COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENERGY & ENVIRONMENTAL AFFAIRS
DEPARTMENT OF ENVIRONMENTAL PROTECTION
ONE WINTER STREET, BOSTON, MA 02108 617-292-5500

DEVAL L. PATRICK
Governor

TIMOTHY P. MURRAY
Lieutenant Governor

IAN A. BOWLES
Secretary

LAURIE BURT
Commissioner

Final
Massachusetts State Implementation Plan To Demonstrate Attainment of the National Ambient Air Quality Standard for Ozone

January 31, 2008

This information is available in alternate format. Call Donald M. Gomes, ADA Coordinator at 617-556-1057. TDD Service - 1-800-298-2207.

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Massachusetts State Implementation Plan To Demonstrate Attainment of the National Ambient Air Quality Standard for Ozone

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Acronyms and Abbreviations

ACT	Alternative Control Techniques
AIM	Architectural and Industrial Maintenance
ASM	2525 Accelerated Simulation Mode Vehicle Emissions Test (25 mph/25% Load)
BEIS-3	Biogenic Emission Inventory System (Version 3.0)
BOTW	Beyond on the Way (controls)
BTU	British Thermal Unit
CAA	Clean Air Act
CAIR	Clean Air Interstate Rule
CALEV	California Low Emission Vehicle Program
CAP	Criteria Air Pollutants
CARB	California Air Resources Board
CASTNet	Clean Air Status and Trends Network
CE	Control Efficiency
CFR	Code of Federal Regulations
CI	Compression Ignition
CMAQ	EPA's Models-3/Community Multi-scale Air Quality Modeling System
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CTG	Control Technique Guideline
DV	Design Value
DV_B	Baseline Measured Concentration
DV_F	Estimated Future Design Value
DVMT	Daily Vehicle Miles Traveled
EGU	Electric Generating Unit
EPA	Environmental Protection Agency
FHWA	Federal Highway Administration
FHWA CMAQ	Federal Highway Congestion Mitigation and Air Quality
FIP	Federal Implementation Plan
FMVCP	Federal Motor Vehicle Control Program
FR	Federal Register
FY	Fiscal Year
GVWR	Gross Vehicle Weight Rating
HC	Hydrocarbon
HEDD	High Electrical Demand Day
hp	Horsepower
HOV	High-Occupancy Vehicle
ICI	Industrial/Commercial/Institutional
I/M	Inspection and Maintenance
ISO-NE	Independent Systems Operator – New England
LEV	Low Emission Vehicle
LPG	Liquid Propane Gas
MassDEP	Massachusetts Department of Environmental Protection
MACT	Maximum Available Control Technology
MANE-VU	Mid-Atlantic/Northeast Visibility Union
MARAMA	Mid-Atlantic Regional Air Management Association

MHD	Massachusetts Highway Department
MISER	Massachusetts Institute for Social and Economic Research
MM5	Mesoscale Meteorological Model
MMBtu	Million British Thermal Units
MNGE	Mean Normalized Gross Error
MNB	Mean Normalized Bias
MOU	Memorandum of Understanding
MOBILE6.2	EPA's On-Road Mobile Source Emissions Estimation Model
MPO	Metropolitan Planning Organization
MVEB	Motor Vehicle Emission Budgets
MW	Megawatt
MWh	Megawatt Hour
MWC	Municipal Waste Combustor
NAICS	North American Industrial Code System
NAAQS	National Ambient Air Quality Standards
NARSTO	North American Research Strategy for Tropospheric Ozone
NEI	National Emissions Inventory
NIF	NEI Input Format
NESCAUM	Northeast States for Coordinated Air Use Management
NH3	Ammonia
NLEV	National Low Emission Vehicle Program
NO	Nitrogen Oxide
NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
NONROAD	EPA's Non-Road Emissions Estimation Model 2005 Version
NSR	New Source Review
NYSDEC	New York State Department of Environmental Conservation
OBD-II	On-Board Diagnostics – Phase 2
OEM	Original Equipment Manufacturer
ORVR	Onboard Refueling Vapor Recovery
OTC	Ozone Transport Commission
OTAQ	Office of Transportation and Air Quality (EPA)
OTB	On the Books (controls)
OTB/W	On the Books/On the Way (Post 2009 controls)
OTR	Ozone Transport Region
PAMS	Photochemical Assessment Monitoring Station
PEI	Periodic Emission Inventory
PFC	Portable Fuel Container
PM	Particulate Matter
$PM_{2.5}$	Fine Particulate Matter (particles with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers)
PM_{10}	Particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers
ppb	Parts per billion
ppm	Parts per million
PV	Pressure Vacuum
RACM	Reasonably Available Control Measure

RACT	Reasonably Available Control Technology
RE/RP	Rule Effectiveness/Rule Penetration
RFG	Reformulated Gasoline
RFP	Reasonable Further Progress
RH	Regional Haze
RI	Rhode Island
ROP	Rate of Progress
RPO	Regional Planning Organization
RRF	Relative Response Factor
RRF	Resource Recovery Facility
RVP	Reid Vapor Pressure
SCAQMD	South Coast Air Management Quality District
SI	Spark Ignition
SIP	State Implementation Plan
SLAMS/ NAMS	State & Local Air Monitoring System and National Air Monitoring System
SMOKE	Sparse Matrix Operator Kernel Emissions
SO_2	Sulfur Dioxide
STIP	Statewide Transportation Improvement Program
SUV	Sport Utility Vehicle
TCM	Transportation Control Measure
TDM	Travel Demand Model
TIP	Transportation Improvement Program
TNMOC	Total Non-Methane Organic Carbon
TPSD	Tons per summer day
TPWD	Tons per winter day
TPY	Tons per year
TSD	Technical Support Document
UMD	University of Maryland at College Park
USEPA	United States Environmental Protection Agency
VMT	Vehicle Miles Traveled
VOC	Volatile Organic Compound
WOE	Weight-of-Evidence

SECTION 1 INTRODUCTION AND BACKGROUND

1.1 Summary and Purpose of Document

The Massachusetts Department of Environmental Protection (MassDEP) is submitting this *State Implementation Plan (SIP) to Demonstrate Attainment of the National Ambient Air Quality Standard for Ozone* to the U.S. Environmental Protection Agency (EPA) to demonstrate that the Eastern Massachusetts nonattainment area (EMA) and the Western Massachusetts nonattainment area (WMA)[1] will attain the National Ambient Air Quality Standard (NAAQS) for ozone by the end of the 2009 ozone season. MassDEP relies on modeling to demonstrate that both areas will attain the standard by this date, supplemented by additional evidence that further supports this conclusion. MassDEP also demonstrates that by 2008, EMA and WMA will achieve Reasonable Further Progress (RFP) towards attainment of the ozone standard.

This submission includes the 2002 Massachusetts Base Year Emissions Inventory, which estimates Massachusetts 2002 in-state emissions of pollutants that contribute to ozone formation. The inventory serves as the base year for estimating emissions in 2008 and 2009, as required for the RFP and attainment demonstrations. MassDEP has also included 2012 emissions projections to demonstrate that emissions from Massachusetts sources will continue to decrease in subsequent years.

To meet RFP and attainment requirements, MassDEP has adopted, or is committing to adopt, new control measures to reduce the emissions of volatile organic compounds (VOCs) and nitrogen oxides (NOx) that contribute to the formation of ozone. New measures include NOx controls on electric generating units and other large boilers under the Massachusetts Clean Air Interstate Rule (Mass CAIR) and tighter emission controls for certain sources of VOCs. Existing MassDEP and numerous federal measures will also result in continued reductions of these pollutants.

This submittal addresses ozone standard requirements for the adoption of Reasonably Available Control Technology (RACT) for sources subject to RACT requirements. MassDEP is adopting regulations to tighten its existing RACT standards for certain source sectors. For the Municipal Waste Combustor RACT source sector, MassDEP commits to do additional analysis. For other RACT sectors, it concludes that existing RACT meets the ozone standard requirements.
In addition to RACT, MassDEP has reviewed other potential control measures based on EPA's criteria for adoption of Reasonably Available Control Measures (RACM). MassDEP concludes that there are no other RACM that could be adopted in Massachusetts that would result in attainment in either EMA or WMA earlier than 2009.

The submittal demonstrates that EMA and WMA have contingency measures in place that will result in additional reductions in ozone precursor emissions if, despite the RFP and attainment demonstrations that are made in this SIP, either area fails to meet its RFP or attainment

[1] The counties in EMA are: Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Worcester, Suffolk, Plymouth and Norfolk. The counties in WMA are: Hampden, Hampshire, Berkshire and Franklin. For a map of the two areas see Section 5, *Attainment Demonstration*, page 2, Figure AD1.

requirements. The additional reductions will be achieved without further state or federal action, as EPA requires.

This submittal includes on-road mobile source Transportation Conformity Budgets for EMA and WMA for the 2008 RFP year and for the 2009 attainment demonstration year.

1.2 Ozone Formation and Health Impacts

Ground level (tropospheric) ozone is formed when NOx, VOCs and to a lesser extent, carbon monoxide (CO), interact in the presence of sunlight. NOx and VOCs, the primary ozone precursors, are emitted into the air from many human activities, including power plants, industrial boilers, automobiles, and consumer and industrial products. VOCs are also emitted from vegetation. Ozone and ozone precursors are often transported into Massachusetts from pollution sources in other states. Variability in weather patterns contributes to yearly differences in the magnitude and frequency of ozone concentrations.

Ozone has adverse effects on human health. It can irritate the respiratory system, causing wheezing and coughing, and irritate the eyes and nose. Ozone can affect lung function, reducing the amount of air that can be inhaled and limiting the maximum rate of respiration, even in healthy individuals. Exposure to ozone can also increase the frequency and severity of asthma attacks, resulting in more emergency room visits, medication treatments and lost school or workdays. Other possible short-term effects from exposure to high levels of ozone include aggravation of symptoms of emphysema, bronchitis and chronic obstructive pulmonary disease and increased susceptibility to respiratory infections. Health studies raise the concern that repeated short-term exposure to ozone might lead to permanent damage in lung function, especially in children. Recent analysis of health research in the U.S. and Europe has also found a strong linkage between increases in ozone and risk of premature death. Recent studies also indicate that ozone may contribute to cardiac morbidity. These relationships indicate that the costs and health consequences of not reducing ozone pollution are far higher than previously realized.

1.3 1-Hour Ozone NAAQS

In 1979, EPA adopted a NAAQS for ozone set at 0.125 parts per million (ppm) averaged over a 1-hour period (the 1-hour ozone standard). Nonattainment areas were required to adopt programs to attain the standard by 1987. Massachusetts violated the 1-hour ozone standard and, as required by the Federal Clean Air Act (CAA) and EPA regulations, adopted regulations and programs to reduce emissions of ozone-precursors. Despite significant improvement in measured ozone levels, Massachusetts (along with many other areas) continued to violate the 1-hour ozone standard throughout the 1980s.

The 1990 CAA Amendments required EPA to classify ozone nonattainment areas as marginal, moderate, serious, severe or extreme and imposed new control requirements. EPA classified EMA and WMA as “serious” nonattainment areas. (56 FR 56694, November 6, 1991) Massachusetts adopted additional measures to reduce emissions of ozone precursors during the

1990s and submitted numerous SIP revisions to EPA documenting its progress towards attainment. In 1998, MassDEP submitted to EPA a SIP demonstrating that WMA would attain the 1-hour ozone standard by the end of 2003. In 2002, it submitted a SIP demonstrating that EMA would attain the standard by 2007.
As of June 15, 2005, EPA revoked the 1-hour standard as part of its implementation of the new 8-hour ozone standard. Therefore, areas are no longer required to monitor 1-hour ozone levels.

1.4 8-Hour Ozone NAAQS

In 1997, based on studies that indicated that longer-term exposures to lower ozone concentrations cause adverse health effects, EPA issued a new standard set at 0.08 ppm averaged over eight hours (the 8-hour ozone standard).[2] In 2001, following legal challenges to the new standard, the U.S. Supreme Court upheld the standard. In 2004, EPA designated every county in the U.S. as attainment, non-attainment or unclassifiable and classified 8-hour ozone standard nonattainment areas according to the severity of their ozone violations. EMA and WMA are classified as moderate non-attainment areas under the 8-hour standard, based on monitored ozone readings for the 2001 – 2003 period. (69 FR 23858, April 15, 2004)

EPA promulgated implementation rules for the 8-hour ozone Standard in two phases; Phase 1 was promulgated on April 30, 2004 (the Phase 1 Rule)[3] and Phase 2 was promulgated on November 29, 2005 (the Phase 2 Rule).[4] The Phase 2 Rule requires that areas submit to EPA by June 15, 2007, a SIP demonstrating attainment by the end of the 2009 ozone season (the year prior to the June 15, 2010 attainment deadline) and demonstrating emission reductions by 2008 sufficient to establish that they are making Reasonable Further Progress (RFP) towards attainment. The Phase 2 rule also requires that areas submit a SIP addressing 8-hour ozone RACT requirements.

The SIP for moderate nonattainment areas must include the elements listed below. This SIP submittal addresses all of the required elements in the Sections noted.

- Reasonable Further Progress (RFP) demonstration of a 15% reduction in in-state VOC and/or NOx emissions within 6 years after the baseline year of 2002 (e.g., by 2008). (Section 4)
- Attainment demonstration that uses modeling and other technical analyses to demonstrate that attainment of the 8-hour NAAQS is projected by the end of the 2009 ozone season. (Section 5)
- Reasonably Available Control Technology (RACT) for RACT source sectors and for major sources of VOC and NOx . (Section 6)
- Reasonably available control measures (RACM) for all sources. (Section 7)

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[2] The 8-hour ozone standard is met when the 3-year average of the 4th-highest daily maximum 8-hour average does not exceed 0.08 parts per million (ppm) at any one monitor (effectively, 0.084, given accepted rounding conventions).
[3] *Final Rule to Implement the 8-Hour Ozone National Ambient Air Quality Standard - Phase 1,* 69 FR 23951 April 30, 2004.
[4] *Final Rule to Implement the 8-Hour Ozone National Ambient Air Quality Standard – Phase 2,* 70 FR 71612, November 29, 2005.

- Contingency measures to be implemented upon failure to meet RFP or attainment milestones. (Section 8)
- Transportation conformity budgets for RFP milestone and attainment years. (Section 9)
- Inspection and Maintenance (I/M) program for light-duty motor vehicles. (Adopted in Massachusetts under the 1-hour ozone standard; see Appendix 3A)
- Stage II vapor recovery for gas stations. (Adopted in Massachusetts under the 1-hour ozone standard; see Appendix 3A)
- New Source Review (NSR) program for major sources, including offsets for VOC and NOx at a 1.15 to 1 ratio and a permit program for new or modified sources. (Adopted in Massachusetts under the 1-hour ozone standard; see Appendix 3A)

In December 2006, the U.S. Court of Appeals for the D.C. Circuit issued a ruling vacating EPA's Phase 1 rule, holding that parts of the rule violated provisions of the CAA. On June 8, 2007, the Court clarified its decision stating that it was vacating only parts of the rule, while leaving other sections in effect. It urged EPA to promptly promulgate a revised rule. It is unclear how the future resolution of this litigation may impact 8-hour ozone SIP requirements. This SIP is based on the requirements of the published EPA rule that remain in effect and a memo from EPA concerning the implications of the June 15, 2007 opinion of the court.[5] Revisions to this SIP may be required upon resolution of the litigation and/or promulgation by EPA of a revised implementation rule.

1.5 Massachusetts 8-Hour Ozone NAAQS Compliance

In Section 5, *Attainment Demonstration*, MassDEP has demonstrated through modeling that EMA and WMA will attain the 8-hour ozone standard in 2009. The modeling for EMA and WMA shows that ozone concentrations will be 0.084 parts per million, or lower, at all monitors in 2009 (see Section 5, Table AD 9). MassDEP has provided evidence, in addition to the modeling, that further supports its expectation that Massachusetts will attain the standard statewide by 2009.

However, in addition to demonstrating attainment in the attainment year through modeling, monitored ozone concentrations in EMA and WMA must actually meet the standard in the attainment year. As noted in footnote 2, ozone design values are based on a 3-year average of the 4th highest monitored reading. In 2007, Massachusetts (and other Northeast States) had a number of days when monitored ozone concentrations exceeded the concentrations recorded in recent years. As a consequence, for the 2005–2007 period, two monitors in WMA have 3-year averages exceeding the 8-hour standard: Chicopee (0.092 ppm) and Ware (0.087 ppm). In EMA, one monitor (Blue Hill - 0.086 ppm) exceeded the standard during the 2005-2007 period.

When EPA makes its determination whether to approve this SIP, it will consider whether EMA and WMA are monitoring ozone concentrations that are consistent with the modeled attainment demonstration that forms the basis of Section 5, *Attainment Demonstration*. EPA will consider

[5] U.S. EPA, Memorandum from Robert J. Meyers, Acting Assistant Administrator, June 15, 2007, *Decision of the U.S. Court of Appeals for the District of Columbia Circuit on our Petition for Rehearing of the Phase 1 Rule to Implement the 8-Hour Ozone NAAQS.*

the most recent 3-years of monitored data that is available, including data for 2007, 2008 and possibly 2009, depending on when EPA proposes action concerning this submission.

MassDEP is confident that the monitors that are only slightly over the standard for the 2005-2007 period will meet the standard by the 2009 attainment year because of the substantial emission reductions that will take place prior to that date. However, the monitor in Chicopee in WMA had 4th- high readings of 0.90 ppm in 2006 and 0.98 ppm in 2007. Therefore, there is a significant risk that the Chicopee monitor will not monitor attainment in the 2006 – 2008 and 2007-2009 periods.[6]

MassDEP expects that if the Chicopee monitor is not in attainment for the 3-year period on which EPA bases its determination, WMA will meet the criteria to be eligible for a 1-year extension of the attainment date in 2009.[7] Massachusetts, and upwind states, will continue to achieve ozone precursor emission reductions after 2009[8] and additional reductions will be realized by the 2010 ozone season. Therefore, if WMA does not attain the standard in 2009, the likelihood that it will reach attainment in 2010 is high.

High ozone concentrations in WMA are generally attributable to ozone transport from Connecticut and other states directly upwind of the WMA monitors. Ozone transport is especially problematic on days when high electricity demand can dramatically increase emissions for electric generation (High Electric Demand Days – HEDD). HEDD emissions often occur during the meteorological conditions most conducive to producing the highest levels of ozone.[9]

Mindful of the HEDD problem, the states of Connecticut, New York and New Jersey, Pennsylvania, Delaware and Maryland entered into an Ozone Transport Commission Memorandum of Understanding to address this problem. These states have committed to a variety of energy efficiency and other strategies that will reduce HEDD emissions. Massachusetts did not enter into that MOU, but MassDEP continues to review the potential for HEDD strategies, including energy efficiency and demand response on peak demand days, for

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[6] This 4th-highest reading (.098 ppm), which occurred on August 30, was highly unusual for so late in the season. As discussed in Section 5, *Attainment Demonstration*, Subsection 5.19.5, this high concentration may be attributable to two factors: an unusual weather pattern and the presence of smoke from distant forest fires.

[7] Under EPA's Phase 1 ozone implementation rule, an area with a 2009 attainment year is eligible for a one-year extension of its attainment deadline if, in 2009, its 4th highest ozone reading is 0.084 ppm or less. An area that has received the first of the 1-year extensions under the 8-hour standard would be eligible for a *second* extension if the area's 4th highest daily 8-hour value, averaged over both the original attainment year and the first extension year, is 0.084 ppm or less. The unusual nature of the high concentrations that occurred in WMA in 2007 supports MassDEP's expectation that the 4th highest reading in WMA in 2009 is likely to be less than 0.084 ppm and that WMA will be eligible for an extension of its attainment year in 2009.

[8] Modeling conducted for 2012 projects MA ozone concentrations at levels considerably below the projected 2009 values. See Section 5.19.4, *2012 Future Year Simulation*.

[9] For WMA, the most favorable meteorological conditions for ozone production include high temperatures on sunny summer days, with lower level transport winds from the southwest and upper level transport winds from the west, regions that produce significant emissions from electric generating units

Massachusetts sources. Given the risk that WMA may fail to attain the standard by 2009, MassDEP is participating as an observer in the Connecticut process to review HEDD strategies that will reduce emissions that impact WMA on HEDDs.

1.6 Public Review Process

A proposed version of this SIP was made available for public review and comment more than 30 days prior to the public hearings that were held in Boston and Springfield on January 18, 2008. Comments on the proposed SIP were submitted to MassDEP from U.S. EPA and other interested parties. The commenters, a summary of the comments received, and MassDEP's responses thereto, are in the *Response To Comments* that is being submitted to EPA with the final Ozone SIP. EPA will undertake a review of this final Ozone SIP and decide whether to approve it. EPA will provide notice and opportunity for public review of any action it proposes to take in this regard.

SECTION 2 EMISSIONS INVENTORIES

2.1 Purpose of Section

The CAA and EPA regulations require that states compile estimates of certain air pollutants emitted from sources within their borders. States with moderate or above ozone nonattainment areas must prepare emission inventories of VOCs, NOx and CO every three years and must include the latest inventory of these pollutants in their attainment demonstration SIP. *The Massachusetts 2002 Base Year Emissions Inventory – September 2007* (MA 2002 Base Year Inventory, Appendix 2A to this document) satisfies the inventory requirements for the EMA and WMA ozone nonattainment areas. This Section provides a brief summary of the Mass 2002 Base Year Inventory results.

For the purposes of showing the overall downward trend of emissions in Massachusetts, this Section also provides a summary of the 2008 projections developed to demonstrate RFP (See Section 4, *Reasonable Further Progress*), the 2009 projections used in the ozone attainment modeling (See Section 5, *Attainment Demonstration*) and summary of projected emissions in 2012.

2.2 2002 Base Year Inventory Pollutants

The MA 2002 Base Year Inventory estimates in-state emissions of the following pollutants as of 2002: VOCs, NOx, CO, particulate matter (PM[1]), ammonia (NH_3) and sulfur dioxide (SO_2). In addition to meeting the inventory requirements for ozone nonattainment areas, the inventory meets the requirements of EPA's 2002 Consolidated Emissions Reporting Rule (CERR). The CERR requires that, irrespective of a state's NAAQS attainment status, every three years it must develop and update a single, statewide annual inventory of the following pollutants: VOCs, NOx, CO, PM, NH_3 and SO_2. The MA 2002 Base Year Inventory estimates annual emissions of pollutants from all source sectors in the state, as required by the CERR.

Because high ozone concentrations are generally associated with warmer weather and emissions may vary seasonally, the inventory also includes emissions estimates of VOCs, NOx, and CO on a ton per summer day (TPSD) basis.

A June 2006 version of the MA 2002 Base Year Inventory was available for informal public review on MassDEP's website from July 2006 through October 2007. The September 2007 version (Appendix 2A) makes minor revisions to the *Introduction* of the June 2006 version, (Section 1), and includes methodology changes for Section 3.3-2, *Surface Cleaning/Degreasing* and Section 3.3-7, *Cutback and Emulsified Asphalt Paving.* It also adds a section estimating emissions from *Adhesives and Sealants*. The complete MA 2002 Base Year Inventory - September 2007 is part of this Massachusetts 8-Hour Ozone Attainment Demonstration SIP; it is available on MassDEP's web site at: http://mass.gov/dep/air/priorities/aqdata.htm. It contains extensive

1 The inventory includes estimates of both PM_{10} and $PM_{2.5}$. PM_{10} refers to particles equal to or smaller than 10 micrometers in diameter. $PM_{2.5}$ refers to particles equal to or smaller than 2.5 micrometers in diameter.

narrative explaining the methodology for development of the inventory and the extensive data files supporting the emission estimates.

2.3 2008 and 2009 Projected Inventories

In addition to calculating emissions in the base year, nonattainment areas must also estimate emissions in future milestone years. For purposes of demonstrating RFP towards attainment, areas must project emissions for the RFP milestone year – 2008 for EMA and WMA. EPA's Phase 2 Rule established 2002 as the base year for demonstrating compliance with the 8-hour ozone standard RFP requirements. For purposes of RFP, areas may take credit for reductions that occur subsequent to 2002, but before their RFP milestone year. (The methodology for developing the 2008 projections is discussed in Section 4, *Reasonable Further Progress.)*

To demonstrate attainment, areas must project emissions in the attainment year for use in their modeled attainment demonstration. For attainment demonstration purposes, EPA recommended, but did not require, that states use 2002 as the baseline year for their attainment demonstration modeling. MassDEP is using 2002 as its base year for the 2009 regional attainment modeling, as discussed in Section 5, *Attainment Demonstration*. (The methodology for developing the 2009 projections is also discussed in Section 5.)

2.4 2012 Projected Inventory

Massachusetts is not required to estimate emissions in years subsequent to its 2009 attainment year for 8-hour ozone purposes. However, to comply with the requirements of an EPA rule related to Regional Haze,[2,] the Mid-Atlantic/Northeast Visibility Union (MANE-VU)[3] developed emissions estimates for 2012 for all states in the MANE-VU region, including Massachusetts. Because these 2012 estimates[4] are available, MassDEP has included them in Table 2.1 below in order to demonstrate the continued downward trend in Massachusetts' emissions.

2.5 Emissions Inventory Trends

Table EI -1 provides the statewide ozone season 2002 MA Base Year Inventory emissions of VOC and NOx by source sector and the projected emissions for each sector in 2008, 2009 and 2012. Figures 2-1 and 2-2 illustrate the reductions of VOCs and NOx that are projected to take place in Massachusetts by the 2008 milestone year for RFP, by the 2009 attainment demonstration milestone year, and by 2012. Note that because of different methods use to project emissions from the various

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2 EPA's Regional Haze Rule requires that states address regional haze and visibility impairment in Class 1 Federal areas (certain parks and wilderness areas). This is a separate EPA rule unrelated to ozone attainment.

3 The Mid-Atlantic and Northeastern states, tribes, and federal agencies formed MANE-VU to coordinate regional haze planning activities for the region.

4 Mid-Atlantic Regional Air Management Association, *Development of Emission Projections for 2009, 2012 and 2018 for NonEGU Point, Area, and Nonroad Sources in the MANE-VU Region, Final Report*, February 2007. www.marama.org/visibility/Inventory%20Summary/FutureEmissionsInventory.htm

sectors in the three projection years, estimates are only roughly comparable. As noted above, the methods used to develop the 2008 and 2009 are discussed in Sections 4 and 5.

Table EI - 1 MA 2002 Emissions and Projections for 2008, 2009 and 2012****

STATEWIDE Tons per summer day	2002 Base Year VOC	VOC 2008 Projected	VOC 2009 Projected	VOC 2012 Projected	2002 Base Year NOx	NOx 2008 Projected	NOx 2009 Projected	NOx 2012 Projected
Point EGU	1.5	1.4	1.4	1.5	82.8	37.3	56.0	56.0
Point Non-EGU	14.5	15.0	15.2	16.5	46.8	48.4	47.7	49.5
POINT TOTAL	16.0	16.4	16.6	18.0	129.6	85.8	103.7	105.5
AREA	327.6	332.4	277.9	268.3	39.1	44.0	44.5	45.3
ON-ROAD***	151.9	80.1	74.2	56.2	453.1	222.6	202.7	132.4
OFF-ROAD	223.8	178.9	171.6	159.8	144.6	128.4	124.3	105.8
TOTAL	**719.3**	**607.7**	**540.3**	**502.3**	**766.3**	**480.7**	**475.2**	**389.0**

** As discussed in Section 5, *Attainment Demonstration*, 2009 projections used in attainment modeling are based on: 1) Appendix 5L – *Development of Emission Projections for NonEGU Point, Area and Nonroad Sources in the MANE-VU Region*, prepared by MACTEC Federal Programs, Inc., February 2007; 2) Mobile Source emissions developed by NESCAUM, with Mobile 6.2 inputs provided by the states; and 3) Integrated Planning Model (IPM) runs for EGU emissions (see List of References – Reference #8 re: IPM runs). 2012 EGU projections are also based on IPM runs.

IPM projections are for the May - September ozone season. MassDEP has derived a tons per summer day estimate from the IPM ozone season estimate (ozone season emissions/153 days.)

*** On-Road Mobile projections are based on the estimates developed for the 2008 and 2009 Conformity Budgets (described in Section 9, *Transportation Conformity).* For 2012, MassDEP extrapolated from the 2009 projections.

File: rfp-2002-12-trends nov/21/2007

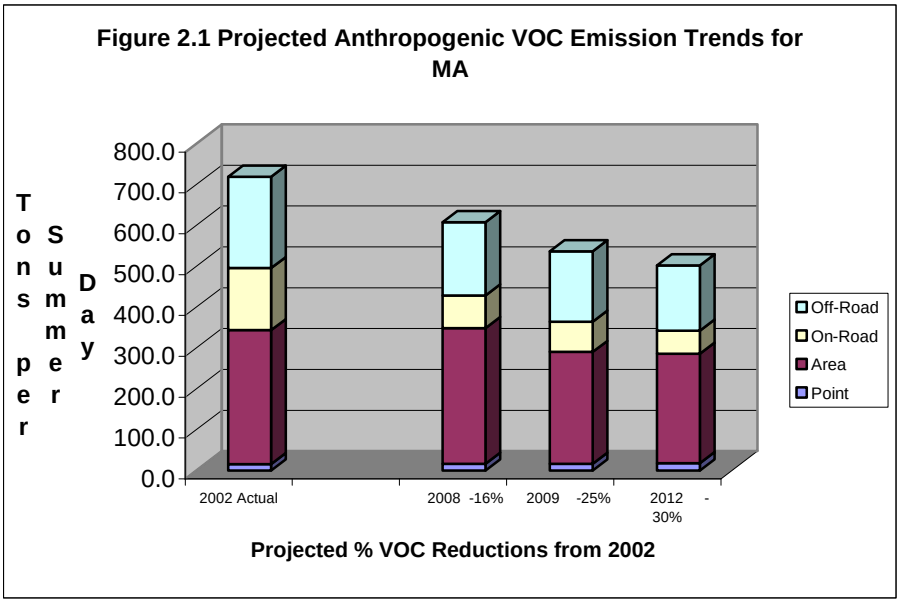
By 2008, MassDEP estimates that statewide emissions of VOCs during the summer ozone season (May –September) will decrease from 2002 levels by 16% and of NOx by 37%. As discussed in Section 4, *Reasonable Further Progress*, EMA and WMA are able to demonstrate that reductions of VOC and NOx by 2008 in each area will substantially exceed the required 15% reduction needed to demonstrate RFP toward attainment.

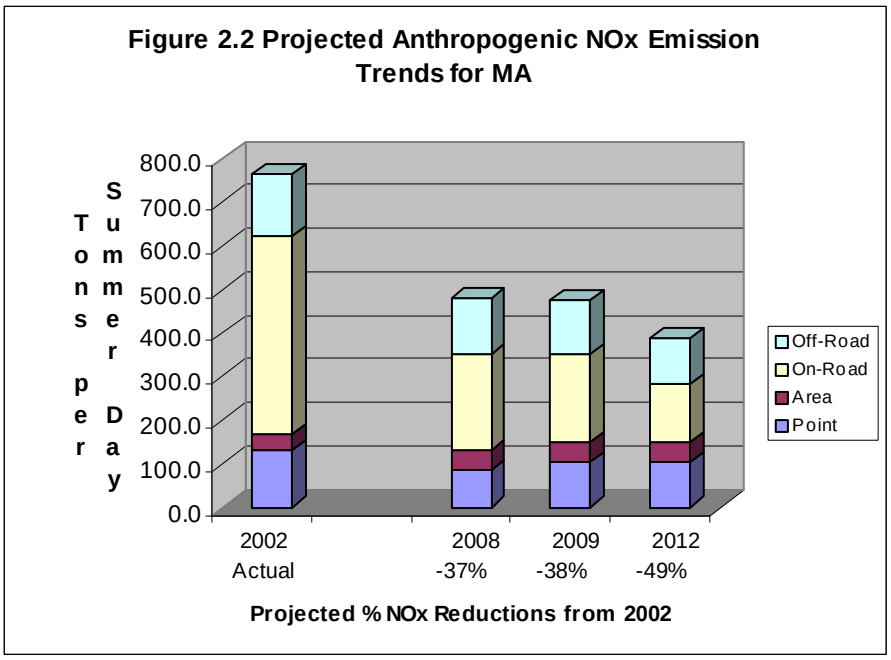
By 2009, MassDEP estimates that statewide emissions of VOCs during the summer ozone season will decrease from 2002 levels by 25% and of NOx by 38%. These reductions are the result of both existing and new Massachusetts and federal control measures. As discussed in Section 3, *Control Measures*, and Section 5, *Attainment Demonstration*, the 2009 projected emissions inventory[5] used in the OTC modeling process incorporates these anticipated reductions in Massachusetts.

By 2012, MassDEP estimates that statewide emissions of VOCs will decrease from 2002 levels by 30% and of NOx by 49%. These reductions will result from state and federal control measures already in effect and taken into account in the 2009 attainment demonstration. Additional reductions

5 It should be noted that the inventory data used in the attainment modeling is based on annual emissions (as discussed in Section 5), rather than summer ozone season emissions. Therefore, percentage reductions that are cited in Section 5 may differ from the estimates provided in this Section.

will continue to accrue from these measures and ensure that ozone concentrations will continue to decrease in years subsequent to the 2009 attainment demonstration year.





SECTION 3 CONTROL MEASURES

3.0 Purpose of Section

This Section identifies and briefly describes the Massachusetts and federal control measures that will result in reductions of VOCs and/or NOx emissions from Massachusetts sources by 2008, for purposes of demonstrating Reasonable Further Progress (RFP) towards attainment (Section 4, *Reasonable Further Progress)*, and by 2009, for purposes of demonstrating attainment of the ozone standard (Section 5, *Attainment Demonstration*). MassDEP has already promulgated regulations related to some of the measures for which it is taking credit in its RFP and attainment demonstrations. For other measures, it is committing to adopt regulations and submit them to EPA as SIP revisions, according to the schedule included in this Section.

The Massachusetts and federal control measures described in the narrative below are listed in Table CM 2, with the date of their effectiveness noted. The estimated reductions in VOC and/or NOx that the measures will achieve in the 2008 and/or 2009 milestone years in EMA and WMA are shown in Table CM 3.

3.1 Massachusetts Post -2002 Emissions Reductions

EMA and WMA are allowed to take credit for RFP and attainment demonstration purposes for emissions reductions of VOCs and/or NOx that will be achieved after the 2002 base year. Reductions may be from state or federal control measures already "on-the-books/on-the-way,"[1] provided that the reductions from such measures will take place after 2002, but before the years by which RFP and attainment must be demonstrated.

3.1.1 Massachusetts 1-Hour Ozone Standard SIP Measures

Generally, the reductions from control measures that were adopted as part of the 1-hour ozone standard attainment SIPs for EMA and WMA are already reflected in the MA 2002 Base Year Inventory. (The control measures adopted under the Massachusetts 1-hour ozone standard SIPs are listed in Appendix 3A, *MA 1-Hour Ozone Standard Control* M*easures*.) Therefore, no credit has been taken in the 2008 RFP analysis and 2009 attainment demonstration for 1-hour measures, with two exceptions: the Massachusetts Low Emission Vehicle (LEV) program and the Massachusetts NOx Budget Program. The LEV program (discussed in subsection 3.5.1) was adopted in 1995, but will continue to generate emission reductions in 2008 and 2009. The NOx Budget Program (discussed in subsection 3.5.2) was adopted in 1999, for implementation in the 2003-2008 ozone seasons. Therefore, the post-2002 reductions from these two "on-the-way" measures adopted in 1-hour ozone standard SIPs are taken into account in the 2008 RFP and 2009 attainment demonstrations.

[1] The term "on-the-books/on-the-way" was used during the Ozone Transport Commission (OTC) regional attainment process to describe control measures that states already expected to be in place by the 2009 8-hour attainment year; they are referred to in this Section as "on-the-way" measures. They are distinguished from the new control measures that the OTC recommended as an outcome of the regional 8-hour ozone standard attainment planning process.

3.1.2 New Massachusetts Control Measures

MassDEP is adopting new control measures that were not part of its 1-hour ozone standard SIP commitments. In addition to helping Massachusetts demonstrate attainment of the ozone standard in 2009, the new measures will:

1) Address Massachusetts'contribution to ozone non-attainment in other states;[2]
2) Meet Reasonably Available Control Technology (RACT) requirements (See Section 6, *RACT*); and
3) Reflect MassDEP's commitment to adopt additional controls along with other Ozone Transport Commission[3] (OTC) states pursuant to the regional 8-hour ozone standard attainment planning process.

The OTC recognized that some states within the OTC would not be able to attain the 8-hour ozone standard without more reductions than will be achieved under EPA's Clean Air Interstate Rule (CAIR) and other state and federal control measures expected to be in place by the 2009 attainment year. It recommended that OTC states adopt new or additional controls for a number of source categories.[4] The OTC went through a similar process under the 1-hour ozone standard and, in 2001, recommended new controls to help member states attain the 1-hour ozone standard. As part of its 8-hour ozone attainment strategy, MassDEP is adopting a number of 2001 and 2006 OTC recommended control measures, as discussed below (Sections 3.6.2 – 3.6.4).

3.1.3 Emissions from States Upwind of Massachusetts

Air quality in Massachusetts is significantly impacted by the transport of emissions from upwind states. However, nonattainment areas do not receive credit towards RFP for the reductions achieved in upwind states, even though such measures are likely to significantly improve downwind air quality. For attainment purposes, the modeling on which the attainment demonstration for EMA and WMA are based takes into account substantial emission reductions that will take place in upwind states by 2009, as discussed in Section 5, *Attainment Demonstration*.

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[2] MassDEP is simultaneously submitting to EPA the final *Massachusetts State Implementation Plan Revision to Meet Clean Air Act Section 110(a)(2)(D)(i) Interstate Air Pollution Transport Requirements (Transport SIP*), which demonstrates that Massachusetts sources are not contributing to nonattainment of the NAAQS for ozone or fine particles ($PM_{2.5}$) in areas that are located downwind of Massachusetts.

[3] Sections 184(a) and 176A of the CAA established the Northeast Ozone Transport Region (OTR) and the Ozone Transport Commission (OTC). The OTR is comprised of the District of Columbia, a portion of Northern Virginia, and the states of Maine, Vermont, New Hampshire, Massachusetts, Connecticut, Rohde Island, New York, Pennsylvania, New Jersey, Delaware, and Maryland. The CAA requires the OTC to assess the degree of interstate transport of ozone and its precursors throughout the OTR and recommend strategies to help the OTR meet the NAAQS for ozone.

[4] The OTC regional 8-hour ozone planning process is discussed in greater detail in Section 5, *Attainment Demonstration* and Section 7, *Reasonably Available Control Measures*.

3.2 Federal "On-the Way" On-Road Mobile Source Measures

EPA has promulgated federal regulations that will result in emission reductions from on-road vehicles in all states in future years. These federal on-road control measures, which are briefly described below (subsections 3.2.1 and 3.2.2), will result in significant emission reductions from mobile sources in EMA and WMA in 2008 and 2009. The 2008 and 2009 mobile source emissions estimates for EMA and WMA are based on EPA's MOBILE 6.2 model, which incorporates the benefits of all federal regulations that apply to the on-road mobile source sector. (Technical inputs to the Mobile 6.2 model runs are more fully described in Section 4, *Reasonable Further Progress* (for 2008) and Section 9, *Transportation Conformity* (for 2009). More information concerning the federal measures discussed below is available at EPA's website: http://www.epa.gov/otaq/hwy.htm.

3.2.1 Tier 2/Fuel Standards

In 2003, EPA adopted final rules requiring stricter tailpipe emission standards (Tier 2) for all new passenger vehicles, including cars, sport utility vehicles, minivans, vans, and pick-up trucks. At the same time that it promulgated the Tier 2 standards, EPA also promulgated a regulation lowering the sulfur content in gasoline over the 2004-2007 phase-in periods. The Tier 2 standards do not apply in Massachusetts, which has adopted the stricter California Low Emission Vehicle Program tailpipe standards discussed in Subsection 3.6.1 below. However, the low sulfur fuel requirements will reduce post-2002 motor vehicle emissions in EMA and WMA and are reflected in the MOBILE 6.2 model runs for 2008 and 2009.

3.2.2 Heavy-Duty Engine and Fuel Standards

In 2000, EPA published rules setting the first phase of more stringent NOx and hydrocarbon (HC) emission standards for heavy-duty diesel engines and vehicles starting with the 2004 vehicle model year. The rules also set tighter NOx and HC standards for heavy-duty gasoline engines and vehicles starting with the 2005 vehicle model year. (Standards vary by vehicle weight and fuel-type.) The rules requires that certain heavy-duty vehicles (HDVs) be equipped with on-board gasoline vapor recovery systems phased-in over 2004 – 2006 model year vehicles.

In 2001, EPA published a second phase of heavy-duty motor vehicle emission standards. The rule requires additional, significant reductions of NOx and HC (as well as particulate matter) emissions from heavy-duty engines and vehicles, beginning with vehicle model year 2007. It also requires lowering the sulfur content of diesel fuel to 15 parts per million (ppm) from previous levels of 500 ppm, beginning in 2006.

3.3 Federal "On-the-Way" Non-Road Mobile Source Measures

EPA has adopted national regulations that impose emission and fuel standards on new non-road engines. The non-road measures, which are discussed below (subsections 3.3.1 – 3.3.4), apply to engines such as those used in construction equipment, lawn and garden equipment, recreational vehicles, marine vessels, locomotives and aircraft. MassDEP estimated the emissions from the non-road source sector using EPA's NONROAD Model (version 2005A, Feb. 2006), which has built-in

growth factors and control factors for the federal measures. The federal controls will result in significant emission reductions from this source sector in EMA and WMA in the 2008 and 2009 milestone years. Additional information concerning these non-road measures below can be found at EPA's website at http://www.epa.gov/nonroad.

3.3.1 Non-Road Diesel Engine and Fuel Standards

EPA regulations establish four tiers of emission standards for new non-road diesel engines. Tier 1 emission standards were issued in 1994 for most large (greater than 50 horsepower (hp)), land-based non-road diesel engines used in agricultural and construction equipment. These were phased-in between 1996 and 2000. In 1998, EPA promulgated Tier 1 standards for smaller (< 50 hp) diesel engines, which were phased-in between 1999 and 2000. At that time, EPA also issued more stringent Tier 2 emission standards for all non-road diesel engine sizes, with a 2001- 2006 phase-in, and Tier 3 standards for new diesel engines between 50 and 750 hp, with a 2006 - 2008 phase-in.

In 2004, EPA promulgated regulations that integrate new non-road diesel engine emission standards (Tier 4 standards) with requirements to decrease the allowable levels of sulfur in non-road diesel fuel. The regulations set emission standards for engines used in most construction, agricultural, industrial, and airport equipment beginning in 2008. Fuel requirements will decrease the sulfur levels in non-road diesel fuel to prevent damage to emission-control systems. Current sulfur levels of about 3,000 ppm will be reduced to a maximum of 500 ppm in 2007. The second phase will reduce sulfur levels in non-road diesel fuel to 15 ppm in 2010, except for locomotive and marine diesel fuel, which will be reduced to 15 ppm in 2012.

3.3.2 Non-Road Spark Ignition (Gasoline) Engine and Fuel Standards

In 1995, EPA issued Phase 1 standards for model year 1997 and newer small (< 25 hp) non-road spark-ignited engines, which are used primarily in lawn and garden equipment. In 1999, EPA issued more stringent Phase 2 emission standards for small non-handheld engines (e.g., lawn mowers, generator sets, air compressors) and, in 2000, for small handheld engines (e.g., leaf blowers, chain saws, augers). Phase 2 standards were phased-in from 2001 to 2007 for non-handheld engines and from 2002 to 2007 for handheld engines.

In 1996, EPA finalized emission standards for new gasoline spark-ignition marine engines to be phased-in between 1998 and 2000. These engines are used for outboard engines, personal watercraft, and jet boats.

In 2002, EPA promulgated new engine emission standards for large spark-ignition engines rated over 19 kilowatts (kW), or >25 hp. These are used in a variety of commercial and industrial settings, including forklifts, electric generators, airport baggage transport vehicles, farming and construction. The standards were implemented in two tiers - Tier 1 started in 2004 and Tier 2 in 2007. EPA's 2002 rulemaking also include exhaust emission standards for engines in recreational vehicles including snowmobiles, off-highway motorcycles, and all-terrain-vehicles (ATVs). These standards are phased-in in 2006 and 2007, except for snowmobiles, which have until 2009 to be fully phased-in. Plastic fuel tanks and rubber hoses available on recreational vehicles will also be subject to permeation standards effective in 2008.

3.3.3 Marine Diesel Engines

In 1999, EPA promulgated regulations setting emission standards for certain classes of new commercial marine diesel engines starting in 2004 and for other classes in 2007. In 2002, EPA promulgated new emission standards for recreational marine diesel engines, which are used in yachts, cruisers, and other types of pleasure craft. The standards are phased-in, beginning in 2006, depending on the size of the engine. By 2009, emission standards will be in effect for all new recreational, marine diesel engines.

3.3.4 New Federal Portable Fuel Containers (PFCs) Regulation

In 2001, the OTC developed a model rule for reducing emissions for PFCs (gas cans) based on the California PFC regulation. The OTC developed a revised 2006 model rule for this category, based on revisions to the California regulation. MassDEP did not adopt a PFC regulation for 1-hour ozone standard purposes, but intended to do so as part of its 8-hour attainment strategy. However, in February 2007, EPA finalized a national regulation to reduce hazardous air pollutant emissions from mobile sources, which includes standards to reduce PFC emissions from evaporation, permeation, and spillage. The standards apply to containers manufactured on or after January 1, 2009. Emission reductions will be realized incrementally as consumers replace older PFCs with new ones. Because EPA's rule has been finalized with a 2009 effective date and will achieve reductions equivalent to the OTC model rule, MassDEP no longer intends to adopt a state rule for this category.

3.4 Massachusetts "On-the-Way" Control Measures

There are two control measures adopted in Massachusetts 1-hour ozone standard SIPS that continue to generate post-2002 emission reductions for which EMA and WMA can take credit in 2008 and/or 2009 - the Low-Emission Vehicle Program and the NOx Budget Program.

3.4.1 Low Emission Vehicle Program (LEV)

In 1990, Massachusetts adopted the California Low Emission Vehicle (LEV) standards for 1995 and later model year vehicles sold and registered in Massachusetts. The LEV standards now apply to all vehicles weighing up to 14,000 pounds, which must be certified to California emissions standards. Since the LEV Program was adopted in 1990, the Department has amended the LEV regulation to adopt: 1) the fleet-wide emission average for non-methane organic gases (NMOG); 2) the next generation of California emission standards known as "LEV II"; 3) the LEV I & II emission standards for medium-duty vehicles (including diesel vehicles and engines); 4) revisions to the ZEV regulations with an alternative compliance plan; and 5) and California's "Not-to-Exceed" (NTE) emission standards and test procedures for heavy-duty diesel engines (HDDE) and vehicles.

Emission reductions from the LEV program are estimated using the MOBILE 6.2 model. MassDEP used EPA-approved inputs to the model to incorporate benefits from the LEV program in 2008 and 2009. Due to fleet turnover and the declining fleet wide average requirement under the LEV program regulations, the program will generate emission reductions in these milestone years.

3.4.2 NOx Budget Program

In 1999, MassDEP promulgated 310 CMR 7.28, *NOx Allowance Trading Program*, (the NOx Budget Program) and submitted it to EPA as a SIP revision. The regulation established a NOx cap-and-trade program consistent with EPA's NOx "SIP Call", which required NOx emission reductions from power plants in 22 Eastern states and the District of Columbia. (63 FR 57,356, 1998). The program set a statewide annual, ozone season cap of 12,860 tons of NOx emissions from electric generating units (EGUs, as defined in the regulation) and large industrial boilers in Massachusetts for the 2003 through 2008 ozone seasons. The NOx emissions reductions achieved under this program are taken into account in 2008 for RFP purposes.

3.5 Massachusetts New or Revised Regulations

MassDEP is adopting new regulations, or revising existing regulations, in 2007 and 2008 that will reduce emissions of NOx and or VOCs in 2009 and beyond. For some of these measures, the new or revised regulations have been promulgated prior to this SIP submission. For others, MassDEP is committing to promulgate regulations according to the schedule below. Emission reductions from these new measures, which are described in the narrative that follows, have been taken into account in the 2009 attainment demonstration modeling.

Table CM 1 MassDEP Schedule for Control Measure Regulations

Regulation	Date of promulgation (if final)	Date by which public hearings to be held	Final Promulgation by	Submittal to EPA for Inclusion in SIP	Effective Date of reductions
MA Clean Air Interstate Rule (CAIR)	5/4/2007			3/31/2007	2009 ozone season
AIM Coatings/Consumer Products	10/19/2007			3/1/2008	1/1/2009
Solvent Metal Degreasing		4/1/2008	8/1/2008	8/1/2008	4/1/2009
Adhesives and Sealants		4/1/2008	8/1/2008	8/1/2008	4/1/2009
Gasoline Vapor Recovery (Stage II Vent Caps)		3/1/2008	7/1/2008	8/1/2008	1/1/2009
Asphalt Paving		8/1/2008	1/1/2009	1/1/2009	5/1/2009
Enhanced I/M revisions			6/15/2008	6/15/2008	10/1/2008

3.5.1 Clean Air Interstate Rule (CAIR)

In EPA's Clean Air Interstate Rule (CAIR), promulgated in May 2005, EPA concluded that NOx emissions in 25 states and the District of Columbia contribute significantly to ozone nonattainment in downwind states and that NOx and sulfur dioxide (SO_2) emissions from 23 states and the District of Columbia contribute significantly to $PM_{2.5}$ nonattainment in downwind states. CAIR set an ozone season NOx cap for each state contributing to ozone nonattainment and annual NOx and SO_2 caps for each state contributing to $PM_{2.5}$ nonattainment. EPA concluded that Massachusetts significantly contributes to ozone nonattainment in Connecticut and Rhode Island, but does not contribute to downwind PM2.5 nonattainment. Therefore, Massachusetts is subject to the CAIR seasonal program, which caps NOx emissions starting with the 2009 ozone season.

To meet CAIR requirements, on March 30, 2007, MassDEP submitted to EPA a SIP revision that included new regulation 310 CMR 7.32, *Massachusetts Clean Air Interstate Rule* (Mass CAIR), and amendments to existing regulation 310 CMR 7.28, *NOx Allowance Trading Program*. EPA approved the MassCAIR SIP on December 3, 2007 (72 FR 67854).

Beginning with the 2009 ozone season, Mass CAIR will replace the existing NO_x Budget Program, which has capped ozone-season NO_x emissions from EGUs and other large boilers since 2003 at a less stringent cap. Mass CAIR covers all sources subject to the existing NOx Budget Program and lowers the total ozone season NOx budget from 12,861 tons to 7,914 tons in 2009 and to 6,656 tons in 2015 and thereafter.

By electing to make all Massachusetts sources that were part of the NOx Budget Program subject to Mass CAIR, MassDEP is limiting emissions from 15 NOx sources that do not meet EPA's CAIR applicability criteria and were not required to be included in Mass CAIR.

3.6.2 RACT Measures

RACT requirements for 8-hour ozone nonattainment areas are discussed in detail in Section 6, *Reasonably Available Control Technology (RACT).* As noted in that Section, MassDEP has determined that its existing solvent metal degreasing, gasoline dispensing vapor recovery, and asphalt paving regulations do not constitute RACT under the 8-hour ozone standard. MassDEP intends to revise its regulations for these categories to require tighter VOC controls. The proposed new regulations for these categories are described in Section 6.

MassDEP expects that the solvent degreasing regulation revisions will be effective by April 1, 2009. It anticipates that its asphalt paving regulation amendments will be effective by May1, 2009. These emissions benefits are taken into account for purposes of the attainment demonstration modeling, as discussed in Section 5, *Attainment Demonstration*. MassDep has not estimated the reductions that will take place as a result of the gasoline dispensing vapor recovery rule revisions for RFP or attainment demonstration purposes. It expects that the reductions will be minimal because of the small number of facilities that have vapor balance systems on underground tanks.

3.6.3 Consumer Products and Architectural & Industrial Maintenance (AIM) Coatings

MassDEP has adopted amendments to existing regulation 310 CMR 7.25, *Best Available Controls for Consumer and Commercial Products*, to further reduce emissions of VOCs from architectural and maintenance (AIM) coatings and consumer products. The regulations were promulgated on October 19, 2007.

Most states in the OTR adopted new regulations for these categories based on 2001 OTC Model Rules; however, Massachusetts did not. During the 2006 ozone strategies review process, the OTC reviewed the potential for additional VOC reductions from consumer products and AIM coatings. The OTC did not recommend further reductions from the AIM category. For consumer products it recommended additional VOC controls (based on 2005 revisions to the California consumer products regulation) and developed a 2006 OTC model rule for consumer products.

The Massachusetts 2007 amendments to 310 CMR 7.25 incorporate the 2001 OTC model rule VOC content controls for consumer products and AIM coatings. For consumer products, the amendments incorporate the additional restrictions in the 2006 OTC model rule. Because the reductions are effective as of January 2009, they are not taken into account for RFP purposes, but are taken into account for the 2009 attainment demonstration modeling.

3.6.4 Adhesives and Sealants

Adhesives, sealants, adhesive primer, and sealant primer are used in product manufacturing, packaging, construction, and installation of metal, wood, rubber, plastic, ceramics, or fiberglass materials. The 2001 OTC model rule for consumer products contains VOC limits for adhesives and sealants. However, with the exception of aerosol adhesives, the definitions of these products generally exempt products sold in larger containers.

The OTC identified this as a category where additional reductions could be achieved in the industrial and commercial use of these materials and developed a 2006 OTC model rule, based on a reasonably available control technology determination prepared by the California Air Resources Board in 1998. The OTC model rule addresses emissions from these materials by providing options for VOC content that meets specified limits or for use of add-on controls. It also imposes labeling and storage requirements for these materials. MassDEP intends to adopt a new regulation based on the OTC model rule with an effective date of April 1, 2009. No reductions from this measure are taken into account for RFP purposes, but have been included in the 2009 attainment demonstration modeling.

3.6.5 Effective Date of Control Measures and Estimated Reductions

The control measures discussed above are listed in Table CM 2 with an indication of whether reductions from the measures have been included for RFP purposes and/or for attainment demonstration purposes. Table CM 3 reflects the estimated reductions that MassDEP expects the measures to achieve in the milestone years.

Table CM 2 Federal and Massachusetts Post-2002 Control Measures

Source Sector	"X" indicates that reductions occur by the milestone year	VOC 2008	VOC 2009	NOx 2008	NOx 2009
Point	(MA regulations)				
	MA NOx Budget Program (NOx SIP Call) [1]			x	
	MA Clean Air Interstate Rule (CAIR)				x
Area	**(**Federal and MA regulations)				
	Consumer Products (MA)		x		
	Architectural/Industrial Maintenance Coatings (MA)		x		
	Adhesives & Sealants (MA)		x		
	Solvent Cleaning (MA)		x		
	Asphalt Paving Operations (MA)		x		
On-Road Mobile (Federal and MA regulations)					
	Portable Fuel Containers (part of federal mobile HAP rule; phased in reductions estimated @ 10% per year starting in 2009)		x		
	Federal Tier 2/ Low Sulfur Fuel	x	x	x	x
	Federal Heavy Duty Engine and Fuel Standards	x	x	x	x
	MA LEV	x	x	x	x
	Gasoline Dispensing Vapor Recovery (vent caps)		x		
Non-Road Mobile (Federal regulations**)**					
	Non-Road Diesel Engine and Fuel Standards	x	x	x	x
	Non-Road Spark Ignition (Gasoline) Engine and Fuel Standards	x	x	x	x
	Marine Diesel Engines				

[1] MA NOx Budget Program in effect from 2003 to 2008. MA CAIR replaces NOx Budget in 2009.

Table CM 3 Estimated Reductions From Post-2002 Control Measures

	EMA				**WMA**			
Tons per summer day	**Reductions by 2008 under NOx Budget**		**Reductions by 2009 under Mass CAIR**		**Reductions by 2008 under NOx Budget**		**Reductions by 2009 under Mass CAIR**	
Point Sources	NOx				**NOx**			
Sources in NOx Budget and Mass CAIR programs	40.9				4.6			
			Cap reduced but sources already at or near cap in 2008.				As in EMA	
	2008		**2009**		**2008**		**2009**	
	VOC	NOx	VOC	NOx	VOC	NOx	VOC	NOx
Mobile On Road[5]	59.1	190.1	63.9	206.4	12.7	40.4	13.7	44.0
Mobile Non Road[6]	41.2	14.4	47.3	18.0	4.1	2.3	5.0	2.9

Area Regulations will not take effect prior to 1/1/2009.	**2009 Estimated Benefits from Area Source Controls**[7]		
	EMA	**WMA**	**STATE**
Portable Fuel Containers (federal rule)	1.9	0.3	**2.2**
Consumer Products	8.9	1.3	**10.2**
AIM Coatings	16.7	2.4	**19.1**
Adhesives & Sealants	7.5	1.3	**8.8**
Solvent Cleaning	7.0	1.1	**8.0**
Asphalt Paving	7.1	1.0	**8.1**
Gasoline Dispensing Vapor Recovery (Vent Caps)	Minimal		Minimal

[5] Reductions are estimated using the 2002 MA Base Year Inventory and the 2008 and 2009 mobile emissions estimates used to set the Transportation Conformity Budgets discussed in Section 9, *Transportation Conformity*.
[6] EPA's NONROAD model incorporates growth factors and emission control factors for federal non-road controls.
[7] Reductions from the PFC, consumer products, adhesives and asphalt paving categories are based on the OTC regional ozone attainment planning process analysis, discussed in detail in Appendix 5K, *Identification and Evaluation of Candidate Control Measures: Final Technical Support Document*, MACTEC, February 28, 2007. As noted in that document, the 2009 benefit is the incremental reduction from the measure (the difference between the 2009 projected emissions before the control and 2009 post-control emissions). The calculations on which Appendix 5K are based are available on the Ozone Transport Commission website: *http://www.otcair.org/document.asp?fview=Report#*, as Appendix D to the Control Measures 2007 - Technical Support Document. Reduction estimates for the AIM and solvent categories are based on MassDEP's calculations and noted in Appendix 3B.

SECTION 4 REASONABLE FURTHER PROGRESS DEMONSTRATION

4.1 Purpose of Section

This section demonstrates that EMA and WMA will meet the 8-hour ozone standard requirement related to Reasonable Further Progress (RFP). EPA's Phase 2 Rule requires that, by the end of 2008, emissions of ozone precursors (VOCs and NOx) in each nonattainment area decrease by at least 15% of the MA 2002 Base Year Inventory.[1] MassDEP has projected 2008 emissions after taking into account anticipated growth in the economy and any additional control measures expected to be in effect by that date. Its projections demonstrate that emissions will decrease in both areas by a significantly greater percentage than the 15% reduction required to demonstrate RFP.

4.2 Reasonable Further Progress Requirements and Methodology

Under the CAA, ozone nonattainment areas are required to demonstrate progress towards attaining the ozone standard prior to their attainment year. EPA's Phase 2 Rule RFP requirements for 8-hour ozone non-attainment areas vary according to: 1) whether an area's attainment year is more than 5 years after EPA's 2004 nonattainment designations; and 2) whether an area was previously required to submit a 15% VOC Rate of Progress[2] plan under the 1-hour ozone standard. EMA and WMA have a 2010 attainment year and under the 1-hour ozone standard they were required to submit 15% Rate of Progress SIPs.[3] The applicable RFP requirement, therefore, is to reduce emissions of VOCs and/or NOx by 15% within the six years after the 2002 Base Year Inventory - that is, by the end of 2008.

The procedures and methodology for demonstrating compliance with the 1-hour ozone standard Rate of Progress requirements were established in a 1992 EPA guidance document; these are still applicable for purposes of the 8-hour ozone standard RFP.[4] EPA's method for demonstrating that RFP requirements are met calls for:

1. Developing a 2002 base year inventory for a nonattainment area that takes into account certain adjustments for RFP purposes;
2. Establishing a "target level" of emissions for the last year of the RFP period (the "milestone" year) that reflects the required 15% reduction from the base year;

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1 As noted in Section 2, the MA 2002 Base Year Inventory is Appendix 2A.
2 Generally, the phrase "rate of progress" has been used in connection with 1-hour ozone standard requirements, while EPA has described 8-hour standard requirements as "reasonable further progress".
3 The 15% Rate of Progress requirement was to demonstrate a 15% reduction in emissions of VOCs from the 1990 baseline inventory by 1996. An additional 9% reduction in VOCs, NOx or a combination of both, was required by 1999. MassDEP submitted a number of SIP revisions between 1993 and 2002 demonstrating compliance with these 1-hour ozone standard ROP requirements.
4 *Guidance on the Adjusted Base Year Emissions Inventory and the 1996 Target for the 15 Percent Rate of Progress Plans*, U.S. EPA, Office of Air Quality Planning and Standards, EPA-452/R-92-005, October 1992.

3. Developing a projected inventory of VOC and NOx emissions for the nonattainment area in the milestone year; and
4. Demonstrating that the projected milestone year emissions of NOx and VOC will be less than, or equal to, the target level for that year.

Consistent with EPA's methodology, MassDEP demonstrates in the calculations below that the EMA and WMA nonattainment areas have met the RFP requirements.

4.3 2002 RFP Adjusted Base Year Inventory

The MA 2002 Base Year Inventory estimates anthropogenic and biogenic emissions of VOC and NOx. Pursuant to EPA's RFP methodology, for RFP purposes, MassDEP has adjusted the inventory to exclude:

1. biogenic VOC emissions; and
2. non-creditable reductions from the Federal Motor Vehicle Control Program (FMVCP).[5]

Table RFP-1 reflects the emissions estimates of VOC and NOx from the MA 2002 Base Year Inventory for EMA and WMA by source categories, with these adjustments. The result is the 2002 RFP Adjusted Base Year Inventory.

5 The CAA (Section 182(b)(1)(D)) provides that reductions from the following measures are not creditable toward the required reductions: (1) Federal Motor Vehicle Control Program (FMVCP) tailpipe and evaporative standards issued in 1990; (2) Federal regulations limiting the Reid Vapor Pressure (RVP) of gasoline in ozone nonattainment areas issued by June 15, 1990; (3) State regulations correcting deficiencies in reasonably available control technology (RACT) rules; (4) Measures required to be enacted immediately after passage of the 1990 CAA Amendments concerning corrections to vehicle inspection and maintenance (I/M) programs. Only the FMVCP continues to generate emission reductions through 2008 in Massachusetts.

Table RFP 1 2002 RFP Adjusted Base Year Inventory

MA 2002 Base Year Inventory (From Appendix 2A)	EMA VOC	WMA VOC	EMA NOx	WMA NOx
(tons per summer day)				
POINT	13.6	2.4	116.6	13.0
AREA	282.0	45.5	33.9	5.2
ON-ROAD	127.4	24.5	381.4	71.7
OFF-ROAD	196.2	27.7	122.1	22.4
BIOGENICS	535.7	254.6	4.4	1.1
TOTAL ALL CATEGORIES	1,154.9	354.7	658.4	113.4
Adjustments for RFP				
TOTAL ANTHROPOGENIC (after subtraction of biogenics)	619.2	100.1	654.0	112.3
FMVCP adjustment (Mobile On-Road)[6]	-15.3	-2.9	-45.2	-8.5
2002 RFP ADJUSTED BASE YEAR INVENTORY	**603.9**	**97.2**	**608.8**	**103.8**

Note: Small discrepancies may result due to rounding

4.4 Target Level of Emissions

MassDEP must demonstrate that the 2008 projected emissions for EMA and WMA will be at least 15% below the 2002 RFP Adjusted Base Year Inventory shown in Table RFP-1 above. The reductions can be of VOCs, NOx or any combination thereof. MassDEP is establishing its target levels based on a combined reduction of 12% NOx emissions and 3% VOC emissions in both EMA and WMA. The 2008 Target Levels are depicted in Table RFP 2; projected emissions in 2008 may not exceed these Target Levels. The amount of reductions of each pollutant needed to achieve the Target Levels based on the 12% NOx and 3% VOC breakdown is also shown.

6 The calculation method for the FMVCP non-creditable emissions reductions is described in Appendix 4C, July 27, 2007 MassDEP Memo, *RFP Analysis; MOBILE6 input files description*. The emission factors used for the 2008 Mobile 6 model runs are in Appendix 4B, Tables 4B1 – 4B6.

Table RFP 2 - 2008 Target Levels and Reductions Needed (TPSD)

	EMA VOC	WMA VOC	EMA NOx	WMA NOx
1. 2002 RFP Adjusted Base Year Inventory (from Table RFP 1)	**603.9**	**97.2**	**608.8**	**103.8**
2. Selected combination of reductions	**3%**	**3%**	**12%**	**12%**
3. Required Reductions (line 1 x line 2)	**18.1**	**2.9**	**73.1**	**12.5**
4. 2008 Target Levels (line 1 – line 3)	**585.8**	**94.3**	**535.7**	**91.3**

4.5 2008 Projected Emissions Inventory

The projected emissions in 2008 are calculated by estimating anticipated growth in emissions between 2002 and 2008 and then adjusting for any controls that will reduce emissions during that time period. The basic methodology for growing point and area source emissions is the application of socio-economic growth factors to the base year data. For on-road and non-road sources, projected emissions are estimated using the current EPA emission models, which have built-in control factors. The NONROAD model also has built-in growth factors.

Appendix 4A, *MA 2008 Projections by Categories*, is based on the source category list used in the MA 2002 Base Year Inventory. It shows the growth factor that was applied to each source category to project 2008 emissions. It also indicates whether post-2002 controls have been taken into account. The projection methodology for the different source sectors listed in Appendix 4A is discussed below. Table RFP 3 summarizes the total 2008 projected emissions for EMA and WMA for all source sectors.

4.5.1 Stationary Point Sources

The Stationary Point Source sector of the MA 2002 Base Year Inventory includes emissions from Electric Generating Units (EGUs) and other industrial point sources. For EGUs and certain large boilers that have been subject to the NOx Budget Program, instead of using 2002 base year

data to project 2008 emissions,[7] MassDEP is using 2006 actual emissions[8] to which it applied growth factors based on the U.S. Department of Energy Forecast[9] for New England.

For all other point sources (non-NOx Budget Program sources), MassDEP used MA 2002 Base Year emissions. To project 2008 emissions from this group of point sources, MassDEP interpolated from 2009 projected emissions developed for MANE-VU[10] for attainment demonstration modeling purposes.[11] MANE-VU used EPA's Economic Growth and Analysis System (EGAS, version 5.0) and the *Annual Energy Outlook* of the U.S. Department of Energy's Energy Information Administration (DOE/EIA) to project 2009 emissions for the non-EGU point source sector. MassDEP did not take any post-2002 control measures into account in projecting 2008 emissions from this group of point sources.

4.5.2 Area Sources

For most area sources, MassDEP projected 2008 emissions based on the MA 2002 Base Year Inventory combined with growth factors based on employment data from the Massachusetts Department of Employment and Training (MA-DET). For the consumer products and architectural coatings (paints) categories, projections were based on population growth factors from the U.S. Census population projections. For residential, commercial and small industrial fuel use, MassDEP used the growth factors that MANE-VU developed from DOE-EIA data and EGAS.

4.5.3 On-Road and Non-Road Mobile Sources

The Massachusetts Executive Office of Transportation and Public Works, Office of Transportation and Planning (EOT) estimated on-road mobile source emissions in 2008 for purposes of establishing the Transportation Conformity budgets required for the 2008 RFP milestone year. (Transportation Conformity budget requirements are discussed in Section 9, *Transportation Conformity.)* These 2008 on-road mobile source projections are used in this section as part of the RFP calculations.

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7 The NOx Budget Program is discussed in Section 3,*Control Measures*. Because the program began in 2003, 2002 base year data does not provide a good basis from which to project future year emissions from sources covered by the program.

8 EPA Clean Air Markets Division 2006 NOx Budget Program Emissions Report for Massachusetts. Available at: http://camddataandmaps.epa.gov/gdm/index.cfm.

9 U.S. Department of Energy, Energy Information Administration (DOE/EIA), Forecasts and Analysis, Table 1 - Energy Consumption by Sector and Source -New England –01 http://www.eia.doe.gov/oiaf/forecasting.html

10 The Mid-Atlantic and Northeastern states, tribes, and federal agencies formed The Mid-Atlantic/Northeast Visibility Union (MANE-VU) to coordinate regional haze planning activities for the region. MANE-VU and the OTC coordinated the development of combined inventories for purposes of regional ozone and PM2.5 attainment planning and regional haze planning.

11 See Appendix 5K,"*Development of Emission Projections for 2009, 2012 and 2018 for NonEGU Point, Area and Nonroad Sources in the MANE-VU Region,* Prepared by MACTEC Federal Programs, Inc., Feb. 28, 2007.

EOT used the latest version of its Travel Demand Model to project 2008 vehicle miles traveled (VMT). EPA's MOBILE 6.2 model generated emission factors based on MassDEP inputs to the model that reflect state and federal mobile source control programs that will be in place in 2008. EOT combined the emission factors generated from MOBILE 6.2 with VMT to estimate on-road mobile emissions in 2008.[12]

The MassDEP on-road mobile control programs that were adopted under the 1-hour ozone standard and that are reflected in the 2002 and 2008 input files include: MA Enhanced Inspection and Maintenance (I/M) program, the California Low Emission Vehicle (LEV) program, Stage II vehicle refueling control and reformulated gasoline (RFG). MassDEP does not anticipate changing the parameters of any state mobile source control program after 2002 and prior to the end of 2008. Therefore, the inputs for the 2002 base year and the 2008 projection year are the same.[13] (MassDEP expects to implement program revisions for the I/M program beginning in late 2008.)

For non-road mobile emissions, MassDEP used EPA's NONROAD Model (version 2005a, Feb.2006) to project 2008 emissions from this sector. The model has built-in state and county growth factors and factors for the federal control measures for non-road engines that will be in effect in 2008. (See Section 3, *Control Measures*) For the non-road category of airport emissions, MassDEP applied growth factors for Logan Airport to develop Suffolk County (EMA) projected emissions. The growth factors for other airports in each county in EMA and WMA were derived from MANE-VU projections. Growth factors for Commercial Marine Vessels and Locomotives were also derived from MANE-VU.

4.6 Summary

The 2008 projections are summarized in Table RFP 3 below. Reductions anticipated by 2008 are compared to the reductions required to meet RFP. As shown, both areas have demonstrated reductions significantly greater than the 15% reduction needed to meet RFP requirements.

12 Section 9, *Transportation Conformity*, includes additional discussion of the planning assumptions used to estimate mobile source emissions for the 2008 and 2009 Transportation Conformity Budgets.
13 Non-road input and output data and non-road emissions by county are contained in Appendix 4b, Tables 4B-7 and 4B-8.

TABLE RFP 3

2002 RFP Adjusted Base Year, 2008 Projected Emissions & Target Level Comparison

Tons per Summer Day

ks/inv2002-sip-rfp/ rfp-2002-8-target /jan-8-2008

SOURCE SECTOR	EMA 2002 RFP ADJ VOC	EMA 2008 PROJECT VOC	WMA 2002 RFP ADJ VOC	WMA 2008 PROJECT VOC	EMA 2002 RFP ADJ NOx	EMA 2008 PROJECT NOx	WMA 2002 RFP ADJ NOx	WMA 2008 PROJECT NOx
Point	13.6	13.9	2.4	2.4	116.6	77.2	13.0	8.6
Area	282.0	286.0	45.5	46.3	33.9	38.1	5.2	5.9
On-Road (Adjusted)	112.1	68.3	21.6	11.8	336.2	191.3	63.2	31.3
Off-Road	196.2	155.3	27.7	23.6	122.1	108.1	22.4	20.3
1. 2002 RFP Adjusted Base Year Emissions (Table RFP 1)	**603.9**		**97.2**		**608.8**		**103.8**	
2. Total 2008 Projected Emissions		**523.5**		**84.1**		**414.7**		**66.1**
3. Required VOC/NOx Reductions (must total 15%)	**3%**		**3%**		**12%**		**12%**	
4. **15% Reductions in tons** (to calculate 2008 Target Levels = *Line 1* line 3)*		**18.1**		**2.9**		**73.1**		**12.5**
5. **2008 RFP Target Levels (Table RFP 2)** *Line 1 - line 4*		**585.8**		**94.3**		**535.7**		**91.3**
6. **Projected reductions by 2008** *Line 1 - line 2*		**80.4**		**13.1**		**194.1**		**37.7**
7. **Tons (and %) by which 2008 projected emissions exceed required reductions** *Line 6 - line 4, (Line 7 / line 5)*		**62.3 (10.6%)**		**10.2 (10.8%)**		**121.0 (22.6%)**		**25.2 (27.6%)**

SECTION 5 ATTAINMENT DEMONSTRATION

5.1 Purpose of Section

EPA requires states with moderate ozone nonattainment areas to prepare and adopt SIP revisions demonstrating attainment of the 8-hour ozone standard using photochemical grid modeling and weight-of-evidence (WOE) analyses. States with moderate nonattainment areas are required to attain the 8-hour ozone NAAQS by June 15, 2010. However, because the June 15, 2010 deadline occurs in the middle of the ozone season, according to EPA modeling guidance, modeled attainment must be based on the ozone season preceding 2010. Therefore, the target year for attainment monitoring is calendar year 2009.

The following attainment demonstration demonstrates that, as a result of reductions in ozone precursor emissions in Massachusetts and upwind of Massachusetts, EMA and WMA (Figure AD1) will attain the 8-hour ozone NAAQS by 2009. The attainment demonstration is based upon the regional ozone attainment planning process undertaken by the OTC and OTC states to develop a SIP-quality ozone modeling platform and to prepare candidate control strategies for ozone attainment demonstrations.

5.2 Ozone Conceptual Model

5.2.1 Conceptual Description for Ozone Episodes in Massachusetts

The Northeast States for Coordinated Air Use Management (NESCAUM), on behalf of the OTC, produced a comprehensive conceptual description of the meteorological processes underlying the formation of ozone episodes. The NESCAUM report (NESCAUM, 2006) was intended as a reference for SIP attainment demonstrations and is contained in Appendix A. State-specific information for Massachusetts is presented below.

5.2.2 Geographical Considerations

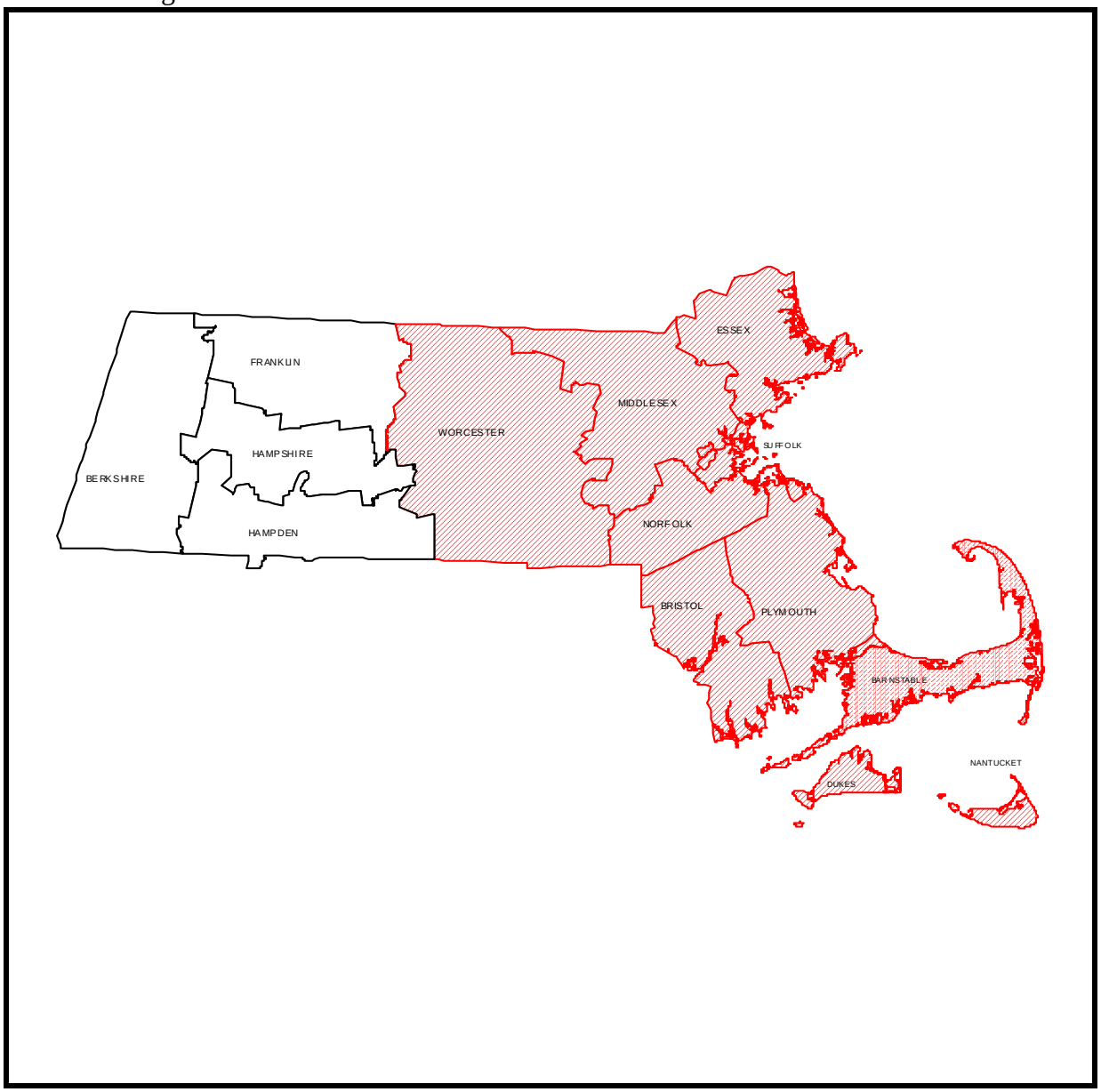
Massachusetts, at about 42 degrees north latitude, lies closer to the mean position of the polar front than do states in the Ozone Transport Region[1] (OTR) to the south of Massachusetts. This gives Massachusetts (and areas to its north) more frequent cooling and cleansing cold frontal passages than do areas to its south, with the consequence being fewer and shorter ozone episodes, though not necessarily weaker.

Massachusetts, though it does contribute to pollutant levels in New Hampshire and Maine, is considered to be a downwind state, being a recipient of ozone and precursors from much of the northeast corridor including Baltimore, Washington D.C., Philadelphia, New Jersey, and New York City. Stagnation, which occasionally results in elevated ozone in southern states, is not much of a factor in Massachusetts' episodes. Exceedances in Massachusetts are almost always

[1] The Northeast Ozone Transport Region (OTR) comprises Connecticut, Delaware, the District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and northern Virginia. The OTC was created under the CAA to address ozone transport issues within the OTR.

due to local emissions combined with elevated ozone and precursor transported from upwind areas.

Figure AD1: Eastern and Western Massachusetts Non-Attainment Areas



WMA Non-Attainment Area Counties	EMA Non-Attainment Area Counties	
Berkshire	Barnstable	Nantucket
Bristol County	Norfolk	Franklin
Hamden	Dukes	Plymouth
Hampshire	Middlesex	Worcester
	Essex	Suffolk

5.2.3 Transport

Global scale circulations, while not a direct cause of Massachusetts ozone episodes, govern the location and strength of synoptic scale features, such as high and low pressure systems and fronts, which are normally associated with ozone episodes. Global systems ultimately control the duration of weather patterns and how often they recur, thus determining the severity of an ozone season. When a summertime air mass spends lengthy residence time over the eastern U.S. and this pattern becomes recurrent, Massachusetts is likely to experience a severe ozone season.

Mesoscale features can influence the spatial pattern of ozone development in Massachusetts. Sea breezes will often draw cleaner air onshore, thus lowering ozone concentrations, but they sometimes have the opposite effect. If a plume of ozone lies offshore, such circulations can bring polluted air onto the land, causing a rapid rise in ozone readings. Lee troughs, induced by mountain ranges, such as the Appalachians, align the southwesterly airflow with the mountains, resulting in more highly concentrated streams of pollution entering Massachusetts's airways. Low-level nocturnal jets are relative newcomers in our understanding of ozone transport. This rapid transit mechanism can move pollution long distances from southwest to northeast to spread ozone episodes hundreds of miles overnight.

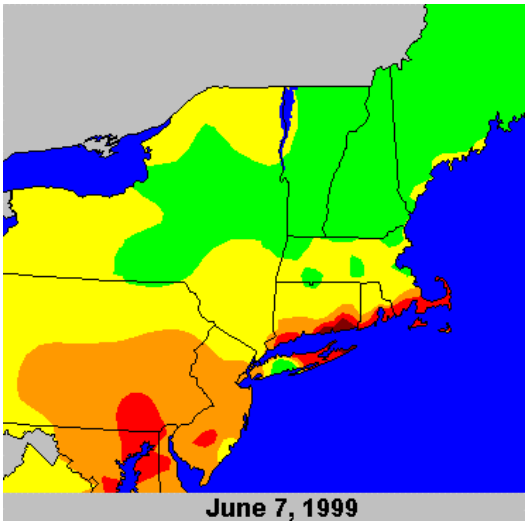
Smaller microscale circulations include the whorls and eddies that transfer heat and energy vertically. This transfer mechanism often shuts down in the evening when the earth cools and temperature inversions form. Ozone trapped near the ground gets destroyed through chemical transformation and deposition. But ozone aloft remains relatively undepleted and mixes back to the surface the following morning when heating-induced eddies grow and erode the inversion. This mechanism is basic to the diurnal rise and fall of surface ozone values.

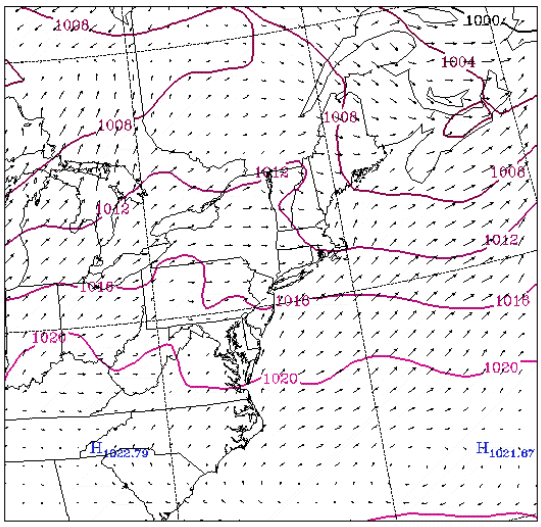
5.2.4 Primary Meteorological Regimes for Massachusetts

Two primary synoptic meteorological patterns typically trigger severe ozone episodes in Massachusetts, and result in episodes having markedly different ozone signatures. The first synoptic type affects the immediate south coast and Cape Cod and is controlled by the Atlantic oceanic anticyclone (high pressure area), which extends westward well into interior eastern U.S. This results in westerly to west-northwesterly surface winds over Massachusetts, with pollution transport from the New York and New Jersey area eastward across Long Island Sound, bringing ozone and precursors to coastal Connecticut, Rhode Island and Massachusetts. The westerly flow also blocks the plume's northward penetration, keeping the rest of the state's air relatively clean. A good example of this episode type is shown in Figure AD2, with (on the left) a distinct ribbon of high ozone along the New England south coast with (on the right) the westerly surface winds that forced the plume seaward. Also, note the thin strip of moderate ozone along Maine's coast and the southerly airflow just offshore. This strongly suggests an air trajectory from eastern Massachusetts to the Maine coast.

The second synoptic type occurs when the Atlantic anticyclone has a more northeast-southwest orientation (as opposed to the west – east orientation in the previous example) with less extension into interior eastern U.S. This pattern generates a more south-southwesterly wind across Massachusetts, which carries pollutants from the New York City area northeastward into

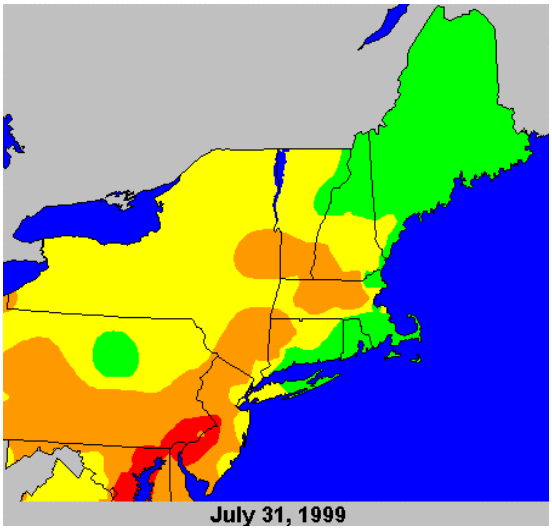
Figure AD2: July 7, 2002 Ozone and Isobar Maps

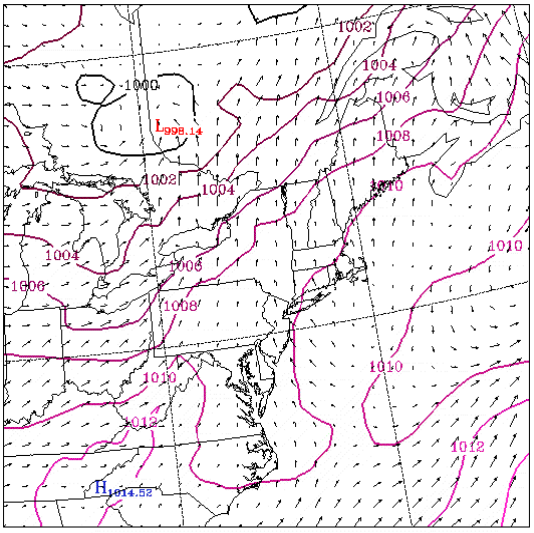




LEFT: EPA ozone mapping showing peak 8-hr values on June 7, 1999. Colors range from green (good air quality) to maroon (very unhealthy.) RIGHT: Surface isobars (sea-level pressure) and wind vectors at 1PM EST, June 7, 1999. (NOAA Air Resources Lab)

Figure AD3: July 31, 2002 Ozone and Isobar Maps





LEFT: EPA ozone mapping showing peak 8-hr values on July 31, 1999. Colors range from green (good air quality) to red (unhealthy.) RIGHT: Surface isobars (sea-level pressure) and wind vectors at 1PM EST, July 31, 1999 (NOAA Air Resources Lab)

western and central Massachusetts. This flow keeps the main pollutant plume west of Cape Cod and the south coast, where the southerly breezes draw in cleaner marine air. In this case, the ozone gradient is reversed from the first episode type discussed above. Here, the south coast and Cape Cod and Islands have relatively low ozone, with elevated values across the interior of the state. A good example of this second flow pattern appears in Figure AD3, showing clean air along the south coast extending inland with higher ozone over more western interior sections. The surface flow with marine air drawn inland along south coastal locales can be seen on the right side of Figure AD3.

These two meteorological regimes occurred many times during 2002 and resulted in elevated ozone levels in many portions of Massachusetts. This indicated that the 2002 ozone season was appropriate for ozone attainment demonstration modeling in Masssachusetts. The 2002 ozone season also experienced a significant number of ozone exceedance days in many other portions of the eastern U. S.

5.3 OTC Modeling Protocol

5.3.1 Modeling Protocol (2002)

In 2002 the Ozone Transport Commission embarked on the task of developing a SIP modeling system for exercising photochemical grid models to assess the impact of candidate ozone control strategies in the OTR. EPA's Community Multi-scale Air Quality Modeling System (CMAQ) was selected for attainment demonstrations in the OTC states. Air quality staff from the OTC states subsequently prepared a modeling protocol for attainment demonstrations in the OTR. The modeling protocol, entitled "Modeling Protocol for the OTC SIP Quality Modeling System For Assessment of the Ozone National Ambient Air Quality Standard in the Ozone Transport Region", was endorsed by OTC Commissioner at the November 12-13, 2003 Fall meeting.

5.3.2 Modeling Protocol (2006)

The modeling protocol, now dated December 31, 2006, has been modified several times since then to incorporate CMAQ model modifications, boundary condition estimates and emission inventory improvements. The New York Department of Environmental Conservation (NY DEC), under the direction of the OTC Modeling Committee, agreed to be the lead agency for developing and using the SIP quality ozone modeling system as specified in the modeling protocol. The subject protocol, which describes the modeling procedures and databases to be used for SIP attainment demonstrations in the OTR, is contained in Appendix B.

5.4 Review of 2002 Ozone Episodes

5.4.1 Episode Selection Criteria

Ozone-based research has shown that model performance evaluations and the model response to emission reductions need to consider relatively long time periods. In order to examine the response to ozone control strategies, EPA recommends that episode days should be meteorologically representative of typical high ozone exceedance days and so severe that any

control strategies predicted to attain the ozone NAAQS for that episode day would also result in attainment for all other exceedance days (EPA, 2007). Time periods to be modeled should display increasing ozone concentrations over time, followed by a ramp-down period to cleaner conditions to allow for a more complete evaluation of model performance under a variety of meteorological conditions.

5.4.2 Episode Selection Procedure

Because of the large areal extent of the OTR modeling domain, the OTC Modeling Committee decided to model the entire 5-month ozone season in order to investigate numerous ozone episodes and to provide for better assessment of simulated pollutant fields. The 2002 ozone season was selected since a significant number of exceedance days were recorded across the eastern U. S. that year. A multi-year review (1997-2003) of elevated ozone days in the OTR indicted that associated meteorological regimes during high ozone days in 2002 were for the most part very similar to those found to occur in other years. The multi-year review, prepared by Environ (Environ, 2005) is contained in Appendix C. Based on this work, the OTC Modeling Committee is confident that the 2002 season is representative for purposes of photochemical modeling for ozone SIP attainment demonstrations.

5.5 Modeling Domain

5.5.1 Description

The OTR modeling domain is displayed in Figure AD4. The OTR modeling domain is embedded in the national grid that was adopted by the five U.S. Regional Haze Regional Planning Organizations (RPOs) for photochemical grid modeling. Individual RPOs are shown in Figure AD5.

The OTR modeling domain was designed to both capture the effects of emissions transported into the OTR and to test the effectiveness of 2009 control strategies in the OTR states. OTR states consist of Connecticut, Delaware, Washington D.C., Maryland, Maine, Massachusetts, New Jersey, New York, New Hampshire, Pennsylvania, Rhode Island, Vermont and Virginia. Non-OTR states in the OTR modeling domain consist of Alabama, Arkansas, Georgia, Iowa, Louisiana, Illinois, Indiana, Kentucky, Michigan, Minnesota, Missouri, North Carolina, Ohio, South Caroline, Tennessee, Virginia and Wisconsin. The horizontal grid resolution is 12 km and there are 172 grids in the east-west and 172 grids in north-south direction. Details of the modeling system grid setup are contained in Appendix D.

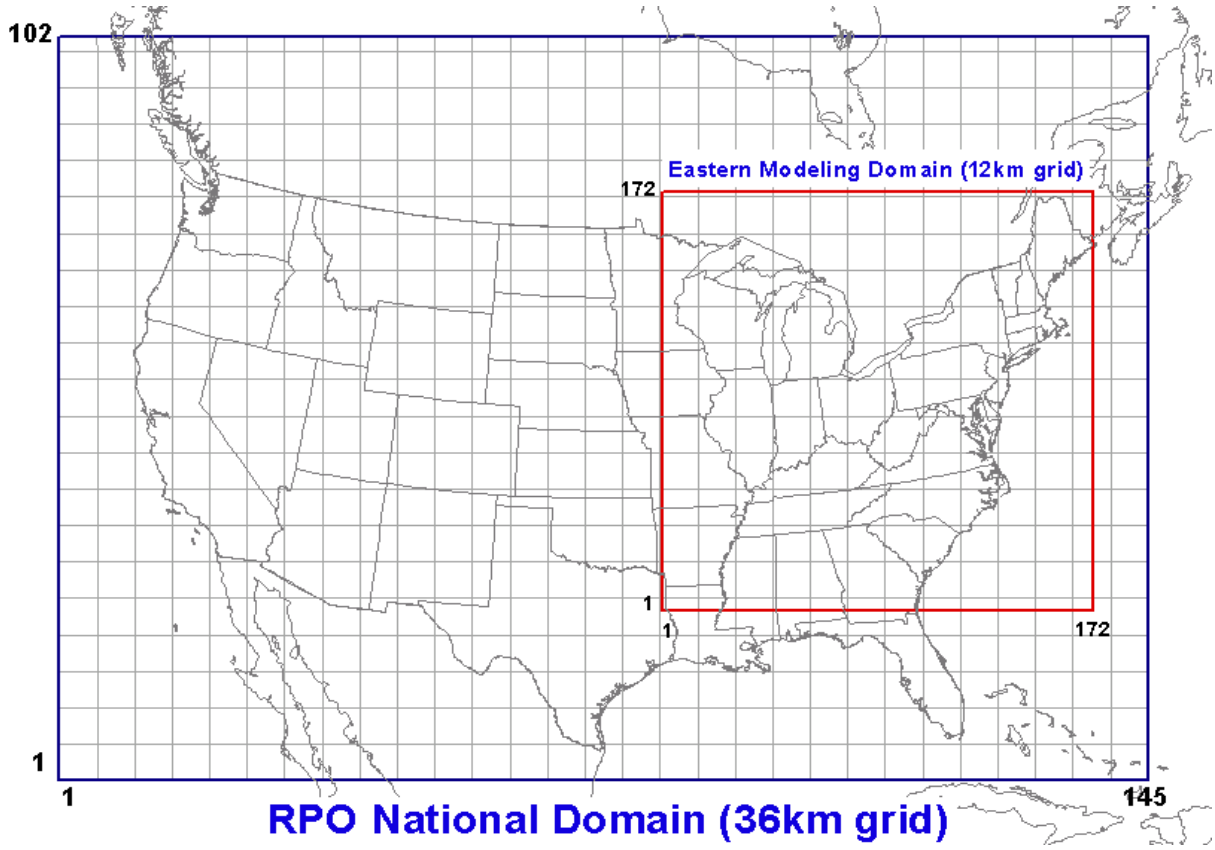
5.5.2 Horizontal Grid Size

Following EPA guidance and as noted above, a 12 km grid resolution was used for the domain. Details of the horizontal grid layers are contained in Appendix D.

5.5.3 Number of Vertical Layers

Although the definition of the vertical structure can be adopted on a one-to-one basis with the meteorological model (which is 29 layers), it was decided not to do so. Given the available

Figure AD4: OTR Photochemical Grid Modeling Domain (Eastern Modeling Domain)



computational resources and runtime needs, it was decided to limit the number of vertical layers in the photochemical model to 22, with the lowest 16 layers (where most of the ozone chemistry takes place) set one-to-one with those of the meteorological model. Details of vertical grid layers are contained in Appendix D.

5.6 Photochemical Grid Modeling System

5.6.1 Photochemical Grid Modeling System

EPA's Community Multi-scale Air Quality Modeling System (CMAQ) was selected for ozone attainment demonstrations in the OTR because it addresses multiple pollutants and different spatial scales (http://www.epa.gov/asmdnerl/CMAQ/index.html). The CMAQ platform is also being used for regional haze applications in the OTR and for PM2. 5 attainment demonstrations (for those jurisdictions within the OTR designated as non-attainment for the PM2.5). The CMAQ framework is an advanced computational platform that provides a sophisticated and powerful modeling environment for science and regulatory communities. CMAQ has a "one atmosphere" perspective; it was specifically designed to approach air quality as a whole by including state-of-the-science capabilities to address multiple air quality issues, including tropospheric ozone, fine particles, toxics, acid deposition, and visibility degradation. The target grid resolutions and

Figure AD5: Regional Haze Regional planning Organizations (RPOs)

domain sizes for CMAQ can range spatially and temporally over several orders of magnitude. In addition, CMAQ also has temporal flexibility; simulations can be performed for long-term (annual to multi-year) pollutant climatologies as well as short term (weeks to months) to simulate transport of precursor emissions from localized sources.

5.6.2 CMAQ Modeling System Source Codes

The CMAQ modeling system contains three types of modeling components: a meteorological modeling system (MM5) for the description of atmospheric states and motions; an emission model (SMOKE) for man-made and natural emissions that are injected into the atmosphere; and a chemistry-transport modeling system (CMAQ) for simulation of the chemical transformation and fate. Because CMAQ is designed to handle scale-dependent meteorological formulations and

a large amount of system flexibility, CMAQ's governing equations are expressed in a generalized coordinate system. The generalized coordinate system determines the necessary grid and coordinate transformations, and it can accommodate various vertical coordinates and map projections. The SMOKE and CMAQ codes are available at http://www.cmascenter.org/ and MM5 codes can be obtained at http://www.mmm.ucar.edu/mm5/

5..3 CMAQ Model Setup for the OTR Domain

The CMAQ Model (Version 4.5.1) was used to predict ozone concentrations in the OTR modeling domain. The CMAQ model configuration and the MM5/SMOKE/CMAQ modeling system grid specifications employed by the NY DEC are presented in Appendix D.

5.7 Meteorological Modeling System

5.7.1 MM5 Meteorological Model

The Fifth-Generation Pennsylvania State University/NCAR mesoscale model, referred to as MM5, was used by the University of Maryland (UMD) to generate meteorological fields for the OTR modeling domain. MM5 is a limited-area, non-hydrostatic, terrain-following sigma-coordinate model designed to simulate mesoscale atmospheric circulation. MM5 codes can be obtained at http://www.mmm.ucar.edu/mm5/. The set of options used by UMD for running MM5 (Version 3.6) in consultation with NY DEC are listed in Appendix E.

5.7.2 MM5 Meteorological Fields

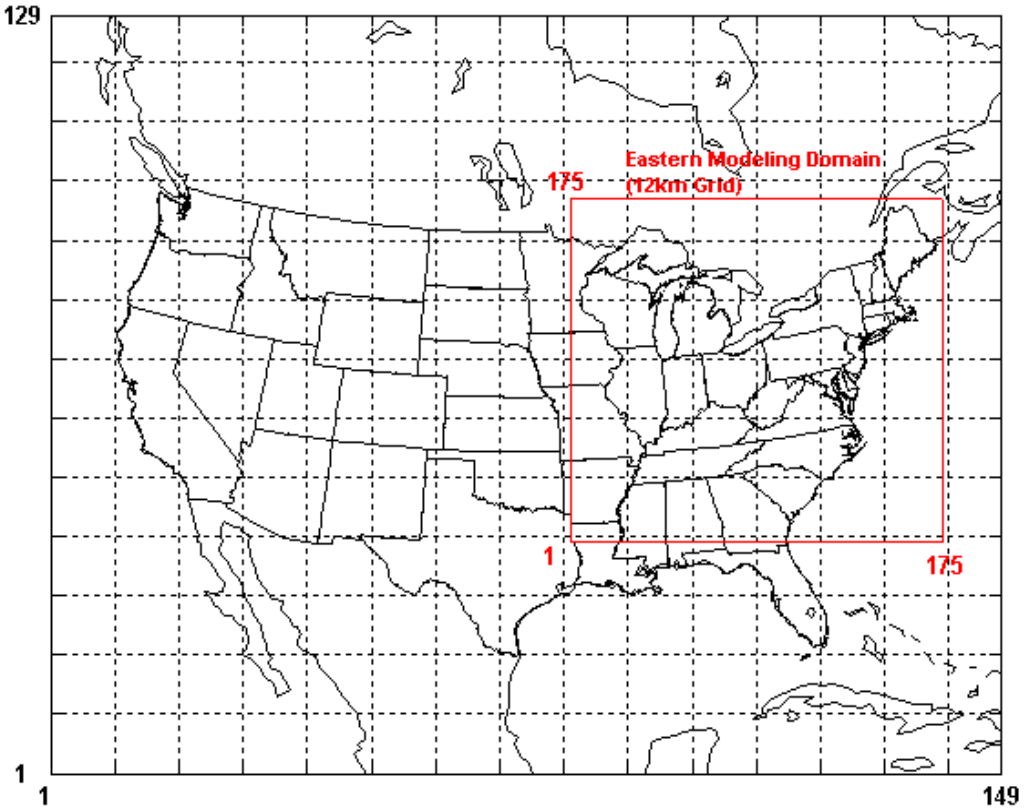
The National Weather Service NCEP ETA 40 km resolution-forecasting model was employed to initialize the MM5 model and to provide outer edge boundary conditions for the MM5 model. To minimize model error, the model applied four-dimensional data assimilation nudging techniques employing National Weather Service surface wind and upper air data (Zheng and Zheng, 2004). The model was applied in a Lambert conformal map projection over two-way nested domains. The coarse grid (36 km) domain and the fine grid (12 km) domain are shown in Figure AD6. MM5 was used to produce hourly meteorological fields for the calendar year 2002.

Since there are a variety of options that can be exercised with MM5, initial testing was performed for a high ozone event of 2002 with commonly used default options as well as with modified boundary layer schemes (Zhang and Zheng 2004). Based on this work, a modified Blackadar scheme was employed in order to produce more accurate diurnal cycles of surface winds and temperatures. A description of the preparation of MM5 meteorological fields for the OTR modeling domain is contained in Appendix F.

5.7.3 MM5 Model Performance

NY DEC and UMD tested several MM5 configurations before settling on one that included a modification to the Blackadar planetary boundary scheme in order to obtain an accurate rendering of three-dimensional meteorological fields over the OTR modeling domain. This work was coordinated through the OTC Modeling Committee.

Figure AD6: MM5 Modeling Domains (36 km and 12 km)



After MM5 hourly meteorological fields were prepared, the simulated meteorological fields for 2002 ozone season (May 1 to September 30) were compared to National Weather Service (NWS) and CASTNet surface temperature, wind speed, and humidity observations. CASTNet is the nation's primary source of rural ground-level ozone measurements and associated meteorological data. Comparisons with CASTNet data provide a more independent assessment of the MM5 model since CASTNet data, unlike NWS data, is not used to in the MM5 applicationto improve model performance (model nudging). MM5 results were also compared with wind profiler data and cloud data derived from satellite images to diagnose if the MM5 simulation is yielding the right type of dynamics in the vertical. These analyses (Appendix F) indicate that the performance of MM5 is reasonable across the OTR both at the surface and in the vertical, thereby providing confidence in the use of MM5 results for the CMAQ simulations.

5.8 Biogenic emissions

5.8.1 BEIS Modeling System

Biogenic emissions of VOCs, NOx and CO from natural sources for the time period from January 1, 2002 – December 31, 2002 were calculated by the NY DEC using the Biogenic Emissions Inventory System (BEIS version 3.12) integrated within SMOKE2.1. The procedures used to calculate biogenic emissions are contained in Appendix G.

5.8.2 OTR Modeling Domain Biogenic Emissions

NY DEC used gridded land use data and emissions factors to produce gridded normalized biogenic emissions for 34 species/compounds in the OTR modeling domain. The gridded land use file utilized by NY DEC included the fractional coverage of 230 different land use types for each of the 12-km grid cells in the OTR modeling domain. MM5/MCIP meteorological variables were then used to compute hour-specific, gridded biogenic emissions, which were then converted to CO, NO, and the Carbon Bond IV (CB-IV) VOC species utilized in CMAQ Model.

5.9 Boundary and Initial Conditions

5.9.1 Generation of Boundary Conditions

NY DEC prepared boundary conditions for the OTR 12 km domain by performing a CMAQ simulation for a continental U.S. grid with a 36 km grid spacing. The simulation utilized the 2002 emissions data provided from the five U.S. RPOs and the 2002 MM5 meteorological fields developed by the UMD (Section 7). Clean initial conditions were employed, and boundary conditions for the continental USA simulation were extracted from a simulation of the GEOS-CHEM global chemical model. The interface program used to extract 36 km boundary conditions from the GEOS-CHEM global model was developed by University of Houston (Moon and Byun, 2004). The CMAQ 36km simulation ran from December 15, 2001 to December 31, 2002 with the first 15 days in December 2001 as ramp up period. The boundary conditions simulation is described in more detail in Appendix H.

5.9.2 OTR Modeling Domain Boundary Conditions

The hourly boundary fields for the 12km CMAQ domain were obtained by using a boundary condition program (BCON) to extract the 3-D concentration fields from the NY DEC continental CMAQ run at the boundaries of the OTC 12 km modeling domain. Boundary conditions were obtained for the ozone season simulation period (May 1 through September 30) with the first 14 days of May set as a ramp-up period to minimize the propagation of the boundary fields into the areas of concern. Clean initial conditions were employed at the start of the ramp-up period.

5.10 CMAQ Emission Files for 2002

5.10.1 Regional Planning Organization Annual Emission Inventories for 2002

The OTR modeling domain (previously shown on Figure AD4) contains states from 4 of the 5 U. S. RPOs: Mid-Atlantic/Northeast Visibility Union (MANE-VU), Central Regional Air Planning Association (CENRAP), Midwest Regional Planning Organization (MRPO) and the Visibility Improvement State and Tribal Association of the Southwest (VISTAS). These RPOs were established by EPA to support regional haze planning activities, including the development of coordinated multi-purpose emission inventories. Each RPO has prepared detailed emission inventories for calendar year 2002 that are being used for ozone, PM2.5 and regional haze SIP attainment demonstrations. RPO boundaries were previously shown in Figure AD5.

5.10.2 MANE-VU Annual Emission Inventory for 2002

The OTR states, except for Virginia, are members of the MANE-VU RPO (Virginia is in the VISTAS RPO). The Mid-Atlantic Regional Air Management Association (MARAMA) directed the preparation of the 2002 MANE-VU emission inventory. The MANE-VU states consist of Connecticut, Delaware, the District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont. A detailed technical support document describing the development of 2002 MANE-VU emission inventory is contained in Appendix I.

The 2002 MANE-VU emission inventory was based upon point, area, on-road, and non-road emission inventory data submitted by MANE-VU states to EPA in 2004 as a requirement of the Consolidated Emissions Reporting Rule. Under contract to MARAMA, E.H. Pechan & Associates (Pechan) collected this information and ran EPA format and content quality assurance programs and other checks to identify format and data content issues. Data gaps were filled in accordance with a Quality Assurance Project Plan prepared for this project (MANE-VU, 2004a).

After making corrections and filling data gaps, emission files for sulfur dioxide (SO_2), oxides of nitrogen (NO_x), volatile organic compounds (VOC), carbon monoxide (CO), ammonia (NH_3) and particles with aerodynamic diameters less than or equal to a nominal 10 and 2.5 micrometers (primary PM_{10} and $PM_{2.5}$) were prepared in National Emissions Inventory Input Format (NIF 3.0) and placed on the MARAMA ftp site.

Table AD1: MANE-VU 2002 Anthropogenic Emissions (Ton/Year)

2002 Version 3 Base Case	CO	NOX	VOC	NH3	SO2	PM10	PM2_5	PMC
Connecticut	992201	125208	162492	8598	32077	27061	15795	11266
Delaware	273433	58764	41120	14376	79868	15214	7931	7284
District of Columbia	101372	15389	14893	415	2939	2889	1276	1613
Maine	759882	94932	166501	11060	39362	64103	28458	35645
Maryland	1905406	283387	265220	31712	315251	72234	34805	37428
Massachusetts	1838763	276530	294703	25737	164112	89984	40667	49317
New Hampshire	594257	67326	111333	3678	55295	25796	19479	6316
New Jersey	2276006	303053	378877	24931	91273	47021	29350	17671
New York	5223096	655774	921593	83801	448322	229391	90977	138413
Pennsylvania	4448357	806061	594355	91842	1077658	228459	82467	145992
Rhode Island	312263	29418	57200	1789	8022	5058	2486	2571
Vermont	351716	28290	50461	10608	6022	21218	8330	12888
Total	19076752	2744133	3058749	308548	2320202	828427	362022	466405

Several versions of the emission inventory were prepared by Pechan to address corrections, improvements and ongoing state-of-the-art changes (for example, the non-road inventory was completely redone in Version 3 due to EPA modifications to the NONROAD2005 model). The most current version of the MANE-VU emission inventory (Version 3) was used for OTR state attainment demonstrations. MANE-VU state emission totals are shown in Table AD1.

5.10.3 Emission files for the OTR Domain

CMAQ-ready emission files for each RPO in the OTR domain (MANE-VU, CENRAP, MRPO, and VISTAS) were prepared by NY DEC. Emission files for portions of Canada in the OTR domain were also prepared by NY DEC. Emission processing procedures are summarized below and described in more detail in Appendix J.

5.10.3.1 MANE-VU Emission Files for 2002

Point, area, and non-road source emissions for MANE-VU states (MANE-VU Version 3 emission inventory) were obtained from the MARAMA ftp site and mobile emissions were obtained from the NESCAUM ftp site. NY DEC processed these emission files with SMOKE2.2 to prepare CMAQ-ready hourly emission input files

5.10.3.2 CENRAP Emission Files for 2002

CENRAP states in the OTR modeling domain consist of Arkansas, Iowa, Louisiana, Minnesota, and Missouri. Point, area, mobile and non-road source emissions for CENRAP states (CENRAP Version BaseB emission inventory) were obtained from the CENRAP ftp site by NY DEC and processed with SMOKE2.2 to prepare CMAQ-ready hourly emission input files.

5.10.3.3 MRPO Emission Files for 2002

MRPO states in the OTR modeling domain consist of Illinois, Indiana, Michigan Ohio, and Wisconsin. Point, area, mobile and non-road emissions for MRPO states were generated by Alpine Geophysics through a contract from MARAMA to convert the MRPO BaseK emission inventory to IDA format. The files were then obtained from the MARAMA ftp site by NY DEC and processed with SMOKE2.2 to prepare CMAQ-ready hourly emission input files.

5.10.3.4 VISTAS Emission Files for 2002

VISTAS states in the OTR modeling domain consist of Alabama, Georgia, Kentucky, North Carolina, South Caroline, Tennessee and Virginia. Point, area, mobile and non-road emission files for VISTAS states (VISTAS BaseG emission inventory) were obtained from the Alpine Geophysics ftp site by NY DEC and processed with SMOKE2.2 to prepare CMAQ-ready hourly emission input files.

5.10.3.5 Canadian Emission Files for 2002

Canadian non-road and mobile source emission files were obtained from EPA and processed with SMOKE2.1 by NY DEC. Non-EGU and EGU point source emissions were obtained from Canadian National Pollutant Release Inventory (NPRI) database. NY DEC inserted SCC code estimates (NPRI has no SCC codes) and then processed the emission files with SMOKE2.2 to prepare CMAQ-ready hourly emission input files.

5.11 New OTR Control Measures for 2009

5.11.1 Potential Beyond On the Way (BOTW) Control Measures

Preliminary ozone modeling efforts (EPA, 2004) to support the proposed Clean Air Interstate Air Quality Rule (CAIR) indicated that additional controls beyond federal and state CAA control measures would be needed to attain the 8-hour ozone NAAQS in several portions of the OTR. Accordingly, OTC staff and member states formed several OTC workgroups to identify and evaluate potential control measures. Control measures were identified through published sources such as the U.S. Environmental Protection Agency's Control Technique Guidelines, STAPPA/ALAPCO Menu of Options documents, the AirControlNET database, emission control initiatives in member states, state/regional consultations, and stakeholder input. OTC workgroups compiled and reviewed a list of approximately 1,000 candidate control measures from which 30 control measures were selected for detailed analyses.

5.11.2 Final OTC Beyond On the Way (BOTW) Control Measures

The OTC workgroups discussed the candidate control measures during a series of conference calls and workshops from the spring of 2004 through the autumn of 2006. OTC workgroups collected and evaluated information regarding emission benefits, cost-effectiveness, and implementation issues, and stakeholders were provided opportunity to review and provide input. The procedures used to develop and evaluate these control measures (MACTEC, 2007b) are contained in Appendix K.

Based on this information, OTC Commissioners recommended that States consider emission reductions from the following source categories: Consumer Products, Portable Fuel Containers, Adhesives and Sealants Application, Diesel Engine Chip Reflash, Cutback and Emulsified Asphalt Paving, Asphalt Production Plants, Cement Kilns, Glass Furnaces, Industrial, Commercial, and Institutional (ICI) Boilers and Regional Fuels. These control measures are collectively referred to as beyond on the way (BOTW) control measures.

As part of its 8-Hour Ozone Attainment Demonstration SIP, MassDEP either has, or expects to adopt, regulations to reduce emissions from the following BOTW control measures: Consumer Products, Adhesives and Sealants and Asphalt Paving. In addition, MassDEP either has, or intends to adopt regulations reducing emissions from Solvent Metal Degreasing and from Architectual and Industrial Maintenance(AIM) coatings. (These control measures are described

in Section 3, *Control Measures*, or Section 6 *RACT*. The anticipated effective dates and estimated reductions from these measures are also discussed.)

5.12 CMAQ Emission Files for 2009 with OTC BOTW Control Measures

5.12.1 Regional Planning Organization Annual Emission Inventories for 2009

The CENRAP, MRPO, VISTAS and MANE-VU RPOs prepared future year emission inventories for 2009 by applying growth and control measures to the 2002 base year emission inventories. The control measures reflected all control programs that are already on the way and in effect by 2009. These emission inventories, referred to as "on the way" emission inventories, reflect NOx SIP Call and CAIR requirements (http://www.epa.gov/interstateairquality/), federal on-road and off-road fuels, federal motor vehicle standards and state LEV (low emission vehicle) programs, federal MACT rules, 2001 OTC model rules for consumer products, architectural coatings, distributed generation and any other state-specific rules in effect by 2009. The inter-RPO work group utilized the Integrated Planning Model (IPM) to develop state and unit-level EGU emissions reflecting EPA's Clean Air Interstate Rule (CAIR) in the CENRAP, MRPO, VISTAS and MANE-VU RPOs (ICF, 2005).

5.12.2 MANEVU Annual Emission Inventory with BOTW Control Measures for 2009

The Mid-Atlantic Regional Air Management Association (MARAMA) contracted MACTEC to prepare 2009 emissions for non-EGU point sources, area sources and non-road sources that reflected control measures that were already on the way and in effect by 2009. MACTEC in consultation with MANE-VU states developed the necessary growth and control factors and applied them to the 2002 MANE-VU emission inventory (Version 3) previously described in Section 10. Details of this work effort are contained in Appendix L (MACTEC, 2007a). Mobile source emissions were prepared by VA DEQ and NESCAUM, using MOBILE 6 input files and projected 2009 VMTs supplied by the MANE-VU states.

MACTEC then calculated "beyond on the way" (BOTW) emission reductions reflecting the new OTC 2006 model rules for non-EGU point sources and several area source categories in the OTR states (previously described in Section 5.11). The BOTW control measures were developed because preliminary ozone modeling efforts indicated additional controls would be needed to attain the 8-hour ozone NAAQS in portions of the OTR. Emission reduction calculations are presented in Appendix K (MACTEC, 2007b). State totals for the MANE-VU 2009 emission inventory reflecting BOTW control measures are shown in Table AD2. BOTW emission reductions were incorporated into the 2009 MANE-VU 2009 emission inventory and all emission files were placed on the MARAMA ftp site

5.12.3 Emission files for the OTR Domain

CMAQ-ready emission files for 2009 for each RPO in the OTR modeling domain (MANE-VU, CENRAP, MRPO, and VISTAS) were prepared or obtained by NY DEC. Emission files for portions of Canada in the OTR domain were also prepared by NY DEC. Emission processing procedures are summarized below and described in more detail Appendix M.

Table AD2: MANE-VU 2009 Anthropogenic Emissions with BOTW Controls (Ton/Yr)

2009 Version 3 BOTW	CO	NOX	VOC	NH3	SO2	PM10	PM2_5	PMC
Connecticut	751975	82139	122353	9255	22796	26481	15037	11443
Delaware	231392	49658	32109	14695	42569	15372	7694	7679
District of Columbia	67904	10433	10403	436	2297	2006	1124	882
Maine	579671	60201	141619	12974	38737	64881	27633	37247
Maryland	1373959	147710	205097	38971	114046	80496	39550	40946
Massachusetts	1290133	180391	229386	26513	64733	93839	42428	51411
New Hampshire	443286	44339	94330	4266	18597	26087	19511	6577
New Jersey	1778637	185314	285559	27935	49535	46183	28753	17430
New York	3730881	456457	710567	100682	325621	242237	98945	143293
Pennsylvania	3422688	518109	477042	113344	403150	259116	107315	151801
Rhode Island	240906	21900	44612	2144	8359	5410	2608	2802
Vermont	236142	17793	43063	13038	5966	22103	8099	14004
Total	14147574	1774443	2396138	364252	1096404	884212	398696	485516

5.12.3.1 MANE-VU Emission Files for 2009

Non-EGU point source and area source emissions for MANE-VU states (2009 MANE-VU Version 3 emission inventory) reflecting BOTW control measures were obtained from the MARAMA ftp site by NY DEC and processed with SMOKE2.2 to prepare CMAQ-ready emission input files. Mobile source emissions for MANE-VU states were obtained from the MARAMA ftp site by NY DEC and processed with SMOKE2.2 to prepare CMAQ-ready emission input files. Non-road source emissions (2009 MANE-VU Version 3 emission inventory) were obtained from the MARAMA ftp site by VA DEQ and processed with SMOKE2.2 to prepare CMAQ-ready emission input files. EGU emissions (IPM2.1.9) were obtained from ICF (ICF, 2005) by VA DEQ and processed with SMOKE2.2 to prepare CMAQ-ready hourly emission input files.

5.12.3.2 CENRAP Emission files for 2009

Non-EGU point, area, mobile and non-road emissions for CENRAP states in the OTR domain (2009 CENRAP BaseB emission inventory) were obtained from the CENRAP ftp site by VA DEQ and processed with SMOKE2.2 to prepare CMAQ-ready emission input files for the 2009 simulation. EGU emissions (IPM2.1.9) were obtained from ICF (ICF,

2005) by VA DEQ and processed with SMOKE2.2 to prepare CMAQ-ready hourly emission input files.

5.12.3.3 MRPO Emission files for 2009

Area and non-road emissions for MRPO states in the OTR domain (2009 MRPO BaseK emission inventory) were obtained from the MRPO by NY DEC and processed with SMOKE2.2 to prepare CMAQ-ready emission files for the 2009 simulation. Non-EGU and mobile emissions were obtained from the 2009 MRPO BaseK emission inventory by VA DEQ and processed with SMOKE2.2 to prepare CMAQ-ready emission input files. EGU emissions (IPM2.1.9) were obtained from ICF (ICF, 2005) by VA DEQ and processed with SMOKE2.2 to prepare CMAQ-ready hourly emission input files.

5.12.3.4 VISTAS Emission Files for 2009

Non-EGU point, area, mobile and non-road emission files for VISTAS states in the OTR domain (2009 VISTAS BaseG emission inventory) were obtained from the Alpine Geophysics ftp site by VA DEQ and processed with SMOKE2.2 to prepare CMAQ-ready emission input files for the 2009 simulation. VISTAS EGU emissions were obtained from ICF (ICF, 2005) by VA DEQ and processed with SMOKE2.2 to prepare CMAQ-ready hourly emission input files.

5.12.3.5 Canadian Emission Files for 2009

NY DE obtained area, non-road and mobile source emission files for 2010 from EPA and obtained EGU point source emissions for 2010 from Environment Canada. These were considered to be a reasonable surrogate for 2009. Non-EGU point source emissions for 2002 (Section 10.3) were used as a surrogate for 2009. NY DEC processed these Canadian emission files with SMOKE2.2 to prepare CMAQ-ready hourly emission input files.

5.13 Quality Assurance of CMAQ Databases

All air quality, emissions, and meteorological data were reviewed to ensure completeness, accuracy, and consistency before proceeding with modeling. Any errors, missing data or inconsistencies were addressed using standard practices. All modeling was benchmarked through the duplication of a set of standard modeling results including benchmark runs with five modeling centers in the OTR (New York Department of Environmental Conservation, University of Maryland, NESCAUM, Rutgers University, and Virginia Department of Environment Quality).

Quality assurance activities were carried out for the various emissions, meteorological, and photochemical modeling components of the modeling study. Emissions inventories obtained

from all RPOs (CENRAP, MANE-VU, MWRPO and VISTEAS) were examined to check for errors in the emissions estimates. When such errors were discovered, the problems in the input data files were corrected.

The MM5 meteorological and CMAQ air quality model inputs and outputs were plotted and examined by NY DEC to ensure accurate representation of the observed data in the model-ready fields, and temporal and spatial consistency and reasonableness. Both MM5 and CMAQ underwent operational and scientific evaluations by NYDEC and the OTC Modeling Committee to facilitate the quality assurance review of meteorological and air quality modeling procedures.

5.14 CMAQ Model Simulation for 2002 Base Case

5.14.1 CMAQ Model 2002 Application

The CMAQ 2002 base case simulation was performed by NY DEC using a one-way nesting approach for the 12 km OTR modeling domain. The OTR modeling domain was previously described in Section 4. CMAQ (version 4.5.1) was used with CB-IV chemistry, the aerosol module for $PM_{2.5}$ and the Regional Air Deposition Model (RADM) cloud scheme. The simulation ran from May 1 to September 30, with the first 14 days of May used as a ramp-up period to minimize the propagation of boundary fields into areas of concern. The CMAQ results used for the performance evaluation were from May 15 through September 30. Details of the CMAQ setup and application are listed in Appendix N.

5.14.2 CMAQ Input Files for 2002

5.14.2.1 Emission Files for 2002 simulation

The CMAQ-ready hourly emission files described in Sub-Section 10 for all RPO states and Canadian Provinces in the OTR modeling domain were used for the 2002 CMAQ base case simulation. As described in Section 8, NY DEC used the BEIS model to prepare gridded normalized biogenic emission files for CO, NO, and the CB-IV VOC species for the 2002 simulation.

5.14.2.2 Boundary and Initial Conditions for 2002 simulation

As described in Sub-Section 9, hourly boundary fields for the 12km CMAQ domain were obtained by NY DEC using the BCON program to extract the 3-D concentration fields from the NY DEC continental USA CMAQ run at the four edges of the OTR modeling domain. Clean initial conditions were employed.

5.14.2.3 Meteorological Files for 2002 simulation

The meteorological data for the 2002 simulation were based on the MM5 modeling described in Sub-Section 7. The MM5 fields for the May 1 to September 30 MM5 simulation were processed with Meteorology Chemistry Interface Processor (MCIP

Version 3.0) obtained from the CMAS Modeling Center (http://www.cmascenter.org) in order to provide CMAQ model-ready hourly meteorological input files.

5.14.2.4 Photolysis Rates

Photolysis rate lookup tables were generated by NY DEC for each day using CMAQ's Photolysis Rates Processor (JPROC) software (http://www.cmascenter.org). Daily ozone column measurements from NASA's Earthprobe Total Ozone Mapping Spectrometer (TOMS) instrument (ftp://toms.gsfc.nasa.gov/pub/eptoms/data/ozone/Y2002/) were downloaded and used as input to the JPROC processing software.

5.14.3 CMAQ Output Files

Predicted hourly ozone concentrations for each ozone monitoring station location in all OTR states are listed in Appendix O. Daily ozone maps for the 2002 ozone season are contained in Appendix P. All input and output files for the 2002 Base Case CMAQ simulation for the OTR modeling domain are listed in Appendix U. Files are available in electronic format from NY DEC for use with the SMOKE/CMAQ system. Please contact Gopal Sistla at 518-402-8402 data file requests.

5.15 Performance Evaluation of 2002 Simulation

5.15.1 NY DEC Performance Evaluation for OTR Modeling Domain

NY DEC conducted a detailed performance evaluation of the OTC CMAQ modeling platform simulation for the 2002 ozone season (Appendix Q). The CMAQ simulation ran from May 1 to September 30; May 1 through May 14 was the ramp up period to minimize effects of boundary conditions and the results for May 15 though September 30 were used for the performance evaluation. Air quality predictions for O_3, CO, NO, NO2, SO2, C_2H_4, C_5H_8, HCHO, $PM_{2.5}$ and several regional haze aerosol species were compared to measurements in every grid cell where air quality data were available. Hourly ozone measurements from 234 monitors were available to assess CMAQ model performance in the OTR.

A variety of model performance metrics for each of these pollutants - observed average, predicted average, correlation coefficient (R2), normalized mean error, root mean square error (RMSE), mean absolute gross error (MAGE), mean normalized gross error (MNGE), mean bias (MB), mean normalized bias (MNB), mean fractionalized bias (MFB), normalized mean bias (NMB), along with temporal plots and daily ozone maps were prepared in order to help assess model performance. In general, the observed and predicted composite average ozone concentrations track well, although there was fairly substantial under-prediction during the mid-August period. Model performance was better in the vicinity of urban areas and along the northeastern corridor, compared to the performance in rural areas where the model tended to under-predict daily maximum concentrations. A complete set of model performance statistics for all OTR monitoring locations is contained in Appendix R.

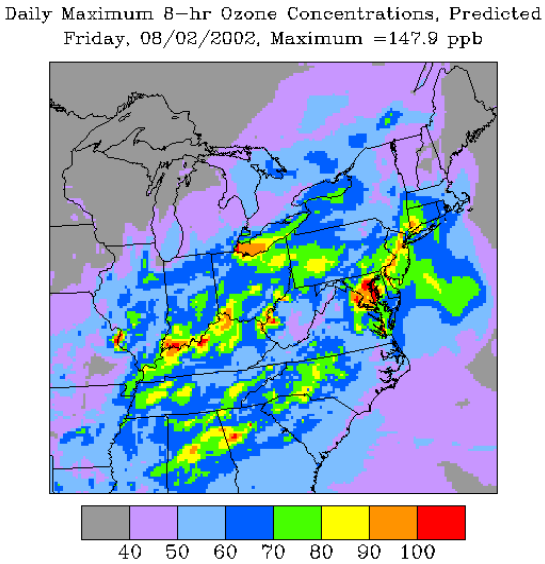
5.15.2 CMAQ Spatial Performance in New England States

In assessing spatial performance of the CMAQ model, two elements are critical: (1) the model's ability to replicate the general spatial pattern of ozone across most of the domain and, in particular, the New England region, and (2) whether the model can reproduce concentration gradients often observed along and within a few miles of the New England coast. A review of side-by-side maps of observed and predicted peak ozone values for the 2002 ozone season indicate the CMAQ model is doing a fairly good job of replicating spatial patterns and concentration gradients. A complete set of daily maps is contained in Appendix P.

Figures AD7-AD10 reveal good consistency between predicted and observed daily peak 8-hour ozone values. The simulations in Figure AD7 and AD8, for example, capture the narrow strip of elevated ozone from around Maryland northeastward to southern New England. The CMAQ model reproduced the splotchy areas of high ozone from the Midwest down across Tennessee (Figure AD8), as well as the clean areas near the Carolina coasts. In Figure AD9, not only are the New England plume and broad Midwest region of high ozone captured, but the area of relative minimum ozone across Pennsylvania and New York is also replicated.

In addition, and perhaps most importantly for New England, it appears that the model correctly handles the effect of slight wind trajectory differences on ozone patterns across the southern New England coast. Figure AD9 shows that the CMAQ model correctly predicted high ozone values across southern New England, along with a clean area on the south coast caused by marine air blowing onshore. A reverse of that pattern is shown in Figure AD10, in which south coastal New England has elevated ozone while values in interior southern New England are low. This typical westerly (as opposed to southwesterly) flow scenario draws polluted air from the New York City/New Jersey areas eastward along the New England south coast. Air reaching interior sections of New England had earlier crossed central New York and thus arrived fairly clean. That the model discerned these two episode types and reproduced the north-south gradient is encouraging, and gives confidence that the CMAQ model can replicate daily maximum 8-hour ozone concentrations in New England.

Figure AD7: Maximum 8-Hour Values on August 8, 2002



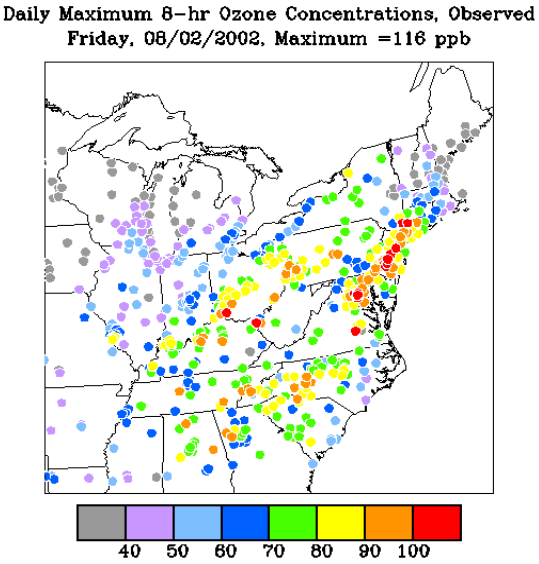
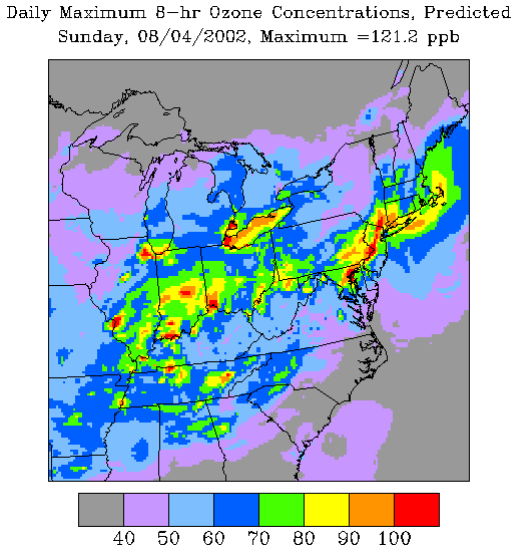


Figure AD8: Maximum 8-Hour Values on August 8, 2002



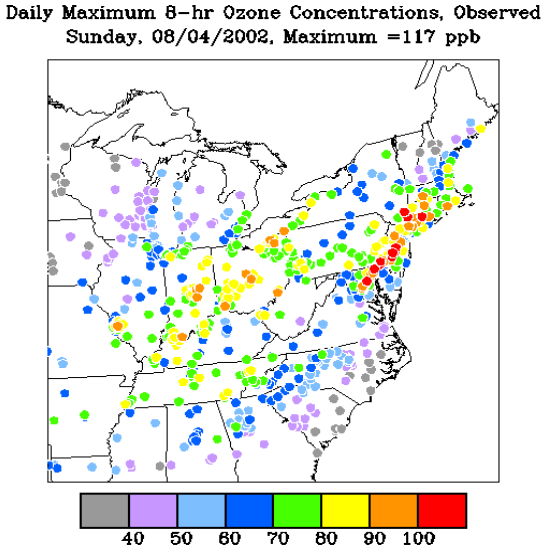
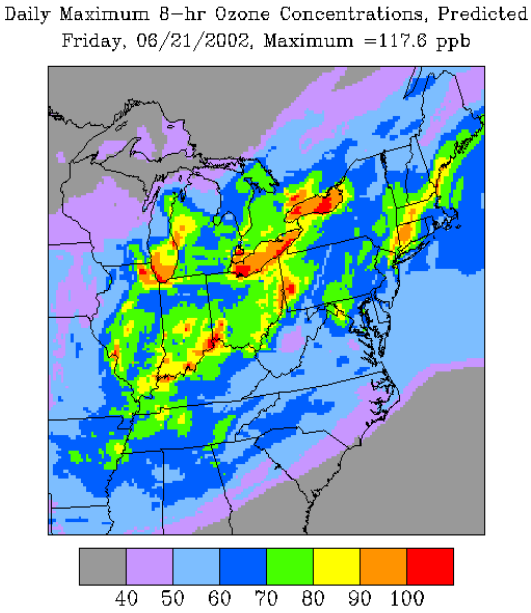


Figure AD9: Maximum 8-Hour Values on June 21, 2002



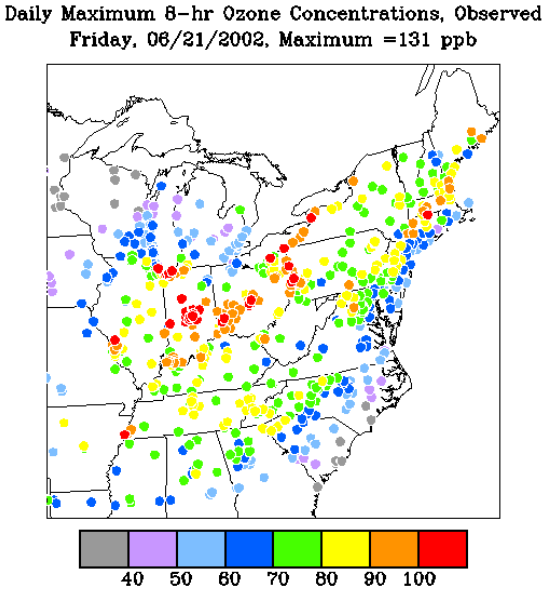


Figure AD10: Maximum 8-Hour Values on July 18, 2002

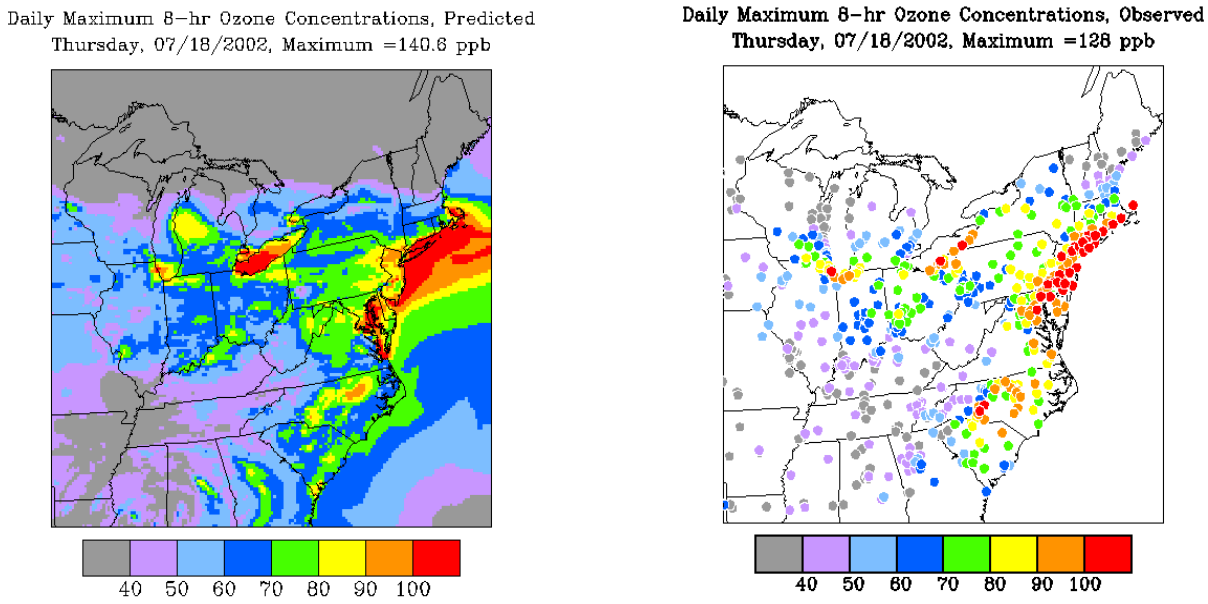
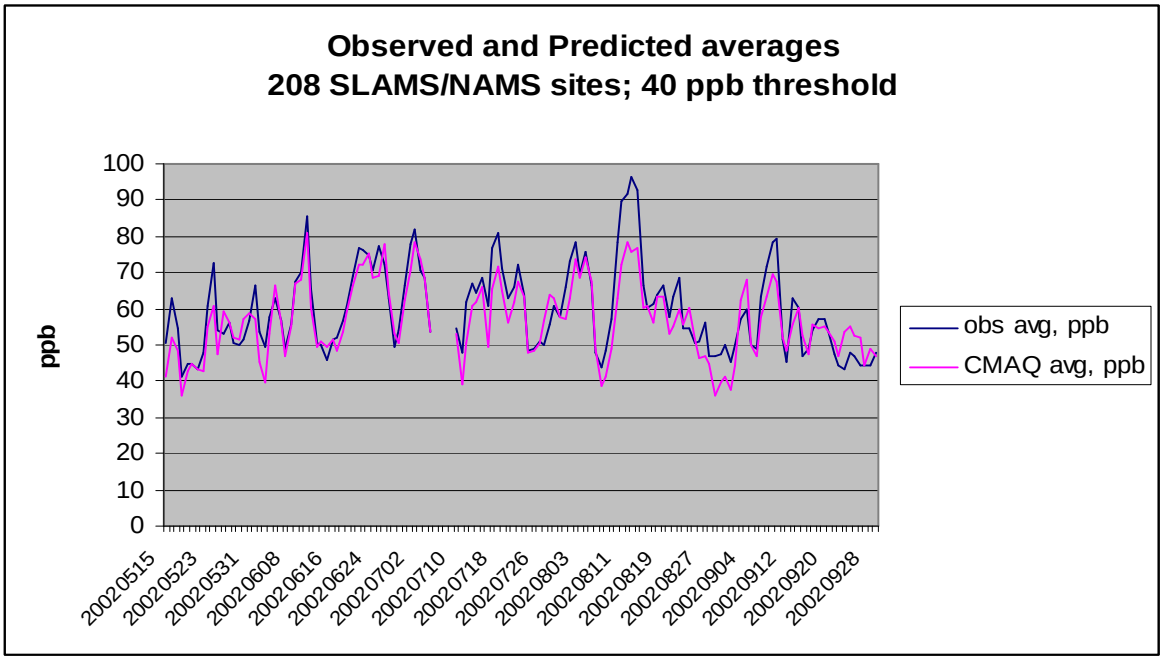


Figure AD11: Hourly Ozone Values for 2002 Ozone Season



Finally, the CMAQ model appears to do a reasonable job of be simulating ground level ozone diurnal buildup and decay. Figure AD11 is a time series of observed and modeled peak 8-hour ozone values averaged over the domain for the entire modeling period (NYDEC, 2006). Although an under prediction is evident, it is consistent, and the predictions do track the observations well. The model's under prediction of ozone is not a big concern since CMAQ modeling results are to be used in a relative sense, and because the under-prediction is consistent over the modeling period and across the modeling domain.

5.15.3 CMAQ Selected Model Metrics for New England States

EPA recommends that several statistical metrics be developed for air quality modeling (EPA, 2007). Two metrics that are most often used to assess performance are mean normalized gross error (MNGE) and the mean normalized bias (MNB). The mean normalized gross error provides an overall assessment of model performance and can be interpreted as precision, and the mean normalized bias parameter measures a model's ability to reproduce observed spatial and temporal patterns, and can be interpreted as accuracy. EPA suggests a mean normalized gross error (MNGE) of less than 35% above a threshold of 40-60 ppb and a mean normalized bias (MNB) of less than ±15% as a reasonable test for acceptable model performance. The mean normalized gross error (MNGE) and the mean normalized bias (MNB) for maximum daily 8-hour concentrations at or above 60 ppb at Massachusetts ozone monitors for the 2002 CMAQ simulation are shown in Table AD3.

Table AD3: Mean Normalized Gross Error and Mean Normalized Bias for MA Ozone Monitors

State	AIRS-ID	Location	Observed ppb	CMAQ ppb	MNGE %	MNB %
MA	250010002	Truro	76.3	82.8	14.0	9.1
MA	250034002	Adams	73.6	61.2	16.4	-16.0
MA	250051002	Fairhaven	74.3	74.6	11.5	1.6
MA	250090005	Lawrence	80.0	72.3	14.6	-8.0
MA	250092006	Lynn	80.8	71.6	13.7	-10.7
MA	250094004	Newbury	79.4	87.6	14.7	10.3
MA	250130003	Agawam	76.6	67.1	15.1	-11.7
MA	250130008	Chicopee	76.4	65.2	15.3	-14.0
MA	250150103	Amherst	73.8	65.6	12.9	-10.9
MA	250154002	Ware	76.0	66.7	14.9	-11.7
MA	250171102	Stow	76.3	66.2	13.7	-12.8
MA	250213003	Milton	79.6	68.3	15.4	-13.7
MA	250250041	Boston (Long I)	76.7	76.1	17.1	0.2
MA	250250042	Boston (Harris)	72.4	65.8	12.9	-8.4
MA	250270015	Worcester	82.7	65.9	19.8	-19.8
AVE					14.8	-7.8

Mean normalized gross error was well below the EPA 35% criteria at all Massachusetts ozone monitors. Mean normalized bias was slightly above the ±15% criteria at the Adams and the Worcester monitors (-16% and -19.8 %). This was not considered to be a significant concern since the 2002 design values for these two monitors, 83 ppb and 84 ppb respectively, are already below the ozone NAAQS (Table AD9, Section 17).

The mean normalized gross error (MNGE) and the mean normalized bias (MNB) for maximum daily 8-hour concentrations at or above 60 ppb at all other New England state ozone monitors are listed in Tables AD4-AD8. The other New England state ozone monitors meet the MNGE criteria of 35%. The MNB values are above the ±15% criteria at several ozone monitoring locations in Vermont and New Hampshire. This under-prediction in Vermont and New Hampshire is not considered to be a significant concern since the 2002 design values at these monitors (Table AD13 and Table AD14) are already close to the ozone NAAQS. In addition, CMAQ modeling results are being used in a relative way which helps minimize the under-prediction of peak ozone concentrations.

Table AD4: Mean Normalized Gross Error and Mean Normalized Bias for RI Ozone Monitors

State	AIRS-ID	Location	Observed ppb	CMAQ ppb	MNGE %	MNB %
RI	440030002	Alton Jones	77.9	75.7	10.5	-1.8
RI	440071010	Francis School	77.6	74.0	10.8	-4.3
RI	440090007	EPA Lab	76.9	83.3	14.9	9.4
AVE					12.1	1.1

Table AD5: Mean Normalized Gross Error and Mean Normalized Bias for CT Ozone Monitors

State	AIRS-ID	Location	Observed ppb	CMAQ ppb	MNGE %	MNB %
CT	090010017	Greenwich	78.2	77.8	13.8	0.3
CT	090011123	Danbury	80.9	73.4	13.4	-8.7
CT	090013007	Stratford	80.8	80.0	17.1	-0.1
CT	090019003	Westport	80.7	78.9	12.2	-1.8
CT	090031003	E. Hartford	77.8	78.6	13.8	2.3
CT	090050005	Cornwall	78.8	64.5	20.2	-17.8
CT	090070007	Middletown	80.5	77.9	10.7	-3.7
CT	090093002	Madison	83.1	83.8	14.5	1.7
CT	090099005	Hamden	79.4	78.0	13.0	-1.0
CT	090110008	Groton	75.5	94.4	30.3	28.1
CT	090131001	Stafford	78.2	71.1	12.2	-8.7
AVE					15.6	-0.9

Table AD6: Mean Normalized Gross Error and Mean Normalized Bias for NH Ozone Monitors

State	AIRS-ID	Location	Observed ppb	CMAQ ppb	MNGE %	MNB %
NH	330012004	Laconia	70.1	52.7	24.6	-24.6
NH	330031002	Conway	67.5	52.8	21.8	-21.3
NH	330050007	Keene	75.9	64.5	15.9	-14.5
NH	330074001	Mt Washington top	72.3	50.5	30.0	-30.0
NH	330074002	Mt Washington base	66.7	57.0	17.4	-14.5
NH	330074003	Pittsburg	68.7	54.7	20.5	-20.5
NH	330090008	Haverhill	68.0	52.8	22.1	-22.1
NH	330110020	Manchester	74.5	62.9	15.5	-15.0
NH	330111010	Nashua	76.1	66.0	13.9	-12.3
NH	330115001	Peterborough	80.9	60.3	24.7	-24.7
NH	330130007	Concord	74.2	58.5	20.9	-20.7
NH	330150012	Rye	78.2	69.6	13.4	-11.1
NH	330150013	999	73.9	61.9	16.7	-15.3
NH	330150015	Portsmouth	79.1	72.4	9.7	-8.5
NH	330173002	Rochester	74.7	64.0	15.5	-14.0
NH	330190003	Claremont	72.1	55.9	22.2	-22.2
AVE					19.0	-18.2

Table AD7: Mean Normalized Gross Error and Mean Normalized Bias for VT Ozone Monitors

State	AIRS-ID	Location	Observed ppb	CMAQ ppb	MNGE %	MNB %
VT	500030004	Bennington	70.9	59.2	16.5	-15.7
VT	500070007	Underhill	74.8	56.1	24.2	-24.2
AVE					20.3	-19.9

Table AD8: Mean Normalized Gross Error and Mean Normalized Bias for ME Ozone Monitors

State	AIRS-ID	Location	Observed ppb	CMAQ ppb	MNGE %	MNB %
ME	230052003	Cape Elizabeth	76.0	72.4	13.6	-3.1
ME	230090102	ANP Cadillac M	79.0	70.3	12.8	-10.7
ME	230090103	ANP McFarland	76.4	69.4	11.6	-8.5
ME	230090301	Castine	72.3	73.7	10.2	2.8
ME	230112005	Gardiner Pray	77.3	65.4	17.2	-14.8
ME	230130004	Port Clyde	73.1	77.1	15.6	5.6
ME	230173001	North Lovell	67.6	51.8	24.0	-24.0
ME	230194008	Holden Rider B	74.1	58.7	21.1	-20.3
ME	230230004	Georgetown	75.6	83.4	12.5	11.0
ME	230310038	West Buxton	76.8	62.1	19.0	-19.0
ME	230313002	Kittery	82.3	71.6	15.9	-11.8
ME	230312002	Kennebunkport	80.3	70.1	13.8	-12.3
ME	239010001	Scotia Prince Ferry	73.0	64.7	17.8	-11.6
AVE					15.8	-9.0

5.16 CMAQ Model Simulation for 2009 Control Strategy

5.16.1 CMAQ Model 2009 Application

The CMAQ 2009 base case simulation was performed by NY DEC in the same manner as the CMAQ 2002 base case simulation. The simulation period ran from May 1 to September 30, with the first 14 days of May as a ramp-up period to minimize the propagation of the boundary fields into areas of concern. The actual CMAQ results for the CMAQ control strategy evaluation were from May 15 through September 30.

5.16.2 CMAQ Input Files for 2009.

5.16.2.1 Emission Files for 2009 simulation

The CMAQ 2009 control strategy simulation employed the 2009 CMAQ-ready hourly emission files described in Sub-Section 12 for RPO states and Canadian Provinces in the OTR modeling domain. These emission files reflect “beyond on the way” (BOTW) controls in all OTR states and “on the way controls” (OTW) controls in CENRAP, MRPO and VISTAS states in the OTR modeling domain**.** The 2002 hourly biogenic

were also used for 2009 CMAQ simulations since significant change in land use would not be expected to occur between 2002 and 2009.

5.16.2.2 Boundary and Initial Conditions for 2009 simulation

The 2002 hourly boundary condition files (Section 14) were used for the 2009 future year CMAQ simulation. This was considered to be a reasonable and conservative approach since air pollution levels and emissions are expected to be lower in 2009.

5.16.2.3 Meteorological Files for 2009 simulation

The 2002 hourly meteorological files (Section 14) were used for the 2009 simulation.

5.16.2.4 Photolysis Rates

The photolysis rate tables generated for 2002 (Section 14) were used for 2009 simulation.

5.16.3 CMAQ Output Files

All input and output files for 2009 BOTW CMAQ simulation for the OTR modeling domain are listed in Appendix S. Files are available in electronic format for the 12km domain from NYSDEC for use with the SMOKE/CMAQ system. Please contact NY DEC Gopal Sitla at 518-402-8402) for data file requests.

5.17 Predicted Design Values for 2009

5.17.1 Design Values for 2002 Base Case

Design values at each monitoring site were calculated in accordance with 40 CFR Part 50.10, Appendix I. The design value for a three-year period of time is calculated as the 3-year average of the fourth highest monitored daily 8-hour maximum value. For example, the design value for the 2000-2002 periods is the average of the fourth highest monitored daily 8-hour maximum values in 2000, 2001 and 2002.

For the modeled attainment test, EPA guidance (EPA, 2007) recommends averaging three design values that straddle the baseline inventory year (the baseline inventory year is 2002). Therefore, the 2002 design value for the attainment demonstration is the average of the “2002 design value” (determined from 2000-2002 observations), the “2003 design value” (determined from 2001-2003 observations), and the “2004 design value” (determined from 2002-2004 observations).

The 2002 design value (DVC) was calculated in ppb, and carried to 1 significant digit. The 2002 design values for Massachusetts ozone monitors are listed in Table 9 and the 2002 design values for the other New England states are shown in Table 10-14. The design values for all other ozone monitors in the OTR are listed in Appendix T.

5.17.2 Relative Response Factor for 2009 (RRF)

In order to minimize the under-prediction or over-prediction of peak ozone concentrations, EPA recommends that photochemical grid models be used in a relative way for modeled attainment demonstrations (EPA, 2007). Instead of using the absolute modeled results for 2009, EPA recommends that the change in predicted ozone concentrations between 2002 and 2009 be used for the attainment demonstration. EPA recommends that the 2009 design value be determined by multiplying the 2002 design value by a quantity referred to as a relative response factor (RRF). The RRF is the ratio of the 2009 ozone prediction divided by the 2002 ozone prediction.

The EPA guidance requires that an average daily RRF be determined for each monitor using the CMAQ model results from grid cells that are at and near a monitor with near being defined as a 3 by 3 grid array centered on the monitoring station location. For each day, the maximum predicted 2002 base case concentration and the maximum predicted 2009 BOTW emission scenario concentration are selected from the 3 X 3 grid array surrounding for each monitor.

Because photochemical models are less responsive to emission reductions on days of lower ozone concentrations, EPA guidance recommends applying screening criteria minimize using low ozone days when calculating RRFs (EPA, 2007). At least 10 days above 85 ppb are required to calculate the RRF at each monitoring location; if 10 days above 85 ppb are not available, EPA guidance allows for a smaller number of days at lower ozone concentrations. The minimum criteria is 5 days at or above 70 ppb for calculating a meaningful average daily RRF value. The detailed criteria for selecting high ozone days and calculating RRFs (to 3 significant digits) are described in Appendix T.

The 2009 relative response factors (RRFs) calculated for each Massachusetts ozone monitor for the 2009 BOTW emission scenario are listed in Table AD9, and the 2009 RRFs for all other New England states are shown in Table AD10-AD14. The RRFs for each ozone monitor in the OTR are contained in Appendix U.

5.17.3 Design Values for 2009

The 2009 future case design value (DVF) for the BOTW emission scenario was determined by multiplying the 2002 DVC for each monitor by the 2009 relative response factor (RRF) determined for each monitor. After the DVF was calculated, the DVF was truncated at the decimal point and then compared to the ozone 8-hour NAAQS. A truncated value at or below 84 ppb is considered to be a demonstration of modeled attainment (EPA, 2007).

The 2009 DVFs for Massachusetts monitors are shown in Table AD9. The highest predicted 2009 DVF is 82 ppb (at both Lynn and Milton), below the modeled attainment test of 84 ppb. The 2009 DVFs for other New England states are shown in Table AD10-AD14. The highest 2009 DVFs in New Hampshire, Maine and Vermont, areas that are subject to transport of ozone and ozone precursors from Massachusetts, are 74 ppb, 79 ppb and 70 ppb, well below the modeled attainment test of 84 ppb. The 2009 DVFs for all ozone monitors in the OTR for the 2009 BOTW emission scenario are contained in Appendix U.

Table AD9: 2009 Design Values (DVF) in Massachusetts for 2009 BOTW Emission Scenario

State	AIRS-ID	Location	DVC	RRF 2009	DVF 2009
MA	250010002	Truro	92.0	0.877	80
MA	250034002	Adams	83.3	0.877	73
MA	250051002	Fairhaven	91.0	0.878	79
MA	250090005	Lawrence	70.0	0.880	61
MA	250092006	Lynn	90.0	0.916	82
MA	250094004	Newbury	86.0	0.882	75
MA	250130003	Agawam	83.0	0.873	72
MA	250130008	Chicopee	92.0	0.872	80
MA	250150103	Amherst	74.7	0.874	65
MA	250154002	Ware	86.3	0.873	75
MA	250171102	Stow	85.7	0.870	74
MA	250213003	Milton	91.0	0.911	82
MA	250250041	Boston (Long I)	88.7	0.909	80
MA	250250042	Boston (Harris)	73.0	0.908	66
MA	250270015	Worcester	84.0	0.863	72

Table AD10: 2009 Design Values (DVF) in New Hampshire for 2009 BOTW Emission Scenario

State	AIRS-ID	Location	DVC	RRF 2009	DVF 2009
NH	330012004	Laconia	76.5	below criteria	below criteria
NH	330031002	Conway	67.0	below criteria	below criteria
NH	330050007	Keene	74.3	0.865	64
NH	330090008	Haverhill	70.3	below criteria	below criteria
NH	330111010	Nashua	86.0	0.867	74
NH	330115001	Peterborough	84.0	0.873	73
NH	330130007	Concord	74.7	below criteria	below criteria
NH	330150012	Rye	83.5	0.869	72
NH	330150013	Rockingham	80.0	0.858	68
NH	330150015	Portsmouth	68.0	0.869	59
NH	330173002	Rochester	78.5	0.860	67
NH	330190003	Claremont	74.3	below criteria	below criteria

Table AD11: 2009 Design Values (DVF) in Connecticut for 2009 BOTW Emission Scenario

State	AIRS-ID	Location	DVC	RRF 2009	DVF 2009
CT	090010017	Greenwich	95.7	0.913	87
CT	090011123	Danbury	95.7	0.897	85
CT	090013007	Stratford	98.3	0.919	90
CT	090019003	Westport	94.0	0.909	85
CT	090031003	E. Hartford	88.0	0.876	77
CT	090050005	Cornwall	89.0	0.870	77
CT	090070007	Middletown	95.7	0.888	84
CT	090093002	Madison	98.3	0.905	88
CT	090099005	Hamden	93.3	0.912	85
CT	090110008	Groton	90.0	0.879	79
CT	090131001	Stafford	92.3	0.867	80

Table AD12: 2009 Design Values (DVF) in Maine for 2009 BOTW Emission Scenario

State	AIRS-ID	Location	DVC	RRF 2009	DVF 2009
ME	230038001	Ashland135	64.0	below criteria	below criteria
ME	230052003	Cape Elizabeth	84.3	0.873	73
ME	230090102	ANP Cadillac M	91.7	0.869	79
ME	230090103	ANP McFarland	83.7	0.871	72
ME	230090301	Castine	75.0	0.879	65
ME	230112005	Gardiner Pray	78.0	0.869	67
ME	230130004	Port Clyde	83.7	0.871	72
ME	230173001	North Lovell	60.7	below criteria	below criteria
ME	230194007	Howland	66.7	below criteria	below criteria
ME	230194008	Holden Rider B	79.0	below criteria	below criteria
ME	230310038	West Buxton	75.0	0.860	64
ME	230312002	Kennebunkport	88.3	0.875	77
ME	230313002	Kittery	85.3	0.869	74

Table AD13: 2009 Design Values (DVF) in Vermont for 2009 BOTW Emission Scenario

State	AIRS-ID	Location	DVC	RRF 2009	DVF 2009
VT	500030004	Bennington	79.7	0.883	70
VT	500070007	Underhill	77.0	below criteria	below criteria

Table AD14: 2009 Design Values (DVF) in Rhode Island for 2009 BOTW Emission Scenario

State	AIRS-ID	Location	DVC	RRF 2009	DVF 2009
RI	440030002	West Greenwich	93.3	0.862	80
RI	440071010	Providence	89.7	0.868	77
RI	440090007	Narragansett	93.3	0.876	81

5.18 Estimating Design Values at Unmonitored Locations

5.18.1 Massachusetts Ozone Monitoring Network

Based on our understanding of ozone formation, transport, and destruction, MassDEP considers Massachusetts' network of ozone monitors to be adequate for measuring the highest ozone values occurring in the state. The Massachusetts ozone network used for determining 2002 and 2009 design values is shown in Figure AD12.

Generally, ozone production via chemical transformation occurs some distance downwind of areas containing significant precursor emissions. What happens still farther downwind depends on the number and size of precursor emission sources in that area. If it lacks such sources, ozone will eventually be depleted because of its high reactivity (provided transport is over land). It would then follow that, in areas where ozone levels drop off, additional monitoring would be unnecessary.

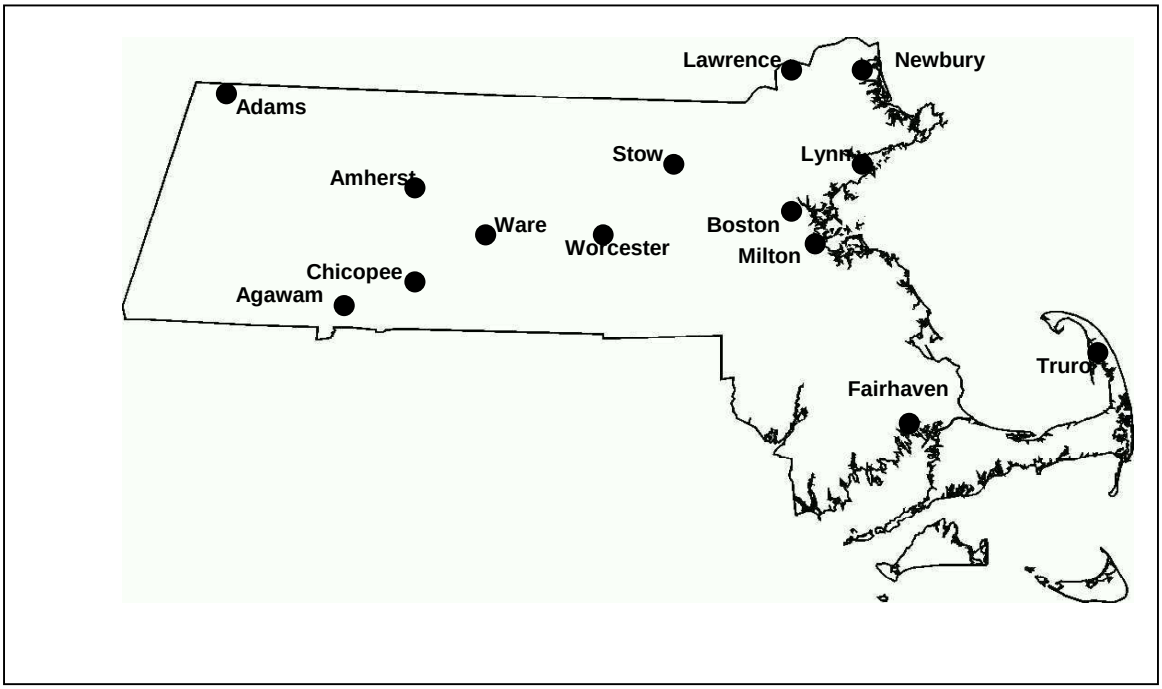
The primary source of ozone in Massachusetts is the stream of pollution from upwind states to our southwest. While Massachusetts contributes to this stream, it typically measures lower concentrations than does Connecticut, which lies closer to the area of highest emissions. There is further depletion of ozone moving northward from Chicopee and Ware to Amherst. This is due to fewer "fresh" (non-transport) emissions in that area that might otherwise stimulate ozone production.

It is that area, to the north of Amherst across the northern tier of the state, from the Charlemont area eastward to Groton, which has no ozone monitor. But because of the area's low population density and lack of significant industry, MassDEP is confident that ozone readings are relatively low here, and that additional monitoring coverage is unnecessary.

5.18.2 Future Year Design Values at Unmonitored Locations

Since VOC and NOx emissions are trending lower in Massachusetts and elsewhere, MassDEP is confident that using design values from the 2002 network to construct future year design values provides a reasonable estimate of maximum predicted design values in Massachusetts for 2009 and beyond.

Figure AD12: Massachusetts Ozone Monitors for 2002



5.19 Weight of Evidence

EPA modeling guidance provides that a state include in its attainment demonstration additional evidence to support its modeling analysis and to better assess the likelihood of attainment. EPA will review all of the evidence and make its determination as to the likelihood that the area will attain the ozone standard in the attainment year based on the entire "weight of evidence"(WOE). A WOE analysis must be included in the attainment demonstration when the modeling is deemed "inconclusive". EPA's guidance establishes the "inconclusive" range for 8-hour ozone modeling results at 82 ppb through 87 ppb for the required attainment year. The predicted design values for monitors in EMA and WMA are shown in Table AD17. The highest 2009-modeled design values are in Lynn and Milton at 82 ppb; all other modeled design values in EMA and WMA are below 82 ppb.

5.19.1 Air Quality Trends

Figures AD13 and AD14 display ozone design values from 2002-2007. For comparison, the predicted design values for the 2009 BOTW emission scenario were inserted on the chart. The graphs suggest that EMA is on track to meet the ozone NAAQS (85 ppb) by 2009. Since 2002, the trend appears to be continuing downward. For WMA, there is no clear trend in monitored data but ,.other factors discussed in this Section support the expectation that WMA will attain in 2009. If it does not, as discussed in Section 1, *Introduction*, MassDEP is confident that in 2009 WMA will be eligible to seek an extension of its attainment year.

Figure AD13: Design Value Trends in Eastern Massachusetts

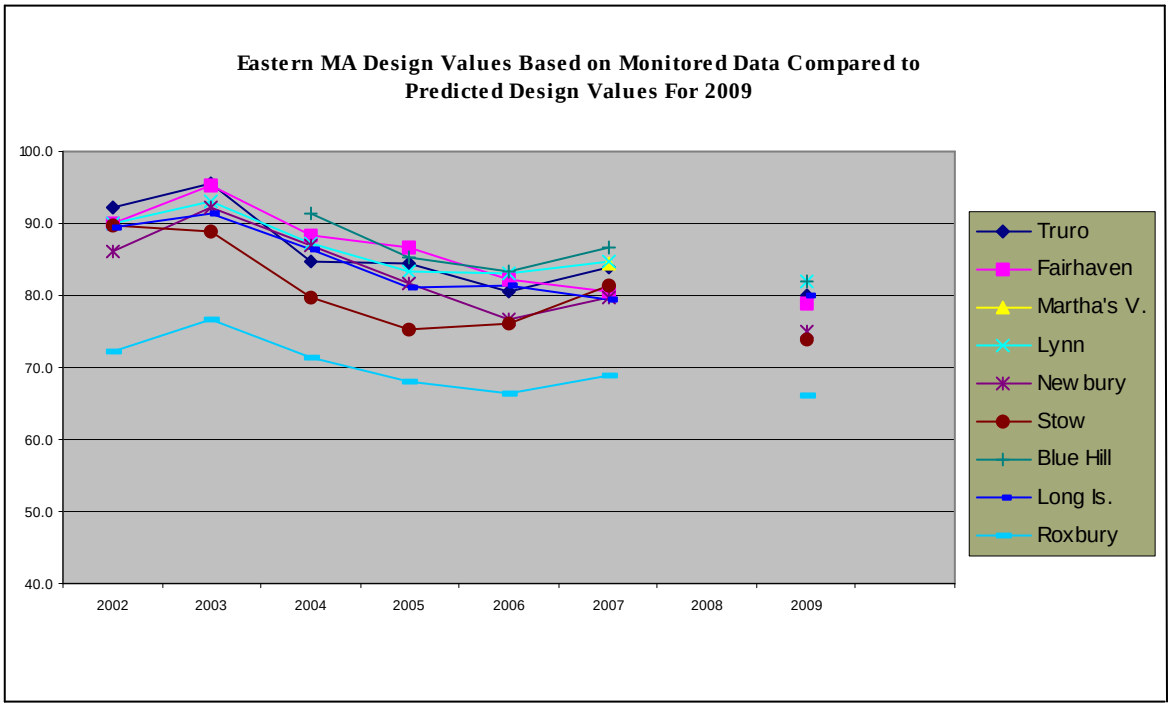
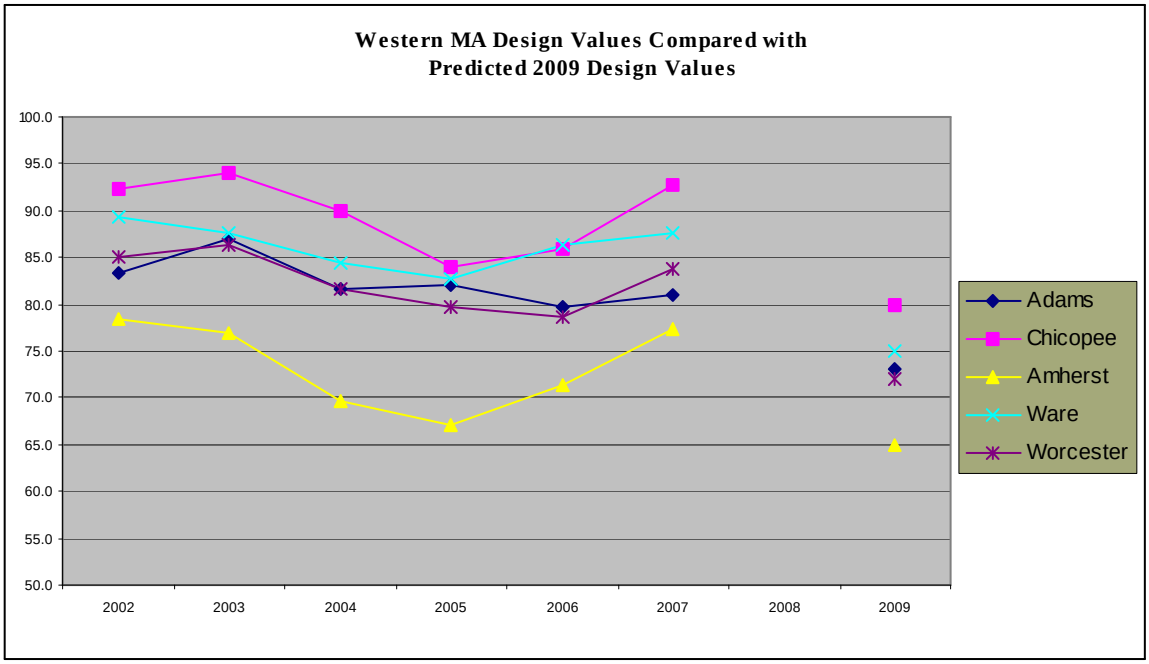


Figure AD14: Design Value Trends in Western Massachusetts



5.19.2 Emission Trends

The principal precursors for ozone are NOX and VOCs. Substantial NOX and VOC emission reductions will take place between 2002 and 2009 in the OTR. Most of these reductions are associated with the NOx SIP Call, CAIR, federal on-road and off-road fuels, federal motor vehicle standards and state LEV (low emission Vehicle) programs, federal MACT rules, 2001 OTC model rules for consumer products, architectural coatings, distributed generation and many state-specific rules in effect by 2009. In addition to these reductions, new 2006 OTC recommended control measures previously discussed in Section 11 (BOTW emission scenario) will provide for additional reductions by 2009. Finally, on-road and off-road federal motor vehicle control measures will provide substantial additional reductions between 2009 and 2012.

MANE-VU state emission inventory totals for 2002, 2009 and 2012 are shown in Table AD15. NO2 and VOC emissions for MANE-VU states (which includes all of OTR states except for Virginia) trend downward between 2002 and 2012. As shown on Table AD15, Massachusetts annual NOx and VOC emissions are estimated to go down by 35% and 22%, respectively, between 2002 and 2009. Massachusetts NOx and VOC emissions in 2002, 2009 and 2012 are graphically displayed in Figure AD15. Similar emission reductions are taking place in states upwind of Massachusetts. NOX and VOC emissions in Connecticut, Rhode Island, New York and New Jersey are estimated to go down by 33% and 23%, respectively, between 2002 and 2009. NOx and VOC emissions in 2002, 2009 and 2012 for Connecticut, Rhode Island, New York and New Jersey are graphically displayed in Figure AD16.

5.19.3 Extra Ozone Reductions

The percent ozone reductions needed for modeled attainment (84 ppb) are shown in Table AD16 along with the percent reduction actually predicted at each monitor location for the 2009 BOTW emission scenario. The percent reductions from BOTW controls are substantially more than that needed to attain the ozone NAAQS. For example, the percent reduction for the 2009 BOTW scenario at the Milton monitor is 8.9%, approximately 15 percent more than that needed to attain 84 ppb. The extra ozone reductions predicted for Massachusetts indicate that Massachusetts can attain the ozone NAAQS by 2009 with a small margin of safety.

5.19.4 2012 Future Year Simulation

In addition to the 2009 BOTW scenario, the NY DEC also performed a CMAQ run using BOTW emissions for 2012. The purpose of the run was to estimate the effects of NOx and VOC reductions associated with on-road and off-road Federal Motor Vehicle controls scheduled to be in effect by 2012.

The results of the 2012 run were encouraging, particularly for Massachusetts. As shown in Table AD17, design values were predicted to be 3-5 ppb lower at Massachusetts ozone monitors by 2012. The highest predicted design value was 79 ppb (at both Lynn and Milton), well below the modeled attainment test of 84 ppb. The 2012 design values for all monitors in the OTR for the 2012 BOTW emission scenario are contained in Appendix T.

Table AD15: MANE-VU Anthropogenic Emissions in Tons/Year for 2002, 2009 and 2012)

2002	CO	NOX	VOC	NH3	SO2	PM10	PM2_5	PMC
Connecticut	992201	125208	162492	8598	32077	27061	15795	11266
Delaware	273433	58764	41120	14376	79868	15214	7931	7284
District of Columbia	101372	15389	14893	415	2939	2889	1276	1613
Maine	759882	94932	166501	11060	39362	64103	28458	35645
Maryland	1905406	283387	265220	31712	315251	72234	34805	37428
Massachusetts	1838763	276530	294703	25737	164112	89984	40667	49317
New Hampshire	594257	67326	111333	3678	55295	25796	19479	6316
New Jersey	2276006	303053	378877	24931	91273	47021	29350	17671
New York	5223096	655774	921593	83801	448322	229391	90977	138413
Pennsylvania	4448357	806061	594355	91842	1077658	228459	82467	145992
Rhode Island	312263	29418	57200	1789	8022	5058	2486	2571
Vermont	351716	28290	50461	10608	6022	21218	8330	12888
Total	19076752	2744133	3058749	308548	2320202	828427	362022	466405

2009	CO	NOX	VOC	NH3	SO2	PM10	PM2_5	PMC
Connecticut	751975	82139	122353	9255	22796	26481	15037	11443
Delaware	231392	49658	32109	14695	42569	15372	7694	7679
District of Columbia	67904	10433	10403	436	2297	2006	1124	882
Maine	579671	60201	141619	12974	38737	64881	27633	37247
Maryland	1373959	147710	205097	38971	114046	80496	39550	40946
Massachusetts	1290133	180391	229386	26513	64733	93839	42428	51411
New Hampshire	443286	44339	94330	4266	18597	26087	19511	6577
New Jersey	1778637	185314	285559	27935	49535	46183	28753	17430
New York	3730881	456457	710567	100682	325621	242237	98945	143293
Pennsylvania	3422688	518109	477042	113344	403150	259116	107315	151801
Rhode Island	240906	21900	44612	2144	8359	5410	2608	2802
Vermont	236142	17793	43063	13038	5966	22103	8099	14004
Total	14147574	1774443	2396138	364252	1096404	884212	398696	485516

2012	CO	NOX	VOC	NH3	SO2	PM10	PM2_5	PMC
Connecticut	716977	70344	113054	9144	22782	25280	14543	11516
Delaware	217500	45374	28928	14764	46425	12993	7807	7583
District of Columbia	63117	8713	9282	444	1079	1951	1056	896
Maine	545508	52012	135942	13688	29498	64502	26653	38060
Maryland	1434921	126588	189071	41735	102051	74010	39364	41825
Massachusetts	1236508	153735	213427	26552	45138	90182	41579	51925
New Hampshire	419134	38130	89589	4480	18534	24088	19399	6737
New Jersey	1717360	157134	260638	28984	47989	41630	28016	17120
New York	3588481	382581	665562	107242	238667	223662	91306	144133
Pennsylvania	3244603	450213	446570	121446	338335	225539	101838	151963
Rhode Island	230659	19093	40867	2239	4460	5089	2365	2862
Vermont	226049	15010	41333	13938	5964	22500	8025	14505
Total	13640817	1518927	2234263	384654	900922	811427	381952	489125

Figure AD15: Emissions in MA for 2002, 2009 and 2012 BOTW Emission Scenarios

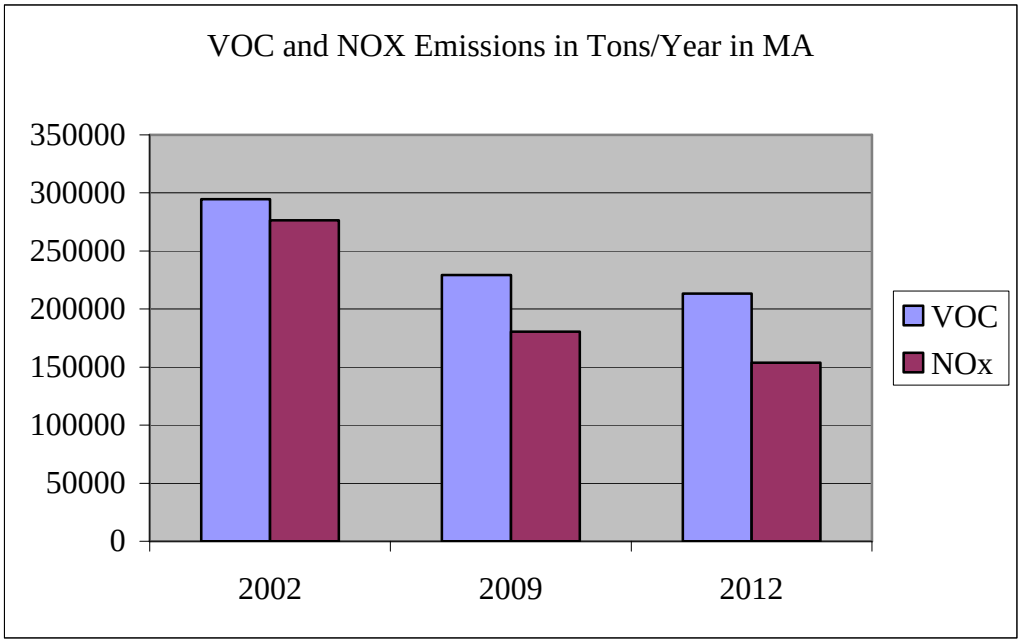


Figure AD16: Emissions in CT, RI, NY and NJ for BOTW Emission Scenarios

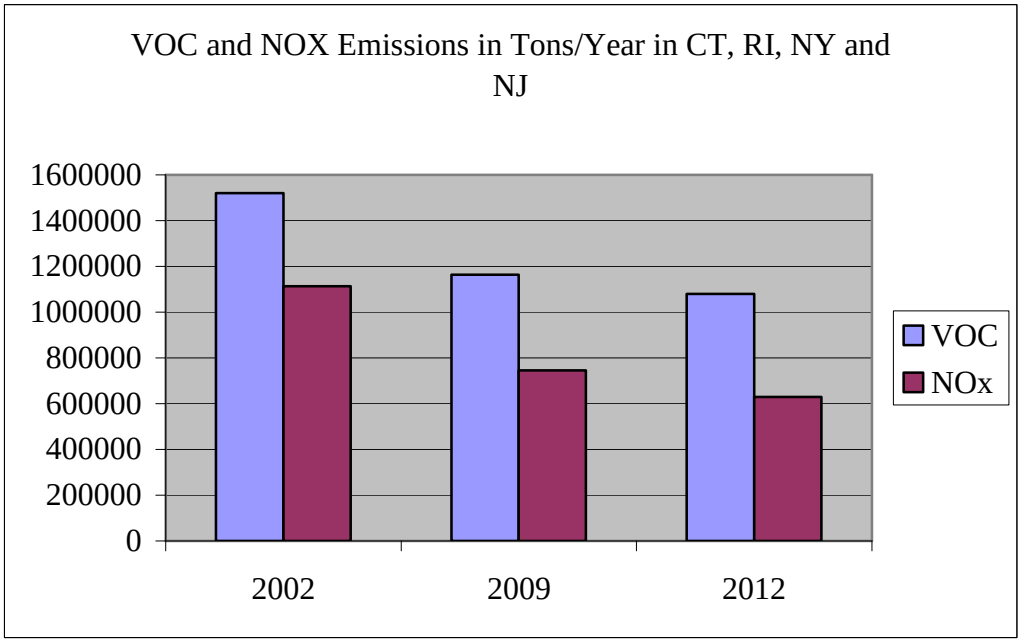


Table AD16: Percent Ozone Reductions at MA Ozone Monitors

Monitor	**DVC 2002**	**DVF 2009**	**% Reduction to Attain 84 ppb**	**% Reduction from BOTW**
Truro	92.0	80.0	8.7	12.3
Adams	83.3	73.0		12.3
Fairhaven	91.0	79.0	7.7	12.2
Lawrence	70.0	61.0	-	12.0
Lynn	90.0	82.0	6.7	8.4
Newbury	86.0	75.0	2.3	11.8
Agawam	83.0	72.0	-	12.7
Chicopee	92.0	80.0	8.7	12.8
Amherst	74.7	65.0	-	12.6
Ware	86.3	75.0	2.7	12.7
Stow	85.7	74.0	2.0	13.0
Milton	91.0	82.0	7.7	8.9
Boston (Long I)	88.7	80.0	5.3	9.1
Boston (Harris)	73.0	66.0	-	9.2
Worcester	84.0	72.0	-	13.7

Table AD17: Design Values in Massachusetts for 2009 and 2012 BOTW Emissions

AIRS-ID	**Monitor**	**2002 Base**	**2009 BOTW**	**2012 BOTW**
250010002	Truro	92	80	75
250034002	Adams	83.3	73	68
250051002	Fairhaven	91	79	75
250090005	Lawrence	70	61	58
250092006	Lynn	90	82	79
250094004	Newbury	86	75	71
250130003	Agawam	83	72	68
250130008	Chicopee	92	80	75
250150103	Amherst	74.7	65	61
250154002	Ware	86.3	75	70
250171102	Stow	85.7	74	70
250213003	Milton	91	82	79
250250041	Boston (Long I)	88.7	80	77
250250042	Boston (Harris)	73	66	63
250270015	Worcester	84	72	67

Figure AD17: NO2 Reductions by Sector between 2009 and 2012

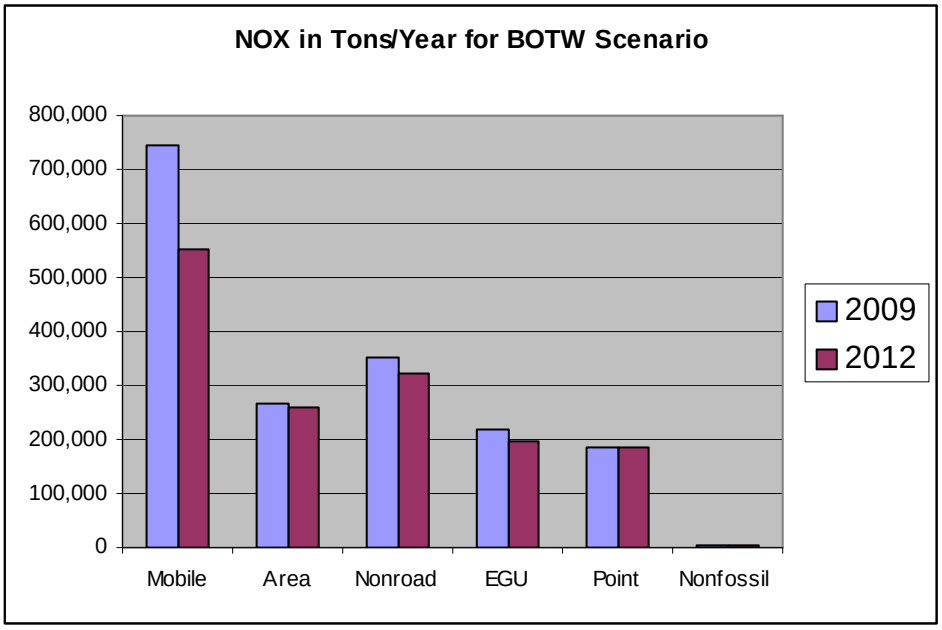
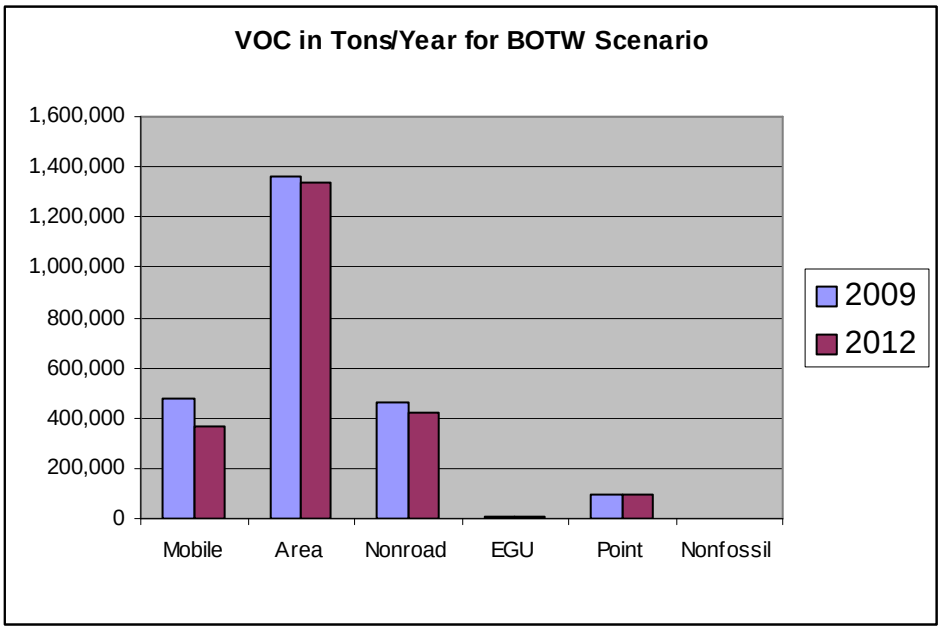


Figure AD18: VOC Reductions by Sector between 2009 and 2012



The results of the 2012 run are not surprising in light of the substantial emission reductions that can be deduced from Table AD15. For example, a reduction of more than 14% (255,516 tons per year) in MANE-VU NOx emissions will take place between 2009 and 2012. As shown on

Figure AD17 and Figure AD18, the bulk of these NOx and VOC reductions are associated with on-road and off-road on-road Federal Motor Vehicle control measures in effect by 2012. These additional emission reductions will provide a substantial safety net of approximately 5 ppb in 2012 at the highest ozone monitors in Massachusetts.

5.19.5 Elevated Ozone Episodes in 2007

August 30, 2007

The Chicopee ozone monitor in WMA registered its 4th highest 8-hour ozone value for the 2007 ozone season, 98 ppb, on August 30. This unusually high reading for so late in the season could be attributed to an unusual weather pattern that day and to smoke from distant forest fires. Typically ozone buildups in WMA occur under a southwesterly flow regime in which polluted air gets transported along the northeast corridor before entering MA. (Figure AD19) While pollutant transport did exist on 8/30/07, other factors likely caused concentrations to reach even higher. Figure AD20 points to a zone of converging air over western New England. In Figure AD21, the pressure field indicates a trough of low pressure over western and northern New England. It is this trough that induced air to converge. When air converges, pollutants are apt to build to higher levels than they otherwise would. In addition, wind speeds shown in Figure AD22 are near calm within the area of the trough. This suggests that the air converged onto WMA and then went nowhere, allowing ozone concentrations to build further.

The second factor is the presence of smoke from distant forest fires, a not uncommon occurrence during the summer months, but one that is thought to augment ozone production when smoke is highly concentrated. The satellite image in Figure AD23 below shows the presence of a smoke plume covering portions of WMA into NY. This is corroborated by PM2.5 measurements at the ground shown in Table AD18, which indicate that hourly values, mainly at WMA monitors, jumped up, clearly the result of the smoke plume.

Figure AD19 – Synoptic Pattern for
Typical Ozone Episode

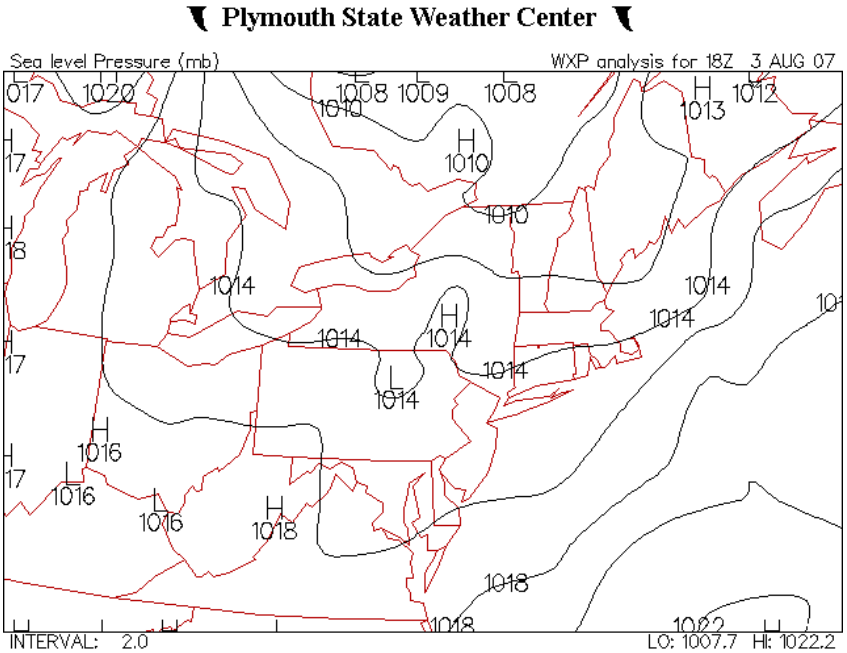


Figure AD20- Streamline Analysis on 8/30/07

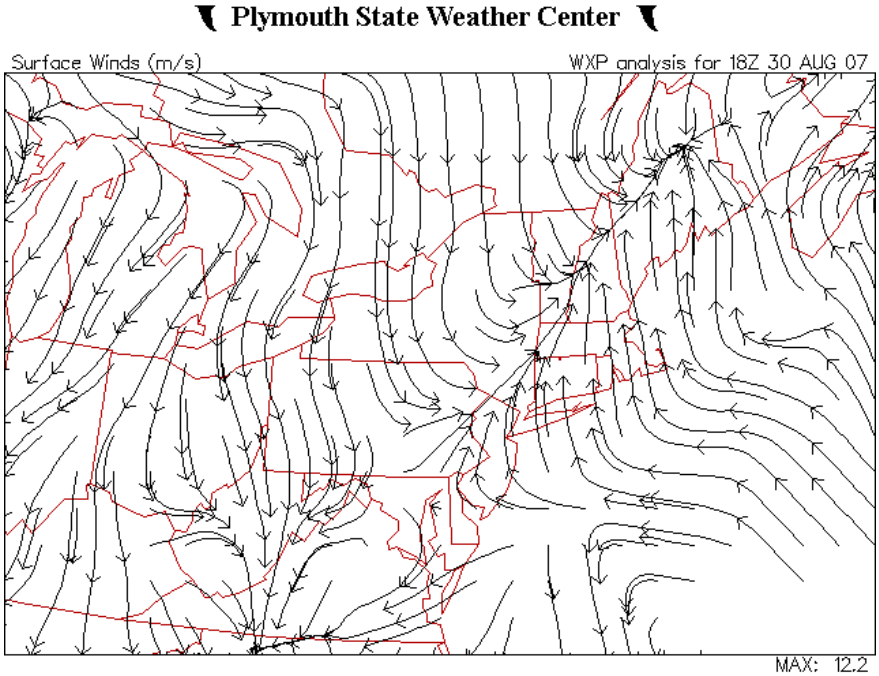


Figure AD21 – Synoptic Pattern on 8/30/07

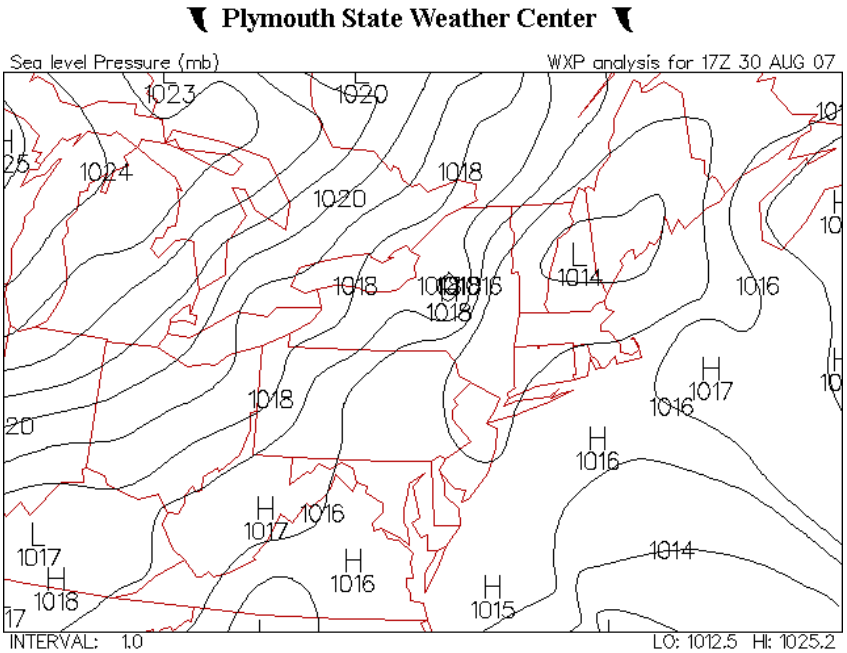


Figure AD22 – Wind Speeds 8/30/07 at 11 AM EDT

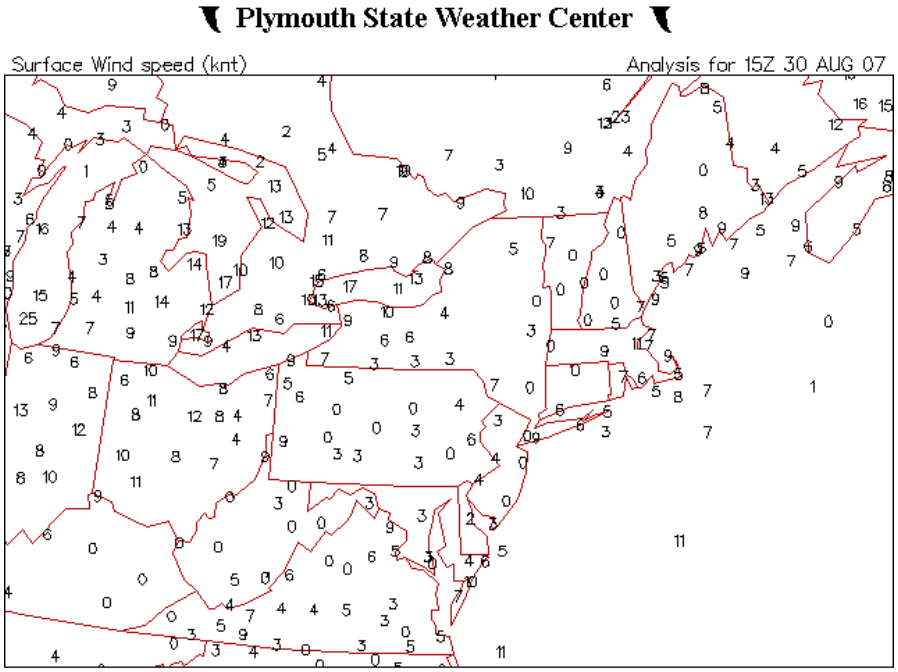


Figure AD23 – Satellite Photo 8/30/07

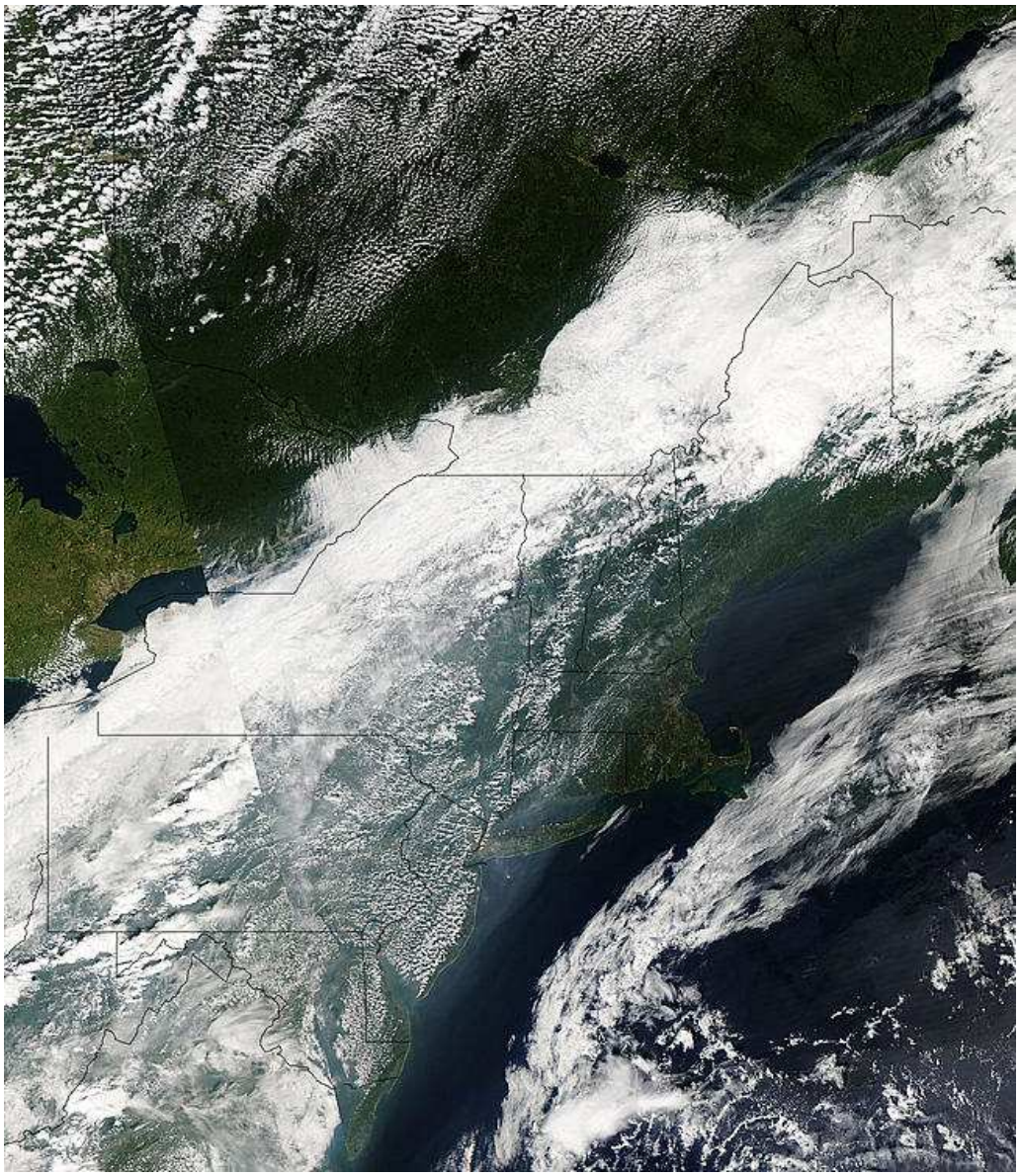


Table AD18 – PM2.5 CONCENTRATIONS
8/30/07

Site Name	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Fall River	3.1	3.3	5.2	4.1	4.4	4.9	5.3	9.1	10.8	11.8	15.3	16.3	11.5	12	12.6	12.5	12.9	14.2	15.3	19.5	10.7	10.4	8.1	8.3
Boston - North End	5.8	10.2	8	7.1	8.5	7.8	9.1	10.3	12.2	22.8	17.2	25.3	20.7	16.2	19.2	16.1	19.4	16.4	19.4	17.7	17.2	17.8	17.7	17
Haverhill	16.2	17.6	11.6	13	12.5	15.7	14.1	22.6	20.9	23.6	31	34.2	37.3	38.6	35.7	25.7	14	13.7	13.1	16.7	13.5	12.1	8.8	9.9
Pittsfield	38.3	42.1	32.6	32.1	36.8	42.6	32.6	35.4	44.4	26	24.7	26.3	30.3	32.3	33.7	34	33.9	33.3	35.4	30.7	42.2	39	29.2	27.1
E. Milton - Blue Hill	7.9	5.6	6	4.9	3.5	7.6	9.4	8.4	9.8	12.1	15.3	17.9	13.3	13.1	15.9	12.4	10.8	11.4	10.2	8.9	10.8	10.4	11	14.8
Springfield	11.3	10.3	9.5	5.5	3.5	5.8	10.9	10.7	10.7	13.2	23.7	31.6	41	37.6	40.9	43.9	46.2	46.1	37	39.8	27.8	25.6	21.8	16.5
Worcester	7.4	8.8	11.3	12.6	10.2	8.7	8.1	11.2	18.2	26.2	27.3	26.8	31.1	38.5	25.6	31	28.1	28.9	29.1	26.8	25.4	17.9	19.4	19.1
WARE	15.5	14	20	6.6	17	11.9	13.9	17.6	16.9	16	30.1	36.6	48.4	45.2	37.7	41	40.2	43.8	45.6	35.2	35.3	37.8	27.2	29.1
LYNN	8.9	12.2	11.2	9.5	15.5	9	9.6	10.1	12.2	25.7	17	18.8	14.7	20.6	17.5	11	16.9	16.4	12.5	12.9	13.1	19.9	11.3	24.1
Boston - Roxbury	9.8	10.9	11.1	8	8	9.4	10.1	10.9	12.8	21	23	14.7	25.1	22.1	19.5	18.3	13.5	14.5	14.6	16.5	22.7	23.1	13.5	18.7

August 3, 2007

The third-highest monitored reading (102 ppb) at the Chicopee monitor in 2007 was recorded on August 3. Meteorological conditions on that date were conducive to the production of abundant ground level ozone in WMA. The synoptic pattern (Figure AD19, above) featured a Bermuda High well east of the Carolinas, surface temperatures generally reached the mid 90s (Figure AD23), and surface winds were southwesterly (Figure AD24). However, also likely contributing to ozone formation that day was smoke from distant forest fires, as revealed in the satellite photo below (Figure AD25) and Table AD18. While there are no means of quantifying the contribution of smoke to ozone production, it is possible that absent this smoke, ozone concentrations on this date would have been lower.

Figure AD24 – Max Temperatures 8/3/07
(from 8pm 8/2/07 – 8pm 8/3/07)

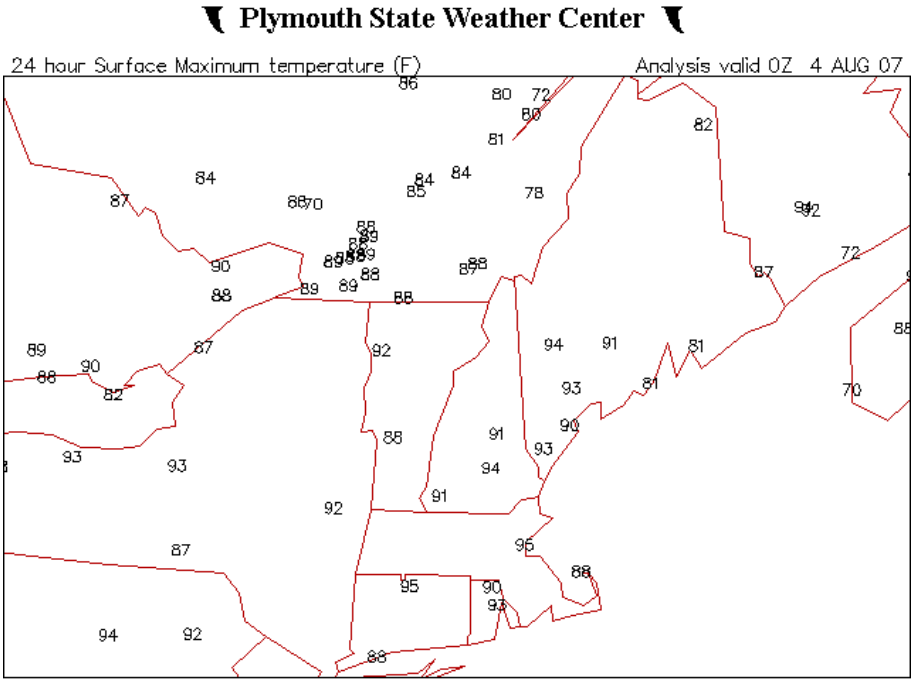


Figure AD25 – Wind Vectors 8/3/07 11 EDT

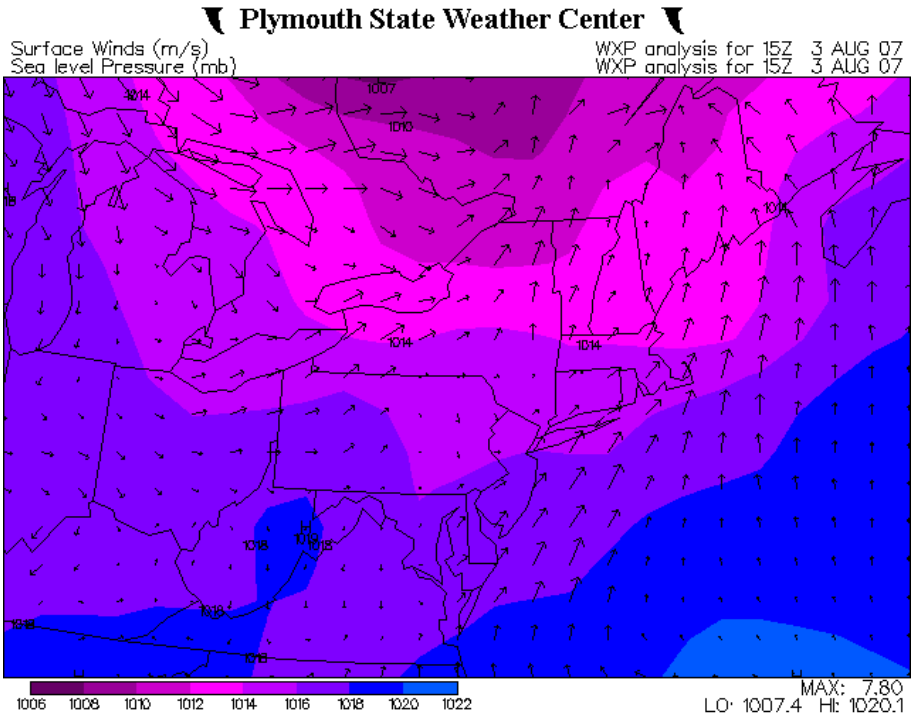


Figure AD26 – Satellite Photo 8/3/07

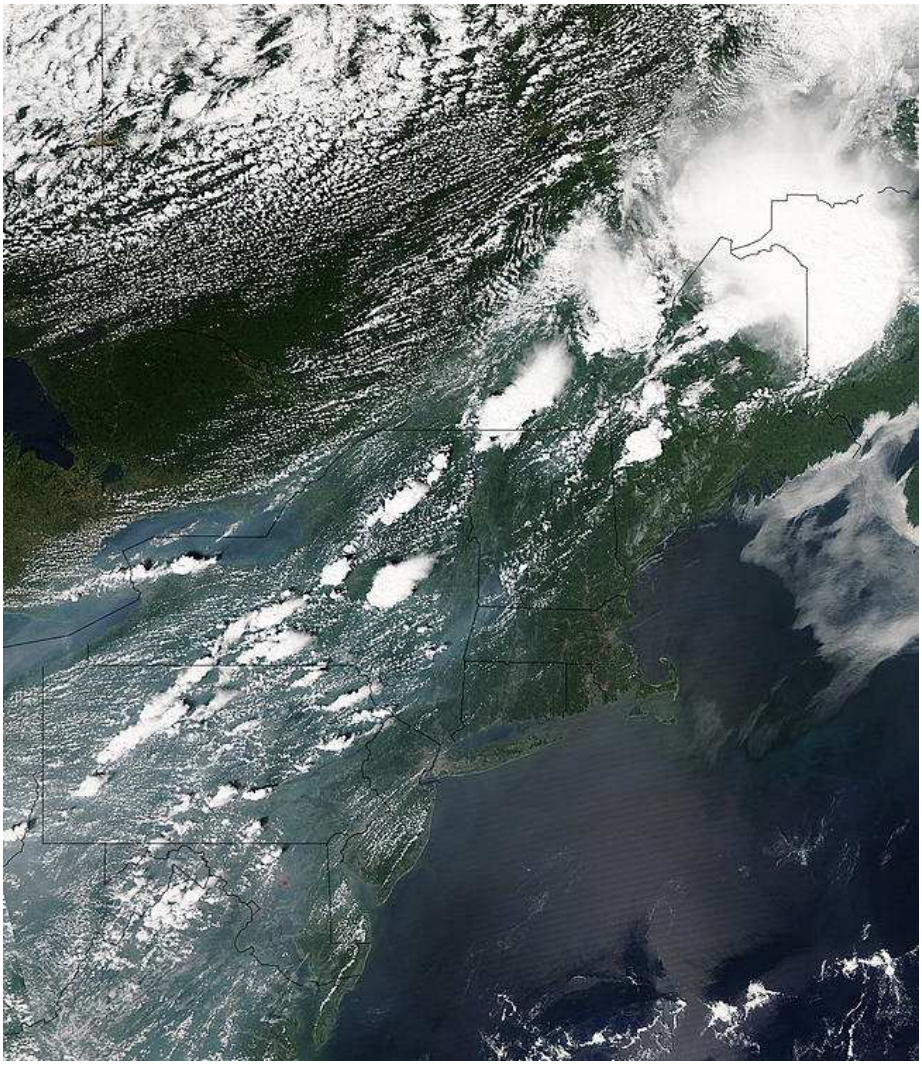


Table AD18 – PM 2.5 Concentrations 8/3/07

Site Name	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
WARE	37.4	35.6	34	36.9	32.3	32.1	28.9	38.7	40.5	37.1	46.9	48.6	50.2	52	40.7	43	53			40.2	50.4	25.5	31.8	34.8
Boston - Roxbury	37.2	30.5	35.8	37.3	35.5	36.4	39.1	41.4	38.2	43														
E. Milton - Blue Hill	25.7	27.9	21.5	26.8	28.1	27.1	29.1	31.4	33.7	33.9	33.1	35.5	32.8	34	26.9	37.5	36.4	34.1	34.5	27.9	28.5	26.9	17.5	21.4
Springfield	27.7	29.4	36	28.3	29.4	37.7	35.3	35	32.2	34	40.5	42.1	39.9	36.9	35	40.5	42.1	44.6	41.9	32.2	33.3	-980	23	17.4
Haverhill	25.9	27	28.5	23.5	32.3	29.7	35	27.6	31.7	36.4	34.1	40.8	37.6	35	24.3	32	30.2	41.1	41.4	38.5	39.8	25.2	32.4	29.8
Fall River	39.8	37.2	40.5	32.7	36.9	25.7	27.9	22.5	26.4	38	34.6	42.6	29.9	42.6	39.2	28.8	30.4	24.2	21.9	22.9	17.3	12	21	10.8
LYNN	27.2	27.8	32	31.3	34.6	30.7	31.3	40	36.9	37.1	36.1	34.6	35.2	37	31.9	33.1	39.8	44	41.5	33.2	39.6	26	28.9	27.1
Worcester	17.7	22.4	19.2	32	25	33.6	32.3	33.5	36.4	40.4	24.4	27.3	25.3	32	37.1	38.7	44	37.7	35.6	32.8	28.5	31	16.9	18.5
PITTSFIELD	23.5	26.9	19.3	19.7	20.8	23.2	18	26.7	31.1	32.8	54.8	33.5	43.4	50.6	49.9	50	50	50	50	22.1	42.5	47.9	45.7	49
Boston - North End	31.7	39.2	28.4	26.3	29.9	32.7	39.4	43.4	43.2	41.2	38.1	34.9	41.2	29.5	33.9	34.9	46.9	47.2	44.3	41.5	38.1	28.9	28.4	25.5

5.20 Conclusions

The Massachusetts attainment demonstration demonstrates that reductions in ozone precursor emissions in Massachusetts and upwind of Massachusetts will result in statewide attainment of the 8-hour ozone NAAQS by 2009. The attainment demonstration was based on SIP-quality CMAQ ozone modeling results for 2002 and 2009. The attainment demonstration consisted of choosing a base year (2002) to test model performance and then rerunning the model using a future year emission scenario (2009) in order to determine the predicted reductions in ozone calculate levels in and downwind of Massachusetts.

The 2002 ozone season was selected as the base year for OTR attainment demonstrations because a significant number of exceedance days were recorded that year over the eastern United States. A multi-year review of elevated ozone days in the OTR indicted that meteorological regimes associated with high ozone levels also occurred during 2002. In other words, 2002 meteorology contained a good set of meteorological conditions for testing the effectiveness of ozone control strategies. The 2002 CMAQ model run results indicated that the CMAQ model was performing adequately and was acceptable for simulating future year emission scenarios in and downwind of Massachusetts.

In 2006, all states in the OTR modeling domain prepared future year emission inventories for 2009 by applying growth and control measures to 2002 base year emission inventories. The control measures reflected controls programs that were already on the way and in effect by 2009. These emission inventories, referred to as “on the way” emission inventories, reflect the NOx SIP Call and CAIR requirements, federal on-road and off-road fuels, federal motor vehicle standards and state LEV (Low Emission Vehicle) programs, 2001 OTC model rules for consumer products, architectural coatings, distributed generation and any other state-specific rules in effect by 2009. In addition, OTC states prepared a “beyond on the way” (BOTW) emission inventory for selected non-EGUs and area sources in the OTR. The BOTW emissions reflect new OTC 2006 model rules for several source categories in OTR states. The BOTW control measures were developed because preliminary ozone modeling efforts indicated additional controls would be needed to attain the 8-hour ozone NAAQS in portions of the OTR.

The CMAQ model was run using emission input files prepared for the 2009 emission scenario (“on the way” emissions throughout the OTR modeling domain and “beyond on the way” control measures in OTC states). The 2009 and 2002 modeling results were then compared to determine the percent reduction in ozone levels between 2002 and 2009. The percent reduction was applied to the 2002 ozone design value at each ozone monitoring location in the OTR in order to calculate a design value for 2009. The maximum 2009 design value in Massachusetts was 82 ppb, indicating that Massachusetts will attain the ozone NAAQS (85 ppb) with “on the way” control measures throughout the OTR modeling domain and “beyond on the way” control measures in OTC states.

Ozone precursor trends indicate that EMA and WMA will attain the 8-hour ozone NAAQS. Emission reductions by 2009 appear to be slightly more than needed to attain the NAAQS in

Massachusetts. A 2012 CMAQ modeling run by NY DEC also indicated that additional reductions, primarily due to Federal Motor Vehicle control measures, will lower maximum design values in Massachusetts to 79 ppb, a significant safety net in the event that 2009 monitored design values are still above the ozone NAAQS.

Based upon ozone modeling results, ozone air quality trends and ozone precursor trends, MassDEP expects that the EMA will attain the 8-hour ozone NAAQS by 2009 and that, while WMA may attain by 2009, if it does not, it will be eligible for a 1-year extension of the 2009 attainment date.

SECTION 6 REASONABLY AVAILABLE CONTROL TECHNOLOGY (RACT)

6.1 Purpose of Section

This Section addresses the requirements for 8-hour ozone standard nonattainment areas with respect to Reasonably Available Control Technology (RACT). MassDEP certifies that all RACT measures adopted and in effect in Massachusetts pursuant to the 1-hour ozone standard continue to constitute RACT under the 8-hour ozone standard for all large point sources subject to RACT and for all source categories subject to RACT, except the following categories: solvent metal degreasing; gasoline dispensing vapor control; and asphalt paving. For these three categories, MassDEP has concluded that RACT measures previously adopted no longer constitute RACT and either has promulgated, or is committing to promulgate, revised regulations that will further reduce emissions from these three source categories. For the category of Municipal Waste Combustors, MassDEP intends to conduct additional analysis as to whether existing NOx controls on this category still constitute RACT. Massachusetts RACT source categories and large point sources are listed in Tables 1-3 at the end of this Section.

6.2 Overview of 1-Hour Ozone Standard RACT

6.2.1 Pre-1990 VOC RACT Requirements

Prior to the 1990 CAA Amendments, RACT requirements were governed by CAA Section 172(c), which provides that non-attainment areas must implement ... "all reasonably available control measures [RACM]...including such reductions in emissions from existing sources in the area as may be obtained through the adoption ... of reasonably available control technology [RACT]." EPA has defined RACT as the lowest emission limit that a polluting source is capable of meeting if it uses pollution control equipment and/or material or process changes that are reasonably available considering costs and current technology. (44 FR 53762, September 17, 1979)

To assist states with implementation of RACT, EPA issued Control Technique Guidelines (CTGs) for various source categories of VOC emissions.[1] CTGs establish a ``presumptive norm" for RACT for the VOC source category addressed. Some CTGs cover only major[2] sources of VOC emissions. Other CTGs apply at thresholds below the major source level. In addition, states were required to adopt RACT controls for all major sources of VOCs, whether or not within a CTG source category.

6.2.2 1990 CAA Amendments

1. Prior to the 1990 CAA Amendments, EPA issued three sets of CTG documents: Group 1: 15 CTGs issued before January 1978; Group 2: 9 CTGs issued in 1978; and Group III: 5 CTGs issued in the early 1980s. (A list of all CTGs, as compiled by EPA, is in Table RACT-1.)

2. The emission threshold for a major source varies. Prior to the 1990 CAA Amendments, major VOC sources were those with a potential to emit $\geq$100 tons of VOCs per year. After the 1990 Clear Air Act amendments, major source thresholds for VOC and NOx were tied to a non-attainment areas classification and whether the state is located within an ozone transport region.

The 1990 CAA Amendments made the general Section 172 RACT requirements more specific. Amendments to section 182(a)(2)(A) required that ozone non-attainment areas classified as marginal or above "fix" any deficient VOC RACT rules by May 1991. A new provision, Section 182(f), required states to adopt RACT for all major stationary NOx sources. Amendments to Section 184, which addresses control of ozone in an Ozone Transport Region,[3] lowered the major source applicability threshold of RACT for states within the OTR from sources with a potential to emit 100 tons of VOC per year to sources with a potential to emit 50 tons per year.

To assist states with NOx RACT implementation, EPA issued Alternative Control Technology Documents (ACTs), which provide analyses of the reductions that can be achieved with various controls at various levels of stringency, and the costs per ton to achieve those levels of control. Unlike CTGs, ACTs do not establish a presumptive RACT level of control.

6.2.3 Massachusetts 1-Hour RACT Compliance

During the late 1970s and the 1980s, MassDEP adopted and from time-to-time amended 310 CMR 7.18 - *Volatile and Halogenated Organic Compounds* and 310 CMR 7.24 - *Organic Material Storage and Distribution*. These regulations established emissions controls on VOC sources consistent with EPA's pre-1990 CTGs. EPA approved these regulations as meeting RACT and incorporated them into the Massachusetts ozone SIP.[4]

The CTGs issued by EPA and the MassDEP regulation that was adopted to meet the presumptive level of RACT established in the CTG for RACT is listed in Table RACT-1. If there were no facilities within a CTG source category in the State, MassDEP submitted a "negative declaration" to EPA. The negative declarations are also listed in Table RACT 1.

For major sources not within a CTG category, 310 CMR 7.18(17) provided for imposition of RACT controls through single-source RACT SIPs. Pursuant to this provision MassDEP determined what constituted RACT on a facility-by-facility basis for non-CTG major sources. EPA approved these single-source RACT determinations as part of the Massachusetts SIP; the facilities subject to single-source RACT are listed in Table RACT-2.

To meet the 1990 CAA Amendment requirements, in 1991 MassDEP submitted SIP revisions to 310 CMR 7.18 to correct RACT SIP deficiencies concerning automobile and metal parts coating and other minor deficiencies identified by EPA. In 1992, MassDEP amended its regulations to incorporate the lower RACT major source threshold of =>50 tons of VOC per year (vs. 100 tons).

To address the 1990 CAA NOx RACT requirement, MassDEP adopted 310 CMR 7.19, *Reasonably Available Control Technology (RACT) for Sources of Oxides of Nitrogen (NOx)*, which established RACT for large, medium and small boilers; stationary combustion turbines;

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3 The Northeast Ozone Transport Region (OTR) comprises Connecticut, Delaware, the District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and northern Virginia. The OTC was created under the CAA to address ozone transport issues within the OTR.
4 See 40 CFR 52.1167 for a complete list of the EPA-approved Massachusetts SIP revisions, including those related to RACT regulations and determinations.

stationary reciprocating internal combustion engines; and glass melting furnaces. 310 CMR 7.19(12) provided for single source NOx RACT determinations for major "miscellaneous" NOx sources with a potential to emit 50 tons or more per year of NOx. EPA approved the Massachusetts NOx RACT controls requirements, although Massachusetts NOx RACT regulations were in some cases adopted prior to issuance of EPA's ACTs and therefore were not based on EPA's ACT analysis.

Massachusetts has no outstanding 1-hour requirements to revise any existing RACT rules nor are there unresolved issues with respect to any Massachusetts 1-hour RACT determinations and SIP submittals. It has fully complied with all 1-hour RACT requirements.

6.2.4 Results of 1-Hour RACT Implementation in Massachusetts

Pursuant to MassDEP RACT regulations, Massachusetts sources subject to RACT substantially reduced their emissions of VOCs and NOx. These reductions are dramatic in the stationary point source sector[5], as illustrated in Figure RACT-1 below. As a result of the significant emissions reductions that have already been achieved in Massachusetts by large industrial sources, there are few, if any, cost-effective opportunities for sources to adopt any RACT controls that will further reduce VOC and NOx emissions.

Between 1980 and 1987, VOC emissions from Massachusetts major VOC sources decreased from an estimated 192 tons per summer day in 1980 to 80 tons per summer day in 1987. (See *Massachusetts Demonstration of Reasonable Further Progress, Ozone SIP, 1987*, submitted September 1988, page 14, Table III-5; numbers have been converted from kilograms per year as reported in that SIP to tons per summer day.)

VOC emissions from point sources continued to decrease during the 1990s. The 2002 MA Base Year Inventory (Section 2) includes the following trends data for stationary point source[6] VOC emissions:

Figure RACT-1
Massachusetts Stationary Point Source VOC Emissions Trends

	Tons per summer day	Tons per year
1990	64	17,324
1993	61	19,165
1996	43	11,580
1999	28	9,831
2002	16	5,647

5. "Stationary point sources" is a term used for emissions inventory purposes; it refers to all facilities that report actual emissions of 10 tons per year or more of VOC.
6. The universe of sources subject to VOC RACT is not identical to the universe of sources included in the stationary point source sector of the 2002 inventory because some CTG/RACT categories also cover smaller area source.

Massachusetts stationary point sources thus emit 48 TPSD fewer of VOCs (75% less) in 2002 than in 1990 based on these estimates.

As a result of the significant emission reductions that have taken place due to RACT regulations, as well as due to plant closures, point sources account for just 2% of total in-state anthropogenic VOC emissions, as shown in the following Figure RACT-2 taken from the 2002 MA Base Year Inventory.

Figure RACT-2
Massachusetts 2002 VOC Emissions by Source Sector

2002 VOCs	Tons per year (TPY)	TPY % of total VOC inventory	Tons per summer day (TPSD)	TPSD % of total VOC inventory
Stationary Point	**5,647**	**2%**	**16**	**2%**
Stationary Area	159,753	57%	328	46%
On-Road Mobile	57,186	21%	152	21%
Off-Road Mobile	56,577	20%	224	31%
Total	279,163	100%	719	100%

With the adoption of NOx RACT regulations and the promulgation, in 1999, of MassDEP regulation 310 CMR 7.28, *NOx Allowance Trading Program* (NOx Budget Program - see discussion in Section 3, *Control Measures*), major NOx sources have significantly reduced emissions. The following data from the 2002 MA Base Year Inventory illustrates the amount of reductions.

Figure RACT-3
Massachusetts Stationary Point Source NOx Emissions Trends

	Tons per summer day	Tons per year
1990	318.1	115,752
1993	297.7	92,876
1996	171	56,883
1999	180	60,272
2002	129.6	45,590

Massachusetts stationary point sources[7] emit 188 TPSD fewer (60% less) NOx in 2002 than in 1990 based on these estimates. As a result of the significant emission reductions that have taken

7 As noted in footnote 5, this sector includes facilities with actual emissions over 10 tons per year NOx as reported annually by the facilities.

place due RACT regulations as well as plant closures, point sources now account for only 17.1% of total in-state NOx emissions on an annual basis and 16.9 % on a tons per summer day basis as shown in Figure RACT-4.

Figure RACT- 4 **Massachusetts 2002 NOx Emissions by Source Sector**				
2002 NOx	Tons per year (TPY)	TPY % of Inventory	Tons per summer day (TPSD)	TPSD % of Inventory
Stationary Point	45,590	17.1%	129.6	16.9%
Stationary area	34,371	12.9%	39.1	5.1%
On-Road Mobile	143,368	53.9%	453.1	59.1%
Off-Road Mobile	42,906	16.1%	144.5	18.9%
TOTAL	266,235	100%	766.3	100%

6.3 8-Hour Ozone Standard RACT Requirements

6.3.1 Required Analysis

With respect to RACT, EPA's Phase 2 Rule provides:

> Where a State has adopted, and EPA has approved, a control measure as RACT for a specific major stationary source or source category for the 1-hour ozone NAAQS and absent data indicating that the previous RACT determination is no longer appropriate, the State may submit a certification that the source is subject to a SIP-approved RACT requirement (70 FR 71652).

Subsequent to the issuance of the Phase 2 Rule, EPA developed questions and answers (Q&A) to further explain 8-hour ozone standard RACT SIP requirements. The Q&A document states that in order for a state to certify that previously required RACT controls or newly applied controls represent RACT for 8-hour ozone standard purposes, a state should evaluate RACT for a source or source category by examining EPA guidance and other information. When a state concludes that the existing level of control is RACT and that no control is required beyond what was required for the 1-hour standard, it must submit its conclusions in its RACT SIP.

The state may address RACT through adoption of rules, submission of permits or through negative declarations stating that there are no sources subject to RACT. If the state determines that additional controls are needed to meet 8-hour ozone standard RACT requirements, the controls must be made federally enforceable through a SIP revision. Any new RACT

requirements must be implemented no later than May 1, 2009. Pursuant to EPA's Phase 2 Rule, Massachusetts was required to submit a SIP addressing 8-hour ozone RACT requirements within 29 months of EPA's April 15, 2004 non-attainment areas designation.

6.3.2 Applicable Thresholds

As noted previously, after the 1990 CAA Amendments, the applicable EPA major source thresholds for RACT in Massachusetts as a "serious" 1-hour non-attainment area were 50 tons per year for both VOCs and NOx.[8] As a "moderate" 8-hour non-attainment area the applicable EPA RACT thresholds for Massachusetts are 50 tons per year for VOC and 100 tons per year for NOx.

EPA revoked the 1-hour standard as of June 15, 2005; therefore, the 1-hour classification scheme and corresponding EPA RACT thresholds no longer apply. However, under EPA's anti-backsliding requirements (40 CFR 51.905) a state may not remove RACT requirements for sources that were subject to 1-hour standard RACT, even if they would not be subject to RACT under the non-attainment area's 8-hour classification and applicable RACT threshold. Thus, any source subject to NOx RACT because of the 50-ton per year threshold will continue to be subject to applicable regulations and existing permit conditions based on this threshold.

However, pursuant to EPA's Phase 2 Implementation Rule, a state is only required to certify that RACT under the 8-hour ozone standard is met for those non-CTG sources that EPA defines as major under the 8-hour ozone standard "moderate" classification (100 tons per year of NOx and 50 tons per year of VOCs). Table RACT-2 indicates which Massachusetts sources are major under these EPA thresholds.

As required by the Phase 2 Rule, MassDEP has reviewed its current RACT requirements. It has determined that VOC controls previously adopted as RACT for CTG source categories and non-CTG major sources still constitute RACT for 8-hour ozone standard purposes, except for four categories - solvent metal degreasing, gasoline dispensing vapor control, asphalt paving and Municipal Waste Combustor (MWCs). For the first three categories, MassDEP is adopting tighter regulations; for MWCs it will conduct additional analysis to determine if existing NOx controls on this category still constitute RACT.

It has also determined that RACT controls adopted for major sources of NOx (100 tons per year) continue to constitute RACT. MassDEP has, therefore, certified in Tables RACT-1 and RACT-2 that its current RACT controls meet 8-hour RACT requirements, except for the categories of solvent metal degreasing, gasoline dispensing vapor control and asphalt paving. MassDEP is committing to revise its regulations for these three categories.

6.4 VOC RACT Analysis

8. In general, RACT applicability is based on a source's potential to emit – i.e., uncontrolled emissions. However, under certain circumstances a source may not be subject to RACT if it has a federally enforceable restriction on the emission level or on its hours of operation, emission rate and throughput, that limit its potential to emit to below the RACT applicability threshold.

6.4.1 CTGs

As noted under the 1-hour RACT discussion, a state regulation imposing VOC controls that met EPA's presumptive CTG control levels met 1-hour RACT requirements. Table RACT-1 lists the VOC source categories for which EPA issued CTGs and the existing MassDEP RACT regulation for each of these categories. MassDEP regulations that imposed VOC RACT requirements are 310 CMR 7.18 - *Volatile and Halogenated Organic Compounds* and 310 CMR 7.24 - *Organic Material Storage and Distribution.* For all CTG categories, these MassDEP regulations either incorporated the CTG recommended controls or achieved reductions equivalent to the CTG controls and were approved by EPA for 1-hour RACT purposes.

MassDEP has reviewed 310 CMR 7.18 and 310 CMR 7.24 to determine if the levels of control required by these regulations continue to constitute VOC RACT under the 8-hour ozone standard for sources covered by CTGs. It has determined that the current regulations governing emissions from CTG source categories constitute RACT, except for the three categories noted above and discussed below under "RACT Revisions for 8-Hour Ozone Standard." Pursuant to the requirement of the Phase 2 Rule, MassDEP certifies in Table RACT-1 for each category that current RACT control meets 8-hour RACT.

The CTG categories for which MassDEP submitted negative declarations stating that it did not have sources within a CTG category are also listed in Table RACT-1. MassDEP has reviewed its 2002 stationary point source inventory by reviewing its point source database for facilities with North American Industrial Classification System (NAICS) codes that correspond to the CTG categories for which Massachusetts submitted negative declarations. The 2002 inventory data does not reflect the existence of any sources with NAICS codes that correspond to these categories. Therefore, MassDEP certifies in Table RACT-1 to the continued applicability of these negative declarations.

6.4.2 New CTGs

In October 2006, EPA adopted five new CTGs for the following source categories: three categories of printing: Lithographic Printing Materials, Letterpress Printing Materials, and Flexible Packaging Printing Materials; Flat Wood Paneling Coatings; and Industrial Cleaning Solvents. (71 FR 58745, October 5, 2006) States must submit SIP revisions incorporating these new CTGs within one year of EPA's promulgation of the final CTG. SIP revisions for these CTGs are due by October 4, 2007.

MassDEP has determined that there are no Massachusetts facilities that are subject to the Flat Wood Paneling CTG. The CTG for Industrial Cleaning Solvents contains VOC content, operations and equipment requirements for all industrial cleaning categories and operations[9] that have VOC emissions of at least 15 lb/day. However, the CTG recommends that states exclude from regulation under this CTG, cleaning operations that are covered by other CTGs that have

9 EPA states that all operations evaluated to date by EPA can be categorized under one of the nine "Unit Operations" (UO) identified in the CTG: Spray Gun Cleaning; Spray Booth Cleaning; Large Manufactured Components Cleaning; Parts Cleaning; Equipment Cleaning; Line Cleaning; Floor Cleaning; Tank Cleaning; and Small Manufactured Components Cleaning.

been, or may be developed for other categories, such as wood furniture coating, shipbuilding and repair coatings, metal furniture coatings, and plastic parts coatings. MassDEP has adopted VOC regulations addressing numerous other coating operations pursuant to previously-issue CTGs that include requirements related to cleaning solvents specific to these categories.(See Table RACT 1.)

MassDEP's current Solvent Metal Degreasing regulations, 310 CMR 7.18(8), regulates solvent content within the Metal Degreasing category. MassDEP intends to adopt an amendment to that regulation to limit solvent vapor pressure. (See discussion of this proposed amendment under Section 6.6, *RACT Revisions*.) With the adoption of that amendment in 2008, MassDEP believes it will meet the requirements of this new CTG.

With respect to the three CTGs for printing, MassDEP believes that its existing regulations for these categories may include controls that are equivalent to the CTG. It intends to analyze the CTG and Massachusetts sources that are covered by it and determine, in consultation with EPA, if that is the case. If additional regulations are required to meet the CTG for this category, MassDEP will adopt regulations and file a subsequent RACT SIP incorporating any regulations necessary to meet the presumptive RACT limits established in these new CTGs.

On October 9, 2007, EPA issued new CTGs for the following source categories: 1. paper, film, and foil coatings; 2.metal furniture coatings, and; 3. large appliance coatings. States are required to submit SIP revisions addressing the new CTGs within one year of the date that they were issued. MassDEP has made a preliminary determination that there are no facilities in the state that are subject to the Large Appliance Coating CTG, as it has been proposed. It has made a preliminary determination that there are seven facilities that are subject to the proposed Paper, Film and Foil coating CTG and two facilities that are subject to the proposed Metal Furniture coating CTG. Once these CTGs are finalized, MassDEP will analyze them and, if necessary, adopt regulations and file a subsequent RACT SIP incorporating any regulations it determines are necessary to meet the presumptive RACT limits established in these new CTGs.

6.4.3 Non-CTG Major VOC Sources

As previously discussed, States were required to adopt RACT controls for any non-CTG major VOC source. Massachusetts regulation 310 CMR 7.18(17) established requirements for major facilities not covered by a CTG. Such facilities are required to restrict emissions to a rate that is achievable through the implementation of RACT as required in an emission control plan specific to that facility. MassDEP issued a number of single-source RACT determinations pursuant to this provision. The single-source VOC RACT determinations, which were approved by EPA as part of the Massachusetts SIP, are listed in Table RACT-2 along with the date of the approvals and the current status of the facilities. For facilities that are still operating, MassDEP has concluded that these controls constitute RACT under the 8-hour standard.

6.5 NOx RACT Analysis

MassDEP has reviewed 310 CMR 7.19, *Reasonably Available Control Technology (RACT) for Sources of Oxides of Nitrogen (NOx)*, which established RACT for a number of NOx source

categories and provided for single source RACT determinations for major miscellaneous sources. The source categories covered in this regulation are: large, medium and small boilers; stationary combustion turbines; stationary reciprocating internal combustion engines; glass melting furnaces; and miscellaneous sources. (Massachusetts adopted this NOx RACT regulation in 1995 prior to EPA's issuance of some of the ACTs for NOx. As noted above, ACTs do not establish presumptive RACT limits.)

Except for MWCs (see below), MassDEP has determined that the NOx controls required by 310 CMR 7.19 regulation continue to constitute NOx RACT under the 8-hour ozone standard for each of the source categories covered by that rule as well as for major sources of NOx for which single-source RACT determinations were made pursuant to 310 CMR 7.19(12). It certifies in Table RACT-1 that current Massachusetts NOx RACT constitutes 8-hour NOx RACT for the NOx categories listed and for the facilities for which single-source RACT determinations were made.

6.5.1 Municipal Waste Combustors (MWCs)

Massachusetts regulation, 310 CMR 7.19(9), established NOx RACT for the seven MWCs in Massachusetts, with a total of 16 combustor units, in 1995. The NOx emission limits for five of the facilities, with a total of 11 combustor units, were further restricted by 310 CMR 7.08(2), effective in 2000. These currently applicable limits are more stringent than 310 CMR 7.19(9) and are equivalent to emission limits established under EPA's emissions guidelines (40 CFR 60 Subpart Cb) for MWCs with a combustor capacity greater than 250 tons per day. One unit is subject to the more stringent emission limit in the New Source Performance Standard (NSPS) (40 CFR 60 Subpart Eb). The other two facilities have a combustor capacity less 250 tons per day, but are subject to the emission limitations contained in 310 CMR 7.08(2) and in the Operating Permit for each facility. The NSPS and emission guidelines require compliance with emission limitations for nine pollutants, including NOx, that reflect performance of what EPA has determined in the maximum achievable control technology (MACT) for these units. All of the MWCs in Massachusetts meet the emissions limits set in EPA's MACT standard.

In response to comments submitted by EPA on the proposed Ozone SIP with respect to MWCs, MassDEP will re-examine whether its current MACT regulations for MWCs, 310 CMR 7.08 (2), still constitute RACT. By April 1, 2008, it commits to do an additional analysis on whether it is cost effective to further reduce NOx emissions from existing MWCs. MassDEP will include stakeholders (i.e. the MWCs, municipalities, and environmental organizations) as part of this process.

MassDEP expects to propose revisions to its MWC regulations by December 31, 2008 to comply with the U.S. EPA's Standards of Performance for New Stationary Sources and Emission Guidelines for Existing Stationary Sources: Large Municipal Waste Combustors, 40 CFR 60 subpart Cb. Based on the findings of the additional RACT analysis, MassDEP will consider whether to include a proposal for more stringent NOx limits when it proposes the revisions to the Massachusetts MWC regulations.

6.5.2 NOx Cap-and-Trade Program Sources

Electric generation units (EGUs) and large industrial boilers in Massachusetts are subject to 310 CMR 7.28, *NO_x Allowance Trading Program (*NOx Budget Program*)*, which caps emissions of NOx from covered sources for the 2003 through 2008 ozone seasons. This regulation was adopted in 1999 to meet the requirements of EPA's NOx SIP Call (63 CFR 61712). EPA's Phase 2 Rule provides that compliance with the NOx SIP Call, regardless of the manner of compliance by individual sources (e.g. control equipment installation or purchase of allowances from other sources), constitutes RACT. States need not submit 8-hour RACT analyses for sources in compliance with a SIP meeting the NOx SIP Call. EPA determined that the Massachusetts NOx Budget Program met the NOx SIP Call and approved it as part of the Massachusetts 1-hour Ozone SIP. Therefore, MassDEP certifies that all NOx sources regulated by 310 CMR 7.28 meet 8-hour ozone RACT requirements for 2003 - 2008. (These sources are listed in Table RACT-3.)

Following the promulgation of EPA's CAIR in 2005 (See Section 3, *Control Measures* for a discussion of CAIR and Massachusetts Clean Air Interstate Rule (Mass CAIR), the NOx SIP Call and MassDEP's NOx Budget Program will be phased out. The Phase 2 Rule provides that EGU sources subject to CAIR, and non-EGU sources subject to the NOx SIP Call that are brought into the state's CAIR program, meet 8-hour ozone RACT requirements. Mass CAIR, 310 CMR 7.32, was promulgated on May 4, 2007 and approved by EPA on December 3, 2007 (72 FR 67854). It regulates the same sources covered under the NOx Budget Program, but imposes a lower ozone season NOx cap. Accordingly, MassDEP certifies that, all NOx sources regulated under MassCAIR (Table RACT-3) will meet 8-hour ozone standard RACT requirements, starting with the 2009 ozone season.

A significant subset of the largest fossil fuel-fired EGUs in Massachusetts are also subject to annual NOx emission limitations under 310 CMR 7.29, *Emissions Standards for Power Plants,* adopted in 2001. Depending upon the compliance path selected by the affected facilities, the facilities will comply with these more stringent than RACT output-based standards between 2004 and 2008. The NOx provisions of 310 CMR 7.29 will be submitted to EPA as a SIP revision by March 1, 2008.

6.6 RACT Revisions

MassDEP has determined that its existing solvent metal degreasing, gasoline dispensing vapor recovery, and asphalt paving regulations do not constitute RACT under the 8-hour ozone standard**.** It is revising its regulations for these categories to require additional VOC controls, as discussed below.

6.6.1 Solvent Degreasing

The CTG covering solvent metal degreasing applies to units that clean/degrease metal in three types of systems - cold cleaning, open top vapor degreasers and conveyorized degreasers. The control measures for this sector generally cover operating practices rather than establish emission

limits. Massachusetts regulation 310 CMR 7.18(8) incorporated the CTG requirement for this sector and met 1-hour RACT as noted in Table RACT-1.

MassDEP believes that its existing regulation for this category does not constitute what is currently reasonably available technology in light of the adoption in a number of other states in the OTC region of a vapor pressure limit for solvents used in cold cleaning. MassDEP will propose an amendment to 310 CMR 7.18 (8) to include the vapor pressure limitation for solvents used in cold cleaning consistent with the OTC Model Rule. Upon completion of this rule amendment process, Massachusetts will meet 8-hour RACT control requirements for this source category. MassDEP anticipates that the revised control requirements will be effective by January 1, 2009.

6.6.2 Gasoline Dispensing Vapor Control

The distribution of gasoline results in evaporative VOC emissions from each stage of the distribution process. Control of gasoline vapors during transfer of gasoline from tank trucks to gasoline storage tanks is referred to as "Stage I" control. EPA issued a CTG for Stage I controls in 1975. MassDEP regulation 310 CMR 7.24(3), Distribution of Motor Vehicle Fuel, governs Stage 1 controls. Control of gasoline vapors during vehicle refueling is referred to as "Stage II" control and is addressed in 310 CMR 7.24(6), Dispensing of Motor Vehicle Fuel. EPA did not issue a CTG related to Stage II control.

Stage II control systems return vapors to gasoline tanks using either "vapor balance" or "vacuum assist" systems. Under the current requirements of 310 CMR 7.24(6), vapor balance systems installed on above ground gasoline storage tanks and all vacuum assist systems are required to install pressure/vacuum (P/V) vent caps, to further capture gasoline vapors. However, vapor balance systems installed on underground gasoline storage tanks are not required to install P/V vent caps. (MassDEP has, for many years, encouraged facilities to voluntarily install P/V vent caps.)

MassDEP has concluded that the P/V vent caps should be required on vapor balance systems installed on underground storage tanks to further reduce evaporative emissions from vehicle refueling. MassDEP intends to amend 310 CMR 7.24(6) to require that motor vehicle fuel dispensing facilities with vapor balance systems install a PV vent cap on each underground motor vehicle fuel storage tank vent. It anticipates that the revisions will be effective by January 1, 2009.

6.6.3 Asphalt Paving

Asphalt paving is used to pave, seal and repair surfaces such as roads, parking lots, and walkways. Asphalt paving is grouped into three general categories: hotmix, cutback, and emulsified. Hot-mix asphalt, the most commonly used paving asphalt, produces minimal VOC emissions. Cutback asphalt is prepared by blending asphalt cement with a diluent, typically from 25 to 45 percent by volume of petroleum distillates. Emulsified asphalt is a lower emitting alternative to cutback asphalt; emulsified asphalts use a blend of asphalt cement, water and an emulsifying agent, such as soap. Some emulsified asphalts may contain virtually no VOCs; others may contain up to 12% VOC by volume.

The EPA published a CTG for the use of cutback asphalt in December 1977. The CTG recommended replacing cutback asphalt binders with emulsified asphalt during the ozone season. In 1979, EPA added a specification for emulsified asphalt to the CTG recommendations to limit the content of oil distillate in emulsified asphalt to no higher than 7 percent oil distillate. Massachusetts regulation 310 CMR 7.18(9) incorporated the CTG requirement for this sector and met 1-hour RACT as noted in Table 1. It bans the use of cutback asphalt during the ozone season, but with a number of exceptions. It does not address emulsified asphalt.

During its review of additional control measures that states should consider adopting as part of the OTC regional 8-hour ozone attainment strategy, the OTC identified asphalt paving as a category where further VOC emission reductions could be achieved. It developed a model rule for the asphalt paving control measure that prohibits the use of cutback asphalt during the ozone season and limits the use of emulsified asphalt to that which contains not more than 0.5 mL of oil distillate from a 200 mL sample (as determined using American Society for Testing and Materials Methods) regardless of application. (This is equivalent to a VOC content of 0.25 percent.)

MassDEP will propose an amendment to 310 CMR 7.18(9) to eliminate all exceptions to the ozone-season ban on use of cutback. It will also propose to limit the VOC content of emulsified asphalt to the level proposed in the OTC model rule, or to such other level as is determined to be feasible in Massachusetts. Upon completion of this rule amendment process, Massachusetts will meet 8-hour RACT control requirements for this source category. MassDEP anticipates that the revised control requirements will be effective by April 2009.

6.7 Conclusions

By fully complying with all 1-hour ozone standard RACT requirements, Massachusetts has reduced emissions of VOCs and NOx from stationary point and area sources significantly over the past 30 years. In order to meet the 8-hour ozone standard RACT requirements, MassDEP is committing to further reduce VOC emissions for the categories of solvent metal degreasing, gasoline dispensing vapor control, and asphalt paving by adopting revised regulations with an anticipated effective date no later than January 1, 2009.
For large EGUs and other large NOx sources covered by the NOx Budget Program and Mass CAIR, those cap-and-trade programs meet RACT

MassDEP intends to review the three printing CTGs finalized by EPA in October 2006 and will determine in consultation with EPA whether existing Massachusetts regulations covering these source categories may be equivalent to the CTGs. If not, it will propose new regulations that will meet the CTG requirements.

With the exception of MWCs, as discussed in Section 6.5.1,for all other CTG RACT categories and major non-CTG sources of VOC and NOx emissions, MassDEP has concluded that current RACT controls, as adopted and approved by EPA under the 1-hour ozone standard, constitute RACT under the 8-hour ozone standard.

TABLE RACT-1

MassDEP 1-hour Ozone Standard RACT Regulations and 8-Hour Ozone Standard RACT Certification

EPA Control Technology Guidelines (CTGs) for VOCs	MassDEP RACT Regulations: Title and 310 CMR section number	Negative Declaration	EPA MA RACT SIP Approval Dates	MassDEP Certification: 8-hour Ozone Standard RACT	Comments
Pre-1990 CTGs: Group 1					
1. Stage I Vapor Control Systems (1975)	Organic Material Storage and Distribution, 7.24(3). (See comments)		5/25/78, 43 FR22356 9/16/80, 45 FR 61293 3/10/89, 54 FR10148 6/30/93, 58 FR 34911 9/3/99, 64 FR 48304	MassDEP commits to revise 7.24 to require pressure vent caps on all Stage II vacuum assist systems.	Gasoline distribution regulations were previously in 7.02(12). In 1990, all provisions were incorporated into 7.24.
2. Surface Coating of Cans, Coils, Paper, Fabrics, Automobiles, and Light-duty trucks (1977)	Volatile and Halogenated Organic Compounds: 7.18(4) -cans 7.18(7) -autos/ light duty trucks 7.18(10) – coils 7.18(14) – paper 7.18(15) - fabrics 7.18(16) – vinyl		9/16/80, 45 FR 61293 3/8/82, 47 FR 9836 11/9/83, 48 FR 51480	Current regulation meets 8-hour RACT for all categories.	
3. Refinery Vacuum Producing Systems, Wastewater Separators, and Process Unit Turnarounds (1977)		Yes	9/3/99, 64 FR 171	There are still no sources in MA.	
4. Solvent Metal Cleaning (1977)	Volatile and Halogenated Organic Compounds, 7.18(8) – Solvent Metal Degreasing		9/16/80, 45 FR 61293 11/9/83, 48 FR 51480 9/3/99, 64 FR 48304 1/11/93, 58 FR 3495	MassDEP commits to revise 7.18 to incorporate a	

			6/10/93, 58 FR 34911	solvent vapor pressure limit of 1.0 mm Hg to meet 8-hour RACT.	
5. Tank Truck Gasoline Loading Terminals (1977).	Organic Material Storage and Distribution: 7.24(2), 7.24 (4)		9/25/85, 50 FR 38804 5/4/89, 54 FR 19184 9/3/99, 64 FR 48304	Current regulation meets 8-hour RACT.	
6. Surface Coating Metal Furniture (1977)	Volatile and Halogenated Organic Compounds, 7.18(3)		9/16/80, 45 FR 61293	Current regulation meets 8-hour RACT.	
7. Surface Coating Magnet Wire (1977)	Volatile and Halogenated Organic Compounds, 7.18(6)		9/16/80, 45 FR 61293	Current regulation meets 8-hour RACT.	
8. Surface Coating Large Appliances (1977)	Volatile and Halogenated Organic Compounds, 7.18(5)		9/16/80, 45 FR 61293	Current regulation meets 8-hour RACT.	
9. Bulk Gasoline Plants (1977)	Organic Material Storage and Distribution, 7.24(1)		9/16/80, 45 FR 61923 9/3/99, 64 FR 48304	Current regulation meets 8-hour RACT.	
10. Fixed Roof Petroleum Tanks (1977)	Organic Material Storage and Distribution, 7.24(1);		9/16/80, 45 FR 61923 3/8/84, 49 FR 8611 9/3/99, 64 FR 48304	Current regulation meets 8-hour RACT.	
11. Use of Cutback Asphalt (1977)	Volatile and Halogenated Organic Compounds, 7.18(9)		9/16/80, 45 FR 61293 11/9/83, 48 FR 51480 1/1/93, 58 FR 3495	MassDEP commits to revise regulation to further restrict cutback use and limit VOC content in emulsified asphalt.	

Pre-1990 CTGs: Group II					
12. Surface Coating Misc. Metal Parts (1978)	Volatile and Halogenated Organic Compounds, 7.18(11)		6/2/82, 47 FR 23927 1/11/93, 58 FR 3495 6/30/93, 58 FR 34911	Current regulation meets 8-hour RACT.	
13. Surface Coating Flat Wood Paneling (1978)	Volatile and Halogenated Organic Compounds, 7.18(24)		9/3/99, 64 FR 171	Current regulation meets 8-hour RACT.	
14. Leaks from Petroleum Refinery Equipment (1978)		Yes	9/3/99, 64 FR 171	There are still no sources in MA.	
15. Manufacture of Synthetic Pharmaceutical Product (1978)		Yes	9/3/99, 64 FR 171	There are still no sources in MA.	
16. Manufacture of Pneumatic Rubber Tires (1978)		Yes	9/3/99, 64 FR 171	There are still no sources in MA.	
17. Graphic Arts – Rotogravure & Flexography (1978)	Volatile and Halogenated Organic Compounds, 7.18(12)		6/2/82, 47 FR 23927 9/3/99, 64 FR 48304	Current regulation meets 8-hour RACT.	
18. Petroleum Storage in External Floating Roof Tanks (1978)	Organic Material Storage and Distribution, 7.24(1)		3/8/84, 49 FR 8611 6/30/93 58 FR 34911 9/3/99, 64 FR 48304	Current regulation meets 8-hour RACT.	
19. Perchloroethylene Dry Cleaning Systems (1978)			6/02/82, 47 FR 23927 11/09/83, 48 FR 51480 8/31/87, 52 FR 32792	No certification required.	CTG became moot when EPA delisted perc. as a VOC.
20. Leaks from Gasoline Tank Trucks and Vapor Collection System (1978)	Organic Material Storage and Distribution, 7.24(4)		9/25/85, 50 FR 38804 9/3/99, 64 FR 48304	Current regulation meets 8-hour RACT.	
Pre-1990 CTGs: Group III					
21. Large Petroleum Dry Cleaners (1982)		Yes	64 FR 171, 9/3/99	There are still no sources in MA.	.
22. Manufacture of High-Density Polyethylene, Polypropylene and Polystyrene Resins (1983)		Yes	52 FR 32792, 8/31/87 64 FR 171, 9/3/99	There are still no sources in MA.	
23. Natural Gas/Gasoline Process Leaks (1983)		Yes	52 FR 32792, 8/31/87	There are still no sources in MA.	

24. Synthetic Organic Chemical Mfg Equipment Fugitive Emissions (1984)	Volatile and Halogenated Organic Compounds, 7.18(19)		11/19/87	Current regulation meets 8-hour RACT	
25. Synthetic Organic Chemical Mfg Air Oxidation Processes (1984)		Yes	52 FR 32792, 8/31/87 64 FR 171, 9/3/99	There are still no sources in MA.	
Post – 1990 CTGs					
1. Synthetic Organic Chemical Manufacturing Industry (SOCMI) Distillation Operations and Reactor Processes (1993)	One facility (Solutia) subject to CTG for distillation operations. Control system with a control efficiency of >85% (BACT in federally enforceable plan approval) determined to be equivalent to CTG RACT in 2002.	Yes, for reactor processes.	67 FR 62190, 10/4/02	There are still no reactor process sources in MA. Current requirements for distillation operations meet 8-hour RACT.	See Table 2 - Single Source RACT
2. Wood Furniture Manufacturing (1996)	Volatile and Halogenated Organic Compounds, 7.18(23) – wood products. EPA determined in 2002 that a combination of VOC regulations and BACT and RACT plan approvals for the 6 facilities covered by this CTG met 1-hr. RACT.		64 FR 48304, 9/3/99 67 FR 62190, 10/4/02	Current requirements meet 8-hour RACT.	See Table 2 - Single Source RACT
3. Ship Building and Repair (1996)		Yes	67 FR 62190, 10/4/02	There are still no sources in MA.	
4. Aerospace Coatings (1996 draft)	EPA determined in 2002 that current requirements - a combination of VOC regulations and BACT and RACT plan approvals for the 2 facilities covered by CTG - met 1-hr. RACT		67 FR 62190, 10/4/02	Current requirements meet 8-hour RACT.	See Table 2 - Single Source RACT
5. Flat Wood Paneling (2006)		Yes			
6. Industrial Cleaning Solvents (2006)	MassDEP intends to propose amendments to its Solvent Metal Degreasing regulation, 310 CMR 7.18(8), which, along with other MassDEP existing regulations that address cleaning operations within specific coating source categories, will meet the 2006 CTG.				

7. Lithographic print materials (2006)	MassDEP intends to analyze whether its existing regulations for this category are equivalent to the CTG. If necessary, it will adopt new regulations and file them as an amendment to the RACT SIP when finalized.				
8. Letterpress printing materials (2006)	See #7.				
9. Flexible packaging printing materials (2006)	See #7.				

OTHER MassDEP VOC RACT REGULATIONS					
In 1992, to address the lower VOC threshold of 50 tons, MassDEP grouped similar industrial processes and promulgated a CTG-like regulation for these processes, which were not covered by an EPA CTG.	7.18(21) – plastic parts 7.18(22) – leather 7.18(24) - flat wood paneling 7.18(25) – offset lithog. printing 7.18(26) – textile finishing 7.18(27) – coating mixing tanks		64 FR 48304, 9/3/99	Current requirements meet 8-hour RACT.	
NOx RACT Categories					
EPA's NOx Achievable Control Technology (ACT) documents are listed below only to illustrate NOx RACT source categories. Massachusetts NOx RACT regulation, 310 CMR 7.19, was promulgated before EPA issued some of the ACTs listed below. ACTs do not establish presumptive levels of control, therefore, MassDEP is not required to certify that RACT is consistent with the ACTs.	RACT for Sources of Oxides of Nitrogen (7.19) applies to all sources with a potential to emit $\geq$ 50 tons per year of NOx, with certain exceptions. Applicability to an individual unit at a source is based on exceedance of a minimum capacity rating.				

1. Nitric and Adipic Acid Plants (1991)	No sources.	Yes		There are still no sources in MA.	
2. Combustion Turbines (1993)	RACT for Sources of Oxides of Nitrogen, 7.19(7)			Current regulation meets 8-hour RACT.	
3. Process Heaters (1993)	RACT for Sources of Oxides of Nitrogen, 7.19			Current regulation meets 8-hour RACT.	
4. Internal Combustion Engines (1993)	RACT for Sources of Oxides of Nitrogen 7.19(8)			Current regulation meets 8-hour RACT.	

5. Utility Boilers (1994)	RACT for Sources of Oxides of Nitrogen 7.19(4) NOx Allowance Trading Program, 7.28 MA CAIR, 7.32 Emission Standards for Power Plants, 7.29			Current regulations meet 8-hour RACT. NOx Allowance Trading Program sources are included in MA CAIR regulation. Annual NOx emission standards in 7.32 apply to largest MA power plants	MA will submit 7.29 as a SIP revision prior to 2009
6. Cement Manufacturing (1994, updated 2000)	No sources.			There are still no sources in MA.	
7. ICI Boilers (1994)	RACT for Sources of Oxides of Nitrogen: 7.19 (4); 7.19(5); 7.19(6)			Current Regulations meet 8-hour RACT.	
8. Glass Manufacturing (1994)	RACT for Sources of Oxides of Nitrogen, 7.19(11)			Current regulation meets 8-hour RACT.	
9. Iron and Steel (1994)	No sources.			There are still no sources in MA.	
10. Municipal Waste Combustors (no ACT)	RACT for Sources of Oxides of Nitrogen, 7.19(9) and Incinerators, 7.08(2)		9/2/99 64 FR 48098	Will re-analyze as discussed in final Section 6.	

TABLE RACT-2

MassDEP Single Source 1-Hour Ozone Standard RACT Determinations
And 8-Hour Ozone Standard RACT Certification

Single Source VOC RACT determinations were made for major VOC sources not covered by a CTG pursuant to 310 CMR 7.18(17).

Single Source NOx RACT determinations were made for major NOx sources pursuant to 310 CMR 7.19(12), which covers major "miscellaneous" sources of NOx.

FACILITY	EPA APPROVAL of SINGLE SOURCE RACT SIP	OPEN FACILITY (Yes or Closed)	Major for 1-hr Ozone? NOx > 50 TPY &/or VOC > 50 TPY	Major for 8-hr Ozone? NOx>100 TPY&/or VOC> 50 TPY	Certification of 8-hour RACT if an 8-hr major source	Comments
Cranston Print Works	11/3/89	Yes	VOC	VOC	Current requirements meet 8-hour RACT.	
Spalding	11/8/89	Closed			Not required	
Duro Textile Printers	11/8/89	Yes	VOC	VOC	Current requirements meet 8-hour RACT.	
Monsanto Chemical (Currently Solutia)	2/21/90 10/4/02	Yes	VOC	VOC	Current requirements meet 8-hour RACT.	See discussion in Table 1, under Post 1990 CTGs, #1 - SOCMI
Boston Whaler – Norwell	8/3/90	Closed			Not required	
Boston Whaler - Rockland	8/3/90	Closed			Not required	
Philips Lighting	11/2/89	Closed			Not required	
General Motors	2/19/91	Closed			Not required	
Acushnet	6/13/90	Yes	VOC	VOC	Current requirements meet 8-hour RACT.	RACT superceded by more stringent BACT

Erving Paper Mills	10/16/90	Yes	VOC	VOC	Current requirements meet 8-hour RACT.	
Dartmouth Finishing	12/14/92	Closed			Not required	
S. Bent &Brothers	7/28/94	Closed			Not required	
Nichols and Stone	1/6/95	Yes	VOC	VOC	Current requirements meet 8-hour RACT.	
Britteny Dyeing and Finishing	3/6/95	Yes	VOC	VOC	Current requirements meet 8-hour RACT.	
Gillette	10/4/02	Yes	VOC	VOC	Current requirements meet 8-hour RACT.	
Norton (currently St. Gobain Abrasives, Inc.	10/4/02	Yes	VOC	VOC	Current requirements meet 8-hour RACT.	
Rex	10/4/02	Closed			Not required	
Barnet (currently Alliance Leather)	10/4/02	Yes	VOC	VOC	Current requirements meet 8-hour RACT.	
Specialty Minerals	9/2/99	Yes	NOx	NOx	Current requirements meet 8-hour RACT	
Monsanto (currently Solutia)	9/2/99	Yes	NOx	NOx	Current requirements meet 8-hour RACT	
Indeck Energy Services (Turners Falls)	9/2/99	Closed			Not required	
Medusa Minerals (currently Old Castle Stone)	4/16/99	Yes	NOx	NOx	Current requirements meet 8-hour RACT.	

TABLE RACT-3 NOx Allowance Trading Program (310 CMR 7.28) and Mass CAIR (310 CMR 7.32) Sources

Sources subject to 310 CMR 7.28 are listed below (37 facilities). All of these sources are also subject to 310 CMR 7.32. Sources subject to 310 CMR 7.29, Emissions Controls for Power Plants, are highlighted.

BELLINGHAM COGENERATION, BELLINGHAM
ANP BELLINGHAM, BELLINGHAM
ANP BLACKSTONE, BLACKSTONE
MILLENNIUM POWER PARTNERS LP, CHARLTON
EXELON WEST MEDWAY LLC, MEDWAY
ANP MILFORD POWER LP, MILFORD
INDECK PEPPERELL POWER, PEPPERELL
MBTA SOUTH BOSTON POWER, BOSTON
EXELON NEW BOSTON LLC, BOSTON
TRIGEN BOSTON ENERGY, BOSTON
BRAINTREE ELECTRIC - POTTER, BRAINTREE
HARVARD UNIVERSITY, CAMBRIDGE
MIRANT KENDALL LLC, CAMBRIDGE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE
BOSTON GENERATING MYSTIC I LLC, EVERETT
EXELON FRAMINGHAM LLC, FRAMINGHAM
LOWELL COGEN COMPANY, LOWELL
LPG ASSOCIATES LP - LOWELL POWER, LOWELL
GENERAL ELECTRIC AIRCRAFT ENGINES, LYNN
PEABODY MUNICIPAL LIGHT - WATERS RIVER, PEABODY
DOMINION ENERGY-SALEM HARBOR LLC, SALEM
FORE RIVER DEVELOPMENT LLC, WEYMOUTH
DARTMOUTH POWER ASSOCATES, DARTMOUTH
BG DIGHTON POWER LLC, DIGHTON
MIRANT CANAL, SANDWICH
SOMERSET POWER LLC, SOMERSET
DOMINION ENERGY-BRAYTON POINT LLC, SOMERSET
TAUNTON MUNICIPAL LIGHT - CLEARY FLOOD, TAUNTON
BERKSHIRE POWER LLC, AGAWAM
MT TOM GENERATING COMPANY LLC, HOLYOKE
CEEMI-WOODLAND ROAD, LEE
STONY BROOK ENERGY CENTER, LUDLOW
CEEMI-DOREEN STREET, PITTSFIELD
PITTSFIELD GENERATING, PITTSFIELD
MASSPOWER, SPRINGFIELD
CEEMI-WEST SPRINGFIELD STATION, WEST SPRINGFIELD

SECTION 7 REASONABLY AVAILABLE CONTROL MEASURES (RACM)

7.1 Purpose of Section

This section addresses whether there are any reasonably available control measures (RACM) that could be adopted in Massachusetts that would result in EMA and/or WMA attaining the 8-hour ozone standard earlier than 2009. Consistent with EPA guidance on RACM, MassDEP has examined potential control measures for point and area sources and potential Transportation Control Measures (TCMs) for mobile sources based on whether such measures: 1) provide sufficient emissions reductions to accelerate attainment; and 2) are feasible both economically and technically. MassDEP concludes that there are no control measures that could be adopted in Massachusetts that satisfy these RACM criteria.

7.2 RACM Analysis Criteria

Section 172(c)(1) of the CAA requires that SIPs contain RACM, as necessary, to provide for attainment as expeditiously as practicable, and that RACM include, at a minimum, reductions in emissions from existing sources as may be obtained from RACT (See Section 6).
EPA's Phase 2 Rule provides that states must include a RACM analysis with their attainment demonstration SIPs.

EPA guidance[1] interpreting the RACM requirements of section 172(c)(1) provides that for purposes of attainment demonstration SIPs, potentially available control measures can be justified as not meeting RACM if a measure (a) is not technically or economically feasible, or (b) does not advance the attainment date for the area. EPA's guidance further provides that states may consider local conditions, including economic impacts and implementation issues, in rejecting potential control measures. EPA does not require that all sources apply RACM if less than all RACM will suffice for reasonable further progress and attainment and application of RACM will not advance the attainment date.

According to EPA modeling guidance, areas that have an attainment date of June 15, 2010 (EMA and WMA) must implement the emission reductions needed for attainment no later than June 2009. Thus, to advance the attainment date, the potential RACM measures would have to achieve the emission reductions needed for attainment during the 2008 ozone season.

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1 *EPA Memorandum, "Guidance on the RACM Requirement and Attainment Demonstration Submissions for Ozone Nonattainment Areas"*, from John S. Seitz, EPA Director, Office of Air Quality Planning and Standards to the Regional Air Division Directors, November 1999. *EPA Memorandum, "Additional Submission on RACM From States With Severe 1-hour Ozone Nonattainment Area SIPs"*, from John S. Seitz, EPA, Director Office of Air Quality Planning and Standards and Marge Oge, EPA Director, Office of Transportation and Air Quality, to Regional Air Division Directors, December 14, 2000.
66 Federal Register No. 2, January 3, 2001, *Final Rule for Approval and Promulgation of Air quality Implementation Plans: Connecticut, 1-Hour Ozone Attainment Demonstration for the Greater Connecticut Ozone Nonattainment Area.*

7.3 OTC Regional RACM Analysis

As discussed in Section 5, *Attainment Demonstration*, the OTC conducted an extensive regional 8-hour ozone standard attainment planning process. That planning effort included an assessment of the nature and magnitude of the ozone problem in the region, a comprehensive review and analysis of potential additional controls within the OTC region, regional modeling under various control scenarios, and formal recommendations by the OTC to its member states to adopt selected control measures.

At the November 2004, OTC Meeting, the OTC directed its Stationary and Area Sources Committee to review programs to address emissions from all stationary and area sources. At the same meeting, it directed the Mobile Source Committee to identify mobile source control measures for evaluation.[2]

OTC staff compiled an initial list of over 1,000 candidate control measures identified through published sources such as EPA's Control Technique Guidelines, STAPPA/ALAPCO "Menu of Options" documents, emission control initiatives in other states including California, state/regional consultations, and stakeholder input.[3]

From that list, workgroups comprised of OTC staff and member states'air quality staff eliminated measures that were not feasible because of technical, economic and/or implementation issues. The list was narrowed to approximately 50 candidate control measures that were considered to have the potential to advance ozone attainment in the OTC states.

These measures were subjected to more detailed analysis of the potential for reductions of VOCs or NOx, cost effectiveness, likelihood of implementation, and effectiveness in reducing ozone levels in the OTC region. After consideration of these criteria, the OTC Control Measures Workgroup identified the most promising candidates from the list of approximately 50 measures and developed separate Control Measures Summary Sheets for these measures. The Control Measure Summary Sheets are in Appendix 5K[4]. They provide they the following information for each measure:

1. A summary of potential additional controls for the sector.
2. A review of existing controls in OTC states and in other states (most often California).
3. A detailed description of the candidate control measures, including estimates of cost per ton of emissions reductions, estimate of reductions that could be achieved, time in which the measure could be implemented, and technical and implementation issues.
4. A rationale for the proposed strategy and a policy recommendation with respect to whether it should be adopted by the OTC as a recommendation to the states.

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2 OTC Formal Actions related to the regional ozone planning process are available on the OTC website at http://www.otcair.org/document.asp?fview=Formal

3 The initial list of control measures is on the OTC web site at http://www.otcair.org/document.asp?fview=Report# [3] under "Documents/OTC Reports/Control Measures 2007.

4 All of the Control Measure Summary Sheets relate to controls for point and area sources, with the exception of Reformulated Gasoline, a mobile source control measure.

These Control Measures Summary Sheets are a product of the comprehensive review and analysis of OTC member states' staff with a wide range of expertise concerning the potential for control measures for point and area sources. Iterations of the proposed control measures were made available to stakeholders who commented on the technical and economic feasibility of the various measures, the proposed timeframes for implementation and other issues. Frequently, the summary sheets were modified to reflect stakeholder comments. Thus, the Control Measures Summary Sheets are the outcome of a thorough analysis of the availability and feasibility of additional control measures for all point and area source sectors.

The OTC Workgroup made its recommendations concerning the control measures to the OTC Commissioners. After further review, the OTC Commissioners recommended to OTC member states that they individually consider adoption of additional measures.[5] These measures are listed in Table RACM 1.

7.4 **Point and Area Source RACM Analysis for Massachusetts**

MassDEP has reviewed its own sources within the sectors identified as candidates for additional control by the OTC Workgroup and recommended by the OTC Commissioners. The result of the MassDEP analysis is summarized in Table RACM 1. The OTC regional review and analysis of potential control measures, in combination with MassDEP assessment of the applicability and potential for these measures to meet the RACM criteria, constitute a comprehensive point and area source RACM analysis for Massachusetts. MassDEP has determined that there are no RACM for point and area sources that could be adopted in EMA or WMA that would advance the attainment year to 2008.

5 As noted in footnote 2, all OTC formal actions are available on the OTC website. The formal recommendations concerning control measures are at Documents/Formal Actions.

Table RACM 1 OTC Recommended Control Measures and MA RACM Analysis

Source Categories with OTC Control Measure Worksheets	OTC 2006 Recommendation for Additional Controls	MassDEP RACM Analysis
Adhesives and Sealants	**Yes**	MassDEP is committing to adopt controls for this category consistent with the OTC Model Rule, with a 4/1/2009 effective date.
Architectural and Industrial Maintenance Coatings	**No**[6]	MassDEP has finalized amendments to 310 CMR 7.25, consistent with the 2001 OTC Model Rule, with a 1/1/2009 effective date.
Asphalt Paving (Emulsified and Cutback)	**Yes**	MassDEP is committing to adopt controls for this category effective 5/1/2009.
Asphalt Production Plants	**Yes**	MA facilities are already subject to fuel combustion requirements and case-by-case RACT determinations for major sources (310 CMR 7.19). MassDEP has concluded that additional controls (low NOx burners, flue gas recirculation) are not economically feasible for these facilities.
Automotive Refinish Coatings	**No**	Already subject to 310 CMR 7.18(28)
Cement Kilns	**Yes**	No sources in MA
Chip Reflash (Heavy Duty Diesel Engines)	**Yes**	See discussion under *Mobile Sources.*
Consumer Products	**Yes**	MassDEP has finalized amendments to 310 CMR 7.25, effective 1/1/2009, consistent with the 2001 OTC Model Rule, and including the additional controls recommended by the OTC in 2006.

6 In 2001, the OTC recommended additional VOC controls for this category. It decided against recommending additional controls from this category during the 2006 review.

Glass and Fiberglass Furnaces	**Yes**	Only 1 facility in MA
Industrial, Commercial, Institutional Boilers	**Yes**	MassDEP has reviewed the potential for additional emissions reductions from this category as part of its RACT review and concludes that no additional controls are reasonably available (Section 6, RACT).
Industrial Surface Coatings: Fabric Printing, Coating, and Dyeing; Large Appliances; Metal Cans; Metal Coils; Metal Furniture; Miscellaneous Metal Parts;Paper and Web Coating; Plastics Parts; Wood Building Products; All Categories	**No**	Already subject to VOC RACT, 310 CMR 7.18.
Lime Kilns	**No**	.
Municipal Waste Combustors	**No** No regional measure recommended but individual states should evaluate.	MassDEP has reviewed the potential for additional emissions reductions from this category as part of its RACT review. It concludes that no additional controls are reasonably available (Section 6, RACT).
Printing and Graphic Arts	**No**	Already subject to VOC RACT requirements (310 CMR 7.18) and MassDEP Environmental Results Program 310 CMR.
Portable Fuel Containers	**Yes**	EPA's regulation of this category will take effect 1/1/2009. It would be impractical for MassDEP adopt a state regulation with an earlier effective date.

7.5 Mobile Source RACM

States are generally precluded from regulating engines and fuels used in on-road and non-road vehicles and engines.[7] RACM analysis for mobile sources, therefore, focuses on the availability and feasibility of transportation control measures (TCMs).

7 The only OTC recommendation concerning mobile source controls was that states that had not already adopted reformulated gas (RFG) statewide do so. Massachusetts already has RFG statewide.

Section 108(f) of the CAA lists 16 types of TCM's:

- Programs for improved public transit
- High occupancy vehicle (HOV) lanes
- Employer-based transportation management plans
- Trip reduction ordinances
- Traffic flow improvement programs
- Fringe and transportation corridor parking for high occupancy vehicle programs
- Limits or restrictions on vehicle use in specified areas
- HOV and shared-ride programs
- Bicycle and pedestrian facilities, lanes and restrictions
- Bicycle storage, travel lanes and related improvements and programs
- Control of idling vehicles
- Reduction of extreme cold start emissions
- Employer-sponsored flexible work schedules
- Facilitation of non-automobile, HOV, and mass transit travel
- Pedestrian and non-motorized vehicle facilities, paths and areas
- Voluntary retirement of pre-1980 light duty vehicles

MassDEP has already implemented and included in its 1-hour ozone standard SIPs for EMA and WMA many TCMs. (See Appendix 3A, *Massachusetts 1-Hour Standard Control Measures*). Massachusetts committed to expand existing public transit systems and to implement a significant number of other TCMs and Transportation Demand Management (TDM) measures over a decade ago in connection with its Central Artery/Third Harbor Tunnel (CA/T) project. The TCMs that have been implemented in EMA and WMA are noted below:

Table RACM 2 Transportation Control Measures Adopted in EMA and WMA

CAA Section 108(f) TCMs	In EMA SIP	In WMA SIP	Comments
Programs for improved public transit	Yes	Yes	Numerous improvement and expansion projects: fixed rail, bus rapid transit, commuter trains, etc.
High occupancy vehicle (HOV) lanes	Yes	No	
Employer-based transportation management plans	Yes	Yes	
Trip reduction ordinances	Yes	No	
Traffic flow improvement programs	Yes	Yes	
Fringe and transportation corridor parking for high occupancy vehicle programs	Yes	Yes	Park and ride available adjacent to HOV corridors
Limits or restrictions on vehicle use in specified areas	Yes	No	Parking Freeze regulations
HOV and shared-ride programs	Yes	No	
Bicycle and pedestrian facilities, lanes and restrictions	Yes	Yes	
Bicycle storage, travel lanes and related improvements and programs	Yes	Yes	
Control of idling vehicles	Yes	Yes	Anti-idling law 90 section 16a
Employer-sponsored flexible work schedules	Yes	Yes	
Facilitation of non-automobile, HOV, and mass transit travel	Yes	No	
Pedestrian and non-motorized vehicle facilities, paths and areas	Yes	No	

7.6 Massachusetts Congestion Mitigation and Air Quality Projects

One of the funding sources for transportation projects is the Federal Highway Administration's Congestion Mitigation and Air Quality (FHWA CMAQ) Program. FHW CMAQ funds are used for projects that reduce emissions from vehicles, improve traffic congestion, and/or improve air quality. Through the FHWA CMAQ program, Massachusetts continues to fund transportation projects that reduce ozone precursor emissions. A list of FHWA CMAQ projects approved for funding in Federal Fiscal Year 2007 is Appendix 7A. An estimate of the reductions in VOC and NOx emission reductions that are realized from these projects is provided.

One of the major programs listed for 2007 FHW CMAQ funding is the MassDEP Diesel School Bus Retrofit Program. The Executive Office of Transportation is providing approximately $16

million in FHWA CMAQ and state matching funds to develop and implement the program, which will reduce air pollution from public school buses. MassDEP anticipates launching this program early in 2008, with the goal of retrofiting all eligible school buses by Fall 2010.

While the Diesel School Bus Retrofit Program and other FHWA CMAQ programs are important efforts, they result in relatively small amounts of emissions reductions and, therefore, do not meet RACM criteria.

7.7 Mobile Source RACM Conclusions

Massachusetts is currently implementing all of the reasonably available TCMs listed in the Clean Air Act. Massachusetts has also included in its SIP a wide range of emissions-reducing programs, including California LEV and Stage 2. The State is also implementing transit improvements and transportation-related environmental actions as an integral part of the Central Artery/Third Harbor Tunnel project. It continues to fund new TCMs through the FHW CMAQ program. However, there are no RACM for mobile sources that would allow EMA to reach attainment any sooner than 2009.

7.8 Overall RACM Conclusions

There are no control measures that could be implemented in Massachusetts for any source sectors that meet the RACM feasibility criteria and that would advance the attainment year for EMA or WMA to 2008.

SECTION 8 CONTINGENCY MEASURES

8.1 Purpose of Section

This section demonstrates that EMA and WMA meet the requirements for SIP contingency measures related to both Reasonable Further Progress (RFP) and to the attainment of the ozone standard. If implemented, the contingency measures discussed in this section would result in reductions in addition to those required to demonstrate RFP (discussed in Section 4) and in addition to those that have been taken into account in the attainment demonstration (discussed in Section 5). Contingency measures ensure that if EMA or WMA fail to achieve the 15% required RFP reductions by the 2008 RFP milestone year, or fail to attain the ozone standard by 2010[1], additional reductions will occur without further state or federal action.

8.2 Contingency Requirements

Section 172(c)(9) of the CAA and EPA's Phase 2 Rule require that nonattainment areas include contingency measures in their RFP and attainment SIPs. If a state receives a notification from EPA that a nonattainment area within its borders has failed to achieve the level of reductions demonstrated in the RFP SIP by the milestone year (2008 for EMA and WMA), or has failed to attain the standard by the attainment date (June 2010 for EMA and WMA), the area must be able to implement contingency measures within one year after EPA's notice.

The RFP contingency and the attainment contingency must each provide for reductions equivalent to at least 3% of the 2002 RFP Adjusted Base Year VOC emissions inventory.[2] The contingency reductions are in addition to the 15% reduction required to demonstrate RFP and in addition to the reductions taken into account in the attainment demonstration.

8.3 RFP Contingency

As discussed in Section 4, MassDEP is meeting the requirement to reduce emissions by 15% in the 2008 RFP milestone year through a combination of reductions of NOx (12%) and VOCs (3%) in both EMA and WMA. To satisfy the contingency requirement, MassDEP must be able to demonstrate that if EMA or WMA fails to achieve a 12% reduction in NOx and a 3% reduction in VOCs by 2008, without further state or federal action, an additional 3% reduction could be achieved from control measures not already taken in account in calculation of the 15% RFP reduction.

According to EPA's interpretation of this requirement, the RFP contingency may be met by showing reductions in the 2008 RFP milestone year of at least 18% by 2008 (15% RFP + 3% RFP contingency).[3] As demonstrated in Section 4 Table RFP 3, both EMA and WMA have

[1] The attainment date for moderate nonattainment areas is June 15, 2010. For attainment contingency purposes, this is the milestone year. This is in contrast to the milestone year for the attainment demonstration, which is the ozone season prior to the attainment year – 2009.

[2] The RFP Adjusted Base Year Inventory is based on the MA 2002 Base Year Inventory adjusted for RFP purposes, as discussed in detail in Section 4.

[3] U.S. EPA Memorandum from Michael H. Shapiro to Region 1 through 10 Air Directors, *Guidance on Issues Related to 15% Rate-of-Progress Plans*, August 23, 1993.

demonstrated reductions significantly greater than the 15% reductions needed to meet RFP requirements and the additional 3% reductions needed to meet the contingency requirements. Therefore, EMA and WMA have both met the RFP contingency requirement.

8.4 Attainment Contingency

EPA will assess whether EMA and WMA have attained the standard by June 2010, presumably based on monitored ozone readings for 2007 – 2009. If either area is not meeting the standard based on readings for the 3-year period, EPA may issue a notification of failure to attain. The notification will trigger a requirement for MassDEP to implement contingency reductions within one year of the notification. For purposes of this contingency analysis, MassDEP is assuming that EPA would issue the notice in June 2010, and that the contingency measures would need to be in place by June 2011. Therefore, to meet the attainment contingency requirement, MassDEP must identify control measures that will achieve additional reductions in emissions after 2009 and by June 2011 from control measures that will be effective without any further state or federal action.

The amount of additional reductions that must be achieved in order to meet the attainment contingency requirement is 3% of the 2002 RFP Adjusted Base Year VOC emissions.[4] The amount of reductions is shown below.

Table CGM 1 Required Attainment Contingency

	2002 RFP Adjusted Base Year Inventory (TPSD)		**3% of 2002 VOCs = Required Contingency Reduction**
	VOC	**NOx**	
EMA	603.9	608.8	**18.1**
WMA	97.2	103.8	**2.9**
STATE	701.1	712.6	21.0

MassDEP will meet this attainment contingency requirement by taking credit for emission reductions that will be achieved from the existing federal on-road mobile source control measures described in Section 3, *Control Measures, Federal "On-the-Way" On-Road Mobile Source Measures* (Fuel Standards and Heavy-Duty Engine Standards) and from the Massachusetts Low-Emission Vehicle (LEV) Program (also discussed in Section 3). These measures will continue to provide substantial VOC and NOx emission reductions through 2011 (and beyond) as newer, less-polluting vehicles replace the older fleet. The projected reductions from the on-road mobile sector during the contingency period – after the June 2009 attainment

[4] While the required reductions are calculated as a percentage of the 2002 VOC emissions, NOx reductions can be used as a direct substitute for up to 90% of the required reductions of 3% of VOCs Therefore, only 0.3% of the reductions achieved by the contingency measures must be VOCs; this equates to 0.05 TPSD in EMA and 0.01 TPSD in WMA.

date and before the 2011 ozone season -- are shown in Table CGM 2. The estimated reductions during this time period exceed the required attainment contingency reduction.

Table CGM 2 Comparison: 2011 Projections and Contingency Requirement

(TPSD)	**On-Road Mobile 2009 & 2011 Projected emissions and reductions[5]**						**Combined On-Road VOC & NOx reductions compared to required contingency**	
	VOC 2009	VOC 2011	VOC Reduction 2009 to 2011	NOx 2009	NOx 2011	NOx Reduction 2009 to 2011	Combined VOC/NOx Reductions	Required attainment contingency reductions (from Table CGM 1)
EMA	63.5	52.5	**11.0**	175.0	132.1	**42.9**	**53.9**	**18.1**
WMA	10.7	8.9	**1.9**	27.7	20.9	**6.8**	**8.7**	**2.9**
STATE	74.2	61.4	12.9	202.7	153.0	49.7	62.6	21.0

8.5 Conclusions

EMA and WMA have met the RFP contingency by demonstrating that the reductions of VOC and NOx projected by 2008 are significantly greater than the 18% reduction that is required (15% for RFP and 3% for RFP contingency). For the attainment contingency, the reductions of VOC and NOx that will be achieved during the 2009-2011 period from the on-road mobile source control measures already in effect are significantly greater than reductions needed to meet the 3% attainment contingency requirement. Therefore, EMA and WMA meet the attainment contingency requirement.

[5] The methodology and calculations used to develop the 2011 projected emissions shown in Table CGM 2 are described in Appendix 8A

SECTION 9 CONFORMITY

9.1 Purpose of Section

This section establishes Transportation Conformity budgets for the on-road mobile source sector for EMA and WMA in the 2008 RFP milestone year and in the 2009 attainment demonstration year. The Transportation Conformity budgets set the levels of mobile source emissions that may not be exceeded in the each area in the budget years. The budgets were developed using methods agreed upon by staff of the Massachusetts Executive Office of Transportation and Public Works, Office of Transportation and Planning (EOT), MassDEP, and EPA Region 1 through the conformity consultation process. Technical data files related to the Mobile 6 model runs used to estimate mobile source emissions in the budget years are in the Appendix 9.

9.2 Background

Transportation conformity is required by section 176(c) of the CAA to ensure that transportation plans, programs and projects receiving federal funds are consistent with the SIP. Conformity to a SIP means that transportation activities will not produce new air quality violations, worsen existing violations, or delay timely attainment of a NAAQS.

EPA's Phase 2 Implementation Rule provides that nonattainment areas establish motor vehicle emissions budgets for the RFP milestone year (2008) and for the attainment demonstration year (2009). The budgets are set at the level of emissions from the on-road mobile sector projected for these years. Emissions of VOC and NOx from this sector may not exceed the budget levels. Emissions in years for which no budget is set may not exceed the budget established for the most recent prior year.

MassDEP established conformity budgets for EMA and WMA under the 1-hour ozone standard. For WMA, MassDEP submitted to EPA a 1-hour ozone standard attainment demonstration in 1998, which established budgets for the 2003 attainment year. EPA found the WMA budgets adequate for conformity purposes on February 9, 1999. For EMA, MassDEP submitted to EPA a 1-hour ozone standard attainment demonstration in September 2002, which established budgets for the 2007 attainment year. EPA found the EMA budget adequate for conformity purposes on December 6, 2002. (The 2003 WMA and 2007 EMA budgets are shown in Table 9.1)

These 2008 and 2009 transportation conformity budgets, once deemed adequate by EPA, will replace the conformity budgets previously submitted and approved.

9.3 Methodology

Conformity budgets are set through a conformity consultation process. The 2008 and 2009 budgets for EMA and WMA were developed using methods agreed upon by staff from the Office of Transportation Planning (EOT), MassDEP, and EPA Region 1 pursuant to the consultation process. EOT has summarized these methods as follows:

- The latest version of the Massachusetts Statewide Travel Demand model[1] was the primary source used to estimate travel speeds and vehicle miles of travel (VMT), based on the latest planning assumptions, socio-economic data, and professional judgment about travel characteristics and growth. The statewide model was used for all areas in Massachusetts except for the Boston and Berkshire Metropolitan Planning Organization (MPO) areas (where regional models were used to be fully consistent with the latest planning assumptions).

- The travel demand model reflects the highway network and has a "base year" of 2000, which has been initially "calibrated" to replicate traffic patterns from that year, based on various information, including recorded traffic counts and 2000 U.S. Census data.

- A 2008 RFP year and 2009 attainment year model were developed from the base year model, which contains the latest planning assumptions regarding growth projections, including socio-economic changes and updating the roadway network in the model to incorporate regionally significant highway projects reasonably expected to be completed by 2008 and by 2009.

- Emission rates (usually in grams of pollutant per mile at given travel speeds) are applied to VMT and speed results from the model to estimate total vehicle emissions. The emission rates were provided by DEP and are based on EPA's MOBILE 6.2 model. These rates – developed specifically for the years 2008 and 2009 – are based on a variety of assumptions about vehicle fleet mix and technology, fuel composition, and pollution control programs. Two sets of rates were used: One set for expressway travel and another for non-expressway travel. (Emission rates are in Appendix 9A.)

- Estimates of emissions from the model are factored to VMT data from the Highway Performance Monitoring System (HPMS), as federal regulations require HPMS VMT to be the primary measure of VMT within a nonattainment area. These "HPMS factors" are calculated from the results of the base year model; the factors are equal to the ratio of 2000 HPMS VMT to 2000 modeled VMT, and vary by MPO region. (See Appendix 9 B)

- A seasonal adjustment factor is also applied to the statewide travel demand model and regional model results to replicate summertime conditions (when ozone concentrations are typically highest). Most travel models represent spring or fall conditions, where certain input data (employment, schools) are more representative of year-round figures. The seasonal adjustment factor represents the ratio of summer traffic levels to annual average traffic.

- Model VMT and speed output were separated by region, and further split into expressway vs. non-expressway results. Then the appropriate emission rates were applied to produce the rough emission totals. These totals were then factored to HPMS data, and finally seasonally adjusted to produce the modeled emission totals.

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[1] While the Statewide Travel Demand Model is often updated, there are no specific dates or version numbers attached to the updates. The version used for the 2008 and 2009 conformity budgets was the latest update as of 10/17/07.

• In EMA, net emission estimates from commuter rail, bus, and boat services are included in the totals, with most accounted for in the results for the Boston MPO region. The remaining "off-model" estimates – covering several regions and categorized as “Other Eastern Massachusetts” – were calculated by the Central Transportation Planning Staff (CTPS) of the Boston MPO, and include: 1) Additional net commuter rail emissions generated outside the Boston MPO region, and 2) Emission estimates of daily VMT savings realized from carpooling at various park and ride lots located in several regions. The off-model estimates were added to the modeled emission totals to produce the final 2008 mobile source emission estimate totals used for the RFP budget development. (The “off-road” estimates are described in Appendix 9 C.)

• Calibration of a travel demand model is often a continuing process in order to achieve results that are more accurate and to keep pace with changes in the latest planning assumptions and growth projections. As in the past with other model sets, future model output and HPMS adjustment factors can change as the statewide model and regional models are made more accurate and updated assumptions are incorporated.

9.4 Mobile Source Budgets

Application of the methods described above results in projected emissions for the 2008 and 2009 years for the EMA and WMA attainment years as shown in Table 9.1. These emissions represent the 8-hour ozone standard budgets for EMA and WMA.[2]

Table TC 1 2008 and 2009 EMA and WMA Mobile Source Budgets

Tons per summer day				
	2008	**2008**	**2009**	**2009**
	VOC	**NOx**	**VOC**	**NOx**
Eastern MA	68.30	191.30	63.50	174.96
Western MA	11.80	31.30	10.73	27.73
Prior 1-hour budgets	*2007*	2007		
EMA	86.70	226.36		
WMA	*2003*	2003		
	23.77	49.11		

[2] Emissions estimated by Metropolitan Planning Organization Region are in Appendix 9 D.