources from the MWRPO and VISTAS.
- "mod_w_mrpok" files include both MRPO and CENRAP sources

Onroad

M6List – BaseG_2018_mobile_m6.tar.gz or in the sub-directory input
VMT – cenrap2018_vmt_072005.ida

- bronze.nescaum.org/Private/junghun/CMV_mobile/
- To save SMOKE processing all mobile source inventories where processed with mobile sources from the MWRPO and VISTAS.

Point

EGU – ptinv_egu_2018_cenrap_11sep2006.txt
Non-EGU – ptinv_negu_cenrap2018_25aug2006_xfact.ida

- "_xfact" version is the adjusted version for fugitive dust as described
- Obtained from Alpine Geophysics contracted by MARAMA ftp.alpinegeophysics.com/Work_Order_1/Task_2_BaseK_2018\ (12-Sep06) – username: marama, password: emisdata
- Used IPM2.1.9 without adjustments

MANE-VU:

MARAMA developed the future year OTB/OTW emissions inventories for non-EGU point, area, and nonroad sources accounting for the OTB/OTW inventories, based on the MANE-VU 2002 Version 3 inventory. (MARAMA, 2007b).

County-specific correction factors were applied to take into account fugitive dust for SCCs listed at: www.epa.gov/ttn/chief/emch/invent/index.html#dust; the factors were obtained from www.epa.gov/ttn/chief/emch/invent/transportfractions.xls; this adjustment was performed outside of SMOKE with FORTRAN for area and point sources.

Area

MANEVU_OTB2018_Area_IDA3V_2.txt (Nov 2006)
ftp.marama.org/2009.12.18 OTB Version 3.1/AREA/Area IDA files/
Inventory Development Notes:

- After the release of version 3, Massachusetts revised their inventory for heating oil emissions due to two changes: (1) SO_2 emission factors were adjusted for the sulfur content from 1.0 to 0.03; (2) use of the latest DOE-EIA 2002 fuel use data instead of the previous version from 2001. These two changes significantly altered the 2002 SO_2 emissions for area source heating oil combustion. The revised version was used to do the projections.
- The District of Columbia discovered a gross error in the 2002 residential, non-residential, and roadway construction sources. It requested that for PM10-PRIM and PM25-PRIM for SCCs 23110X0000, different values be used for the 2002 base year and as the basis for the 2009/2012/2018 projections

Nonroad

MANEVU_OTB2018_NR_IDAV3_1.txt (Oct 2006)
ftp.marama.org/2009.12.18 OTB Version 3.1/NONROAD/NONROAD_IDA_Files_v3.1/

- MACTEC utilized the NMIM2005 model to develop projections for nonroad engines included in the NONROAD2005 model. Projected emission estimates were calculated using NMIM default data. Prior to starting the NMIM2005 runs, MACTEC confirmed with USEPA's Office of Transportation and Air Quality (OTAQ) that the database used for fuel sulfur content, gas Reid Vapor Pressure (RVP) values, and reformulated fuel programs was current and up to date for the MANE-VU region.
- Emission calculations were made at the monthly level and consolidated to provide annual values. This enabled monthly temperatures and changes in reformulated gas to be captured by the program.

Onroad

ManevuFutureM6_v2_20051103_wjh.tar.gz

- bronze.nescaum.org/Private/junghun/CMV_mobile/

Point

Non-EGU: MANEVU2018NonEGUV3_0_Point_IDA.txt (Jun 2006)
ftp.marama.org/2009.12.18 OTB Version 3.1/non-EGU Point/nonEGU IDA Files/

MRPO:

Alpine Geophysics was contracted by MARAMA to convert MRPO BaseK NIF formatted inventory to IDA a SMOKE ready inventory format. Files can be found at ftp.alpinegeophysics.com/Work_Order_1/Task_2_BaseK_2018/ – username: marama or on MARAMA's ftp site ftp.marama.org – username: mane-vu, password: exchange. Obtained between April and June 2006.

Where data sets are month dependant, {MMM} represents jan, feb, mar, etc. and {MM} is 01, 02, 03, etc.

Area

Other Area Sources – arinv_other_mrpok_2018_22aug2006.txt
Agricultural Ammonia – arinv_nh3_2018_mrpok_{MMM}_22aug2006.txt
Wind Erosion Fug-Dust Base F – dustinv_mrpo_basef_2018_29jul05.ida
- In order to save time, all area source categories were processed simultaneously for CENRAP, MRPO and VISTAS.

Nonroad

arinv_mar_mrpok_2018_22aug2006.txt
nrinv_2018_mrpok_apr_22aug2006.txt
- To save SMOKE processing all nonroad source inventories where processed with nonroad sources from the MWRPO and VISTAS.

On-road

M6LIST – .in files can be found in the sub-directory input
VMT - mbinv_vistas+mrpo_18g_vmt_12jun06.ida
- bronze.nescaum.org/Private/junghun/CMV_mobile/
- To save SMOKE processing all mobile source inventories where processed with mobile sources from the CENRAP and VISTAS.

Point

EGU: ptinv_egu_2018_mrpok_11sep006.txt
Non-EGU: ptinv_negu_2018_mrpok_23aug2006_xfact.txt
- "_xfact" version is the adjusted version for fugitive dust as described
- Used IPM2.1.9 includes post-IPM adjustments

VISTAS:

The header lines of these files indicate that the fugitive dust correction was already applied, so no further correction was performed. Where data sets are month dependant {MMM} is jan, feb, mar, etc. and {MM} is 1, 2, 3, etc.

Area

arinv_vistas_2018g_2453922_w_pmfac.txt
- To save SMOKE processing, area source inventories where processed with area sources from the MWRPO and CENRAP.

Lo-Fire: area_level_fires_vistas2018_baseg.ida

Nonroad

marinv_vistas_2018g_2453972.txt
nrinv_vistas_2018g_2453908.txt
- To save SMOKE processing, all nonroad source inventories were processed with nonroad sources from the MWRPO and VISTAS.

Onroad

M6LIST – .in files can be found in the sub-directory input
VMT - mbinv_vistas+mrpo_18g_vmt_12jun06.ida
- bronze.nescaum.org/Private/junghun/CMV_mobile/
- Based off Base G inventory BaseG_2018_mobile_m6.tar and Baseg_2018_mv_vmt.tar

- To save SMOKE processing all mobile source inventories where processed with mobile sources from the MWRPO and CENRAP.

Point

EGU: egu_18_vistas_g_2453993.txt
Non-EGU: negu_ptinv_vistas_2018_baseg_2453957_xfact.txt
Hourly: pthour_2018_baseg_{MMM}_2453993.ems
Hi-Fire: ptinv.plume.vistasbaseg18.{MM}.ida
ptday.plume.vistasbaseg18.{MM}.ida
Hi-Fire hourly plume-rise: pthour.plume.vistasbaseg18.{MM}.ida
- Used IPM2.1.9 includes post-IPM adjustments

1.3.4. 2018 "Beyond on the Way" (BOTW) Emission Inventory

The emissions processing for a "beyond on the way" (BOTW) inventory was conducted in a very similar manner to other future projection scenarios relative to the 2002 base year, but with different inventories. These inventories were based on additional control measures that the MANE-VU states are considering for attaining various regional haze, ozone, and $PM_{2.5}$ National Ambient Air Quality Standards (NAAQS) goals. The resulting CMAQ simulation (BOTW) is the same run that has been used by the OTC Modeling Committee for projecting the long-term benefits of regional ozone control programs and was conducted on the Integrated SIP Modeling Platform by the five regional modeling centers.

CANADA:

Same as 2018OTB/OTW

CENRAP:

Same as 2018OTB/OTW

MANE-VU:

MARAMA produced the Nonroad, Area and Non-EGU projections for 2018 under different scenarios (MARAMA, 2007b).

The EGU inventories were developed by ICF Consulting for the RPOS using the Integrated Planning Model (IPM version 2.1.9). Alpine Geophysics processed the results into IDA inventory format for MANE-VU.

Fugitive dust correction was applied as county-specific correction factors for SCCs listed at http://www.epa.gov/ttn/chief/emch/invent/index.html#dust; the correction factors were obtained from http://www.epa.gov/ttn/chief/emch/invent/transportfractions.xls; this adjustment was performed outside of SMOKE with FORTRAN.

Area

manevu_botw2018_area_IDAV3_2_xfact.txt

- "_xfact" version is the adjusted version for fugitive dust as described

Nonroad

nrinv_manevu_18_19oct05.txt

Onroad

Same as 2018 OTB/OTW

Point

EGU: ptinv_egu_2018_manevu_11sep2006.txt

- bronze.nescaum.org/Private/junghun/POINT_2018BOTW_B4

Non-Fossil 2009: manevu_nonfossil_2009_19sept2006.txt

- Alpines ftp – marama -- Work_Order_1/Task_4_2009_Nonfossil/

Non-EGU: MANEVU_BOTW2018_nonegu_IDAV3_1_xfact.txt

- "_xfact" version is the adjusted version for fugitive dust as described

MRPO:

Same as 2018OTB/OTW

VISTAS:

Same as 2018OTB/OTW

1.3.5. 2018 Sulfate Tagging (BOTW) Emission Inventory

An additional BOTW inventory was prepared specifically to allow for a state-by-state tagging run with REMSAD and a sensitivity run with the CMAQ Particle and Precursor Tagging Methodology (CMAQ-PPTM) system. The inventory used for these runs was essentially the same inventory described for the regular BOTW scenario; however, in order to process this inventory for use with the tagging methodology, various components of the inventory were processed separately and identified as a specific "type" of sulfur dioxide so that it could be tracked through the system.

The state-by-state tagging used the identical inventory to the 2018 BOTW inventory described in the previous section. It was processed such that each state's SO_2 emissions were separately tagged requiring three separate REMSAD simulations to accommodate 29 eastern states, Canada, and the boundaries.

A separate CMAQ-PPTM simulation was conducted using the same inventory, but modified to reflect additional controls due to a number of strategies to be tested. The specific scenarios that were tracked by this run include:

1. OTB/OTW
2. S-1 fuel oil strategy (500 ppm distillate; 0.5% fuel-sulfur content by weight for No. 6 residual oil; 0.25% fuel-sulfur content by weight for No. 4 residual oil.)
3. S-2 fuel oil strategy (15 ppm distillate; 0.5% fuel-sulfur content by weight for No. 6 residual oil; 0.25% fuel-sulfur content by weight for No. 4 residual oil.)
4. BART (approximately 35,000 tons of SO_2 reductions at specific facilities identified by state survey of permitting staff)

5. "167 Stack" Strategy; (90% control on all EGUs in the 167 stacks identified as having the most significant impact on MANE-VU Class I areas)

Two additional tags were required to account for corrections to the assumed baseline fuel sulfur content of distillate and to add EGU emissions reductions back into the system as a result of potential permit trading in response to the 167 stack strategy. These strategies are described in more detail in Chapter 4.

1.4. Model Platforms

Currently two regional-scale air quality models have been evaluated and used by NESCAUM to perform air quality simulations. These are the Community Multi-scale Air Quality modeling system (CMAQ; Byun and Ching, 1999) and the Regional Modeling System for Aerosols and Deposition (REMSAD; SAI, 2002). CMAQ was developed by USEPA, while REMSAD was developed by ICF Consulting/Systems Applications International (ICF/SAI) with USEPA support. CMAQ has undergone extensive community development and peer review (Amar et al., 2005) and has been successfully used in a number of regional air quality studies (Bell and Ellis, 2003; Hogrefe et al., 2004; Jimenez and Baldasano, 2004; Mao and Talbot, 2003; Mebust et al., 2003). REMSAD has also has been peer reviewed (Seigneur et al., 1999) and used by USEPA for regulatory applications (www.epa.gov/otaq/regs/hd2007/frm/r00028.pdf and www.epa.gov/clearskies/air_quality_tech.html) to study ambient concentrations and deposition of sulfate and other PM species.

1.4.1. CMAQ

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

To date, MANE-VU SIP modeling on both 36 km and 12 km domains used CMAQv4.5.1, IOAPI V2.2 and NETCDF V3.5 libraries. The CMAQ model is configured with the Carbon Bond IV mechanism (Gery et al., 1989) using the EBI solver for gas phase chemistry rather than the SAPRC-99 mechanism due to better computing efficiency with no significant model performance differences for ozone and PM as compared to observations.

NY DEC has completed annual 2002 CMAQ modeling on the 36 km domain to provide dynamic boundary conditions for all simulations performed on the 12 km domain. Three-hourly boundary conditions for the outer domain were derived from an annual model run performed by researchers at Harvard University using the GEOS-

CHEM global chemistry transport model (Park et al., 2004). Model resolution was species dependent at either 4° latitude by 5° longitude or 2° by 2.5°.

Five modeling centers are working collectively to maximize efficiency of computing resources in MANE-VU for SIP modeling. These centers include NY DEC, NJ DEP/Rutgers, VA DEQ, UMD, and NESCAUM. Annual CMAQ modeling on the 12 km domain is divided into five periods. UMD is responsible for the period from January 1 to February 28; NJ DEP/Rutgers are responsible for the period from March 1 to May 14; NY DEC is responsible for the period from May 15 to September 30; VA DEQ is responsible for the period from October 1 to October 31; and NESCAUM is responsible for the period from November 1 to December 31. Each period uses a 15 day spin up run to minimize the impact of the default initial concentration fields. Each group performs CMAQ simulations on its period for a series of scenarios including 2002 Base Case, 2009 Base Case, 2018 Base Case, 2009 Control Case, and 2018 Control Case. All scenarios adopt the same meteorological field (2002) and boundary conditions, varying only emission inputs. To ensure consistency, a benchmark test was conducted by each modeling group.

In addition to the annual simulations conducted with CMAQ by the five modeling centers, NESCAUM has conducted limited sensitivity analysis of several control measures using the beta version of CMAQ with the particle and precursor tagging methodology (CMAQ-PPTM) (ICF, 2006). These runs and their results are described separately in Chapter 5.

1.4.2. REMSAD

The Regional Modeling System for Aerosols and Deposition (REMSAD) is a three-dimensional Eulerian model designed to support a better understanding of the distributions, sources, and removal processes relevant to fine particles and other airborne pollutants. It calculates the concentrations of both inert and chemically reactive pollutants by simulating the physical and chemical processes in the atmosphere that affect pollutant concentrations. The basis for the model is the atmospheric diffusion equation representing a mass balance in which all of the relevant emissions, transport, diffusion, chemical reactions, and removal processes are expressed in mathematical terms. The REMSAD model performs a four-step solution procedure: emissions, horizontal advection/diffusion, vertical advection/diffusion and deposition, and chemical transformations during one half of each advective time step, and then reverses the order for the following half time step. The maximum advective time step for stability is a function of the grid size and the maximum wind velocity or horizontal diffusion coefficient. Vertical diffusion is solved on fractions of the advective time step to keep their individual numerical schemes stable.

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

The model parameterizes aerosol chemistry and dynamics for PM and calculates secondary organic aerosol (SOA) yields from emitted hydrocarbons. REMSAD V7.12 and newer versions have capabilities that allow model tags of sulfur species (up to 11 tags), nitrogen (4 tags), mercury (up to 24 tags), and cadmium (up to 10 tags) to identify the impact of specific tagged species.

Unlike CMAQ, REMSAD provides no choice of chemical and physical mechanisms. The modeling configuration for future work with REMSAD will be similar to the CMAQ modeling setup. The initial concentrations and boundary conditions will be generated using the same concentration profile used by CMAQ. The approach is to use similar model inputs to allow comparison of REMSAD with CMAQ to better understand differences between the two models. Due to the simplified chemistry mechanism, REMSAD may not simulate atmospheric processes as well as CMAQ. However, advantages such as the tagging feature for sulfur, more efficient modeling, and reasonable correspondence with measurements for many species, make REMSAD an important source apportionment tool for MANE-VU.

In our present REMSAD modeling, we use the same 12 km domain (i.e., domain2) presented in the previous section for three full annual runs for the base year (2002). Multiple runs are necessary to permit tagging of sulfur emissions for all of the states in the domain, Canada, and the boundary conditions.

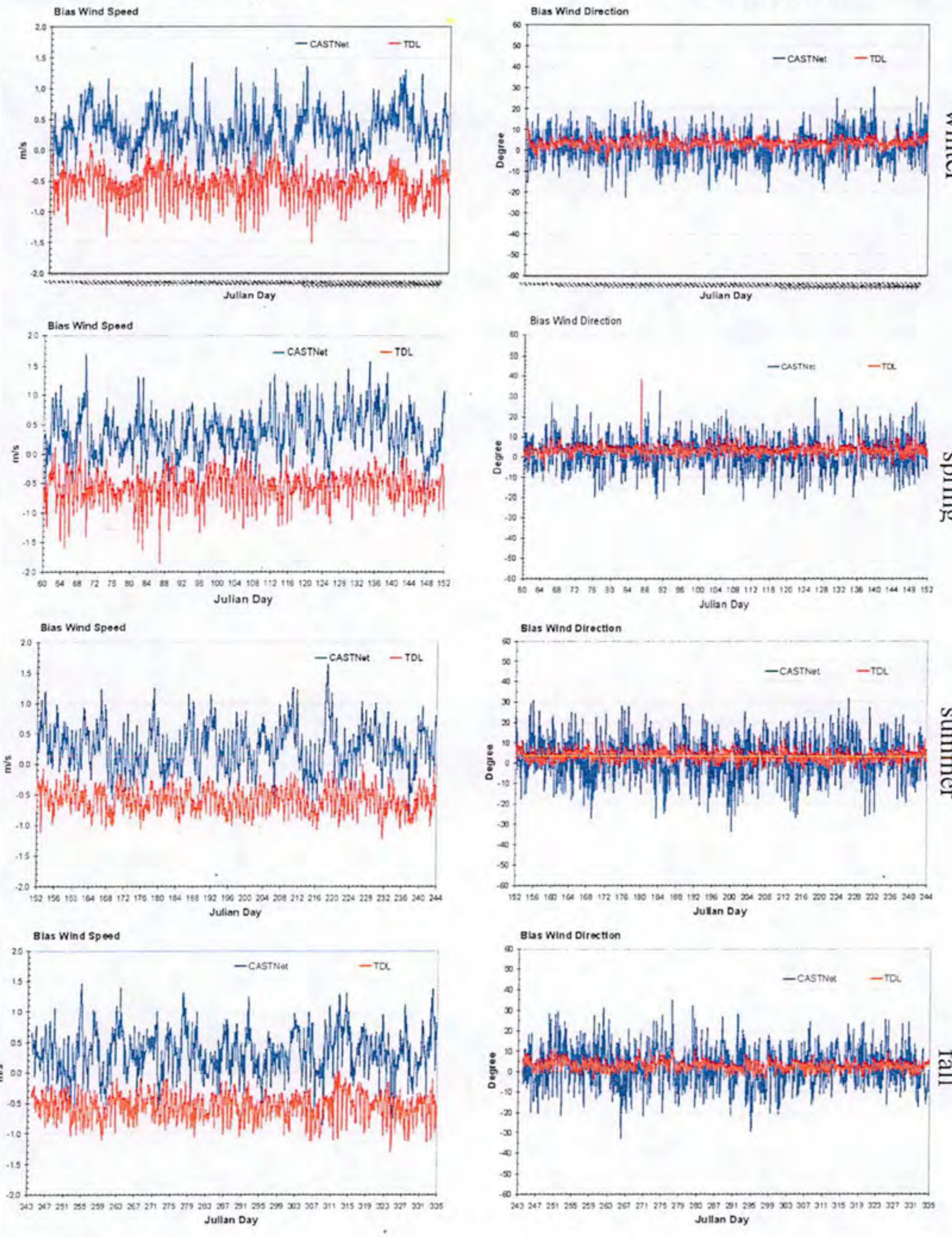
2. PERFORMANCE EVALUATION

2.1. Meteorological Evaluation

The 2002 annual 12 km resolution meteorological fields generated by MM5 have been evaluated by NESCAUM using ENVIRON's METSTAT program. Model results of surface wind speed, wind direction, temperature, and humidity are 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. Figure 2-1 presents domain-wide average hourly bias of wind speed (left panel) and wind direction (right panel) between the MM5 results and two sets of measurement for every season in 2002 (winter includes Jan., Feb., and Dec.; spring includes Mar., Apr., and May; summer includes Jun., Jul., and Aug.; fall includes Sep., Oct., and Nov.). It shows that MM5 capably predicts wind speed with reasonably small bias and equal consistency. Within the domain, MM5 tends to overestimate wind speed (hourly bias up to 1.7 m/s) at CASTNET sites, and underestimate wind speed (hourly bias up to -1.85 m/s) at TDL sites. Seasonal mean bias of MM5 wind speed to CASTNET wind speed is ~0.3 to 0.4 m/s, while seasonal mean bias of MM5 wind speed to TDL wind speed is about ~-0.5 to -0.6 m/s. No significant seasonal variation on this wind speed bias is observed. MM5 prediction of wind direction shows a larger variation with CASTNET wind direction (hourly bias from ~-30 degree to ~30 degree) than with TDL wind direction (hourly bias from ~-5 degree to ~10 degree). However, seasonal mean bias of MM5 wind direction to CASTNET wind direction (~2 degree) is smaller than seasonal mean bias of MM5 wind direction to TDL wind direction (~3 degree) because the large variation of positive and negative bias offset each other.

Figure 2-1. 2002 seasonal average hourly bias of wind speed and direction

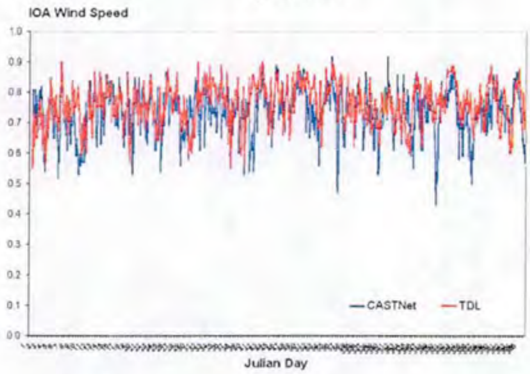
Wind Speed Wind Direction



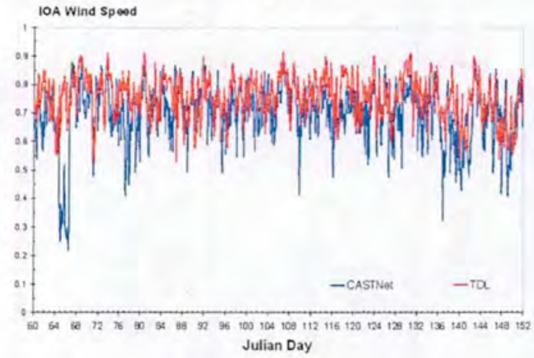
Index of Agreement (IOA) is a statistical measure of difference between prediction and measurement, calculated as a ratio of Root Mean Square Error to the sum of the difference between prediction and mean observation and difference between observation and mean observation. IOA varies from 0 to 1, with a value of 1 indicating the perfect agreement between model prediction and observation, and a value larger than 0.5 IOA indicating acceptable model performance. Domain-wide average hourly IOAs of wind speed are presented in Figure 2-2. MM5 predictions of wind speed values are in good agreement (IOA from ~0.5 to ~0.9) to both CASTNET data and TDL data with similar IOA variation. Seasonal mean values of IOA are ~ 0.7. No particular season of the year stands out in terms of its agreement with measurement.

Figure 2-2. 2002 seasonal hourly average index of agreement for wind speed

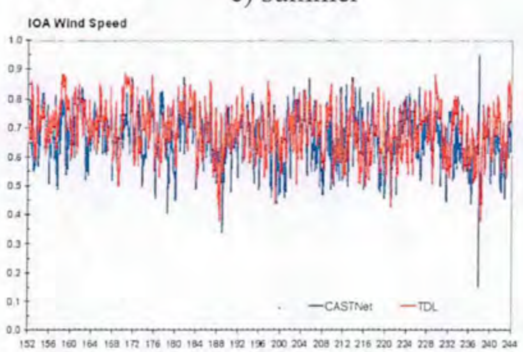
a) winter



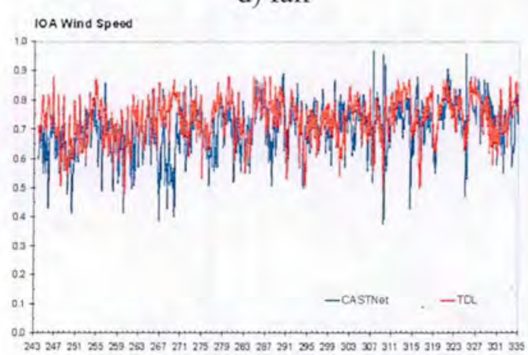
b) spring



c) summer



d) fall



Quarterly correlation coefficients in Figure 2-3 show good MM5 performance on hourly wind speed for each observation site. MM5 predictions exhibit similar spatial patterns of correlation with CASTNET (left panel) and TDL (right panel) measurements – stronger correlation in north than in south. Over the year, the model has stronger correlation in the 1st quarter (Jan., Feb., Mar., top 1st row), 2nd quarter (Apr., May, Jun., 2nd row) and 4th quarter (Oct., Nov., Dec., bottom row) than it does in the 3rd quarter (Jun., Jul., Aug., 3rd row), with an average of 0.1 correlation coefficient difference. Generally, MM5 predictions and measurements have strongest correlation (0.8~0.9) within the midwestern U.S., strong correlation (0.7~0.8) within the northeastern U.S. and along the coastline, and acceptable correlation (0.5~0.7) within the southern U.S. and interior portions of the U.S. East Coast. MM5 predictions consistently show very similar spatial patterns and temporal variations for wind direction (as shown in Figure 2-4) and wind speed. There is strong correlation (>0.7) between prediction and measurement for wind direction at most of sites.

Figure 2-3. Quarterly correlation coefficient (r) of hourly wind speed between modeling and measurement for each observation site in 2002

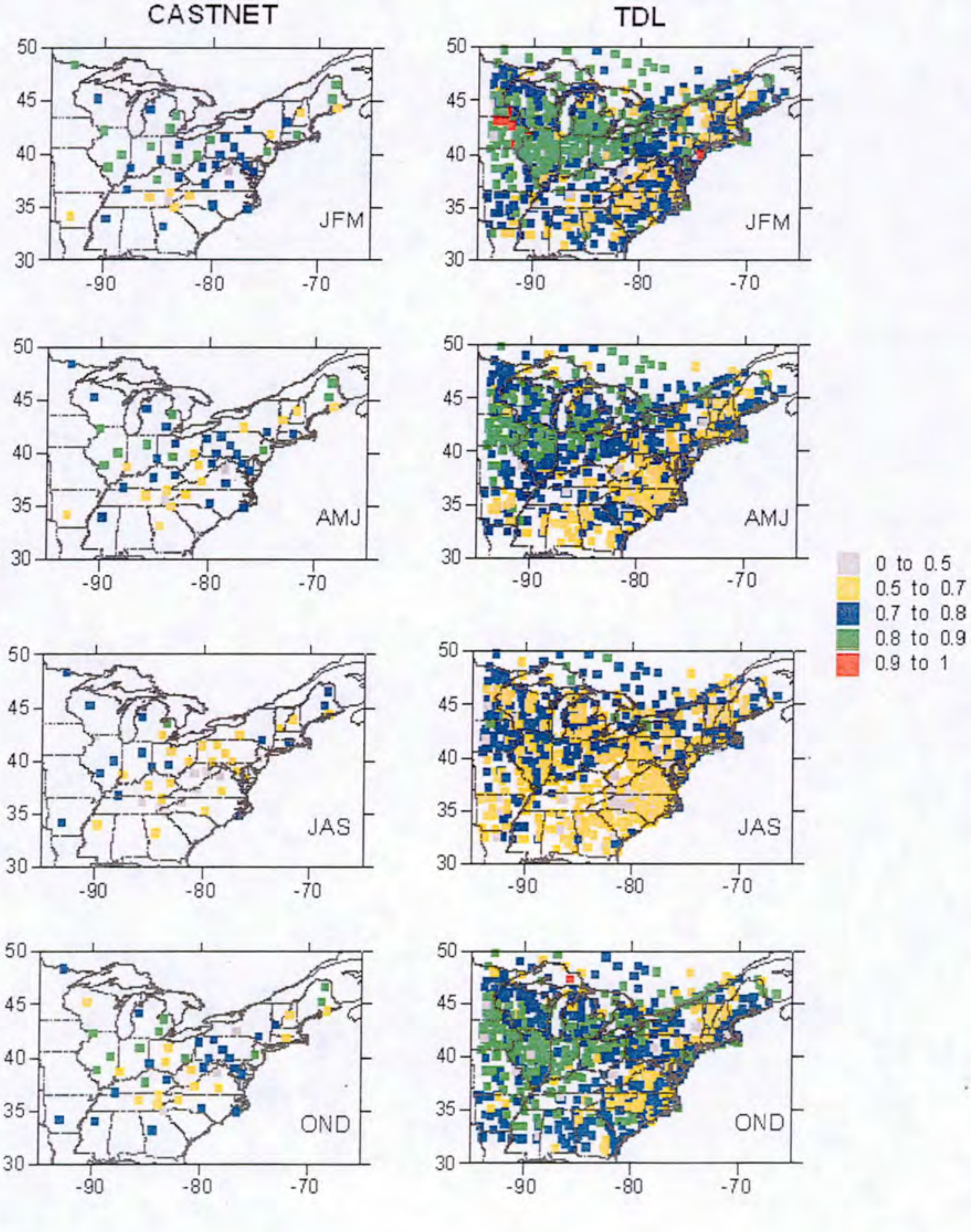


Figure 2-4. Quarterly correlation coefficient (r) of hourly wind direction between modeling and measurement for each observation site in 2002

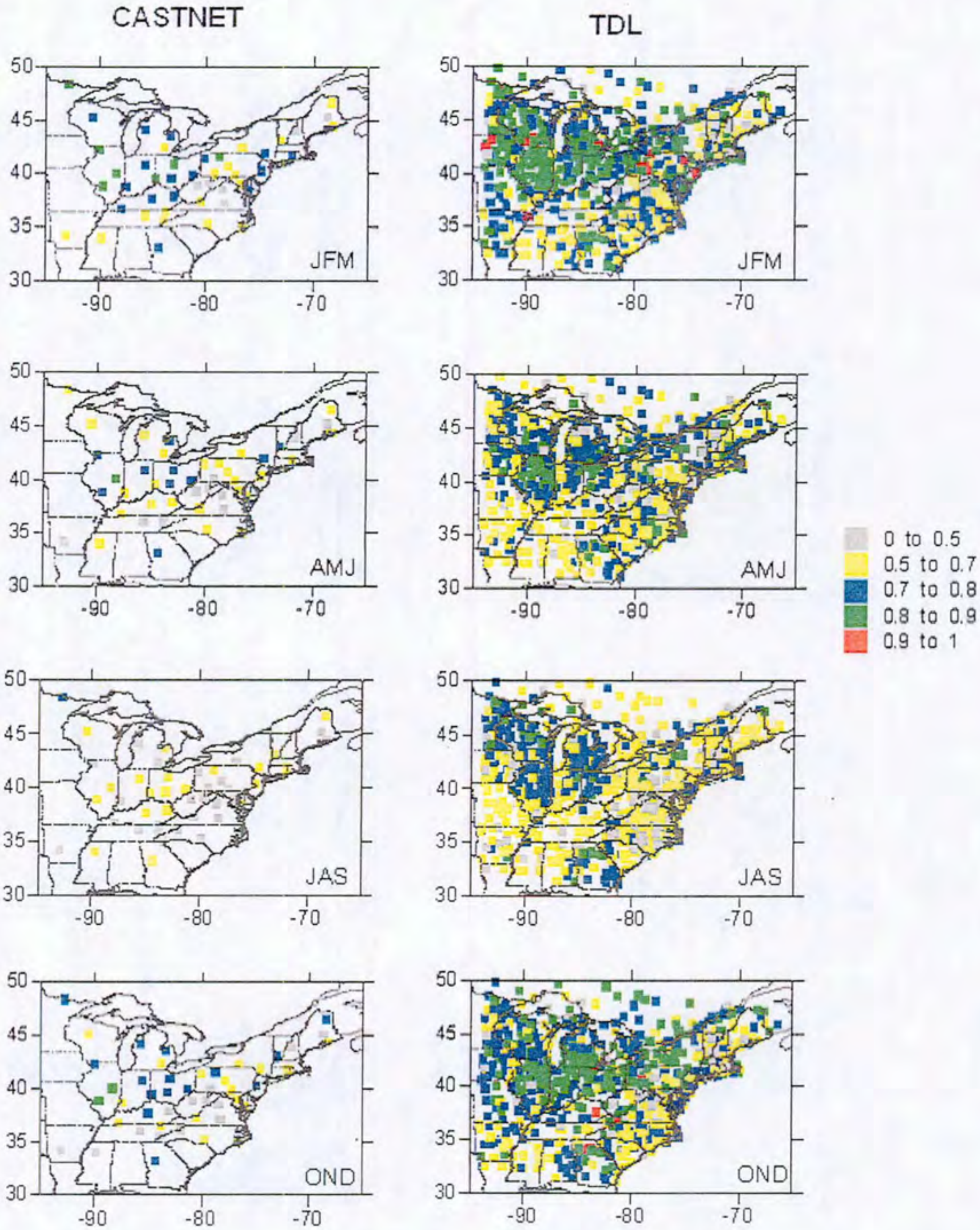


Figure 2-5 presents domain-wide average hourly bias of surface temperature between MM5 results and CASTNET and TDL for every season. MM5 tends to underestimate temperature at TDL sites throughout the year and at CASTNET sites for non-ozone season months. The seasonal mean temperature bias values are from ~-1 K (winter) to ~-0.3 K (summer) for TDL sites and ~-1 K (winter) to ~0.5 K (summer) for CASTNET sites. MM5 predictions show significantly larger variations of temperature bias at CASTNET sites (-4 K~9 K) than at TDL sites (-3 K~1 K).

Domain-wide average hourly IOA values of temperature are shown in Figure 2-6. Model predicted temperatures have significantly better agreement with TDL data (average IOA as ~0.95) than with CASTNET data (average IOA as ~0.85), although both indicate accurate MM5 performance on temperature.

Figure 2-7 shows the spatial distribution of quarterly correlation coefficients between MM5 prediction and measurement of surface temperature. It reveals very strong correlation (>0.95) over most of the domain for TDL data, with strong correlation (>0.8) for the majority of CASTNET sites. No spatial patterns or quarterly variations are apparent. MM5 performs consistently well throughout the year and the domain.

The TDL network also provides humidity measurements. Comparison between MM5 prediction of hourly surface humidity and TDL measurement are presented in Figure 2-8. MM5 captures the general trend of humidity change. It tends to underestimate humidity during the ozone season (seasonal mean bias as ~0.35g/kg), and overestimate it during the rest of year (seasonal mean bias range from ~0.17 to ~0.4). Domain-wide average hourly humidity bias shows a large diurnal variation, as much as 2g/kg. Domain-wide average hourly IOA in Figure 2-9 shows that MM5 predicted humidity values are in good agreement with TDL data (average IOA as ~0.9) throughout year. Spatial distribution of quarterly correlation coefficient in Figure 2-10 shows a distinctive spatial pattern and temporal trend. MM5 results have stronger correlation to TDL data in the northern US than in the Southern US. Through the year, the strongest correlation between MM5 prediction and measurement occurs in the 4th Quarter (>0.95), followed by the 1st and 2nd Quarters, and finally, the 3rd Quarter, which shows the weakest correlation (0.5~0.9).

Based on this statistical comparison between model prediction and data from 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.

Figure 2-5. 2002 Seasonal Hourly Average Bias of Temperature

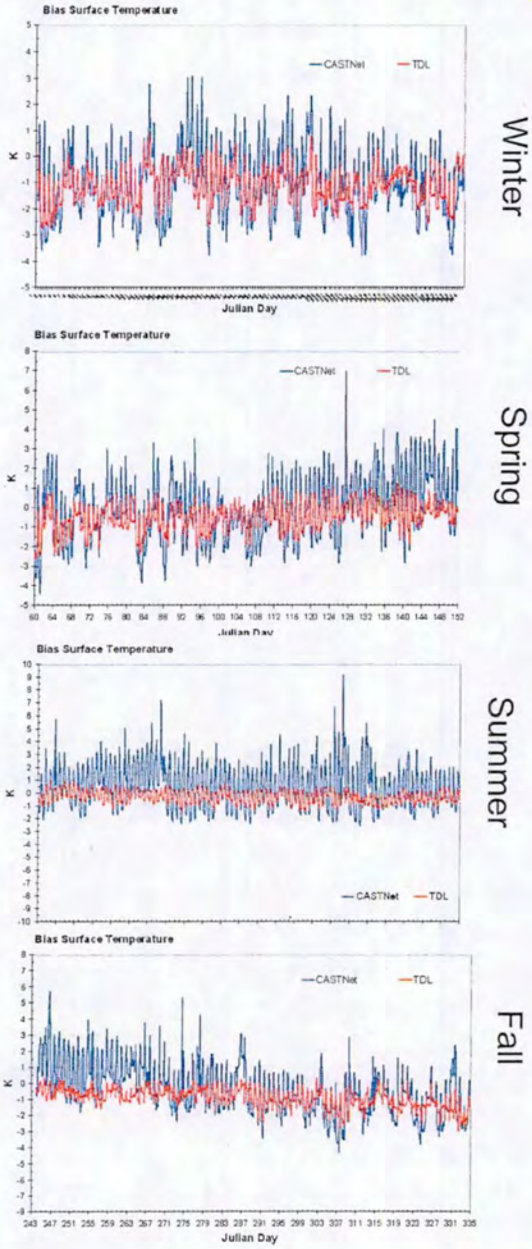


Figure 2-6. 2002 Seasonal Hourly Average Index of Agreement

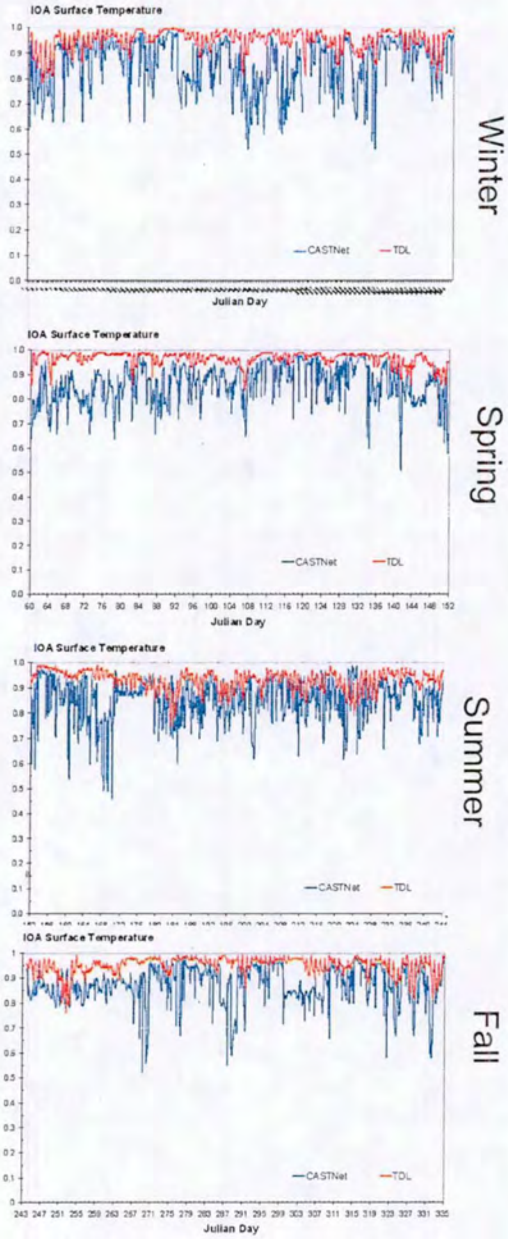


Figure 2-7. Quarterly correlation coefficient (r) of hourly temperature between modeling and measurement for each observation site in 2002

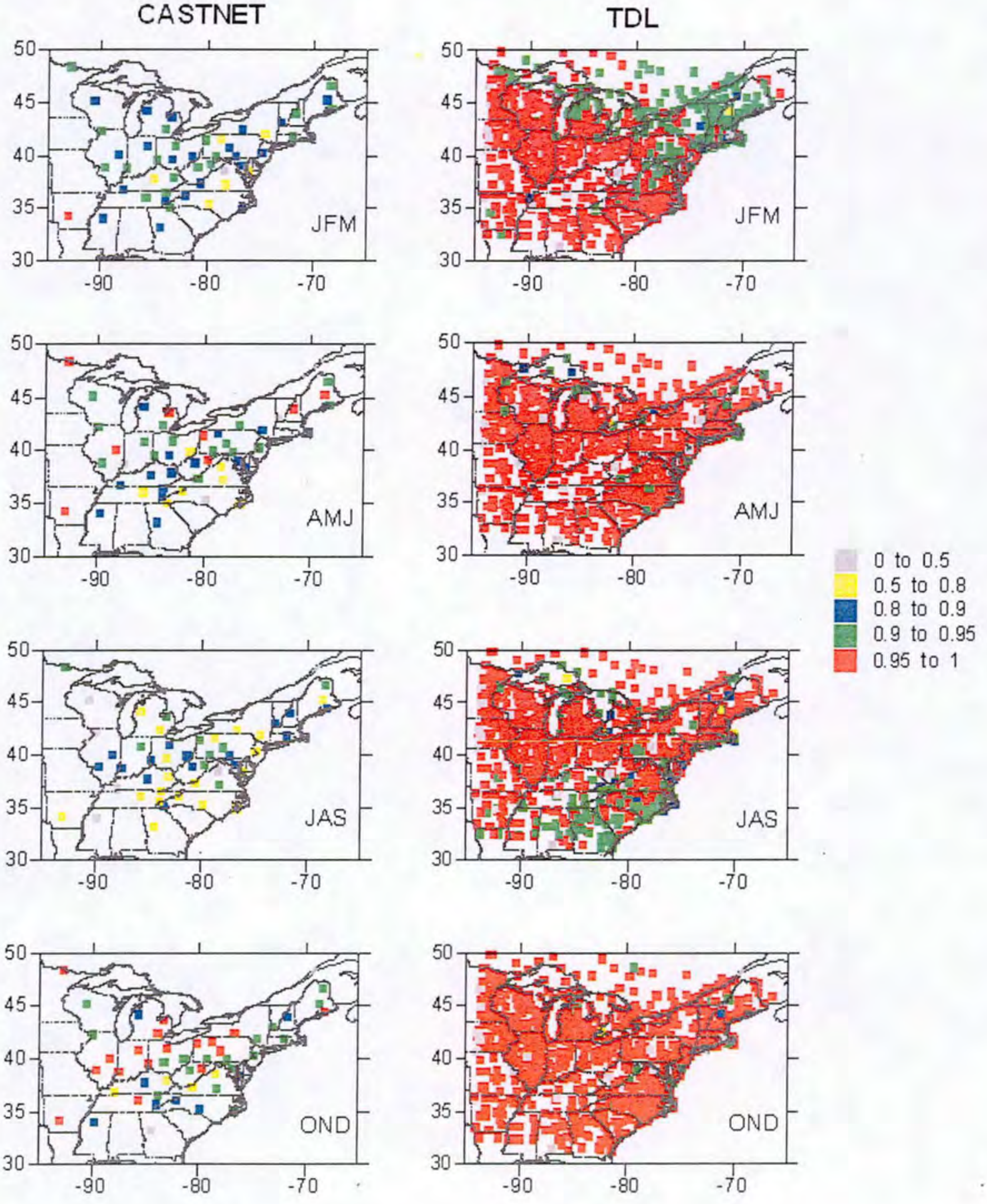


Figure 2-8. 2002 Seasonal average hourly bias of humidity

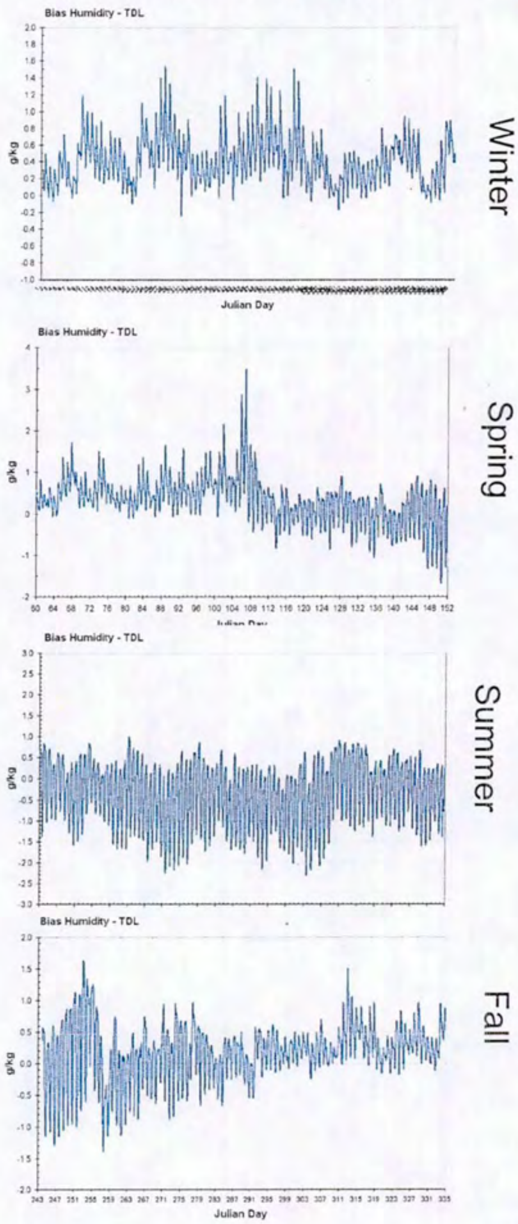


Figure 2-9. 2002 seasonal hourly average index of agreement

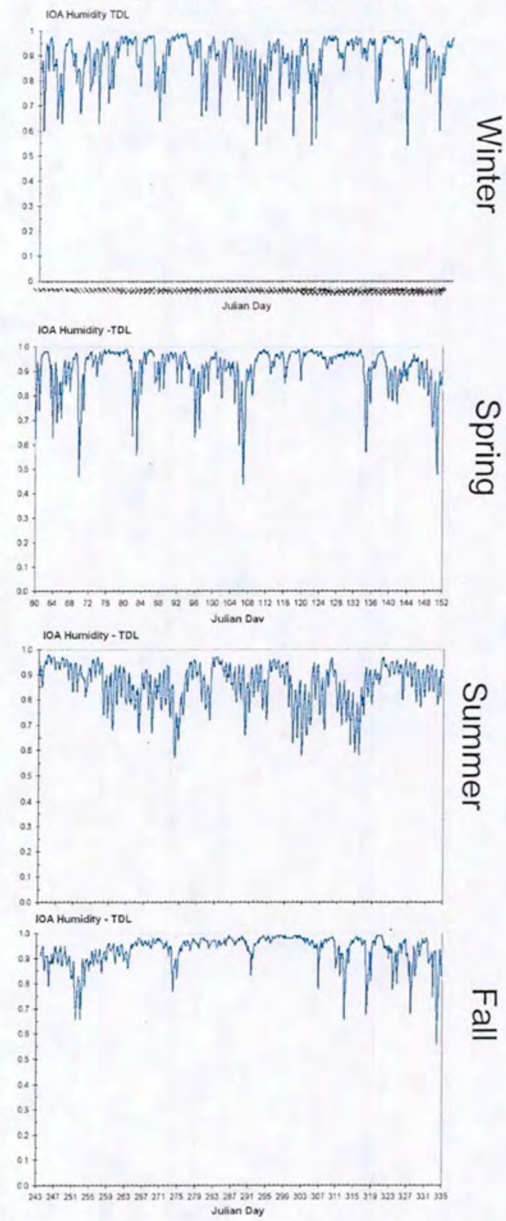
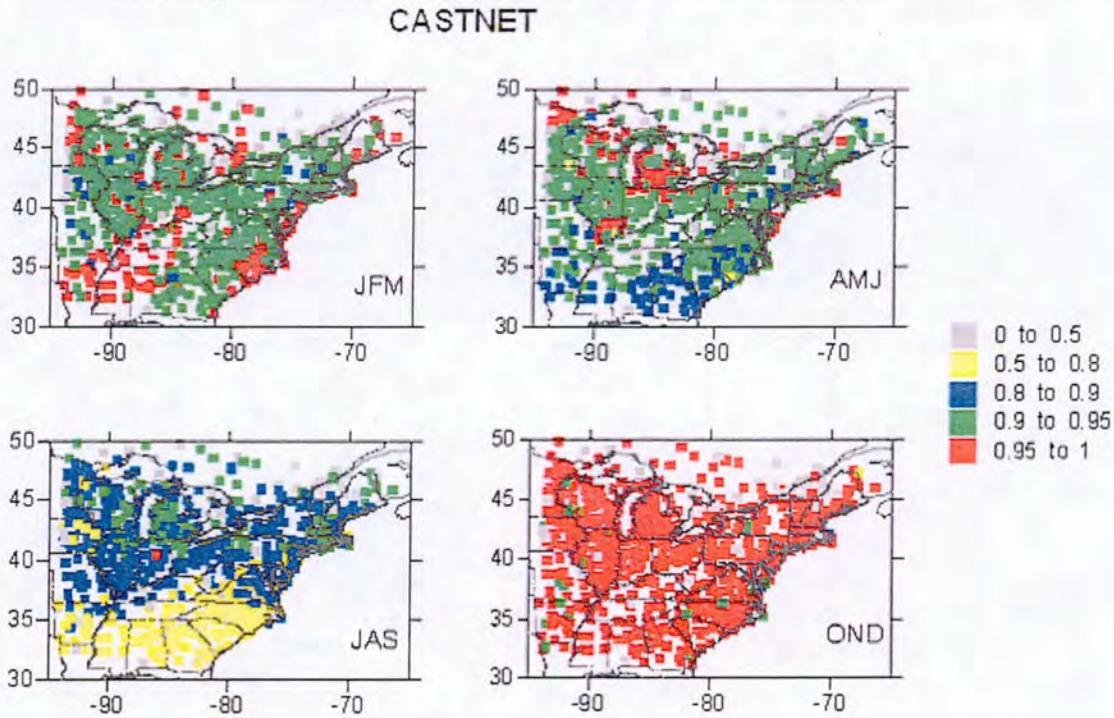


Figure 2-10. Quarterly correlation coefficient (r) of hourly humidity between modeling and measurement for each observation site in 2002



2.2. Model Evaluation

CMAQ modeling has been conducted for the year 2002 (completed by cooperative modeling efforts from NYDEC, UMD, NJDEP, Rutgers, VADEP, and NESCAUM) under the Base B4 emission scenario described in Chapter 1. CMAQ performance for $PM_{2.5}$ species and visibility is examined based on this CMAQ run on a 12 km resolution domain. Measurements from IMPROVE and STN networks are paired with model predictions by location and time for evaluation. Figure 2-11 presents the domain-wide paired comparison of $PM_{2.5}$ species (sulfate, nitrate, OC, EC, fine soil, and $PM_{2.5}$) daily average concentration from the CMAQ simulation and two sets of observations (STN and IMPROVE). It shows that predicted $PM_{2.5}$ sulfate (top row left panel) and measured sulfate are in a good 1:1 linear relationship with r^2 varying from 0.6 to 0.7. $PM_{2.5}$ nitrate (top row right panel) also has close to a 1:1 linear relationship between the model and observations, although the r^2 values are much lower (from ~0.2 to ~0.5) than for sulfate. Paired OC (middle row left panel) concentrations have a scattered distribution with over- and under-estimation and a very weak linear relationship (r^2 of ~0.1). CMAQ tends to overestimate EC (middle row right panel) and fine soil (bottom row left panel) concentrations.

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

Because sulfate is the dominant $PM_{2.5}$ species, modeled $PM_{2.5}$ (bottom row right panel) shows a relatively strong near 1:1 linear relationship (slope between 0.7–0.8 with r^2 of 0.4–0.5). Figure 2-12 describes the spatial distribution of the correlation coefficient of sulfate between CMAQ prediction and observations (STN data on the top row and IMPROVE data on the bottom row) at network sites. CMAQ predictions show a similar spatial pattern of correlation with both networks.

Generally, the northern region of the domain has stronger correlations than does the southern region. Correlation coefficients within the MANE-VU region are highest (~0.9 on average) compared to other RPO regions. The spatial distribution of correlation coefficient for $PM_{2.5}$ is presented in Figure 2-13. The $PM_{2.5}$ correlation coefficient spatial pattern follows $PM_{2.5}$ sulfate correlation coefficient, although at the same observation site coefficient values are ~0.1 lower than the sulfate coefficient value. Like $PM_{2.5}$ sulfate, CMAQ also performs the best for $PM_{2.5}$ in the MANE-VU region with a ~0.7 annual average for the correlation coefficient.

The goal and the criteria for $PM_{2.5}$ evaluation suggested by Boylan and Baker (2004) have been adopted by every RPO for SIP modeling. The proposed performance goals are: Mean Fractional Error (MFE) $\leq$ +50%, and Mean Fraction Bias (MFB) $\leq$ ±30%; while the criteria are proposed as: MFE $\leq$ +75%, and MFB $\leq$ ±60%.

CMAQ prediction of $PM_{2.5}$ species from 40 STN sites and 17 IMPROVE sites within MANE-VU region are paired with measurements and statistically analyzed to generate MFE and MFB values. Figure 2-14 presents MFE of $PM_{2.5}$ sulfate, nitrate, OC, EC, fine soil, and $PM_{2.5}$, and curves of the goal and criteria. MFB values are shown in Figure 2-15. Considering CMAQ performance in terms of MFE and MFB goals, sulfate, nitrate, OC, EC, and $PM_{2.5}$ all have the majority of data points within the goal curve, some are between the goal and acceptable criteria, and only a few are outside the criteria curve. Only fine soil has the majority of points outside the criteria curve, but there are 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 is calculated following the IMPROVE formula with modeled daily $PM_{2.5}$ species concentration and relative humidity factors from IMPROVE. The approaches used here and throughout this analysis, have used natural background visibility estimates and the haze index following EPA Guidance.

Figure 2-16 shows the paired comparison between prediction and measurement of daily B_{ext} from seven sites for 2002. The modeled B_{ext} shows 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.

CMAQ prediction of the B_{ext} agrees well with IMPROVE observation because CMAQ performs well on sulfate, which dominates aerosol extinction. Further, the modeled haze index (HI) is calculated based on modeled B_{ext}. Figure 2-17 presents the paired comparison between CMAQ prediction and IMPROVE measurement for 2002 of HI values at seven Class I sites in the eastern U.S.. Acadia and Moosehorn show the best model performance with regression slopes of 0.97 and r^2 of ~0.6., The poorest model performance occurs at Lye Brook and Shenandoah, with regression slopes less than 0.6 and r^2 of ~0.3. Note the regression equations and best fit lines are not plotted.

Figure 2-11. Domain-wide paired comparison of daily average $PM_{2.5}$ species between CMAQ predictions and measurements from IMPROVE networks

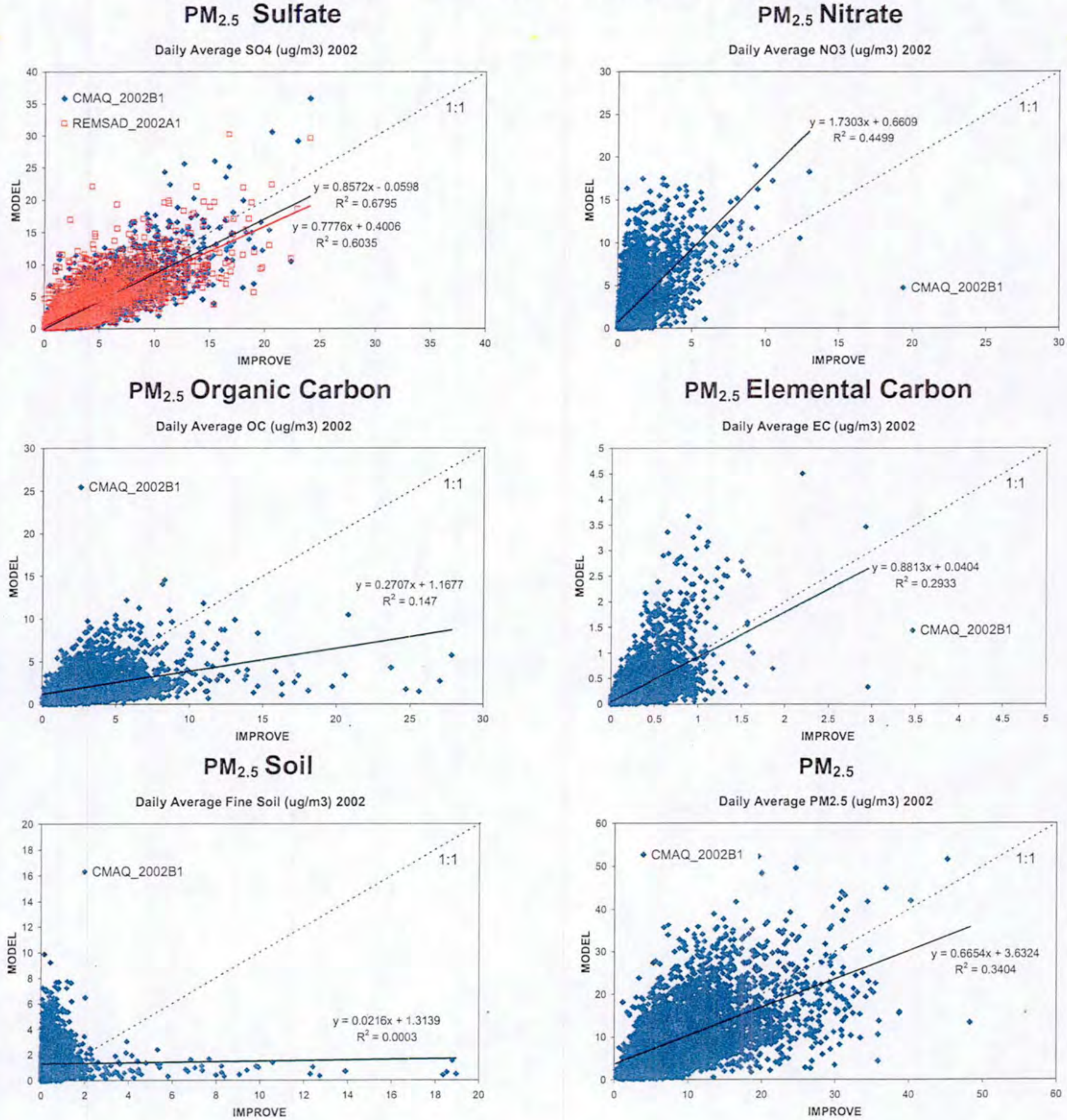


Figure 2-12. Spatial distribution of correlation coefficient between $PM_{2.5}$ Sulfate and measurement

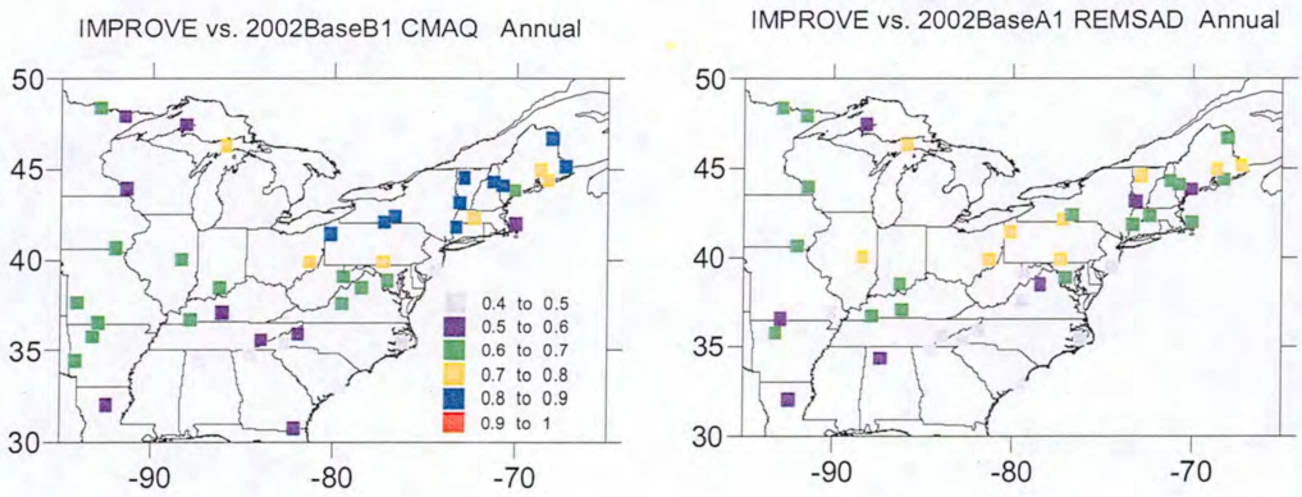


Figure 2-13. Spatial distribution of correlation coefficient between $PM_{2.5}$ and measurement

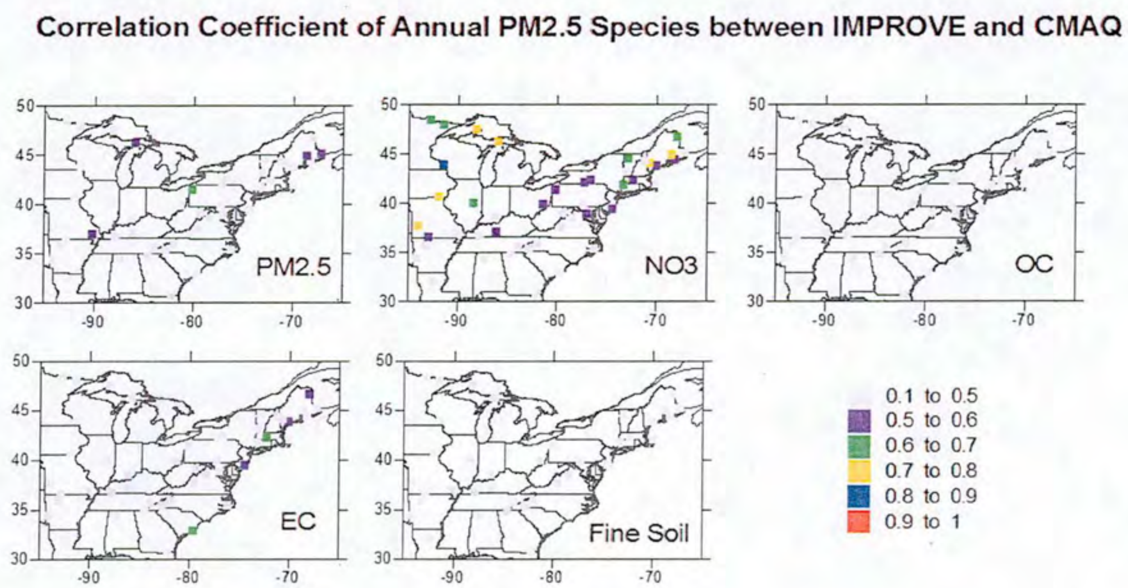


Figure 2-14. Mean Fractional Error of $PM_{2.5}$ species within MANE-VU region

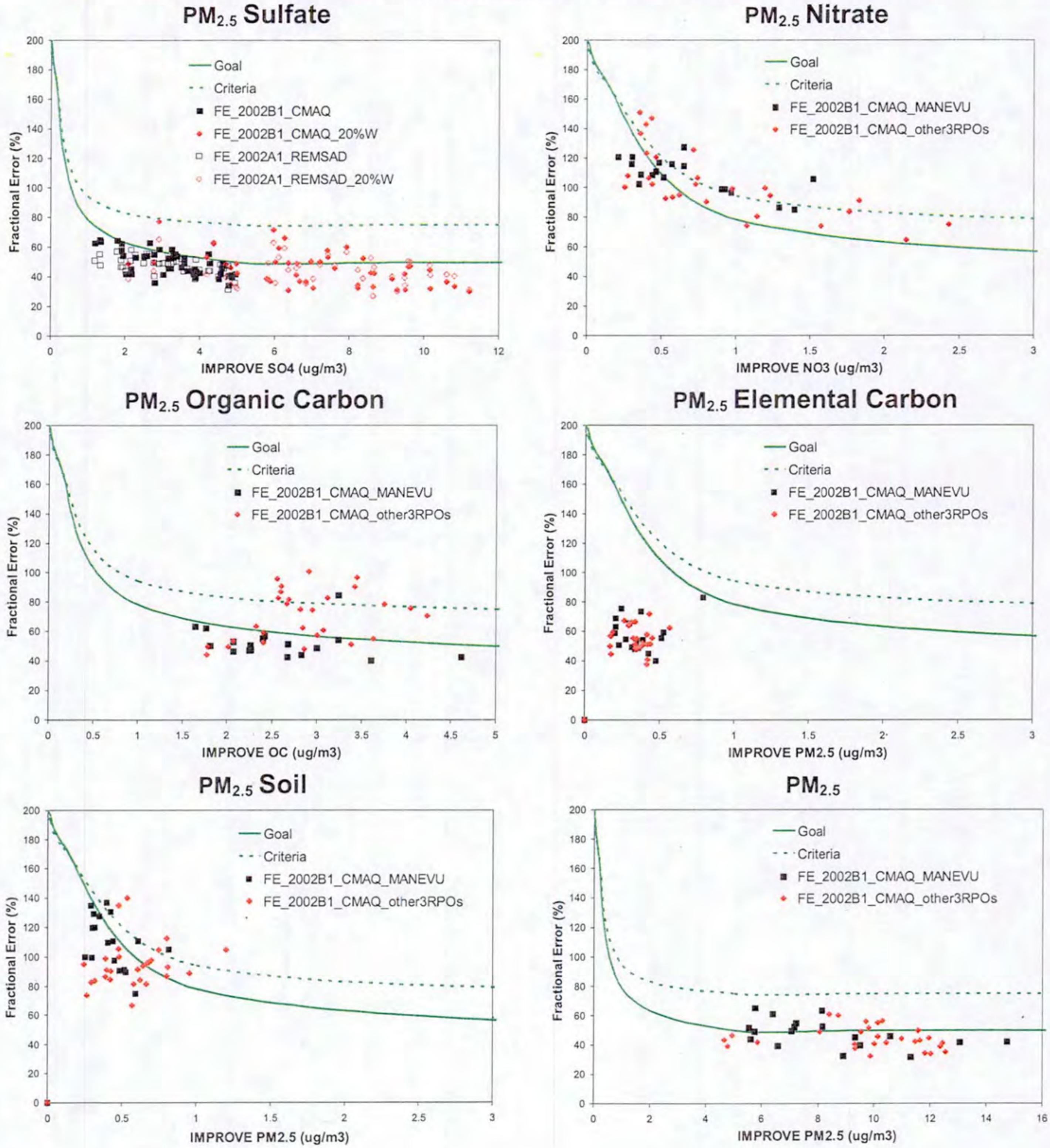


Figure 2-15. Mean Fraction Bias of $PM_{2.5}$ species within MANE-VU region

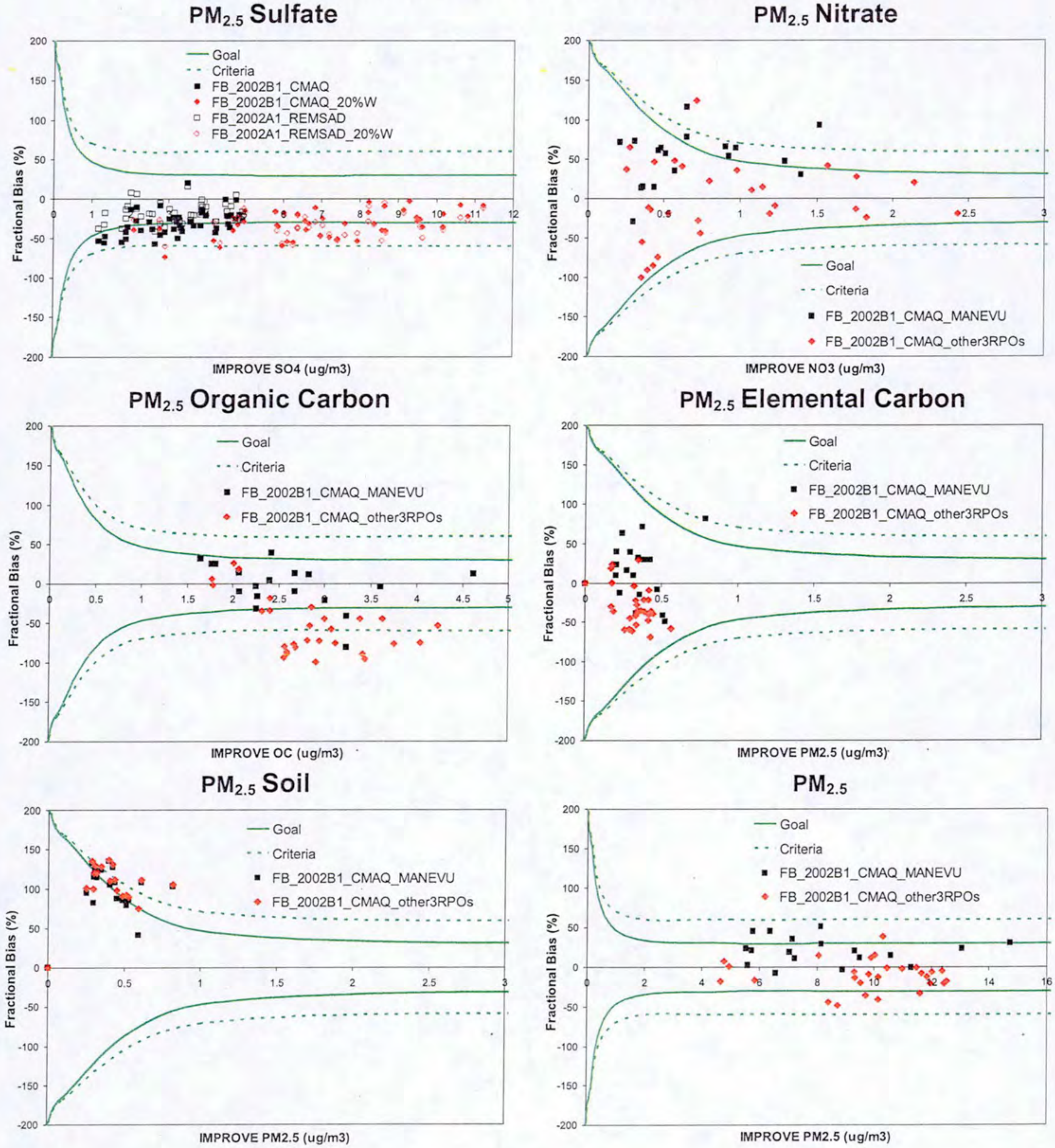


Figure 2-16. Paired comparison of extinction coefficient between CMAQ prediction and IMPROVE measurement

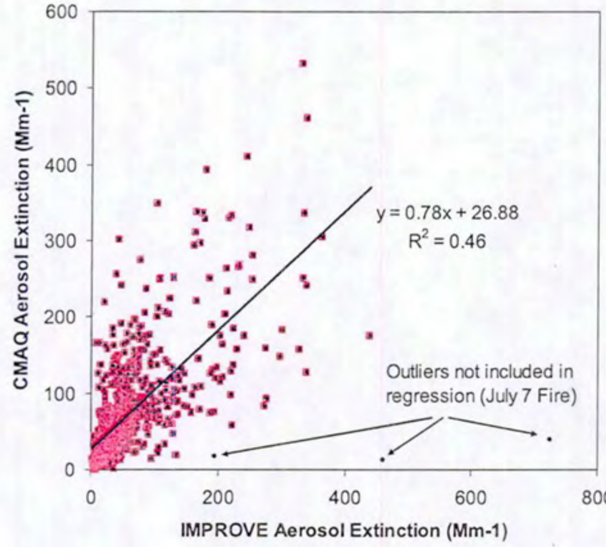
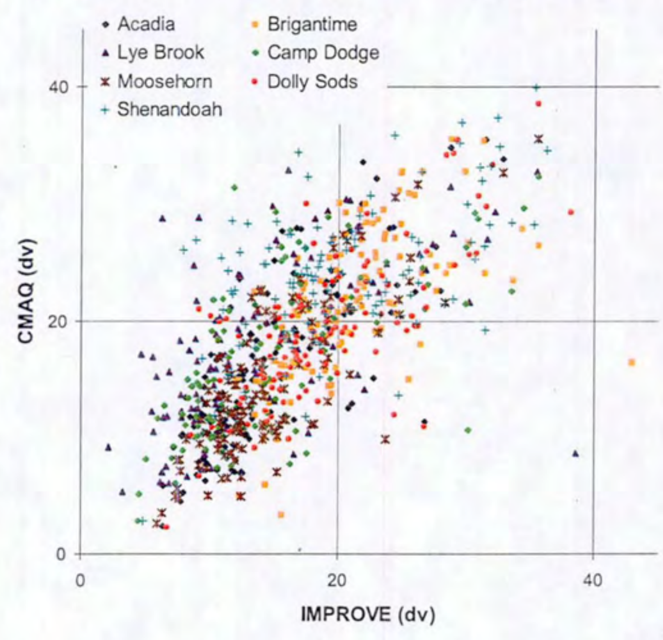


Figure 2-17. Paired Comparison of Haze Index between CMAQ prediction and IMPROVE measurement at selected Class I sites



3. 2018 BOTW PROJECTIONS

In order to assess the projected visibility improvement at MANE-VU Class I areas prior to consideration of potential reasonable measures for adoption in a long-term emissions management strategy, a simulation of the MANE-VU "Beyond on the Way" (BOTW-1) inventory was conducted. As indicated in Chapter 2, this inventory/scenario combination represents additional measures beyond existing regulations that have been accepted by the OTC Modeling Committee for attainment of the 8-hour ozone and $PM_{2.5}$ NAAQSs. These measures include regulations on portable fuel containers, architectural and maintenance (AIM) coatings, and some consumer products. In addition, at the point that this inventory was "closed" for further changes, most states had indicated a willingness to adopt regulations limiting fuel sulfur content of distillate fuel oil to 500 ppm or lower.[4] While all states have subsequently agreed that they will pursue regulation of distillate AND residual fuel oil and that these regulations would cap distillate at 15 ppm fuel sulfur content by 2018, this additional level of reduction is not reflected in the BOTW-1 simulation discussed below.

The BOTW-1 scenario was processed through SMOKE for 2009 by NYDEC and for 2018 by NESCAUM and distributed to the other modeling centers in a manner similar to the 2002 base year scenario that was SMOKE processed by NYDEC. After each center had completed its portion of the processing, NESCAUM obtained the results for all projection years for analysis of haze metrics.

The results of this run are shown in Table 3-1 and Figures 3-1 and 3-2, which show relative reduction factors at each Class I area by species and the overall projected improvement in visibility in deciviews based on the 2009 (NYDEC) and 2018 (NESCAUM) BOTW-1 projections, respectively.

Table 3-1. 2018 twenty percent worst days relative reduction factors.

	Shenandoah	Dolly Sods	Brigantine	Great Gulf	Lye Brook	Moosehorn	Acadia
Sulfate	0.49	0.51	0.53	0.59	0.58	0.63	0.60
Nitrate	0.46	0.63	0.95	0.87	0.91	0.73	0.80
EC	0.58	0.71	0.62	0.73	0.67	0.77	0.75
OC	0.88	0.92	0.98	0.86	0.93	0.95	0.95
Sea Salt	1	1	1	1	1	1	1
Soil	1.27	1.26	1.28	1.16	1.13	1.09	1.10

[4] Delaware and Vermont had not given an indication by the time the inventory was closed.

Figure 3-1. Projected improvement in visibility at four Northeast sites based on 2009 and 2018 BOTW-1 projections.

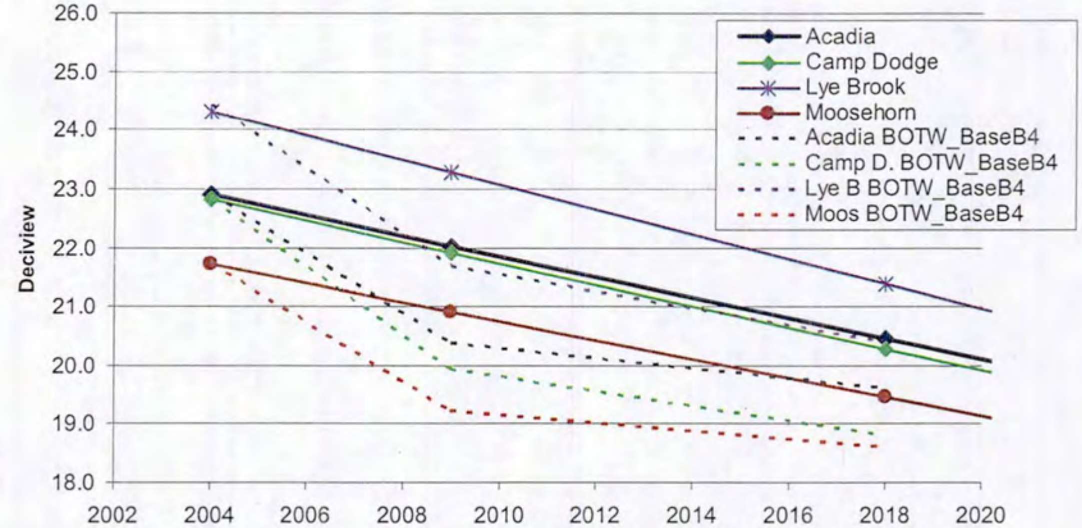
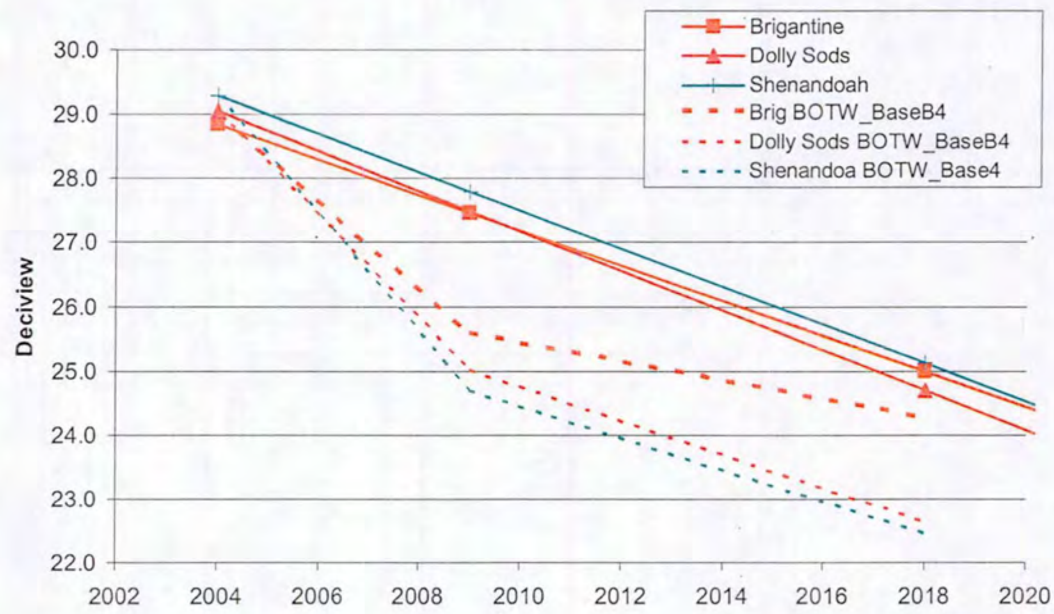


Figure 3-2. Projected improvement in visibility at three Mid-Atlantic sites based on 2009 and 2018 BOTW-1 projections.



The projections for the BOTW-1 scenario indicate that the adoption of 500 ppm distillate regulations by all MANE-VU states is sufficient to achieve visibility improvements beyond the uniform rate of progress defined by the 2064 natural conditions visibility goal. However, it should be noted that USEPA guidance for setting reasonable progress goals asks states to consider reviewing all measures identified through the four-factor analysis process and to adopt each measure that is determined to be reasonable.

While the interpretation of USEPA guidance on this subject continues to be debated by various stakeholders and some states outside the MANE-VU region, MANE-VU believes that the four-factor analysis provisions in the Clean Air Act requires states to analyze additional measures and adopt those that are reasonable. We have identified and analyzed several additional measures for consideration in determining regional haze reasonable progress goals and these options are explored in Chapter 5.

4. 2018 POLLUTION APPORTIONMENT

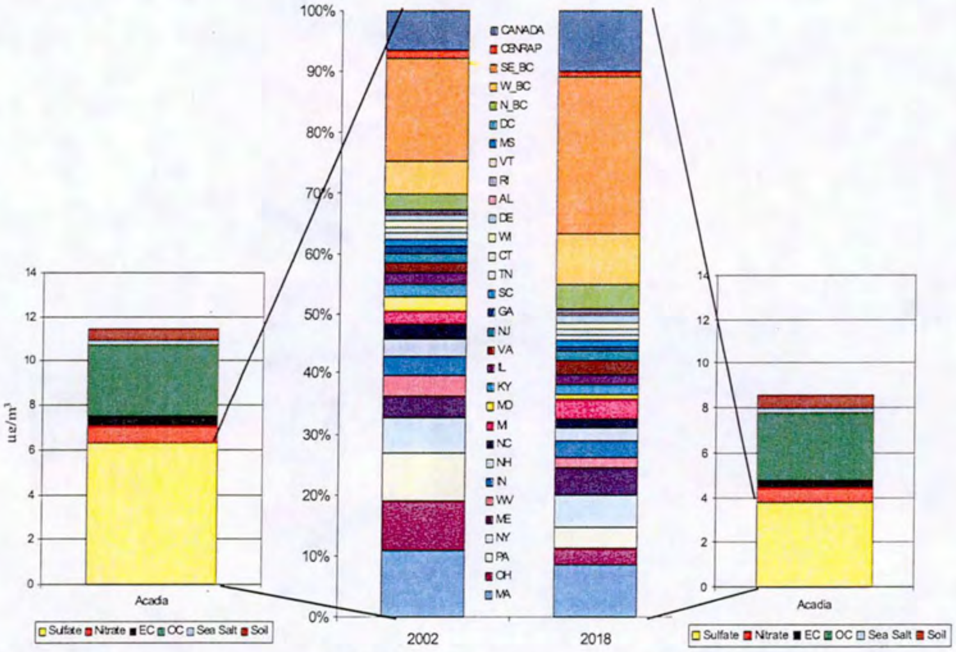
One requirement of the regional haze rule is a "pollution apportionment" that provides an assessment of the major contributors to MANE-VU visibility impairment by geographical region or by sector. MANE-VU had conducted an extensive apportionment of 2002 visibility impairment from sulfate in the prior *Contribution Assessment* report (NESCAUM, 2006a) and conceptual description (NESCAUM, 2006b). In order to update this work to reflect changes in the contributions by various states to visibility impairment projected for 2018, we have utilized the 2018 BOTW emission inventory and tagged all SO_2 emissions from each of 29 states in the eastern U.S. This required three separate runs with 11 tags per run. In addition, three tags for baseline (2002) boundary conditions (**N**orth, **S**outh_**E**ast, and **W**est) provide an estimate for sulfate contributions external to the model domain. Note their contribution includes emissions that originated within the domain, but were advected out of the modeling domain only to recirculate back into the domain (i.e. the state-specific tagged contributions represent, in this sense, a lower-bound).

This tagging scheme provides a comprehensive reporting of the influence of most of these states to visibility impairment within the model domain. It also provides a partial accounting of the influence of several states along the western and southern edge of the model domain where only a portion of the states' emissions were tracked.

Results indicate that the relative contribution of states within the domain will decrease significantly due, in large part, to the anticipated SO_2 emissions reductions from the CAIR program. As a result, we see large *increases* in the *relative* contribution from Canada and the boundaries. This apparent increase is simply due to the fact that we are showing relative contributions and as a share of the total, these fixed contributions contribute a larger share after CAIR has reduced the contribution within the domain.

Figures 4-1 through 4-5 show the absolute magnitude of measured and projected sulfate at each MANE-VU class I monitor as well as the relative contributions of each state to that sulfate as contrasted against their 2002 contributions.

Figure 4-1. a. Measured and projected mass contributions in 2002 and 2018 at Acadia National Park on twenty percent worst visibility days.



IMPROVE mass 00-04 REMSAD Contribution to Sulfate CMAQ RRF-Based 2018 Mass

b. 2002 and 2018 sulfate mass from at Acadia National Park, twenty percent worst days apportioned by REMSAD

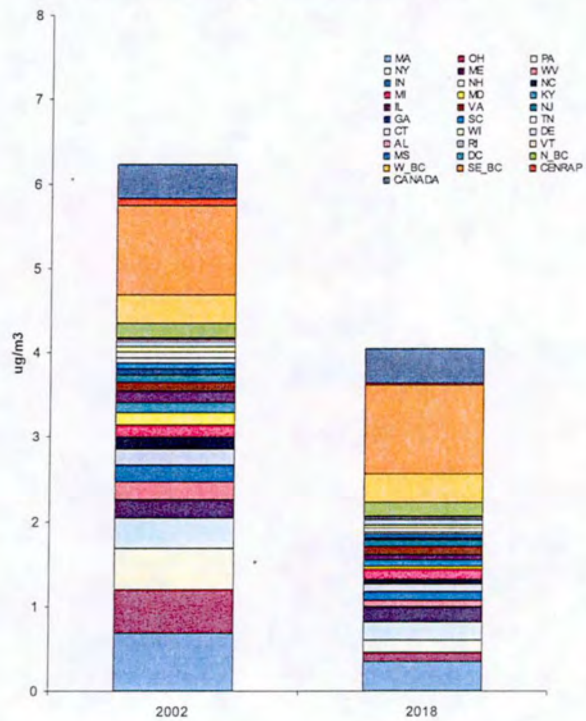
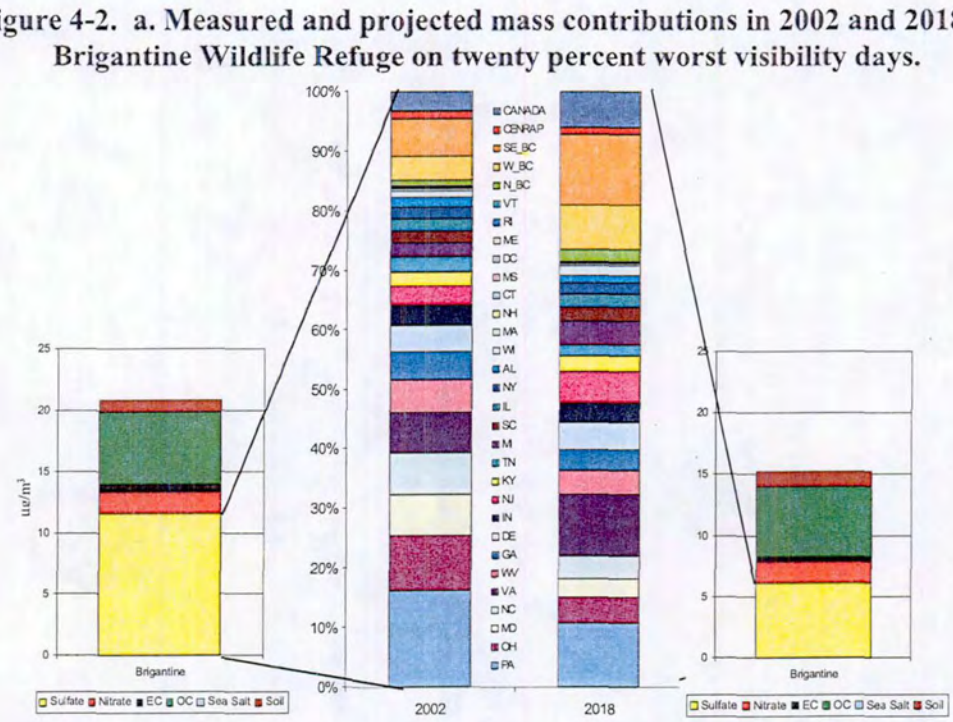


Figure 4-2. a. Measured and projected mass contributions in 2002 and 2018 at Brigantine Wildlife Refuge on twenty percent worst visibility days.



IMPROVE mass 00-04 REMSAD Contribution to Sulfate CMAQ RRF-Based 2018 Mass

b. 2002 and 2018 sulfate mass from Brigantine Wildlife Refuge, twenty percent worst days from REMSAD

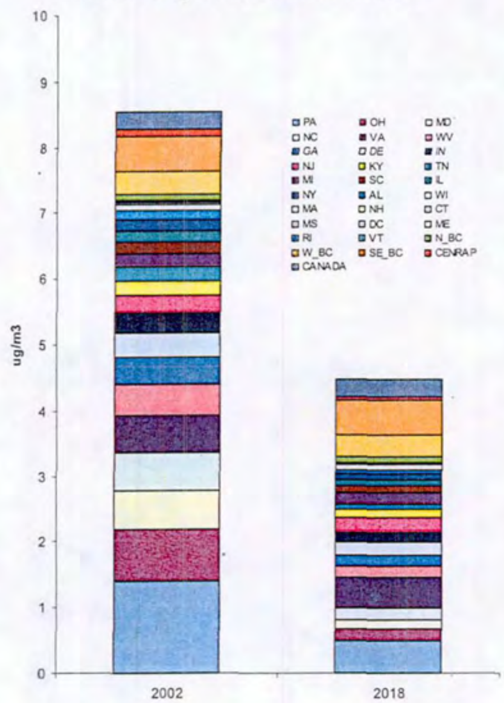
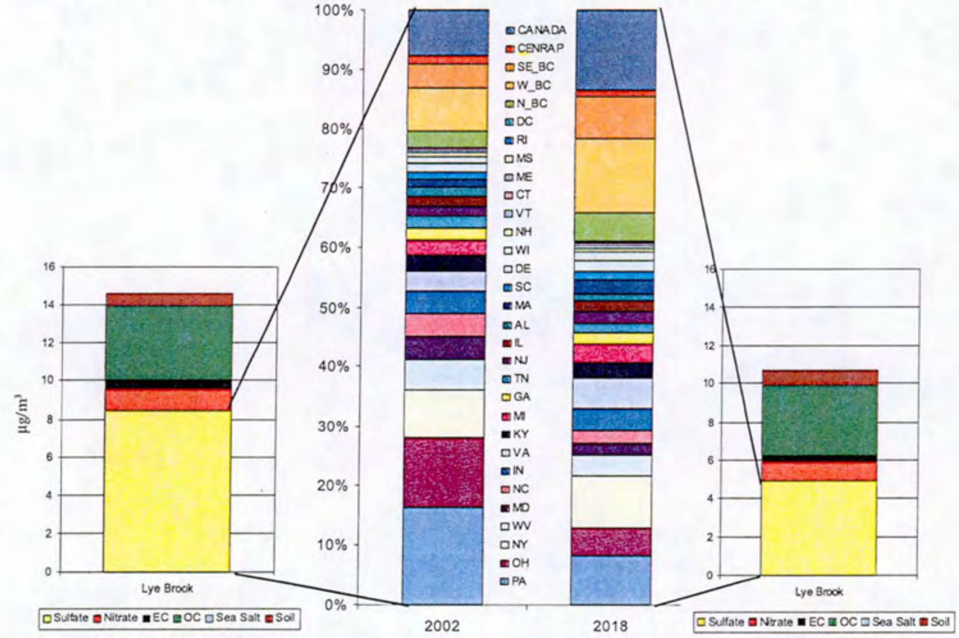


Figure 4-3. a. Measured and projected mass contributions in 2002 and 2018 at Lye Brook Wilderness Area on twenty percent worst visibility days.



IMPROVE mass 00-04 REMSAD Contribution to Sulfate CMAQ RRF-Based 2018 Mass

b. 2002 and 2018 sulfate mass from Lye Brook Wilderness Area, twenty percent worst days from REMSAD

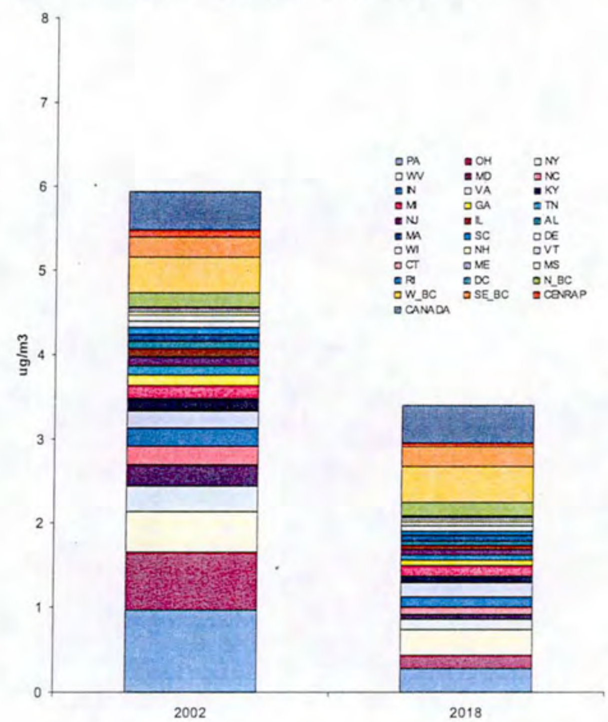
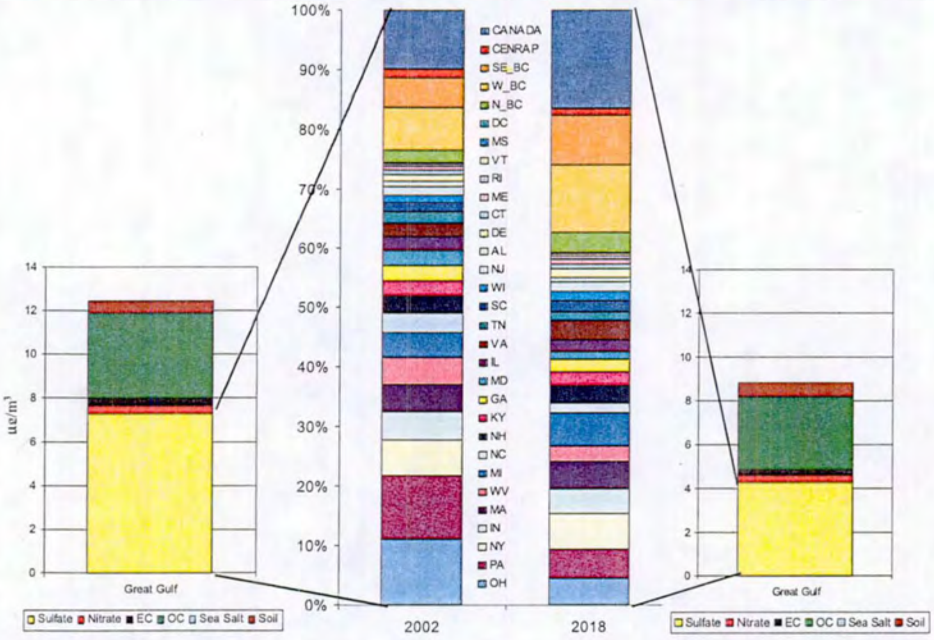


Figure 4-4. a. Measured and projected mass contributions in 2002 and 2018 at Great Gulf Wilderness Area on twenty percent worst visibility days.



IMPROVE mass 00-04 **REMSAD Contribution to Sulfate** **CMAQ RRF-Based 2018 Mass**

b. 2002 and 2018 sulfate mass from Great Gulf Wilderness Area, twenty percent worst days from REMSAD

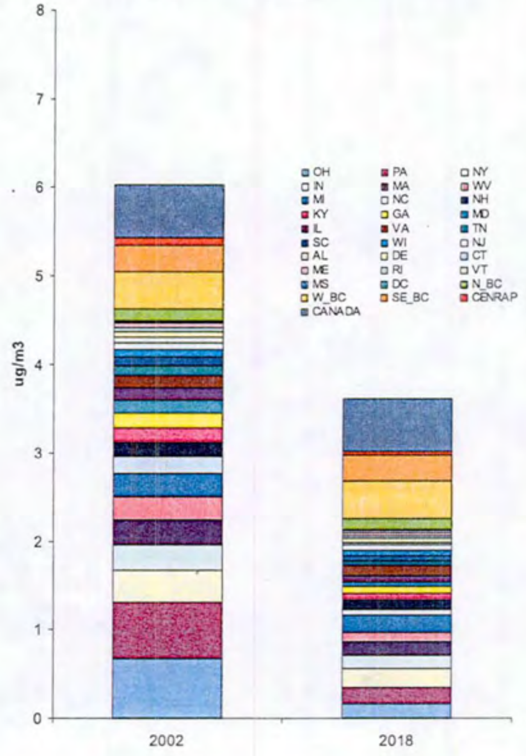
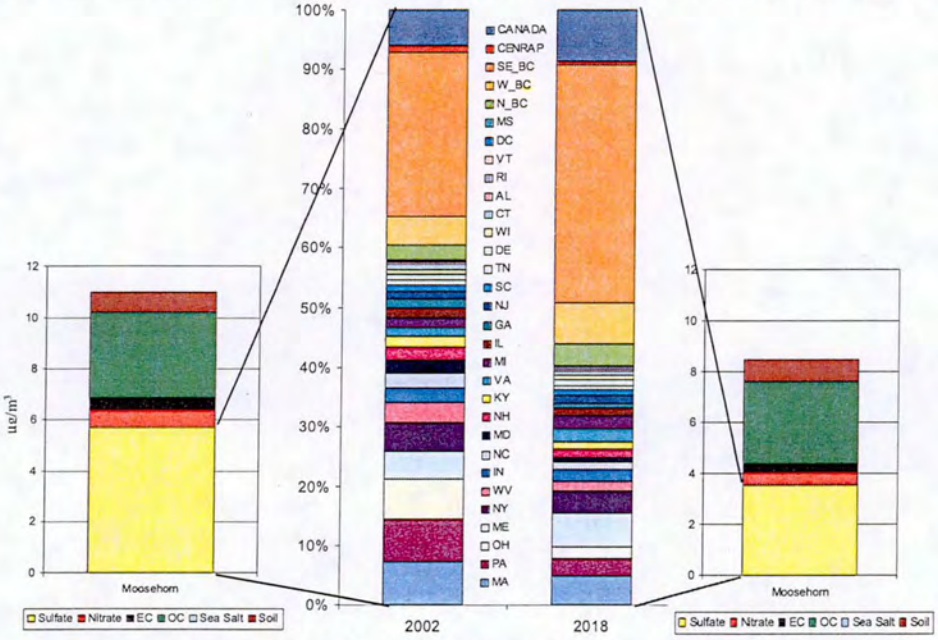
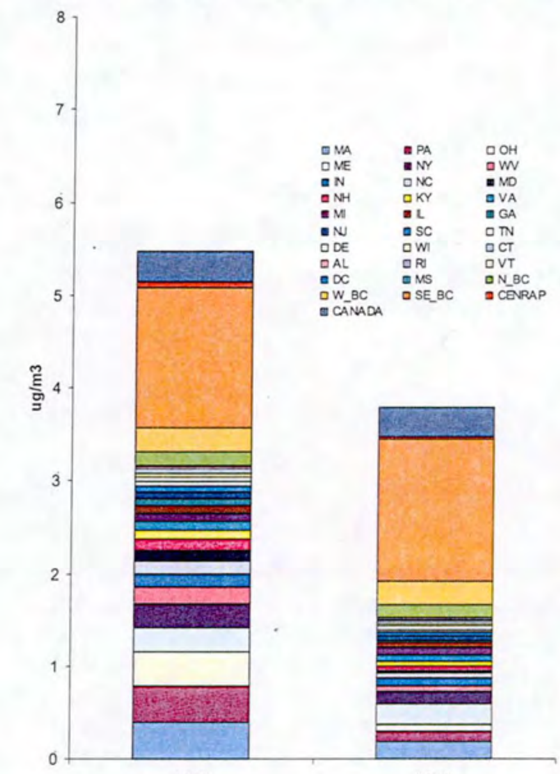


Figure 4-5. a. Measured and projected mass contributions in 2002 and 2018 at Moosehorn National Wildlife Refuge on twenty percent worst visibility days.



IMPROVE mass 00-04 **REMSAD Contribution to Sulfate** **CMAQ RRF-Based 2018 Mass**

b. 2002 and 2018 sulfate mass from Moosehorn National Wildlife Refuge, twenty percent worst days from REMSAD



5. CONTROL STRATEGY EVALUATION

We evaluated the visibility benefits of four potential control strategies aimed at reducing regional haze at Class I areas in the MANE-VU region beyond what has been included in the "OTB/OTW" scenario described earlier. These programs include two separate but linked low-sulfur content fuel initiatives (the S1 and S2 strategies), the BART provisions of the Regional Haze Rule, and controls on EGUs at the 167 stacks most likely to affect MANE-VU Class I areas ("167 EGU strategy"). This chapter reviews the control strategies in more detail, describes the potential emissions reductions, and evaluates the potential visibility benefits of each strategy in combination with the others.

5.1. Reduced sulfur fuel content (S1 and S2)

The MANE-VU states have agreed through consultations to pursue a low sulfur fuel strategy within the region. This phased strategy would be implemented in two steps; however, both components of the strategy are to be fully implemented by 2018. We have analyzed both steps of the program as separate strategies, but it is the combined benefit of implementing the program that is relevant to the question of program benefits in 2018.

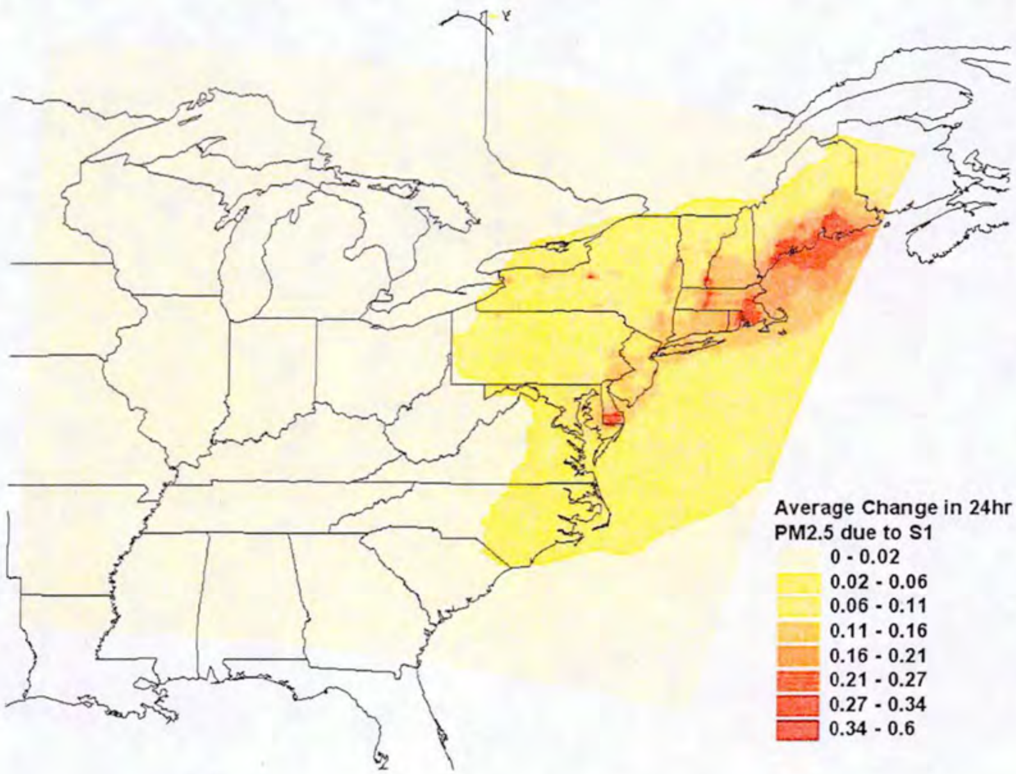
The S1 strategy involves the lowering of fuel-sulfur content in distillate (No. 2 oil) from current levels that range between 2,000 and 2,300 ppm down to 500 ppm by weight. It also restricts the sale of heavier blends of residual oil (No. 4 fuel oil and No. 6 bunker fuels) that have sulfur content greater than 0.25 percent sulfur and 0.5 percent sulfur by weight, respectively. The S2 strategy further reduces the fuel-sulfur content of the distillate fraction to 15 ppm sulfur by weight. The residual oil is maintained at the same S1 level for this strategy.

The S1 strategy and S2 strategy are to be implemented in sequence with slightly different timing for an "inner zone"[5] and the remainder of MANE-VU. All states, however, have agreed to pursue the adoption and implementation of an "emission management" strategy, as appropriate and necessary, to reduce the sulfur content of distillate oil and residual fuel oil as specified in the MANE-VU statements adopted June 20, 2007 by the MANE-VU Board. Thus for the purposes of this analysis, we have examined the benefits of the S1 and S2 strategies separately below.

Based on the fuel sulfur limits within the S1 strategy, we estimated a decrease of 140,000 tons of SO_2 emitted from distillate combustion and 40,000 tons of SO_2 from residual combustion in MANE-VU. Figure 5-1 displays the resulting average change in 24-hr average $PM_{2.5}$ between the baseline case (OTB/OTW) and the control case where the S1 fuel strategy has been implemented.

[5] The inner zone includes New Jersey, Delaware, New York City, and potentially portions of eastern Pennsylvania.

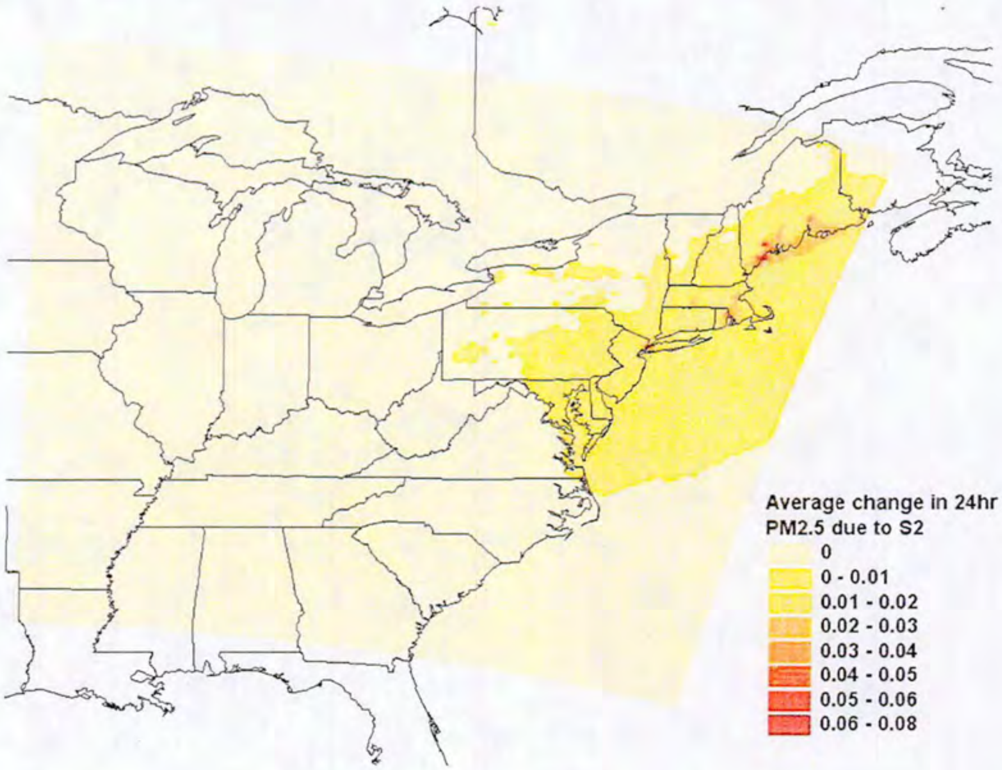
Figure 5-1. Average change in 24-hr $PM_{2.5}$ due to S1 emission reductions ($\mu g/m^3$)



We used the concentration changes in Figure 5-1 above to derive visibility benefits. Because the S1 fuel sulfur program only affects sources within MANE-VU, that region sees the largest $PM_{2.5}$ reduction and the greatest visibility benefits.

The S2 fuel strategy further reduces the sulfur content of distillate from 500 ppm to 15 ppm while keeping the sulfur limits on residual oils to 0.25 percent and 0.5 percent for No. 4 and No. 6 oils, respectively. By lowering the distillate fuel sulfur limit from 500 ppm to 15 ppm, we estimate an additional reduction of 27,000 tons of SO_2 emissions in MANE-VU from distillate combustion in 2018. Figure 5-2 displays the average change in 24-hr $PM_{2.5}$ calculated from CMAQ modeled concentrations between the S1 scenario and the S2 scenario. It reflects the predicted change in $PM_{2.5}$ due solely to the change from 500 ppm to 15 ppm distillate. Due to a high baseline fuel sulfur level, the incremental change in $PM_{2.5}$ concentration is much smaller between 500 ppm and 15 ppm than the baseline to 500 ppm levels observed in the S1 scenario.

Figure 5-2. Average change in 24-hr $PM_{2.5}$ due to S2 emission reductions, relative to S1 ($\mu g/m^3$)



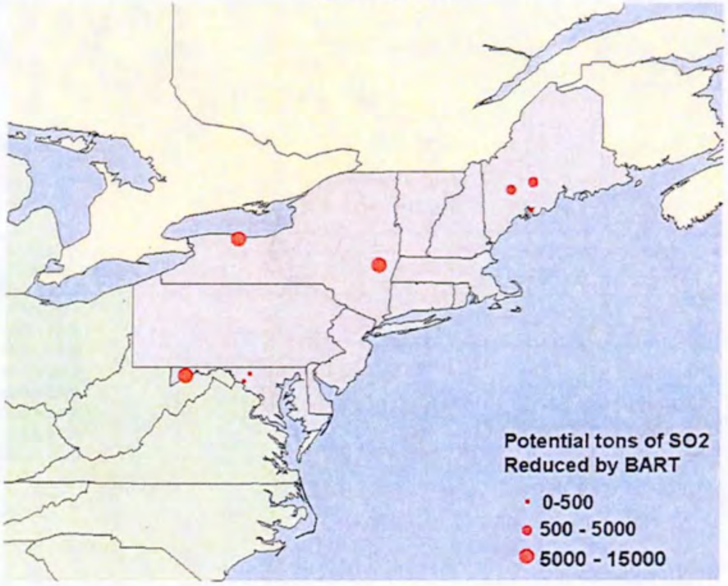
To determine the full benefit of the fuel strategies being considered relative to the OTB/OTW baseline, we can look at the combined benefits from the S1 (500 ppm distillate and 0.25/0.5 percent residual oil) strategy *and* the S2 (15 ppm distillate) strategy. The combined benefits can be gauged in Figures 5-6 through 5-14 and are shown in the results presented in Table 5-2 at the end of this section.

5.2. Best Available Retrofit Program (BART)

To assess the impacts of the implementation of the BART provisions of the Regional Haze Rule, we included estimated reductions anticipated for BART-eligible facilities in the MANE-VU region in the 2018 CMAQ modeling analysis. An inital survey of state staff indicated that these 14 units would likely be controlled under BART alone and were modeled in this analysis. These states provided potential control technologies and levels of control, which were in turn incorporated into the 2018 emission inventory projections. NESCAUM (2007) provides the survey approach. Updates to this preliminary assessment (including the removal of six Pennsylvania sources with combined emissions reductions of 6600 tons of SO_2) will be incorporated into the Best and Final modeling run scheduled to be completed in March, 2008. Figure 5-3 displays the locations of the BART sources and estimated SO_2 reductions expected in

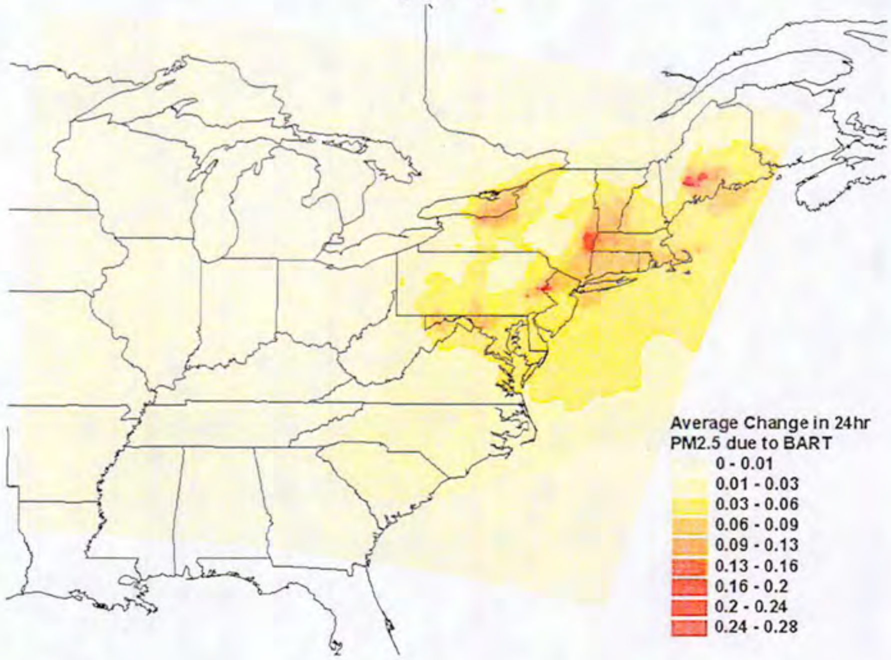
2018. Additional visibility benefits are likely to result from installation of controls at BART-eligible facilities that are located in adjacent RPOs. These benefits are not accounted for in the present analysis.

Figure 5-3. Potential reductions from BART-eligible sources in the MANE-VU region (tons)



We applied the SO_2 reductions at the initial 14 facilities relative to the 2018 OTB/OTW emissions inventory. Figure 5-4 shows the average change in 24-hr $PM_{2.5}$ concentrations within the modeling domain used to calculate the visibility benefits.

Figure 5-4. Average change in 24-hr $PM_{2.5}$ due to BART emission reductions ($\mu g/m^3$)



5.3. 167 EGU Strategy

The MANE-VU states have recognized that SO_2 emissions from power plants are the single largest contributing sector to the visibility impairment experienced in the Northeast's Class I areas. The SO_2 emissions from power plants continue to dominate the inventory. Sulfate formed through atmospheric processes from SO_2 emissions are responsible for over half the mass and approximately 70-80 percent of the extinction on the worst visibility days (NESCAUM, 2006a,b). In order to ensure that EGU controls are targeted at those EGUs with the greatest impact on visibility in MANE-VU, a modeling analysis was conducted to determine which sources those were. A list of 167 EGU stacks was developed (MANE-VU, 2007) that includes the 100 largest impacts at each MANE-VU Class I site during 2002. MANE-VU is currently asking for 90 percent control on all units emitting from those stacks by 2018 as part of consultations within MANE-VU and with other RPOs. MANE-VU recognizes that this level of control may not be feasible in all cases. The Best and Final modeling run currently underway will incorporate State comments gathered during the inter-RPO consultation process.

The "167 EGU strategy," if implemented as defined here, could lead to large reductions in SO_2 emissions due to installation of stack control technologies such as SO_2 scrubbers. To determine the possible health benefits of this EGU control program, we modeled 2018 emissions for the 167 EGUs in the Northeast, Southeast, and Midwest at levels equal to 10 percent of their 2002 emissions. We used CMAQ to model sulfate concentrations in 2018 after implementation of this control program and converted sulfate concentrations to $PM_{2.5}$ concentrations. Figure 5-5 displays the average change in 24-hr $PM_{2.5}$ seen between the OTB/OTW baseline and the EGU stack control program.

Figure 5-5. Average change in 24-hr $PM_{2.5}$ due to 167 EGU emission reductions ($\mu g/m^3$)

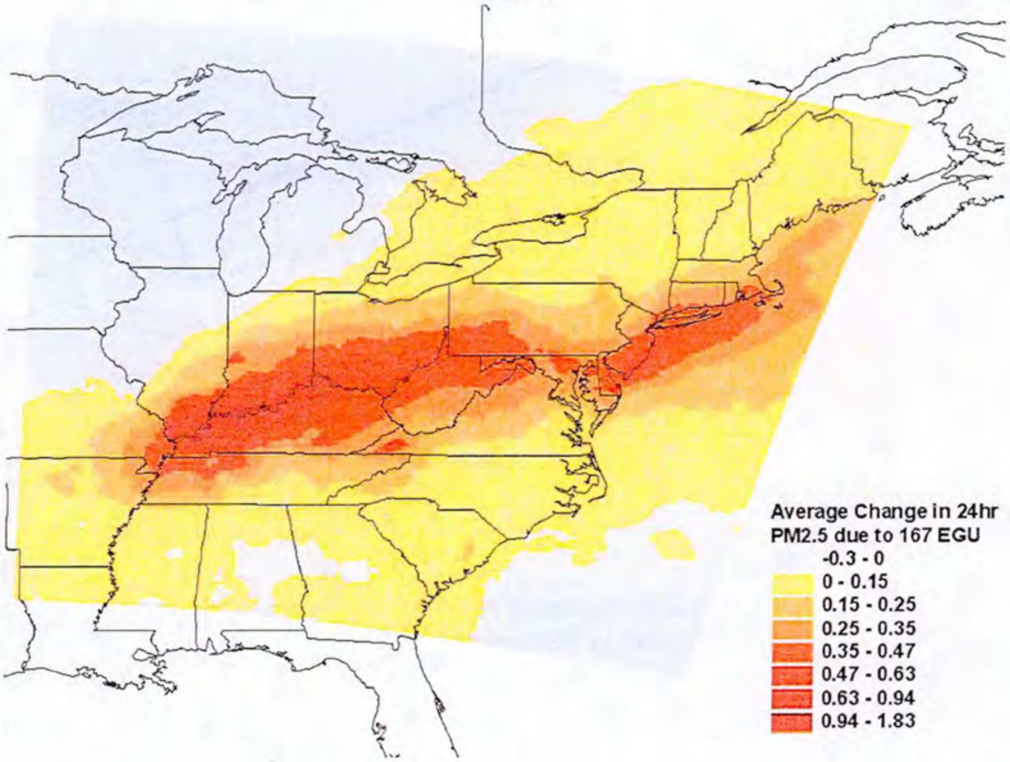


Figure 5-5 shows that significant reductions of $PM_{2.5}$ are predicted for the MANE-VU region as well as for portions of the VISTAS and Midwest RPO regions as a result of the targeted EGU strategy.

Figures 5-6 through 5-14 show the visibility benefits – relative to the uniform rate of progress determined our national visibility goal of natural conditions in 2064 – of the OTB/OTW scenario as well as for the four potential measures analyzed here. In addition to these measures, MANE-VU has asked neighboring RPOs to consider non-EGU emissions reductions comparable to our low sulfur fuel strategies, which are expected to achieve a greater than 28 percent reduction in non-EGU SO_2 emissions in 2018. The figures indicate that additional progress could be achieved depending upon what strategies are identified by VISTAS and the Midwest RPO in response to this request.

Figure 5-6. Visibility improvement relative to uniform rate of progress at Acadia National Park

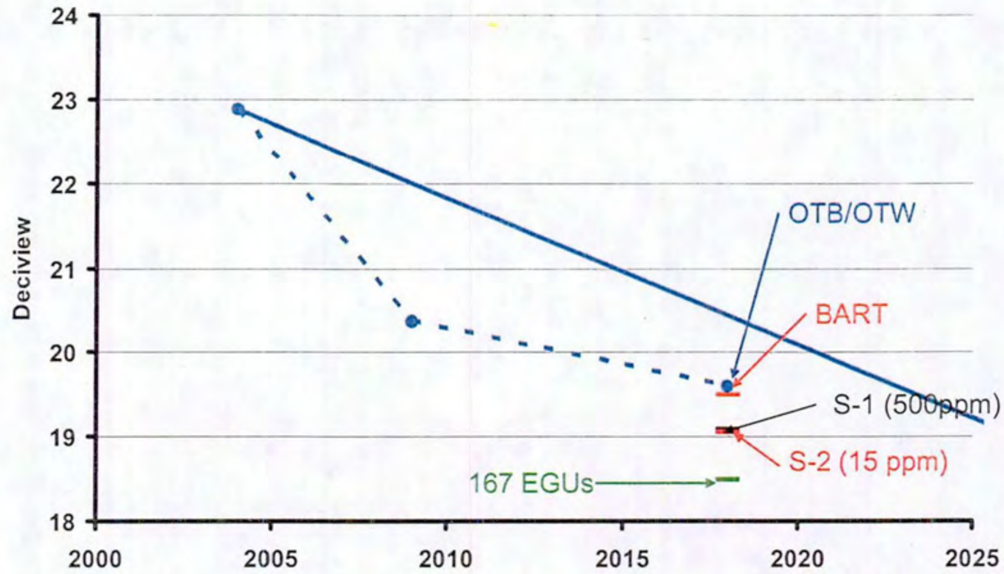


Figure 5-7. Visibility improvement relative to uniform rate of progress at Brigantine National Wildlife Refuge.

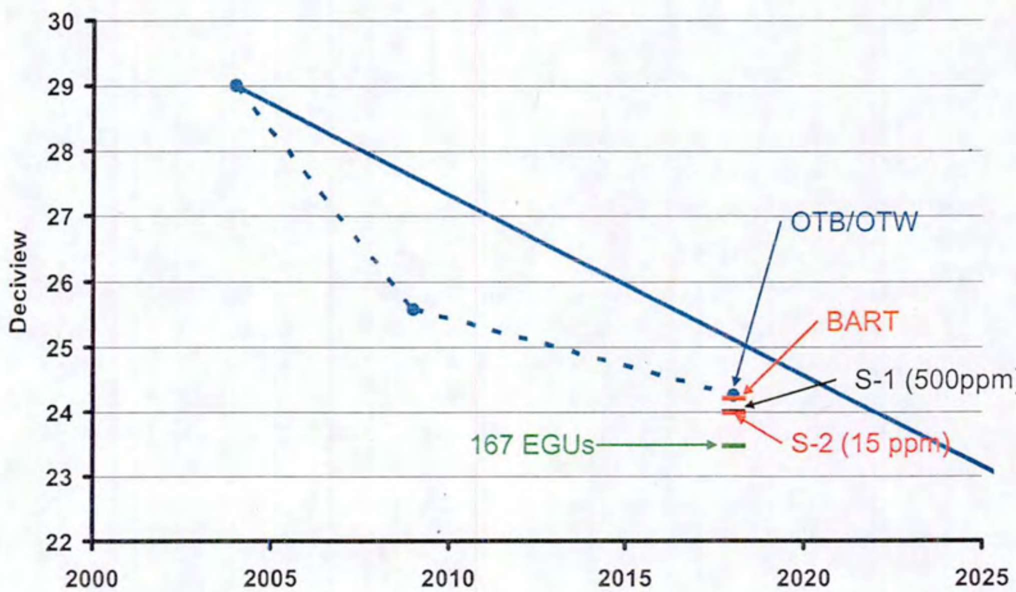


Figure 5-8. Visibility improvement relative to uniform rate of progress at Great Gulf Wilderness Area

Figure 5-9. Visibility improvement relative to uniform rate of progress at Lye Brook Wilderness Area

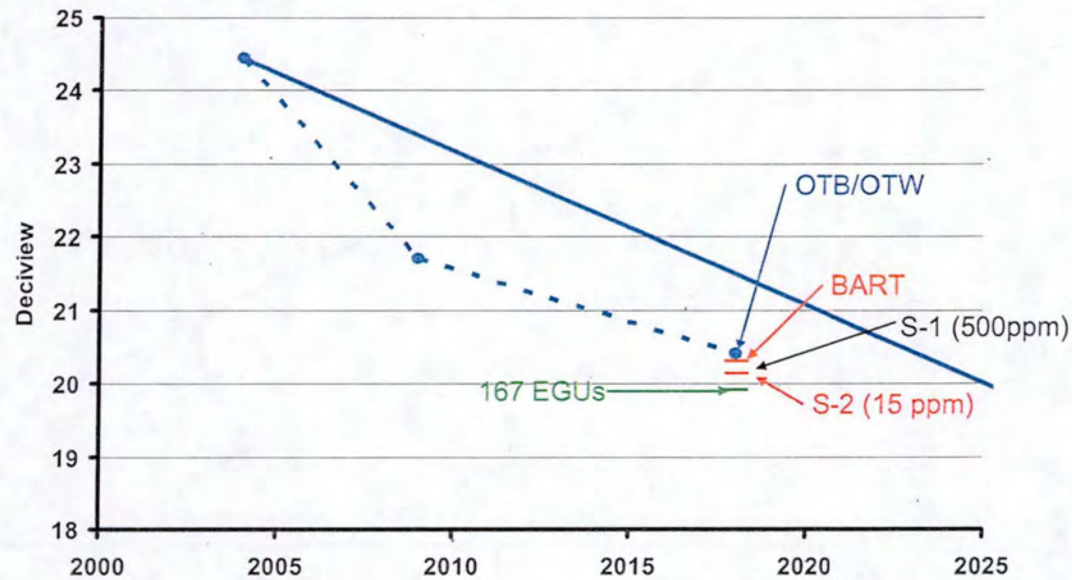


Figure 5-10. Visibility improvement relative to uniform rate of progress at Moosehorn National Wildlife Refuge

Figure 5-11. Visibility improvement relative to uniform rate of progress at Shenandoah National Park

Figure 5-12. Visibility improvement relative to uniform rate of progress at Dolly Sods Wilderness Area

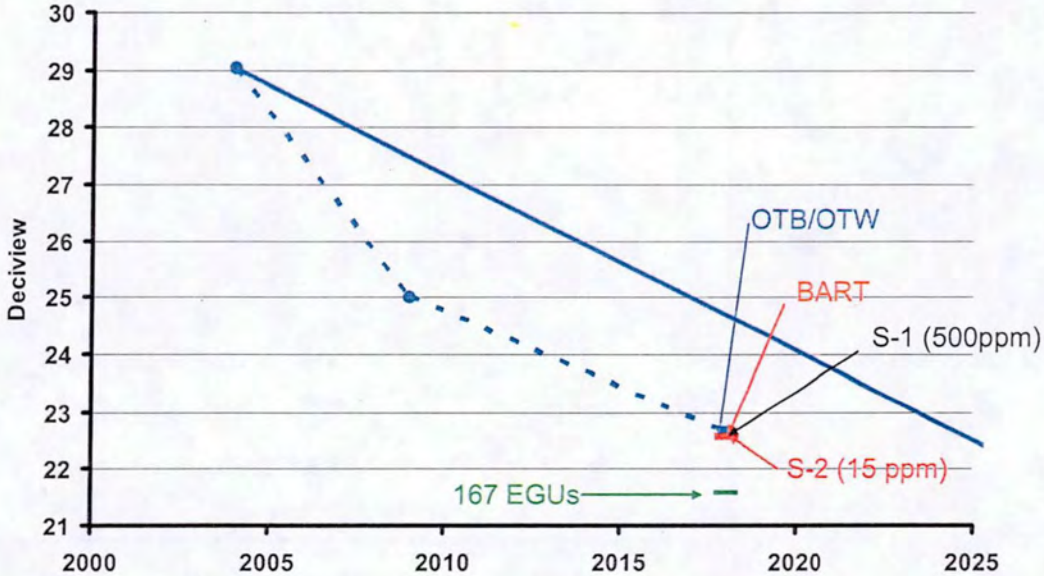


Figure 5-13. Visibility improvement relative to uniform rate of progress at Presidential Range-Dry River Wilderness Area

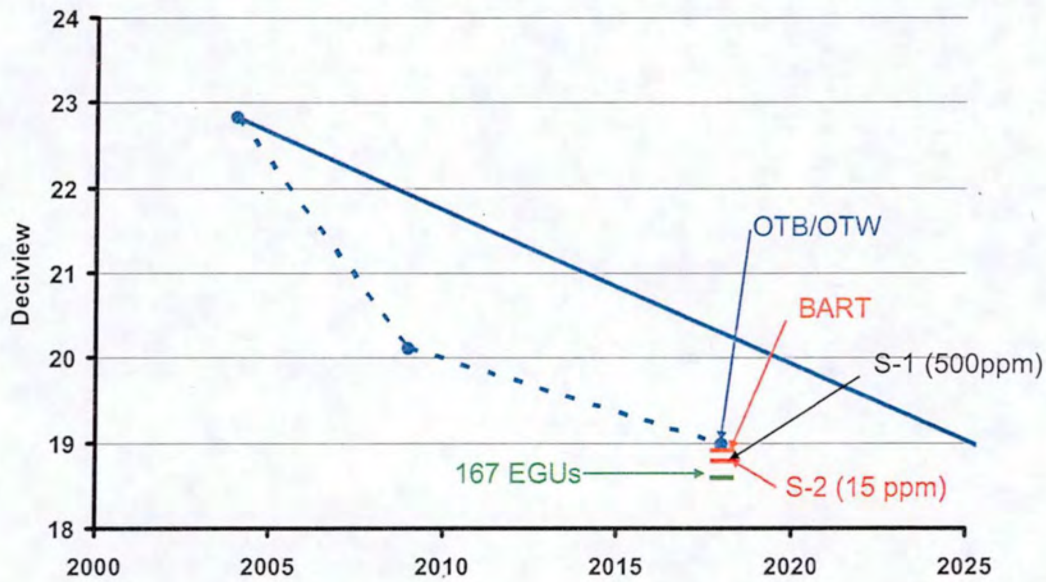
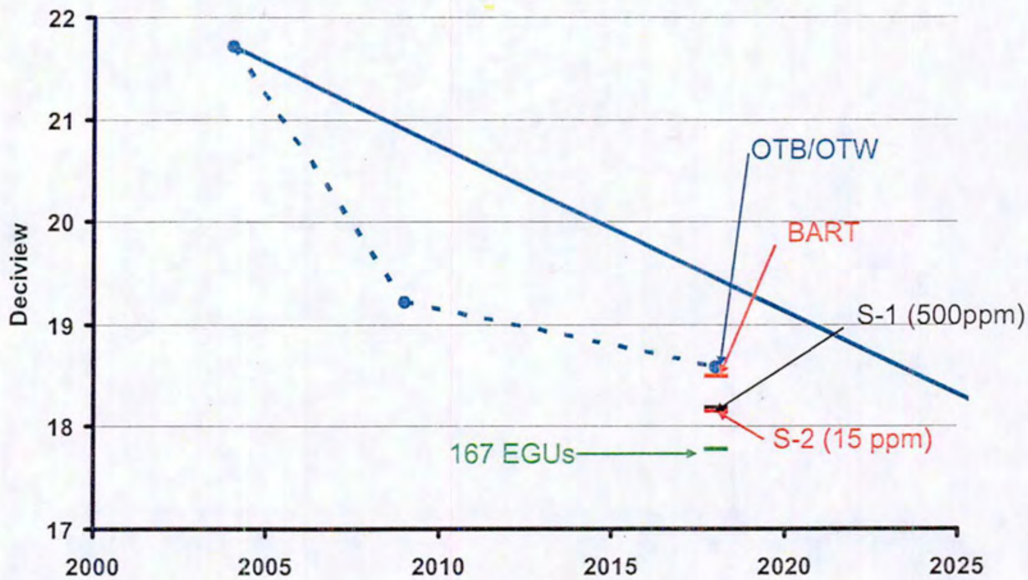


Figure 5-14. Visibility improvement relative to uniform rate of progress at Roosevelt-Campobello International Park



Tables 5-1 and 5-2 summarize the sulfate mass reductions and the deciview targets that represent the progress shown in the prior figures.

Table 5-1. Projected 2018 twenty percent worst day sulfate mass reduction at MANE-VU Class I areas under various control assumptions.

MANE-VU Class I Area	Baseline [2000-2004]	OTB/OTW [2018]	BART	S-1	S-2	167 EGUs
Acadia National Park, ME	6.32	2.40	0.08	0.29	0.03	0.37
Brigantine Wilderness, NJ	11.58	5.35	0.07	0.20	0.02	0.51
Great Gulf Wilderness, NH	7.28	2.96	0.06	0.09	0.01	0.13
Lye Brook Wilderness, VT	8.46	3.49	0.09	0.13	0.01	0.18
Moosehorn Wilderness, ME	5.67	2.03	0.07	0.21	0.03	0.24
Presidential Range – Dry River Wilderness, NH	7.28	2.96	0.06	0.09	0.01	0.13
Roosevelt-Campobello International Park, NB	5.67	2.03	0.07	0.21	0.03	0.24

Notes on Table 5-1:

1. Baseline values represent the average sulfate mass ($\mu g/m^3$) over the 5 year baseline period on the 20 percent worst days.
2. OTB/OTW represents the combined estimated mass reduction ($\mu g/m^3$) due to all "on the books" measures.
3. BART mass reduction reflects preliminary estimates of emission reductions resulting from BART determinations. These determinations are still in the process of being conducted, however, and thus are subject to change.
4. S-1 oil strategy assumes the adoption of 500 ppm distillate, 0.25 percent S for all No. 4 oil and 0.5 percent S for all No. 6 residual oil.
5. S-2 oil strategy assumes the adoption of 15 ppm distillate, 0.25 percent S for all No. 4 oil and 0.5 percent S for all No. 6 residual oil.
6. 167 EGU strategy benefits are based on net reductions after each of the 167 stacks is controlled to at least the 90 percent level and after the identified emissions reductions (beyond 2018 projections contained in the Base B emissions files) are redistributed among all other CAIR-eligible EGUs in the modeling domain.

Table 5-2. Projected 2018 twenty percent worst day deciview goals for MANE-VU Class I areas under various control assumptions

MANE-VU Class I Area	Baseline [2000-2004]	OTB/OTW [2018]	+BART	+S-1	+S-2	+167 EGUs
Acadia National Park, ME	22.89	19.62	19.51	19.10	19.05	18.50
Brigantine Wilderness, NJ	29.01	24.26	24.19	24.00	23.98	23.47
Great Gulf Wilderness, NH	22.82	18.81	18.74	18.62	18.61	18.43
Lye Brook Wilderness, VT	24.45	20.40	20.29	20.13	20.12	19.90
Moosehorn Wilderness, ME	21.72	18.59	18.50	18.20	18.16	17.80
Presidential Range – Dry River Wilderness, NH	22.82	18.98	18.90	18.78	18.77	18.59
Roosevelt-Campobello International Park, NB	21.72	18.58	18.49	18.19	18.15	17.79

Notes on Table 5-2:

1. Baseline values represent the 5-year average baseline conditions (dv) on the 20 percent worst days.
2. OTB/OTW represents the projected deciview goal due to all OTB/OTW measures.
3. Pluses indicate that the deciview goals assume implementation of all measures to the left of and including the column indicated.
4. BART reflects preliminary estimates of emissions reductions due to BART determinations. These determinations are still in the process of being conducted and thus are subject to change.
5. S-1 oil strategy assumes the adoption of 500 ppm distillate, 0.25 percent S for all No. 4 oil and 0.5 percent S for all No. 6 residual oil.
6. S-2 oil strategy assumes the adoption of 15 ppm distillate, 0.25 percent S for all No. 4 oil and 0.5 percent S for all No. 6 residual oil.
7. 167 EGU strategy benefits are based on net reductions after each of the 167 stacks is controlled to at least the 90 percent level and after the identified emissions reductions (beyond 2018 projections contained in the Base B emissions files) are redistributed among all other CAIR-eligible EGUs in the modeling domain.

6. CONCLUSIONS

This report provides details on modeling platforms and input data as well as a description of the processing steps that were undertaken to prepare inputs for use in simulating future air quality on an eastern U.S. domain that includes MANE-VU Class I areas. The findings are consistent with previous work documenting the role of SO_2 emissions in the formation of visibility impairing fine particulate in the eastern U.S. (NESCAUM, 2006a, b). This report goes further, however, in terms of providing detailed simulations of (1) projected visibility impairment in 2018 under a "beyond on the way" scenario that represents a starting point for the regional haze program; (2) state-by-state apportionment of 2018 emissions for that 2018 "beyond on the way" scenario; and (3) sensitivity analysis of the projected benefits of several additional measures that are being considered by the MANE-VU states for inclusion in reasonable progress goals.

The findings of these simulations suggest that:

- The "beyond on the way" scenario – defined by CAIR with other "on the books" measures and the limitation of fuel sulfur content to 500 ppm for all No. 2 "distillate" fuel oil sold in the MANE-VU region – is sufficient to achieve visibility improvement beyond the so-called "uniform rate of progress" defined by uniform visibility improvement between now and 2064, the planning horizon for the regional haze program.
- The 2018 pollution apportionment suggests that this improvement is due to significant reductions in the relative contributions of almost all eastern U.S. states, resulting in a *relative* increase (though not an absolute increase) in the projected contribution from areas outside the modeling domain (e.g., Canada and the model domain boundary conditions).
- Potential additional emissions reduction strategies (including the reduction of fuel sulfur content of No. 2 distillate to 15 ppm, limits on sulfur content of residual oil, control of BART-eligible sources, and additional EGU controls beyond CAIR) could yield significant further reductions of sulfate and corresponding significant visibility improvements at MANE-VU Class I areas and should be considered with respect to the four statutory factors in setting reasonable progress goals.

As MANE-VU states consider these results and conduct consultations with each other and neighboring RPOs, NESCAUM will prepare a "best and final" modeling scenario for 2018 that may assist the Class I states in setting reasonable progress goals based on their assessment of which measures are reasonable to implement. This final model run is anticipated to be complete in March 2008.

7. REFERENCES

Amar, P., D. Chock, A. Hansen, M. Moran, A. Russell, D. Steyn, and W. Stockwell. *2005: Final Report: Second Peer Review of the CMAQ Model,* Report submitted to the Community Modeling and Analysis System Center, University of North Carolina at Chapel Hill, July 2005.

K.W. Appel, A. Gilliland, and B. Eder. *An Operational Evaluation of the 2005 Release of Models-3 CMAQ*, 2005 CMAQ Workshop, Chapel Hill, NC.

Bell, M., and H. Ellis. *Comparison of the 1-hr and 8-hr National Ambient Air Quality Standards for ozone using Models-3,* J. Air Waste Manage. Assoc. 53, 1531-1540, 2003.

Boylan, J., and K. Baker. *Photochemical Model Performance and Consistency.* National RPO Modeling Meeting, Denver, CO, May 26, 2004.

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.

Gery M.W., G.Z. Whitten, J.P. Killus, and M.C. Dodge. *A photochemical kinetics mechanism for urban and regional scale computer modeling*, J. Geophys. Res. 94, 12925-12956, 1989.

Hao, W., M. Ku, and G. Sistla. *Analysis of MM5 Simulations based on three PBL schemes over the eastern US for August 6 to 16, 2002*, NYSDEC-DAR. Albany, NY, March 4, 2004.

Hogrefe, C., J. Biswas, B. Lynn, K. Civerolo, J.-Y. Ku, J. Rosenthal, C. Rosenzweig, C. Goldberg, and P.L. Kinney. *Simulating regional-scale ozone climatology over the eastern United States: Model evaluation results,* Atmos. Environ. 38, 2627-2638, 2004.

ICF, Implementation of Mercury Tagging in the Community Multi-Scale Air Quality (CMAQ) Model, Draft Project Report, prepared by Sharon Douglas, Tom Meyer, Yihua Wei for USEPA Office of Air Quality Planning and Standards, ICF Consulting, San Rafael, CA, July 7, 2006.

Jimenez P., and J. M. Baldasano. *Ozone response to precursor controls in very complex terrains: Use of photochemical indicators to assess O3-NOx-VOC sensitivity in the northeastern Iberian Peninsula*, J. Geophys. Res. V109, D20309, 2004.

Ku, K. et al. *Comparison of RPO model results,* National RPO Modeling Meeting, Denver, CO, Dec. 2005.

MARAMA, MANE-VU emission inventories were developed by the Mid-Atlantic Regional Air Management Agency (MARAMA) and can be accessed at: http://www.marama.org/visibility/EI_Projects/index.html, 2007a.

MARAMA. *Development of Emission Projections for 2009, 2012, and 2018 for NonEGU Point, Area, and Nonroad Source in the MANE-VU Region,* http://www.marama.org/visibility/Inventory%20Summary/MANEVU_Emission_Projections_TSD_022807.pdf, 2007b.

Mao H., and R. Talbot. *Role of meteorological processes in two New England ozone episodes during summer 2001*, J. Geophys. Res. V109, D20305, 2004.

Mebust, M.R., B.K. Eder, F.S. Binkowski, S.J. Roselle. *Models-3 Community Multiscale Air Quality (CMAQ) model aerosol component 2. Model evaluation*, J. Geophys. Res. V108, D6, 4184, 2003.

NESCAUM. *Contributions to Regional Haze in the Northeast and Mid-Atlantic U.S.*, available at: http://www.nescaum.org/documents/contributions-to-regional-haze-in-the-northeast-and-mid-atlantic--united-states/, Northeast States for Coordinated Air Use Management, Boston, MA, 2006a.

NESCAUM. *The Nature of the Fine Particle and Regional Haze Air Quality Problems in the MANE-VU Region: A Conceptual Description*, Available at: http://www.nescaum.org/documents/2006-1102-pm-conceptual-model.pdf/, Northeast States for Coordinated Air Use Management, Boston, MA, 2006b.

NESCAUM. *Five-Factor Analysis of BART-Eligible Sources; Survey of Options for Conducting BART Determinations*, available at: http://www.nescaum.org/documents/bart-final-memo-06-28-07.pdf, Northeast States for Coordinated Air Use Management, Boston, MA, 2007.

Park, R. J., D. J. Jacob, B. D. Field, R. M. Yantosca, and M. Chin. *Natural and transboundary pollution influences on sulfate-nitrate-ammonium aerosols in the United States: implications for policy*, J. Geophys. Res. D15204, 10.1029/2003JD004473, 2004.

Ray, J.D., R.L. Heavner, M. Flores, and C.W. Michaelsen. *Surface-level measurements of ozone and precursors at coastal and offshore locations in the Gulf of Maine.* J. Geophys. Res. 101, 29005-29011, 1996.

SAI, User's Guide to the Regional Modeling System for Aerosols and Deposition (REMSAD), Version 8, ICF Consulting/SAI, San Francisco, CA., 2005. Available at www.remsad.com.

Seigneur C., G. Hidy, I. Tombach, J. Vimont, and P. Amar. *Scientific peer-review of the Regulatory Modeling System for Aerosols and Deposition (REMSAD),* September 1999.

Timin, B., C. Jang, P. Dolwick, N. Possiel, T. Braverman. *Operational Evaluation and Comparison of CMAQ and REMSAD- An Annual Simulation*. CMAS Annual Workshop, RTP, NC. October 22, 2002.

Tonnesen, G., Z. Wang, C.J. Chien, M. Omary, B. Wang, R. Morris, Z. Adelman, T. Tesche, D. Olerud. *Regional Haze Modeling: Recent Modeling Results for VISTAS and WRAP*. CMAS Annual Meeting, RTP, NC. October 27, 2003.

CMAQ Peer Review Report. *Final Report Summary: December 2003 Peer Review of the CMAQ Model* August 2004 http://www.cmascenter.org/html/CMAQ%20peer%20review%20final_CMAS-web.pdf.

CMAQ website http://www.cmascenter.org/ , 2007.

CMAQ Manual http://www.epa.gov/asmdnerl/models3/doc/science/science.html , 2007.

SMOKE website http://cf.unc.edu/cep/empd/products/smoke/index.cfm , 2007.

SMOKE Manual http://cf.unc.edu/cep/empd/products/smoke/version2.1/html/ , 2007.

MM5 website http://www.mmm.ucar.edu/mm5/ , 2007.

REMSAD website http://www.remsad.com.

ATTACHMENT H

Documentation of 2018 Emissions from EGUs in the Eastern United States

Documentation of 2018 Emissions from Electric Generating Units in the Eastern United States for MANE-VU's Regional Haze Modeling

Final Report

16 August 2009

Prepared for:

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

Prepared by:

Alpine Geophysics, LLC
387 Pollard Mine Road
Burnsville, NC 28714

Mid-Atlantic Regional Air Management Association (MARAMA)
8900 LaSalle Road
Suite 636
Towson, MD 21286

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Greg Stella of Alpine prepared a final draft of this document for MANE-VU/MARAMA under Work Order #7 of the MANE-VU Future Year Emissions Inventory Umbrella Contract. This work was supported by funds provided to MARAMA by the Ozone Transport Commission (OTC) through their memorandum of agreement. OTC's funding for this work was provided by the U.S. Environmental Protection Agency under assistance agreement XA 97318101.

MARAMA further revised Section 5 of the document after receipt of Mr. Stella's final work product. MARAMA provided text and tables to reflect emissions inventory analysis that continued after the expiration of Alpine's contract. MARAMA also revised the document in response to comments received from stakeholders on the April 28, 2008 Revised Final Draft.

Special recognition is given to Julie McDill, MARAMA's project manager, who initiated the collection and aggregation of documentation used to prepare this report. Ms. McDill and Susan Wierman, MARAMA's Executive Director provided analytical and editorial contributions to the preparation of this document, and Patrick Davis of MARAMA and Dr. John Graham of NESCAUM contributed to emissions inventory data analysis and summaries.

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1 INTRODUCTION

1.1 Purpose

Development of an emissions inventory is an important foundation for performing regional scale atmospheric modeling for regulatory air quality management. The accuracy of the atmospheric model's prediction of air quality depends, in part, on the accurate representation of emissions from a variety of source sectors including point, area, non-road, on-road and biogenic sources. Electric generating units (EGUs) are an important point source sector and are often considered for controls to meet air quality objectives. Therefore, it is especially important to accurately represent and document EGU emissions and associated characteristics in a regulatory modeling application.

This report describes the development of future year EGU emission estimates for use in Mid-Atlantic/Northeast Visibility Union (MANE-VU) 2018 regional haze modeling.

This document synthesizes information from several documents that already describe parts of the process of preparing emissions estimates and provides information not yet included in other documents. It covers the following major steps in that process: preparation of the inter-Regional Planning Organization (RPO) Integrated Planning Model® (IPM) runs commonly referred to as the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) IPM runs, the post-processing of those runs to create Sparse Matrix Operator Kernel Emissions (SMOKE) input files, the modification of those files to reflect state estimates of emissions, and the adjustments made by MANE-VU modelers to maintain the Clean Air Interstate Rule (CAIR) cap. It also provides background information about preparing EGU forecasts and related work by the U.S. Environmental Protection Agency (EPA).

1.2 Background on Emissions Projections

Emission projections for point sources depend on changes in source level activity, the emission factors or installed controls. The approach taken to project point source emissions depends on the level of detail necessary in the projection. Changes in point source emissions are accounted for by a combination of growth, control, and retirement rates. Growth rates are applied to estimate the overall change in activity, while retirement rates are applied to estimate the decrease in emissions activity from existing sources. Retirement (and replacement of these sources with new sources) must be considered because regulations affecting new sources may differ from those affecting existing sources.

The projection year control factor accounts for both changes in emission factors due to technology improvements and new levels of control required by regulations. The control factor accounts for three variables: regulation control, rule effectiveness, and rule penetration.

Control factors are closely linked to the type of emission process (identified by Source Classification Code (SCC)) and secondarily to the type of industry identified by Standard Industrial Classification (SIC). Point source projections should account for Federal, State, and local regulations affecting these categories.

A complicating factor is the requirement for emission offsets in nonattainment areas through New Source Review requirements. This may be accounted for by 1) restricting growth under the assumption that it will be offset; 2) applying reductions to selected source categories to account for the emission growth which must be offset; or 3) selecting the individual sources, based on a cost analysis, from which offsets are likely to come.

1.3 Factors Causing Variation in EGU Emissions Forecasts

There are various sources of uncertainty in estimating future EGU emissions. These include the relative prices of various fuels (especially coal, oil, and natural gas), predictions of which plants will be shut down, the size, type, and location of new plants, the total demand for electricity, and requirements imposed by state-specific or plant-specific regulations or orders. Emissions estimates based on the methods described in this report represent the MANE-VU states' best effort to forecast future emissions in light of these and other uncertainties.

When projecting Electricity Generating Unit (EGU) emissions in the Eastern United States, emission trading should be considered. There are three general approaches to performing projections while accounting for such trading schemes. The first option is to optimize control levels across the domain based on the cost of alternative controls. The second option is to survey individual sources to determine how they will comply (will they apply controls and sell or buy allowances) and use this as the basis for the future year control level. The third option is to apply the control level used to establish the budget to all affected sources and ignore which sources may choose to buy or sell credits/allowances.

Other factors which must be considered include programs, such as fuel switching, designed to provide source flexibility in meeting future air quality requirements. Fuel switching refers to instances where a unit historically burned one primary fuel, such as coal, and under a "fuel switching" program the unit would burn an alternate fuel, such as natural gas, during a certain period of time and may switch back to the "historic" fuel for some or all of the year. Fuel switching is often done in cases where sources average their emissions to meet federal mandates. Fuel switching may also be used as a seasonal compliance strategy (e.g., switching from residual fuel oil to natural gas in order to reduce NOx emissions during the ozone season. The variation in emissions over the course of the year caused by fuels switching must be calculated properly in projections.

Repowering is another example of a planned change in emission rates which should be considered. In this case, the unit may be switching entirely from coal to natural gas or may be completing a major modification which would lower the emission rate.

Spatial allocation is another factor which must be considered, particularly if air quality modeling will be performed using the projection. For point sources, important questions are which facilities will retire and where new growth will occur. Changes in land use patterns may also impact the location of point source emissions. As undeveloped and rural areas become suburban and urban areas, the number of point sources in that area will increase.

As can be seen from the discussion above, any number of complicating issues can lead to emission forecasts which may differ from user to user. An inconsistent decision made between two parties can lead to significant differences in growth, control, or placement of emissions from point source forecasts. For this reason, the Regional Planning Organizations (RPOs) in the Eastern U.S. made a decision to utilize consistent forecasting methods for EGU emissions, as they are one of the most significant contributors to regional haze in the United States. This decision, to coordinate on the projection of EGU source emissions, led to the preparation of an EGU forecast methods document from which a coordinated decision was made on methods to develop EGU emissions in future years. Each RPO ends up using somewhat different estimates, as discussed below, but there was a great deal of cooperation and data sharing throughout the process.

2 PREPARATION OF EGU FORECASTS

2.1 Decision to Use the IPM Model

Early in the planning process there was a joint agreement by the RPOs to work together to develop future year EGU emissions estimates based on the use of the Integrated Planning Model® (IPM). The decision to use IPM modeling resulted in part from a study of EGU forecast methods prepared by E.H. Pechan and Associates, Inc. (Pechan) for the Midwest Regional Planning Organization (MRPO) (Pechan, 2004), which recommended IPM as a viable methodology. Although IPM results were available from work conducted by EPA to support their rulemaking for the Clean Air Interstate Rule (CAIR), the RPOs concluded that certain model inputs needed to be revised. Thus, the RPOs decided to work together to hire contractors to conduct new IPM modeling and to post-process the IPM results. This section describes the recommendation to use IPM.

The Lake Michigan Air Directors Consortium (LADCO) sought contractor assistance in reviewing emissions inventory growth for existing and new EGUs (Pechan, 2004). Because the results of EGU emission forecasts are used in urban or regional scale air quality modeling exercises to estimate future year air pollutant concentrations, growth methods are needed to supply model-ready emission model inputs. The purpose of LADCO's project was to begin to examine EGU growth methods.

The primary pollutants of interest were sulfur dioxide (SO_2), oxides of nitrogen (NO_x), particulate matter (PM), ammonia (NH_3), and mercury (Hg). Projection years of interest included 2009 (the approximate time for ozone and $PM_{2.5}$ attainment) and 2018 (a longer term regional haze planning horizon). The geographic area of interest was the eastern half of the United States (to capture the trading issues affecting the Midwest States).

This 2004 Pechan report provided a detailed evaluation of three EGU growth modeling methods of interest to the LADCO States for consideration in developing its own approach. These evaluations addressed the following attributes of each modeling approach:

- Description of primary analytical modeling methods;
- Geographic areas of application;
- Advantages; and
- Disadvantages.

The material in this evaluation was intended to be used to determine which of the currently available modeling approaches might be best suited for use by the LADCO States (and other RPOs) for future state implementation plan (SIP) and air dispersion modeling work. The models evaluated in this report included the Integrated Planning Model® (IPM), the National Energy Modeling System (NEMS), and the Electric Power Market Model (EPMM).

Based on the conclusions and summary of the report (Pechan, 2004), the four participating RPOs (MANE-VU, MRPO, VISTAS, and the Central Regional Air Planning Association, CENRAP) decided to use IPM as the tool for forecasting EGU emissions.

2.2 The Integrated Planning Model (IPM)

IPM was developed by ICF Consulting, Inc. (ICF) and used to support public and private sector clients. This model is a proprietary, multi-regional, dynamic, deterministic linear programming model of the U.S. electric power sector. It provides forecasts of least-cost capacity expansion, electricity dispatch, and emission control strategies for meeting energy demand and environmental, transmission, dispatch, and reliability constraints. It can be used to evaluate the cost and emissions impacts of proposed policies to limit emissions of SO_2, NO_x, carbon dioxide (CO_2), and Hg from the electric power sector. The IPM model was a key analytical tool used by EPA in developing the Clean Air Interstate Rule (CAIR) and the Clean Air Mercury Rule (CAMR).

Among the factors that make IPM particularly well suited to model multi-emissions control programs are (1) its ability to capture complex interactions among the electric power, fuel, and environmental markets; (2) its detail-rich representation of emission control options encompassing a broad array of retrofit technologies along with emission reductions through fuel switching, changes in capacity mix and electricity dispatch strategies; and (3) its capability to model a variety of environmental market mechanisms, such as emissions caps, allowances, trading, and banking. The model's ability to capture the dynamics of the allowance market and its provision of a wide range of emissions reduction options are particularly important for assessing the impact of multi-emissions environmental policies like CAIR and CAMR.

2.3 U.S. EPA Use of IPM

The U.S. EPA uses IPM to analyze the projected impact of environmental policies on the electric power sector in the 48 contiguous states and the District of Columbia. The next two sections describe EPA modeling results available to the RPOs early in the planning process. Then Section 2.3.3 reviews the limitations of the EPA results that led the RPOs to conduct additional IPM modeling.

2.3.1 EPA's Base Case 2004

The EPA's Base Case 2004 (EPA, 2005a) served as the starting point against which EPA compared various policy scenarios. It is a projection of electricity sector activity that takes into account federal and state air emission laws and regulations whose provisions were either in effect or enacted and clearly delineated at the time the base case was finalized in August 2004. Regulations mandated under the Clean Air Act Amendments of 1990 (CAAA), but whose provisions have not yet been finalized, were not included in the base case. These include:

- Measures to Implement Ozone and Particulate Matter (PM) Standards: EPA Base Case 2004 predates and so does not include the provisions of CAIR, the primary federal regulatory measure for achieving the National Ambient Air Quality Standards (NAAQS) for ozone (8-hour standard of 0.08 ppm) and fine particles (24-hour average of 65 ug/m3 or less and annual mean of 15 ug/m3 for particles of diameter 2.5 micrometers or less, i.e., $PM_{2.5}$). EPA Base Case 2004 was used to evaluate policy alternatives which ultimately resulted in CAIR. The final CAIR was issued on March 10, 2005. EPA Base Case 2004 includes measures to implement ozone and particulate matter standards to the extent that some of the state regulations included in EPA Base Case 2004 contain measures to bring non-attainment areas into attainment. Individual permits issued by states in response to ozone and particulate matter standards are not captured in the base case.

• Mercury Regulations on Electric Steam Generating Units: EPA Base Case 2004 predates both CAMR, which was issued by EPA on March 15, 2005 and the "Maximum Achievable Control Technology" (MACT) standards that were scheduled to be promulgated by December 15, 2004, but, pending litigation, were superseded by CAMR. Consequently, this base case did not include any federal regulatory measures for mercury control. (CAMR was vacated in 2008.)

• Clean Air Visibility Rules: On July 1, 1999, EPA issued Regional Haze Regulations to meet the national goal for visibility established in Section 169A of the CAAA, which calls for "prevention of any future, and the remedying of any existing, impairment of visibility in Class I areas [156 national parks and wilderness areas], which impairment results from manmade air pollution." The regulations required states to submit revised SIPs that (1) establish goals that provide for reasonable progress towards achieving natural visibility conditions at Class I areas, (2) adopt a long-term control strategy that includes such measures as are necessary to achieve the reasonable progress goals, and (3) require Best Available Retrofit Technology (BART) for sources in listed source categories placed in operation between 1962 and 1977.

In effect, EPA Base Case 2004 offered a snapshot projection of the electric sector assuming that the only future environmental regulations were those with provisions known at the time that the base case assumptions were finalized. While not necessarily an accurate reflection of what would actually occur, this assumption ensured that the base case was policy neutral with respect to future environmental policies.

2.3.2 EPA CAIR Case

On January 30, 2004, EPA proposed CAIR, which set emission reduction requirements for 29 States and the District of Columbia. Those emission reduction requirements were based on achieving highly cost-effective emission reductions from large electricity generating units.

While EPA believed that the modeling it initially performed for the January 2004 proposal provided a reasonable estimate of the impact of requiring highly cost-effective emission reductions from electricity generating units, it did not exactly model the proposed control region. For both SO_2 and NO_x, EPA used modeling assumptions that differed slightly from the January 2004 CAIR proposal. For SO_2 in particular, EPA modeled the program assuming a cap on national emissions rather than in the 29 States proposed. Although EPA believed the modeling done at that time provided a reasonable approximation of the impacts of the original CAIR, because 92 percent of the SO_2 emissions in the 48 contiguous States occur in the 28 States that were covered by the proposal, EPA completed additional analysis. This additional analysis examined the effect of covering the geographic region proposed in the January 30, 2004 proposal using the NO_x emissions cap and a close approximation of the SO_2 cap proposed for CAIR (EPA, 2005a).

For the supplemental proposal, EPA performed refined modeling of the emission reduction requirements proposed on January 30, 2004. In this refined modeling, EPA modeled the exact control regions for both SO_2 and NO_x, as proposed.

2.3.3 EPA's CAIR Modeling Limitations

The U.S. EPA's modeling was based on its best judgment for various input assumptions that were uncertain, particularly assumptions for future fuel prices and electricity demand growth (EPA, 2004). In addition, EPA's modeling using IPM did not take into account the potential for advancements in the capabilities of pollution control technologies for SO_2 and NO_x removal as well as reductions in their costs over time.

Retirement Ratios: EPA issued a CAIR supplemental notice of proposed rulemaking that proposed two alternatives for how the SO_2 reduction target would be achieved. The proposal took comment on implementing the reduction requirements in the second phase either by using a 2.86 to 1 ratio (which would match the 65 percent SO_2 reduction target) of acid rain allowances to emissions, or alternatively, by implementing the reductions using a 3 to 1 ratio (for administrative simplicity) and then letting States create and distribute additional allowances equal to the surplus created by the 3 to 1 ratio to achieve the proposed 65 percent reduction. In either case, the effective cap on SO_2 emissions from the power sector would be the same.

Modelers assumed a 3 to 1 Title IV allowance retirement ratio for 2015 and beyond to implement the reductions in the proposed control region. The model did not add back the 130,000 tons of SO_2 from over-compliance that would result from this ratio. Therefore, in this modeling, EPA analyzed slightly greater SO_2 emission reductions than required by the proposal. This assumption was made for modeling simplicity and was expected to result in a slight overestimate of costs for the proposal and of the emissions reductions achieved.

BART: The EPA did not incorporate any best achievable retrofit technology (BART) modeling in this analysis. BART would achieve reductions in non-CAIR States and had the potential to mitigate leakage issues.

Demand Response: EPA's 2004 CAIR case includes a demand response to increased natural gas prices but not electricity prices. In the model, increased gas prices would prompt the public to curtail their use of gas and encourage them to seek substitutes. However, no provision for demand response was included for electricity prices. If demand had been allowed to change in response to increasing prices of electricity, one can assume that consumers would have reduced their demand for electricity, lowering electricity prices and reducing generation and emissions to some extent.

State Rules: Only some State-adopted rules were incorporated into EPA's modeling framework. A list of the State Multi-pollutant regulations used in IPM 2.1, IPM 2.1.6, and IPM 2.1.9 can be located in Appendix 3-2 of EPA's Standalone Documentation for EPA Base Case 2004 (v.2.1.9) Using the Integrated Planning Model (EPA, 2005a).

Because of the limitations noted above, the RPOs decided to initiate their own IPM modeling based on the EPA's latest update of the IPM input framework, called IPM 2.1.9. EPA completed the input framework for IPM 2.1.9 in March of 2003.

2.4 RPO Use of IPM – Phase I

In August 2004, VISTAS contracted with ICF to run IPM to provide revised utility forecasts for 2009 and 2018 under two future scenarios – Base Case and CAIR Case (ICF, 2004). The Base Case represented the current operation of the power system under laws and regulations as known at the time the run was made, including those that come into force in the study horizon. The CAIR Case was the Base Case with the proposed CAIR rule superimposed. Run results were parsed at the unit level for the 2009 and 2018 run years. [1]

In August 2004, MRPO contracted with Pechan to post-process the VISTAS' IPM outputs to provide the (National Emission Inventory Input Format) NIF formatted emission files needed for the regional inventory. The IPM output files were delivered by ICF to VISTAS in November 2004 and the post-processed data files were delivered by Pechan to the MRPO in December 2004.

These IPM runs (VISTAS_CAIR_2) and the NIF files that were generated from the parsed data sets are commonly referred to as the Phase I Inter-RPO runs. The Phase I runs were ultimately not used in RPO modeling of regional haze, as further revisions to the inputs were necessary once the final version of CAIR was adopted.

2.5 RPO Use of IPM – Phase II

On March 10, 2005, EPA issued the final CAIR. A consortium of RPOs, (MANE-VU, VISTAS, MRPO, and CENRAP) conducted another round of IPM modeling which reflected changes to control assumptions based on the final CAIR as well as additional changes to model inputs based on state and local agency and stakeholder comments. Several conference calls were conducted in the spring of 2005 among the participating RPOs to discuss and provide comments on IPM assumptions related to six main topics: power system operation, generating resources, emission control technologies, set-up parameters, financial assumptions, and fuel assumptions. Based on these discussions, VISTAS sponsored a new set of IPM runs to reflect the final CAIR

[1] "Parsing" results refers to allocating emissions estimates to individual units. Results may be analyzed in aggregate form but must be parsed in order to be used in air quality modeling. (See Section 3.2)

requirements as well as certain changes to IPM assumptions that were agreed to by the RPOs. ICF performed the following four runs using IPM during the summer of 2005. This set of IPM runs is referred to as the VISTAS Phase II analysis or Inter-RPO v.2.1.9 runs.

- Base Case with EPA 2.1.9 coal, gas, and oil price assumptions (VISTASII_BC_1Z1).
- Base Case with EPA 2.1.9 coal and gas supply curves adjusted for the U.S. Energy Information Administration's most recent Annual Energy Outlook (AEO 2005) reference case price and volume relationships (VISTASII_BC_2Y).
- Strategy Case with EPA 2.1.9 coal, gas and oil price assumptions (VISTASII_PC_1f).
- Strategy Case with EPA 2.1.9 coal and gas supply curves adjusted for AEO 2005 reference case price and volume relationships (VISTASII_PC_2C).

The above runs were parsed for 2009 and 2018 run years. The output taken from the Strategy Case with EPA 2.1.9 coal, gas, and oil price assumptions (VISTASII_PC_1f) is also referred to as the Inter-RPO CAIR Case IPM 2.1.9 or RPO 2.1.9 IPM and is the basis for discussion in the remainder of this report. That run was also parsed for 2012. The RPO 2.1.9 IPM parsed results were post-processed for 2009, 2012, 2018, as described in Section 3.2.1

The Phase II scenarios were based on VISTAS Phase I and EPA IPM 2.1.9 assumptions (EPA, 2005b). Additional changes that were implemented in the above four runs are summarized below and in associated documentation (ICF, 2007):

- Unadjusted AEO 2005 electricity demand projections were used. (U.S. EPA runs were adjusted to reflect reduced demand due to voluntary conservation projects sponsored by U.S. EPA)
- Gas supply curves were adjusted for AEO 2005 reference case price and volume relationships. The EPA 2.1.9 gas supply curves were scaled such that IPM solved for AEO 2005 gas prices when the power sector gas demand in IPM is consistent with AEO 2005 power sector gas demand projections.
- The coal supply curves used in EPA 2.1.9 were scaled such that the average mine mouth coal prices that the IPM was solving in aggregated coal supply regions were comparable to AEO 2005. Coal grades and supply regions contained in AEO 2005 and EPA 2.1.9 were not directly comparable. An iterative approach was used to obtain comparable results. The coal transportation matrix was not updated with Energy Information Administration (EIA) assumptions due to significant differences between the EPA 2.1.9 and EIA AEO 2005 coal supply and coal demand region configurations.
- The cost and performance of new units were updated to AEO 2005 reference case levels.
- The run years 2008, 2009, 2012, 2015, 2018, 2020 and 2026 were modeled.
- The AEO 2005 life extension costs for fossil and nuclear units were incorporated.
- The extensive NEEDS comments provided by VISTAS, MRPO, CENRAP and MANE-VU were incorporated into the Phase I NEEDS input file.
- MANE-VU's comments in regards to the northeast state regulations were incorporated.
- Northeast Renewable Portfolio Standards (RPS) were modeled based on the Regional Greenhouse Gas Initiative analysis. A single RPS cap was modeled for MA, RI, NY, NJ, MD, and CT. These states could buy credits from NY or from the PJM Interconnection and New England model regions.

- Selective Catalytic Reduction (SCR) and Scrubber Feasibility Limits: No limits were applied in 2008, 2009 and 2010 to the capacity for installing these emissions controls.
- The Clean Air Visibility Rule (CAVR) was not modeled.
- Modelers assumed a Title IV SO_2 Bank for 2007 of 4.98 million tons.
- The investments required under the Illinois Power, Mirant and First Energy NSR settlements (as identified during spring 2005) were incorporated in the above runs.

For the Phase II inter-RPO set of IPM runs, ICF generated two different parsed files for each of the two strategy case scenarios (VISTAS II_PC_1f and VISTAS II_PC_2c). One file includes all fuel burning units (fossil, biomass, landfill gas) as well as non-fuel burning units (hydro, wind, etc.). The second file contains just the fossil-fuel burning units (e.g., emissions from biomass and landfill gas are omitted). In all RPOs the fossil-only file was used for modeling. This is consistent with EPA, since EPA used the fossil only results for CAIR analyses.

2.6 State Results – Phase II

Table 1 presents unmodified State level fuel use and emission results from the 2018 Inter-RPO CAIR Case IPM v. 2.1.9 fossil-only parsed file (VISTASII_PC_1f). Note that IPM produces only NO_x and SO_2 emissions estimates.

2.7 MANE-VU Sponsored CAIR Plus IPM Modeling

Using the IPM Phase II RPO modeling platform MANE-VU contracted with ICF to evaluate the impact of both tightening the SO_2 and NO_x CAIR caps and expanding the CAIR region to include the electricity generating sector in additional states the Eastern United States. As part of this analysis, ICF developed a new Base Case that implemented EPA's CAIR, CAMR and CAVR policies and a Policy Case with lower SO_2 and NO_x CAIR caps in an extended region. The new Base Case was developed for comparison to the Policy Case. The model assumptions and data used in this analysis are somewhat different than those in the RPO Phase II analysis and are described in Section B of the project report (ICF, 2007). Neither the base or policy cases from the CAIR Plus project were used in subsequent SIP modeling.

Table 1. State Level Fuel Use and Emission Summary; 2018 VISTASII_PC_1f.xls. (fossil only)

		Fuel Use (TBtu)		Emissions (Tons)		
State	**RPO**	**Summer**	**Annual**	**Summer NOx**	**Annual NOx**	**Annual SO2**
Connecticut	MANE-VU	62.1572	142.7141	1,521	3,418	6,697
Delaware	MANE-VU	41.9472	92.7542	5,485	12,341	35,442
District Of Columbia	MANE-VU	2.0774	4.8716	49	103	83
Maine	MANE-VU	21.8494	49.8748	804	1,827	5,436
Maryland	MANE-VU	195.3393	437.8991	6,832	14,709	28,065
Massachusetts	MANE-VU	188.0653	433.3227	8,004	18,157	17,486
New Hampshire	MANE-VU	32.4638	73.8699	1,393	3,089	7,469
New Jersey	MANE-VU	140.8000	304.7240	6,432	13,636	32,495
New York	MANE-VU	282.4272	669.0821	10,926	24,376	51,445
Pennsylvania	MANE-VU	687.1446	1,540.1322	36,329	82,881	135,946
Rhode Island	MANE-VU	15.1701	40.0407	244	576	55
Vermont	MANE-VU	1.3677	3.0597	74	105	35
	MANE-VU Total	**1,670.8093**	**3,792.3450**	**78,093**	**175,219**	**320,651**
Alabama	VISTAS	605.2513	1,329.1117	19,416	41,715	190,029
Florida	VISTAS	831.5942	1,813.5433	26,620	56,506	139,526
Georgia	VISTAS	687.9659	1,530.2279	26,228	56,180	178,196
Kentucky	VISTAS	494.6026	1,121.9188	27,904	64,099	229,596
Mississippi	VISTAS	211.7079	443.3923	4,269	8,895	27,226
North Carolina	VISTAS	431.1262	984.5996	25,412	57,774	102,217
South Carolina	VISTAS	326.3757	749.2039	20,240	46,318	118,584
Tennessee	VISTAS	300.8087	672.6405	13,348	29,873	112,343
Virginia	VISTAS	305.6546	710.9991	18,443	43,144	80,602
West Virginia	VISTAS	477.7910	1,080.9570	22,556	51,208	124,464
	VISTAS Total	**4,672.8781**	**10,436.5940**	**204,435**	**455,711**	**1,302,784**
Illinois	MRPO	564.3359	1,281.6624	31,214	71,234	241,136
Indiana	MRPO	665.8976	1,534.4126	40,820	95,376	376,864
Michigan	MRPO	537.6731	1,257.6784	42,629	98,685	398,562
Ohio	MRPO	773.6334	1,785.3989	35,888	83,129	215,501
Wisconsin	MRPO	303.7451	691.5260	19,794	45,701	155,369
	MRPO Total	**2,845.2851**	**6,550.6783**	**170,345**	**394,124**	**1,387,433**
Arkansas	CENRAP	211.9455	479.1864	14,836	33,097	82,605
Iowa	CENRAP	238.7101	548.7369	22,252	51,119	147,305
Kansas	CENRAP	213.4288	465.8685	37,207	83,333	81,486
Louisiana	CENRAP	225.6282	481.9880	14,240	30,432	74,263
Minnesota	CENRAP	175.6582	388.8279	17,940	41,029	85,847
Missouri	CENRAP	416.5504	918.5720	34,350	77,660	280,887
Nebraska	CENRAP	113.8064	255.2901	22,524	50,781	73,629
Oklahoma	CENRAP	357.5522	745.1097	36,695	76,048	113,680
Texas	CENRAP	1,710.8244	3,236.6605	79,449	153,837	339,433
	CENRAP Total	**3,664.1040**	**7,520.2400**	**279,493**	**597,336**	**1,279,135**
Arizona	WRAP	442.6160	1,022.0551	36,168	81,858	60,640
California	WRAP	602.8505	1,403.6297	10,464	23,767	5,447
Colorado	WRAP	215.1782	486.7281	31,074	70,171	87,163
Idaho	WRAP	14.5575	34.1372	309	718	0
Montana	WRAP	88.4363	200.1442	17,034	38,504	22,066
Nevada	WRAP	179.3334	408.0758	20,978	47,404	31,172
New Mexico	WRAP	155.2294	344.7868	32,965	74,010	52,917
North Dakota	WRAP	131.5025	297.0199	31,745	71,711	108,645
Oregon	WRAP	109.6842	255.3128	4,968	11,330	10,034
South Dakota	WRAP	16.3929	36.8730	6,457	14,574	12,085
Utah	WRAP	146.1278	330.1164	26,905	60,782	37,819
Washington	WRAP	155.7190	362.9219	11,625	26,379	12,236
Wyoming	WRAP	202.3566	457.1643	35,935	81,182	40,265
	WRAP Total	**2,459.9843**	**5,638.9652**	**266,628**	**602,390**	**480,488**
National Total		**15,313.0609**	**33,938.8226**	**998,994**	**2,224,779**	**4,770,490**

3 POST PROCESSING OF IPM OUTPUT

3.1 Use of SMOKE Emissions Processing Model

On behalf of MANE-VU, modelers from The Northeast States for Coordinated Air Use Management (NESCAUM) used an emissions processing model to prepare data produced by the IPM model for use in air quality and visibility modeling. The Sparse Matrix Operator Kernel Emissions (SMOKE) Modeling System is an emissions processing system designed to create gridded, speciated, hourly emissions for input into a variety of air quality models, such as EPA's Community Multi-Scale Air Quality (CMAQ) model and Regional Modeling System for Aerosols and Deposition (REMSAD) (Houyoux, et. al., 2000). SMOKE supports area, biogenic, mobile (both onroad and nonroad), and point source emissions processing for criteria, particulate, and toxic pollutants. For biogenic emissions modeling, SMOKE uses the Biogenic Emission Inventory System, version 2.3 (BEIS2) and version 3.09 and 3.12 (BEIS3). SMOKE is also integrated with the onroad emissions model MOBILE6.

The sparse matrix approach used throughout SMOKE permits rapid and flexible processing of emissions data. Flexible processing comes from splitting the processing steps of inventory growth, controls, chemical speciation, temporal allocation, and spatial allocation into independent steps whenever possible. The results from these steps are merged together in the final stage of processing using vector-matrix multiplication. It allows individual steps (such as adding a new control strategy, or processing for a different grid) to be performed and merged without having to redo all of the other processing steps. Individual emission scenarios were simulated for MANE-VU using the SMOKE Modeling System.

NESCAUM, on behalf of MANE-VU and its participating States, conducted regional air quality simulations for calendar year 2002 and several future periods (NESCAUM, 2008). This work was directed at satisfying a number of goals under the Haze State Implementation Plan (SIP), including a contribution assessment, a pollution apportionment for 2018, and the evaluation of visibility benefits of control measures being considered for achieving reasonable progress goals and establishing a long-term emissions management strategy for MANE-VU Class I areas. The modeling tools utilized for these analyses include the Fifth-Generation NCAR / Penn State Mesoscale Model (MM5), SMOKE, CMAQ and REMSAD, and incorporate tagging features that allow for the tracking of individual source regions or measures. These tools have been evaluated and found to perform adequately relative to U.S. EPA modeling guidance.

As described below, in order for NESCAUM to process the EGU emissions generated by the IPM® procedures noted above, a series of intermediate steps were required to get the activity and emission data into the appropriate format for SMOKE processing.

3.2 Preparing IPM Output for Use in SMOKE Model

IPM can produce projections at the regional, state, plant, or unit level. Data must be parsed to provide the unit level information required for chemical transport modeling. Parsing involves developing detailed unit level information from the model's projections at the model plant level. ICF parsed the VISTASII_PC_1f data for use by the RPOs.

Further post-processing of IPM parsed output is needed to prepare the files for use by the SMOKE emissions processing model. The following sections describe the intermediate steps necessary to make these conversions. The first step is the augmentation of the IPM parsed output files to include additional unit level characteristics and pollutant estimates necessary for one atmosphere modeling. This step converts the IPM parsed data files into EPA's National Emission Inventory Input Format (NIF). The second step is the additional conversion of these NIF files into the Inventory Data Analyzer (IDA) format required by the SMOKE emissions processor.

3.2.1 IPM to NIF

After running IPM, ICF provided an initial spreadsheet file containing unit-level records for both:

(1) "existing" units (those currently in operation during the modeled base year) and
(2) committed/planned or new generic aggregates (new generic units expected to come online or identified as needed to meet electric generation demand in a geographic area).

IPM parsed file records include unit and fuel type data; existing, retrofit (for SO_2 and NO_x), and separate NO_x control information; annual SO_2 and NO_x emissions and heat input; summer season (May-September) NO_x and heat input; July day NO_x and heat input; coal heat input by coal type; nameplate capacity megawatt (MW), and State FIPS codes (Federal Information Processing codes used to identify geographic areas). Existing units also had county FIPS codes, a unique plant identifier (ORISPL) and unit ID (also called boiler ID) (BLRID); generic units did not have these data.

The processing of IPM parsed data to NIF format included estimating emissions of pollutants not generated by IPM and adding control efficiencies, stack parameters, latitude-longitude coordinates, and State identifiers (plant ID, point ID, stack ID, process ID) from a series of lookup tables or by matching to individual units as configured in base year 2002 emission files (Pechan, 2005). Additionally, new generic units created by IPM were sited in a county and given appropriate IDs. This processing is described in more detail below.

Generic Units: The new generic units and associated data were prepared by transforming the generic aggregates into units similar in size and fuel to existing units in terms of the available data. Generic aggregates were split into smaller generic units based on their unit types and capacity. Each generic unit was provided a dummy ORIS unique plant and boiler ID, and was given a county FIPS code based on an algorithm that sited each generic unit by assigning a sister plant that is in a county based on its attainment/nonattainment status. Within a State, existing plants (in county then ORIS plant code order) in attainment counties were used first as sister sites to new generic units (to obtain county location), followed by existing plants in PM nonattainment counties, followed by existing plants in 8-hour ozone nonattainment counties. No States identified counties that should not be considered when siting new generic units, so this process was identical to the one used for EPA IPM post-processing under CAIR.

SCCs were assigned to existing units using unit/fuel/firing/bottom type data. SCCs were assigned to generic units using unit and fuel type information. Latitude-longitude coordinates were assigned, first using the EPA-provided data files, secondly using an in-house contractor developed latitude-longitude file, and lastly using county centroids. These additional location files were only used when the data were not provided in the original 2002 base year files. Stack parameters were then assigned to each unit, first using the EPA-provided data files, secondly using an in-house stack parameter file based on previous EIA-767 data, and lastly using an EPA June 2003 SCC-based default stack parameter file. These data were only used when the data were not provided in the 2002 base year files.

IPM does not calculate emissions for all pollutants necessary for regional haze modeling. Therefore additional data were required to estimate VOC, CO, filterable primary PM_{10} and $PM_{2.5}$, PM condensable, and NH_3 emissions. Thus, ash and sulfur contents were assigned by first using 2002 EIA-767 values for existing units or SCC-based defaults; filterable PM_{10} and $PM_{2.5}$ efficiencies were obtained from the 2002 EGU NEI that were based on 2002 EIA-767 control data and the PM Calculator program (a default of 99.2 percent is used for coal units if necessary); fuel use was back calculated from the given heat input and a default SCC-based heat content; and emission factors were obtained from an EPA-approved emission factor file based on AP-42 emission factors. Table 2 presents the SCC-based default heat content and stack parameters used when actual data were not available. Table 3 (worksheet sccemfac100704 from MRPOpostprocdatafiles.xls, Pechan 2005) reflects emission factors used to develop emission estimates of CO, VOC, filterable PM, and NH_3.

Table 2. SCC Default Heat Content and Stack Parameters from IPM to NIF Conversion.

			Stack Parameters			
SCC	**Fuel**	**Heat Content (Btu/SCC Unit)**	**Height (ft)**	**Diameter (ft)**	**Temp (degrees F)**	**Velocity (ft/s)**
10100201	Bituminous Coal	23.4286	603.2	19.8	281.2	76.5
10100202	Bituminous Coal	23.4286	509.7	14.6	226.0	62.0
10100203	Bituminous Coal	23.4286	491.6	16.6	278.4	80.5
10100204	Bituminous Coal	23.4286	225.0	0.6	67.2	2.4
10100211	Bituminous Coal	23.4286	0.0	0.0	0.0	0.0
10100212	Bituminous Coal	23.4286	445.6	17.4	275.2	77.6
10100217	Bituminous Coal	23.4286	399.3	10.8	245.6	40.1
10100221	Subbituminous Coal	17.8870	983.0	22.8	350.0	110.0
10100222	Subbituminous Coal	17.8870	468.5	16.0	254.7	65.6
10100223	Subbituminous Coal	17.8870	446.8	15.9	308.0	93.6
10100224	Subbituminous Coal	17.8870	255.5	10.0	251.3	15.3
10100226	Subbituminous Coal	17.8870	495.8	18.9	259.2	91.2
10100238	Subbituminous Coal	17.8870	600.0	22.5	315.0	78.0
10100301	Lignite Coal	12.9149	427.5	22.3	232.8	74.2
10100302	Lignite Coal	12.9149	483.5	21.0	229.4	92.4
10100303	Lignite Coal	12.9149	462.0	21.7	271.3	72.5
10100317	Lignite Coal	12.9149	326.7	12.3	326.7	74.7
10100601	Natural Gas	1023.8846	263.9	10.3	236.0	46.9
10100801	Coke	27.4376	371.3	5.5	122.4	20.4
10102018	Waste Coal	12.0929	0.0	0.0	0.0	0.0
20100201	Natural Gas	1023.8846	62.0	10.0	585.3	61.3
20100301	Gasified Coal	1023.8846	62.0	10.0	585.3	61.3

Table 3. EPA-Approved Emission Factor File for CO, VOC, filterable PM, and NH_3.

SCC	FUEL	COEF	VOCEF	PM10EF	PM25EF	NH3EF	PMFLAG
10100201	BIT	0.5000	0.0400	2.6000	1.4800	0.030	A
10100202	BIT	0.5000	0.0600	2.3000	0.6000	0.030	A
10100203	BIT	0.5000	0.1100	0.2600	0.1100	0.030	A
10100204	BIT	5.0000	0.0500	13.2000	4.6000	0.030	
10100211	BIT	0.5000	0.0400	2.6000	1.4800	0.030	A
10100212	BIT	0.5000	0.0600	2.3000	0.6000	0.030	A
10100217	BIT	18.0000	0.0500	12.4000	1.3640	0.030	
10100221	SUB	0.5000	0.0400	2.6000	1.4800	0.030	A
10100222	SUB	0.5000	0.0600	2.3000	0.6000	0.030	A
10100223	SUB	0.5000	0.1100	0.2600	0.1100	0.030	A
10100224	SUB	5.0000	0.0500	13.2000	4.6000	0.030	
10100226	SUB	0.5000	0.0600	2.3000	0.6000	0.030	A
10100238	SUB	18.0000	0.0500	16.1000	4.2000	0.030	
10100301	LIG	0.2500	0.0700	1.8170	0.5214	0.030	A
10100302	LIG	0.6000	0.0700	2.3000	0.6600	0.030	A
10100303	LIG	0.6000	0.0700	0.8710	0.3690	0.030	A
10100317	LIG	0.1500	0.0300	12.0000	1.4000	0.030	
10100601	NG	84.0000	5.5000	1.9000	1.9000	3.200	
10100801	PC	0.6000	0.0700	7.9000	4.5000	0.397	A
10102018	WC	0.1500	0.0300	12.0000	1.4000	0.030	
20100201	NG	83.8628	2.1477	1.9380	1.9380	6.560	
20100301	IGCC	34.6500	2.2050	11.5500	11.5500	6.560	

Notes:

1. SCCs beginning with 101002 (coal), 101003 (coal), 101008 (coke), or 101020 (waste coal), emission factors in LB/TON; SCCs beginning with 101006 (natural gas), 201002 (natural gas), or 201003 (IGCC), emission factors are in LB/E6FT3.
2. If PMFLAG = 'A', then multiply ash content with PM emission factor.

Source: Table derived from worksheet sccemfac100704 from MRPOpostprocdatafiles.xls, Pechan 2005.

Condensable PM: To estimate total primary PM emissions, additional calculations were conducted to derive condensable PM emissions from these sources. In MANE VU and VISTAS PM condensable emissions were calculated based on factors derived from AP-42 defaults. In MRPO no condensable emissions were estimated or included in the inventory. (Janssen, 2008) Table 4 (worksheet pmcdef from MRPOpostprocdatafiles.xls, Pechan 2005) shows these PM condensable emission factors and SCC assignments.

Table 4. EPA-Approved Condensable PM Emission Factor Assignment.

SCC	PMCDEF (LB/E6BTU)
10100201, 10100202, 10100203, 10100211, 10100212, 10100221, 10100222, 10100223, 10100226, 10100301, 10100302, 10100303	0.0200[2]
10100201, 10100202, 10100203, 10100211, 10100212, 10100221, 10100222, 10100223, 10100226, 10100301, 10100302, 10100303 [1]	(0.1 * sulfur content - 0.03)[3]
10100204, 10100224	0.0400
10100217, 10100238, 10100317, 10102018	0.0100
10100601	0.0057
10100801	0.0100
20100201, 20100301	0.0047

Notes:

1. If the emission factor is less than 0.01, then it is set equal to 0.01.
2. AND there is either an SO_2 FGD or a PM scrubber (for MRPO post-processing); or AND there is an SO_2 wet FGD (for EPA post-processing).
3. AND there is any PM control other than a scrubber and there is no SO_2 control (for MRPO post-processing); or AND there is any control other than an SO_2 wet FGD (for EPA post-processing).

Source: Table derived from worksheet pmcdef from MRPOpostprocdatafiles.xls, Pechan 2005.

Additional Pollutants: As noted above, in processing IPM parsed data to convert it to NIF format, emissions of additional pollutants were estimated. Emissions for 28 temporal-pollutant combinations were estimated since there are seven pollutants (VOC, CO, primary PM_{10} and $PM_{2.5}$, NH_3, SO_2 and NO_x) and four temporal periods (annual, summer season, winter season, and July day).

Crosswalk Match to 2002 Inventory: The final step in the IPM to NIF conversion process was to match the IPM unit IDs with the identifiers in the base year 2002 inventory for existing EGUs. A crosswalk file was used to obtain FIPS State and county, plant ID (within State and county), and point ID. If the FIPS State and county, plant ID and point ID were in the 2002 base year NIF tables, then the process ID and stack ID were obtained from the NIF; otherwise, defaults, described above, were used.

The post-processed files were then provided in NIF 3.0 format. Two sets of tables were developed : "NIF files" for IPM units that had a crosswalk match and were in the 2002 base year inventory, and "NoNIF files" for IPM units that were not in the 2002 base year inventory (which included existing units with or without a crosswalk match as well as generic units). Two special cases relating to the crosswalk match were handled as follows:

1. One-to-many match: At a given plant, if one IPM boiler ID was matched to more than one point ID, the boiler data were put on the first point ID records; records from the other point IDs were deleted from the relevant tables.

2. Many-to-one match: At a given plant, if more than one IPM boiler ID was matched to one point ID, all the boilers' emissions (tons), throughput (really heat input in MMBtu), and capacity (MW) were summed ("summed boiler") and put on that point

ID's records in the relevant tables. The values for stack parameters and latitude-longitude values were those from the first record summed.

3.3 State Results – Phase II Augmented

Summarizing the results of the estimation of additional pollutants, Table 5 presents additional pollutant augmented State level emission results from the 2018 Inter-RPO CAIR Case IPM v. 2.1.9 fossil-only parsed file (VISTASII_PC_1f with pollutant augmentation; found in modeling file *ida_egu_18_basef_2453605.txt* from VISTAS BaseF). A comparison of RPO totals for SO_2 and NO_x shows that these are the same as presented in Table 1.

3.4 NIF to IDA

The main purpose of the SMOKE conversion task was to convert EGU emission inventories provided in NIF format into the IDA format required by the SMOKE model for the criteria pollutants VOC, NO_x, CO, SO_2, PM_{10}, $PM_{2.5}$, and NH_3. Annual and seasonal emissions were taken directly from the NIF structured inventories with no alternate temporal calculations performed (e.g., estimate seasonal emissions from annual or annual from seasonal). The temporal allocation module of the SMOKE emissions processor was intended to be used to further define temporal distribution of these emissions.

No quality assurance (QA) related to the reported values in the NIF files was conducted (e.g., it was assumed that reported emission levels were correct) and therefore the QA focus was to maintain the integrity of the mass files in the conversion to IDA.

Each set of NIF structured data had a unique set of relational tables necessary to maintain the information required in each source sector based on its reporting requirements. Conversion scripts to read the information from each of these relational data sets and convert them to the IDA structures required by this task were implemented by Alpine (Alpine, 2006). Prior to and after the conversion from NIF to IDA, a list of emission summary reports was developed to check that the emissions input into the conversion process were the same as output into the IDA formatted files.

Table 5. State Level Emission Summary; 2018 VISTASII_PC_1f with Pollutant Augmentation. Modeling file *ida_egu_18_basef_2453605.txt* from VISTAS Base F. (fossil-only)

		Annual Emissions (Tons)						
		IPM Generated		Augmented Pollutants				
State	**RPO**	**NOx**	**SO2**	**VOC**	**CO**	**PM-10**	**PM-2.5**	**NH3**
Connecticut	MANE-VU	3,418	6,697	145	9,837	959	927	341
Delaware	MANE-VU	12,341	35,442	117	1,183	2,950	2,438	76
District Of Columbia	MANE-VU	103	83	5	154	104	99	12
Maine	MANE-VU	1,827	5,436	53	4,057	296	279	139
Maryland	MANE-VU	14,709	28,065	575	11,831	8,253	6,433	435
Massachusetts	MANE-VU	18,157	17,486	484	13,860	3,918	3,233	1,059
New Hampshire	MANE-VU	3,089	7,469	73	1,697	2,268	2,156	124
New Jersey	MANE-VU	13,636	32,495	352	7,611	4,017	3,515	564
New York	MANE-VU	24,376	51,445	758	22,242	11,031	9,343	1,472
Pennsylvania	MANE-VU	82,881	135,946	1,920	41,445	31,580	23,756	1,790
Rhode Island	MANE-VU	576	55	42	1,627	157	156	127
Vermont	MANE-VU	105	35	3	117	26	25	9
	MANE-VU Total	**175,218**	**320,651**	**4,528**	**115,659**	**65,558**	**52,360**	**6,148**
Alabama	VISTAS	41,714	190,029	1,599	27,888	20,401	15,936	2,009
Florida	VISTAS	56,506	139,526	2,027	58,982	24,804	18,403	3,948
Georgia	VISTAS	56,180	178,196	1,940	33,040	25,929	19,087	2,374
Kentucky	VISTAS	64,099	229,596	1,623	17,103	24,659	18,813	782
Mississippi	VISTAS	8,895	27,226	511	12,228	7,270	4,358	918
North Carolina	VISTAS	57,774	102,217	1,232	14,386	31,797	26,551	847
South Carolina	VISTAS	46,318	118,584	932	11,263	26,740	22,629	793
Tennessee	VISTAS	29,873	112,343	922	7,391	15,008	12,988	449
Virginia	VISTAS	43,144	80,602	863	16,482	19,652	17,300	881
West Virginia	VISTAS	51,208	124,464	1,447	12,946	23,538	16,968	721
	VISTAS Total	**455,711**	**1,302,784**	**13,096**	**211,709**	**219,798**	**173,034**	**13,722**
Illinois	MRPO	71,233	241,136	2,229	17,868	32,650	30,132	1,152
Indiana	MRPO	95,376	376,864	2,105	19,416	35,082	27,835	1,274
Michigan	MRPO	98,685	398,562	1,623	17,522	38,902	34,276	1,091
Ohio	MRPO	83,129	215,501	2,254	23,832	42,754	33,323	1,773
Wisconsin	MRPO	45,701	155,369	1,101	11,901	15,629	14,246	626
	MRPO Total	**394,124**	**1,387,432**	**9,312**	**90,539**	**165,016**	**139,813**	**5,915**
Arkansas	CENRAP	33,097	82,605	696	11,429	3,897	3,326	814
Iowa	CENRAP	51,119	147,305	770	8,759	10,033	8,615	569
Kansas	CENRAP	83,333	81,486	798	7,203	8,520	6,807	461
Louisiana	CENRAP	30,432	74,263	660	11,043	3,966	3,590	919
Minnesota	CENRAP	41,029	85,847	674	5,563	8,162	7,034	343
Missouri	CENRAP	77,660	280,887	1,579	13,165	18,456	16,769	800
Nebraska	CENRAP	50,781	73,629	450	3,590	2,296	1,915	217
Oklahoma	CENRAP	76,048	113,680	1,008	28,182	5,561	4,840	1,355
Texas	CENRAP	153,837	339,433	4,988	102,583	38,952	31,631	6,424
	CENRAP Total	**597,336**	**1,279,135**	**11,622**	**191,518**	**99,842**	**84,528**	**11,902**
Arizona	WRAP	81,858	60,640	1,170	29,037	11,515	9,644	2,189
California	WRAP	23,767	5,447	1,496	56,188	5,442	5,337	4,402
Colorado	WRAP	70,171	87,163	667	12,139	4,751	4,166	609
Idaho	WRAP	718	0	36	1,398	113	113	109
Montana	WRAP	38,504	22,066	326	3,035	7,217	4,636	193
Nevada	WRAP	47,404	31,172	479	9,862	5,244	4,315	750
New Mexico	WRAP	74,010	52,916	554	5,991	13,435	7,637	388
North Dakota	WRAP	71,711	108,645	784	9,937	5,670	4,757	324
Oregon	WRAP	11,330	10,034	276	9,322	1,311	1,305	722
South Dakota	WRAP	14,574	12,085	110	536	362	297	33
Utah	WRAP	60,782	37,819	423	3,523	6,459	4,881	211
Washington	WRAP	26,379	12,236	451	11,848	3,780	3,192	898
Wyoming	WRAP	81,182	40,265	678	5,672	8,537	7,116	341
	WRAP Total	**602,389**	**480,488**	**7,449**	**158,487**	**73,834**	**57,395**	**11,170**
National Total		**2,224,778**	**4,770,490**	**46,007**	**767,912**	**624,049**	**507,129**	**48,857**

4 MODIFICATIONS BY OTHER REGIONS

4.1 Emission Control Modifications within VISTAS, MRPO, and CENRAP

State and local agencies and invited stakeholders from VISTAS, MRPO, and CENRAP reviewed the results of the Inter-RPO Phase II set of IPM runs. These stakeholders primarily reviewed and commented on the IPM results with respect to IPM decisions on NO_x post-combustion controls and SO_2 scrubbers and provided additional information on when and where new SO_2 and NO_x controls were planned to come online based on the best available data from state rules, enforcement agreements, compliance plans, permits, and discussions/commitments from individual companies. They also reviewed the IPM results to verify that known and existing controls and emission rates were properly reflected in the IPM runs. After considering comments, those RPOs adjusted the IPM results for specific units using new information they had as part of the permitting process or other contact with the industry that indicated which units would install controls as a result of CAIR and when these new controls would come on-line (MACTEC, 2007; MRPO 2006; ENVIRON 2007).

As described in the following section, some entities specified changes to the controls assigned by IPM to reflect their best estimates of emission control levels. These changes typically involved either 1) adding selective catalytic reduction (SCR) or scrubber controls to units where IPM did not predict SCR or scrubber controls, or 2) removing IPM-assigned SCR or scrubber controls at units where the commenting entity indicated there were no firm plans for controls at those units.

At this point in the process MANE-VU decided not to make any changes to the northeastern state IPM output regardless of state knowledge of discrepancies with actual conditions. MANE-VU determined that IPM provided a reasonable estimate of the impact of the CAIR cap and trade program consistent with methods used by EPA, and planners were concerned that adjustments would not reflect the allocation of all allowed emissions under CAIR.

In MANE-VU's final modeling, many of the changes made by the other RPOs were included, but due to the timing of the release of revised data, the location with respect to the modeling domain, and need to progress with modeling, MANE-VU did not incorporate changes reflected in the final CENRAP EGU files.

4.2 Emission Factor and Control Modifications for VISTAS Emission Sources

VISTAS reviewed the PM and NH_3 emissions from its States' EGUs provided after the original IPM to NIF conversation conducted for the RPOs and identified significantly higher emissions in 2009/2018 than in 2002. VISTAS determined this conversion used a set of PM and NH_3 emission factors that were "the most recent EPA approved uncontrolled emission factors" for estimating 2009/2018 EGU emissions but were most likely not the same emission factors used by States for estimating these emissions in 2002. Thus, the emission increase from 2002 to 2009/2018 was simply an artifact of the change in emission factors, not anything to do with changes in activity or control technology application. During this review, VISTAS additionally identified an inconsistent use of SCCs for determining emission factors between the base and future years.

Documentation (Alpine, 2005a, b) indicates that VISTAS adjusted the 2002 base year emissions inventory to account for these discrepancies in base year and future year PM and NH_3 emission factor use. Using the latest "EPA-approved" uncontrolled emission factors by SCC, Alpine utilized data collected under EPA's Consolidated Emissions Reporting Rule (CERR) or data reported by VISTAS. Alpine used reported annual heat input, fuel throughput, heat, ash, and sulfur content to estimate annual uncontrolled 2002 emissions for units identified as having corresponding output from IPM. This step was conducted for non-CEM pollutants (CO, VOC, PM, and NH_3) only. For PM emissions, the condensable component of emissions was calculated and added to the resulting PM primary estimations. The resulting 2002 emissions were then adjusted by any control efficiency factors reported in the CERR or VISTAS data collection effort. The second adjustment was to the future year inventories. Alpine updated the SCCs in the future year inventory to assign the same SCC used in the base year. Using the same methods as described for the 2002 revisions, those non-IPM generated pollutants were estimated using IPM predicted fuel characteristics and base year 2002 SCC assignments.

In addition to the changes to the emission factor assignments, SCC, and IPM-assigned controls, VISTAS also specified other changes to the IPM results or converted IPM to NIF files. Comments on changes in stack parameters from the 2002 inventory were implemented in the converted files for the 2018 inventory. Changes to stack parameters were also made in cases where new controls were scheduled to be installed. In cases where an emission unit was projected to have an SO_2 scrubber by 2018, some States were able to provide revised stack parameters for some units based on design features for the new control system. Other units projected to install scrubbers by 2018 were not far enough along in the design process to have specific design details. For those units, VISTAS made the following assumptions: 1) the scrubber is a wet scrubber; 2) keep the current stack height the same; 3) keep the current flow rate the same, and 4) change the stack exit temperature to 169 degrees F (this is the virtual temperature derived from a wet temperature of 130 degrees F) (MACTEC, 2007). VISTAS determined that exit temperature (wet) of 130 degrees F +/- 5 degrees F is representative of different size units and wet scrubber technology.

4.3 Emission Inventory Replacement by Western States

During the development of their EGU emission forecast, the Western Regional Air Partnership (WRAP) conducted an exercise where IPM was not used to prepare emission estimates from EGU sources. Using capacity factor adjustments and emission control assumptions, WRAP developed a forecast of EGU emissions based on its initial 2002 base year inventory (ERG, 2006). This revised forecast was used by some of the other RPOs and replaced the emissions generated for the domain by IPM. This change by WRAP is reflected in the difference in State emission totals between Tables 5 and 6. As WRAP is outside the MANE VU modeling domain, this change was not reflected in MANE-VU modeling. MANE-VU did not change its boundary conditions to reflect this change.

4.4 Eliminating Double Counting of EGU Units

An additional set of procedures was used by MANE-VU and VISTAS to avoid double counting of EGU emissions in the 2018 point source inventory (MACTEC, 2006, 2007). Since each

RPO's 2002 emissions inventory file contained both EGUs and non-EGU point sources, and EGU emissions were projected using IPM, it was necessary to split the 2002 point source file into two components. The first component contained those emission units accounted for in the IPM forecasts. The second component contained all other point sources not accounted for in IPM.

As described in the previous section, 2018 NIF files for EGUs were prepared from the IPM parsed files. All IPM matched units were initially removed from the 2018 point source inventory to create the non-EGU inventory (which was projected to 2018 using non-EGU growth and control factors). This was done on a unit-by-unit basis based on a cross-reference table that matched IPM emission unit identifiers (ORISPL plant code and BLRID emission unit code) to NIF emission unit identifiers (FIPSST state code, FIPSCNTY county code, State Plant ID, State Point ID). When there was a match between the IPM ORISPL/BLRID and the emission unit ID, the unit was assigned to the EGU inventory; all other emission units were assigned to the non-EGU inventory.

If an emission unit was contained in the NIF files created from the IPM output, the corresponding unit was removed from the initial 2018 point source inventory. For VISTAS, the NIF 2018 EGU files from the IPM parsed files were then merged with the non-EGU 2018 files to create a complete 2018 point source scenario.

Next, several ad-hoc QA/QC queries were done to verify that there was no double-counting of emissions in the EGU and non-EGU inventories:

- The IPM parsed files were reviewed to identify EGUs accounted for in IPM. This list of emission units was compared to the non-EGU inventory derived from the IPM-NIF cross-reference table to verify that units accounted for in IPM were not double-counted in the non-EGU inventory. As a result of this comparison, a few adjustments were made in the cross-reference table to add emission units for plants to ensure these units accounted for in IPM were moved to the EGU inventory.

- The non-EGU inventory was further reviewed to identify remaining emission units with an Standard Industrial Classification (SIC) code of "4911 Electrical Services" or Source Classification Code of "1-01-xxx-xx External Combustion Boiler, Electric Generation". The list of sources meeting these selection criteria were compared to the IPM parsed file to ensure that these units were not double-counted.

- VISTAS invited various stakeholder groups to review the 2018 point source inventory to verify whether there was any double counting of EGU emissions. In some instances, corrections were provided where an emission unit was double counted.

4.5 Preliminary Results from Phase II Additional Modifications

Table 6 summarizes the Base G emissions inventory for EGUs, presenting State level emission results from the 2018 Inter-RPO CAIR Case IPM v. 2.1.9 parsed file modified by VISTAS, MRPO, and WRAP per the methods noted in the above sections. Note that no changes occurred to the MANE-VU state emissions as a result of these changes.

Table 6. State Level Emission Summary; 2018 VISTAS Base G Modeling file ptinv_egu_2018_11sep2006.txt. Based on 2018 VISTASII_PC_1f (fossil-only) with adjustments from VISTAS, MRPO, and WRAP.

		Annual Emissions (Tons)						
State	**RPO**	**NOx**	**SO2**	**VOC**	**CO**	**PM-10**	**PM-2.5**	**NH3**
Connecticut	MANE-VU	3,418	6,697	145	9,836	959	927	341
Delaware	MANE-VU	12,341	35,442	117	1,183	2,950	2,438	76
District Of Columbia	MANE-VU	103	83	5	154	104	99	12
Maine	MANE-VU	1,827	5,436	53	4,057	296	279	139
Maryland	MANE-VU	14,709	28,065	575	11,831	8,253	6,433	435
Massachusetts	MANE-VU	18,157	17,486	484	13,860	3,917	3,233	1,059
New Hampshire	MANE-VU	3,089	7,469	73	1,697	2,268	2,156	124
New Jersey	MANE-VU	13,636	32,495	352	7,611	4,017	3,515	564
New York	MANE-VU	24,376	51,445	758	22,242	11,031	9,343	1,471
Pennsylvania	MANE-VU	82,881	135,946	1,919	41,446	31,580	23,756	1,790
Rhode Island	MANE-VU	576	55	42	1,627	157	156	127
Vermont	MANE-VU	105	35	3	117	26	25	9
	MANE-VU Total	**175,219**	**320,651**	**4,528**	**115,660**	**65,558**	**52,360**	**6,148**
Alabama	VISTAS	62,860	135,782	1,620	21,611	7,385	4,380	1,033
Florida	VISTAS	56,827	133,037	1,857	42,573	9,287	6,288	2,665
Georgia	VISTAS	69,308	226,477	1,805	35,584	18,217	11,319	1,676
Kentucky	VISTAS	59,740	211,225	1,344	12,125	6,194	4,067	436
Mississippi	VISTAS	10,455	15,143	1,055	11,822	7,007	6,853	545
North Carolina	VISTAS	56,526	96,402	1,147	16,376	32,676	26,014	608
South Carolina	VISTAS	50,068	87,202	860	13,078	28,110	24,454	578
Tennessee	VISTAS	30,008	112,353	886	7,126	15,861	13,321	241
Virginia	VISTAS	60,615	109,391	921	14,017	13,505	11,757	553
West Virginia	VISTAS	51,177	115,322	1,382	11,896	6,344	3,643	177
	VISTAS Total	**507,583**	**1,242,334**	**12,877**	**186,205**	**144,586**	**112,094**	**8,513**
Illinois	MRPO	71,233	241,136	2,229	17,868	32,649	30,132	1,152
Indiana	MRPO	95,376	351,858	2,105	19,416	35,081	27,835	1,274
Michigan	MRPO	78,605	288,006	1,623	17,521	38,902	34,276	1,091
Ohio	MRPO	83,129	215,501	2,254	23,832	42,753	33,322	1,772
Wisconsin	MRPO	45,701	155,369	1,101	11,901	15,629	14,246	626
	MRPO Total	**374,044**	**1,251,871**	**9,311**	**90,539**	**165,015**	**139,812**	**5,915**
Arkansas	CENRAP	33,097	82,605	696	11,429	3,897	3,326	814
Iowa	CENRAP	51,119	147,305	770	8,758	10,033	8,615	569
Kansas	CENRAP	83,333	81,486	798	7,203	8,520	6,807	461
Louisiana	CENRAP	30,432	74,263	660	11,043	3,966	3,590	919
Minnesota	CENRAP	41,029	85,847	674	5,563	8,162	7,035	343
Missouri	CENRAP	77,660	280,887	1,579	13,165	18,456	16,769	799
Nebraska	CENRAP	50,781	73,629	450	3,590	2,296	1,914	217
Oklahoma	CENRAP	76,048	113,680	1,008	28,182	5,561	4,840	1,355
Texas	CENRAP	153,837	339,433	4,988	102,581	38,952	31,630	6,424
	CENRAP Total	**597,336**	**1,279,135**	**11,622**	**191,515**	**99,842**	**84,527**	**11,901**
Arizona	WRAP	59,774	55,941	724	17,806	2,811	634	630
California	WRAP	17,537	1,528	2,558	31,173	1,219	1,059	0
Colorado	WRAP	77,113	60,914	1,465	18,939	3,138	307	537
Idaho	WRAP	2,236	1,683	50	3,283	335	87	0
Montana	WRAP	44,733	31,303	565	11,818	1,796	247	13
Nevada	WRAP	54,300	22,118	1,570	10,598	4,230	768	903
New Mexico	WRAP	32,925	17,796	695	10,976	794	627	43
North Dakota	WRAP	82,741	152,828	909	13,647	3,958	2,645	383
Oregon	WRAP	15,742	15,096	474	5,753	1,288	323	219
South Dakota	WRAP	17,681	13,522	118	689	247	217	52
Utah	WRAP	76,136	41,394	597	17,150	4,637	2,000	1,350
Washington	WRAP	16,884	7,011	249	4,008	1,474	1,027	12
Wyoming	WRAP	104,142	96,745	1,147	18,871	10,445	7,411	404
	WRAP Total	**601,942**	**517,879**	**11,122**	**164,711**	**36,371**	**17,353**	**4,547**
National Total		**2,256,124**	**4,611,869**	**49,460**	**748,629**	**511,371**	**406,146**	**37,024**

4.6 Revised Results – VISTAS Base G2 Adjustment

VISTAS further refined their future predictions based on further state input. The resulting modeling file was called the Base G2 inventory. Table 7 presents State level emission results from the Base G2 2018 Inter-RPO CAIR Case IPM v. 2.1.9 parsed file modified by VISTAS.

Some states specified changes to the controls assigned by IPM to reflect their best estimates of emission control levels. These changes typically involved either 1) adding selective catalytic reduction (SCR) or scrubber controls to units where IPM did not predict SCR or scrubber controls, or 2) removing IPM-assigned SCR or scrubber controls at units where the commenting entity indicated their were no firm plans for controls at those units. These changes were based on those states' best available information about where and when emissions controls were expected to be installed, as well as information concerning IPM-predicted plant closures that were deemed unlikely to occur. In comparing Table 7 with Table 6, it can be seen that the changes included in the Base G2 inventory were requested by the states of Florida, Georgia, and North Carolina.

Note that no changes were made at this time by the MANE-VU states. The net effect of these changes was to reduce emissions of SO_2 relative to either Table 5 or Table 6.

Table 7. State Level Emission Summary; 2018 VISTAS Base G2 Modeling file egu_18_vistas_g2_20feb2007.txt. Based on 2018 VISTASII_PC_1f (fossil-only) with adjustments from VISTAS, MRPO, and WRAP.

		Annual Emissions (Tons)						
State	**RPO**	**NOx**	**SO2**	**VOC**	**CO**	**PM-10**	**PM-2.5**	**NH3**
Connecticut	MANE-VU	3,418	6,697	145	9,836	959	927	341
Delaware	MANE-VU	12,341	35,442	117	1,183	2,950	2,438	76
District Of Columbia	MANE-VU	103	83	5	154	104	99	12
Maine	MANE-VU	1,827	5,436	53	4,057	296	279	139
Maryland	MANE-VU	14,709	28,065	575	11,831	8,253	6,433	435
Massachusetts	MANE-VU	18,157	17,486	484	13,860	3,917	3,233	1,059
New Hampshire	MANE-VU	3,089	7,469	73	1,697	2,268	2,156	124
New Jersey	MANE-VU	13,636	32,495	352	7,611	4,017	3,515	564
New York	MANE-VU	24,376	51,445	758	22,242	11,031	9,343	1,471
Pennsylvania	MANE-VU	82,881	135,946	1,919	41,446	31,580	23,756	1,790
Rhode Island	MANE-VU	576	55	42	1,627	157	156	127
Vermont	MANE-VU	105	35	3	117	26	25	9
	MANE-VU Total	**175,219**	**320,651**	**4,528**	**115,660**	**65,558**	**52,360**	**6,148**
Alabama	VISTAS	62,860	135,782	1,620	21,611	7,385	4,380	1,033
Florida	VISTAS	58,341	139,200	1,904	42,947	9,355	6,331	2,665
Georgia	VISTAS	69,308	75,051	1,805	35,584	18,217	11,319	1,676
Kentucky	VISTAS	59,740	211,225	1,344	12,125	6,194	4,067	436
Mississippi	VISTAS	10,455	15,143	1,055	11,822	7,007	6,853	545
North Carolina	VISTAS	56,526	102,680	1,147	16,376	32,676	26,014	608
South Carolina	VISTAS	50,068	87,202	860	13,078	28,110	24,454	578
Tennessee	VISTAS	30,008	112,353	886	7,126	15,861	13,321	241
Virginia	VISTAS	60,615	109,391	921	14,017	13,505	11,757	553
West Virginia	VISTAS	51,177	105,932	1,382	11,896	6,344	3,643	177
	VISTAS Total	**509,098**	**1,093,959**	**12,923**	**186,579**	**144,654**	**112,137**	**8,513**
Illinois	MRPO	71,233	241,136	2,229	17,868	32,649	30,132	1,152
Indiana	MRPO	95,376	351,858	2,105	19,416	35,081	27,835	1,274
Michigan	MRPO	78,605	288,006	1,623	17,521	38,902	34,276	1,091
Ohio	MRPO	83,129	215,501	2,254	23,832	42,753	33,322	1,772
Wisconsin	MRPO	45,701	155,369	1,101	11,901	15,629	14,246	626
	MRPO Total	**374,044**	**1,251,871**	**9,311**	**90,539**	**165,015**	**139,812**	**5,915**
Arkansas	CENRAP	33,097	82,605	696	11,429	3,897	3,326	814
Iowa	CENRAP	51,119	147,305	770	8,758	10,033	8,615	569
Kansas	CENRAP	83,333	81,486	798	7,203	8,520	6,807	461
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Minnesota	CENRAP	41,029	85,847	674	5,563	8,162	7,035	343
Missouri	CENRAP	77,660	280,887	1,579	13,165	18,456	16,769	799
Nebraska	CENRAP	50,781	73,629	450	3,590	2,296	1,914	217
Oklahoma	CENRAP	76,048	113,680	1,008	28,182	5,561	4,840	1,355
Texas	CENRAP	153,837	339,433	4,988	102,581	38,952	31,630	6,424
	CENRAP Total	**597,336**	**1,279,135**	**11,622**	**191,515**	**99,842**	**84,527**	**11,901**
Arizona	WRAP	59,774	55,941	724	17,806	2,811	634	630
California	WRAP	17,537	1,528	2,558	31,173	1,219	1,059	0
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Idaho	WRAP	2,236	1,683	50	3,283	335	87	0
Montana	WRAP	44,733	31,303	565	11,818	1,796	247	13
Nevada	WRAP	54,300	22,118	1,570	10,598	4,230	768	903
New Mexico	WRAP	32,925	17,796	695	10,976	794	627	43
North Dakota	WRAP	82,741	152,828	909	13,647	3,958	2,645	383
Oregon	WRAP	15,742	15,096	474	5,753	1,288	323	219
South Dakota	WRAP	17,681	13,522	118	689	247	217	52
Utah	WRAP	76,136	41,394	597	17,150	4,637	2,000	1,350
Washington	WRAP	16,884	7,011	249	4,008	1,474	1,027	12
Wyoming	WRAP	104,142	96,745	1,147	18,871	10,445	7,411	404
	WRAP Total	**601,942**	**517,879**	**11,122**	**164,711**	**36,371**	**17,353**	**4,547**
National Total		**2,257,639**	**4,463,494**	**49,506**	**749,003**	**511,439**	**406,189**	**37,024**

5 ADDITIONAL ADJUSTMENTS BY NORTHEASTERN STATES AND MODELERS FOR REGIONAL HAZE SIP MODELING

5.1 Introduction

MANE VU used the G2 inventory as the basis for further adjustments to incorporate MANE-VU state changes and also to represent the MANE VU control strategy for key EGUs. These modifications resulted in a) SO_2 emissions reductions at one MANE-VU EGU source subject to Best Available Retrofit Technology (BART) requirements, 2) emissions increases in MANE-VU to reflect states' best estimates that some sources predicted by IPM to be closed would continue to operate and information about where and when emission controls would or would not be installed, 3) SO_2 emissions reductions at key EGUs (or alternative facilities) to reflect the MANE-VU EGU strategy, and 4) increases in SO_2 emissions to estimate the predicted effect of emissions trading under the CAIR program. Each of these is explained below.

5.2 Best Available Retrofit Technology (BART)

To assess the impacts of the implementation of the BART provisions of the Regional Haze Rule, NESCAUM included estimated reductions anticipated for BART-eligible facilities not covered by CAIR in the MANE-VU region in the 2018 CMAQ modeling analysis. A survey of state staff indicated that eight units would likely be controlled under BART alone. State-provided potential control technologies and levels of control for these sources were incorporated into the 2018 emission inventory projections used in MANE-VU's March 2008 modeling run (NESCAUM, 2008b). The eight BART-eligible units included one EGU point source, which is located in Maine (Wyman Station).

5.3 MANE-VU State Modifications of IPM Results

Previously, during development of the Base G and Base G2 inventories, MANE-VU states had relied on the RPO IPM model results (Base F) without revisions. In 2007, the MANE-VU states decided that they should revise the estimates, as other RPOs had done, to reflect their best estimates of future source operations and controls. State and regional staff reviewed and revised the IPM results with respect to when and where new SO_2 controls were planned to come online. Modifications were based on state rules, enforcement agreements, compliance plans, permits, and commitments from individual companies. States reviewed the IPM results to verify that known and existing controls and emission rates were properly reflected in the IPM results. In addition, states noted that some units predicted by IPM to close were very unlikely to cease operation.

The net effect of these adjustments was an increase in SO_2 emissions in the MANE-VU region as a whole. In Delaware SO_2 emissions decreased due to controls on a major source. Emissions in Connecticut, the District of Columbia, Rhode Island, and Vermont remained the same as predicted by RPO IPM 2.1.9 (Base F). Emissions of SO_2 in other MANE-VU states increased. No changes were made in emissions of other pollutants.

5.4 MANE-VU EGU Strategy

MANE-VU states have recognized that SO_2 emissions from power plants are the single largest contributing sector to visibility impairment in the Northeast's Class I areas. Sulfate formed through atmospheric processes from SO_2 emissions are responsible for over half the mass and approximately 70-80 percent of the extinction on the worst visibility days (NESCAUM, 2006a, and b). The emissions from power plants dominate the SO_2 inventory.

A modeling analysis was conducted to identify those EGUs with the greatest impact on visibility in MANE-VU. As part of the MANE VU Contribution Assessment, two MANE-VU modeling centers undertook CALPUFF modeling to identify the top 100 stacks that impacted three of the MANE VU Class I areas in the base year, 2002. These three areas are Acadia, Brigantine and Lye Brook. Details of the modeling are provided in Appendix D of the Contribution Assessment. (NESCAUM, 2006a) Appendix D of the Contribution Assessment includes a model performance evaluation, including comparisons of CALPUFF results from two different modeling groups using different meteorological drivers, as well as comparisons to other models and to ambient data. The overall CALPUFF results were similar and performance was acceptable.

The CALPUFF modeling results were sorted to identify the individual stacks causing the highest 24-hr concentrations at each of the three Class I areas. Impacts were not summed for all stacks at a facility. The 100 top stacks for each Class I area are listed in Tables 10 and 20 from Appendix D "Dispersion Model Techniques" of the Contribution Assessment.

The two modeling centers used 2002 U.S. EPA Continuous Emission Monitoring System (CEMS) data reported by the power companies, which is stack based rather than emission unit based. A power plant may have several stacks. Each stack may vent emissions from one or more units at the plant. The two modeling centers also used different meteorological data—one used data from the MM5 model and the other used National Weather Service observation-based meteorology.

There are differences between results from the two centers because of the differences in meteorological input data and also because of rounding when summing annual emissions. As a result the MM5-based modeling identified some stacks as being in the top 100 impacting a MANE-VU Class I area that were not identified by the observation-based modeling, and vice versa. For purposes of identifying key stacks, all stacks on either list were included.

MARAMA combined the lists of the top 100 EGU stacks in Tables 10 and 20 from Appendix D of the Contribution Assessment and eliminated both duplications and stacks that were outside the MANE-VU consultation area. (The consultation area includes states contributing at least 2% of the sulfate monitored at MANE-VU Class I areas in 2002.) This process resulted in 167 unique stacks impacting one or more of the three MANE-VU Class I areas. The use of stacks rather than units or facilities was chosen as more consistent with the results of the modeling presented in the Contribution Assessment. The Contribution Assessment Appendix D tables did not identify the units or facilities that were modeled, only providing a CEMS Identification number.

MARAMA used information contained in IPM input files to match the plant name and type where the stack was located. The resulting list of 167 stacks is found in Appendix A of this report.

MANE-VU asked states in the consultation area to pursue 90 percent control on all units emitting from those stacks by 2018. MANE-VU recognized that this level of control may not be feasible in all cases. NESCAUM modelers incorporated State comments gathered during the inter-RPO consultation process in estimating the impact of this strategy on visibility at Class I areas. This process is described below in Section 5.5.

5.5 Implementation of MANE-VU Control Strategy for Key EGUs

As part of the MANE-VU strategy to improve visibility, MANE-VU asked states to pursue a 90 percent reduction in SO_2 emissions from the 167 EGU stacks identified as described in Section 5.4 and listed in Appendix A. MARAMA gathered information from MANE-VU, MRPO, and VISTAS states and regional staff to obtain information about anticipated emissions changes.

State and local agencies and individual stakeholders from MANE-VU, MRPO and VISTAS reviewed and revised the IPM results with respect to controls planned to come online. They also reviewed the IPM results to verify that known and existing controls and emission rates were properly reflected in the IPM runs. In addition, commenters noted that some units predicted by IPM to be shutdown would not shutdown.

Adjustments to the IPM results were made to specific units using information states had obtained as part of the permitting process or other contact with the industry that indicated which units would install controls as a result of CAIR and when these new controls would come on-line (Koerber, 2007; VISTAS 2007). In general, the changes at specific EGUs provided by VISTAS reflected their Base G2 inventory, and, as discussed with MRPO, the changes NESCAUM made to emissions from sources in the MRPO were consistent with sources where controls were predicted in EPA's IPM 3.0 run for 2018, since MRPO modeling relied on IPM 3.0. In addition to the 167 stacks, MANE-VU incorporated further corrections to source emissions as requested by VISTAS states at the following locations: North Carolina (Cliffside), South Carolina (Jefferies), Kentucky (Spurlock), and Virginia (Chesapeake and Clinch River). .

NESCAUM determined the desired emissions levels for the 167 key stacks based on a 90 percent reduction in continuous emissions monitoring data from 2002. This established a target emissions level for the region from those stacks. NESCAUM compared these levels with the information provided by the states for those sources. In each region, predicted 2018 emissions exceeded the target level. Therefore, emissions reductions from other EGU sources were considered in order to meet the target emissions reductions for the region (both within MANE-VU and in other RPOs). This resulted in a net decrease in emissions in all three affected RPOs. Emissions of SO_2 would have decreased by over 14,000 tons per year in MANE-VU, over 304,000 tons per year in the Midwest, and over 197,000 tons per year in the VISTAS region.

However, MANE-VU planners recognized that CAIR allows emissions trading, and that reductions at one unit could be offset increases at another unit within the CAIR region. Because most states do not restrict trading, MANE-VU decided that emissions should be increased to represent the implementation of the strategy for the 167 stacks within the limits of the CAIR program. Therefore, NESCAUM increased the emissions from states subject to the CAIR cap and trade program. For MANE-VU, 75,809 tons were added back, leaving total regional emissions from the MANE-VU region greater than the original Inter-RPO IPM-based estimate but consistent with state projections. The remaining 440,541 tons added back were allocated to VISTAS and MRPO based on the fraction of their contribution to the total SO_2 emissions. The additional emissions correspond to an increase of 20.5 percent, with a total of 223,856 tons added to MRPO and 216,685 added to VISTAS.

Table 8 shows the emissions difference between the results of two IPM runs and the modeling inventories used by three Regional Planning Organizations (RPOs). VISTAS used Base G2, MANE-VU used the March 2008 Modeling Inventory, and MRPO used IPM 3.0..

Table 8. Comparison of Regional SO_2 Emissions Estimates for 2018
(1000 tons per year)

	MANE-VU	MRPO	VISTAS	TOTAL
RPO 2.1.9 (VISTASII_PC_1f) (fossil only)	**321**	**1,387**	**1,303**	**3,011**
Reductions made by VISTAS and MRPO (Base G2)	0	-136	-209	-344
Net additional changes made by MANE-VU	66	24	222	311
MANE-VU March 2008 Modeling Inventory (fossil only)	**387**	**1,276**	**1,316**	**2,978**
MANE-VU minus RPO 2.1.9 (negative numbers mean MANE-VU's modeling inventory was less than RPO 2.1.9)	66	-112	13	-33
EPA 3.0 (fossil only)	**421**	**1,328**	**1,458**	**3,207**
RPO 2.1.9 minus EPA 3.0 (negative number means RPO 2.1.9 was less than EPA 3.0)	-100	59	-155	-196
MANE-VU 3/08 minus EPA 3.0 (negative numbers mean MANE-VU's modeling inventory was less than EPA 3.0)	-34	-53	-142	-229

The intent of the MANE-VU modelers' final EGU emissions adjustments was to retain the same level of emissions as predicted by the RPO CAIR IPM run for the three regions together, but to modify the locations of the emissions to better reflect the states' estimates and to achieve reductions at the 167 stacks identified as important contributors to regional haze at MANE-VU Class I areas. As shown in Table 8, above, the MANE-VU adjustments resulted in total emissions from the three regions being less than the SO_2 emissions predicted by the RPO 2.1.9 IPM run but greater than emissions in the G2 inventory used by VISTAS modelers. In both the MANE-VU and VISTAS regions, the MANE-VU Modeling Inventory is greater than the VISTAS/Inter-RPO IPM run and in MRPO it is smaller. Results from IPM 3.0 also are provided for comparison, and are uniformly greater than the MANE-VU Modeling Inventory for EGUs.

All future EGU emissions estimates involve uncertainty. MANE-VU believes its process of adding back emissions resulted in a reasonable, conservative estimate of the implementation of the MANE-VU request for a 90% reduction at key EGU facilities.

5.6 State Results – Northeastern State Adjustments

Table 9 presents State level emission results as modified by the Northeastern States per the methods noted in the above sections. This table summarizes the input data used in the MANE-VU 2018 March 2008 Modeling run as documented in NESCAUM's *2018 Visibility Projections* report dated March 2008. Appendix A provides details for the top 167 EGU stacks.

Table 9. State Level 2018 Emission Summary; March 2008 MANE-VU EGU Modeling Inventory. (See next page for file names.)

		Annual Emissions (Tons)						
State	**RPO**	**NOx**	**SO2**	**VOC**	**CO**	**PM-10**	**PM-2.5**	**NH3**
Connecticut	MANE-VU	3,418	6,697	145	9,836	959	927	341
Delaware	MANE-VU	12,341	10,941	117	1,183	2,950	2,438	76
District Of Columbia	MANE-VU	103	83	5	154	104	99	12
Maine	MANE-VU	1,827	6,806	53	4,057	296	279	139
Maryland	MANE-VU	14,709	43,764	575	11,831	8,253	6,433	435
Massachusetts	MANE-VU	18,157	45,941	484	13,860	3,917	3,233	1,059
New Hampshire	MANE-VU	3,089	10,766	73	1,697	2,268	2,156	124
New Jersey	MANE-VU	13,636	15,918	352	7,611	4,017	3,515	564
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Rhode Island	MANE-VU	576	55	42	1,627	157	156	127
Vermont	MANE-VU	105	35	3	117	26	25	9
	MANE-VU Total	**175,219**	**386,584**	**4,528**	**115,660**	**65,558**	**52,360**	**6,148**
Alabama	VISTAS	62,860	163,567	1,620	21,611	7,385	4,380	1,033
Florida	VISTAS	58,341	167,685	1,903	42,946	9,355	6,330	2,665
Georgia	VISTAS	69,308	90,408	1,805	35,584	18,217	11,319	1,676
Kentucky	VISTAS	59,740	255,559	1,344	12,125	6,194	4,067	436
Mississippi	VISTAS	10,455	18,241	1,055	11,822	7,007	6,853	545
North Carolina	VISTAS	56,526	126,042	1,147	16,376	32,676	26,014	608
South Carolina	VISTAS	50,068	105,436	860	13,078	28,110	24,454	578
Tennessee	VISTAS	30,008	135,344	886	7,126	15,861	13,320	241
Virginia	VISTAS	60,615	125,849	921	14,017	13,505	11,757	553
West Virginia	VISTAS	51,177	127,609	1,382	11,896	6,344	3,643	177
	VISTAS Total	**509,098**	**1,315,740**	**12,922**	**186,579**	**144,653**	**112,137**	**8,512**
Illinois	MRPO	71,233	208,832	2,229	17,868	32,649	30,132	1,152
Indiana	MRPO	95,376	403,473	2,105	19,416	35,081	27,835	1,274
Michigan	MRPO	78,605	213,066	1,623	17,521	38,902	34,276	1,091
Ohio	MRPO	83,129	353,293	2,254	23,832	42,753	33,322	1,772
Wisconsin	MRPO	45,701	96,934	1,101	11,901	15,629	14,246	626
	MRPO Total	**374,044**	**1,275,598**	**9,311**	**90,539**	**165,015**	**139,812**	**5,915**
Arkansas	CENRAP	33,097	82,605	696	11,429	3,897	3,326	814
Iowa	CENRAP	51,119	147,305	770	8,758	10,033	8,615	569
Kansas	CENRAP	83,333	81,486	798	7,203	8,520	6,807	461
Louisiana	CENRAP	30,432	74,263	660	11,043	3,966	3,590	919
Minnesota	CENRAP	41,029	85,847	674	5,563	8,162	7,035	343
Missouri	CENRAP	77,660	280,887	1,579	13,165	18,456	16,769	799
Nebraska	CENRAP	50,781	73,629	450	3,590	2,296	1,914	217
Oklahoma	CENRAP	76,048	113,680	1,008	28,182	5,561	4,840	1,355
Texas	CENRAP	153,837	339,433	4,988	102,581	38,952	31,630	6,424
	CENRAP Total	**597,336**	**1,279,135**	**11,622**	**191,515**	**99,842**	**84,527**	**11,901**
Arizona	WRAP	59,774	55,941	724	17,806	2,811	634	630
California	WRAP	17,537	1,528	2,558	31,173	1,219	1,059	0
Colorado	WRAP	77,113	60,914	1,465	18,939	3,138	307	537
Idaho	WRAP	2,236	1,683	50	3,283	335	87	0
Montana	WRAP	44,733	31,303	565	11,818	1,796	247	13
Nevada	WRAP	54,300	22,118	1,570	10,598	4,230	768	903
New Mexico	WRAP	32,925	17,796	695	10,976	794	627	43
North Dakota	WRAP	82,741	152,828	909	13,647	3,958	2,645	383
Oregon	WRAP	15,742	15,096	474	5,753	1,288	323	219
South Dakota	WRAP	17,681	13,522	118	689	247	217	52
Utah	WRAP	76,136	41,394	597	17,150	4,637	2,000	1,350
Washington	WRAP	16,884	7,011	249	4,008	1,474	1,027	12
Wyoming	WRAP	104,142	96,745	1,147	18,871	10,445	7,411	404
	WRAP Total	**601,942**	**517,879**	**11,122**	**164,711**	**36,371**	**17,353**	**4,547**
National Total		**2,257,639**	**4,774,936**	**49,505**	**749,003**	**511,439**	**406,188**	**37,023**

Files used in preparing Table 9 include for CENRAP and WRAP, the VISTAS Base G2 Modeling file (egu_18_vistas_g2_20feb2007.txt.), and the following additional files:

MANE-VU:
- EGU2018_MANEVUv3_nonSO2.ida
- EGU2018_MANEVU_SO2_non167plus.ida
- EGU2018_MANEVU_SO2_167plus.ida

VISTAS:
- EGU2018_VISTASG2_SO2_non167plus_CAIR addback.ida
- EGU2018_VISTASG2_SO2_167plus_CAIRadd back.ida
- EGU2018_VISTASG2_nonSO2.ida

MRPO:
- EGU2018_MWRPO_SO2_167plus_CAIRaddback. ida
- EGU2018_MWRPO_SO2_non167p_non65_CAIR addback.ida
- EGU2018_MWRPO_SO2_65_CAIRaddback.ida
- EGU2018_MWRPO_nonSO2.ida

6 EGU PREPARATION TIMELINE

The following section provides a chronological review of the events and milestones that occurred during the preparation of EGU emission forecasts in support of regional haze SIP preparation.

2004

- VISTAS/MRPO sponsor first IPM 2.1.6 runs for 2018 (Phase I)
- Phase I (VISTAS_CAIR_2) results released

2005

- RPOs move to IPM 2.1.9 (Phase II)
- Revisions to NEEDS input file and global parameters submitted by RPOs for revised runs
- Phase II (VISTAS_II_PC_1f) results released
- IPM parsed to NIF and NIF to SMOKE IDA format conversion occurs
- Initial RPO adjustments and modifications of IPM results
- RPOs share IPM 2.1.9 inputs and configuration from Phase II with EPA
- EPA releases IPM 2.1.9 results of CAIR/CAMR modeling

2006

- Additional RPO control and modeling file adjustments to Phase II runs
- RPOs simulate 2018 forecast year to support regional haze SIP submittals
- RPOs work with EPA to configure NEEDS 3.0 for next round of EPA modeling
- EPA releases IPM 2006 revised projections
- RPOs identify potential control measures and estimate benefits for meeting reasonable progress goals
- Additional RPO control and modeling file adjustments to Phase II runs

2007

- RPOs analyze cost and other factors associated with potential control measures
- RPOs coordinate with EPA on inputs and runs of IPM 3.0
- EPA releases IPM 3.0 results of revised CAIR/CAMR/CAVR modeling
- Interstate and inter-regional consultation regarding potential control measures
- MANE-VU states agree to pursue several control measures
- RPOs begin regional modeling to assess visibility impacts of controls

2008

- RPOs model to determine progress goals for regional haze SIP

7 REFERENCES

Alpine Geophysics, LLC, 2005a. *EGU Emission Factors and Emission Factor Assignment*, technical memorandum prepared for VISTAS EGU Special Interest Workgroup, 2005.

Alpine Geophysics, LLC, 2005b. *Emission Factor/Rate Development for IPM Post-Processing*, technical memorandum prepared for VISTAS EGU Special Interest Workgroup.

Alpine Geophysics, LLC, 2006. *Future Year Emissions Inventories, Draft Work Assignment #1, Technical Memorandum - Task 1,* prepared for MARAMA, 2006.

E.H. Pechan & Associates, Inc., 2004. *Electricity Generating Unit (EGU) Growth Modeling Method Task 2 Evaluation – Final Report,* prepared for Lake Michigan Air Directors Consortium, 2004.

E.H. Pechan & Associates, Inc., 2005. *LADCO IPM Model Parsed File Post-Processing Methodology and File Preparation (January 2005) – Technical Memorandum*, prepared for Lake Michigan Air Directors Consortium, 2005.

ENVIRON, 2007. *Technical Support Document for CENRAP Emissions and Air Quality Modeling to Support Regional Haze State Implementation Plans*, prepared for Central Regional Air Planning Association.

EPA, 2004. *Analysis in Support of the Clean Air Interstate Rule Using the Integrated Planning Model*, Technical Support Document for the Final Clean Air Interstate Rule, 2004.

EPA, 2005a. *Modeling of Control Costs, Emissions, and Control Retrofits for Cost Effectiveness and Feasibility Analyses*, Technical Support Document for the Final Clean Air Interstate Rule, 2005.

EPA, 2005b. *Standalone Documentation for EPA Base Case 2004 (V.2.1.9) Using the Integrated Planning Model*, EPA 430-R-05-011. Available at http://www.epa.gov/airmarkets/progsregs/epa-ipm/past-modeling.html#version2004.

ERG, 2006. *WRAP Point and Area Source Emissions Projections for the 2018 Base Case Inventory, Version 1*, prepared for Emission Inventory Workgroup, 2006.

Houyoux, M.; Vukovich, J.; Brandmeyer, J., 2000. Sparse Matrix Operator Kernal Emissions Modeling System (SMOKE) User Manual, Version 1.1.2 Draft, MCNC-North Carolina Supercomuting Center Environmental Programs.

ICF Resources, LLC, 2005. *Future Year Electricity Generating Sector Emission Inventory Development Using the Integrated Planning Model (IPM®) in Support of Fine Particulate Mass and Visibility Modeling in the VISTAS and Midwest RPO Regions*, prepared for VISTAS, 2005.

ICF Resources, LLC, 2007. *Comparison of CAIR and CAIR Plus Proposal using the Integrated Planning Model (IPM®)*, prepared for MARAMA.

Koerber, 2007. Personal and electronic communication from Mark Janssen to Julie McDill, MARAMA and Andy Bodnarik, New Hampshire DEP.

MACTEC, 2006. *Development of Emission Projections for 2009, 2012, and 2018 for NonEGU Point, Area, and Nonroad Sources in the MANE-VU Region*, prepared for MARAMA.

MACTEC, 2007. *Documentation of the Base G 2002 Base Year, 2009 and 2018, Emission Inventories for VISTAS*, prepared for VISTAS, 2007.

MRPO, 2006. Personal and electronic communication from Mark Janssen to Gregory Stella, Alpine Geophysics, LLC., 2006.

NESCAUM, 2006a. *Contributions to Regional Haze in the Northeast and Mid-Atlantic U.S.*, Northeast States for Coordinated Air Use Management, Boston, MA, 2006a.

NESCAUM, 2006b. *The Nature of the Fine Particle and Regional Haze Air Quality Problems in the MANE-VU Region: A Conceptual Description*, Available at: http://www.nescaum.org/documents/2006-1102-pm-conceptual-model.pdf/, Northeast States for Coordinated Air Use Management, Boston, MA, 2006b.

NESCAUM, 2008a. *MANE-VU Modeling for Reasonable Progress Goals Model performance evaluation, pollution apportionment, and control measure benefits*, prepared for MANE-VU, 2008a.

NESCAUM, 2008b. *2018 Visibility Projections*, prepared for MANE-VU.

VISTAS, 2007. Electronic communication from Doris McLeod 11/7/2007.

Janssen, 2008. Personal communication from Mark Janssen 3/28/2008.

Appendix A

TOP ELECTRIC GENERATING EMISSION POINTS CONTRIBUTING TO VISIBILITY IMPAIRMENT IN MANE-VU IN 2002

For each of three MANE-VU Class I Areas the 100 Electric Generating Unit (EGU) stacks with the most significant 2002 impact on visibility impairment were identified by CALPUFF modeling conducted by two modeling centers.[2] Many of these stacks have a regional impact and therefore significantly impact more than one Class I Area. When the "Top Impacting" stacks for each of the three areas are aggregated into a single group there are 167 individual "Top Impacting" stacks identified. Figure A-1 indicates the location of the 167 stacks, and the tables following the map provides identifying information, emissions used in the CALPUFF modeling, and predicted impacts.

The following information may be found in the listed columns of Table A-1:

1. Row Number (1 through 167)
2. CEMS Unit ID: an arbitrary number identifying the CEMS unit
3. ORIS ID: a standard identification number associated with each unit
4. Acadia MM5: The rank of this source based on its predicted sulfate ion annual impact on Acadia in 2002 using meteorological data from the MM5 model. (A blank in columns 4, 5, 6, 7, 8, or 9 indicates this source was not among the top 100 for this Class I area as predicted by the indicated model.)
5. Acadia VTDEC: The rank of this source in terms of its predicted sulfate ion annual impact on Acadia in 2002 using National Weather Service data.
6. Brig MM5: The rank of this source in terms of its predicted sulfate ion annual impact on Brigantine in 2002 using meteorological data from the MM5 model.
7. Brig VTDEC: The rank of this source in terms of its predicted sulfate ion annual impact on Brigantine in 2002 using National Weather Service data.
8. Lye MM5: The rank of this source in terms of its predicted sulfate ion annual impact on Lye Brook in 2002 using meteorological data from the MM5 model.
9. Lye VTDEC: The rank of this source in terms of its predicted sulfate ion annual impact on Lye Brook in 2002 using National Weather Service data.
10. MM5 2002 SO_2 Tons per Year: Emissions calculated from CEMS data and used by modelers who used the MM5 generated meteorological data
11. VTDEC 2002 SO_2 Tons per Year: Emissions calculated from CEMS data and used by modelers who used the national weather service generated meteorological data
12. Plant Number (1 through 105): The 167 stacks are located at 105 plants.
13. Plant Name—table is in alphabetical order by plant within each state
14. Plant Type: coal fired or oil/gas fired electric generating units
15. State Name—table is in alphabetical order by state
16. State Code

[2] For more information and detailed modeling results, see Appendix D: Source Dispersion Model Methods, in NESCAUM 2006a.

Note that this list was created using 2002 emissions. By 2018 some of the units using these stacks will have emission controls installed or be repowered or shut down. This list represents the EGU stacks that had the largest individual impacts on baseline visibility in 2002 at three MANE-VU Class 1 areas.

Table A-2 presents predicted 2018 emissions estimates for the same list of key stacks. Column 6 of Table A-2 gives the 2018 emissions predicted by the IPM run VISTAS_PC_1f. Column 7 lists the revised 2018 emissions used in MANE-VU's March 2008 modeling. Column 8 provides the basis for revising the emissions. See Section 5.5 of this report for more information.

Figure A-1. Top 167 US Electric Generating Facility Stacks Affecting MANE-VU Class I Areas in 2002.

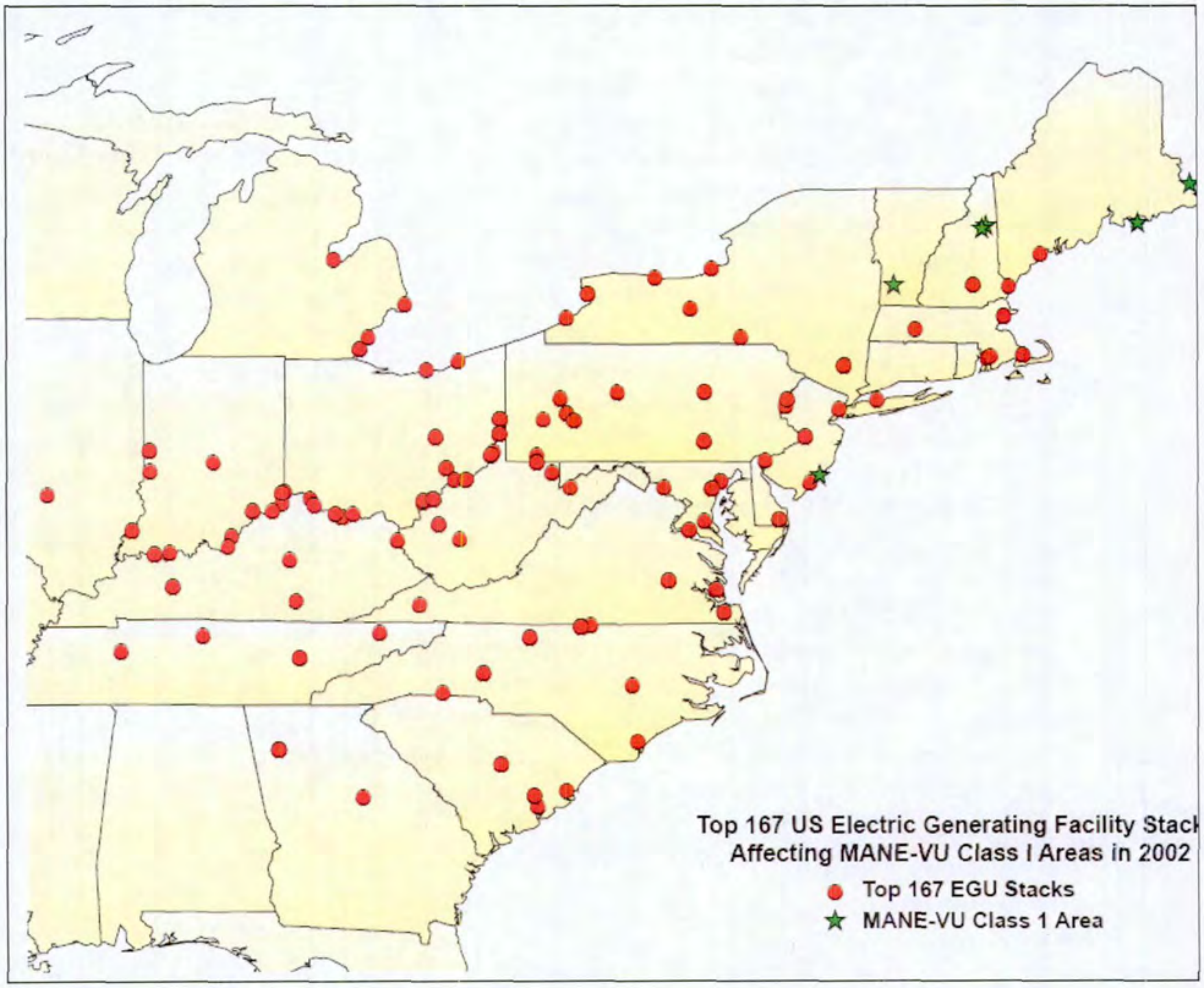


Table A-1. 2002 Data for Key EGU Stacks

Row number	CEMS Unit	ORIS ID	Acadia MM5	Acadia VTDEC	Brig MM5	Brig VTDEC	Lye MM5	Lye VTDEC	MM5 2002 S02 TPY	VTDEC 2002 SO2 TPY		Plant Name	Plant Type	State Name	State Code
1	D005935	593			90	54			2,138	2,136	1	EDGE MOOR	O/G Steam	Delaware	10
2	D005941	594				95				3,742	2	INDIAN RIVER	Coal Steam	Delaware	10
3	D005942	594				74				3,760	2	INDIAN RIVER	Coal Steam	Delaware	10
4	D005943	594			84	44			4,686	4,682	2	INDIAN RIVER	Coal Steam	Delaware	10
5	D005944	594			69	21			7,390	7,384	2	INDIAN RIVER	Coal Steam	Delaware	10
6	D007031LR	703	79			86		75	38,520	38,486	3	BOWEN	Coal Steam	Georgia	13
7	D007032LR	703	72		89		61	68	37,289	37,256	3	BOWEN	Coal Steam	Georgia	13
8	D007033LR	703	71	99	74	64	63	94	43,067	43,029	3	BOWEN	Coal Steam	Georgia	13
9	D007034LR	703	69	95	86	58	60	89	41,010	40,974	3	BOWEN	Coal Steam	Georgia	13
10	D00709C02	709		84		75	89	71	47,591	47,549	4	HARLLEE BRANCH	Coal Steam	Georgia	13
11	D00861C01	861	28	96		65	46	62	42,355	42,318	5	COFFEEN	Coal Steam	Illinois	17
12	D010011	1001			53				28,876	28,851	6	CAYUGA	Coal Steam	Indiana	18
13	D010012	1001	95		46	68			26,016	25,992	6	CAYUGA	Coal Steam	Indiana	18
14	D00983C01	983					52		19,922		7	CLIFTY CREEK	Coal Steam	Indiana	18
15	D00983C02	983					54		18,131		7	CLIFTY CREEK	Coal Steam	Indiana	18
16	D0099070	990		55	100	70		37	29,801	29,774	8	ELMER W STOUT	O/G Steam	Indiana	18
17	D06113C03	6113	30	48	14	43	22	41	71,182	71,119	9	GIBSON	Coal Steam	Indiana	18
18	D06113C04	6113	44	70	97	83	73	83	27,848	27,823	9	GIBSON	Coal Steam	Indiana	18
19	D01008C01	1008			73		100	47	24,109	24,087	10	R GALLAGHER	Coal Steam	Indiana	18
20	D01008C02	1008			98			55	23,849	23,828	10	R GALLAGHER	Coal Steam	Indiana	18
21	D06166C02	6166	62	44	30	81	33	57	51,708	51,663	11	ROCKPORT	Coal Steam	Indiana	18
22	D00988C03	988						77		15,946	12	TANNERS CREEK	Coal Steam	Indiana	18
23	D00988U4	988	14	29	52	34	7	19	45,062	45,022	12	TANNERS CREEK	Coal Steam	Indiana	18
24	D01010C05	1010	43	32	12	28	31	17	60,747	60,693	13	WABASH RIVER	Coal Steam	Indiana	18
25	D067054	6705	34	60	34		44	73	40,118	40,082	14	WARRICK	Coal Steam	Indiana	18
26	D06705C02	6705	92		75		96		27,895		14	WARRICK	Coal Steam	Indiana	18
27	D01353C02	1353	38	30	15	26	85	29	41,545	41,508	15	BIG SANDY	Coal Steam	Kentucky	21

Row number	CEMS Unit	ORIS ID	Acadia MM5	Acadia VTDEC	Brig MM5	Brig VTDEC	Lye MM5	Lye VTDEC	MM5 2002 S02 TPY	VTDEC 2002 SO2 TPY		Plant Name	Plant Type	State Name	State Code
28	D01384CS1	1384	22				58		21,837	21,817	16	COOPER	Coal Steam	Kentucky	21
29	D01355C03	1355	21		51	99	68	52	38,104	38,070	17	E W BROWN	Coal Steam	Kentucky	21
30	D060182	6018	83				39		12,083		18	EAST BEND	Coal Steam	Kentucky	21
31	D01356C02	1356	93	71		88	50	59	25,646	25,623	19	GHENT	Coal Steam	Kentucky	21
32	D060411	6041	61						18,375		20	H L SPURLOCK	Coal Steam	Kentucky	21
33	D060412	6041	53		91			98	20,491	20,473	20	H L SPURLOCK	Coal Steam	Kentucky	21
34	D013644	1364			81				7,185		21	MILL CREEK	Coal Steam	Kentucky	21
35	D013782	1378					87		20,245		22	PARADISE	Coal Steam	Kentucky	21
36	D013783	1378	76	100	11	84	55	42	46,701	46,660	22	PARADISE	Coal Steam	Kentucky	21
37	D015074	1507	78						1,170		23	WILLIAM F WYMAN	O/G Steam	Maine	23
38	D006021	602	90		38			100	20,014	19,996	24	BRANDON SHORES	Coal Steam	Maryland	24
39	D006022	602	99		29			99	19,280	19,263	24	BRANDON SHORES	Coal Steam	Maryland	24
40	D015521	1552			63				17,782	17,767	25	C P CRANE	Coal Steam	Maryland	24
41	D015522	1552			68				14,274	14,262	25	C P CRANE	Coal Steam	Maryland	24
42	D01571CE2	1571	42	47	1	4	20	28	48,566	48,522	26	CHALK POINT	Coal Steam	Maryland	24
43	D01572C23	1572	73	79	47	45	69	32	32,188	32,159	27	DICKERSON	Coal Steam	Maryland	24
44	D015543	1554			77				10,084	10,075	28	HERBERT A WAGNER	O/G Steam	Maryland	24
45	D015731	1573	67	50	16	12	56	38	36,823	36,790	29	MORGANTOWN	Coal Steam	Maryland	24
46	D015732	1573	59	53	10	13	51	39	30,788	30,761	29	MORGANTOWN	Coal Steam	Maryland	24
47	D016191	1619	37	80					9,252	9,244	30	BRAYTON POINT	Coal Steam	Massachusetts	25
48	D016192	1619	35	66					8,889	8,881	30	BRAYTON POINT	Coal Steam	Massachusetts	25
49	D016193	1619	4	14	65	56	79		19,325	19,308	30	BRAYTON POINT	Coal Steam	Massachusetts	25
50	D015991	1599	5	36			65		13,014	13,002	31	CANAL	O/G Steam	Massachusetts	25
51	D015992	1599	7	27			74		8,980	8,971	31	CANAL	O/G Steam	Massachusetts	25
52	D016061	1606						48		5,249	32	MOUNT TOM	Coal Steam	Massachusetts	25
53	D016261	1626	85						3,430		33	SALEM HARBOR	Coal Steam	Massachusetts	25
54	D016263	1626	91	78					4,971	4,966	33	SALEM HARBOR	Coal Steam	Massachusetts	25

Row number	CEMS Unit	ORIS ID	Acadia MM5	Acadia VTDEC	Brig MM5	Brig VTDEC	Lye MM5	Lye VTDEC	MM5 2002 S02 TPY	VTDEC 2002 SO2 TPY		Plant Name	Plant Type	State Name	State Code
55	D016264	1626	32	25					2,880	2,878	33	SALEM HARBOR	O/G Steam	Massachusetts	25
56	D016138	1613	94						4,376		34	SOMERSET	Coal Steam	Massachusetts	25
57	D01702C09	1702						96		4,565	35	DAN E KARN	Coal Steam	Michigan	26
58	D01733C12	1733	49	24	80	80	45	22	46,081	46,040	36	MONROE	Coal Steam	Michigan	26
59	D01733C34	1733	27	26		76	26	27	39,362	39,327	36	MONROE	Coal Steam	Michigan	26
60	D017437	1743		91						15,805	37	ST CLAIR	Coal Steam	Michigan	26
61	D017459A	1745					76	61	18,341	18,324	38	TRENTON CHANNEL	Coal Steam	Michigan	26
62	D023641	2364	2	57					9,356	9,348	39	MERRIMACK	Coal Steam	New Hampshire	33
63	D023642	2364	1	17	99		28	87	19,453	19,435	39	MERRIMACK	Coal Steam	New Hampshire	33
64	D080021	8002	45	74					5,033	5,028	40	NEWINGTON	O/G Steam	New Hampshire	33
65	D023781	2378		81	2	15			9,747	9,738	41	B L ENGLAND	Coal Steam	New Jersey	34
66	D024032	2403	63	97	25	50	40	44	18,785	18,768	42	HUDSON	O/G Steam	New Jersey	34
67	D024081	2408			95				8,076		43	MERCER	Coal Steam	New Jersey	34
68	D024082	2408			60				5,675		43	MERCER	Coal Steam	New Jersey	34
69	D02549C01	2549		64	41		42	72	25,343	25,320	44	C R HUNTLEY	Coal Steam	New York	36
70	D02549C02	2549					99		12,317		44	C R HUNTLEY	Coal Steam	New York	36
71	D024804	2480					71		7,720		45	DANSKAMMER	O/G Steam	New York	36
72	D02554C03	2554	33	51	62		27	51	30,151	30,125	46	DUNKIRK	Coal Steam	New York	36
73	D02526C03	2526					78		14,929		47	WESTOVER	Coal Steam	New York	36
74	D025276	2527					80		12,650		48	GREENIDGE	Coal Steam	New York	36
75	D025163	2516			96				7,359		49	NORTHPORT	O/G Steam	New York	36
76	D025945	2594		76						1,747	50	OSWEGO	O/G Steam	New York	36
77	D02642CS2	2642					91		14,086		51	ROCHESTER 7	Coal Steam	New York	36
78	D080061	8006						93		3,817	52	ROSETON	O/G Steam	New York	36
79	D080062	8006						88		2,840	52	ROSETON	O/G Steam	New York	36
80	D080421	8042	13	12	18	5	10	34	57,820	57,769	53	BELEWS CREEK	Coal Steam	North Carolina	37
81	D080422	8042	23	15	32	10	15	49	45,296	45,256	53	BELEWS CREEK	Coal Steam	North Carolina	37
82	D027215	2721	98	45	87	39	97	85	19,145	19,128	54	CLIFFSIDE	Coal Steam	North Carolina	37
83	D027133	2713		61						14,460	55	L V SUTTON	Coal Steam	North Carolina	37

Row number	CEMS Unit	ORIS ID	Acadia MM5	Acadia VTDEC	Brig MM5	Brig VTDEC	Lye MM5	Lye VTDEC	MM5 2002 S02 TPY	VTDEC 2002 SO2 TPY		Plant Name	Plant Type	State Name	State Code
84	D027093	2709				97				9,390	56	LEE	Coal Steam	North Carolina	37
85	D027273	2727	100	40		48	75	84	26,329	26,305	57	MARSHALL	Coal Steam	North Carolina	37
86	D027274	2727	89	39	83	51	66	82	27,308	27,284	57	MARSHALL	Coal Steam	North Carolina	37
87	D06250C05	6250	60	59		35	37		27,395	27,371	58	MAYO	Coal Steam	North Carolina	37
88	D027121	2712				59			12,031	12,020	59	ROXBORO	Coal Steam	North Carolina	37
89	D027122	2712	82	41	54	23	94		29,337	29,310	59	ROXBORO	Coal Steam	North Carolina	37
90	D02712C03	2712	56	37	57	24	21	78	30,776	30,749	59	ROXBORO	Coal Steam	North Carolina	37
91	D02712C04	2712	88	72		47	47		22,962	22,941	59	ROXBORO	Coal Steam	North Carolina	37
92	D0283612	2836	55	20	48	89	29	35	41,432	41,395	60	AVON LAKE	Coal Steam	Ohio	39
93	D028281	2828	29	9	31	30	24	8	37,307	37,274	61	CARDINAL	Coal Steam	Ohio	39
94	D028282	2828						56	20,598	20,580	61	CARDINAL	Coal Steam	Ohio	39
95	D028283	2828						80		15,372	61	CARDINAL	Coal Steam	Ohio	39
96	D028404	2840	3	1	6	2	2	3	87,801	87,724	62	CONESVILLE	Coal Steam	Ohio	39
97	D02840C02	2840	84	73			81	63	22,791	22,771	62	CONESVILLE	Coal Steam	Ohio	39
98	D028375	2837		86	56		35	70	35,970	35,938	63	EASTLAKE	Coal Steam	Ohio	39
99	D081021	8102			23	71	59	95	18,207	18,191	64	GEN J M GAVIN	Coal Steam	Ohio	39
100	D081022	8102				78			12,333	12,322	64	GEN J M GAVIN	Coal Steam	Ohio	39
101	D028501	2850	36	67	39	53		45	30,798	30,771	65	J M STUART	Coal Steam	Ohio	39
102	D028502	2850	24	65	40	49	98	46	28,698	28,673	65	J M STUART	Coal Steam	Ohio	39
103	D028503	2850	26		72	62			27,968	27,944	65	J M STUART	Coal Steam	Ohio	39
104	D028504	2850	20	77	45	52	88	54	27,343	27,319	65	J M STUART	Coal Steam	Ohio	39
105	D060312	6031			67	77		90	19,517	19,500	66	KILLEN STATION	Coal Steam	Ohio	39
106	D02876C01	2876	40	7	3	9	30	10	72,593	72,529	67	KYGER CREEK	Coal Steam	Ohio	39
107	D028327	2832	65	28	59	22	48	20	46,991	46,950	68	MIAMI FORT	Coal Steam	Ohio	39
108	D02832C06	2832				60	43	64	23,694	23,673	68	MIAMI FORT	Coal Steam	Ohio	39
109	D028725	2872	74	92	78		90	36	30,079	30,052	69	MUSKINGUM RIVER	Coal Steam	Ohio	39
110	D02872C04	2872	6	19	13	6	19	15	83,134	83,060	69	MUSKINGUM RIVER	Coal Steam	Ohio	39
111	D02864C01	2864	70	56	61	63	49	24	35,193	35,162	70	R E BURGER	Coal Steam	Ohio	39

Row number	CEMS Unit	ORIS ID	Acadia MM5	Acadia VTDEC	Brig MM5	Brig VTDEC	Lye MM5	Lye VTDEC	MM5 2002 S02 TPY	VTDEC 2002 SO2 TPY		Plant Name	Plant Type	State Name	State Code
112	D07253C01	7253		89	58	57		33	30,977	30,949	71	RICHARD GORSUCH		Ohio	39
113	D028665	2866		82				53	19,796	19,779	72	W H SAMMIS	Coal Steam	Ohio	39
114	D028667	2866	57	16	42	41	41	16	33,601	33,572	72	W H SAMMIS	Coal Steam	Ohio	39
115	D02866C01	2866	97	54	93	96	92	30	24,649	24,627	72	W H SAMMIS	Coal Steam	Ohio	39
116	D02866C02	2866		69	92			50	26,022	25,999	72	W H SAMMIS	Coal Steam	Ohio	39
117	D02866M6A	2866		85				58	19,564	19,546	72	W H SAMMIS	Coal Steam	Ohio	39
118	D060191	6019		93		72		60		21,496	73	W H ZIMMER	Coal Steam	Ohio	39
119	D028306	2830	46	38	70	40	12	69	30,466	30,439	74	WALTER C BECKJORD	Coal Steam	Ohio	39
120	D031782	3178	77	63				81	16,484	16,469	75	ARMSTRONG	Coal Steam	Pennsylvania	42
121	D031403	3140	31	34	9	46	18	18	38,801	38,767	76	BRUNNER ISLAND	Coal Steam	Pennsylvania	42
122	D03140C12	3140	52	46	49	69	25	23	29,736	29,709	76	BRUNNER ISLAND	Coal Steam	Pennsylvania	42
123	D082261	8226	25	21	33	42	36	9	40,268	40,232	77	CHESWICK	Coal Steam	Pennsylvania	42
124	D03179C01	3179	16	10	5	8	5	4	79,635	79,565	78	HATFIELD'S FERRY	Coal Steam	Pennsylvania	42
125	D031221	3122	11	6	26	38	17	14	45,754	45,714	79	HOMER CITY	Coal Steam	Pennsylvania	42
126	D031222	3122	9	4	37	92	13	11	55,216	55,167	79	HOMER CITY	Coal Steam	Pennsylvania	42
127	D031361	3136	8	2	4	14	6	1	87,434	87,357	80	KEYSTONE	Coal Steam	Pennsylvania	42
128	D031362	3136	18	3	8	19	8	2	62,847	62,791	80	KEYSTONE	Coal Steam	Pennsylvania	42
129	D03148C12	3148			71		84		17,214		81	MARTINS CREEK	Coal Steam	Pennsylvania	42
130	D031491	3149	19	8	35	7	1	6	60,242	60,188	82	MONTOUR	Coal Steam	Pennsylvania	42
131	D031492	3149	15	5	21	20	3	5	50,276	50,232	82	MONTOUR	Coal Steam	Pennsylvania	42
132	D031131	3113			82				9,674		83	PORTLAND	Coal Steam	Pennsylvania	42
133	D031132	3113			36		93		14,294		83	PORTLAND	Coal Steam	Pennsylvania	42
134	D03131CS1	3131	54	31	79		32	65	22,344	22,324	84	SHAWVILLE	Coal Steam	Pennsylvania	42
135	D033193	3319				10 0				11,045	85	JEFFERIES	O/G Steam	South Carolina	45
136	D033194	3319		90		87				11,838	85	JEFFERIES	O/G Steam	South Carolina	45
137	D03297WT1	3297		68		61				17,671	86	WATEREE	Coal Steam	South Carolina	45
138	D03297WT2	3297		83		73				17,199	86	WATEREE	Coal Steam	South Carolina	45
139	D03298WL1	3298		35	94	37			25,170	25,148	87	WILLIAMS	Coal Steam	South Carolina	45

Row number	CEMS Unit	ORIS ID	Acadia MM5	Acadia VTDEC	Brig MM5	Brig VTDEC	Lye MM5	Lye VTDEC	MM5 2002 S02 TPY	VTDEC 2002 SO2 TPY		Plant Name	Plant Type	State Name	State Code
140	D062491	6249		58		82				17,920	88	WINYAH	Coal Steam	South Carolina	45
141	D03403C34	3403			85				20,314		89	GALLATIN	Coal Steam	Tennessee	47
142	D03405C34	3405	39						19,368		90	JOHN SEVIER	Coal Steam	Tennessee	47
143	D03406C10	3406	10	11	27	33	4	43	104,523	104,431	91	JOHNSONVILLE	Coal Steam	Tennessee	47
144	D03407C15	3407	64	87		66	67	76	37,308	37,274	92	KINGSTON	Coal Steam	Tennessee	47
145	D03407C69	3407	48	98		91	82	91	38,645	38,611	92	KINGSTON	Coal Steam	Tennessee	47
146	D038033	3803				55				9,493	93	CHESAPEAKE	Coal Steam	Virginia	51
147	D038034	3803		94		16				10,806	93	CHESAPEAKE	Coal Steam	Virginia	51
148	D037974	3797				90				9,293	94	CHESTERFIELD	Coal Steam	Virginia	51
149	D037975	3797		88	44	27	86		19,620	19,602	94	CHESTERFIELD	Coal Steam	Virginia	51
150	D037976	3797	66	18	7	3	34	66	40,570	40,534	94	CHESTERFIELD	Coal Steam	Virginia	51
151	D03775C02	3775	47						16,674		95	CLINCH RIVER	Coal Steam	Virginia	51
152	D038093	3809		52	64	29			10,477	10,468	96	YORKTOWN	Coal Steam	Virginia	51
153	D03809CS0	3809	96	43	19	17	62		21,219	21,201	96	YORKTOWN	Coal Steam	Virginia	51
154	D039423	3942						79		10,126	97	ALBRIGHT	Coal Steam	West Virginia	54
155	D039431	3943	51	23	20	32	16	13	42,385	42,348	97	FORT MARTIN	Coal Steam	West Virginia	54
156	D039432	3943	50	22	22	31	14	12	45,850	45,809	97	FORT MARTIN	Coal Steam	West Virginia	54
157	D039353	3935	41	33	28	11	64	26	42,212	42,174	98	JOHN E AMOS	Coal Steam	West Virginia	54
158	D03935C02	3935	17	42	43	1	11	21	63,066	63,010	98	JOHN E AMOS	Coal Steam	West Virginia	54
159	D03947C03	3947	86	62	55		57	25	38,575	38,541	99	KAMMER	Coal Steam	West Virginia	54
160	D03936C02	3936				98			15,480	15,467	100	KANAWHA RIVER	Coal Steam	West Virginia	54
161	D03948C02	3948	58	13	17	36	9	7	55,405	55,356	101	MITCHELL	Coal Steam	West Virginia	54
162	D062641	6264	75	49	50	18	77	40	42,757	42,719	102	MOUNTAINEER	Coal Steam	West Virginia	54
163	D03954CS0	3954	68		24	25	23	67	20,130	20,112	103	MT STORM	Coal Steam	West Virginia	54
164	D0393851	3938				79		97	12,948	12,936	104	PHILIP SPORN	Coal Steam	West Virginia	54
165	D03938C04	3938				94			26,451	26,427	104	PHILIP SPORN	Coal Steam	West Virginia	54
166	D060041	6004			66		83	31	21,581	21,562	105	PLEASANTS	Coal Steam	West Virginia	54
167	D060042	6004			88			92	20,550	20,532	105	PLEASANTS	Coal Steam	West Virginia	54

Table A-2. Predicted 2018 SO_2 Emissions from Key EGU Stacks

State	Facility Name	ORIS ID	Unit ID	Unit Type	ORIGINAL 2018 (1) SO_2 TPY	REVISED 2018 (2) SO_2 TPY	BASIS FOR CHANGE (3)
Delaware	Edge Moor	593	5	O/G Steam	0.0	1,406.0	State Comments
Delaware	Indian River	594	1	Coal Steam	4,289.2	0.0	State Comments
Delaware	Indian River	594	2	Coal Steam	4,538.9	0.0	State Comments
Delaware	Indian River	594	3	Coal Steam	764.1	1,759.0	State Comments
Delware	Indian River	594	4	Coal Steam	19,665.8	3,657.0	State Comments
Georgia	Bowen	703	1 BLR	Coal Steam	4,830.8	2,909.7	VISTAS_2018G2
Georgia	Bowen	703	2 BLR	Coal Steam	4,864.7	2,930.1	VISTAS_2018G2
Georgia	Bowen	703	3 BLR	Coal Steam	6,111.3	3,681.0	VISTAS_2018G2
Georgia	Bowen	703	4 BLR	Coal Steam	6,294.3	3,791.1	VISTAS_2018G2
Georgia	Harllee Branch	709	3	Coal Steam	1,158.1	1,395.1	VISTAS_2018G2
Georgia	Harllee Branch	709	4	Coal Steam	1,132.6	1,364.4	VISTAS_2018G2
Illinois	Coffeen	861	01	Coal Steam	3,314.6	4,761.8	IPM 3.0
Illinois	Coffeen	861	02	Coal Steam	5,444.3	7,365.8	IPM 3.0
Illinois	Alcoa Allowance Management Inc (WARRICK)	6705	1	Coal Steam	0.0	10,013.5	IPM 3.0

State	Facility Name	ORIS ID	Unit ID	Unit Type	ORIGINAL 2018 (1) SO_2 TPY	REVISED 2018 (2) SO_2 TPY	BASIS FOR CHANGE (3)
Illinois	Alcoa Allowance Management Inc (WARRICK)	6705	2	Coal Steam	**0.0**	**9,604.4**	**IPM 3.0**
Illinois	Alcoa Allowance Management Inc (WARRICK)	6705	4	Coal Steam	**628.1**	**4,091.5**	**IPM 3.0**
Indiana	Cayuga	1001	1	Coal Steam	**4,660.7**	**6,298.8**	**IPM 3.0**
Indiana	Cayuga	1001	2	Coal Steam	**4,501.3**	**6,405.7**	**IPM 3.0**
Indiana	Clifty Creek	983	1	Coal Steam	**944.3**	**2,594.3**	**IPM 3.0**
Indiana	Clifty Creek	983	2	Coal Steam	**7,682.7**	**2,528.4**	**IPM 3.0**
Indiana	Clifty Creek	983	3	Coal Steam	**7,636.7**	**2,513.2**	**IPM 3.0**
Indiana	Clifty Creek	983	4	Coal Steam	**7,604.8**	**2,502.7**	**IPM 3.0**
Indiana	Clifty Creek	983	5	Coal Steam	**7,440.8**	**2,448.8**	**IPM 3.0**
Indiana	Clifty Creek	983	6	Coal Steam	**903.4**	**2,889.3**	**IPM 3.0**
Indiana	Gibson	6113	1	Coal Steam	**5,640.1**	**7,994.7**	**IPM 3.0**
Indiana	Gibson	6113	2	Coal Steam	**5,735.6**	**8,039.2**	**IPM 3.0**
Indiana	Gibson	6113	3	Coal Steam	**5,784.9**	**7,875.5**	**IPM 3.0**
Indiana	Gibson	6113	4	Coal Steam	**8,032.4**	**13,116.6**	**IPM 3.0**

State	Facility Name	ORIS ID	Unit ID	Unit Type	ORIGINAL 2018 (1) SO_2 TPY	REVISED 2018 (2) SO_2 TPY	BASIS FOR CHANGE (3)
Indiana	Harding Street Station (EW Stout)	990	70	Coal Steam	**1,845.9**	**5,476.9**	**IPM 3.0**
Indiana	R Gallagher	1008	1	Coal Steam	**5,383.2**	**3,571.1**	**IPM 3.0**
Indiana	R Gallagher	1008	2	Coal Steam	**5,284.7**	**3,505.7**	**IPM 3.0**
Indiana	R Gallagher	1008	3	Coal Steam	**5,309.2**	**3,522.0**	**IPM 3.0**
Indiana	R Gallagher	1008	4	Coal Steam	**5,383.2**	**3,571.1**	**IPM 3.0**
Indiana	**Rockport**	6166	MB1	Coal Steam	**32,349.8**	**15,531.2**	**IPM 3.0**
Indiana	**Rockport**	6166	MB2	Coal Steam	**32,660.4**	**15,680.3**	**IPM 3.0**
Indiana	**Tanners Creek**	988	U1	Coal Steam	**5,222.0**	**6,756.8**	**IPM 3.0**
Indiana	**Tanners Creek**	988	U2	Coal Steam	**3,770.1**	**6,562.1**	**IPM 3.0**
Indiana	**Tanners Creek**	988	U3	Coal Steam	**5,289.8**	**9,211.3**	**IPM 3.0**
Indiana	**Tanners Creek**	988	U4	Coal Steam	**4,507.6**	**12,433.5**	**Mark Janssen IPM 3.0**
Indiana	Wabash River	1010	2	Coal Steam	**3,037.1**	**5,827.8**	**Mark Janssen IPM 3.0**
Indiana	Wabash River	1010	3	Coal Steam	**3,071.1**	**5,397.1**	**Mark Janssen IPM 3.0**
Indiana	Wabash River	1010	4	Coal Steam	**3,071.1**	**5,640.3**	**Mark Janssen IPM 3.0**
Indiana	Wabash River	1010	5	Coal Steam	**3,528.1**	**5,954.8**	**Mark Janssen IPM 3.0**

State	Facility Name	ORIS ID	Unit ID	Unit Type	ORIGINAL 2018 (1) SO_2 TPY	REVISED 2018 (2) SO_2 TPY	BASIS FOR CHANGE (3)
Indiana	Wabash River	1010	6	Coal Steam	3,039.6	4,192.7	**Mark Janssen IPM 3.0**
Kentucky	**Big Sandy**	1353	BSU 1	Coal Steam	675.7	814.0	VISTAS_2018G2
Kentucky	**Big Sandy**	1353	BSU 2	Coal Steam	4,203.4	5,063.5	VISTAS_2018G2
Kentucky	Cooper	1384	1	Coal Steam	4,400.5	5,301.0	VISTAS_2018G2
Kentucky	Cooper	1384	2	Coal Steam	596.5	718.6	VISTAS_2018G2
Kentucky	E W Brown	1355	2	Coal Steam	748.0	901.1	VISTAS_2018G2
Kentucky	E W Brown	1355	3	Coal Steam	1,767.0	2,128.6	VISTAS_2018G2
Kentucky	East Bend	6018	2	Coal Steam	2,221.6	2,676.2	VISTAS_2018G2
Kentucky	Ghent	1356	3	Coal Steam	5,104.1	6,148.5	VISTAS_2018G2
Kentucky	Ghent	1356	4	Coal Steam	4,976.7	5,995.1	VISTAS_2018G2
Kentucky	H L Spurlock	6041	1	Coal Steam	767.6	924.7	VISTAS_2018G2
Kentucky	H L Spurlock	6041	2	Coal Steam	4,871.5	5,868.4	VISTAS_2018G2
Kentucky	Mill Creek	1364	4	Coal Steam	12,822.6	15,446.5	VISTAS_2018G2
Kentucky	Paradise	1378	2	Coal Steam	7,940.5	9,565.4	VISTAS_2018G2
Kentucky	Paradise	1378	3	Coal Steam	22,538.5	27,150.6	VISTAS_2018G2

State	Facility Name	ORIS ID	Unit ID	Unit Type	ORIGINAL 2018 (1) SO_2 TPY	REVISED 2018 (2) SO_2 TPY	BASIS FOR CHANGE (3)
Maine	William F Wyman	1507	4	O/G Steam	0.0	1162.5	manevu_2002v3
Maryland	Brandon Shores	602	1	Coal Steam	3,799.8	5,392.0	State Comments
Maryland	Brandon Shores	602	2	Coal Steam	3,673.3	5,627.0	State Comments
Maryland	C P Crane	1552	1	Coal Steam	900.0	1,532.0	State Comments
Maryland	C P Crane	1552	2	Coal Steam	875.2	1,646.0	State Comments
Maryland	Chalk Point	1571	1	Coal Steam	1,506.2	2,606.0	State Comments
Maryland	Chalk Point	1571	2	Coal Steam	1,510.5	2,733.0	State Comments
Maryland	Dickerson	1572	1	Coal Steam	797.4	1,238.0	State Comments
Maryland	Dickerson	1572	2	Coal Steam	867.2	1,355.0	State Comments
Maryland	Dickerson	1572	3	Coal Steam	768.7	1,285.0	State Comments
Maryland	Herbert A Wagner	1554	3	Coal Steam	1,551.1	1,239.0	State Comments
Maryland	Morgantown	1573	1	Coal Steam	3,037.1	4,646.0	State Comments
Maryland	Morgantown	1573	2	Coal Steam	2,987.2	4,679.0	State Comments
Massachusetts	Brayton Point	1619	1	Coal Steam	1,924.7	925.2	State Comments
Massachusetts	Brayton Point	1619	2	Coal Steam	1,875.6	888.9	State Comments

State	Facility Name	ORIS ID	Unit ID	Unit Type	ORIGINAL 2018 (1) SO_2 TPY	REVISED 2018 (2) SO_2 TPY	BASIS FOR CHANGE (3)
Massachusetts	Brayton Point	1619	3	Coal Steam	4,775.0	4,775.0	State Comments
Massachusetts	Canal	1599	1	O/G Steam	0.0	13066.0	manevu_2002v3
Massachusetts	Canal	1599	2	O/G Steam	0.0	8948.3	manevu_2002v3
Massachusetts	Mount Tom	1606	1	Coal Steam	242.6	242.6	State Comments
Massachusetts	Salem Harbor	1626	1	Coal Steam	3,421.5	3,421.5	IPM 2.1.9
Massachusetts	Salem Harbor	1626	3	Coal Steam	405.2	405.2	IPM 2.1.9
Massachusetts	Salem Harbor	1626	4	O/G Steam	0.0	2,897.0	manevu_2002v3
Massachusetts	Somerset	1613	8	Coal Steam	2,372.8	2,372.8	IPM 2.1.9
Michigan	Dan E Karn	1702	3	O/G Steam ?	0.0	3,358.5	2002 CEMS data
Michigan	Dan E Karn	1702	4	O/G Steam ?	0.0	2,169.2	2002 CEMS data
Michigan	Monroe	1733	1	Coal Steam	27,485.9	19,089.8	Mark Janssen IPM 3.0
Michigan	Monroe	1733	2	Coal Steam	27,806.6	19,530.4	Mark Janssen IPM 3.0
Michigan	Monroe	1733	3	Coal Steam	28,043.9	2,035.8	Mark Janssen IPM 3.0
Michigan	Monroe	1733	4	Coal Steam	30,584.3	1,987.6	Mark Janssen IPM 3.0

State	Facility Name	ORIS ID	Unit ID	Unit Type	ORIGINAL 2018 (1) SO_2 TPY	REVISED 2018 (2) SO_2 TPY	BASIS FOR CHANGE (3)
Michigan	St. Clair	1743	7	Coal Steam	17,052.2	11,925.8	Mark Janssen IPM 3.0
Michigan	Trenton Channel	1745	9A	Coal Steam	17,832.6	13,868.9	Mark Janssen IPM 3.0
New Hampshire	Merrimack	2364	1	Coal Steam	1,894.6	1,894.6	State Comments
New Hampshire	Merrimack	2364	2	Coal Steam	1,091.1	1,091.1	State Comments
New Hampshire	Newington	8002	1	O/G Steam	0.0	3,297.0	State Comments
New Jersey	B L England	2378	1	Coal Steam	5,201.3	520.1	State Comments
New Jersey	Hudson	2403	2	Coal Steam	10,958.4	1,095.8	State Comments
New Jersey	Mercer	2408	1	Coal Steam	1,921.0	1,921.0	State Comments
New Jersey	Mercer	2408	2	Coal Steam	1,921.0	1,921.0	State Comments
New York	C R Huntley	2549	63	Coal Steam	0.0	0.0	NOT-IN_ manevu_2002v3
New York	C R Huntley	2549	64	Coal Steam	3,602.1	0.0	IPM 2.1.9
New York	C R Huntley	2549	65	Coal Steam	0.0	0.0	NOT-IN_ manevu_2002v3
New York	C R Huntley	2549	66	Coal Steam	0.0	7,085.0	manevu_2002v3
New York	C R Huntley	2549	67	Coal Steam	633.0	0.0	State Comments
New York	C R Huntley	2549	68	Coal Steam	633.5	0.0	State Comments

State	Facility Name	ORIS ID	Unit ID	Unit Type	ORIGINAL 2018 (1) SO_2 TPY	REVISED 2018 (2) SO_2 TPY	BASIS FOR CHANGE (3)
New York	Danskammer	2480	4	Coal Steam	763.5	763.5	State Comments
New York	Dunkirk	2554	3	Coal Steam	667.4	0.0	State Comments
New York	Dunkirk	2554	4	Coal Steam	647.4	7,085.0	State Comments
New York	Goudey	2526	11	Coal Steam	1,921.1	1,921.1	State Comments
New York	Goudey	2526	12	Coal Steam	1,921.1	1,921.1	State Comments
New York	Goudey	2526	13	Coal Steam	3,856.1	3,856.1	IPM 2.1.9
New York	Greenidge	2527	6	Coal Steam	390.1	605.0	State Comments
New York	Northport	2516	3	O/G Steam	0.0	7,359.0	2002 CEMS data
New York	Oswego	2594	5	O/G Steam	0.0	1,747.0	2002 VTDEC data
New York	Rochester 7	2642	3	Coal Steam	2,800.4	0.0	State Comments
New York	Rochester 7	2642	4	Coal Steam	3,231.3	200.0	State Comments
New York	Roseton	8006	1	O/G Steam	0.0	3,817.0	2002 VTDEC data
New York	Roseton	8006	2	O/G Steam	0.0	2,840.0	2002 VTDEC data
North Carolina	Belews Creek	8042	1	Coal Steam	2,535.5	3,054.3	VISTAS_2018G2
North Carolina	Belews Creek	8042	2	Coal Steam	3,217.5	3,875.9	VISTAS_2018G2

State	Facility Name	ORIS ID	Unit ID	Unit Type	ORIGINAL 2018 (1) SO_2 TPY	REVISED 2018 (2) SO_2 TPY	BASIS FOR CHANGE (3)
North Carolina	Cliffside	2721	5	Coal Steam	1,951.7	2,351.1	VISTAS_2018G2
North Carolina	L V Sutton	2713	3	Coal Steam	1,036.5	1,248.6	VISTAS_2018G2
North Carolina	Lee	2709	3	Coal Steam	697.6	8,403.5	VISTAS_2018G2
North Carolina	Marshall	2727	3	Coal Steam	2,242.9	2,701.9	VISTAS_2018G2
North Carolina	Marshall	2727	4	Coal Steam	2,207.8	2,659.6	VISTAS_2018G2
North Carolina	Mayo	6250	1A	Coal Steam	953.9	1,149.1	VISTAS_2018G2
North Carolina	Mayo	6250	1B	Coal Steam	953.4	1,148.5	VISTAS_2018G2
North Carolina	Roxboro	2712	1	Coal Steam	998.7	1,203.1	VISTAS_2018G2
North Carolina	Roxboro	2712	2	Coal Steam	2,438.0	2,936.9	VISTAS_2018G2
North Carolina	Roxboro	2712	3A	Coal Steam	1,071.1	1,290.3	VISTAS_2018G2
North Carolina	Roxboro	2712	3B	Coal Steam	1,071.1	1,290.3	VISTAS_2018G2
North Carolina	Roxboro	2712	4A	Coal Steam	1,253.0	1,509.4	VISTAS_2018G2
North Carolina	Roxboro	2712	4B	Coal Steam	1,253.0	1,509.4	VISTAS_2018G2
Ohio	Avon Lake	2836	12	Coal Steam	5,809.5	3,201.9	Mark Janssen IPM 3.0
Ohio	**Cardinal**	2828	1	Coal Steam	2,417.1	6,964.7	Mark Janssen IPM 3.0

State	Facility Name	ORIS ID	Unit ID	Unit Type	ORIGINAL 2018 (1) SO_2 TPY	REVISED 2018 (2) SO_2 TPY	BASIS FOR CHANGE (3)
Ohio	**Cardinal**	2828	2	Coal Steam	**5,320.9**	**7,356.2**	**Mark Janssen IPM 3.0**
Ohio	**Cardinal**	2828	3	Coal Steam	**5,366.8**	**8,505.4**	**Mark Janssen IPM 3.0**
Ohio	**Conesville**	2840	1	Coal Steam	**582.1**	**701.2**	**IPM 2.1.9**
Ohio	**Conesville**	2840	2	Coal Steam	**592.8**	**714.1**	**IPM 2.1.9**
Ohio	**Conesville**	2840	4	Coal Steam	**7,333.9**	**6,616.6**	**Mark Janssen IPM 3.0**
Ohio	Eastlake	2837	5	Coal Steam	**5,113.7**	**13,883.0**	**Mark Janssen IPM 3.0**
Ohio	**Gen J M Gavin**	8102	1	Coal Steam	**6,479.2**	**8,584.7**	**Mark Janssen IPM 3.0**
Ohio	**Gen J M Gavin**	8102	2	Coal Steam	**6,464.9**	**8,565.7**	**Mark Janssen IPM 3.0**
Ohio	J M Stuart	2850	1	Coal Steam	**4,810.1**	**5,629.2**	**Mark Janssen IPM 3.0**
Ohio	J M Stuart	2850	2	Coal Steam	**4,718.1**	**5,497.4**	**Mark Janssen IPM 3.0**
Ohio	J M Stuart	2850	3	Coal Steam	**4,815.9**	**5,615.2**	**Mark Janssen IPM 3.0**
Ohio	J M Stuart	2850	4	Coal Steam	**4,828.2**	**5,637.7**	**Mark Janssen IPM 3.0**
Ohio	Killen Station	6031	2	Coal Steam	**4,879.0**	**5,823.1**	**Mark Janssen IPM 3.0**
Ohio	Kyger Creek	2876	1	Coal Steam	**942.9**	**1,521.3**	**Mark Janssen IPM 3.0**
Ohio	Kyger Creek	2876	2	Coal Steam	**953.8**	**1,539.0**	**Mark Janssen IPM 3.0**

State	Facility Name	ORIS ID	Unit ID	Unit Type	ORIGINAL 2018 (1) SO_2 TPY	REVISED 2018 (2) SO_2 TPY	BASIS FOR CHANGE (3)
Ohio	Kyger Creek	2876	3	Coal Steam	**954.8**	**1,540.6**	**Mark Janssen IPM 3.0**
Ohio	Kyger Creek	2876	4	Coal Steam	**964.0**	**1,555.4**	**Mark Janssen IPM 3.0**
Ohio	Kyger Creek	2876	5	Coal Steam	**951.0**	**1,534.5**	**Mark Janssen IPM 3.0**
Ohio	Miami Fort	2832	5-1	Coal Steam	**1,502.5**	**1,035.5**	**Mark Janssen IPM 3.0**
Ohio	Miami Fort	2832	5-2	Coal Steam	**1,502.5**	**1,035.5**	**Mark Janssen IPM 3.0**
Ohio	Miami Fort	2832	6	Coal Steam	**6,285.1**	**3,790.2**	**Mark Janssen IPM 3.0**
Ohio	Miami Fort	2832	7	Coal Steam	**2,209.2**	**4,771.7**	**Mark Janssen IPM 3.0**
Ohio	**Muskingum River**	2872	1	Coal Steam	**883.8**	**7,366.3**	**Mark Janssen IPM 3.0**
Ohio	**Muskingum River**	2872	2	Coal Steam	**865.4**	**7,213.6**	**Mark Janssen IPM 3.0**
Ohio	**Muskingum River**	2872	3	Coal Steam	**913.4**	**9,149.2**	**Mark Janssen IPM 3.0**
Ohio	**Muskingum River**	2872	4	Coal Steam	**848.0**	**8,494.4**	**Mark Janssen IPM 3.0**
Ohio	**Muskingum River**	2872	5	Coal Steam	**5,033.7**	**5,430.2**	**Mark Janssen IPM 3.0**
Ohio	R E Burger	2864	1	Coal Steam	**0.0**	**0.0**	**2002 CEMS data**
Ohio	R E Burger	2864	2	Coal Steam	**0.0**	**0.0**	**2002 CEMS data**
Ohio	R E Burger	2864	3	Coal Steam	**0.0**	**0.0**	**2002 CEMS data**

State	Facility Name	ORIS ID	Unit ID	Unit Type	ORIGINAL 2018 (1) SO_2 TPY	REVISED 2018 (2) SO_2 TPY	BASIS FOR CHANGE (3)
Ohio	R E Burger	2864	4	Coal Steam	**0.0**	**0.0**	**2002 CEMS data**
Ohio	R E Burger	2864	5	Coal Steam	**462.2**	**2,096.3**	**Mark Janssen IPM 3.0**
Ohio	R E Burger	2864	6	Coal Steam	**1,491.5**	**2,096.3**	**Mark Janssen IPM 3.0**
Ohio	R E Burger	2864	7	Coal Steam	**1,317.7**	**1,528.3**	**Mark Janssen IPM 3.0**
Ohio	R E Burger	2864	8	Coal Steam	**790.3**	**1,615.6**	**Mark Janssen IPM 3.0**
Ohio	Richard Gorsuch	7253	1	Coal Steam	**1,806.3**	**6,938.7**	**IPM 3.0**
Ohio	Richard Gorsuch	7253	2	Coal Steam	**1,436.9**	**8,117.3**	**IPM 3.0**
Ohio	Richard Gorsuch	7253	3	Coal Steam	**1,440.9**	**6,867.5**	**IPM 3.0**
Ohio	Richard Gorsuch	7253	4	Coal Steam	**1,801.4**	**6,520.9**	**IPM 3.0**
Ohio	W H Sammis	2866	1	Coal Steam	**836.0**	**4,510.1**	**Mark Janssen IPM 3.0**
Ohio	W H Sammis	2866	2	Coal Steam	**841.5**	**4,557.2**	**Mark Janssen IPM 3.0**
Ohio	W H Sammis	2866	3	Coal Steam	**862.5**	**4,713.0**	**Mark Janssen IPM 3.0**
Ohio	W H Sammis	2866	4	Coal Steam	**828.6**	**4,417.3**	**Mark Janssen IPM 3.0**
Ohio	W H Sammis	2866	5	Coal Steam	**1,357.2**	**7,004.0**	**Mark Janssen IPM 3.0**
Ohio	W H Sammis	2866	6A	Coal Steam	**3,544.3**	**3,217.1**	**Mark Janssen IPM 3.0**

State	Facility Name	ORIS ID	Unit ID	Unit Type	ORIGINAL 2018 (1) SO_2 TPY	REVISED 2018 (2) SO_2 TPY	BASIS FOR CHANGE (3)
Ohio	W H Sammis	2866	7	Coal Steam	**3,446.4**	**3,245.3**	**Mark Janssen IPM 3.0**
Ohio	Walter C Beckjord	2830	6	Coal Steam	**1,790.1**	**9,715.7**	**Mark Janssen IPM 3.0**
Ohio	W H Zimmer	6019	1	Coal Steam	**4,658.1**	**7,552.8**	**Mark Janssen IPM 3.0**
Pennsylvania	Armstrong	3178	2	Coal Steam	**779.1**	**1,674.1**	**State Comments**
Pennsylvania	Brunner Island	3140	1	Coal Steam	**1,072.8**	**599.0**	**IPM 2.1.9**
Pennsylvania	Brunner Island	3140	2	Coal Steam	**1,206.8**	**884.3**	**IPM 2.1.9**
Pennsylvania	Brunner Island	3140	3	Coal Steam	**2,289.6**	**1,963.3**	**IPM 2.1.9**
Pennsylvania	Cheswick	8226	1	Coal Steam	**4,636.9**	**2,011.6**	**IPM 2.1.9**
Pennsylvania	Hatfields Ferry	3179	1	Coal Steam	**2,215.0**	**2,784.8**	**IPM 2.1.9**
Pennsylvania	Hatfields Ferry	3179	2	Coal Steam	**2,220.1**	**2,650.8**	**IPM 2.1.9**
Pennsylvania	Homer City	3122	1	Coal Steam	**3,502.4**	**2,288.0**	**State Comments**
Pennsylvania	Homer City	3122	2	Coal Steam	**3,246.1**	**2,767.8**	**State Comments**
Pennsylvania	Keystone	3136	1	Coal Steam	**4,763.7**	**4,385.7**	**State Comments**
Pennsylvania	Keystone	3136	2	Coal Steam	**4,679.7**	**3,145.3**	**State Comments**
Pennsylvania	Martins Creek	3148	1	Coal Steam	**1,331.7**	**0.0**	**IPM 2.1.9**

State	Facility Name	ORIS ID	Unit ID	Unit Type	ORIGINAL 2018 (1) SO_2 TPY	REVISED 2018 (2) SO_2 TPY	BASIS FOR CHANGE (3)
Pennsylvania	Martins Creek	3148	2	Coal Steam	1,198.1	0.0	IPM 2.1.9
Pennsylvania	Montour	3149	1	Coal Steam	3,958.5	3,050.5	State Comments
Pennsylvania	Montour	3149	2	Coal Steam	3,993.4	2,522.4	State Comments
Pennsylvania	Portland	3113	1	Coal Steam	589.9	9,740.2	State Comments
Pennsylvania	Portland	3113	2	Coal Steam	830.2	14,568.8	State Comments
Pennsylvania	Shawville	3131	1	Coal Steam	444.0	7,144.7	State Comments
South Carolina	Jefferies	3319	3	Coal Steam	1,261.9	8,144.7	VISTAS_2018G2
South Carolina	Jefferies	3319	4	Coal Steam	1,233.6	7,962.0	VISTAS_2018G2
South Carolina	Wateree	3297	WAT 1	Coal Steam	15,017.8	1,809.1	VISTAS_2018G2
South Carolina	Wateree	3297	WAT 2	Coal Steam	875.2	1,054.3	VISTAS_2018G2
South Carolina	Williams	3298	WIL1	Coal Steam	1,279.9	1,541.8	VISTAS_2018G2
South Carolina	Winyah	6249	1	Coal Steam	680.9	820.2	VISTAS_2018G2
Tennessee	Gallatin	3403	3	Coal Steam	579.8	698.4	VISTAS_2018G2
Tennessee	Gallatin	3403	4	Coal Steam	573.1	690.4	VISTAS_2018G2
Tennessee	John Sevier	3405	3	Coal Steam	451.4	543.8	VISTAS_2018G2

State	Facility Name	ORIS ID	Unit ID	Unit Type	ORIGINAL 2018 (1) SO_2 TPY	REVISED 2018 (2) SO_2 TPY	BASIS FOR CHANGE (3)
Tennessee	John Sevier	3405	4	Coal Steam	463.8	558.7	VISTAS_2018G2
Tennessee	Johnsonville	3406	1	Coal Steam	5,030.4	6,059.8	VISTAS_2018G2
Tennessee	Johnsonville	3406	2	Coal Steam	4,729.2	5,696.9	VISTAS_2018G2
Tennessee	Johnsonville	3406	3	Coal Steam	4,559.1	5,492.0	VISTAS_2018G2
Tennessee	Johnsonville	3406	4	Coal Steam	4,722.8	5,689.3	VISTAS_2018G2
Tennessee	Johnsonville	3406	5	Coal Steam	4,576.6	5,513.1	VISTAS_2018G2
Tennessee	Johnsonville	3406	6	Coal Steam	4,540.0	5,469.0	VISTAS_2018G2
Tennessee	Johnsonville	3406	7	Coal Steam	6,287.6	7,574.2	VISTAS_2018G2
Tennessee	Johnsonville	3406	8	Coal Steam	5,584.7	6,727.4	VISTAS_2018G2
Tennessee	Johnsonville	3406	9	Coal Steam	5,474.9	6,595.2	VISTAS_2018G2
Tennessee	Johnsonville	3406	10	Coal Steam	4,869.1	5,865.5	VISTAS_2018G2
Tennessee	Kingston	3407	1	Coal Steam	371.9	448.0	VISTAS_2018G2
Tennessee	Kingston	3407	2	Coal Steam	371.9	448.0	VISTAS_2018G2
Tennessee	Kingston	3407	3	Coal Steam	371.9	448.0	VISTAS_2018G2
Tennessee	Kingston	3407	4	Coal Steam	371.9	448.0	VISTAS_2018G2

State	Facility Name	ORIS ID	Unit ID	Unit Type	ORIGINAL 2018 (1) SO_2 TPY	REVISED 2018 (2) SO_2 TPY	BASIS FOR CHANGE (3)
Tennessee	Kingston	3407	5	Coal Steam	**486.8**	**586.4**	**VISTAS_2018G2**
Tennessee	Kingston	3407	6	Coal Steam	**486.8**	**586.4**	**VISTAS_2018G2**
Tennessee	Kingston	3407	7	Coal Steam	**486.8**	**586.4**	**VISTAS_2018G2**
Tennessee	Kingston	3407	8	Coal Steam	**486.8**	**586.4**	**VISTAS_2018G2**
Tennessee	Kingston	3407	9	Coal Steam	**602.3**	**725.5**	**VISTAS_2018G2**
Virginia	Chesapeake	3803	3	Coal Steam	**691.5**	**3,332.0**	**VISTAS_2018G2**
Virginia	Chesapeake	3803	4	Coal Steam	**1,038.8**	**5,005.2**	**VISTAS_2018G2**
Virginia	Chesterfield	3797	4	Coal Steam	**743.8**	**896.0**	**VISTAS_2018G2**
Virginia	Chesterfield	3797	5	Coal Steam	**1,560.6**	**1,879.9**	**VISTAS_2018G2**
Virginia	Chesterfield	3797	6	Coal Steam	**3,633.3**	**4,376.8**	**VISTAS_2018G2**
Virginia	**Clinch River**	3775	1	Coal Steam	**539.0**	**6,542.3**	**VISTAS_2018G2**
Virginia	**Clinch River**	3775	2	Coal Steam	**545.3**	**6,618.2**	**VISTAS_2018G2**
Virginia	Yorktown	3809	1	Coal Steam	**6,169.6**	**743.3**	**VISTAS_2018G2**
Virginia	Yorktown	3809	2	Coal Steam	**6,521.3**	**785.4**	**VISTAS_2018G2**
Virginia	Yorktown	3809	3	Coal Steam	**0.0**	**3,342.8**	**VISTAS_2018G2**

State	Facility Name	ORIS ID	Unit ID	Unit Type	ORIGINAL 2018 (1) SO_2 TPY	REVISED 2018 (2) SO_2 TPY	BASIS FOR CHANGE (3)
West Virginia	Albright	3942	3	Coal Steam	660.1	795.2	VISTAS_2018G2
West Virginia	Fort Martin	3943	1	Coal Steam	4,922.1	5,929.3	VISTAS_2018G2
West Virginia	Fort Martin	3943	2	Coal Steam	4,890.0	5,890.6	VISTAS_2018G2
West Virginia	**John E Amos**	3935	1	Coal Steam	6,612.7	7,965.8	VISTAS_2018G2
West Virginia	**John E Amos**	3935	2	Coal Steam	6,693.9	8,063.7	VISTAS_2018G2
West Virginia	**John E Amos**	3935	3	Coal Steam	10,821.0	13,035.3	VISTAS_2018G2
West Virginia	**Kammer**	3947	1	Coal Steam	951.1	1,145.8	VISTAS_2018G2
West Virginia	**Kammer**	3947	2	Coal Steam	949.2	1,143.4	VISTAS_2018G2
West Virginia	**Kammer**	3947	3	Coal Steam	948.7	1,142.8	VISTAS_2018G2
West Virginia	**Kanawha River**	3936	1	Coal Steam	902.7	1,087.5	VISTAS_2018G2
West Virginia	**Kanawha River**	3936	2	Coal Steam	900.3	1,084.5	VISTAS_2018G2
West Virginia	**Mitchell**	3948	1	Coal Steam	7,646.2	9,210.8	VISTAS_2018G2
West Virginia	**Mitchell**	3948	2	Coal Steam	7,581.9	9,133.4	VISTAS_2018G2
West Virginia	**Mountaineer**	6264	1	Coal Steam	11,433.5	13,773.1	VISTAS_2018G2
West Virginia	Mount Storm	3954	1	Coal Steam	5,318.3	3,843.9	VISTAS_2018G2

State	Facility Name	ORIS ID	Unit ID	Unit Type	ORIGINAL 2018 (1) SO_2 TPY	REVISED 2018 (2) SO_2 TPY	BASIS FOR CHANGE (3)
West Virginia	Mount Storm	3954	2	Coal Steam	5,318.3	3,843.9	VISTAS_2018G2
West Virginia	Philip Sporn	3938	11	Coal Steam	668.1	804.8	VISTAS_2018G2
West Virginia	Philip Sporn	3938	21	Coal Steam	647.6	780.1	VISTAS_2018G2
West Virginia	Philip Sporn	3938	31	Coal Steam	643.0	774.6	VISTAS_2018G2
West Virginia	Philip Sporn	3938	41	Coal Steam	633.2	762.8	VISTAS_2018G2
West Virginia	**Philip Sporn**	3938	51	Coal Steam	1,942.6	2,340.1	VISTAS_2018G2
West Virginia	Pleasants	6004	1	Coal Steam	6,334.0	1,898.0	VISTAS_2018G2
West Virginia	Pleasants	6004	2	Coal Steam	6,164.7	1,847.3	VISTAS_2018G2
Wisconsin	Pleasant Prairie	6170	1	Coal Steam	1,735.2	1,769.6	IPM 3.0
Wisconsin	Pleasant Prairie	6170	2	Coal Steam	1,748.1	1,782.9	IPM 3.0

ATTACHMENT I

Comments from Federal Land Managers and EPA (with Responses)

J. UNDERHILL

United States Department of the Interior

FISH AND WILDLIFE SERVICE
National Wildlife Refuge System
Branch of Air Quality
7333 W. Jefferson Ave., Suite 375
Lakewood, CO 80235-2017

IN REPLY REFER TO:

FWS/ANWS-AR-AQ

RECEIVED
NEW HAMPSHIRE

AUG 0 ᵕ 2006

AIR RESOURCES DIVISION

August 1, 2006

Mr. Robert Scott
Director, Air Resources Division
New Hampshire Department of Environmental Services
P.O. Box 95
Concord, New Hampshire 03302-0095

Subject: Regional Haze Rule Consultation with Federal Land Management Agencies

Dear Mr. Scott:

Over the past several years, the U.S. Fish and Wildlife Service (FWS), National Park Service (NPS), and Forest Service have participated in regional planning efforts addressing ways for States, and Tribes if they so choose, to protect and improve visibility in Class I national parks and wildernesses through implementation of the Regional Haze Rule (RHR). Along with other stakeholders, we have had many opportunities to contribute to ongoing Regional Planning Organization (RPO) development of policy guidance and technical information. As States begin to develop their regional haze State implementation plans (SIPs) based on RPO work, we are interested in working directly with your staff to offer our perspective as managers of affected Class I areas and to maintain our support for an effective national regional haze program.

The primary purpose of this letter is to provide you general insights about FWS and NPS interests with respect to upcoming SIP development and consultation activities. It is not intended to dictate policy or guidance. Rather, in the enclosure to this letter we include discussion on a list of topics to enhance your understanding of our views on key SIP components. We also provide lead contacts for FWS and NPS staff that will be available to work with your staff during early phases of SIP development as well as coordinate the required formal 60-day review/consultation with the official Federal Land Manager (FLM) for the Department of the Interior.

The RHR requires States to inform the FLMs of the appropriate State contact for exchange of information regarding SIP development. Many States provided us with a contact person shortly after the RHR was published. It would be helpful if you could confirm your contact or provide a current single point of contact for your State to the individuals noted in the enclosure. Additional information regarding your SIP timelines would also be very helpful.

Our highest priority in working with you over the course of the next year and a half will be to help you develop a successful SIP. We understand the complexities of developing a plan reliant on non-linear relationships between emissions and subsequent visibility improvements. Our emphasis is to work with you and, as your partners, to ensure each plan utilizes all reasonable means to obtain realistic goals. We share the common goal of improving visibility in all Class I areas throughout the United States, and we would like to use this planning process to maximize goal achievement. Our hope is that through this communication we can complete the RHR requirement of formal consultation with ease and productivity.

We are looking forward to continuing our work with you and your staff as the regional haze SIPs are developed. Please don't hesitate to contact us with questions.

Sincerely,

Sandra V. Silva
Chief, Air Quality Branch
U.S. Fish and Wildlife Service

Christine L. Shaver
Chief, Air Resources Division
National Park Service

Enclosure

cc:
Forest Service: Rich Fisher, Donna Lamb
EPA Regional Air Division Directors
Regional Planning Organization Directors

Regional Haze State Implementation Plan Coordination
Fish & Wildlife Service and National Park Service
August 1, 2006

This document is designed to provide you general insights about U.S. Fish and Wildlife Service (FWS) and National Park Service (NPS) interests with respect to upcoming Regional Haze Rule (RHR) State Implementation Plan (SIP) development and consultation activities. It is not intended to dictate policy or guidance.

Baseline, Natural Condition, and Uniform Rate

These factors apply mainly to States that have Class I areas. Other States that contribute to visibility impairment in Class I areas should consider including discussion and conclusions on these factors in their individual plans.

As you know, the basic calculation of baseline, natural condition, and uniform rate builds the foundation for the entire RHR SIP process. Considerable discussion and debate at the science and policy level has occurred regarding appropriate methods to be used. As a consequence, several equations that include varying parameters or multipliers are available. Because these calculations can have a significant effect on the resulting progress goal, it is critical that the State provide a detailed description of the methods used in its SIP. If calculations include only portions of established methods or utilize previously undocumented or unsupported approaches, more justification should be included in the SIP or its supporting documentation. We encourage States to consider calculations that are based on equations recommended by the IMPROVE steering committee and that are consistent with recommended approaches from the appropriate RPO and Environmental Protection Agency (EPA) region.

Emission Inventories

Given the complexities associated with modern, comprehensive emission inventories, considerable effort should be placed on describing how these inventories were developed and used. We would like to see emission descriptions demonstrate an evolution that includes: an actual, base-year inventory used to evaluate model performance; a typical, base-year inventory that represents the five year, average condition which establishes modeled visibility impacts; and various future year, control scenarios (e.g., for required air pollution control programs or long term strategy measures) that demonstrate future visibility conditions. It would assist our review if future year inventories were clearly partitioned to delineate source types (by text, charts, or graphics) that are included in each model simulation. Improved future visibility conditions claimed in the SIP that are not also clearly identified in a future inventory or are not clearly included in future model analysis, will likely need additional and possibly considerable, attention and justification.

One part of your emission inventory includes the implementation of "Best Available Retrofit Technology" (BART) on a subset of pre-Prevention of Significant Deterioration sources. BART source identification, elimination, and control determinations will be of particular interest for review. We would prefer to see a clear progression through the three basic BART phases and a thorough description of the RHR prescribed factor analysis (if applicable). Discussions should clearly identify whether BART control levels apply to individual or grouped source categories.

Area of Influence

As you are aware, the area of influence of significant, visibility-impairing sources is an important SIP element. This area should clearly be identified or apportioned by State, or other geographic means, to encompass emission sources that contribute significant levels of pollutants to each Class I area as identified in your regional haze SIP. As such, these areas should be developed in conjunction with neighboring States and Tribes. Discussions of source areas of influence at both the base- and future-year levels can help establish a strong showing for SIP progress. States should consider the benefits of presenting this information in the form of transported mass by pollutant or through individually calculated visibility impairment indices. Using a percentage or "Top 10" ranking for current contributions by geographic area may not clearly describe progress over time.

Reasonable Progress Goals and Long Term Strategy

As you also know, establishing reasonable progress goals for Class I areas in your State and/or acknowledging reasonable progress goals for Class I areas in other States that are affected by emissions from your State, as well as defining associated emissions strategies to meet these goals, form the basis of the SIP process under the RHR.

In developing the Long Term Strategy (LTS) required by the RHR, your State has broad flexibility when determining reasonable progress goals and associated emissions. As noted earlier, the RHR includes a requirement for States to assess a uniform rate of progress and compare that rate to the reasonable progress goals set by those States with Class I areas. We believe that this uniform rate of progress assessment is useful in determining the geographic and economic extent a State should consider when developing the LTS associated with the reasonable progress goals.

In general, we are looking at the degree to which the LTS is supported by RPO technical work and at the level of consistency among the contributing States. For Class I areas where the State is setting a 2018 reasonable progress goal of equal or less impairment compared to the uniform rate of progress, it would assist our review to present information on how local, regional, and national emission strategies were considered and applied to address visibility impairment broken down by source category.

For Class I areas where the reasonable progress goal is more impaired than the uniform rate of progress, States should consider presenting additional information on a component basis. Components could consist of emission source categories as before, but also include contributions from individual pollutants or by geographic source area. Our intent is to better understand where and why a strategy falls short of the uniform progress rate goal. Because each region has focused their emission control strategy on different conditions, presenting results in a component format may assist in showing what level of progress was made in the focus area, versus other less controllable factors.

Fire

Your State has considerable flexibility as it addresses all anthropogenic sources of visibility impairment, including fire. The RHR requires consideration of smoke management techniques for agricultural and forestry management practices in the development of the LTS part of the SIP. On a short-term basis, fire, both natural and anthropogenic, has the potential to cause significant visibility reduction in Class I areas. If anthropogenic fire contributes to the index used to track long-term, reasonable progress in a Class I area, the visibility SIP should identify how it will be addressed. Your State may already have a smoke management program (SMP) that adequately describes how visibility impairment from fire will be addressed. If fire has been determined to contribute to visibility impairment, the SIP should contain a comprehensive emissions inventory for all fire emissions and a statement relating to its accuracy. It should also identify whether or not fire emissions are projected to increase, decrease, or stay the same, and how these projections were determined. For those States with a SMP, the SIP should identify its type, i.e., a basic smoke management program or an enhanced smoke management plan, and if the plan has been certified consistent with EPA's *Interim Air Quality Policy on Wildland and Prescribed Fire*. It would also be useful to know specific SMP requirements for minimizing visibility impairment in Class I areas and classification of the various types of wildland fire (wildfire, prescribed fire, and wildland fire use fire) as either natural or anthropogenic. Any differences regarding the regulation of agricultural burning versus prescribed burning by private, State or Federal land managers should also be identified with discussion of the basis for any differences provided.

Regional Consistency

The Regional Planning Organizations (RPOs) have been working toward regionally-consistent approaches to address visibility impairment throughout the SIP development process. There may be circumstances when different methods were used or impairment assessments reached different conclusions. We understand that each State knows what emission control methods or air quality management strategies work best for its areas. Each State may wish to develop strategies that are independent from their RPO or neighboring areas.

In this context, our review of "regional consistency" will have less to do with individual discretion each State has in making decisions, and more on how well a group of States identifies and addresses similar goals for each Class I area within a common area of influence.

Regional consistency can also be difficult to evaluate if neighboring SIPs (or portions of SIPs) are released for review at different times. It is our hope that thorough inter-State consultation processes will lead to consistent descriptions of apportionment and emission control goals, thus resulting in development of similar progress goals, regardless of release dates.

Verification and Contingencies

Little emphasis has been placed in the RHR on verification and even less on contingency planning. Each SIP must identify monitoring data as part of the original baseline and should include continued monitoring data collection and assessment as part of an ongoing progress review at five year intervals. Given the uncertain future of any individual monitoring site, the SIP should address the representativeness of both primary and alternative data sites.

We encourage States to not only consider the need for these data to measure progress, but also how the plan accounts for and reconciles both unexpected and reasonably foreseeable emissions growth, changes to the geographic distribution of emissions, and substantive errors that may be found in emission inventories or other technical bases of the SIPs. These factors, as well as other unanticipated circumstances, may adversely affect your State's ability to achieve the emissions reductions projected by the SIP. Considering these factors through adaptive management or routine review processes may assist in mitigating these circumstances.

Coordination and Consultation

The 1999 RHR requires States to consult with the Federal Land Management agencies at least 60 days prior to holding any public hearing on a RHR SIP or SIP revision (40 CFR 51.308(i)). Specifically, the Federal Land Manager (FLM) for the Department of the Interior (DOI) is the Assistant Secretary for Fish and Wildlife and Parks. However, assistance in the development and technical review of Regional Haze SIPs will be conducted by the FWS Branch of Air Quality and NPS Air Resources Division.

To help facilitate consultation with the FLMs, each Bureau has developed a review strategy that includes a single point of contact for all interaction with us. For your State, primary DOI contact names are:

Tim Allen
U.S. Fish & Wildlife Service

Mailing Address:
7333 W. Jefferson, Suite 375
Lakewood, CO 80235
Phone: 303-914-3802 Fax: 303-969-5444
Email: Tim_Allen@fws.gov

Bruce Polkowsky
National Park Service

Mailing Address:	Overnight Packages:
NPS-ARD	NPS-ARD
P.O. Box 25287	12795 W. Alameda Parkway
Denver, CO 80225	Lakewood, CO 80228
Phone: 303-987-6944	Fax: 303-969-2822

Email: Bruce_Polkowsky@nps.gov

All questions and inquires regarding formal or informal consultation can be directed to these contacts. We would appreciate communications in electronic form as much as possible. This will allow us to quickly share appropriate documents among staff and between agencies. The contacts listed above will also be able to inform you of additional resources and information we can provide. Resource and information examples include progress reports, discipline experts, or implementation advice. Although the RHR places a strong emphasis on individual discretion in developing these plans, the NPS and FWS would be happy to provide more specific suggestions or information, in a form most useful to you, upon request.

USDA United States Department of Agriculture | Forest Service | Eastern Region | 626 E. Wisconsin
Suite 800
Milwaukee, WI 53202

File Code: 2580-2
Date: OCT 1 3 2006

Mr. Robert Scott
Director, Air Resources Division
New Hampshire Department of Environmental Services
6 Hazen Drive
Concord, NH 03301

Dear Mr. Scott:

Over the past several years, members of both our staff and yours have participated with neighboring states and tribes in the Central States Regional Air Partnership to develop best approaches and tools for preparing plans that will reduce haze in Class I areas. With preparation of your Regional Haze State Implementation Plan (SIP) at hand, we want to focus on collaboration with you and your staff to ensure success. As you know, consultation with you is required in the Regional Haze Rule (RHR). This is a priority for our air program.

Our focus will be on Class I wildernesses, which the United States Department of Agriculture (USDA) Forest Service (FS) is responsible for. We are coordinating with the other Class I area managers, the National Park Service, and the US Fish and Wildlife Service to facilitate a common message from all federal land managers (FLM). We anticipate leveraging strengths of each FLM to our joint advantage. Since the FLM will be seeking a close working relationship with every state in this SIP writing process, the expectation is to share ideas from across the nation. The objective of every SIP is to play a critical role in a national emissions reduction plan.

Enclosed are detailed perspectives pertinent to the SIP preparation. Any comments or questions should be directed to Ann Acheson, the principal FS point of contact, at (740) 373-9055 ext. 23 or aacheson@fs.fed.us. She will consult on your SIP throughout the required 60-day comment period, sharing our best insights and recommendations. Ann will also work with others on our staff, especially our National Haze Coordinator, Ann Mebane and the Department of Interior. Ann Mebane can be contacted at (307) 587-4597 or amebane@fs.fed.us.

As required in the RHR, please identify, at your earliest convenience, your key point(s) of contact. Send all correspondence electronically to both Trent Wickman and Ann Mebane to ensure a successful consultation and SIP.

Sincerely,

for RANDY MOORE
Regional Forester

Enclosure

Enclosure 1

Subject: New Hampshire and Regional Haze Rule Consultation with the United States Department of Agriculture (USDA) Forest Service (FS)
September 2006

The following perspectives are merely suggestions or recommendations not direction or requirements. They are deliberately very similar to those prepared by the Department of Interior to contribute to a common sense of purpose for improving haze in all Class I areas. We are sending these perspectives to each state. In so doing, we hope to facilitate inter-state coordination. At the same time, we fully acknowledge the discretion afforded in the Regional Haze Rule (RHR) for unique and creative solutions by individual states in writing plans that reduce haze.

Natural Condition and Uniform Rate
These factors apply mainly to states that have Class I areas. Other states that contribute to visibility impairment in Class I areas located in a different state might consider including discussion and conclusions on these factors in their individual plans.

The basic calculation of baseline, natural condition, and uniform rate builds the foundation for the entire RHR State Implementation Plan (SIP) process. Considerable discussion and debate at the science and policy level has occurred regarding appropriate methods to be used. As a consequence, several equations that include varying parameters or multipliers are available. Because these calculations can have a significant effect on the resulting progress goal, it is important to provide a detailed description of the methods used in the SIP. Calculations that include only portions of established methods or utilize unique approaches will be better understood if the rationale for these differences is fully explained in the SIP or its supporting documentation. We encourage states to use calculations that are based on equations recommended by the Interagency Monitoring of Protected Visual Environments (IMPROVE) steering committee and that are consistent with recommended approaches from the pertinent Regional Planning Organization (RPO) and the Environmental Protection Agency (EPA) region.

Emission Inventories
Given the complexities associated with modern comprehensive emission inventories, spending some considerable effort in describing how these inventories were developed and used will be important. Emission descriptions will be most informative if they include an evolutionary discussion that includes an actual, base-year inventory used to evaluate model performance; a typical base-year inventory that represents the five year, average state which establishes modeled visibility impacts; and various future year, controlled inventories that demonstrate future visibility conditions. Consider adding future year inventories that are clearly partitioned to delineate source types (by text, charts, or graphics) that are included in each model simulation. Benefits to future visibility conditions suggested in the SIP that are not also clearly linked to a future inventory or are not clearly included in future model analysis, will warrant additional discussion.

clearly identify since states may use diff inv.

One part of your emission inventory includes the implementation of "Best Available Retrofit Technology" (BART) on a subset of pre-Prevention of Significant Deterioration sources. The BART source identification, elimination, and level determination will be of particular interest for review. We would prefer to see a clear progression through the three basic BART phases and a thorough description of the RHR prescribed factor analysis (if applicable). Consider discussing whether BART levels apply to individual or grouped source categories.

look at 5 factor for sources

Area of Influence

The area of influence of significant visibility-impairing sources is an important SIP element. We suggest that that each state clearly identify and apportion by state, or other geographic means, the significant levels of pollutants contributed to each Class I area by source. Developing this information together with neighboring States and Tribes will facilitate consistency. Discussions of changing source area contributions at both the base- and future-year levels will help demonstrate SIP progress. Consider the benefits of presenting this information in the form of transported mass by pollutant or through individually calculated visibility impairment measures. Using a percentage or "Top 10" ranking for current contributions by geographic area may or may not clearly describe progress over time.

Reasonable Progress Goals and Long Term Strategy

consistent

Establishing reasonable progress goals for Class I areas in your state and/or acknowledging reasonable progress goals for Class I areas in other states that are affected by emissions from your state, as well as defining associated emissions strategies to meet these goals, form the basis of the SIP process under the RHR.

In developing the statute's required Long Term Strategy (LTS), your state is offered broad flexibility when determining reasonable progress goals and associated emissions. As noted earlier, the RHR includes a requirement for states to assess a uniform rate of progress and compare that rate to the reasonable progress goals set by those states with Class I areas. We feel that this uniform rate of progress assessment is useful in determining the geographic and economic extent a state can consider when developing the LTS associated with the reasonable progress goals.

In general, we will be looking at the degree to which the LTS is supported by RPO technical work and at the level of consistency among the contributing states. For Class I areas where your state is setting a year 2018 reasonable progress goal of equal or less impairment compared to the uniform rate of progress, our review will focus holistically on (1) whether strategies are applied equitably across source types; (2) if both local and regional emission strategies have been fully examined; and (3) how consistent assessments and strategies are applied regionally.

For Class I areas where the reasonable progress goal is more impaired than the uniform rate of progress, consider presenting information on a component basis. Components could consist of emission source category as before, but also include contributions from individual pollutants or by geographic source area. Our intent is to better understand where and why a strategy falls short of the uniform progress rate goal.

Because each region has focused their emission control strategy on different conditions, presenting results in a component format may assist in showing what level of progress was made in the focus area, verses other less controllable factors.

Wildland Fire

Your state has considerable flexibility as it addresses all anthropogenic sources of visibility impairment, including fire. The RHR requires consideration of smoke management techniques for agricultural and forestry management practices in the development of the LTS part of the SIP. On a short-term basis, fire has the potential to cause significant visibility reduction in Class I areas. If fire contributes to the index used to track long-term, reasonable progress in a Class I area, the visibility SIP should identify how it will be addressed. Your state may already have a smoke management program (SMP) that adequately describes how visibility impairment from fire will be addressed. If fire has been determined to contribute to visibility impairment, we suggest including a fire emissions inventory along with a comment about its reliability and a projection for changes to the future inventory. If your state has a SMP, is it a basic smoke management program or an enhanced smoke management plan? And has the SMP been certified by the Environmental Protection Agency (EPA) Interim Air Quality Policy on Wildland and Prescribed Fire? Identify the specific SMP requirements for minimizing visibility impairment in Class I areas. Are there differences in state regulation for the way in which smoke from agricultural burning and forest fires are treated? Is there a difference in the way emissions from wildfire, prescribed fire, and wildland-fire-use (WFU) fire are identified and treated on private, state, and federal lands?

Regional Consistency

The RPOs have been working toward regionally-consistent approaches to address visibility impairment throughout the SIP development process. There may be circumstances when different methods were used or impairment assessments reached different conclusions. The FLM understands that each state knows what emission control methods or air quality management strategies work best for its areas. Each state may wish to develop strategies that are independent from RPO or neighboring areas.

In this context, our review of "regional consistency" will have less to do with individual discretion each state has in making decisions, and more on how well a group of states identifies and addresses similar agreed upon goals for each Class I area within a common area of influence.

Regional consistency can also be difficult to evaluate if neighboring SIPs (or portions of SIPs) are released for review at different times. We expect that thorough inter-state consultation processes will lead to consistent descriptions of apportionment and emission control goals, thus resulting in development of similar progress goals, regardless of release dates.

Verification and Contingencies

Little emphasis has been placed in the RHR on verification and even less on contingency planning. By rule, each SIP must identify the monitoring data used to specify the original baseline and also as part of an ongoing progress review at five year intervals.

don't need to include – try to address how will deal w/ in future technology and change

Given the uncertain future of any individual monitoring site, we suggest that the SIP address the representation of both primary and alternative data sites for each Class I area.

Consider not only the data necessary to measure progress, but also how to account for and mitigate both unexpected and reasonably foreseeable emissions growth, changes to the geographic distribution of emissions, and substantive errors that may be found in emission inventories or other technical bases of the SIPs. These factors, as well as other unanticipated circumstances, may adversely affect your state's ability to achieve the emissions reductions projected by the SIP. Considering these factors through adaptive management or continual review strategies may assist in avoiding these circumstances.

Coordination and Consultation

The 1999 RHR requires states to consult with the FLM agencies at least 60 days prior to holding any public hearing on a RHR, SIP, or SIP revision (40 CFR 51.308(i). As named in the cover letter to this enclosure, a single FS air specialist has been assigned to your state.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 1
1 Congress Street, Suite 1100
BOSTON, MA 02114-2023

July 10, 2008

Jeff Underhill
Air Resources Division
New Hampshire Department of Environmental Services
29 Hazen Drive, PO Box 95
Concord, NH 03302-0095

Dear Mr. Underhill:

On May 28, 2008, we received your preliminary draft Regional Haze State Implementation Plan (SIP). EPA staff have reviewed this draft and you will find our comments in the Enclosure.

If you have any questions on the enclosed comments, please contact me at 617-918-1047.

Sincerely,

Anne E. Arnold

Anne E. Arnold, Manager
Air Quality Planning Unit

Enclosure

cc: Charles Martone, NH DES
Andy Bodnarik, NH DES

Enclosure

EPA'S COMMENTS ON NEW HAMPSHIRE'S PRELIMINARY DRAFT REGIONAL HAZE SIP

The purpose of these comments is to provide the NH DES with some early feedback on their preliminary draft Regional Haze SIP. The focus of these comments is on the New Hampshire specific information stated in the draft. These comments are preliminary and may be amended as more detail is provided.

2.0 Areas Contributing to Regional Haze

1) The fifth paragraph on page 17 discusses the decline in sulfate concentration expected in the Great Gulf and Presidential Dry River Wilderness areas by 2018. The discussion should indicate which modeling results/control strategies are being used to develop these projections.

2.2 States Contributing to Visibility Impairment in New Hampshire's Class I Areas

2) In the discussion of states or regions contributing to visibility impairment at New Hampshire's Class I areas, MANE-VU is noted as contributing 27.83% (per Table 2.2). The next highest contribution is from "Other" at 23.54%. Given the magnitude of this category relative to the total MANE-VU contribution, NH should include some discussion of the components of the "Other" category.

3.2.5 State/Tribe and Federal Land Manager Coordination

3) As noted on page 32, the Regional Haze rule requires a 60 day comment period for Federal Land Managers (FLMs) before the public hearing. While timing may preclude the development of a response to these comments before the hearing, we recommend that any comments submitted by the FLMs be included in the materials provided for the public hearing.

6.3.1 Stationary Point Sources

4) On page 51, regarding Electrical Generating Units (EGUs) emissions inventories, there is discussion of the use of continuous emissions monitoring (CEM) data to develop hourly emissions profiles. Although use of CEM data makes sense given its high degree of accuracy, emissions from EGUs can vary widely from one day to another, and also vary greatly from season to season. How were the CEM hourly emissions profiles determined? NH should note that use of seasonal or annual average profiles may lead to an underestimation of visibility impacts on the worst 20% days. NH should include additional detail on how CEM data was used to develop hourly emission profiles.

6.4 Summary of Emissions Inventories

5) It is not clear why there is such a significant drop in PM_{10} from area sources between the 2018 BOTW and 2018 most recent modeling (Table 6-3 vs. Table 6-4). NH should provide additional detail on this issue.

9.5.1 BART Determinations and Required Control Levels

6) The attachment which details the analysis for New Hampshire's BART sources has not been provided. EPA needs to review this attachment in order to determine if New Hampshire's BART determinations and required control levels are reasonable. However, we do have some preliminary feedback on the limited information that was provided in main text.

Table 9.2 indicates that the BART emission limit for Newington Station unit NT-1 is "limited to no more than 1.0% sulfur by weight for #6 fuel oil." The MANE-VU BART Workgroup Recommendations DRAFT Presumptive Control Levels (Updated September 7, 2006) for Non-CAIR EGUs is to use 0.3% sulfur content oil. Was this level of control analyzed?

In addition, Table 9.2 indicates a BART control level of 80% control of SO_2 for Merrimack Station and 50% control of SO_2 for Newington Station. Both of these sources are included in the MANE-VU "167 stacks." MANE-VU is requesting 90% control of the 167 stacks. On page 28, New Hampshire states, "NHDES has determined that controlling the latter facility (Newington) to the 90 percent level of the Ask is not reasonable at this time and will seek alternative measures to achieve the equivalent overall reduction in SO_2 emissions." NH should include a discussion of the analysis that led to this determination, as well as more information on the referenced alternative measures.

Furthermore, Tables 9.3 and 9.4 indicate that, for NOx and PM, respectively, "current controls (ESP, SCR, etc.) are BART." It should be noted that BART requirements must be federally enforceable. Therefore, the BART discussion should reference the specific existing federally enforceable requirements that require these "current controls." Alternatively, if the requirements implementing the current controls are not yet federally enforceable, they must be submitted to EPA as a SIP revision.

11.5 Additional Factors Considered

7) Section 51.308(d)(3)(v) of the Regional Haze rule states, "The States must consider, at a minimum, the following factors in developing its long term strategy:

...

(B) Measures to mitigate the impacts of construction activities;

(C) Emission limitations and schedules for compliance to achieve reasonable progress goals;

...

(E) Smoke management techniques for agriculture and forestry management purposes including plans as currently exist within the state for these purposes."

New Hampshire's SIP should include more detail in these areas.

11.6 - 11.7 New Hampshire's share of Emission Reductions

8) More discussion should be included that connects New Hampshire emissions, and emission reductions, with meeting the reasonable progress goals for the Class I areas that New Hampshire impacts. Also, New Hampshire should discuss how it is meeting its apportionment of emission reductions agreed upon in the regional planning process.

New Hampshire Regional Haze SIP Revision
Summaries of Conference Calls with Federal Land Managers

August 28, 2008, and September 18, 2008

Conference calls with the Federal Land Managers (FLMs) were arranged on two separate dates to discuss New Hampshire's draft Regional Haze SIP. The first conference call covered all aspects of the plan except BART. The second conference call focused on New Hampshire's BART analyses.

Conference Call – August 28, 2008

Attendees:

USDOI, National Park Service – Bruce Polkowsky, Holly Salazer
USDOI, Fish and Wildlife Service – Tim Allen
USDA, Forest Service – Anne Acheson, Scott Copeland
USEPA – Anne Arnold, Anne McWilliams
NHDES – Andy Bodnarik, Charlie Martone, Jeff Underhill

Notes:

On August 27, 2008, the day before the conference call, NHDES received preliminary comments on the draft SIP by email from the U.S. Department of the Interior (DOI), National Park Service (NPS) and U.S. Fish and Wildlife Service (FWS). On the day of the call, NHDES received preliminary comments by email from the U.S. Department of Agriculture, U.S. Forest Service (USFS). The ensuing discussion during the call indicated the consensus of the FLMs that the draft SIP was well written and comprehensive but needed some "slight adjustments."

The call began with a general discussion of the overall SIP process with special reference to the vacatur of CAIR. All parties agreed that the vacatur was a major issue that needed to be addressed in the SIP but was not sufficient reason to delay moving toward completion of the SIP. It was noted that New Hampshire's draft plan was heavily dependent on implementation of CAIR by upwind states, even though New Hampshire was not a CAIR state itself.

It was suggested that New Hampshire's SIP make reference to CAIR up front, address the uncertainty created by the vacatur, and include a commitment to review the situation as it evolves. The review would include an updating of emission inventories, a check of other states' SIPs to determine whether the MANE-VU "Ask" (or equivalent measures) was incorporated, a comparison of "where we are now versus where we thought we would be," and appropriate revisions to the SIP by the first progress report due in 2012.

The remainder of the call was devoted to specific points raised by the FLMs in their emailed preliminary comments. New Hampshire's responses to these comments are provided in the accompanying document, "New Hampshire Regional Haze SIP Revision: Response to Federal Land Managers' Comments." Some additional points arising from the conference call were as follows:

- It was suggested that 1996 and 1999 national emissions inventory data were extraneous and could be removed from the SIP.
- A VISTAS report on smoke emissions (from prescribed fires and woodstoves) was available and might serve as a useful reference to New Hampshire.

- CALMET and CALPUFF were not modeled by MANE-VU exactly per EPA guidance. This distinction should be explained in the text.
- The SIP includes no contingency plan for discontinuance of monitoring sites. In the event of reduced federal funding or other cause, New Hampshire should consult with the FLMs on what actions could be taken to avoid loss of monitoring data.
- It should be noted in the SIP that Prevention of Significant Deterioration and regional haze planning are complementary programs.
- Final comments from USDA would be delayed perhaps 90 days.

Conference Call – September 18, 2008

Attendees:

USDOI, National Park Service – Bruce Polkowsky, Holly Salazer
USDOI, Fish and Wildlife Service – Sandra Silva
USDA, Forest Service – Scott Copeland
USEPA – Anne McWilliams
NHDES – Andy Bodnarik, Charlie Martone, Gary Milbury, Jeff Underhill

Notes:

This conference call was reserved for discussion of New Hampshire's BART analyses. NHDES received draft comments on the BART analyses from the National Park Service by email on September 16, 2008. Discussion during the conference call adhered closely to, and reiterated points contained in, the written comments. As a general comment, it was stated that New Hampshire's BART analyses needed more documentation and fine-tuning, with greater detail in the description of sources. It was requested that New Hampshire submit draft permits for the BART sources to the FLMs when the drafts become available.

The parties acknowledged that the latest projected costs of SO_2 scrubber controls for Merrimack Station were very high at around $1,000/kW – about triple what they were when first estimated in 2003. NPS has found that SO_2 scrubbers for other BART-eligible facilities typically have cost half this amount or less, but costs have been rising sharply. It was suggested that the BART analyses focus not just on incremental costs.

Some recent BART analyses conducted elsewhere have evaluated the project costs in terms of dollars per deciview of visibility improvement. BART control costs have been reported to be on the order of $10-15 million per deciview.

New Hampshire's responses to specific points raised by the FLMs in their emailed comments may be found in the accompanying document, "New Hampshire Regional Haze SIP Revision: Response to Federal Land Managers' Comments."

Postscript:

The day after September 18 conference call, Don Shepherd sent an email to NHDES providing technical information and costs on BART proposals for facilities in other parts of the country.

NHDES received final comments from DOI – NPS in a letter dated September 26, 2008. The final comments were not substantially changed from the preliminary comments received earlier.

United States Department of the Interior
NATIONAL PARK SERVICE
Air Resources Division
P.O. Box 25287
Denver, CO 80225

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:

September 26, 2008

N3615 (2350)

Robert R. Scott, Director
Air Resources Division
New Hampshire Department of Environmental Services
P.O. Box 95
29 Hazen Drive
Concord, New Hampshire 03302-0095

Dear Mr. Scott:

On August 1, 2008, the State of New Hampshire submitted a draft implementation plan describing your proposal to improve air quality regional haze impacts at mandatory Class I areas across your region. We appreciate the opportunity to work closely with the State through the initial evaluation, development, and, now, subsequent review of this plan. Cooperative efforts such as these ensure that, together, we will continue to make progress toward the Clean Air Act's goal of natural visibility conditions at all of our most pristine National Parks and Wilderness Areas for future generations.

This letter acknowledges that the U.S. Department of the Interior, U.S. Fish and Wildlife Service (FWS), and National Park Service (NPS) have received and conducted a substantive review of your proposed Regional Haze Rule implementation plan in fulfillment of your requirements under the federal regulations 40 CFR 51.308(i)(2). Please note, however, that only the U.S. Environmental Protection Agency (EPA) can make a final determination regarding the document's completeness and, therefore, ability to receive federal approval from EPA.

As outlined in a letter to each State dated August 1, 2006, our review focused on eight basic content areas. The content areas reflect priorities for the Federal Land Manager agencies, and we have enclosed comments associated with these priorities. We look forward to your response, as per section 40 CFR 51.308(i)(3). For further information, please contact Holly Salazer (NPS Northeast Region) at (814) 865-3100, or Tim Allen of the FWS Branch of Air Quality at (303) 914-3802.

Again, we appreciate the opportunity to work closely with the State of New Hampshire and compliment you on your hard work and dedication to significant improvement in our nation's air quality values and visibility.

Sincerely,

John Bunyak

for Christine L. Shaver
Chief, Air Resources Division
National Park Service

Sincerely,

Sandra V. Silva

Sandra V. Silva
Branch of Air Quality
U.S. Fish & Wildlife Service

Enclosure

cc:
Stephen Perkins (Suite 1100 CAA)
Director, Office of Ecosystem Protection
EPA New England
1 Congress Street, Suite 1100
Boston, Massachusetts 02114-2023

National Park Service and U.S. Fish and Wildlife Service Comments Regarding New Hampshire Draft Regional Haze Rule State Implementation Plan

On August 1, 2008, the State of New Hampshire (NH) submitted a draft Regional Haze Rule State implementation plan (SIP), pursuant to the requirements codified in federal rule at 40 CFR 51.308(i)(2), to the U.S. Department of the Interior, National Park Service (NPS) and U.S. Fish & Wildlife Service (FWS). The air program staff of the NPS and FWS have conducted a substantive review of the New Hampshire draft plan, and have provided the comments listed below. We look forward to the New Hampshire Department of Environmental Services (NHDES) response as per section 40 CFR 51.308(i)(3). For further information regarding these comments, please contact Holly Salazer of the NPS Northeast Regional Office at (814) 865-3100, or Tim Allen of the FWS Branch of Air Quality at (303) 914-3802.

General Comments:

Foremost, this is a well-written comprehensive SIP submission. The following two general issues, (1) the Clean Air Interstate Rule (CAIR) vacatur and (2) discrepancies in modeling between regional planning organizations (RPOs) are highlighted as broad range topics that merit more discussion through the consultation process.

The most significant issue is the CAIR vacatur and how eastern states are going to deal with this appropriately. As written, the draft SIP does not acknowledge the impact of the CAIR vacatur on emission inventories, modeling, Reasonable Progress Goals (RPG) calculations and Long Term Strategy (LTS) development, all of which depend on CAIR implementation. We suggest acknowledging the vacatur of CAIR in a more meaningful discussion within the narrative of the SIP rather than as a footnote stating the court remanded the rule back to EPA.

In addition, the SIP includes a comprehensive discussion of the MANE-VU "Ask" as an important part of the region and state's long-term emission control strategy. This issue is two-fold. First, as mentioned previously, there are discrepancies in modeling between MANE-VU's best and final runs and those of other RPO's due to the inclusion of the "Ask" in MANE-VU modeling runs. It is important that stakeholders understand how the RPO modeling runs differ and why the results may not be comparable between the RPOs. We commend the state on acknowledging this issue and trying to describe how MANE-VU made the modeling decisions that it did (Section 3.2.3 Technical Ramifications of Differing Approaches). Second, based on our experience, not all MANE-VU states will be incorporating the "Ask" commitments into their individual SIPs. If the final modeling includes reductions expected from the "Ask," and if not all MANE-VU states include the "Ask" in their SIP as commitments, New Hampshire (and other MANE-VU states as well) need to address this shortfall. New Hampshire states they support all state SIPs that include the "Ask" commitments, but there is no mention of how the state plans to deal with those states that do not.

Specific Comments:

Page 1, paragraph 5 – Edit "A state's long term strategy must including" to "must include".

Page 2, 1[st] footnote – See general comment above. Recommend including footnote in text and discuss how the vacatur affected NH decision-making.

Page 12 – Since visibility monitoring is accomplished by one site for both NH Class I areas, recommend changing title and text to reflect Figure 1.7 would be trend information for both wilderness areas and not just Great Gulf as the current text implies. Or establish early on that Great Gulf will be representative of both Class I areas throughout the SIP.

Page 13 – Recommend clarifying last set of bullets on trend plots. Since NHDES plots Worst Natural and Best Natural, the bullets should include this separation. For example, the worst 20% days are approximately 10 DV greater than Worst Natural. And the same is true for the second bullet, delineate which Natural trend line (worst or best) you are referring too.

Page 13, last paragraph into Page 14 – Need to revise text to reflect the CAIR vacatur. Currently, the text states that there will be significant decreases in SO2 emissions due to CAIR.

Page 14 – Recommend reminding reader that there is only one site for both Class I areas in NH and hence the decision to just include Great Gulf mass contributions OR include same figure titled Presidential Range-Dry River to reflect the state's knowledge of both Class I areas.

Page 20 – Recommend clarifying that both formal and informal consultation within MANE-VU has been on-going since establishment in 2001 with the bulk of formal consultation occurring in 2007 as outlined by Table 3.3.

Pages 22-23 – The state provides a comprehensive summary of its consultation efforts taken within and outside MANE-VU. However, the state does not include the end result of its consultation efforts with each of those states (not including the Canadian provinces, which NH includes). As stated, NH sent letters to all MANE-VU states, but what was their response? Same comment applies to meetings with MRPO and VISTAS. If results are included in an Appendix, then a summary of those results should be included in the SIP text. Or recommend referencing future sections that deal with consultation issues and results, e.g., section 3.2.2.3. and Section 3.2.4

Page 23, 2[nd] paragraph – Reference to CAIR needs to be addressed.

Page 25-26 – It is fair to state that non-MANE-VU states have not included the MANE-VU Ask in their SIPs, considering most of VISTA states have already submitted SIPs to EPA.

Page 29 – The state can include the date of August 1, 2008, as the date submitted to the NPS/FWS.

Page 29 – Text should be more specific as to the availability of FLM comments for public review and comment prior to the SIP submission to EPA.

Page 35, 1st bullet in 5.2 – Add "New" to the beginning of sentence #3.

Page 37, Figure 5.2 – Suggest including deciview measurements on the figure for context, same comment for Figure 5.4, 5.6, 5.7 (if deciview information is available), 5.10, 5.11, and 5.14.

Page 48 – Suggest deleting "The" in front of "New Hampshire" in paragraph 1, second half of sentence #3. Same comment for following paragraph.

Page 49, last paragraph – Change "calculated directed" to "calculated directly".

Page 58 –Identifies organic carbon (OC) as second largest contributor to haze but goes on to focus on large scale SO2 control measures. In Section 10.2.1, NH acknowledges the importance of OC but, based on the Contribution Assessment, it is determined that an early focus on additional SO2 reduction is more beneficial than targeting OC emissions at this current time. Organic emissions will play a more important role as regional haze planning moves into future planning periods. Organic carbon emissions need to be identified in terms of fire emissions and a commitment to tracking these emissions should be included in Section 11 under Agricultural and Forestry Smoke Management.

Page 58, second paragraph under 8.1 – Change Figure 8.11 to Figure 8.1.

Page 59, 2nd paragraph – Delete the first "one" in "one just one of".

Page 73 – "Thus, to the extent that these types of activities are found to affect visibility at Northeastern Class I areas, control measures targeted at crustal material may prove beneficial." Referring to PM coarse and fine contribution, SIP should state that further action on this item is the purview of EPA or state agencies.

Page 79, Section 9.0 BART – We understand that NH is currently working on completing draft permits for the two BART-eligible sources discussed below. We request that the state share the temporary permits with the FLMs when available.

Merrimack Station
According to the CAM database, the Merrimack Station consists of two coal-fired cyclone boilers with SCR for NOx control and ESPs for PM control, and two oil-fired combustion turbines. Based on the ages of these units, only one coal-fired cyclone boiler, Unit 2, is subject to BART. According to the CAM database, in 2007, emissions from Unit #2 were: 25,000 tpy SO2 (@ 2 lb/mmBtu) and 2,200 tpy NOx (@ 0.19 lb/mmBtu).

- NH concluded that a 90% efficient Flue Gas Desulfurization (FGD) system recently proposed by PSNH represents BART for SO2. NH provides no discussion of why this level of control was chosen.
- NH concluded that the current 85% efficient SCR system represents BART for NOx. NH provides no discussion of why this level of control was chosen.
- NH concluded that the current ESP represents BART for PM. NH provides no discussion of why this level of control was chosen.
- In conversation with NH staff regarding this BART determination, we learned that both coal-fired units will be controlled under legislation to reduce mercury emissions and they will share a common stack. In the regional haze SIP, NH should clarify which pollutants are being addressed and identify the associated emission limits, for each pollutant, at each boiler.

No economic or visibility benefits analysis was conducted because NH stated it was proposing the "most effective control option" for each pollutant. While it may be true that NH has proposed the "most effective control" option for each pollutant, NH is still obligated to evaluate each proposed control technology to determine the appropriate level of control efficiency for each control technology. For example, it is generally assumed that wet scrubbers can achieve at least 95% control efficiency, and that SCR can remove 90% of incoming NOx. NH should show why the Merrimack controls cannot perform as well.

Newington Station

According to the CAM database, the Newington Station consists of one oil- and gas-tangentially-fired boiler with an ESP for PM control, and two gas- and oil-fired combined cycle combustion turbines equipped with Dry-Low-NOx Burners and SCR. In conversation with NH staff, we have learned that only the coal-fired Unit #1 is subject to BART. According to the CAM database, in 2007, emissions from Unit #1 were: 2,300 tpy SO2 (@ 1 lb/mmBtu) and 415 tpy NOx (@ 0.16 lb/mmBtu).

- NH concluded that a FGD system is too expensive. (No cost analysis was provided.) NH proposes that the sulfur limit on the #6 residual oil be reduced to 1%. NH provides no discussion of why this level of control was chosen as BART for SO2.
- NH concluded that the current combustion controls represent BART for NOx. NH eliminates SNCR ($3,000 - $5,000/ton) and SCR ($5,000 - $6,000/ton) on the bases of costs, but provides no information on how these costs were estimated.
- NH concluded that the current ESP, combined with use of cleaner fuel oil, represents BART for PM.

No basis for the economic analyses was provided and no visibility benefits analyses were conducted. While this is a relatively small, clean boiler, NH is still obligated to evaluate each proposed control strategy to determine the appropriate level of control for each source. For example, it may be that fuel oil with sulfur content lower than the proposed 1% is economically feasible; NH should evaluate that option, as well as provide a cost analysis for adding a FGD system.

Page 86-87 – Recommend referencing section in 3.0 regarding Canada consultation as source for the input for RPG.

Page 89, Section 10.2.2 – Reference to CAIR satisfying BART in CAIR states.

Page 90, Section 10.2.3 – Concern that not all MANE-VU states have committed to low-sulfur fuel oil strategy.

Page 97, Reasonableness of Targeted EGU SO2 Reduction Strategy – SIP needs to acknowledge CAIR vacatur.

Page 99 – Base case modeling used CAIR as baseline, with the vacatur of CAIR, how will that affect modeling assumptions and outputs?

Page 103 – Recommend clarification of last sentence of first paragraph, i.e. that the 4 factor analysis *for the low-sulfur fuel oil strategy* was described in Section 10.2.3 of this section.

Page 105, Table 10.7 – typo in 3rd row (caol to coal). Typo in 4th row (High-Sulfur).

Page 100-107, 10.2.5 Non-EGU SO2 Emissions Reduction Strategy for Non-MANE-VU States – Our experience is that non-MANE-VU states have not committed to this 28% reduction from ICI Boilers in their RH SIPs. How will this affect NH's overall LTS?

Page 113, Section 11.3 Existing Commitments to Reduce Emissions – Recommend providing a reference to future sections for the specifics on control programs assessed, e.g. sections 11.3.1, 11.3.2, and 11.3.3.

Page 114, 11.3.1 Controls on EGUs Expected by 2018 – Individual state control programs are highlighted, in addition to North Carolina Clean Smokestacks Act and consent decrees in VISTAS, but CAIR remains the most significant strategy for controls on EGUs.

Page 116, 1st bullet under NH EGU Regulations – Suggest adding "fuel" to "fossil-fired".

Page 121 – NH's Long Term Strategy includes planned commitments by other states that are not enforceable.

Page 122 – Admits states "have agreed to pursue" the suite of additional control measures (i.e., the "Ask") and "hopes" non-MANE-VU states do the same or equivalent over the next 10 years.

Page 122 – 11.4.1 Implementation of BART – Question of the assumption (which is no longer so) of CAIR satisfying BART for the EGU sector.

Page 123, Section 11.4.3 Targeted EGU Strategy – Recommend revising last sentence of 1st paragraph to include, "…to mitigating haze pollution in wilderness areas *and national parks* of the Northeast states."

Page 123 – Explanation as to why MANE-VU is asking for 90% reduction on targeted EGUs in other RPOs when NH is only netting a 75% reduction from one of their two BART sources.

Page 126, 11.7 Agricultural and Forestry Smoke Management, 1st sentence of 3rd paragraph – typo "… the cause off" to "… the cause of".

Page 126 – Suggest adding whether or not NH anticipates the potential of smoke impacts to stay the same, increase or decrease by 2018. Also, since Organic Carbon is the second largest contributor to visibility impairment in the MANE-VU region and will become more important for regional haze planning, recommend adding a commitment to track fire emissions in the future. Research would also be helpful in determining whether emissions from wood-burning stoves or fire emissions from agriculture or forestry management are more significant to the region.

Page 127, 2nd to last paragraph, 2nd sentence – Typo "to obtained 2018 projected concentrations for each day" to "to *obtain* 2018 projected concentrations…"

Page 128 last paragraph – Suggest ending the explanation of the position of the purple star to state that "Similarly, the position of the purple star below the dashed line indicates predicted improvements on days of best visibility *may be greater than predicted natural background conditions.*"

Page 129 – Figure 11.1, the light-green dash (–) that represents the theoretical 20 percent best visibility value under natural conditions (i.e., no anthropogenic emissions) at 2064 can not be seen. Same comment true for Figure 11.6 on page 132.

Page 133 – Need to deal with CAIR no longer a part of the LTS.

Page 134 Section 11.11 Enforceability of Emission Limitations and Compliance Schedules – Whereas the SIP text talks about the specific BART determinations being codified (and hence enforceable) within state law, the enforceability of the other components of the LTS, such as fuel oil strategy and targeted EGU strategy, is not mentioned or dealt with. This is a critical requirement of the SIP, to have all expected (and modeled) emission reductions enforceable throughout the MANE-VU region.

USDA United States Department of Agriculture | Forest Service | White Mountain National Forest | 719 N. Main Street
Laconia, NH 03246
Comm: (603) 528-8721
TTY: (603) 528-8722

File Code: 2580-2
Date: October 2, 2008

Commissioner Thomas Burack
NH Department of Environmental Services
PO Box 95, 29 Hazen Drive
Concord, NH 03302-0095

Dear Commissioner Burack:

On July 21st, 2008, we received a draft implementation plan from the State of New Hampshire that describes your proposal to improve air quality regional haze impacts at mandatory Class I areas in your state. We appreciate the opportunity to work closely with the State through the initial evaluation, development, and now, subsequent review of this plan. Cooperative efforts such as these ensure that, together, we will continue to make progress toward the Clean Air Act's goal of natural visibility conditions at our Class I wilderness areas and parks.

This letter acknowledges that the U.S. Department of Agriculture, U.S. Forest Service has received and conducted a substantive review of your proposed Regional Haze Rule implementation plan. Please note, however, that only the U.S. Environmental Protection Agency (EPA) can make a final determination about the document's completeness, and therefore, only the EPA has the ability to approve the document. The Forest Service's participation in the State of New Hampshire's administrative process does not waive any legal defenses or sovereignty rights it may have under the laws of the United States, including the Clean Air Act and its implementing regulations.

Our review focused on eight basic content areas which reflect priorities for the Forest Service. We have attached comments to this letter. We look forward to your response required by 40 CFR 51.308(i)(3). For further information, please contact Scott Copeland, Regional Haze SIP Review Coordinator, at (307) 332-9737 or Ann Acheson, National Air Program Manager, at (202) 205-0800.

Again, we appreciate the opportunity to work closely with the State of New Hampshire. The Forest Service compliments you on your hard work and dedication to significant improvement in our nation's air quality values and visibility.

If there is anything I can do personally to help coordinate our agencies interaction on this important work please do not hesitate to contact me at 528-8774.

Sincerely,

THOMAS G. WAGNER
Forest Supervisor

cc: Ann Acheson, Scott A Copeland, Livia Crowley, Thomas R Doane

White Mountain National Forest Comments on New Hampshire's Regional Haze State Implementation Plan

Clean Air Interstate Rule (CAIR) Vacatur – New Hampshire Department of Environmental Services (DES) has chosen to submit a draft State Implementation Plan (SIP) which contains language which is heavily dependent on the results of CAIR for emissions projections, reasonable progress goals, etc. The reasons provided for this include the fact that NH DES was not notified by EPA to change its assumptions and that CAIR states are assumed to need to reduce emissions commensurate with CAIR to achieve regional haze and other air quality goals. We support this decision and add the following supporting reasoning:

- NH is not a CAIR state. Hence its proposed control strategies aren't affected by the vacatur.
- NH demonstrates its "fair share" of emissions reductions compared to CAIR states.
- Removing references to CAIR from the SIP would not result in any reductions in impacts at Class I areas. In fact since Best Available Retrofit Technology (BART) controls are to be in effect within 5 years of SIP approval, revising the SIP would actually SLOW controls expected to have a real impact at nearby Class I areas.
- There is no guarantee that the successor to CAIR will be forthcoming any time soon, hence waiting for new modeling efforts could add years to a SIP which is already 7 months late.
- The iterative process of the Regional Haze Rule allows a perfect opportunity for NH to thoroughly review regional haze in a post CAIR world in the 2012 progress report, and **NH should commit to do this.**

Table 10.8 (Page 107) -

Worst Day baseline is 22.8 deciview (dv), Reasonable Progress Goal (RPG) for 2018 is 19.1dv, and Improvement by 2018 is 2.7dv. These numbers do not add up. Is the RPG supposed to be 20.1 or is the improvement supposed to be 3.7 dv?

Agriculture and Forestry Smoke – Suggest changes to last paragraph of p 126 to read:

"Nevertheless, New Hampshire intends to consult with the Forest Protection Bureau of the New Hampshire Department of Agriculture and with the New Hampshire Department of Resources and Economic Development (DRED) to consider smoke management in agricultural and forestry practices to address visibility effects at MANE-VU Class I Areas. The results of these efforts will be documented in the first regional haze SIP progress report in 2012."

Shifting smoke impacts from clear and hazy days to other days is not consistent with the intent of the Regional Haze Rule, and all nearby Class I areas need to be considered, not just Great Gulf and Presidential Range - Dry River.

PSD as an element of RH SIP –
We feel it would be appropriate for NH DES to discuss the relationship between the Regional Haze Plan and requirements of the Prevention of Significant Deterioration (PSD) program within the SIP. **Specifically, how does NH DES anticipate addressing new sources of air pollution in the PSD process in regards to its reasonable progress goals and long term strategy; and how will it analyze the effects of emissions from these new sources on progress toward the interim visibility goals established under this SIP.**

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 1
1 Congress Street, Suite 1100
BOSTON, MA 02114-2023

October 24, 2008

Jeff Underhill
Air Resources Division
New Hampshire Department of Environmental Services
29 Hazen Drive, PO Box 95
Concord, NH 03302-0095

Dear Mr. Underhill:

Previously, EPA received a preliminary draft of New Hampshire's Regional Haze State Implementation Plan (SIP). EPA provided written comments on the preliminary draft to New Hampshire in a letter dated July 10, 2008.

Subsequently, we received a revised version of New Hampshire's draft Regional Haze SIP. We have reviewed the revised draft and found that New Hampshire has adequately addressed most, but not all, of our previous comments. You will find our comments on the revised draft in the Enclosure.

If you have any questions on these comments, please contact Anne McWilliams of my staff at 617-918-1697.

Sincerely,

Anne Arnold

Anne Arnold, Manager
Air Quality Planning Unit

Enclosure

Enclosure

EPA Comments on New Hampshire's Draft Regional Haze SIP (7/18/08)

BART Determinations

As mentioned on page 81, 40 CFR 51.308(e)(1)(A) states "The determination of BART (Best Available Retrofit Technology) must be based on an analysis of the best system of continuous emission control technology available and associated emission reductions achievable for each BART-eligible source that is subject to BART within the State. In this analysis, the State must take into consideration the technology available, the cost of compliance, the energy and non-air quality environmental impacts of compliance, any pollution control equipment in use at the source, the remaining useful life of the source, and the degree of improvement in visibility which may reasonably be anticipated to result from the use of such technology."

Although NHDES referenced the MANE-VU five factor analysis of BART-eligible sources for available control options and general analysis of the required factors, additional detail is needed specific to the New Hampshire BART sources, particularly in the areas of expected visibility improvement and cost of compliance. This is especially important in the case where NHDES is proposing a level of control less stringent than that recommended by the MANE-VU BART workgroup.

Merrimack Station:

SO_2

Under the "Available Retrofit Technologies for SO_2 Control," New Hampshire discusses control via a wet flue gas desulphurization (FDG or "scrubber") system. This discussion indicates that FGD "can be designed to remove greater than 95 percent of incoming SO_2." Therefore, NHDES should explain why New Hampshire is proposing a final control level of only 90%.

Page 82, Footnote 17 – This footnote indicates that the New Hampshire Clean Powers Act requires an 80% control level from the FGD. It further indicates that once the unit demonstrates a sustainable control level greater than 80%, the requirement is raised to that higher level. NHDES should expand on what is considered demonstrating a sustainable control level and the anticipated timeframe for achieving this higher level of control.

PM_{10}

The Appendix X discussion of the current control level in respect to PM_{10} for the Merrimack unit lists the current control as electrostatic precipitators (ESP)s with a control level of 85%. On page 84, Table 9.4, "PM_{10} Emission Reductions Resulting from Application of BART Controls," lists the current control as 97% control. NHDES should clarify whether 85% or 97% is the current level of control, and clearly state what level of control has been determined to represent BART.

Newington Station:

SO_2

Newington Station is one of the 167 stacks which impacts a Class 1 area as well as a BART source. FGD would be expected to reduce SO_2 emissions by 95%, while New Hampshire's proposal to require 1% sulfur fuel would only achieve a 50% reduction. In addition, the MANE-VU "ask" includes 0.5% sulfur fuel for the 167 stacks and 0.3% sulfur fuel has been recommended as BART by the MANE-VU BART workgroup. Therefore, it is not clear why New Hampshire has determined that a less stringent requirement of 1% sulfur fuel represents BART for this source. NHDES should include an analysis of the feasibility of implementing these other control strategies at Newington, as well as a discussion of the visibility impacts of various strategies, especially if NHDES determines that an option less stringent than the MANE-VU recommendations is BART.

PM_{10}

Appendix X indicates that Newington currently has a permitted daily cap of 0.22 lb/MMBtu and currently operates an ESP. Table 9.4, "PM_{10} Emission Reductions Resulting from Application of BART controls," lists the current level of control (which is proposed as BART) to be 56%. The MANE-VU BART workgroup recommendation for non-CAIR EGUs, however, is 0.02 – 0.04 lb/MMBtu. Also, as stated in the available retrofit technologies for PM_{10} control, rebuilt ESPs can achieve collection efficiencies of more than 99%. Therefore, it is not clear why New Hampshire has determined that current controls, which are less stringent than the MANE-VU recommendation, are sufficient for BART. NHDES should examine (and document) other options before concluding that current controls are BART.

Enforceability

Table 9.3 and 9.4 indicate that, for NOx and PM, respectively, "current controls (ESP, SCR, etc.) are BART." It should be noted that BART requirements must be federally enforceable. Therefore, the BART discussion should reference the specific existing federally enforceable requirements that require these "current controls." Alternatively, if the requirements implementing the current controls are not yet federally enforceable, they must be submitted to EPA as a SIP revision.

Section 9.4.2 Bart-Eligible EGUs and the role of CAIR

Massachusetts is classified as a seasonal CAIR state and should not be included in the list of Non-CAIR states.

Section 3.2.2.2 Meeting the "Ask" – New Hampshire

Merrimack Station and Newington Station have both been identified as BART sources and as two of the top 167 stacks contributing to visibility impairment in a MANE-VU Class I area. The MANE-VU "Ask" requests that the 167 stacks be controlled to the 90% level. This section of New Hampshire's SIP states that NHDES has determined that 90% control is not reasonable for the Newington station at this time but that NHDES anticipates that controls installed at the Merrimack station will result in over-compliance, thereby partially offsetting the lesser control at Newington. According to the BART determination, however, Merrimack station is only expected to be controlled at the 90% level. NHDES should explain why 90% control of SO_2 at Newington is not reasonable and why BART for SO_2 at Merrimack station is set at 90% if the level of control is expected to be greater than 90%.

Section 11.9 New Hampshire's Share of Emission Reductions

In discussing New Hampshire's obligation to meet its share of emission reductions, NHDES references:

> "Emission controls on targeted in-state EGUs that contribute to visibility impairment at Class I area in the region – more specifically, compliance with New Hampshire law RSA 125-O, Multiple Pollutant reduction Program, which mandates the installation of scrubbers on PSNH Merrimack Station Units 1 and 2 by July 1, 2013, to control SO_2 and mercury emissions; these controls will reduce SO_2 emissions by a minimum of 80% from 2002 levels;"

In the "meeting the ask" section, the control level of Merrimack station is stated to be in excess of 90%, while in the BART discussion it is expected to be 90%, and the discussion above references 80%. NHDES should clarify what level of SO_2 control will be required and what mechanism is going to be used to make the SO_2 control federally enforceable.

In addition, this section discusses a low sulfur fuel strategy. What mechanism is New Hampshire planning to use to make the low sulfur fuel strategy federally enforceable?

New Hampshire Regional Haze SIP Revision
Response to EPA's Comments

NHDES received comments from the U.S. Environmental Protection Agency (EPA) on New Hampshire's preliminary draft Regional Haze SIP. The purpose of these comments was to provide early feedback on New Hampshire's efforts, focusing on information specific to New Hampshire. NHDES made substantive changes to the draft SIP in the period following receipt of EPA's comments on July 10, 2008, before distributing a revised version to EPA and the FLMs on July 22, 2008. NHDES received additional comments from EPA on the revised draft SIP in a letter dated October 24, 2008.

The following is a point-by-point response to specific comments by EPA. Because the SIP document has been repaginated, reference is made to sections or parts instead of page numbers. **Comments are written in *italics* and responses are written in regular font.**

2. Areas Contributing to Regional Haze – *"The fifth paragraph on page 17* [now page 16] *discusses the decline in sulfate concentration expected in the Great Gulf and Presidential Dry River Wilderness areas by 2018. The discussion should indicate which modeling results/control strategies are being used to develop these projections."*

The following has been added to the text: "The modeling that produced these results is described in Section 7, Air Quality Modeling, and in '2018 Visibility Projections,' May 13, 2008 (Attachment Q). The emission control programs responsible for the projected visibility improvements are described in Section 11, Long-Term Strategy."

2.2 States Contributing to Visibility Impairment in New Hampshire's Class I Areas – *"In the discussion of states or regions contributing to visibility impairment at New Hampshire's Class I areas, MANE- VU is noted as contributing 27.83% (per Table 2.2). The next highest contribution is from 'Other' at 23.54%. Given the magnitude of this category relative to the total MANE-VU contribution, NH should include some discussion of the components of the 'Other' category."*

A statement defining the "Other" category has been added to the text.

3.2.2.2 Meeting the "Ask" – New Hampshire – *"Merrimack Station and Newington Station have both been identified as BART sources and as two of the top 167 stacks contributing to visibility impairment in a MANE- VU Class I area. The MANE- VU "Ask" requests that the l67 stacks be controlled to the 90% level. This section of New Hampshire's SIP states that NHDES has determined that 90% control is not reasonable for the Newington station at this time but that NHDES anticipates that controls installed at the Merrimack station will result in over-compliance thereby partially offsetting the lesser control at Newington. According to the BART determination, however, Merrimack station is only expected to be controlled at the 90% level. NHDES should explain why 90% control of SO_2 at Newington is not reasonable and why BART for SO_2 at Merrimack station is set at 90% if the level of control is expected to be greater than 90%."*

A required minimum control level of 90 percent for SO_2 emissions has been included as an operating condition in Merrimack Station's air permit. As a practical matter, because no facility can operate exactly at the minimum required performance level in a continuous fashion without excursions, it will be necessary to overshoot the minimum to ensure compliance. In actual practice, therefore, the effective level of SO_2 emission reductions is expected to exceed 90 percent on average. Furthermore, the air permit requires the facility to achieve the maximum sustainable rate of control (above the specified minimum) as determined from NHDES's review of monthly performance data submitted after December 31, 2014. It is important to note that the FGD for Merrimack Station will be optimized for mercury reductions (80% minimum), with performance guarantees for same. The vendor would not provide a simultaneous guarantee for SO_2 removal. Nevertheless, the expectation is that this FGD system will provide an SO_2 control level not significantly different from units optimized for SO_2 reduction.

With respect to Newington Station, the facility's low capacity factor, coupled with the high cost of flue gas desulfurization (estimated to be well in excess of $1,000/kW for this facility), make 90 percent control of SO_2 economically infeasible.

Section 9, Best Available Retrofit Technology (BART), and Attachment X, BART Analyses for Sources in New Hampshire, have been revised and expanded to provide further description of these matters.

3.2.5 State/Tribe and Federal Land Manager Coordination – *"As noted on page 32, the Regional Haze rule requires a 60 day comment period for Federal Land Managers (FLMs) before the public hearing. While timing may preclude the development of a response to these comments before the hearing, we recommend that any comments submitted by the FLMs be included in the materials provided for the public hearing."*

NHDES has incorporated responses to the FLMs' comments into the draft final SIP more than 30 days prior to the public hearing.

6.3.1 Stationary Point Sources – *"On page 51, regarding Electrical Generating Units (EGUs) emissions inventories, there is discussion of the use of continuous emissions monitoring (CEM) data to develop hourly emissions profiles. Although use of CEM data makes sense given its high degree of accuracy, emissions from EGUs can vary widely from one day to another, and also vary greatly from season to season. How were the CEM hourly emissions profiles determined? NH should note that use of seasonal or annual average profiles may lead to an underestimation of visibility impacts on the worst 20% days. NH should include additional detail on how CEM data was used to develop hourly emission profiles."*

The text states: "The base-year inventory for EGU sources was based on 2002 continuous emissions monitoring (CEM) data reported to EPA in compliance with the Acid Rain Program or 2002 state emissions inventory data. The CEM data provided actual hourly emission values used in the modeling of SO_2 and NO_X emissions from these large sources…" The relevant fact is that the data employed for the base-year inventory were actual hourly emissions values taken directly from the CEM outputs. Therefore, the original description is accurate. The following has been added to the text: "See Chapter II, Section A.2.a.i of the 'Technical Support Document for 2002 MANE-VU SIP Modeling Inventories,' Version 3 (Attachment M) for a discussion of the quality assurance steps performed on the CEM data that were included in the 2002 baseline modeling inventory."

6.4 Summary of Emissions Inventories – *"It is not clear why there is such a significant drop in PM 10 from area sources between the 2018 BOTW and 2018 most recent modeling (Table 6-3 VB. Table 6-4). NH should provide additional detail on this issue."*

The following footnote was added to Table 6.4 to explain discrepancies in area source PM_{10} values among the four tables:

> "An adjustment factor was applied during the processing of area source emissions data to restate fugitive particulate matter emissions. Grid models have been found to overestimate fugitive dust impacts when compared with ambient samples; therefore, an adjustment is typically applied to account for the removal of particles by vegetation and other terrain features. The summary emissions for PM_{10} in Table 6.4 reflect this adjustment. Comparable adjustments were not made to PM_{10} values listed in Tables 6.1 through 6.3."

9.4.1 BART Determinations and Required Control Levels –

"The attachment which details the analysis for New Hampshire's BART sources has not been provided. EPA needs to review this attachment in order to determine if New Hampshire's BART determinations and required control levels are reasonable. However, we do have some preliminary feedback on the limited information that was provided in main text."

The relevant attachments included with the SIP are as follows:

ATTACHMENT W – MANE-VU Five-Factor Analysis of BART-Eligible Sources
ATTACHMENT X – BART Analyses for Sources in New Hampshire
ATTACHMENT Z – Assessment of Control Technology Options for BART-Eligible Sources

"Table 9.2 indicates that the BART emission limit for Newington Station unit NT-l is 'limited to no more than 1.0% sulfur by weight for #6 fuel oil.' The MANE-VU BART Workgroup Recommendations DRAFT Presumptive Control Levels (Updated September 7, 2006) for Non-CAIR EGUs is to use 0.3% sulfur content oil. Was this level of control analyzed?"

A review of fuel oil availability indicates that reliable supplies of residual fuel oil with a sulfur content of 0.5% or lower cannot be assured over the near term. Therefore, use of ultra-low-S residual fuel oil cannot be recommended as BART at this time. The question of ultra-low-S fuel availability will be reviewed and reconsidered in advance of the first regional haze progress report in 2013.

"In addition, Table 9.2 indicates a BART control level of 80% control of SO_2 for Merrimack Station and 50% control of SO_2 for Newington Station. Both of these sources are included in the MANE-VU '167 stacks.' MANE-VU is requesting 90% control of the 167 stacks. On page 28, New Hampshire states, 'NHDES has determined that controlling the latter facility (Newington) to the 90 percent level of the Ask is not reasonable at this time and will seek alternative measures to achieve the equivalent overall reduction in SO_2 emissions.' NH should include a discussion of the analysis that led to this determination, as well as more information on the referenced alternative measures."

Please see response given for 3.2.2.2 regarding the 90% percent control level for SO_2 emissions. The 80% control level is for mercury emissions, for which Merrimack Station will be optimized. The FGD system controlling mercury emissions to this level is expected to achieve a simultaneous reduction in SO_2 emissions of *at least* 90%. NHDES believes that actual SO_2 emission reductions in excess of 90% for Merrimack Station, coupled with lower emissions resulting from the use of low-sulfur fuel and recently reduced utilization rates for Newington Station after the 2002 baseline year, will yield overall SO_2 emission reductions equivalent to the Ask. These reductions do not count potential benefits from additional control measures that would reduce SO_2 emissions or yield equivalent reductions in other visibility-impairing pollutants – including but not limited to further emission controls for industrial, commercial, and institutional boilers; strengthened controls on various VOC sources, and use of ultra-low-sulfur fuels. NHDES will be examining the feasibility of implementing additional control measures in advance of the first regional haze progress report in 2013.

"Furthermore, Tables 9.3 and 9.4 indicate that, for NOx and PM, respectively, 'current controls (ESP, SCR, etc.) are BART.' It should be noted that BART requirements must be federally enforceable. Therefore, the BART discussion should reference the specific existing federally enforceable requirements that require these 'current controls.' Alternatively, if the requirements implementing the current controls are not yet federally enforceable, they must be submitted to EPA as a SIP revision."

Enforceable emission control requirements for Merrimack Station Unit MK2 and Newington Station Unit NT1 are specified in the current air permits for these facilities: Merrimack Station, Temporary Permit #TP-0008; and Newington Station, Title V Operating Permit #TV-OP-054.

"As mentioned on page 81, 40 CFR 51.308(e)(l)(A) states 'The determination of BART (Best Available Retrofit Technology) must be based on an analysis of the best system of continuous emission control technology available and associated emission reductions achievable for each BART-eligible source that is subject to BART within the State. In this analysis, the State must take into consideration the technology available, the cost of compliance; the energy and non-air quality environmental impacts of compliance, any pollution control equipment in use at the source, the remaining useful life of the source and the degree of improvement in visibility which may reasonably be anticipated to result from the use of such technology.'

"Although NHDES referenced the MANE-VU five factor analysis of BART-eligible sources for available control options and general analysis of the required factors, additional detail is needed specific to the New Hampshire BART sources, particularly in the areas of expected visibility improvement and cost of compliance. This is especially important in the case where NHDES is proposing a level of control less stringent than that recommended by the MANE-VU BART workgroup."

The BART analyses for New Hampshire's two BART-eligible sources have been revised and expanded to provide a more complete description of visibility improvements and estimated control costs. See Section 9, Best Available Retrofit Technology (BART), and Attachment X, BART Analyses for Sources in New Hampshire.

Merrimack Station, SO_2:

"Under the 'Available Retrofit Technologies for SO_2 Control,' New Hampshire discusses control via a wet flue gas desulphurization (FDG or "scrubber) system. This discussion indicates that FGD 'can be designed to remove greater than 95 percent of incoming SO_2.' Therefore, NHDES should explain why New Hampshire is proposing a final control level of only 90%."

"Page 82, Footnote 17 - This footnote indicates that the New Hampshire Clean Powers Act requires an 80% control level from the FGD. It further indicates that once the unit demonstrates a sustainable control level greater than 80%, the requirement is raised to that higher level. NHDES should expand on what is considered demonstrating a sustainable control level and the anticipated timeframe for achieving this higher level of control."

Please see response given for 3.2.2.2. New Hampshire has specified a *minimum* SO_2 control level of 90% for Merrimack Station. The *actual* control level may approach the 95% rate that is typical of new FGD systems. The reference to 80% control is for mercury emissions, for which Merrimack Station will be optimized. Clarifying language on emission rates and expected control levels is provided in Section 9 and Attachment X of the SIP revision.

Merrimack Station, PM_{10}:

"The Appendix X discussion of the current control level in respect to PM_{10} for the Merrimack unit lists the current control as electrostatic precipitators (ESP)s with a control level of 85%. On page 84, Table 9.4, 'PM₁₀ Emission Reductions Resulting from Application of BART Controls,' lists the current control as 97% control. NHDES should clarify whether 85% or 97% is the current level of control, and clearly state what level of control has been determined to represent BART."

The BART determination for Merrimack Station Unit MK2 calls for the continued use of the two ESPs in series, at existing control levels. Based on emissions records for the 2002 baseline year, the control levels were estimated to be 99+% for total filterable PM and 97% for filterable PM_{10} (not accounting for condensable fraction of particulate matter).

Newington Station, SO_2:

"Newington Station is one of the 167 stacks which impacts a Class 1 area as well as a BART source. FGD would be expected to reduce SO_2 emissions by 95%, while New Hampshire s proposal to require 1 % sulfur fuel would only achieve a 50% reduction. In addition, the MANE-VU 'ask' includes 0.5% sulfur fuel for the 167 stacks and 0.3% sulfur fuel has been recommended as BART by the MANE-VU BART workgroup. Therefore, it is not clear why New Hampshire has determined that a less stringent requirement of 1 % sulfur fuel represents BART for this source. NHDES should include an analysis of the feasibility of implementing these other control strategies at Newington as well as a discussion of the visibility impacts of various strategies, especially if NHDES determines that an option less stringent than the MANE-VU recommendations is BART."

Please see previous response given for 3.2.2.2 regarding the 167 stacks as well as the previous response given in reference to Table 9.2 about the use of ultra-low-sulfur residual fuel oil for Newington Station.

Newington Station, PM_{10}:

"Appendix X indicates that Newington currently has a permitted daily cap of 0.22 lb/MMBtu and currently operates an ESP. Table 9.4, 'PM₁₀ Emission Reductions Resulting from

Application of BART controls,' lists the current level of control (which is proposed as BART) to be 56%. The MANE-VU BART workgroup recommendation for non-CAIR EGUs, however, is 0.02 - 0.04 lb/MMBtu. Also, as stated in the available retrofit technologies for PM_{10} control, rebuilt ESPs can achieve collection efficiencies of more than 99%. Therefore, it is not clear why New Hampshire has determined that current controls, which are less stringent than the MANE-VU recommendation, are sufficient for BART. NHDES should examine (and document) other options before concluding that current controls are BART."

The 2002 baseline PM emissions for Newington Station Unit NT1 were 196 tons, representing an estimated removal efficiency of 42% (as corrected in new Table 9.3 and Attachment X). Control costs for ESP technology at this throughput level are estimated to exceed $20,000 per ton removed. Given the very low utilization rates for this plant since 2002 and the high costs of PM control technology, additional measures for PM control at this facility cannot be justified as BART.

Enforceability:

"Table 9.3 and 9.4 indicate that, for NOx and PM, respectively, 'current controls (ESP, SCR, etc.) are BART.' It should be noted that BART requirements must be federally enforceable. Therefore, the BART discussion should reference the specific existing federally enforceable requirements that require these 'current controls.' Alternatively, if the requirements implementing the current controls are not yet federally enforceable, they must be submitted to EPA as a SIP revision."

Please see previous response given in reference to Tables 9.3 and 9.4 regarding enforceable requirements and facility permits.

9.4.2 Bart-Eligible EGUs and the role of CAIR – *"Massachusetts is classified as a seasonal CAIR state and should not be included in the list of Non-CAIR states."*

The corresponding statement in the text (now located in Part 9.3.3 of Section 9) has been corrected.

11.5 Additional Factors Considered –

"Section 51.308(d)(3)(v) of the Regional Haze rule states, 'The States must consider, at a minimum, the following factors in developing its long term strategy:

(B) Measures to mitigate the impacts of construction activities;

(C) Emission limitations and schedules for compliance to achieve reasonable progress goals;

(E) Smoke management techniques for agriculture and forestry management purposes including plans as currently exist within the state for these purposes.'

New Hampshire's SIP should include more detail in these areas."

The text on construction activities has been expanded and is now found at 11.6 Measures to Mitigate the Impacts of Construction Activities.

Text on emission limitations and compliance schedules has been added at 11.10 Emission Limitations and Compliance Schedules. Additional relevant text is located at 11.11 Enforceability of Emission Limitations and Control Measures.

The text on agricultural and forestry smoke management has been expanded and is now found at 11.7 Agricultural and Forestry Smoke Management.

11.8-11.9 New Hampshire's share of Emission Reductions – *"More discussion should be included that connects New Hampshire emissions, and emission reductions, with meeting the reasonable progress goals for the Class I areas that New Hampshire impacts. Also, New Hampshire should discuss how it is meeting its apportionment of emission reductions agreed upon in the regional planning process."*

An expanded description, now found at 11.8 Estimated Effects of Long-Term Strategy on Visibility Improvement, demonstrates that MANE-VU's long-term strategy will achieve visibility improvements surpassing the calculated uniform rate of progress. A new subsection, 11.9 New Hampshire's Share of Emission Reductions, has been added to describe how New Hampshire will meet its share of emission reductions, consistent with the reasonable progress goals.

11.9 New Hampshire's Share of Emission Reductions – *"In discussing New Hampshire s obligation to meet its share of emission reductions, NHDES references: 'Emission controls on targeted in-state EGUs that contribute to visibility impairment at Class I area in the region – more specifically, compliance with New Hampshire law RSA l25-O , Multiple Pollutant reduction Program, which mandates the installation of scrubbers on PSNH Merrimack Station Units l and 2 by July 1 , 2013 , to control SO_2 and mercury emissions; these controls will reduce SO_2 emissions by a minimum of 80% from 2002 levels;' In the 'meeting the ask' section, the control level of Merrimack station is stated to be in excess of 90%, while in the BART discussion it is expected to be 90%, and the discussion above references 80%. NHDES should clarify what level of SO_2 control will be required and what mechanism is going to be used to make the SO_2 control federally enforceable. In addition, this section discusses a low sulfur fuel strategy. What mechanism is New Hampshire planning to use to make the low sulfur fuel strategy federally enforceable?"*

Please see previous response given for 3.2.2.2 about SO_2 control level and previous response provided in reference to Tables 9.3 and 9.4 regarding enforceability. NHDES has prepared a proposed rule change to require use of low-sulfur fuel oil (see Attachment FF, Draft Revisions to Env-A 1604, Sulfur Content Limits for Liquid Fuels).

New Hampshire Regional Haze SIP Revision
Response to Federal Land Managers' Comments

NHDES received preliminary comments on New Hampshire's draft Regional Haze SIP from the U.S. Department of the Interior (DOI), National Park Service (NPS) and U.S. Fish and Wildlife Service (FWS) on August 27, 2008, and from the U.S. Department of Agriculture, U.S. Forest Service (USFS) on August 28, 2008. Final comments from DOI – NPS and FWS were received in a letter dated September 26, 2008. Final comments from USFS were received in a letter dated October 2, 2008. Conference calls to discuss the agencies' comments were held on August 28 and September 18, 2008, with representatives from NPS, USFS, USFWS, EPA, and NHDES in attendance. NHDES's responses to the FLMs' comments are described below.

Comments from the U.S. Department of the Interior, National Park Service and U.S. Fish and Wildlife Service

General Comments: DOI – NPS and FWS found New Hampshire's Regional Haze SIP to be well written and comprehensive. The vacatur of CAIR and discrepancies in modeling (especially inclusion of the MANE-VU Ask) between MANE-VU and other RPOs were identified as broad topics that warrant further discussion through the consultation process.

General Response: NHDES acknowledges that the vacatur (now remand) of CAIR has represented a significant difficulty for the states in attempting to comply with the Regional Haze Rule. While NHDES sees the unresolved CAIR situation as a complicating factor, it is not an absolute impediment to making visibility progress in the near term. For reasons explained in the SIP text, NHDES believes that future emissions and air quality levels under CAIR-successor scenarios are not likely to be vastly different from values predicted by MANE-VU's completed modeling, even though that modeling was based on implementation of a differently structured CAIR. Consequently, the reasonable progress goals and long-term strategy developed for New Hampshire's regional haze SIP still represent a defensible position from which to go forward with measures to improve visibility at MANE-VU's Class I Areas. In any case, New Hampshire will have the opportunity – and the obligation – to review the situation as it develops and to revise the SIP as required by no later than 2012.

Despite extensive consultations among the affected states, NHDES also acknowledges that not all states have included, or are likely to include, the provisions of the MANE-VU "Ask" in their SIPs. New Hampshire continues to hold that the strategies outlined in the Ask are reasonable. If certain states have chosen not to incorporate the provisions of the Ask in their SIPs, then it will be the responsibility of EPA, as established in the Regional Haze Rule, to find an acceptable resolution of any discrepancies among the individual states' plans.

Specific Comments/Responses: The following is a point-by-point response to specific comments submitted by DOI – NPS and FWS. Because the SIP document has been repaginated, reference is made to sections or parts instead of page numbers. **Comments are written in *italics* and responses are written in regular font.** (Comments related to typographical errors are omitted.)

1. The Regional Haze Issue – *"Recommend including footnote in text and discuss how the vacatur affected NH decision-making."*

A new subsection, 1.1 Regional Haze Planning after Remand of CAIR, has been inserted near the beginning of the document to address the effects of the original vacatur and subsequent remand of CAIR on New Hampshire's regional haze SIP. Also, references to CAIR that were included in the previous draft have been modified throughout the document to reflect the current situation.

1.4.3 Monitoring and Recent Visibility Trends – *"Since visibility monitoring is accomplished by one site for both NH Class I areas, recommend changing title and text to reflect Figure 1.7 would be trend information for both wilderness areas and not just Great Gulf as the current text implies. Or establish early on that Great Gulf will be representative of both Class I areas throughout the SIP."*

This part is now moved to 1.5.3. The text and titles have been revised there and elsewhere to clarify that the Great Gulf monitor serves the two New Hampshire Class I Areas. A statement to this effect has been added under 5.3 Monitoring Sites for MANE-VU Class I Areas.

1.4.3 Monitoring and Recent Visibility Trends – *"Recommend clarifying last set of bullets on trend plots. Since NHDES plots Worst Natural and Best Natural, the bullets should include this separation. For example, the worst 20% days are approximately 10 DV greater than Worst Natural. And the same is true for the second bullet, delineate which Natural trend line (worst or best) you are referring too."*

The last bullet in this part has been revised to provide greater specificity.

2. Areas Contributing to Regional Haze – *"Need to revise text to reflect the CAIR vacatur. Currently, the text states that there will be significant decrease in SO2 emissions due to CAIR."*

The vacatur and remand of CAIR has been noted. Please see response to comment for 1. The Regional Haze Issue.

2. Areas Contributing to Regional Haze – *"Recommend reminding reader that there is only one site for both Class I areas in NH and hence the decision to just include Great Gulf mass contributions OR include same figure titled Presidential Range-Dry River to reflect the state's knowledge of both Class I areas."*

Please see response to first comment for 1.4.3 Monitoring and Recent Visibility Trends.

3.2 Regional Consultation and the "Ask" – "Recommend clarifying that both formal *and informal consultation within MANE-VU has been on-going since establishment in 2001 with the bulk of formal consultation occurring in 2007 as outlined by Table 3.3."*

The last paragraph before Table 3.3 has been revised accordingly.

3.2.1 New Hampshire-Specific Consultations – *"The state provides a comprehensive summary of its consultation efforts taken within and outside MANE-VU. However, the state does not include the end result of its consultation efforts with each of those states (not including the Canadian provinces, which NH includes). As stated, NH sent letters to all MANE-VU states, but what was their response? Same comment applies to meetings with MRPO and VISTAS. If results are included in an Appendix, then a summary of those results should be included in the*

SIP text. Or recommend referencing future sections that deal with consultation issues and results, e.g., section 3.2.2.3 and Section 3.2.4."

Statements regarding consultations with other states have been added to 3.2.1 New Hampshire-Specific Consultations and 3.2.2.3 Meeting the "Ask" – States Outside MANE-VU. New Hampshire has not received individual responses from other states. MANE-VU did receive comments from VISTAS and the West Virginia Department of Environmental Protection (see attachment F).

3.2.1 New Hampshire-Specific Consultations – *"Reference to CAIR needs to be addressed."*

The vacatur and remand of CAIR has been noted. Please see response to comment for 1.0 The Regional Haze Issue.

3.2.2.3 Meeting the "Ask" – States outside MANE-VU – *"It is fair to state that non-MANE-VU states have not included the MANE-VU Ask in their SIPs, considering most of VISTA states have already submitted SIPs to EPA."*

Please see response to first comment for 3.2.1 New Hampshire-Specific Consultations.

3.2.5 State/Tribe and Federal Land Manager Coordination – *"The state can include the date of August 1, 2008 as the date submitted to the NPS/FWS."*

The indicated date has been added to the text.

3.2.5 State/Tribe and Federal Land Manager Coordination – *"Text should be more specific as to the availability of FLM comments for public review and comment prior to the SIP submission to EPA."*

The text pertaining to public review has been expanded and made more specific.

5.3 Monitoring Sites for MANE-VU Class I Areas, Figure 5.2 – *"Suggest including deciview measurements on the figure for context, same comment for Figure 5.4, 5.6, 5.7 (if deciview information is available), 5.10, 5.11, and 5.14."*

Deciview values are unavailable for the photos in these figures.

8.1 Fine-Particle Pollutants – *"Identifies OC as second largest contributor to haze but goes on to focus on large scale SO2 control measures. In Section 10.2.1, NH acknowledges the importance of OC but based on Contribution Assessment it is determined that an early focus on additional SO2 reduction is more beneficial than targeting OC emissions at this current time (page 87). Organic emissions will play a more important role as regional haze planning moves into future planning periods. Organic carbon emissions need to be identified in terms of fire emissions and a commitment to tracking these emissions should be included in section 11 under Agricultural and Forestry Smoke Management."*

Text has been added to the end of this part to explain the focus on SO_2 emissions and the comparative role of OC emissions. Also, please see response to comment for 11.7 Agricultural and Forestry Smoke Management.

8.3.4 Primary Particulate Matter (PM_{10} and $PM_{2.5}$) – *"'Thus, to the extent that these types of activities are found to affect visibility at Northeastern Class I areas, control measures targeted at crustal material may prove beneficial.' Referring to PM coarse and fine contribution, SIP should state that further action on this item is the purview of EPA or state agencies."*

The last sentence in the fourth paragraph in this part has been modified as requested.

9.0 Best Available Retrofit Technology (BART) –

"We understand that NH is currently working on completing draft permits for the two BART-eligible sources discussed below. We request that the state share the temporary permits with the FLMs when available."

Temporary Permit # TO-0008 has been issued for Merrimack Station, a copy of which is provided in Attachment EE of the SIP. No draft permit is available for Newington Station at this time. The required switch to low-sulfur residual fuel oil for this facility will be governed by the proposed rule change to Env-A 1604, Sulfur Content Limitations for Liquid Fuels (see Attachment FF).

Merrimack Station:

"According to the CAM database, the Merrimack Station consists of two coal-fired cyclone boilers with SCR for NOx control and ESPs for PM control, and two oil-fired combustion turbines. Based on the ages of these units, only one coal-fired cyclone boiler, Unit 2, is subject to BART. According to the CAM database, in 2007, emissions from Unit #2 were: 25,000 tpy S02 (@ 2 1b/mmBtu) and 2,200 tpy NOx (@ 0.19 lb/mmBtu).

- *NH concluded that a 90% efficient Flue Gas Desulfurization (FGD) system recently proposed by PSNH represents BART for S02. NH provides no discussion of why this level of control was chosen.*
- *NH concluded that the current 85% efficient SCR system represents BART for NOx. NH provides no discussion of why this level of control was chosen.*
- *NH concluded that the current ESP represents BART for PM. NH provides no discussion of why this level of control was chosen.*
- *In conversation with NH staff regarding this BART determination, we learned that both coal-fired units will be controlled under legislation to reduce mercury emissions and they will share a common stack. In the regional haze SIP, NH should clarify which pollutants are being addressed and identify the associated emission limits, for each pollutant at each boiler.*

"No economic or visibility benefits analysis was conducted because NH stated it was proposing the "most effective control option" for each pollutant. While it may be true that NH has proposed the "most effective control" option for each pollutant, NH is still obligated to evaluate each proposed control technology to determine the appropriate level of control efficiency for each control technology. For example, it is generally assumed that wet scrubbers can achieve at least 95% control efficiency, and that SCR can remove 90% of incoming NOx. NH should show why the Merrimack controls cannot perform as well."

The BART analyses for New Hampshire's two BART-eligible sources have been revised and expanded to provide a more complete description of technology options, control levels, estimated costs, visibility improvements, and reasoning behind the BART determinations. The particular circumstances that distinguish Merrimack Station Unit MK2 from other FGD applications are explained, and the expected SO_2 control level for this facility is clarified. See Section 9, Best Available Retrofit Technology (BART), and Attachment X, BART Analyses for Sources in New Hampshire.

Newington Station:

"According to the CAM database, the Newington Station consists of one oil- and gas-tangentially-fired boiler with an ESP for PM control, and two gas- and oil-fired combined cycle combustion turbines equipped with Dry-Low-NOx Burners and SCR. In conversation with NH staff, we have learned that only the coal-fired Unit #1 is subject to BART. According to the CAM database, in 2007, emissions from Unit #1 were: 2,300 tpy S02 (@ 1 lb/mmBtu) and 415 tpy NOx (@ 0.16 lb/mmBtu).

- *NH concluded that a FGD system is too expensive. (No cost analysis was provided.) NH proposes that the sulfur limit on the #6 residual oil be reduced to 1%. NH provides no discussion of why this level of control was chosen as BART for S02.*
- *NH concluded that the current combustion controls represent BART for NOx. NH eliminates SNCR ($3,000 - $5.000/ton) and SCR ($5,000 - $6,000/ton) on the bases of costs, but provides no information on how these costs were estimated.*
- *NH concluded that the current ESP, combined with use of cleaner fuel oil, represents BART for PM."*

Newington Station's BART-eligible facility is an oil- and/or natural-gas-fired boiler that has served primarily as a peaking unit for PSNH since 2002. Updated descriptions with revised cost data are provided in Section 9 and Attachment X, including explanations for the determination that existing PM and NOx controls represent BART for this plant. A significant factor in these determinations is the facility's low utilization rate. With respect to SO_2 emissions, the options for lower-sulfur fuels are described and information is presented to support the determination that 1.0%-S residual fuel oil is BART for this unit.

10.2 Identification of (Additional) Reasonable Control Measures – *"Recommend referencing section in 3.0 regarding Canada consultation as source for the input for RPG."*

A parenthetical note has been added making reference to relevant consultations in 3.2.1 New Hampshire-Specific Consultations.

10.2.2 Best Available Retrofit Technology Controls – *"Reference to CAIR satisfying BART in CAIR states."*

The first paragraph has been revised to acknowledge the previous role of CAIR with respect to BART and the possibility of CAIR-successor legislation or rulemaking.

10.2.3 Low-Sulfur Fuel Strategy – *"Concern that not all MANE-VU states have committed to low sulfur fuel oil strategy."*

The first paragraph after the bullets has been revised to include the following statement: "While all MANE-VU states have agreed to pursue implementation of both phases to full effect by the end of 2018, it is possible that not every state can make a firm commitment to these measures today. States are expected to review the situation by the time of the first regional haze SIP progress report in 2012 and to seek alternate, equivalent reductions if necessary."

10.2.4 Targeted EGU Strategy for SO_2 Reductions – *"Reasonableness of Targeted EGU SO2 Reduction Strategy – SIP needs to acknowledge CAIR vacatur."*

The vacatur and remand of CAIR has been noted. Please see response to comment for 1.0 The Regional Haze Issue.

10.2.4 Targeted EGU Strategy for SO_2 Reductions – *"Base case modeling used CAIR as baseline, with the vacatur of CAIR, how will that affect modeling assumptions and outputs?"*

Please see response to comment for 1.0 The Regional Haze Issue.

10.2.4 Targeted EGU Strategy for SO_2 Reductions – *"Recommend clarification…that the 4 factor analysis for the low-sulfur fuel oil strategy was described in Section 10.2.3 of this section."*

The requested clarification has been included.

10.2.5 Non-EGU SO2 Emissions Reduction Strategy for Non-MANE-VU States – *"Non-EGU SO2 Emissions Reduction Strategy for Non-MANE-VU States – Our experience is that non-MANE-VU states have not committed to this 28% reduction from ICI Boilers in their RH SIPs – how does this affect your overall LTS?"*

New Hampshire acknowledges that a number of non-MANE-VU states have not included, or may not include, the requested 28-percent reduction in non-EGU SO_2 emissions in their State Implementation Plans at present. A paragraph to this effect has been added with the advisory that the reasonable progress goals and long-term strategy could be amended as necessary to reflect actual future actions by the non-MANE-VU states by 2012, when the first regional haze SIP progress report is due.

11.3 Existing Commitments to Reduce Emissions – *"Existing Commitments to Reduce Emissions – Recommend providing a reference to future sections for the specifics on control programs assessed, e.g. sections 11.3.1, 11.3.2, and 11.3.3."*

References to Parts 11.3.1, 11.3.2, and 11.3.3 have been added.

11.3.1 Controls on EGUs Expected by 2018 – *"Individual state control programs are highlighted, in addition to North Carolina Clean Smokestacks Act and consent decrees in VISTAS, but CAIR remains the most significant strategy for controls on EGUs."*

The vacatur and remand of CAIR has been noted. Please see response to comment for 1.0 The Regional Haze Issue.

11.4 Additional Reasonable Measures – *"NH's Long Term Strategy includes planned commitments by other states that are not enforceable."*

The text has been expanded to address this matter with more specificity (see 11.11 Enforceability of Emission Limitations and Control Measures).

11.4 Additional Reasonable Measures – *"Admits states 'have agreed to pursue' the suite of additional control measures (i.e., the 'Ask') and 'hopes' non-MANE-VU states do the same or equivalent over the next 10 years."*

The MANE-VU Ask is just that – an agreement among the member states to pursue certain control measures. For its part, NHDES is committed to bringing about these control measures in New Hampshire by helping to prepare the necessary legislation and/or rulemaking that will ensure enforceability. Because the final decisions to adopt specific control measures will reside with New Hampshire's governor and legislature, NHDES cannot provide assurances beyond the present "agreement to pursue." New Hampshire is expecting other states to do their respective parts by taking similar actions. The word "hopes" is not present in the current text.

11.4.1 BART – *"Question of the assumption (which is no longer so) CAIR satisfying BART for the EGU sector."*

The vacatur and remand of CAIR has been noted. Please see response to comment for 1.0 The Regional Haze Issue.

11.4.3 Targeted EGU Strategy – *"Recommend revising last sentence of 1st paragraph to include, '…to mitigating haze pollution in wilderness areas **and national parks** of the Northeast states.'"*

The suggested wording has been added.

11.4.3 Targeted EGU Strategy – *"Explanation as to why MANE-VU is asking for 90% reduction on targeted EGUs in other RPOs when NH is only netting a 75% reduction from their two BART sources."*

The description of New Hampshire's three targeted EGUs (which include two BART-eligible units) has been expanded with the addition of a new table and text. Total projected SO_2 reductions from these units are conservatively estimated at 81 percent for the present analysis but are more likely to exceed 90 percent in actual performance, as explained in the text.

11.7 Agricultural and Forestry Smoke Management – *"Suggest adding whether or not NH anticipates the potential of smoke impacts to stay the same, increase or decrease by 2018. Also, since Organic Carbon is the second largest contributor to visibility impairment in the MANE-VU region and will become more important for regional haze planning, recommend adding a commitment to track fire emissions in the future. Research would also be helpful in determining whether emissions from wood-burning stoves or fire emissions from agriculture or forestry management are more significant to the region."*

Text has been added stating that New Hampshire has no information indicating that the contribution from smoke emissions will be significantly different from the current situation over the next decade; i.e., this source of fine-particle emissions will continue to be a very minor contributor to visibility extinction in MANE_VU Class I Areas. In addition, a statement has been added declaring New Hampshire's intention to consider ways to improve the inventory of smoke emissions and to achieve a better understanding of the relative importance of the various sources of wood smoke – including agricultural and forestry sources and residential wood stoves – as contributors to regional haze. As noted, the results of these efforts will be documented in the first regional haze SIP progress report in 2012.

11.8 Estimated Effects of Long-Term Strategy on Visibility – *"Suggest ending the explanation of the position of the purple star to state that 'Similarly, the position of the purple star below the dashed line indicates predicted improvements on days of best visibility may be greater than predicted natural background conditions.'"*

The first paragraph below the bullets has been reworded.

11.8 Estimated Effects of Long-Term Strategy on Visibility, Figure 11.1 – *"The light-green dash (–) that represents the theoretical 20 percent best visibility value under natural conditions (i.e., no anthropogenic emissions) at 2064 can not be seen. Same comment true for Figure 11.6 on page 132."*

The missing information has been added to the figures.

11.9 New Hampshire's Share of Emission Reductions – *"Need to deal with CAIR no longer a part of the LTS."*

Please see response to comment for 1.0 The Regional Haze Issue.

11.11 Enforceability of Emission Limitations and Control Measures – *"Whereas the SIP text talks about the specific BART determinations being codified (and hence enforceable) within state law, the enforceability of the other components of the LTS, such as fuel oil strategy and targeted EGU strategy, is not mentioned or dealt with. This is a critical requirement of the SIP, to have all expected (and modeled) emission reductions enforceable throughout the MANE-VU region."*

The text has been expanded to address more specifically the matter of enforceable provisions for New Hampshire's targeted EGUs, BART-eligible EGUs, and use of low-sulfur fuel oil.

Comments from the U.S. Department of Agriculture, U.S. Forest Service

General Comments: USFS also found New Hampshire's Regional Haze SIP to be well written and thorough. The agency observed that New Hampshire's draft SIP was "heavily dependent on the results of CAIR for emission projections, reasonable progress goals, etc." and supported New Hampshire's assumption that CAIR states will "need to reduce emissions commensurate with CAIR to achieve regional haze and other air quality goals." USFS further noted that New

Hampshire is not a CAIR state; will meet its "fair share" of emissions; would experience further delay by waiting for new modeling to be completed; and will have a "perfect opportunity" to review regional haze, post-CAIR, in the 2012 progress report.

General Response: NHDES concurs with the CAIR overview presented by USFS.

Specific Comments/Responses: The following is a point-by-point response to specific comments submitted by USFS. Because the SIP document has been repaginated, reference is made to sections or parts instead of page numbers. **Comments are written in *italics* and responses are written in regular font.**

10.3 Reasonable Progress Goals for Class I Areas in the State, Table 10.8 – *"Worst Day baseline is 22.8 dv, RPG for 2018 is 19.1dv, and Improvement by 2018 is 2.7dv. These numbers do not add up. Is the RPG supposed to be 20.1 or is the improvement supposed to be 3.7 dv?"*

The improvement by 2018 has been corrected to read 3.7 dv.

11.7 Agricultural and Forestry Smoke Management – *"Suggest changes to last paragraph of p 126 to read: 'Nevertheless, New Hampshire intends to consult with the Forest Protection Bureau of the New Hampshire Department of Agriculture and with the New Hampshire Department of Resources and Economic Development (DRED) to consider smoke management in agricultural and forestry practices to address visibility effects at MANE-VU Class I Areas. The results of these efforts will be documented in the first regional haze SIP progress report in 2012.' Shifting smoke impacts from clear and hazy days to other days is not consistent with the intent of the Regional Haze Rule, and all nearby Class I areas need to be considered, not just Great Gulf and Presidential Range - Dry River."*

The suggested rewording has been made.

10.0 Reasonable Progress Goals and 11.0 Long-Term Strategy – *"We feel it would be appropriate for NH DES to discuss the relationship between the Regional Haze Plan and requirements of the Prevention of Significant Deterioration (PSD) program within the SIP. Specifically, how does NH DES anticipate addressing new sources of air pollution in the PSD process in regards to its reasonable progress goals and long term strategy; and how will it analyze the effects of emissions from these new sources on progress toward the interim visibility goals established under this SIP."*

A new subsection, 11.12 Prevention of Significant Deterioration, has been added to the long-term strategy section of the SIP. The additional language describes New Hampshire's PSD program requirements in the context of the Statewide Permit System and federal provisions for visibility protection at Class I areas under the Regional Haze Rule.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 1
1 CONGRESS STREET, SUITE 1100
BOSTON, MASSACHUSETTS 02114-2023

June 26, 2009

Jeff Underhill
Air Resources Division
New Hampshire Department of Environmental Services
29 Hazen Drive, PO Box 95
Concord, NH 03302-0095

Dear Mr. Underhill:

Previously, EPA received two preliminary drafts of New Hampshire's Regional Haze State Implementation Plan (SIP). EPA provided DES written comments on these drafts in letters dated July 10, 2008 and October 24, 2008.

Subsequently, we received New Hampshire's proposed Regional Haze SIP. We have reviewed the proposal and you will the Agency's comments in the Enclosure.

If you have any questions on these comments, please contact Anne McWilliams of my staff at 617-918-1697.

Sincerely,

Anne Arnold, Manager
Air Quality Planning Unit

Enclosure

Enclosure
EPA Comments on New Hampshire's
May 2009 Proposed Regional Haze SIP

General BART Comments

1. New Hampshire indicates it used the CALGRID model for assessing the visibility improvement expected from the installation of Best Available Retrofit Technology (BART) controls for its two BART sources, Merrimack station and Newington Station. The CALGRID modeling results indicated that the installation of a scrubber at Merrimack would only result in a visibility improvement of 0.1 deciview (dv) and switching to lower sulfur fuel at Newington would result in negligible visibility improvement. The reader is directed to Attachment X for additional discussion on this analysis. However, Attachment X does not provide any information regarding the performance or appropriateness of the CALGRID model for this type of application, the Attachment only discusses the use of CALGRID for ozone modeling purposes.

The MANE-VU modeling results indicate that both BART sources are among the top 167 stacks impacting a MANE-VU Class I area. Therefore, it does not seem to make sense that controlling SO_2 emissions by more than 90% at Merrimack would lead to a visibility improvement of only 0.1 dv and that 50% control of SO_2 at Newington would result in negligible visibility improvement. Please include an explanation of how the CALGRID and MANE-VU modeling relate to each other, especially in respect to pre-control visibility impacts.

Furthermore, New Hampshire may want to consider using CALPUFF to assess visibility impacts of potential BART controls. As noted in the BART Guidelines (40 CFR Part 51, Appendix Y Section (IV)(D)(5)):

> "Use CALPUFF, or other appropriate dispersion model to determine the visibility improvement expected at a Class I area from the potential BART control technology applied to the source."

2. Implementation of the selected BART control strategies for each of the three pollutants (SO_2, NOx, and $PM_{2.5}$) at both BART facilities must be federally enforceable. The Regional Haze SIP must clearly indicate how this is being accomplished in each case. Specifically, the relevant rules or permits should be included as part of New Hampshire's Regional Haze SIP revision or the SIP revision should cite specific rules or permits conditions that are already federally enforceable.

BART Determination for PSNH - Newington Station

3. For SO_2, New Hampshire determined that the BART level of SO_2 control for PSNH Newington Station unit NT1 is to switch from 2% sulfur content by weight residual oil to 1% sulfur content by weight residual oil.

PSNH Newington Station unit NT1 is a tangentially-fired steam generating unit. The Title V permit indicates that NT1 can burn crude oil or No. 6 fuel oil at no more than 2% sulfur content by weight, No. 2 fuel oil at no more than 0.4% sulfur content by weight, or natural gas. Based on recent data submitted to EPA's Clean Air Market Division, it appears that changing the enforceable sulfur-in-fuel limit from 2% sulfur No. 6 oil to 1% sulfur No. 6 oil will provide minimal reductions in SO_2 emissions since average SO2 emission rates are near the levels emitted while burning 1% sulfur No. 6 oil. (See Table 1 below which contains 2007 data for PSNH Newington Station.) Thus, other fuel switching options should also be explored. These options include: (1) the use of natural gas, (2) the use of 0.3% sulfur No. 6 oil as recommended by the MANE-VU BART workgroup or (3) the use of No. 2 fuel oil at no more than 0.3% sulfur content by weight.

Currently, the only consideration of natural gas as a primary fuel source shown in the proposal is the statement, "In recent years, there have been sudden and dramatic swings in the price of natural gas relative to fuel oil as supply/demand have shifted. The future price and availability of natural gas are difficult to discern."

Recent data from the Energy Information Administration, however, indicates the Average Cost of Natural Gas and Residual Oil are projected to remain comparable. (See Figure 1, "Historic and Projected Power generation Fuel Costs – National.") Therefore, EPA recommends that greater consideration be given to the use of natural gas as the primary fuel at Newington station, with No. 2 fuel oil and/or No. 6 fuel oil being used as the secondary fuel, with a constraint on the number of gallons burned per year.

If, however, it is not possible to utilize natural gas as the primary fuel type for this unit, then New Hampshire should explain why 1% sulfur No. 6 oil was determined to be BART, rather than the MANE-VU BART workgroup recommended sulfur fuel oil limit of 0.3% sulfur content by weight. This limit is currently required of facilities in Connecticut pursuant to Connecticut's Section 22a-174-19a regulation.

Additionally, New Hampshire should explain why 0.5% sulfur fuel oil is not BART as well. The proposal indicates that the cost effectiveness of using 1% versus 0.5% fuel oil is the same at $1900/ton. This argues for the implementation of 0.5% sulfur fuel oil. Also, other facilities in New England are currently limited to 0.5% for No. 6 fuel oil. (See the Title V permit for Salem Harbor Unit #4.)

In table 1 below is a listing of all of the electric generating steam units in New England that were operational in 2007 and which use residual oil as their primary fuel. As illustrated in the table, most of the units have current SO2 emissions rates well below the emission rate proposed as BART for PSNH Newington Station.

4. For NOx, New Hampshire has determined that BART is met for Newington Unit 1 through use of the current suite of NOx controls; low NOx burners, an overfire air system, and water injection. New Hampshire indicates that the current emission limits are a daily average of 0.35 lb/MMBtu when burning oil and 0.25 lb/MMBtu when burning a combination of oil and gas. The MANE-VU BART workgroup, however, recommended a level of NOx control for non-CAIR EGUs of 0.1 – 0.25 lb/MMBtu, depending on boiler and fuel type. Therefore, New Hampshire should analyze if a more stringent emission limit is appropriate for this unit.

In New England, there is a least one oil-fired electric generating steam unit with selective catalytic reduction installed (Unit #1 at Canal Electric in Sandwich, MA) and at least three oil-fired electric generating steam units with selective non-catalytic reduction installed (Units #1 and #2 at Norwalk Harbor Station in Norwalk, CT and Unit #3 at Middletown Station in Middletown, CT).

5. For $PM_{2.5}$, the proposal indicates that the currently installed electro-static precipitator (ESP) is sufficient for BART, yet only cites a 42% control efficiency. According to the BART analysis, a rebuilt ESP can achieve collection efficiencies of more than 99%. Therefore, the BART determination should include an analysis of the feasibility of an upgraded or rebuilt ESP for this unit. Furthermore, the MANE-VU BART workgroup recommendation for non-CAIR EGUs is a PM emission rate of 0.02 – 0.04 lb/MMBtu. New Hampshire should provide greater detail as to why the state considers its current limit of 0.22 lb/MMBtu as sufficient for BART.

BART Determination for PSNH – Merrimack Station

6. For SO_2, New Hampshire has determined that BART is the installation of flue gas desulfurization (FGD) controls and has issued a temporary permit to the facility which is included in Attachment EE of the submittal. EPA previously reviewed a draft of this permit and submitted comments to the DES in a letter dated March 3, 2009. We have reviewed the version of the permit included in the proposal and note that all of our previous comments have been adequately addressed.

7. For NOx, New Hampshire has determined the year round use of selective catalytic reduction (SCR) is considered BART for Unit MK2. This determination seems reasonable. New Hampshire, however, states that its current federally enforceable limit for this unit is 0.86 lb/MMBtu, while the MANE-VU recommended level of BART control for non-CAIR EGUs is 0.1 – 0.25 lb/MMBtu, depending on the boiler and fuel type. A review of the data in the CAMD database indicates that MK2 is achieving an emission rate well below 0.86 lb/MMBtu. For example, the highest monthly average emission rate in 2008 was 0.30 lb/ MMBtu. Therefore, New Hampshire should impose a more stringent emission limit for this unit.

8. For $PM_{2.5}$, New Hampshire has determined that the use of two currently installed ESPs is considered BART for Unit MK2. This seems reasonable. The proposal, however, indicates that the current air permit imposes a 0.227 lb/MMBtu limit, while the MANE-VU recommended level of BART control for non-CAIR EGUs is 0.02-0.04 lb/MMBtu. Therefore, New Hampshire should analyze if a more stringent emission limit is appropriate for this unit.

Other Comments

9. We recommend the 5th paragraph on page 6 be revised as follows:

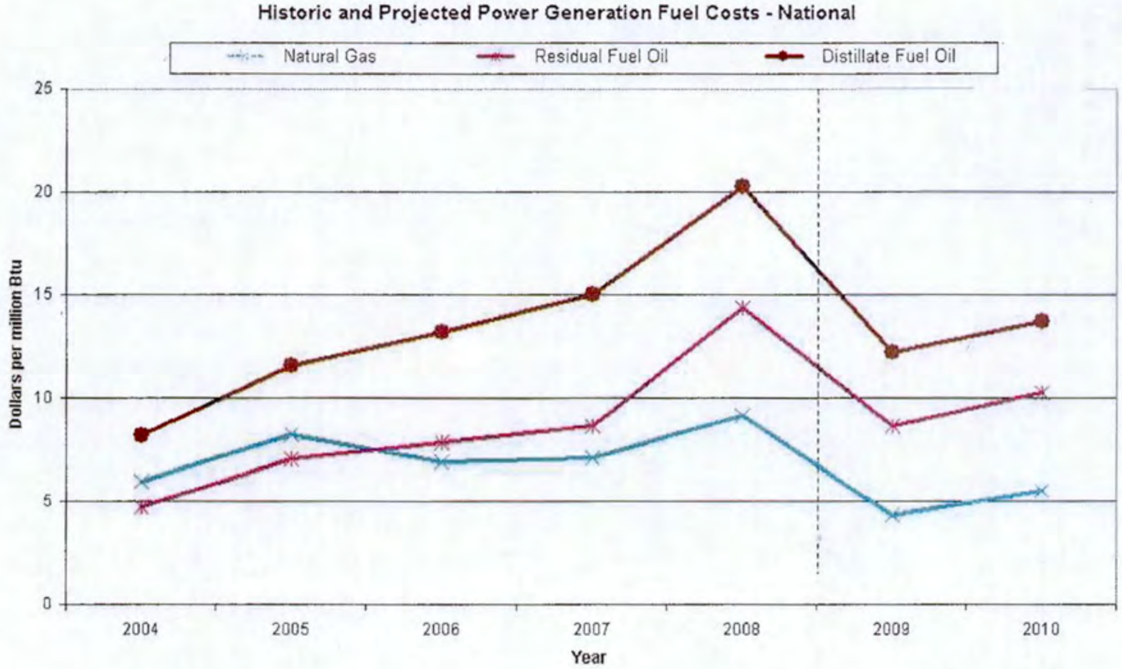
> "About half of the worst visibility days in the New Hampshire Class I Areas occur in the summer when meteorological conditions are more conducive to the formation of sulfate from SO_2 and to the oxidations of organic aerosols. ~~In addition, winter and summer transport patterns are different, possibly leading to different contributions from upwind source regions. As a result,~~ The remaining worst visibility days are divided nearly equally among spring, winter and fall. In addition, winter and summer transport patterns are different, possibly leading to different contributions from upwind source regions."

10. In Section 6.1.2, the Beyond-on-the way (BOTW) emissions scenario is described as "accounting for controls from potential regulations that may be necessary to meet attainment and other air quality goals, mainly for ozone." Based on the list of measures provided on page 123, it is unclear how New Hampshire expects to reduce area source emissions by 4,303 tons per year, as depicted in Table 6.3 2018 BOTW Emissions Inventory Summary for New Hampshire.

11. The MANE-VU "Ask" includes a low sulfur fuel oil strategy. With regard to this strategy, on page 141 of New Hampshire's proposal, the state indicates that it plans to revise its Env-A 1604 regulation and a draft of the revised rule is provided in Attachment FF. These revised provisions will need to be adopted and submitted to EPA as a SIP revision so they may become a federally enforceable part of New Hampshire's Regional Haze SIP. The proposal currently indicates that New Hampshire commits to revising this rule "at the earliest practicable date." New Hampshire should include a schedule for adoption of the revised regulation.

In addition, the discussion of the low sulfur fuel oil strategy in Section 10.2.3 (page 98) of the proposal notes a concern for potential supply disruptions for residual fuels in northern states. This discussion also states, "MANE-VU has identified several mechanisms that could be implemented to address disruptions, including seasonal averaging and emergency waivers. A seasonal averaging approach would reduce potential supply constraints by allowing the use of higher-sulfur during periods of peak demand." The proposal, however, does not further elaborate on whether or not New Hampshire plans to allow seasonal averaging and emergency waivers. If such provisions are allowed, then there should also be a mechanism to ensure that the use of higher-sulfur oil during peak demand times does not correspond with meteorological conditions leading to the 20% worst visibility days.

Figure 1.



Source: Energy Information Administration (EIA) Official Energy Statistics Short-Term Energy Outlook. Release Data: June 09, 2009 (http://tonto.eia.doe.gov/cfapps/STEO_TableBuilder/index.cfm)

Historical data: Latest data available from EIA databases supporting the following reports: Petroleum Marketing Monthly, DOE/EIA- 0380; Weekly Petroleum Status Report, DOE/EIA-0208; Natural Gas Monthly, DOE/EIA-0130; Electric Power Monthly, DOE/EIA-0226; and Monthly Energy Review, DOE/EIA-0035. Natural gas Henry Hub spot price from NGI's Daily Gas Price Index (http://Intelligencepress.com); WTI crude oil price from Reuter's News Service (http://www.reuters.com).

Projections: Generated by simulation of the EIA Regional Short-Term Energy Model.

Table 1 – SO2 Emissions and Emission Rate for All Residual Oil Burning Electric Generating Steam Boilers in New England

State	Facility Name	Unit ID	2007 Operating Hours	2007 SO2 MASS (TPY)	2007 SO2 RATE (lbs/mmBtu)	2007 HEAT INPUT (lbs/mmBtu)	Boiler Type	Primary Fuel Type	Secondary Fuel Type	BART Eligible
CT	Middletown	2	2,828.0	99.4	0.098	2,030,305	Dry bottom wall-fired	Residual Oil	Natural Gas	
CT	Montville	5	912.0	46.9	0.179	523,358	Tangentially-fired	Residual Oil	Natural Gas	
CT	Middletown	3	2,069.4	272.4	0.182	2,989,410	Cyclone	Residual Oil	Natural Gas	Yes
CT	New Haven Harbor	NHB1	2,634.0	815.0	0.237	6,890,274	Tangentially-fired	Residual Oil	Diesel Oil, Natural Gas	Yes
CT	Montville	6	423.7	80.1	0.253	633,758	Tangentially-fired	Residual Oil		Yes
CT	Middletown	4	568.0	142.2	0.257	1,107,873	Tangentially-fired	Residual Oil		Yes
CT	Bridgeport Harbor	BHB2	802.3	52.2	0.281	371,551	Cyclone	Residual Oil	Diesel Oil	
CT	Norwalk Harbor	1	2,584.5	222.4	0.293	1,518,125	Tangentially-fired	Residual Oil		
CT	Norwalk Harbor	2	3,184.1	338.0	0.295	2,291,675	Tangentially-fired	Residual Oil		Yes
MA	Mystic	7	6,687.7	1,922.4	0.314	12,251,958	Tangentially-fired	Residual Oil	Natural Gas	Yes
MA	Salem Harbor	4	729.1	164.4	0.492	668,060	Dry bottom wall-fired	Residual Oil		Yes
MA	Canal	2	3,463.1	1,506.2	0.498	6,050,203	Dry bottom wall-fired	Residual Oil	Natural Gas	Yes
MA	Canal	1	7,599.8	5,169.0	0.545	18,976,807	Dry bottom wall-fired	Residual Oil		Yes
MA	West Springfield	3	1,858.8	366.1	0.609	1,202,764	Tangentially-fired	Residual Oil	Natural Gas	
ME	Wyman	4	1,439.2	1,050.2	0.654	3,212,458	Dry bottom wall-fired	Residual Oil		Yes
MA	Cleary Flood	8	127.2	14.4	0.815	35,436	Dry bottom wall-fired	Residual Oil	Diesel Oil	Yes
MA	Brayton Point	4	1,018.3	741.3	0.901	1,645,406	Dry bottom wall-fired	Residual Oil	Natural Gas	Yes
NH	Newington	1	1,503.1	2,269.2	1.054	4,303,867	Tangentially-fired	Residual Oil	Natural Gas	
ME	Wyman	1	977.9	96.2	1.228	156,729	Dry bottom wall-fired	Residual Oil		
ME	Wyman	3	1,073.0	452.5	1.313	689,029	Tangentially-fired	Residual Oil		Yes
ME	Wyman	2	421.5	55.0	1.346	81,691	Dry bottom wall-fired	Residual Oil		

Source: EPA's Clean Air Markets Acid Rain Database (http://camddataandmaps.epa.gov/gdm/)

12-20-10

New Hampshire Regional Haze SIP Revision
Responses to EPA's Comments

On June 26, 2009, the New Hampshire Department of Environmental Services (NHDES) received comments from the U.S. Environmental Protection Agency (EPA) on New Hampshire's draft final Regional Haze SIP, May 22, 2009. The following are NHDES's responses to EPA's comments. **Comments are written in *italics* and responses are written in regular font.**

General BART Comments

1. New Hampshire indicates it used the CALGRID model for assessing the visibility improvement expected from the installation of Best Available Retrofit Technology (BART) controls for its two BART sources, Merrimack station and Newington Station. The CALGRID modeling results indicated that the installation of a scrubber at Merrimack would only result in a visibility improvement of 0.1 deciview (dv) and switching to lower sulfur fuel at Newington would result in negligible visibility improvement. The reader is directed to Attachment X for additional discussion on this analysis. However, Attachment X does not provide any information regarding the performance or appropriateness of the CALGRID model for this type of application, the Attachment only discusses the use of CALGRID for ozone modeling purposes.

The MANE-VU modeling results indicate that both BART sources are among the top 167 stacks impacting a MANE-VU Class I area. Therefore, it does not seem to make sense that controlling SO_2 emissions by more than 90% at Merrimack would lead to a visibility improvement of only 0.1 dv and that 50% control of SO_2 at Newington would result in negligible visibility improvement. Please include an explanation of how the CALGRID and MANE-VU modeling relate to each other, especially in respect to pre-control visibility impacts.

Furthermore, New Hampshire may want to consider using CALPUFF to assess visibility impacts of potential BART controls. As noted in the BART Guidelines (40 CFR Part 51, Appendix V Section (IV)(D)(5D:

> *"Use CALPUFF, or other appropriate dispersion model to determine the visibility improvement expected at a Class I area from the potential BART control technology applied to the source."*

- NHDES Response: NHDES agrees with EPA that CALPUFF (or other appropriate dispersion model) is the recommended model for assessing maximum potential impacts of single sources to distant Class I areas. Consistent with that, CALPUFF is EPA's preferred model for assessing visibility impacts during PSD impact studies for permitting purposes. EPA has subsequently recommended application of CALPUFF to visibility screening of individual sources. Because CALPUFF's strength is in estimating maximum possible impacts, including visibility impairment, it is a preferred model for determining BART eligibility. In fact, New Hampshire and the other MANE-VU states used CALPUFF for BART eligibility screening because the model is conservative, effectively predicts potential worst case visibility impacts, and therefore represents the ideal scenario for BART inclusion analyses. NHDES believes that the BART guideline's preference for use of CALPUFF is rooted in the need to include all potentially significant sources of visibility degradation.

NHDES disagrees with EPA that CALPUFF provides the best and most useful predictions of the visibility benefit of BART controls. Because of how the model handles wind fields without regard to visibility conditions, CALPUFF's predictions can be very conservative and possibly oversensitive to changes in visibility conditions. When the modeling results are applied to calculate the benefits of emission controls, those benefits can be overstated by the inflation of deciview improvements and the calculated cost-per-deciview ($/dv) BART control metric. CALPUFF's handling of background pollutants is indirect and rather mechanical in nature. As a result, it does not track how its modeled impacts relate to background visibility, best visibility, and worst visibility days. Extra effort by the modeler is needed to present a realistic modeling result that aligns wind directions with appropriate, manually entered background conditions.

Unlike CALPUFF and other single-source dispersion models, regional grid models such as CALGRID excel at accounting for the impacts of widespread sources contributing to total visibility impairment. To that end, for the impact assessment of New Hampshire's BART-eligible sources, NHDES originally chose to use CALGRID, the sister model to CALPUFF. CALGRID includes much of the same chemistry as CALPUFF but uses gridded dispersion as opposed to the puff dispersion used in CALPUFF. In fact, CALGRID includes about 20 percent more enhanced aerosol chemistry than CALPUFF and is therefore considered to be the more advanced model. Moreover, CALGRID easily isolates the 20% worst visibility days to allow a direct, realistic result without the need for manual adjustments. It is important to isolate these 20% worst visibility days because it is possible (and perhaps probable) that a targeted BART facility will not actually contribute its maximum impact on those days. CALPUFF always assumes maximum emissions impact at Class I areas on both best and worst days – conditions that may or may not happen in reality. While the CALPUFF model's CALPOST post-processor has an option for application on 20% best visibility days, it does not isolate those 20% best days for analysis. It simply changes the background values used by the model to what is estimated to be appropriate background conditions. The post-processed results do not account for wind directions that may be preferentially included or excluded on such days.

The BART guidelines suggest that models be used in a "relative" way to estimate the expected visibility benefits of BART controls. As explained above, while CALPUFF is EPA's preferred model for visibility assessments of individual sources, it still has its weaknesses. The model is not designed to perform complex calculations in which a large number of emission sources are factored-in across several emission sectors. Compounding the problem is the fact that, in order to apply the model in a relative sense, the visibility assessment has to be done with a non-linear metric, the deciview. The guidance uses CALPUFF to estimate the benefits of BART controls on a single source under the conditions of 20% worst visibility days when, in fact, a multitude of sources actually contribute to visibility impact. The model can easily calculate the concentration benefits from the chosen source controls, but the conversion of the data into deciview units involves a non-linear estimation. A CALPUFF post-processor allows a simple selection of background visibility conditions and then performs deciview benefit calculations in a crude way.

Because both EPA and the FLMs filed comments expressing their preference for CALPUFF modeling results, NHDES performed a limited set of CALPUFF runs for the New Hampshire BART-eligible sources under controlled and uncontrolled conditions. Rather than use CALPOST's post-processing option for the 20% best and worst days, NHDES applied the CALPUFF modeling results in a relative way, in recognition of EPA's guidance for BART modeling. NHDES normalized the CALPUFF modeling results and then applied the predicted concentrations to a logarithmic best-fit equation of the actual observed $PM_{2.5}$-to-deciview relationship measured at Acadia NP, Great Gulf NW, and Lye Brook NW. Thus, CALPUFF was applied in a relative way using real observed data as the basis. At this point, a number of background visibility scenarios could be calculated from the resulting PM-mass-to-deciview equation. In accordance with BART guidance, the natural visibility condition (about 7 dv) was used for exemption purposes; and 20% worst visibility (22.8 dv) was used for assessment of BART control effectiveness.

Merrimack Station Unit MK2: BART Eligibility Modeling

The BART eligibility modeling conducted by MANE-VU used natural visibility conditions (about 7 dv) to produce the most conservative modeling results to minimize sources from modeling out of BART. Under these conditions, uncontrolled emissions from Unit MK2 produce theoretical CALPUFF worst-case impacts of 2.29 dv at Acadia National Park. EPA considers acceptable source exemptions when this form of conservative modeling indicates a source produces less than 0.5 dv of impact. MANE-VU considers an exemption level of 0.2 to 0.3 dv to be more appropriate but prefers, and has applied, a more conservative exemption level of 0.1 dv. CALPUFF modeling results for baseline emissions from Unit MK2 exceed all of these exemption levels.

Merrimack Station Unit MK2: BART Benefit Assessment Modeling

The BART assessment modeling provides a comparison of visibility impacts from current allowable emissions with those from the post-control emission level (or levels) being evaluated. In accordance with EPA guidance, NHDES used CALPUFF to estimate the magnitude of the source's impacts on visibility after implementation of BART controls. Results are tabulated for the average of the 20% worst visibility (in this case, about 22.8 dv) modeled days at each nearby Class I area. For any pair of control levels evaluated, the difference in the level of impairment predicted is the degree of improvement in visibility expected.

For Merrimack Station Unit MK2, the CALPUFF-predicted visibility benefits from BART controls on 20% worst visibility days are as follows:

CALPUFF Modeling Results for Merrimack Station Unit MK2: Visibility Improvements from BART Controls on the 20% Worst Visibility Days

Pollutant	Control Technology	Control Level	Visibility Improvement (dv)		
			Acadia NP	Great Gulf NW	Lye Brook NW
SO_2	FGD	90%	0.28	0.22	0.03
NO_X	SCR Upgrade	89%	0.01	0.01	< 0.01*
PM	ESP Upgrade	99.4%	<0.01*	<0.01*	< 0.01*
	Baghouse	99%	-0.02	-0.02	-0.01

* below sensitivity limit of model

While Unit MK2 was predicted to have up to 2.29 dv impact at Acadia National Park under natural conditions, the basis of the BART assessment evaluation changes to 20% worst visibility days. On those days, a 90% reduction in sulfur emissions at Unit MK2 results in only a 0.28 dv visibility improvement. At first these results may appear to be incorrect; however, on further examination, it is found that CALPUFF predicts the same amount of sulfate from Unit MK2 reaching Acadia under both best and worst visibility conditions. The difference is that there is greater than an order of magnitude more sulfate coming from other sources on the 20% worst visibility days, raising the background concentrations to much higher levels. Because the deciview scale is logarithmic, the same mass reduction of 0.26 $\mu g/m^3$ of sulfate from this one source results wide differences in deciview impacts for different background visibility conditions at opposite ends of the range.

The above analysis indicates that CALPUFF and CALGRID have aligned better in their predictions than might be expected. This result may be attributed to the similar chemistry used in both models and to the specific circumstances of this case in which the prevailing wind direction on the 20% worst visibility days carries Unit MK2 emissions directly toward Acadia National Park. The big discrepancy occurs under best visibility days, when CALGRID (correctly) does not align the source to receptor, but CALPUFF (incorrectly) applies wind directions for worst visibility days to the best day calculations.

Newington Station Unit NT1: BART Eligibility Modeling

The BART eligibility modeling conducted by MANE-VU used natural visibility conditions (about 7 dv) to produce the most conservative modeling results to minimize sources from modeling out of BART. Under these conditions, uncontrolled emissions from Unit NT1 produce theoretical CALPUFF worst-case impacts of 1.22 dv at Acadia National Park. As in the case of Unit MK2, CALPUFF modeling results for baseline emissions from Unit NT1 exceed all of these exemption levels.

Newington Station Unit NT1: BART Benefit Assessment Modeling

For Newington Station Unit NT1, the CALPUFF-predicted visibility benefits from BART controls on 20% worst visibility days are smaller than those for Merrimack Station Unit MK2:

CALPUFF Modeling Results for Newington Station Unit NT1: Visibility Improvements from BART Controls on the 20% Worst Visibility Days

Pollutant	Control Technology	Control Level	Visibility Improvement (dv)		
			Acadia NP	Great Gulf NW	Lye Brook NW
SO_2	1% S Fuel Oil	50%*	0.08	0.06	< 0.01**
	0.5% S Fuel Oil	75%*	0.12	0.09	0.01
	0.50 lb SO_2/MMBtu	77%*	0.12	0.09	0.01
	0.3% S Fuel Oil	85%*	0.13	0.10	0.01
	FGD	90%*	0.14	0.11	0.02
NOx	LNB	40%	< 0.01**	< 0.01**	< 0.01**
	LNB-OFA	50%	0.01	< 0.01**	< 0.01**
	SNCR	50%	0.01	< 0.01**	< 0.01**
	SCR	85%	0.03	0.02	< 0.01**
PM	Baghouse	99%	<0.01**	<0.01**	< 0.01**

* from maximum permitted level ** below sensitivity limit of model

Notes on CALGRID Model Performance

As noted in EPA comments, CALGRID has been accepted in the past by EPA for photochemical modeling of ozone for SIP purposes. Over the past several years, most regional models have evolved in use and performance since their original photochemical use and now effectively model $PM_{2.5}$ and visibility impacts. CMAQ and CAMx are two other regional grid models that are more commonly used than CALGRID; however, CALGRID has found a niche in the Northeast and in other parts of the world for use as a screening model.

Formal performance testing for CALGRID's ozone predictions was done prior to its use for $PM_{2.5}$ and regional haze modeling. Rigorous statistical performance testing for $PM_{2.5}$ was not done since CALGRID is only being used in a screening mode and simple comparative testing demonstrated that CALGRID performs reasonably in comparison to the REMSAD model. NHDES recognizes that EPA requires performance evaluations on a modeling platform before it can be applied to predicting SIP attainment of a NAAQS. Instead, CALGRID has been applied in SIP supportive and informational work.

CALGRID testing for $PM_{2.5}$ species was performed on a period of approximately two weeks that included high PM and poor visibility days as well as relatively clean days. Most focus of the testing was on the OTR; however, performance in upwind areas was also noted because it's an important source of emissions that transport into the OTR. As is typical for photochemical model performance, the models often did better on higher pollution days than on cleaner days, but overall performance we determined to be good and adequate for use.

While no formal documentation of this testing was completed, plots and graphs that were created for the work have been reviewed. NHDES concludes that CALGRID model performance for $PM_{2.5}$ and regional haze is good and is thus a reasonable modeling tool to use for screening modeling. The Delaware Department of Natural

Resources and Environmental Control similarly reviewed the model's performance and has accepted it for $PM_{2.5}$ and haze modeling.

It should also be noted that CALGRID predicts sulfates, nitrates, PM, and several organic species and reconstructs visibility according to the IMPROVE deciview equation. The CALPUFF processors do not predict organics and use a less refined process to predict visibility changes.

2. Implementation of the selected BART control strategies for each of the three pollutants (SO_2, NOx, and $PM_{2.5}$) at both BART facilities must be federally enforceable. The Regional Haze SIP must clearly indicate how this is being accomplished in each case. Specifically, the relevant rules or permits should be included as part of New Hampshire's Regional Haze SIP revision or the SIP revision should cite specific rules or permits conditions that are already federally enforceable.

▶ NHDES Response: The BART controls and enforceable provisions for Unit MK2 and Unit NT1 are summarized in the tables below:

PSNH Merrimack Station Unit MK2

Pollutant	BART Controls / Emission Limitations	Regulatory Citations*	Compliance Date
NO_X	SCR (existing); NOx emission limit of 0.37 lb/MMBtu, calendar monthly average (proposed)	Draft Title V operating permit (TV-0055); Administrative Rule Env-A 2300 Mitigation of Regional Haze (proposed);	Rule: July 1, 2013
PM	Two ESPs in series (existing) TSP emission limit of 0.08 lb/MMBtu (proposed)	Draft Title V operating permit (TV-0055); Administrative Rule Env-A 2300 Mitigation of Regional Haze (proposed)	Rule: July 1, 2013
SO_2	Fuel sulfur limits (existing); Flue gas desulfurization (FGD), with required SO_2 percent reduction set at maximum sustainable rate, but not less than 90% as a calendar monthly average (proposed)	Administrative Rule Env-A 1606.01 Maximum Sulfur Content Allowable in Coal (existing); Temporary permit for FGD system (TP-0008); Draft Title V operating permit (TV-0055)	FGD: July 1, 2013

PSNH Newington Station Unit NT1

Pollutant	BART Controls / Emission Limitations	Regulatory Citations*	Compliance Date
NO_X	Overfire air and water injection (existing); NOx emission limits of 0.35 lb/MMBtu with oil and 0.25 lb/MMBtu with oil/gas, 24-hour calendar day average (existing)	Title V operating permit (TV-OP-054)	N.A (Existing controls are BART)
PM	Electrostatic precipitator (existing); TSP emission limit of 0.22 lb/MMBtu (existing)	Title V operating permit (TV-OP-054)	N.A (Existing controls are BART)
SO_2	SO_2 emission limit of 0.50 lb/MMBtu, calendar monthly average, applicable to any fuel type or mix (proposed)	Administrative Rule Env-A 2300 Mitigation of Regional Haze (proposed)	Rule: July 1, 2013

BART Determination for PSNH Newington Station Unit NT1

3. For SO_2 New Hampshire determined that the BART level of SO_2 control for PSNH Newington Station unit NT1 is to switch from 2% sulfur content by weight residual oil to 1% sulfur content by weight residual oil.

PSNH Newington Station unit NT1 is a tangentially-fired steam generating unit. The Title V permit indicates that NT1 can burn crude oil or No. 6 fuel oil at no more than 2% sulfur content by weight, No. 2 fuel oil at no more than 0.4% sulfur content by weight, or natural gas. Based on recent data submitted to EPA's Clean Air Market Division, it appears that changing the enforceable sulfur-in-fuel limit from 2% sulfur No. 6 oil to 1% sulfur No. 6 oil will provide minimal reductions in SO_2 emissions since average SO_2 emission rates are near the levels emitted while burning 1% sulfur No. 6 oil. (See Table 1 below which contains 2007 data for PSNH Newington Station.) Thus, other fuel switching options should also be explored. These options include: (1) the use of natural gas, (2) the use of 0.3% sulfur No. 6 oil as recommended by the MANE-VU BART workgroup or (3) the use of No. 2 fuel oil at no more than 0.3% sulfur content by weight.

NHDES Response: EPA has suggested greater use of natural gas and/or low-sulfur distillate fuel oil in place of residual fuel oil. The substitution of No. 2 distillate fuel oil for No. 6 residual fuel oil would not be not be practical for this facility because of the high capital costs involved. Burner replacements to allow the boilers to combust distillate fuel oil could exceed \$20 to \$30 million in direct capital costs, not including the additional costs of engineering and any required auxiliary equipment. Please refer to the next response in reference to the use of natural gas versus residual fuel oil.

Reducing the permitted fuel sulfur limit to 1.0 % or 0.5 % would yield significant reductions in SO_2 emissions at Newington Station. Note that from 2002 to 2007, the average annual sulfur content of #6 fuel oil burned at Unit NT1 ranged between 0.93 and 1.53 percent by weight, with no discernable trend. For New Hampshire's BART analysis, the following fuel sulfur values were assumed:

Nominal %S (Permit Limitation)	Assumed Actual %S (Chemical Assay)
2.0	1.2
1.0	0.8
0.5	0.4

Under these assumptions, switching from 2.0 %S (nominal) to 1.0 %S (nominal) residual fuel oil would produce a one-third reduction in sulfur emissions, and switching to 0.5 %S (nominal) residual fuel oil would produce a two-thirds reduction in sulfur emissions at this facility. The use of 0.3 %S residual fuel oil was considered but not evaluated in detail because this fuel is in very limited use within the region, and its future availability and price are uncertain for northern New England. Its potential use will continue to be evaluated as the market for it in the region develops and supplies and prices can be better projected and assured.

Currently, the only consideration of natural gas as a primary fuel source shown in the proposal is the statement, "In recent years, there have been sudden and dramatic swings in the price of natural gas relative to fuel oil as supply/demand have shifted. The future price and availability of natural gas are difficult to discern."

Recent data from the Energy Information Administration, however, indicates the Average Cost of Natural Gas and Residual Oil are projected to remain comparable. (See Figure 1, "Historic and Projected Power generation Fuel Costs — National.") Therefore, EPA recommends that greater consideration be given to the use of natural gas as the primary fuel at Newington station, with No. 2 fuel oil and/or No. 6 fuel oil being used as the secondary fuel, with a constraint on the number of gallons burned per year.

- ▶ NHDES Response: Unit NT1 can be fired with either natural gas or liquid fuel (i.e., residual fuel oil or biofuel), or it can be co-fired with both types of fuel at the same time. However, because of physical limitations to the boiler design, the unit cannot operate at full capacity when fueled solely by natural gas. In order to reach maximum heat input, the boiler must either burn liquid fuel or be co-fired with both fuel types. (Unit NT1 can operate at up to approximately 50 percent of maximum heat input from natural gas, with no corresponding limitation on liquid fuel.) There is already a natural incentive for PSNH to operate Unit NT1 with natural gas (provided a reliable supply exists) whenever the price of natural gas is competitive with or less than the price of residual fuel oil.

  In recognition of the dual-fuel capability of this unit, NHDES has prepared a draft rule that will reduce sulfur dioxide emissions by imposing an SO_2 emission limit of 0.50 lb/MMBtu for this facility regardless of fuel type. The rule would allow the facility the flexibility to burn natural gas and/or fuel oil in any feasible ratio, depending on market conditions.

If, however, it is not possible to utilize natural gas as the primary fuel type for this unit, then New Hampshire should explain why 1% sulfur No. 6 oil was determined to be BART, rather than the MANE-VU BART workgroup recommended sulfur fuel oil limit of 0.3% sulfur content by weight. This limit is currently required of facilities in Connecticut pursuant to Connecticut's Section 22a-l74-19a regulation.

Additionally, New Hampshire should explain why 0.5% sulfur fuel oil is not BART as well. The proposal indicates that the cost effectiveness of using 1% versus 0.5% fuel oil is the same at $1900/ton. This argues fur the implementation of 0.5% sulfur fuel oil. Also, other facilities in New England are currently limited to 0.5% for No. 6 fuel oil. (See the Title V permit for Salem Harbor Unit #4.)

- ▶ NHDES Response: There is greater assurance today of the availability 0.5%-sulfur residual fuel oil than when the original BART determination was drafted. Maine, Massachusetts, New Jersey, and possibly other states within MANE-VU have already made commitments to require the use of 0.5%-sulfur residual fuel oil, thus ensuring the presence of a regional market for this commodity. The use of 0.3%-sulfur residual fuel oil in Connecticut does not guarantee the availability of this fuel in northern New England, which obtains its bulk oil shipments through different ports.

  New Hampshire's draft rule creating a sulfur dioxide emission limit of 0.50 lb/MMBtu for Unit NT1 will cause a substantial reduction in emissions of this pollutant without concern for relative fuel supplies and prices, which are largely unknown. For the first regional haze progress report, to be submitted circa 2013, NHDES will review fuel usage, fuel supplies, fuel prices, and plant utilization/ capacity factors to determine whether the proposed fuel sulfur limitation is still appropriate as BART control for Unit NT1. Should the review indicate a different

BART control level, the facility's Title V operating permit will be amended as necessary before its expiration date of March 31, 2012, fifteen months prior to the effective date of proposed BART control measures.

In table 1 below is a listing of all of the electric generating steam units in New England that were operational in 2007 and which use residual oil as their primary fuel. As illustrated in the table, most of the units have current SO_2 emissions rates well below the emission rate proposed as BART for PSNIH Newington Station.

- ▶ NHDES Response: The newly proposed sulfur dioxide emission limit of 0.50 lb/MMBtu would fall below many of the SO_2 emission rates listed in the table.

4. For NOx, New Hampshire has determined that BART is met for Newington Unit I through use of the current suite of NOx controls; low NOx burners, an overfire air system, and water injection. New Hampshire indicates that the current emission limits are a daily average of 0.35 lb/MMBtu when burning oil and 0.25 lb/MMBtu when burning a combination of oil and gas. The MANE-VU BART workgroup, however, recommended a level of NOx control for non-CAIR EGUs of 0.1 - 0.25 lb/MMBtu, depending on boiler and fuel type. Therefore, New Hampshire should analyze if a more stringent emission limit is appropriate for this unit.

- ▶ NHDES Response: The MANE-VU BART Workgroup draft presumptive control levels are found in Appendix C of NESCAUM's "Five-Factor Analysis of BART Eligible Sources: Survey of Options for Conducting BART Determinations," June 1, 2007 (special emphasis on *draft*). The presumptive limits are generally applicable to BART facilities having greater than 750 MW capacity and may not be representative of smaller EGUs like Unit NT1. Also, the workgroup's draft recommendations for non-CAIR EGUs do not take into account the effects of scale when a facility operates at very low utilization rates and capacity factors.

  In the case of Unit NT1, since 2006 the average annual capacity factor has been below 10 percent; and preliminary data for January through September of 2009 indicate that the plant was effectively offline for all but the first month of the year. Consequently, the capital costs associated with SCR or SNCR to achieve a control level of 0.1 - 0.25 lb/MMBtu cannot be justified for this EGU at this time, especially on a visibility benefit basis. NHDES finds that the existing NOx RACT limits reasonably represent the sustainable performance capabilities of this unit and are sufficient as BART control levels for NOx on a 30-day averaging basis.

In New England, there is a least one oil-fired electric generating steam unit with selective catalytic reduction installed (Unit #1 at Canal Electric in Sandwich, MA) and at least three oil-fired electric generating steam units with selective non-catalytic reduction installed (Units #1 and #2 at Norwalk Harbor Station in Norwalk, CT and Unit #3 at Middletown Station in Middletown, CT).

- ▶ NHDES Response: While SCR or SNCR may be appropriate for certain oil-fired EGUs elsewhere in New England, the particular circumstances of Newington Station do not support the implementation of either technology as BART for Unit NT1. It is difficult to justify any significant capital expenditure in the context of the plant's recent operating history and the limited visibility benefit that might be obtained.

5. For PM the proposal indicates that the currently installed electro-static precipitator (ESP) is sufficient for BART, yet only cites a 42% control efficiency. According to the BART analysis, *a rebuilt ESP can achieve collection efficiencies of more than 99%. Therefore, the BART determination should include an analysis of the feasibility of an upgraded or rebuilt ESP for this unit. Furthermore, the MANE-VU BART workgroup recommendation for non-CAIR EGUs is a PM emission rate of 0.02 - 0.04 lb/MMBtu. New Hampshire should provide greater detail as to why the state considers its current limit of 0.22 lb/MMBtu as sufficient for BART.*

- NHDES Response: The 42 percent efficiency value was obtained by comparing the PM emission factor from a 2001 controlled stack test report with an AP-42 emission factor for uncontrolled PM, and is therefore a crude approximation of particulate removal efficiency. NHDES has located a 1971 performance specification for this unit from Buell Envirotech Corp. The efficiency is stated as 93 percent under normal operating conditions and a maximum of 98 percent under design conditions. It is unknown whether these higher control rates are representative of the unit's actual long-term performance. The emission rate calculated from the 2001 stack testing (the only data available) was 0.058 lb/MMBtu. This emission rate is within the expected range for a properly operating ESP at a plant like Newington and may be a better measure of performance than the stated efficiencies.

  The single stack test result is insufficient to support consideration of a BART performance level more restrictive than the current permit limit. The facility's Title V operating permit requires that a compliance stack test for PM emissions be performed on Unit NT1 before the permit expires on March 31, 2012. NHDES will review the stack test results, and may request additional information from the facility's owner, to ascertain the unit's performance. NHDES will then incorporate any new limit, as appropriate, into a permit amendment by the permit expiration date. The permit expiration date precedes the effective date of proposed BART control measures by fifteen months.

BART Determination for PSNH Merrimack Station Unit MK2

6. For SO_2, New Hampshire has determined that BART is the installation of flue gas desulfurization (FGD) controls and has issued a temporary permit to the facility which is included in Attachment EE of the submittal. EPA previously reviewed a draft of this permit and submitted comments to the DES in a letter dated March 3, 2009. We have reviewed the version of the permit included in the proposal and note that all of our previous comments have been adequately addressed.

7. For NOx, New Hampshire has determined the year round use of selective catalytic reduction (SCR) is considered BART for Unit MK2. This determination seems reasonable. New Hampshire, however, states that its current federally enforceable limit for this unit is 0.86 lb/MMBtu, while the MANE-VU recommended level of BART control for non-CAIR EGUs is 0.1 - 0.25 lb/MMBtu, depending on the boiler and fuel type. A review of the data in the CAMD database indicates that MK2 is achieving an emission rate well below 0.86 lb/MMBtu. For example, the highest monthly average emission rate in 2008 was 0.30 lb/ MMBtu. Therefore, New Hampshire should impose a more stringent emission limit for this unit.

- NHDES Response: Unit MK2 is required to meet a federal acid rain limit of 0.86 lb NOx/MMBtu, an additional NOx RACT Order limit of 15.4 tons per calendar day, and a NOx RACT Order limit of 29.1 tons per calendar day for Units MK1 and

MK2 combined. The 15.4 ton/day limit is more stringent than the acid rain limit: based on a gross heat input rating of 3,473 MMBtu/hr, the daily limit is equivalent to an emission rate of 0.37 lb/MMBtu (= 15.4 ton/day × 2,000 lb/ton ÷ 24hr/day ÷ 3,473 MMBtu/hr).

Since January 2001, the SCR on Unit MK2 has reduced NOx emissions to between 0.15 and 0.37 lb/MMBtu (calendar monthly average), with a few excursions outside this range. Data available from the period of 1993 to early 1995, prior to operation of the SCR, provide a baseline for uncontrolled NOx emissions in the range of 2.0 to 2.5 lb/MMBtu. Taken together, this information indicates that Unit MK2 achieves a control level greater than 85 percent most of the time.

The presumptive BART control level of 0.1 to 0.25 lb/MMBtu is applicable to power plants having greater than 750 MW capacity and may not be representative of smaller EGUs like Unit MK2. Because this unit's cyclone boiler has a relatively high uncontrolled NOx emission rate, it follows that the controlled emission rate, even as control efficiencies approach 90 percent, would frequently exceed the presumptive norm attributed to larger EGUs.

NHDES finds that the effective NOx RACT limit of 0.37 lb/MMBtu reasonably represents the sustainable performance capabilities of this unit and is also satisfactory as a BART emission limit for NOx on a calendar monthly averaging basis. Note, however, that PSNH may continue to have a monetary incentive to surpass the NOx RACT requirement because lower emissions allow the utility to accrue Discrete Emission Reductions (DERs) under New Hampshire rules.

8. For PM New Hampshire has determined that the use of two currently installed ESPs is considered BART for Unit MK2. This seems reasonable. The proposal, however, indicates that the current air permit imposes a 0.227 lb/MMBtu limit, while the MANE-VU recommended level of BART control for non-CAIR EGUs is 0.02-0.04 lb/MMBtu. Therefore, New Hampshire should analyze if a more stringent emission limit is appropriate for this unit.

- NHDES Response: The 0.227 lb/MMBtu limit derives from the formula established in Env-A 2002.06 and does not reflect the true capabilities of the ESPs serving Unit MK2 to control particulate emissions. Stack testing on three separate dates in 1999 and 2000 found actual TSP emissions to be 0.043, 0.041, and 0.021 lb/MMBtu after controls. The most recent test, in May 2009, produced an emission rate of 0.032 lb/MMBtu.

  The volume of field data is insufficient to establish a conclusive, long-term BART performance level of 0.04 lb/MMBtu or lower for this unit. Accordingly, NHDES has developed a draft rule that will hold TSP emissions to no greater than 0.08 lb/MMBtu, but on a broader scope than required under BART: this standard will apply to Unit MK1 (not a BART-eligible facility) as well as Unit MK2. In the current draft Title V operating permit, Unit MK1 has a TSP emission limit of 0.27 lb/MMBtu, or more than three times the proposed limit of 0.08 lb/MMBtu. Including Unit MK2 in the rule has the effect of reducing the allowable combined TSP emissions from the two coal-fired units at Merrimack Station to less than the total emissions that would be allowed if the limit for Unit MK2 were set at 0.04 lb/MMBtu and the limit for Unit MK1 remained as is (377 lb/hr vs. 473 lb/hr).

Other Comments

9. We recommend the 5^{th} paragraph on page 6 be revised as follows:

"About half of the worst visibility days in the New Hampshire Class I Areas occur in the summer when meteorological conditions are more conducive to the formation of sulfate from SO_2 and to the oxidations of organic aerosols. ~~In addition, winter and summer transport patterns are different, possibly leading to different contributions from upwind source regions. As a result, The~~ remaining worst visibility days are divided nearly equally among spring, winter and fall. In addition, winter and summer transport patterns are different, possibly leading to different contributions from upwind source regions."

- NHDES Response: The recommended text revision has been made.

10. In Section 6.1.2, the Beyond-on-the way (BOTW) emissions scenario is described as "accounting for controls from potential regulations that may be necessary to meet attainment and other air quality goals, mainly for ozone." Based on the list of measures provided on page 123, it is unclear how New Hampshire expects to reduce area source emissions by 4,303 tons per year, as depicted in Table 6.3 2018 BOTW Emissions Inventory Summary for New Hampshire.

- NHDES Response: The 4,303 ton/year reduction in SO_2 emissions is attributable to the proposed BOTW control measure that reduces the sulfur content of residential and commercial distillate (heating) oil. The following description is taken from Part 5.2.6 of MANE-VU's Final Technical Support Document "Development of Emission Projections for 2009, 2012, and 2018 for NonEGU Point, Area, and Nonroad Sources in the MANE-VU Region" (Attachment N):

  > "The BOTW control measure for heating oil is based on NESCAUM's report entitled 'Low Sulfur Heating Oil in the Northeast States: An Overview of Benefits, Costs and Implementation Issues.' NESCAUM estimates that reducing the sulfur content of heating oil from 2,000 ppm to 500 ppm lowers SO_2 emissions by 75 percent, PM emissions by 80 percent, NOx emissions by 10 percent. The 500 ppm sulfur heating oil is not expected to [be] available on a widespread basis until 2012 at the earliest. These percent reductions were applied to residential distillate oil category (SCC 21-04-004-xxx) and commercial distillate oil category (SCC 21-03-004-xxx)."

  These SO_2 control measures would precede additional required reductions in fuel sulfur content as delineated in MANE-VU's low-sulfur fuel strategy. Such additional measures were included in the 2018 most recent emissions inventory ("best and final" scenario) as represented by the data in Table 6.4.

11. The MANE-VU "Ask" includes a low sulfur fuel oil strategy. With regard to this strategy, on page 141 of New Hampshire's proposal, the state indicates that it plans to revise its Env-A 1604 regulation and a draft of the revised rule is provided in Attachment FF. These revised provisions will need to be adopted and submitted to EPA as a SIP revision so they may become a federally enforceable part of New Hampshire's Regional Haze SIP. The proposal currently indicates that New Hampshire commits to revising this rule "at the earliest practicable date." New Hampshire should include a schedule for adoption of the revised regulation.

- NHDES Response: New Hampshire commits to introducing the MANE-VU low-sulfur fuel strategy as a bill into the New Hampshire legislature by January 2012. NHDES originally expected to implement the low-sulfur oil strategy by revision of administrative rule Part Env-A 1604, Sulfur Content Limitations for Liquid Fuels. However, with the generally rising cost of fuels, including home heating oil, any NHDES rule that might further exacerbate fuel prices or create uncertainty regarding adequacy of supplies could be politically sensitive. This is therefore a matter more appropriately addressed by New Hampshire's elected lawmakers. A legislative approach towards implementing a low-sulfur fuel strategy is also preferable because New Hampshire regulations sunset every five years. Consequently, any fully adopted low-sulfur fuel regulation with a compliance date of 2017 included in this SIP would sunset prior to that date.

In addition, the discussion of the low sulfur fuel oil strategy in Section 10.2.3 (page 98) of the proposal notes a concern for potential supply disruptions for residual fuels in northern states. This discussion also states, "MANE-VU has identified several mechanisms that could be implemented to address disruptions, including seasonal averaging and emergency waivers. A seasonal averaging approach would reduce potential supply constraints by allowing the use of higher-sulfur during periods of peak demand." The proposal, however, does not further elaborate on whether or not New Hampshire plans to allow seasonal averaging and emergency waivers. If such provisions are allowed, then there should also be a mechanism to ensure that the use of higher-sulfur oil during peak demand times does not correspond with meteorological conditions leading to the 20% worst visibility days.

NHDES Response: New Hampshire would follow procedures established by EPA in the event of a fuel supply emergency. As described at EPA's fuel waivers website at http://www.epa.gov/compliance/resources/faqs/civil/fuelwaiver.html, the agency, with the concurrence of the Department of Energy, may temporarily waive a fuel or fuel additive requirement if doing so will alleviate the fuel supply emergency. Clean Air Act Section 211(c)(4)(C), which authorizes fuels waivers, specifies the criteria for granting a fuel waiver and the conditions that must be included in a fuel waiver. In the case of an emergency disruption of low-sulfur fuel supplies, NHDES would seek a short-term emergency waiver on fuel sulfur content. To the extent feasible, it would be the intent of any such waiver to moderate the degree of visibility degradation resulting from temporary use of higher-sulfur fuels in a supply disruption. The details would be worked out in response to the particulars of the emergency situation at the time of any waiver request.

United States Department of the Interior
NATIONAL PARK SERVICE
Air Resources Division
P.O. Box 25287
Denver, CO 80225

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June 26, 2009

N3615 (2350)

Robert R. Scott, Director
Air Resources Division
New Hampshire Department of Environmental Services
P.O. Box 95
29 Hazen Drive
Concord, New Hampshire 03302-0095

Dear Mr. Scott:

Enclosed are our comments on the Best Available Retrofit Technology (BART) determinations proposed by the New Hampshire Department of Environmental Services (NHDES) for Public Service New Hampshire's (PSNH) Merrimack Station Unit MK2 and Newington Station Unit NT1. These comments supplement the Septemgber 26, 2008, comments that we submitted on the draft NHDES visibility protection plan. We commend NHDES for its proposals that would lead to significant reductions in sulfur dioxide emissions from both units. We note that, even though those reductions may be the result of other programs in the state, they are also required under the BART provisions of the Regional Haze regulations. We request that emission limits be established, as required by EPA's BART Guidelines, to ensure that the emission control technologies proposed by NHDES as BART are operated to the fullest reasonable extent of their capabilities. We also ask that NHDES provide further documentation in support of its BART determinations.

Again, we appreciate the opportunity to work closely with the State of New Hampshire and compliment you on your hard work and dedication to significant improvement in our nation's air quality values and visibility. For further information, please contact Holly Salazer (NPS Northeast Region) at (814) 865-3100, or Don Shepherd of the NPS Air Resources Division at (don_shepherd@nps.gov, 303-969-2075).

Sincerely,

Bruce Polkowsky for/

John Bunyak
Chief, Policy, Planning and Permit Review Branch

Enclosures

cc:

Stephen Perkins (Suite 1100 CAA)
Director, Office of Ecosystem Protection
EPA New England
1 Congress Street, Suite 1100
Boston MA 02114-2023

BART Review Comments
National Park Service (NPS)
Public Service New Hampshire (PSNH) Merrimack Station

PSNH Merrimack Station has two coal-fired steam-generating boilers that operate nearly full time to meet baseload electric demand. Unit MK2, the only BART-eligible unit, is a wet-bottom, cyclone-type boiler with a heat input rating of 3,473 mmBtu/hr and an electrical output of 320 MW. Installed in 1968, this generating unit is equipped with selective catalytic reduction (SCR) to remove oxides of nitrogen (NO_X) formed during the combustion process. Two electrostatic precipitators (ESPs) operate in series to capture particulate matter (PM). Also, construction has begun on a scrubber system that will reduce sulfur dioxide (SO_2) emissions. According to EPA's Clean Air Markets (CAM) database, in 2007, emissions from Unit #2 were: 25,064 tpy SO_2 (@ 1.97 lb/mmBtu) and 2,248 tpy NO_X (@ 0.19 lb/mmBtu).

Retrofit options for this unit are limited because the facility already has controls in place for NO_X and PM, and only a few emission control technologies are compatible with the type of boiler design employed.

<u>BART Analysis for SO_2</u>

STEP 1 – Identify all available retrofit emissions control techniques
New Hampshire Department of Environmental Services (NHDES): SO_2 control technologies available and potentially applicable to Unit MK2 are wet flue gas desulfurization (FGD) and use of low-sulfur coal.
NPS: PSNH has proposed wet FGD which potentially provides the highest level of reduction.

STEP 2 – Eliminate technically infeasible options
NPS: No SO_2 control options were eliminated on this basis.

STEP 3 – Evaluate control effectiveness of remaining control options
NHDES: SO_2 removal efficiencies for existing wet limestone scrubbers range from 31 to 97 percent, with an average of 78 percent (NESCAUM, 2005).
NPS: NHDES should include requirements that PSNH optimize operation of the wet FGD.

STEP 4 – Impact analysis
NHDES: Using 2002 baseline emissions of 30,657 tons of SO_2 from Units MK1 and MK2 combined, and a minimum capture efficiency of 90 percent for this pollutant, the annualized capital cost equates to about $1,400 per ton of SO_2 removed.
NPS: The estimated cost is within the range of reasonable costs suggested by EPA.

STEP 5 – Determine visibility impacts
see below

Determination of BART for SO_2

NHDES: New Hampshire law requires PSNH Merrimack Station to install and operate a scrubber system for both MK1 and MK2 by July 1, 2013. While the primary intent of this law is to reduce mercury emissions from the company's coal-fired power plants, a major co-benefit is SO_2 removal. Pursuant to this statutory obligation, New Hampshire issued a permit to PSNH on March 9, 2009, for the construction of a wet, limestone-based FGD system to control mercury and SO_2 emissions at Merrimack Station. The permit requires an SO_2 control level of at least 90 percent for Unit MK2. Because this installation is already mandated and because it will attain SO_2 removal rates approaching the BART presumptive norm of 95 percent (applicable to EGUs substantially larger than Merrimack Station), the FGD system is considered to be BART for SO_2 on Unit MK2. NHDES is not requesting further action of Merrimack station at this time in order to comply with BART.

NPS: NHDES should include requirements that PSNH optimize operation of the wet FGD.

BART Analysis for NO_x

STEP 1 – Identify all available retrofit emissions control techniques

NHDES: The only NO_X control technology options available and potentially applicable to Unit MK2 are selective non-catalytic reduction (SNCR) and SCR.

NPS: PSNH has proposed SCR which potentially provides the highest level of reduction.

STEP 2 – Eliminate technically infeasible options

NPS: No NO_X control options were eliminated on this basis.

STEP 3 – Evaluate control effectiveness of remaining control options

NHDES: NO_X emission reductions of about 75 to 90 percent have been obtained with SCR on coal-fired boilers in the U.S. In 1994, PSNH installed an SCR system on Unit MK2, the first such system to be used on a coal-fired wet-bottom cyclone boiler in the U.S. Designed to meet NO_X Reasonably Available Control Technology (RACT) limits, the SCR has reduced NO_X emissions by 85 to 92 percent. Unit MK2 is also required to meet a federal acid rain limit of 0.86 lb NO_x /mmBtu, an additional NO_X RACT Order limit of 15.4 tons per calendar day, and a NO_x RACT Order limit of 29.1 tons per calendar day for Units MK1 and MK2 combined. PSNH is allowed to meet the 15.4 ton-per-day limit for Unit MK2 by using ozone-season discrete emission reductions (DERs). In 2002, actual NO_X emissions for Unit MK2 were reported as 2,871 tons.

NPS: NHDES should explain why the SCR (with or without addition of combustion controls) cannot achieve better than the estimated 85 percent control. NHDES should include requirements that PSNH optimize operation of the SCR.

STEP 4 – Impact analysis

NHDES: Because Unit MK2 already has SCR controls in place, the listed costs serve for comparative purposes only. In 1998, PSNH estimated that its SCR costs would be about $400/ton for year-round operation and about $600/ton for operation limited to the ozone season (May 1 through September 30). These costs are approximately equal to $530/ton

and \$790/ton, respectively, in 2008 dollars. PSNH currently operates Unit MK2 full time in order to meet NO_X RACT requirements. Year-round operation is EPA's presumptive norm for BART (applicable to EGUs of 750 MW capacity or greater) for units that already have seasonally operated SCRs. Assuming that operating costs are proportional to operating time, the difference in cost between year-round and seasonal SCR operation for Unit MK2 is about \$3,300,000, based on PSNH's 1998 cost estimates. The cost differential could be about half that amount, if based on the current (but more generic) estimates presented in Table 2-1.
NPS: The estimated cost is within the range of reasonable costs suggested by EPA.

STEP 5 – Determine visibility impacts
see below

Determination of BART for NO_x
NHDES: Because Unit MK2 already has SCR controls in place, the listed costs serve for comparative purposes only. The estimated costs of NO_X emission controls for SNCR and SCR at Merrimack Station Unit MK2 are presented in Table 2-1 of the BART report. These estimates are based on assumptions used in EPA's Integrated Planning Model for the EPA Base Case 2006 (V.3.0), for retrofitting an EGU the size of Unit MK2. Because the SCR system is already in place to meet other air program requirements and can be operated year-round at reasonable cost, full-time operation of the existing SCR is considered to be BART for NO_X control on Unit MK2.
NPS: Because the only federally-enforceable NO_x limit (described above) does not reflect the full capability of SCR and is well above the presumptive 0.10 lb/mmBtu BART limit for a cyclone furnace, NHDES should include limits that reflect the full capability of the NO_x reduction system.

BART Analysis for PM

STEP 1 – Identify all available retrofit emissions control techniques
NHDES: The only PM control technologies available and potentially applicable to Unit MK2 are electrostatic precipitators, fabric filters, mechanical collectors, and particle scrubbers.
NPS: NHDES should have considered simple, inexpensive upgrades for the ESPs to achieve greater control.

STEP 2 – Eliminate technically infeasible options
NPS: No PM control options were eliminated on this basis.

STEP 3 – Evaluate control effectiveness of remaining control options
NHDES: PSNH Merrimack Station Unit MK2 has two electrostatic precipitators (ESPs), dry type, operating in combination with a fly ash reinjection system. Installation of the ESPs has reduced PM emissions from this unit by about 99 percent, based on a review of 2002 emissions data. The current air permit for the facility requires that Unit MK2 meet a total suspended particulate (filterable TSP) limit of 0.227 lb/mmBtu and a TSP emissions cap of 3,458.6 tons/year. Actual TSP emissions from this unit were 210 tons in 2002.

NPS: A properly designed and operated ESP should be able to achieve 0.015 lb filterable PM/mmBtu. In fact, the data presented by NHDES indicates that the ESPs achieved 0.019 lb TSP/mmBtu in 2002 based upon CAM data heat input of 22,013,515 mmBtu in 2002.

STEP 4 – Impact analysis

NHDES: Because Unit MK2 already has two dry ESPs installed and operating, the tabulated costs are useful for comparative purposes only. Approximate cost ranges are provided for two types of ESPs and two types of fabric filters applicable to a retrofit installation the size of Unit MK2. The costs for ESPs and fabric filters are of similar magnitude, with total annual costs ranging from about $2.6 million to $8.3 million, or $90 to $280 per ton of PM removed. Because Unit MK2 already has two dry ESPs installed and operating, the tabulated costs are useful for comparative purposes only.

NPS: NHDES conducted no analysis of the cost of upgrading the ESPs.

Determination of BART for PM

NHDES: ESPs already exist, physical space at the facility is limited, and the addition of an FGD system is now in progress. The existing ESPs, operating in conjunction with the FGD process, will provide the most cost-effective controls for particulate emissions. Therefore, continued operation of the existing ESPs is considered to be BART for PM control on Unit MK2.

NPS: Although the existing ESPs may well represent BART, NHDES should evaluate possible upgrades, or, at least, establish a federally-enforceable permit limit that reflects the actual capabilities of the units.

STEP 5 – Determine visibility impacts

NHDES: The NHDES conducted a screening-level analysis of the anticipated visibility effects of BART controls at PSNH Merrimack Station Unit MK2. Specifically, one modeling run using the CALGRID photochemical air quality model was performed to assess the effects of installing an FGD system on Unit MK2. The CALGRID model outputs took the form of ambient concentration reductions for SO_2, $PM_{2.5}$, and other haze-related pollutant within the region. NHDES post-processed the modeled concentration reductions to estimate the corresponding visibility improvements at Class I areas such as Acadia National Park, Moosehorn National Wildlife Refuge, and Lye Brook Wilderness Area (i.e., concentration impacts were converted to visibility impacts). For the affected Class I areas (located 100 to 500 kilometers away), reductions in the maximum predicted concentrations of SO_2, $PM_{2.5}$, and other haze-related pollutants, combined, are expected to yield a nominal improvement in visibility (about 0.1 deciview) on direct-impact hazy days.

NPS: EPA recommends use of CALPUFF for modeling single sources in situations like this. CALGRID is more appropriate for multi-source regional modeling and under-predicts impacts relative to CALPUFF. It is likely that, had NHDES applied CALPUFF, it would have produced results that predict significantly higher estimates of visibility benefits that would result from the proposed emission controls.

BART Review Comments
National Park Service (NPS)
Public Service New Hampshire (PSNH) Newington Station Unit NT1

Unit NT1 is the sole electrical generating unit at PSNH Newington Station. It operates at irregular times, principally during periods of peak electric demand. Power is derived from an oil- and/or natural-gas-fired steam-generating boiler with a heat input rating of 4,350 mmBtu/hr and an electrical output of 400 MW. Installed in 1968, the boiler is equipped with Low-NO_X burners, an overfire air system, and water injection to minimize the formation of oxides of nitrogen (NO_X) during the combustion process. The facility also has an electrostatic precipitator to capture particulate matter (PM) in the flue gases. Partial control of SO_2 emissions is provided by sulfur content limits on the fuel oil. According to EPA's Clean Air Markets (CAM) database, in 2002, which were the basis of the New Hampshire Department of Environmental Services (NHDES) BART analysis, emissions from Unit #1 were: 5,226 tpy SO_2 (@ 1.08 lb/mmBtu) and 943 tpy NO_X (@ 0.18 lb/mmBtu).[1]

BART Analysis for SO_2

STEP 1 – Identify all available retrofit emissions control techniques

NHDES: SO_2 control technologies available and potentially applicable to Unit NT1 are wet flue gas desulfurization (FGD) and use of low-sulfur oil.
NPS: NHDES identified a reasonable suite of options.

STEP 2 – Eliminate technically infeasible options

NPS: No SO_2 control options were eliminated on this basis.

STEP 3 – Evaluate control effectiveness of remaining control options

NHDES: SO_2 removal efficiencies for existing wet limestone scrubbers range from 31 to 97 percent, with an average of 78 percent (NESCAUM, 2005).
NPS: NHDES should explain what control efficiency is assumed for the hypothetical new scrubber.

STEP 4 – Impact analysis

NHDES: Despite expressing concern about the high cost estimates,[2] NHDES used the latest Merrimack Station estimate of $1,055/kW for scaling purposes to estimate that the total capital cost of a wet limestone FGD system for Newington Station Unit NT1 would be roughly $422,000,000. NHDES states that "Much caution is necessary in relating this number to the Newington facility: Note that the cost of FGD on oil-fired boilers previously has been estimated to be about *twice* the cost of FGD on coal-fired boilers of

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[1] According to the CAM database, in 2007, emissions from Unit #1 were: 2,269 tpy SO_2 (@ 1.05 lb/mmBtu) and 415 tpy NO_X (@ 0.16 lb/mmBtu).

[2] However, PSNH's estimated cost per kilowatt is at least triple the cost range for FGD systems as reported in MACTEC Federal Programs, Inc., "Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas," Final, July 9, 2007 (see Reasonable Progress Report, Attachment Y). The PSNH estimated cost is also more than double the recent estimate of $300/kW to $500/kW as reported in a 2008 survey of FGD systems (George W. Sharp, "What's That Scrubber Going to Cost?," *Power*, March 1, 2009).

comparable size (NESCAUM, 2005)." NHDES did not estimate annual costs or cost-effectiveness for this option.

According to NHDES, "The costs of fuel switching at Unit NT1 would depend on the incremental costs of purchasing the lower-sulfur fuel at prevailing market prices. The long-term price differential between 1.0%-sulfur (low-S) residual fuel oil and 2.0%-sulfur residual fuel oil is estimated to be about 7.5 cents/gallon. The differential between 0.5%-sulfur (ultra-low-S) residual fuel oil and 2.0%-sulfur residual fuel oil is estimated to be about twice this amount, or 15 cents/gallon (both estimates in 2008$ based on Energy Information Agency compiled price data for the period 1983-2008.) Using these unit prices, the total cost of switching to low-S residual fuel oil is approximately $3.3 million per year, or $1,900 per ton of SO_2 emissions removed; and the cost of switching to ultra-low-S residual fuel oil is approximately $6.6 million per year, or also $1,900 per ton of SO_2 emissions removed (both estimates based on 2002 actual fuel oil usage; note that fuel oil usage in 2006-2008 has been below 2002 levels). These results imply that the cost of fuel switching may be relatively constant on a $/ton basis as long as supplies are adequate...Switching to lower-sulfur fuel oil generally reduces boiler maintenance requirements because less particulate matter is emitted. With fewer material deposits occurring on internal boiler surfaces, the intervals between cleanings/outages can be longer. Also, because lower-sulfur oil reduces the formation of sulfuric acid emissions, corrosion is reduced and equipment life is extended."

STEP 5 – Determine visibility impacts

NHDES: The NHDES conducted a screening level analysis of the anticipated visibility effects of BART controls at PSNH Newington Station Unit NT1. Specifically, one modeling run using the CALGRID photochemical air quality model was performed to assess the effects of installing an FGD system on Unit NT1. The CALGRID model outputs took the form of ambient concentration reductions for SO_2, $PM_{2.5}$, and other haze-related pollutant within the region. NHDES post-processed the modeled concentration reductions to estimate the corresponding visibility improvements at Class I areas such as Acadia National Park, Moosehorn National Wildlife Refuge, and Lye Brook Wilderness Area (i.e., concentration impacts were converted to visibility impacts). For the affected Class I areas, reductions in the maximum predicted concentrations of SO_2, $PM_{2.5}$, and other haze-related pollutants, combined, are expected to yield a negligible improvement in visibility, according to NHDES.

NPS: EPA recommends use of CALPUFF for modeling single sources in situations like this. CALGRID is more appropriate for multi-source regional modeling and under-predicts impacts relative to CALPUFF. It is likely that, had NHDES applied CALPUFF, it would have produced results that predict significantly higher estimates of visibility benefits that would result from the proposed emission controls.

Determination of BART for SO_2

NHDES: Flue gas desulfurization is a potential SO_2 control option for PSNH Newington Station Unit NT1. However, the cost per ton for FGD on oil-fired boilers is estimated to be about twice the cost of this technology on coal-fired boilers and could be well in excess of \$1,000/kW for Newington Station. Given the high costs of this option, it is apparent that FGD would be uneconomical as a retrofit for a peak-demand plant the size of Unit NT1.

Use of a lower-sulfur fuel is a practical option for controlling SO_2 emissions at Newington Station. When natural gas is available at reasonable cost relative to residual fuel oil, natural gas is the preferred fuel because of its very low sulfur content. Otherwise, use of low-sulfur residual fuel oil is a reasonable option. For relatively minor increases in the cost of fuel, switching to 1.0%-S or 0.5%-S residual fuel oil provides significant reductions in fuel sulfur content with proportional reductions in SO_2 emissions.

When not firing on natural gas, Unit NT1 has burned 2.0%-sulfur residual fuel oil (actual average fuel sulfur content was 1.2% in 2002). It is estimated that switching to 1.0%-sulfur residual fuel oil would reduce SO2 emissions by about one-third, and switching to 0.5%-sulfur residual fuel oil would cut SO2 emissions by about two-thirds. At the 2002 production level of 700 million kilowatt-hours, estimated annual costs (long-term average, 2008\$), would be about \$3.3 or \$6.6 million (equivalent to \$0.0047 or \$0.0094 per kWh), respectively. The cost per kilowatt-hour would vary more or less in proportion to the fuel price differential and would not change significantly with increases or decreases in production level.

Fuel switching could be accomplished without capital outlay and would have predictable costs tied directly to fuel consumption and fuel price differentials. A major consideration is fuel availability. In recent years, there have been sudden and dramatic swings in the price of natural gas relative to fuel oil as supply/demand has shifted. The future price and availability of natural gas are difficult to discern. While regional and national supplies of 1.0%-sulfur residual fuel oil appear to be adequate to meet current demand, the present and future availability of 0.5%-sulfur residual fuel oil, in particular, is uncertain and speculative.

After consideration of projected costs, ease of implementation, and fuel availability, it is determined that using 1.0%-sulfur (low-sulfur) residual fuel oil is currently the Best Available Retrofit Technology for PSNH Newington Station Unit NT1 when natural gas is not available at reasonable cost. The use of 0.5%-sulfur (ultra-low-sulfur) residual fuel oil remains a future possibility that should be re-evaluated within the next few years. A further reduction in the sulfur content of fuel oil burned at this facility would be consistent with MANE-VU's plan to reduce sulfur levels to 0.25-0.5% for all fuel oils throughout the region by 2018.

NPS: NHDES concluded that a FGD system is too expensive. We agree with the NHDES approach that use of lower-sulfur fuels is BART for this EGU. And, we commend NHDES for its proposal to reduce the sulfur limit on the #6 residual oil to 1%. Although NHDES also concludes that the cost of switching to 0.5% sulfur fuel oil is also reasonable (@ \$1,900/ton—the same as the cost to go to 1.0% sulfur oil—it has deferred proposing that this additional reduction be required at this time. NHDES suggests that "future availability of 0.5%-sulfur residual fuel oil, in particular, is uncertain and speculative" and that its use "should be re-evaluated within the next few years." To support this contention, NHDES should present information from fuel oil suppliers concerning the uncertain availability of 0.5% sulfur oil. Furthermore, NHDES should explain how and when it would re-evaluate that issue and implement a requirement for 0.5% sulfur oil if it found it to be sufficiently available.

We believe that, if 0.5% sulfur fuel oil is found by NHDES to be reasonably available in the future, a determination that BART is 0.5% sulfur would be consistent with, and enhance the goals of the Northeast states as discussed in the document: "Low Sulfur Heating Oil in the Northeast States: An Overview of Benefits, Costs and Implementation Issues" provided by NHDES as attachment AA. For example, the Executive Summary of that document states:

> The analysis summarized in this White Paper supports the Northeast states' conclusion that significant reductions in SO_2, NO_X, and PM emissions can be achieved by mandating lower sulfur heating oil. Importantly, these reductions can be achieved with an expected cost savings to the consumer. Adding the public health and environmental benefits associated with lower sulfur fuel increases the favorable cost-benefit ratio of a regional 500 pm sulfur heating fuel program.

BART Analysis for NO_x

STEP 1 – Identify all available retrofit emissions control techniques

NHDES: NO_X control technology options available and potentially applicable to Unit NT1 are combustion controls, selective non-catalytic reduction, and selective catalytic reduction.

NPS: NHDES identified a reasonable suite of options.

STEP 2 – Eliminate technically infeasible options

NPS: No NO_X control options were eliminated on this basis.

STEP 3 – Evaluate control effectiveness of remaining control options

NHDES: NO_X emission reductions of about 75 to 90 percent have been obtained with selective catalytic reduction (SCR) on coal-fired boilers in the U.S.

NPS: NHDES should explain why the SCR cannot achieve better than the estimated 85 percent control.

STEP 4 – Impact analysis

NHDES: The estimated costs of NO_X emission controls for SNCR and SCR at Newington Station Unit NT1 are presented in Table 2-1. These estimates are based on assumptions used in EPA's Integrated Planning Model for the EPA Base Case 2006 (V.3.0), for retrofitting an EGU the size of Unit NT1. For SNCR, the total annual cost is estimated to be about \$730,000, or \$1,030/ton of NO_X removed. For an SCR system, the total annual cost is estimated to be \$1,410,000 or \$1,180/ton. Because Unit NT-1 is primarily a peak-load generator, these estimates are based on a 20-percent capacity factor.[3]

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[3] Estimates are derived from USEPA, *Documentation for EPA Base Case 2006 (V.3.0) Using the Integrated Planning Model*, November 2006. Costs are scaled for boiler size. All costs are adjusted to 2008 dollars. Total annual cost is for retrofit of a 400-MW unit with 20% capacity factor and 701million kWh

NPS: When we applied different assumptions for SCR (e.g., 90% NO_x control, 20-year life, 7% interest) we arrived at a slightly higher ($1,278) cost/ton. Furthermore, Newington's capacity utilization and emissions have dropped so much in recent years that it is doubtful that any major capital expenditures would be justified as long as that low utilization continues. For example, in 2007, CAM data show that heat input had declined to 4.3 trillion Btu, and that NO_X emissions were 415 tons.

STEP 5 – *Determine visibility impacts*
(same as above for SO_2)

Determination of BART for NO_x
NHDES: For the reasons below, the existing controls, which include Low- NO_X burners, overfire air, and water injection, are determined to be BART for Newington Station Unit NT1:

- Many of the NO_X reduction benefits acquired through the implementation of low excess air are already being achieved at Unit NT1 through the use of Low-NOX burners and overfire air.
- The additional reductions in NO_X emissions that would result from adding SCR or SNCR would come at a cost of about $0.7 to $1.3 million annually, with incremental NO_X reductions in the 300 to 700 ton/year range. This cost range does not include costs related to redesign of the site layout to accommodate existing spatial constraints. Also, this estimate is based on 2002 emission levels, when the plant's capacity factor was around 20 percent. With the capacity factor having fallen to less than 10 percent over the period 2006-2008, it is difficult today to justify additional technology retrofits to reduce NO_X emissions at this facility.
- For SNCR, the total annual cost is estimated to be about $730,000, or $1,030/ton of NO_X removed. For an SCR system, the total annual cost is estimated to be $1,410,000 or $1,180/ton. SCR and SNCR are not cost-effective as Best Available Retrofit Technology for this facility and will not be considered further.
- Another consideration with SCR or SNCR is flue gas and fugitive ammonia emissions. Based on past operation of Unit NT1 and on typical ammonia "slip" rates, it is estimated that fugitive ammonia emissions with either technology would be in the vicinity of 32 tons annually. Ammonia is a regulated toxic air toxic pollutant in New Hampshire and is also a significant contributor to visibility impairment.

NPS: We agree that the reduced capacity utilization makes it difficult today to justify additional technology retrofits[4] to reduce NO_X emissions at this facility. NHDES should propose federally-enforceable BART limit(s) that reflect its BART determination.

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annual generation. Total annual cost includes amortization of capital cost over 15 years at 3.0% interest rate. Average cost per ton is based on an estimated 704 tons of NO_X removed for SNCR and an estimated 1,196 tons of NO_X removed for SCR.

[4] NHDES has approved SCR (and the associated issues with ammonia) at Merrimack and must explain how it arrived at its estimate for ammonia slip and why ammonia is more of a problem at Newington. If NHDES believes that ammonia slip will impair visibility, it must show why that outweighs the benefits of reducing NO_x.

BART Analysis for PM

STEP 1 – Identify all available retrofit emissions control techniques
NHDES: The only PM control technologies available and potentially applicable to Unit NT1 are electrostatic precipitators, fabric filters, mechanical collectors, and particle scrubbers.

NPS: NHDES should have considered simple, inexpensive upgrades for the ESPs to achieve greater control.

STEP 2 – Eliminate technically infeasible options
NPS: No PM control options were eliminated on this basis.

STEP 3 – Evaluate control effectiveness of remaining control options
NHDES: Existing electrostatic precipitators (ESPs) are typically 40 to 60 percent efficient. New or rebuilt ESPs can achieve collection efficiencies of more than 99 percent. Collection efficiencies of baghouses may exceed 99 percent.

NPS: NHDES assumed 42% for the existing ESP at Newington. Because this is far short of the capabilities of a rebuilt ESP, NHDES should have evaluated that option.

STEP 4 – Impact analysis
NHDES: The costs for ESPs and fabric filters are of similar magnitude, with total annual costs ranging from about $3.2 million to $10.4 million, or $14,000 to $63,000 per ton of PM removed. Because Unit NT1 already has an ESP installed and operating, the tabulated costs are useful for comparative purposes only.

NPS: NHDES should have evaluated upgrading the ESP.

Determination of BART for PM
NHDES: PSNH currently operates an electrostatic precipitator on Unit NT1. ESPs perform with removal efficiency rates similar to those of fabric filters but operate at about half the cost for plants of this size. Because of the estimated cost differential and the fact that an ESP is already installed and operating, the existing ESP is determined to satisfy BART requirements for PM removal at PSNH Newington Station Unit NT1.

NPS: However, NHDES has assumed that the existing ESP is only 42% efficient—which is not "similar' to a fabric filter. NHDES should propose a limit that reflects the 99% control it assumed in its analyses for a new ESP or fabric filter. Although the existing ESPs may well represent BART, NHDES should evaluate possible upgrades, or, at least, establish a federally-enforceable permit limit that reflects the actual capabilities of the unit.

New Hampshire Regional Haze SIP Revision
Responses to Federal Land Managers' Comments

On June 26, 2009, the New Hampshire Department of Environmental Services (NHDES) received written comments on New Hampshire's draft final Regional Haze SIP, May 22, 2009, from the U.S. Department of the Interior, National Park Service (NPS). These comments specifically addressed the Best Available Retrofit Technology (BART) provisions of New Hampshire's regional haze plan. The following are NHDES's responses to NPS's comments. **Comments are reproduced in *italics* and responses appear in regular font.**

PSNH Merrimack Station Unit MK2

PSNH Merrimack Station has two coal-fired steam-generating boilers that operate nearly full time to meet baseload electric demand. Unit MK2, the only BART-eligible unit, is a wet-bottom, cyclone-type boiler with a heat input rating of 3,473 mmBtu/hr and an electrical output of 320 MW. Installed in 1968, this generating unit is equipped with selective catalytic reduction (SCR) to remove oxides of nitrogen (NOx) formed during the combustion process. Two electrostatic precipitators (ESPs) operate in series to capture particulate matter (PM). Also, construction has begun on a scrubber system that will reduce sulfur dioxide (SO_2 emissions. According to EPA Clean Air Markets (CAM) database, in 2007, emissions from Unit #2 were: 25,064 tpy SO_2 (@ 1.97 lb/mmBtu) and 2,248 tpy NOx (0.19 lb/mmBtu).

Retrofit options for this unit are limited because the facility already has controls in place for NOx and PM, and only a few emission control technologies are compatible with the type of boiler design employed.

BART Analysis for SO_2

STEP 1 – Identify all available retrofit emissions control techniques

NHDES: SO_2 control technologies available and potentially applicable to Unit MK2 are wet flue gas desulfurization (FGD) and use of low-sulfur coal.

NPS: PSNH has proposed wet FGD which potentially provides the highest level of reduction.

STEP 2 – Eliminate technically infeasible options

NPS: No SO_2 control options were eliminated on this basis.

STEP 3 – Evaluate control effectiveness of remaining control options

NHDES: SO_2 removal efficiencies for existing wet limestone scrubbers range from 31 to 97 percent, with an average of 78 percent (NESCAUM, 2005).

NPS: NHDES should include requirements that PSNH optimize operation of the wet FGD.

- ▶ <u>NHDES Response</u>: In order to meet the conditions set by state law, the wet FGD is currently being optimized for mercury emission reductions. It is unreasonable to require state-of-the-art performance for SO_2 removal as if it were the only pollutant of interest. However, after undertaking the large financial commitment necessary to construct and operate the FGD system, PSNH has a vested interest in reducing emissions of both pollutants to the maximum practicable extent. There is little advantage to be gained by PSNH in accepting less than optimum performance of this system because doing so could create other operational problems.

The Temporary Permit for this facility (Attachment EE of Regional Haze SIP) includes provisions that will reset the required SO_2 percent reduction to the maximum sustainable rate with the new FGD system after an initial operating period. The specific language of the permit is as follows: "The Owner shall submit a report no later than December 31, 2014 that includes the calendar month average SO_2 emission rates at the inlet and outlet of the FGD and the corresponding calendar month average emissions reductions during the preceding 12 months of operation, excluding the initial startup and commissioning period and any periods when the FGD system is not operating…DES shall establish the maximum sustainable rate of SO_2 emissions reductions based on a statistical analysis of the data submitted to DES…This established rate shall be incorporated as a permit condition for MK2. Under no circumstances shall the SO_2 removal efficiency for MK2 be less than 90 percent."

Also, it should be noted that PSNH has worked to control the sulfur content of the coal in order to reduce SO_2 emissions. Because the particular boiler design does not permit the burning of straight low-sulfur coal, the company blends coals to bring average sulfur content to a level that is consistent with sustainable boiler operations.

STEP 4 – Impact analysis

NHDES: Using 2002 baseline emissions of 30,657 tons of SO_2 from Units MKI and MK2 combined, and a minimum capture efficiency of 90 percent for this pollutant, the annualized capital cost equates to about \$1,400 per ton of SO_2 removed.

NPS: The estimated cost is within the range of reasonable costs suggested by EPA.

STEP 5 – Determine visibility impacts

see below

Determination of BART for SO_2

NHDES: New Hampshire law requires PSNH Merrimack Station to install and operate a scrubber system for both MK1 and MK2 by July 1, 2013. While the primary intent of this law is to reduce mercury emissions from the company's coal-fired power plants, a major co-benefit is SO_2 removal. Pursuant to this statutory obligation, New Hampshire issued a permit to PSNH on March 9, 2009, for the construction of a wet, limestone-based FGD system to control mercury and SO_2 emissions at Merrimack Station. The permit requires an SO_2 control level of at least 90 percent for Unit MK2. Because this installation is already mandated and because it will attain SO_2 removal rates approaching the BART presumptive norm of 95 percent (applicable to EGUs substantially larger than Merrimack Station), the FGD system is considered to be BART for SO_2 on Unit MK2. NHDES is not requesting further action of Merrimack station at this time in order to comply with BART.

NPS: NHDES should include requirements that PSNH optimize operation of the wet FGD.

- ▶ NHDES Response: Please see previous response.

BART Analysis for NOx

STEP 1 – Identify all available retrofit emissions control techniques

NHDES: The only NOx control technology options available and potentially applicable to Unit MK2 are selective non-catalytic reduction (SNCR) and SCR.

NPS: PSNH has proposed SCR which potentially provides the highest level of reduction.

STEP 2 – Eliminate technically infeasible options

NPS: No NOx control options were eliminated on this basis.

STEP 3 – Evaluate control effectiveness of remaining control options

NHDES: NOx emission reductions of about 75 to 90 percent have been obtained with SCR on coal-fired boilers in the U.S. In 1994, PSNH installed an SCR system on Unit MK2, the first such system to be used on a coal-fired wet-bottom cyclone boiler in the U.S. Designed to meet NOx Reasonably Available Control Technology (RACT) limits, the SCR has reduced NOx emissions by 85 to 92 percent. Unit MK2 is also required to meet a federal acid rain limit of 0.86 lb NOx/mmBtu, an additional NOx RACT Order limit of 15.4 tons per calendar day, and a NOx RACT Order limit of 29.1 tons per calendar day for Units MK and MK2 combined. PSNH is allowed to meet the 15.4 ton-per-day limit for Unit MK2 by using ozone-season discrete emission reductions (DERs). In 2002, actual NOx emissions for Unit MK2 were reported as 2,871 tons.

NPS: NHDES should explain why the SCR (with or without addition of combustion controls) cannot achieve better than the estimated 85 percent control. NHDES should include requirements that PSNH optimize operation of the SCR.

- NHDES Response: Since January 2001, the SCR on Unit MK2 has reduced NOx emissions to between 0.15 and 0.37 lb/MMBtu (calendar monthly average), with a few excursions outside this range. (Note that the existing NOx RACT limit of 15.4 tons per calendar day is mathematically equivalent to 0.37 lb/MMBtu.) Data available from the period of 1993 to early 1995, prior to operation of the SCR, provide a baseline for uncontrolled NOx emissions in the range of 2.0 to 2.5 lb/MMBtu. Taken together, this information indicates that Unit MK2 achieves a control level greater than 85 percent most of the time. PSNH may also have a monetary incentive to surpass the NOx RACT requirement because further emission reductions allow the utility to accumulate DERs. With respect to optimization, Unit MK2 has an early-generation SCR that previously received retrofits to improve its performance. Additional upgrades would require major redesign and construction at a location where physical space is already constrained. Capital costs would be comparable to installing a new SCR and would achieve only marginal additional reductions in NOx emissions.

STEP 4 – Impact analysis

NHDES: Because Unit MK2 already has SCR controls in place, the listed costs serve for comparative purposes only. In 1998, PSNH estimated that its SCR costs would be about $400/ton for year-round operation and about $600/ton for operation limited to the ozone season (May 1 through September 30). These costs are approximately equal to $530/ton and

$790/ton, respectively, in 2008 dollars. PSNH currently operates Unit MK2 full time in order to meet NOx RACT requirements. Year-round operation is EPA's presumptive norm for BART (applicable to EGUs of 750 MW capacity or greater) for units that already have seasonally operated SCRs. Assuming that operating costs are proportional to operating time, the difference in cost between year-round and seasonal SCR operation for Unit MK2 is about $3,300,000, based on PSNH's 1998 cost estimates. The cost differential could be about half that amount, if based on the current (but more generic) estimates presented in Table 2-1.

NPS: The estimated cost is within the range of reasonable costs suggested by EPA.

STEP 5 – Determine visibility impacts

see below

Determination of BART for NOx

NHDES: Because Unit MK2 already has SCR controls in place, the listed costs serve for comparative purposes only. The estimated costs of NOx emission controls for SNCR and SCR at Merrimack Station Unit MK2 are presented in Table 2-1 of the BART report. These estimates are based on assumptions used in EPA Integrated Planning Model for the EPA Base Case 2006 (V.3.0), for retrofitting an EGU the size of Unit MK2. Because the SCR system is already in place to meet other air program requirements and can be operated year-round at reasonable cost, full-time operation of the existing SCR is considered to be BART for NOx control on Unit MK2.

NPS: Because the only federally-enforceable NOx limit (described above) does not reflect the full capability of SCR and is well above the presumptive 0.10 lb/mmBtu BART limit for a cyclone furnace, NHDES should include limits that reflect the full capability of the NOx reduction system.

- NHDES Response: The presumptive BART limit is generally applicable to power plants having greater than 750 MW capacity and may not be representative of smaller EGUs like Unit MK2. In the case of Unit MK2, the cyclone boiler has a relatively high uncontrolled NOx emission rate (≥2.0 lb/MMBtu), so it follows that the controlled emission rate, even at 90 percent control efficiency, would be above the presumptive norm applicable to larger facilities. As seen in the past decade of emissions records for Unit MK2, monthly average NOx emissions have normally ranged between 50 and 100 percent of the RACT limit. The existing NOx RACT limit of 15.4 ton/day, equivalent to of 0.37 lb/MMBtu, corresponds to a NOx control rate of about 85 percent. NHDES finds that the NOx RACT limit reasonably represents the sustainable performance capabilities of this unit and is also satisfactory as a BART control level for NOx on a 30-day averaging basis.

BART Analysis for PM

STEP 1 – Identify all available retrofit emissions control techniques

NHDES: The only PM control technologies available and potentially applicable to Unit MK2 are electrostatic precipitators, fabric filters, mechanical collectors, and particle scrubbers.

NPS: NHDES should have considered simple, inexpensive upgrades for the ESPs to achieve greater control.

STEP 2 – Eliminate technically infeasible options

NPS: No PM control options were eliminated on this basis.

STEP 3 – Evaluate control effectiveness of remaining control options

NHDES: PSNH Merrimack Station Unit MK2 has two electrostatic precipitators (ESPs), dry type, operating in combination with a fly ash reinjection system. Installation of the ESPs has reduced PM emissions from this unit by about 99 percent, based on a review of 2002 emissions data. The current air permit for the facility requires that Unit MK.2 meet a total suspended particulate (filterable TSP) limit of 0.227 lb/mmBtu and a TSP emissions cap of 3,458.6 tons/year. Actual TSP emissions from this unit were 210 tons in 2002.

NPS: A properly designed and operated ESP should be able to achieve 0.015 lb filterable PM/mmBtu. In fact, the data presented by NHDES indicates that the ESPs achieved 0.019 lb TSP/mmBtu in 2002 based upon CAM data heat input of 22,013,515 mmBtu in 2002.

- ▶ NHDES Response: The 0.227 lb/MMBtu limit derives from the formula established in Env-A 2002.06 and does not reflect the true capabilities of the ESPs serving Unit MK2 to control particulate emissions. Stack testing on three separate dates in 1999 and 2000 found actual TSP emissions to be 0.043, 0.041, and 0.021 lb/MMBtu after controls. The most recent test, in May 2009, produced an emission rate of 0.032 lb/MMBtu.

STEP 4 – Impact analysis

NHDES: Because Unit MK2 already has two dry ESPs installed and operating, the tabulated costs are useful for comparative purposes only. Approximate cost ranges are provided for two types of ESPs and two types of fabric filters applicable to a retrofit installation the size of Unit MK2. The costs for ESPs and fabric filters are of similar magnitude, with total annual costs ranging from about $2.6 million to $8.3 million, or $90 to $280 per ton of PM removed...

NPS: NHDES conducted no analysis of the cost of upgrading the ESPs.

- ▶ NHDES Response: The existing ESPs were previously upgraded to include state-of-the-art electronic controls. Further upgrading would require either major equipment substitutions or the addition of a third ESP in series with the two existing units. Adding a third ESP might be physically impossible because of severe spatial limitations following past improvements to emission control systems. To undertake either major equipment replacement or installation of a third ESP, if it could be done at all, would require a major capital expenditure. Typical equipment replacement costs for ESP upgrades may be in the range of $10,000 to $30,000 per MW. For Unit MK2, additional costs of this magnitude are not easily justified when weighed against the visibility improvement (less than 0.01 dv on the 20 percent worst visibility days) that would be realized.

Determination of BART for PM

NHDES: ESPs already exist, physical space at the facility is limited, and the addition of an FGD system is now in progress. The existing ESPs, operating in conjunction with the FGD process, will provide the most cost-effective controls for particulate emissions. Therefore, continued operation of the existing ESPs is considered to be BART for PM control on Unit MK2.

NPS: Although the existing ESPs may well represent BART, NHDES should evaluate possible upgrades, or, at least, establish a federally-enforceable permit limit that reflects the actual capabilities of the units.

- NHDES Response: Despite the existence of former stack test results, the volume of data is deemed insufficient to establish a conclusive, long-term BART performance level of 0.04 lb/MMBtu or lower for this unit. Accordingly, NHDES has developed a draft rule that will hold TSP emissions to no greater than 0.08 lb/MMBtu, but on a broader scope than required under BART: this standard will apply to Unit MK1 (not a BART-eligible facility) and Unit MK2. In the current draft Title V operating permit, Unit MK1 has a TSP emission limit of 0.27 lb/MMBtu, or more than three times the proposed limit of 0.08 lb/MMBtu. By including Unit MK1 in the rule, the combined allowable TSP emissions from the two coal-fired units at Merrimack Station (377 lb/hr) will be reduced to less than the total allowable TSP emissions under a hypothetical scenario in which the limit for Unit MK2 would be revised to 0.04 lb/MMBtu and the limit for Unit MK1 would remain unchanged (473 lb/hr).

STEP 5 – Determine visibility impacts

NHDES: The NHDES conducted a screening-level analysis of the anticipated visibility effects of BART controls at PSNH Merrimack Station Unit MK2. Specifically, one modeling run using the CALGRID photochemical air quality model was performed to assess the effects of installing an FGD system on Unit MK2. The CALGRID model outputs took the form of ambient concentration reductions for SO_2, $PM_{2.5}$, and other haze-related pollutant within the region. NHDES post-processed the modeled concentration reductions to estimate the corresponding visibility improvements at Class I areas such as Acadia National Park, Moosehorn National Wildlife Refuge, and Lye Brook Wilderness Area (i.e., concentration impacts were converted to visibility impacts). For the affected Class I areas (located 100 to 500 kilometers away), reductions in the maximum predicted concentrations of SO_2, $PM_{2.5}$, and other haze-related pollutants, combined, are expected to yield a nominal improvement in visibility (about 0.1 deciview) on direct-impact hazy days.

NPS: EPA recommends use of CALPUFF for modeling single sources in situations like this. CALGRJD is more appropriate for multi-source regional modeling and under- predicts impacts relative to CALPUFF. It is likely that, had NHDES applied CALPUFF, it would have produced results that predict significantly higher estimates of visibility benefits that would result from the proposed emission controls.

- NHDES Response: According to EPA guidance, CALPUFF or other EPA-approved model may be used to estimate the magnitude of a source's impacts on visibility after implementation of various BART control levels. NHDES agrees with NPS that, if the CALPUFF model had originally been used to perform this assessment, then higher estimates of visibility improvement may have been predicted. CALPUFF is EPA's preferred model for performing long-range visibility assessments of individual sources to distant Class I areas, in part because it is considered to be a conservative model or one that is capable of estimating worst-case impacts rather than expected impacts. This makes CALPUFF ideally suited to screening BART sources for exemption purposes because it is likely to identify virtually all sources that could provide visibility benefits when their emissions are controlled.

CALGRID is a sister program to CALPUFF and shares much of the same chemistry; however, it works as a gridded model rather than a puff tracking model, and it has the advantage of easily tracking 20% worst visibility days and cumulative impacts by modeling all source sectors. NHDES chose to use CALGRID since it is much easier to track the dynamics of impacts from single sources to multiple Class I areas on targeted days, rather than just applying the maximum impact conditions that may or may not be associated with 20% worst days. While the CALPUFF model's CALPOST post-processor has an option for application on 20% best visibility days, it does not in fact isolate those 20% best days for analysis. It simply changes the background values the model uses to adjust what it estimates to be appropriate background levels. It does not account for wind directions that may be preferentially included or excluded on such days.

Nevertheless, to provide a comparison with New Hampshire's CALGRID modeling results, NHDES conducted a limited set of CALPUFF runs for the New Hampshire BART-eligible sources under controlled and uncontrolled conditions.

In previous modeling, MANE-VU used CALPUFF to assist in the identification of BART-eligible sources. This modeling assumed natural visibility conditions (about 7 dv) to produce the most conservative results possible, thereby minimizing the number of sources that would "model out" of BART requirements. Under these conditions, uncontrolled emissions from Unit MK2 produce theoretical CALPUFF worst-case impacts of 2.29 dv at Acadia National Park. EPA considers acceptable source exemptions when this form of conservative modeling indicates a source produces less than 0.5 dv of impact. MANE-VU considers an exemption level of 0.2 to 0.3 dv to be more appropriate but prefers, and has applied, an even more conservative exemption level of 0.1 dv. CALPUFF modeling results for baseline emissions from Unit MK2 exceed all of these exemption levels.

The BART assessment modeling provides a comparison of visibility impacts from current allowable emissions with those from the post-control emission level (or levels) being assessed. Results are tabulated for the average of the 20% worst visibility (in this case, about 22.8 dv) modeled days at each nearby Class 1 area. For any pair of control levels evaluated, the difference in the level of impairment predicted is the degree of improvement in visibility expected.

Rather than use CALPOST to manually manipulate background deciview calculations, NHDES normalized CALPUFF modeling results and then applied predicted concentrations to a logarithmic best-fit equation to the actual observed $PM_{2.5}$-to-deciview relationship measured at Acadia NP, Great Gulf NW, and Lye Brook NW. Thus, as recommended by BART modeling guidance, CALPUFF was applied in a relative way using real observed data as the basis. At this point, a number of background visibility scenarios could be calculated from the resulting PM-mass-to-deciview equation. According to BART guidance, the natural visibility condition (about 7 dv) was used for exemption purposes, and 20% worst visibility (22.8 dv) was used for assessment of BART control effectiveness. The CALPUFF-predicted visibility benefits from BART controls on 20% worst visibility days are as follows:

CALPUFF Modeling Results for Merrimack Station Unit MK2: Visibility Improvements from BART Controls on the 20% Worst Visibility Days

Pollutant	Control Technology	Control Level	Visibility Improvement (dv)		
			Acadia NP	Great Gulf NW	Lye Brook NW
SO_2	FGD	90%	0.28	0.22	0.03
NO_X	SCR Upgrade	89%	0.01	0.01	< 0.01*
PM	ESP Upgrade	99.4%	<0.01*	<0.01*	< 0.01*
	Baghouse	99%	-0.02	-0.02	-0.01

* below sensitivity limit of model

While Unit MK2 was predicted to have up to 2.29 dv impact at Acadia National Park under natural conditions, the basis of the BART assessment evaluation changes to 20% worst visibility days. On those days, a 90% reduction in sulfur emissions at Unit MK2 results in only a 0.28 dv visibility improvement. At first these results may appear to be incorrect; however, on further examination, it is found that CALPUFF predicts the same amount of sulfate from Unit MK2 reaching Acadia under both best and worst visibility conditions. The difference is that there is greater than an order of magnitude more sulfate coming from other sources on the 20% worst visibility days, raising the background concentrations to much higher levels. Because the deciview scale is logarithmic, the same mass reduction of 0.26 $\mu g/m^3$ of sulfate from this one source results in wide differences in deciview impacts for different background visibility conditions at opposite ends of the range.

The above analysis indicates that CALPUFF and CALGRID have aligned better in their predictions than might be expected. This result may be attributed to the similar chemistry used in both models and to the specific circumstances of this case in which the prevailing wind direction on the 20% worst visibility days carries Unit MK2 emissions directly toward Acadia National Park. The big discrepancy occurs under best visibility days, when CALGRID (correctly) does not align the source to receptor, but CALPUFF (incorrectly) applies wind directions for worst visibility days to the best day calculations.

PSNH Newington Station Unit NT1

Unit NT1 is the sole electrical generating unit at PSNH Newington Station. It operates at irregular times, principally during periods of peak electric demand. Power is derived from an oil- and/or natural-gas-fired steam-generating boiler with a heat input rating of 4,350 mmBtu/hr and an electrical output of 400 MW. Installed in 1968, the boiler is equipped with low-NOx burners, an overfire air system, and water injection to minimize the formation of oxides of nitrogen (NOx) during the combustion process. The facility also has an electrostatic precipitator to capture particulate matter (PM) in the flue gases. Partial control of SO_2 emissions is provided by sulfur content limits on the fuel oil. According to EPA's Clean Air Markets (CAM) database, in 2002, which were the basis of the New Hampshire Department of Environmental Services (NHDES) BART analysis, emissions from Unit #1 were: 5,226 tpy SO_2 (1.08 lb/mmBtu) and 943 tpy NOx (@ 0.18 lb/mmBtu).[1]

[1] *According to the CAM database, in 2007, emissions from Unit #1 were: 2,269 tpy SO_2 (@ 1.05 lb/mmBtu) and*

BART Analysis for SO_2

STEP 1 – Identify all available retrofit emissions control techniques

NHDES: SO_2 control technologies available and potentially applicable to Unit NT1 are wet flue gas desulfurization (FGD) and use of low-sulfur oil.

NPS: NHDES identified a reasonable suite of options.

STEP 2 – Eliminate technically infeasible options

NPS: No SO_2 control options were eliminated on this basis.

STEP 3 – Evaluate control effectiveness of remaining control options

NHDES: SO_2 removal efficiencies for existing wet limestone scrubbers range from 31 to 97 percent, with an average of 78 percent (NESCAUM, 2005).

NPS: NHDES should explain what control efficiency is assumed for the hypothetical new scrubber.

- ▶ NHDES Response: For FGD systems installed at large (>750 MW) coal-fired power plants, the presumptive norm is 95 percent reduction of SO_2 emissions. Newington Station Unit NT1 is a considerably smaller (400 MW), oil-fired unit; and there is only limited experience with FGD systems on oil-fired EGUs. However, it may be assumed that a hypothetical new scrubber system for Newington Station would perform at a similar level, achieving SO_2 removal efficiencies of 90 percent or greater.

STEP 4 – Impact analysis

NHDES: Despite expressing concern about the high cost estimates,[2] NHDES used the latest Merrimack Station estimate of $l,055/kW for scaling purposes to estimate that the total capital cost of a wet limestone FGD system for Newington Station Unit NT1 would be roughly $422,000,000. NHDES states that "Much caution is necessary in relating this number to the Newington facility: Note that the cost of FGD on oil-fired boilers previously has been estimated to be about twice the cost of FGD on coal-fired boilers of comparable size (NESCAUM, 2005)." NHDES did not estimate annual costs or cost-effectiveness for this option.

NPS: According to NHDES, "The costs of fuel switching at Unit NT1 would depend on the incremental costs of purchasing the lower-sulfur fuel at prevailing market prices. The long-term price differential between 1.0%-sulfur (low-S) residual fuel oil and 2.0%-sulfur residual fuel oil is estimated to be about 7.5 cents/gallon. The differential between 0.5%-sulfur (ultra-low-S) residual fuel oil and 2.0%-sulfur residual fuel oil is estimated to be about twice this amount, or 15 cents/gallon (both estimates in 2008$ based on Energy Information Agency

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415 tpy NOx (@ 0.16 lb/mmBtu).

[2] *However, PSNH's estimated cost per kilowatt is at least triple the cost range for FGD systems as reported in MACTEC Federal Programs, Inc., "Assessment of Reasonable Progress for Regional Haze in MANE- VU Class I Areas," Final, July 9, 2007 (see Reasonable Progress Report, Attachment Y). The PSNH estimated cost is also more than double the recent estimate of $300 to $500/kW as reported in a 2008 survey of FGD systems (George W. Sharp, "What's That Scrubber Going to Cost?,"* Power, *March 1, 2009).*

compiled price data for the period 1983-2008.) Using these unit prices, the total cost of switching to low-S residual fuel oil is approximately \$3.3 million per year, or \$1,900 per ton of SO_2 *emissions removed; and the cost of switching to ultra-low-S residual fuel oil is approximately \$6.6 million per year, or also \$1,900 per ton of* SO_2 *emissions removed (both estimates based on 2002 actual fuel oil usage; note that fuel oil usage in 2006-2008 has been below 2002 levels). These results imply that the cost of fuel switching may be relatively constant on a \$/ton basis as long as supplies are adequate...Switching to lower-sulfur fuel oil generally reduces boiler maintenance requirements because less particulate matter is emitted. With fewer material deposits occurring on internal boiler surfaces, the intervals between cleanings/outages can be longer. Also, because lower-sulfur oil reduces the formation of sulfuric acid emissions, corrosion is reduced and equipment life is extended."*

STEP 5 – Determine visibility impacts

NHDES: The NHDES conducted a screening level analysis of the anticipated visibility effects of BART controls at PSNH Newington Station Unit NT1. Specifically, one modeling run using the CALGRID photochemical air quality model was performed to assess the effects of installing an FGD system on Unit NT1. The CALGRID model outputs took the form of ambient concentration reductions for SO_2, $PM_{2.5}$, *and other haze-related pollutant within the region. NHDES post-processed the modeled concentration reductions to estimate the corresponding visibility improvements at Class I areas such as Acadia National Park, Moosehorn National Wildlife Refuge, and Lye Brook Wilderness Area (i.e., concentration impacts were converted to visibility impacts). For the affected Class I areas, reductions in the maximum predicted concentrations of* SO_2, $PM_{2.5}$, *and other haze-related pollutants, combined, are expected to yield a negligible improvement in visibility, according to NHDES.*

NPS: EPA recommends use of CALPUFF for modeling single sources in situations like this. CALGRID is more appropriate for multi-source regional modeling and under-predicts impacts relative to CALPUFF. It is likely that, had NHDES applied CALPUFF, it would have produced results that predict significantly higher estimates of visibility benefits that would result from the proposed emission controls.

- NHDES Response: The same methodologies used for the CALPUFF modeling work for Merrimack Station Unit MK2 were applied to Newington Station Unit NT1.

  The BART eligibility modeling conducted by MANE-VU used natural visibility conditions (about 7 dv) to produce the most conservative modeling results to minimize sources from modeling out of BART. Under these conditions, uncontrolled emissions from Unit NT1 produce theoretical CALPUFF worst-case impacts of 1.22 dv at Acadia National Park. EPA considers acceptable source exemptions when this form of conservative modeling indicates a source produces less than 0.5 dv of impact. MANE-VU considers an exemption level of 0.2 to 0.3 dv to be more appropriate but prefers, and has applied, a more conservative exemption level of 0.1 dv. CALPUFF modeling results for baseline emissions from Unit NT1 exceed all of these exemption levels. The CALPUFF-predicted visibility benefits from BART controls on 20% worst visibility days are as follows:

CALPUFF Modeling Results for Newington Station Unit NT1:
Visibility Improvements from BART Controls on the 20% Worst Visibility Days

Pollutant	Control Technology	Control Level	Visibility Improvement (dv)		
			Acadia NP	Great Gulf NW	Lye Brook NW
SO_2	1% S Fuel Oil	50%*	0.08	0.06	< 0.01**
	0.5% S Fuel Oil	75%*	0.12	0.09	0.01
	0.50 lb SO_2/MMBtu	77%*	0.12	0.09	0.01
	0.3% S Fuel Oil	85%*	0.13	0.10	0.01
	FGD	90%*	0.14	0.11	0.02
NOx	LNB	40%	< 0.01**	< 0.01**	< 0.01**
	LNB-OFA	50%	0.01	< 0.01**	< 0.01**
	SNCR	50%	0.01	< 0.01**	< 0.01**
	SCR	85%	0.03	0.02	< 0.01**
PM	Baghouse	99%	<0.01**	<0.01**	< 0.01**

* from maximum permitted level   ** below sensitivity limit of model

Determination of BART for SO_2

NHDES: Flue gas desulfurization is a potential SO_2 control option for PSNH Newington Station Unit NT1. However, the cost per ton for FGD on oil-fired boilers is estimated to be about twice the cost of this technology on coal-fired boilers and could be well in excess of $1,000/kW for Newington Station. Given the high costs of this option, it is apparent that FGD would he uneconomical as a retrofit for a peak-demand plant the size of Unit NT1.

Use of a lower-sulfur fuel is a practical option for controlling SO_2 emissions at Newington Station. When natural gas is available at reasonable cost relative to residual fuel oil, natural gas is the preferred fuel because of its very low sulfur content. Otherwise, use of low-sulfur residual fuel oil is a reasonable option. For relatively minor increases in the cost of fuel, switching to 1.0%-S or 0.5%-S residual fuel oil provides significant reductions in fuel sulfur content with proportional reductions in SO_2 emissions.

When not firing on natural gas, Unit NT1 has burned 2.0%-sulfur residual fuel oil (actual average fuel sulfur content was 1.2% in 2002). It is estimated that switching to 1.0%-sulfur residual fuel oil would reduce SO_2 emissions by about one-third, and switching to 0.5%-sulfur residual fuel oil would cut SO_2 emissions by about two-thirds. At the 2002 production level of 700 million kilowatt-hours, estimated annual costs (long-term average, 2008$), would be about $3.3 or $6.6 million (equivalent to $0.0047 or $0.0094 per kWh), respectively. The cost per kilowatt-hour would vary more or less in proportion to the fuel price differential and would not change significantly with increases or decreases in production level.

Fuel switching could be accomplished without capital outlay and would have predictable costs tied directly to fuel consumption and fuel price differentials. A major consideration is fuel availability. In recent years, there have been sudden and dramatic swings in the price of natural gas relative to fuel oil as supply/demand has shifted. The future price and availability of natural gas are difficult to discern. While regional and national supplies of 1.0%-sulfur residual fuel oil appear to be adequate to meet current demand, the present and future availability of 0.5%-sulfur residual fuel oil, in particular, is uncertain and speculative.

After consideration of projected costs, ease of implementation, and fuel availability, it is determined that using 1.0%-sulfur (low-sulfur) residual fuel oil is currently the Best Available Retrofit Technology for PSNH Newington Station Unit NT1 when natural gas is not available at reasonable cost. The use of 0.5%-sulfur (ultra-low-sulfur) residual fuel oil remains a future possibility that should be re-evaluated within the next few years. A further reduction in the sulfur content of fuel oil burned at this facility would be consistent with MANE-VU's plan to reduce sulfur levels to 0.25-0.5% for all fuel oils throughout the region by 2018.

NPS: NHDES concluded that a FGD system is too expensive. We agree with the NHDES approach that use of lower-sulfur fuels is BART for this EGU. And, we commend NHDES for its proposal to reduce the sulfur limit on the #6 residual oil to 1%. Although NHDES also concludes that the cost of switching to 0.5% sulfur fuel oil is also reasonable (@ $1,900/ton – the same as the cost to go to 1.0% sulfur oil – it has deferred proposing that this additional reduction be required at this time. NHDES suggests that "future availability of 0.5%-sulfur residual fuel oil, in particular, is uncertain and speculative" and that its use "should be re-evaluated within the next few years." To support this contention, NHDES should present information from fuel oil suppliers concerning the uncertain availability of 0.5% sulfur oil. Furthermore, NHDES should explain how and when it would re-evaluate that issue and implement a requirement for 0.5% sulfur oil if it found it to be sufficiently available.

We believe that, if 0.5% sulfur fuel oil is found by NHDES to be reasonably available in the future, a determination that BART is 0.5% sulfur would be consistent with, and enhance the goals of the Northeast states as discussed in the document: "Low Sulfur Heating Oil in the Northeast States: An Overview of Benefits, Costs and Implementation Issues" provided by NHDES as attachment AA. For example, the Executive Summary of that document states:

> *The analysis summarized in this White Paper supports the Northeast states' conclusion that significant reductions in SO_2, NOx, and PM emissions can be achieved by mandating lower sulfur heating oil. Importantly, these reductions can be achieved with an expected cost savings to the consumer. Adding the public health and environmental benefits associated with lower sulfur fuel increases the favorable cost-benefit ratio of a regional 500 pm [sic] sulfur heating fuel program.*

- NHDES Response: There is greater assurance today of the availability 0.5%-sulfur residual fuel oil than when the original BART determination was drafted. Maine, Massachusetts, New Jersey, and possibly other states within MANE-VU have already made commitments to require the use of 0.5%-sulfur residual fuel oil, thus ensuring the presence of a regional market for this commodity. In recognition of the dual-fuel capability of this unit, NHDES has prepared a draft rule that will reduce sulfur dioxide emissions by imposing an SO_2 emission limit of 0.50 lb/MMBtu for this facility regardless of fuel type. The rule would allow the facility the flexibility to burn natural gas and/or fuel oil in any feasible ratio, depending on market conditions. (The boiler for Unit NT1 has a physical limitation of about 50 maximum heat input from natural gas, with no corresponding limitation on fuel oil.)

  For the first regional haze progress report, to be submitted circa 2013, NHDES will review fuel usage, fuel supplies, fuel prices, and plant utilization/capacity factors to determine whether the fuel sulfur limitation described above is still appropriate as BART control for Unit NT1. Should the review indicate a different BART control level, the facility's Title V operating permit will be amended as necessary before its expiration date of March 31, 2012, exactly fifteen months prior to the effective date of proposed BART control measures.

BART Analysis for NOx

STEP 1 – Identify all available retrofit emissions control techniques

NHDES: NOx control technology options available and potentially applicable to Unit NT1 are combustion controls, selective non-catalytic reduction, and selective catalytic reduction.

NPS: NHDES identified a reasonable suite of options.

STEP 2 – Eliminate technically infeasible options

NPS: NOx control options were eliminated on this basis.

STEP 3 – Evaluate control effectiveness of remaining control options

NHDES: NOx emission reductions of about 75 to 90 percent have been obtained with selective catalytic reduction (SCR) on coal-fired boilers in the U.S.

NPS: NHDES should explain why the SCR cannot achieve better than the estimated 85 percent control.

- ▶ NHDES Response: A hypothetical SCR system retrofit for Newington Station Unit NT1 would be expected to achieve a NOx control rate of 85 to 90 percent or better.

STEP 4 – Impact analysis

NHDES: The estimated costs of NOx emission controls for SNCR and SCR at Newington Station Unit NT1 are presented in Table 2-1. These estimates are based on assumptions used in EPA's Integrated Planning Model for the EPA Base Case 2006 (V.3.0), for retrofitting an EGU the size of Unit NTI. For SNCR, the total annual cost is estimated to be about $730,000, or $1,030/ton of NOx removed. For an SCR system, the total annual cost is estimated to be $1,410,000 or $1,180/ton. Because Unit NT1 is primarily a peak-load generator, these estimates are based on a 20-percent capacity factor.[3]

NPS: When we applied different assumptions for SCR (e.g., 90% NOx control, 20-year life, 7% interest) we arrived at a slightly higher ($1,278) cost/ton. Furthermore, Newington's capacity utilization and emissions have dropped so much in recent years that it is doubtful that any major capital expenditures would be justified as long as that low utilization continues. For example, in 2007, CAM data show that heat input had declined to 4.3 trillion Btu, and that NOx emissions were 415 tons.

STEP 5 – Determine visibility impacts

(same as above for SO_2)

- ▶ NHDES Response: It is useful to consider NOx emission reductions in the context of other emission reductions – especially sulfur dioxide. MANE-VU determined that SO_2 was the target pollutant for maximizing visibility improvements. The

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[3] *Estimates are derived from USEPA, Documentation for EPA Base Case 2006 (V 3.0 Using the Integrated Planning Model, November 2006. Costs are scaled for boiler size. All costs are adjusted to 2008 dollars. Total annual cost is for retrofit of a 400-MW unit with 20% capacity factor and 701 million kWh annual generation. Total annual cost includes amortization of capital cost over 15 years at 3.0% interest rate. Average cost per ton is based on an estimated 704 tons of NOx removed for SNCR and an estimated 1,196 tons of NOx removed for SCR.*

modeling results posted above for Unit NT1 predict minimal visibility improvements for SO_2 reductions ranging from 50% to 85%. NOx, while also an important visibility impairing pollutant, is less hydrophilic and impairs visibility less effectively than a similar mass of SO_2; therefore, in comparable mass emission reductions of SO_2 and NOx, there would be less visibility benefit from the NOx reductions. Further, potential NOx emission reductions resulting from installation of SNCR/SCR at Newington Station would be in the order of 20 to 50%. Therefore, it is not surprising that CALPUFF predicts visibility improvements of only about 0.03 dv for SNCR/SCR at this facility.

Determination of BART for NOx

NHDES: For the reasons below, the existing controls, which include low-NOx burners, overfire air, and water injection, are determined to be BART for Newington Station Unit NT1:

- *Many of the NOx reduction benefits acquired through the implementation of low excess air are already being achieved at Unit NT1 through the use of low-NOx burners and overfire air.*
- *The additional reductions in NOx emissions that would result from adding SCR or SNCR would come at a cost of about $0.7 to $1.3 million annually, with incremental NOx reductions in the 300 to 700 ton/year range. This cost range does not include costs related to redesign of the site layout to accommodate existing spatial constraints. Also, this estimate is based on 2002 emission levels, when the plant's capacity factor was around 20 percent. With the capacity factor having fallen to less than 10 percent over the period 2006-2008, it is difficult today to justify additional technology retrofits to reduce NOx emissions at this facility.*
- *For SNCR, the total annual cost is estimated to be about $730,000, or $1,030/ton of NOx removed. For an SCR system, the total annual cost is estimated to be $1,410,000 or $1,180/ton. SCR and SNCR are not cost-effective as Best Available Retrofit Technology for this facility and will not be considered further.*
- *Another consideration with SCR or SNCR is flue gas and fugitive ammonia emissions. Based on past operation of Unit NT1 and on typical ammonia "slip" rates, it is estimated that fugitive ammonia emissions with either technology would be in the vicinity of 32 tons annually. Ammonia is a regulated toxic air toxic pollutant in New Hampshire and is also a significant contributor to visibility impairment.*

NPS: We agree that the reduced capacity utilization makes it difficult today to justify additional technology retrofits[4] *to reduce NOx emissions at this facility. NHDES should propose federally-enforceable BART limit(s) that reflect its BART determination*

▶ NHDES Response: Because additional retrofits are not proposed for Unit NT1, the

[4] *NHDES has approved SCR (and the associated issues with ammonia) at Merrimack and must explain how it arrived at its estimate for ammonia slip and why ammonia is more of a problem at Newington. If NHDES believes that ammonia slip will impair visibility, it must show why that outweighs the benefits of reducing NOx.*

▶ NHDES Response: The issue is not so much the magnitude of ammonia slip or visibility impairment as it is the fact that ammonia slip would occur at all. For a situation such as this one in which SCR or SNCR is essentially ruled out as not cost-effective, ammonia slip only adds to the list of reasons for not implementing either technology.

BART assessment for this facility revolves around its long-term performance capability. NHDES reviewed emissions data for Unit NT1 for the period from 2003 to 2005, when more than 99 percent of the gross heat input came from residual fuel oil. Monthly average NOx emissions ranged between 0.21 and 0.30 lb/MMBtu. These values compare favorably with the facility's NOx RACT limit of 0.25 lb/MMBtu, daily average, when burning natural gas and 0.35 lb/MMBtu, daily average, when burning fuel oil. However, the volume of the data record is insufficient to demonstrate that the facility could sustainably meet more restrictive emission limits. The current NOx RACT limitations for Unit NT1 are therefore considered to represent the BART control levels.

BART Analysis for PM

STEP 1 – Identify all available retrofit emissions control techniques

NHDES: The only PM control technologies available and potentially applicable to Unit NT1 are electrostatic precipitators, fabric filters, mechanical collectors, and particle scrubbers.

NPS: NHDES should have considered simple, inexpensive upgrades for the ESPs to achieve greater control.

- NHDES Response: It may be technically feasible to install upgrades such as replacement of the existing ESP control systems with newer electronic controllers or replacing old-style wire and plate systems inside the ESP with new, rigid electrode systems. The problem arises in the cost-effectiveness of such measures. Specifically, it is difficult to justify any major capital expense at this facility in light of its recent operating record. Since 2006, the plant's capacity factor has been below 10 percent. Preliminary data for the first nine months of 2009 indicate that the plant was effectively offline for all but the first month.

STEP 2 – Eliminate technically infeasible options

NPS: No PM control options were eliminated on this basis.

STEP 3 – Evaluate control effectiveness of remaining control options

NHDES: Existing electrostatic precipitators (ESPs) are typically 40 to 60 percent efficient. New or rebuilt ESPs can achieve collection efficiencies of more than 99 percent. Collection efficiencies of baghouses may exceed 99 percent.

NPS: NHDES assumed 42% for the existing ESP at Newington. Because this is far short of the capabilities of a rebuilt ESP, NHDES should have evaluated that option.

- NHDES Response: The 42 percent efficiency value was obtained by comparing the PM emission factor from a 2001 controlled stack test report with an AP-42 emission factor for uncontrolled PM, and is therefore a crude approximation of particulate removal efficiency. NHDES has located a 1971 performance specification for this unit from Buell Envirotech Corp. The efficiency is stated as 93 percent under normal operating conditions and a maximum of 98 percent under design conditions. It is unknown whether these higher control rates are representative of the unit's actual long-term performance. The emission rate calculated from the 2001 stack testing (the only data available) was 0.058 lb/MMBtu. This emission rate is within the expected range for a properly operating ESP at a plant like Newington and may be a better measure of performance than the stated efficiencies.

STEP 4 – Impact analysis

NHDES: The costs for ESPs and fabric filters are of similar magnitude, with total annual costs ranging from about $3.2 million to $10.4 million, or $14,000 to $63,000 per ton of PM removed, Because Unit NT1 already has an ESP installed and operating, the tabulated costs are useful for comparative purposes only.

NPS: NHDES should have evaluated upgrading the ESP.

- NHDES Response: Please refer to previous response on upgrades.

Determination of BART for PM

NHDES: PSNH currently operates an electrostatic precipitator on Unit NT1. ESPs perform with removal efficiency rates similar to those of fabric filters but operate at about half the cost for plants of this size. Because of the estimated cost differential and the fact that an ESP is already installed and operating, the existing ESP is determined to satisfy BART requirements for PM removal at PSNH Newington Station Unit NT1.

NPS: However, NHDES has assumed that the existing ESP is only 42% efficient – which is not "similar' to a fabric filter. NHDES should propose a limit that reflects the 99% control it assumed in its analyses for a new ESP or fabric filter. Although the existing ESPs may well represent BART, NHDES should evaluate possible upgrades, or, at least, establish a federally-enforceable permit limit that reflects the actual capabilities of the unit.

- NHDES Response: The single available stack test indicates that the ESP at Unit NT1 produces controlled emission rates in the vicinity of 0.06 lb/MMBtu. For comparison, the existing TSP limit is 0.22 lb/MMBtu (Permit TV-OP-054, March 9, 2007; administrative amendment, December 17, 2007). The extent of the data record is insufficient to support consideration of a BART performance level more restrictive than the current permit limit. The facility's Title V operating permit requires that a compliance stack test for PM emissions be performed on Unit NT1 before the permit expires on March 31, 2012. NHDES will review the stack test results to ascertain the unit's performance and incorporate any new limit into a permit amendment by the permit expiration date, as appropriate. The permit expiration date precedes the effective date of proposed BART control measures by fifteen months.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 1
5 POST OFFICE SQUARE, SUITE 100
BOSTON, MA 02109-3912

FEB 2 9 2010

Thomas S. Burack, Commissioner
New Hampshire Department of Environmental Services
29 Hazen Drive, PO Box 95
Concord, NH 03302-0095

Re: New Hampshire's Regional Haze State Implementation Plan

Dear Commissioner Burack:

As you know, on January 15, 2009, the Environmental Protection Agency (EPA) made a finding that the state of New Hampshire failed to submit a state implementation plan (SIP) addressing Regional Haze in mandatory class I Federal areas (our Nation's National Parks and wilderness areas) as required by the Clean Air Act (CAA) and federal regulations. The Regional Haze SIP was due to EPA by December 17, 2007. As a result of this finding, EPA must within two years (that is, by January 15, 2011) either fully approve New Hampshire's Regional Haze SIP or promulgate a federal implementation plan (FIP).

On January 29, 2010, the New Hampshire Department of Environmental Services (DES) submitted a final Regional Haze SIP to EPA. We have reviewed New Hampshire's submittal and note that it appropriately addresses many of the necessary components of a Regional Haze SIP. The plan is, however, incomplete with respect to best available retrofit technology (BART) requirements. Consequently, the BART portion of the submittal can not be processed as a revision to the New Hampshire SIP and EPA is returning that portion of the submittal to the DES. Therefore, the incomplete BART portion is no longer pending EPA action.

Specifically, in order for EPA to determine a SIP revision complete, it must include the necessary administrative and technical support materials to meet the criteria outlined in 40 CFR Part 51, Appendix V. New Hampshire's January 29, 2010 Regional Haze SIP submittal does not meet these criteria with respect to BART requirements. In particular, the SIP submittal lacks enforceable emission limitations, work practice standards and recordkeeping/reporting requirements, to ensure BART requirements are implemented.

In addition, EPA is very concerned with the BART rulemaking schedule outlined in the SIP submittal. This schedule calls for a rough draft of the BART rule in January 2012 and a final rule to be adopted in May 2013. As noted above, EPA's deadline to issue a FIP is January 15, 2011.

Also, New Hampshire has not yet submitted an adopted regulation implementing the state's low sulfur fuel oil measure which was included as an element of New Hampshire's long term Regional Haze strategy.

Therefore, we would like to request a meeting with your Air Director and staff working on the Regional Haze SIP to further discuss this issue, in order to ensure these requirements are met in a timely and effective manner.

My staff will contact DES staff to schedule a mutually acceptable time for this meeting. If you or your staff have any questions on Regional Haze issues, please contact Anne McWilliams at 617-918-1697.

Sincerely,

Stephen S. Perkins, Director
Office of Ecosystems Protection

cc Robert R. Scott, NH DES
Jeff Underhill, NH DES
Charles Martone, NH DES

Air / Regional Ha

The State of New Hampshire
DEPARTMENT OF ENVIRONMENTAL SERVICES

Thomas S. Burack, Commissioner

March 10, 2010

Mr. Stephen S. Perkins
Director, Office of Ecosystems Protection
USEPA New England, Region I
5 Post Office Square, Suite 100
Boston, MA 02109-3912

Re: New Hampshire State Implementation Plan for Regional Haze

Dear Mr. Stephen Perkins:

Thank you for your letter of February 26, 2010 regarding the New Hampshire Regional Haze State Implementation Plan (SIP) revision. As you know, New Hampshire is a Class I Area state and takes seriously its obligations and those of states contributing to the haze observed in our state. We appreciate your work to ensure regional and national consistency in SIP commitments to improve air quality nationwide.

On January 29, 2010, the New Hampshire Department of Environmental Services (NHDES) submitted its final Regional Haze SIP in order to fulfill the requirements of the Clean Air Act (CAA) section 169A, pertaining to protection of visibility and regional haze. This filing followed years of extensive study and planning and an ongoing commitment that does not end upon implementation. Unfortunately, the SIP filing was delayed beyond our target date due to several factors including complications arising from inter-state consultation and the vacated Clean Air Interstate Rule – the backbone of the regional haze compliance for many states.

In addition, New Hampshire and the other MANE-VU states looked beyond the basic BART and CAIR compliance requirements in order to identify "other reasonable measures" to incorporate into the long term strategies. Some of these measures were to be developed and incorporated immediately into the SIPs and others were known to require more time to study and implement and were to be phased in over a period of 10 years. The low sulfur oil strategy identified in the New Hampshire SIP is one of those measures intended for finalization and adoption after the filing of this SIP but before May 2013. There were three primary reasons for this timeline. First, the strategy is not a specified requirement of the federal regional haze rule. It was selected as a reasonable extra measure to become part of the SIP when it is fully developed. Second, when the MANE-VU commission signed the strategy statement (see attached), they took into account that supplies and costs would vary across the region and that more research was going to be needed before all the member states could finalize their rules. The statement specifies that states are to "pursue" the adoption of rules within 10 years as "appropriate and necessary." The statement provides flexibility on the terms and timing of the measures. And third, in New Hampshire's case, rule adoption of the low sulfur strategy at this time is not possible because the rule will sunset prior to actual implementation and so this will not survive the legal and public process required by the state. NHDES chose instead to commit in its January 2010 SIP an implementation schedule for the low sulfur oil strategy that meets the MANE-VU timeline and can be included in the required mid-course look-back report.

DES Web Site: www.des.nh.gov
P.O. Box 95, 29 Hazen Drive, Concord, New Hampshire 03302-0095
Telephone: (603) 271-3503 Fax: (603) 271-2181 TDD Access: Relay NH 1-800-735-2964

Your letter also raises concerns about lacking enforceable emission limits, work practices, and recordkeeping provisions of the BART requirement. This information was submitted in a draft rule (Env-A 2300) on a CD disk mailed to EPA as part of the formal submission. NHDES would appreciate EPA comments on this draft rule. NHDES would also like to inform EPA that this rulemaking process has already started and we anticipate final adoption in December 2010 and thus is well ahead of the timeline indicated in the SIP.

Finally, NHDES would like to accept EPA's offer to meet regarding these issues. My staff will be contacting you shortly to arrange for such a meeting.

Please contact me at (603) 271-1088 if you have any questions regarding the information contained in this letter.

Sincerely,

Robert R. Scott
Director, Air Resources Division

enclosure: MANE-VU Statement

cc: Thomas Burack, NHDES
David Conroy, USEPA Region I
Anne Arnold, USEPA Region I
Anne McWilliams, USEPA Region I

Mid-Atlantic/Northeast Visibility Union
MANE-VU

Reducing Regional Haze for Improved Visibility and Health

STATEMENT OF THE MID-ATLANTIC/NORTHEAST VISIBILITY UNION (MANE-VU) CONCERNING A COURSE OF ACTION WITHIN MANE-VU TOWARD ASSURING REASONABLE PROGRESS

The federal Clean Air Act and Regional Haze rule require States that are reasonably anticipated to cause or contribute to impairment of visibility in mandatory Class I Federal areas to implement reasonable measures to reduce visibility impairment within the national parks and wilderness areas designated as mandatory Class I Federal areas. Most pollutants that affect visibility also cause unhealthy concentrations of ozone and fine particles. In order to assure protection of public health and the environment, any additional air pollutant emission reduction measures necessary to meet the 2018 reasonable progress goal for regional haze should be implemented as soon as practicable .

To address the impact on mandatory Class I Federal areas within the MANE-VU region, the Mid-Atlantic and Northeast States will pursue a coordinated course of action designed to assure reasonable progress toward preventing any future, and remedying any existing impairment of visibility in mandatory Class I Federal areas and to leverage the multi-pollutant benefits that such measures may provide for the protection of public health and the environment. This course of action includes pursuing the adoption and implementation of the following "emission management" strategies, as appropriate and necessary:

- timely implementation of BART requirements; and
- a low sulfur fuel oil strategy in the inner zone States (New Jersey, New York, Delaware and Pennsylvania, or portions thereof) to reduce the sulfur content of: distillate oil to 0.05% sulfur by weight (500 ppm) by no later than 2012, of #4 residual oil to 0.25% sulfur by weight by no later than 2012, of #6 residual oil to 0.3 – 0.5% sulfur by weight by no later than 2012, and to further reduce the sulfur content of distillate oil to 15 ppm by 2016; and
- a low sulfur fuel oil strategy in the outer zone States (the remainder of the MANE-VU region) to reduce the sulfur content of distillate oil to 0.05% sulfur by weight (500 ppm) by no later than 2014, of #4 residual oil to 0.25 – 0.5% sulfur by weight by no later than 2018, and of #6 residual oil to no greater than 0.5 % sulfur by weight by no later than

444 North Capitol Street, NW - Suite 638 - Washington, DC 20001
202.508.3840 p - 202.508.3841 f
www.mane-vu.org

2018, and to further reduce the sulfur content of distillate oil to 15 ppm by 2018, depending on supply availability; and

- A 90% or greater reduction in sulfur dioxide (SO_2) emissions from each of the electric generating unit (EGU) stacks identified by MANE-VU (Attachment 1 - comprising a total of 167 stacks – dated June 20, 2007) as reasonably anticipated to cause or contribute to impairment of visibility in each mandatory Class I Federal area in the MANE-VU region. If it is infeasible to achieve that level of reduction from a unit, alternative measures will be pursued in such State; and

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

This long-term strategy to reduce and prevent regional haze will allow each state up to 10 years to pursue adoption and implementation of reasonable and cost-effective NOx and SO_2 control measures.

Adopted by the MANE-VU States and Tribes on 20 June 2007

David Littell, Commissioner – Maine Dept. of Environmental Protection
Chair

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 1
5 Post Office Square, Suite 100
Boston, MA 02109-3912

November 22, 2010

Karla McManus
Air Resources Division
New Hampshire Department of Environmental Services
29 Hazen Drive, PO Box 95
Concord, NH 03302-0095

Dear Ms McManus:

On October 1, 2010, the New Hampshire Department of Environmental Services proposed Chapter Env-A 2300, Mitigation of Regional Haze, for public comment. This rule establishes emission standards for certain fossil-fuel-fired power plants that contribute to regional haze.

We have reviewed the proposed regulation and we believe there are a number of revisions that need to be made to Chapter Env-A 2300 in order for EPA to be able to approve this rule as BART (Best Available Retrofit Technology). You will find our comments on Chapter Env-A 2300 in the Enclosure. These comments only include concerns about Chapter Env-A 2300 and do not include comments on the revisions to New Hampshire's Regional Haze SIP that were recently proposed on November 19, 2010. EPA will fully review the materials proposed on November 19, 2010 and send you comments by December 20, 2010.

We would recommend that you not finalize Chapter Env-A 2300 before receiving our comments on the November 19 proposal as concerns raised on the BART supporting documentation in the November 19 proposal may necessitate further revisions to Chapter Env-A 2300.

If you have any questions on these comments, please contact Anne McWilliams of my staff at 617-918-1697.

Sincerely,

David B. Conroy, Chief
Air Programs Branch

Enclosure

cc: Bob Scott, NH DES
Jeff Underhill, NH DES

Enclosure
EPA Comments on New Hampshire's
Proposed Env-2300 Mitigation of Regional Haze

1) In Env-A 2301.01, New Hampshire states that the purpose of the rule is to ensure compliance with regional haze program requirements, "including but limited to the provisions for Best Available Control Technology (BART)." With its final submission of Env-2300 Mitigation of Regional Haze to its State Implementation Plan (SIP), NH DES must submit a five factor analysis supporting the proposed BART requirements. It appears that such an analysis is part of the revisions to the Regional Haze SIP proposed on November19, 2010. EPA will fully review this analysis and send comments in the future.

2) Env-A 2302.01(a)(1), 2302.01(a)(2), 2302.01(b)(1), 2302.02(b), and 2302.02(c) all contain a reference to "limitations specified in permit conditions established in accordance with Env-A 600." Similar references are also made in Env-A 2304.01(a) and Env-A 2304.02(a) pertaining to performance testing requirements. Since New Hampshire is relying on these conditions to implement the BART and long term strategy requirements of its Regional Haze SIP, these permit conditions must be submitted to EPA as part of the state's Regional Haze SIP. Currently, the Regional Haze SIP contains the following attachments for Merrimack Station and Newington Station:

ATTACHMENT EE – Temporary Permit for PSNH Merrimack Station
ATTACHMENT HH – Draft Title V Operating Permit for PSNH Merrimack Station
ATTACHMENT II – Title V Operating Permit for PSNH Newington Station

For Merrimack Station, it is not clear what is intended to be incorporated into the SIP as BART since the Temporary Permit for PSNH Merrimack Station has an expiration date of September 30, 2010 on it and the Title V Operating Permit is only in draft form.

For Newington Station, it is not clear what specific sections of the Title V Operating Permit are intended to be incorporated into the SIP as BART.

Moreover, EPA has not had adequate time to review the supporting BART materials that are part of the November 19, 2010 revisions to the Regional Haze SIP. EPA will fully review these materials and send comments in the future. EPA will look to see how the comments we submitted to NH DES on June 26, 2009 regarding BART for Merrimack Station and Newington were addressed.

3) In Env-A 2302.01(b)(2), New Hampshire is proposing a NOx emission limit of 0.37 lb per million BTUs on a calendar monthly average basis. Under the proposed regulation, this emission limitation would be applicable to the MK2 boiler at Public Service of New Hampshire's Merrimack Station.

EPA's Guidelines for BART Determinations Under the Regional Haze Rule (see 70 FR 39172; July 6, 2005) specifies that the averaging time for EGUs should be a 30-day rolling average, with a definition of "boiler operating day" that is consistent with the definition in the New Source Performance Standards (NSPS) for utility boilers in 40 CRF Part 60, subpart Da. Therefore, we would suggest the following language be added to the proposed regulation:

> **Emission Limits:** The term "30-day rolling average," as used in this regulation shall be determined by calculating an arithmetic average of all hourly rates for the current boiler operating day and the previous 29 boiler operating day. A new 30-day rolling average shall be calculated for each boiler operating day, which means any twenty-four hour period between midnight and the following midnight during which any fuel is combusted at any time at the steam generating unit. Each 30-day rolling average rate shall include start-up, shutdown, emergency and malfunction periods. The 30-day rolling average emission rate is calculated as follows:

- Calculate the hourly average emission rate for any hour in which any fuel is combusted in the boiler.

- Calculate the 30-day rolling average emission rate as the arithmetic average of all valid hourly average emission rates for the 30 successive boiler operating days.

In addition, we note that a NOx emission limit of 0.37 lb per million BTUs is not consistent with the MANE-VU recommended level of BART NOx control for non-CAIR EGUs, which is 0.1 – 0.25 lb per million BTUs. Moreover, NOx CEM data available from EPA's Clean Air Markets Division data base indicates that the NOx controls on PSNH's MK2 boiler are capable of meeting much lower NOx emission rates on a 30-day rolling average than proposed in Env-A 2302.01(b)(2). The attached three graphs show the daily NOx emissions rate and the corresponding rolling 30-day average NOx emission rate from MK2 during 2008 and 2009, as reported to EPA's EPA's Clean Air Markets Division data base. In 2009, at no point was a 30-day rolling average of 0.25 lbs per million BTU exceeded. A limitation of 0.37 lb per million BTUs is approximately 50% higher than the emission limitation achieved in practice by the SCR installed on MK2. It is also not consistent with Controlled Emissions from MK2 that were contained in the November 19, 2010 draft Attachment X to your Region Haze SIP, which was recently posted on your web site (see http://des.nh.gov/organization/divisions/air/do/asab/rhp/documents/x.pdf). On page 16 of this document, "Controlled Emissions" from MK2 with the existing SCR are stated to be 2,871 tons NOx/year. However, at a rate of 0.37 lb per million BTUs, "Controlled Emissions" would be significantly higher than this. During the 5-year period from 2002-2006, the average annual heat input from MK2 was 23,433,641 mmBTU. At a rate of 0.37 lbs.mmBTU, controlled emissions would exceed 4,300 tons NOx/year.

4) In Env-A 2302.01(b)(3), New Hampshire is proposing that TSP emissions shall not exceed 0.08 lb per million BTUs. Under the proposed regulation, this emission limitation would be applicable to the MK2 boiler at PSNH's Merrimack Station.

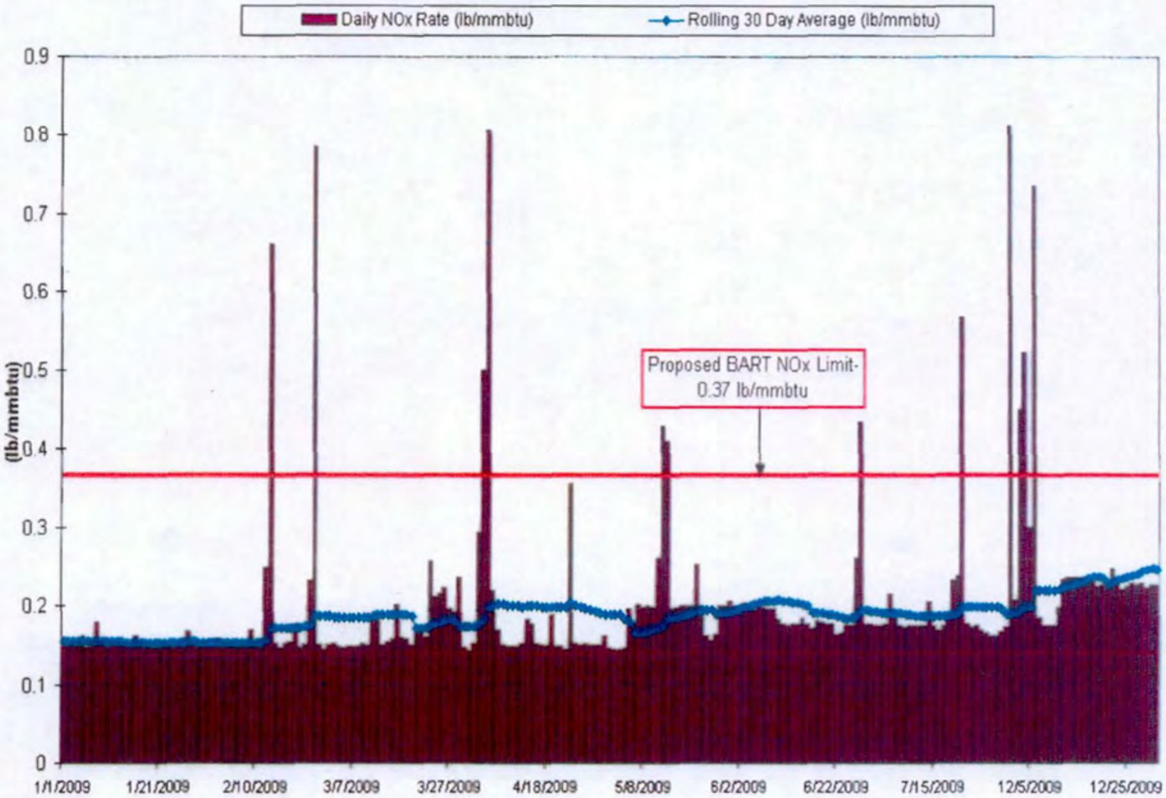
This limitation is also not consistent with the MANE-VU recommended level of BART PM control for non-CAIR EGUs, which is 0.02-0.04 lb per million BTUs. It is not clear why New Hampshire is imposing a less stringent limit. In the November 19, 2010 draft Attachment X to your Region Haze SIP, the controlled PM emissions from MK2 with the current ESPs are stated to be 210 tons per year. Based on the average annual heat input from 2002-2006, this would be equivalent to an emission rate of less than 0.02 lbs per million BTU. Therefore, additional documentation is needed to support an emission limit of 0.08 lb per million BTUs.

5) In Env-A 2302.02(a), New Hampshire is proposing an SO_2 emission limit of 0.50 lb per million BTUs on a calendar monthly average basis. This would be applicable to PSNH's Newington Station Unit NT1.

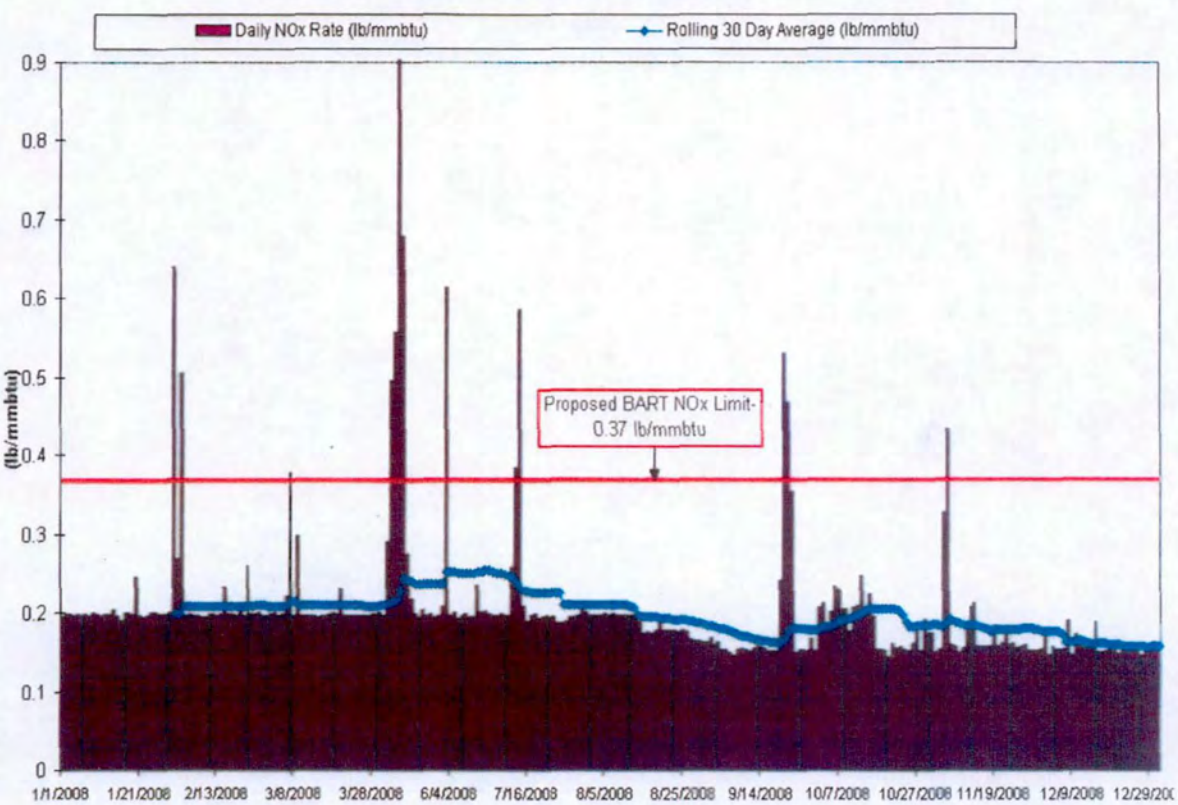
This limitation is not consistent with the MANE-VU recommended level of BART SO_2 control for non-CAIR EGUs, which is the use of natural gas or 0.3% sulfur content by weight fuel oil. Also, as referenced in comment #3 above, New Hampshire should use a 30-day rolling average as stated in EPA's Guidelines for BART Determinations Under the Regional Haze Rule.

EPA will need additional documentation to support an emission limit of 0.50 lbs per million BTUs. We note that we recently received draft revisions to your Regional Haze SIP dated November 19, 2010. EPA will provide further comments to NH DES regarding the documentation provided to support a BART limit of 0.50 lbs per million BTU.

2009 NOx Emissions
PSNH Merrimack Station Unit MK2



2008 NOx Emissions
PSNH Merrimack Station Unit MK2



The State of New Hampshire
DEPARTMENT OF ENVIRONMENTAL SERVICES

Thomas S. Burack, Commissioner

December 9, 2010

Mr. David B. Conroy
Chief, Air Programs Branch
US EPA New England
5 Post Office Square, Suite 100
Boston MA 02109-3912

Re: Response to EPA's Comments on New Hampshire's Regional Haze SIP and Proposed Administrative Rule Chapter Env-A 2300 Mitigation of Regional Haze

Dave
Dear Mr. ~~Conroy~~:

Thank you for your letter of November 22, 2010, providing comments on New Hampshire's SIP revision and proposed administrative rule for regional haze. The Department of Environmental Services (DES) understands that EPA has not had sufficient time to review the revised SIP revision in its entirety and will provide additional comments to us by December 20, 2010. We anticipate that many of your initial comments and questions will be addressed in the complete reading of the revised SIP, especially the BART analyses presented in Attachment X.

Your letter included comments in five specific areas. Our response to your initial comments is provided below in the same order in which they appeared.

1. EPA will find the five-factor analysis for BART in Attachment X. This document has been amended in response to earlier comments received from EPA and the FLM's to include further clarification and documentation in support of the BART evaluation process.

2. DES will attach the applicable permits and will quote or reference the specific language of those permits that is included in the SIP to meet BART requirements.

3. DES will replace the calendar monthly averaging period, wherever it occurs, with the 30-day rolling averaging period, and will insert the requested definition and calculation method into the SIP. In the proposed rule Chapter Env-A 2300 Mitigation of Regional Haze, the NOx performance standard for PSNH Merrimack Station Unit MK2 has been reduced from 0.37 lb/MMBtu to 0.30 lb/MMBtu. This change will be reflected in the final revision of the BART analysis submitted as part of the final SIP.

4. For PSNH Merrimack Station Unit MK2, the selection of 0.08 lb/MMBtu as the BART performance level for PM is documented in Attachment X.

DES Web Site: **www.des.nh.gov**
P.O. Box 95, 29 Hazen Drive, Concord, New Hampshire 03302-0095
Telephone: (603) 271-3503 Fax: (603) 271-2181 TDD Access: Relay NH 1-800-735-2964

5. For PSNH Newington Station Unit NT1, the selection of 0.50 lb/MMBtu as the BART performance level for SO_2 is documented in Attachment X.

As I recently discussed with you, DES intends to adhere to the original schedule to adopt Chapter Env-A 2300 with appropriate revisions in December of this year. We view this action as necessary to meet the January 15, 2011, deadline for submittal of the Regional Haze SIP. If you have any questions on this matter please contact me at (603) 271-1088.

Sincerely,

Robert R. Scott
Director
Air Resources Division

rrs/chm
cc: Anne Arnold
Anne McWilliams

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 1
5 Post Office Square, Suite 100
Boston, MA 02109-3912

December 20, 2010

Karla McManus
Air Resources Division
Department of Environmental Services
29 Hazen Drive, PO Box 95
Concord, NH 03302-0095

Dear Ms McManus:

On January 29, 2010, the New Hampshire Department of Environmental Services (DES) submitted a final Regional Haze State Implementation Plan (SIP) to EPA. On February 26, 2010, EPA notified New Hampshire that the best available retrofit technology (BART) element of the Regional Haze SIP was incomplete. On October 1, 2010, New Hampshire proposed Chapter Env-A 2300, Mitigation of Regional Haze, to implement BART requirements. EPA provided comments on the proposed rule on November 22, 2010.

Meanwhile, on November 19, 2010, New Hampshire proposed a revised Regional Haze SIP for public comment. The proposal contains changes to the BART analysis and BART emission limits. EPA has reviewed the proposed SIP and has provided comments in the Enclosure. As discussed in more detail in the enclosed comments, the final SIP submittal must include additional documentation to support some of the BART emission limits.

If you have any questions on these comments, please contact Anne McWilliams of my staff at 617-918-1697.

Sincerely,

Anne Arnold

Anne Arnold, Manager
Air Quality Planning Unit

Enclosure

cc: Jeff Underhill, NH DES
Robert Scott, NHDES

Enclosure
EPA Comments on New Hampshire's Proposed Regional Haze SIP Revision
Dated November 19, 2010

Low-Sulfur Oil Strategy

1) New Hampshire's proposed SIP includes a demonstration that the MANE-VU low sulfur fuel oil strategy is reasonable. This strategy includes:

- the reduction in the sulfur content of distillate (#1 and #2) fuel oils to 0.05% sulfur by weight by no later than 2014;
- the reduction in the sulfur content of #4 residual oil to 0.25-0.5% sulfur by weight by no later than 2018;
- the reduction of #6 residual oil to no greater that 0.5% sulfur by weight by no later than 2018; and
- the further reduction of distillate oil to 15 ppm by 2018.

New Hampshire, however, has not yet adopted a regulation imposing these requirements. The proposed SIP indicates that New Hampshire plans to introduce legislation on this issue in January 2012. EPA urges New Hampshire to move forward with this strategy more quickly than stated in this proposal and include in its final SIP submittal a commitment to adopt and submit a final rule to EPA by a date certain in 2011.

BART Visibility Modeling

2) Tables 9-4 and 9-5 show the results of CALPUFF modeling for the visibility improvement from BART controls on the 20% worst visibility modeled days, based on baseline visibility conditions, at each nearby Class I area. However, 40 CFR Part 51, Appendix Y, Section (IV)(D)(5), "Step 5: How should I determine visibility impacts in the BART determination?" clearly states:

> "Use the 24-hour average actual emission rate from the highest emitting day of the meteorological period modeled (for the pre-control scenario). Calculate the model results for each receptor as the change in deciviews compared against natural visibility conditions."

A BART analysis should determine the visibility impact of the source, not the impact of the source in conjunction with all other impacting sources. New Hampshire must recalculate the visibility improvement using the calculated worst 20% natural conditions: 12.4 deciviews (dv) for Acadia National Park; 11.7 dv for Lye Brook Wilderness; and 12.0 dv for Moosehorn Wilderness and Great Gulf Wilderness.

Newington Station NT1 BART – SO_2

3) Based on the "Final Proposal" of Env-A 2300 "Mitigation of Regional Haze," posted on your web site and dated December 1, 2010, (see des.nh.gov/organization/commissioner/legal/rulemaking/documents/env-a2300-fp-fxd.pdf), it appears that NH DES has made a final decision that BART for NT1 is an SO_2 emission limit of 0.5 lb/MMBtu on a 30-day rolling average basis. EPA has previously expressed concerns with such a limit since it is not consistent with the MANE-VU recommended level for BART SO_2 control for non-CAIR EGUs, which is the use of natural gas or 0.3% sulfur content by weight fuel oil. The final SIP must include additional documentation to support an SO_2 BART limit of 0.50 lbs per million BTU for NT1.

Specifically, the BART Analysis for PSNH Newington Station Unit NT1 (Attachment X), Table 2-5, Cost of Fuel Switching based on Historical Fuel Oil Prices indicates the cost of switching from 2% to 0.3% sulfur in fuel oil as ranging from $627 to $2,664 per ton, which is not unreasonable. As noted in comment #2, New Hampshire must re-calculate the visibility improvements associated with each control strategy. Although the costs of switching to 0.3% sulfur in fuel oil may be reasonable, it is appropriate to consider these costs along with the anticipated visibility improvement. A minimal additional visibility improvement for 0.3% sulfur in fuel oil would provide support for New Hampshire's proposed 0.5 lb/MMBtu limit.

In addition, there are inconsistencies between the final BART limits in Env-A 2300 and the proposed November 19, 2010 New Hampshire Regional SIP that need to be addressed. Those inconsistencies are:

a) The SO_2 BART emission limit in Table 9.3 is stated as a calendar month average.
b) The SO_2 BART emission limit in Table 9.7 is stated as a calendar month average.

4) For Table 9.3, New Hampshire's initial proposal (dated May 26, 2009) included a 1,742 ton per year (tpy) SO_2 reduction from NT1. In the January 2010 SIP submittal and the November 19, 2010 proposal, Table 9.3 indicates a 3,484 tpy SO_2 reduction from this unit. However, Table 11.2 of the January 2010 SIP submittal and the November 19, 2010 proposal were not updated to reflect this change.

Newington Station NT1 BART – PM

5) New Hampshire has proposed that the existing PM permitted rate of 0.22 lb/MMBtu is BART for NT1. As noted in EPA's previous comments, this limit is well above the MANE-VU recommended limit of 0.02 – 0.04 lb/MMBtu. In the discussion of current PM emissions and controls, it is mentioned that NT1 has an electrostatic precipitator to capture PM emissions and a previous stack test at this facility indicated an emission rate 0.058 lb/MMBtu. At this point, DES has not presented sufficient evidence that the existing PM limit represents BART for unit NT1. The final SIP submittal must include further technical justification to demonstrate why it is not feasible for this unit to meet a more stringent limit.

Merrimack Station MK2 BART – NOx

6) Based on the "Final Proposal" of Env-A 2300 "Mitigation of Regional Haze," posted on your web site and dated December 1, 2010, it appears that NH DES has made a final decision that BART for MK2 is a NOx emission limit of 0.30 lb/MMBtu on a 30-day rolling average basis.

This is more stringent than the NOx emission rate that was originally proposed in Env-A 2300. However, as stated in our comments dated November 22, 2010, it appears MK2 is capable of meeting NOx emission rates lower than this on a 30-day rolling average. Specifically, data available from EPA's Clean Air Markets Division data base indicates that, in 2009, at no point did the unit exceed a 30-day rolling average of 0.25 lbs per million BTU.

A level of 0.25 lbs NOx per million BTU on a 30-day rolling average seems to be an appropriate BART emission limitation for MK1 based on our evaluation of the performance of the SCR over the last 5 years through September 30, 2010. In fact, prior to MK2 coming back on line in November 2009, the 30-day rolling average NOx emission rate met by the SCR was generally below 0.20 lbs per million BTU.

Moreover, it is unclear the basis of the statement in Attachment X saying that "the estimated costs of reducing the NOx limit to 0.34 lb/MMBtu (a reduction of 0.03 lb/MMBtu) would fall between $3,000 and $10,000 per ton of NOX removed," given that it does not appear that this rate has ever been exceeded in recent times. Therefore, in order to support a 0.30 lb per million BTU limit, further technical justification is necessary to demonstrate why it is not cost effective for this unit to meet a more stringent limit.

In addition, there are inconsistencies between the final BART limits in Env-A 2300 and the proposed November 19, 2010 New Hampshire Regional SIP and attachments that need to be addressed. Those inconsistencies are:

a) The NOx BART emission limit in Table 9.2 is stated as 0.37 lb/MMBtu calendar monthly average.
b) The NOx BART emission limit in Table 9.6 is stated as 0.37 lb/MMBtu calendar monthly average.
c) The discussion in section 6.1 of Attachment X saying that NHDES finds that the current NOx RACT limit, expressed as 0.37 lb/MMBtu, is also appropriate as a BART control level.

Implementing BART and Reasonable Further Progress Limits

7) The proposed SIP includes the following attachments for Merrimack Station and Newington Station:

Attachment EE – Temporary Permit for PSNH Merrimack Station
Attachment HH – Draft Title V Operating Permit for PSNH Merrimack Station

Attachment II – Title V Operating Permit for PSNH Newington Station

As noted in our November 22, 2010 comments, the temporary permit for Merrimack Station has expired and the Title V operating permit is in draft form. As such, these documents should not be incorporated into the SIP. Therefore, it is not clear how some of the BART and reasonable further progress emission limits for MK2 and MK1, respectively, will be made enforceable.

Specifically, for MK2, although the BART NOx emission limits and monitoring requirements are stated in Env-A 2300, this rule points to permit conditions for the associated testing requirements. Also, although the rule includes BART TSP emission limits and stack testing requirements for MK2, there are no associated monitoring requirements included in the rule. In addition, the rule relies on permit conditions for the SO_2 BART emission limits and testing requirements for MK2, and does not include any SO_2 monitoring requirements for MK2.

For MK1, Env-A 2300 relies on permit conditions for the NOx and SO_2 emission limits and testing requirements, and is silent as to the associated monitoring requirements. In addition, although the rule includes TSP emission limits and testing requirements for MK1, the rule is silent as to the associated monitoring requirements.

Therefore, since the Merrimack Station permits are not valid, and Env-A 3200 does not include all of the necessary emission limits, monitoring, and testing requirements, the DES will need to ensure that the deficient aspects noted above are addressed in the final SIP submittal, in order to ensure that all of the BART and reasonable further progress limits for Merrimack Station are enforceable.

Furthermore, for Newington Station, the final SIP submittal should indicate which provisions of the Attachment II permit are to be incorporated into the SIP. For example, the permit includes a 2% sulfur content by weight fuel oil requirement for NT1 that has since been superseded by the 0.5 lb/MMBtu limit in Env-A 3200. In such a case, the provision in the permit should not be incorporated into the SIP.

New Hampshire Regional Haze SIP Revision
Responses to EPA's Comments

On December 20, 2010, the New Hampshire Department of Environmental Services (NHDES) received comments from the U.S. Environmental Protection Agency (EPA) on New Hampshire's draft final Regional Haze SIP, November 19, 2010 . The following are NHDES's responses to EPA's comments. **Comments are written in *italics* and responses are written in regular font.**

Low-Sulfur Fuel Strategy

1) New Hampshire's proposed SIP includes a demonstration that the MANE-VU low sulfur fuel oil strategy is reasonable...New Hampshire, however, has not yet adopted a regulation imposing these requirements. The proposed SIP indicates that New Hampshire plans to introduce legislation on this issue in January 2012. EPA urges New Hampshire to move forward with this strategy more quickly than stated in this proposal and include in its final SIP submittal a commitment to adopt and submit a final rule to EPA by a date certain in 2011.

- **NHDES Response:** NHDES cannot make commitments as to the timing of legislation but will recommend new legislation to implement the low-sulfur fuel oil strategy, as envisioned in the MANE-VU low-sulfur fuel strategy, as soon as fuel supply and cost data are deemed sufficient and favorable for legislative success. It remains New Hampshire's goal to implement the MANE-VU strategy by 2018, in accordance with the original timetable. If, in EPA's view, this statement of intention is insufficient, NHDES will remove the low-sulfur fuel strategy from the regional haze SIP.

BART Visibility Modeling

2) Tables 9-4 and 9-5 show the results of CALPUFF modeling for the visibility improvement from BART controls on the 20% worst visibility modeled days, based on baseline visibility conditions, at each nearby Class I area. However, 40 CFR Part 51, Appendix Y, Section (IV)(D)(5), "Step 5: How should I determine visibility impacts in the BART determination?" clearly states:

> *"Use the 24-hour average actual emission rate from the highest emitting day of the meteorological period modeled (for the pre-control scenario). Calculate the model results for each receptor as the change in deciviews compared against natural visibility conditions."*

A BART analysis should determine the visibility impact of the source, not the impact of the source in conjunction with all other impacting sources. New Hampshire must recalculate the visibility improvement using the calculated worst 20% natural conditions: 12.4 deciviews (dv) for Acadia National Park; 11.7 dv for Lye Brook Wilderness; and 12.0 dv for Moosehorn Wilderness and Great Gulf Wilderness.

- **NHDES Response:** NHDES has adjusted the visibility modeling for BART and made corresponding revisions to the descriptive text and tables of the regional haze SIP and BART analyses. Please see the attached CALPUFF Modeling Assessment.

<u>Newington Station NT1 BART – SO_2</u>

3) Based on the "Final Proposal" of Env-A 2300 "Mitigation of Regional Haze," posted on your web site and dated December 1, 2010,...it appears that NH DES has made a final decision that BART for NT1 is an SO_2 emission limit of 0.5 1b/MMBtu on a 30-day rolling average basis. EPA has previously expressed concerns with such a limit since it is not consistent with the MANE-VU recommended level for BART SO_2 control for non-CAIR EGUs, which is the use of natural gas or 0.3% sulfur content by weight fuel oil. The final SIP must include additional documentation to support an SO_2 BART limit of 0.50 lbs per million BTU for NT1.

Specifically, the BART Analysis for PSNH Newington Station Unit NT1 (Attachment X), Table 2-5, Cost of Fuel Switching based on Historical Fuel Oil Prices indicates the cost of switching from 2% to 0.3% sulfur in fuel oil as ranging from $627 to $2,664 per ton, which is not unreasonable. As noted in comment #2, New Hampshire must re-calculate the visibility improvements associated with each control strategy. Although the costs of switching to 0.3% sulfur in fuel oil may be reasonable, it is appropriate to consider these costs along with the anticipated visibility improvement. A minimal additional visibility improvement for 0.3% sulfur in fuel oil would provide support for New Hampshire's proposed 0.5 lb/MMBtu limit.

- **NHDES Response:** NHDES believes that 0.50 lb/MMBtu is appropriate as the BART control level for SO_2 for this unit. This determination is based on a number of factors, the following in particular:

  - The availability and cost of 0.3% sulfur residual fuel oil remain uncertain, i.e., Newington Station cannot be assured of a steady supply of this fuel at reasonable cost over the next 5-10 years.

  - The plant has a sizeable quantity of higher-sulfur residual fuel oil in storage tanks on site. There is no practical way to offload and replace this inventory with a lower-sulfur residual fuel oil, so the existing stock of higher-sulfur fuel oil will have to be used up before Unit NT1 can be fired exclusively with low-sulfur fuel oil.

  - Even if supplies could be guaranteed at reasonable cost, the visibility improvement in going from an emission limit of 0.50 lb/MMBtu to a fuel limitation of 0.3% S residual fuel oil is almost negligible. Please refer to the revised modeling results for Unit NT1 in Table 5-1 of the BART analysis (Attachment X).

In addition, there are inconsistencies between the final BART limits in Env-A 2300 and the proposed November 19, 2010 New Hampshire Regional SIP that need to be addressed. Those inconsistencies are:

a) The SO_2 BART emission limit in Table 9.3 is stated as a calendar month average.
b) The SO_2 BART emission limit in Table 9.7 is stated as a calendar month average.

- **NHDES Response:** The inconsistencies between Env-A 2300 and the SIP have been corrected in the final documents.

4) For Table 9.3, New Hampshire's initial proposal (dated May 26, 2009) included a 1,742 ton per year (tpy) SO_2 reduction from NT1. In the January 2010 SIP submittal and the November 19, 2010 proposal, Table 9.3 indicates a 3,484 tpy SO_2 reduction from this unit. However, Table 11.2 of the January 2010 SIP submittal and the November 19, 2010 proposal were not updated to reflect this change.

- **NHDES Response:** The projected emissions in Table 11.2 represent MANE-VU's 2018 "Best and Final" modeling emissions inventory that was used in the final visibility modeling and reflect the assumptions used at the time the modeling was performed. This inventory incorporates the additional reasonable control measures, including the targeted EGU strategy, the low-sulfur fuel strategy, and the timely implementation of BART. For the targeted EGU strategy for Unit NT1 specifically, a 50% reduction in SO_2 emissions was assumed, representing a switch from 2% to 1% sulfur fuel. This emissions inventory and modeling analysis, and therefore the values in Table 11.2, were not adjusted to reflect revisions made by NHDES to the BART analysis between the time of the initial proposal and the January 2010 submittal. Thus, the table remains consistent with the completed MANE-VU modeling. Note, however, that the BART emission limit and expected emission reductions for Unit NT1 in the January 2010 SIP submittal are more stringent than those that were assumed in the final MANE-VU visibility modeling. NHDES has added a statement in the SIP to explain these differences.

Newington Station NT1 BART – PM

5) New Hampshire has proposed that the existing PM permitted rate of 0.22 lb/MMBtu is BART for NT1. As noted in EPA's previous comments, this limit is well above the MANE-VU recommended limit of 0.02-0.04 lb/MMBtu. In the discussion of current PM emissions and controls, it is mentioned that NT1 has an electrostatic precipitator to capture PM emissions and a previous stack test at this facility indicated an emission rate 0.058 lb/MMBtu. At this point, DES has not presented sufficient evidence that the existing PM limit represents BART for unit NT1. The final SIP submittal must include further technical justification to demonstrate why it is not feasible for this unit to meet a more stringent limit.

- **NHDES Response:** The single available stack test report for this unit is a decade old and is not a sufficient basis for resetting the PM emission limit. As indicated in the BART analysis of Attachment X, the facility's Title V operating permit requires that a compliance stack test for PM emissions be performed on Unit NT1 before the permit expires on March 31, 2012. In recent years this unit has operated as a peaking plant. It is impractical to fire up the boiler for the sole purpose of stack testing. Therefore, some flexibility is needed with respect to the testing schedule. PSNH and NHDES will coordinate the effort to perform the testing at the earliest practical date but cannot commit to a specific test schedule under current circumstances. NHDES will review the new stack test results to ascertain the unit's performance and incorporate any new limit into a permit amendment by the permit expiration date, as appropriate. Such limit will be made consistent with BART requirements. The permit expiration date precedes the effective date of proposed BART control measures by fifteen months, so the air quality benefits of a reduced PM emission limit will be realized earlier than would otherwise be the case under New Hampshire's BART implementation schedule.

Merrimack Station MK2 BART – NOx

6) Based on the "Final Proposal" of Env-A 2300 "Mitigation of Regional Haze," posted on your web site and dated December 1, 2010, it appears that NH DES has made a final decision that BART for MK2 is a NOx emission limit of 0.30 lb/MMBtu on a 30-day rolling average basis.

This is more stringent than the NOx emission rate that was originally proposed in Env-A 2300. However, as stated in our comments dated November 22, 2010, it appears MK2 is capable of meeting NOx emission rates lower than this on a 30-day rolling average. Specifically, data available from EPA's Clean Air Markets Division data base indicates that, in 2009, at no point did the unit exceed a 30-day rolling average of 0.25 lbs per million BTU. A level of 0.25 lbs NOx per million BTU on a 30-day rolling average seems to be an appropriate BART emission limitation for MKl based on our evaluation of the performance of the SCR over the last 5 years through September 30, 2010. In fact, prior to MK2 coming back on line in November 2009, the 30-day rolling average NOx emission rate met by the SCR was generally below 0.20 lbs per million BTU.

Moreover, it is unclear the basis of the statement in Attachment X saying that "the estimated costs of reducing the NOx limit to 0.34 lb/MMBtu (a reduction of 0.03 lb/MMBtu) would fall between $3,000 and $10,000 per ton of NOx removed," given that it does not appear that this rate has ever been exceeded in recent times. Therefore, in order to support a 0.30 lb per million BTU limit, further technical justification is necessary to demonstrate why it is not cost effective for this unit to meet a more stringent limit.

- **NHDES Response:** In new data provided to support the BART analyses for Unit MK2 (see Attachment X), PSNH estimates that a reduction in the NOx emission limit to 0.30 lb/MMBtu (an effective reduction of 0.07 lb/MMBtu) would have an incremental cost of approximately $800 per ton of NOx removed, which falls within the generally accepted cost-effective range. At the same time, PSNH estimates that further reduction of the NOx emission limit to 0.25-0.30 lb/MMBtu would have diminishing returns, with an incremental cost per ton approximately one order of magnitude greater. In the context of BART requirements, NHDES finds that the higher costs associated with a NOx emission limit below 0.30 lb/MMBtu are not justifiable given the fact of negligible visibility benefit.

  NHDES concurs with EPA that Unit MK2 is likely to surpass this performance level routinely by a significant margin. However, the ability of this unit to perform at a lower NOx emission rate most of the time does not, by itself, constitute BART. The facility needs some flexibility to operate at higher emission levels during occasional reduced-load incidents, which drive up the average emission rate. It is reasonable to expect that Unit MK2, in order to comply with a BART emission limitation of 0.30 lb/MMBtu on a 30-day rolling average basis, will continue to operate well below this limit whenever it can so as to counterbalance the possible higher emissions that occur from largely unplanned periods of low-load operation. PSNH has stated, and the historical record suggests, that the company regularly operates at a target NOx emission rate that is 0.15 lb/MMBtu below the permitted limit.

  NHDES will be re-evaluating this unit for future compliance with NOx RACT requirements, which could be more stringent than BART. The BART analyses, whose intent is visibility improvement, will remain separate from the NOx RACT review process. The latter will be undertaken to assure compliance with pending revisions to the ozone standards. Being health-based, the ozone standards serve a different, albeit related, purpose.

In addition, there are inconsistencies between the final BART limits in Env-A 2300 and the proposed November 19, 2010 New Hampshire Regional SIP and attachments that need to be addressed. Those inconsistencies are:

a) *The NOx BART emission limit in Table 9.2 is stated as 0.37 lb/MMBtu calendar*

b) *The NOx BART emission limit in Table 9.6 is stated as 0.37 lb/MMBtu calendar monthly average.*

c) *The discussion in section 6.1 of Attachment X saying that NHDES finds that the current NOx RACT limit, expressed as 0.37 lb/MMBtu, is also appropriate as a BART control level.*

- **NHDES Response:** These entries in the SIP have been updated to agree with the lower BART emission limit of 0.30 lb/MMBtu, 30-day rolling average basis.

Implementing BART and Reasonable Further Progress Limits

7) The proposed SIP includes the following attachments for Merrimack Station and Newington Station:

Attachment EE - Temporary Permit for PSNH Merrimack Station
Attachment HH - Draft Title V Operating Permit for PSNH Merrimack Station
Attachment II - Title V Operating Permit for PSNH Newington Station

As noted in our November 22, 2010 comments, the temporary permit for Merrimack Station has expired and the Title V operating permit is in draft form. As such, these documents should not be incorporated into the SIP. Therefore, it is not clear how some of the BART and reasonable further progress emission limits for MK2 and MK1, respectively, will be made enforceable.

- **NHDES Response:** Temporary Permit TP-0008 is a valid permit, reissued on August 2, 2010, with an expiration date of September 30, 2011. Future reissuance(s) will be made as necessary in accordance with Env-A 607.09 until such time as the relevant provisions of the temporary permit have been incorporated into the final Title V Operating Permit for Merrimack Station. The previously issued permits for this facility remain in effect because of a timely application filing for renewal. The proposed Title V Operating Permit for Merrimack Station has passed the public comment phase but is under appeal before the New Hampshire Air Resources Council. The appeal hearing is tentatively scheduled for February or March 2011. The Title V Operating Permit for Newington Station is valid until its expiration on March 31, 2012.

  Because the Title V Permit for Merrimack Station is the only permit in this group that is not final, it would appear to be the one most relevant to the question of enforceability. For that permit, current state and federal rules adequately address enforceability. Please see response below.

Specifically, for MK2, although the BART NOx emission limits and monitoring requirements are stated in Env-A 2300, this rule points to permit conditions for the associated testing requirements. Also, although the rule includes BART TSP emission limits and stack testing requirements for MK2, there are no associated monitoring requirements included in the rule.

In addition, the rule relies on permit conditions for the SO_2 BART emission limits and testing requirements for MK2, and does not include any SO_2 monitoring requirements for MK2.

For MK1, Env-A 2300 relies on permit conditions for the NOx and SO_2 emission limits and testing requirements, and is silent as to the associated monitoring requirements. In addition, although the rule includes TSP emission limits and testing requirements for MK1, the rule is silent as to the associated monitoring requirements.

Therefore, since the Merrimack Station permits are not valid, and Env-A 3200 [sic] does not include all of the necessary emission limits, monitoring, and testing requirements, the DES will need to ensure that the deficient aspects noted above are addressed in the final SIP submittal, in order to ensure that all of the BART and reasonable further progress limits for Merrimack Station are enforceable.

- **NHDES Response:** The monitoring, recordkeeping, and reporting requirements for Units MK1 and MK2 that are listed in both the Temporary Permit and the proposed Title V Operating Permit are based on existing federal and state requirements specified in one or more of the following regulations: 40 CFR Part 75 (federal CEM requirements), Env-A 800 (state testing and monitoring procedures), and Env-A 900 (state recordkeeping and reporting requirements). Both Env-A 800 and Env-A 900 are elements of New Hampshire's SIP. Merrimack Station is subject to these provisions regardless of the status of the Title V Operating Permit or Env-A 2300 (state regional haze rule). Moreover, NHDES anticipates that the proposed Title V Operating Permit will be issued in final form well before the BART implementation date of July 1, 2013. In summary, NHDES believes that Env-A 2300 already provides for the requisite monitoring and testing of emissions for enforcement of BART. Note that the inclusion of Unit MK1 in New Hampshire's regional haze rule was done for practical reasons related to BART compliance (the two units will share a common stack) and was not meant to address reasonable further progress, although that may be an additional benefit.

Furthermore, for Newington Station, the final SIP submittal should indicate which provisions of the Attachment II permit are to be incorporated into the SIP. For example, the permit includes a 2% sulfur content by weight fuel oil requirement for NT1 that has since been superseded by the 0.5 lb/MMBtu limit in Env-A 3200 [sic]. In such a case, the provision in the permit should not be incorporated into the SIP.

- **NHDES Response:** The New Hampshire Code of Administrative Rules, Env-A 100 et seq., Rules Governing the Control of Air Pollution, and the permits issued by NHDES in accordance with those rules, contain many examples of overlapping requirements. The most stringent conditions always apply. In the present example, Unit NT1 must meet both the 2% maximum sulfur requirement *and* the 0.50 lb/MMBtu SO_2 limitation. Because the latter standard is the more stringent, it will be the governing condition. Env-A 609.19 includes provisions for reopening permits for cause, but the example cited would not meet any of the criteria for reopening the existing Title V operating permit. NHDES believes that overlapping requirements, redundancies, etc. are most easily addressed by amending the permit upon renewal (in this case, no later than March 31, 2012).

CALPUFF Modeling Assessment

In its first regional haze State Implementation Plan (SIP) draft submitted to the Environmental Protection Agency (EPA) and the federal land managers (FLMs) for comment, the New Hampshire Department of Environmental Services (NHDES) used an alternative model (CALGRID) to provide visibility improvement estimates for potential best available retrofit technology (BART) emission controls. Both EPA and the FLMs requested that DES redo the analysis with the "preferred" model, CALPUFF, as it was anticipated that the model would provide higher visibility benefit estimates for each potential BART control scenario. NHDES provided the requested CALPUFF modeling results in its official final filing to EPA in January, 2010. During a March 2010 meeting between EPA and NHDES, EPA requested additional documentation to support the modeling results and requested that a full year be modeled to better represent the visibility benefits due to NOx emission controls during periods of cold weather. NHDES revisited this modeling as requested and found that the modeling results did not change substantively.

On April 21, 2010, NHDES provided a general description of the proposed CALPUFF modeling procedures to EPA for comment. In that communication, NHDES let EPA know that it planned to exercise some flexibility as allowed under guidance to better represent more realistic estimates of anticipated visibility benefits for potential BART controls. NHDES used CALPUFF as specified in the BART guidance; however, rather than allowing the model to calculate deciviews from default data, NHDES applied relative modeling changes to monitored extinction to deciview relationship data to determine more realistic deciview predictions for the New England airshed. On August 6, 2010, EPA provided brief comments expressing concern and confusion regarding the proposed NHDES process (see attached). NHDES had subsequent telephone discussions with EPA regarding how New Hampshire intended to use the modeling in a relative way. EPA also asked whether it was appropriate to introduce current monitoring data since the blend of atmospheric species in 2064 is likely to be very different than it is now. NHDES took this question to the Cooperative Institute for Research in the Atmosphere (CIRA) for its thoughts on the matter. Based on CIRA's input, NHDES slightly revised the methodology to take a more speciated approach and calculated extinction before introducing the monitoring data into the calculations. This approach was incorporated into the NHDES analysis and is described in greater detail below.

EPA also expressed concern regarding NHDES's interpretation of the EPA BART modeling guidance. The concern focused on the wording for using the 20% worst modeled days, which NHDES interpreted to mean 20% worst visibility days since the two correlate so highly in the northeast region of the country. This interpretation also made logical sense to NHDES since the regional haze rule targets visibility improvement on those 20% worst visibility days while maintaining current visibility on the 20% best days. As was recently pointed-out, EPA's intent was to use the worst (or maximum) modeled BART source impacts as applied to the best visibility days. The wording of the guidance has been made clearer since its draft version, but having been told that the guidance had not been changed substantively, NHDES did not notice its misinterpretation until recently. NHDES's continued misinterpretation of the modeling guidance is demonstrated in the April 2010 correspondence between NHDES and EPA, where EPA recommends the use of the 98^{th} percentile data (for BART source modeling) and NHDES responds by asking if this was for the 98^{th} percentile worst days of monitoring (see attached NHDS-EPA correspondence). Now with a correct interpretation of the guidance, NHDES provides the requested CALPUFF modeled data for the 20% best visibility days in addition to the 20% worst visibility days. Even though these new results have been added, it is NHDES's opinion that any benefits predicted based on the 20% best visibility days are not likely to be realized in 2018 because of the wind patterns in the area and the alignment of sources with Class I areas. Given the alignment of the New Hampshire BART source to Class 1 areas and how there is a strong correlation of this alignment with that wind direction for worst visibility days, NHDES believes that the data provided for the 20% worst visibility days is a much more realistic prediction for anticipated benefits of controls, than the estimate for the 20% best days.

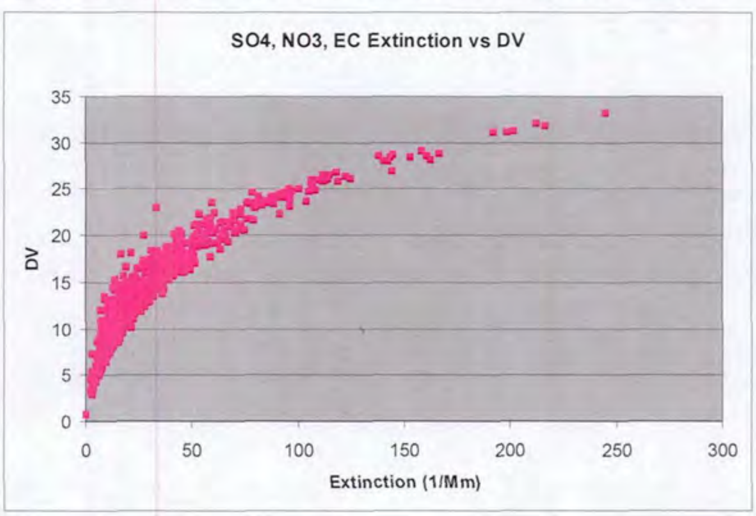
Additional process description and data are provided in sections below.

Description of the NHDES Modeling Process

The EPA modeling guidelines suggest that using models in a "relative" way could be useful to estimate the expected visibility benefits of BART controls. As explained above, while CALPUFF is EPA's preferred model for visibility assessments of individual sources, it still has some weaknesses. NHDES prefers the relative approach to improve the non-linear (deciview) visibility assessment with actual response data measured at nearby Class 1 areas rather than using national default data.

As specified by guidance, the NHDES modeling uses CALPUFF to estimate the benefits of BART controls on a single source under the conditions of 20% best (and worst visibility days). The model calculates the concentration benefits from the chosen source controls, but the conversion of the data into deciview units involves a non-linear estimation heavily dependent on background air pollution levels which can vary greatly in species concentrations. The resulting concentrations were normalized to match the scale of the previously submitted MANE-VU CALPUFF modeling to ensure consistency and comparability with the original MANE-VU modeling platform. Next, the normalized modeled species concentrations were used to calculate predicted visibility extinctions using the EPA-recommended reconstructed extinction equation. Finally, these results were used to calculate design values based on a best-fit equation for observed design value to extinction data for nearby New England Class I areas (Acadia NP, Great Gulf NWR, and Lye Brook NWR) (see Figure 1). Because of the logarithmic relationship of deciviews and concentration, background visibility must be added to the modeled concentrations prior to the extinction calculation so that the correct portion of the curve is applied. Extinctions corresponding to 20% best visibility days at Acadia NP (12.4 dv), Great Gulf / Presidential Range (12.0 dv) and Lye Brook (11.7 dv) were used. 22.8 dv was used for 20% worst visibility days.

Figure 1. Monitored $PM_{2.5}$ Extinction to Deciview Relationship in the Northeast



In short, the CALPUFF post-processor (CALPOST) uses a generic blend of background visibility conditions and then performs deciview benefit calculations in a crude way based on specification of background conditions. NHDES's approach rigorously assesses relative changes predicted in CALPUFF modeling with (monitor-based) monitoring data derived visibility benefits. The NHDES approach allows visibility calculations to be made at any level of background visibility within the range of observed data at the nearby Class 1 areas.

EPA guidelines recommend the use of five years of meteorology for BART modeling. Further, in order to prevent a single outlier from dominating the process, the 98th percentile single source impact should be used for BART determination. Because NHDES has only one year of meteorology suitable for regional CALPUFF modeling, it was decided to use the single maximum impact for that one year. This reduced the likelihood that a higher 98th percentile was missed and ensured that conservative results were used.

Emission Scenarios:

Each leading BART control option was modeled for visibility benefit at nearby Class I areas. However, scenarios were not modeled where affected units are currently operating at lower emission rates, or at rates equal to potential BART emission limits. If there are no actual emission reductions to be gained from lower emission limits, then there are no benefits that would result through modeling.

CALPUFF Modeling Inputs and Assumptions
The inputs and assumptions that were used in the CALPUFF BART visibility impact modeling are listed below.

Models Used
CALPUFF Version 6.262
CALPOST Version 6.221
CALPro Standard 6.4.0.05_27_2008 Graphical User Interface

Meteorology
CALMET 1990 (full year) meteorological field produced by NHDES on 8/26/2005

Reason for NHDES Process

While recognizing that CALPUFF is the recommended model for long distance visibility assessments for Class I areas, NHDES disagrees with EPA that CALPUFF provides the best and most useful predictions of the visibility benefit of BART controls. CALPUFF excels at predicting worst-case impacts in the mid- to long-field, thus looking for that maximum point, and it does reasonably well at predicting that related concentration. It does not do as well in predicting the related deciview impact because the model is not wired to match a facility's impact with the actual background visibility for any specific day. Instead, the worst-case concentration is simply added to a generalized model background concentration for a deciview target specified in a model post-processor (CALPOST). This is perhaps the purpose of the exercise, to be conservative and theoretical rather than to produce a truly realistic anticipated benefit. As a result, it does not track realistic modeled impacts as they might relate to background visibility, best visibility, and worst visibility days. Extra effort by the modeler is needed to present a realistic modeling result that aligns wind directions with appropriate, manually entered background conditions.

Because the model handles wind fields without regard to visibility conditions, CALPUFF's predictions can be very conservative and possibly oversensitive to changes in visibility conditions when assessing the most likely benefits of emission controls. In the case of the New Hampshire BART sources, the alignment of the sources to the most affected Class I area (Acadia N.P.) is also the direct alignment of the most common wind trajectory on worst visibility days; thus maximum source contributions occur at times when transported air pollution from further away is also at a maximum. This phenomenon can lead to some of the worst visibility days. This alignment also makes it very difficult for NH BART sources to contribute maximum impacts at times when impacts from additional transport are not occurring, which would be the case on best visibility days. Therefore, when the best visibility day results are artificially overlaid on maximum source impact days and then the modeling results are used to calculate the benefits of emission controls, those benefits can be unrealistically overstated. As a result, predicted deciview improvements and the calculated cost-per-deciview ($/dv) BART control metric are not truly anticipated or expected. If a control is deemed reasonable because full attention is given to a scenario that is unlikely ever to occur based on monitored observations, NHDES questions the validity of calling the modeled results as an "anticipated benefit." The exception to this case, however, is Lye Brook: because of its location in southern Vermont and its alignment with NH BART sources, the impacts from those sources are likely to be highest at Lye Brook on best visibility days when winds are from the east. Therefore, for Lye Brook, the predictions for best visibility days may be reasonable.

EPA recommends and encourages states to use the CALPUFF model for BART modeling, largely because regional models have not yet been proven to be effective for modeling impacts from individual sources. However, unlike CALPUFF and other dispersion models, regional grid models such as CALGRID excel at accounting for the impacts of widespread sources contributing to the species that cause visibility impairment. To that end, for the impact assessment of New Hampshire's BART-eligible sources, NHDES originally chose to use CALGRID, the sister model to CALPUFF. CALGRID includes much of the same chemistry as CALPUFF but uses gridded dispersion as opposed to the puff dispersion used in CALPUFF. In fact, CALGRID2.45 includes about 20 percent more enhanced aerosol chemistry than CALPUFF and is therefore considered to be the more advanced model. Moreover, CALGRID easily matches and isolates the 20% best and worst visibility days to allow a direct, realistic result without the need for manual modeling adjustments to account for those specifics. CALGRID can easily isolate the best visibility days where a BART source actually contributes to visibility impairment, giving a more realistic sense of what benefits are reasonably anticipated. CALPUFF always assumes maximum emissions impact at Class I areas on both best and worst days – conditions that may or may not happen in reality. While the CALPUFF model's CALPOST post-processor has an option for application on 20% best visibility days, it does not isolate those 20% best days for analysis. It simply changes the background values used by the model to what is estimated to be appropriate background conditions. The post-processed results do not account for wind directions that may be preferentially included or excluded on such days. Even though NHDES sees value in the application of CALGRID for identifying anticipated visibility impacts with consideration to daily contributions of a single source relative to all sources, NHDES has agreed to also apply the CALPUFF model. NHDES still applies significant credibility to the CALGRID modeling results because they provide substantial insight into what scenarios are most realistic and just how much benefit is likely to occur in a given year.

CALPUFF Modeling Results

Merrimack Station Unit MK2: BART Eligibility Modeling

The BART eligibility modeling conducted by MANE-VU used natural visibility conditions (about 7 dv) to produce the most conservative modeling results to minimize sources from modeling out of BART. Under natural background conditions, uncontrolled emissions from Unit MK2 produce CALPUFF worst-case impacts of 2.24 dv at Acadia National Park. This value was replicated in the NHDES CALPUFF modeling effort. EPA considers it acceptable to exempt sources when this form of conservative modeling indicates that a source produces less than 0.5 dv of impact. MANE-VU considers an exemption level of 0.2 to 0.3 dv to be more appropriate but prefers, and has applied, a more conservative exemption level of 0.1 dv. CALPUFF modeling results for baseline emissions from Unit MK2 exceed all of these exemption levels.

According to EPA regional haze documentation, a difference of 1 deciview is visibly noticeable by observers and a difference of 0.1dv is the minimum perceptible by the human eye.

Merrimack Station Unit MK2: BART Benefit Assessment Modeling

> The BART assessment modeling provides a comparison of visibility impacts from current allowable emissions with those from the post-control emission level (or levels) being evaluated. In accordance with EPA guidance, NHDES used CALPUFF to estimate the magnitude of the source's impacts on visibility after implementation of BART controls. Results are tabulated for the average of the 20% best and worst visibility (in this case, about 11.7 to 12.4 dv for best and 22.8 dv for worst) modeled days at each nearby Class I area. For any pair of control levels evaluated, the difference in the level of impairment predicted is the degree of improvement in visibility expected.

For Merrimack Station Unit MK2, the CALPUFF-predicted visibility benefits from BART controls on 20% best and 20% worst visibility days are shown below.

CALPUFF Modeling Results for Merrimack Station Unit MK2: Visibility Improvements from BART Controls

On the 20% Best Visibility Days (deciviews)				
Pollutant	**Control Level**	**Acadia**	**Great Gulf**	**Lye Brook**
SO_2	90% with FGD	1.07	0.83	**0.17**
NOx	Additional 25% with SCR upgrade	0.21	0.18	**0.10**
PM	90% with upgraded controls	0.16	0.12	**0.03**
On the 20% Worst Visibility Days (deciviews)				
Pollutant	**Control Level**	**Acadia**	**Great Gulf**	**Lye Brook**
SO_2	90% with FGD	**0.26**	**0.20**	0.03
NOx	Additional 25% with SCR upgrade	**0.07**	**0.06**	0.03
PM	90% with upgraded controls	**0.07**	**0.05**	<0.01*

* below sensitivity limit of model

Note: Values in **boldface** are considered as having greater validity in the modeling estimation of maximum visibility benefits from BART controls.

While Unit MK2 was predicted by the MANE-VU modeling to have up to 2.24 dv impact at Acadia National Park under natural conditions, the basis of the BART assessment evaluation changes to 20% worst visibility days. On those days, a 90% reduction in sulfur emissions at Unit MK2 results in only a maximum of 0.26 dv visibility improvement. At first these results may appear to be too low; however, on further examination, it is found that CALPUFF predicts the same amount of sulfate from Unit MK2 reaching Acadia under both best and worst visibility conditions. The difference is that there is greater than an order of magnitude more background sulfate coming from other sources on the 20% worst visibility days, raising the background concentrations (and deciviews) to much higher levels. Because the deciview scale is logarithmic, the same mass reduction of 0.259 $\mu g/m^3$ of sulfate from this one source results in wide differences in deciview impacts for different background visibility conditions at opposite ends of the range.

On the 20% best visibility days, if the full impact (or benefit of control for the FGD) could somehow be realized at nearby Class I areas without the influence of regional transport from other sources, then the benefit could be as high as 1.07 dv. NHDES does not believe this 1.07 dv of benefit is a realistic expectation for this SIP, which focuses on 2018.

Detailed CALPUFF Modeling Results for Merrimack Station Unit MK2 for 20% Best Days:

20% Best Days Load	Acadia DV Base	Acadia DV Control	Acadia DV Benefit	Acdia DV Source Contribution	Great Gulf DV Base	Great Gulf DV Control	Great Gulf DV Benefit	Great Gulf DV Source Contribution	Lye Brook DV Base	Lye Brook DV Control	Lye Brook DV Benefit	Lye Brook DV Source Contribution
MK2 Base	14.65	14.65	-	2.25	13.81	13.81	-	1.81	12.31	12.31	-	0.61
MK2 FGD	14.65	13.57	**1.07**	1.17	13.81	12.98	**0.83**	0.98	12.31	12.14	**0.17**	0.44
MK2 SNCR												
MK2 SCR Upgrade	14.65	14.44	**0.21**	2.04	13.81	13.62	**0.18**	1.62	12.31	12.21	**0.097**	0.51
MK2 Baghouse	14.65	14.98	**(0.33)**	2.58	13.81	14.07	**(0.26)**	2.06	12.31	12.37	**(0.06)**	0.67
MK2 ESP Upgrade	14.65	14.49	**0.16**	2.09	13.81	13.69	**0.12**	1.68	12.31	12.28	**0.03**	0.58

Detailed CALPUFF Modeling Results for Merrimack Station Unit MK2 for 20% Worst Days:

20% Worst Days Load	Acadia DV Base	Acadia DV Control	Acadia DV Benefit	Acdia DV Source Contribution	Great Gulf DV Base	Great Gulf DV Control	Great Gulf DV Benefit	Great Gulf DV Source Contribution	Lye Brook DV Base	Lye Brook DV Control	Lye Brook DV Benefit	Lye Brook DV Source Contribution
MK2 Base	23.85	23.85	-	1.02	23.58	23.58	-	0.76	24.72	24.72	-	1.89
MK2 FGD	23.85	23.59	**0.26**	0.76	23.58	23.38	**0.20**	0.56	24.72	24.68	**0.03**	1.86
MK2 SNCR												
MK2 SCR Upgrade	23.85	23.78	**0.07**	0.95	23.58	23.52	**0.06**	0.70	24.72	24.69	**0.03**	1.86
MK2 Baghouse	23.85	23.99	**(0.14)**	1.16	23.58	23.69	**(0.11)**	0.87	24.72	24.74	**(0.02)**	1.91
MK2 ESP Upgrade	23.85	23.78	**0.07**	0.96	23.58	23.53	**0.05**	0.71	24.72	24.71	**0.009**	1.88

The above analysis indicates that CALPUFF and CALGRID have aligned better in their predictions than might be expected on worst visibility days. As presented in earlier drafts of the New Hampshire regional haze SIP, CALGRID predicted a maximum visibility benefit of about 0.1 dv (on the more realistic worst visibility days vs. 0.26 dv on the best visibility days) at Acadia National Park for a 90% reduction in SO_2 emissions. This result may be attributed to the similar chemistry used in both models and to the specific circumstances of this case in which the prevailing wind direction on the 20% worst visibility days carries Unit MK2 emissions directly toward Acadia National Park. The big discrepancy occurs under best visibility days, when CALGRID does not account for meteorology that brings significant New Hampshire BART source contributions to nearby Class I areas on best visibility days.

Newington Station Unit NT1: BART Eligibility Modeling

The BART eligibility modeling conducted by MANE-VU used natural visibility conditions (about 7 dv) to produce the most conservative modeling results to minimize sources from modeling out of BART. Under natural background conditions, uncontrolled emissions from Unit

NT1 produce theoretical CALPUFF worst-case impacts of 1.22 dv at Acadia National Park. As in the case of Unit MK2, CALPUFF modeling results for baseline emissions from Unit NT1 exceed all of the EPA and MANE-VU exemption levels.

Newington Station Unit NT1: BART Benefit Assessment Modeling

For Newington Station Unit NT1, the CALPUFF-predicted visibility benefits from BART controls on 20% best and 20% worst visibility days are smaller than those for Merrimack Station Unit MK2:

CALPUFF Modeling Results for Newington Station Unit NT1:
Visibility Improvements from BART Controls

On the 20% Best Visibility Days (deciviews)				
Pollutant	**Control Level**	**Acadia**	**Great Gulf**	**Lye Brook**
SO_2	FGD (90% sulfur reduction*)	0.57	0.45	**0.09**
	1.0%-S residual fuel oil (50% sulfur reduction*)	0.30	0.24	**0.05**
	0.5%-S residual fuel oil (75% sulfur reduction*)	0.46	0.36	**0.07**
	0.3%-S residual fuel oil (85% sulfur reduction*)	0.52	0.40	**0.08**
	0.50 lb SO_2/MMbtu (77% sulfur reduction*)	0.47	0.37	**0.08**
	Switch from 0.50 lb SO_2/MMbtu emission limit to 0.3%S residual fuel oil	*<0.05*	*0.03*	***<0.01****
NOx	SNCR (25% NOx reduction**)	0.11	0.10	**0.04**
	SCR (78% NOx reduction**)	0.34	0.30	**0.12**
PM	Baghouse (85% PM reduction**)	0.05	0.04	**0.01**
On the 20% Worst Visibility Days (deciviews)				
Pollutant	**Control Level**	**Acadia**	**Great Gulf**	**Lye Brook**
SO_2	FGD (90% sulfur reduction*)	**0.13**	**0.10**	<0.01***
	1.0%-S residual fuel oil (50% sulfur reduction*)	**0.07**	**0.06**	<0.01***
	0.5%-S residual fuel oil (75% sulfur reduction*)	**0.11**	**0.09**	0.01
	0.3%-S residual fuel oil (85% sulfur reduction*)	**0.13**	**0.10**	0.01
	0.50 lb SO_2/MMbtu (77% sulfur reduction*)	**0.11**	**0.09**	0.01
	Switch from 0.50 lb SO_2/MMbtu emission limit to 0.3%S residual fuel oil	***0.01***	***0.01***	*<0.01****
NOx	SNCR (25% NOx reduction**)	**0.04**	**0.03**	0.01
	SCR (78% NOx reduction**)	**0.11**	**0.10**	0.03
PM	Baghouse (85% PM reduction**)	**0.02**	**0.02**	<0.01***

* from maximum permitted level

** from baseline level with existing controls

*** below sensitivity limit of model

Note: Values in **boldface** are considered as having greater validity in the modeling estimation of maximum visibility benefits from BART controls.

As presented in an earlier draft of the New Hampshire regional haze SIP, CALGRID predicted a maximum negligible visibility benefit (less than 0.1 dv) at Acadia National Park for a 75% reduction in SO_2 emissions.

Detailed CALPUFF Modeling Results for Newington Station Unit NT1 for 20% Best Days:

20% Best Days Load	Acadia DV Base	Acadia DV Control	Acadia DV Benefit	Acdia DV Source Contribution	Great Gulf DV Base	Great Gulf DV Control	Great Gulf DV Benefit	Great Gulf DV Source Contribution	Lye Brook DV Base	Lye Brook DV Control	Lye Brook DV Benefit	Lye Brook DV Source Contribution
NT1 Base	13.62	13.62	-	1.22	12.99	12.99	-	0.99	11.98	11.98	-	0.28
NT1 1% S	13.62	13.32	**0.30**	0.92	12.99	12.75	**0.24**	0.75	11.98	11.93	**0.05**	0.23
NT1 0.5% S	13.62	13.16	**0.46**	0.76	12.99	12.63	**0.36**	0.63	11.98	11.91	**0.07**	0.21
NT1 0.50 lb SO2/MMBtu	13.62	13.15	***0.47***	0.75	12.99	12.62	**0.37**	0.62	11.98	11.91	***0.08***	0.21
NT1 0.3% S	13.62	13.10	**0.52**	0.70	12.99	12.59	**0.40**	0.58	11.98	11.90	**0.08**	0.20
NT1 FGD	13.62	13.05	**0.57**	0.65	12.99	12.54	**0.45**	0.54	11.98	11.89	**0.09**	0.19
NT1 SNCR	13.62	13.51	**0.11**	1.11	12.99	12.89	**0.10**	0.89	11.98	11.94	**0.04**	0.24
NT1 SCR	13.62	13.28	**0.34**	0.88	12.99	12.69	**0.30**	0.69	11.98	11.86	**0.12**	0.16
NT1 ESP (real)	13.62	13.08	**0.54**	1.11	12.99	12.56	**0.43**	0.89	11.98	11.87	**0.12**	0.24
NT1 Baghouse	13.62	13.03	***0.05***	1.11	12.99	12.51	***0.04***	0.89	11.98	11.86	**0.01**	0.24

Detailed CALPUFF Modeling Results for Newington Station Unit NT1 for 20% Worst Days:

20% Worst Days Load	Acadia DV Base	Acadia DV Control	Acadia DV Benefit	Acdia DV Source Contribution	Great Gulf DV Base	Great Gulf DV Control	Great Gulf DV Benefit	Great Gulf DV Source Contribution	Lye Brook DV Base	Lye Brook DV Control	Lye Brook DV Benefit	Lye Brook DV Source Contribution
NT1 Base	23.42	23.42	-	0.59	23.24	23.24	-	0.42	24.61	24.61	-	1.79
NT1 1% S	23.42	23.34	**0.07**	0.52	23.24	23.19	**0.06**	0.36	24.61	24.61	**0.008**	1.78
NT1 0.5% S	23.42	23.31	**0.11**	0.48	23.24	23.16	**0.09**	0.33	24.61	24.60	**0.01**	1.78
NT1 0.50 lb SO2/MMBtu	23.42	23.30	**0.11**	0.48	23.24	23.15	**0.09**	0.33	24.61	24.60	**0.01**	1.78
NT1 0.3% S	23.42	23.29	**0.13**	0.47	23.24	23.14	**0.10**	0.32	24.61	24.60	**0.01**	1.78
NT1 FGD	23.42	23.28	**0.13**	0.46	23.24	23.14	**0.10**	0.31	24.61	24.60	**0.01**	1.78
NT1 SNCR	23.42	23.38	**0.04**	0.56	23.24	23.21	**0.03**	0.38	24.61	24.60	**0.01**	1.78
NT1 SCR	23.42	23.31	**0.11**	0.48	23.24	23.14	**0.10**	0.32	24.61	24.58	**0.03**	1.76
NT1 ESP (real)	23.42	23.19	**0.23**	0.56	23.24	23.06	**0.18**	0.38	24.61	24.58	**0.04**	1.78
NT1 Baghouse	23.42	23.17	**0.02**	0.56	23.24	23.04	**0.02**	0.38	24.61	24.57	**0.003**	1.78

Emissions and Reduction Scenarios as Follows:

Maximum Source Contributions to Nearby Class I Areas after Potential BART Controls at MK2 on 20% Best Visibility Days

BART Controls	Control Level (%)	CALPUFF Source Contribution (DV) Highest 24-Hour Period
SO_2 Lower S Coal (ex)	40	2.25
NOx SCR (ex)	85	
PM Two ESPs (ex)	99+	
SO_2 FGD	90	1.17
NOx SCR Upgrade	to 90	2.04
PM ESP Upgrade	99.5	2.09

Note: Currently permitted emissions produced a CALPUFF visibility impact of 2.25 dv on 20% Best visibility days.

Maximum Source Contributions to Nearby Class I Areas after Potential BART Controls at NT1 on 20% Best Visibility Days

BART Controls	Control Level (%)	CALPUFF Source Contribution (DV) Highest 24-Hour Period
2% S Oil (from existing 1.5%)	0	1.22
NOx overfire (ex)	33	
PM ESPs (ex)	42	
SO_2 FGD	90	0.63
SO_2 1% S (from 1.5%)	50	0.92
SO_2 0.5% S	75	0.76
SO_2 0.3% S	85	0.70
SO_2 0.50 lb SO_2/MMBtu	77	0.75
NOx SNCR	50	1.11
NOx SCR	85	0.88
PM Fabric Filters	99	1.11

Note: Currently permitted emissions produced a CALPUFF visibility impact of 1.22 dv on 20% Best visibility days.

Federal Register Modeling recommendations (FR 69/87 May 5, 2004)

Page 25193
For modeling an individual BART-eligible source located more than 50 km from a Class I area, we propose that an air quality model, such as CALPUFF be used.

Page 25194
Converting a 5 percent change in light extinction to a change in deciviews yields a change of approximately 0.5 deciviews. This is a natural breakpoint at which to set the exemption level, since visibility degradation may begin to be recognized by human observer at this extinction level. Thus we are proposing a 0.5 deciview change as the threshold for determining that an individual source is causing visibility impairment at a Class I area. This level would be calculated by measuring the air quality screening modeling results for an individual source against natural visibility conditions.

Page 25189 and Page 25203
For assessing the 5^{th} factor, the degree of improvement in visibility from various BART control levels, we are proposing that States require individual sources to run CALPUFF, or other EPA-approved model, using site-specific data. To estimate a source's impact on visibility, the source would run the model using current allowable emissions, and then again at the post-control emissions level (or levels) being assessed. Results would then be tabulated for the average of the 20% worst modeled days at each receptor. The difference in the resulting level of impairment predicted is the degree of improvement in visibility expected.

Attachment:

Email Communication with EPA Region 1 Regarding BART Modeling

-----Original Message-----
From: mcwilliams.anne@epamail.epa.gov
[mailto:mcwilliams.anne@epamail.epa.gov]
Sent: Friday, August 06, 2010 1:22 PM
To: Healy, David
Subject: Fw: PSNH BART Modeling with CALPUFF

Hi Dave,

I have concerns regarding the approach to BART visibility impact modeling proposed in Jeff's e-mail of 4/20/10 (below). In this e-mail, NHDES is proposing to determine visibility improvement from installation of controls in respect to current background conditions.

> " The changes in predicted concentrations (with and without control) were converted to changes in visibility (DV) using the logarithmic relationship between DV and concentrations at the regional Class 1 areas (based on actual monitoring data collected from 1996 to 2008)."

CFR Part 51, Appendix Y clearly states:

"For each source, run the model, at pre-control and post-control emission rates according to the accepted methodology in the protocol.
Use the 24-hour average actual emission rate from the highest emitting day of the meteorological period modeled (for the pre-control scenario). Calculate the model results for each receptor as the change in deciviews compared against natural visibility conditions."

The goal of the Regional Haze Rule is to return the Class 1 areas to natural visibility conditions by 2064. By calculating the expected visibility improvements of BART controls based on current conditions, the analysis is not supporting this goal. Furthermore, if the BART determination is based on current conditions, the impact of that source on visibility in the Class 1 areas will increase over time as the influence of other sources are lessen through the installation of controls, once again leading to a failure to adequately assess the impact of BART controls for that source on the Class 1 area.

Anne

Anne McWilliams
Air Quality Planning
EPA - New England
Tel: 617 918-1697
Fax: 617 918-0697

Mailing Address:

EPA Region 1
Five Post Office Square - Suite 100
Mail Code - OEP05-02
Boston, MA 02109-3912

----- Forwarded by Anne McWilliams/R1/USEPA/US on 08/06/2010 12:56 PM -----

From:	"Underhill, Jeff" <Jeffrey.Underhill@des.nh.gov>
To:	Anne McWilliams/R1/USEPA/US@EPA
Cc:	"Healy, David" <David.Healy@des.nh.gov>
Date:	04/20/2010 03:30 PM
Subject:	RE: PSNH BART Modeling with CALPUFF

Anne,
I'm having a little trouble understanding the 98th percentile approach you describe below. Are you referring to the 98th percentile (8th highest DV day) based on monitoring for baseline year (2002), for annual CALPUFF modeling with all sources, or for maximum impact days for the BART facility in question?

NHDES took a different approach to this CALPUFF modeling since I have concerns with how the model actually works. I have to believe that the NH alternative approach gives realistic results that are supported by traditional science, but the approach is different which may cause you concern for consistency. The guidance for modeling does provide latitude and I believe we are within that guidance.

While we are working on a more formal write-up, I can briefly describe the process to you. CALPUFF was used to model the NH BART sources with and without controls. A full year of met data was used. Maximum predicted 24-hour concentrations for the source were isolated for each Class 1 area. The changes in predicted concentrations (with and without control) were converted to changes in visibility (DV) using the logarithmic relationship between DV and concentrations at the regional Class 1 areas (based on actual monitoring data collected from 1996 to 2008). This last step provides for the application of using the model in a relative way as preferred by EPA guidance. For BART exemption purposes, a background visibility of 7DV (natural conditions) was used to define the set point and for 20% worst days, the baseline 22.8DV submitted with the SIP was used. These set points reflected the location on the DV to concentration logarithmic relationship curve to use a starting point for visibility impact benefit assessment.

We chose this approach because CALPUFF uses a generic approach to calculating DVs based on national averages. I would suggest that our use of actual regional IMPROVE monitoring is more scientifically rigorous and defendable based on the nature of our prevailing mix of concentrations.

So, if I have a question in here somewhere, it would be, would you prefer that we capture CALPUFF's 8th highest impact for the year (instead of the 1st highest) to use for our assessment? Or would you prefer that we use the 8th worst visibility day for the baseline year (2002) to use as background DV? I think we have the second option relatively well covered by using the baseline value which is the average of the 20% worst days.

Thanks!
Jeff

-----Original Message-----
From: Healy, David
Sent: Friday, April 16, 2010 4:31 PM
To: Underhill, Jeff
Subject: FW: PSNH BART Modeling with CALPUFF

Hi again, Jeff. FYI, here are some communications that I've been having with Anne McWilliams.

Dave

-----Original Message-----
From: mcwilliams.anne@epamail.epa.gov
[mailto:mcwilliams.anne@epamail.epa.gov]
Sent: Friday, April 16, 2010 4:22 PM
To: Healy, David
Subject: RE: PSNH BART Modeling with CALPUFF

Hi Dave,

Many of the BART visibility protocols call for the visibility change expected on the 8th highest 24 hr visibility impact day (98th percentile) due to the installation of control. This value was used in conjunction with the use of 3 yrs of meteorology. In discussions with Maine and Massachusetts, we have discussed using the change in visibility due to installation of controls on highest impacted day when only using 1 yr of meteorology. However, several of the sources still included the change in visibility impact for the 8th highest visibility impacted day.

Anne

Anne McWilliams
Air Quality Planning
EPA - New England
Tel: 617 918-1697
Fax: 617 918-0697

Mailing Address:

EPA Region 1
Five Post Office Square - Suite 100
Mail Code - OEP05-02
Boston, MA 02109-3912

United States Department of the Interior
NATIONAL PARK SERVICE
Air Resources Division
P.O. Box 25287
Denver, CO 80225

TAKE PRIDE® IN AMERICA

IN REPLY REFER TO:

December 20, 2010

N3615 (2350)

Jeffrey T. Underhill, Chief
Atmospheric Science & Analysis
NHDES Air Resources Division
29 Hazen Drive; PO Box 95
Concord, New Hampshire 03302-0095

Dear Mr. Underhill:

In June 2009, the National Park Service provided comments on New Hampshire Department of Environmental Services' (NHDES) determination of Best Available Retrofit Technology (BART) for Public Service New Hampshire's (PSNH) Merrimack Station Unit MK2. In January 2010, NHDES submitted a final State Implementation Plan for regional haze and BART determination for PSNH Merrimack Station Unit MK2. In February 2010, the Environmental Protection Agency (EPA) Region 1 determined that NHDES's BART determination for Merrimack Station was incomplete and returned that portion of the SIP to NHDES to be revised to meet the BART requirements. NHDES provided notice to the National Park Service on November 22, 2010, that the revised SIP was available for public comment. Our comments here are provided in consultation with the Fish and Wildlife Service and are in response to the revised BART determination for PSNH Merrimack Station.

We disagree with the methods used by NHDES to demonstrate the visibility response to BART controls at PSNH Merrimack Station. In the CALPUFF model, natural background visibility conditions are to be used to evaluate the visibility impacts from the BART source at Class I receptors. Natural background visibility conditions are to be used with current emissions from the source and again when comparing visibility benefits of alternative emissions control options. The Federal Land Managers (FLMs) have recommended to the northeastern states that since only one year of meteorological data is being modeled, the 20% best natural background visibility conditions should be used in the analysis. The maximum impact value at the Class I area receptors should be used to determine the visibility impact of the source before control and assuming control installation. If three years of meteorological data are processed with observational data, the FLMs have recommended that the annual average of the natural background visibility conditions can be used in the comparison with the 8^{th} highest impact value in each year to determine the source's visibility impact. NHDES has incorrectly used the 20% worst days from current visibility conditions to evaluate the benefits of controls at Merrimack Station. Instead, the 20% best natural background visibility condition and the maximum visibility impact on any day should be used to evaluate the benefits of controls. NHDES' approach is not appropriate and does not meet the BART modeling guidance. Since the maximum impact of the source may actually be on a good visibility day, and since the objective is to compare the source impact to clean natural background visibility conditions, the analysis of the visibility impact of controls at Merrimack Station is not acceptable and needs to be redone.

We appreciate the opportunity to work closely with NHDES on the development and review of your plans to improve visibility in our Class I national parks and wilderness areas. For further information regarding our comments, please contact Tim Allen of Fish and Wildlife Service at (303) 914-3802 or Pat Brewer of my staff at (303) 969-2153.

Sincerely,

John Bunyak

John Bunyak
Acting Chief, Air Resources Division

cc: Karla McManus
NH Dept. of Environmental Services
29 Hazen Drive; PO Box 95
Concord, NH 03302-0095

Anne McWilliams
U.S. EPA Region 1
5 Post Office Square
OEP05-2
Boston, MA 02109-3912

01-14-11

New Hampshire Regional Haze SIP Revision
Responses to Federal Land Managers' Comments

On December 20, 2010, the New Hampshire Department of Environmental Services (NHDES) received written comments from the U.S. Department of the Interior, National Park Service (NPS) regarding the November 19, 2010, draft final revision of New Hampshire's Regional Haze SIP. These comments were provide in consultation with the U.S. F … vere in response to the revised Best Available Retrofit Technology … ;NH Merrimack Station Unit MK2. The following is NHDES' … ents. **Comments are reproduced in *italics* and the response app…**

Response to FLM's Comments 01-14-11 5

<u>NPS Comments</u>: *We disagree with the methods used by NHD… y response to BART controls at PSNH Merrimack Station. In th… background visibility conditions are to be used to evaluate the … ART source at Class I receptors. Natural background visibility conditions are to be used with current emissions from the source and again when comparing visibility benefits of alternative emissions control options. The Federal Land Managers (FLMs) have recommended to the northeastern states that since only one year of meteorological data is being modeled, the 20% best natural background visibility conditions should be used in the analysis. The maximum impact value at the Class I area receptors should be used to determine the visibility impact of the source before control and assuming control installation. If three years of meteorological data are processed with observational data, the FLMs have recommended that the annual average of the natural background visibility conditions can be used in the comparison with the 8th highest impact value in each year to determine the source's visibility impact. NHDES has incorrectly used the 20% worst days from current visibility conditions to evaluate the benefits of controls at Merrimack Station. Instead, the 20% best natural background visibility condition and the maximum visibility impact on any day should be used to evaluate the benefits of controls. NHDES' approach is not appropriate and does not meet the BART modeling guidance. Since the maximum impact of the source may actually be on a good visibility day, and since the objective is to compare the source impact to clean natural background visibility conditions, the analysis of the visibility impact of controls at Merrimack Station is not acceptable and needs to be redone.*

- <u>NHDES Response</u>: In the current revision of the SIP, NHDES has addressed the technical issues raised by NPS, which arose from a misinterpretation of the guidance by NHDES. Please refer to "New Hampshire Regional Haze SIP Revision, Responses to EPA's Comments." In particular, please see the CALPUFF Modeling Assessment, included as an attachment to that response document.