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**DELAWARE 1996 MILESTONE DEMONSTRATION
FOR KENT AND NEW CASTLE COUNTIES**

**Demonstrating Adequate Progress toward Attainment of the 1-Hour
National Ambient Air Quality Standard
for Ground-Level Ozone**

Submitted to:

US Environmental Protection Agency

By

**Delaware Department of Natural Resources
and Environmental Control**



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Acronym List

AQM	-	Air Quality Management Section of DNREC
BEA	-	Bureau of Economic Analysis
BY	-	Base year
CAAA	-	Clean Air Act Amendments of 1990
CMSA	-	Consolidated Metropolitan Statistical Area
CO	-	Carbon Monoxide
DAWM	-	Division of Air and Waste Management of DNREC
DelDOT	-	Delaware Department of Transportation
DNREC	-	Delaware Department of Natural Resources and Environmental Control
EID	-	Emission Inventory Development
EPA	-	United States Environmental Protection Agency
FMVCP	-	Federal Motor Vehicle Control Program
HPMS	-	Highway Performance Monitoring System
I/M	-	Inspection and Maintenance
LEV	-	Low Emission Vehicle
NAA	-	Nonattainment Area
NAAQS	-	National Ambient Air Quality Standard
NLEV	-	National Low Emission Vehicle
NO _x	-	Oxides of Nitrogen
OAQPS	-	Office of Air Quality Planning and Standards of EPA
OTAG	-	Ozone Transport Assessment Group
OTC	-	Ozone Transport Commission
OTR	-	Ozone Transport Region
PCP	-	Planning and Community Protection Branch of DNREC
PEI	-	Periodic Emission Inventory
PERC	-	Perchloroethylene
POTW	-	Publicly Owned Treatment Works
RACT	-	Reasonably Available Control Technology
RPP	-	Rate-of-Progress Plan
RVP	-	Reid Vapor Pressure
SCC	-	Source Classification Code
SIC	-	Standard Industrial Classification
SIP	-	State Implementation Plan
TPD	-	Tons per day
TPY	-	Tons per year
VHB	-	Vanasse Hangen Brustlin, Inc.
VOC	-	Volatile Organic Compound

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2. *The 1990 Base Year Ozone SIP Emissions Inventory for VOC, CO, and NOx*. Air Quality Management Section, Department of Natural Resources and Environmental Control, Dover, Delaware, revised as of May 3, 1994.
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8. *Guidance on Preparing Enforceable Regulations and Compliance Programs for the 15 Percent Rate-of-Progress Plans*. EPA-452/R-93-005, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, March 1993.
9. *Rate-of-Progress Plan Guidance for the 15% Calculations*. Memorandum from D. Kent Berry, Acting Director, Air Quality Management Division, U.S. Environmental Protection Agency, Washington, D.C., October 29, 1993.
10. *The 1993 Periodic Ozone State Implementation Plan Emission Inventory for VOC, NOx, and CO*. Air Quality Management Section, Department of Natural Resources and Environmental Control, Dover, Delaware, January 1998.
11. *The 1996 Periodic Ozone State Implementation Plan Emission Inventory for VOC, NOx, and CO*. Air Quality Management Section, Department of Natural Resources and Environmental Control, Dover, Delaware, November 1999.
12. *Summary of EPA's Nonroad Engine Control Programs*. EPA-420-F-96-016, Office of Mobile Sources, U.S. Environmental Protection Agency, Ann Arbor, Michigan, February 1997.

Summary

This document addresses Delaware's 1996 milestone demonstration regarding attainment of the 1-hour National Ambient Air Quality Standard for the ground-level ozone. Under the Clean Air Act Amendments of 1990 (CAAA), Kent and New Castle Counties in Delaware are classified as severe nonattainment areas with respect to the 1-hour ozone standard. Under Sections 182(b)(1) and 182(d) of the CAAA, Delaware is required to achieve a 15% reduction in emissions of volatile organic compounds (VOC) from its 1990 levels in these two counties. Under this requirement, the 1996 target level of VOC emissions in Kent and New Castle Counties has been determined to be 115.815 tons per day (TPD) in the peak ozone season. To achieve this target, Delaware implemented numerous control measures over a large variety of VOC emission sources from 1990 to 1996. Delaware's 1996 periodic emission inventory, which has been recently compiled, shows that the 1996 actual VOC emissions in Kent and New Castle Counties are 101.870 TPD. Thus, Delaware demonstrates herein that its 1996 milestone for VOC emission reductions has been successfully met.

1. Introduction

1.1 Background

The Clean Air Act Amendments of 1990 (CAAA) set forth National Ambient Air Quality Standards (NAAQS) for six air pollutants that pose public health risks and environmental threats. Delaware exceeds the standard for only one of these pollutants, i.e., the ground-level ozone. High levels of ozone can harm the respiratory system and cause breathing problems, throat irritation, coughing, chest pains, and greater susceptibility to respiratory infection. Children, the elderly and individuals with respiratory diseases are especially vulnerable to the ozone threat. Even healthy individuals can be harmed if they attempt strenuous activity on days with high ozone levels. High levels of ozone also cause serious damage to forests and agricultural crops, resulting in economic losses to logging and farming operations.

The CAAA classifies five nonattainment areas (NAA) that exceed the 1-hour ozone NAAQS based on the severity of the pollution problem. In order of increasing severity, they are marginal, moderate, serious, severe, and extreme. Attainment dates depend on the nonattainment designation for individual areas (Section 181, CAAA). The Philadelphia Consolidated Metropolitan Statistical Area (CMSA) is classified as a severe nonattainment area (Figure 1), which has an attainment date of 2005. As shown in Figure 1, Kent and New Castle Counties in Delaware fall within the Philadelphia CMSA. Thus, these two counties are subject to all requirements set forth for the severe ozone nonattainment class. All discussions and data presented in this document apply only to Kent and New Castle Counties.

Ozone is generally not directly emitted to the atmosphere, but formed in the lower atmosphere by photochemical reactions mainly between volatile organic compounds (VOC) and nitrogen oxides (NO_x) in the presence of sunlight. Thus, VOC and NO_x are defined as two major ozone precursors. In order to reduce ozone concentrations in the ambient air, the CAAA requires all ozone nonattainment areas to achieve specific reductions in anthropogenic VOC emissions and/or NO_x emissions over several specified periods of years until the ozone standard is attained. These periodic emission reductions are termed as “rate of progress” toward the attainment of the 1-hour ozone standard (Reference 1).

Under Section 182(d) of CAAA, Delaware is required to develop and submit State Implementation Plans (SIP) to the United States Environmental Protection Agency (EPA) for each of the milestone years of 1996, 1999, 2002 and 2005. In these plans, Delaware has to show that, by adopting and implementing adequate control measures, it can achieve adequate rate-of-progress reductions in VOC and/or NO_x emissions for its severe ozone nonattainment area, i.e., Kent and New Castle Counties. Since these state implementation plans construct the path of Delaware's rate of progress toward the attainment of ozone standard, they are termed as Delaware's Rate-of-Progress Plans (RPPs).

Under Section 182(a) of the CAAA, Delaware is required to develop comprehensive emission inventories of ozone precursors for 1993, 1996, 1999, 2002 and 2005 to monitor actual VOC and NO_x emissions from its nonattainment areas along the path of rate of progress. These emission inventories are termed as Delaware's periodic emission inventories (PEIs). Under

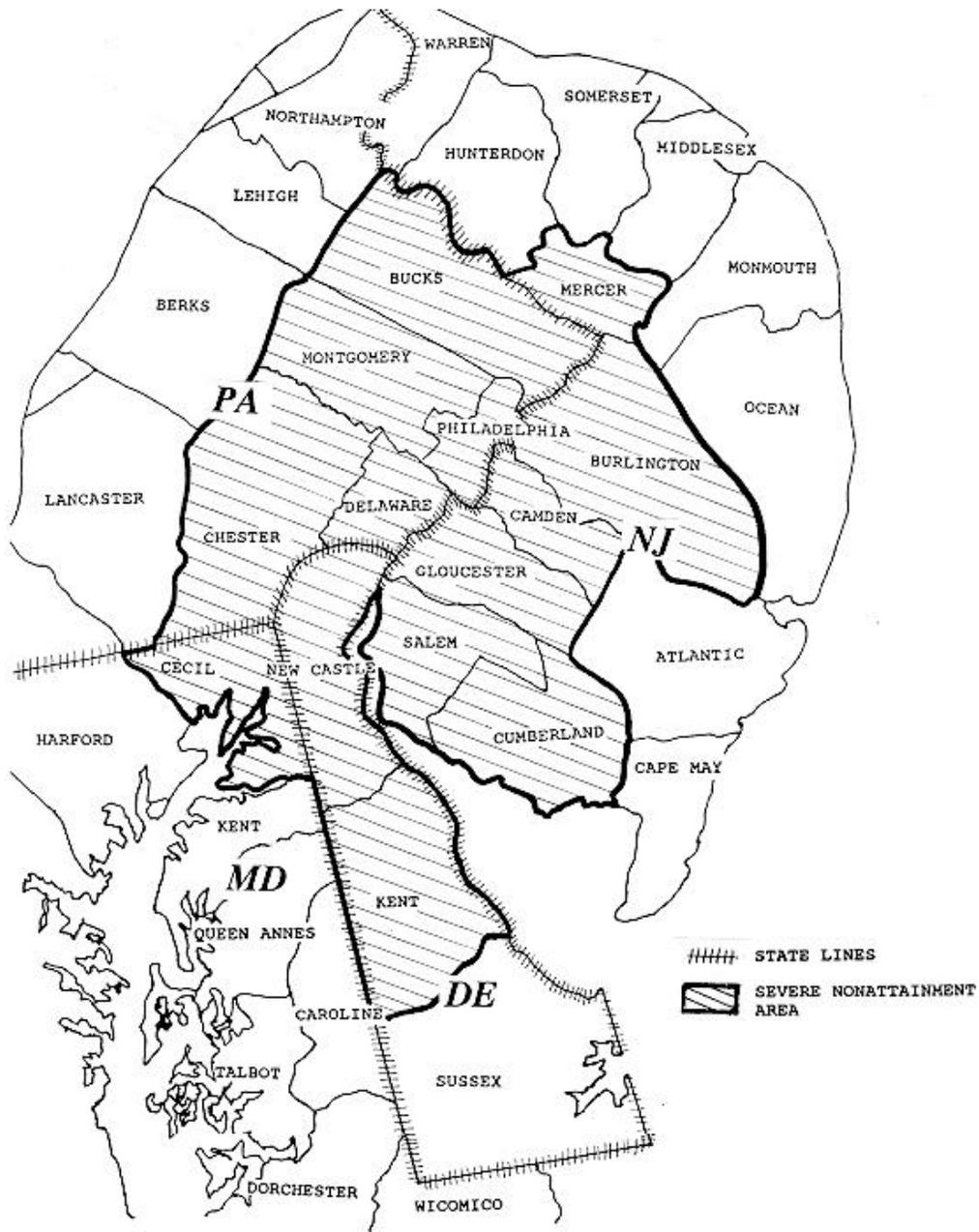


Figure 1. Philadelphia Consolidated Metropolitan Statistical Area (CMSA) Nonattainment Area.¹

¹ This map is adapted from *Major CO, NO₂ and VOC Sources in the 25-Mile Boundary Around Ozone Nonattainment Areas, Volume 1: Classified Ozone Nonattainment Area*, EPA/4-92-005a, U.S. Environment Protection Agency, Office of Air Quality Planning and Standards, Office of Air and Radiation, Research Triangle Park, NC, February, 1992.

Sections 182(a) and 182(g) of the CAAA, Delaware is required to use these periodic emission inventories (except 1993 PEI) to demonstrate whether Delaware meets its required emission reductions as specified in its rate-of-progress plans in individual milestone years. This demonstrating process is termed as periodic milestone demonstration (Reference 1).

This document contains Delaware's State Implementation Plan (SIP) revision for demonstrating Delaware 1996 compliance with adequate progress in emission reductions toward attainment of the 1-hour ozone NAAQS as required by the CAAA. The document is hereafter referred to as "Delaware 1996 Milestone Demonstration."

1.2 Responsibilities

The agency with direct responsibility for preparing and submitting this document is the Delaware Department of Natural Resources and Environmental Control (DNREC), Division of Air and Waste Management (DAWM), Air Quality Management Section (AQM), under the direction of Darryl D. Tyler, Program Administrator. The Delaware Department of Transportation (DelDOT), in conjunction with the consulting firm Vanasse Hangen Brustlin, Inc. (VHB), Watertown, MA, is responsible for performing the work associated with the on-road mobile source emissions included in this document.

The working responsibility for Delaware's air quality management planning falls within the Planning and Community Protection (PCP) Branch of AQM Section, DAWM of DNREC, under the management of Raymond H. Malenfant, Program Manager. Alfred R. Deramo, Program Manager of the State Implementation Planning (SIP) Program within the PCP Branch, is the project manager of this document. Frank F. Gao, Environmental Engineer of the SIP Program, is the project leader and principal author of this document. Margaret A.J. Pomatto, Environmental Scientist of the Emission Inventory Development (EID) Program within the PCP Branch, is the quality assurance reviewer and technical editor of this document. Questions or comments regarding this document should be addressed to A. Deramo or F. Gao, (302)739-4791, AQM, 156 South State Street, Dover, DE 19901.

2. Submittal and Summary of Delaware State Implementation Plans

2.1 Delaware 1990 Base Year Emission Inventory

Section 182(a)(1) of the CAAA requires each state with ozone nonattainment areas to develop a comprehensive and accurate 1990 emission inventory for ozone precursors for its nonattainment areas. The emission inventory must be submitted as a state implementation plan (SIP) revision to EPA for approval. This "1990 base year emission inventory" is used as the basis for a state to develop its rate-of-progress plans and control strategies toward attainment of the 1-hour ozone standard. Delaware's 1990 base year emission inventory was submitted to the EPA in May 1994, and approved by EPA in March 1996. The inventory is hereafter referred to as the 1990 Base Year Inventory (Reference 2).

The 1990 Base Year Inventory is categorized by source sectors, i.e., point, stationary area, off-road mobile, on-road mobile and biogenic source sectors (Appendix A). Since volatile organic compounds (VOC), nitrogen oxides (NO_x) and carbon monoxide (CO) are precursors forming ground level ozone, their emissions in 1990 are inventoried and reported in the 1990 Base Year Inventory. Because contribution of CO to ozone formation is considered insignificant and Delaware does not contain any CO nonattainment area, the CO component of the 1990 Base Year Inventory is not included in Delaware's rate-of-progress planning for ozone attainment. A summary of VOC and NO_x emissions by county in the 1990 Base Year Inventory is presented in Table 1. The unit of emissions reported in Table 1 is tons per day (TPD) in the peak ozone season. The peak ozone season in Delaware is defined as from June 1 through August 31.

Table 1. Summary of VOC and NO_x Emissions (TPD) in 1990 Base Year Inventory*

Source Sector	Kent		New Castle		Total NAA	
	VOC	NO _x	VOC	NO _x	VOC	NO _x
Point Sources	3.242	6.130	27.078	85.767	30.320	91.897
Stationary Area Sources	12.967	1.202	34.754	5.398	47.721	6.600
Off-Road Mobile Sources	3.494	7.891	16.674	18.777	20.168	26.668
On-Road Mobile Sources	13.070	10.620	35.280	27.060	48.350	37.680
Biogenic Sources**	32.460	0	17.510	0	49.970	0
Total Emissions	65.233	25.843	131.296	137.002	196.529	162.845

*Data obtained from Delaware 1990 Base Year Emission Inventory (Reference 2).

** Biogenic NO_x emissions are assumed to be negligible.

2.2 Delaware 1996 Rate-of-Progress Plan

Under Sections 182(b)(1) and 182(d), Delaware is required to develop a rate-of-progress plan (as a SIP revision) for the period from 1990 to 1996, which describes how Delaware will achieve an actual VOC emission reduction by 1996 that is at least 15% of its VOC emission level in 1990. This plan is thus termed as the Delaware 1996 Rate-of-Progress Plan or 15% Rate-of-Progress Plan (RPP). Delaware developed the 1996 RPP and submitted it to EPA for approval in

February 1995 (Reference 3). In this plan, Delaware first established a VOC emission target for 1996 to meet the rate-of-progress requirements specified in the CAAA. Delaware then presented its control measures being promulgated in the 1990-1996 period, and demonstrated that through these measures the required VOC emission target can be met in 1996. A summary of the 1996 RPP is provided in Appendix B of this document. This section presents a brief discussion of the major contents of the 1996 RPP and provides data necessary for the milestone compliance demonstration.

2.2.1 Delaware 1996 VOC Emission Target

The 15% rate-of-progress VOC emission reduction in the period of 1990 to 1996 is estimated from the 1990 baseline level. Section 182(b)(1)(B) defines the baseline emissions as the total amount of actual VOC emissions from all anthropogenic sources in the nonattainment areas. Thus, the 1990 Base Year Inventory VOC emissions in Table 1 must be modified to exclude emissions from biogenic sources and sources outside the nonattainment areas. In addition, emissions of perchloroethylene (PERC) were included in the 1990 Base Year Inventory because it was originally classified by EPA as a photochemically reactive VOC contributing to the formation of ozone. The EPA reclassified PERC as photochemically non-reactive after Delaware's 1990 Base Year Inventory was compiled. Thus, PERC emissions, which are now considered not to participate in the formation of ozone, need to be subtracted from the 1990 Base Year Inventory. The biogenic VOC emissions in the 1990 Base Year Inventory are 32.460 TPD and 17.510 TPD for Kent and New Castle Counties, respectively (Table 1). The PERC emissions in Kent County are 0.188 TPD, all from the area source sector. For New Castle County, the PERC emissions are 0.140 TPD from the point source sector and 0.388 TPD from the area source sector. Details of determination of the PERC emissions can be found in Appendix A of Reference 2. The modified 1990 base year VOC emissions, or the 1990 baseline VOC emissions, are presented in Table 2.

Table 2. Delaware 1990 Baseline and Adjusted Inventory of VOC Emissions (TPD)

Source Sector	Kent		New Castle		Total NAA	
	1990 Baseline	1990 Adjusted	1990 Baseline	1990 Adjusted	1990 Baseline	1990 Adjusted
Point Sources	3.242	3.242	26.938	26.938	30.180	30.180
Stationary Area Sources	12.779	12.779	34.366	34.366	47.145	47.145
Off-Road Mobile Sources	3.494	3.494	16.674	16.674	20.168	20.168
On-Road Mobile Sources	13.070	10.245	35.280	28.515	48.350	38.760
Total Emissions	32.585	29.760	113.258	106.493	145.843	136.253

According to Section 182(b)(1)(D) of the CAAA, emission reductions resulted from the Federal Motor Vehicle Control Program (FMVCP) and Reid Vapor Pressure (RVP) regulations promulgated prior to 1990 are not creditable for achieving the 15% rate-of-progress VOC emission reductions in the 1996 RPP. Therefore, the 1990 baseline VOC emissions in Table 2 must be adjusted by removing the VOC emission reductions expected from FMVCP and RVP. The adjusting procedures are provided in an EPA guidance document (Reference 4). Details of the

adjustments are provided in Delaware 1996 RPP (Reference 3). The FMVCP/RVP adjustments for Kent and New Castle Counties are 2.825 TPD and 6.765 TPD, respectively. The results of the adjustment are the 1990 Adjusted Baseline Emissions (as shown in Table 2), which are the basis for calculating the required rate-of-progress emission reductions and the emission target for the milestone year 1996.

The 15% VOC emission reductions are required for the entire nonattainment area, i.e., Kent and New Castle Counties. Thus, for Delaware's 1996 RPP, the total required emission reduction (ER_{1996}) in TPD is

$$ER_{1996} = EMIS_{1990-Adj} \times 15\% = 136.253 \times 15\% = 20.438 \text{ TPD}$$

where $EMIS_{1990-Adj}$ is the adjusted 1990 baseline VOC emissions as shown in Table 2. The VOC emission target level in 1996 RPP in TPD is

$$EMIS_{1996T} = EMIS_{1990-Adj} - ER_{1996} = 136.253 - 20.438 = 115.815 \text{ TPD}$$

2.2.2 Control Measures and Expected VOC Emissions in 1996 RPP

To achieve the 1996 VOC emission target determined in the previous subsection, Delaware proposed numerous control measures in its 1996 RPP. The control measures included federal mandatory rules and Delaware's regulations to be promulgated prior to the peak ozone season of 1996 (Reference 5). These rules and regulations cover a large variety of VOC emission sources in all source sectors. A list of the control measures, along with their implementation dates, is given in Table 3. Detailed descriptions of individual rules and regulations have been presented in Delaware 1996 RPP (Reference 3).

In the 1996 RPP, Delaware also projected the 1996 VOC emissions in the peak ozone season assuming all control measures listed in Table 3 could be implemented as expected. The projections were termed as "control strategy projections" and conducted following the methods and procedures specified in EPA's guidance documents (References 4, 6, 7, 8, 9). In the projection calculations, factors such as growth, control efficiency, rule effectiveness, and rule penetration, were considered whenever appropriate for point sources, stationary area sources and non-road mobile sources. Emission projections for on-road mobile sources were conducted using EPA's MOBILE5a software. Details of the control strategy projections were presented in the 1996 RPP (Reference 3). A summary of the 1996 VOC control strategy emission projections is given in Table 4.

Table 4 indicates that the total VOC emissions projected for Delaware's entire nonattainment area (Kent and New Castle Counties) would be 115.336 TPD, which was smaller than the 1996 target level of 115.815 TPD. Thus, it was concluded in the 1996 RPP that the proposed control measures could be adequate and enough for Delaware to meet the 15% rate-of-progress requirement on VOC emission reductions.

Table 3. Control Measures Proposed in Delaware's 1996 RPP

Control Measures and Regulations	Creditability	Effective Date
Point Source Controls		
RACT "Catch-Ups" in Kent County:		
Solvent Metal Cleaning	Creditable	31-May-95
Surface Coating of Metal Furniture	Creditable	31-May-95
Leaks from Synthetic Organic Chemical, Polymer, and Resin Manufact. Equip.	Creditable	31-May-95
New RACT Regulations:		
Bulk Gasoline Marine Tank Vessel Loading Facilities	Creditable	31-Dec-95
SOCMI Reactor Processes and Distillation Operations	Creditable	1-Apr-96
Batch Processing Operations	Creditable	1-Apr-96
Offset Lithography	Creditable	1-Apr-96
Aerospace Coatings	Creditable	1-Apr-96
Industrial Cleaning Solvents	Creditable	29-Nov-94
Non-CTG RACT	Creditable	31-May-95
Federal Benzene Waste Rule	Creditable	Spring 1995
Sanitary Landfills	Creditable	9-Oct-93
Irreversible Process Changes	Creditable	1-Jan-96
Stationary Area Source Controls		
RACT "Catch-Ups" in Kent County:		
Solvent Metal Cleaning	Creditable	31-May-95
Cutback Asphalt	Creditable	31-May-95
New RACT Regulations:		
Stage I Vapor Recovery-Gasoline Dispensing Facilities	Creditable	15-Nov-94
Emulsified Asphalt	Creditable	31-May-93
Motor Vehicle Refinishing	Creditable	1-Apr-96
Offset Lithography	Creditable	1-Apr-96
Aerospace Coatings	Creditable	1-Apr-96
Stage II Vapor Recovery	Creditable	15-Nov-94
Open Burning	Creditable	8-Feb-95
Off-Road Mobile Source Controls		
Reformulated Fuel	Creditable	1-Jan-95
On-Road Mobile Source Controls		
FMVCP and RVP	Noncreditable	Pre-1990
Tier I Vehicle Emissions Standards	Creditable	Model Year 1994
a. Basic I/M for Kent County	Creditable	1-Jan-91
b. ATP and Pressure Test in Kent County	Creditable	1-Jan-95
ATP and Pressure Test in New Castle County	Creditable	1-Jan-95
Reformulated Fuel	Creditable	1-Jan-95

Table 4. Delaware 1996 Control Strategy Projections for VOC Emissions (TPD)

Source Sector	Kent County	New Castle County	Total NAA
Point	1.268	21.391	22.659
Stationary Area	10.770	29.832	40.602
Off-Road Mobile	3.722	16.753	20.475
On-Road Mobile	8.030	23.570	31.600
Total Emissions	23.790	91.546	115.336

2.3 Delaware 1993 and 1996 Periodic Emission Inventories

Under Section 182(a) of the CAAA, Delaware is required to compile comprehensive periodic emission inventories of ozone precursors for 1993, 1996, 1999, 2002 and 2005. The emission data in these periodic inventories are either reported directly by individual sources (e.g., point sources such as industrial facilities), or calculated from current-year activity data obtained from sources or other agencies (e.g., area sources). Thus, the emissions in a periodic inventory are considered actual emissions in the subject calendar year. Delaware's first periodic inventory after 1990 is the 1993 periodic emission inventory (PEI), which compiles emissions of VOC, NO_x, and CO in 1993 from all sources included in the 1990 Base Year Emission Inventory. The 1993 PEI was submitted to EPA as a SIP revision in January 1998 (Reference 10). A summary of the 1993 PEI is presented in Appendix C. The emissions in the 1993 PEI are reported on both an annual basis (in tons per year, or TPY) and a daily basis in the peak ozone season (in tons per day, or TPD). For comparison purposes in this document, daily anthropogenic VOC emissions in the peak ozone season from Kent and New Castle Counties in the 1993 PEI are presented in Table 5.

Table 5. Anthropogenic VOC Emissions (TPD) in Delaware's 1993 Periodic Emission Inventory

Source Sector	Kent County	New Castle County	Total NAA
Point Sources	2.857	24.913	27.770
Stationary Area Sources	11.749	35.271	47.020
Off-Road Mobile Sources	3.671	16.824	20.495
On-Road Mobile Sources	10.000	30.510	40.510
TOTAL EMISSIONS	28.277	107.518	135.795

Delaware's 1996 periodic emission inventory (PEI) compiles emissions of VOC, NO_x, and CO in 1996 from all sources included in the 1990 Base Year Emission Inventory. The compilation of the 1996 PEI has been recently finished, and will be submitted to EPA as a SIP revision in November 1999. A summary of the 1996 PEI is provided in Appendix D. The emissions in the 1996 PEI are reported on both an annual basis (in tons per year, or TPY) and a daily basis in the peak ozone season (in tons per day, or TPD) (Reference 11). For comparison purposes in this

document, daily anthropogenic VOC emissions in the peak ozone season from Kent and New Castle Counties in the 1996 PEI are presented in Table 6. In the next section, emission data in Table 6 will be used to conduct the 1996 milestone compliance demonstration.

Table 6. Anthropogenic VOC Emissions (TPD) in Delaware's 1996 Periodic Emission Inventory

Source Sector	Kent County	New Castle County	Total NAA
Point Sources	0.638	14.340	14.978
Stationary Area Sources	6.301	25.905	32.206
Off-Road Mobile Sources	4.030	17.046	21.076
On-Road Mobile Sources	7.520	26.090	33.610
TOTAL EMISSIONS	18.489	83.381	101.870

3. Delaware 1996 Milestone Compliance Demonstration

3.1 Milestone Compliance Demonstration

In the 1996 RPP, Delaware has determined that the 1996 target level of VOC emissions for its nonattainment area (i.e., Kent and New Castle Counties) would be 115.815 TPD in the peak ozone season. Delaware has also assessed that, through implementing necessary emission control measures proposed in the 1996 RPP, the target level could be achieved. In the 1996 PEI, Delaware has shown that the actual total VOC emission in 1996 is 101.870 TPD in the peak ozone season. The 1996 target level, the 1996 control strategy projection, and the 1996 PEI actual emission are summarized in Table 7. Since the 1996 PEI actual VOC emission is lower than the required target level, Delaware demonstrates herein that its 1996 milestone for VOC emission reductions has been successfully met.

Table 7. Milestone Compliance Demonstration for 1996

1996 Required Emission Target (TPD)	1996 Control Strategy Projection (TPD)	1996 PEI Actual Emission (TPD)
115.815	115.336	101.870

3.2 Effectiveness of Control Measures in Individual Source Sectors

In the 1996 RPP, Delaware has anticipated that control measures proposed for individual source sectors would lead to specific VOC emission levels in the corresponding source sectors in the 1996 milestone year. The anticipated VOC emission levels, or the control strategy projections, for individual source sectors are summarized in Table 8. For comparison purposes, the 1996 PEI actual VOC emission levels from individual source sectors are also listed in Table 8. In addition,

differences between the 1996 RPP anticipated emission levels and the 1996 PEI actual emission levels are also presented in Table 8. Comparison and analysis of the 1996 RPP data and the 1996 PEI data will help assess relative effectiveness of controls in individual source sectors and direct future attention and efforts to VOC emission controls.

From Table 8, it can be seen that the 1996 PEI emissions from point and area source sectors are lower than the 1996 RPP anticipated levels. This fact reflects the effectiveness of VOC emission controls, primarily those of Reasonably Available Control Technology (RACT), implemented prior to the peak ozone season of 1996 upon stationary point and area sources (Table 3). In contrast, the 1996 PEI emissions from off-road and on-road mobile sources are higher than the 1996 RPP anticipated emission levels. It should be noted that the off-road sector was the least controlled sector in the 1996 RPP. The only control measure for this sector was the requirement of using reformulated gasoline in gasoline-fueled off-road engines. The VOC emission reduction from this sector was anticipated to be only 0.509 *TPD* in the peak ozone season (Reference 3). Delaware speculates that the lack of effective control measures over the off-road engines, especially diesel engines, would be a major cause of not achieving the anticipated VOC emission level in this source sector. In recent years, EPA has realized this lack of controls and begun turning its attention to off-road mobile sources that are believed to contribute significantly to air pollution (Reference 12). Delaware's finding provides supporting evidence for EPA's efforts in controlling VOC emissions from off-road mobile sources.

Table 8. Comparison of VOC Emissions between 1996 RPP Control Strategy Projections and 1996 PEI Actual Emissions (*TPD*)

Source Sector	1996 RPP (a)	1996 PEI (b)	Difference (c)*	% (d)**
Point Sources	22.659	14.978	-7.681	-33.9%
Stationary Area Sources	40.602	32.206	-8.396	-20.7%
Off-Road Mobile Sources	20.475	21.076	0.601	2.9%
On-Road Mobile Sources	31.600	33.610	2.010	6.4%
Total Emissions (<i>TPD</i>)	115.336	101.870	-13.466	-11.7%

* $(c)=(b)-(a)$. ** $(d)=(c)/(a)$.

The on-road mobile source sector has also shown a higher-than-anticipated VOC emission level in the 1996 PEI (Table 8). A comparison of the mobile source emissions in Table 4 and Table 6 by county indicates that the higher PEI VOC emission is produced in New Castle County. A contributing factor might be the increase in population. According to Delaware Department of Transportation, an unexpected population increase happened in New Castle County in the 1990s, with an annual average of 0.8% higher than that originally projected. This population increase caused an increase in VMT, especially in the employment-based trips.

As shown in Table 8, the total VOC emissions in the 1996 PEI are 11.7% lower than the control strategy projections calculated in the 1996 RPP. This demonstrates that the overall effectiveness of all control measures as a whole in the main plan of the 1996 RPP has actually met

the 15% rate-of-progress requirements for VOC emission reductions. Thus, there is no need to introduce any additional controls specified in the contingency plan of the 1996 RPP (Reference 3). The contingency measures thereof can be then carried over to Delaware's next rate-of-progress plan (i.e., the 1999 RPP), which will be addressed in a separate SIP revision document.

3.3 Trends of VOC Emissions from 1990 to 1996

Prior to the peak ozone season of the 1996 milestone year, Delaware implemented numerous control measures over a large variety of VOC emission sources in its nonattainment area (Table 3). The effectiveness of these control measures has been discussed in the previous subsection. An analysis of emission trends from 1990 to 1996 will provide additional information in assessing the effectiveness of these controls and understanding the emission situations in individual source sectors. For this purpose, the actual anthropogenic VOC emissions from Delaware 1990 base year inventory, the 1993 PEI and the 1996 PEI are summarized in Table 9.

Table 9. Trends of Anthropogenic VOC Emissions in Delaware Nonattainment Area from 1990 Base Year to 1996 Milestone Year

Source Sector	VOC Emissions (TPD)			% Change*
	1990 Baseline	1993 PEI	1996 PEI	1990-1996
Point Sources	30.180	27.770	14.978	-50.4%
Stationary Area Sources	47.145	47.020	32.206	-31.7%
Off-Road Mobile Sources	20.168	20.495	21.076	4.5%
On-Road Mobile Sources	48.350	40.510	33.610	-30.5%
Total Emissions	145.843	135.795	101.870	-30.2%

* % Change = (1996 PEI - 1990 Baseline)/1990 Baseline.

As shown in Table 9, the total anthropogenic VOC emissions in Delaware's nonattainment area decreased continuously from 1990 to 1996. The total VOC emission reported in the 1993 PEI is 6.9% lower than the 1990 baseline level. The total VOC emission in the 1996 PEI is 30.2% lower than the 1990 baseline level. The decreasing trend in anthropogenic VOC emissions from 1990 to 1996 is also plotted in Figure 2 using the total emission data in Table 9. The more rapid reduction between 1993 and 1996, as shown in Figure 2, is due to the fact that a majority of controls over VOC emissions were implemented in that period (Table 3).

The anthropogenic VOC emissions from individual source sectors are also summarized in Table 9. The trends of these emissions from 1990 to 1996 are plotted in Figure 3. From Table 9 and Figure 3, it can be seen that VOC emissions from point, stationary area and on-road mobile source sectors show significant reductions of 50.4%, 31.7% and 30.5%, respectively, from 1990 to 1996. In contrast, VOC emissions in the off-road mobile sector show an unexpected 4.5% increase in this period. Again, this increase indicates that closer attention and more control measures are needed in this source sector in Delaware's post-1996 rate-of-progress planning.

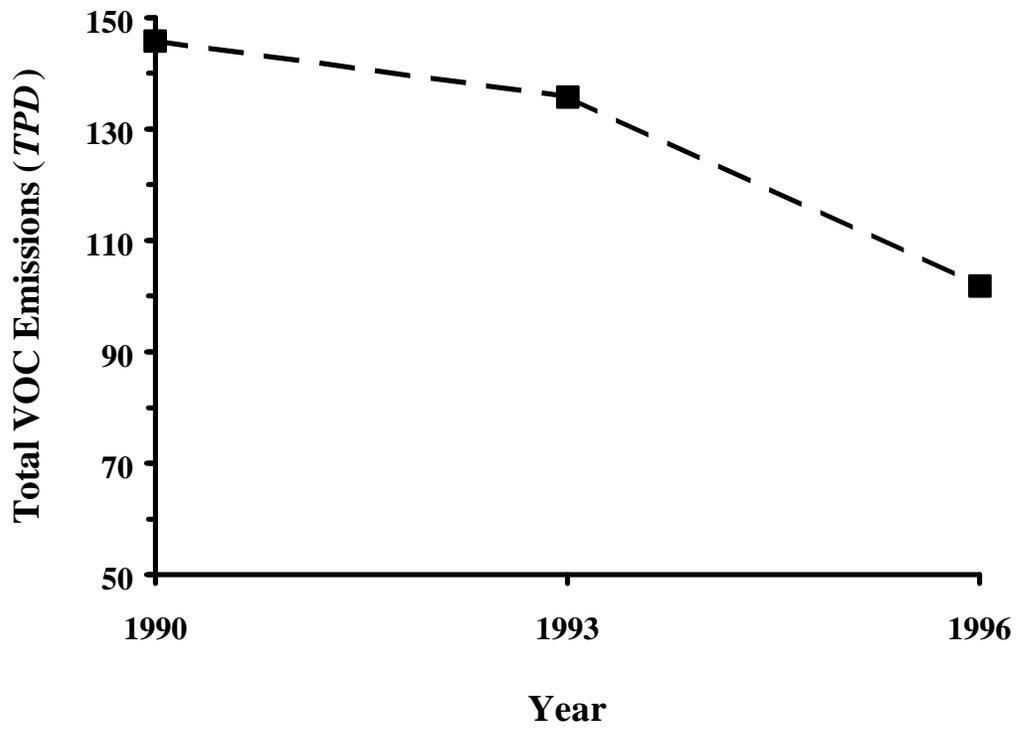


Figure 2. Trend of Total VOC Emissions in Delaware Nonattainment Area from the 1990 Base Year to the 1996 Milestone Year

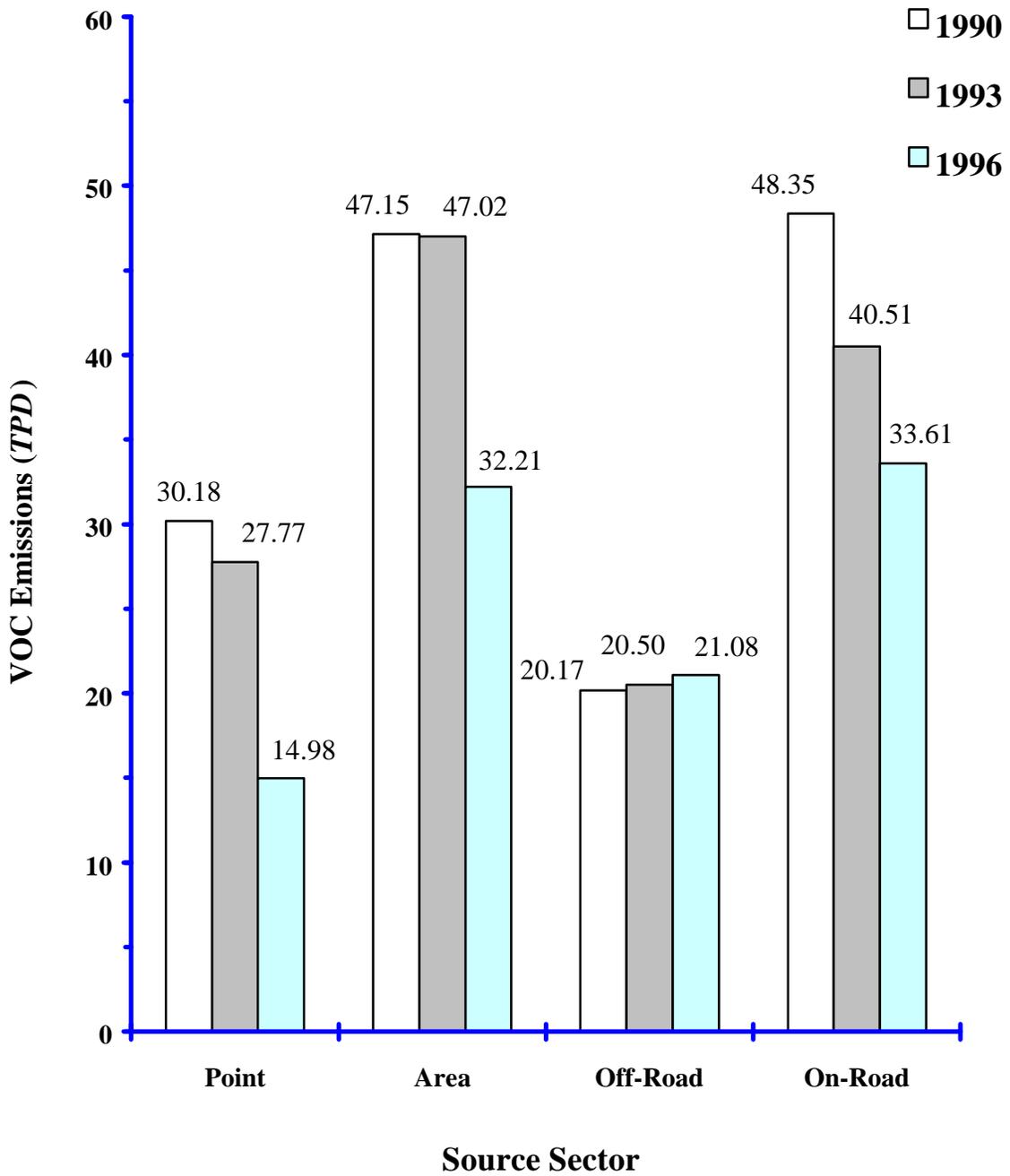


Figure 3. Comparison of Actual VOC Emissions in Individual Source Sectors in Delaware Nonattainment Area from 1990 to 1996

4. Documentation

APPENDIX A. Summary of Delaware's 1990 Base Year Emission Inventory

APPENDIX B. Summary of Delaware's 1996 (15%) Rate-of-Progress Plan

APPENDIX C. Summary of Delaware's 1993 Periodic Emission Inventory

APPENDIX D. Summary of Delaware's 1996 Periodic Emission Inventory

(Hard copies of these appendixes are available upon request. Written requests should be addressed to Mr. A. Deramo, Program Manager, SIP Development Program, PCP-AQM-DAWM, DNREC, 156 South State Street, Dover, DE 19901, or at e-mail address: aderamo@dnrec.state.de.us)

APPENDIX A

Summary of Delaware's 1990 Base Year Emission Inventory

APPENDIX B

Summary of Delaware's 1996 (15%) Rate-of-Progress Plan

APPENIDX C

Summary of Delaware's 1993 Periodic Emission Inventory

APPENDIX D

Summary of Delaware's 1996 Periodic Emission Inventory