4.0 NO_x 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. Natural Gas-Fired Industrial, Commercial, and Institutional Boilers, Steam Generators, Process Heaters, and Water Heaters;
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.

4.1 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. 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 Stationary Generators Model Rule.

4.1.1 Federal Standards

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 shown below in Table 4-1:

Table 4-1

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 below in Table 4-2:

Table 4-2

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

For existing, non-emergency generators, the emissions standard would be as listed below in Table 4-3:

Table 4-3

	Emission	**Emission**

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

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.

4.1.2 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, except for 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. Compliance with EPA's NSPS standards is required for new, emergency generators. For new, non-emergency generators, the emissions standards would be equivalent to the most stringent requirements under the NSPS standards listed above. 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.

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.

4.1.3 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 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 4-4:

Table 4-4

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 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.

4.1.4 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.

4.1.5 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.

4.2 Control of Nitrogen Oxide (NOx) Emissions from Natural Gas-Fired Industrial, Commercial, and Institutional (ICI) Boilers, Steam Generators, Process Heaters, and Water Heaters

This OTC model rule addresses NO_x emissions from industrial, commercial and institutional (ICI) boilers, steam generators, process heaters, and water heaters by using ultra low NO_x burners (ULNBs) to control emissions. This OTC model rule separates 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

4.2.1 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. 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 NO_x Emissions from Industrial, Commercial and Institutional (ICI) Boilers, Steam Generators, Process Heaters, and Water Heaters Model Rule.

4.2.2 The OTC Measure

For Type 1 units and Type 2 units, the OTC model rule applies to any person who supplies, sells, offers for sale, installs, or solicits the installation of, any new or replacement natural gas-fired boiler, steam generator, process heater, or water heater with a maximum rated heat input capacity greater than or equal to 75,000 Btu/hr and up to but less than 2.0 million Btu/hr.

For Type 3 units the OTC model rule applies to any new or replacement natural gas-fired boiler, steam generator, or process heater with a maximum rated heat input capacity of 2.0 million Btu/hr up to and including 5.0 million Btu/hr units.

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

States also have the option to adopt one or both of the following exemptions:

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;

The NO_x limits for natural gas-fired boilers, steam generators, process heaters, or water heaters supplied, sold, offered for sale, installed, or solicited for installation within a Model State are as follows:

a. Type 1 units manufactured on or after <xx months from date of rule adoption>: 0.093 lbs NO_x /MMBtu heat input at 3 % stack oxygen by volume on a dry basis.

b. Type 2 units manufactured on or after <xx months from date of rule adoption>: 0.036 lbs NO_x /MMBtu heat input at 3% stack oxygen by volume on a dry basis.

c. Type 3 units – Upon installation of a new or replacement unit on or after <xx months from date of rule adoption>:

   i. For Atmospheric Units: 0.014 lb NO_x /MMBtu heat input or 12 ppmv at 3% stack oxygen by volume on a dry basis.
   ii. For Non-Atmospheric Units: 0.011 lb NO_x /MMBtu heat input or 9 ppmv at 3% stack oxygen by volume on a dry basis.

4.2.3 Emissions Reduction Benefit

On October 20, 2005, the San Joaquin Valley Air Pollution Control District (SJVAPCD) adopted Rule 4308 for boilers, steam generators, process heaters, and water heaters equal to or greater than 75,000 Btu/hr but less than 2.0 million Btu/hr (Type 1 and Type 2 units) and estimated that there were approximately 15,000 units subject to Rule 4308 and that emission control would result in 2.0 tons per day of NO_x reductions in the SJVAPCD.

On October 16, 2008, the SJVAPCD adopted amendments to Rule 4307 for boilers, steam generators, and process heaters in the range from 2.0 million Btu/hr up to and including 5.0 million Btu/hr (Type 3 units). The SJVAPCD included an emissions reduction analysis for proposed Rule 4307 in Appendix B to the rule. The District staff report indicated that additional NO_x reductions could be achieved by the retrofit and replacement of boilers, steam generators and process heaters not covered by SJVAPCD Rule 4308. District staff estimated that there were a total of 469 units affected by the amendments to Rule 4307 and that the amendments to Rule 4307 would achieve 1.15 tons per day of NOx reductions in the District. One method for estimating potential NO_x reductions for the OTC states from both Rule 4307 and Rule 4308 is to compare the population in the San Joaquin Valley to the population in the OTC states and calculate the proportional NO_x reductions.

The results from using a population-based method for estimating potential NO_x reductions if the OTC model rule was adopted in the OTC states are shown below in the Table 4-5:

Table 4-5

Potential NO_x Reductions (tons/day)

OTC State	If Rule 4308 Adopted	If Rule 4307 Adopted	If Full Control Measure Adopted
Connecticut	**1.84**	**1.06**	**2.89**
Delaware	**0.45**	**0.26**	**0.70**
D.C.	**0.30**	**0.18**	**0.48**
Maine	**0.69**	**0.40**	**1.09**
Maryland	**2.94**	**1.69**	**4.64**
Massachusetts	**3.37**	**1.94**	**5.31**
New Hampshire	**0.69**	**0.40**	**1.09**
New Jersey	**4.57**	**2.63**	**7.20**
New York	**10.12**	**5.82**	**15.94**
Pennsylvania	**6.52**	**3.75**	**10.27**

Rhode Island	**0.56**	**0.32**	**0.88**
Vermont	**0.33**	**0.19**	**0.52**
Virginia*	**1.14**	**0.66**	**1.80**
OTR Total	**33.53**	**19.28**	**52.81**

* For Virginia the NO_x emission reduction estimate includes only: the City of Alexandria, Arlington County, Fairfax City, Fairfax County, Falls Church City, Loudoun County, Manassas City, Manassas Park City, Prince William County and Stafford County. Since in many OTC states these smaller units may not currently be subject to air pollution control regulations, it is likely that previous emission reduction estimates do not exist for these smaller units.
** The values in this column are rounded and the therefore not precise to the hundredth place.

Since in many OTC states these smaller units may not currently be subject to air pollution control regulations, it is likely that previous emission reduction estimates do not exist for these smaller units.

4.2.4 Control Cost Estimates

A method originally developed by MACTEC was revised and updated by OTC in 2008 and then used to estimate the NO_x control costs for ULNBs on ICI boilers as small as 25 million Btu/hr heat input. However, the revised and updated OTC method has not been applied to individual, smaller ICI boilers, process heaters, or water heaters. Cost data from the SJVAPCD Cost Effectiveness analyses described below could be used in the MACTEC method in order to derive updated NO_x control cost estimates for ULNB for these smaller units.

In October 2005, the SJVAPCD performed a cost effectiveness analysis for Rule 4308, which can be found in Appendix C of the Final Draft Staff report for the SJVAPCD model rule. 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 has performed a cost effectiveness analysis for proposed amendments to Rule 4307 which can be found in Appendix C for the SJVAPCD proposed rule. In that analysis, District staff found that the average cost effectiveness for Low NO_x burners 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.

4.2.5 Emissions Reduction Benefits for Other Pollutants

Particulate Matter and Greenhouse Gas emissions might be reduced due to increased burner combustion efficiencies resulting in less pollution and/or decreased fuel usage.

4.3. 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.

4.3.1 Federal Standards

Table 4-6 summarizes the applicable Federal New Source Performance Standards (NSPS).

Table 4-6

Federal Maximum Allowable Emission Limits of NO_x for New Turbines

40 CFR 60.4300 NSPS Subpart KKKK[a] (effective after 02/18/05)			
Applicability	Heat Input (HHV)	NO_x standards	
	MMBtu/hr	Concentration or (ppm @ 15% O_2)	Useful Output (lb/MWh)
Natural Gas			
Construction	≤ 50	42	2.3
	> 50 and ≤ 850	25	1.2
	> 850	15	0.43
Modification, or Reconstruction	≤ 50	150	8.7
	> 50 and ≤ 850	42	2.0
	> 850	15	0.43

Oil			
Construction	≤ 50	96	5.5
	> 50 and ≤ 850	74	3.6
	> 850	42	1.3
Modification, or Reconstruction	≤ 50	150	8.7
	> 50 and ≤ 850	96	4.7
	> 850	42	1.3
[a] Source: 71 FR 38497, July 6, 2006 Note: 50 MMBtu/hr is equivalent to 14.65 MWh; 850 MMBtu/hr is equivalent to 249.11 MWh			

4.3.2 The OTC Measure

4.3.2.1 Performance Standards

The model rule requires HEDDCTs to meet the NO_x performance standards in Table 4-7.

Table 4-7
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	Ea. calendar day <or 24-hr rolling avg>
	Distillate Fuel Oil	1.20	0.16	42	Ea. calendar day <or 24-hr rolling avg>
Simple cycle	Natural Gas	1.00	0.10	25	Ea. calendar day <or 24-hr rolling avg>
	Distillate Fuel Oil	1.60	0.16	42	Ea. calendar day <or 24-hr rolling avg>

[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 4-7 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.

4.3.2.2 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.

4.3.2.3 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 4-7. 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 4-8. These control methods are widely used in industry throughout the United States and are reasonably available given their extensive use.

Table 4-8
Reasonably Available NO_x Emission Control Technologies for HEDDCT

Fuel Type	Available Control Methods[1]	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%[2]

4.3.3 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.[3] 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 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 <u>tons per O_3 season</u>.

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.

4.3.4 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

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[1] 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.

[2] 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.

[3] 2007 CAMD database for HEDD units within the OTR provided by MARAMA

with low capacity factor.[4,5] 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.[6] 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]

4.3.5 Emissions Reduction Benefits for Other Pollutants

Not applicable to this measure.

4.4 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 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.

4.4.1 Federal Standards

See Table 4-9 below for applicable Federal Regulations.

Table 4-9
Federal Maximum Allowable Emission Limits of NO_x 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)**

[4] http://www.state.nj.us/dep/baqp/rapt/final_scs_workgroup_report.pdf
[5] http://www.nj.gov/dep/rules/proposals/080408a.pdf

[6] 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.

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

4.4.2 The OTC Measure

4.4.2.1 Performance Standards

The proposed NO_x rates identified in Table 4-10 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 4-10
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 4-10 above are identical to the rule adopted by New York (NYCRR Part 227-2)[7] 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

[7] http://www.dec.ny.gov/regulations/65983.html

existing N.J.A.C. 7:27- 27.7(d),[8] Delaware Regulation Number 1146[9] and possibly Maryland 26.11.27[10].

4.4.2.2 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.

4.4.3 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 4-11 below.

Table 4-11
Estimates of NO_x Emissions Reductions from Oil/Gas-fired EGUs

[8] http://www.state.nj.us/dep/aqm/Sub27.pdf

[9] http://regulations.delaware.gov/AdminCode/title7/1000/1100/1146.shtml#TopOfPage

[10] http://www.dsd.state.md.us/comar/subtitle_chapters/26_Chapters.htm#Subtitle11

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	24400	7.5	222.9	32.0	108.6	32.6	19.6	40.0
DC	2	6400	2.0	65.7	61.5	65.3	61.7	6.0	40.9
DE	2	5875	1.8	120.0	62.4	40.4	60.9	10.0	66.1
MA	11	31200	9.6	300.4	24.1	120.5	24.4	14.1	40.2
MD	7	23710	7.3	157.9	27.9	139.9	31.9	8.3	28.3
ME	4	8740	2.7	40.4	20.4	13.1	23.5	0.8	24.3
NH	1	4420	1.4	20.7	27.1	23.5	31.0	3.0	41.1
NJ	8	13953	4.3	40.5	33.8	30.5	33.2	6.7	44.2
NY	49	158714	48.9	1026.6	17.8	760.5	14.4	42.1	32.1
PA	12	34524	10.6	479.3	50.7	135.3	38.8	22.0	51.3
VA	3	12172	3.8	187.8	35.8	74.9	20.5	6.2	35.4
Total	109	324327	100.0	3020.1	23.1	1516.5	19.9	130.3	30.7

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.

4.4.4 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 4-12 below.

Table 4-12
Available NO_x Emission Control Devices, Emission Reductions and Estimated Costs[11]
(Derived by using the OTC/LADCO 2008 Version of the MACTEC spreadsheets)

Fuel Type	Pollutant	Available Control Device	NOx	Expected Emission Reduction	Control Cost

[11] New Hampshire Department of Environmental Services. (October, 2008). Draft ICI Boiler NO_x and SO_2 Control Cost Estimates. [PowerPoint slides]. (A. Bodnarik, 2009)

			Controlled Emission Rate (lb/MMBtu)	(%)	**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

4.4.5 Emissions Reduction Benefits for Other Pollutants

Not applicable to this measure.