OZONE TRANSPORT COMMISSION

OTC Model Regulations for Nitrogen Oxides (NOx) and Photo-reactive Volatile Organic Compounds (VOCs)

Technical Support Document

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1.0 INTRODUCTION

The Ozone Transport Commission (OTC) is a multi-jurisdictional organization created under the Clean Air Act (CAA) amendments of 1990. The OTC is responsible for advising the United States Environmental Protection Agency (EPA) on ozone transport problems facing the Ozone Transport Region (OTR), and for developing and implementing regional solutions to the ground-level ozone problem across the Northeast and Mid-Atlantic regions. To supplement local and state-level efforts to reduce ozone precursor emissions, which are likely insufficient to attain federal standards, the OTC member states are considering control measures appropriate for adoption by all states in the region as part of their planning to attain and maintain compliance with the 8-hour ozone National Ambient Air Quality Standards (NAAQS).

The development of the control measures described in this document mirrors prior efforts. The OTC developed a series of model rules in 2001, 2006, and these 2009/2010 model rules for the states to consider in adopting control measures to reduce volatile organic compound (VOC) emissions and oxides of nitrogen (NO_x), which are ozone precursors, to: (1) assist in the attainment of the old one-hour and more recent eight-hour ozone health standard, (2) address the VOC and NO_x emission reduction shortfalls identified by EPA, and (3) assist in the implementation of State Implementation Plan (SIP) commitments to EPA.

The report provides a description of the stationary source model rules adopted by the OTC from 2009 to 2016 to help states attain the 8-hour ozone NAAQS. The OTC model rules for VOC are for the following categories:

- Stationary Above Ground Storage Tanks;
- Consumer Products;
- Motor Vehicle and Mobile Equipment Non-assembly Line Coating Operations;
- Architectural, Industrial and Maintenance Coatings
- Solvent Degreasing.

The OTC model rules for NO_x are from the following categories:

- Stationary Generators;
- New Natural Gas-Fired Boilers, Steam Generators, Process Heaters, and Water Heaters, 75,000 - 5,000,000 BTU/hr
- Performance Standards for High Electric Demand Day Combustion Turbines (HEDDCT);
- Oil and Gas Boilers Serving Electricity Generating Units (EGUs).

Section 3.0 contains VOC model rules along with a summary of the existing Federal and State regulations, the major elements of the model rule, quantification of the emission benefits, anticipated costs, and cost-effectiveness of the rule.

Section 4.0 contains similar information for the NO_x source categories. This document is intended to provide states with a guide to help in their individual state rulemaking process, and is specifically written to be applicable OTR wide. OTC understands that states can, and should, supplement these documents and sections as needed to include state specific needs and changes in their own rules.

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OTC has welcomed stakeholder input for all eight of the model rules throughout every stage of the rule development process. Each OTC model rule workgroup, as well as the entire Stationary and Area Source Committee, received and reviewed written comments from stakeholder groups and carefully considered input from all interested stakeholders during the model rule development process. The OTC is grateful to those stakeholders who participated in the process, and encourages stakeholder input on all future OTC-wide efforts.

2.0 VOLATILE ORGANIC COMPOUND (VOC) ANALYSIS METHODS

This Section summarizes OTC control measures from 2009 to 2014 to reduce VOC emissions from five source categories:

1. Stationary Above Ground Storage Tanks
2. Consumer Products
3. Motor Vehicle and Mobile Equipment Non-assembly Line Coating Operations
4. Architectural, Industrial and Maintenance Coatings.
5. Solvent Degreasing

The existing federal and state rules, requirements of the model OTC control measures, and the methods used to quantify emissions reduction benefits for each of the above categories are described and discussed in separate subsections. These summaries provide an estimate of the anticipated costs of the control measures and identify other emissions reduction benefits.

2.1 Stationary Above Ground Storage Tanks

The OTC model rule addresses high vapor pressure volatile organic compounds (VOCs), such as gasoline, stored in large aboveground stationary storage tanks, which are typically located at refineries, terminals and pipeline breakout stations. On June 3, 2010, the OTC adopted a Resolution wherein member states agreed to pursue, as necessary and appropriate, state-specific rulemakings to update state rules in accordance with the 2009 OTC Stationary Above Ground Storage Tanks Model Rule.

The available control measures can be grouped into five categories as described below:

- **Deck fittings**:
  - Losses: Evaporative losses can occur from deck fittings, particularly slotted guidepoles, and rim seal systems.
  - Control measures: include gasketing deck fittings, installing pole sleeves and floats on slotted guidepoles, and gap requirements for rim seals.
- **Domes:**
  - Losses: Wind blowing across external floating roof tanks causes evaporative losses.
  - Control measures: proposed measure is to install domes on external floating roof tanks that have contents with vapor pressure greater than 3 psia at 70^{o} F, excluding crude oil, slop oil, and wastewater.
- **Roof landing Controls:**
  - Losses: When enough liquid is removed from a floating roof tank such that the roof is lowered to the height at which it is lowered no further (i.e., the roof rests on its legs or suspended by cables or hangers), the contact between the floating roof and the liquid VOC is broken as the remaining liquid is removed. This is referred to as a “roof landing.” A vapor space is created between the floating roof and the liquid surface, which enables vapors from the VOC remaining in the tank to accumulate. These vapors escape from the vapor space as the tank is sitting idle and when they are displaced during refilling. Also, some of the liquid VOC being used to refill the tank may evaporate and be expelled from the tank during refilling. For gasoline storage tanks, emissions generally range from 0.25 tons to 3 tons or more per roof landing.

- Control measures: Options include requiring use of lowest lander height setting for in-service roof landings (to minimize the vapor space) and, for tanks with landing emissions over 5 tons/year, installation of vapor recovery/control for use when roof is landed or modifying the tank to reduce the landed height to less than one foot (implemented over 10-year period).

- **Degassing and Cleaning:**
- Losses: VOC stationary storage tanks must be cleaned periodically. Before a tank is cleaned, it must be degassed (which is the removal of gases, such as gasoline vapor) so personnel can safely enter to clean the tank and remove accumulated sludge. The sludge removed from the tank can contain residual VOC liquid that may evaporate when exposed to the atmosphere.
- Control measures: include control of emissions during degassing and controlling exhaust from sludge receiving vessels (such as vacuum trucks). In New Jersey's adopted rule, the control measures are only required during ozone season (beginning 2010).

- **Inspection and Maintenance:**
- Control measures: An inspection and maintenance program to reduce VOC emissions by assuring that tank components are in good condition and operating properly.

2.1.1 Federal Standards

Certain storage tanks are subject to Federal Standards, such as New Source Performance Standards (NSPS) Subparts K, Ka, and Kb, as well as Maximum Available Control Technology (MACT) Subpart R (Gasoline Terminals and Pipeline Breakout Stations), 40 CFR 63 Subpart BBBBBB (Area Source Gasoline Terminals and Pipeline Breakout Stations), Subpart WW (Storage Tanks), and MACT Subpart CC (Petroleum Refineries). There is some overlap between the model rule and these Federal standards, particularly with regard to deck fitting, seal, and tank inspection requirements. However, unlike the model rule, federal standards do not generally address roof landings and tank cleaning, and they do not require external floating roof tanks to be covered with domes.

2.1.2 OTC Measure

The OTC model rule has proposed the following controls by category:

- **Deck fittings, seals:** Gap width requirements for deck fitting gaskets and rim seals, pole sleeves and floats on slotted guidepoles (based on California's South Coast Air Quality Management District (SCAQMD) Rule 1178, similar to MACT WW) which could result in up to 80% reduction in standing loss emissions on external floating roof tanks.
- **Domes:** Installing domes on external floating roof tanks can result in about 60% reduction of emissions remaining after deck fittings upgraded.
- **Roof Landing Controls:** Options include use of a vapor recovery and control system for roof landings, or minimizing the vapor space by reducing the lander height to one foot or less. The vapor recovery/control option in the model rule requires 90% control until the floating roof is within 90% by volume of being refloated for a total of 81% control. Lowering landing height to one foot or less can result in 60% to 100% reduction in roof landing cycle emissions, depending on how tank is operated (drained dry or heal remaining).

- **Cleaning and Degassing:** The model rule requires 95% control of emissions during degassing (until the concentration level in the tank is 5,000 ppm as methane), and control of exhaust from receiving vessel (e.g. vacuum truck). The model rule requires compliance with this provision 10 years from adoption. However, it can be reasonable to require compliance sooner, within 1-2 years after adoption, as this provision does not require physical modifications to a tank. This time frame is sufficient for facilities to arrange for control contractors and obtain necessary permits. In New Jersey, this requirement which only applies during ozone season began in 2010.
- **Inspection and Maintenance:** For external floating roof tanks, the rule includes full inspection of gap widths for deck fittings and secondary seals annually, and of primary seals every 5 years. For internal floating roof tanks, the model rule includes annual visual inspection (without entering the tank) and full inspection of deck fitting and seal gaps each time the tank is emptied and degassed (no less than every 10 years).

2.1.3 Emissions Reduction Benefit

AP-42 (TANKS) can estimate VOC reductions from deck fitting, seal, and doming requirements) and estimate losses from uncontrolled floating roof landings using the methodology in AP-42 Chapter 7.1.3.2.2 (added November 2006)[1]. Total estimated reductions for New Jersey, which the OTC rule was based on, are approximately 2,000 tons per year (tpy) by 2020. Projected reductions include 1,400 tpy from roof landings, 265 tpy from controlling tank cleaning and degassing, 187 tpy from the deck fitting and seal measures, and 130 tpy from installing domes on external floating roof tanks. Roof landing emissions in New Jersey totaled over 2,000 tons in 2006. Some facilities did not report roof landing emissions prior to that year.

The emissions reduction in New Jersey, which come from 860 floating roof tanks having an average capacity of about 3.4 million gallons per tank, amount to about 2.3 tons per tank, or 0.68 tons per million gallons of tank capacity. These figures could be used to extrapolate reductions to other states.

2.1.4 Control Cost Estimates

In its August 4, 2008 rule proposal, the New Jersey Department of Environmental Protection (NJDEP) estimated the cost of various control measures to range from $3,000 - 29,000 per ton of VOC reduced.

The NJDEP estimated that the cumulative costs of retrofitting guidepoles with pole sleeves, cover and wipers ($10,000) and upgrading other deck fittings ($500.00 per fitting) on external floating roof tanks storing an applicable VOC would be about $29,000 (in 2001 dollars) per ton of VOC emissions reduced (SCAQMD 2001 Report[2]). Installing gasketed covers or flexible fabric sleeves on each roof column or well and upgrading other deck fittings on an internal floating roof tank has a cost-effectiveness of $6,000 (in 2001 dollars)

[1]AP 42, Fifth Edition, Volume I Chapter 7: Liquid Storage Tanks https://www3.epa.gov/ttnchie1/ap42/ch07/

[2] RULE 1178. FURTHER REDUCTIONS OF VOC EMISSIONS FROM STORAGE TANKS AT PETROLEUM FACILITIES (Adopted December 21, 2001)(Amended April 7, 2006) http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1178.pdf

per ton of VOC removed (SCAQMD 2001 Report). NJDEP estimates that upgrading the seals on any floating roof tank storing an applicable VOC has a cost-effectiveness of $13,200 (in 2001 dollars) per ton of VOC reduced as the tank is filled and emptied (SCAQMD 2001 Report). However, NJDEP expects that most floating roof tanks are already in compliance with the proposed seal requirements.

The NJDEP estimated the cost-effectiveness of doming external floating roof tanks to be $12,036 (in 2001 dollars) per ton of VOCs reduced, based on a SCAQMD 2001 report. In its comment on the OTC model rule, the American Petroleum Institute claimed that doming costs $47,000 per ton while a British Petroleum refinery in Carson, CA reported having spent $15.4 million dollars to dome 32 external floating roof tanks. Improved deck fittings and installing domes provide additional benefits that could affect a tank's operating expenses by protecting floating roofs from the weather, reducing maintenance, reducing wastewater, reducing risk of product contamination, and reducing risk of tank fires.

One possible modification to address roof landings is to include replacing an existing floating roof with one that has an opening to accommodate a vapor recovery line that would go to a vapor control device. This is currently being done in parts of California, such as in the SCAQMD, in Texas and in New Jersey. Another possible modification is to retrofit a tank to meet the landing height requirement although this might be cost prohibitive if it required piping, sumps, or other hardware to be placed underneath the tank. Tanks with roof landing emissions below 5 tpy would not require modifications.

Estimates of cost-effectiveness in performing these modifications and operating the installed controls varies from $2,288 - $20,000 per ton of VOC reduced based on tank size (SCAQMD 1987 Report and the San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD) 2005 Report). Control measures have been found to be more cost-effective for larger tanks than for smaller ones. The cost per ton of VOC reduced has been estimated to be $4,000 - $20,000 by SCAQMD, $2,288 - $4,290 by SJVUAPCD, and about $3,000 by the Bay Area Air Quality Management District (BAAQMD) in its 1997 Report.[3] The low cost estimate from BAAQMD is for modifications performed on a large (approximately 5 million gallon) tank which included the cost of converting an external floating roof tank to an internal floating roof tank, as well as the cost of vapor control

The estimated cost to control emissions during a degassing operation is $6,283 - $11,781 for a 62,832-barrel floating roof tank, with a cost-effectiveness of $2,288 - $4,290 per ton of VOC emissions reduced (SJVUAPCD 2005 Report). There will be additional cost for tank cleaning that can vary significantly depending on tank size, contents stored, liquid heel height, sludge level, and solids content. The proposed degassing amendments will affect tanks greater than 40,000 gallons in size that store primarily gasoline, ethanol, or methyl-tertiary-butyl-ether (MTBE). The larger the tank and the higher the vapor pressure of the stored contents, the lower the cleaning cost per ton of emissions.

[3] http://www.otcair.org/upload/Interest/StationaryArea%20Sources/VOC%20OTC%20White%20paper.doc

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In New Jersey, the NJDEP expects costs for inspections to be minimal because most owners or operators are already required to perform inspections under Federal NSPS regulations and/or MACT regulations. The proposed inspection requirements can be performed concurrently with other inspections.

The proposed new rules and amendments may have a small effect on gasoline prices at the pump. The NJDEP estimated that the overall annualized compliance cost to this industry in its entirety would be a maximum of $58,000,000 for 2,000 tpy of VOC reductions in 2018. In 2006 the throughput of gasoline in these tanks exceeded 10 billion gallons. Based on that figure, if owners or operators of VOC stationary storage tanks choose to pass on the compliance costs to distributors and retailers, the Department expects gasoline prices at the pump to increase less than $0.01 per gallon. Distributors and retailers may be impacted if the potential increase in costs of gasoline increases their expenses and dampens demand.

2.1.5 Emissions Reduction Benefits for Other Pollutants

The OTC model rule will also reduce other VOC Hazardous Air Pollutants (HAPs), such as Benzene. Since VOC can be a precursor to Particulate Matter of 2.5 microns in size ($PM_{2.5}$), the levels of that pollutant may be reduced as well.

2.2 Consumer Products

2.2.1 Federal Standards

On September 11, 1998 EPA published their final consumer products rule as 40 CFR Part 59, Subpart C, Part 59 in the Federal Register. The rule regulated 24 product categories representing 48 percent of the consumer products inventory, nationally, and reduced VOC emissions from that inventory by 20 percent. The national rule was based on existing CARB rules, but not as stringent.

2.2.2 OTC Model Rule

The consumer products rules limit the VOC content of products that they regulate. The rules aim to achieve VOC reductions through reformulation of the affected product categories by the manufacturers. This may involve switching to a water-based formulation, using exempt VOC solvents, increasing product solids, or formulating with a non-VOC component. Manufacturers can also comply with the proposed model rule through the use of Innovative Products Exemption (IPE) or the Alternate Control Plan (ACP). The model rule for consumer products would apply to anyone who sells, supplies, offer for sale, or manufactures consumer products for use in a state or region. The rule applies to a vast range of consumer products that are used across the country.

The OTC consumer products model rule revisions of June 3, 2010[4] (rule limit effective date of 2014) or OTC consumer products model rule Phase 3, are based on the California Air Resources Board's (CARB) 2006 Consumer Products Regulatory Amendments. These

[4] http://www.otcair.org/upload/Documents/Model%20Rules/OTC%20State%202001%20Rule%20adoption%20090519%20NY_1.pdf

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rules, which exclude windshield wiper fluids and oven cleaners, cover two product categories (anti-static products and shaving gels) from CARB'S 2004 amendments, and one category (nail polish removers, although regulated differently in the OTC due to the definition of VOC) from their 1999 amendments that was revised in 2006. The majority of the CARB limits had an effective date of December 31, 2008 or earlier with one being effective on 12/31/2009, and three on December 31, 2010. On June 3, 2010, the OTC adopted a Resolution wherein member states agreed to pursue, as necessary and appropriate, state-specific rulemakings to update state rules in accordance with the 2010 OTC Consumer Products Model Rule.[5]

The 2010 OTC model rule amendments have more restrictive VOC limits for 14 existing consumer product categories (15, including subcategories), and 3 new categories (5, including subcategories; disinfectant, sanitizer, and temporary hair color) will be regulated for the first time with VOC limits. Hand sanitizers were not included in CARB's amendments because representatives from the Centers for Disease Control (CDC), California's Department of Health Services (DHS), and the Food and Drug Administration (FDA) indicated that regulating hand sanitizers would not be appropriate. The CARB amendments also clarified or modified previously defined or regulated categories and included a prohibition on the use of chlorinated toxic compounds in certain consumer product categories (construction, panel, and floor covering, oven cleaner, general purpose cleaner, and bathroom and tile cleaner).

The OTC revised the 2010 model rule on May 10, 2012[6] (OTC model rule Phase 4) to include CARB's limits for multi-purpose solvents and paint thinners based on the CARB 2009 Consumer Products Regulatory Amendments. Then the OTC revised the model rule again on May 21, 2013[7] with a minor amendment that did not affect emissions calculations. The "dual purpose air freshener/disinfectant, aerosol" category was added to the OTC model rule to make it consistent with the CARB Consumer Product rule. The dual purpose air freshener/disinfectant category had been regulated in California since 1994 at a 60% VOC limit.

Additional minor administrative amendments to the May 12, 2013 OTC model rule are being drafted. The revised model rule will be posted on the OTC website when complete at:

http://www.otcair.org/document.asp?fview=modelrules

The CARB and OTC model rules are more stringent for several of the consumer products categories than the USEPA's National consumer products rule that was adopted in September 1998.

[5] http://www.otcair.org/upload/Documents/Formal%20Actions/MOU_adoption_of_new_regional_controls[1].pdf

[6] http://www.otcair.org/upload/Documents/Model%20Rules/OTC%20CP%20Model%20Rule%202012%20CLEAN_vs 2010.2012%2005%2010.pdf

[7] http://www.otcair.org/upload/Documents/Model%20Rules/OTC%20CP%20Model%20Rule%20Final%20Clean%20 2013%20Revision%20Clean.pdf

2.2.3 Emissions Reduction Benefit

CARB's estimated emissions reduction from the categories regulated by the 2010 OTC model rule (2006 CARB amendments, excluding windshield wiper fluids, oven cleaners and nail polish removers, and including two categories from the 2004 CARB amendments, anti-static products and shaving gels) are approximately 10.8 tons per day (tpd) of VOC emission reductions in California by 2010.

CARB also regulates chlorinated toxic compounds (methylene chloride (MC), perchloroethylene (PCE), and trichloroethylene (TCE), in automotive repair consumer products (brake cleaners, carburetor or fuel-injection air intake cleaners, engine degreasers, and general purpose degreasers) in a separate rulemaking. A portion of the estimated VOC reductions assume that these chlorinated toxic compounds are banned in these products also. It is estimated that the VOC reductions in the OTC region, based on CARB's estimates, would be approximately 20 - 27 tpd, depending on whether the chlorinated toxics are banned in all OTC states. This equates to an estimated 4.7% reduction of the total consumer products inventory for states that include CARB's ban of chlorinated toxic compounds in automotive repair products, and an estimated 3.1% reduction of the total consumer products inventory for states that did not ban such compounds.

The categories regulated by the 2012 OTC model rule (from the 2009 CARB amendments for multi-purpose solvents and paint thinners) are estimated to reduce VOC emissions by approximately 12.3 tpd by 2013 in CA. It is estimated that the VOC reductions in the OTC region for the 2012 OTC model rule, based on CARB's estimates, would be approximately 51 tpd which amounts to a 10.3% reduction of the total consumer products inventory, in addition to the reductions from the 2010 model rule discussed above.

Together the OTC 2010 and 2012 model rules are estimated to be a 15% VOC emission reduction of the entire consumer products inventory for states that include CARB's ban of chlorinated toxic compounds in automotive repair products, and an estimated 13.4% reduction for states that did not ban such compounds.

The emissions reduction estimates and calculations are provided in **Appendix A.**

2.2.4 Control Cost Estimates

CARB estimated the cost effectiveness of the proposed VOC limits in the 2010 OTC model rule to be about $2.35 per pound of VOC reduced and the total cost incurred by industry to comply with this regulation to be about $20 million per year. The estimated average increase in cost per unit to the manufacturer to be about $0.06 and CARB expects most manufacturers to be able to absorb such added cost without an adverse impact on their profitability.

For the 2012 OTC model rule, CARB estimated the cost effectiveness of the proposed VOC limits for their 2009 amendments (including double phase air fresheners, which are not included in the OTC model rule) to be about $0.29 per pound of VOC reduced which is significantly lower than other control measures for consumer product and paint. The total cost incurred by industry to comply with the products in the OTC model rule (multipurpose solvents and paint thinners) is estimated by CARB to be $2.2 million per year for 10 years. CARB estimates a potential increase in cost to the consumer of about $0.75 per unit or $1.50 per gallon.

2.2.5 Emissions Reduction Benefits for Other Pollutants

The OTC model rule also includes reductions of chlorinated toxic compounds (methylene chloride, perchloroethylene and trichloroethylene), consistent with the CARB consumer product rule in some consumer products such as construction, panel, and floor covering adhesive, oven cleaners, general purpose cleaner, bathroom and tile cleaner. Since VOC can be a precursor to $PM_{2.5}$, the levels of that pollutant may be reduced as well.

2.3 Motor Vehicle and Mobile Equipment Non-assembly Line Coating Operations

The 2009 OTC model rule for Motor Vehicle and Mobile Equipment Non-assembly Line Coating Operations (2009 OTC MVMERR Model Rule) seeks to limit the VOC content in coatings and cleaning solvents used in motor vehicle and mobile equipment non-assembly line coating operations. Implementation of the 2009 OTC MVME Model Rule will reduce VOC emissions by limiting the VOC content of coatings and cleaning solvents, and will provide work practice standards for preventing emissions from equipment cleaning and cleaning supplies storage. On November 5, 2009, the OTC adopted a Resolution wherein member states agreed to pursue, as necessary and appropriate, state-specific rulemakings to update state rules in accordance with the 2009 OTC MVME Model Rule.

2.3.1 Federal Standards

Federal standards for autobody refinishing facilities were finalized in 1998 and can be found in 40 CFR Part 59, Subpart B. The 1998 federal standards apply only to manufacturers and importers of automobile refinish coatings or coating components which are manufactured for sale or distribution in the United States. The VOC content limits in the federal standards for automobile refinish coatings and coating components were estimated to result in a 37% emissions reduction from uncontrolled 1998 emissions at an estimated cost of $118 (in 1990 dollars) per ton of VOC emissions reduced.

2.3.2 OTC Model Rule

2.3.2.1 The 2002 OTC MERR Model Rule

The 2002 OTC Mobile Equipment Repair and Refinishing (MERR) Model Rule was developed from the Pennsylvania regulation (Title 25 Pa. Code §129.75) related to mobile equipment repair and refinishing, which was effective November 27, 1999 (29 Pa.B. 6003) and had a compliance date of November 27, 2000.

The 2002 OTC MERR Model rule established requirements for using higher efficiency coating application equipment, such as high volume-low pressure paint guns, using spray gun cleaning equipment that minimizes solvent loss, and enclosed spray gun cleaning. The Federal VOC limits on the paints was maintained in the model rule.

The OTC Rule applies to people who perform mobile equipment repair and refinishing, or color matching coatings to mobile equipment or its components, and has an

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estimated control cost of $1,534 per ton of VOC emissions reduced across the ozone transport region (OTR). The 2002 OTC MERR Model Rule has been adopted by most states across the OTR.

2.3.2.2 The 2009 OTC MVME Model Rule

The 2009 OTC MVME Model Rule is an update of the 2002 OTC MERR Model Rule. The OTC developed the 2009 OTC MVME Model Rule using the CARB 2005 Suggested Control Measure (SCM) for Automotive Coatings as a guideline.

The 2009 OTC MVME Model Rule applies to people who supply, sell, offer for sale, distribute, manufacture, use or apply automotive coatings and associated cleaning solvents subject to the Model Rule. The new model rule limits the VOC content of coatings used in non-assembly line coating operations and limits the VOC content of cleaning solvent to 25 g/l. The 2009 OTC MVME Model Rule allows the use of higher VOC content cleaning solutions for special uses and sets lower VOC content limits for many of the formulations used which results in switching from solvent-based to water-based formulations. Additionally, the new model rule continues the requirements for the use of high transfer-efficiency painting methods found in the 2002 OTC MERR Model Rule. The 2009 OTC MVME Model Rule has a recommended compliance date of January 1, 2012. The estimated control cost for the 2009 OTC MVME Model Rule is $2,680 per ton of VOC emissions reduced across the OTR.

2.3.3 Emissions Reduction Benefit

2.3.3.1 Emissions Reduction Benefit

The control measures in the 2002 OTC MERR Model Rule were estimated to result in emission reductions of 38% from 2002 OTC baseline emissions (post-1998 federal standard emissions). From a 2002 OTC baseline of 28,483 tons, this measure resulted in a VOC emission reduction of approximately 10,824 (38% x 28,483) tons across the OTR.

The 2009 OTC MVME Model Rule incorporates control measures from the CARB 2005 Suggested Control Measures (SCM). The CARB 2005 SCM estimates a 65% reduction in VOC emissions from 2002 CARB baseline emissions, which are post-1998 federal standard emissions. Unlike California, most of the OTC states adopted the 2002 OTC MERR Model Rule, which provided additional emissions reduction from the 1998 federal standards baseline, with all reductions achieved by January 1, 2009. Similar reductions of 65% are expected from the implementation of the 2009 OTC MVME Model Rule. The emissions reduction expected from implementation of the 2009 OTC MVME Model Rule are based on the 2009 OTC remaining emissions that resulted after implementation of the 2002 OTC MERR Model Rule. From the 2009 OTC remaining emissions of 17,659 tons, the 2009 OTC MVME Model Rule is estimated to provide a VOC emissions reduction of approximately 11,478 (65% x 17,459) tons across the OTR after implementation by the OTC states.

The 2005 CARB SCM recommends a VOC content limit of 25 g/l for solvent used for surface preparation and cleanup. Emission reduction estimates resulting from this limit were not quantified by CARB because usage data for this category was not collected by CARB during the development of the SCM.

2.3.3.2 Emissions Reduction Estimation Methodology

The 2002 baseline emissions are calculated using data from the 2002 MANE-VU inventory[8]. The 2002 OTC baseline emissions estimate of 28,483 tons is the total emissions reported for SCC 2401005-xxx by the District of Columbia and the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont. Emissions from northern Virginia counties included in the OTC were not included in this calculation because emissions from Virginia were not included in the 2002 MANE-VU Inventory.

The emissions reduction estimate for the 1998 federal standards and the uncontrolled OTC emissions prior to 2002 were calculated inversely from the 2002 OTC baseline emissions. The uncontrolled OTC emissions were calculated using the following equation:

(2002 OTC Baseline) / ((100 - the percent reduction)/100) = Uncontrolled OTC emissions prior to 2002

28,483 tons / ((100 - 37)/100) = 45,211 tons

The 2002 OTC emissions reduction due to the implementation of the 1998 federal standards was calculated from the difference between the 2002 OTC baseline emissions and the uncontrolled OTC emissions prior to 2002.

Uncontrolled OTC emissions - 2002 OTC Baseline = 2002 OTC Reduction

45,211 tons – 28,483 tons = 16,728 tons

The 2002 OTC MERR Model Rule estimated a 38% reduction from the 2002 OTC baseline emissions. The 2009 OTC reduction from the implementation of the 2002 OTC MERR Model Rule was calculated using the following equation:

(2002 OTC Baseline) * (the percent reduction/100) = 2009 OTC Reduction

28,483 tons * (38/100) = 10,824 tons

The 2009 OTC remaining emissions are calculated using the following equation:

(2002 OTC Baseline) – (2009 OTC Reduction) = 2009 OTC Remaining

28,483 tons – 10,824 tons = 17,659 tons

The CARB 2005 SCM estimates a 65% reduction in VOC emissions and a similar reduction in remaining emissions is expected in the OTR from the implementation of the 2009 OTC MVME Model Rule (in January 1, 2012) since this Rule is very similar to the SCM

[8] http://www.marama.org/visibility/Inventory%20Summary/2002EmissionsInventory.htm

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The 2012 emissions reduction due to the OTC MVME Model Rule is calculated using the following equation:

(2009 OTC Remaining) * (the percent reduction/100) = 2012 OTC Reduction

17,659 tons * (65/100) = 11,478 tons

The 2012 OTC remaining emissions are calculated using the following equation:

(2009 OTC Remaining) – (2012 OTC Reduction) = 2012 OTC Remaining

17,659 tons – 11,478 tons = 6,181 tons

2.3.4 Control Cost Estimate

The control cost estimate for the 2009 OTC MVME Model Rule, as estimated in the CARB 2005 SCM Staff Report, is $2,680 per ton of VOC emissions reduced. The EPA issued a final rule for National Emission Standards for Hazardous Air Pollutants: Paint Stripping and Miscellaneous Surface Coating Operations at Area Sources (referred to as 6H MACT) on January 9, 2008. The 6H MACT requires training for coating applicators, identifies approved spray application techniques and specifies minimum equipment requirements. The CARB 2005 SCM estimate includes costs for training and equipment that may already be required under the 6H MACT rule. Actual costs may be significantly lower than the CARB 2005 SCM estimate. However, there is currently no way to quantify the difference without additional information about each potentially affected facility's compliance with the requirements of the 6H MACT.

2.3.5 Emissions Reduction Benefits for Other Pollutants

The proposed measure does not directly reduce other criteria pollutants. However, some VOCs are also considered hazardous air pollutants (HAP). The 2009 OTC MVME Model Rule would decrease HAP emissions through coating reformulation and solvent substitution, and increased coating application efficiency. Since VOC can also be a precursor to Particulate Matter of 2.5 microns in size ($PM_{2.5}$), the levels of that pollutant may be reduced as well.

2.4 Architectural, Industrial, and Maintenance (AIM) Coatings

2.4.1 Standards Background

Pursuant to the Clean Air Act, the OTC is tasked to develop and implement enforceable strategies that will help bring the region into attainment for ozone. The Architectural and Industrial Maintenance (AIM) coatings model rule is part of that effort.

In 1993, EPA provided a memo to states stating that a federal rule was to be developed that would have resulted in a 25% reduction in VOCs from this category. The process of developing a national rule was terminated in September 1994.

On June 25, 1996, EPA issued a proposed federal AIM rule that EPA claimed would result in a 20% reduction of VOCs from this sector. However, the proposed EPA rule was not as stringent as some State rules due to exceedance fee and variance provisions and a limited amount of coating categories. This prompted States to work together via the Ozone

Transport Commission (OTC) to develop a regional AIM program to ensure actual VOC reductions were realized.

On September 11, 1998 EPA published their final AIM rule as 40 CFR Part 59, Subpart D in the Federal Register. This rule covers sixty one coating categories and established an exceedance fee program as well as a VOC tonnage exemption.

With areas within the OTR in nonattainment for ozone additional VOC reductions were required and the 2002 OTC model rule was developed. The 2002 AIM model rule followed the 2000 CARB suggested control measure (SCM).

In 2007, the California Air Resources Board (CARB) generated a study based on survey data to examine VOC levels in coatings and developed a new 2007 CARB SCM. The 2007 CARB AIM SCM generally lowered VOC limits through product reformulation as well as improved definitions. Of the 47 coating categories regulated in the 2000 SCM, 15 categories were eliminated (replaced by new categories or deemed unnecessary), 10 categories were added, and 19 have stricter VOC limits. The updated SCM also contains some revised compliance and reporting requirements.

On June 3, 2010, the OTC adopted a Resolution wherein member states agreed to pursue, as necessary and appropriate, state-specific rulemakings to update state rules in accordance with the 2009 OTC Architectural, Industrial and Maintenance Model Rule, which is based on the 2007 CARB SCM as well as their survey data. The model rule was updated with minor revisions by the OTC workgroup on October 13, 2014.

The OTC Model Rule is an adaptation of the 2007 CARB SCM with some revisions including the assignment of different limits for some categories of products as well as the addition of some categories that are specific to the OTR and not included in the 2007 CARB SCM.
CARB originally approved an SCM for architectural coatings in 1977 and amended it in 1985, 1989, and 2000. On August 14, 1998, EPA issued the final version of its National Volatile Organic Compound Emission Standards for Architectural Coatings under Section 183(e) of the Clean Air Act. This final rule, which applied only to manufacturers and importers of architectural coatings, and set VOC content limits for 61 coating categories, specifically allowed states or local governments to adopt more stringent coating limits.

The OTC adopted the 2002AIM Model Rule more stringent than the national rule in 2002 which is based primarily on the 2000 CARB SCM. The 2002 AIM model rule has been adopted by nearly all OTC states.

2.4.2 OTC AIM Model Rule

Key provisions of the AIM model rule include:

- Eliminate 15 coating categories and sub-categories and combine them with other categories
- Add 12 coating categories
- Lower VOC limits on 12 coating categories
- Broaden the scope of States data collecting authority
- Add transitional language

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- Update definitions and codes as necessary
- Clarify the quart exemption

Eliminate 15 coating categories and sub-categories

All coating categories and sub-categories eliminated will be absorbed into existing or new categories with the exception of "temperature indicator safety coatings." Surveys conducted by the California Air Resources Board (CARB) in 2001 and 2005 showed that "temperature indicator safety coatings" were not produced in either year. Furthermore, if a manufacturer decides to begin production of this type of coating in the future, it will fall under the category "industrial maintenance." The corresponding VOC limits for all the categories to be eliminated will either remain the same or be reduced, ensuring no increased emissions due to this action.

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The proposed categories for elimination with the category which it is proposed to be absorbed by:

Table 2-1 Eliminated and Absorbed Categories

Eliminated Category	Absorbed By
Antenna Coatings (530 grams per liter (g/l))	Industrial Maintenance (250 g/l)
Antifouling Coatings (400 g/l)	Industrial Maintenance (250 g/l)
Clear Wood Coatings • Clear Brushing Lacquers (680 g/l) • Lacquers (550 g/l) • Sanding Sealers (350 g/l) • Varnishes (350 g/l)	Wood Coatings (275 g/l)
Fire Retardant Coatings • Clear (650 g/l) • Opaque (350 g/l)	Industrial Maintenance (250 g/l)
Flow Coatings (420 g/l)	Industrial Maintenance (250 g/l)
Quick Dry Enamels (250 g/l)	Flat (50 g/l) or Nonflat (100 g/l) or Nonflat High Gloss (150 g/l)
Quick Dry Primers, Sealers & Undercoaters (200 g/l)	Specialty Primers, Sealers & Undercoaters (100 g/l)
Swimming Pool Repair & Maintenance Coatings (340 g/l)	Swimming Pool Coatings (340 g/l)
Temperature Indicator Coatings (550 g/l)	Industrial Maintenance (250 g/l)
Waterproofing Sealers (250 g/l)	Basement Specialty Coatings (400 g/l) or Concrete/Masonry Sealers (100 g/l) or Waterproofing Membranes (250 g/l)
Waterproofing Concrete/Masonry Sealers (400 g/l)	Basement Specialty Coatings (400 g/l) or Concrete/Masonry Sealers (100 g/l) or Waterproofing Membranes (250 g/l)

Add 12 coating categories

The new categories are added due to consolidation of eliminated categories or manufacturing progress/updates. Three new categories "basement specialty coatings," "concrete/masonry sealer" and "waterproofing membranes" will absorb the two eliminated categories "waterproofing sealers" and "waterproofing concrete/masonry sealers" depending on the type of coating technology used and corresponding substrate. A new category "wood coatings" will absorb the eliminated category "clear wood coatings" with sub-categories "clear brushing lacquers", "lacquers", "sanding sealers" and "varnishes." The remaining new categories, "aluminum roof," "conjugated oil varnish," "reactive penetrating sealer," "reactive penetrating carbonate stone sealer," "stone consolidants," "tub and tile refinish" and "zinc-rich primer" are a result of new data, manufacturing updates and stakeholder input.

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The proposed categories for addition are:

Table 2-2 New Coating Categories

New Category	Limit (g/l)
Aluminum Roof	450
Basement Specialty Coatings	400
Concrete/Masonry Sealer	100
Conjugated Oil Varnish	450
Driveway Sealer	50
Reactive Penetrating Sealer	350
Reactive Penetrating Carbonate Stone Sealer	500
Stone Consolidants	450
Tub and Tile Refinish	420
Waterproofing Membranes	250
Wood Coatings	275
Zinc-Rich Primer	340

Lower VOC limits on 12 coating categories

The proposed categories for lowered VOC limits are:

Table 2-3 Proposed categories for lowered VOC limits

Category	Limit lowered (g/l)
Bituminous Roof Coatings	From 300 to 270
Dry Fog Coatings	From 400 to 150
Flat Coatings	From 100 to 50
Floor Coatings	From 250 to 100
Industrial Maintenance	From 340 to 250
Mastic Texture Coatings	From 300 to 100
Nonflat Coatings	From 150 to 100
Nonflat-High Gloss	From 250 to 150
Primers, Sealers & Undercoaters	From 200 to 100
Rust Preventative	From 400 to 250
Specialty Primers, Sealers & Undercoaters	From 350 to 100
Traffic Marking	From 150 to 100

Add transitional language

This model rule revises the definitions and standards sections by including transitional language to the definitions and VOC limits. Because this model rule also proposes to include new coating categories, this language provides clarity to the definition of coating categories as well as clearly stating when one category is phased out and another one phased in. Instead of deleting the definition of the categories that are proposed for elimination, the model rule language will keep the existing definition, with additional language clarifying the date on which it is proposed to be eliminated and the category that it may be replaced with. This type of transitional language was requested by stakeholders. Furthermore, the proposed language will allow for a three-year sell through; while the Model Rule states that the manufacture of certain coatings will stop on January 1, 2018, sale of the coating may continue for an additional three years.

Update definitions and codes as necessary

This Model Rule revises the definitions section to clarify and update specific definitions that are currently unclear.

This Model Rule revises the default "category" provision of the rule. When a product does not meet the definition for any of the specialty AIM coating categories listed in the definitions, the rule automatically defaults to the "flat", "nonflat", or "nonflat high-gloss" categories and their respective VOC content limits of 50, 100, and 150 grams per liter. Currently a coating that does not fit one of the specialty categories but is described (wording on container, product literature etc.) as falling within one or more of the specialty categories potentially could bypass the default category provision in favor of the "most restrictive limit" provision. The end result could be much higher VOC products in the marketplace that can't be enforced against. With the modifications to the default category provision the OTC intends to eliminate this confusion.

Clarify the liter exemption

The OTC model rule revises the applicability section to clarify the "liter exemption." Currently, the 2002 AIM model rule does not regulate coatings sold in containers with a volume of one liter (1.057 quart) or less. Some manufacturers and suppliers have attempted to circumvent this rule by selling their coatings in bundles of quart containers inside a larger pail, implying that the user would empty the quart containers into the larger container. To prevent this from occurring, the OTC model rule modifies the language to clearly prohibit this type of "bundling".

Broaden the scope of States data collection authority

This OTC model rule broadens the scope of the States authority to collect information pursuant to the "reporting requirements" in section of the rule. The revisions grant more time for manufacturers to respond and allow the States to request more information than the existing rule. The current 2002 AIM model rule does not allow States to request information on products manufactured for use outside of the state (which could then be sold back into the state) or sold in the state in containers of one liter or less. In the past, some manufacturers have voluntarily provided this information when requested, but others have resisted. The collection of this information is important in developing emission inventories and enforcing the rule in the States which adopt it.

Variations and Updates from Other Rules

The Ozone Transport Commission (OTC) staff worked with stakeholders to determine where VOC limits could be lowered to allow for future emissions reductions. During the stakeholder process it was determined that most of the CARB VOC limits were feasible for the OTC region, and in most cases already being sold to the public already. While largely based on the 2007 CARB SCM, there are some areas where the OTC AIM model rule does not match the 2007 CARB SCM.

The current OTC model rule is an update to the 2002 AIM Model Rule. The 2007 CARB SCM, which served as the basis for this model rule, had compliance dates of 1/1/2010 for 40 of 42 product categories, and 1/1/2012 for the remaining 2 categories (although some of these limits have not changed from the 2000 SCM).The OTC model rule which has an effective date of January 1, 2014 includes all new categories defined in the 2007 CARB SCM as well as the following 8 specialty coating categories specific to the Ozone Transport Region:

From 2002 OTC Model Rule

- Calcimine Recoaters
- Concrete Surface Retarders
- Conversion Varnish
- Impacted Immersion coatings
- Nuclear Coatings
- Thermoplastic Rubber Coatings and Mastics

2010 OTC Model Rule Additions

- Reactive Penetrating Carbonate Stone Sealer
- Conjugated Oil Varnish

Six of the above eight coating categories were added into the 2002 AIM model rule and the justification for these coatings can be found in its Preamble. After extensive discussions with stakeholders, two new categories (Conjugated Oil Varnish and Reactive Penetrating Carbonate Stone Sealer) were added to this newer AIM model rule with the following justifications:

Conjugated Oil Varnish

Used in high end floor restoration/renovation and results in a unique finish which matches older varnish. This is a small volume niche coating product used primarily by contractors, and is generally more expensive compared to other consumer applied floor finish products (2007 CARB SCM, P5-211).

Reactive Penetrating Carbonate Stone Sealer

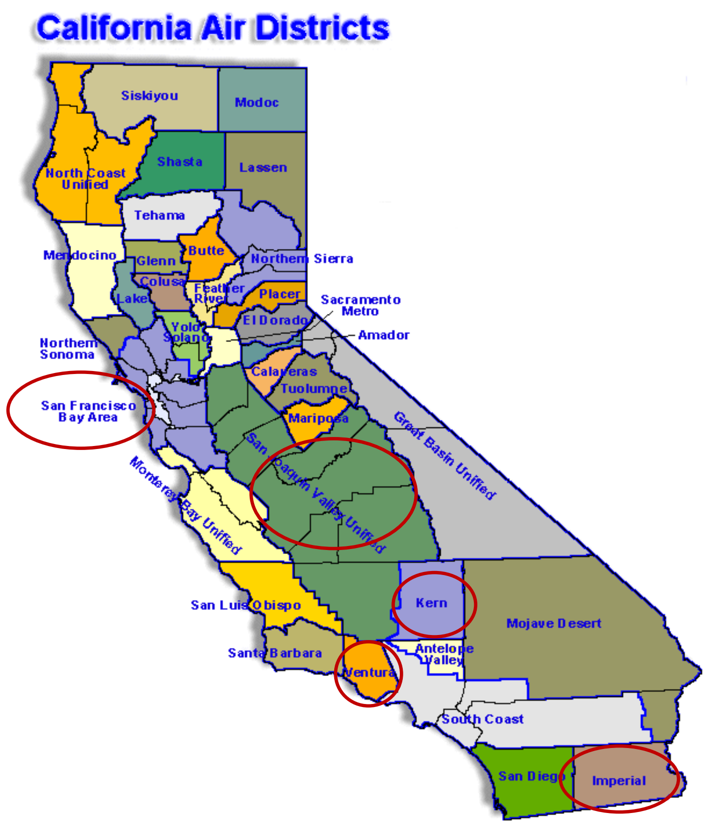
Carbonate stone is widely used in the Northeast as exterior and façade components in commercial and institutional construction. The northeastern United States has an estimated inventory of 50,000 buildings, 10,000 memorials, and tens of millions of grave markers constructed of carbonate stone subject to acid rain degradation. This sealer is another small volume niche coating product which has a specific use in the OTR and the OTC recognizes the need for this coating category in historical preservation/renovation.

In addition, the following 3 specialty coating categories have higher limits in the OTC model rule compared to the 2007 CARB SCM:

- Aluminum Roof
- Bituminous Roof
- Roof

After extensive discussions with stakeholders, CARB staff, and careful review of the CARB SCM, the OTC decided that lowering the VOC limit of these roof coatings at this time was not appropriate. Although the lower limit is listed in the 2007 CARB SCM, at the time of this review only five California Air Districts (all in warmer climates) had adopted the roof coating limits: BAAQMD, SJVUAPCD, Ventura County APCD, Imperial County APCD, and Kern County APCD (see figure below). In addition, stakeholders felt that they could not, at this time, formulate roof coatings which would be effective. This category will be reviewed in the future at which time we anticipate setting lower limits.

Figure 2-1 California Air Districts with Roof Coating Limits



2.4.3 Emissions Reduction Benefit

For its proposed SCM CARB performed an emissions reduction estimate based on 2004 sales survey data from California. CARB estimates that its proposed SCM will result in a 28% VOC emissions reduction in the architectural coatings sector in areas of California covered by the SCM. Ninety-five percent of these VOC reductions result from more stringent limits on the nine largest coating categories (flat; non-flat; non-flat high gloss; concrete/masonry sealer; dry fog; primer/sealer/undercoater; rust preventative; specialty primer/sealer/undercoater; and wood coatings).

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The 28% VOC emissions reduction predicted by CARB equates to a reduction of 15.2 tons of VOC per day in California. By assuming a similar per-capita reduction, the adoption of these VOC limits throughout the OTR would yield reductions of approximately 50.3 tpd.

In addition to the limits in the 2007 CARB SCM, the OTC model rule also includes a more stringent VOC limit for the Industrial Maintenance (IM) coating category that was included in the 2000 CARB SCM. The 2000 CARB SCM proposed a limit of 250 g/L with an optional limit of 340 g/L for colder climates. The 2002 OTC model rule included the 340 g/l due to concerns about the ability to comply in the colder Northeast climate. Because of the success in implementing the revised limit throughout California and the advent of t-butyl acetate as a delisted solvent, OTC believes a 250 g/L VOC limit is now feasible and has included this new lowered limit in its proposed new AIM model rule.

Considering the variations in the OTC model rule from the 2007 CARB SCM, including the lowered industrial maintenance coating reduction, OTR specific percent reductions in the architectural and industrial maintenance coating sector were calculated based on the CARB data. This resulted in the following reductions for the OTC model rule:

Flat, Non Flat % Reduction = 32.4%
Traffic Marking % Reduction = 9.7%
Industrial Maintenance % Reduction = 38%
Other Specialty Coatings % Reduction = 34.3%
Overall AIM Coating % Reduction (including all above inventory categories) = 33.7%

The calculations are provided in **Appendix A.**

2.4.4 Control Cost Estimate

For its proposed SCM, CARB did a study of affected businesses to determine the control costs that would be incurred. CARB estimates a per-limit cost-effectiveness ranging from a net savings to $13.90 per pound of VOC reduced, with an overall cost-effectiveness of $1.12 per pound of VOC reduced (in 2007 dollars). These values were based on the assumption that companies absorbed all costs (i.e. none were passed down to consumers) and may therefore be slightly inflated. CARB computed an average 2.1% decline in return on owner's return on equity (ROE—calculated by dividing net profit by net worth), and used this to gauge economic impact. CARB felt that this should not significantly impact the profitability of most businesses, although it may have a serious impact on the smallest operations. Overall, business profitability and job opportunities would not be significantly affected.

In addition to CARB's estimated costs related to the 2007 SCM, companies that sell coatings in OTC states will incur costs associated with lowering the VOC limit of the IM coating category. The 2000 CARB SCM calculated the cost-effectiveness of lowering the IM coating VOC limit from 340 g/L to 240 g/L to be $5.59 per pound of VOC reduced. Since companies have already had to reformulate their IM coatings to comply with this standard in California, costs to reformulate in OTC states can be expected to be lower.

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2.4.5 Emissions Reduction Benefits for Other Pollutants

Some VOCs can also be categorized as toxic air contaminants or hazardous air pollutants. Since VOC can also be a precursor to Particulate Matter of 2.5 microns in size ($PM_{2.5}$), the levels of that pollutant may be reduced as well.

2.5 Solvent Degreasing

2.5.1 Federal Standards

There is a 1994 ACT[9] and a more recent 2006 CTG or Control Techniques Guidelines[10] which reviews existing state rules for various solvent cleaning operations and draws conclusions and recommends certain types for inclusion in ozone non-attainment area state rules. A CTG is used by the EPA in lieu of a national rule. This particular CTG recommended for parts cleaning operations states should consider a VOC limit of the cleaning solution used of 50 grams per liter or a solvent with a vapor pressure at 20^{o}C of 8 mm Hg, which EPA considered to offer the same emissions level. We strongly disagree with this position as there have been no studies conducted linking the emissions from a solvent cleaner using a 50 gm VOC per liter solvent and emissions from a solvent cleaner using a VOC solvent with a vapor pressure of 8 mm Hg at 20 degrees C. According to the AP-42[11], evaporation of VOC from bulk solvent in a degreaser is only one avenue of cold cleaner emissions. One also has to consider drag-out losses which AP-42 studies show are more than losses from evaporation of bulk solvent from cold cleaners.

Current EPA regulations on solvent degreasers cover only the halogenated solvents (and machines that use them) such as MC, PCE, TCE, 1,1,1,-trichloroethane (TCA), halogenated solvent blends, or their vapors, used to remove soils such as grease, oils, waxes, carbon deposits, fluxes, and tars from metal, plastic, fiberglass, printed circuit boards, and other surfaces. Halogenated solvent cleaning is typically performed prior to processes such as painting, plating, inspection, repair, assembly, heat treatment, and machining. Types of solvent cleaning machines include, but are not limited to, batch vapor, in-line vapor, in-line cold, and batch cold solvent cleaning machines. Buckets, pails, and beakers with capacities of 7.6 liters (2 gallons) or less are not considered solvent cleaning machines. Halogenated solvent cleaning does not constitute a distinct industrial category, but is an integral part of many major industries. As part of the SCAQMD Rule 1122 “Solvent Degreasers”[12], stakeholders asked that the EPA requirements for halogenated solvents be added to Rule 1122. In preparing the OTC model rule, the team did not adopt that approach.

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[9] Alternative Control Techniques Document “Industrial Cleaning Solvents”, February 1994, EPA-453/R-94-015, NTIS PB94-181-694

[10] Control Techniques Guidelines for “Industrial Solvent Cleaning “, EPA 453/R-06-001, September 2006

[11] AP-42 Fifth Edition, Volume 1, Chapter 4 “Evaporation Source Losses”, Section 4.6 “Solvent Degreasing”, April 1981.

[12] “Staff Report for Proposed Amended Rule 1122 – Solvent Degreasers” by Rizaldy Calungcagin, 2001.

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On May 3, 2007, EPA issued a final rule on Halogenated Solvent Cleaners (as part of National Air Emission Standards for Hazardous Air Pollutants), promulgating a facility-wide emission limit of 60,000 kg/yr MC equivalent[13]:

Table 2-4 Emission Limits for Halogenated Solvent Cleaners

TABLE 1.—SUMMARY OF THE PROPOSED FACILITY-WIDE ANNUAL EMISSION LIMITS

Solvents emitted	Proposed facility-wide annual emission limits in kg/yr—option 1	Proposed facility-wide annual emission limits in kg/yr—option 2
PCE only	[a] 3,200 [b] (26,700)	[a] 2,000 [b] (16,700)
TCE only	10,000	6,250
MC only	40,000	25,000
Multiple solvents—Calculate the MC-weighted emissions using equation 1	40,000	25,000

[a] *PCE emission limit calculated using California EPA (CalEPA) Unit Risk Estimate (URE).*
[b] *PCE emission limit calculated using the EPA Office of Prevention, Pesticides and Toxic Substances (OPPTS) Unit Risk Estimate (URE).*

2.5.2 California's South Coast Air Quality Management District (SCAQMD) Standards

SCAQMD's solvent cleaning rule in effect since 1979 has been revised and made more stringent over the years to attain ever lower VOC emissions. SCAQMD has two key components in its ozone reduction strategy "Rule 1171 - Solvent Cleaning Operations" and "Rule 1122 - Solvent Degreasers" which are used in tandem to control VOC emissions from numerous uses of solvents in industrial, commercial, and general purpose cleaning and degreasing activities and solvent waste generated during production, repair, maintenance, or servicing of products, tools, machinery, and general work areas. SCAQMD dropped the use of vapor pressure to set a VOC limit at 50 g/l in Rule 1171 in 1999 when material VOC calculations were introduced, and later adopted the limit into Rule 1122.

Rule 1122 as revised on 9/1/2001, lowered material VOC limits for all cold cleaners from 50 g/l to 25 g/l effective 1/1/2003. All vapor degreasers required a solvent VOC of 25 g/l or less effective 1/1/2006 (prior to which there were no VOC limits for vapor degreasers).

SCAQMD Rule 1122 as revised on 5/1/2009, served as the model for the proposed OTC model rule using the VOC limits defined in the 9/1/2001 revision and dropping the NESHAP halogenated solvents provisions. We also did not extend the SCAQMD 25 g/l VOC limit to vapor degreasers, but left them the same as the OTC 2002 rule required. Since vapor degreasing accounts for only a small percentage of total degreasing (8 % or less) the impact on VOC reductions is minimal. Other changes from the old model rule were to (1) allow cold cleaners to use heated (but non-boiling) cleaning solvent (2) apply to all types of parts not just metal parts (3)set a VOC solvent content limit of 150 grams VOC per liter for cleaning printed circuit boards and related electronic parts (4) set no lower size limit for cold cleaners (was contain more than one liter of VOC) and (5) clarify the difference between in-line cold and in-line vapor cleaning machines.

[13] EPA May 3, 2007, FR 72 (No. 85) 40 CFR Part 63: Final rule - National Air Emission Standards for Hazardous Air Pollutants: Halogenated Solvent Cleaning. https://www3.epa.gov/ttn/caaa/t3/fr_notices/degreasfinalfr2007.pdf

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2.5.3 OTC Measure / Model Rule

The OTC Model Rule addresses control measures for VOC emissions from cold cleaning machines (the major source of solvent degreasing VOC emissions), open-top vapor degreasers, all types of conveyorized degreasers, and air-tight and airless cleaning systems that carry out solvent degreasing operations with a VOC-containing solvent. Batch and conveyorized cold (non-boiling) degreasers will use solvent with a material VOC content of 25 g/l or less. The cleaning solvent vapor pressure limit (1.0 mmHg) for cold cleaning defined in the former 2001 OTC Model Rule on “Solvents and Cleaners” will no longer be applicable. Open-top and conveyorized vapor degreasers and airless and airtight cleaning systems regulation will remain essentially the same as in the 2001 model rule. However, unlike the 2001 model rule, the regulated degreasing will now include all substrates and not be limited to metal parts. Electronic manufacturers requested the VOC limit be raised for printed circuit board cleaning and related electronic parts. After some discussion a limit of 150 grams VOC per liter was established.

Issues: Without close attention to special exemptions for small but critical operations such as aerospace, medical, specialized electronics, etc., significant resistance may be encountered. Most of this resistance will likely be based upon a lack of understanding of a technology (water-based parts cleaning) foreign to the user. State stakeholders will likely need help in gaining acceptance of this technology. Exemptions for specialized operations may tend to be higher than in other rules and are somewhat state-specific (i.e. since the OTC model rule cannot include specialized operations that are specific to only a few states, each state may be required to search out these specialized operations). Forgoing regulation of vapor degreasing as practiced in SCAQMD (where they now require a solvent limit of 25 g/l in vapor degreasers) removed many potentially adverse stakeholder concerns with this solvent degreaser model rule.

2.5.4 Emissions Reduction Benefit

The 2001 Pechan Report[14] covering the then current OTC control measures stated that VOC emissions in the OTR, following the adoption of the 2001 OTC Model Rule for Solvent Cleaning, would be 1.2 pounds per capita per year. This was based upon a control effectiveness of 66%, a rule penetration of 100%, and a rule effectiveness of 100%. Based upon an estimate of the 2014 population in the OTC region of 67 million people this would correlate with VOC emissions of 111 tpd in the OTR. Assuming that cold cleaning represents 92% of the total degreasing machine universe, the OTR emissions from cold cleaners would be 102 tpd. In 2003, the SCAQMD Rule 1122 operating at 25 g/l for cold degreasers and without a VOC limit for vapor degreasing, had emissions of 3.14 tpd. Extrapolating those emissions from 2003 SCAQMD (whose population then was 16.5 million) to the OTR in 2014 gives the region VOC emissions from cold cleaners in 2014 of 12.8 tons/day from cold cleaners. Then the VOC reduction experienced in the OTC region in 2014 would be 102 - 12.8 tpd = ~89 tpd in the OTR.

[14] Pechan Report on Control Measure Development Support Analysis of Ozone Transport Commission Model Rules, March 31 2001. http://www.ct.gov/deep/lib/deep/air/ozone/ozone_sip_revision/pec.pdf

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Later, an arbitrary safety factor was applied to the expected VOC reduction in the OTR resulting in a VOC reduction of 81 tpd[15]. Applying this reduction to the 111 solvent degreasing emissions in the OTR post-2002 model rule results in 81/111 = 73% reduction.

2.5.5 Control Cost Estimate

Control costs are expected to be in the range of $1,400 per ton VOC reduced, based on data presented in the SCAQMD Staff Report for the 2001 amendments to Rule 1122.

2.5.6 Emissions Reduction Benefits for Other Pollutants

Halogenated solvents, like perchloroethylene, may be used under this new solvent degreaser model rule (they are not banned) but then the federal NESHAP rule will regulate certain aspects of that solvents use. States are encouraged to add such restrictions to their rendition of the new solvent degreasing model rule as they require. The federal rule can be found at 40 CFR Part 63 Subpart T. Note that if the concentration of the covered halogenated solvents is below 5 wt % then Subpart T is not applicable.

2.6 Appendices

2.6.1 Appendix A: Data spreadsheets on VOC emissions calculations

[15] Ali Mirzakhalili (DE) in OTC Stationary Area Sources presentation, 03/12/2012. http://www.otcair.org/upload/Documents/Meeting%20Materials/OTC%20SAS%20Committee%20-%20Annual%20Meeting%202012.pdf

3.0 NITROGEN OXIDES (NOx) ANALYSIS METHODS

This section describes the analysis of the 2009/2010 OTC control measures to reduce NO_x emissions from four source categories:

1. Stationary Generators;
2. New Natural Gas-Fired Boilers, Steam Generators, Process Heaters, and Water Heaters 75,000 BTUs/hr to 5,000,000 BTUs/hr;
3. High Electric Demand Day Combustion Turbines (HEDDCT); and
4. Oil and Gas Boilers Serving Electricity Generating Units (EGUs).

For each of the categories, there are separate subsections that discuss existing Federal and state rules, summarize the requirements of the model OTC control measures, and describe the methods used to quantify the emissions reduction benefit, provide an estimate of the anticipated costs of the control measure, and identify other emissions reduction benefits.

3.1 Stationary Generators

Fossil fuel-fired generators powered by reciprocating internal combustion engines emit very high rates of air contaminants, and contribute to the formation of ground-level ozone and fine particulate matter. Among other things, the purpose of a stationary generator regulation is to help ensure that the air emissions from new and existing stationary generators do not cause or contribute to these existing air quality problems; on a rate, tons per day (TPD), or tons per year (TPY) basis. A stationary generator regulation would require emissions standards, recordkeeping, reporting, operating, and notification requirements for stationary generators, both for emergency and non-emergency uses. The model regulation also allows non-emergency generators to take credit for fuels that would otherwise be flared, combined heat and power applications, and the use of non-emitting resources.

Emergency generators have an important function in providing electricity when there is grid failure and alternative electricity generation is needed in order to avoid damages and loss. For example, hospitals and other health care facilities use emergency backup generators to provide power whenever ordinary electric service is not available. Emergency situations that require backup generation may occur at any time of the year.

Some organizations that aggregate stationary generators for the financial benefit of participating in wholesale demand response programs have noted the ability of these stationary generators to forestall serious voltage changes or electrical blackout and, therefore, request the ability to operate additional hours under “emergency demand response” conditions in order to avoid potential operation problems on the system. However, such requested additional operating hours could cover a wide range of operational conditions that occur on the system, from a reserve shortage deficiency to actual brownouts and blackouts. No one would deny that these stationary generators, as a last resort, could certainly help forestall serious system emergencies. Operation of such generators outside of periods of system emergencies may result in significant financial gains for the generator owners and may result in operation of these stationary generators during peak demand periods rather than only during periods of actual system emergencies. In fact, the ability for these stationary generators to participate in demand response markets may actually move the economic dispatch curve, such that these types of aggregated units could be available at a lower cost on the dispatch curve displacing somewhat higher cost, but more efficient and cleaner generation.

Nonetheless, electric utilities have devised demand response programs that are contrary to the anticipated use of emergency power generation and whose impacts are directly and adversely related to increased air emissions. Not only do these generators used for demand response emit hazardous air pollutants during this contrary operation, such operation often occurs exactly when conditions leading to the formation of ground-level ozone are at their worst, on the hottest days of the summer. Older generators are very high NO_x emitters, and non-emergency generation during peaking times has the potential to increase emissions. Thus, the OTC stationary generator model regulation aims to ensure that the emissions from all stationary generation, for both emergency and non-emergency uses, are controlled.

3.1.1 Federal Standards

The federal standards which apply to stationary generators are covered by the New Source Performance Standards (NSPS) for compression-ignition and spark-ignited engines (40 CFR Part 60, Subparts IIII and JJJJ, respectively). The NSPS requirements set emissions standards which must be met by manufacturers of new stationary engines, both for emergency and non-emergency use, but owners and operators of stationary engines must follow these requirements as well. While the NSPS sets emissions standards for the criteria pollutants of NOx, CO, PM, and HC, the National Emissions Standards for Hazardous Air Pollutants (NESHAP) for Reciprocating Internal Combustion Engines (RICE) helps to control hazardous air pollutants (HAP). Under the RICE NESHAP (40 CFR Part 63, Subpart ZZZZ), CO emissions standards are set in order to control HAPs, based upon EPA's determination that CO is a suitable surrogate for controlling HAPs.

3.1.2 The OTC Measure

Specifically, the OTC model rule would apply to all stationary generators (new and existing, as well as emergency and non-emergency) in a state, which have a standby power rating of X kW or less (as determined by the state). The following types of generators would be exempt from the model rule:

- engines used at a nuclear power plant as an emergency generator, which are subject to regulations of the Nuclear Regulatory Commission (NRC);
- marine internal combustion engines operated by the United States Navy for the purpose of testing and operational training;
- mobile generators; or
- generators with a standby power rating of X kW or less (as determined by the state).

No specific control technology is being recommended, since the regulation would be technology and fuel neutral. Existing, emergency generators should be compliant no later than 30 days after the adoption of the measure, and existing, non-emergency generators should be compliant within 1 year after the adoption of the measure. New generators should be compliant prior to initial operation. Non-emergency generators must verify their compliance with the applicable emissions standards every five years.

For new, emergency generators, compliance with EPA's New Sources Performance Standard (NSPS) is required. For new, non-emergency generators, the emissions standards would be equivalent to the most stringent requirements under the NSPS standards, as shown in Table 3-1:

Table 3-1 New Sources Performance Standard for non-emergency generators

Pollutant	Emission Standards	
	lb/MWh	g/kWh
Nitrogen Oxides	0.88	0.4
Nonmethane Hydrocarbons	0.41	0.19
Particulate Matter (liquid-fueled reciprocating engines only)	0.044	0.02
Carbon Monoxide	7.7	3.5

For all new, non-emergency generators fueled by waste or landfill gases, the emissions standards would be as listed in Table 3-2:

Table 3-2 Emissions standards for all new, non-emergency generators fueled by waste or landfill gases

Pollutant	Emission Standards (lbs/MWh)	Emission Standards (g/kWh)
Nitrogen Oxides	2.2	1.0
Non-methane Hydrocarbons	0.7	0.32
Carbon Monoxide	10.0	4.5

For existing, non-emergency generators, the emissions standard would be as listed in Table 3-3:

Table 3-3 Emissions standard for existing, non-emergency generators

Pollutant	Emission Standard (lbs/MWh)	Emission Standard (g/kWh)
Nitrogen Oxides	4.0	1.8
Non-methane Hydrocarbons	1.9	0.86
Particulate Matter (liquid-fueled reciprocating engines only)	0.7	0.32
Carbon Monoxide	10.0	4.5

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The final control measure does not include alternate carbon monoxide (CO) standards based upon EPA's 3/3/10 promulgation of amendments to 40CFR63 Subpart ZZZZ (RICE NESHAP) requirements. Instead it includes a note to the implementing state that the Subpart ZZZZ CO requirements may be more stringent, depending on the specific circumstances. EPA included a requirement for applicable engines to use ultra low sulfur diesel fuel (15ppm S) as part of the amendments to the RICE NESHAP. The control measure will incorporate such a requirement in order to control emissions of sulfur dioxide.

A concern has been raised about the validity of requiring the generators to meet the emissions standards "at all times," including times of startup, shutdown, and malfunction (SSM). Since the emissions of a generator may not be ideal during SSM due to exhaust temperatures and other variables, it is hard to expect a generator to meet the emissions standards "at all times". In order to alleviate this, the language of the model control measure requires generators to meet applicable emissions standards "under full load design conditions or at the load conditions specified by the applicable testing methods." The use of this language would ensure that the generator is compliant with the required emissions standards outside of SSM conditions. Further, the model regulation requires add-on controls to be operating within 10 minutes after startup, or as soon as reasonable per the manufacturer's guidance for the particular unit.

The OTC model rule requires that monthly and yearly records of the following data be recorded and maintained on the property where the generator is located:

- Fuel usage, by type;
- Operating hours for each generator, via the use of a non-resettable hour meter; and
- Operating, maintenance, and testing hours.

All records should be kept for 5 years. There is an optional provision at the end of the recordkeeping section that could require non-emergency generators to submit their records to the state on an annual basis.

Furthermore, no emergency generator may operate for testing or maintenance purposes on any day when air quality is predicted by the State or designated Agency to be at least "unhealthy for sensitive groups" as defined in the U.S. EPA's Air Quality Index. Each and every generator must register with the state permitting authority by submitting the following data:

- Generator owner's name, address, and telephone number;
- The physical address of the generator, along with lat/long coordinates;
- The make, model, and serial number of the generator;
- The manufacture date and installation date of the generator;
- The standby power rating and prime power rating (if known); and
- A declaration of the use of the generator: emergency or non-emergency.

3.1.3 Emissions Reduction Benefit

The OTC model rule, if adopted, would require new, emergency generators to meet emissions standards set by EPA, which would ensure that all new installations would at

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least be meeting a minimum level of control. For existing, non-emergency generators, each generator would be required to make an approximate 90% reduction in its NO_x emissions. Each new, non-emergency generator would be required to make an approximate 90% reduction in their NO_x emissions beyond the EPA standards for manufacturers of emergency generators. As for estimating emission reductions from non-emergency generators, the number of units in a state would have to be known in order to estimate total reductions from the amount of NO_x emissions reduced per generator.

NESCAUM's report titled "Stationary Diesels in the Northeast" lists the estimated number of diesel engines in the NESCAUM region by number and capacity. The list from the NESCAUM report is shown below in Table 3-4:

Table 3-4 Stationary Diesels in the Northeast region by number and capacity

Number Totals	Emergency	Peak	Baseload	Total		Capacity Totals (MW)	Emergency	Peak	Baseload	Total
25-50 kW	1,768	0	0	**1,768**		**25-50 kW**	59	0	0	**59**
50-100 kW	5,798	1,375	107	**7,280**		**50-100 kW**	462	114	9	**584**
100-250 kW	9,226	2,236	95	**11,557**		**100-250 kW**	1,564	371	14	**1,949**
250-500 kW	5,918	1,231	7	**7,156**		**250-500 kW**	2,126	443	3	**2,572**
500-750 kW	1,296	316	47	**1,659**		**500-750 kW**	801	196	29	**1,026**
750-1000 kW	1,164	292	51	**1,507**		**750-1000 kW**	921	230	40	**1,191**
1000-1500 kW	641	677	39	**1,357**		**1000-1500 kW**	769	837	48	**1,654**
1500+ kW	1,073	284	37	**1,394**		**1500+ kW**	2,053	615	68	**2,736**
Total	**26,884**	**6,411**	**383**	**33,678**		**Total**	**8,756**	**2,805**	**211**	**11,772**

The NESCAUM report does not estimate emissions for all of these engines because of the significant uncertainties associated with the more general estimates of engine population and because information on actual engine operation is not available for the broader region. Since the existing emergency engines would not have any emissions standards applied to them, there would be no reduction benefit if the OTC model rule were applied region-wide. For the peak and baseload engines, their combined capacity would have the potential to emit about 48 tons of NO_x for every hour of operation (based upon the assumption of no controls on the engine and an average emission factor of 32 lb/MWh NO_x, per AP-42). If these peak and baseload engines were controlled, their emissions

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could be reduced by approximately 90%, which would result in a regional reduction of about 43 tons of NO_x for every hour of operation.

3.1.4 Control Cost Estimate

Based upon one case in Delaware, the estimated cost to retrofit a 1-2 MW, 1950's diesel generator with selective catalytic reduction (SCR) technology ranged from $39,700 to $79,700 per ton-per-day of NO_x reduced. As for system costs, estimates from Boulden Energy Systems in Pennsylvania run between $145,000 to $165,000 for SCR systems designed for generators between 1750 kW and 2500 kW. Another SCR retrofit on a 1MW generator in Delaware had an estimate of $180,000 for a complete installation.

3.1.5 Emissions Reduction Benefits for Other Pollutants

The OTC model rule includes emission standards for NO_x, NMHC, PM, and CO for non-emergency generators. Additionally, the NSPS standards (which would apply to new, emergency generators) would include NO_x, NMHC, CO, and PM standards. If implemented, CO standards would also help control HAP emissions, via EPA's assumption that controls for CO will help to reduce formaldehyde emissions, a major component of stationary engine emissions.

3.2 New Natural Gas-Fired Boilers, Steam Generators, Process Heaters, and Water Heaters; 75,000 BTUs/hr to 5,000,000 BTUs/hr

3.2.1 Federal Standards

There are no EPA NO_x emission limits for individual units of this size. The only federal standards are U.S. Department of Energy (U.S. DOE) energy conservation standards (manufacturer standards) for residential water heaters, direct heating equipment and pool heaters that can be found in 10 CFR 430.

3.2.2 The OTC Measure

The provisions of this OTC model rule limit NO_x emissions from **new**, small, natural gas-fired, industrial, commercial, institutional and residential boilers, steam generators, process heaters, and water heaters, 75,000 BTUs/hr to 5,000,000 BTUs/hr. Manufacturers generally comply with the rule by using ultra low NO_x burners (ULNBs) to control emissions.

This model rule contains specific NOx emission limits for three sizes (three types) of units ranging from 75,000 Btu per hour heat input up to 5.0 million Btu per hour heat input. On June 3, 2010, the OTC adopted a Resolution, wherein member states agreed to pursue, as necessary and appropriate, state-specific rulemakings to update state rules in accordance with this model rule. The rule was updated by the OTC workgroup on August 31, 2011.

The emission limits of this model rule were developed from requirements in effect in certain jurisdictions, including: (1) San Joaquin Valley Air Pollution Control District Rule 4308 for boilers, steam generators, process heaters and water heaters with maximum rated heat input capacity equal to or greater than 75,000 Btu/hr and up to but less than

2.0 million Btu/hr; (2) San Joaquin Valley Air Pollution Control District Rule 4307 for gas-fired and liquid fuel-fired boilers, steam generators, and process heaters with maximum rated capacity of 2.0 million Btu/hr up to and including 5.0 million Btu/hr; (3) South Coast Air Quality Management District (SCAQMD) Rules 1146.1 and 1146.2 and other similar rules adopted by other California Air Pollution Control Districts and the State of Texas.

The OTC model rule NOx limits apply to any person who manufactures, distributes, supplies or imports for sale, lease or rent in (State), sells or offers for sale in (State), installs or solicits the installation of in (State), any **new** or replacement natural gas-fired boiler. The OTC model rule regulates small boilers, steam generators, process heaters, and water heaters by size as follows:

a. Type 1 unit – maximum rated heat input capacity greater than or equal to 75,000 Btu/hr, but no more than 400,000 Btu/hr;
b. Type 2 unit – maximum rated heat input capacity greater than 400,000 Btu/hr but less than 2.0 million Btu/hr; and
c. Type 3 unit – maximum rated heat input capacity of 2.0 million Btu/hr up to and including 5.0 million Btu/hr

The OTC model rule does not apply to the following units:

a. Units using a fuel other than natural gas;
b. Units used in recreational vehicles;
c. Units installed in manufactured homes;
d. Humidifiers, where the products of combustion come into direct contact with the material to be heated;
e. Units intended for shipment and use outside of state X

The specific NOx emission limits contained in the model rule are shown below in Table 3-5

Table 3-5 Specific NOx emission limits contained in the model rule

NOx Emission Limits for New Small Natural Gas-Fired Boilers, Steam Generators, Process Heaters & Water Heaters 75,000 BTUs/hr to 5,000,000 BTUs/hr			
Unit Type	**Unit Size (MMBtu/hr)**	**NOx Emission Limit (lbs/MMBtu @ 3.0% O_2 dry basis)**	**Compliance Method**
Type 1	0.075 – 0.400	0.093	Certified Product*
Type 2	>0.400 – <2.00	0.036	Certified Product*
Type 3	2.00 – 5.00	0.014 (or 12 ppmv) (atmospheric units)	Certified Product or Source Test**
		0.011 (or 9 ppmv) (non-atmospheric units)	

Note(s): *SJVAPCD uses certified products - SJVAPCD rule 4308.
**SJVAPCD uses certified products <u>or</u> source tests - SJVAPCD rule 4307

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There are also optional sections in the model rule for states for Type 3 units only for combustion tune-ups, a compliance certification program, compliance monitoring, record keeping and reporting. If a state chooses these options that apply to owners/operators of Type 3 units, they also have the option to adopt one or both of the following exemptions, for these owner/operator sections only (not for the sale of new units):

1. Units located in residential dwellings designed for 4 or fewer families;
2. Units burning less than 9,000 therms of gas per calendar year based on gas bills;

3.2.3 Emissions Reduction Benefit

Emission Reductions for the OTR were estimated using the emission reduction calculations from the San Joaquin Valley Air Pollution Control District (SJVAPCD) Rule proposals for rules 4307 and 4308, upon which the OTC model rule was based. Estimates were calculated proportioning emission reductions by natural gas usage. Since the rule regulates the sale of new units, emission reductions are achieved with the turnover of old units being replaced with new units. The calculations assume a 15 year turnover rate starting in 2014.

The results of these calculations are summarized below in Table 3-6:

Table 3-6 Estimated NOx Reductions from New Small Boiler Rule

Estimated NOx Reductions from New Small Boiler Rule (1)			
OTC States	**2029 Total Emission Reduction Estimates (tons per year)**	**2029 Total Emission Reduction Estimates (tons per day)**	**2021 Total Emission Reduction Estimates (tons per day)**
	Annual	**Summer**	**Summer**
Connecticut	917	1.46	0.73
Delaware	252	0.40	0.20
D.C.	153	0.24	0.12
Maine	357	0.57	0.28
Maryland	957	1.53	0.76
Massachusetts	1,978	3.15	1.58
New Hampshire	278	0.44	0.22
New Jersey	3,004	4.79	2.39
New York	5,507	8.77	4.39
Pennsylvania	3,953	6.30	3.15
Rhode Island	433	0.69	0.34
Vermont	39	0.06	0.03
Virginia (partial)	509	0.81	0.41
OTR Total	**18,334**	**29.21**	**14.61**

Notes:

1. Assumes a 2014 effective date of rule and 15 year implementation based on turnover of equipment

Additional calculations were performed proportioning emission reductions by population. The results for the total OTR emissions were the same. There were some variations by state, as certain states use more natural gas than others regardless of population. Therefore, the natural gas estimates are more representative for the model rule.

More detailed calculations can be found in Appendix B.

3.2.4 Control Cost Estimates

The SJVAPCD performed a cost effectiveness analysis for Rule 4308 (75,000 Btu/hr to 2.0 million Btu/hr, Type 1 and Type 2 units in this model rule), which can be found in Appendix C of the Final Draft Staff report for the SJVAPCD rule dated October 20, 2005. District staff found that the technology to reduce NO_x emissions from this category of boilers, steam generators, and process heaters was currently available and that most small boiler manufacturers offer at least one model that meets the limits in Rule 4308. The estimated cost effectiveness ranged from a savings of \$1,108 to \$2,775 per ton NO_x reduced for larger units and the cost effectiveness for smaller units ranged from \$187 to \$5,385 per ton of NO_x reduced.

The SJVAPCD performed a cost effectiveness analysis for Rule 4307 (2.0 million Btu/hr to 5.0 million Btu/hr, Type 3 units in this model rule), which can be found in Appendix C of the Proposed Rule Amendments dated October 16, 2008. In that analysis, District staff found that the average cost effectiveness for low NO_x burners (30 ppmv to 9 ppmv) was from \$12,000/ton to \$18,000/ton and the absolute cost effective range was \$10,000/ton to \$23,000/ton.

District staff also found that the average cost effectiveness for a new ultra low NO_x burner (30 ppmv to 9 ppmv) was \$100,000/ton and the absolute cost effectiveness range was \$58,000/ton to \$130,000/ton. For a retrofit ultra low NO_x burner (30 ppmv to 9 ppmv) District staff found that the average cost effectiveness was \$7,700/ton and that the absolute cost effectiveness range was \$3,300/ton to \$16,000/ton. The term "average value" is the average for the range of units with the spread indicating the different fuel usages that were analyzed. The "absolute value" is the lowest and the highest values calculated for a given compliance scenario and typically represents the cost for larger, high use units and smaller low use units.

3.2.5 Emissions Reduction Benefits for Other Pollutants

NOx is a precursor to particulate matter, therefore, reduction of NOx also reductions particulate matter. Greenhouse Gas emissions might also be reduced due to increased burner combustion efficiencies resulting in less pollution and/or decreased fuel usage.

3.3. Performance Standards for High Electric Demand Day Combustion Turbines (HEDDCT)

This OTC model rule applies to high electric demand day combustion turbines (HEDDCT). For the purpose of this rule, a HEDDCT is defined as a [5 – 15] megawatts (MW) or larger (depending on distribution of generating units in individual states) natural gas or distillate fuel oil fired combustion turbine that generates electricity, at least part of which is delivered to the power grid for commercial sale, that began operating prior to May 1, 2007 and was operated less than or equal to 50 percent of the time during the ozone seasons of 2007 through 2009. Boilers serving EGUs and Distributed Generators are not addressed by this rule; instead they are covered under a separate OTC model rule.

This rule is an update to the June 13, 2007 OTC MOU that resolves to develop long-term NOx performance standards on High Electric Demand Days for these units. On November 10, 2010, the OTC adopted a Resolution, wherein member states agreed to pursue, as necessary and appropriate, state-specific rulemakings to update state rules in accordance with the 2009 OTC Performance Standards for High Electric Demand Day Combustion Turbines (HEDDCT) Model Rule.

3.3.1 Federal Standards

Table 3-7 summarizes the applicable Federal New Source Performance Standards (NSPS).

Table 3-7 Federal Maximum Allowable Emission Limits of NOx for New Turbines

Federal Regulations	40 CFR 60.4300 NSPS Subpart KKKK (Effective After 2/18/05) (Source: 71 FR 38497, July 6, 2006)
Pollutant	NO_x
Performance Standards	**Natural Gas** **Construction:** <=50 MMBtu/hr: 2.3 pounds/MWh or 42 ppm >50 and <=850 MMBtu/hr: 1.2 pounds/MWh or 25 ppm >850 MMBtu/hr: 0.43 pounds/MWh or 15 ppm **Reconstruction:** <=50 MMBtu/hr: 8.7 pounds/MWh or 150 ppm >50 and <=850 MMBtu/hr: 2.0 pounds/MWh or 42 ppm >850 MMBtu/hr: 0.43 pounds/MWh or 15 ppm **Modification:** <=50 MMBtu/hr: 8.7 pounds/MWh or 150 ppm >50 and <=850 MMBtu/hr: 2.0 pounds/MWh or 42 ppm >850 MMBtu/hr: 0.43 pounds/MWh or 15 ppm **Oil** **Construction:** <=50 MMBtu/hr: 5.5 pounds/MWh or 96 ppm >50 and <=850 MMBtu/hr: 3.6 pounds/MWh or 74 ppm >850 MMBtu/hr: 1.3 pounds/MWh or 42 ppm **Reconstruction:** <=50 MMBtu/hr: 8.7 pounds/MWh or 150 ppm >50 and <=850 MMBtu/hr: 4.7 pounds/MWh or 96 ppm >850 MMBtu/hr: 1.3 pounds/MWh or 42 ppm **Modification:** <=50 MMBtu/hr: 8.7 pounds/MWh or 150 ppm >50 and <=850 MMBtu/hr: 4.7 pounds/MWh or 96 ppm >850 MMBtu/hr: 1.3 pounds/MWh or 42 ppm

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Note: 50 MMBtu/hr is equivalent to 14.65 MWh; 850 MMBtu/hr is equivalent to 249.11 MWh

3.3.2 The OTC Measure

3.3.2.1 Performance Standards

The model rule requires HEDDCTs to meet the NO_x performance standards in Table 3-8.

Table 3-8 Performance Standards for HEDDCT
(Effective May 1, 2015)

Type of Turbine	Type of Fuel[4]	NO_x Emission Rate[1]			Compliance Period[3]
		lb/MWh[2]	lb/MMBtu	ppm @15% O_2	
Combined Cycle or Regenerative Cycle	Natural Gas	0.75	0.10	25	24-hour average
	Distillate Fuel Oil	1.20	0.16	42	24-hour average
Simple cycle	Natural Gas	1.00	0.10	25	24-hour average
	Distillate Fuel Oil	1.60	0.16	42	24-hour average

[1] Or as specified in a permit if a more stringent emission limit is imposed by PSD or a more stringent State requirement.
[2] lb/MWh emission rates calculated using an efficiency of 35% for simple cycle CTs and 46% for combined cycle CTs [lb/MWh = lb/MMBtu * 3.413 / efficiency]
[3] Between May 1 and September 30 over each calendar day <or a 24-hour rolling average>; and from October 1 through April 30 of the following year, over the 30-day period ending on each such day.
[4] The above emission limits shall apply to all turbines that combust natural gas or distillate fuel oil by themselves. For turbines that combust a mixture of natural gas and distillate fuel oil, the applicable emission limit shall be determined by calculating a weighted average of the above emission limits based on the amount (as measured in heat input) of each fuel that is combusted.

The proposed NO_x emission limits in Table 3-7 would apply to any HEDDCT during all periods of electric generation. However such turbines could be exempt from these emission limits during the following periods of operation:

- Startup - The period of time beginning when combustion of fuel in the turbine commences and ending when generation of electricity begins.
- Shutdown - The period of time beginning when generation of electricity ceases and ending when combustion of fuel in the turbine ceases.
- The duration of startup and shutdown shall not exceed 10 minutes unless the manufacturer of the turbine or control device recommends a longer startup or shutdown period or a longer period is approved in an existing permit.

3.3.2.2 Combustion Process Adjustment

The model rule requires that the turbine's combustion process be adjusted as recommended in the manufacturer's maintenance guide and schedule.

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3.3.2.3 Alternate RACT Provision

The model rule provides an alternative to complying with the emission limits in 4.3.2.1. The alternative is only available if a HEDDCT is unable to comply with the performance standards listed in Table 3-7. An evaluation of any available control devices must be performed to demonstrate that the available controls would be either technically or economically infeasible for that turbine. If any control device or method of modifying the turbine or the turbine operation to reduce NO_x emissions is technically and economically feasible, it must be applied, even if it does not reduce the NO_x emissions enough to comply with the above limits. The permitting agency may then approve an alternative emission limit that is higher than the performance standards listed above but is determined to be reasonably achievable by that turbine.

In most cases, the performance standards can be achieved by applying one of the control methods listed in Table 3-9. These control methods are widely used in industry throughout the United States and are reasonably available given their extensive use.

Table 3-9 Reasonably Available NO_x Emission Control Technologies for HEDDCT

Fuel Type	Available Control Methods[16]	Expected Emission Reduction
Primary (pollution prevention):		
Natural Gas, Distillate Fuel Oil	Water Injection (WI)	40%
Natural Gas	Dry Low NO_x Combustors (DLN)	90%
Secondary (add-on control):		
Natural Gas, Distillate Fuel Oil	Selective Catalytic Reduction (SCR)	70 – 90%[17]

3.3.3 Emissions Reduction Benefit

The expected emission reduction resulting from adoption of the OTC HEDDCT model rule region-wide is a preliminary estimate based on actual NO_x emissions from HEDDCT in the 2007 ozone season.[18] Assumptions include that all HEDDCT currently utilize water injection to reduce NO_x emissions by 40% and add on control, such as Selective Catalytic Reduction (SCR) which is capable of achieving 90% efficiency, would be necessary to

[16] Northeast States for Coordinated Air Use Management (NESCAUM). "Status Report on NOx controls for Gas Turbines, Cement Kilns, Industrial boilers, Internal Combustion Engines Technologies & cost Effectiveness" December, 2000.
[17] United States Environmental Protection Agency (EPA). "Technical Bulletin Nitrogen Oxides (NO_x), Why and How They are Controlled" EPA 456/F-99-006R. November, 1999.
[18] 2007 CAMD database for HEDD units within the OTR provided by MARAMA

achieve the proposed limits. Total NO_x from all units is 5000 (tons per 2007 O_3 season) based on:

- Reduction = 5000 TPY x (90 - 40)/100 control efficiency = **2500** in tons per O_3 season.

Additional reductions may be obtained if turbines are shut down, over-controlled or replaced with state of the art turbines. In addition, additional reductions may be obtained by units which do not currently have water injection installed on them, as was conservatively assumed.

If all current New Jersey HEDDCTs comply with these applicable emission limits, New Jersey specific emission reductions are expected to be at about 55 tons per day on a HEDD similar to July 26, 2005.

3.3.4 Control Cost Estimates

Compliance with the proposed emission limits assumes that existing HEDD turbines will either install control or be replaced. The cost effectiveness of installing water injection is approximately $44,000 per ton of "ozone day" NO_x emission reductions for a peaking turbine with low capacity factor.[19] This is equivalent to $4400 per ton for calendar year reductions. Dividing by a factor of 10 approximates the cost effectiveness of continuous operation, assuming 36 days per year of ozone season operation. SCR technology has advanced in recent years and is technically feasible for both low- and high-temperature turbine applications. The cost effectiveness of SCR depends on the size and type of turbine, capacity factor, and baseline NO_x emissions in particular. For example the range of retrofit costs of SCR for a 75 MW simple cycle turbine having a capacity factor of 0.45 can vary from $1,800 to $20,000. The ozone season cost effectiveness for turbine retrofits with DLN range from $1,100 to $9,000 depending on the capacity factor and percent reduction.[20] The total_replacement cost, including maintenance and operation, for a simple cycle combustion turbine ranges from $0.5 to 0.8 million per MW. [6]

3.3.5 Emissions Reduction Benefits for Other Pollutants

Not applicable to this measure.

3.4 Oil and Gas Boilers Serving Electric Generating Units (EGUs)

The OTC model rule seeks to regulate oil-fired and gas-fired boilers that provide steam to an electric generating unit with a nameplate capacity of 25 MW or greater. This includes a unit serving a cogeneration facility. This model rule would not apply to any boiler that serves a HEDD unit if the NO_x emissions from that boiler are already controlled by a HEDD rule or regulation which is effective during all periods of boiler operation on an annual basis. The proposed model rule assumes use of low NO_x burners and/or a selective non-catalytic reduction system on existing oil and gas-fired boilers. These control devices are used widely in industry throughout the United States and are reasonably available given their extensive

[19] http://www.state.nj.us/dep/baqp/rapt/final_scs_workgroup_report.pdf

[20] Northeast States for Coordinated Air Use Management (NESCAUM). "Status Report on NOx controls for Gas Turbines, Cement Kilns, Industrial boilers, Internal Combustion Engines Technologies & Cost Effectiveness" December, 2000.

use. On June 3, 2010, the OTC adopted a Resolution, wherein member states agreed to pursue, as necessary and appropriate, state-specific rulemakings to update state rules in accordance with the 2009 OTC Oil and Gas Boilers Serving Electric Generating Units Model Rule.

3.4.1 Federal Standards

See Table 3-10 below for applicable Federal Regulations.

Table 3-10 Federal Maximum Allowable Emission Limits of NOx for Boilers

Federal Regulations	**40 CFR 60.40bNSPS Subpart Db (Effective After 6/19/84)** **(Source: 72 FR 32742, June 13, 2007)**	**40 CFR 60.40Da NSPS Subpart Da (Effective After 2/28/05)** **(Source: 72 FR 32722, July 13, 2007)**
Source	**Boilers (29MW – 73MW)**	**Boilers (> 73MW)**
Pollutant	**NO_x**	**NO_x**
Performance Standards[1]	**Boilers with a heat release rate of 730,000 J/sec-m^3 or less:** 0.10 lb/MMBtu **Boilers with a heat release rate greater than 730,000 J/sec-m^3:** 0.20 lb/MMBtu	**Construction:** 1.0 lb/MWhr **Reconstruction:** 1.0 lb/MWhr or 0.11 lb/MMBtu **Modification:** 1.4 lb/MWhr or 0.15 lb/MMBtu

[1] Compliance based on 30 day rolling average

3.4.2 The OTC Measure

3.4.2.1 Performance Standards

The proposed NO_x rates identified in Table 3-11 below can be achieved by installing low NO_x burners and/or a selective non-catalytic reduction system on existing oil and gas-fired boilers. The following NO_x emission rates are based on "fuel" and not "boiler type." Existing NO_x control technology is capable of providing high emission control rate efficiency for all sources, regardless of boiler type and fuel firing method.

Table 3-11 Proposal for NO_x Emission Limits for Boilers serving EGUs

Source	Type of Fuel	NO_x Emission Rate (lb/MMBtu)	Compliance Period
Oil/gas Boilers serving EGUs	Natural Gas	0.08	Rolling 24-hour daily average
	No. 2 and lighter Oil	0.15	Rolling 24-hour daily average
	Heavier than No. 2 Oil	0.15	Rolling 24-hour daily average

The standards shown in Table 3-10 above are identical to the rule adopted by New York (NYCRR Part 227-2)[21] and are comparable with existing requirements in New Jersey (N.J.A.C. 7:27-19.4). These performance standards are also comparable with the emission rates included in the multi-pollutant provisions of the mercury rule for coal-fired boilers in New Jersey at existing N.J.A.C. 7:27- 27.7(d),[22] Delaware Regulation Number 1146[23] and possibly Maryland 26.11.27[24].

3.4.2.2 Alternate RACT Provision

The OTC model rule provides an alternative to complying with the emission limits at 4.4.2.1. This alternative is only available to the owner or operator of a boiler that is unable to comply with the presumptive NO_x RACT emission limitation listed above. Such an owner or operator must evaluate all available control devices and demonstrate that the use of each one to control NO_x emissions from that particular boiler would be either technically or economically infeasible. If any method of reducing the NO_x emissions is technically and economically feasible, the owner or operator must implement that method, even if it does not reduce the NO_x emissions enough to comply with the above limits. The permitting agency may then approve an alternative emission limit that is higher than that listed above but is determined to be reasonably achievable by that boiler.

3.4.3 Emissions Reduction Benefit

Estimated emission reductions if the OTC model rule is adopted on a regional basis are based on NO_x inventory emissions, the control efficiencies of the reasonably available control technologies, and whether or not existing controls are in place and operable. The estimates of the potential NO_x emissions reductions that could be expected from implementing the EGU boiler performance standards for oil and gas-fired units in the OTR are outlined in Table 3-12 below.

[21] http://www.dec.ny.gov/regulations/65983.html
[22] http://www.state.nj.us/dep/aqm/Sub27.pdf
[23] http://regulations.delaware.gov/AdminCode/title7/1000/1100/1146.shtml#TopOfPage
[24] http://www.dsd.state.md.us/comar/subtitle_chapters/26_Chapters.htm#Subtitle11

Table 3-12 Estimates of NO_x Emissions Reductions from Oil/Gas-fired EGUs

State	No. of Gas or Oil-Fired EGU Boilers	Total Rated Heat Input Capacity (MMBTU/hr)	Percentage of Total Heat Input Capacity	Annual Estimated NOx Reduction (tons)	Annual Estimated NOx Reduction (%)	OS Estimated NOx Reduction (tons)	OS Estimated NOx Reduction (%)	Hi NOx Rate Day Estimated NOx Reduction (tons)	Hi NOx Rate Day Estimated NOx Reduction (%)
CT	10	24490	7.6	222.9	32.0	108.6	32.6	19.6	49.0
DC	2	6460	2.0	56.7	51.5	55.3	51.7	6.8	49.9
DE	2	5875	1.8	120.0	62.4	40.4	58.9	10.8	66.1
MA	11	31260	9.6	309.4	24.1	128.5	24.4	14.1	40.2
MD	7	23710	7.3	197.9	27.9	139.9	31.9	8.3	26.3
ME	4	8740	2.7	49.4	28.4	13.1	23.5	0.8	24.3
NH	1	4429	1.4	28.7	27.1	23.5	31.0	3.0	41.1
NJ	8	13953	4.3	49.6	33.8	38.5	33.2	6.7	44.2
NY	49	158714	48.9	1926.6	17.8	758.5	14.4	42.1	32.1
PA	12	34524	10.6	479.3	50.7	135.3	36.8	22.0	51.3
VA	3	12172	3.8	187.8	35.0	74.9	29.5	5.2	35.4
Total	109	324327	100.0	3628.1	23.1	1516.5	19.9	139.3	39.7

The estimates above are based on 2008 annual data, 2008 ozone season data, 2008 ozone season high NO_x rate day data, and data from the available 2009 ozone season (May and June) high NO_x rate data. For the annual data, the values are the annual averages. For the ozone season data, the values are the ozone season average. For the high NO_x rate days, the values are the daily average for the day that the individual unit exhibited its highest daily average NO_x emission rate (not necessarily a date that corresponds to any other units high NO_x rate day) for that respective ozone season. Because not all of these units had a peak NO_x rate day on the same date, it is likely that the total reductions shown would tend to be optimistic for any given day. This spreadsheet exhibits the data on a per unit basis.

3.4.4 Control Cost Estimate

Oil and gas-fired boilers may require a control apparatus, such as a low NO_x burner (LNB) or a Selective Non-Catalytic Reduction (SNCR) system, installed on them in order to comply with the proposed maximum allowable NO_x emission rates. The cost-effectiveness of installing, maintaining and operating various types of NO_x control equipment on a 100 MMBtu/hr boiler operating at 66 percent capacity and operating 8,760 hours per year are shown in Table 3-13 below.

Table 3-13 Available NOx Emission Control Devices, Emission Reductions and Estimated Costs (Derived by using the OTC/LADCO 2008 Version of the MACTEC spreadsheets)

Fuel Type	**Pollutant**	**Available Control Device**	**NOx Controlled Emission Rate** (lb/MMBtu)	**Expected Emission Reduction** (%)	**Control Cost Estimates 2008$**[a] ($/ton removed)
Gas-Fired	NO_x	Low NO_x Burners (LNB)	0.10	50%	$5,460 – $21,800
Distillate Oil-Fired	NO_x	Low NO_x Burners (LNB)	0.10	50%	$5,460 – $21,800
Residual Oil-Fired	NO_x	Low NO_x Burners (LNB) LNB plus Flue Gas Recirculation (FGR) Selective Non-Catalytic Reduction (SNCR) LNB plus SNCR Selective Catalytic Reduction (SCR)	0.20 0.16 0.20 0.14 0.0675	50% 60% 50% 65% 85%	$2,730 – $10,900 $6,600 – $13,400 $5,900 – $8,040 $7,370 – $14,600 $5,800 – $20,100

Note: [a]Cost estimates shown are in 2008 dollars for a 100 MMBtu/hr boiler operating at 66 percent capacity and operating 8,760 hours per year

3.4.5 Emissions Reduction Benefits for Other Pollutants

Not applicable to this measure.

3.5 Nonroad Diesel Equipment Anti-Idling

Emission control standards for diesel engines, and nonroad diesel engines, have lagged behind standards for other mobile sources such as passenger cars. Because of this, diesel engines contribute disproportionately to the overall mobile source pollutant emissions inventory. Over the last ten years, EPA has introduced a series of highway and nonroad diesel fuel quality and emission standards that when fully implemented will reduce diesel emissions from newer engines by more than 90 percent (Figure, Figure 3-1). Emissions from existing engines, however, will continue to emit high levels of pollution for many years. To begin to address this problem, states and EPA have introduced measures to reduce emissions from existing engines such as retrofit and anti-idling programs.

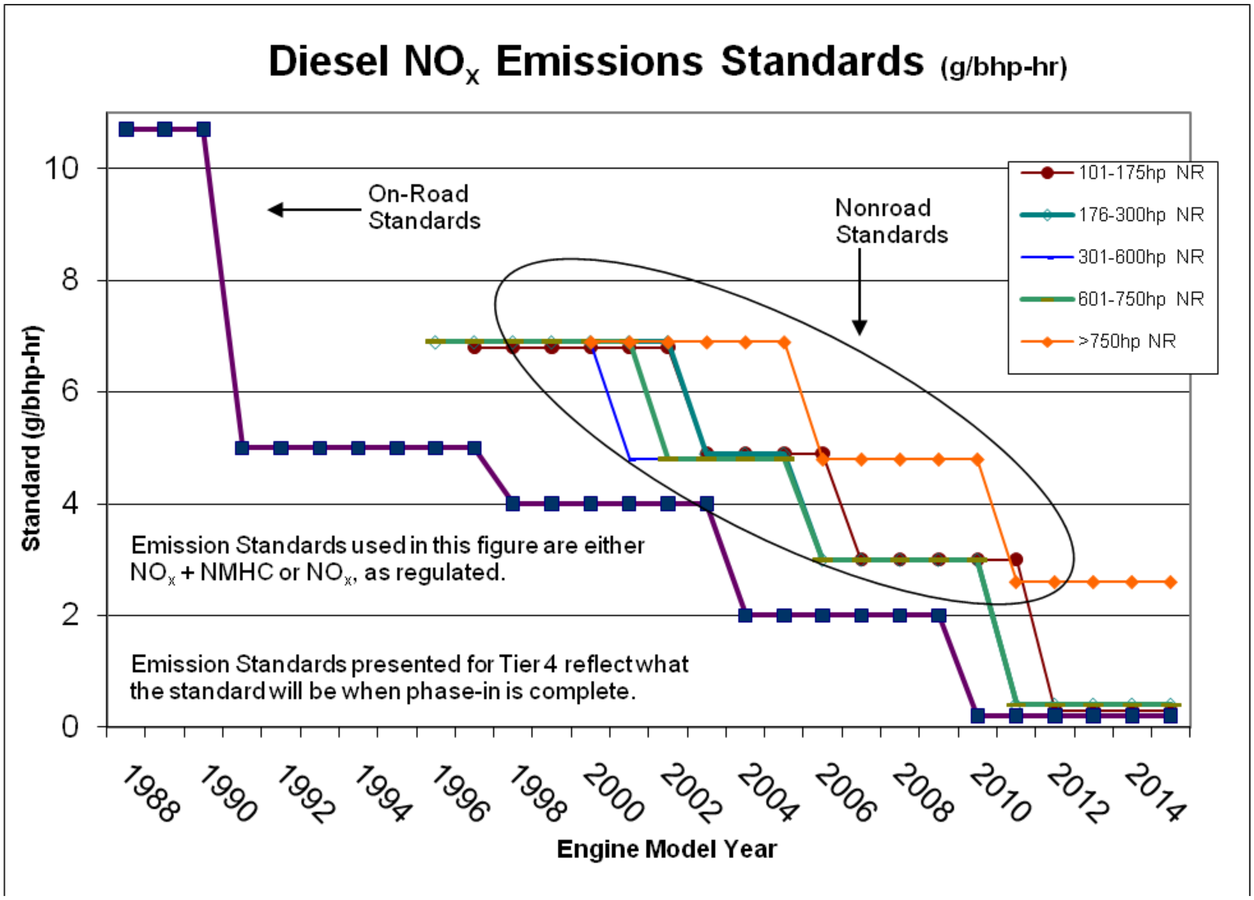

Figure 3-1 Diesel NO_X Emissions Standards (g/bhp-hr)

There are numerous reasons why nonroad construction equipment is left idling for extended periods: to perform work, to keep the operator warm, to keep the machine ready for work while waiting for supplies and equipment to be moved, union rules, and common practice. Increasing amounts of data are available to assist in the development of an emissions inventory for nonroad engine idling. Although in-use hours and emissions from nonroad equipment are estimated by EPA's NONROAD model, the model does not provide an explicit estimate of time spent or emissions resulting from nonroad idling. Anecdotal data and some in-use testing data are available. Some of the in-use testing data indicate that nonroad construction equipment may spend as much as half of in-use hours idling.

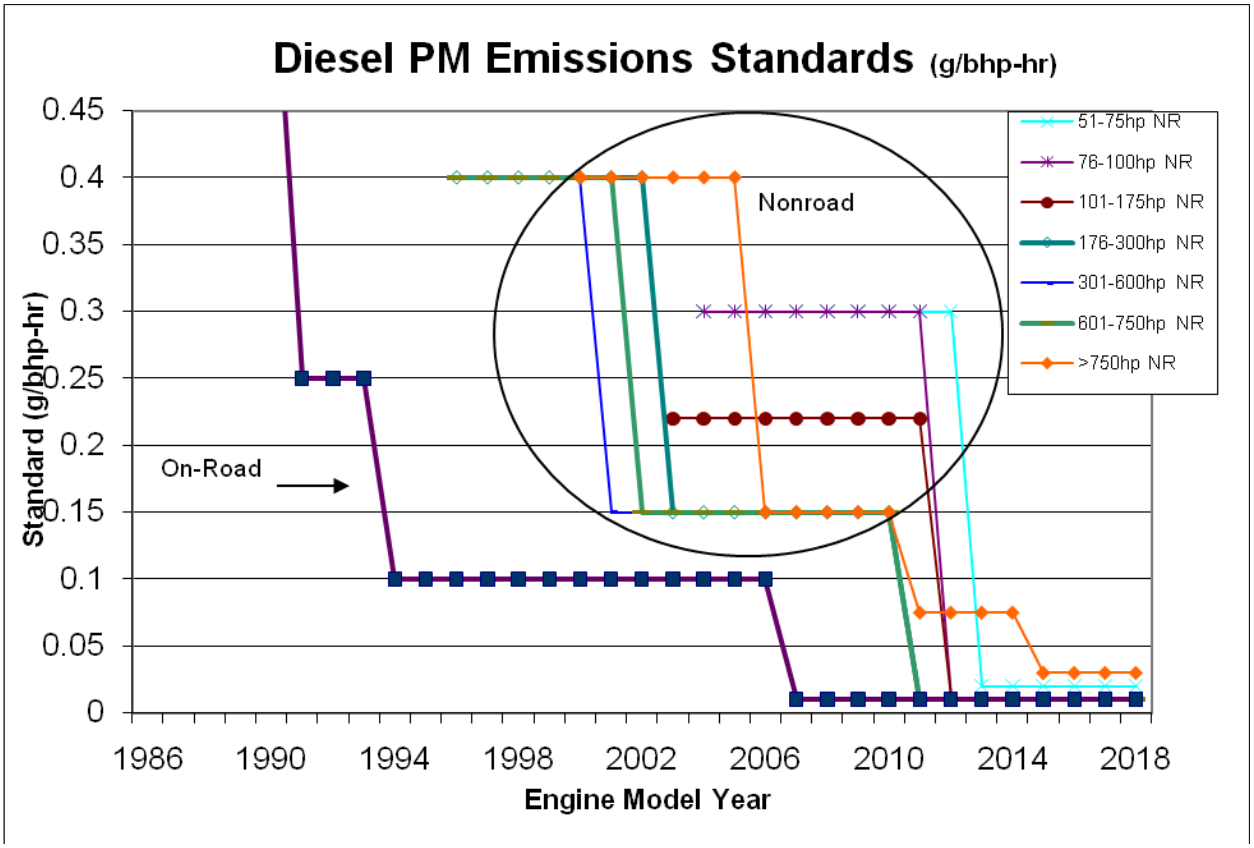

Figure 3-1 Diesel PM Emissions Standards (g/bhp-hr)

3.5.1 Existing Standards

To date, four states (Connecticut, Massachusetts, New Jersey, and Rhode Island) in the Ozone Transport Region (OTR) place restrictions on nonroad idling. The idling restrictions of Connecticut, Massachusetts, and Rhode Island apply respectively to "mobile sources" and "diesel engines," both of which include nonroad construction equipment. Connecticut explicitly exempts from its idling regulation nonroad diesel engines in marine and locomotive applications. Conversely, Massachusetts and Rhode Island's regulations include marine vessels and locomotives. New Jersey's regulation applies to nonroad construction equipment and marine engines, but not to locomotives. Additionally, California places restrictions on nonroad idling. California Air

Table 3-14 Application of existing nonroad idling rules in the OTR

	Non Road Application		
	Construction Equipment	Marine	Locomotive
CT	A	\	\
MA	A	A	A
NJ	A	A	\
RI	A	A	A
CARB	A	\	\

A = Rule applies to the engine application.
\ = Rule does not apply to application.

Resources Board (CARB)'s nonroad idling provision, like Connecticut's does not cover marine or locomotive engines.

3.5.2 The OTC Measure

The OTC model rule would apply to all nonroad diesel engines, except for locomotive engines; generator sets used on locomotives; marine engines; recreational vehicles; farming equipment; military equipment when it is being used during training exercises; emergency or public safety situations; or any use of a nonroad diesel engine that is not for compensation. This model rule was developed as a framework for each state to consider in developing rules for that individual state, based on state-specific statutory and regulatory authority. Each state would then follow the specific rulemaking proposal and adoption processes required for their agency.

Nonroad diesel equipment is often used in processes that require the engine to idle in order to perform a function. Examples of this include cement agitation, operation of a boom lift, and operating hydraulic systems. To allow this necessary flexibility to operators in order for the operators to perform their tasks and clarify situations where idling is not considered unnecessary, several exemptions are provided for in the model rule:

- To ensure the safe operation of the equipment, including idling to verify that the equipment is in good working order, or other conditions specified by the equipment manufacturer in the manual or other technical document accompanying the nonroad diesel engine;
- For testing, servicing, repairing, or diagnostic purposes, including regeneration of a diesel particulate filter;
- For less than fifteen (15) minutes when queuing, i.e., when nonroad diesel equipment, situated in a queue of other vehicles, must intermittently move forward to perform work or a service. This does not include the time an operator may wait motionless in line in anticipation of the start of a workday or opening of a location where work or a service will be performed. Idling will be limited to fifteen (15) minutes when queuing;
- When used in an emergency or public safety capacity; and
- For inspection to verify that all equipment is in good working order, if idling is required as part of the inspection.

To clarify these exemptions, and other aspects of the model rule, an accompanying guidance document was produced to help members of industry more clearly understand the exemptions. Additionally, the guidance document will aid enforcement officers so that violations can be properly addressed.

To ensure compliance with the rule, the model rule is structured to allow enforcement to be conducted by a municipal or local government or state agents that are granted the right to enter a property or location where a nonroad diesel engine is located. This provides the flexibility for each state to alter the model rule in order to match their existing enforcement authority. Also, depending on specific state statutory authority/regulations, the enforcement officer that has jurisdiction can penalize any person, entity, owner, or operator of a property or location where a nonroad diesel engine is operated, owners and operators of a nonroad diesel engine, or the holder of the permit for the activity for which the nonroad diesel engine is being operated, for an infraction.

3.5.3 NO_X Emissions Reduction Benefit

Data on idling activity as compared to total usage time are scarce. Three sources of data were relied on for this estimation: CARB, John Deere, and EPA. To estimate the emissions benefit for its nonroad idling rule, CARB asked individuals with significant experience in the industry to estimate the time off-road construction equipment spends idling unnecessarily. Their inquiry resulted in two estimates: 1) publicly owned fleets idle for 1.8% of the hours they are in use, and 2) privately-owned fleets idle 7.5% of the time. CARB further assumes that 95% of nonroad equipment is privately owned, giving an average idle rate of 7.2%.

NESCAUM on behalf of OTC obtained information from John Deere distributors in the Northeast, who collected data from telematic devices installed on 19 construction machines. These devices allow equipment owners to monitor, in real-time, exactly how the machine is operating, including whether it is idling. The average idling rate from the John Deere survey is 42%, considerably higher than CARB's estimate.

NESCAUM also analyzed idling PM emissions data for 19 engines tested by Southwest Research Institute (SWRI) for EPA (Fritz and Starr March 1998)[25]. However, the data collected from EPA correspond to the data obtained from John Deere and because of this, and because the EPA data were only for a very small number of equipment the EPA was not included in further analysis.

In order to estimate idling emissions in the OTR, idling emissions rates (emission factors) and activity (hours spent idling) for different types of nonroad construction equipment were determined. Idling emissions data were analyzed for 35 engines tested as part of a study of nonroad emissions conducted by North Carolina State University (Frey et al. 2008)[26]. Regressions were run based on Equation 1 using as the dependent variable three types of pollutants, Oxides of Nitrogen (NO_X), Particulate Matter (PM), and Total Hydrocarbons (THC), as well as diesel fuel consumption. Significant relationships were found between rated power and the level of emissions of NO_X that occur during idling, as well as between rated power and fuel consumption. The equipment's rated power displayed no effect on the level of PM and THC emissions that result during idling, essentially making it zero. Additionally, the variables of whether an engine was Tier 1 or was Tier 2 or greater were found to have significant coefficients for all species of emissions. These results provide high quality equations for estimating emissions from idling from across the sector.

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[25] Fritz, SG and Starr, ME 1998, *Emission Factors for Compression Ignition Nonroad Engines Operated on Number 2 Highway and Nonroad Diesel Fuel*, accessed from <https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=9100SELP.txt>.

[26] Frey, HC, Rasdorf, W, Kim, K, Pang, S-H, Lewis, P and Abolhassani, S 2008, 'Real-world duty cycles and utilization for construction equipment in North Carolina', Dept. of Civil, Construction, and Environmental Engineering, North Carolina State University, Raleigh, NC, accessed August 25, 2016, from <http://ntl.bts.gov/lib/32000/32300/32323/2006-08FinalReport.pdf>.

Equation 1: Regression Equation for Calculating Emissions

$$Idling\ Emissions = \alpha * RatedPower + \beta * Tier1 + \gamma * Tier2Plus + \varepsilon$$

In order to account for the likely differences in emission factors for each equipment class, OTC isolated equipment classes for further analysis based on their Source Classification Code (SCC). The NONROAD model was used to estimate populations of 65 nonroad engine types in each of the 13 OTC states during the 2009 baseline year. The population data were further disaggregated by emissions tier and power class and the annual activity (hours in operation) for each equipment type and for three size classes and three emissions tiers was calculated using default values contained in NONROAD input data files and supporting documentation.

Table 3-15 Emissions from Avoidable Nonroad Idling, OTC States 2009 (tpy)

	Idling Rate	Necessary Idling Per Hour	NO_X
John Deere	42%	0 min	35,146
		3 min	30,753
		5 min	28,117
CARB	7.2%	n/a	6,151
Total Emissions from Sector			194,831

Table 3-15 shows the potential emissions benefit for the OTC states. For the 42% case it was assumed that the activity rate included necessary idling so multiple emission reductions were provided based on the range of idling limits provided in section Env-A XXXX.05 of the model rule, where it was assumed that these limits would occur every hour. For the 7.2% case, since the survey specifically asked about unnecessary idling only the one estimate is included. These estimates are compared to total emissions from the sector as estimated from the NONROAD model. Significant NO_X emissions could be reduced if idling beyond 5 minutes is to be eliminated in the OTR for construction equipment machines.

Emission inventories contain estimates of actual emissions to the air during the relevant time period. Factors that concern how widespread the impact of the rule is and how effective the rule is are just important as the efficiency of the control itself when estimating actual emissions. An equation to calculate how these factors impact emission can be seen in Equation 2. For the case of the nonroad idling model rule the control efficiency would be 100% since the control involves simply turning the engine off, which would result in zero emissions production in a controlled situation. Rule penetration should be based on the exemptions in the model rule and should be calculated individually on a state by state basis. If an exemption is in place for a particular SCC that SCC should be removed from the dataset or zeroed out. Rule effectiveness is largely based on how well enforcement officers are enforcing the rule, with the predominant factor being how often they find violations when visiting a site, a value which would have to be determined on a state by state basis. Another important factor impacting rule effectiveness is the degree of success of outreach efforts to the

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regulated community. It should be noted that existing EPA guidance for the development of emissions inventories does specify that rule effectiveness is not directly applicable to mobile sources.

Equation 2: Equation for Calculating Controlled Emissions

*Uncontrolled Emissions * (1–(Control Efficiency * Rule Penetration * Rule Effectiveness)) = Controlled Emissions*

3.5.4 Control Cost Estimate

We estimate that this regulation would provide economic benefits to the owners and operators rather than economic costs due to the nature of the control. The 35 engines tests completed by North Carolina State University included data points for the amount of fuel that was consumed during engine idling. The same methodology that was employed to calculate emission factors was employed to calculate fuel usage. If one assumes that the price of diesel is $2.3/gallon this would result in the economic benefits listed in Table 3-16.[27] Additionally, there are economic benefits associated with reductions in maintenance and replacement costs due to the reduction in the amount of time equipment engines are left running, but this cost was not estimated.

Table 3-16 Benefits from Avoidable Nonroad Idling, OTC States 2016

	Idling Rate	Necessary Idling Per Hour	Fuel (g)	2016 $
John Deere	42%	0 min	30,327,964	69,754,316
		3 min	26,536,968	61,035,027
		5 min	24,262,371	55,803,453
CARB	7.2%	n/a	5,307,394	12,207,006

[27] US Energy Information Administration 2016, 'Gasoline and Diesel Fuel Update', Gasoline and Diesel Fuel Update, accessed from <http://www.eia.gov/petroleum/gasdiesel/>.

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3.5.5 Emissions Reduction Benefits for Other Pollutants

Table 3-17 Emissions from Avoidable Nonroad Idling, OTC States 2009 (tpy)

	Idling Rate	Necessary Idling Per Hour	THC	PM
John Deere	42%	0 min	4,394	253
		3 min	3,845	221
		5 min	3,515	202
CARB	7.2%	n/a	769	44
Total Emissions from Sector			18,464	16,711

Reducing idling from nonroad diesel engines inherently reduces other pollutants that are produced by nonroad diesel engines. The same techniques used to calculate NO_X emissions benefits from the regulation were used to determine reductions that would occur from implementing the rule in the OTR for THC and PM. The potential emission benefit for the OTC states is in Table 3-17.

3.6 Aftermarket Catalytic Converters

Catalytic converters reduce emissions through chemical reactions formed in the engine during combustion but prior to the exhaust leaving the tailpipe. Several precious metals, most notably platinum, palladium and rhodium, help to convert harmful pollution into carbon dioxide, as well as the non-toxic gasses of water and nitrogen. As the catalytic converter ages, reactions occur with sulfur dioxide, which results in buildup on the surfaces of the catalyst, in effect, "poisoning" it and making it less effective.

Catalytic converters first obtained wide-spread use in 1975 in the United States and reduced pollution from unburned hydrocarbons and carbon monoxide (CO), the former of which acts as an ozone precursor. These types of catalytic converters are known as two-way catalysts. Technological advances in the early 1980s allowed for catalytic converters to also reduce oxides of nitrogen (NO_X) which are also precursors to ozone pollution. The converters that reduce NO_X are commonly known as a three-way catalyst.

Many states have programs to inspect vehicles for malfunctioning catalytic converters called Inspections and Maintenance (I/M) programs. When a catalytic converter fails the emissions tests from an I/M program there are three options for replacement, a converter manufactured by the original manufacturer of the car (OEM), a still functional converter taken from another car (used), and a converter manufactured by a third party (aftermarket). To ensure that aftermarket converters meet standards there exists two certification regimes, one headed by USEPA and one by the California Air Resources Board (CARB).

The anti-tampering provisions of section 203(a)(3) of the Clean Air Act prohibits against the removal, or rendering inoperative, of emission control devices such as the catalytic converter.

Therefore, replacement of a malfunctioning catalytic converter should take place using one of the three aforementioned options, even within states, or areas, without an I/M program.

3.6.1 Existing Standards

A federal policy was put in place in 1986. The standard is efficiency based (70% HC -70% CO -30% NO_X) and must meet one of these options:

- Option 1: aftermarket catalytic converters that meet the requirements of the current USEPA aftermarket catalytic converters policy, provided the aftermarket catalytic converter warranty is honored when the OBDII system indicates a catalyst malfunction during the 25,000 mile warranty period or;
- Option 2: aftermarket catalytic converters that meet the requirements of the California aftermarket catalytic converter/OBDII procedures provided the aftermarket catalytic converters warranty is honored when the OBDII system indicates a catalyst malfunction during the 25,000 mile warranty period, and provided that the information described above is submitted to the USEPA.

Used (reconditioned) converters are also covered under the 1986 policy with a requirement that each converter being individually tested.

Two states (Maine and New York) in the Ozone Transport Region (OTR) already require CARB Executive Orders for aftermarket catalytic converters sold in their respective states to be installed on CA LEV vehicles.

3.6.2 The OTC Measure

After adoption by a member state, the OTC model rule would apply to all sales of aftermarket catalytic converters in the state. The measure would in no way impact the sale of OEM converters. Only aftermarket catalytic converters meeting CARB performance standards are permitted to be sold and installed. When a converter meets the performance standards CARB signs an Executive Order (EO) allowing for its sale. The measure provides optional language for a state to allow used converters to be sold if they are compatible with, and installed on, an OBD II vehicle.

3.6.3 NO_X Emissions Reduction Benefit

Estimated emission benefits from the OTC's recommended catalytic converter program were projected for 2015. This year was chosen because it would reflect lead time until rule adoption.

Tailpipe tests conducted by the Manufacturers of Emissions Control Association (MECA) were used to determine the benefits of installing CARB converters in lieu of federal converters (Manufacturers of Emissions Control Association 2013)[28]. CARB and EPA catalytic converters were tested for three classes of light duty vehicles and two classes of light duty trucks in the study. The light duty vehicle and light duty truck emission rates were averaged separately. Different deterioration rates were observed in the study

[28] Manufacturers of Emissions Control Association 2013, 'Emission Performance of California and Federal Aftermarket TWC Converters', in Detroit, MI, accessed January 7, 2013, from <http://papers.sae.org/2013-01-1298/>.

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between 0 -25,000 miles and 25,000-50,000 miles so two sets of emission reductions were calculated. We assumed that the difference in emissions from installing a CARB certified catalyst in lieu of an EPA certified catalyst would be the same across all vehicle make and model years.

Linearly interpolated MOVES inputs for vehicle miles traveled and vehicle population were developed for each year from 2011-2015, for cars and trucks separately and for each state, except Pennsylvania and Virginia. These interpolations were based on 2007 and 2020 MOVES inputs. 2020 MOVES inputs were not available for NY so 2007 values were held across the entire time period. Since only counties in Northern Virginia in the OTR were analyzed for Virginia, it was assumed that vehicle miles traveled to vehicle population were more similar to DC than to VA as a whole so DC's ratios were used.

To simplify this analysis several additional assumptions were made. First, model years prior to 1981 were excluded from the analysis since it was assumed that older vehicles would be the most likely to be scrapped if the owner is facing a major repair. Since several states have model year limits on testing, many of these vehicles would not have been tested anyway. Also model years more recent than 2011 were excluded since newer vehicles would mostly likely be under the federal warranty (8 years or 80,000 miles) and thus owners would replace their catalytic converters with OEM converters. The mileage accumulation calculation was conducted by multiplying the average annual VMT (for cars 10,600 miles, for trucks 14,700 miles), separately for cars and trucks, by the number of years (Federal Highway Administration 2010)[29]. In the case that the threshold was crossed midway through the year, it was assumed that accumulation was at a steady daily rate so the results were multiplied by the ratio of miles traveled out of the warranty over average annual VMT.

Secondly, it was assumed that vehicle owners that installed converters would not scrap their cars before the end of the analysis period.

Thirdly, we assumed that converters would not fail while still under their warranty period. Since EPA certified catalysts only have a 25,000 mile warranty; the replacements would begin to go out of warranty halfway through the 2011-2015 period (for those that were replaced in 2011). Since the converter still could function for longer we provided two sets of estimates, one assuming that the EPA converters were replaced after two and a half years and one assuming they lasted a full five years.

Finally, it was assumed that the age distributions from 2011-2015 would remain consistent and could be based on the 2007 age distributions, which were the best available data. Given that the prolonged economic downturn of 2008 that likely has resulted in depressed fleet turn over in subsequent years this analysis will show less of an emission reductions benefit since the vehicles fleet on the road currently is older and

[29] Federal Highway Administration 2010, 'Annual Vehicle Distance Traveled in Miles and Related Data - 2010 By Highway Category and Vehicle Type', Annual Vehicle Distance Traveled in Miles and Related Data - 2010 By Highway Category and Vehicle Type, accessed August 14, 2012, from <http://www.fhwa.dot.gov/policyinformation/statistics/2010/vm1.cfm>

dirtier than our estimates. Though the Car Allowance Rebate System ("Cash for Clunkers") program of 2009 would have had a slight counteracting effect it should be minor.

One uncertainty was how many people would purchase an OEM catalyst (either new or used since both are allowed in OTC's proposed program). OTC assumed that all failures that occurred under the federal warranty (cars that are less than 8 years old or have driven less than 80,000 miles) would be addressed by replacing the catalyst through the dealer using a new OEM catalyst, and thus would not fall under the universe impacted by this program.

When considering vehicles that are no longer under warranty, owners have the options of purchasing a new or used OEM or an aftermarket catalyst. We assumed that the vast majority of owners would replace their catalysts with aftermarket converters if their vehicle was no longer under warranty, with the exception of people with specialty vehicles that have a very low market share for which aftermarket converters are not manufactured, as CARB assumed in their analysis (California Air Resources Board 7 September 2007)[30]. We also assumed that people would opt for aftermarket converters over used converters given the risk factor associated with purchasing a used converter with no warranty. Additionally, for the few instances where vehicle owners would purchase a used converter, the converter would still have to pass regular emission tests and we assume would still result in emission reductions over a failing converter.

An additional level of uncertainty that is introduced for the emission estimates involves potential regulations affecting vehicle emissions that have not yet been adopted. Some examples of these are state adoption of CARB ZEV provisions, EPA promulgation of Tier 3, or state adoption of "boutique" fuels. We have chosen to only consider on-the-book regulations that would affect the vehicle fleet in the OTR for 2015 in this analysis.

Table 3-18 NOx Emission Reduction Estimates from an updated Aftermarket Catalytic Converter Program in the OTR in 2015

	Range of Reductions in NO_X	
Annual Reductions (tons per year)	7,100	10,000
Daily Reductions (tons per day)	20	28

3.6.4 Control Cost Estimate

OTC employed the cost estimates presented in the 2011 recommendation "OTC Mobile Source Committee Recommended Federal Aftermarket Catalytic Converter Program (FACCP)" for each class of converter, $100 for EPA certified converters, $200-$300 for non-OBD updated converters and $350-$500 for OBD updated converters. OBD converters cost more since more metals are necessary to meet the more stringent

[30] California Air Resources Board, Public Hearing to Consider Amendments to Regulations Regarding New. Aftermarket Catalytic Converters and Used Catalytic Converters Offered for Sale and Use in California (2007).

emission standards, making them more expensive. Projected replacements were divided into categories for pre-1996 and 1996 and after model years so that the separate cost estimates could be used. Given that a range was presented for the updated converters a high and low estimate were calculated.

Given our assumptions on the length of time aftermarket converters would last, differing time periods were used calculating the levels of depreciation. All CARB certified converters were depreciated for five years and EPA certified converters were depreciated for two and half and five years to match the range of emission reductions estimated earlier. The straight line method was employed to calculate the amount of annual depreciation. The result was an estimate that the benefits from reducing NO_X would be between $4,000/ton and $7,000/ton.

3.6.5 Emissions Reduction Benefits for Other Pollutants

Updating the aftermarket catalytic converter standards brings with it benefits from reducing other pollutants as well. The same technique was used to calculate these reductions as was used to calculate the benefits from reducing NO_X and the benefits are listed in Table 3-19.

Table 3-19 Other Emission Reduction Estimates from an updated Aftermarket Catalytic Converter Program in the OTR in 2015

	Range of Reductions in NMHC		**Range of Reductions in CO**	
Annual Reductions (tons per year)	1,900	2,200	16,000	25,000
Daily Reductions (tons per day)	5	6	43	70
Cost Benefit (2010 dollars)	$20,000	$31,000	$2,000	$3,000