Control Measure Development Support Analysis of Ozone Transport Commission Model Rules

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March 31, 2001

Pechan Rpt. No. 01.02.001/9408.000

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CONTENTS

CONTENTS (continued)

CONTENTS (continued)

TABLES

FIGURES

ACRONYMS AND ABBREVIATIONS

AIM	architectural and industrial maintenance
ARB	Air Resources Board
BEA	Bureau of Economic Analysis
Btus	British thermal units
CAA	Clean Air Act
CBG	Cleaner Burning Gasoline
CE	control efficiency
E-GAS	Economic Growth Analysis System
EGU	electricity generating unit
EIC	emission inventory code
EPA	U.S. Environmental Protection Agency
FIRE	Factor Information Retrieval
g/l	grams per liter
HAP	hazardous air pollutant
km	kilometers
lbs/yr/person	pounds per year per person
lbs/capita	pounds per capita
MACT	maximum achievable control technology
MERR	mobile equipment repair and refinishing
MOU	Memorandum of Understanding
NAAQS	National Ambient Air Quality Standards
NET96	1996 National Emission Trends Inventory
NO_x	nitrogen oxides
NPCA	National Paint and Coatings Association
OTC	Ozone Transport Commission
OTR	Ozone Transport Region
PADD	Petroleum Administration for Defense Districts
PM	particulate matter
ppm	parts per million
psi	pounds per square inch
RACT	reasonably available control technology
RE	rule effectiveness
RP	rule penetration
RVP	Reid vapor pressure
SCAQMD	South Coast Air Quality Management District
SCC	Source Classification Code
SCM	Suggested Control Measure
SICs	Standard Industrial Classifications
SIP	State Implementation Plan
STAPPA/	State and Territorial Air Pollution Program Administrators/
ALAPCO	Association of Local Air Pollution Control Officials
TNRCC	Texas Natural Resource Conservation Commission
tpd	tons per day
VOC	volatile organic compound

EXECUTIVE SUMMARY

The States of the Ozone Transport Commission (OTC) are considering adopting additional control measures as part of their attainment and maintenance plans for the health-based Federal ozone standard. The analyses in this report provide estimates of the emission reductions and associated costs for adopting five volatile organic compound (VOC) model rules and one nitrogen oxides (NO_x) model rule throughout the Ozone Transport Region (OTR). The VOC model rules have the potential to reduce emissions from consumer products, portable fuel containers, architectural and industrial maintenance (AIM) coatings, mobile equipment refinishing and repair operations, and solvent cleaning operations. The NO_x model rule has the potential to reduce emissions from stationary internal combustion engines, gas turbines, industrial boilers, and cement kilns. This NO_x model rule will yield additional reductions for smaller NO_x sources that are not regulated under current regional or Federal NO_x programs.

The analysis for this study assesses additional emission reductions from OTC model rules taking into account the expected emissions reduction from current Federal and State regulations and State Implementation Plan (SIP) assumptions; this ensures no double counting. Population based emission factors were used for the four VOC source category model rules. The portable fuel container analysis was done for residential and commercial usage using housing and business indicators.

The NO_x model rule analysis presented in this report is the product of an extensive review of available data and a review process with the OTC States during the project period. This was important because previous regulatory efforts have focused on NO_x sources that are larger than those affected by the OTC NO_x model rule.

Table ES-1 summarizes the expected model rule emission reductions for the three severe ozone nonattainment areas in the Northeast OTR: the Baltimore, Maryland area; the Philadelphia-Wilmington-Trenton area; and the New York-Northern New Jersey-Long Island-Southwest Connecticut area. The emission reductions listed in this table are either for 2005 or 2007, depending on the area's attainment date.

Figure ES-1 shows the OTC VOC model rule expected 2005 emission reductions by State. The largest estimated VOC emission reductions are in the most populous States – Pennsylvania and New York. Emission reduction estimates for each State are proportional to population: those areas with regulation already in place will show smaller reductions. Since these rules will yield additional reductions beyond 2005, those States having 2007 attainment dates will report higher emission reductions for SIP accounting purposes.

Table ES-1
OTC Model Rule Estimated Benefits for Severe Ozone Nonattainment Areas

Nonattainment Area	Attainment Date	Model Rule	2005/2007 Benefit (tpd)		EPA Shortfall (tpd)	
			NO_x	VOC	NO_x	VOC
Baltimore, MD	2005	NO_x Model Rule	5	0		
		Consumer Products	0	4		
		Portable Fuel Containers	0	2		
		AIM Coatings	0	8		
		Mobile Equipment Refinishing	0	0		
		Solvent Cleaning Operations	0	0		
		Total	**5**	**13**	**0**	**13**
Philadelphia-Wilmington-Trenton, PA-NJ-DE-MD	2005	NO_x Model Rule	6	0		
		Consumer Products	0	9		
		Portable Fuel Containers	0	5		
		AIM Coatings	0	19		
		Mobile Equipment Refinishing	0	6		
		Solvent Cleaning Operations	0	20		
		Total	**6**	**59**	**3**	**62**
New York-N. New Jersey-Long Island, NY-NJ-CT	2007	NO_x Model Rule	22	0		
		Consumer Products	0	26		
		Portable Fuel Containers	0	25		
		AIM Coatings	0	42		
		Mobile Equipment Refinishing	0	20		
		Solvent Cleaning Operations	0	7		
		Total	**22**	**120**	**7**	**85**

NOTES: Emission benefits estimates in this table are provided as integer values. Any emission benefit of less than 0.5 tpd is listed as a zero in this table. Totals may not equal the sum of the individual rule benefits because of rounding.

Figure ES-1
OTC VOC Model Rule Benefits by State within the OTR for 2005
(in tons per day)

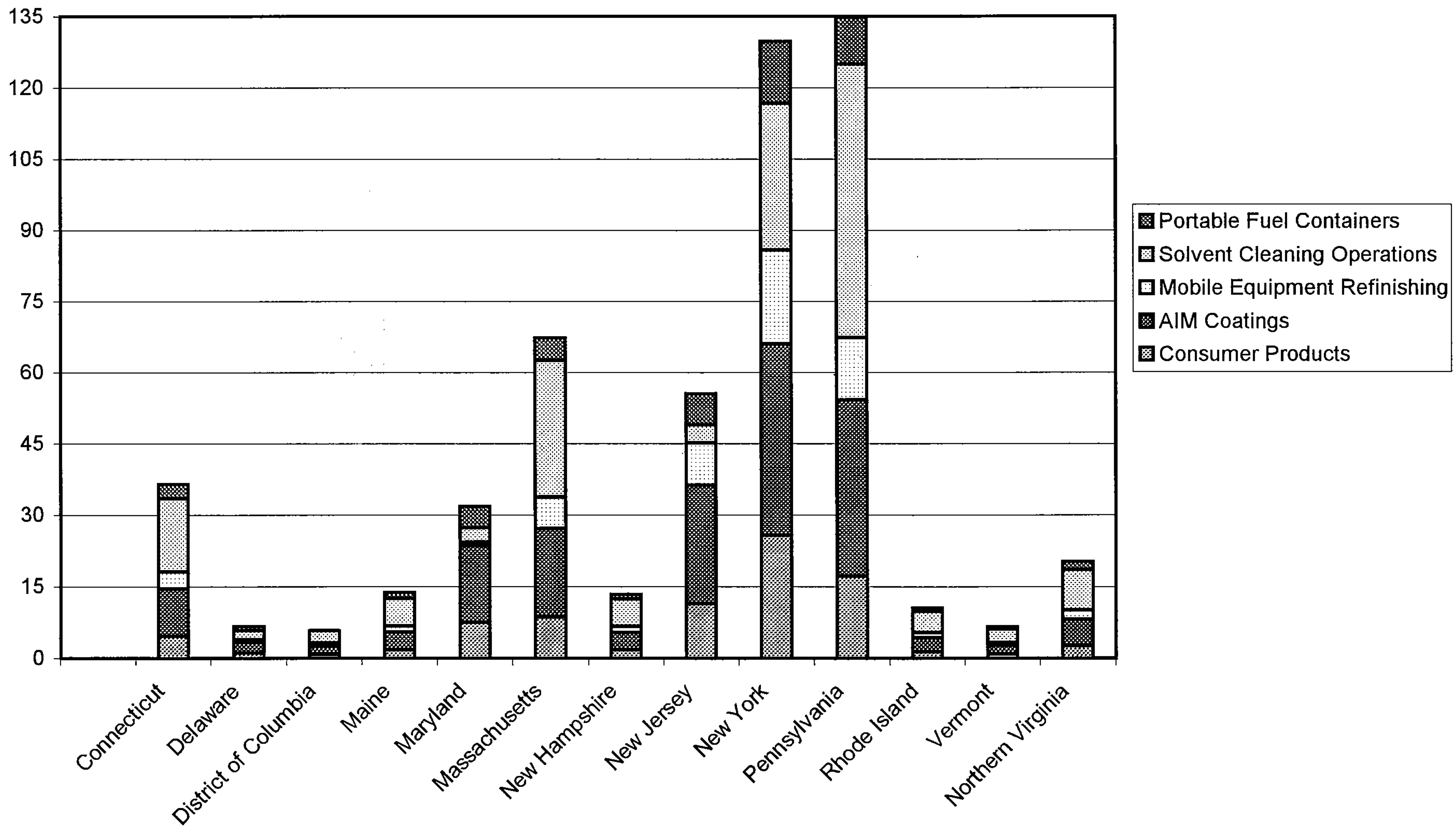


Figure ES-2 provides a similar display for the NO_x model rule. The biggest NO_x model rule-associated emission reductions are expected in New York, followed by those in New Jersey and Pennsylvania.

Figure ES-3 summarizes the expected VOC and NO_x emission reductions from the OTC model rules for the different geographic areas that have been examined in this analysis. The total emission reductions in the three severe ozone nonattainment areas for all of the model rules combined in 2005 are 180 tons VOC per day and 32 NO_x tons per day (tpd). Expanding the analysis area to counties within 100 kilometers (km) of these three severe ozone nonattainment areas provides an additional 168 tpd in VOC emission benefits, and another 11 tpd in NO_x emission reductions. OTR-wide model rule benefits total 533 VOC tpd and 65 NO_x tpd in 2005.

Figure ES-2
OTC NOx Model Rule Benefits by State within the OTR for 2005
(in tons per day)

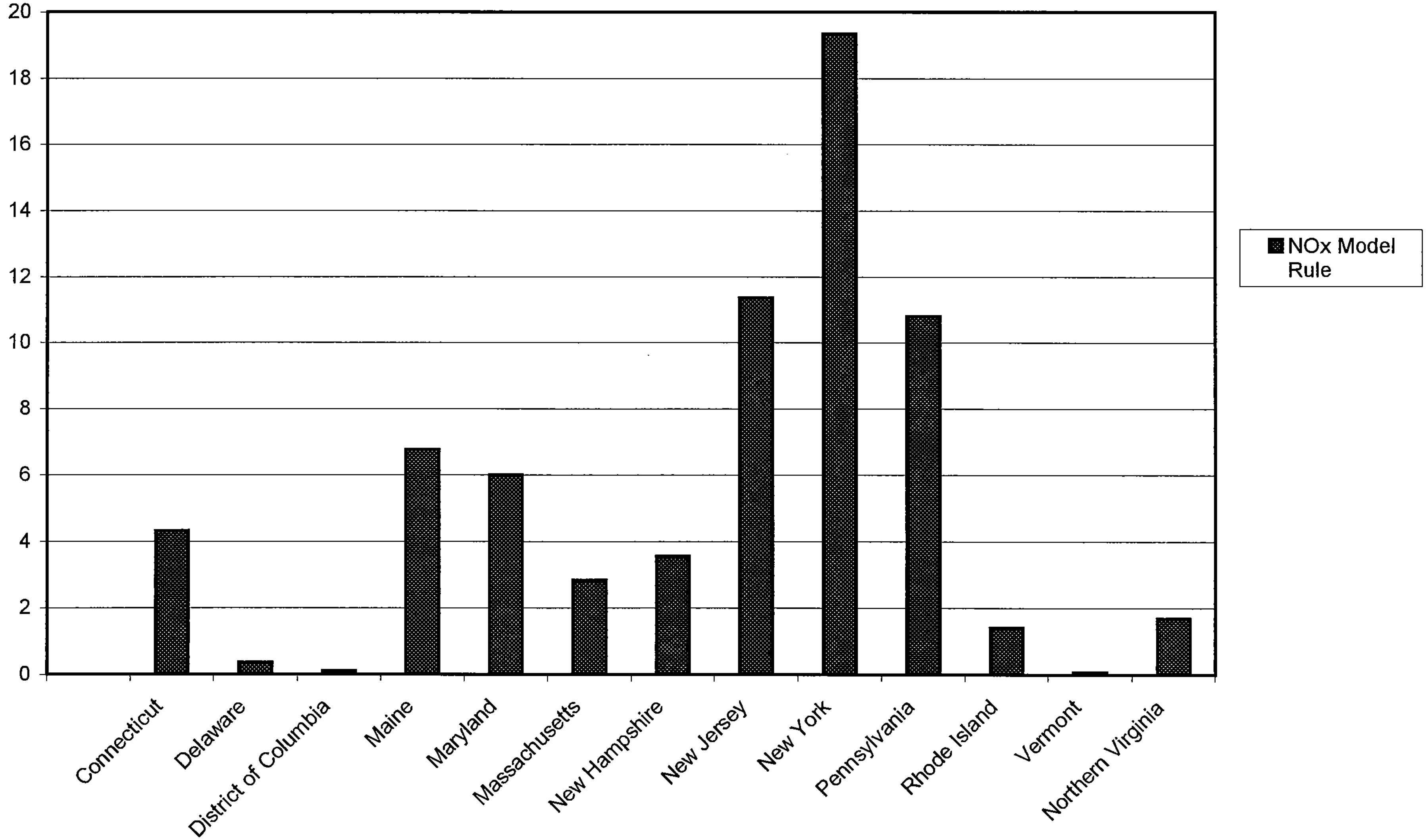
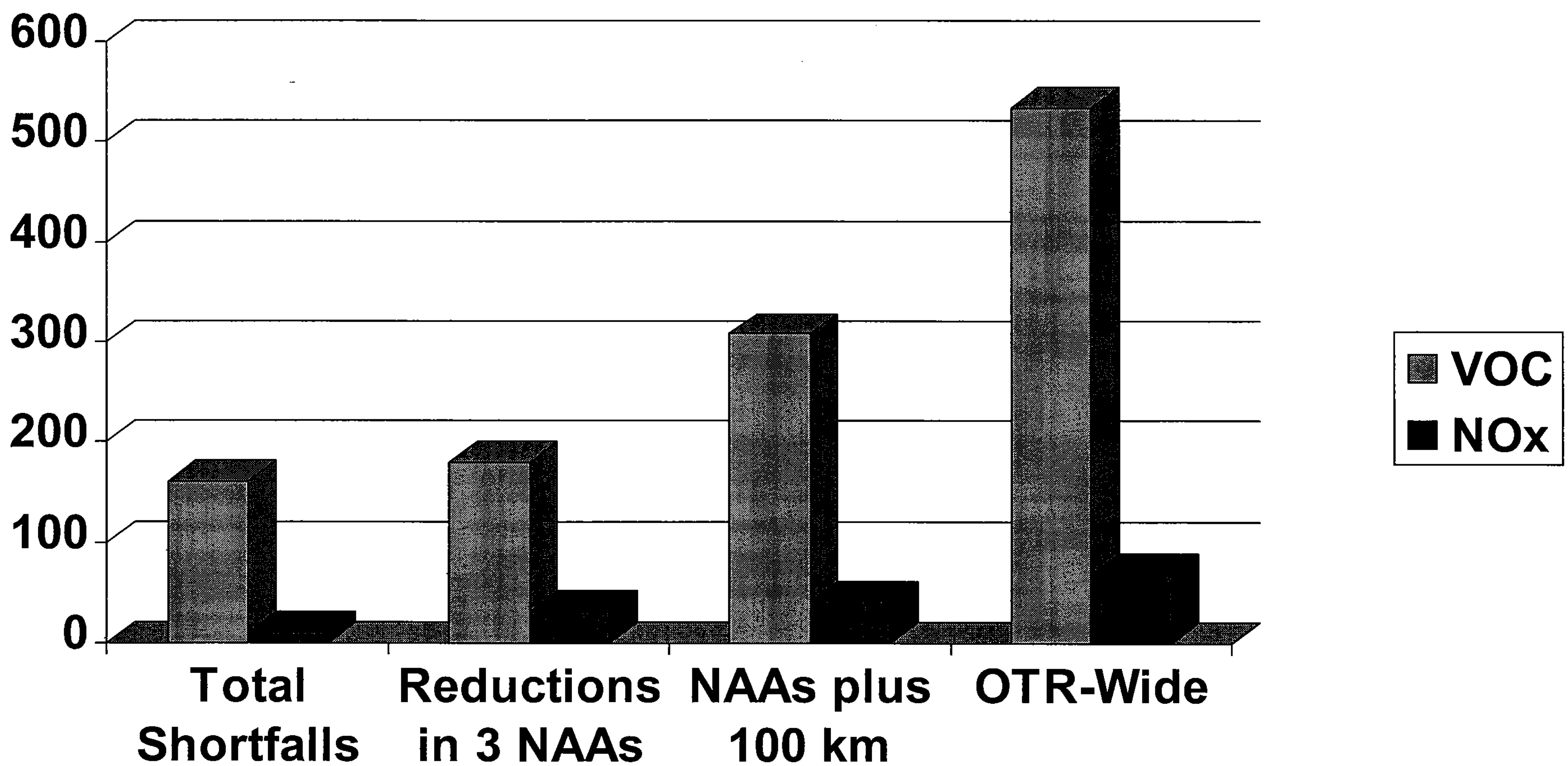


Figure ES-3
Estimated Reductions from Six OTC Model Rules in 2005
(in tons per day)



CHAPTER I
INTRODUCTION

The OTC was formed by Congress through the Clean Air Act (CAA) Amendments of 1990 to help coordinate control plans for reducing ground-level ozone in the Northeast and mid-Atlantic States. Since its inception, OTC has focused on a number of tasks, including: assessing the nature and magnitude of the ozone problem in the region, evaluating potential control approaches, and recommending regional control measures. Twelve States and the District of Columbia are represented in the OTC.

OTC States continue to work individually and collectively to ensure attainment and maintenance of the National Ambient Air Quality Standards (NAAQS). This includes identifying any remaining control measures that may be necessary to attain and maintain the one-hour NAAQS, as well as to start reducing eight-hour average ozone levels. Six States (Connecticut, Delaware, Maryland, New Jersey, New York, and Pennsylvania) in particular are focusing on additional control measures as a part of their one-hour attainment demonstrations. However, all States will benefit from additional emission reductions of ozone precursors for purposes of maintaining the one-hour standard.

The analysis in this report provides estimates of the emission reductions and associated costs for adopting five VOC model rules and one NO_x model rule throughout the Northeast OTR. The VOC model rules have the potential to reduce emissions from consumer products, portable fuel containers, AIM coatings, mobile equipment refinishing and repair operations, and solvent cleaning operations. The NO_x model rule has the potential to reduce emissions from stationary internal combustion engines, gas turbines, industrial boilers, and cement kilns. This NO_x model rule will yield additional reductions for smaller NO_x sources that are not covered under current regional NO_x programs.

Chapter II describes the methods used to estimate the emission benefits of the VOC model rules. This chapter delineates the existing OTC State regulations that affect VOC emissions from the model rule source categories. It has separate sections that describe analysis methods for each of the individual VOC model rules.

NO_x model rule analysis methods are described in Chapter III. Existing State regulations affecting NO_x emissions from industrial boilers, internal combustion engines, gas turbines, and cement kilns are presented in the first section of this chapter. This chapter also describes the data bases that were developed and applied in this analysis, and the methods used to estimate model rule benefits.

Chapter IV presents estimates of the expected 2005/2007 model rule emission benefits. Estimated emission benefits are presented first for the three severe ozone nonattainment areas within the Northeast OTR. These are the areas for which the U.S. Environmental Protection Agency (EPA) has estimated emission shortfalls. Because the model rules may not achieve all of the needed VOC and NO_x emission reductions to meet these shortfalls, the analysis also examines the expected emission benefits within 100 km of these severe ozone nonattainment areas.

Chapter V provides the results of an AIM coatings market survey, which was performed to investigate the availability of AIM coatings that comply with the VOC limits of the OTC Model Rule. Chapter VI is the diesel fuel sampling plan. Caveats and uncertainties associated with this analysis are described in Chapter VII.

CHAPTER II
VOC MODEL RULE ANALYSIS METHODS

Base and future year VOC emission estimates for the consumer products rule, the AIM coatings rule, the mobile equipment refinishing and repair rule, and the solvent cleaning rule use per capita emission factors. U.S. Census Bureau *1996 County Population Estimates* were used to estimate 1996 VOC emissions for these States (Census, 2000). The July 1, 1996 population estimates were used for each OTC State. The U.S. Census Bureau released these population estimates to the public in March 2000. They contain revisions of estimates from previous years and the results of special censuses and test censuses conducted by the U.S. Census Bureau.

The Economic Growth Analysis System (E-GAS) model was run to obtain specific growth factors for both the nonattainment areas and remaining counties in a State. These growth factors were then applied to 1996 population to project county-level populations for 2005 and 2007.

A. EXISTING STATE RULES

Table II-1 summarizes OTC State VOC regulations for four of the source categories whose emissions are potentially affected by the OTC draft model VOC rules. If no regulation is listed in Table II-1, then the future VOC emissions from that source category are limited by the applicable Federal rule. There are no State regulations that affect portable fuel container VOC emissions, so this source category is not included in the table.

B. CONSUMER PRODUCTS RULE

1. Model Rule Summary

The Federal consumer product rule became effective in December 1998 (63FR48819, 1998). It regulates 24 product categories representing 48 percent of the consumer products inventory, nationally, and reduces VOC emissions from those product categories by 20 percent. Over one-half of the inventory is unregulated in the OTR. In order to capture additional emission reductions from this sector, the OTC is developing a model rule for this source category.

The OTC model rule regulates approximately 80 consumer product categories, and uses more stringent VOC content limits than the Federal rule. Some of the limits are currently in effect in California, and are known to be technologically feasible; others have future effective dates. The proposed compliance date for the model rule limits is January 1, 2005. Manufacturers are to ensure compliance with the limits by reformulating

Table II-1
OTC State VOC Regulations for the Model Rule Categories

State	Consumer Products	AIM Coating	Solvent Cleaning Operations	Mobile Equipment Repair and Refinishing
Connecticut	n/a	n/a	- MERR sources can opt in to a general permit which requires the use of HVLP sprayers, electrostatic equipment, or other application methods guaranteed to achieve at least 65% transfer efficiency. Closed applicator cleaning devices and work practices minimizing solvent losses are also required. VOC limits are not specified, but total VOC emissions are limited to 5 tpy (facilities constructed/ modified after 1998) or major source thresholds (facilities constructed/modified through 1998). Many eligible sources have opted into the general permit. - No previous SIP credit has been requested for this permitting program.	n/a
District of Columbia	n/a	n/a	n/a	n/a
Maine	n/a	n/a	n/a	n/a
Delaware	n/a	n/a	- Regulation #24, Section 33 - Effective May 31, 1995 - Standards for cold cleaning, open top vapor degreasing, and conveyorized degreasing	- Regulation #24, Section11 - Effective April 1, 1996 - This rule sets limits on VOC content of the coatings - VOC limits similar to National Rule

Table II-1 (continued)

State	Consumer Products	AIM Coating	Solvent Cleaning Operations	Mobile Equipment Repair and Refinishing
Maryland	n/a	n/a	- COMAR 26.11.19.09 - Final State Implementation Plan (SIP) rule was effective in 1997 - After May 15, 1996, a person may not use any VOC degreasing material that has a vapor pressure greater than 1 millimeter mercury at 20° C. - The use of any halogenated substance that is a VOC is prohibited. - The use of VOC degreasing material is prohibited, unless the vapor degreaser is equipped with a condenser or a pollution control device with an overall control efficiency of at least 90%	- COMAR 26.11.19.23 - Final SIP rule was effective in 1997 - The rule establishes standards for vehicle refinishing based on VOC content of coatings - Requires both the use of HVLP spray guns and enclosures for cleaning spray guns and lines - This rule sets a VOC limit for precoat coatings, which is not included in the National Rule
Massachusetts	- 310 CMR 7.25 (12) - Effective 1995 - VOC limits similar to NY/NJ Rule and National Rule - National Rule covers more product categories than the MA Rule - Provision in MA Rule stating that EPA VOC limits will override MA VOC limits	- 310 CMR 7.25 (11) - Effective 1995 - VOC limits similar to NJ Rule - National Rules covers more AIM Coatings categories than the MA Rule - For some categories, the MA Rule has more stringent VOC limits than the National Rule, and vice versa - Provision in MA Rule stating that EPA VOC limits will override MA VOC limits	- EPA's Compliance Technical Guideline - Effective early 1980s	- 310 CMR 7.18 (28) - Effective 1995 - VOC limits similar to National Rule - HVLP guns and enclosed gun cleaning requirements or equivalent.
New Hampshire	n/a	n/a	n/a	n/a

Table II-1 (continued)

State	Consumer Products	AIM Coating	Solvent Cleaning Operations	Mobile Equipment Repair and Refinishing
New Jersey	- Title 7, Chapter 27, Subchapter 24 - Effective 1995 - Rule covers entire State - VOC limits similar to National Rule - Provision in NJ Rule stating that EPA VOC limits will override NJ VOC limits	- Title 7, Chapter 27, Subchapter 23 - Effective 1989 - Rule covers entire State - VOC limits similar to National Rule and NY Rule - National Rules covers more AIM Coatings categories than the NJ Rule - For some categories, the NJ Rule has more stringent VOC limits than the National Rule, and vice versa	- Title 7, Chapter 27 Subchapter 16 - EPA's Compliance Technical Guideline effective 1986	n/a
New York	- 6 NYCRR Part 235 - Effective 1996 (last amended) - Rule covers entire State - VOC limits similar to National Rule - National Rule covers more product categories than the NY Rule	- 6 NYCRR Part 205 - Effective 1989 - Rule covers only NYC metropolitan area - VOC limits similar to National Rule - National Rules covers more AIM Coatings categories than the NY Rule - For some categories, the NY Rule has more stringent VOC limits than the National Rule, and vice versa	- 6 NYCRR Part 226 - Effective in the NYC metropolitan area for 1990 and 1996 - This rule implements good housekeeping procedures for surface cleaning operations - In 1999, the NYC metropolitan area will be subject to the NESHAP for Solvent Cleaning (40 CFR 63,460, Subpart T, Vol. 59, No. 231)	- 6 NYCRR Part 228 - Effective 1990 for the NYC metropolitan area/LOCMA - In 1996, the entire State will be effected by the National Rule
Pennsylvania	n/a	n/a	- Section 129.63 Degreasing Operations	- Section 129.75 adopted November 24, 1999, effective November 27, 1999
Rhode Island	- Regulation #31 - Effective 1994 (last amended 1996) - VOC limits similar to National Rule	- Regulation #33 - Effective 1996 - VOC limits similar to NJ Rule - National Rules covers more AIM Coatings categories than the RI Rule - For some categories, the RI Rule has more stringent VOC limits than the National Rule, and vice versa	- EPA's Compliance Technical Guideline-Effective 1979 - Organic Solvent Cleaning NESHAP-Effective 1996	- Regulation #30 - Effective 1994 (last amended 1996) - VOC limits similar to National Rule - HVLP guns and enclosed gun cleaning requirements or equivalent
Vermont	n/a	n/a	n/a	n/a
Virginia	n/a	n/a	n/a	n/a

NOTE: Portable fuel containers are not included in this table because they are not currently regulated by any OTC States.

products and substituting products with compliant products that are already on the market.

The OTC model rule contains requirements for approximately 80 product categories. Examples include aerosol adhesives, floor wax strippers, dry cleaning fluids, and general purpose cleaners. It also contains administrative requirements for labeling, reporting, code-dating, and a "most restrictive limit" scenario. There is a reporting requirement, such that manufacturers may be required to submit information to the State upon written notice.

A California Air Resources Board (ARB) test method would be primarily used to demonstrate compliance. Alternative accepted test methods are also allowed. Enforcement with the product VOC content limits and other requirements would be performed on a State-by-State basis.

If complying with the VOC content limits becomes difficult, flexibility options are provided for in the draft model rule. These include an innovative product exemption (e.g., a non-compliant product with a delivery system that puts it in compliance with the limits); variances; exemptions; an alternative control plan; and a provision that allows products to be sold that are manufactured before the rule applicability date.

2. Analysis Methods

The VOC emission reductions in 2005 and 2007 attributable to the EPA final rule regulating consumer products were estimated using the EPA guidance that was issued June 22, 1995 (Seitz, 1995a). At that time, development of a Federal consumer products rule was still in progress. The purpose of the Seitz memo was to provide guidance concerning credit that could be taken in rate-of-progress plans for reductions associated with the consumer products rule.

The memorandum said that the States were allowed to take credit for a 20 percent reduction from the national consumer products rule. Based on EPA's study, baseline emissions from the categories covered by this rule (i.e., a subset of all consumer products) were estimated to be approximately 3.9 pounds per capita annually. A 20 percent reduction would be about 0.8 pounds per capita annually. A control efficiency (CE) of 14.2 percent was developed from the 20 percent reduction anticipated from the Federal regulation. A rule effectiveness (RE) value of 100 percent was applied because any Federal rule would require all products to comply. A rule penetration (RP) value of 48.6 percent was applied in the analysis because VOC content limits only apply to that portion of the potentially affected products.

The equation for computing the VOC emission factor for consumer products after control by the National/Federal Rule is listed below:

Post-control emission factor = Pre-control emission factor [1-CE(RP)(RE)]
Post-control emission factor = 7.84 pounds per capita (lbs/capita) [1-(.2)(1.00)(0.486)]
= 7.06 lbs/capita

The OTC model rule requires manufacturers of particular products to reformulate them to meet VOC limits. The VOC limits in the model rule are based on rules adopted or under consideration by ARB. Consumer product emission reductions for the OTC model rule are estimated to be 14.2 percent of the total consumer product inventory of the national rule reduction. These estimated reductions were based on information in the ARB staff report and surveys (ARB, 1989; 1999a). Recent information can be found on the ARB website *Consumer Products Program* section (http://www.arb.ca.gov/consprod/consprod.htm). A rule penetration value of 100 percent is applied for the OTC model rule because the estimated 14.2 percent control efficiency accounts for the percentage of affected projects. Rule effectiveness is 100 percent because compliance is via product reformulation.

The credit for the OTC model rule affecting consumer products relative to the National Rule was computed as shown below:

Post OTC model rule control emission factor = 7.06 lbs/capita [1-(0.142)(1.00)(1.00)]
= 6.06 lbs/capita

3. Cost Estimates

ARB has estimated the cost of their rule to be $800 per ton (ARB, 1999a). Since the OTC model rule emission limits are based on California's, this value should be approximate costs that would be incurred to meet the same limits in the OTC States. However, because compliance costs are spread over a larger portion of sales in the OTC than in California, costs incurred by manufacturers are expected to be lower than $800 per ton.

C. PORTABLE FUEL CONTAINER RULE

1. Model Rule Summary

This draft model rule addresses VOC emissions from portable fuel containers. The rule specifies performance standards for portable fuel containers and/or spouts which are intended to reduce emissions from storage, transport and refueling activities. The rule states that any portable fuel container and/or spout must provide the following:

- only one opening for both filling and pouring;
- an automatic shut-off to prevent overfill during refueling;
- automatic closing and sealing of the container and/or spout when not dispensing fuel;
- a fuel flow rate and fill level as specified in the rule;
- a permeation rate of less than or equal to 0.4 grams per gallon per day; and
- a warranty by the manufacturer as specified in the rule.

The draft model rule applies to any person or entity who will sell, supply, offer for sale or manufacture for sale portable fuel containers and/or spouts on or after January 1, 2003. Manufacturers of portable fuel containers are required to verify compliance through testing and record-keeping. The rule also specifies administrative and labeling requirements. The rule affects all portable fuel containers and/or spouts except:

- containers with a capacity of less than or equal to one quart;
- rapid refueling devices with capacities greater than or equal to four gallons;
- safety cans and portable marine fuel tanks that operate in conjunction with outboard engines; and
- products which result in cumulative VOC emissions below those of a representative container and/or spout.

2. Analysis Methods

Base case emissions were calculated by accounting for emissions from five different components related to gas container use, including permeation, diurnal, transport-spillage, spillage and vapor displacement emissions for two sectors: residential and commercial. Emission estimation methodologies for portable fuel containers were obtained from ARB's Mailout MSC 99-25, "Public Meeting to Consider Approval of CA's Portable Gasoline-Container Emissions Inventory," (ARB, 1999b). The estimated portable fuel container population and usage data for both residential and commercial sectors were developed using survey information collected by ARB. Emission rates were based on tests conducted by ARB and EPA for various portable fuel container activities.

To estimate permeation, diurnal, and transport-spillage emissions, the number of portable fuel containers for both residential and commercial sectors was used as activity data. Spillage and vapor displacement emissions are estimated using data on the population of nonroad equipment assumed to be refueled with portable fuel containers. The method for estimating activity data for each of these is discussed below.

The number of residential containers in the OTR was estimated using the number of housing units as an indicator. Occupied housing units by county were obtained for the year 1990 from the U.S. Census Bureau (Census, 1999). These data were then grown to 1996 using the change in U.S. Census Bureau estimates of county-level population estimates between 1990 and 1996. The 1996 occupied housing units by county were then projected to the years 2005 and 2007 using population as an indicator. Growth factors corresponding to the change in population between 1996 and 2005, as well as between 1996 and 2007 were obtained from the E-GAS model. The expected number of containers per household, the portable gas can material, amount of fuel stored and storage condition (open/closed) were based on the ARB survey results.

The number of portable fuel containers used by commercial businesses was estimated using the number of establishments expected to have at least one gas can. The number of establishments for 1996 was taken from the Dun & Bradstreet Marketplace3.0 Database. Establishment data for all counties within the OTR were compiled for the following Standard Industrial Classifications (SICs), which are the establishments most likely to own and use portable gasoline containers:

- 01 - Agricultural Crops
- 02 - Agricultural Livestock
- 07 - Agricultural Service (except 074 and 075)
- 08 - Forestry
- 15, 16, 17 - Construction
- 55 - Automotive Dealers and Gasoline Service Stations

- 75 - Automotive Repair, Services and Parking

Establishment data were then projected from 1996 to 2005 and 2007 using employment projections from the U.S. Department of Labor's Bureau of Labor Statistics (BLS, 1999). Employment projections were only available for the years 1998 and 2008. Employment in 2005 and 2007 was estimated using linear interpolation. Growth factors were developed for all of the above SIC codes, and then weighted based on the number of establishments within each SIC. A weighted growth factor was then applied to the number of total establishments per county in all of the above SIC codes. The expected number of containers per commercial business, the portable gas can material, amount of fuel stored, and storage condition (open/closed) were obtained from the ARB survey results.

Spillage and vapor displacement emissions are estimated using data on the population of nonroad equipment assumed to be refueled with gas cans. Data on the characteristics of nonroad engines were used as the activity (e.g., amount of fuel consumed per day, fuel tank size). The calculations only account for equipment likely to be refueled with a gas can, instead of at the pump. Daily fuel consumption estimates by county were obtained from EPA's NONROAD model for the years 1996 and 2007 (EPA, 2000a). Fuel consumption estimates for 2005 were estimated by applying an average annual rate of change each year from 1996 to 2007.

Baseline emissions for permeation, diurnal, transport-spillage, spillage and vapor displacement emissions were then calculated for the years 1996, 2005 and 2007. Emission estimates were calculated using the emission rates and equations developed by ARB. For the vapor displacement emission factor, an average Reid vapor pressure (RVP) of 7.8 pounds per square inch (psi) and an average temperature of 88°F were assumed. These values were based on RVP and temperature values used to estimate highway vehicle emissions in the Philadelphia, PA SIP.

Table II-2 compares the emissions estimates calculated for the OTC to those calculated for California. The region of New York, New Jersey and Connecticut was selected for the comparison since they have similar residential housing unit and commercial business populations to California. The emission estimates for permeation, diurnal, and transport-spillage for both the residential and commercial sectors are similar to those estimated for California. Spillage and refueling vapor displacement are estimated for both residential and commercial simultaneously using combined fuel consumption data calculated from the NONROAD model. The emission estimates for spillage and vapor displacement for NY, NJ, and CT are significantly higher than the emission estimates produced for California. This is due to higher fuel consumption estimates produced by the NONROAD model compared to fuel consumption from ARB's Off-Highway Emissions Estimate Model (OFFROAD).

Table II-2
Comparison of OTC and California Emission Estimates

	Residential Emissions (tons per day [tpd])		Commercial Emissions (tpd)		Total by Emissions Type (tpd)	
	CT, NJ, NY	CA	CT, NJ, NY	CA	CT, NJ, NY	CA
Population	10,812,566	11,390,000	193,928	84,712		
Emission Type						
Permeation	6.6	6.8	1.0	0.4	7.6	7.2
Diurnal	57.4	59.1	10.1	5.2	67.5	64.3
Transport-Spillage	3.1	3.2	6.1	2.6	9.2	5.8
Spillage					27.7	6.9
Refuel Vapor Displace					7.6	2.3
Total	**67.2**	**69.1**	**17.1**	**8.2**	**119.6**	**86.5**

The OTC model rule requires manufacturers to comply with the requirements by January 1, 2003. Rule penetration can be assessed through sales and container turnover as consumers buy new compliant fuel containers to replace existing ones. California conducted an industry survey on portable fuel container sales, and determined that there is a five-year turnover rate for fuel containers. For the purpose of this analysis, the OTC chose to assume a more conservative ten-year turnover rate, with 100 percent rule penetration by January 1, 2013.

For the purposes of this analysis, a constant rate of turnover was assumed (i.e., every year after 2003, 1/10 of the total fuel containers would be replaced, until all are replaced by 2013). Therefore, the emission benefits were calculated for July of 2005 and 2007, 2-1/2 and 4-1/2 years, respectively, from the compliance date. The number of replaced units was assumed to be 0.25 and 0.45 of the total number of containers in the base year of 1996.

ARB has identified gasoline containers as a potentially significant source of VOC emissions during the ozone season. Emission estimates for the five evaporative components (permeation, diurnal, transport-spillage, spillage and vapor displacement emissions) need to be allocated to a specific Source Classification Code (SCC) for reporting in the inventory.

Spillage and *vapor displacement* emissions occur during the refueling of some nonroad equipment with gas cans. Spillage emissions result when fuel is spilled during the refueling process, and vapor displacement emissions result when new liquid added to a fuel tank displaces fuel vapors already present in the tank. EPA's NONROAD model calculates spillage and vapor displacement emissions (in addition to diurnal emissions from fuel present in the equipment tank). Therefore, if a State is using NONROAD to develop their emission inventory, evaporative VOC emissions for spillage and vapor displacement during nonroad equipment refueling with gas cans is already taken into account. If a State then added emission estimates for these components developed using ARB's method to their nonroad inventory, double counting of refueling emissions may occur. For States not using EPA's NONROAD model, the SCC-level estimates that were generated for this analysis using the ARB methodology can be used directly.

If a State developed VOC exhaust emission estimates for specific nonroad SCC's using a method besides the NONROAD model, potential overlapping SCCs reporting exhaust and refueling emissions would need to be identified. In these cases, the evaporative VOC component would need to be added to the exhaust VOC component to estimate total VOC emissions. The NONROAD model automatically adds the exhaust and evaporative VOC emissions together to estimate total VOC.

Diurnal and *permeation* emissions associated with the fuel present in stored gas cans, and *transport-spillage* emissions associated with refueling of a gas can at the gasoline pump are not modeled in NONROAD. These emissions result during gas can storage and transport and are not tied directly to nonroad equipment. An EPA SCC is not available for gas container evaporative emissions. In the absence of an existing SCC, the diurnal, permeation, and transport-spillage emissions could be reported under nonroad equipment SCCs based on the contribution of nonroad categories to refueling emissions. Table II-3 shows the VOC refueling emission estimates calculated for the OTR for this analysis using ARB methods. The percentage contribution for each nonroad category is also presented. For some categories, the percent contribution is less than 1 percent. When assigning the remaining non-refueling emissions to SCCs, these categories could be ignored. States could also evaluate the refueling emissions for their own State and calculate their own refueling emissions distribution. If EPA's NONROAD model is used, the NONROAD model refueling estimates could also be used to calculate the appropriate allocation percentages.

Table II-3
Summary of 1996 Refueling Emissions for the OTC States, and Percent Contribution for Nonroad Equipment Categories

SCC	SCC Description	Spillage Emissions (tpd)	Vapor Displacement Emissions (tpd)	Total Refueling Emissions (tpd)	% Refueling Total
2260001xxx	2-stroke gasoline recreational	0.197	0.163	0.360	0%
2260003xxx	2-stroke gasoline industrial	0.000	0.001	0.001	0%
2260004xxx	2-stroke gasoline lawn and garden	24.114	1.601	25.715	28%
2260006xxx	2-stroke gasoline light commercial	0.189	0.049	0.237	0%
2260007xxx	2-stroke gasoline logging	5.834	0.427	6.260	7%
2265001xxx	4-stroke gasoline recreational	0.021	0.043	0.064	0%
2265003xxx	4-stroke gasoline industrial	0.097	0.503	0.601	1%
2265004xxx	4-stroke gasoline lawn and garden	34.683	13.374	48.057	53%
2265006xxx	4-stroke gasoline light commercial	6.389	2.119	8.509	9%
2265007xxx	4-stroke gasoline logging	0.041	0.014	0.054	0%
2282xxxxxx	Gasoline recreational marine	0.184	0.493	0.677	1%
	Total	**71.8**	**18.8**	**90.5**	**100%**

ARB accounts for gasoline container diurnal, permeation and transport-spillage emissions under a separate emission inventory code (EIC). ARB's EIC system is comparable to EPA's SCC reporting system. Calculations for estimating these three components are modeled in their OFFROAD model, which also estimates the nonroad equipment spillage and vapor displacement emissions. Since the emissions from a particular gas can could potentially be associated with multiple nonroad equipment types, especially for residential uses, ARB decided to create a separate EIC for gasoline containers.

Additional information about the ARB emission estimation methods for portable fuel containers is provided in Appendix A.

3. Cost Estimates

Sales prices of portable fuel containers were based on the ARB staff report (ARB, 1999c). The ARB report includes both average sales prices of existing portable fuel containers and estimates of sales prices for containers which meet the draft model rule performance specifications. Costs vary based on container size. These cost estimates are presented in Table II-4.

Table II-4
Estimated Sales Price for Portable Gas Containers

Size of Container (gallons)	Percent of Total Containers	Average Unit Cost of Container (1998 $)	Estimated Unit Cost of Container which Meets Rule Specifications (1998 $)	Incremental Cost to Meet Rule Requirements
1 - 1.5	39%	$2.62	$9.00	$6.38
2 - 2.5	36%	$3.79	$12.00	$8.21
5 - 6	25%	$7.44	$18.00	$10.56

The annual gas can population turnover and the estimated sales prices for each container are used to calculate the incremental cost of the draft model rule on an annual basis. The total VOC reductions for 2007 and the annual incremental cost were used to calculate the cost of compliance in dollars per ton. Table II-5 presents the cost of compliance in 1998 dollars.

Table II-5
Cost of Compliance with Portable Gas Container Rule

Estimate of Containers Sold in OTR Annually	Incremental Cost ($/year)	VOC Reductions (tons/year)	Cost of Compliance ($/ton)
2,282,330	$18,452,882	31,752	581

D. AIM COATINGS RULE

1. Model Rule Summary

The OTC Model Rule for AIM Coatings (AIM OTC Model Rule) requires manufacturers to reformulate coatings to meet specified VOC content limits, which are specified in grams per liter. The VOC content limits contained in the AIM OTC Model Rule are based on the Suggested Control Measure (SCM) adopted by ARB, and the State and Territorial Air Pollution Program Administrators/Association of Local Air Pollution Control Officials (STAPPA/ALAPCO) model rule for AIM Coatings.

All products manufactured for sale or use within an OTC State after January 1, 2005 would need to comply with the VOC content limits in the AIM OTC Model Rule. A provision allows products to be sold that are manufactured before the rule applicability date. Testing to demonstrate compliance will primarily be done in accordance with EPA Method 24, although alternative test methods may be allowed.

2. Analysis Methods

Emissions for 1996 were estimated using an emission factor of 6.7 lbs/capita/yr, applied to county-level populations. The emission factor of 6.7 lbs/capita/yr represents a combined value for architectural coatings, traffic markings, and two subcategories of industrial maintenance coatings, including high-performance maintenance and other special purpose coatings. These emission factor values were obtained from EPA guidance (EPA, 1991).

In 1985, the New York Department of Environmental Conservation performed an AIM survey in the New York Metropolitan area, and used the survey results to derive an emission factor of 3.1 lbs/capita. This VOC emission factor is lower than the national emission factor, in part, because of the high population density in New York City. This 3.1 lbs/capita VOC emission factor was used to estimate baseline and Federal rule emission rates for New York counties within the New York ozone nonattainment area. Ozone season daily emissions were estimated by dividing annual emission estimates by 365 days per year. The emission generating activity is estimated to occur 7 days per week during the ozone season. A seasonality factor of 1.3 is applied to this source category to reflect higher ozone season activity for coating applications. A 1.3 factor means that average daily emissions are multiplied by 1.3 to estimate ozone season daily emissions.

For 2005 and 2007, the National Rule is estimated to yield VOC reductions of 20 percent. This value is consistent with policy issued by EPA (Seitz, 1995b), which recommends that States claim a 20 percent emission reduction credit for this rule. For this analysis, a 20 percent control effectiveness was assumed, which seems justifiable given that water-borne coating technology is resulting in products with VOC contents well below the National Rule limits. Rule penetration and rule effectiveness values are both 100 percent for this source category, reflecting the compliance and distribution practices of this industry.

The equation for computing the VOC emission for AIM coatings after control by the National/Federal Rule is listed below:

Post-control emission factor = Pre-control emission factor [1-CE(RP)(RE)]
Post-control emission factor = 6.7 lbs/capita [1-(.2)(1.00)(1.00)]
= 5.36 lbs/capita

The AIM Coatings model rule is estimated to provide a 31 percent VOC emissions reduction from the National/Federal Rule. This reduction was computed using information from data provided by the Industry Insights Survey for the National Paints and Coatings Association (Industry Insights, 1993). This same data set was used in the regulatory negotiation process by EPA and stakeholders when the Federal architectural coatings rule was established. OTC model rule emission reductions were computed on a constant solids basis.

The credit for the OTC model rule affecting AIM coatings relative to the National/ Federal Rule was computed as shown below:

Post OTC model rule control factor = 5.36 lbs/capita [1-(0.31)(1.00)(1.00)]
= 3.7 lbs/capita

A survey of manufacturers in the OTR is presently being conducted to investigate the availability of AIM coatings that are compliant with the VOC limits of the AIM OTC Model Rule. Once final survey results are compiled and analyzed, this information may be used to refine the estimated AIM coatings rule benefits. Preliminary survey findings to date are summarized in Chapter V of this report.

3. Cost Estimates

A cost of $6,400 per ton of VOC reduced was estimated based on ARB's SCM cost analysis. This average cost-effectiveness was weighted by emission reductions across all the proposed limits. Details on the assumptions used for ARB's cost analysis are provided in the "Staff Report for the Proposed Suggested Control Measure for Architectural Coatings," (ARB, 2000a).

E. MOBILE EQUIPMENT REPAIR AND REFINISHING RULE

1. Model Rule Summary

The OTC has developed a model rule that addresses VOC emissions from mobile equipment repair and refinishing operations. The rule includes VOC limits for paints used in the industry that are consistent with the Federal limits for mobile equipment refinishing materials. The rule also establishes requirements for using improved transfer efficiency application equipment and enclosed spray gun cleaning, and requires minimal training.

In addition to requiring that refinishing materials meet the Federal VOC limits, the model rule proposes a number of pollution prevention initiatives. For example, the coating application requirements specify using improved transfer efficiency spray equipment such as high volume-low pressure (HVLP) equipment. Using higher transfer efficiency equipment would reduce paint use and consequently reduce painting-related emissions. Reduced "overspray" from painting operations would reduce the frequency of booth filter replacement and related disposal and replacement costs, making operations more economical for the facility owners.

Operators would be required to use spray gun cleaning equipment that minimizes solvent loss. While commercially available spray gun cleaners are desirable, the proposal would allow other containers for spray gun cleaning to be used, as long as the container is closed when not in use.

Operators would be required to complete minimum training in proper use of equipment and materials, and maintain a record of the training. The training requirement could be met through attending formalized training centers or through information provided by paint and equipment representatives during routine shop visits.

2. Analysis Methods

The 1996 emissions for mobile equipment repair and refinishing were estimated using a per capita emission factor of 2.3 pounds VOC per capita per year. This emission factor was obtained from 1991 EPA guidance (EPA, 1991). The National Rule promulgated in 1998 called for VOC limits that have been incorporated into the OTC model rule. Similar limits are already in place in some OTC States (e.g., PA Rule 129.75). EPA estimated a 37 percent reduction for the National Rule (Seitz, 1994). Because this rule affects manufacturers, a 100 percent rule-effectiveness is used, which assumes that instructions on how to apply the coatings are followed. In addition, rule penetration is 100 percent because the rule affects all sources within the category. Ozone season daily emissions were estimated by dividing annual emission estimates by 365, and assuming 5 days per week of operation. The 5 days per week assumption is applied by multiplying average daily emissions by 7/5.

The equation for computing the VOC emission factor for mobile equipment repair and refinishing after control by the National/Federal Rule is listed below:

Post-control emission factor = Pre-control emission factor [1-CE(RP)(RE)]
Post-control emission factor = 2.30 lbs/capita [1-(.37)(1.00)(1.00)]
= 1.45 lbs/capita

Incremental to the National Rule, the OTC model rule requires the use of high transfer-efficiency painting methods (e.g., high volume low pressure spray guns), and controls on emissions from equipment (e.g., spray gun) cleaning, housekeeping activities (e.g., use of sealed containers for clean-up rags), and operator training. An incremental control effectiveness of 38 percent was estimated for the OTC model rule relative to the National Rule. This estimate includes a 35 percent reduction from the use of high transfer-efficiency spray guns and another 3 percent from the use of enclosed spray gun cleaners.

The credit for the OTC model rule affecting mobile equipment refinishing and repair relative to the National Rule was computed as shown below:

Post OTC model rule control emission factor = 1.45 lbs/capita [1-(.38)(1.00)(1.00)]
= 0.90 lbs/capita

In addition, the State of Maryland had SIP rules in place by 1996 that affected all serious and severe nonattainment area counties, which contain limits and requirements comparable to the National Rule and the OTC model rule. As such, the per capita emission factor for these counties was adjusted for 1996, as well as for the 2005 and 2007 base cases. Therefore, no OTC model rule emission benefits were estimated for these Maryland counties. The State of Delaware had a rule for mobile equipment repair and refinishing in place in 1997 that affected all counties in that State. This Delaware rule contains VOC limits that are the same as those in the OTC model rule, but the operating requirements were different. Therefore, the additional requirements in the OTC model rule will yield VOC benefits.

3. Cost Estimates

A cost of $1,534 per ton of VOC reduced was estimated based on the use of HVLP spray guns and a gun cleaning system, as estimated for Pennsylvania for Rule 129.75.

F. SOLVENT CLEANING OPERATIONS RULE

1. Model Rule Summary

The Solvent Cleaning Operations draft model rule establishes hardware and operating requirements and alternative compliance options for vapor cleaning machines used to clean metal parts. These requirements are based on the Federal maximum achievable control technology (MACT) standard for chlorinated solvent vapor degreasers. The requirements implement higher levels of technology than required under most existing State requirements, based on EPA's Control Technique Guidance. The cold cleaner solvent volatility provisions are based on regulatory programs in place in several States, including Maryland and Illinois.

Vapor cleaning machines are generally used in manufacturing operations to clean soils, including grease, oil, waxes, and the like, from parts where the highest level of cleanliness is necessary. Such manufacturing operations include the electronics industry and high quality metal machining and finishing operations. Typically, these machines have used VOC and hazardous air pollutant (HAP) solvents, but as the MACT standard is implemented, there are indications that VOC/HAP solvents are being replaced with non-HAP VOCs. The proposed requirements would apply to operators of vapor cleaning machines with a solvent surface area greater than one square foot.

In contrast, cold cleaners are used less frequently in manufacturing operations. They are more typically used in automobile repair and maintenance facilities, and in industrial maintenance shops. It is estimated that in excess of 50 percent of cold cleaning units are in automotive maintenance facilities. These units are either small remote reservoir machines or small immersion cleaning machines. The machines are useful in removing heavy soils where extreme cleanliness is not required.

The cold cleaner provisions would primarily affect small business and solvent suppliers. Most of the cold cleaning machines are provided to users through contract with regional and national companies. The machine providers would be responsible for assuring that the cold cleaner solvent meets the volatility limit. In other cases, the users and solvent providers would have to assure that the solvent meets the required limit. All limits would apply only to cold cleaners containing greater than one liter of solvent.

Overall, the requirements would apply only to cold cleaners and vapor cleaning machines cleaning metal parts. Exemptions would be provided in situations where safety concerns result from using low volatility cold cleaning solvents.

2. Analysis Methods

Emissions for 1996 were estimated using per capita emission factors for the different solvent cleaning categories as follows:

Cold Cleaning

- Automotive Repair - 2.5 pounds per year per person (lbs/yr/person); and
- Manufacturing - 1.1 lbs/yr/person.

These emission factors were taken from 1991 EPA procedures guidance (EPA, 1991). Ozone season daily emissions were estimated by dividing annual emission estimates by 365, and assuming 5 operating days per week. The 5 days per week assumption is applied by multiplying average daily emissions by 7/5.

A MACT standard is in place that controls HAPs from this category. For this analysis, the VOC emission reductions due to the Federal standard are assumed to be minimal to negligible (e.g., most of the HAPs covered are not considered to be VOC).

The OTC model rule establishes hardware and operating requirements for specified vapor cleaning machines, as well as solvent volatility limits and operating practices for cold cleaners. An incremental control effectiveness of 66 percent was estimated for the OTC model rule relative to the base case. This value is based on: (1) a previous estimate made by the State of Maryland for the emission reduction benefits of their solvent cleaning rule (mentioned below) and claimed in their SIP; and (2) an assessment made by Pechan of the impacts that lower vapor pressure limits will have in reducing the use of petroleum distillate solvents (e.g., mineral spirits). Rule penetration and rule effectiveness values are both 100 percent for this source category, because there are a small number of firms that supply the affected solvents, so a high level of compliance is expected.

Comments received on the control effectiveness estimates above include concerns on the use of RP and RE values of 100 percent. The 66 percent control effectiveness reflects anticipated emission reductions from the cold cleaning portion of the source category which will be gained from the lower volatility requirements (i.e., the minimal additional emission benefits for vapor degreasers and from cold cleaning operating requirements were not factored in). Further, based on previous experience with this source category, exempt cold cleaners (containing less than 1 liter of solvent) are believed to contribute a negligible amount of the total emissions.

Another comment was on the incorporation of the effects of existing requirements (e.g., CTG) into the base case emission factors. As described in the following paragraphs, the effects of existing state rules were factored in to the base case emission factors shown in Table II-6. Further, since the CTG only included operating requirements for cold cleaners, the emission reductions attributable to it are thought to be small.

The equation for computing the VOC emission factor for solvent cleaning after control by the OTC model rule is listed below:

Post-control emission factor = Pre-control emission factor [1-CE(RP)(RE)]
Post-control emission factor = 3.6 lbs/capita [1-(0.66)(1.00)(1.00)]
= 1.2 lbs/capita

The credits for rules affecting solvent cleaning differed by geographic area according to local surveys that have been performed to quantify emissions, and when and where State regulations have already been implemented.

Pechan examined 1989 EPA solvent consumption data, which many States based their 1990 emission estimates on. These data showed that mineral spirits made up 56 percent of the VOC solvents (petroleum distillate solvents, such as mineral spirits, will be phased out based on their vapor pressure of about 40 millimeters mercury). There will also be additional smaller emission reductions associated with the phase out of other high vapor pressure VOC solvents (e.g., alcohols, ketones) and with the operating requirements for both cold cleaning and vapor degreasing. These smaller reductions could net another 10 to 30 percent reductions based on the 1989 EPA solvent consumption data. Since it is not known what products solvent suppliers will use in the OTC to replace the popular petroleum distillate-based products, there is some uncertainty as to the upper end of the control effectiveness estimate. For example, aqueous solvents may still contain small amounts of VOC that can be emitted during drag out from the solvent tank. However, 66 percent appears to be a reasonable estimate for an overall control efficiency for the model rule.

In addition, the States of Maryland and Delaware had SIP rules in place by 1996 that apply to all serious and severe nonattainment area counties, and requires the same vapor pressure limits (i.e., 1 millimeter mercury) as the OTC model rule. The State of Delaware has a rule for solvent cleaning operations in place in 1993 that affects all Delaware counties. This rule is not specific to any category, but applies to all solvent degreasing equipment, and has no vapor pressure limit. For Maryland, the per capita emission factor for nonattainment area counties was adjusted by 66 percent for 1996, as well as for 2005 and 2007 base case. Therefore, no emission benefits were estimated for these Maryland areas.

3. Cost Estimates

A cost effectiveness of $1,400 per ton of VOC reduced was estimated based on the South Coast Air Quality Management District's (SCAQMD's) cost analysis for their solvent cleaning rule (Rule 1122) (SCAQMD, 1997). These costs correspond to the capital costs for aqueous cleaning technologies for batch-loaded cold cleaners (e.g., heated baths, dryers, rinse tanks, and skimmers). According to SCAQMD staff (Leibel, 1999), costs for the auto repair (service station) industry, which constitutes a large fraction of this source category, will be close to zero based on what has occurred to date in the South Coast of California.

G. SUMMARY

Table II-6 summarizes the VOC emission factors used in the VOC model rules analyses for all of the affected categories except portable fuel containers. Portable fuel container emission estimation methods are more complex, and are summarized earlier in this chapter. Table II-6 lists VOC emission factors for a baseline case (which is typical of 1996 emission rates in most areas), National/Federal Rule emission factors, and OTC model rule emission factors. This indicates areas within the OTC where baseline, and National/ Federal Rule emission factors are expected to differ from the norm.

The day-of-week and seasonality factors listed in Table II-6 are used to provide a best estimate of ozone season weekday emissions.

Table II-6
OTC VOC Model Rule Analysis Assumptions: Emission Factors, Percentage Reductions, Day-of-Week Factors, and Seasonality Factors

Model Rule	Baseline (1990) Emission Factor	National/ Federal Rule (EIIP) Emission Factor	Percent Reduction (EIIP from 1990 Baseline)	OTC Model Rule Emission Factor	Percent Reduction (OTC Model Rule from EIIP)	Day-of-Week Factor	Seasonality Factor
Mobile Equipment Repair & Refinishing	2.3	1.45 1.2 - DE only	37%	0.9	38%	7/5	1
AIM Coatings	6.7 3.1 - NYC only	5.36 3.1 - NYC only	20% N/A - NYC only	3.7 2.14 - NYC only	31%	7/7	1.3
Solvent Cleaning	3.6 1.44 - NJ only	3.6 1.44 - NJ only 1.2 - NYC only 2.16 - DE NC* 3.16 - DE K&S**	Various	1.2	66%	7/5	1
Consumer Products	7.84	7.06	20% (assumes 48.6% rule penetration)	6.06	14.2%	7/7	1

NOTES: VOC emission factors are in pounds per capita per year.
Unless otherwise noted, emission and other factors are for all OTC counties included in the analysis.
*Delaware New Castle County only.
**Delaware Kent and Sussex Counties only.

CHAPTER III
NO_x MODEL RULE ANALYSIS METHODS

A. MODEL RULE SUMMARY

The NO_x Model Rule affects NO_x emissions from industrial boiler, stationary combustion turbine, cement kiln, and internal combustion engine sources in the OTC. This model rule is intended to address the one-hour ozone standard NO_x emission shortfalls identified by EPA and to make progress towards reducing eight-hour ozone levels. The rule is intended to achieve NO_x reductions from stationary point sources that are not expected to be regulated by either the EPA NO_x SIP Call or Phase III of the OTC NO_x Memorandum of Understanding (MOU).

The model rule proposes to reduce NO_x emissions from many sources ranging in size from large to very small. These sources are numerous, and most emit high levels of NO_x on a per-hour or per-unit of energy basis. Affected sources include: (1) boilers that are used to heat institutional, commercial, and large residential building complexes, and for heat and power in industrial applications; (2) small to large internal combustion engines that can be used as stand-alone power generation units and at pipeline compressor stations; (3) turbines that are typically used as on-site backup electric power generators; and (4) cement kilns.

NO_x emission reductions are achieved by establishing NO_x emission rate limits or requirements for percentage NO_x reductions for source categories based on size (i.e., number of British thermal units [Btus] per hour heat input). Table III-1 summarizes the OTC NO_x Model Rule and provides the emission rates and size cut-offs.

B. ANALYSIS METHOD

1. Data Base And Sources Used In The Analysis

The point source emission inventory that serves as the starting point for Pechan's analysis is version 3.12 of EPA's 1996 National Emission Trends Inventory (NET96). This national inventory contains process specific emission estimates for all point sources in the United States. State data from the NET96 inventory were provided to the States for review and comment. Emission inventory updates were provided by Delaware, the District of Columbia, New Jersey, New York, Pennsylvania, and Rhode Island. These States supplied Pechan with new emission inventories that were used to replace the EPA data. In addition, Connecticut, Maryland, Massachusetts, New Hampshire, New York, Pennsylvania, Vermont, and Virginia provided additional information about their point source inventories that included updates to emissions, additional capacity information, identification of sources affected by the NO_x SIP Call or OTC MOU, and case-by-case reasonably available control technology (RACT) limits (where applicable). The data base

Table III-1
NO_x Model Rule Summary

Source Category	Applicability Threshold	Emission Rate Limit		Percent NO_x Reduction Required
Industrial Boilers	**MMBtu/hr heat input**	**lbs/MMBtu heat input**		
Smallest	5-50	None		Tune-up Only
Small	50-100	Gas-fired: 0.10 lbs Oil, Coal-fired: 0.30 lbs		50%
Large	100-250	Gas-fired: 0.10 lbs Oil, Coal-fired: 0.20 lbs		50%
Largest	>250*	Gas-fired: 0.17 lbs Oil, Coal-fired: 0.17 lbs		50%
Stationary Combustion Turbines**	**MMBtu/hr heat input**	**ppm dry volume corrected to 15% oxygen**		
Simple Cycle:			lbs/MWhr	
Gas-fired without oil back-up	>25	2.2	55	
Gas-fired with oil back-up	>25	2.2 3.0	On Gas: 55 On Oil: 75	
Oil-fired	>25	3.0	75	
Combined or Regenerative Cycle:				
Gas-fired without oil back-up	>25	1.3	42	
Gas-fired with oil back-up	>25	1.3 2.0	On Gas: 42 On Oil: 65	
Oil-fired	>25	2.0	65	
Stationary IC Engines		**g/bhp-hr**		
Spark-ignited Rich Burn	>200 hp	1.5		
Spark-ignited Lean Burn	>200-2000 hp ≥2000 hp	1.5 1.5		80% 90%
Compression Ignition Diesel Fuel	>200 hp	2.3		
Compression Ignition Dual-fuel	>200 hp	2.3		
Landfill Gas or Digester Gas	>200 hp	2.0		
Cement Kilns	**tons/hr**			
Long Dry	12	**Control Options:** Low NO_x burners installed and operating, or Mid-kiln firing utilized when operating, or 30% NO_x emission reduction achieved, or equivalent or greater NO_x removal efficiency.		
Long Wet	10			
Preheater 1	16			
Preheater 2	22			

NOTES: *Only for boilers not subject to EPA's NO_x SIP Call.
**Emergency generators and load shaving units would not be subject to these requirements unless the combined potential NO_x emissions of all emission units at a facility exceed the major source threshold for the specific nonattainment area.

was then modified by excluding the source types that are not subject to the regulation under the OTC draft model rule. The SCCs that were determined to be affected by the NO_x Model Rule are listed in Appendix B.

An evaluation of the updated emission inventory showed that several data records had missing emission factors and design capacities. These data elements are required for this analysis, since they are used to determine if and how a source is affected by the model rule. Missing emission factors were obtained by SCC from EPA's Factor Information Retrieval (FIRE) Data System (Version 6.23). Emission factors were set to the RACT emission limits for sources determined to be affected by State RACT requirements. Missing design capacities (applicability thresholds) were calculated using the emission factors and tpd NO_x emission estimates assuming 24-hour per day operation. The NO_x SIP Call affected sources were identified using the EPA NO_x SIP Call data base, information supplied by the States, and where necessary, calculated design capacities. This was necessary, since it is assumed that the model rule does not apply to units affected by the NO_x SIP Call.

2. Existing State Rules

State regulations affecting stationary source non-electricity generating unit (EGU) NO_x emissions were researched and summarized in Tables III-2 through III-9. State regulation summaries were prepared for Connecticut, Delaware, District of Columbia, Maryland, Massachusetts, New Hampshire, New Jersey, and New York. The States of Maine, Rhode Island, Vermont, and Virginia were not examined for the purposes of this analysis. Pennsylvania regulations were examined but determined to be a case-by-case situation. The focus was on States that are in, or near, the three severe ozone nonattainment areas in the Northeast OTR.

In several cases, State rules are expressed in units that differ from those units used to express model rule emission limits in Table III-1. For these cases, conversion factors were applied as follows:

Gas Turbines - Natural Gas (lbs/MMBtu) * 250 = Gas Turbines - Natural Gas (ppm)
Gas Turbines - Oil (lbs/MMBtu) * 272 = Gas Turbines - Oil (ppm)

Note that Tables III-2 through III-9 are organized using a common format for each State to efficiently include the State-by-State differences in these regulations in the NO_x model rule analysis. In some instances, this organization may seem to over simplify the source categories and size limitations that differ from State-to-State. This structure matches the organization of the emission data bases being used in the analysis.

C. METHODS APPLIED TO ESTIMATE RULE BENEFITS

The 1996 NO_x emission estimates were projected to 2005 and 2007 using the expected NO_x SIP Call emission control levels, where applicable (e.g., 60 percent NO_x control for industrial boilers), and SIC code based growth factors (BEA, 1995). The emissions benefits of the model rule were then estimated by comparing the actual source emission limits with the limits imposed by adoption of the model rule. The least stringent of the emission limit, or the percentage reduction was used to estimate the rule benefits at each unit.

Table III-2
Connecticut NO_x RACT Regulations Summary

State ID	Nonattainment Area	Pod_nox	Pod Name	Emission Limits by Size				Units
				Size 1	Size 2	Size 3	Size 4	
09		50	Gas Turbines - Jet Fuel	55.00	55.00	244.80	244.80	ppm
		24	Gas Turbines - Natural Gas	75.00	75.00	225.00	225.00	ppm
		23	Gas Turbines - Oil	55.00	55.00	244.80	244.80	ppm
		14	ICI Boilers - Coal/Cyclone	0.43	0.43	0.43	0.43	lbs/MMBtu
		12	ICI Boilers - Coal/FBC	0.29	0.29	0.29	0.29	lbs/MMBtu
		13	ICI Boilers - Coal/Stoker	0.38	0.38	0.38	0.38	lbs/MMBtu
		11	ICI Boilers - Coal/Wall-face wet bottom	0.38	0.38	0.38	0.38	lbs/MMBtu
			ICI Boilers - Coal/Wall-face dry bottom	0.38	0.38	0.38	0.38	lbs/MMBtu
			ICI Boilers - Coal-tangential-dry bottom	0.38	0.38	0.38	0.38	lbs/MMBtu
		42	ICI Boilers - Coke	NL	NL	NL	NL	lbs/MMBtu
		16	ICI Boilers - Distillate Oil	0.20	0.20	0.20	0.20	lbs/MMBtu
		45	ICI Boilers - Liquid Waste	NL	NL	NL	NL	lbs/MMBtu
		43	ICI Boilers - LPG	0.20	0.20	0.20	0.20	lbs/MMBtu
		20	ICI Boilers - MSW/Stoker	0.20	0.20	0.20	NL	lbs/MMBtu
		17	ICI Boilers - Natural Gas	0.20	0.20	0.20	0.20	lbs/MMBtu
		41	ICI Boilers - Process Gas	0.20	0.20	0.20	0.20	lbs/MMBtu
		15	ICI Boilers - Residual Oil	0.25	0.25	0.25	0.25	lbs/MMBtu
		18	ICI Boilers - Wood/Bark/Stoker	NL	NL	NL	NL	lbs/MMBtu
		22	Internal Combustion Engines - Gas-Rich Burn	2.50	2.50	2.50	2.50	g/bhp-hr
			Internal Combustion Engines - Gas-Lean Burn	2.50	2.50	2.50	2.50	g/bhp-hr
		21	Internal Combustion Engines - Oil	8.00	8.00	8.00	8.00	g/bhp-hr
		46	IC Engines - Gas, Diesel, LPG	8.00	8.00	8.00	8.00	g/bhp-hr

NOTES: For boilers, Size 1 = ≥ 250 MMBtu/hour, Size 2 = 100-250 MMBtu/hour, Size 3 = 50-100 MMBtu/hour, Size 4 = 5-50 MMBtu/hour
For turbines, Size 1 = ≥ 250 MMBtu/hour, Size 2 = 100-250 MMBtu/hour, Size 3 = 25-100 MMBtu/hour, Size 4 = 5-25 MMBtu/hour
For IC engines, Size 1 = ≥ 4,400 hp, Size 2 = 2,000-4,400 hp, Size 3 = 500-2,000 hp, Size 4 = 200-500 hp
NL = No Limit
The gas turbine regulations listed above apply to simple cycle turbines only. CT State regulations should be consulted for information about applicable emission limits for combined cycle.

Table III-3
District of Columbia NO_x RACT Regulations Summary

State ID	Nonattainment Area	Pod_nox	Pod Name	Emission Limits by Size				Units
				Size 1	Size 2	Size 3	Size 4	
11		50	Gas Turbines - Jet Fuel	75.00	75.00	NL	NL	ppm
		23	Gas Turbines - Oil	75.00	75.00	NL	NL	ppm
		13	ICI Boilers - Coal/Stoker	0.43	0.43	NL	NL	lbs/MMBtu
			ICI Boilers - Coal/Wall-face dry bottom	0.43	0.43	NL	NL	lbs/MMBtu
			ICI Boilers - Coal-tangential-dry bottom	0.43	0.43	NL	NL	lbs/MMBtu

NOTES: For boilers, Size 1 = $\geq$ 250 MMBtu/hour, Size 2 = 100-250 MMBtu/hour, Size 3 = 50-100 MMBtu/hour, Size 4 = 5-50 MMBtu/hour
For turbines, Size 1 = $\geq$ 250 MMBtu/hour, Size 2 = 100-250 MMBtu/hour, Size 3 = 25-100 MMBtu/hour, Size 4 = 5-25 MMBtu/hour
For IC engines, Size 1 = $\geq$ 4,400 hp, Size 2 = 2,000-4,400 hp, Size 3 = 500-2,000 hp, Size 4 = 200-500 hp
NL = No Limit

Table III-4
Delaware NO_x RACT Regulations Summary

State ID	Nonattainment Area	Pod_nox	Pod Name	Emission Limits by Size				Units
				Size 1	Size 2	Size 3	Size 4	
10		50	Gas Turbines - Jet Fuel	88.00	88.00	88.00	88.00	ppm
		24	Gas Turbines - Natural Gas	42.00	42.00	42.00	42.00	ppm
		23	Gas Turbines - Oil	88.00	88.00	88.00	88.00	ppm
		13	ICI Boilers - Coal/Stoker	0.40	0.40	NL	NL	lbs/MMBtu
		11	ICI Boilers - Coal/Wall-face dry bottom	0.38	0.38	NL	NL	lbs/MMBtu
			ICI Boilers - Coal-tangential-dry bottom	0.38	0.38	NL	NL	lbs/MMBtu
		16	ICI Boilers - Distillate Oil	0.25	0.25	NL	NL	lbs/MMBtu
		43	ICI Boilers - LPG	0.25	0.25	NL	NL	lbs/MMBtu
		17	ICI Boilers - Natural Gas	0.25	0.25	NL	NL	lbs/MMBtu
		41	ICI Boilers - Process Gas	0.25	0.25	NL	NL	lbs/MMBtu
		15	ICI Boilers - Residual Oil	0.25	0.25	NL	NL	lbs/MMBtu

NOTES: For boilers, Size 1 = $\geq$ 250 MMBtu/hour, Size 2 = 100-250 MMBtu/hour, Size 3 = 50-100 MMBtu/hour, Size 4 = 5-50 MMBtu/hour
For turbines, Size 1 = $\geq$ 250 MMBtu/hour, Size 2 = 100-250 MMBtu/hour, Size 3 = 25-100 MMBtu/hour, Size 4 = 5-25 MMBtu/hour
For IC engines, Size 1 = $\geq$ 4,400 hp, Size 2 = 2,000-4,400 hp, Size 3 = 500-2,000 hp, Size 4 = 200-500 hp
NL = No Limit

Table III-5
Massachusetts NO_x RACT Regulations Summary

State ID	Nonattainment Area	Pod_nox	Pod Name	Emission Limits by Size				Units
				Size 1	Size 2	Size 3	Size 4	
25		50	Gas Turbines - Jet Fuel	100.00	100.00	100.00	NL	ppm
		24	Gas Turbines - Natural Gas	65.00	65.00	65.00	NL	ppm
		23	Gas Turbines - Oil	100.00	100.00	100.00	NL	ppm
		14	ICI Boilers - Coal/Cyclone	NL	NL	NL	NL	lbs/MMBtu
		13	Coal Stoker	0.33	0.33	0.43	NL	lbs/MMBtu
		11	ICI Boilers - Coal/Wall-face wet bottom	NL	NL	NL	NL	lbs/MMBtu
			ICI Boilers - Coal/Wall-face dry bottom	0.45	0.45	0.43	NL	lbs/MMBtu
			ICI Boilers - Coal-tangential-dry bottom	0.38	0.38	0.43	NL	lbs/MMBtu
		16	ICI Boilers - Distillate Oil	0.30	0.30	0.12	NL	lbs/MMBtu
		43	ICI Boilers - LPG	0.30	0.30	0.30	NL	lbs/MMBtu
		17	ICI Boilers - Natural Gas	0.20	0.20	0.10	NL	lbs/MMBtu
		41	ICI Boilers - Process Gas	0.20	0.20	0.10	NL	lbs/MMBtu
		15	ICI Boilers - Residual Oil	0.28	0.30	0.30	NL	lbs/MMBtu
		22	Internal Combustion Engines - Gas-Rich Burn	1.50	1.50	1.50	NL	g/bhp-hr
			Internal Combustion Engines - Gas-Lean Burn	3.00	3.00	3.00	NL	g/bhp-hr
		21	Internal Combustion Engines - Oil	9.00	9.00	9.00	NL	g/bhp-hr
		46	IC Engines - Gas, Diesel, LPG	9.00	9.00	9.00	NL	g/bhp-hr

NOTES: For boilers, Size 1 = ≥ 250 MMBtu/hour, Size 2 = 100-250 MMBtu/hour, Size 3 = 50-100 MMBtu/hour, Size 4 = 5-50 MMBtu/hour
For turbines, Size 1 = ≥ 250 MMBtu/hour, Size 2 = 100-250 MMBtu/hour, Size 3 = 25-100 MMBtu/hour, Size 4 = 5-25 MMBtu/hour
For IC engines, Size 1 = ≥ 4,400 hp, Size 2 = 2,000-4,400 hp, Size 3 = 500-2,000 hp, Size 4 = 200-500 hp
NL = No Limit

Table III-6
Maryland NO_x RACT Regulations Summary

State ID	Nonattainment Area	Pod_nox	Pod Name	Emission Limits by Size				Units
				Size 1	Size 2	Size 3	Size 4	
24		14	ICI Boilers - Coal/Cyclone	0.70*	0.50	NL	NL	lbs/MMBtu
		11	ICI Boilers - Coal/Wall-face wet bottom	0.70*	0.50	NL	NL	lbs/MMBtu
			ICI Boilers - Coal/Wall-face dry bottom	0.70*	0.50	NL	NL	lbs/MMBtu
			ICI Boilers - Coal-tangential-dry bottom	0.70*	0.50	NL	NL	lbs/MMBtu
		16	ICI Boilers - Distillate Oil	0.70*	0.25	NL	NL	lbs/MMBtu
		17	ICI Boilers - Natural Gas	0.70*	0.20	NL	NL	lbs/MMBtu
		41	ICI Boilers - Process Gas	0.70*	0.20	NL	NL	lbs/MMBtu
		15	ICI Boilers - Residual Oil	0.70*	0.25	NL	NL	lbs/MMBtu

NOTES: For boilers, Size 1 = $\geq$ 250 MMBtu/hour, Size 2 = 100-250 MMBtu/hour, Size 3 = 50-100 MMBtu/hour, Size 4 = 5-50 MMBtu/hour
For turbines, Size 1 = $\geq$ 250 MMBtu/hour, Size 2 = 100-250 MMBtu/hour, Size 3 = 25-100 MMBtu/hour, Size 4 = 5-25 MMBtu/hour
For IC engines, Size 1 = $\geq$ 4,400 hp, Size 2 = 2,000-4,400 hp, Size 3 = 500-2,000 hp, Size 4 = 200-500 hp
NL = No Limit but subject to combustion optimization requirements
*Non EGUs limited to: 0.70 lbs/MMBtu during ozone season; and 0.99 during non-ozone season
Regulations apply to person who owns or operates an installation that causes emissions of NO_x and is located at premises that have total potential to emit:
- > 25 tons in Nonattainment Area 0720 (Baltimore, MD) and 6161 (Philadelphia- Wilmington-Trenton, PA-NJ-DE-MD)
- > 50 tons in Nonattainment Area 8842 (Washington, DC-MD-VA)
- > 100 tons in Nonattainment Areas 3805 (Kent & Queen Anne's Co, MD) and remainder of State of Maryland

Table III-7
New Jersey NO_x RACT Regulations Summary

State ID	Nonattainment Area	Pod_nox	Pod Name	Emission Limits by Size				Units
				Size 1	Size 2	Size 3	Size 4	
34		50	Gas Turbines - Jet Fuel	108.80	108.80	108.80	NL	ppm
		24	Gas Turbines - Natural Gas	50.00	50.00	50.00	NL	ppm
		23	Gas Turbines - Oil	108.80	108.80	108.80	NL	ppm
		14	ICI Boilers - Coal/Cyclone	0.55	0.55	0.55	NL	lbs/MMBtu
		11	ICI Boilers - Coal/Wall-face wet bottom	1.00	1.00	1.00	NL	lbs/MMBtu
			ICI Boilers - Coal/Wall-face dry bottom	0.45	0.45	0.43	NL	lbs/MMBtu
			ICI Boilers - Coal-tangential-dry bottom	0.38	0.38	0.38	NL	lbs/MMBtu
		16	ICI Boilers - Distillate Oil	0.28	0.28	0.12	NL	lbs/MMBtu
		43	ICI Boilers - LPG	0.20	0.20	NL	NL	lbs/MMBtu
		17	ICI Boilers - Natural Gas	0.20	0.20	0.10	NL	lbs/MMBtu
		41	ICI Boilers - Process Gas	NL	NL	NL	NL	lbs/MMBtu
		15	ICI Boilers - Residual Oil	0.28	0.28	0.30	NL	lbs/MMBtu
		22	Internal Combustion Engines - Gas-Rich Burn	1.50	1.50	1.50	NL	g/bhp-hr
			Internal Combustion Engines - Gas-Lean Burn	2.50	2.50	2.50	NL	g/bhp-hr
		21	Internal Combustion Engines - Oil	8.00	8.00	8.00	NL	g/bhp-hr
		46	IC Engines - Gas, Diesel, LPG	NL	NL	NL	NL	g/bhp-hr

NOTES: For boilers, Size 1 = $\geq$ 250 MMBtu/hour, Size 2 = 100-250 MMBtu/hour, Size 3 = 50-100 MMBtu/hour, Size 4 = 5-50 MMBtu/hour
For turbines, Size 1 = $\geq$ 250 MMBtu/hour, Size 2 = 100-250 MMBtu/hour, Size 3 = 25-100 MMBtu/hour, Size 4 = 5-25 MMBtu/hour
For IC engines, Size 1 = $\geq$ 4,400 hp, Size 2 = 2,000-4,400 hp, Size 3 = 500-2,000 hp, Size 4 = 200-500 hp
NL = No Limit

Table III-8
New York NO_x RACT Regulations Summary

State ID	Nonattainment Area	Pod_nox	Pod Name	Emission Limits by Size				Units
				Size 1	Size 2	Size 3	Size 4	
36		50	Gas Turbines - Jet Fuel	100.00	100.00	100.00	100.00	ppm
		24	Gas Turbines - Natural Gas	50.00	50.00	50.00	50.00	ppm
		23	Gas Turbines - Oil	100.00	100.00	100.00	100.00	ppm
		14	ICI Boilers - Coal/Cyclone	0.60	NL	NL	NL	lbs/MMBtu
		12	ICI Boilers - Coal/FBC	0.50	0.50	NL	NL	lbs/MMBtu
		13	ICI Boilers - Coal/Stoker	0.30	0.30	NL	NL	lbs/MMBtu
		11	ICI Boilers - Coal/Wall-face wet bottom	1.00	NL	NL	NL	lbs/MMBtu
			ICI Boilers - Coal/Wall-face dry bottom	0.45	NL	NL	NL	lbs/MMBtu
			ICI Boilers - Coal-tangential-dry bottom	0.42	NL	NL	NL	lbs/MMBtu
		16	ICI Boilers - Distillate Oil	0.25	0.30	0.12	NL	lbs/MMBtu
		17	ICI Boilers - Natural Gas	0.20	0.20	0.10	NL	lbs/MMBtu
		41	ICI Boilers - Process Gas	0.20	0.20	0.10	NL	lbs/MMBtu
		15	ICI Boilers - Residual Oil	0.25	0.30	0.30	NL	lbs/MMBtu
		22	Internal Combustion Engines - Gas-Rich Burn	2.00	2.00	2.00	NL	g/bhp-hr
			Internal Combustion Engines - Gas-Lean Burn	3.00	3.00	3.00	NL	g/bhp-hr
		21	Internal Combustion Engines - Oil	9.00	9.00	9.00	NL	g/bhp-hr
	New York City	22	Internal Combustion Engines - Gas-Rich Burn	2.00	2.00	2.00	2.00	g/bhp-hr
			Internal Combustion Engines - Gas-Lean Burn	3.00	3.00	3.00	3.00	g/bhp-hr
		21	Internal Combustion Engines - Oil	9.00	9.00	9.00	9.00	g/bhp-hr

NOTES: For boilers, Size 1 = ≥ 250 MMBtu/hour, Size 2 = 100-250 MMBtu/hour, Size 3 = 50-100 MMBtu/hour, Size 4 = 5-50 MMBtu/hour
For turbines, Size 1 = ≥ 250 MMBtu/hour, Size 2 = 100-250 MMBtu/hour, Size 3 = 25-100 MMBtu/hour, Size 4 = 5-25 MMBtu/hour
For IC engines, Size 1 = ≥ 4,400 hp, Size 2 = 2,000-4,400 hp, Size 3 = 500-2,000 hp, Size 4 = 200-500 hp
NL = No Limit
The gas turbine regulations above apply to simple cycle turbines only. NY State regulations should be consulted for information about applicable emission limits for combined cycle.

Table III-9
New Hampshire NO_x RACT Regulations Summary

State ID	Nonattainment Area	Pod_nox	Pod Name	Emission Limits by Size				Units
				Size 1	Size 2	Size 3	Size 4	
33		50	Gas Turbines - Jet Fuel	75.00	75.00	75.00	75.00	ppm
		24	Gas Turbines - Natural Gas	55.00	55.00	55.00	55.00	ppm
		23	Gas Turbines - Oil	75.00	75.00	75.00	75.00	ppm
		14	ICI Boilers - Coal/Cyclone	0.92	0.92	NL	NL	lbs/MMBtu
		13	ICI Boilers - Coal/Stoker	0.30	0.30	0.30	NL	lbs/MMBtu
		11	ICI Boilers - Coal/Wall-face wet bottom	1.00	1.00	NL	NL	lbs/MMBtu
			ICI Boilers - Coal/Wall-face dry bottom	0.50	0.50	0.50	NL	lbs/MMBtu
			ICI Boilers - Coal-tangential-dry bottom	0.38	0.38	0.38	NL	lbs/MMBtu
		16	ICI Boilers - Distillate Oil	0.25	0.25	0.12	NL	lbs/MMBtu
		17	ICI Boilers - Natural Gas	0.10	0.10	0.10	NL	lbs/MMBtu
		15	ICI Boilers - Residual Oil	0.30	0.30	0.30	NL	lbs/MMBtu
		22	Internal Combustion Engines - Gas-Rich Burn	1.50	1.50	1.50	NL	g/bhp-hr
			Internal Combustion Engines - Gas-Lean Burn	2.50	2.50	2.50	NL	g/bhp-hr
		21	Internal Combustion Engines - Oil	8.00	8.00	8.00	NL	g/bhp-hr
		46	IC Engines - Gas, Diesel, LPG	8.00	8.00	8.00	NL	g/bhp-hr

NOTES: For boilers, Size 1 = $\geq$ 250 MMBtu/hour, Size 2 = 100-250 MMBtu/hour, Size 3 = 50-100 MMBtu/hour, Size 4 = 5-50 MMBtu/hour
For turbines, Size 1 = $\geq$ 250 MMBtu/hour, Size 2 = 100-250 MMBtu/hour, Size 3 = 25-100 MMBtu/hour, Size 4 = 5-25 MMBtu/hour
For IC engines, Size 1 = $\geq$ 4,400 hp, Size 2 = 2,000-4,400 hp, Size 3 = 500-2,000 hp, Size 4 = 200-500 hp
NL = No Limit

1. Exception

Many aspects of the OTC model rule are already incorporated into the Delaware NO_x RACT rule. Delaware opted to apply the model rule to fuel switching sources, and limits the emission rate to 0.1 lbs NO_x/MMBtu for sources firing gaseous fuel and 0.2 lbs NO_x/MMBtu for sources firing distillate oil. This requirement does not apply to fuel burning equipment with a rated heat input capacity of less than 100 MMBtu/hr and any source that is equipped with low NO_x burner technology. Therefore, the Delaware rule applies only to three units (with design capacity of 165 MMBtu/hr) at Sun Company Inc. Because these three units switch to natural gas during the ozone season, the Delaware rule limits the emission rate to 0.1 lbs NO_x MMBtu for these three units.

2. Sample Calculation

The sample calculation below shows how emissions benefits were calculated for an example affected unit. The example shown is for a larger oil-fired boiler source in Coos County, New Hampshire. Benefits are estimated for both 2005 and 2007, assuming full implementation of the rule in 2005. Italics are used to indicate the variable names.

Inputs provided in 1996 Emission Inventory are as follows:

- *fipsst-fipscnty-plantid-pointid-stackid-segment* = 33-007-0001-012-912-01
- *SCC* = 10200401 - External Combustion Boiler; Industrial; Residual Oil; Grade 6 Oil
- *SIC* = 2611
- Design Capacity = 155 MMBtu/hr - "Large" (see Table III-1)
- 1996 Ozone Season Daily NO_x Emission = *nox_96* = 0.61 tpd
- New Hampshire RACT Limit = *ractlimit* = 0.3 lbs/MMBtu (for Size 2, ICI Boilers-Residual Oil in Table III-9)
- OTC Model Rule Limit = *mrlimit* = 0.2 lbs/MMBtu OR 50 percent NO_x reduced

Step 1 - Calculate 2005 and 2007 Emissions:

Emissions are grown from 1996 to 2005 and 2007 using Bureau of Economic Analysis (BEA) Activity Factors, which are based on State and 2-digit SIC codes.

- 1996 BEA Activity (*grow96*) = 290.5
- 2005 BEA Activity (*grow05*) = 326.4
- 2007 BEA Activity (*grow07*) = 333.8

2005 Ozone Season Daily NO_x (*nox_05*) =
nox_96 * (*grow05* / *grow96*) = 0.61 * (326.4 / 290.5) = 0.685 tpd

2007 Ozone Season Daily NO_x (*nox_07*) =
nox_96 * (*grow07* / *grow96*) = 0.61 * (333.8 / 290.5) = 0.701 tpd

Step 2 - Calculate Model Rule Benefit

The control efficiency applied is calculated from the model rule emission limit and the emission factor (or RACT limit).

Applied Control Efficiency (*nox_ce*) = 1 - (*mrlimit / ractlimit*) = 1 - (0.2 / 0.3) = 0.33 or 33%

(Because 33% is less than 50%, the emission rate limit of 0.2 lbs/MMBtu (a 33 percent reduction) is applied.)

2005 Model Rule Ozone Season Daily NO_x (*nox_05rule*) =
nox_05 *(1-*nox_ce*) = 0.685 *(1-0.33) = 0.457 tpd

2005 Model Rule Benefit (*nox_05diff*) =
nox_05 * *nox_ce* = 0.685 * 0.33 = 0.228 tpd

2007 Model Rule Ozone Season Daily NO_x (*nox_07rule*) =
nox_07 *(1-*nox_ce*) = 0.701 *(1-0.33) = 0.467 tpd

2007 Model Rule Benefit (*nox_07diff*) =
nox_07 * *nox_ce* = 0.701 * 0.33 = 0.234 tpd

D. CEMENT INDUSTRY ANALYSIS

As part of the model rule analysis, Pechan investigated whether there were cement kilns in the Northeast OTR that were not affected by the NO_x SIP Call, either because they were outside the NO_x SIP Call area, or within the SIP Call area, but below the size cutoffs established for NO_x SIP Call rule applicability. This analysis was performed by comparing a recent EPA-sponsored study of the cement industry with the information in the NET96 data base (EC/R, 2000a). Table III-10 summarizes the State-level information about cement kilns and clinker capacity from the EPA study. It was found that all cement kilns within the SIP Call area are affected by the NO_x SIP Call. There is one cement plant (in Maine) that is outside the NO_x SIP Call area, but inside the Northeast OTR. Therefore, the portion of the OTC NO_x model rule affecting NO_x emissions from cement kilns is expected to provide limited NO_x reductions within the OTC States.

Table III-10
United States Cement Company 1998 Clinker Capacities by State*
in the OTC States

State	Clinker (1000 tons per year)	Number of Facilities	Number of Kilns
Pennsylvania	6,809	10	21
New York	2,745	3	4
Maryland	1,719	3	7
Maine	392	1	1

There are no clinker producing plants in the following States:

District of Columbia	Connecticut
Massachusetts	Vermont
New Jersey	Delaware
Rhode Island	New Hampshire
Virginia (Northern Virginia portion)	

NOTE: *Includes gray and white plants.

SOURCE: EC/R, 2000a.

CHAPTER IV
EXPECTED 2005/2007 MODEL RULE EMISSION BENEFITS

This chapter describes the results of the emission benefit calculations for the OTC States. For the purposes of this report, the emission reduction benefits have been calculated and characterized as follows: (1) emission reduction benefits within the three identified nonattainment areas (Baltimore, Philadelphia, and New York); (2) emission reduction benefits from nonattainment areas plus nearby counties generally within 100 km of the nonattainment areas; and (3) emission reduction benefits for all counties located in the OTR (OTR-wide). Emission benefit calculations were performed as described in Chapters II and III.

A. SEVERE OZONE NONATTAINMENT AREA SUMMARIES

Table IV-1 summarizes the nonattainment area-level analysis of emission benefits by model rule for the Baltimore, Maryland area, Philadelphia-Wilmington-Trenton area, and New York-Northern New Jersey-Long Island, New York-Connecticut ozone nonattainment area. The emission reductions listed in this table are either for 2005, or 2007, depending on the area's attainment date. Attainment dates are 2005 for Baltimore and Philadelphia-Wilmington-Trenton, and 2007 for New York-Northern New Jersey-Long Island.

Expected emission reductions from the VOC model rules in the three severe ozone nonattainment areas range from 13 tpd in the Baltimore area to 59 tpd in Philadelphia-Wilmington-Trenton, to 120 tpd in New York-Northern New Jersey-Long Island. The two primary factors that affect the estimated VOC model rule emission reductions in Table IV-1 are the populations in the respective areas, and the extent to which some of the model rule affected source categories are already regulated by States beyond current Federal requirements.

The NO_x model rule-associated emission reductions shown in Table IV-1 range from 5 tpd in the Baltimore area to 6 tpd in Philadelphia-Wilmington-Trenton, to 22 tpd in New York-Northern New Jersey-Long Island. As expected, NO_x model rule reductions are greatest in the areas which have stationary NO_x sources in the size ranges to which the rule applies.

Table IV-2 provides county-level emission benefit estimates for the OTC model rules for the three severe ozone nonattainment areas. This table shows that for the Baltimore ozone nonattainment area, most of the NO_x model rule benefit is expected to occur in Baltimore City and Howard County. Negligible NO_x emission reductions are expected in the other Baltimore area nonattainment counties. The AIM coatings rule provides the most VOC reduction benefits in the Baltimore area (greater than that of the other four VOC rules combined). This occurs in part because mobile equipment refinishing and solvent cleaning operations rules have no estimated benefit in the Baltimore area.

Maryland rules already reduce VOC emissions to the limits contained in the OTC model rules.

For the Philadelphia-Wilmington-Trenton nonattainment area, the solvent cleaning and AIM coating rules have the most significant VOC emission reduction benefits. The NO_x model rules primarily affect industrial boiler and reciprocating internal combustion engine emissions in this area.

For the New York City nonattainment area, model rule emission benefits are fairly evenly spread throughout the nonattainment area. The only exception to this is for the solvent cleaning operations rule, which has no expected benefit in the New York counties because of the VOC emission limits already in-place in that area.

For industrial boilers in the three severe ozone nonattainment areas, Table IV-3 shows that the expected NO_x benefit is 6.4 tpd for units between 100 and 250 million Btu per hour, and 0.8 tpd for units that are between 50 and 100 million Btu per hour. Thus, more than 80 percent of the emission benefit of the industrial boiler rule in the severe nonattainment areas is expected to be from units in the size range of 100 to 250 million Btu.

Most of the benefit associated with the NO_x model rule affecting gas turbines is found in the New York-Northern New Jersey-Long Island nonattainment area. The severe ozone nonattainment area emission benefit of the internal combustion engine model rule is 16 tpd for engines 2,000 hp or above, and 3.4 tpd for engines between 200 and 2,000 hp. As with gas turbines, most of this emission benefit is expected in the New York-Northern New Jersey-Long Island ozone nonattainment area. No emission benefit from the gas turbine rule was found in the Baltimore area.

The model rule affecting cement kilns does not affect any sources in the three severe ozone nonattainment areas of the Northeast OTR.

Figure IV-1 illustrates the expected NO_x emission reductions in each of the three severe ozone nonattainment areas organized by the source categories affected by NO_x model rules. Cement kilns are not reflected in this figure because no emission reductions are expected *in these areas* from the model rule affecting that source category.

B. WITHIN 100 KM SUMMARIES

Emission reduction benefits were assessed for nonattainment areas plus nearby counties generally within 100 km of each of the nonattainment areas. EPA's Guidance for Implementation of the One-Hour Ozone and Pre-existing PM_{10} NAAQS (December, 1997) states that "an area in nonattainment of the one-hour NAAQS should be allowed to take credit for emissions reductions obtained from sources outside the designated nonattainment area for the post-1999 rate of progress requirement...the geographic area for substitution of VOC emission reductions remains at 100 km from the nonattainment area and the geographic area for substitution of NO_x reductions remains at 200 km from the nonattainment area." Figure IV-2 shows which counties within 100 km of each of the three nonattainment areas were used for the purposes of this analysis. The respective county assignments are shown in Table IV-4. Table IV-5 lists the nonattainment area model rule benefits with the 100 km radius areas included.

For the Baltimore, MD ozone nonattainment area, the large additional VOC emission benefit from including counties within a 100 km radius occurs because this radius captures the additional benefits of the model rules in the Metropolitan Washington area.

The 100 km radius surrounding the Philadelphia-Wilmington-Trenton ozone nonattainment area adds 6 Maryland counties, 1 Delaware county, 10 Pennsylvania counties, and 2 northwest New Jersey counties, and provides an additional 35 VOC tpd and 1 NO_x tpd of emission reductions.

A 100 km radius around the New York City ozone nonattainment area includes parts of Northeast Pennsylvania, Northwest New Jersey, Southern New York State, and all of Connecticut and Rhode Island, and provides an additional 58 tpd VOC reduction and 6 tpd NO_x.

Figure IV-3 shows the expected county-level VOC emission benefits in tpd in the 100 km radius counties. These estimated VOC emission reductions are for the five VOC model rules combined. Including these counties in the analysis would gain an additional 6 tons NO_x and 51 tons VOC for the Baltimore nonattainment area, 7 tons NO_x and 94 tons VOC in Philadelphia-Wilmington-Trenton, and an additional 28 tons NO_x and 178 tons VOC in the New York area.

C. OTR-WIDE RESULTS

State summaries of OTC model rule emission benefits are presented in Table IV-6. The emission benefits listed for Virginia just include the Virginia counties in the Washington, DC area (Northern Virginia). Benefit estimates for all other States include the entire State.

Figure IV-4 shows the OTC VOC model rule expected 2005 emission reductions by State. The largest estimated VOC emission reductions are in the most populous States - Pennsylvania and New York. The height of the bars in Figure IV-4 for each State are proportional to population, with less-than-proportional reductions in State and sub-State areas that have regulations in-place that approach the stringency of the OTC model rules.

Figure IV-5 provides a similar display for the NO_x model rule. The biggest NO_x model rule-associated emission reductions are expected in New York, followed by those in New Jersey and Pennsylvania.

Table IV-7 shows the expected State-level emission benefits of the OTC NO_x model rules by source category. For industrial boilers, the States with the biggest emission benefits include Pennsylvania, New York, and Maine. Maine shows a significant emission benefit for large boilers because this State is not included in the NO_x SIP Call area. The vast majority of the emission benefits of this rule are expected for boilers larger than 100 million Btu.

The State-level gas turbine results indicate that the expected emission reductions of this model rule will be observed in, and around, the New York-Northern New Jersey-Long Island nonattainment area. The expected emission reduction associated with that rule in areas outside the New York and Philadelphia nonattainment areas is only expected to be 0.8 NO_x tpd.

Total NO_x emission reductions in 2005 for internal combustion engines larger than 2,000 hp for this rule amount to 23.5 tpd. New York and New Jersey account for 18.8 tpd.

D. SUMMARY

Figure IV-6 summarizes the expected VOC and NO_x emission reductions from the OTC model rules for the different geographic areas that have been examined in this analysis. The total emission reductions in the three severe ozone nonattainment areas for all of the model rules combined in 2005 are 180 tons VOC per day and 32 NO_x tpd. Expanding the analysis area to counties within 100 km of these three severe ozone nonattainment areas provides an additional 168 tpd in VOC emission benefits, and another 11 tpd in NO_x emission reductions. OTR-wide model rule benefits total 533 VOC tpd and 65 NO_x tpd in 2005.

E. VOC MODEL RULE BENEFIT SAMPLE CALCULATION

This section provides a sample calculation of the VOC model rule benefits for one of the VOC rules. This example is provided for Allegheny County, Pennsylvania, which is in the Pittsburgh-Beaver Valley, Pennsylvania ozone nonattainment area. The sample calculation shown is for the MERR rule. VOC emissions for this source category are estimated using a per capita emission factor. The equation for estimating baseline (1996) emissions is listed below:

Baseline VOC emissions (annual) = 1996 county population * lbs VOC per capita emission factor

Baseline VOC emissions (annual) = (1,292,741) * 2.30 lbs VOC per capita
= 2,973,304 lbs/year
= 1,486 tons/year

The conversion from annual tons to ozone season daily tons for MERR is made by dividing annual emissions by the number of days per year (365), and then multiplying this product by 7/5, which is the ratio of the *total* number of days in a week (7) to the number of days during a week when MERR facilities are expected to be operating (5). The 7/5 ratio converts the average daily emissions to an ozone season weekday equivalent.

For Allegheny County, Pennsylvania, then, baseline ozone season weekday emissions are:

$$\text{Baseline VOC} = (1{,}486\ \frac{\text{tons}}{\text{year}} \div 365\ \frac{\text{days}}{\text{year}}) * \frac{7}{5}\ \frac{\text{days/week}}{\text{weekdays/week}} = 5.67\ \text{tpd}$$

For the 2005 analysis, MERR emissions in Allegheny County, Pennsylvania are based on the expected population in that year. This 2005 population is estimated by multiplying the 1996 population by the EGAS 4.0 model growth factor (1996 to 2005) for western

Pennsylvania. This growth factor is 1.0428. Multiplying this growth factor by the 1996 population for Allegheny County yields a population estimate of 1,348,329 for 2005.

In 2005, without any additional OTC rules, VOC emissions in Allegheny County are estimated using the national rule VOC emission factor of 1.45 lbs/capita.

National rule 2005 VOC (annual) = 2005 county population * lbs VOC per capita emission factor

National rule 2005 VOC (annual) = (1,348,329) * (1.45 lbs VOC per capita)
= 1,955,077 lbs/yr
= 978 tons/yr

The conversion from annual VOC tons to ozone season weekday tons is performed for 2005 using the same methods shown above for 1996.

$$\text{National rule 2005 VOC (tpd)} = \left(978\ \frac{\text{tons}}{\text{year}} \div \frac{365\ \text{days}}{\text{year}}\right) * \frac{7\ \text{days/week}}{5\ \text{weekdays/week}} = 3.73\ \text{tpd}$$

The Allegheny County, Pennsylvania VOC emissions with the OTC model rule applied are estimated for 2005 using an emission factor of 0.9 lbs VOC per capita.

Model rule 2005 VOC (annual) = (1,348,329) (0.9 lbs VOC per capita)
= 1,213,496 lbs/yr
= 607 tons/yr

$$\text{Model rule 2005 VOC (tpd)} = \left(607\ \frac{\text{tons}}{\text{year}} \div 365\ \frac{\text{days}}{\text{year}}\right) * \frac{7\ \text{days/week}}{5\ \text{weekdays/week}} = 2.31\ \text{tpd}$$

So, the Allegheny County, Pennsylvania VOC emission benefit for the MERR model rule is estimated as the national rule 2005 VOC ozone season daily emissions minus the model rule 2005 VOC ozone season daily emissions. This emission reduction is shown below:

National rule 2005 VOC (tpd) - Model rule 2005 VOC (tpd) = Model rule associated emission reduction (tpd)

3.73 tpd - 2.31 tpd = 1.41 tpd

Table IV-1
OTC Model Rule Estimated Benefits for Severe Ozone Nonattainment Areas

Nonattainment Area	Attainment Date	Model Rule	2005/2007 Benefit (tpd)		EPA Shortfall (tpd)	
			NOx	VOC	NOx	VOC
Baltimore, MD	2005	NOx Model Rule	5	0		
		Consumer Products	0	4		
		Portable Fuel Containers	0	2		
		AIM Coatings	0	8		
		Mobile Equipment Refinishing	0	0		
		Solvent Cleaning Operations	0	0		
		Total	**5**	**13**	**0**	**13**
Philadelphia-Wilmington-Trenton,PA-NJ-DE-MD	2005	NOx Model Rule	6	0		
		Consumer Products	0	9		
		Portable Fuel Containers	0	5		
		AIM Coatings	0	19		
		Mobile Equipment Refinishing	0	6		
		Solvent Cleaning Operations	0	20		
		Total	**6**	**59**	**3**	**62**
New York-N. New Jersey-Long Island,NY-NJ-CT	2007	NOx Model Rule	22	0		
		Consumer Products	0	26		
		Portable Fuel Containers	0	25		
		AIM Coatings	0	42		
		Mobile Equipment Refinishing	0	20		
		Solvent Cleaning Operations	0	7		
		Total	**22**	**120**	**7**	**85**

NOTES: Emission benefits estimates in this table are provided as integer values. Any emission benefit of less than 0.5 tpd is listed as a zero in this table. Totals may not equal the sum of the individual rule benefits because of rounding.

Table IV-2

Model Rule Benefits for Nonattainment Areas by County for 2005 and 2007

Nonattainment Area - Attainment Date		Model Rule Benefit for 2005 (tons/day)							Model Rule Benefit for 2007 (tons/day)						
		NOx Model Rule	Consumer Products	AIM Coatings	Mobile Equipment Refinishing	Solvent Cleaning Operations	Portable Fuel Containers	TOTAL VOC	NOx Model Rule	Consumer Products	AIM Coatings	Mobile Equipment Refinishing	Solvent Cleaning Operations	Portable Fuel Containers	TOTAL VOC
County	State	NOx	VOC	VOC	VOC	VOC	VOC		NOx	VOC	VOC	VOC	VOC	VOC	
Baltimore, MD - 2005															
Anne Arundel Co	Maryland	0.01	0.68	1.47	0.00	0.00	0.43	2.58	0.01	0.69	1.49	0.00	0.00	0.78	2.96
Baltimore Co	Maryland	0.00	1.05	2.27	0.00	0.00	0.63	3.96	0.00	1.07	2.30	0.00	0.00	1.15	4.52
Carroll Co	Maryland	0.00	0.21	0.45	0.00	0.00	0.15	0.82	0.00	0.21	0.46	0.00	0.00	0.28	0.95
Harford Co	Maryland	0.00	0.31	0.66	0.00	0.00	0.18	1.15	0.00	0.31	0.67	0.00	0.00	0.33	1.31
Howard Co	Maryland	3.52	0.33	0.71	0.00	0.00	0.24	1.28	3.64	0.33	0.72	0.00	0.00	0.44	1.49
Baltimore	Maryland	1.20	0.99	2.13	0.00	0.00	0.44	3.55	1.23	1.00	2.16	0.00	0.00	0.80	3.96
		4.74	**3.57**	**7.70**	**0.00**	**0.00**	**2.08**	**13.35**	**4.88**	**3.62**	**7.80**	**0.00**	**0.00**	**3.77**	**15.19**
Philadelphia-Wilmington-Trenton,PA-NJ-DE-MD - 2005															
Kent Co	Delaware	0.00	0.17	0.38	0.07	0.48	0.43	1.53	0.00	0.18	0.38	0.07	0.48	0.78	1.89
New Castle Co	Delaware	0.36	0.68	1.46	0.29	0.91	0.13	3.47	0.37	0.68	1.48	0.29	0.92	0.23	3.60
Cecil Co	Maryland	0.00	0.11	0.24	0.00	0.00	0.06	0.42	0.00	0.11	0.25	0.00	0.00	0.11	0.47
Burlington Co	New Jersey	0.29	0.60	1.29	0.46	0.20	0.33	2.88	0.30	0.60	1.30	0.46	0.20	0.59	3.16
Camden Co	New Jersey	0.07	0.72	1.56	0.56	0.24	0.38	3.47	0.08	0.73	1.57	0.56	0.24	0.69	3.80
Cumberland Co	New Jersey	0.80	0.20	0.44	0.16	0.07	0.09	0.95	0.82	0.20	0.44	0.16	0.07	0.16	1.03
Gloucester Co	New Jersey	0.01	0.35	0.75	0.27	0.12	0.19	1.68	0.01	0.35	0.76	0.27	0.12	0.34	1.84
Mercer Co	New Jersey	1.05	0.47	1.02	0.36	0.16	0.27	2.29	1.09	0.48	1.03	0.37	0.16	0.49	2.52
Salem Co	New Jersey	1.02	0.09	0.20	0.07	0.03	0.05	0.45	1.05	0.09	0.20	0.07	0.03	0.10	0.50
Bucks Co	Pennsylvania	0.00	0.83	1.79	0.64	2.78	0.56	6.60	0.00	0.84	1.80	0.64	2.81	1.02	7.11
Chester Co	Pennsylvania	0.46	0.59	1.26	0.45	1.97	0.39	4.66	0.47	0.59	1.27	0.45	1.98	0.70	5.00
Delaware Co	Pennsylvania	0.89	0.78	1.69	0.60	2.63	0.45	6.16	0.91	0.79	1.70	0.61	2.65	0.82	6.57
Montgomery Co	Pennsylvania	0.30	1.02	2.19	0.78	3.42	0.78	8.19	0.31	1.03	2.21	0.79	3.44	1.40	8.87
Philadelphia Co	Pennsylvania	0.59	2.11	4.54	1.62	7.07	0.93	16.28	0.61	2.12	4.58	1.63	7.13	1.69	17.16
		5.84	**8.72**	**18.82**	**6.34**	**20.08**	**5.04**	**59.00**	**6.00**	**8.80**	**18.98**	**6.38**	**20.25**	**9.10**	**63.52**
New York-N. New Jersey-Long Island,NY-NJ-CT - 2007															
Fairfield Co	Connecticut	0.20	1.19	2.56	0.91	3.99	0.93	9.58	0.20	1.20	2.58	0.92	4.02	1.67	10.40
Bergen Co	New Jersey	0.45	1.21	2.61	0.93	0.41	0.84	6.00	0.46	1.22	2.64	0.94	0.41	1.52	6.73
Essex Co	New Jersey	0.74	1.08	2.33	0.83	0.36	0.51	5.11	0.77	1.09	2.35	0.84	0.37	0.92	5.56
Hudson Co	New Jersey	0.93	0.79	1.70	0.61	0.26	0.34	3.70	0.96	0.80	1.72	0.61	0.27	0.61	4.00
Hunterdon Co	New Jersey	0.60	0.17	0.37	0.13	0.06	0.12	0.84	0.61	0.17	0.37	0.13	0.06	0.21	0.94
Middlesex Co	New Jersey	1.17	1.00	2.16	0.77	0.34	0.58	4.86	1.20	1.01	2.18	0.78	0.34	1.05	5.37
Monmouth Co	New Jersey	0.36	0.84	1.82	0.65	0.28	0.54	4.13	0.36	0.85	1.83	0.65	0.29	0.97	4.60
Morris Co	New Jersey	0.28	0.64	1.38	0.49	0.22	0.49	3.23	0.29	0.65	1.40	0.50	0.22	0.89	3.65
Ocean Co	New Jersey	0.40	0.68	1.47	0.52	0.23	0.40	3.29	0.41	0.69	1.48	0.53	0.23	0.71	3.64
Passaic Co	New Jersey	0.21	0.69	1.48	0.53	0.23	0.34	3.27	0.22	0.69	1.49	0.53	0.23	0.61	3.57
Somerset Co	New Jersey	0.93	0.39	0.83	0.30	0.13	0.28	1.92	0.96	0.39	0.84	0.30	0.13	0.50	2.16
Sussex Co	New Jersey	0.05	0.20	0.43	0.16	0.07	0.12	0.97	0.05	0.20	0.44	0.16	0.07	0.21	1.07
Union Co	New Jersey	1.24	0.71	1.53	0.55	0.24	0.37	3.40	1.28	0.72	1.55	0.55	0.24	0.66	3.72
Bronx Co	New York	0.57	1.70	2.12	1.31	0.00	0.60	5.74	0.58	1.72	2.14	1.32	0.00	1.09	6.27
Kings Co	New York	5.97	3.24	4.04	2.50	0.00	1.23	11.01	6.08	3.27	4.08	2.52	0.00	2.24	12.10
Nassau Co	New York	0.61	1.86	2.32	1.43	0.00	1.04	6.65	0.63	1.87	2.34	1.44	0.00	1.88	7.54
New York Co	New York	1.98	2.19	2.73	1.69	0.00	1.18	7.79	2.03	2.21	2.76	1.70	0.00	2.14	8.81
Orange Co	New York	0.12	0.46	0.58	0.36	0.00	0.24	1.64	0.12	0.47	0.58	0.36	0.00	0.44	1.85
Queens Co	New York	1.84	2.82	3.51	2.17	0.00	1.16	9.66	1.88	2.84	3.55	2.19	0.00	2.10	10.68
Richmond Co	New York	0.51	0.57	0.71	0.44	0.00	0.26	1.98	0.52	0.57	0.72	0.44	0.00	0.47	2.20
Rockland Co	New York	0.47	0.40	0.49	0.31	0.00	0.21	1.41	0.48	0.40	0.50	0.31	0.00	0.39	1.59
Suffolk Co	New York	1.60	1.93	2.41	1.49	0.00	1.26	7.10	1.64	1.95	2.43	1.50	0.00	2.28	8.17
Westchester Co	New York	0.18	1.28	1.59	0.99	0.00	0.84	4.70	0.18	1.29	1.61	0.99	0.00	1.52	5.41
		21.40	**26.02**	**41.19**	**20.07**	**6.81**	**13.87**	**107.96**	**21.90**	**26.26**	**41.57**	**20.22**	**6.87**	**25.09**	**120.01**

Table IV-3
Nonattainment Area NOx Model Rule Benefits for Affected Sources by Source Type and Size

Industrial Boilers

		>250 MMBtu/hr				100-250 MMBtu/hr				50-100 MMBtu/hr				
			2005/2007				2005/2007				2005/2007			
Nonattainment Area	Attainment Date	Number of Affected Sources	Baseline NOx (tpd)	Model Rule NOx (tpd)	NOx Benefit (tpd)	Number of Affected Sources	Baseline NOx (tpd)	Model Rule NOx (tpd)	NOx Benefit (tpd)	Number of Affected Sources	Baseline NOx (tpd)	Model Rule NOx (tpd)	NOx Benefit (tpd)	Total Benefit (tpd)
Baltimore, MD	2005	0	0.0	0.0	0.0	18	2.6	1.4	1.2	3	0.4	0.3	0.0	**1.3**
Philadelphia-Wilmington-Trenton,PA-NJ-DE-MD	2005	2	0.6	0.3	0.3	14	4.0	2.1	2.0	4	0.8	0.5	0.3	**2.5**
New York-N. New Jersey-Long Island,NY-NJ-CT	2007	4	0.7	0.3	0.3	42	7.4	4.2	3.2	16	2.5	1.9	0.6	**4.1**
Total		**6**	**1.3**	**0.6**	**0.6**	**74**	**14.0**	**7.7**	**6.4**	**23**	**3.7**	**2.8**	**0.8**	**7.8**

IC Engines

		>2000 HP				200-2000 HP				
			2005/2007				2005/2007			
Nonattainment Area	Attainment Date	Number of Affected Sources	Baseline NOx (tpd)	Model Rule NOx (tpd)	NOx Benefit (tpd)	Number of Affected Sources	Baseline NOx (tpd)	Model Rule NOx (tpd)	NOx Benefit (tpd)	Total Benefit (tpd)
Baltimore, MD	2005	9	4.6	2.2	2.4	3	2.1	1.0	1.1	**3.5**
Philadelphia-Wilmington-Trenton,PA-NJ-DE-MD	2005	39	4.6	2.0	2.6	24	0.7	0.3	0.4	**3.0**
New York-N. New Jersey-Long Island,NY-NJ-CT	2007	164	23.9	10.5	13.4	95	4.3	1.4	2.9	**16.3**
Total		**212**	**33.2**	**14.8**	**18.4**	**122**	**7.1**	**2.7**	**4.4**	**22.8**

Turbines

		>250 MMBtu/hr			
			2005/2007		
Nonattainment Area	Attainment Date	Number of Affected Sources	Baseline NOx (tpd)	Model Rule NOx (tpd)	NOx Benefit (tpd)
Baltimore, MD	2005	0	0	0	0.0
Philadelphia-Wilmington-Trenton,PA-NJ-DE-MD	2005	16	1.1	0.7	0.3
New York-N. New Jersey-Long Island,NY-NJ-CT	2007	35	4.6	3.1	1.5
Total		**51**	**5.7**	**3.9**	**1.8**

Table IV-4
County Assignments for Analyzing Emission Reduction Benefits within 100 km of Nonattainment Areas

Baltimore

VA	MD	DC
Arlington	Calvert	
Fairfax	Charles	
Loudoun	Frederick	
Prince William	Montgomery	
Stafford	Prince Georges	
	St. Mary's	
	Washington	

Philadelphia-Wilmington-Trenton

MD	DE	PA	NJ
Caroline	Sussex	Adams	Atlantic
Dorchester		Berks	Cape May
Kent		Cumberland	
Queen Annes		Dauphin	
Talbot		Lancaster	
Wicomico		Lebanon	
		Lehigh	
		Northampton	
		Schuylkill	
		York	

New York-Northern New Jersey-Long Island

PA	NJ	NY	CT	RI
Carbon	Warren	Columbia	Hartford	Kent
Lackawanna		Delaware	Litchfield	Newport
Luzerne		Duchess	Middlesex	Providence
Monroe		Greene	New Haven	Washington
Pike		Orange	New London	
Wayne		Putnam	Tolland	
		Sullivan	Windham	
		Ulster		

Table IV-5
Nonattainment Area Model Rule Benefits with 100 KM Radius Areas Included

Nonattainment Area	Attainment Date	Model Rule	Nonattainment Area 2005/2007 Benefit (tpd)		NAA PLUS Additional 100 KM AREA 2005/2007 Benefit (tpd)		EPA Shortfall (tpd)	
			NOx	VOC	NOx	VOC	NOx	VOC
Baltimore, MD	2005	NOx Model Rule	5	0	6	0		
		Consumer Products	0	4	0	10		
		Portable Fuel Containers	0	2	0	6		
		AIM Coatings	0	8	0	21		
		Mobile Equipment Refinishing	0	0	0	3		
		Solvent Cleaning Operations	0	0	0	11		
		Total	**5**	**13**	**6**	**51**	**0**	**13**
Philadelphia-Wilmington-Trenton,PA-NJ-DE-MD	2005	NOx Model Rule	6	0	7	0		
		Consumer Products	0	9	0	13		
		Portable Fuel Containers	0	5	0	8		
		AIM Coatings	0	19	0	29		
		Mobile Equipment Refinishing	0	6	0	10		
		Solvent Cleaning Operations	0	20	0	34		
		Total	**6**	**59**	**7**	**94**	**3**	**62**
New York-N. New Jersey-Long Island,NY-NJ-CT	2007	NOx Model Rule	22	0	28	0		
		Consumer Products	0	26	0	33		
		Portable Fuel Containers	0	25	0	33		
		AIM Coatings	0	42	0	57		
		Mobile Equipment Refinishing	0	20	0	26		
		Solvent Cleaning Operations	0	7	0	30		
		Total	**22**	**120**	**28**	**178**	**7**	**85**

NOTES: Emission benefits estimates in this table are provided as integer values. Any emission benefit of less than 0.5 tpd is listed as a zero in this table. Totals may not equal the sum of the individual rule benefits because of rounding.

Table IV-6
OTC-wide Model Rule Benefits by State for 2005 and 2007

State	Model Rule Benefit for 2005 (tons/day)							Model Rule Benefit for 2007 (tons/day)						
	NOx Model Rule	Consumer Products	AIM Coatings	Mobile Equipment Refinishing	Solvent Cleaning Operations	Portable Fuel Containers	TOTAL VOC	NOx Model Rule	Consumer Products	AIM Coatings	Mobile Equipment Refinishing	Solvent Cleaning Operations	Portable Fuel Containers	TOTAL VOC
	NOx	VOC	VOC	VOC	VOC	VOC		NOx	VOC	VOC	VOC	VOC	VOC	
Connecticut	4	5	10	4	15	3	36	4	5	10	4	16	5	39
Delaware	0	1	2	0	2	1	7	0	1	2	0	2	2	7
DC	0	1	2	1	3	0	6	0	1	2	1	3	0	6
Maine	7	2	4	1	6	1	14	7	2	4	1	6	2	15
Maryland	6	7	16	1	3	4	32	6	8	16	1	3	8	36
Massachusetts	3	9	19	7	29	5	67	3	9	19	7	29	9	72
New Hampshire	4	2	4	1	6	1	13	4	2	4	1	6	2	14
New Jersey	11	11	25	9	4	7	56	12	12	25	9	4	12	61
New York	19	26	40	20	31	13	130	20	26	41	20	31	23	141
Pennsylvania	11	17	37	13	58	10	135	11	17	37	13	58	18	144
Rhode Island	1	1	3	1	5	1	11	1	1	3	1	5	1	11
Vermont	0	1	2	1	3	1	7	0	1	2	1	3	1	7
Northern Virginia	2	3	5	2	9	2	20	2	3	6	2	9	3	22
Total	**68**	**85**	**168**	**60**	**172**	**48**	**533**	**70**	**86**	**170**	**60**	**173**	**87**	**575**

NOTES: Emission benefits estimates in this table are provided as integer values. Any emission benefit of less than 0.5 tpd is listed as a zero in this table. Totals may not equal the sum of the individual rule benefits because of rounding.

Table IV-7
OTC-Wide Model Rule Benefits for Affected Sources by Source Type and Size for 2005 and 2007

Industrial Boilers

State		>250 MMBtu/hr			100-250 MMBtu/hr			50-100 MMBtu/hr		
		Number of Affected Sources	2005 NOx Benefit (tpd)	2007 NOx Benefit (tpd)	Number of Affected Sources	2005 NOx Benefit (tpd)	2007 NOx Benefit (tpd)	Number of Affected Sources	2005 NOx Benefit (tpd)	2007 NOx Benefit (tpd)
09	Connecticut	1	0.3	0.3	2	0.4	0.4	5	0.4	0.4
10	Delaware	0	0.0	0.0	3	0.4	0.4	0	0.0	0.0
11	DC	7	0.0	0.0	12	0.1	0.1	0	0.0	0.0
23	Maine	20	3.5	3.6	18	1.7	1.7	9	0.1	0.1
24	Maryland	0	0.0	0.0	22	1.3	1.3	4	0.0	0.0
25	Massachusetts	3	0.1	0.1	53	2.6	2.6	3	0.1	0.1
33	New Hampshire	2	0.0	0.0	11	1.1	1.1	0	0.0	0.0
34	New Jersey	1	0.0	0.0	41	1.9	2.0	0	0.0	0.0
36	New York	8	0.4	0.4	47	5.8	5.9	19	0.7	0.7
42	Pennsylvania	4	1.4	1.4	31	8.0	8.3	10	0.8	0.8
44	Rhode Island	0	0.0	0.0	5	0.7	0.7	6	0.1	0.1
50	Vermont	0	0.0	0.0	0	0.0	0.0	1	0.0	0.0
51	Virginia	0	0.0	0.0	3	1.2	1.2	0	0.0	0.0
		46	**5.7**	**5.9**	**248**	**25.1**	**25.7**	**57**	**2.1**	**2.1**

IC Engines

State		>2000 HP			200-2000 HP		
		Number of Affected Sources	2005 NOx Benefit (tpd)	2007 NOx Benefit (tpd)	Number of Affected Sources	2005 NOx Benefit (tpd)	2007 NOx Benefit (tpd)
09	Connecticut	2	1.3	1.4	21	1.3	1.4
10	Delaware	0	0.0	0.0	0	0.0	0.0
11	DC	0	0.0	0.0	0	0.0	0.0
23	Maine	0	0.0	0.0	0	0.0	0.0
24	Maryland	13	2.6	2.7	18	1.7	1.7
25	Massachusetts	0	0.0	0.0	0	0.0	0.0
33	New Hampshire	44	1.7	1.8	31	0.7	0.7
34	New Jersey	164	6.4	6.5	106	1.9	1.9
36	New York	52	10.0	10.3	23	1.8	1.9
42	Pennsylvania	5	0.6	0.6	0	0.0	0.0
44	Rhode Island	6	0.3	0.4	2	0.3	0.3
50	Vermont	0	0.0	0.0	2	0.0	0.1
51	Virginia	6	0.5	0.5	0	0.0	0.0
		292	**23.5**	**24.1**	**203**	**7.8**	**8.0**

Turbines

State		>25 MMBtu/hr		
		Number of Affected Sources	2005 NOx Benefit (tpd)	2007 NOx Benefit (tpd)
09	Connecticut	2	0.6	0.6
10	Delaware	0	0.0	0.0
11	DC	0	0.0	0.0
23	Maine	0	0.0	0.0
24	Maryland	0	0.0	0.0
25	Massachusetts	9	0.1	0.1
33	New Hampshire	0	0.0	0.0
34	New Jersey	43	1.2	1.2
36	New York	9	0.6	0.6
42	Pennsylvania	0	0.0	0.0
44	Rhode Island	2	0.0	0.0
50	Vermont	1	0.0	0.0
51	Virginia	0	0.0	0.0
		66	**2.5**	**2.6**

Cement Kilns

State		Number of Affected Sources	2005 NOx Benefit (tpd)	2007 NOx Benefit (tpd)
23	Maine	1	1.6	1.6

Figure IV-1
Nonattainment Area NOx Model Rule Benefits by Source Type and Size

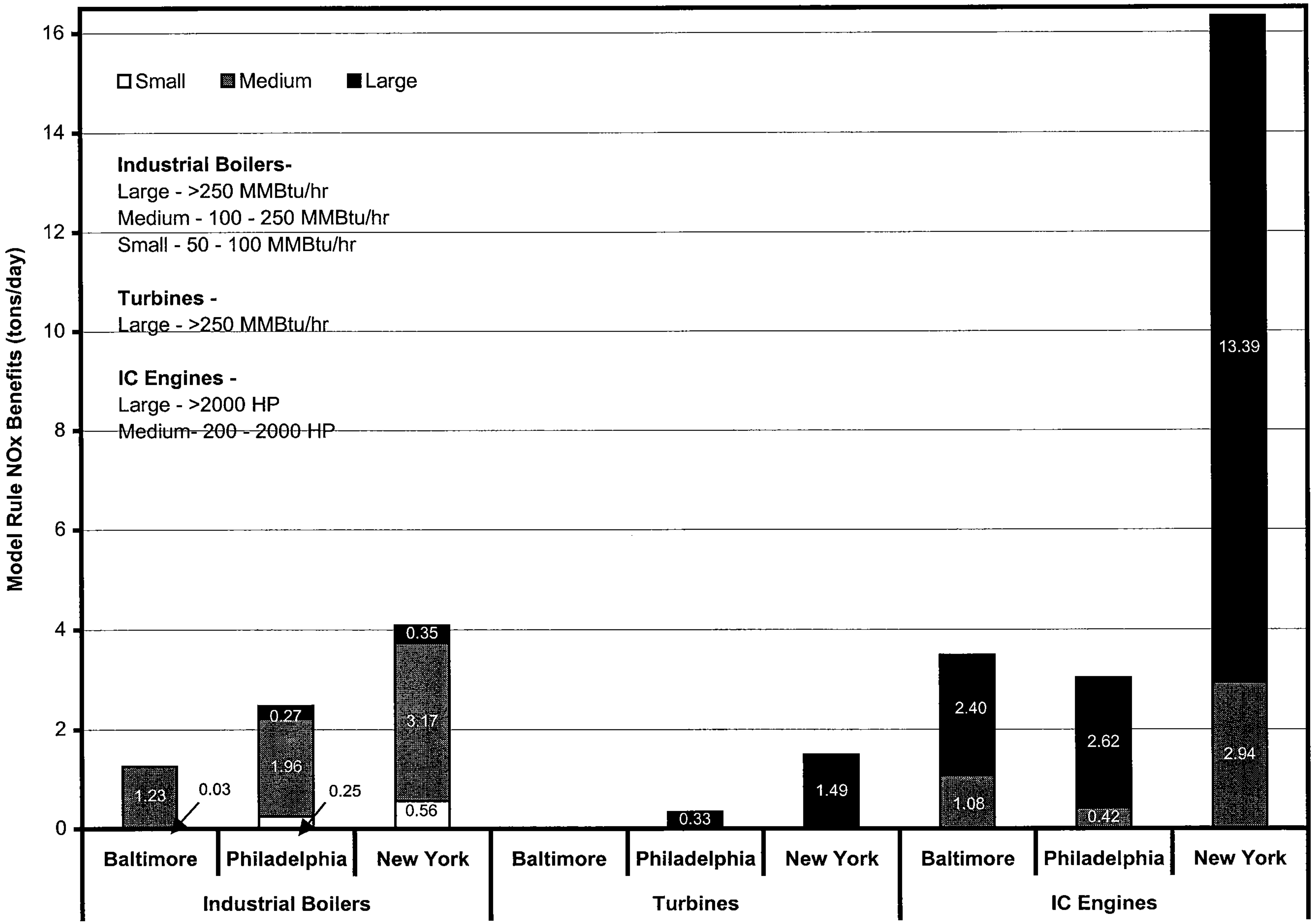


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Figure IV-2
OTC Severe Ozone Nonattainment Areas and Nearby Counties Within 100 km

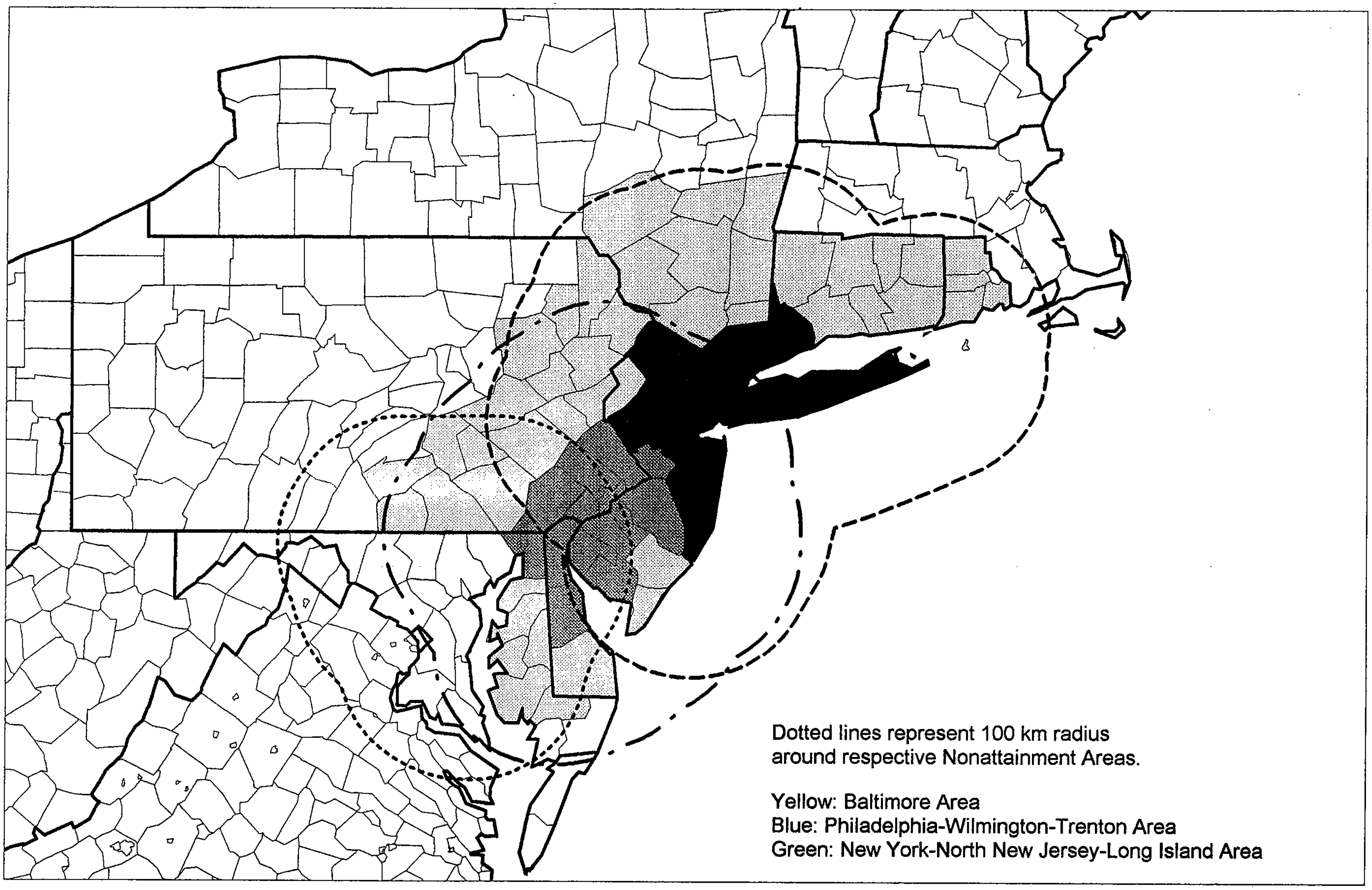

Figure IV-3
OTC Severe Ozone Nonattainment Areas and Expected VOC (tons per day) Model Rule-Associated Reductions

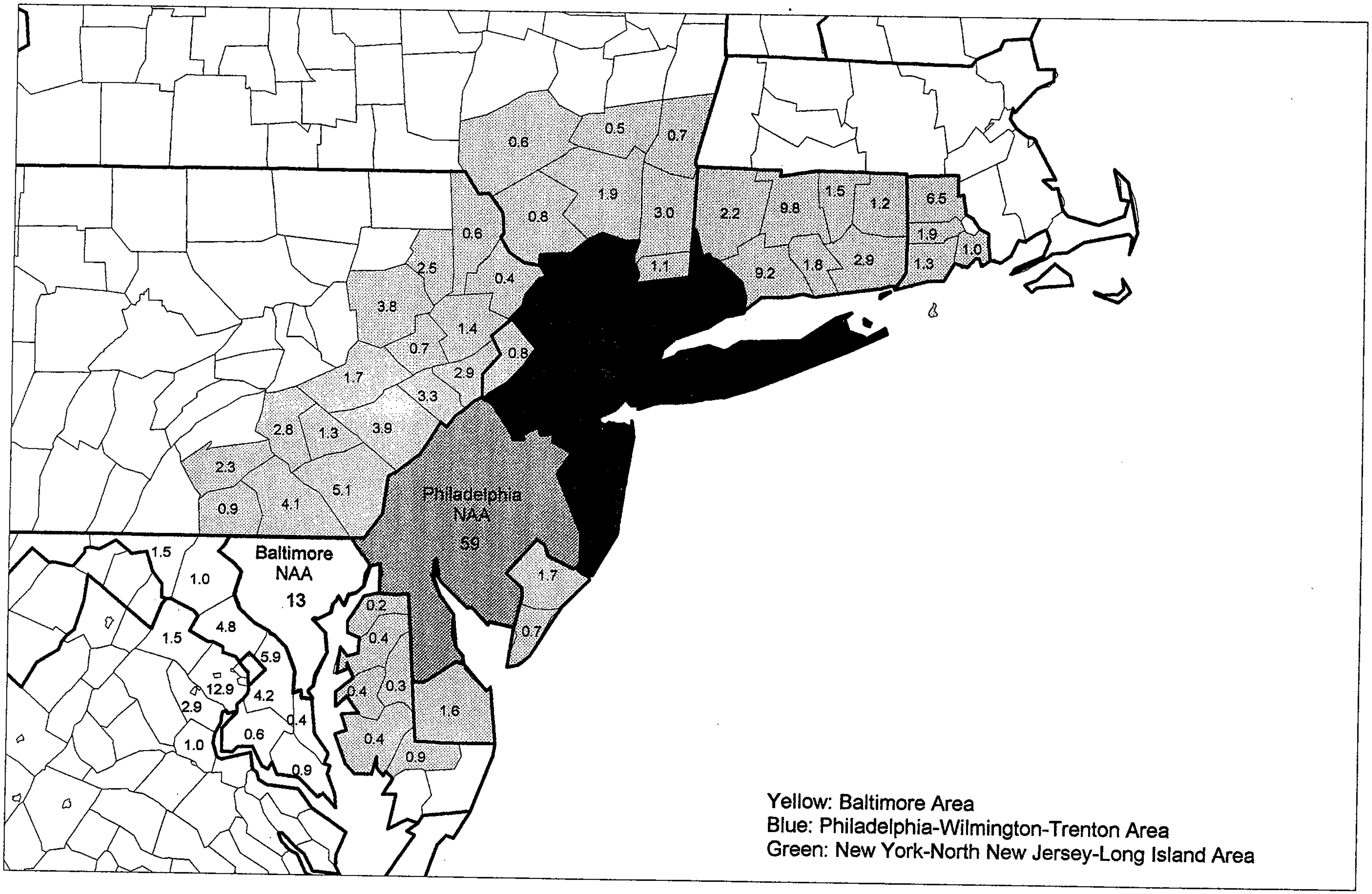

Figure IV-4
OTC VOC Model Rule Benefits by State within the OTR for 2005
(in tons per day)

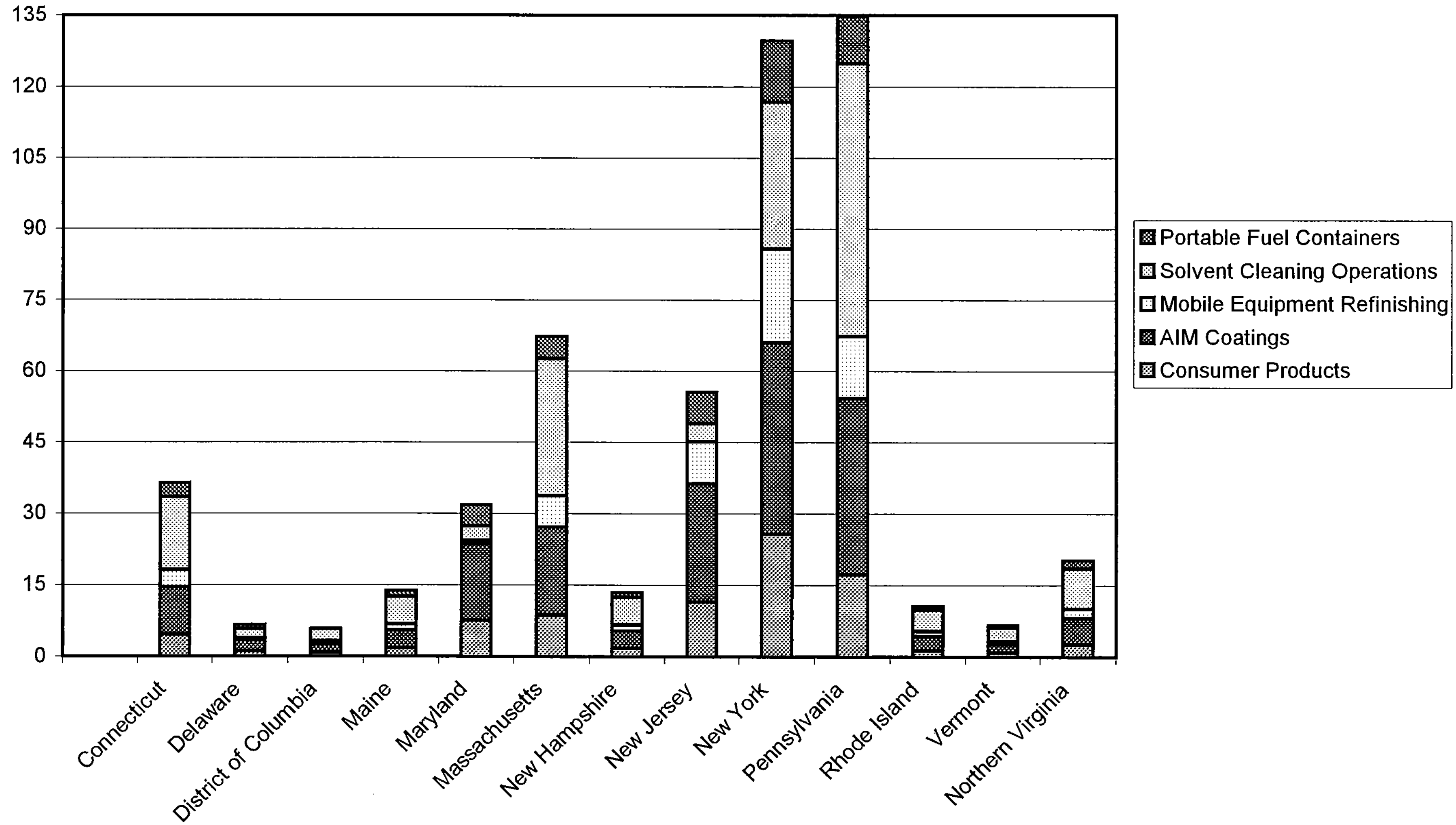

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Figure IV-5
OTC NOx Model Rule Benefits by State within the OTR for 2005
(in tons per day)

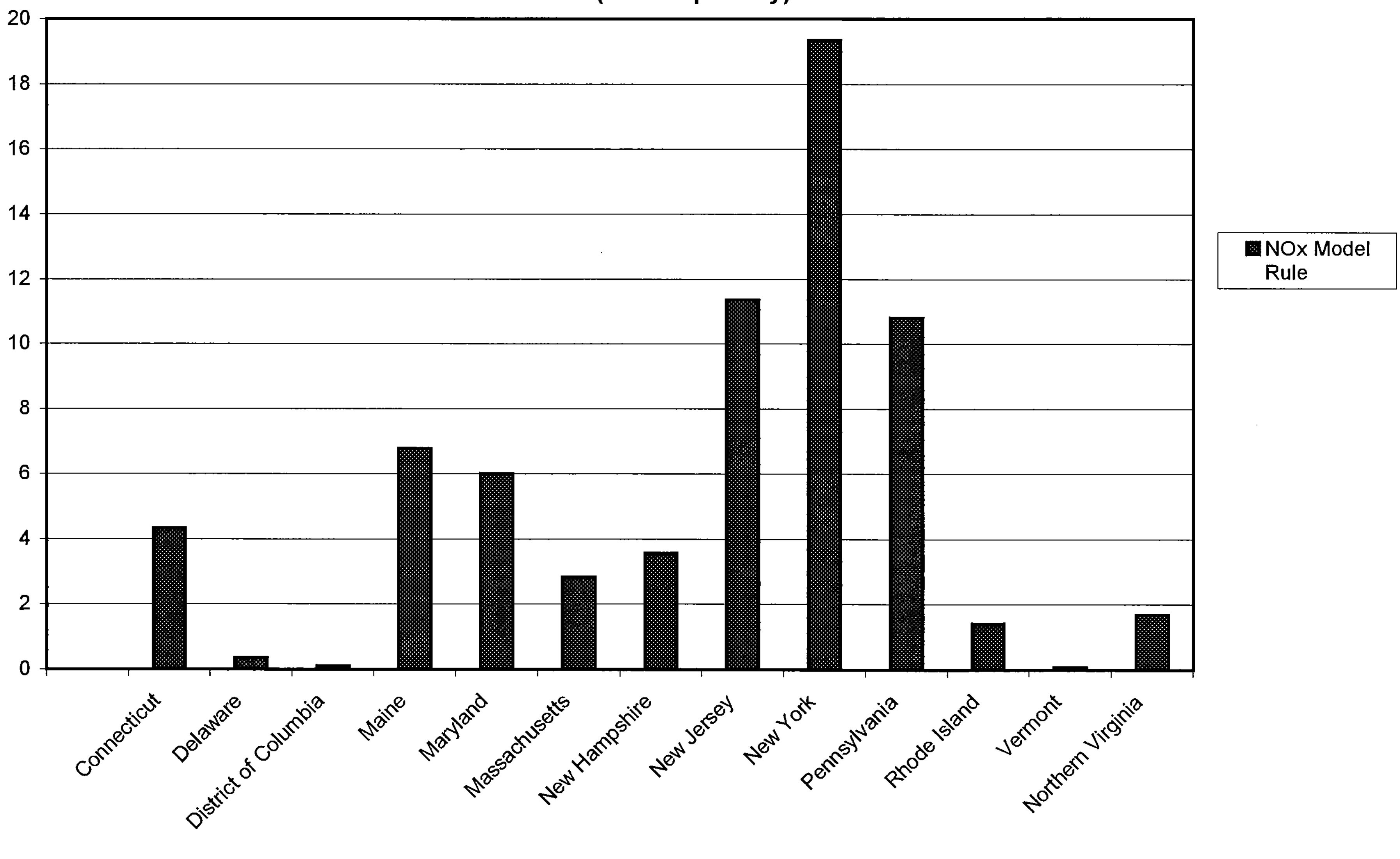
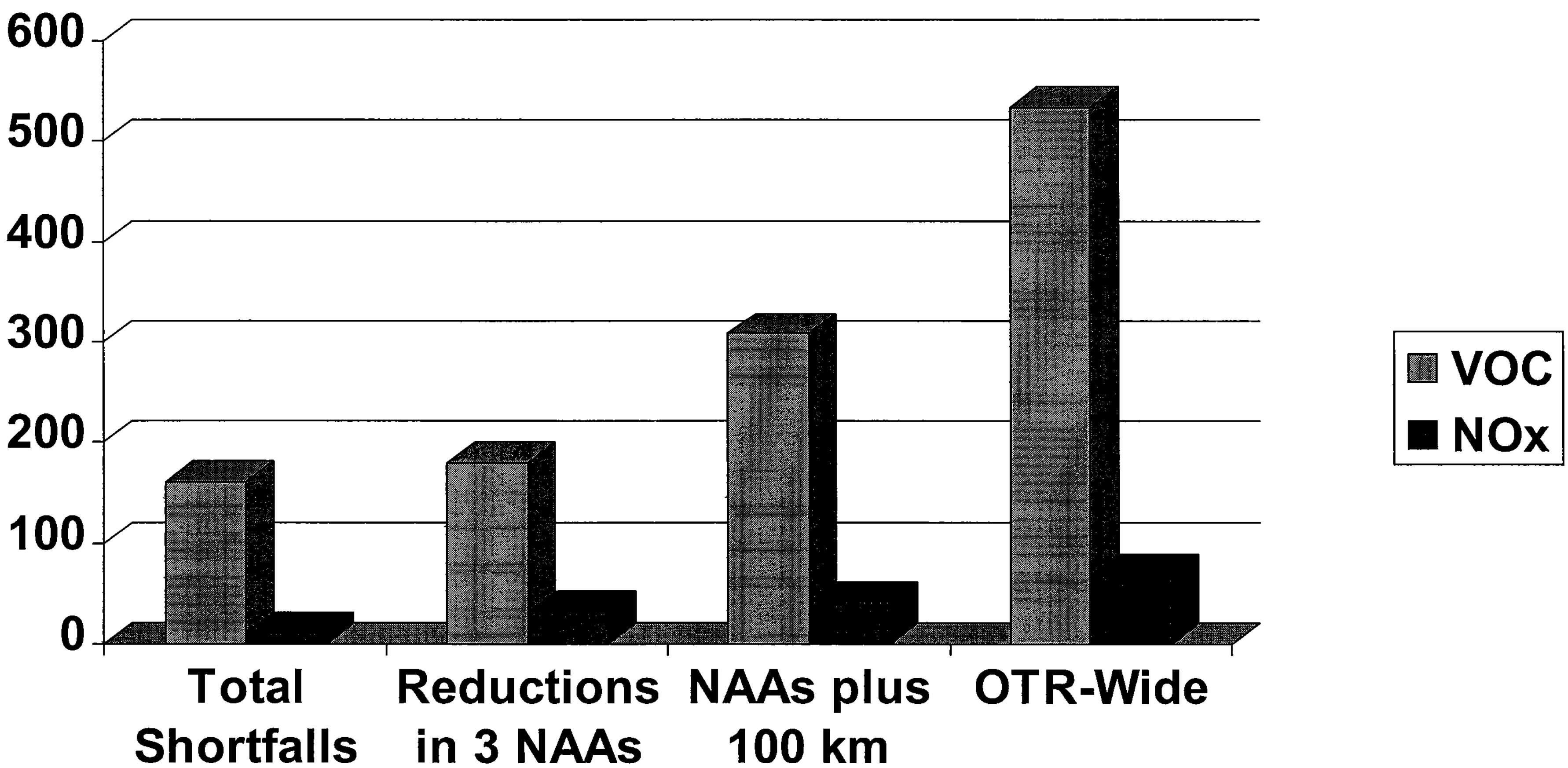


Figure IV-6
Estimated Reductions from Six OTC Model Rules in 2005
(in tons per day)



CHAPTER V
AIM COATINGS MARKET SURVEY

This section presents results of an AIM coatings market survey for the OTR. Starting in December 2000, Pechan conducted a survey to investigate the availability of AIM coatings that are compliant with the VOC limits of the OTC Model Rule for AIM Coatings.

A. SURVEY INSTRUMENT AND METHODS

We focused information gathering efforts on eleven product categories for which new VOC limits were proposed in ARB's SCM. These coating categories include:

- Flat Coatings
- Non-Flat Coatings (except high gloss)
- Lacquers (including sanding sealers)
- Industrial Maintenance Coatings
- Multi-Color Coatings
- Primers, Sealers, and Undercoaters
- Quick Dry Enamels
- Quick Dry Primers, Sealers, and Undercoaters
- Stains
- Swimming Pool Repair and Maintenance Coatings
- Wood Waterproofing Sealers

These coating categories account for about 80 percent of the total emissions in California (ARB, 2000a), and in the rest of the nation. We concentrated survey efforts on manufacturers of flat, non-flat, and industrial maintenance coatings, which are the three largest categories. Major national manufacturers were also selected for the smaller categories.

1. How Did We Identify the Coating Manufacturers that Distribute these Products in the OTR?

Based on information received from ARB concerning their 1998 AIM survey, we identified the top 31 national manufacturers for the above categories (ARB, 1999d). Using sales data compiled by ARB and released to the OTC under a data confidentiality agreement, a prioritized list of companies was developed. Mr. Bob Nelson of the National Paint and Coatings Association (NPCA) also provided assistance in identifying regional (i.e., OTR) AIM coating manufacturers that were not included in ARB's survey. Once a target list of companies was developed, survey letters were sent to the appropriate contacts, requesting data concerning their AIM products. Table V-1 presents a list of companies contacted, and indicates which companies responded to the survey.

2. What Data Were Obtained from Survey Respondents?

Data elements requested for each product included: product name; VOC content (VOC actual and VOC regulatory); percent solids by weight; percent solids by volume; density; and performance information. Companies generally provided this information by sending material safety data sheets and/or product information sheets. Some companies requested that the necessary information be accessed via their company web site. In addition to the above data elements, Pechan also requested any available sales data for the OTR states, which were ensured to be kept confidential. Table V-2 shows examples of the data obtained from the survey respondents.

Once the product information was obtained, we categorized each product into one of the eleven AIM categories. This categorization was performed based on the product name as well as performance information. Manufacturers of multi-color coatings did not provide any product data for this AIM category.

a. VOC Actual and VOC Regulatory Content

Most companies supplied VOC content in pounds of VOC per gallon of coating, which we then converted to grams of VOC per liter of coating. This will enable comparison to the OTC AIM Model Rule limits, which are expressed in g/l. Both VOC actual content and VOC regulatory content were requested. The majority of the companies provided VOC regulatory content.

VOC actual content is the weight of all volatile materials less the weight of water and less the weight of exempt compounds per the entire volume of the coating (ARB, 1999d). VOC actual may also be referred to as the VOC of the material. VOC regulatory content, also known as VOC of the coating, is the VOC content limit or standard codified in architectural coating regulations. VOC regulatory content is the ratio of the weight of VOCs per a given volume of paint (e.g., gallon or liter) with water and exempt VOCs subtracted from both the numerator (weight) and denominator (volume). Formulas for both VOC actual and VOC regulatory are presented below.

$$VOC_{Actual} = \frac{(Total\ Weight\ of\ Volatiles - Weight\ of\ Water - Weight\ of\ Exempt\ VOCs)}{Total\ Weight\ of\ Coating}$$

$$VOC_{Regulatory} = \frac{(Total\ Weight\ of\ Volatiles - Weight\ of\ Water - Weight\ of\ Exempt\ VOCs)}{(Total\ Volume\ of\ Coating - Volume\ of\ Water - Volume\ of\ Exempt\ VOCs)}$$

Expressing VOC content on a regulatory basis provides an equivalent basis for comparing the polluting portion of solvent-borne and water-borne coatings. In addition, VOC content limits codified in AIM regulations are commonly expressed as VOC regulatory. As such, to compare the VOC content of the survey product data with the limits required by the model rule, the VOC content should be on a VOC regulatory basis.

Eighteen of the 31 AIM coating manufacturers contacted provided Pechan with the data requested. The product information for each company was entered into a data base to enable further analysis. None of the companies contacted were able to provide sales data for the OTR States.

B. FINDINGS

1. Are Products Available that Meet the Limits?

A listing of the National Rule and the OTC Model Rule VOC limits by AIM category is provided in Table V-3. Based on the initial survey data collected, individual products are available that meet OTC AIM Model Rule limits. Ideally, one would use data on the volume of coatings sold, in conjunction with VOC content data, to estimate potential emission reductions for each AIM category. Because we did not receive sales data, a more qualitative analysis was performed.

Table V-4 provides a summary of the number of compliant and non-compliant products by AIM category. We compared the product's VOC regulatory content with the VOC limits of the National Rule and the OTC AIM Model Rule. When averaged across all categories, the percentage of products compliant with the OTC AIM Model Rule is 39 percent.

Table V-5 presents a summary of the average VOC content, expressed on a regulatory basis, as well as the range of VOC content among products included in each AIM category. Note that there are some coating categories that include no-VOC products, as indicated by ranges starting with zero.

2. How do OTC AIM Survey Results Compare to California Results?

Table V-6 presents the percent compliant products by category in the OTR according to the OTC survey, for both the National AIM Rule and the OTC AIM Model Rule. These compliance percentages are compared to product data for California according to ARB's 1998 survey. Compliance is determined by comparing reported VOC regulatory content per product to category-specific VOC emission limits required by each rule. It should be noted that some products may comply with the National AIM Rule through alternative compliance options.

The percentage of compliant products varies per category, but the results show that compliant products are present in the OTC, to an extent comparable to that in California. In some cases the product data in the OTR States show a greater degree of compliance than the 1998 California product data (e.g., non-flat, industrial maintenance). Possibly, this is a result of new compliant product formulations being recently introduced. For some categories the percent of compliant products is greater in California. This may be a result of AIM coating rules already in place in California (i.e., SCAQMD Rule 1113) prior to proposal of ARB's revised SCM.

Table V-1
List of AIM Survey Respondents

Company Name	Responded to Survey?
ACE Hardware Corporation	No
AMERON Performance Coatings and Finishes Group	Yes
Amteco, Inc	No
Behr Process Corporation	Yes
Benjamin Moore & Co.	Yes
Bruning Paints	No
Cabot Stains	Yes
California Products Corporation	Yes
Carboline Company	Yes
Deft, Inc	Yes
Duron Paint & Wallcoverings	Yes
Fine Paints of Europe	Yes
Gaco Western, Inc.	Yes
ICI Paints N.A.	Yes
INSL-X Products Corporation	No
International Paints, Inc.	No
Lord Corporation	No
M.A.Bruder and Sons, Inc.	Yes
Masterchem Industries, Inc	Yes
Multicolor Specialties, Inc.	No
PPG Industries	Yes
Rust-Oleum	Yes
Sherwin-Williams Co.	Yes
Spraylet Corporation	No
Textured Coatings of America	Yes
The Flood Company	No
The Valspar Corporation	No
TNEMEC CO. Inc.	Yes
TruServ Manufacturing	No
United Gilsonite Laboratories	No
W. Zinsser & Co.	No
Yenkin-Majestic Paint Corporation	No

Table V-2
Example of Data Requested

Company Name	Product Name	Coating Name	Coating Category	Regulatory VOC Limit	(R) Units	Weight/gal	% Volume Solids	% Weight Solids	Performance Information
Sherwin-Williams Co.	A-100 Exterior Latex	Flat Coatings	1	149	g/l	10.9	31	48	Fade resistant, chalk resistant, blister resistant
Sherwin-Williams Co.	LowTemp 35 Exterior Latex Satin Finish	Non-flat Coatings (except high gloss)	2	102	g/l	10.3	35	47	Recommended for use on primed metal down to a surface and air temperature of 35 degrees Fahrenheit
California Products Corporation	Wilbur & Williams Lacrylic 7110 Clear Solvent Finish	Lacquers (including sanding sealers)	3	680	g/l	7	12.1	17.7	non-yellowing, water, alkali, weak acids, and detergents resistant, abrasion resistant, prevents oxidation and discoloration
Sherwin-Williams Co.	Epo-Plex Multi-Mil Water Based Epoxy	Industrial Maintenance Coatings	4	240	g/l	10.6	41	55	Moisture resistant, abrasion, chemical and impact resistant
Rust-Oleum	6710 Polyurethane Clear Sealer	Sealers	6	574	g/l	8	34	40	improves finishes resistance to hydraulic fluids, solvents, and chemical staining
Sherwin-Williams Co.	A-100 Exterior Oil Wood Primer	Primers and Undercoaters	6	325	g/l	11.6	58	76	Resistance to peeling and blistering, resistance to fading and chalking outstanding durability
ICI Paints N.A.	ULTRA-HIDE Latex Low Lustre Interior Wall & Trim Enamel	Quick-Dry Enamels	7	163	g/l	10.9	40	54	Quick dry, block resistant, washable, non-yellowing, low odor, low VOC, adhesion and moisture resistant
Benjamin Moore & Co.	Fresh Start®® Penetrating Alkyd Primer 100	Quick-Dry Primers, Sealers and Undercoaters	8	350	g/l	13.0	66		Fast drying, mildew resistant
Sherwin-Williams Co.	Woodscapes Ext. Polyurethane Semi-Transparent Stain	Stains	9	473	g/l	8.5	8	11	Mildew resistant
California Products Corporation	Wilbur & Williams RUBBERCOAT Chlorinated Rubber Swimming Pool Paint	Swimming Pool Repair and Maintenance Coatings	10	599	g/l	11.2	38	68	Durable, continuous film minimizes seepage losses
Textured Coatings of America	Tex-Cote RainStopper 120	Wood Waterproofing Sealers	11	600	g/l	6.79	10.23	11.83	silane treatment to repel water and salt for masonry, concrete and limestone

Table V-3
Summary of the National Rule and Selected OTC Model Rule VOC Limits by AIM Category

Coating Name	National Rule VOC Limit (g/l)	OTC Model Rule VOC Limit (g/l)
Flat Coatings	250	100
Non-flat Coatings (except high gloss)	380	150
Lacquers (including sanding sealers)	680	550
Industrial Maintenance Coatings	450	250[1]
Multi-Color Coatings	580	250
Sealers	400	200
Primers and Undercoaters	350	200
Quick-Dry Enamels	450	250
Quick-Dry Primers, Sealers and Undercoaters	450	200
Stains	550	250
Swimming Pool Repair and Maintenance Coatings	_[2]	340
Wood Waterproofing Sealers	600	250

NOTES: [1]OTC model rule has an implementation option of 340 g/l for specialty industrial maintenance coatings.
[2]The National AIM Rule does not specify a VOC content limit for this category.

Table V-4
Summary of Number of Compliant and Non-Compliant Products by AIM Category

Coating Name	# of Products Compliant with National Rule	# of Products Non-Compliant with National Rule[1]	# of Products Compliant with Model Rule	# of Products Non-Compliant with Model Rule	Total # of Products
Flat Coatings	108	12	45	75	120
Non-Flat Coatings (except high gloss)	196	14	88	122	210
Lacquers (including sanding sealers)	12	0	10	2	12
Industrial Maintenance Coatings (250 g/l)	270	19	131	158	289
Industrial Maintenance Coatings (340 g/l)	Not applicable	Not applicable	200	89	289
Multi-Color Coatings	0	0	0	0	0
Sealers	21	8	14	15	29
Primers and Undercoaters	180	52	87	145	232
Quick-Dry Enamels	22	3	12	13	25
Quick-Dry Primers, Sealers, Undercoaters	57	5	14	48	62
Stains	76	3	22	57	79
Swimming Pool Repair and Maintenance Coatings	0	0	0	1	1
Wood Waterproofing Sealers	20	0	1	19	20
% Totals	**89%**	**11%**	**39%[2]**	**61%[2]**	**1,079**

NOTES: [1]Compliance as defined by meeting emission limit; some products comply with National AIM Rule through alternative compliance options.
[2]Total compliance percentages calculated by comparing all industrial maintenance coatings to 250 g/l limit.

Table V-5
VOC Content by AIM Category

Coating Name	Average of VOC Content (g/l)	Range of VOC Content (g/l)[1]
Flat Coatings	144	0 - 440
Non-Flat Coatings (except high gloss)	208	0 - 448
Lacquers (including sanding sealers)	522	285 - 680
Industrial Maintenance Coatings	263	0 - 635
Multi-Color Coatings	0	0
Sealers	265	0 - 680
Primers and Undercoaters	265	0 - 820
Quick-Dry Enamels	333	151 - 541
Quick-Dry Primers, Sealers, Undercoaters	321	0 - 508
Stains	359	102 - 690
Swimming Pool Repair and Maintenance Coatings	599	599
Wood Waterproofing Sealers	377	0 - 600

NOTE: [1]For categories with a range starting with 0, this reflects the availability of no-VOC products within a category.

Table V-6
Percent Compliant AIM Products for OTC Compared to 1998 ARB Survey Data

	National AIM Rule[1]		OTC AIM Model Rule	
	OTC States	California	OTC States	California
Coating Name	% Compliant	% Compliant	% Compliant	% Compliant
Flat Coatings	90%	96%	38%	44%
Non-Flat Coatings (except high gloss)	93%	97%	42%	40%
Lacquers (including sanding sealers)	100%	86%	83%	33%
Industrial Maintenance Coatings (250 g/l)	93%	83%	45%	37%
Industrial Maintenance Coatings (340 g/l)	Not applicable	Not applicable	69%	41%
Multi-Color Coatings	N/A[2]	100%	N/A[2]	50%
Sealers[3]	72%	64%	48%	40%
Primers and Undercoaters, Sealers[4]	78%	80%	38%	50%
Quick-Dry Enamels	88%	87%	48%	1%
Quick-Dry Primers, Sealers, Undercoaters	92%	62%	23%	14%
Stains	96%	87%	28%	31%
Swimming Pool Repair and Maintenance	Not applicable	100%	0%	0%
Wood Waterproofing Sealers	100%	80%	5%	80%

NOTES: [1]Compliance as defined by meeting emission limit; some products comply with National AIM Rule through alternative compliance options.
[2]N/A = not available.
[3]California's compliance percentages do not account for all sealers included in CARB's survey, since some sealers were reported under the primers, undercoaters, and sealers category.
[4]For CARB's 1998 survey, manufacturers included sealers in the primers, undercoaters, and sealers category, so product information for sealers is included in the CARB's compliance percentages.

CHAPTER VI
DIESEL FUEL SAMPLING PLAN

During the OTC States' model rule evaluation process, the primary regional motor vehicle control measure that was considered was to require raising the average cetane number of motor vehicle diesel fuel to 50 during the ozone season. While the OTC States decided not to proceed with a model rule to increase cetane in diesel fuels, there was interest in knowing more about the potential compliance and enforcement issues associated with a regional diesel fuel strategy. This chapter provides some background information about diesel fuel regulatory issues, the diesel fuel distribution system in the OTC States, and makes recommendations about a diesel fuel sampling plan for the region.

A. BACKGROUND

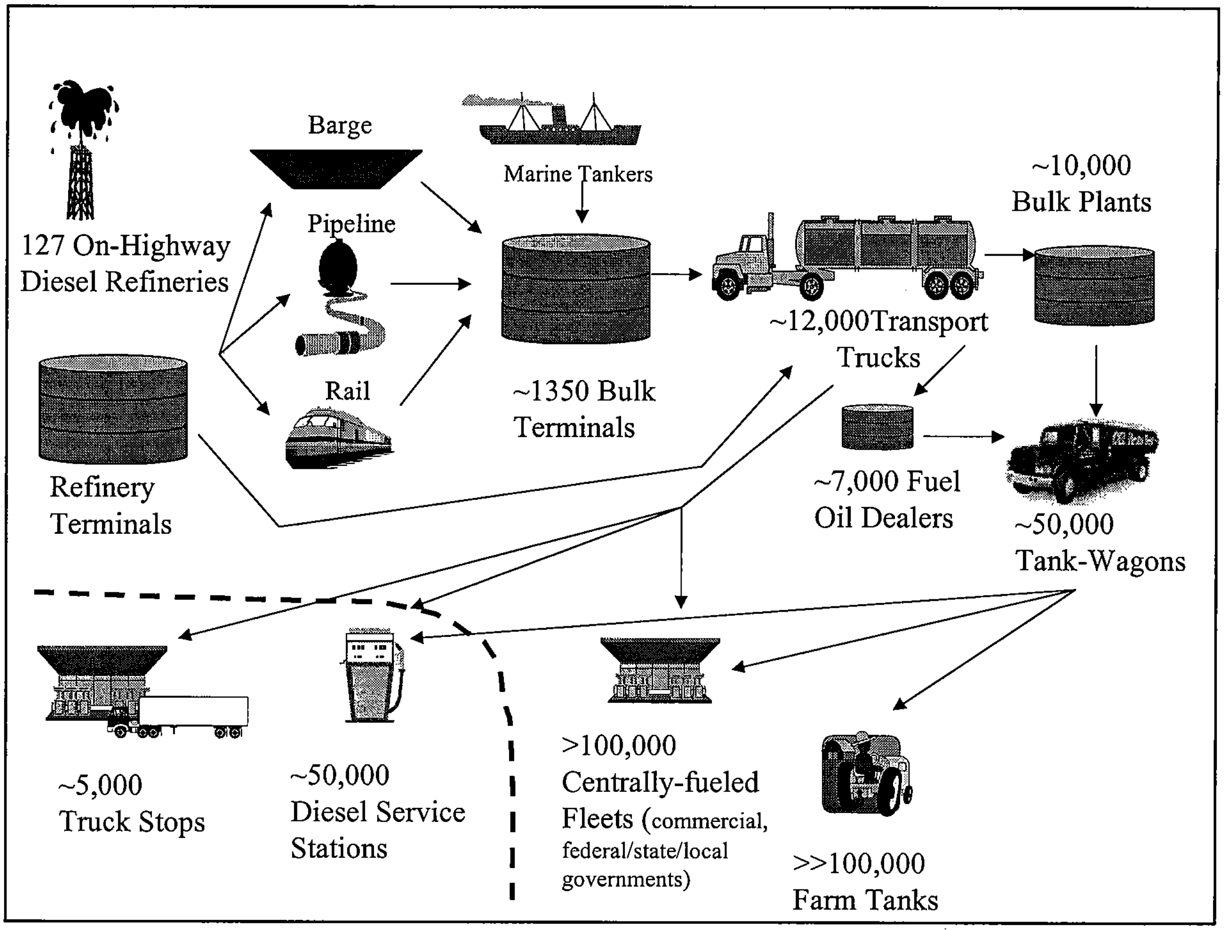
Diesel fuels are made mainly from straight-run refinery components – hydrocarbons derived directly from the distillation of crude oil. Two main hydrocarbon fractions are used to make diesel fuels – the middle distillates, or gas oils, and the residual oils. To these are added small quantities of components from other refining processes, such as catcracking and hydro treating. High-speed diesel engines used in road vehicles run on distillate fuel from gas oil, while low-speed diesel engines used in ships and electric generators use heavy residual fuel oil. Diesel fuels are usually blends because the pattern of fuel demand does not match the output of a simple distillation refinery, and more complex refining patterns have to be used. Also, there is competition between products because fractions yielding diesel fuels are also used to make domestic and industrial heating oils and aviation fuel. Diesel fuel properties are highly dependent on the type of crude oil from which the diesel fuel is refined (Faiz, 1996).

The relationship among fuel characteristics, engine performance, and exhaust emissions is complex, and there is often a trade-off between measures to control one pollutant, and its effect on others. Diesel engines generally tolerate a wide range in fuel characteristics and quality. Thus, fuel properties tend to have a minor influence on emissions compared with the influence of engine design and operating conditions. Nevertheless, the quality and composition of diesel fuel can have important effects on pollutant emissions. Studies of the effects of fuel on diesel emissions indicate that the fuel variables having the most important effects on emissions are sulfur content, cetane number, and the fraction of aromatic hydrocarbons contained in the fuel. Cetane number and aromatic hydrocarbon content are themselves closely related – fuels with high cetane tend to have low aromatic hydrocarbon content, and vice versa. Other fuel properties such as density, back-end volatility and viscosity, also affect emissions, but usually to a much lesser extent. In addition, use of fuel additives may have a significant impact on emissions.

B. OTC STATES DIESEL FUEL DISTRIBUTION

There are a number of links in the highway diesel fuel distribution chain, which runs from the fuel source (i.e., refinery or importer) to the final dispensing location. Figure VI-1 displays the potential connections in the distribution system, and presents estimates of the national number of facilities at each point in the chain (OTC-specific information was not available). Although most highway diesel fuel is transported from refineries to storage tanks at bulk terminals via the pipeline system, some fuel is transported directly from the refinery rack to the final location via tank truck. In some cases, highway diesel fuel is transported to a terminal or to a pipeline connection by barge or marine tanker. This method is used for imports from foreign countries, for example. In cases where pipeline service is limited, fuel is also shipped to the terminal by rail car.

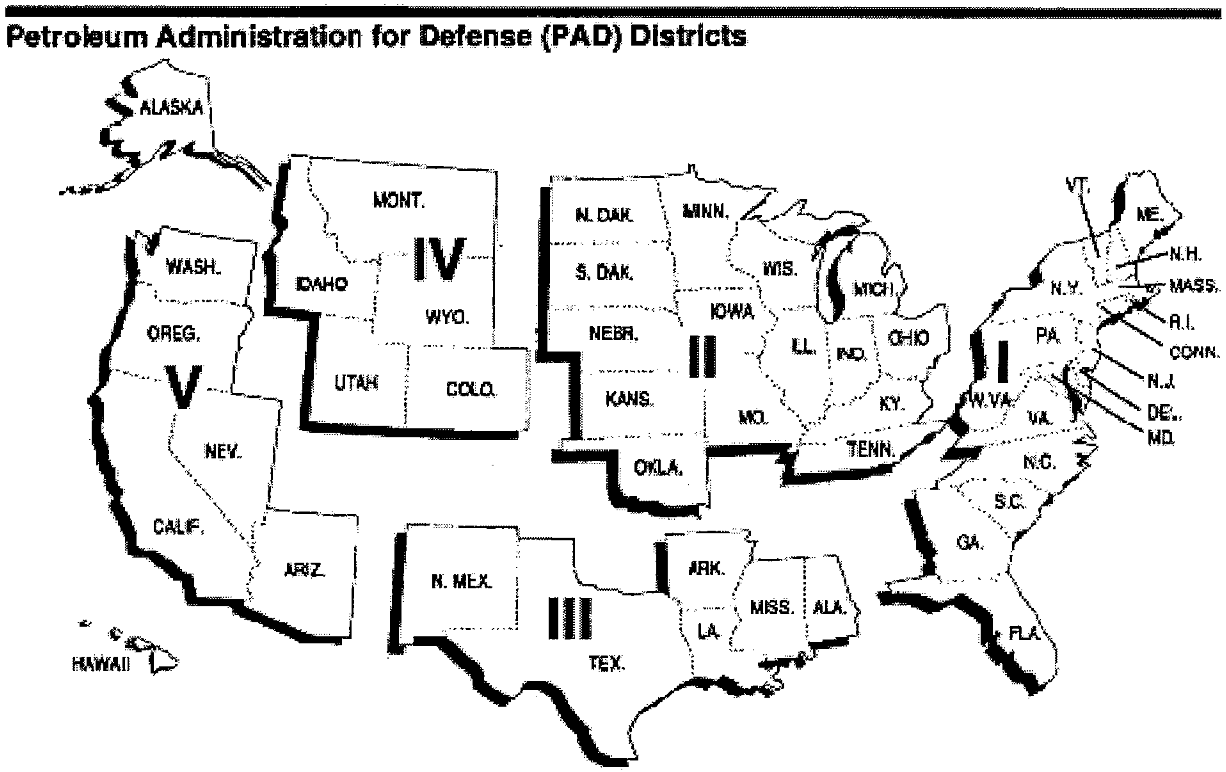
Figure VI-1
Highway Diesel Fuel Distribution Chain



From the bulk terminal storage tanks, fuel can either be trucked directly to the final dispensing location or transferred by tank truck to bulk plants for later transfer to the final destination. Tank trucks are the largest capacity vehicles carrying diesel fuel to final destinations; tanks wagons are smaller capacity vehicles that are used to deliver fuel to smaller retailers, fleet operators, and other customers. Tanks wagons typically have a number of tank compartments to deliver several different fuels on a single delivery route.

In the OTC States, a significant amount of highway diesel fuel originates from non-OTC region sources. Figure VI-2 displays the Petroleum Administration for Defense Districts (PADD) for which the Department of Energy collects diesel fuel production data. All the refineries located in PADD I, which covers the Atlantic coast region that includes the OTC States, produce only 18 percent of PADD I highway diesel demand (EPA, 2000b).

Figure VI-2
Petroleum Administration for Defense Districts (PADD)



Modeling conducted for EPA's recent highway diesel fuel regulations suggests that three PADD I refineries will produce about 135,000 barrels per day of the newly required low-sulfur (15 parts per million [ppm]) diesel. Because highway diesel demand in PADD I is approximately 820,000 barrels per day, EPA forecasts about 82 percent of total highway diesel fuel will be imported from PADD III, via the Colonial and Plantation pipelines, and through foreign imports (EPA, 2000b).

There are two key diesel distribution factors in the OTC region that have implications for the design of a diesel sampling plan. First, much of the OTC's highway diesel fuel is supplied from non-OTC region refineries. Second, the fuel distribution system that handles highway diesel fuel is also used to distribute other products, some of which contain a high sulfur content. Sulfur contamination of highway diesel fuel from mixing of such products can occur at each link in the distribution system, and is cumulative. Of all of the links in the distribution system, the pipeline system has the greatest potential for mixing of highway diesel with high sulfur products. The most significant opportunity for mixing during pipeline shipment results from the common practice of sequentially shipping different products through the same line with no physical separation between the products.

There are also significant concerns related to limiting sulfur contamination in the other links in the distribution chain. These concerns include the potential for contamination of low-sulfur highway diesel fuel when it is put into a stationary storage tank, transfer line, vehicle tank compartment, or delivery line that previously held high-sulfur products. Due to existing contamination concerns, most marine vessel tank compartments used to transport highway diesel fuel are already dedicated for this specific fuel, and there is an increasing trend toward such dedication (EPA, 2000b). Sulfur contamination can also result from leaking valves or from the addition of fuel additives that have a high sulfur content.

The extent to which such product mixing is acceptable, depends on the maximum allowable sulfur content of the highway diesel fuel, the sulfur level of the fuel as it leaves the refinery, and the sulfur content of the highest sulfur product that shares the distribution system with the highway diesel fuel. The highest sulfur product presenting a concern for highway diesel fuel is off-highway diesel fuel, which has a maximum sulfur content of 5,000 ppm and averages approximately 3,000 ppm sulfur. EPA's current sulfur cap for highway diesel fuel is 500 ppm with actual sulfur levels averaging approximately 340 ppm. This currently represents a 1 to 10 ratio of the maximum allowable sulfur content of highway diesel fuel to the highest sulfur content of other products in the distribution chain. This ratio provides an indication of the demonstrated ability of the current distribution system to limit sulfur contamination in highway diesel fuel.

EPA estimates that, in practice, its new sulfur regulations will result in highway diesel fuel leaving the refinery with an average sulfur concentration of approximately 7 ppm (EPA, 2000b). This translates into at least a 1/500 ratio of the maximum allowable sulfur contamination in highway diesel fuel to the highest sulfur level in a product that highway diesel fuel might come into contact with in the distribution chain. This ratio is 50 times the current ratio, and indicates that sulfur contamination will be a much greater issue with the new EPA regulations. The OTC will need to consider this sulfur contamination issue before setting more stringent standards if it is interested in doing so. If future sulfur standards are implemented for non-highway diesel fuel, or if the new EPA regulations result in the development of a separate highway diesel distribution system, then it will be easier to ensure compliance with a more stringent sulfur cap throughout the distribution chain. However, EPA's regulatory impact analysis assumes that the existing distribution system will be able to accommodate the new diesel fuel, and that a separate highway diesel system will not be developed as a result of the new standards (EPA, 2000b).

The current highway diesel distribution chain has two major implications for a future OTC region sampling plan: (1) highway diesel fuel sampling cannot be conducted at the refinery level because many refineries supplying the OTC States are not located in the region; and (2) for any more stringent sulfur standards that the OTC may choose to implement, service stations and other final dispensing locations represent the only link in the chain where sampling can ensure that the fuel burned in highway diesel engines is achieving these standards.

To address test variability concerns, EPA included a downstream tolerance of 2 ppm to the 15 ppm sulfur standard. Downstream of the refinery tank in which it was blended, all diesel fuel testing at 17 ppm or less will be considered to be in compliance with the EPA standard. The purpose of including this tolerance factor is to reflect measurement variability. The standards do not, however, provide a measurement tolerance for refineries. The EPA does not anticipate that distributors will necessarily test for fuel sulfur content after each opportunity for contamination, but rather will rely on procedures set up to minimize the contamination, and obtaining fuel sufficiently below the standard to accommodate the increase in sulfur content from the contamination (EPA, 2000b).

C. DIESEL FUEL REGULATIONS

Diesel fuels in the OTC region are currently regulated by National standards. These national EPA standards, which have been in effect since October 1, 1993, apply only to fuel used in highway diesel engines. The regulations preclude anyone from producing, supplying, dispensing, transporting, or introducing into commerce highway diesel fuel that contains more than 500 ppm sulfur. The existing standards also protect against a rise in the fuel's aromatics content by setting a minimum cetane index of 40, or, alternatively, a maximum aromatics level of 35 volume percent. As a result of these diesel fuel standards, EPA estimates that the current average sulfur level in PADD I highway diesel fuel is approximately 340 ppm (EPA, 2000b). Diesel fuel sold for use in non-highway applications has average sulfur levels of approximately 3,300 ppm.

The Federal Government also currently imposes an excise tax of approximately 24 cents per gallon on diesel fuel that is used on highways. Diesel fuel for off-highway use, such as home heating or construction, is not taxed. Certain entities, such as State and local governments, are exempt from paying tax on diesel fuel they use on highways. In order to improve upon past enforcement of diesel fuel tax collection, the Omnibus Budget Reconciliation Act of 1993 moved the tax collection point from the wholesale level to the point of removal from bulk terminal storage. In addition, EPA and the Internal Revenue Service agreed to require that all tax-exempt diesel fuel (both low- and high-sulfur) removed from a terminal after September 1994 be dyed red. Under this taxing system, the party that has contracted with the terminal operator to store fuel in a terminal is liable for the diesel fuel tax when the fuel is removed from the terminal. If this fuel is subsequently sold for a tax-free use, the Internal Revenue Service is to refund the tax.

EPA recently promulgated regulations controlling emissions from heavy-duty highway vehicles (66 FR 5001, 2001). These regulations are expected to reduce particulate matter and NO_x emissions from heavy-duty engines by 90 and 95 percent below current standard levels, respectively. The new standards are based on the use of high-efficiency catalytic exhaust emission control devices or comparably effective advanced technologies. Because these devices are damaged by sulfur, the EPA regulations require reductions in the level of sulfur in highway diesel fuel beginning in mid-2006.

With some exceptions, the EPA regulations mandate that refiners and importers of highway diesel fuel reduce the sulfur content of this fuel to 15 ppm by June 1, 2006. The regulations incorporate the following exceptions: (1) refiners/importers can produce a maximum of 20 percent of their highway diesel fuel at the current 500 ppm standard between June 1, 2006 and May 31, 2010, with the remainder meeting the 15 ppm specification; and (2) companies that meet the definition of "small refiner" can continue to produce 500 ppm highway diesel fuel until May 31, 2010, provided that the small refiner certifies that ample supplies of 15 ppm highway diesel fuel will be available in its PADD from other suppliers. By May 31, 2010, all highway diesel fuel must meet the 15 ppm sulfur mandate, and all exceptions to the general rule will expire.

In addition, a refiner or importer may generate sulfur credits for the early introduction of 15 ppm highway diesel fuel or for producing/importing more than 80 percent of its production at the 15 ppm standard. These sulfur credits may be bought and sold by refiners and importers. As a result, a refiner that does not meet the 80 percent production mandate may purchase another refiner's credits to come into compliance with the mandate. All credits must be used by May 31, 2010.

As part of the new diesel fuel sulfur program, EPA identified both the sampling methods and the test methods that will be used in determining compliance at all points in the distribution system. The new highway diesel sulfur regulations adopt the sampling methods that are used for EPA's Tier 2/Gasoline Sulfur rule (65 FR 6797, 2000). These sampling methods are ASTM D 4057-95 (manual sampling) and D 4177-95 (automatic sampling from pipelines/in-line blending). The designated compliance test method is called "Test Method for Total Sulfur in Liquid Aromatic Hydrocarbons and Their Derivatives by Oxidative Combustion and Electrochemical Detection," or ASTM D 6428-99. This test method would be the one that EPA would utilize in its own laboratory in order to determine whether a given sample taken at any point in the distribution system is in compliance with the appropriate diesel sulfur standard. EPA also allows the use of alternative test methods as long as they are correlated to EPA's designated test method. Although the final regulations provide that the primary determinant of compliance with the standards will be the approved regulatory test methods, other information may also be used under the rule. Such other information could include test results using non-designated test methods. Under the rule, evidence from the non-regulatory test method could be used to establish the diesel fuel's sulfur level that would have resulted if the regulatory test method had been conducted. Similarly, absent sulfur test results using the regulation method, commercial documents asserting the sulfur level of diesel fuel or additive could be used as some evidence of the product's sulfur level if it had been tested using the regulatory method. EPA is requiring that refiners and importers provide information on commercial product transfer documents that identifies diesel fuel distributed for use in motor vehicles and that states that the fuel complies with the 15 ppm sulfur standard.

If a violation of the rule is detected through random testing or other means, all parties in the distribution chain for that location are presumed liable for the violation. If a violation is detected at a retail outlet, for example, the diesel marketer, transporter, supplier, and refiner are all deemed liable. The rule identifies several types of evidence that can serve to defend against liability:

- The violation was not caused by the person or the person's employee or agent;
- Product transfer documents account for the fuel and/or additive found to be in violation and indicate that the violating product was in compliance with the applicable requirements when it was under the person's control; and
- A quality assurance sampling and testing program was conducted.

A quality assurance sampling and testing program entails periodic sampling and testing to ensure that the highway diesel fuel or additive the person sold, dispensed, supplied, stored, or transported, meets the applicable sulfur standards. Although a quality assurance sampling and testing program is not required by the final rule, such a program will strengthen the defense to an alleged violation of the regulation.

D. FUEL REGULATIONS IN OTHER STATES

1. Georgia Gasoline

Georgia has a 2-phased program for counties in and around the Atlanta ozone nonattainment area that requires lower sulfur gasoline than is required by Federal regulations. Gasoline sold in a 25 county area is regulated by phase 1 requirements that began in 1999. The volume-weighted average sulfur content of gasoline is limited to 150 ppm during the ozone season. There are 25 Georgia counties subject to this gasoline regulation in 1999.

Phase 2 requirements set to achieve additional reductions in gasoline-powered vehicle exhaust will go into effect on April 1, 2003. To achieve this, the volume-weighted average sulfur content of gasoline will be limited to 30 ppm by weight and a 150 ppm gallon cap. This fuel will be required year-round and is consistent with the recent EPA proposal for a national sulfur control program. The area subject to this Georgia gasoline regulation in 2003 will include the 25 counties affected by the phase 1 requirements, plus 20 additional counties.

2. Texas Low Emission Diesel

Texas will require low-emission diesel fuel Statewide for on-road use. In addition, Texas's revisions to its low-emission diesel rules will require low-emission diesel fuel for both on-road and non-road use in the eight counties in the Houston-Galveston area ozone nonattainment area, the four counties of the Dallas-Ft. Worth ozone nonattainment area, the three counties of the Beaumont-Port Arthur ozone nonattainment area, and 95 additional central and eastern Texas counties.

To comply with the State low-emission diesel regulations, diesel fuel producers and importers must ensure that the diesel fuel delivered to the low-emission diesel fuel zone meets the specifications in the Texas rules. These rules require that, beginning May 1, 2002, diesel fuel produced for delivery and ultimate sale to the consumer in the affected area shall not exceed 500 ppm sulfur, must contain less than 100 percent by volume of aromatic hydrocarbons, and must have a cetane number of 48 or greater. In addition, these rules will require that the sulfur content in the diesel fuel supplied to the Dallas-Ft. Worth, Beaumont-Port Arthur, and Houston-Galveston area ozone nonattainment areas and 95 central and eastern Texas counties be reduced to 15 ppm sulfur beginning June 1, 2006. Also, these rules require diesel fuel producers and importers who provide fuel to the affected areas to register with the Texas Natural Resource Conservation Commission (TNRCC) and provide quarterly status reports.

The Texas rules will restrict the registration, reporting, and testing requirements of these programs to those persons who have direct control over changes in fuel content; i.e., those persons who produce or import fuel into the State.

If a new Federal diesel fuel sulfur rule is adopted that covers the areas in Texas that are affected by this rule, and the Federal rule is at least as stringent as these rules, then the commission may consider compliance with the national rule equally effective and may repeal the State sulfur requirements for diesel fuel.

Regarding compliance, Texas rules require all parties in the distribution chain to maintain copies or records of product transfer documents for a minimum of two years. Each party in the distribution chain is required to comply with the rules, and, as with any rule, is subject to enforcement action for a violation. The TNRCC will enforce the requirements after the compliance date and will take appropriate action for noncompliance situations.

No statistical-based sampling is planned in Texas. The primary compliance mechanisms are quarterly reports that diesel fuel suppliers are required to provide to the TNRCC, and TNRCC Regional Office inspections. Regional office enforcement is expected to be via random sampling.

3. Arizona - Cleaner Burning Gasoline

The Arizona Cleaner Burning Gasoline (CBG) program was adopted by the Arizona State Legislature to respond to EPA's classification of the Phoenix Metropolitan area as a serious nonattainment area for both carbon monoxide and ozone. Implementation and enforcement of the Arizona CBG began in the Phoenix Metropolitan area on May 1, 1999.

Arizona receives all of its gasoline supply from two basic sources: the West pipeline suppliers (primarily Southern California refiners) and the East pipeline suppliers (predominately Gulf Coast refiners). The West pipeline runs from Southern California to Yuma and then to Phoenix. The East pipeline runs from El Paso, Texas to Tucson, and then to Phoenix. Of the approximately 1.5 billion gallons of Arizona CBG that are piped or transported to, and consumed within, the CBG Covered Area each year, roughly 70 percent comes from the West pipeline and 30 percent comes from the East pipeline.

Arizona CBG can technically be any one of the following types, or formulations, of gasoline:

Federal Phase 2 Reformulated Gasoline, or Federal Phase 2 Reformulated Gasoline is a basic formulation that is produced in such a way (as regulated by the Federal EPA) as to limit the quantity or levels of those compounds and characteristics of gasoline that lead to poor emissions. All Federal Phase 2 Reformulated Gasoline must pass the Federal Complex Model for use within a controlled area.

CARB (California Air Resources Board) Phase 2 is a formulation that is currently being used throughout California. It is formulated in such a way as to further limit various parameters of a gasoline blend which leads to a greater emissions reduction from motor vehicles. CARB Phase 2 gasoline is viewed as superior to other types of reformulated gasolines, including Federal Phase 2, and is considered the "cleanest burning" gasoline formulation available to date.

Predictive Model Formulations, or PM gasoline, are very similar to CARB Phase 2 gasoline, but differ in that the refiner is given leeway to deviate from the limits imposed on each compound or characteristic of CARB Phase 2, while the resultant emissions reduction meets the required emission expectations of the California Predictive Model.

The Arizona CBG program comprehensively tracks every shipment of gasoline, by batch, to and sold within the CBG Covered Area from the refinery gate and to the retail outlets within the CBG Covered Area.

It is the job of the Arizona Department of Weights and Measures, in consultation with the Arizona Department of Environmental Quality, to enforce the Arizona CBG rule (ACC, Title 20, Chapter 2, Article 7). This is accomplished by: (1) tracking the production and distribution of CBG into and throughout the CBG Covered Area; (2) monitoring fuel quality compliance at the retail end; (3) reviewing RFG Survey Association "surveys" year round; and (4) performing quality assurance "audits" throughout the CBG distribution system from refineries to oxygenate blending facilities.

4. California Diesel Fuel Regulations

ARB adopted diesel fuel regulations in 1988. These regulations are estimated to reduce sulfur dioxide emissions by 82 percent, particulate matter (PM) emissions by 25 percent, and NO_x emissions by 7 percent (ARB, 2001). California diesel fuel also reduces emissions of several toxic pollutants, including polynuclear aromatic hydrocarbons. These regulations took effect in 1993, the same year as the current Federal diesel fuel regulations. The Federal diesel rule, however, only reduces PM emissions by 5 percent and does not reduce NO_x emissions.

a. Diesel Fuel Standards

There are two principal components of California's highway diesel fuel standards: (1) the fuel's maximum sulfur content is set at 0.05 percent (this is the same level as the current Federal standards); and (2) the fuel's aromatic hydrocarbon content is capped at 10 percent, which is about one-third the level of pre-1993 diesel fuel (ARB, 1997). A proportion of the total diesel fuel volume produced by "small refiners" is exempt from the aromatic hydrocarbon content limit.

Unlike the refineries in the OTC States, California's refineries normally produce sufficient amounts of diesel fuel to meet in-State demand. However, diesel fuel can be imported into the State as long as it meets ARB's requirements. If a refinery is unable to produce sufficient diesel due to circumstances beyond its control, it can request a temporary variance from ARB to produce or import diesel that does not meet ARB's standards.

The aromatic hydrocarbon standards can be met through diesel fuel that exceeds the 10 percent aromatic limit if the fuel formulation meets requirements specified by ARB. These requirements specify that the producer/importer certify each alternative fuel formulation with ARB. This certification requires that exhaust emissions testing using the fuel formulation results in NO_x emissions, PM emissions, and the soluble organic fraction of PM emissions that are equivalent or less than those resulting from emissions tests using ARB's reference fuel. In addition, the producer/importer must specify the following limits that the alternative fuel must meet:

- an alternative aromatic hydrocarbon limit;
- a polycyclic aromatic hydrocarbon limit;
- a nitrogen content limit; and
- a minimum cetane number.

The producer/importer must also identify all of the fuel additives and their concentrations in the alternative fuel. Actual concentrations must not be less than those specified for the alternative fuel formulation (except for an additive demonstrated by the applicant to have the sole effect of increasing the cetane number).

b. Testing and Recordkeeping Requirements

ARB's regulations require that producers/importers sample and test each highway diesel final blend produced/shipment imported for aromatic hydrocarbon content using ASTM D-5186-96. Producers/importers are required to maintain records on these samples for a period of two years from the date of the sampling. When producers sell/supply non-highway diesel fuel with an aromatic hydrocarbon content exceeding the ARB's standard, they must maintain records for two years that demonstrate that the fuel was not highway diesel fuel. Producers/importers are required to provide these records to ARB within 20 days of a written request. Producers/importers that fail to provide these records, are presumed to have sold diesel fuel blends that violate the regulations.

c. Compliance/Enforcement

The diesel fuel regulations state that ARB may perform any sampling and testing needed to determine compliance with the standards, and that they can require that special samples be drawn and tested at any time. ARB has specified the use of ASTM Test Method D 2622-94 to identify compliance with the diesel fuel sulfur content limits. ARB has specified the use of ASTM D 5186-96 to identify compliance with the diesel fuel aromatic hydrocarbon limits.

Discussions with ARB compliance division staff indicate that ARB does not utilize a statistical-based method for compliance testing (Lum, 2001). Instead, ARB develops a random testing schedule at the beginning for each calendar year. This schedule places more emphasis on the Southern California area because of the severity of the air pollution problem in this region. ARB indicates that they also respond to reports of "suspicious activity" and target facilities that have had a poor compliance record in the past. ARB compliance personnel also indicate that statistical sampling is not used for reformulated gasoline standard compliance testing.

E. CONCLUSIONS

The RFG Survey Association is a not for profit trade association. Its members include refiners, importers, and blenders of reformulated, or cleaner burning, gasolines. The association's mission is to efficiently and effectively design and implement compliance survey programs for government or industry. This association currently performs the compliance programs for the Federal Reformulated Gasoline program and Arizona's CBG program, among others. It is recommended that the OTC States use this organization to develop a compliance program/sampling program for any regional diesel fuel program that it wants to implement. The RFG Survey Association can design a sampling plan, but it would need to know whether the regional program affects on-road, or non-road diesel (or both) and what diesel characteristics are being regulated (sulfur, cetane, aromatics, etc.).

A diesel fuel sampling plan would be expected to differ from a gasoline sampling plan in that there are fewer retail stations that sell diesel. On the other hand, diesel can be stored in tanks at commercial facilities, farms, and residences because the fuel is much less volatile than gasoline. However, the 1999 Federal regulations affecting fuel storage tanks will make it much less likely with time that small fuel users will have their own tanks (because of liability issues). It is expected that any sampling plan designed by the RFG Survey Association would be based on the primary sampling being at the point of consumption (retail sites).

CHAPTER VII
CAVEATS AND UNCERTAINTIES ASSOCIATED WITH THE ANALYSIS

The VOC model rule analysis uses per capita VOC emission factors to estimate current and future year emissions from model rule affected source categories in the OTC States. This method was chosen in order to produce straightforward emission estimates and to have calculation methods that are consistent throughout the study region. These estimates may differ from those that have been made by the individual States and published in SIPs. EPA guidance allows States some discretion in the VOC emission estimation factors, per employee emission factors, and State or local surveys. State inventories that used per employee emission factors, or surveys to estimate VOC emissions, may not match those presented in this report.

The NO_x model rule analysis presented in this report is the product of an extensive data exchange and review process during the project period among the OTC States and Pechan. This data exchange, and the resulting 1996 NO_x emissions data base, has greatly improved our ability to identify the NO_x sources, and associated emissions, that are likely to be affected by the NO_x model rules. Some uncertainties in NO_x emission benefit estimates still exist; for example, consistent assumptions were used where design capacities were not available for specific sources. NO_x control efficiency estimates associated with source category-control strategy combinations are represented as point estimates.

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APPENDIX A
METHODS FOR ESTIMATING PORTABLE FUEL CONTAINER EMISSIONS

Appendix A
Methods for Estimating Portable Fuel Container Emissions

This appendix describes how the information in the California Air Resources Board's Mail-Out MSC 99-25 can be used to estimate portable fuel container emissions in the OTC States. Most of the text and equations in this appendix are taken directly from MSC 99-25.

Introduction

Gas-can emissions rates for various emissions modes (e.g., evaporation, permeation, etc.) occurring during typical usage are determined using diurnal evaporative and gravimetric test methods. The survey of population and usage are combined with the emissions test results to produce the inventory. This inventory will be used in estimating other inventories, such as those of past and future years, and for other purposes involving planning or air-quality modeling. The gas-can surveys and emissions test methods are discussed in the following sections.

A. Residential-Gas Cans.

1. Surveys.

Residential-gas-can information can be solicited by mail from randomly selected OTC State households and directly from various agency staff.

Gas-can emissions are a function of the can material (i.e., plastic or metal) and the storage conditions. Gas cans are stored in either an "open" or a "closed" condition. An open condition, or system, exists when a can is stored with an open breathing (vent) hole and/or an uncapped main-filler opening or nozzle. A closed system exists when the vent hole is closed and the main-filler opening or spout is capped.

A sample result of an OTC State residential-gas-can-survey is presented in Table 1.

Table 1: Residential-Gas-Can-Survey Results (sample)

Percentage of Households with at Least One Gas Can	46%
Number-of-Gas-Cans per Household	1.8
Percentage of Plastic-Gas Cans/Metal-Gas Cans	76%/24%
Weighted Average Gas Can Capacity (gal.)	2.34
Percentage of Gas Cans Stored With Fuel	70%
Weighted Average Stored Fuel Volume (% of Total Capacity)	49%
Percentage of Plastic-Gas Cans Stored Open/Closed	23%/53%

Percentage of Metal-Gas Cans Stored Open/Closed	11%/13%
Percentage of All Gas Cans Stored Open/Closed	34%/66%

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2. Population.

The residential-gas-can population is calculated as follows:

$$Pop_R = (N)(A)(Count_R) \qquad \text{(Eq. 1)}$$

where:

	Pop_R	=	Statewide Residential-Gas-Can Population
	N	=	Number of Occupied-Housing Units in OTC State (say 11,127,621 on Jan. 1, 2000)
	A	=	Percentage of Households with Gas Cans (46%)
	$Count_R$	=	Average Number of Residential-Gas Cans per Household (i.e., 1.8)

Substituting the appropriate values into Equation 1 yields a statewide population of **9,213,670** residential-gas cans for the 2000 calendar year.

3. Population-Growth Rate.

The 1990–2000 housing unit data from the OTC State Department of Finance can be used to estimate future gas-can growth rates until the 2010 calendar year. These projected growth rates will be normalized to the 1990 calendar year. The housing unit data can be used to extrapolate values of future annual housing units in OTC State until the 2010 calendar year.

4. Emissions.

Gas-can emissions are classified by five different emission processes:

a) Permeation;
b) Diurnal;
c) Transport;
d) Spillage; and,
e) Vapor Displacement During Equipment Refueling.

a) Permeation Emissions.

Permeation emissions are produced after fuel has been stored long enough in a can for fuel molecules to infiltrate and saturate the can material.

An average daily permeation-emission rate can be derived from test data obtained from several plastic-gas cans and metal-gas cans. Each gas can is sealed with a metal-filled epoxy and an overcoat of a non-permeable two-part epoxy resin. Additionally, any plastic caps and plugs are replaced with metal ones whenever possible. Also, all secondary vents are plugged with brass fittings and coated with sealant. Lastly, the gas cans are leak checked and reworked as necessary. The gas cans are filled with certification test fuel (i.e., reformulated gasoline), and subjected to a diurnal-variable temperature profile in a sealed housing for evaporative determination unit (SHED). This temperature profile is the same as is currently required for on-highway motor-vehicle-evaporative emissions testing (ozone episode days). Gravimetric measurements are made of the gas cans after each 24-hour test period. The average daily permeation rate from a plastic-gas can (closed system) is calculated as **grams per gallon per day** (g/gal-day). A permeation-emission rate for metal-gas cans is determined with similar test methods as **g/gal-day**.

Statewide residential-gas-can-permeation emissions are computed as follows:

$$HC_{PR} = \Sigma \left[(Pop_R)(S)(EF_P)(B_R)(Size_R)(Level) \right] \qquad \text{(Eq. 2)}$$

where:

	HC_{PR}	=	Permeation Emissions in tons per day (tpd)
	Pop_R	=	Statewide Residential-Gas-Can Population
	EF_P	=	Appropriate Permeation-Emission Factor (g/gal-day)
	S	=	Percentage of Gas Cans Stored with Fuel (70%)
	B_R	=	Percentage of Cans Stored in Closed Condition with respect to Material (Plastic 53%; Metal 13%)
	$Size_R$	=	Weighted Average Capacity of Residential-Gas Cans (2.34 gal.)
	Level	=	Weighted Average Amount of Stored Fuel (49%)

Substituting the appropriate values into Equation 2, summing the resultant products, and converting grams to tons (i.e., $9.08(10^5)$ grams per ton), produces a statewide total of residential-plastic-gas-can-permeation emissions. Similarly, a permeation-emissions total for residential-metal-gas-cans can be determined.

b) Diurnal Emissions.

Diurnal emissions result when stored fuel vapors escape to the outside of a gas can through any possible openings while the gas can is subjected to the daily cycle of increasing and decreasing ambient temperatures. Diurnal emissions are dependent on the closed- or open-storage condition of a gas can. Accordingly, emissions rates are determined for both conditions.

Closed-System. Plastic-gas-can test data are gathered from, say, several 2-gallon-8-ounce, and five-gallon, size gas cans. These gas cans are filled with certification-test fuel to one-half of the total capacity. One-half of the gas-can capacity approximates the weighted average of stored fuel volume of 49%. The cans are subjected to a diurnal-variable temperature profile in a shed. An average diurnal-emission rate is first calculated using each individual gas-can average daily-emission rate. The average-daily plastic-gas-can permeation rate is then subtracted from that value to yield the resultant diurnal-emission rate for plastic, closed-system gas cans as **g/gal-day**. Similar diurnal-SHED tests of several metal-gas cans can be performed.

Open-System. Plastic-gas-can test data are gathered from several five-gallon, and 2-gallon-8-ounce, size gas cans. Each gas can is weighed, filled with test fuel to various fractions of their total capacities, and weighed again. The gas cans are then stored with open vent and breathing holes. Each gas can is weighed after each subsequent 24-hour period for sixteen consecutive days. The average diurnal-emission rate over the test period can be measured as **g/day**. Note that this diurnal-emission rate is applicable for both plastic- and metal-gas cans that are stored in an open condition.

Diurnal emissions from both open- and closed-system-residential-gas cans are calculated as follows:

$$HC_{DR} = (Pop_R)(S)(EF_D)(B_R)(Size_R)(Level) \qquad \text{(Eq. 3)}$$

where:

HC_{DR} = Diurnal Emissions (tpd) for Residential-Gas Cans with respect to Storage Condition (Open or Closed) and Material (Plastic or Metal)

Pop_R = Statewide Residential-Gas-Can Population

S = Percentage of Gas-Can Population Stored with Fuel (70%)

EF_D = Appropriate Diurnal-Emission Factor with respect to Storage Condition and Material (g/gal-day or g/day)

B_R = Percentage of Gas-Can Population with respect to Storage Condition and Material

$Size_R$ = Weighted Average Capacity of Residential-Gas Cans (2.34 gal.)
Level = Weighted Average Amount of Stored Fuel (49%)

Substituting the appropriate values into Equation 3, and performing the conversion to tons, yields a statewide total residential-gas-can-diurnal emission amount in **tpd** for the 2000 calendar year.

c) Transport-Spillage Emissions.

Transport-spillage emissions arise when fuel escapes (e.g., spills, etc.) from gas cans that are in transit. The transport-emission-spillage factor can be determined from data provided by the U. S. EPA's fuel transport spillage survey of hydrocarbon losses from lawn and garden equipment. Analysis of this data revealed that the emission rates for a gas can (i.e., pump-to-pump losses) were **23.0 grams per gas-can-refill-at-the-pump** (g/refill) for a closed system, and **32.5 g/refill** for an open system. Residential-transport-spillage emissions are determined as:

$$HC_{TR} = (Pop_R)(S)(Refill_R)(EF_T)(B_R) \qquad \text{(Eq. 4)}$$

where:

HC_{TR} = Residential-Gas-Can-Transport-Spillage Emissions (tpd)
Pop_R = Statewide Residential-Gas-Can Population
S = Percentage of Gas Cans Stored with Fuel (70%)
$Refill_R$ = Average Number of Residential-Gas-Cans-Pump-Refills per Day per Can (refill/day from survey)
EF_T = Transport-Emission Factor with respect to Storage Condition (g/refill)
B_R = Percentage of Gas Cans with respect to Storage Condition and Material

Substituting the appropriate values into Equation 4, and converting grams to tons, yields a statewide total residential-gas-can-transport-spillage emission value in **tpd**.

B. Commercial-Gas Cans.

1. Surveys.

Commercial-gas can usage and storage information can be solicited by agency staff directly from various statewide businesses. Targeted businesses may include agricultural, automotive club and tow services, service stations, lawn and garden maintenance services, general contractors, and construction and rental yards.

The results of a sample commercial-gas-can-survey may be as follows:

Table 2: Commercial-Gas-Can-Survey Results (Sample)

Percentage of Businesses with at Least One Gas Can	80%
Gas Cans per Businesses	6.9
Weighted Average Gas Can Capacity (gal.)	3.43
Percentage of Plastic-Gas Cans/Metal-Gas Cans	72%/28%
Percentage of Plastic-Gas Cans Stored Open/Closed	39%/33%
Percentage of Metal-Gas Cans Stored Open/Closed	10%/18%
Percentage of All Gas Cans Stored Open/Closed	49%/51%

2. Population.

The populations of commercial-gas cans held by businesses can be determined using the InfoUSA database. Specific businesses that are expected to utilize gas cans in their normal operations are identified within various industrial classifications (e.g., agricultural services, general building services, etc.). Summing up the individual populations of each business group gives an estimate of the total statewide population of businesses using gas cans.

The commercial-gas-can population is calculated as follows:

$$Pop_C = (N_C)(Count_C) \quad \text{(Eq. 5)}$$

where:
- Pop_C = Statewide Commercial-Gas-Can Population
- N_C = Number of Occupied Businesses in OTC State
- $Count_C$ = Average Number of Gas Cans per Business (6.9)

3. Emissions.

a) Permeation Emissions.

Permeation-emission rates for commercial-gas cans are assumed to be the same as those for residential-gas cans

Statewide commercial-gas-can-permeation emissions are computed as follows:

$$HC_{PC} = \Sigma \left[(Pop_C)(S)(EF_P)(B_C)(Size_C)(Level) \right] \quad \text{(Eq. 6)}$$

where:

HC_{PC}	=	Permeation Emissions (tpd)
Pop_C	=	Statewide Commercial-Gas-Can Population
EF_P	=	Appropriate Permeation-Emission Factor (g/gal-day)
S	=	Percentage of Gas Cans Stored with Fuel (70% for Residential Survey)
B_C	=	Percentage of Applicable Gas Cans Stored in Closed Condition
$Size_C$	=	Weighted Average Capacity of Commercial-Gas Cans (3.43 gal)
Level	=	Weighted Average Amount of Stored Fuel (49% from Residential Survey)

Substituting the appropriate values into Equation 6, summing the resultant products, and converting grams to tons, gives a commercial-gas-can statewide permeation-emissions total in **tpd** for plastic-gas cans and for metal-gas cans.

b) Diurnal Emissions.

Diurnal-emissions rates for commercial-gas cans are expected to be the same as for residential-gas cans.
The amount of diurnal emissions from both open- and closed-system commercial-gas cans is calculated as follows:

$$HC_{DC} = (Pop_C)(S)(EF_D)(B_C)(Size_C)(Level) \quad \text{(Eq. 7)}$$

where:

HC_{DC}	=	Diurnal Emissions (tpd) for Commercial-Gas Cans with respect to Storage Condition (Open or Closed) and Material (Plastic or Metal)
Pop_C	=	Statewide Commercial-Gas-Can Population
EF_D	=	Appropriate Diurnal-Emission Factor with respect to Storage Condition and Material (g/gal-day or g/day)
S	=	Percentage of Gas Cans Stored with Fuel (70% from Residential Survey)
B_C	=	Percentage of Gas Cans with respect to Storage Condition and Material

$Size_C$ = Weighted Average Capacity of Commercial-Gas Cans (3.43 gal.)

Level = Weighted Average Amount of Stored Fuel (49% from Residential Survey)

Substituting the appropriate values into Equation 7, and converting grams to tons, yields commercial-gas-can-diurnal-emission values.

c) Transport-Spillage Emissions.

Transport-Spillage emissions factors for commercial-gas cans are expected to be the same as those for residential-gas cans: 23.0 g/refill per can for a closed system, and 32.5 g/refill per can for an open system. The frequency of gas-can refills at the pump for lawn-and-garden equipment is expected to be different than for all of the other types of commercial equipment. This is due to the higher level of activity for commercial lawn-and-garden equipment; hence, this equipment is expected to be refueled more often than is other commercial equipment. Accordingly, the frequency of average commercial lawn-and-garden-equipment gas-can refills at the pump is derived from the U. S. EPA's fuel transport spillage survey of hydrocarbon losses from lawn and garden equipment data.

The 2000-calendar-year frequency of non-lawn-and-garden-equipment commercial-gas-can refills at the pump is derived as follows:

$$Refill_C = \left[\frac{(\Sigma\ Fuel)}{(Size_C)(POP_{NON})(S)} \right] \quad \text{(Eq. 8)}$$

where:

$Refill_C$ = Average Number of Non-Lawn-and-Garden Equipment Commercial-Gas-Cans Pump Refills per Day per Can (refill/day)

Fuel = Non-Lawn-and-Garden Equipment Fuel Consumption (gal/day) for 2000

$Size_C$ = Weighted Average Capacity of Commercial-Gas Cans (3.43 gal/can-refill)

POP_{NON} = Statewide Commercial-Gas-Can Population with respect to Non-Lawn-and-Garden Businesses

S = Percentage of Gas Cans Stored with Fuel (70% from Residential Survey)

The commercial-transport-spillage emissions are determine as:

$$HC_{TC} = (Pop_C)(S)(B_C)(Refill_C)(EF_{TC}) \qquad \text{(Eq. 9)}$$

where:

- HC_{TC} = Commercial-Gas-Can-Transport-Spillage Emissions (tpd)
- Pop_C = Statewide Commercial-Gas-Can Population
- S = Percentage of Gas Cans Stored with Fuel (70% from Residential Survey)
- B_C = Percentage of Gas Cans with respect to Storage Condition and Material
- $Refill_C$ = Average Number of Gas-Cans Pump Refills per Day per Can
- EF_{TC} = Transport-Spillage Emission Factor (g/refill) with respect to Storage Condition

C. Spillage Emissions During Equipment Refueling.

Spillage emissions are produced when fuel is dispensed from a gas can to an equipment/vehicle fuel tank, another gas can, etc., and fails to either be delivered into the intended reservoir or to remain inside the reservoir. Spillage data provided by the Outdoor Power Equipment Institute (OPEI) in conjunction with the U. S. EPA's NEVES report[1] indicate that the spillage-emission rate for equipment refills from a gas can is 17 grams per refill per equipment unit. This estimate assumes that every refill results in a replenishment of the fuel tank's entire capacity. The spillage-emission rate is applied to only equipment or vehicles that are typically fueled from a gas can (e.g., lawn care equipment, sometimes recreational equipment, etc.), and not typically from a pump.

The amount of daily spillage emissions from all applicable residential- and commercial-gas cans is calculated as follows:

$$HC_S = \Sigma \left\{ \left[\frac{(Fuel)(Spill)}{(Tank)} \right] (Con) \right\} \qquad \text{(Eq. 10)}$$

where:

- HC_S = Daily Spillage Emission from All Gas Cans (tpd)
- Fuel = Applicable Equipment/Vehicle Type Fuel Consumption (gal/day)
- Spill = Spillage-Emission Rate per Refill of Gas Can-Refueled Equipment/Vehicles (17 g/refill)

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[1] "Nonroad Engine and Vehicle Emission Study – Report," U. S. Environmental Protection Agency, November 1991.

Tank = Applicable Equipment/Vehicle Fuel-Tank Capacity (gal/refill)

Con = Frequency of Refuels (per day) with respect to Equipment/Vehicle (none, always, or fraction of always)

D. Refueling-Vapor Displacement.

The refueling-displacement-vapor emissions result when fuel vapor is displaced from equipment and vehicle fuel tanks, gas cans, etc., by fuel dispensed from gas cans. The NEVES report of refueling emissions presented a formula to compute the refueling-vapor-displacement-emission factor. This formula is:

$$DISP = [-5.909 + (0.0884)(TD) + (0.485)(RVP)] \qquad \text{(Eq. 11)}$$

where:

DISP = Daily Spillage-Emission Rate for All Gas Cans (g/gal)

TD = Temperature (°F) of the Dispensed Fuel (ambient temperature)

RVP = Reid Vapor Pressure of Dispensed Fuel (psi)

The amount of daily refueling vapor-displacement emissions from all applicable residential-and commercial-gas cans is calculated as follows:

$$HC_{DISP} = \Sigma \left\{ (DISP)(Fuel)(Con) \right\} \qquad \text{(Eq. 12)}$$

where:

HC_{DISP} = Total Refueling-Vapor-Displacement Emissions from All Gas Cans (tpd)

DISP = Refueling Vapor Displacement Emission Rate (4.52 g/gal)

Fuel = Applicable Equipment/Vehicle Type Fuel Consumptions (gal/day)

Con = Frequency of Refuels (per day) with respect to Equipment/Vehicle (none, always, or fraction of always)

As with the spillage-emission-factor calculation, the vapor-displacement-emission rate is applied only to equipment or vehicles that are typically fueled from a gas can, and not from a pump dispenser.

Summary of Results.

Table 3 can be used to estimate the total emissions:

Table 3: Statewide Gas-Can Emissions for 2000 Calendar Year

Emission Type	Residential Emissions (tpd)	Commercial Emissions (tpd)	Total by Emission Type (tpd)
Permeation			
Diurnal			
Transport-Spillage			
Spillage			
Refueling-Vapor Displ.			
Subtotal:			
Total:	**-**	**-**	**XX.X**

APPENDIX B
SOURCE CLASSIFICATION CODES AFFECTED BY THE NO_x MODEL RULE

Appendix B
Source Classification Codes affected by the NOx model rule

Source Type	SCC	SCC Description
Cement Kilns		
	30500606	Industrial Processes; Mineral Products; Cement Manufacturing (Dry Process); Kilns
	30500706	Industrial Processes; Mineral Products; Cement Manufacturing (Wet Process); Kilns
	30500622	Industrial Processes; Mineral Products; Cement Manufacturing (Dry Process); Preheater Kiln
	30500623	Industrial Processes; Mineral Products; Cement Manufacturing (Dry Process); Preheater/Precalciner Kiln
Stationary Combustion Turbines		
	20100101	Internal Combustion Engines; Electric Generation; Distillate Oil (Diesel); Turbine
	20100201	Internal Combustion Engines; Electric Generation; Natural Gas; Turbine
	20100801	Internal Combustion Engines; Electric Generation; Landfill Gas; Turbine
	20100901	Internal Combustion Engines; Electric Generation; Kerosene/Naphtha (Jet Fuel); Turbine
	20101001	Internal Combustion Engines; Electric Generation; Geysers/Geothermal; Steam Turbine
	20101302	Internal Combustion Engines; Electric Generation; Liquid Waste; Waste Oil - Turbine
	20200101	Internal Combustion Engines; Industrial; Distillate Oil (Diesel); Turbine
	20200103	Internal Combustion Engines; Industrial; Distillate Oil (Diesel); Turbine: Cogeneration
	20200201	Internal Combustion Engines; Industrial; Natural Gas; Turbine
	20200203	Internal Combustion Engines; Industrial; Natural Gas; Turbine: Cogeneration
	20200701	Internal Combustion Engines; Industrial; Process Gas; Turbine
	20200705	Internal Combustion Engines; Industrial; Process Gas; Refinery Gas: Turbine
	20200901	Internal Combustion Engines; Industrial; Kerosene/Naphtha (Jet Fuel); Turbine
	20201011	Internal Combustion Engines; Industrial; Liquified Petroleum Gas (LPG); Turbine
	20201013	Internal Combustion Engines; Industrial; Liquified Petroleum Gas (LPG); Turbine: Cogeneration
	20201601	Internal Combustion Engines; Industrial; Methanol; Turbine
	20201701	Internal Combustion Engines; Industrial; Gasoline; Turbine
	20300102	Internal Combustion Engines; Commercial/Institutional; Distillate Oil (Diesel); Turbine
	20300202	Internal Combustion Engines; Commercial/Institutional; Natural Gas; Turbine
	20300203	Internal Combustion Engines; Commercial/Institutional; Natural Gas; Turbine: Cogeneration
	20300701	Internal Combustion Engines; Commercial/Institutional; Digester Gas; Turbine
	20300801	Internal Combustion Engines; Commercial/Institutional; Landfill Gas; Turbine
	20300901	Internal Combustion Engines; Commercial/Institutional; Kerosene/Naphtha (Jet Fuel); Turbine: JP-4
Industrial Boilers		
	10200060	Ext Comb Boilers - Industrial;Not Classified ?: assumed as bituminous coal
	10200101	External Combustion Boilers; Industrial; Anthracite Coal; Pulverized Coal
	10200102	External Combustion Boilers Industrial Anthracite Coal > 100 mmBtu Stoker (Old NAPAP)
	10200104	External Combustion Boilers; Industrial; Anthracite Coal; Traveling Grate (Overfeed) Stoker
	10200107	External Combustion Boilers; Industrial; Anthracite Coal; Hand-fired
	10200117	External Combustion Boilers; Industrial; Anthracite Coal; Fluidized Bed Boiler Burning Anthracite-Culm Fuel
	10200201	External Combustion Boilers; Industrial; Bituminous/Subbituminous Coal; Pulverized Coal: Wet Bottom
	10200202	External Combustion Boilers; Industrial; Bituminous/Subbituminous Coal; Pulverized Coal: Dry Bottom
	10200203	External Combustion Boilers; Industrial; Bituminous/Subbituminous Coal; Cyclone Furnace
	10200204	External Combustion Boilers; Industrial; Bituminous/Subbituminous Coal; Spreader Stoker
	10200205	External Combustion Boilers; Industrial; Bituminous/Subbituminous Coal; Overfeed Stoker
	10200206	External Combustion Boilers; Industrial; Bituminous/Subbituminous Coal; Underfeed Stoker
	10200210	External Combustion Boilers; Industrial; Bituminous/Subbituminous Coal; Overfeed Stoker **
	10200212	External Combustion Boilers; Industrial; Bituminous/Subbituminous Coal; Pulverized Coal: Dry Bottom (Tangential)
	10200213	External Combustion Boilers; Industrial; Bituminous/Subbituminous Coal; Wet Slurry
	10200217	External Combustion Boilers; Industrial; Bituminous/Subbituminous Coal; Atmospheric Fluidized Bed Combustion: Bubbling Bed (Bituminous Coal)
	10200218	External Combustion Boilers; Industrial; Bituminous/Subbituminous Coal; Atmospheric Fluidized Bed Combustion: Circulating Bed (Bitum. Coal)
	10200221	External Combustion Boilers; Industrial; Bituminous/Subbituminous Coal; Pulverized Coal: Wet Bottom (Subbituminous Coal)
	10200222	External Combustion Boilers; Industrial; Bituminous/Subbituminous Coal; Pulverized Coal: Dry Bottom (Subbituminous Coal)
	10200223	External Combustion Boilers; Industrial; Bituminous/Subbituminous Coal; Cyclone Furnace (Subbituminous Coal)
	10200224	External Combustion Boilers; Industrial; Bituminous/Subbituminous Coal; Spreader Stoker (Subbituminous Coal)
	10200225	External Combustion Boilers; Industrial; Bituminous/Subbituminous Coal; Traveling Grate (Overfeed) Stoker (Subbituminous Coal)

Appendix B
Source Classification Codes affected by the NOx model rule

Source Type	SCC	SCC Description
Industrial Boilers	10200226	External Combustion Boilers; Industrial; Bituminous/Subbituminous Coal; Pulverized Coal: Dry Bottom Tangential (Subbituminous Coal)
	10200300	External Combustion Boilers; Industrial; Lignite; Pulverized Coal: Wet Bottom
	10200301	External Combustion Boilers; Industrial; Lignite; Pulverized Coal: Dry Bottom, Wall Fired
	10200302	External Combustion Boilers; Industrial; Lignite; Pulverized Coal: Dry Bottom, Tangential Fired
	10200303	External Combustion Boilers; Industrial; Lignite; Cyclone Furnace
	10200304	External Combustion Boilers; Industrial; Lignite; Traveling Grate (Overfeed) Stoker
	10200306	External Combustion Boilers; Industrial; Lignite; Spreader Stoker
	10200401	External Combustion Boilers; Industrial; Residual Oil; Grade 6 Oil
	10200402	External Combustion Boilers; Industrial; Residual Oil; 10-100 Million Btu/hr **
	10200403	External Combustion Boilers; Industrial; Residual Oil; < 10 Million Btu/hr **
	10200404	External Combustion Boilers; Industrial; Residual Oil; Grade 5 Oil
	10200406	External Combustion Boilers Industrial Residual Oil ??
	10200501	External Combustion Boilers; Industrial; Distillate Oil; Grades 1 and 2 Oil
	10200502	External Combustion Boilers; Industrial; Distillate Oil; 10-100 Million Btu/hr **
	10200503	External Combustion Boilers; Industrial; Distillate Oil; < 10 Million Btu/hr **
	10200504	External Combustion Boilers; Industrial; Distillate Oil; Grade 4 Oil
	10200601	External Combustion Boilers; Industrial; Natural Gas; > 100 Million Btu/hr
	10200602	External Combustion Boilers; Industrial; Natural Gas; 10-100 Million Btu/hr
	10200603	External Combustion Boilers; Industrial; Natural Gas; < 10 Million Btu/hr
	10200699	Ext Comb Boilers - Industrial;Not Classified
	10200701	External Combustion Boilers; Industrial; Process Gas; Petroleum Refinery Gas
	10200702	External Combustion Boilers Industrial Process Gas ??
	10200704	External Combustion Boilers; Industrial; Process Gas; Blast Furnace Gas
	10200707	External Combustion Boilers; Industrial; Process Gas; Coke Oven Gas
	10200799	External Combustion Boilers; Industrial; Process Gas; Other: Specify in Comments
	10200801	External Combustion Boilers Industrial Process Gas ??
	10200802	External Combustion Boilers; Industrial; Coke; All Boiler Sizes
	10200901	External Combustion Boilers; Industrial; Wood/Bark Waste; Bark-fired Boiler (> 50,000 Lb Steam)
	10200902	External Combustion Boilers; Industrial; Wood/Bark Waste; Wood/Bark-fired Boiler (> 50,000 Lb Steam)
	10200903	External Combustion Boilers; Industrial; Wood/Bark Waste; Wood-fired Boiler (> 50,000 Lb Steam)
	10200904	External Combustion Boilers; Industrial; Wood/Bark Waste; Bark-fired Boiler (< 50,000 Lb Steam)
	10200905	External Combustion Boilers; Industrial; Wood/Bark Waste; Wood/Bark-fired Boiler (< 50,000 Lb Steam)
	10200906	External Combustion Boilers; Industrial; Wood/Bark Waste; Wood-fired Boiler (< 50,000 Lb Steam)
	10200910	External Combustion Boilers; Industrial; Wood/Bark Waste; Fuel cell/Dutch oven boilers
	10200911	External Combustion Boilers; Industrial; Wood/Bark Waste; Stoker boilers
	10200912	External Combustion Boilers; Industrial; Wood/Bark Waste; Fluidized bed combustion boiler
	10201001	External Combustion Boilers; Industrial; Liquified Petroleum Gas (LPG); Butane
	10201002	External Combustion Boilers; Industrial; Liquified Petroleum Gas (LPG); Propane
	10201003	External Combustion Boilers; Industrial; Liquified Petroleum Gas (LPG); Butane/Propane Mixture: Specify Percent Butane in Comments
	10201101	External Combustion Boilers; Industrial; Bagasse; All Boiler Sizes
	10201201	External Combustion Boilers; Industrial; Solid Waste; Specify Waste Material in Comments
	10201202	External Combustion Boilers; Industrial; Solid Waste; Refuse Derived Fuel
	10201301	External Combustion Boilers; Industrial; Liquid Waste; Specify Waste Material in Comments
	10201302	External Combustion Boilers; Industrial; Liquid Waste; Waste Oil
	10201401	External Combustion Boilers; Industrial; CO Boiler; Natural Gas
	10201402	External Combustion Boilers; Industrial; CO Boiler; Process Gas
	10201403	External Combustion Boilers; Industrial; CO Boiler; Distillate Oil
	10201404	External Combustion Boilers; Industrial; CO Boiler; Residual Oil
	10201601	External Combustion Boilers; Industrial; Methanol; Industrial Boiler
	10201701	External Combustion Boilers; Industrial; Gasoline; Industrial Boiler
	10299997	Ext Comb Boilers - Industrial;Not Classified

Appendix B
Source Classification Codes affected by the NOx model rule

Source Type	SCC	SCC Description
Commercial/Institutional Boiler		
	10300101	External Combustion Boilers; Commercial/Institutional; Anthracite Coal; Pulverized Coal
	10300102	External Combustion Boilers; Commercial/Institutional; Anthracite Coal; Traveling Grate (Overfeed) Stoker
	10300103	External Combustion Boilers; Commercial/Institutional; Anthracite Coal; Hand-fired
	10300203	External Combustion Boilers; Commercial/Institutional; Bituminous/Subbituminous Coal; Cyclone Furnace (Bituminous Coal)
	10300205	External Combustion Boilers; Commercial/Institutional; Bituminous/Subbituminous Coal; Pulverized Coal: Wet Bottom (Bituminous Coal)
	10300206	External Combustion Boilers; Commercial/Institutional; Bituminous/Subbituminous Coal; Pulverized Coal: Dry Bottom (Bituminous Coal)
	10300207	External Combustion Boilers; Commercial/Institutional; Bituminous/Subbituminous Coal; Overfeed Stoker (Bituminous Coal)
	10300208	External Combustion Boilers; Commercial/Institutional; Bituminous/Subbituminous Coal; Underfeed Stoker (Bituminous Coal)
	10300209	External Combustion Boilers; Commercial/Institutional; Bituminous/Subbituminous Coal; Spreader Stoker (Bituminous Coal)
	10300211	External Combustion Boilers; Commercial/Institutional; Bituminous/Subbituminous Coal; Overfeed Stoker **
	10300214	External Combustion Boilers; Commercial/Institutional; Bituminous/Subbituminous Coal; Hand-fired (Bituminous Coal)
	10300216	External Combustion Boilers; Commercial/Institutional; Bituminous/Subbituminous Coal; Pulverized Coal: Dry Bottom (Tangential) (Bituminous Coal)
	10300217	External Combustion Boilers; Commercial/Institutional; Bituminous/Subbituminous Coal; Atmospheric Fluidized Bed Combustion: Bubbling Bed (Bituminous Coal)
	10300218	External Combustion Boilers; Commercial/Institutional; Bituminous/Subbituminous Coal; Atmospheric Fluidized Bed Combustion: Circulating Bed (Bitum. Coal)
	10300221	External Combustion Boilers; Commercial/Institutional; Bituminous/Subbituminous Coal; Pulverized Coal: Wet Bottom (Subbituminous Coal)
	10300222	External Combustion Boilers; Commercial/Institutional; Bituminous/Subbituminous Coal; Pulverized Coal: Dry Bottom (Subbituminous Coal)
	10300223	External Combustion Boilers; Commercial/Institutional; Bituminous/Subbituminous Coal; Cyclone Furnace (Subbituminous Coal)
	10300224	External Combustion Boilers; Commercial/Institutional; Bituminous/Subbituminous Coal; Spreader Stoker (Subbituminous Coal)
	10300225	External Combustion Boilers; Commercial/Institutional; Bituminous/Subbituminous Coal; Traveling Grate (Overfeed) Stoker (Subbituminous Coal)
	10300226	External Combustion Boilers; Commercial/Institutional; Bituminous/Subbituminous Coal; Pulverized Coal: Dry Bottom Tangential (Subbituminous Coal)
	10300300	External Combustion Boilers; Commercial/Institutional; Lignite; Pulverized Coal: Wet Bottom
	10300305	External Combustion Boilers; Commercial/Institutional; Lignite; Pulverized Coal: Dry Bottom, Wall Fired
	10300306	External Combustion Boilers; Commercial/Institutional; Lignite; Pulverized Coal: Dry Bottom, Tangential Fired
	10300307	External Combustion Boilers; Commercial/Institutional; Lignite; Traveling Grate (Overfeed) Stoker
	10300309	External Combustion Boilers; Commercial/Institutional; Lignite; Spreader Stoker
	10300401	External Combustion Boilers; Commercial/Institutional; Residual Oil; Grade 6 Oil
	10300402	External Combustion Boilers; Commercial/Institutional; Residual Oil; 10-100 Million Btu/hr **
	10300403	External Combustion Boilers; Commercial/Institutional; Residual Oil; < 10 Million Btu/hr **
	10300404	External Combustion Boilers; Commercial/Institutional; Residual Oil; Grade 5 Oil
	10300501	External Combustion Boilers; Commercial/Institutional; Distillate Oil; Grades 1 and 2 Oil
	10300502	External Combustion Boilers; Commercial/Institutional; Distillate Oil; 10-100 Million Btu/hr **
	10300503	External Combustion Boilers; Commercial/Institutional; Distillate Oil; < 10 Million Btu/hr **
	10300504	External Combustion Boilers; Commercial/Institutional; Distillate Oil; Grade 4 Oil
	10300601	External Combustion Boilers; Commercial/Institutional; Natural Gas; > 100 Million Btu/hr
	10300602	External Combustion Boilers; Commercial/Institutional; Natural Gas; 10-100 Million Btu/hr
	10300603	External Combustion Boilers; Commercial/Institutional; Natural Gas; < 10 Million Btu/hr
	10300701	External Combustion Boilers; Commercial/Institutional; Process Gas; POTW Digester Gas-fired Boiler
	10300799	External Combustion Boilers; Commercial/Institutional; Process Gas; Other Not Classified
	10300811	External Combustion Boilers; Commercial/Institutional; Landfill Gas; Landfill Gas
	10300901	External Combustion Boilers; Commercial/Institutional; Wood/Bark Waste; Bark-fired Boiler
	10300902	External Combustion Boilers; Commercial/Institutional; Wood/Bark Waste; Wood/Bark-fired Boiler
	10300903	External Combustion Boilers; Commercial/Institutional; Wood/Bark Waste; Wood-fired Boiler
	10300910	External Combustion Boilers; Commercial/Institutional; Wood/Bark Waste; Fuel cell/Dutch oven boilers
	10300911	External Combustion Boilers; Commercial/Institutional; Wood/Bark Waste; Stoker boilers
	10300912	External Combustion Boilers; Commercial/Institutional; Wood/Bark Waste; Fluidized bed combustion boilers
	10301001	External Combustion Boilers; Commercial/Institutional; Liquified Petroleum Gas (LPG); Butane
	10301002	External Combustion Boilers; Commercial/Institutional; Liquified Petroleum Gas (LPG); Propane
	10301003	External Combustion Boilers; Commercial/Institutional; Liquified Petroleum Gas (LPG); Butane/Propane Mixture: Specify Percent Butane in Comments
	10301201	External Combustion Boilers; Commercial/Institutional; Solid Waste; Specify Waste Material in Comments
	10301202	External Combustion Boilers; Commercial/Institutional; Solid Waste; Refuse Derived Fuel
	10301301	External Combustion Boilers; Commercial/Institutional; Liquid Waste; Specify Waste Material in Comments
	10301302	External Combustion Boilers; Commercial/Institutional; Liquid Waste; Waste Oil

Appendix B
Source Classification Codes affected by the NOx model rule

Source Type	SCC	SCC Description
Stationary Internal Combustion Engines		
	10301303	External Combustion Boilers; Commercial/Institutional; Liquid Waste; Sewage Grease Skimmings
	20100102	Internal Combustion Engines; Electric Generation; Distillate Oil (Diesel); Reciprocating
	20100202	Internal Combustion Engines; Electric Generation; Natural Gas; Reciprocating
	20100702	Internal Combustion Engines; Electric Generation; Process Gas; Reciprocating
	20100802	Internal Combustion Engines; Electric Generation; Landfill Gas; Reciprocating
	20100902	Internal Combustion Engines; Electric Generation; Kerosene/Naphtha (Jet Fuel); Reciprocating
	20200102	Internal Combustion Engines; Industrial; Distillate Oil (Diesel); Reciprocating
	20200104	Internal Combustion Engines; Industrial; Distillate Oil (Diesel); Reciprocating: Cogeneration
	20200202	Internal Combustion Engines; Industrial; Natural Gas; Reciprocating
	20200204	Internal Combustion Engines; Industrial; Natural Gas; Reciprocating: Cogeneration
	20200252	Internal Combustion Engines; Industrial; Natural Gas; 2-cycle Lean Burn
	20200253	Internal Combustion Engines; Industrial; Natural Gas; 4-cycle Rich Burn
	20200254	Internal Combustion Engines; Industrial; Natural Gas; 4-cycle Lean Burn
	20200255	Internal Combustion Engines; Industrial; Natural Gas; 2-cycle Clean Burn
	20200256	Internal Combustion Engines; Industrial; Natural Gas; 4-cycle Clean Burn
	20200301	Internal Combustion Engines; Industrial; Gasoline; Reciprocating
	20200401	Internal Combustion Engines; Industrial; Large Bore Engine; Diesel
	20200402	Internal Combustion Engines; Industrial; Large Bore Engine; Dual Fuel (Oil/Gas)
	20200403	Internal Combustion Engines; Industrial; Large Bore Engine; Cogeneration: Dual Fuel
	20200501	Internal Combustion Engines; Industrial; Residual/Crude Oil; Reciprocating
	20200702	Internal Combustion Engines; Industrial; Process Gas; Reciprocating Engine
	20200706	Internal Combustion Engines; Industrial; Process Gas; Refinery Gas: Reciprocating Engine
	20200902	Internal Combustion Engines; Industrial; Kerosene/Naphtha (Jet Fuel); Reciprocating
	20201001	Internal Combustion Engines; Industrial; Liquified Petroleum Gas (LPG); Propane: Reciprocating
	20201002	Internal Combustion Engines; Industrial; Liquified Petroleum Gas (LPG); Butane: Reciprocating
	20201012	Internal Combustion Engines; Industrial; Liquified Petroleum Gas (LPG); Reciprocating Engine
	20201014	Internal Combustion Engines; Industrial; Liquified Petroleum Gas (LPG); Reciprocating Engine: Cogeneration
	20201602	Internal Combustion Engines; Industrial; Methanol; Reciprocating Engine
	20201702	Internal Combustion Engines; Industrial; Gasoline; Reciprocating Engine
	20300101	Internal Combustion Engines; Commercial/Institutional; Distillate Oil (Diesel); Reciprocating
	20300201	Internal Combustion Engines; Commercial/Institutional; Natural Gas; Reciprocating
	20300204	Internal Combustion Engines; Commercial/Institutional; Natural Gas; Cogeneration
	20300301	Internal Combustion Engines; Commercial/Institutional; Gasoline; Reciprocating
	20300702	Internal Combustion Engines; Commercial/Institutional; Digester Gas; Reciprocating: POTW Digester Gas
	20300802	Internal Combustion Engines; Commercial/Institutional; Landfill Gas; Reciprocating
	20301001	Internal Combustion Engines; Commercial/Institutional; Liquified Petroleum Gas (LPG); Propane: Reciprocating
	20301002	Internal Combustion Engines; Commercial/Institutional; Liquified Petroleum Gas (LPG); Butane: Reciprocating

APPENDIX C
NO_x MODEL RULE CONTROL COST SUMMARIES

This appendix presents information about the costs of available NO_x control technologies that might be employed by NO_x model rule affected sources in the OTC States. Separate tables are provided for industrial boilers, stationary gas turbines, reciprocating internal combustion engines, and cement kilns. These are the four source categories affected by the OTC NO_x model rule. Each table presents information about the ozone season (five month) and annual cost effectiveness of various NO_x control methods. NO_x control data is differentiated by source size, fuel type, and the expected NO_x control efficiency.

Table C-1
NOx Control Methods for Industrial Boilers

NOx Control Method	Boiler Size (MMBtu/hr)	Fuel Type	Baseline NOx (lb/MMBtu)	Base NOx (t/day)	Controlled NOx (lb/MMBtu)	Control NOx (t/day)	% NOx Reduction	Cost Effectiveness $/ton NOx Removed: Ozone Season	Cost Effectiveness $/ton NOx Removed: Annual
Low NOx Burners									
	10	*gas*					*50%*	*$9,030-$11,300*	
	50	*gas*					*50%*	*$2,560-$3,200*	
	150	*gas*					*45-50%*	*$800-$3,500*	
	350	gas	0.20	0.84	0.15	0.63	25%	$454-$857	$189-$357
	350	gas	0.20	0.84	0.10	0.42	50%	$3,783-$7,145	$1,576-$2,977
	10	*distillate oil*					*45%*	*$5,310-$6,640*	
	50	*distillate oil*					*45%*	*$2,750-$3,440*	
	150	*distillate oil*					*45%*	*$600-$750*	
	10	*residual oil*					*45%*	*$2,910-$3,640*	
	50	*residual oil*					*45%*	*$990-$1,240*	
	150	*residual oil*					*45%*	*$490-$610*	
	680	residual oil	0.43	3.51	0.39	3.18	10%	$38-$72	$16-$30
	350	coal	0.60	2.52	0.45	1.89	25%	$2,522-$4,763	$1,051-$1,985
	350	coal	0.60	2.52	0.38	1.6	36.6%	$1,751-$3,308	$730-$1,378
	500	*coal-pul.*					*50%*	*$760-$2,900*	
SNCR									
	50	*gas*					*30-60%*	*$4,720-$5,910*	
	150	*gas*					*30-60%*	*$3,100-$6,800*	
	50	*distillate oil*					*30-70%*	*$5,040-$6,310*	
	150	*distillate oil*					*30-70%*	*$2,450-$3,060*	
	50	*residual oil*					*30-70%*	*$2,190-$2,740*	
	150	*residual oil*					*30-70%*	*$2,100-$2,630*	
	350	wood	0.45	1.89	0.29	1.22	35%	$2,101-$3,303	$1,300-$1,814
	500	*coal-pul.*					*30-70%*	*$870-$1,450*	
	500	*coal-stok.*					*30-70%*	*$940-$1,170*	

Data taken from "Status Report on NOx Controls for Gas Turbines, Cement Kilns, Industrial Boilers, and I.C. Engines - Technologies & Cost Effectiveness", NESCAUM, December 2000.

Data in italics taken from draft "Assessment of Control Technologies for Reducing Nitrogen Oxides from Non-Utility Point Sources and Major Area Sources", OTAG (2/27/96).

Table C-1 (continued)
NOx Control Methods for Industrial Boilers

NOx Control Method	Boiler Size (MMBtu/hr)	Fuel Type	Baseline NOx (lb/MMBtu)	Base NOx (t/day)	Controlled NOx (lb/MMBtu)	Control NOx (t/day)	% NOx Reduction	Cost Effectiveness $/ton NOx Removed: Ozone Season	Cost Effectiveness $/ton NOx Removed: Annual
SCR									
	50	*gas*					*80-90%*	*$4,830-$5,480*	
	150	*gas*					*80-90%*	*$2,060-$5,600*	
	50	*distillate oil*					*80-90%*	*$5,200-$5,890*	
	150	*distillate oil*					*80-90%*	*$1,560-$1,780*	
	50	*residual oil*					*80-90%*	*$2,070-$2,360*	
	150	*residual oil*					*80-90%*	*$1,290-$1,480*	
	100	gas	0.15	0.18	0.03	0.04	80%	$7,919-$14,479	$3,376-$6,110
	350	gas	0.15	0.63	0.03	0.13	80%	$4,764-$8,519	$2,062-$3,626
	350	coal	0.45	1.89	0.09	0.38	80%	$2,953-$5,046	$1,307-$2,179
	350	coal	0.45	1.89	0.09	0.38	80%	$4,004-$7,030	$1,745-$3,006
	500	*coal-pul.*					*80-90%*	*$1,790-$6,800*	
	500	*coal-stok.*					*80-90%*	*$1,980-$2,230*	
Conventional Gas Reburn									
	500	coal	1.20	7.20	0.60	3.60	50%		$1,215
	500	coal	1.20	7.20	0.60	3.60	50%		$1,482
	640	coal	1.36	8.16	0.685	4.11	50%		$1,246
Fuel Lean Gas Reburn (FLGR)									
	350	coal	0.45	1.89	0.293	1.23	35%	$1,330-$2,000	$890-$1,170
	350	coal	0.45	1.89	0.293	1.23	35%	$1,523-$2,220	$1,083-$1,362
Amine Enhanced FLGR									
	350	coal	0.45	1.89	0.18	0.76	60%	$1,700-$2,455	$1,210-$1,520
	350	coal	0.45	1.89	0.18	0.76	60%	$1,812-$2,604	$1,316-$1,631

Data taken from "Status Report on NOx Controls for Gas Turbines, Cement Kilns, Industrial Boilers, and I.C. Engines - Technologies & Cost Effectiveness", NESCAUM, December, 2000.

Data in italics taken from draft "Assessment of Control Technologies for Reducing Nitrogen Oxides from Non-Utility Point Sources and Major Area Sources", OTAG (2/27/96).

Table C-2
NOx Control Methods for Turbines

NOx Control Method	Turbine Size	Fuel Type	Baseline NOx (ppm)	Controlled NOx (ppm)	% NOx Reduction	Cost Effectiveness $/ton NOx Removed	
						Ozone Season	Annual
In-Combustor Methods							
Dry Low NOx							
	7000 HP	gas	135	50	63%	$4,492-$9,483	$1,872-$3,951
	13,000 HP	gas	167	50	70%	$3,145-$6,640	$1,311-$2,767
	75 MW	gas	154	15	90%	$533-$1,126	$222-$469
	5 MW (Cont.)	*gas*			*60-90%*	*$530-$800*	
	25 MW (Cont.)	*gas*			*60-90%*	*$240-$370*	
	100 MW (Cont.)	*gas*			*60-90%*	*$130-$200*	
	25 MW (2000 P)	*gas*			*60-90%*	*$960-$1,470*	
	100 MW (2000 P)	*gas*			*60-90%*	*$530-$800*	
Diluent Injection							
	21 MW	gas	125	50	60%	$867-$1,217	$638-$784
	21 MW	distillate oil	180	50	72%	$829-$1,031	$697-$781
Water Injection							
	5 MW (Cont.)	*gas*			*70-90%*	*$1,390-$1,780*	
	25 MW (Cont.)	*gas*			*70-90%*	*$690-$880*	
	100 MW (Cont.)	*gas*			*70-90%*	*$500-$640*	
	25 MW (2000 P)	*gas*			*70-90%*	*$1,670-$2,150*	
	100 MW (2000 P)	*gas*			*70-90%*	*$1,050-$2,150*	
	5 MW (Cont.)	*oil*			*70-90%*	*$1,000-$1,300*	
	25 MW (Cont.)	*oil*			*70-90%*	*$560-$710*	
	100 MW (Cont.)	*oil*			*70-90%*	*$440-$560*	
	25 MW (2000 P)	*oil*			*70-90%*	*$1,190-$1,520*	
	100 MW (2000 P)	*oil*			*70-90%*	*$800-$1,020*	

Data taken from "Status Report on NOx Controls for Gas Turbines, Cement Kilns, Industrial Boilers, and I.C. Engines - Technologies & Cost Effectiveness", NESCAUM, December, 2000.

Data in italics taken from draft "Assessment of Control Technologies for Reducing Nitrogen Oxides from Non-Utility Point Sources and Major Area Sources", OTAG (2/27/96).

Table C-2 (continued)
NOx Control Methods for Turbines

NOx Control Method	Turbine Size	Fuel Type	Baseline NOx (ppm)	Controlled NOx (ppm)	% NOx Reduction	Cost Effectiveness $/ton NOx Removed	
						Ozone Season	Annual
In-Combustor Methods							
Diluent Injection (Continued)							
Steam Injection							
	5 MW (Cont.)	*gas*			*70-90%*	*$1,560-$2,000*	
	25 MW (Cont.)	*gas*			*70-90%*	*$760-$970*	
	100 MW (Cont.)	*gas*			*70-90%*	*$520-$670*	
	25 MW (2000 P)	*gas*			*70-90%*	*$2,150-$2,760*	
	100 MW (2000 P)	*gas*			*70-90%*	*$1,370-$1,760*	
	5 MW (Cont.)	*oil*			*70-90%*	*$1,010-$1,300*	
	25 MW (Cont.)	*oil*			*70-90%*	*$520-$670*	
	100 MW (Cont.)	*oil*			*70-90%*	*$380-$480*	
	25 MW (2000 P)	*oil*			*70-90%*	*$1,520-$1,820*	
	100 MW (2000 P)	*oil*			*70-90%*	*$930-$1,190*	
Exhaust Treatment							
SCR							
Simple Cycle Turbines	75 MW	gas	15	3	80%	$12,227-$20,075	$5,171-$8,441
	75 MW	gas	42	7	83%	$4,278-$6,969	$1,859-$2,980
	75 MW	gas	154	15	90%	$1,176-$1,853	$566-$849
	7000 HP	gas	42	5	88%	$16,031-$27,020	$6,756-$11,335
	7000 HP	gas	142	15	89%	$4,763-$7,965	$2,061-$3,395
Combined Cycle Turbines	75 MW	gas	15	3	80%	$8,680-$13,376	$3,693-$5,650
	75 MW	gas	42	7	83%	$3,062-$4,673	$1,353-$2,024
	75 MW	gas	154	15	90%	$869-$1,275	$439-$608
	7000 HP	gas	42	5	88%	$10,023-$15,672	$4,253-$6,607
	7000HP	gas	142	15	89%	$3,013-$4,659	$1,332-$2,018

Data taken from "Status Report on NOx Controls for Gas Turbines, Cement Kilns, Industrial Boilers, and I.C. Engines - Technologies & Cost Effectiveness", NESCAUM, December, 2000.

Data in italics taken from draft "Assessment of Control Technologies for Reducing Nitrogen Oxides from Non-Utility Point Sources and Major Area Sources", OTAG (2/27/96).

Table C-2 (continued)
NOx Control Methods for Turbines

NOx Control Method	Turbine Size	Fuel Type	Baseline NOx (ppm)	Controlled NOx (ppm)	% NOx Reduction	Cost Effectiveness $/ton NOx Removed	
						Ozone Season	Annual
Exhaust Treatment							
SCR (Continued)							
	5 MW (Cont.)	*gas*			*90%*	*$2,180-$2,450*	
	25 MW (Cont.)	*gas*			*90%*	*$1,230-$1,390*	
	100 MW (Cont.)	*gas*			*90%*	*$920-$1,030*	
	25 MW (2000 P)	*gas*			*90%*	*$3,480-$3,920*	
	100 MW (2000 P)	*gas*			*90%*	*$2,400-$2,700*	
	5 MW (Cont.)	*oil*			*90%*	*$1,390-$1,560*	
	25 MW (Cont.)	*oil*			*90%*	*$820-$920*	
	100 MW (Cont.)	*oil*			*90%*	*$630-$710*	
	25 MW (2000 P)	*oil*			*90%*	*$2,170-$2,440*	
	100 MW (2000 P)	*oil*			*90%*	*$1,530-$1,720*	

Data taken from "Status Report on NOx Controls for Gas Turbines, Cement Kilns, Industrial Boilers, and I.C. Engines - Technologies & Cost Effectiveness", NESCAUM, December, 2000.

Data in italics taken from draft "Assessment of Control Technologies for Reducing Nitrogen Oxides from Non-Utility Point Sources and Major Area Sources", OTAG (2/27/96).

Table C-3
NOx Control Methods for IC Engines

NOx Control Method	Engine Type	Engine Size	Fuel Type	Baseline NOx (gm/hp-hr)	Controlled NOx (gm/hp-hr)	% NOx Reduction	Cost Effectiveness $/ton NOx Removed: Ozone Season	Cost Effectiveness $/ton NOx Removed: Annual
In-Cylinder Methods								
Ignition Timing Retard								
	SI Rich Burn	*250 HP*	*gas*			*0-40%*	*$680-$1,130*	
	SI Rich Burn	*1000 HP*	*gas*			*0-40%*	*$370-$610*	
		1100 HP	gas	10	9	10%	$1,476-$1,640	$615-$685
		1100 HP	gas	10	7.5	25%	$589-$657	$274-$245
	SI Rich Burn	*4000HP*	*gas*			*0-40%*	*$270-$450*	
	SI Lean Burn	*250 HP*	*gas*			*0-20%*	*$980-$4,930*	
	SI LeanBurn	*1000 HP*	*gas*			*0-20%*	*$490-$1,470*	
	SI LeanBurn	*4000HP*	*gas*			*0-20%*	*$340-$1,020*	
	CI Diesel (Cont.)	*250 HP*	*diesel*			*20-30%*	*$760-$1,140*	
	CI Diesel (Cont.)	*1000 HP*	*diesel*			*20-30%*	*$420-$630*	
	CI Diesel (Cont.)	*4000 HP*	*diesel*			*20-30%*	*$310-$470*	
	CI Diesel (2000 P)	*250 HP*	*diesel*			*20-30%*	*$1,900*	
	CI Diesel (2000 P)	*1000 HP*	*diesel*			*20-30%*	*$830*	
	CI Diesel (2000 P)	*4000 HP*	*diesel*			*20-30%*	*$515*	
	CI Diesel (200 P)	*250 HP*	*diesel*			*20-30%*	*$13,400*	
	CI Diesel (200 P)	*1000 HP*	*diesel*			*20-30%*	*$4,600*	
	CI Diesel (200 P)	*4000 HP*	*diesel*			*20-30%*	*$2,010*	
	CI Dual Fuel	*250 HP*	*dual fuel*			*20-30%*	*$950-$1,420*	
	CI Dual Fuel	*1000 HP*	*dual fuel*			*20-30%*	*$470-$700*	
	CI Dual Fuel	*4000 HP*	*dual fuel*			*20-30%*	*$320-$480*	

Data taken from "Status Report on NOx Controls for Gas Turbines, Cement Kilns, Industrial Boilers, and I.C. Engines - Technologies & Cost Effectiveness", NESCAUM, December, 2000.

Data in italics taken from draft "Assessment of Control Technologies for Reducing Nitrogen Oxides from Non-Utility Point Sources and Major Area Sources", OTAG (2/27/96).

Table C-3 (continued)
NOx Control Methods for IC Engines

NOx Control Method	Engine Type	Engine Size	Fuel Type	Baseline NOx (gm/hp-hr)	Controlled NOx (gm/hp-hr)	% NOx Reduction	Cost Effectiveness $/ton NOx Removed	
							Ozone Season	Annual
In-Cylinder Methods (Continued)								
High Energy Ignition/ A-F Ratio		2500 HP	gas	15	7	53%	$280-$385	$115-$160
	SI Rich Burn	*250 HP*	*gas*			*10-40%*	*$580-$870*	
	SI Rich Burn	*1000 HP*	*gas*			*10-40%*	*$350-$520*	
	SI Rich Burn	*4000HP*	*gas*			*10-40%*	*$270-$400*	
	SI Lean Burn	*250 HP*	*gas*			*5-30%*	*$980-$4,930*	
	SI LeanBurn	*1000 HP*	*gas*			*5-30%*	*$490-$1,470*	
	SI LeanBurn	*4000HP*	*gas*			*5-30%*	*$340-$1,020*	
Low Emission Combustion Retrofit								
Low Speed Engine		3400 HP	gas	13	3	77%	$1,222-$2,296	$509-$957
Medium Speed Engine		2500 HP	gas	15	3	80%	$585-$1,100	$245-$460
Dual-Fuel Engine		2500 HP	gas/oil	15	3	80%	$1,794-$3,388	$747-$1,412
	SI Rich Burn	*250 HP*	*gas*			*70-90%*	*$4,500-$5,010*	
	SI Rich Burn	*1000 HP*	*gas*			*70-90%*	*$1,850-$2,090*	
	SI Rich Burn	*4000HP*	*gas*			*70-90%*	*$1,190-$1,340*	
	SI Lean Burn	*250 HP*	*gas*			*80-93%*	*$3,970-$4,460*	
	SI LeanBurn	*1000 HP*	*gas*			*80-93%*	*$1,610-$1,820*	
	SI LeanBurn	*4000HP*	*gas*			*80-93%*	*$1,030-$1,150*	

Data taken from "Status Report on NOx Controls for Gas Turbines, Cement Kilns, Industrial Boilers, and I.C. Engines - Technologies & Cost Effectiveness", NESCAUM, December, 2000.

Data in italics taken from draft "Assessment of Control Technologies for Reducing Nitrogen Oxides from Non-Utility Point Sources and Major Area Sources", OTAG (2/27/96).

Table C-3 (continued)
NOx Control Methods for IC Engines

NOx Control Method	Engine Type	Engine Size	Fuel Type	Baseline NOx (gm/hp-hr)	Controlled NOx (gm/hp-hr)	% NOx Reduction	Cost Effectiveness $/ton NOx Removed: Ozone Season	Cost Effectiveness $/ton NOx Removed: Annual
Exhaust Treatment								
SCR								
Gas Engine		1800 HP	gas	10	1	90%	$1,104-$8,245	$533-$3,508
Gas Engine		3130 HP	gas	10	1	90%	$591-$3,884	$319-$1,691
	SI Lean Burn	*250 HP*	*gas*			*90%*	*$4,280-$4,810*	
	SI LeanBurn	*1000 HP*	*gas*			*90%*	*$1,320-$1,490*	
	SI LeanBurn	*4000HP*	*gas*			*90%*	*$580-$660*	
Diesel Engine		1800 HP	diesel oil	10	1	90%	$922-$6,866	$453-$2,929
Diesel Engine		3130 HP	diesel oil	10	1	90%	$614-$4,246	$324-$1,838
	CI Diesel (Cont.)	*250 HP*	*diesel*			*80-90%*	*$4,170-$4,690*	
	CI Diesel (Cont.)	*1000 HP*	*diesel*			*80-90%*	*$1,460-$1,640*	
	CI Diesel (Cont.)	*4000 HP*	*diesel*			*80-90%*	*$780-$880*	
	CI Diesel (2000 P)	*250 HP*	*diesel*			*80-90%*	*$8,750*	
	CI Diesel (2000 P)	*1000 HP*	*diesel*			*80-90%*	*$3,000*	
	CI Diesel (2000 P)	*4000 HP*	*diesel*			*80-90%*	*$1,560*	
	CI Diesel (200 P)	*250 HP*	*diesel*			*80-90%*	*$61`,000*	
	CI Diesel (200 P)	*1000 HP*	*diesel*			*80-90%*	*$20,000*	
	CI Diesel (200 P)	*4000 HP*	*diesel*			*80-90%*	*$10,000*	
	CI Dual Fuel	*250 HP*	*dual fuel*			*80-90%*	*$5,800-$6,530*	
	CI Dual Fuel	*1000 HP*	*dual fuel*			*80-90%*	*$1,970-$2,210*	
	CI Dual Fuel	*4000 HP*	*dual fuel*			*80-90%*	*$1,010-$1,140*	

Data taken from "Status Report on NOx Controls for Gas Turbines, Cement Kilns, Industrial Boilers, and I.C. Engines - Technologies & Cost Effectiveness", NESCAUM, December, 2000.

Data in italics taken from draft "Assessment of Control Technologies for Reducing Nitrogen Oxides from Non-Utility Point Sources and Major Area Sources", OTAG (2/27/96).

Table C-3 (continued)
NOx Control Methods for IC Engines

NOx Control Method	Engine Type	Engine Size	Fuel Type	Baseline NOx (gm/hp-hr)	Controlled NOx (gm/hp-hr)	% NOx Reduction	Cost Effectiveness $/ton NOx Removed	
							Ozone Season	Annual
Exhaust Treatment (Continued)								
Mobile-Source Derivative SCR								
Diesel Engine		1971 HP	diesel oil	7.62	1.91	75%	$769-$3,080	$528-$1,491
Diesel Engine		1971 HP	diesel oil	15	3.75	75%	$577-$1,751	$455-$944
NSCR								
	SI Rich Burn	*250 HP*	*gas*			*90-98%*	*$290-$310*	
	SI Rich Burn	*1000 HP*	*gas*			*90-98%*	*$200-$220*	
	SI Rich Burn	*4000HP*	*gas*			*90-98%*	*$180-$190*	

Data taken from "Status Report on NOx Controls for Gas Turbines, Cement Kilns, Industrial Boilers, and I.C. Engines - Technologies & Cost Effectiveness", NESCAUM, December, 2000.

Data in italics taken from draft "Assessment of Control Technologies for Reducing Nitrogen Oxides from Non-Utility Point Sources and Major Area Sources", OTAG (2/27/96).

Table C-4
NOx Control Methods for Cement Kilns

NOx Control Method	Kiln Type	Kiln Size (tons/hour)	Baseline NOx (lb/ton clinker)	Controlled NOx (lb/ton clinker)	% NOx Reduction	Cost Effectiveness $/ton NOx Removed: Ozone Season	Cost Effectiveness $/ton NOx Removed: Annual
Low NOx Burners							
	Long Wet	*30*			*20-30%*	*$1,130*	
	Long Wet	*50*			*20-30%*	*$880*	
	Long Dry	*25*			*20-30%*	*$1,270*	
	Long Dry	*40*			*20-30%*	*$970*	
	Preheater	*40*			*20-30%*	*$1,330*	
	Preheater	*70*			*20-30%*	*$970*	
	Precalciner	*100*			*20-30%*	*$1,010*	
	Precalciner	*150*			*20-30%*	*$830*	
Mid-Kiln Tire Firing with LNB							
	Long Wet	*30*			*20-40%*	*$550*	
	Long Wet	*50*			*20-40%*	*$450*	
	Long Dry	*25*			*20-40%*	*$610*	
	Long Dry	*40*			*20-40%*	*$470*	
Indirect Firing & Mid-Kiln Tire Firing							
No tipping fee		96	5.0	2.55	49%	$1,766-$4,385	$736-$1,827
With $20 tipping fee		96	5.0	2.55	49%	$1,231-$3,850	$513-$1,604
With $75 tipping fee		96	5.0	2.55	49%	($242)-$2,377	($101)-$991
Mid-Kiln Tire Firing Only							
No tipping fee		40	5.0	4.0	20%	($2,326)-($4,035)	($969)-($1,681)
With $20 tipping fee		40	5.0	4.0	20%	($5,164)-($6,873)	($2,151)-($2,864)
With $75 tipping fee		40	5.0	4.0	20%	($12,966)-($14,675)	($5,403)-($6,115)

Numbers in ( ) mean company is realizing a savings instead of a cost by using control method.
Data taken from draft "Status Report on NOx Controls for Gas Turbines, Cement Kilns, Industrial Boilers, and I.C. Engines - Technologies & Cost Effectriveness", NESCAUM, December, 2000.
Data in italics taken from draft "Assessment of Control Technologies for Reducing Nitrogen Oxides from Non-Utility Point Sources and Major Area Sources", OTAG (2/27/96).

Table C-4 (continued)
NOx Control Methods for Cement Kilns

NOx Control Method	Kiln Type	Kiln Size (tons/hour)	Baseline NOx (lb/ton clinker)	Controlled NOx (lb/ton clinker)	% NOx Reduction	Cost Effectiveness $/ton NOx Removed: Ozone Season	Cost Effectiveness $/ton NOx Removed: Annual
CemStar Process							
net clinker value = $15/ton		40	*200 lb NOx/hr*	*160 lb NOx/hr*	20%	$664-$1,120	$365-$555
net clinker value = $30/ton		40	*200 lb NOx/hr*	*160 lb NOx/hr*	20%	($1,156)-($1,611)	($1,721)-($1,910)
net clinker value = $50/ton		40	*200 lb NOx/hr*	*160 lb NOx/hr*	20%	($4,190)-($4,646)	($4,755)-($4,945)
SNCR							
pre-calciner kiln		<150	*700 lb NOx/hr*	*385 lb NOx/hr*	45%	$890-$1,215	$675-$810
SNCR (Urea)							
	Preheater	*40*			*30-70%*	*$930*	
	Preheater	*70*			*30-70%*	*$790*	
	Precalciner	*100*			*30-70%*	*$880*	
	Precalciner	*150*			*30-70%*	*$800*	
SNCR (Ammonia)							
	Preheater	*40*			*30-70%*	*$1,100*	
	Preheater	*70*			*30-70%*	*$910*	
	Precalciner	*100*			*30-70%*	*$980*	
	Precalciner	*150*			*30-70%*	*$880*	
SCR							
	Long Wet	*30*			*80-90%*	*$3,600*	
	Long Wet	*50*			*80-90%*	*$3,140*	
	Long Dry	*25*			*80-90%*	*$3,630*	
	Long Dry	*40*			*80-90%*	*$3,170*	
	Preheater	*40*			*80-90%*	*$4,120*	
	Preheater	*70*			*80-90%*	*$3,490*	
	Precalciner	*100*			*80-90%*	*$4,870*	
	Precalciner	*150*			*80-90%*	*$4,400*	

Numbers in ( ) mean company is realizing a savings instead of a cost by using control method.

Data taken from draft "Status Report on NOx Controls for Gas Turbines, Cement Kilns, Industrial Boilers, and I.C. Engines - Technologies & Cost Effectiveness", NESCAUM, December, 2000.

Data in italics taken from draft "Assessment of Control Technologies for Reducing Nitrogen Oxides from Non-Utility Point Sources and Major Area Sources", OTAG (2/27/96).