TECHNICAL SUPPORT DOCUMENT

FOR

Amendments to COMAR 26.11.08 – Control of Incinerators

August 14, 2018

PREPARED BY:
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I. PURPOSE OF REGULATORY ACTION

The purpose of this action is to repeal existing nitrogen oxide (NOx) reasonable available control technology (RACT) requirements under COMAR 26.11.09.08H and establish new NOx RACT requirements and analysis of possible additional NOx emission control requirements under COMAR 26.11.08.10 for Large municipal waste combustors (MWCs). Additionally, this action amends opacity requirements under 26.11.01, adds definitions, repeals 26.11.08.08-1 and updates references to 26.11.08.08-2, which is the current emission standards and requirements for hospital, medical and infectious waste incinerators (HMIWIs).

The NOx RACT requirements pertaining to Large MWCs will be submitted to the U.S. Environmental Protection Agency (EPA) for approval as part of Maryland's SIP. The amendments pertaining to Small MWCs and HMIWIs will be submitted to the EPA for approval as part of Maryland's 111(d) and 129 plans.

II. FACTS FOR PROPOSAL

A. Background

Ozone Standards

On March 12, 2008, the EPA revised the National Ambient Air Quality Standards (NAAQS) for ozone to a level of 75 parts per billion (ppb) to provide increased protection of public health and the environment. In 2012, EPA designated portions of Maryland as nonattainment for the 75 ppb ozone NAAQS.

In 2015, the Maryland Department of the Environment (MDE or the Department) demonstrated that the Baltimore area ozone monitor data had achieved the 2008 ozone NAAQS and on June 1, 2015 EPA issued a final Clean Data Determination for the Baltimore ozone nonattainment area. In 2017, EPA proposed that the Washington, D.C. and the Philadelphia ozone nonattainment areas, which include portions of Maryland, had clean monitoring data as well. EPA has not yet finalized re-designation requests for determinations of attainment.

Even with the Clean Data Determination, the designation status of the Baltimore ozone nonattainment area will remain nonattainment for the 2008 75ppb ozone NAAQS until such time as EPA determines that the Baltimore ozone nonattainment area meets the CAA requirements for re-designation to attainment, including an approved re-designation request and maintenance plan. Additionally, the determination of attainment is separate from, and does not influence or otherwise affect, any future designation determination or requirements for the Baltimore Area based on any new or revised ozone NAAQS.

On October 1, 2015, EPA strengthened the NAAQS for ozone to 70 ppb, based on scientific evidence about ozone’s effects on public health and welfare. Reductions in NOx emissions from major sources of NOx are necessary to attain and maintain compliance with the 75 ppb ozone standard and will also be necessary to achieve compliance with the more stringent 70 ppb ozone standard.

NOx RACT Requirements

Under Section 182 of the CAA, 42 U.S.C. § 7511a, sources in ozone nonattainment areas classified as moderate and above are subject to RACT requirements. Therefore, the CAA requires MDE to review and revise RACT requirements in the Maryland SIP as necessary to achieve compliance with the ozone NAAQS. EPA defines RACT as the lowest emissions limitation that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility. As part of Maryland's RACT review, MDE has determined that existing NOx RACT requirements should be updated for Large MWC's. In reviewing existing NOx RACT requirements for adequacy, the Department considers technological advances, the stringency of the revised ozone standard and whether new sources subject to RACT requirements are present in the nonattainment area. The Department must examine existing controls on major sources of NOx to determine whether additional controls are economical and technically feasible, and include any such controls in Maryland's RACT SIP, where appropriate.

Region-wide, several states have proposed or revised NOx RACT standards for Large MWCs. On April 20, 2009, New Jersey adopted Regulation 7:27-19.12 that established a NOx RACT emission rate of 150 parts per million by volume, dry basis (ppmvd) as determined on a calendar day average. In May of 2013, Massachusetts proposed a NOx RACT of 150 ppmvd, that became effective on March 9, 2018, for MWCs equivalent to the type of Large MWC plants operating in Maryland. On August 2, 2016, Connecticut adopted a 150 ppm limit for mass burn waterwall combustors on a 24-hour daily average as specified under Regulation § 22a-174-38(c)(8) Table 32-a. On April 23, 2016, Pennsylvania updated RACT requirements and established a NOx emission rate of 180 ppmvd for MWCs.

Large MWCs in Maryland have demonstrated the ability to reduce NOx emissions by analyzing and optimizing their existing controls. In consideration of regional NOx RACT amendments, optimization studies, and upgrades performed by Maryland sources, the Department has concluded that Maryland's Large MWCs are capable of meeting more stringent NOx RACT requirements.

Hospital, Medical and Infectious Waste Incinerators

On April 2, 2012, Maryland adopted COMAR 26.11.08.08-2 - new emission standards and requirements for hospital, medical and infectious waste incinerators. These new requirements went into effect on October 6, 2014, and replaced the existing HMIWI requirements codified under 26.11.08.08-1. Under this action, Maryland repeals 26.11.08.08-1 and updates references throughout the Chapter to 26.11.08.08-2.

Continuous Opacity Monitoring Requirements

On May 10, 2016, Maryland submitted State Implementation Plan (SIP) Revision #16-04 to EPA containing definitions and requirements for the monitoring of opacity for cement kilns, clinker coolers and municipal waste combustors. The U.S. Environmental Protection Agency (EPA) has informed the Department that the existing definitions of "Continuous burning" and "Operating time" in COMAR 26.11.01.01 create an exemption for MWCs which is not permissible under EPA's startup, shutdown and malfunction (SSM) policy; 40 CFR Part 52. On February 28, 2018 Maryland proposed to repeal these definitions from SIP Revision #16-04, as requested by EPA. Clarifying definitions will be proposed under COMAR 26.11.08.01 with this action.

B. Sources Affected and Location

There are two large MWCs in Maryland, Wheelabrator Baltimore, L.P. (Wheelabrator), and Montgomery County Resource Recovery Facility (MCRRF).

There is one small MWC facility in Maryland, the Fort Detrick Solid Waste Management Plant located in Frederick County. Permits remain in place for this facility, however, the small MWC is currently not in operation.

There are two HMIWI facilities in Maryland, Curtis Bay Energy, L.P. and Fort Detrick Solid Waste Management Plant. Permits remain in place for the Fort Detrick Solid Waste Management Plant, however, the HMIWI is currently not in operation.

C. Requirements

Large MWC NOx RACT

This action establishes new NOx RACT standards and requirements for Large MWCs with a capacity greater than 250 tons per day. New COMAR 26.11.08.10 requires that Maryland's two Large MWCs shall meet new, individual NOx 24-hour block average emission rates by May 1, 2019. The Montgomery County Resource Recovery Facility shall meet a NOx 24-hour block average emission rate of 140 ppmv. The Wheelabrator Baltimore, Inc. facility shall meet a NOx 24-hour block average emission rate of 150 ppmv.

To further ensure consistent long-term operation of NOx control technologies, the Large MWCs must also meet new, individual NOx 30-day rolling average emission rates by May 1, 2020. The Montgomery County Resource Recovery Facility shall meet a NOx 30-day rolling average emission rate of 105 ppmv. The Wheelabrator Baltimore, Inc. facility shall meet a NOx 30-day rolling average emission rate of 145 ppmv.

Large MWCs are required to meet the NOx 24-hour block average and NOx 30-day rolling average emission rates, except during periods of startup and shutdown. Concentration-based emission limits are not practical during startup and shutdown because it is technically infeasible for MWCs to comply with the emission rates due to the "7 percent oxygen correction factor" that is required to be applied to the NOx 24-hour block rates. During periods of startup and shutdown, additional ambient air is introduced into the furnace. Applying the correction factor of 7 percent oxygen during these periods grossly misrepresents the actual NOx emissions produced from startup and shutdown operations. Therefore, an equivalent mass-based emission limit is substituted. During periods of startup and shutdown the Montgomery County Resource Recovery

Facility shall meet a facility wide NOx emission limit of 202 lbs/hr timed average mass loading over a 24-hour period and the Wheelabrator Baltimore, Inc. facility shall meet a facility wide NOx emission limit of 252 lbs/hr timed average mass loading over a 24-hour period. The duration of startup and shutdown procedures for a Large MWC are not to exceed three hours per occurrence, and the NOx 24-hour mass emission limits apply during these times.

The mass emission limits during periods of startup and shutdown incorporate the 24-hour block average NOx RACT rates (these rates are part of the calculation used to derive the mass NOx emission limits) applicable to each Large MWC providing equivalent stringency to those concentration limits, which apply at all other times. Mass based emission calculations are derived utilizing 40 CFR § 60.58b(h)(2) of subpart Eb (Concentration correction to 7 percent oxygen) or 40 CFR 60.45 (Conversion procedures to convert CEM data into applicable standards). EPA Method 19 may also be utilized to determine NOx emission rates based upon oxygen concentrations. Facility average flue gas flow rates are also utilized in the calculations. The calculation methodology for the mass emission limits is based upon the Prevention of Significant Deterioration (PSD) Approval for each affected facility. (See Appendix G)

In addition to the mass-based emission limit, the NOx 24-hour block average emission rate will apply for the 24-hour period after startup and before shutdown, as applicable.

The new NOx RACT further specifies that a Large MWC shall minimize NOx emissions at all times the unit is in operation, including periods of startup and shutdown, by operating and optimizing the unit and all installed pollution control technology and combustion controls consistent with the technological limitations, manufacturers' specifications, good engineering and maintenance practices, and good air pollution control practices for minimizing emissions (as defined in 40 CFR §60.11(d)). Large MWCs shall continuously monitor NOx emissions with a continuous emission monitoring system (CEM) in accordance with COMAR 26.11.01.11. Large MWCs are also required to submit quarterly reports to the Department containing data, information, and calculations which demonstrate compliance with the NOx RACT emission rates and NOx mass loading emission limits. The reports shall include flagging of periods of startup and shutdown and exceedance of emission rates, as well as documented actions taken during periods of startup and shutdown in signed, contemporaneous operating logs.

Additional NOx Emission Control Requirements

The proposed NOx RACT requirements, when effective, will result in immediate reductions in NOx emissions from the Wheelabrator Baltimore Inc. Large MWC. This action also contains possible additional NOx emission control requirements that may be needed by Maryland to attain and maintain compliance with the 2015 ozone NAAQS.

Not later than January 1, 2020, the owner or operator of Wheelabrator Baltimore Inc. shall submit to the Department a feasibility analysis regarding additional control of NOx emissions from the Wheelabrator Baltimore Inc. facility. This analysis shall be prepared by an independent third party and must include: a written narrative and schematics detailing the existing facility operations, boiler design, NOx control technologies and relevant emission performance; a written narrative and schematics detailing various state of the art NOx control technologies for achieving the lowest possible NOx emissions from existing MWCs in consideration of the overall facility design at Wheelabrator Baltimore Inc.; an analysis of whether each identified state of the art control technology could technically be implemented at the Wheelabrator Baltimore Inc. facility; a cost-benefit analysis of capital and operating costs, NOx emission benefits, and air quality impacts resulting from each identified state of the art control technology; and a schedule for installation and implementation of each identified NOx emission control technology.

The feasibility analysis for Wheelabrator Baltimore Inc. should review and examine NOx emission control technologies capable of achieving NOx emission levels comparable to those for a new source (e.g. selective catalytic reduction – SCR). The Department conducted research on existing MWCs around the country and was not able to find examples of existing MWCs that were retrofitted with an SCR. Adding SCR NOx emission control technologies, or other comparable NOx emission reduction strategies, would likely not be considered RACT because of the complex design requirements and cost issues. SCR NOx emission control strategies are standard equipment on new Large MWCs. The intent of the feasibility analysis is to evaluate what lower NOx RACT emission limit could be achieved at Wheelabrator Baltimore Inc. without a re-build of the entire facility.

Based on the results of the feasibility analysis, Wheelabrator Baltimore Inc. shall submit to the Department a NOx 24-hour block average emission rate, NOx 30-day rolling average emission rate, and NOx mass loading emission limitation for periods of startup, shutdown, and malfunction by January 1, 2020. Wheelabrator Baltimore, Inc. shall provide the Department with no less than two weeks notice and the opportunity to observe any optimization procedure, including installation or operation of NOx emission control technology, for the express purpose of developing the feasibility analysis.

D. Projected Emission Reductions

MDE projects the implementation of the new NOx RACT requirements for Large MWCs will result in approximately 200 tons of NOx emissions reduced on an annual basis. There are no expected NOx emission reductions for Small MWCs.

As of October 6, 2014, Maryland sources have already applied control technologies to the incineration process and to post incineration emissions to meet the HMIWI NOx emission standards, and other requirements, as specified in the 111(d) plan of COMAR 26.11.08.08-2.

E. Estimate of Economic Impact

Economic Impact on Affected Sources, the Department, other State Agencies, Local Government, other Industries or Trade Groups, the Public

Large MWCs are expected to incur a small increase in operating costs as a result of optimization of existing control technology. The operating cost increase is projected to be in the range $1,123 to $1,269 per ton of NOx reduced based on the increase in urea consumption. Additional capital costs have been incurred at the Wheelabrator Baltimore, Inc. facility in an effort to meet the proposed NOx RACT emission rates. Wheelabrator Baltimore, Inc. has conducted several analyses of existing operating combustion and control systems, and has modified urea injection systems to be optimized for multiple parameters. The facility has also modified interface combustion controls with SNCR operation and control through automation of the urea feed system. Specific cost information has not been made available to the Department.

There are no expected economic impacts for Small MWCs and HMIWIs. There will be no impact on the Department or other state agencies or local government as a result of this action.

Economic Impact on Small Businesses

The proposed action has minimal or no economic impact on small businesses.

III. COMPARISON TO FEDERAL STANDARDS

There is a corresponding federal standard to this proposed action, but the proposed action is not more restrictive or stringent.

IV. <u>PROPOSED REGULATIONS</u>

26.11.01 General Administrative Provisions

Authority: Environment Article, §§1-101, 1-404, 2-101—2-103, 2-301—2-303, 10-102, and 10-103, Annotated Code of Maryland

.01 Definitions.

A. (text unchanged)

B. Terms Defined.

(1) — (8) (text unchanged)

[(8-1) Continuous Burning.

(a) "Continuous burning" means the continuous, semi-continuous, or batch feeding of municipal solid waste for purposes of waste disposal, energy production, or providing heat to the combustion system in preparation for waste disposal or energy production.

(b) "Continuous burning" does not include the period when municipal solid waste is solely used to provide thermal protection of the grate or hearth.**]**

(9) — (27) (text unchanged)

[(27-1) Operating Time.

(a) "Operating time" means, for the purpose of determining compliance or non-compliance with COM requirements of this chapter for cement kilns, the actual time in hours that an affected unit operates, beginning when the raw feed is being continuously introduced into the kiln for at least 120 minutes or when the raw feed rate exceeds 60 percent of the kiln design limitation rate, whichever occurs first, and ending when the introduction of raw feed to the kiln is halted.

(b) "Operating time" means, for the purpose of determining compliance or non-compliance with COM requirements of this chapter for municipal waste combustors, the actual time in hours that an affected unit operates, beginning when continuous burning of solid waste starts and ending when continuous burning of solid waste ceases.**]**

(28) — (53) (text unchanged)

26.11.08 Control of Incinerators

Authority: Environment Article, §§1-404, 2-103, 2-301—2-303, and 2-406, Annotated Code of Maryland

.01 Definitions.

A. (text unchanged)

B. Terms Defined.

(1) — (7-1) (text unchanged)

(7-2) Continuous Burning.

(a) "Continuous burning" means the continuous, semi-continuous, or batch feeding of municipal solid waste for purposes of waste disposal, energy production, or providing heat to the combustion system in preparation for waste disposal or energy production.

(b) "Continuous burning" begins once municipal solid waste is fed to the combustor.

(8) — (45) (text unchanged)

(46) "Operating day" means a 24-hour period **[**between 12**]** *beginning* midnight *of one day* and *ending* the following midnight, *or an alternate 24-hour period approved by the Department,* during which **[**any amount of hospital waste or medical/infectious waste is combusted at any time in the HMIWI**]** *time an installation consumes fuel or causes emissions*.

(47) — (53) (text unchanged)

(54) Shutdown.

(a) — (d) (text unchanged)

(e) "Shutdown" for the Montgomery County Resource Recovery Facility commences 30 minutes after the chute to the loading hopper of the combustion train is closed and ends no later than 3 hours thereafter.

(f) "Shutdown" for the Wheelabrator Baltimore Inc. facility commences 30 minutes after municipal solid waste feed to the loading hopper has ceased and ends no later than 3 hours thereafter.

(55) (text unchanged)

(55-1) "Small MWC" means a municipal waste combustor which has a capacity of at least 35 tons and less than or equal to 250 tons per day.

(56) — (59) (text unchanged)

(60) Startup.

(a) — (b) (text unchanged)

(c) "Startup" for a Large MWC commences when the unit begins the continuous burning of municipal solid waste and continues for a period of time not to exceed 3 hours, but does not include any warm-up period when the particular unit is combusting fossil fuel or other non-municipal solid waste fuel, and no municipal solid waste is being fed to the combustor.

(61) "30-day rolling average emission rate" means a value of NO_x emissions in ppmv, corrected to 7 percent oxygen, calculated by:

(a) Summing the total hourly ppmv of NO_x emitted from the unit during the current operating day and the previous 29 operating days, excluding periods of startup and shutdown; and

(b) Dividing the total hourly ppmv of NO_x emitted from the unit during the 30 operating days summed in §B(61)(a) of this regulation by 30.

(62) "24-hour block average emission rate" means a value of NO_x emissions in ppmv, corrected to 7 percent oxygen, calculated by:

(a) Summing the hourly average ppmv of NO_x emitted from the unit during 24 hours between midnight of one day and ending the following midnight, excluding periods of startup and shutdown; and

(b) Dividing the total sum of hourly NO_x ppmv values emitted during 24 hours between midnight of one day and ending the following midnight by 24.

[(61)] *(63)* (text unchanged)

.02 Applicability.

A. (text unchanged)

B. Regulation .07 of this chapter applies to **[**an**]** *a Small* MWC that was constructed on or before August 30, 1999 **[**and has a capacity of at least 35 tons and less than or equal to 250 tons per day].

C. — F. (text unchanged)

[G. If there is any discrepancy between the terms defined in this chapter and any federal definition in the Clean Air Act, 42 U.S.C. §§7401—7671 (CAA), and 40 CFR Part 60 Subparts A, B, Eb, and Ec, the federal definition applies.

H. The requirements in Regulation .08-1 of this chapter apply to a person who owns or operates an HMIWI for which construction was commenced on or before June 20, 1996, except as provided in 40 CFR §60.50c(b)—(i).**]**

I. All provisions of Regulation **[**.08-1**]** *.08-2* of this chapter and the related **[**HMIWI**]** 111(d)/129 plan approval, 40 CFR Part 62, Subpart V, *apply to HMIWIs* **[**are applicable, except as amended or revised under Regulation .08-2 of this chapter and approved by EPA as part of the Maryland HMIWI 111(d)/129 plan**]**.

J. Regulation .10 of this chapter applies to Large MWCs.

.04 Visible Emissions.

A. In Areas I, II, V, and VI, the following apply:

(1) Except as provided in Regulations .08 and **[**.08-1**]** *.08-2* of this chapter, a person may not cause or permit the discharge of emissions from any incinerator, other than water in an uncombined form, which is greater than 20 percent opacity;

(2) (text unchanged)

B. — D. (text unchanged)

.05 Particulate Matter.

A. Requirements for Areas I, II, V, and VI.

(1) Calculations. Except as provided in Regulations .08 and **[**.08-1**]** *.08-2* of this chapter, incinerator or hazardous waste incinerator emissions shall be adjusted to 12 percent carbon dioxide.

(2) Incinerators Constructed Before January 17, 1972. Except as provided in Regulations .08 and **[**.08-1**]** *.08-2* of this chapter, a person may not cause or permit the discharge into the outdoor atmosphere from any incinerator constructed before January 17, 1972, particulate matter to exceed the following limitations:

(a) — (b) (text unchanged)

(3) Incinerators Constructed on or After January 17, 1972. Except as provided in Regulations .07, .08, and **[**.08-1**]** *.08-2* of this chapter, a person may not cause or permit the discharge of particulate matter into the outdoor atmosphere from any incinerator or crematory constructed on or after January 17, 1972, to exceed 0.10 grains per standard cubic foot dry 0.10 gr/SCFD (229 mg/dscm).

(4) (text unchanged)

B. Requirements for Areas III and IV.

(1) Calculations. Except as provided in Regulations .08 and **[**.08-1**]** *.08-2* of this chapter, incinerator or hazardous waste incinerator emissions shall be adjusted to 12 percent carbon dioxide.

(2) Except as provided in Regulations .07, .08, and **[**.08-1**]** *.08-2* of this chapter, a person may not cause or permit the discharge of particulate matter into the outdoor atmosphere from any incinerator, hazardous waste incinerator, or crematory to exceed the following limitations:

(a) — (b) (text unchanged)

.07 Requirements for *Small* Municipal Waste Combustors [with a Capacity of 35 tons or greater per day and less than or equal to 250 Tons per Day].

A person may not operate a **[**municipal waste combustor that has a burning capacity of 35 tons or more per day and less than or equal to 250 tons per day**]** *Small MWC* that was constructed on or before August 30, 1999 which results in violation of the provisions of 40 CFR 62 Subpart JJJ.

.08-2 Emission Standards and Requirements for HMIWIs Under 40 CFR 60 Subpart Ce as Revised October 6, 2009.

A. Applicability and Emission Standards. **[**Notwithstanding the requirements of Regulation .08-1 of this chapter, the**]** *The* emission standards and requirements of §B(1)—(7) and §C(1)—(6) of this regulation apply to a person who owns or operates an HMIWI subject to 40 CFR Part 60, Subpart Ce, as revised, October 6, 2009.

B. — H. (text unchanged).

.10 NO_x Requirements for Large Municipal Waste Combustors.

A. The owner and operator of a Large MWC shall minimize NO_x emissions by operating and optimizing the use of all installed pollution control technology and combustion controls consistent with the technological limitations, manufacturers' specifications, good engineering and maintenance practices, and good air pollution control practices for minimizing emissions (as defined in 40 CFR §60.11(d)) for such equipment and the unit at all times the unit is in operation, including periods of startup and shutdown.

B. As of May 1, 2019, the owner or operator of a Large MWC shall meet the following applicable NO_x emission rates, except for periods of startup and shutdown:

Affected Sources	*NO_x 24-hour block average emission rate*
Montgomery County Resource Recovery Facility	*140 ppmv*
Wheelabrator Baltimore Inc.	*150 ppmv*

C. As of May 1, 2020, the owner or operator of a Large MWC shall meet the requirements of §B of this regulation and the following applicable NO_x emission rates, except for periods of startup and shutdown:

Affected Sources	*NO_x 30-day rolling average emission rate*
Montgomery County Resource Recovery Facility	*105 ppmv*
Wheelabrator Baltimore Inc.	*145 ppmv*

D. Startup and Shutdown NO_x Emission Limitations. As of May 1, 2019, during periods of startup and shutdown the following emission limitations shall apply:

(1) For Montgomery County Resource Recovery Facility, a facility-wide NO_x emission limit of 202 lbs/hr timed average mass loading over a 24-hour period.

(2) For Wheelabrator Baltimore Inc., a facility-wide NO_x emission limit of 252 lbs/hr timed average mass loading over a 24-hour period.

(3) On days when the unit is in startup, the NO_x 24-hour block average emission rate under §B of this regulation will apply for the 24-hour period after startup is completed.

(4) On days when the unit is in shutdown, the NO_x 24-hour block average emission rate under §B of this regulation will apply for the 24-hour period prior to the commencement of shutdown.

E. Additional NO_x Emission Control Requirements.

(1) Not later than January 1, 2020, the owner or operator of Wheelabrator Baltimore Inc. shall submit a feasibility analysis for additional control of NO_x emissions from the Wheelabrator Baltimore Inc. facility to the Department. This analysis shall be prepared by an independent third party and include the following:

(a) A written narrative and schematics detailing existing facility operations, boiler design, NO_x control technologies, and relevant emission performance;

(b) A written narrative and schematics detailing various state-of-the-art NO_x control technologies for achieving additional NO_x emission reductions from existing MWCs, including technologies capable of achieving NO_x emission levels comparable to those for a new source in consideration of the overall facility design at Wheelabrator Baltimore Inc.;

(c) An analysis of whether each state-of-the-art control technology identified under §E(1)(b) of this regulation could technically be implemented at the Wheelabrator Baltimore Inc. facility;

(d) Capital and operating costs, NO_x emission benefits, and air quality impacts resulting from installation of each state-of-the-art control technology as identified under §E(1)(b) of this regulation; and

(e) An estimated timeline for installation of each state-of-the-art control technology as identified under §E(1)(b) of this regulation which shall include design time, construction, operational testing, and start up.

(2) Upon written request, Wheelabrator Baltimore Inc. shall submit any other information that the Department determines is necessary to evaluate the feasibility analysis.

(3) Not later than January 1, 2020, based upon the results of the feasibility analysis as required under §E(1) of this regulation, the owner or operator of Wheelabrator Baltimore Inc. shall propose and submit a NO_x 24-hour block average emission rate, NO_x 30-day rolling average emission rate, and NO_x mass loading emission limitation for periods of startup, shutdown and malfunction.

F. The owner or operator of a Large MWC shall continuously monitor NO_x emissions with a continuous emission monitoring system in accordance with COMAR 26.11.01.11.

G. Not later than 45 days after the effective date of this regulation, the owner or operator of a Large MWC shall submit a plan to the Department and EPA for approval that demonstrates how the Large MWC will operate installed pollution control technology and combustion controls to meet the requirements of §A of this regulation. The plan shall summarize the data that will be collected to demonstrate compliance with §A of this regulation. The plan shall cover all modes of operation, including but not limited to normal operations, startup, and shutdown.

H. Beginning July 1, 2019, the owner or operator of a Large MWC shall submit a quarterly report to the Department containing:

(1) Data, information, and calculations which demonstrate compliance with the NO_x 24-hour block average emission rate as required in §B of this regulation;

(2) Data, information, and calculations, including NO_x continuous emission monitoring data and stack flow data, which demonstrate compliance with the startup and shutdown mass NO_x emission limits as required in §D of this regulation;

(3) Flagging of periods of startup and shutdown and exceedances of emission rates;

(4) NO_x continuous emission monitoring data and total urea flow rate to the boiler averaged over a 1-hour period, in a Microsoft Excel format; and

(5) Documented actions taken during periods of startup and shutdown in signed, contemporaneous operating logs.

I. Beginning July 1, 2020, the quarterly report to be submitted pursuant to §H of this regulation shall also include data, information, and calculations which demonstrate compliance with the NO_x 30-day rolling average emission rate as required in §C of this regulation.

J. No less than 2 weeks advance notice and the opportunity to observe activities shall be provided to the Department prior to any optimization procedure, including installation or operation of NO_x emission control technology, for the express purpose of complying with the requirements of §E(1) of this regulation.

K. Compliance with the NO_x emission standards in §§B, C, and D of this regulation shall be demonstrated with a continuous emission monitoring system.

L. Compliance with the NO_x Mass Loading Emission Limitation for the Montgomery County Resource Recovery Facility.

(1) Compliance with the NO_x mass loading emission limitation for periods of startup and shutdown in §D(1) of this regulation shall be demonstrated by calculating the 24-hour average of all hourly average NO_x emission concentrations from continuous emission monitoring systems.

(2)The calculations in §L(1) of this regulation shall utilize stack flow rates derived from flow monitors, for all the hours during the 3-hour startup or shutdown period and the remaining 21 hours of the 24-hour period.

M. Compliance with the NO_x Mass Loading Emission Limitation for the Wheelabrator Baltimore Inc.

(1) Compliance with the NO_x mass loading emission limitation for periods of startup and shutdown in §D(2) of this regulation shall be demonstrated by calculating the 24-hour average of all hourly average NO_x emission concentrations from continuous emission monitoring systems.

(2) The calculations in §M(1) of this regulation shall utilize the applicable Prevention of Significant Deterioration calculation methodology, for all the hours during the 3-hour startup or shutdown period and the remaining 21 hours of the 24-hour period.

26.11.09 Control of Fuel-Burning Equipment, Stationary Internal Combustion Engines, and Certain Fuel-Burning Installations

Authority: Environment Article, §§1-101, 1-404, 2-101—2-103, 2-301—2-303, 10-102, and 10-103, Annotated Code of Maryland

.08 Control of NO_x Emissions for Major Stationary Sources.

A. — G. (text unchanged)

[H. Requirements for Municipal Waste Combustors, and Hospital, Medical, and Infectious Waste Incinerators.

(1) A person who owns or operates a municipal waste combustor shall install, operate, and maintain a CEM for NO_x emissions.

(2) NO_x emissions from municipal waste combustors may not exceed the NO_x emissions standards in COMAR 26.11.08.07 and COMAR 26.11.08.08 or applicable Prevention of Significant Deterioration limits, whichever is more restrictive.

(3) NO_x emissions from hospital, medical, and infectious waste incinerators as defined in COMAR 26.11.08.01B(18) may not exceed the NO_x emission standards in COMAR 26.11.08.08-1A(2) (250 ppm 24-hour average) as applicable.**]**

I.— K. (text unchanged)

BENJAMIN H. GRUMBLES
Secretary of the Environment

Appendix A – Stakeholder Meetings and Comments

Wheelabrator NOx RACT Summary

- SNCR optimization test program was conducted at the Wheelabrator Saugus waste to energy (WTE) facility (Large MWC) in January 2010
- 50% urea solution SNCR system like Baltimore
  - Same SNCR system vendor and basic design
- SNCR optimization test program was required as BART in response to regional haze attainment program
- SNCR vendor-Fuel Tech conducted the program which included
  - furnace gas temperature profiling to establish optimum temperature window
  - Optimization of existing SNCR system
- Facility subject to Subpart Cb and NOx limit of 205 ppm7%
- Goal lowest achievable limit at minimum increase in NH3 slip
  - Subject to NH3 slip limit 10 ppm 7%

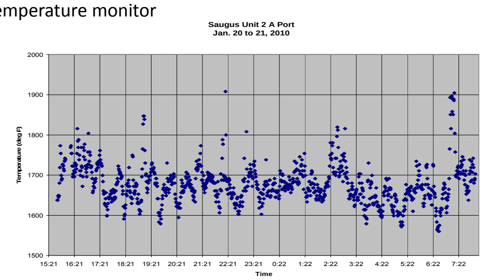
Wheelabrator NOx RACT Summary

SNCR Optimization Test Program Overview

- Vary SNCR system configuration and operating parameters
  - Change injector locations, number in service, atomizing air pressure
  - Vary urea injection rates at different configurations
- SNCR system configuration
  - Eight dual fluid urea injectors (water/air)
  - Multiple injection points in furnace water walls
- Original injector locations determine during system design phase using furnace temperature profiling

Wheelabrator NOx RACT Summary

Furnace temperature profiling example-using continuous temperature monitor



Wheelabrator NOx RACT Summary

SNCR Optimization Test Results

- 4-6 injectors used in various configurations
- Urea injection rates 0 (baseline), 5 and 10 gph
- Baseline NOx 240-280 ppm7%
- Normal NOx set point ~ 200 ppm7% to meet 205 ppm limit
  - 25-28% NOx removal from baseline
  - Urea flow approximately 5-7 gph
- Optimized results
  - NOx 165-186 ppm 7%
  - 32-42% NOx removal
  - Urea flow approximately 10-11 gph
  - 185 ppm7% long term limit/30 day rolling average

Wheelabrator NOx RACT Summary

Baltimore NOx Summary

July 1- Dec 31, 2015 24 Hour Average Summary			
	NOXRPT_1	NOXRPT_2	NOXRPT_3
	(PPMDC)	(PPMDC)	(PPMDC)
Average	171	170	169
Maximum	190	187	196
Minimum	137	145	134
Maximum Hourly Average	217	219	224

- Subpart Cb NOx limit = 205 ppm7%/24 hour average
- PSD NOx limit = 298 lbs/hour Facility Limit
  - approximately 185-195 ppm7% equivalent limit
- Average urea usage approximately 6.3 gph
- Baseline NOx 240-300+ ppm7%% hourly average

Wheelabrator NOx RACT Summary

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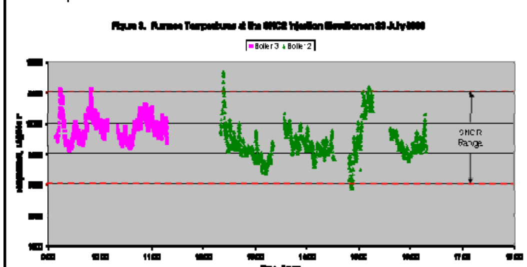


Wheelabrator NOx RACT Summary

Baltimore NOx RACT/SNCR Optimization Approach

- Conduct temperature profiling all 3 units-clean and dirty cycle
- Vary injector configuration and urea flow rates
- Test ammonia slip at most promising opSNCR operating conditions
- Potential for some additional NOx reduction
- Need to carefully evaluate NH3 slip variability given MDE visible emission standard

NOx RACT for Municipal Waste Combustors (MWCs)

Stakeholder Meeting – August 30, 2016

Topics Covered

- Background Information
- Municipal Waste Combustors (MWCs) in Maryland
  - Control technology and emissions
- The "NOx RACT" Requirement
- Existing state and federal control requirements for MWCs
- Current MDE Thinking
- Regulation Timeline

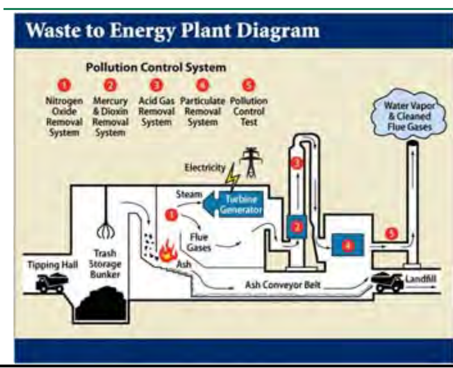
Why NOx?

- Nitrogen oxide or NOx is the most important pollutant to reduce to continue to make progress on ground level ozone in Maryland
  - Ozone is formed when NOx and Volatile Organic Compounds react with sunlight
- There is very little doubt that the State's recent progress on cleaning up ozone air pollution is driven by NOx reductions
- NOx is also a contributor to nitrogen deposition into the Chesapeake Bay, fine particulate pollution in Maryland and regional haze

MD NOx RACT Review for Large MWCs

- The purpose of this review is to establish new NO_x RACT (Reasonably Available Control Technology) requirements for large MWCs with a capacity greater than 250 tons per day.
- There are two large MWCs in Maryland;
  - Wheelabrator Baltimore, L.P. and
  - Montgomery County Resource Recovery Facility (MCRRF).
- The Department has been meeting with affected sources and EPA since the summer of 2015 to discuss MWC operations, emissions data and NOx RACT proposals
- Today's meeting begins the stakeholder process
- MDE is hoping to gather additional information and then draft an updated regulation

What is a MWC?



Wheelabrator

2,250
Tons of Waste Processed per day

730,150
Tons of Waste Processed Last Year

64 MW
Energy Generation Capacity

40,000
Homes Powered

1985
Began Operations

Wheelabrator 2014 NOx Emissions

2015 Top 15 NOx Emission Sources in MD

No.	FACILITY	NOx Emissions(tpy)*
1	NRG Chalk Point Generating Station	3,877
2	Fort Smallwood Road Complex	3,102
3	Lehigh Cement Company LLC	2,936
4	Luke Paper Company	1,887
5	Holcim (US), Inc	1,227
6	**Wheelabrator Baltimore, LP**	**1,123**
7	C P Crane Generating Station	1,078
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9	NRG Morgantown Generating Station	897
10	AES Warrior Run Inc	445
11	Montgomery County Resource Recovery Facility (MCRRF)	441
12	Harford County Resource Recovery Facility	262
13	Constellation Power - Perryman Generating Station	215
14	Mettiki Coal, LLC	144
15	Rock Springs Generation Facility	127

* Facility-wide NOx emissions

Wheelabrator NOx Emissions

Year	NOx Tons	NOx 24-Hr Average
2013	1067	Annual 169 ppm
2014	1076	Annual 162 ppm Max values 190, 188, 183 31% of 24-Hr averages above annual average
2015	1124	Annual 168 ppm Max values, 190, 198, 196 50% of 24-Hr averages above annual average
Average	**1089**	**166 ppm**

Wheelabrator Optimization Study

- February 29 to March 4, 2016 - Wheelabrator conducted optimization tests of existing SNCR system
- Furnace temperature profiles developed and, as a result of the optimization tests, urea injection locations were modified

	NOx ppm	NOx Removal	Urea Utilization
Original Configuration	175	14-21%	25%
Optimized Configuration	150-165	25%	40%

MCRRF

1,800
Tons of Waste Processed per day

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Year	NOx Tons	Long Term (Annual) Average NOx 24-Hr Block Concentration
2013	387.7	85 ppm
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MCRRF NOx Control Technology

- An SNCR system is integrated to a combustion Low NOx (LN™) system with modifications to the location of the injectors
- The Covanta LN™ technology employs a unique combustion system design, including modifications to combustion air flows, reagent injection and control systems logic.
- The LN™ control system and SNCR result in lowering the NOx emission rate range to 85-89 ppm long-term (annual average) basis.
- Approximate 47 percent reduction on long term basis, but subject to high variability on daily basis, lesser can be assured on a short-term basis.
- The LN™ control system installation started in 2008 and was completed in 2010 at a capital cost of $6.7 million and the average operating costs over the last three years has been $566,000 per year.

Federal NOx RACT Requirements

- Under the Clean Air Act (CAA), 42 U.S.C. § 7401 et seq., sources in ozone nonattainment areas classified as moderate and above are subject to a NOx Reasonably Available Control Technology (RACT) requirement.
- Section 182 of the CAA requires States to review and revise NOx RACT requirements as necessary to achieve compliance with ambient air quality standards.
- EPA defines RACT as the lowest emissions limitation (e.g., on a part per million or pound per million Btu basis) that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility.

MDE NOx RACT Review

- MDE considers technological advances, the stringency of the revised ozone standard and whether new sources subject to RACT requirements are present in the nonattainment area.
- MDE also reviews regional RACT SIPs for existing sources to determine if meeting new standards or installing control technologies are economically and technically feasible.

Federal Requirements for MWCs

- On December 19, 1995, EPA adopted standards for new MWC plants in 40 CFR 60 Subpart Eb and Emission Guidelines (EG) for existing MWCs Subpart Cb as part of an action under Section 111(d) and 129 of the CAA.
- On November 17, 1997, the Department adopted these regulations in COMAR 26.11.08.08 which, in part, established a NOx emission standard of 205 ppmv (parts per million by volume) based on a 24 hour average.
- Maryland MWCs are complying with these limits.

Federal 111(d) and 129 Requirements

- Section 111(d) establishes technology-based emission standards for major sources of dangerous air pollutants that are not tied to an air quality value or an ambient standard.
  - There are section 111(d) pollutants, and emission standards by source are set and approved through a "State Plan".
- Section 129 requires plans for solid waste incinerators and establishes emission guidelines for both traditional criteria pollutants and non-criteria pollutants.
- Maryland has adopted these requirements and Maryland MWCs are in compliance.

Federal MACT Update

- The EPA developed Maximum Achievable Control Technology Standards, or MACT standards, to reduce the effects of Hazardous Air Pollutants (HAPs) generated by industry.
- MACT standards affect sources by making them meet specific emissions limits based upon the emissions levels achieved by the best-performing facilities (top 12%).
- EPA plans to propose updates to the MWC MACT in the near future which may take effect as early as 2020.

Maryland NOx RACT for MWCs

- On October 18, 1999, the Department adopted source specific RACT limitations for a variety of major NOx emission sources, including MWCs, under COMAR 26.11.09.08.
- The NOx RACT for Large MWC sources required that NOx emissions may not exceed the NOx emission standards in COMAR 26.11.08.08 or applicable Prevention of Significant Deterioration limits, whichever is more restrictive.

Updates in Other States

- Maryland has worked with the 13 states that make up the Ozone Transport Commission (OTC) on regional model programs for updated MWC RACT.
- Several OTC states have proposed revised NOx RACT standards for large MWCs.
  - New Jersey established a NOx RACT emission rate of 150 ppmvd
    - Includes alternative compliance option allowing MWCs to apply for an alternative NOx emission rate.
  - Massachusetts proposed a NOx RACT of 150 ppmvd for MWCs equivalent to the type of large MWC plants operating in Maryland.
    - To date, Massachusetts proposal has not moved forward for adoption.
  - Recently, Pennsylvania updated their RACT requirements and established a NOx emission rate of 180 ppmvd for MWCs.

MDE Updates to MWC NOx RACT

- Maryland MWCs are already well controlled.
- Based upon regional RACT amendments in other states, review of MWC NOx emissions data, and analysis of optimization studies the Department has concluded that the NOx RACT standards for MWCs can be strengthened within the definition of RACT
- MDE looking at pairing daily (24-hour) limits with longer (30-day rolling average) limits

Real World Complications

- While NOx emissions from MWCs may remain fairly consistent, there is inherent variability introduced in the waste stream (fuel) which may cause a spike in emissions.
- Because of this, should a RACT limit be set at a point to account for this variability…
  - The limit will allow higher emissions on most days when the emission controls and the waste stream are capable of achieving lower emissions.
- MDE is planning to set limits to ensure that emissions are minimized every day.

MDE Current Thinking

- Based upon review of federal rules, rules in other states, emissions & control technology data and the specific configurations of MWCs in Maryland … MDE's very preliminary thinking on updated RACT limits is below
- We are looking for input from stakeholders.

Unit	30 Day Rolling Average Limit	24 Hour Daily Limit
Wheelabrator	Somewhere between 145 and 175 ppmvd	Somewhere between 165 and 180 ppmvd
MCRRF	Somewhere between 105 and 130 ppmvd	Somewhere between 120 and 140 ppmvd

ppmvd = parts per million volume dry

MDE Updates to Small MWC NOx RACT

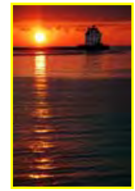
- MDE proposing to maintain existing NOx RACT; just move requirements to a new Chapter in COMAR
- Existing NOx RACT standards for small municipal incinerators are codified in COMAR 26.11.09.08
- MDE is proposing to repeal all MWC NOx RACT requirements from COMAR 26.11.09.08 and establish new requirements within COMAR 26.11.08 – Control of Incinerators
- MDE proposes to retain the existing NOx RACT requirements for MWCs with a capacity of 35 tons or greater per day and less than or equal to 250 tons per day
  - Small MWCs may not exceed the NOx emission standards established in 40 CFR 62, Subpart JJJ

MDE Updates to HMIWI NOx RACT

- Existing NOx RACT standards for hospital, medical, and infectious waste incinerators (HMIWI) are codified in COMAR 26.11.09.08
- MDE is proposing to repeal all HMIWI NOx RACT requirements from COMAR 26.11.09.08 and establish new requirements within COMAR 26.11.08 – Control of Incinerators
- Existing NOx RACT for HMIWIs under COMAR 26.11.09.08H(3) references NOx emission standards established under COMAR 26.11.08.08-1
- As of October 6, 2014, HMIWIs must now meet the updated requirements in COMAR 26.11.08.08-2 (which includes new NOx limits) based upon the size and location of the HMIWI
- MDE proposed NOx RACT will be established to match the NOx emission limits of COMAR 26.11.08.08-2
- MDE plans to repeal outdated COMAR 26.11.08.08-1 in a separate action

Timeline

- Stakeholder Meeting
  - August 30, 2016
- Additional stakeholder discussions
- Air Quality Control Advisory Council (AQCAC) Briefing
  - June 6, 2016
- AQCAC Potential Action Item
  - December 12, 2016
- Regulation Adoption
  - NPA – January 2017
  - Public Hearing – April 2017
  - NFA – May 2017
- Effective Date
  - June 2017



Discussion

Additional Slides

Wheelabrator Baltimore, L.P. MWC

- Wheelabrator, formerly known as Baltimore RESCO, was built in Baltimore City in 1985 and operates three large mass-burn-waterwall MWCs each rated at 750 tons per day (TPD).
  - The facility can generate 60 megawatts (MW) of electricity.
  - Each MWC unit is equipped with a urea injection selective non-catalytic reduction (SNCR) system to control NOx emissions; a "slaked lime" spray dryer absorber system to control acid gas emissions; an activated carbon injection system for mercury and dioxin/furan removal; and a four field electrostatic precipitator to remove particulate matter and metals from the exhaust stream.
  - Continuous monitors are required for carbon monoxide, oxygen, opacity, oxides of nitrogen, and sulfur dioxide.

Montgomery County Resource Recovery Facility (MCRRF)

- The MCRRF is operated by Covanta Montgomery, Inc. on behalf of the Northeast Maryland Waste Disposal Authority.
  - The facility is located in Dickerson, Montgomery County, Maryland and started operation in May 1995.
  - The MCRRF consists of three independent combustion trains and has a nominal design capacity of 1,800 tons per day TPD at 5,500 Btu/lb heating value of refuse.
  - The thermal output from the facility is used to generate 63 MW of electricity. The plant uses approximately 7 to 8 MW per hour of electricity.
- The emission controls consist of an ammonia injection SNCR system for control of NOx, a dry scrubber for primary acid gas control and an activated carbon injection system for mercury control in series with a baghouse for removal of particulate matter.
  - Each unit has a furnace dry lime injection system that is capable of feeding hydrated lime directly into the combustion zone for additional acid gas control on an as needed basis.
  - Continuous monitors are required for carbon monoxide, oxygen, opacity, oxides of nitrogen, and sulfur dioxide.

NOx RACT for Municipal Waste Combustors (MWCs)

Stakeholder Meeting – January 17, 2017

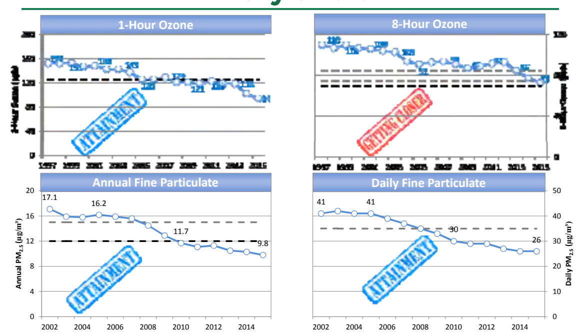
Topics Covered

- Background Information
  - Air Quality Overview
  - MD Efforts to Reduce Pollution
- Municipal Waste Combustors (MWCs) in Maryland
  - Purpose of NOx RACT review
  - MWC sources
  - Control technology and emissions
- MDE NOx RACT update
  - NOx RACT Cost Analysis
- Regulation Timeline

Why NOx?

- Nitrogen oxide or NOx is the most important pollutant to reduce to continue to make progress on ground level ozone in Maryland
  - Ozone is formed when NOx and Volatile Organic Compounds react with sunlight
- There is very little doubt that the State's recent progress on cleaning up ozone air pollution is driven by NOx reductions
- NOx is also a contributor to nitrogen deposition into the Chesapeake Bay, fine particulate pollution in Maryland and regional haze

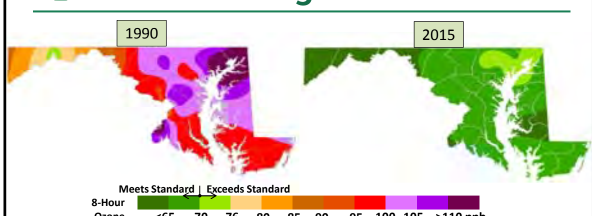
Progress in Cleaning Maryland's Air



Clean Air Progress in Baltimore

- Baltimore has historically measured some of the highest ozone in the East
- From 2013 to 2015, the Baltimore area did not exceed the current ozone standard
  - First time in 30 years … weather did play a role
- EPA has now finalized a "Clean Data Determination"
- With hotter, less ozone friendly weather, Baltimore may see higher ozone … but continued progress is indisputable
- New, lower ozone standard begins in 2017

The Shrinking Ozone Problem



- In 2015 no monitors were above the 75 ppb threshold
- In 2015 only small areas of Baltimore, Harford and Cecil Counties were above the new ozone threshold of 70 ppb

Key Pollutants

- Over the past 10 years, MDE has worked to reduce emissions of many pollutants. Six of the most critical pollutants include:
  - Nitrogen oxide or "NO_x" - the key pollutant to reduce to further lower ozone levels. Also contributes to fine particle pollution and regional haze
  - Sulfur dioxide or "SO_2" - the key pollutant to reduce for fine particulates and the new SO_2 standard. Also a major contributor to regional haze
  - Carbon dioxide or "CO_2" - the primary greenhouse gas that needs to be reduced to address climate change
  - Mercury (Hg) - a very important toxic air pollutant
  - Diesel particulate - diesel exhaust
  - Volatile Organic Compounds or "VOC" - also a contributor to ground level ozone. Many VOCs are also air toxics

Key Emission Reduction Programs

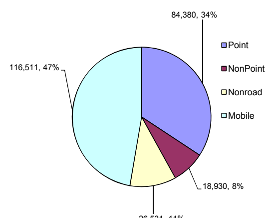
- Since around 2005, Maryland has implemented some of the countries most effective emission reduction programs
  - These efforts have worked
- Power Plants
- Cement Plants
- Cars and Trucks
- Consumer Products
- Area Source VOCs

2005 to 2017 Control Programs

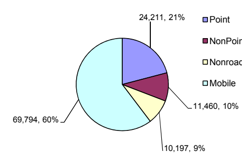
- Power Plants
  - The Maryland Healthy Air Act of 2006
  - 2015 NOx reductions for coal plants
- Portland Cement Plants
  - 2017 NOx RACT updates
- VOC Regulations
  - Architectural and Industrial Coatings
  - Consumer Products
  - Autobody Refinishing
- Mobile Sources
  - The Maryland Clean Cars Act of 2007
  - Diesel Trucks, School Buses, Locomotives

NO_x Emission Reductions 2005 – 2014

2005 Annual NO_x Emissions
246,000 tons per year



2014 Annual NO_x Emissions
115,000 tons per year
More than a 50% reduction



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- The Department has been meeting with affected sources and EPA since the summer of 2015 to discuss MWC operations, emissions data and NOx RACT proposals
- August 30, 2016 – 1st Stakeholder Meeting
- October 27, 2016 – Stakeholder comments received

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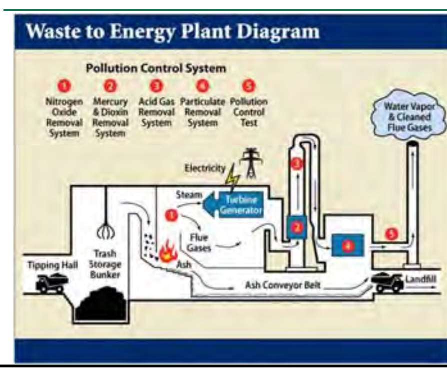

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MDE Current Thinking

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- We are looking for input from stakeholders.

Unit	30 Day Rolling Average Limit	24 Hour Daily Limit
Wheelabrator	Somewhere between 145 and 175 ppmvd	Somewhere between 165 and 180 ppmvd
MCRRF	Somewhere between 105 and 130 ppmvd	Somewhere between 120 and 140 ppmvd

ppmvd = parts per million volume dry

RACT Cost Analysis – NOx Emissions Methodology

- The NOx Average Emissions Inputs for Wheelabrator facility using 2015 data:
  - Unit 1 - 165 ppm
  - Unit 2 – 171 ppm
  - Unit 3 – 168 ppm
- Methodology:
  - The potential NOx emission reductions were projected by calculating the emissions for every day that exceeded 170 ppm
  - For unit 1, for example, the range was 171 to 190 ppm
  - The average NOx emission was calculated for each 24-hr ppm over 170 ppm

    13 lb/day x number of days over 170 ppm x ppm over 170

  - Sum calculation for unit 1, 2 and 3
  - NOx emissions reduced = 18 tons annual

RACT Cost Analysis – NOx Optimization @ 178 24-hour Limit

- Inputs for Wheelabrator facility:
  - Based on 178 ppm 24-hour Daily NOx limit utilizing a 170 ppm upper control limit
  - 2015 average hourly urea injection rates = 5 gph
  - 2015 average urea cost per/gallon = $1.50
  - Urea injection rate increased only on days to meet compliance with 178 ppm 24-hour Daily NOx limit
  - Scenario applied to 2015 NOx emissions data for 3 units
- Results:
  - Urea usage increased by 7 gph as needed to meet 178 ppm 24-hour Daily NOx limit
  - Approximate additional urea used = 46,704 gallons
  - Approximate additional cost = $70,056
  - NOx emissions reduced = 18 tons annual
  - Cost-effectiveness is $ 3,196/ton of NOx reduced

RACT Cost Analysis – NOx Optimization @ 170 24-hour Limit

- Inputs for Wheelabrator facility:
  - Based on 170 ppm 24-hour Daily NOx limit utilizing a 160 ppm upper control limit
  - 2015 average hourly urea injection rates = 5 gph
  - 2015 average urea cost per/gallon = $1.50
  - Urea injection rate increased on all operating days to meet 160 ppm 24-hour Daily NOx upper control limit
  - Scenario applied to 2015 NOx emissions data for 3 units
- Results:
  - Urea usage increased by 5 gph to meet 160 ppm 24-hour Daily NOx upper control limit
  - Approximate additional cost = $179,469
  - NOx emissions reduced = 60 tons annual
  - Cost-effectiveness is $ 2,990/ton of NOx reduced

RACT Cost Analysis – Low NOx

- The NOx RACT analysis for the LN™ control system is based upon the following factors associated with the MCRRF installation:
  - Installation started in 2008 and was completed in 2010 at a capital cost of $6.7 million
  - Average operating costs (2013-15) at $566,000 per year
  - Capital cost projected to 2017 is $7.54 million
  - Life of LN™ control system assumed to 20 years
  - Capital cost on yearly basis $452,652
  - Total cost on yearly basis is capital cost + operating cost = $1.018 million
  - Emission reduction is 500 tons/year
- Cost-effectiveness is projected approximately to $2037/ton of NOx reduced.

RACT Cost Analysis – SCR

- MD's Large MWCs are controlled with SNCR
  - MCRFF also utilizes LN™ control system
- SCR operates similar to SNCR systems in that NOx is removed by injecting ammonia (urea) into the flue gas, but with the addition of passing the mixed gases through a catalyst bed
  - SCR requires additional equipment and impacts the energy production of the facility. SCR requires air-to air heat exchanger and steam reheat module to maintain needed temperature and bigger ID fan
  - High NOx reduction efficiencies can be achieved if the parameters such as residence time, space velocity, and the correct temperature window are controlled
- MDE worked with EPA to identify if any MWCs in the U.S. have been retrofitted with SCR
  - No sources have been identified
  - MDE believes that the potential costs of SCR does not meet the "economic feasibility" criteria of Reasonably Available Control Technology

Timeline

- Stakeholder Meetings
  - August 30, 2016
  - January 17, 2017
  - TBD
- Air Quality Control Advisory Council (AQCAC) Briefing
  - June 6, 2016
- AQCAC Potential Action Item
  - June 19, 2017
- Regulation Adoption
  - NPA – July 2017
  - Public Hearing – October 2017
  - NFA – November 2017
- Effective Date
  - January 2018

Maryland Department of the Environment

Discussion

Maryland Department of the Environment

Stakeholder Comments on Maryland NO_x RACT rulemaking for Large Municipal Waste Combustors

Environmental Integrity Project
Leah Kelly, Attorney
Ben Kunstman, Engineer

Nitrogen Oxides (NO_x)

- NO_x

Air pollutants that affect human health

→ Nitrogen dioxide (NO_2)
→ Fine particulate matter ($PM_{2.5}$)
→ Ozone (why we're here)

Water quality

→Deposi. on of nitrogen (N) in water contributes to dead zones in the Chesapeake Bay
- About 33% of N in Chesapeake Bay comes from air deposition

Nitrogen Dioxide (NO_2)

- Short term exposure to high NO_2 levels can "aggravate respiratory diseases, particularly asthma, leading to respiratory symptoms . . . , hospital admissions, and visits to the emergency room."
- Longer exposures to high levels of NO_2 may contribute to the development of asthma.
- People with asthma, as well as children and the elderly are especially susceptible to these adverse effects.

Source: EPA, Effects of NO2, https://www.epa.gov/no2-pollution/basic-information-about-no2#Effects

Fine Particulate Matter ($PM_{2.5}$)

- Consists of particles that are 2.5 microns or less in diameter, which is 1/30th the size of a human hair.
- Can cause premature mortality due to heart and lung disease, can aggravate asthma, and increases the risk of adverse birth outcomes, including low birth weight and preterm birth.
- Can cause adverse health effects even at levels below federal air quality standards.

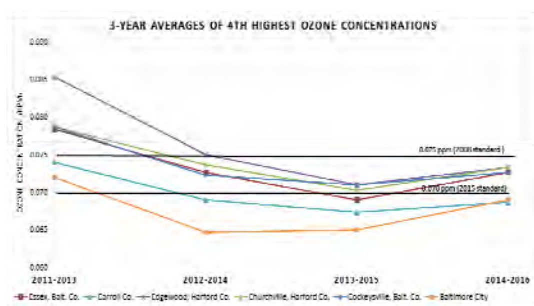
Source: *See generally*, U.S. EPA (2010) Summary of Expert Opinions on the Existence of a Threshold in the Concentration-Response Function for PM2.5-related Mortality, Technical Support Document, available at: http://www3.epa.gov/ttnecas1/regdata/Benefits/thresholdstsd.pdf,

Ozone

- NOx + volatile organic compounds (VOC) + sunlight → Ozone
- Can aggravate respiratory conditions like asthma, bronchitis, and emphysema.
- Can increase susceptibility to lung infections and cause chronic obstructive pulmonary disorder (COPD).
- People at increased risk are asthmatics, children, the elderly, and those who are active outdoors.

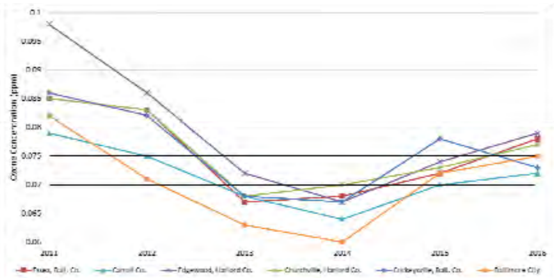
Source: EPA, Health Effects of Ozone Pollution, https://www.epa.gov/ozone-pollution/health-effects-ozone-pollution

Baltimore Area Ozone Trends – Meeting EPA Air Quality Standards



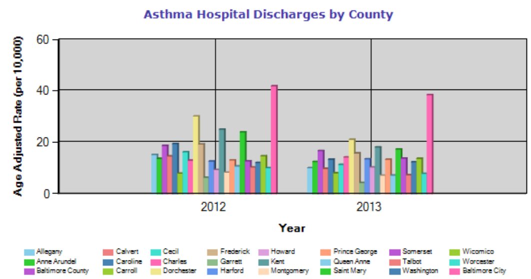
Source: EPA Airdata, https://www.epa.gov/outdoor-air-quality-data

Baltimore Area Ozone Trends by Year (4th highest max)



Source: EPA Airdata, https://www.epa.gov/outdoor-air-quality-data

Asthma Levels in Baltimore



Source: Maryland Department of Health and Mental Hygiene , Maryland Environmental Public Health Tracking Tool https://maps.dhmh.maryland.gov/epht/query.aspxl

NO_x Emissions from BRESCO

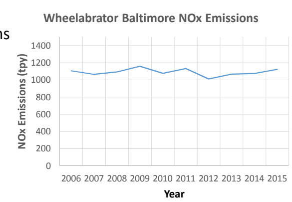
- 6th highest NOx emitter in Maryland in 2015

Rank	Company	NO_x (tons)
1	Raven Power-Ft. Smallwood Complex	3102
2	Lehigh Cement-Union Bridge (cement plant)	2936
3	GENON-Chalk Point/SMECO	2126
4	Luke Paper Company (paper mill)	1887
5	HOLCIM (US), Inc. (cement plant)	1225
6	Wheelabrator-Baltimore (RESCO)	1123
7	Constellation Power-Crane	1078
8	GENON-Dickerson	987
9	NRG -Morgantown	897
10	AES Warrior Run	445
11	Montgomery County RRF	441

Source: 2015 Maryland Emissions Inventory

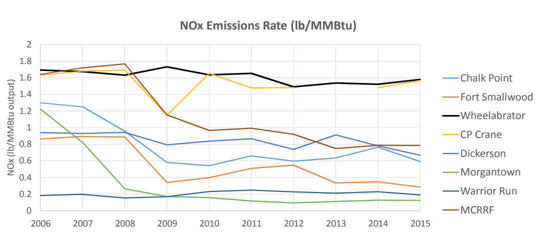
Wheelabrator Baltimore (BRESCO)

- Over last decade, relatively constant annual emissions (tons per year)
- Between 2006-2015, has gone from 13th highest NOx emitter to 6th



Sources: NOx emissions-Maryland Emissions Inventory: 2006-2015
Electricity output and useful thermal output- Energy Information Administration Power Plant Operating Data

Maryland Electrical Generating NOx Sources



Sources: NOx emissions-Maryland Emissions Inventory: 2006-2015
Electricity output and useful thermal output- Energy Information Administration Power Plant Operating Data

Treatment Technologies

- Selective Catalytic Reduction (SCR)
- Regenerative Selective Catalytic Reduction (RSCR)
- Low NOx Controls

- Most effective technology for controlling NOx emissions from variety of sources
- SCR can provide control efficiencies of 75% or greater at MSW incinerators

Source: Maryland Power Plant Research Program (PPRP), Supplemental Environmental Review Document, Motion by Energy Answers Baltimore, LLC, to Amend the Construction Commencement Deadline in its Certificate of Public Convenience and Necessity, Maryland Public Service Commission Docket No. 9199 (June 2012) at 6-6.

Treatment Technologies

- Selective Catalytic Reduction (SCR)
- Regenerative Selective Catalytic Reduction (RSCR)
- Low NOx Controls

- Variation of SCR utilizing flue gas re-heat to improve cost-effectiveness
- Would have been control technology used at Energy Answers
- "Estimated minimum 80% removal efficiency for NOx"
- Energy Answers- 45 ppmdv
- Wheelabrator actual 2015 annual average= 168 ppmdv

Source: Maryland Power Plant Research Program (PPRP), Supplemental Environmental Review Document, Motion by Energy Answers Baltimore, LLC, to Amend the Construction Commencement Deadline in its Certificate of Public Convenience and Necessity, Maryland Public Service Commission Docket No. 9199 (June 2012) at 6-6.

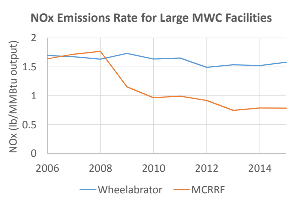
Treatment Technologies

- Selective Catalytic Reduction (SCR)
- Regenerative Selective Catalytic Reduction (RSCR)
- Low NOx Controls

- Modifying combustion processes to maximize NOx reduction
- Retrofit can be combined with existing SNCR systems

Montgomery County Resource Recovery Facility (MCRRF)

- Utilizes SNCR and Low NOx control technology
- Low NOx installed in 2009
- Similar boiler technology, control technology, and pre-2009 emissions rates to Wheelabrator facility



Sources: NOx emissions-Maryland Emissions Inventory: 2006-2015
Electricity output and useful thermal output- Energy Information Administration Power Plant Operating Data

"Low NO_x" Technology – Montgomery County RRF v. BRESCO

Montgomery County RRF Emissions and Waste Processing 2006-2015

Year	NO_x emissions (tons)	Waste processed (tons)
2006	1,041	620,666
2007	1,009	578,804
2008	998	573,293
2009	554	527,623
2010	499	551,670
2011	512	556,266
2012	479	544,647
2013	388	555,716
2014	427	Not available
2015	441	599,250

BRESCO Emissions and Waste Processing 2012-2015

Year	NO_x (tons)	Waste processed (tons)
2012	1,012	697,078
2013	1,067	713,410
2014	1,076	Not available
2015	1,124	730,150

Sources: Maryland Emissions Inventory for emissions; U.S. Energy Information Administration for power generated; Northeast Maryland Waste Disposal Authority for waste processed

Efficiency of BRESCO Current Controls
Selective Non-Catalytic Reduction ("SNCR")

- Wheelabrator optimization tests for existing SNCR system stated optimized NOx removal of 25%

	NOx ppm	NOx Removal	Urea Utilization
Original Configuration	175	14-21%	25%
Optimized Configuration	150-165	25%	40%

*from August 30, 2016 MDE NOx RACT for Municipal Waste Combustors Presentation

- Maryland PPRP's analysis- "SNCR typically achieves minimum control efficiencies in range of 50-60% for MSW incinerators"

Source: Maryland PPRP, *supra*, note 15 at 6-7 (Attachment A).

NOx RACT Limits for Incinerators in Other States

State	NOX limit (ppmvd @ 7% O2)	Action	Averaging time	Notes
Connecticut	150 for mass burn waterwall combustors	Final rule effective 8/2/16	24-hour daily average	Limit effective 8/2/17 12 months to comply
New Jersey	150 for municipal solid waste incinerators	Effective April 2009	Calendar day average	Allows owner/operator to apply for alternative NOx limit
Massachusetts	150 for mass burn waterwall combustors	Proposed May 2013. Not finalized.	Daily average	

Wheelabrator Baltimore
NOx RACT Review

Timothy Porter
Director Air Quality Management

January 17, 2017

Wheelabrator Baltimore
NOx RACT Review

Outline:
- Facility Overview
- NOx Control Overview
- NOx RACT Optimization Program
- LN™ NOx Control Technology Feasibility

NOx RACT Review
Facility

- Three (3)-750 ton per day MSW fired WTE boilers
- Boiler MCR of 325 MMBtu/Hour and 193,600 lbs/hour of steam.
- Von Roll reciprocating grates with Babcock & Wilcox power boilers
- Single pass furnace with superheater and waterwall platen panels
- Power Generation 64 MW-enough for 40,000 homes
  – Combined heat and power facility
  – Steam supply to City of Baltimore
- Air Emission Controls (MACT)
  – SNCR-NOx Control (urea based)
  – Spray Dryer Absorber (SDA)
  – High Efficiency 4-Field ESP
  – Activated Carbon Injection

NOx RACT Review
NOx Limits for Large Massburn MWCs

- EPA MACT(SNCR)
  - New units 150 ppm7%
  - Existing units 205 ppm7%
- NOx RACT(SNCR)
  - NJ (May 2011) 150 ppm7% O2
  - PA (Jan 2017) 180 ppm7% O2
  - CT (Aug 2017) 150 ppm7%O2
  - MA (June 2019?) 150 ppm7% or 185 ppm7% subject to approval
- EPA BACT (SCR) 50 ppm 7% O2
- EPA LAER (SCR) 50 ppm7% O2

NOx RACT Review
SNCR NOx Control–Design Factors

Uncontrolled or baseline NOx levels (MWC Range 150-350 ppm)
- Function of boiler/grate design and combustion controls (low excess air /stage combustion)
- Lower baseline NOx-higher NSR required (reagent to NOx ratio) to achieve target NOx level or NOx removal efficiency
- Slower reaction kinetics
- Reduced reagent utilization

Residence time within optimum temperature and available for mass transfer, reagent transformation and NOx reduction reactions
- Function of furnace design/geometry/gas flow pattern and available furnace volume

Extent of reagent/flue gas mixing achievable

Must minimize ammonia (NH3) slip
- detached ammonium chloride plume formation
- NH3=PM2.5 precursor

NOx RACT Review
SNCR NOx Control-Design Factors

Massburn MWC Boiler vs Coal Fired Utility Boiler SNCR Consideration		
	MWC Boiler	**Utility Boiler**
Fuel Characteristic	Low and Variable Fuel Heating Value (4000-5500 Btu/lb)	High and Constant Heating Value (11,000-15,000 Btu/lb)
Excess Air	High Excess Air (80-100%)-variable	Low Excess Air (<30%)-constant
Furnace Temperature	Variable	Near Constant
SNCR Temp Window	Variable	Near Constant
Furnace Volume to Heat Release Ratio	Large	Small
Fuel Chlorine Content	High (corrosion/plume)	Low

NOx RACT Review

SNCR NOx Control-Baltimore Specific Design Factors

Lower Baseline NOx 200-224 ppm, original WAPC design of 240-260 ppm, 300 (max) ppm

- Good Combustion Control-Low excess air/staged combustion limits NOx formation
- Lower baseline increases difficulty of achieving higher NOx removal
- Need higher NSR or more urea but increases NH3 slip potential (visible detached ammonium chloride plume)

Water wall platens in single pass furnace

- Reduced working furnace volume
- Reduce SNCR window (reagent residence time available for mass transfer and chemical reactions)

MD SIP 0 visible emission standard in Baltimore

- Excessive NH3 slip cannot be reduced in ESP as in baghouse
- Detached visible plume = violation of SIP limit

NOx RACT Review

SNCR-NOx Optimization Test Program

OBJECTIVE: Optimize existing SNCR system to establish facility specific NOx RACT limit

Phase I-Short Term Optimization

- Conducted furnace temperature profiling on clean and slagged boiler to verify furnace temperature range for SNCR (1800-2100 deg F)
- Optimized existing SNCR systems to determine target NOx RACT limit (injector location/number, urea injection rate)

Phase II-Longer Term Evaluation

- Conducted longer term evaluation of target RACT limit from Phase I
- Analyzed results to propose continuously achievable NOx RACT limit.
- Evaluate ammonia slip
- Convert short term performance variation/uncertainty to certainty of long term continuously achievable limit
- Calculate Upper Confidence Limit as done for EPA (MACT)/permit limits

NOx RACT Review

SNCR-NOx Optimization Test Program

Phase I- Conducted Feb 29-Mar 4, 2016.

	Test No.	Steam Flow klbs/hr	Base NOx ppm7%	Controlled NOx ppm7%	NOx REM %	Urea gph	NSR	Urea Utilization
Unit 2	8	192.0	224	167	25%	12.0	0.71	36%
Unit 2	9	192.0	224	157	30%	12.0	0.71	42%
Unit 1	11	192.0	203	150	26%	10.0	0.65	40%
Unit 1	12	192.0	203	144	29%	15.0	0.98	30%
Unit 1	13	192.0	203	150	26%	15.0	0.98	27%

NOx RACT Review

SNCR-NOx Optimization Test Program

Phase II-Conducted March-May 2016:

- Target 160-165 ppm/24 hour average from best of Phase I results
- Establish daily baseline NOx (assume steady for day)
- Run to maintain target NOx for 24 hours
- Operator adjustments as needed to achieve target
- Obtained 23-24 hour averages over several weeks
- Overall Results
- Conduct data analysis

NOx RACT Review

SNCR-NOx Optimization Test Program

Phase II-All Results

	Upper Confidence Limit Summary		
One Tail	0.95	0.975	0.99
Student-t Value	1.714	2.069	2.5
Count	23	23	23
Average ppm7%	169	169	169
Standard Deviation	5.1	5.1	5.1
Upper Confidence Limit ppm7%	**178**	**180**	**182**

Phase II-Results below 170 ppm7%

	Upper Confidence Limit Summary		
One Tail	0.95	0.975	0.99
Student-t Value	1.782	2.179	2.681
Count	13	13	13
Average ppm7%	165	165	165
Standard Deviation	2.3	2.3	2.3
Upper Confidence Limit ppm7%	**169**	**170**	**171**

NOx RACT Review

NOx Variability

Year	NOx Tons	NOx 24-Hr Average
2015	1124	Annual 168 ppm Max values, 190, 198, 196 50% of 24-Hr averages above annual average
2016	1147(est)	Annual 170 ppm Max Values 193, 198,197 170 days above annual average

NOx RACT Review

NOx RACT/SNCR Summary

RACT Cost Effectiveness

- 2016 annual NOx emissions = 1146 tons (est.)
- Proposed RACT limit 170 ppm
- Setpoint to maintain 170 ppm limit = 160 ppm
- NOx annual average=160 ppm
- NOx reduction = 67 tons
- 2016 average urea usage = 5.2 gallons/hour (gph)
- Additional urea required 5 gph x 3 x 8760 x 0.93 = 122,202 gal/yr
- Urea $1.50/gallon = $183,303 additional annual cost
- Cost Effectiveness = $2731/ton

NOx RACT Review

LN^{TM} NOx Control Feasibility at Baltimore

Differences in boiler/furnace design between Baltimore and Montgomery County boilers make it very difficult if not infeasible to apply the LN^{TM} technology at Baltimore.

Application of LN^{TM} technology to Baltimore is limited by:

- Smaller furnace volume-single pass furnace
- Presence of water wall platen panels in furnace radiant section
- Location of pendant superheater in furnace at exit
- Very limited room to add effective tertiary air level at required height above secondary air level in furnace
- Cannot inject urea above tertiary air in furnace cavity between waterwall platens and superheater
  - Severe and rapid superheater corrosion via liquid impingement on boiler tubes

NOx RACT Review

LN^{TM} NOx Control Feasibility at Baltimore

Design Differences Between the Montgomery County and Baltimore Boilers

	Montgomery County	Baltimore
MCR Steamflow (klbs/hr)	171	193.6
Steam pressure and temp	865 psig/830 degF	900 psig/830 degF
Grate System	Martin Gmbh	Hitachi Zosen (Von Roll)
Boiler Design	Tail end-"European"	Vertical (B&W)-"American"
Number of Furnace Passes	2+	1
Superheater Location	Downstream of Two-Pass Furnace and Generating Bank	Exit of One-Pass Furnace
Screen Platens in Furnace	None	12 Large Platens on Front Wall
SNCR Spray Nozzle Elevation	>30 ft. above secondary air and above tertiary air	~17 ft. above secondary Air
Total Excess Air	80%	100%
Combustion Air Distribution	Primary = 60%, Secondary = 20%, Tertiary = 20%	Primary= 55%, Secondary = 45%
Baseline NOx (No SNCR control)	300-320 ppm7% (LN 20% tertiary = 211 ppm7%)	200-224 ppm7%

NOx RACT Review

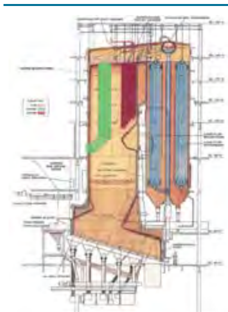
LN^{TM} NOx Control Feasibility at Baltimore

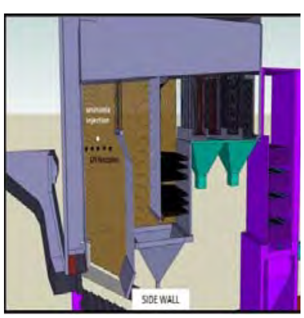
Design Differences Between the Montgomery County and Baltimore Plant Boilers

	Montgomery County	Baltimore
Boiler Design	Tail end-"European"	Vertical (B&W)-"American"
Furnace Exit Gas Temperature Control (critical for minimizing superheater corrosion)	Two-pass waterwall furnace, flue gas passes through a water cooled generating bank section prior to reaching the superheater	High excess air (100% design), limiting heat input, furnace size, and use of the water cooled screen platens for additional heat removal in the upper furnace.
	Larger furnace volume without platens and superheater, lower excess air = longer flue gas residence time for SNCR and no risk of superheater corrosion	Smaller furnace volume with platens and superheater in furnace, shorter flue gas residence time for SNCR, high superheater corrosion

NOx RACT Review

LN^{TM} NOx Control Feasibility at Baltimore





NOx RACT Review

LN^{TM} NOx Control Feasibility at Baltimore

- Baltimore boiler/furnace design significantly different than Montgomery Cty
- Differences are reason why LN^{TM} technology infeasible at Baltimore
- Very limited room to add effective tertiary air level at required height above secondary air level (25-50 ft recommended)
- Tertiary air injection at bottom of water wall platens/superheater
  - increased high temperature corrosion and erosion of platens-cannot remove platens-impact boiler performance/decrease boiler availability
- Cannot relocate urea injectors above tertiary air-cannot inject urea in furnace cavity between waterwall platens and superheater.
  - Severe and rapid corrosion via liquid impingement on platen and superheater boiler tubes
  - Would required major boiler/furnace design/modification and reconstruction
- LN^{TM} is not: "…*reasonably available considering technological and economic feasibility*". (USEPA)

Wheelabrator Baltimore
NOx RACT Review

Timothy Porter
Director Air Quality Management

January 17, 2017

Wheelabrator
TECHNOLOGIES

NOx RACT for Municipal Waste Combustors (MWCs)

Stakeholder Meeting – September 22, 2017

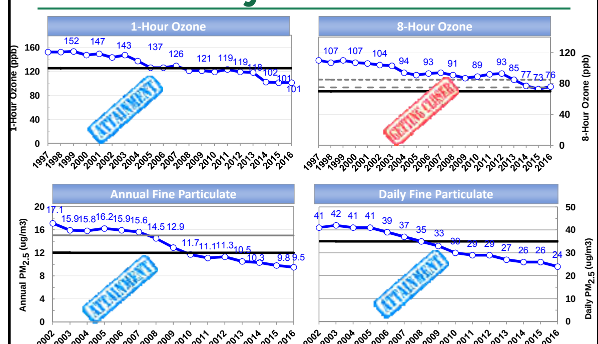
Topics Covered

- Background Information
  - Air Quality Overview
  - MD Efforts to Reduce Pollution
- Municipal Waste Combustors (MWCs) in Maryland
  - Purpose of NOx RACT review
  - Stakeholder comments
  - MWC overview
- MDE NOx RACT update
  - Proposed NOx RACT regulation
- Optional SIP Strengthening requirements
- Regulation Timeline

Why NOx?

- Nitrogen oxide or NOx is the most important pollutant to reduce for continued progress on ground level ozone in Maryland
  - Ozone is formed when NOx and Volatile Organic Compounds react with sunlight
- There is very little doubt that the State's recent progress on cleaning up ozone air pollution is driven by NOx reductions
- NOx is also a contributor to nitrogen deposition into the Chesapeake Bay, fine particulate pollution in Maryland and regional haze

Progress in Cleaning Maryland's Air



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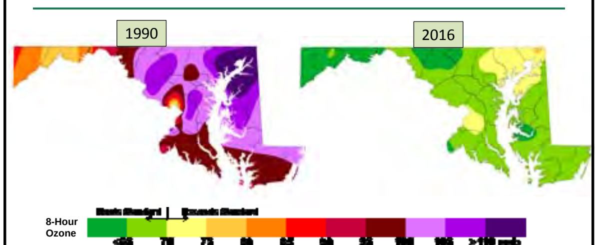
Clean Air Progress in Baltimore

- Baltimore has historically measured some of the highest ozone in the East
- From 2013 to 2015, the Baltimore area did not exceed the 75 ppb ozone standard
  - First time in 30 years … weather did play a role
- EPA has now finalized a "Clean Data Determination"
- With hotter, less ozone friendly weather, Baltimore may see higher ozone … but continued progress is indisputable
- New, lower ozone standard, 70 ppb

The Shrinking Ozone Problem



- In 2016 only areas of Baltimore, Harford, Kent, Cecil, and Prince George's Counties were above the ozone threshold of 70 ppb

Key Pollutants

- Over the past 10 years, MDE has worked to reduce emissions of many pollutants. Six of the most critical pollutants include:
  - Nitrogen oxides or "NO_x" - the key pollutant to reduce to further lower ozone levels. Also contributes to fine particle pollution and regional haze
  - Sulfur dioxide or "SO2" - the key pollutant to reduce for fine particulates and the new SO2 standard. Also a major contributor to regional haze
  - Carbon dioxide or "CO2" - the primary greenhouse gas that needs to be reduced to address climate change
  - Mercury (Hg) - a very important toxic air pollutant
  - Diesel particulate - diesel exhaust
  - Volatile Organic Compounds or "VOC" - also a contributor to ground level ozone. Many VOCs are also air toxics

Key Emission Reduction Programs

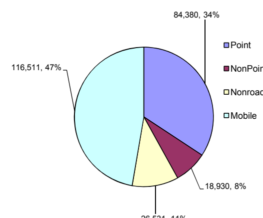
- Since around 2005, Maryland has implemented some of the country's most effective emission reduction programs:
  - Power Plants
  - Cement Plants
  - Cars and Trucks
  - Consumer Products
  - Area Source VOCs

2005 to 2017 Control Programs

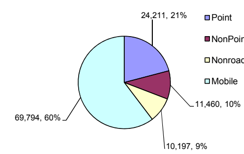
- Power Plants
  - The Maryland Healthy Air Act of 2006
  - 2015 NOx reductions for coal plants
- Portland Cement Plants
  - 2017 NOx RACT updates
- VOC Regulations
  - Architectural and Industrial Coatings
  - Consumer Products
  - Autobody Refinishing
- Mobile Sources
  - The Maryland Clean Cars Act of 2007 and 2017
  - Diesel Trucks, School Buses, Locomotives

NOx Emission Reductions 2005 – 2014

2005 Annual NO_x Emissions
246,000 tons per year



2014 Annual NO_x Emissions
115,000 tons per year
More than a 50% reduction



MD NOx RACT Review for Large MWCs

- The purpose of this review is to establish new NO_x RACT (Reasonably Available Control Technology) requirements for large MWCs with a capacity greater than 250 tons per day
- There are two large MWCs in Maryland;
  - Wheelabrator Baltimore, L.P. and
  - Montgomery County Resource Recovery Facility (MCRRF)
- The Department has been meeting with affected sources and EPA since the summer of 2015 to discuss MWC operations, emissions data and NOx RACT proposals
- August 30, 2016 – 1st Stakeholder Meeting
- October 27, 2016 – Stakeholder comments received
- January 17, 2017 – 2nd Stakeholder Meeting
- May 9, 2017 - Stakeholder comments received

2015-16 Top MD NOx Emissions

No.	2016 Top 15 NOx Emissions Sources in MD	NOx Emissions (Tons Per Year)* 2016	NOx Emissions (Tons Per Year) * 2015
1	Lehigh Cement Company LLC	2,781	2,936
2	Raven Power Fort Smallwood LLC	2,569	3,102
3	NRG Chalk Point Generating Station	2,326	2,126
4	Luke Paper Company	1,927	1,887
5	**Wheelabrator Baltimore, LP**	**1,141**	**1,123**
6	NRG Dickerson Generating Station	987	987
7	NRG Morgantown Generating Station	949	897
8	C P Crane Generating Station	661	1,078
9	**Montgomery County Resource Recovery Facility (MCRRF)**	**418**	**441**
10	AES Warrior Run Inc	359	445
11	Holcim (US), Inc **	331	1,225
12	Constellation Power - Westport	195	65
13	Constellation Power - Perryman Generating Station	150	190
14	Rock Springs Generation Facility	141	127
15	KMC Thermo-Brandywine Power Facility	137	144

* Facility-wide NOx emissions

* * Company converted to preheter/precalciner kiln process, operating hours and NOx emissions were lower – operated for 153 days

Stakeholder Comments

- Detail human health and water quality impacts
- MDE must set a RACT limit no higher than 150 ppm on a 24-hour average
  - Point to NJ, CT and MA adoption of 150 ppm NOx RACT
  - Point to similar Wheelabrator MWCs meeting 150 ppm
- MDE should require Wheelabrator to analyze whether lower limits can be met through modern control technologies
- MDE should go beyond RACT to set lower NOx limits

Maryland Department of the Environment

Wheelabrator

2,250
Tons of Waste Processed per day

722,789
Tons of Waste Processed Last Year

64 MW
Energy Generation Capacity

40,000
Homes Powered

1985
Began Operations

Maryland Department of the Environment

Wheelabrator NOx Emissions

Year	NOx Tons	Long Term (Annual) Average NOx 24-Hr Block Concentration
2013	1067	169 ppm
2014	1076	162 ppm
2015	1123	168 ppm
2016	1141	169 ppm
Average	**1102**	**167 ppm**

Montgomery County Resource Recovery Facility

1,800
Tons of Waste Processed per day

599,250
Tons of Waste Processed Last Year

52 MW
Energy Generation Capacity

37,000
Homes Powered

1995
Began Operations

Maryland Department of the Environment

MCRRF NOx Emissions

Year	NOx Tons	Long Term (Annual) Average NOx 24-Hr Block Concentration
2013	387.7	85 ppm
2014	426.7	88 ppm
2015	441.2	89 ppm
2016	418	87 ppm
Average	**418**	**87 ppm**

MCRRF NOx Control Technology

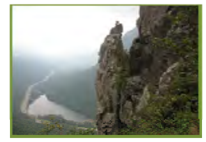
- An SNCR system is integrated to a combustion Low NOx (LN™) system with modifications to the location of the injectors
- The Covanta LN™ technology employs a unique combustion system design, including modifications to combustion air flows, reagent injection and control systems logic
- The LN™ control system and SNCR result in lowering the NOx emission rate range to 85-89 ppm long-term (annual average) basis
- Approximate 47 percent reduction on long term basis, but subject to high variability on daily basis, lesser can be assured on a short-term basis
- The LN™ control system installation started in 2008 and was completed in 2010 at a capital cost of $6.7 million and the average operating costs over the last three years has been $566,000 per year

MDE Updates to MWC NOx RACT

- Based upon:
  - regional RACT amendments in other states
  - review of MWC NOx emissions data analysis of optimization studies
  - recent combustion upgrades at Wheelabrator
- The Department has concluded that the NOx RACT standards for MWCs can be strengthened within the definition of RACT
- MDE proposing to pair daily (24-hour) limits with longer (30-day rolling average) limits

MDE Proposed NOx RACT

- Three key elements:
  - Requirement to optimize control technologies to minimize NOx emissions each day of operation
  - Daily, 24-hour block average limits to ensure peak daily emissions are addressed
  - Longer term, 30-day rolling average limits to ensure that even lower limits are met throughout the year



Maryland Department of the Environment

Requirement to Minimize NOx Emissions Every Day

- .10A - Page 2 of draft regulation
- The owner and operator of a Large MWC shall minimize NOx emissions by operating and optimizing the use of all installed pollution control technology at all times the unit is in operation, including periods of startup and shutdown
  - Ensures NOx control technologies are operated in the best possible manner to minimize emissions
  - Satisfies part of EPA's SSM policy (more on that later)
- Not later than 45 days after effective date of regulation, a plan is due to the Department demonstrating how Large MWCs will operate controls during all modes of operation including but not limited to normal operations, startup and shutdown

Daily and Longer Term Limits

- .10B and C - Pages 2 and 3 of draft regulation
- 24-hour block average rates effective May 1, 2019
- 30-day rolling average rates effective May 1, 2020
  - Allows time to ensure more stringent, long-term rates can be met on a consistent basis

Unit	24 Hour Block Average Rate	30 Day Rolling Average Rate
Wheelabrator	150 ppmv	145 ppmv
MCRRF	140 ppmv	105 ppmv

ppmv = parts per million volume

Reporting Requirements

- .10 I - Page 3 of draft regulation
- Beginning July 1, 2019, the owner or operator of a Large MWC shall submit a quarterly report to the Department containing:
  - (1) Data, information, and calculations which demonstrate compliance with the NOx 24-hour block average emission rates
  - (2) Documented actions taken during periods of startup and shutdown in signed, contemporaneous operating logs
- Beginning July 1, 2020, the owner or operator of a Large MWC shall submit a quarterly report to the Department containing data, information, and calculations which demonstrate compliance with the NO_x 30-day rolling average emission rate

Monitoring and Compliance

- .10G and L - Page 3 of draft regulation
- The owner or operator of a Large MWC shall continuously monitor NOx emissions with a continuous emission monitoring system in accordance with COMAR 26.11.01.11 - Continuous Emission Monitoring (CEM) Requirements
- Compliance with NOx emission standards to be demonstrated with a CEM
- Compliance with NOx mass loading limits for periods of startup and shutdown demonstrated by calculating the 24-hr block averages of all hourly average NOx emission concentrations for all the hours during the 24-hour period that the affected facility is operating, including periods of startup and shutdown

EPA SSM Policy – June 12, 2015

- Provides a mechanism for facilities to meet alternative emission limits during periods of startup/shutdown
- EPA requires seven specific criteria be met when developing SS limits
- MDE addressing SS criteria directly in proposed regulation and within Technical Support Documents

Startup/Shutdown Limits

- .10D - Page 3 of draft regulation
- Higher volumes of air are present in furnace during SS events & adjustment to 7% oxygen does not represent actual NOx emissions
- Mass based emission standards take into account the design flue gas flow rate & represent the worst case actual NOx emissions
  - Applied facility wide on a 24-hour block period
- Mass based calculations based upon 24 hour block average NOx RACT limits

Unit	24 Hour Block Average Rate	Mass Loading NOx Limit
Wheelabrator	150 ppmv	252 lbs/hr
MCRRF	140 ppmv	202 lbs/hr

ppmv = parts per million volume

Optional SIP Strengthening
MDE Seeking Input at Today's Meeting

- MDE considering a "SIP Strengthening" concept that is intended to address the many public comments we have received about the age of the Wheelabrator facility and how to move towards even lower NOx limits as the plant is modernized
- MDE is asking for comment on this option

Optional SIP Strengthening
Basic Concepts

- Establish new NOx limits in 2022 for the Wheelabrator facility
- Builds upon ongoing modernization efforts that are already in place at Wheelabrator
- Two steps:
  - Feasibility study in 2020
  - New NOx limits in 2022

Process for Establishing New 2022 NOx Limits - Feasibility Analysis

- Step 1 - Feasibility Analysis
  - In 2020, Wheelabrator would submit a feasibility analysis describing options for achieving lower NOx emissions based upon ongoing modernization efforts at the plant. Would include information like:
    - A written narrative and schematics detailing existing facility operations, boiler design, control technologies, and relevant emission performance
    - A written narrative and schematics detailing state of the art control technologies for new and retrofit MWCs
    - A feasibility analysis for achieving additional NOx reductions
    - A cost-benefit analysis
    - Proposed 2022 emission limits if appropriate
    - Any other information MDE deems necessary to evaluate the review

Process for Establishing New 2022 NOx Limits

- Step 2 - Two Options
  - Option 1 - Establish 2022 limits in current RACT rule:
    - Presumptive limit; or
    - "Alternative Limit" if supported by the 2020 feasibility study
      - Alternative limit would need to go through full public comment and hearing process required by Maryland law
  - Option 2 - Initiate rulemaking in 2020 or 2021 to adopt new 2022 NOx limits for the Wheelabrator facility

Timeline

- Stakeholder Meetings
  - August 30, 2016
  - January 17, 2017
  - September 22, 2017
- Air Quality Control Advisory Council (AQCAC) Briefing
  - June 6, 2016
- AQCAC Potential Action Item
  - December 11, 2017
- Regulation Adoption
  - NPA – February 2018
  - Public Hearing – March 2018
  - NFA – April 2018
- Effective Date
  - May 2018

Maryland Department of the Environment

Discussion

Maryland Department of the Environment

CHESAPEAKE BAY FOUNDATION
Saving a National Treasure

February 3, 2017

George (Tad) Aburn
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Submitted via Electronic Mail

RE: Preliminary Comments on MDE Process for Setting Reasonably Available Control Technology Limits for NOx Emissions from Large Municipal Waste Combustors

Dear Mr. Aburn:

The Chesapeake Bay Foundation (CBF) submits the following preliminary comments in regards to the ongoing public stakeholder process held by the Maryland Department of the Environment (MDE) to set Reasonably Available Control Technology (RACT) limits for nitrogen oxides (NOx) emissions from Maryland's two large municipal waste combustors ("MWCs"). The two MWCs are Wheelabrator Baltimore, L.P. ("Wheelabrator") and the Montgomery County Resource Recovery Facility (MCRRF).

CBF representatives participated in the second public stakeholder meeting held on January 17, 2017. These preliminary comments outline our general feedback. However, in order to provide fully developed technical comments on the information presented by MDE and Wheelabrator at the January 17th meeting, CBF respectfully requests MDE to extend the deadline to submit final comments to April 21, 2017.

<u>Background</u>

In December of 2010, the U.S. Environmental Protection Agency (EPA) issued the Chesapeake Bay Total Maximum Daily Load ("Bay TMDL") for Nitrogen, Phosphorus, and Sediment.[1] Each of the six watershed States and the District of Columbia then developed Watershed Implementation Plans ("WIPs") which detail each jurisdiction's strategy to meet the pollution reduction goals of the Bay TMDL.[2] Collectively, the Bay TMDL and the WIPs constitute the Chesapeake Bay Clean Water Blueprint. CBF is dedicated to the success of the Blueprint, including Maryland's WIPs and local water quality goals.

[1] U.S. EPA, Chesapeake Bay Total Maximum Daily Load for Nitrogen, Phosphorus, and Sediment (Dec. 2010), *available at* https://www.epa.gov/chesapeake-bay-tmdl/chesapeake-bay-tmdl-document.
[2] *See e.g.*, MDE, Md.'s Phase II Watershed Implementation Plan for the Chesapeake Bay TMDL (Oct. 2012), http://www.mde.state.md.us/programs/Water/TMDL/TMDLImplementation/Pages/FINAL_PhaseII_WIPDocument_Main.aspx.

Atmospheric deposition of nitrogen is the largest source of nitrogen to the Chesapeake Bay watershed, and nitrogen oxides (NOx) are the primary source of this atmospheric nitrogen.[3] NOx are also a primary contributor to ground-level ozone, a pollutant that has numerous negative human health impacts.[4] CBF commends MDE on its previous and ongoing efforts to address NOx pollution and reach ozone attainment levels in Maryland. In particular, CBF supports MDE's Clean Air Act Section 126 Petition submitted to the Environmental Protection Agency (EPA) on November 16, 2016.[5] In the Petition, MDE notes that Maryland has worked diligently for years to reduce harmful regional emissions and continues to put forth its best efforts. MDE should illustrate these best efforts by requiring significant NOx emissions reductions at Wheelabrator through the current RACT rulemaking.

MDE is conducting the current rulemaking process pursuant to Section 182 of the federal Clean Air Act, which requires states to establish RACT standards for major sources of NOx located in areas that are in violation of ozone pollution limits (i.e., "nonattainment areas").[6] The Code of Maryland Regulations defines RACT as "the lowest emissions limit that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility."[7]

MDE reported that Wheelabrator Baltimore emitted 1,123 tons of NOx in 2015.[8] As the sixth largest source of NOx emissions in Maryland in 2015,[9] the RACT standard for NOx emissions from Wheelabrator is an important piece of MDE's overall strategy to reduce NOx emissions and ozone pollution in the State. CBF shares and adopts the human health and air quality concerns outlined in a comment letter submitted by the Environmental Integrity Project (EIP) and a coalition of groups on October 27, 2016.[10] CBF urges MDE to set a standard that further reduces NOx emissions and protects human health.

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[3] *Id*. at Appendix L: Setting the Chesapeake Bay Atmospheric Nitrogen Deposition Allocations, at L-1 (Dec. 2010), https://www.epa.gov/sites/production/files/2015-02/documents/appendix_l_atmos_n_deposition_allocations_final.pdf; *see also*, U.S. EPA, Office of Air Quality Planning & Standards, "Technical Bulletin: Nitrogen Oxides (NOx), Why and How They Are Controlled," at 1 (Nov. 1999), https://www3.epa.gov/ttncatc1/dir1/fnoxdoc.pdf.

[4] EPA, Ozone Basics, https://www.epa.gov/ozone-pollution/ozone-basics.

[5] MDE, Petition to the U.S. EPA Pursuant to Section 126 of the Clean Air Act (Nov. 16, 2016), *available at* http://news.maryland.gov/mde/wp-content/uploads/sites/6/2016/11/MD_126_Petition_Final_111616.pdf.

[6] *See* 42 U.S.C. § 7511a; *see also*, EPA, Current Nonattainment Counties for All Criteria Pollutants, https://www3.epa.gov/airquality/greenbook/ancl.html (listing Baltimore in nonattainment for the 2008 8-hour ozone standard).

[7] COMAR 26.11.01.01(40); see also, Memorandum from Roger Strelow, Assistant Admin., Air and Waste Mgmt., U.S. EPA, to Regional Administrators, Regions I-X, Guidance for Determining Acceptability of SIP Regulations in Non-Attainment Areas, at 3 (Dec. 9, 1976), *available at* https://www3.epa.gov/ttn/naaqs/aqmguide/collection/cp2/19761209_strelow_ract.pdf ("RACT should represent the toughest controls considering technological and economic feasibility that can be applied to a specific situation.").

[8] MDE PowerPoint Presentation, "NOx RACT for Municipal Waste Combustors (MWCs): Stakeholder Meeting – January 17, 2017," at slide 14.

[9] *Id*.

[10] Letter from EIP, *et al.*, to MDE, Re: Public Stakeholder Process for Setting Reasonably Available Control Technology Limits for Nitrogen Oxides Emissions from Large Municipal Waste Combustors (Oct. 27, 2016).

Preliminary Comments

Representatives for MDE, EIP, and Wheelabrator Baltimore gave presentations at the January 17th stakeholder meeting. These presentations included a discussion of currently available emission control technologies for municipal waste combustors (MWCs). CBF appreciates this initial analysis and information. However, due to the technical nature of the information, CBF requests additional time to review the materials and consult an engineer with relevant expertise. In particular, CBF intends to further review and provide feedback on the following:

- The feasibility of installing Low NOx™ Control Technology at Wheelabrator (a Low NOx™ system is currently operating at MCRRF leading to reduced NOx emissions);
- Wheelabrator's concerns regarding ammonia slip and the visible emissions limit;
- The physical and technical constraints of the current boiler configuration as outlined in Wheelabrator's presentation.

In addition, CBF plans to obtain and review data, information, results, and reports from tests and analyses performed for or considered in any way during MDE's evaluation of RACT for NOx emissions from the Wheelabrator facility including, but not limited to: raw data and results of the optimization tests conducted for the existing Selective Non-Catalytic Reduction (SNCR) system at Wheelabrator; information and results of any computational fluid dynamics modeling performed at Wheelabrator; and information or analyses related to the waste stream processed by the Wheelabrator facility. Depending upon the review of this information, CBF's feedback may address issues beyond those listed above.

Finally, CBF intends to further research and provide feedback regarding nitrogen deposition to the Bay from the two MWC's NOx emissions and information related to human health impacts.

Conclusion

CBF appreciates MDE's stakeholder process thus far and the opportunity to participate and submit comments. Due to the volume and complexity of materials, the need to obtain additional records and information as detailed above, and our intent to provide substantive and useful comments, CBF respectfully requests an extended deadline to submit final comments by April 21, 2017. This proposed deadline assumes there will be no extensive delay in obtaining the records and information described above. Thank you for your time and consideration.

Sincerely,

Alison Prost, Esq.
Maryland Executive Director
Chesapeake Bay Foundation

cc:
Randy E. Mosier
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February 3, 2017

Via E-mail
George (Tad) Aburn
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Maryland Department of the Environment
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george.aburn@maryland.gov

RE: Public Stakeholder Process for Setting Reasonably Available Control Technology Limits for Nitrogen Oxides Emissions from Large Municipal Waste Combustors

Dear Mr. Aburn:

I am writing on behalf of the Environmental Integrity Project ("EIP") with respect to the public stakeholder process that the Maryland Department of the Environment ("MDE") is conducting to set Reasonably Available Control Technology ("RACT") limits for nitrogen oxides ("NO_x") emissions from Maryland's two large municipal waste combustors ("MWCs" or "incinerators"). EIP appreciates MDE's efforts to make this process transparent and accessible to the public. We are currently conducting a close review of the technical information presented at the stakeholder meeting held on January 17, 2017 as well as additional information. We will provide MDE with the results of this review by April 21, 2017.

<u>Background</u>

MDE initiated a public stakeholder process on the NO_x RACT rule for large MWCs in the summer of 2016, holding an initial stakeholder meeting on August 30, 2016. On October 27, 2016, EIP and several other organizations submitted written comments to MDE regarding the NO_x RACT limit for the Baltimore Refuse Energy Systems Company ("BRESCO") incinerator in Baltimore City, which is owned and operated by Wheelabrator Baltimore, LP ("Wheelabrator"). In that letter, we raised concerns regarding the effectiveness of the current pollution control system for NO_x at the BRESCO plant and posed questions about the feasibility of installing new, more effective NO_x controls at BRESCO. We also requested that MDE hold additional public stakeholder meetings at which Wheelabrator would respond to the questions raised in our letter.

On January 17, 2017, MDE held a public stakeholder meeting at which Wheelabrator presented detailed technical information in support of its arguments that (1) it should not have to install new NO_x pollution controls at BRESCO under the RACT standard; and (2) its NO_x RACT limit should be 170 parts per million by volume, dry basis (ppmvd) at 7% oxygen. Following that meeting, MDE requested that stakeholder comments be submitted by February 3, 2017.[1]

Comments

EIP appreciates MDE's responsiveness to our October 27, 2016 letter. Specifically, we appreciate that MDE held the January 17, 2017 stakeholder meeting on this rulemaking, which allowed EIP and our community and organizational partners to learn more about operations at the BRESCO incinerator. As we have stated previously, emissions from the BRESCO plant are of serious concern to EIP as well as other health and environmental groups and residents living near the incinerator. This concern is heightened because of Baltimore's high asthma rates and the fact that ozone levels have been increasing over the past two years in Baltimore City and the Baltimore ozone nonattainment area. It is extremely important that MDE provide a transparent process that allows residents affected by BRESCO's emissions to participate in this rulemaking in a meaningful way, and we appreciate that MDE has been providing such a process.

EIP is currently conducting an in-depth review of the technical information presented by Wheelabrator at the January 17, 2017 stakeholder meeting. We will also be analyzing information sought under a Public Information Act ("PIA") request that we submitted in early January 2017, which may need to be supplemented with one additional PIA request. Our goal is to ensure that Baltimoreans benefit as much as possible from this process, and that NO_x emissions are reduced at BRESCO as much as possible. Our analysis will address issues including the following:

- Whether there is adequate support for Wheelabrator's claim that it is technically infeasible to install the Low NO_x™ system operating at Maryland's other incinerator, the Montgomery County Resource Recovery Facility, at the BRESCO plant;
- Whether Wheelabrator can optimize its existing control technology to achieve consistent emission rates below its proposed limit, 170 ppmvd, without increasing its ammonia slip in a way that violates its visible emissions limit;[2]
- Additional options for reducing NO_x by modifying the existing BRESCO system or adding NO_x pollution controls that are technically and economically feasible to install on BRESCO; and
- Whether NO_x could be reduced, and public health further protected, by limiting the nitrogen content of the waste being burned at BRESCO.

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[1] Comment periods during the stakeholder process are separate from, and in addition to, the formal written public comment period, which must be held following the publication of a proposed rule in the Maryland Register.

[2] We note that Wheelabrator's presentation did not address the amount of ammonia slip caused by urea injection during the optimization tests already performed at BRESCO. It appears that ammonia slip of up to 20 ppm amount will not cause a violation of the applicable visible emissions limit. The Energy Answers incinerator, which would have also been located in Baltimore City, was subject to an ammonia slip limit of 20 ppmvd @ 7% O2, averaged over 24 hours, under Condition A-22 of its now-revoked Certificate of Public Convenience and Necessity ("CPCN"). This incinerator was subject to the same visible emissions limit that applies to BRESCO. In addition, Connecticut has a NOx RACT limit of 150 ppmvd @ 7% O2 for large MWCs, like BRESCO, that use mass burn waterwall combustors. Regs. Conn. State Agencies § 22a-174-38(8). The same regulation establishes an ammonia slip limit of 20 ppmvd @ 7% O2 for any large MWC operating selective non-catalytic reduction ("SNCR") for NOx control. *Id.* at (c)(16).

As MDE is aware, it takes time to thoroughly analyze technical information and to present the conclusions of such an analysis. EIP is not able to submit a comprehensive set of comments by today, February 3, 2017, detailing our analysis of the information presented by Wheelabrator. However, we will be able to submit such a set of comments by April 21, 2017, assuming that there are no extensive delays in our receipt of records requested under the PIA.

Again, EIP appreciates the time that MDE has taken to make this process transparent to the public and we look forward to providing the results of our technical review. We are also aware that our partner groups, many of which were signatories to our October 27, 2016 letter, are looking forward to further engagement in this process as are other residents of Baltimore City and the Baltimore area.

Sincerely,

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Cc: *Via E-mail*

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May 9, 2017

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Submitted via Electronic Mail

RE: Comments on MDE Process for Setting Reasonably Available Control Technology (RACT) Limits for NOx Emissions from Large Municipal Waste Combustors

Dear Mr. Aburn:

The Chesapeake Bay Foundation (CBF) submits the following comments and recommendations in regards to the public stakeholder process conducted by the Maryland Department of the Environment (MDE) to set Reasonably Available Control Technology (RACT) limits for nitrogen oxides (NOx) emissions from Maryland's two large municipal waste combustors ("MWCs"). The two MWCs are Wheelabrator Baltimore, L.P. ("Wheelabrator") and the Montgomery County Resource Recovery Facility (MCRRF). These comments focus on Wheelabrator Baltimore.

CBF representatives participated in the second public stakeholder meeting held on January 17, 2017. CBF submitted preliminary comments on February 3, 2017. The following comments provide MDE with CBF's recommendations for the RACT analysis and rulemaking process. In an effort to provide MDE with the most useful feedback possible, CBF worked with two expert consultants to inform the following comments and recommendations: Dr. H. Andrew Gray, to conduct air modeling, and Dr. Ranajit Sahu, to conduct an engineering analysis. Their reports are included here as Attachments A and B. The RACT standard for NOx emissions from Wheelabrator is an important piece of MDE's overall strategy to reduce NOx emissions and ozone pollution in the State. CBF encourages MDE to take this opportunity to require significant emission reductions from the facility.

Background

The Wheelabrator Baltimore facility is a municipal waste incinerator that began operations in 1985 and now processes up to 2,250 tons of waste per day.[1] The facility consists of three large mass burn waterwall combustors. As a waste-to-energy facility, Wheelabrator is recognized as a Tier 1 Renewable Energy Facility pursuant to Maryland's Renewable Energy Portfolio Standard ("RPS").[2] Accordingly, it appears that Wheelabrator

[1] Wheelabrator, https://www.wtienergy.com/plant-locations/energy-from-waste/wheelabrator-baltimore.
[2] *See* Md. Code Ann., Pub. Util. § 7-701.

received almost $3.5 million dollars in renewal energy credits (RECs) in 2015. [3] The intent of the RPS is to recognize the benefits of Renewable Energy Facilities, which are presumed to result in "long-term decreased emissions" and "a healthier environment."[4] Notably, and also in 2015, MDE reported that Wheelabrator Baltimore emitted 1,123 tons of NOx—an increase from 2013 and 2014 emissions—and was the sixth largest source of NOx emissions in Maryland.[5]

Water Quality Impacts

In December of 2010, the U.S. Environmental Protection Agency (EPA) issued the Chesapeake Bay Total Maximum Daily Load ("Bay TMDL") for Nitrogen, Phosphorus, and Sediment.[6] Each of the six watershed States and the District of Columbia then developed Watershed Implementation Plans ("WIPs") which detail each jurisdiction's strategy to meet the pollution reduction goals of the Bay TMDL.[7] Collectively, the Bay TMDL and the WIPs constitute the Chesapeake Bay Clean Water Blueprint. CBF is dedicated to the success of the Blueprint, including Maryland's WIPs and local water quality goals.

At the time the Bay TMDL was established, atmospheric deposition of nitrogen was the largest source of nitrogen to the Chesapeake Bay watershed; nitrogen oxides (NOx) are the primary source of this atmospheric nitrogen.[8] Maryland—like all jurisdictions within the Chesapeake Bay watershed—is subject to a specific nitrogen allocation in the Bay TMDL.[9]

CBF commissioned Dr. H. Andrew Gray to conduct air modeling, using the CALPUFF model, to estimate the amount of nitrogen deposited to land and water within the Chesapeake Bay watershed from Wheelabrator's NOx emissions. The full results and methodology of this modeling are detailed in the enclosed report, Attachment A. The air modeling results showed that Wheelabrator's NOx emissions lead to the deposition of an

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[3] Pub. Serv. Comm'n of Md., Renewable Energy Portfolio Standard Report, App. A, p. 19 (Jan. 2017), *available at* http://www.psc.state.md.us/wp-content/uploads/RPS-Report-2017.pdf (Page 7 of the Report identifies the average cost of a non-solar Tier 1 REC between 2008 and 2015 as $13.87. Page 19 indicates that Wheelabrator retired 248,377 RECs in 2015; 248,377 RECs at $13.87 equals $3,444,988.).

[4] *See* Md. Code Ann., Pub. Util. § 7-702(b)(1).

[5] MDE PowerPoint Presentation, "NOx RACT for Municipal Waste Combustors (MWCs): Stakeholder Meeting – January 17, 2017," at slide 14-15, *available at* http://www.mde.state.md.us/programs/regulations/air/Documents/SHMeetings/MunicipalWasteCombustors/MWCNOxRACTPresentation.pdf.

[6] U.S. EPA, Chesapeake Bay Total Maximum Daily Load for Nitrogen, Phosphorus, and Sediment (Dec. 2010), *available at* https://www.epa.gov/chesapeake-bay-tmdl/chesapeake-bay-tmdl-document.

[7] *See e.g.*, MDE, Md.'s Phase II Watershed Implementation Plan for the Chesapeake Bay TMDL (Oct. 2012), http://www.mde.state.md.us/programs/Water/TMDL/TMDLImplementation/Pages/FINAL_PhaseII_WIPDocument_Main.aspx.

[8] Bay TMDL at Appendix L: Setting the Chesapeake Bay Atmospheric Nitrogen Deposition Allocations, at L-1 (Dec. 2010), https://www.epa.gov/sites/production/files/2015-02/documents/appendix_l_atmos_n_deposition_allocations_final.pdf; *see also*, U.S. EPA, Office of Air Quality Planning & Standards, "Technical Bulletin: Nitrogen Oxides (NOx), Why and How They Are Controlled," at 1 (Nov. 1999), https://www3.epa.gov/ttncatc1/dir1/fnoxdoc.pdf.

[9] Bay TMDL, Section 9. Chesapeake Bay TMDLs, "Table 9-1. Chesapeake Bay TMDL total nitrogen (TN) annual allocations (pounds per year) by Chesapeake Bay segment to attain Chesapeake Bay WQS," at 9-2 (2010), *available at* https://www.epa.gov/sites/production/files/2014-12/documents/cbay_final_tmdl_section_9_final_0.pdf.

estimated 94,179 pounds of nitrogen per year (almost 43 metric tons) to land and water within the Chesapeake Bay watershed; of that total, an estimated 40,973 lbs/year are deposited to land and water within Maryland. *See* Att. A, Table 3.

The 94,179 pounds of nitrogen deposited within the Bay watershed accounts for about 14 percent of Wheelabrator's annual nitrogen emissions (emitted as NOx). *See* Att. A, at 15. A portion of this nitrogen is deposited directly to tidal waters. However, a greater amount of nitrogen (about 95% of the nitrogen deposited via NOx emissions from Wheelabrator) falls upon land surfaces in the Bay watershed. Maryland and its local governments are responsible for managing this land-based nitrogen deposition in the State through the installation of expensive stormwater and agricultural best management practices.[10]

Human Health Impacts

NOx is a primary contributor to ground-level ozone, a pollutant that has numerous, well-documented negative human health impacts.[11] "Baltimore has historically measured some of the highest ozone in the East."[12] Nitrogen dioxide (NO_2), a species of NOx and precursor to ozone, can also have negative impacts to human health.

> Breathing air with a high concentration of NO_2 can irritate airways in the human respiratory system. Such exposures over short periods can aggravate respiratory diseases, particularly asthma, leading to respiratory symptoms (such as coughing, wheezing or difficulty breathing), hospital admissions and visits to emergency rooms. Longer exposures to elevated concentrations of NO_2 may contribute to the development of asthma and potentially increase susceptibility to respiratory infections. People with asthma, as well as children and the elderly are generally at greater risk for the health effects of NO_2.[13]

NO_2 is a criteria pollutant for which the Clean Air Act (CAA) requires EPA to establish National Ambient Air Quality Standards (NAAQS).[14] The NAAQS for NO_2 include two types of standards: primary standards, to protect public health, and secondary standards, to protect the public welfare, including environmental resources. The NAAQS for NO_2 are as

[10] *See* Bay TMDL, App. L, at L-23 ("The deposition on the land becomes part of the allocated load to the jurisdictions…once the nitrogen is deposited on the land, it would be managed and controlled along with other sources of nitrogen that are present on that parcel of land…In contrast, the nitrogen deposition directly to the Bay's tidal surface waters is a direct loading with no land-based management controls and, therefore, needs to be linked directly back to the air sources and air controls as EPA's allocation of atmospheric nitrogen deposition.").

[11] EPA, Ozone Basics, https://www.epa.gov/ozone-pollution/ozone-basics; *see also*, EPA, Ozone (O_3) Standards – Risk and Exposure Assessments from Current Review, https://www.epa.gov/naaqs/ozone-o3-standards-risk-and-exposure-assessments-current-review.

[12] MDE PowerPoint Presentation, *supra* note 5, at slide 5.

[13] *See* EPA, Nitrogen Dioxide (NO_2) Pollution, https://www.epa.gov/no2-pollution/basic-information-about-no2; *see also*, EPA, Policy Assessment for the Review of the Primary National Ambient Air Quality Standards for Oxides of Nitrogen (Apr. 2017), https://www.epa.gov/sites/production/files/2017-04/documents/policy_assessment_for_the_review_of_the_no2_naaqs_-_final_report.pdf.

[14] EPA, NAAQS Table, https://www.epa.gov/criteria-air-pollutants/naaqs-table.

follows: a primary standard of 100 parts per billion ("ppb") as a one-hour average and 53 ppb averaged over a year; and a secondary standard of 53 ppb averaged over a year.[15]

CBF commissioned Dr. Gray to conduct air modeling, using AERMOD, to estimate the local and regional concentrations of NO_2 resulting from Wheelabrator's emissions. As explained in more detail in the air modeling report enclosed as Attachment A, Wheelabrator's emissions contribute NO_2 to the neighboring communities surrounding the facility. Specifically, "the model indicated that the maximum 1-hour NO_2 concentration due to Wheelabrator exceeded 50 µg/m3 [26.6 ppb] over an area of approximately 11.4 sq. km." *See* Att. A, Table 1/Figure A.6. Although the modeling results do not show a violation of the 1-hour NO_2 NAAQS, the results "indicate that the Wheelabrator facility, on its own, contributes more than one-fourth (28 percent) of the allowable 1-hour NAAQS design value for the cumulative impact from all sources in the community." *See* Att. A, at 7.

In short, Wheelabrator Baltimore contributes a significant amount of NO_2 to the communities surrounding the facility. Both short-term and long-term exposure to NO_2 can lead to negative human health impacts. A stringent NOx RACT standard will reduce the amount of NOx, including NO_2, that is emitted from the Wheelabrator incinerator.

NOx Regulation in Maryland

Acknowledging the significant environmental and human health impacts resulting from NOx emissions, CBF appreciates MDE's previous and ongoing efforts to address NOx pollution and reach ozone attainment levels in Maryland. CBF supports MDE's Clean Air Act Section 126 Petition submitted to the EPA on November 16, 2016.[16] In the Petition, MDE notes that Maryland has worked diligently for years to reduce harmful regional emissions and continues to put forth its best efforts. The current NOx RACT rulemaking is an important moment for MDE to reaffirm this effort to protect human health and the environment.

MDE is conducting the current rulemaking process pursuant to Section 182 of the federal CAA, which requires states to establish RACT standards for major sources of NOx located in areas that are in violation of ozone pollution limits (i.e., "nonattainment areas") and EPA's 2008 ozone implementation rule.[17] The Code of Maryland Regulations defines RACT as "the lowest emissions limit that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility."[18]

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[15] *Id*.
[16] MDE, Petition to the U.S. EPA Pursuant to Section 126 of the Clean Air Act (Nov. 16, 2016), *available at* http://news.maryland.gov/mde/wp-content/uploads/sites/6/2016/11/MD_126_Petition_Final_111616.pdf.
[17] *See* 42 U.S.C. § 7511a; *see also*, EPA, Current Nonattainment Counties for All Criteria Pollutants, https://www3.epa.gov/airquality/greenbook/ancl.html (listing Baltimore in nonattainment for the 2008 8-hour ozone standard); Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements, 80 Fed. Reg. 12264 (Mar. 6, 2015).
[18] COMAR 26.11.01.01(40); *see also*, Memorandum from Roger Strelow, Assistant Admin., Air and Waste Mgmt., U.S. EPA, to Regional Administrators, Regions I-X, Guidance for Determining Acceptability of SIP Regulations in Non-Attainment Areas, at 3 (Dec. 9, 1976), *available at*

Sections 172(c)(1) and 182(b)(2) of the CAA require states to implement RACT for major stationary sources in areas classified as moderate (and higher) non-attainment for ozone. Section 184(b)(1)(B) of the CAA requires RACT for major stationary sources in states located in the Ozone Transport Region (OTR). NOx RACT emission limits vary within the OTR and a variety of technologies are used to control NOx emissions.[19] Wheelabrator contributes to areas designated by EPA as "nonattainment" for ozone and is located within Maryland, an OTR member state.[20]

Comments and Recommendations re: the NOx RACT Standard

In recognition of the impacts to water quality and human health from Wheelabrator's NOx emissions, MDE should use its authority to require significant NOx reductions at Wheelabrator Baltimore. MDE has indicated that it is considering a 24-hour daily RACT standard between 165 and 180 ppmvd @7% 0_2.[21] However, prior to establishing the NOx RACT standard, MDE should conduct a thorough evaluation of whether Wheelabrator Baltimore can implement a hybrid SNCR/SCR control system. Such a hybrid system would allow for NOx reductions of up to 75% and would warrant a NOx RACT limit closer to 50 ppmvd. If, *and only if*, hybrid SNCR/SCR is determined to be unavailable for Wheelabrator—after thorough review by MDE, including analysis of all information discussed in Attachments B and C, and public input—MDE should set a daily RACT standard of no higher than 150 ppmvd, as demonstrated in other OTR states for MWCs similar to Wheelabrator Baltimore.

I. MDE Should Thoroughly Investigate Hybrid SNCR/SCR as a NOx Control Option for Wheelabrator Baltimore.

Hybrid SNCR/SCR involves a hybrid combination of a Selective Non-Catalytic Reduction (SNCR) NOx control system (the existing technology at Wheelabrator) and one or more layers of Selective Catalytic Reduction (SCR) catalyst placed at the appropriate locations in the gas path. *See* Sahu Report, Att. B, at 4. Hybrid SNCR/SCR control systems allow for significant NOx reductions between 50 and 75%. *See id*. MDE should thoroughly evaluate whether a hybrid SNCR/SCR system is a feasible control option for Wheelabrator Baltimore. In order to conduct this thorough evaluation, MDE must request additional information from Wheelabrator.[22]

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https://www3.epa.gov/ttn/naaqs/aqmguide/collection/cp2/19761209_strelow_ract.pdf ("RACT should represent the toughest controls considering technological and economic feasibility that can be applied to a specific situation.").

[19] Ozone Transport Comm'n, Stationary Area Sources Committee, White Paper on Control Technologies and OTC State Regulations for Nitrogen Oxides (NOx) Emissions from Eight Source Categories, at 28–30 (Feb. 10, 2017), *available at* http://www.otcair.org/upload/Documents/Reports/OTC_White_Paper_NOx_Controls_Regs_Eight_Sources_Final_Draft_02152017.pdf.

[20] EPA, 8-Hour Ozone (2008) Designated Area/State Information, https://www3.epa.gov/airquality/greenbook/hbtc.html.

[21] *See* MDE PowerPoint Presentation, *supra* note 5, at slide 23.

[22] COMAR 26.11.01.05(A) ("The Department may require a person who owns or operates an installation or source to establish and maintain records sufficient to provide the information necessary to…[a]ssist the Department in the development of an…air emissions standard…").

As MDE acknowledged at a 2016 Air Quality Control Advisory Council Meeting, "Maryland MWCs have demonstrated the potential to reduce NOx emissions through analysis and optimization of existing controls."[23] However, based on the publicly available information, CBF is concerned with the adequacy of Wheelabrator's optimization study, as detailed by Dr. Sahu in Attachment B. At the January 17, 2017 Stakeholder Meeting, Wheelabrator claimed technical limitations at the facility that, in Wheelabrator's opinion, narrow the scope of feasible optimization and control technologies. MDE should request the additional information, described herein and attached, from Wheelabrator so that it can adequately analyze these claims and consider the possibility of a hybrid SNCR/SCR system. *See* Att. B. Any claim of technical infeasibility must be thoroughly supported with evidence provided by Wheelabrator and reviewed by MDE and public stakeholders.

MDE should request clarifying and additional information pertaining to Wheelabrator as detailed by Dr. Sahu in Attachment B including, but not limited to, the following:

i. Computational fluid dynamics (CFD) modeling for the boilers;
ii. Details related to the Quinapoxet Optimization Study, including responses to the list of questions submitted to MDE on April 4, 2017 and enclosed here as Attachment C;
iii. Information regarding NOx generation and fuel composition (i.e., nitrogen,[24] moisture, and oxygen content of the waste stream);
iv. A detailed description of the combustion process.

II. <u>If Hybrid SNCR/SCR is Proven to be Infeasible, MDE Should Set a RACT Standard for MWCs of No Higher Than 150 ppmvd.</u>

A NOx RACT standard for MWCs of 150 ppmvd is technologically and economically feasible, as demonstrated by the RACT standards set for MWCs in neighboring states in the Ozone Transport Region, including MWCs similar to Wheelabrator Baltimore. All MWCs in Connecticut, including two owned and operated by Wheelabrator, L.P., are required to meet a RACT standard of 150 ppmvd.[25] Similarly, all MWCs in New Jersey are required to meet a RACT standard of 150 ppmvd.[26] Three Wheelabrator plants that appear similar to the Wheelabrator Baltimore facility are now, or will soon be, subject to a NOx RACT limit of 150 ppmvd. See section II.A.ii. in the Environmental Integrity Project's comment letter, submitted May 9, 2017, for a more detailed analysis of these three similar incinerator facilities.

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[23] MDE, PowerPoint Presentation, "NOx RACT for Municipal Waste Combustors", at slide 15 (June 6, 2016), http://mde.maryland.gov/programs/workwithmde/Documents/MWC-AQCAC-Briefing-06-06-2016.pdf.
[24] "Because of the relatively low temperatures at which MWC furnaces operate, 70 to 80 percent of NOx formed in MWCs is associated with nitrogen in the waste." EPA, AP 42, Fifth Ed. Compilation of Air Pollutant Emission Factors, Vol. I, Chapter 2: Solid Waste Disposal, at 2.1.3.5 (Oct. 1996), *available at* https://www3.epa.gov/ttnchie1/ap42/ch02/final/c02s01.pdf.
[25] Conn. Agencies Regs. § 22a-174-38(c)(8); *see also*, Ozone Transport Comm'n, White Paper, *supra* note 19, at App. D: Municipal Waste Combustors in Ozone Transport Region (Feb. 10, 2017).
[26] N.J. Admin. Code § 7:27-19.12 (setting standard at 150 ppmvd and providing an option to obtain an alternative standard).

However, in light of the considerable impacts on local and regional water quality and human health due to the significant NOx emissions from Wheelabrator, MDE should *first* pursue a hybrid SNCR/SCR control option for Wheelabrator and the much higher reductions achievable with such a control system.

Conclusion

CBF appreciates MDE's stakeholder process thus far and the opportunity to participate and submit comments. Please do not hesitate to contact us with questions.

Sincerely,

Alison Prost, Esq.
Maryland Executive Director
Chesapeake Bay Foundation

cc:
Randy E. Mosier
Division Chief, Air Quality Regulations Division, MDE
randy.mosier@maryland.gov

ATTACHMENT A

MODELING OF THE WHEELABRATOR BALTIMORE MUNICIPAL WASTE INCINERATOR

Dr. H. Andrew Gray
Gray Sky Solutions
May 9, 2017

The Wheelabrator Baltimore municipal waste incinerator ("Wheelabrator" or "the facility"), located in Baltimore, Maryland, is a large source of nitrogen oxides (NO_X), which contribute to smog and Chesapeake Bay pollution.[1] A computer modeling study was conducted to estimate local NO_2 air quality impacts in addition to the regional deposition rates of nitrogen associated with the NO_X emissions from the Wheelabrator facility.

Two separate modeling exercises were conducted: (1) Short-term and long-term nitrogen dioxide (NO_2) concentration impacts were estimated in the area immediately surrounding the Wheelabrator facility, and (2) Long-term nitrogen deposition impacts were estimated to the Chesapeake Bay Watershed. The methodology and results for these two modeling assessments are presented below.

Local-scale NO_2 Concentration Impacts

The AERMOD model (v16216r) was used to compute hourly NO_2 concentrations in the area surrounding the Wheelabrator facility. Previous modeling of the Wheelabrator facility performed by MDE[2] and Energy Answers[3] were used to satisfy many of the source and meteorological data requirements. The AERMOD inputs, options, and model results are described below:

Source Data

Emission data for the Wheelabrator facility were obtained from EPA's National Emissions Inventory (NEI) for the year 2011.[4] According to EPA's NEI, the

[1] *See* Order Responding to Petitioners' Request that the Administrator Object to the Issuance of a Title V Operating Permit, In the Matter of Wheelabrator Baltimore, L.P., Permit No. 24-510-01886, at 3 (Apr. 14, 2010) ("The Wheelabrator incinerator is a major stationary source of numerous air pollutants, including sulfur oxides (SOx), nitrogen oxides (NOx), and hazardous air pollutants (HAPs).").
[2] SO_2 Characterization Modeling Analysis for the H.A. Wagner and Brandon Shores Power Plants, Maryland Department of the Environment, April 19, 2016.
[3] Energy Answers, Modeling of Proposed Facility (modeling files, dated Sep. 2012). Energy Answers modeled the Wheelabrator facility as part of a multi-source analysis using AERMOD, which consisted of modeling emissions from a proposed Energy Answers source located near the Baltimore Harbor and other existing sources near the proposed facility.
[4] https://www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei

Wheelabrator facility emitted 1,133.54 tons of NO_X in 2011.[5] The NEI 2011 NO_X emission rate for the Wheelabrator facility (1,133.54 tpy = 32.61 g/s) was used for the current AERMOD modeling. Although there are three boilers at the Wheelabrator facility, they are all emitted from the same stack (with identical stack properties), so the entire facility was modeled as a single emission unit.

MDE's recent AERMOD modeling included stack parameter data for the Wheelabrator facility, which were used in the current modeling.[6] The Wheelabrator emissions from the three boilers are exhausted from a stack that is 96.01 m (315 ft) high (with a base elevation of 5.6 m), from three identical ports, each with a diameter of 2.13 m (7 ft). The exhaust temperature was assumed to be 415F (485.93K), and the exhaust velocity was assumed to be 74 fps (22.55 m/s).

Receptor Data

Receptors were placed within a 4 km x 4 km fine grid surrounding the source using 50m grid spacing (there were 81 x 81 = 6,561 fine grid receptors), which was nested inside a 20 km by 20 km coarse grid with 400m grid spacing (there were 2,480 additional coarse grid receptors). The modeling domain is shown in Figure 1, below. Elevations for each fine and coarse grid receptor were determined using the AERMAP program (v11103), for which the 1/3 arc-second National Elevation Dataset (NED) data[7] were input.

Meteorological Data

Two different meteorological data sets were used for the AERMOD modeling of the Wheelabrator facility: (1) the Energy Answers 2005-2009 AERMET data, and (2) a meteorological data set for 2006-2010 developed with AERMET for a previous modeling assessment of two nearby power plants.[8] Both data sets make use of surface meteorological data (hourly data and one-minute wind data) from Baltimore Airport and upper air radiosonde data from Sterling, Virginia.

The model results (see Tables 1 and 2, below) using the two independently developed meteorological data sets were quite similar (especially the modeled NAAQS design values), which may be expected given that (1) the sources of airport meteorological data used to develop both data sets were the same, (2) the same version of AERMET

[5] Energy Answers modeled the Wheelabrator facility as part of their AERMOD modeling exercise (performed in late 2012). Their modeled NO_X emission rate for Wheelabrator was 37.55 g/s, which is about 15 percent higher than the 2011 NEI total (1133.54 tpy = 32.61 g/s).
[6] Energy Answers used identical stack parameters for Wheelabrator as in MDE's recent modeling. The stack height and diameter were confirmed with GoogleEarth. The source location UTM coordinates were determined using GoogleEarth. The stack is located in UTM zone 18S, at (359352m, 4348001m).
[7] Multi-Resolution Land Characteristics Consortium (MRLC). https://www.mrlc.gov/.
[8] Modeling the Short-term SO_2 Impacts Due to Wagner and Crane Power Plant Emissions, report prepared for Sierra Club by H. Andrew Gray, Gray Sky Solutions. September 2011.

(v11059) was used during the development of both data sets, and (3) four of the five modeled years were the same.[9]

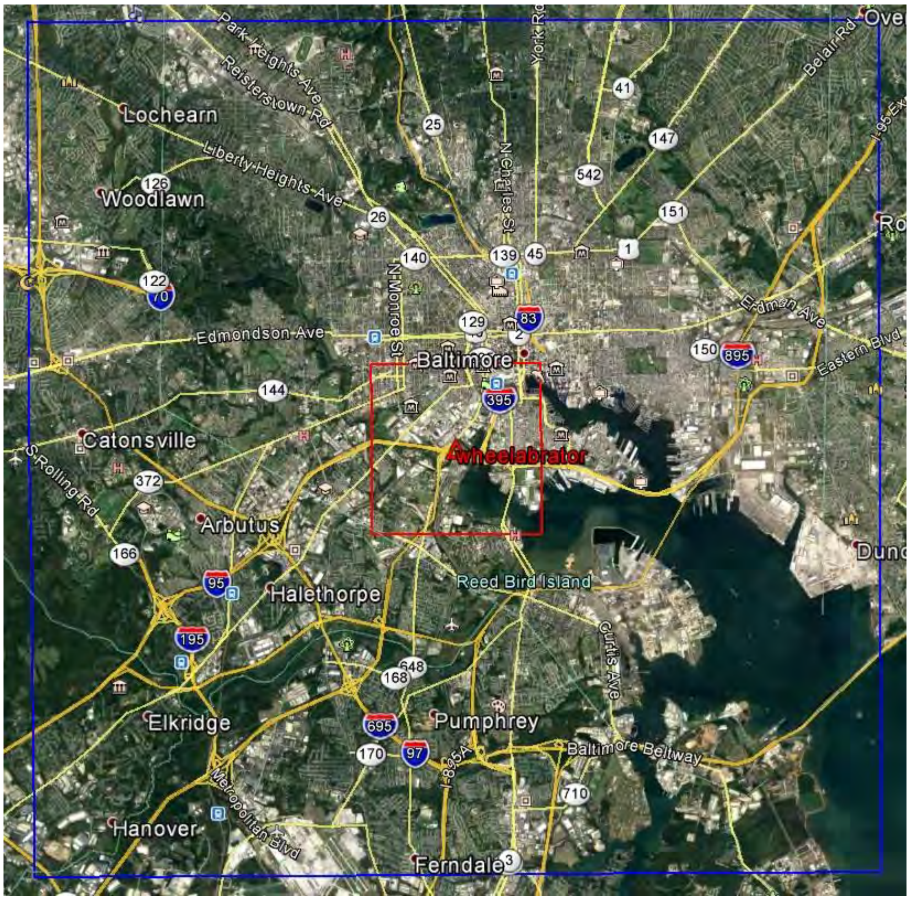

Figure 1. AERMOD Receptor Grids (red: fine 4x4 km 50m grid; blue: coarse 20x20 km 400m grid)

Model Options

The Wheelabrator facility is located in Baltimore, an urban area (est. population: 635,815[10]), and therefore the “URBAN” modeling option was selected within AERMOD. Testing of the model with and without the effects of building downwash confirmed that the plume exiting Wheelabrator’s tall stack would be unaffected by any of the nearby buildings (and therefore inclusion of the building downwash parameterization within

[9] Comparison of the two independently developed AERMET meteorological data sets confirmed that the wind speeds and directions were completely identical for the four overlapping years (2006-2009).
[10] Baltimore population (635,815) that was input to AERMOD was identical to the Energy Answers modeled population.

AERMOD was not necessary). The NO_2 conversion rate was assumed to be 100% (i.e., assuming complete conversion of NO_X to NO_2).[11]

Model Results

The AERMOD model was used to estimate the average NO_2 concentration due to Wheelabrator's NO_X emissions for every hour of the five-year modeling period at every fine and coarse grid receptor location. The maximum hourly average NO_2 concentrations were determined at each receptor, as well as the 8th highest hourly average during the five-year modeling period. In addition, concentrations corresponding to the design values for both the 1-hour and annual average NO_2 NAAQS were computed. The design value for the 1-hour NO_2 NAAQS is equal to the 98th percentile (8th highest) daily maximum 1-hour average concentration, averaged over all five model years. The annual average NO_2 design value is equal to the modeled five-year average concentration.

The maximum value for each of the modeled concentration impact metrics discussed above was determined across all modeled receptor locations, as shown in Table 1, below. The AERMOD model results (NO_2 concentrations) in Table 1 can be scaled in proportion to the NO_X emission rate to estimate the NO_2 concentration impacts for a different assumed emission rate.

Table 1 shows the modeled peak NO_2 concentrations (maximum 1-hour average, 8th highest 1-hour average, 1-hour NAAQS design value concentration, and annual average NAAQS design value concentration) that were predicted to occur due to Wheelabrator's NO_X emissions. All modeled peak NO_2 concentrations were located within the fine 4 km x 4 km modeling grid. The table indicates the UTM coordinates of each predicted peak concentration, and the location relative to the Wheelabrator facility.

The AERMOD model predicted that elevated peak concentrations occur over a large area surrounding the Wheelabrator facility. For example, using the 2005-2009 meteorological data, the model indicated that the maximum 1-hour NO_2 concentration due to Wheelabrator exceeded 50 $\mu g/m^3$ (26.6 ppb) over an area of approximately 11.4 sq. km.[12] The peak modeled 1-hour NO_2 concentration exceeded 40 $\mu g/m^3$ (21.3 ppb) across a 26 sq. km area.[13]

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[11] The AERMOD model was tested using various options for the NO_2 conversion, including PVRM, in which the equilibrium NO_2/NO_X ratio (a function of ambient ozone concentrations) is 0.9 (with fairly slow conversion), and the ARM method, which effectively results in an 80% conversion at the locations of the peak concentrations. Using the default 100% conversion may result in a slight overestimation of NO_2 concentrations.

[12] The 11.4 sq. km area in which the maximum modeled 1-hour NO_2 exceeded 50 $\mu g/m^3$ includes 9.8 sq. km (out of the total 16 sq. km) within the fine grid and 1.6 sq. km within the coarse receptor grid.

[13] The 26 sq. km area in which the maximum modeled 1-hour NO_2 exceeded 40 $\mu g/m^3$ includes 14.2 sq. km (out of the total 16 sq. km) within the fine grid and 11.7 sq. km within the coarse receptor grid.

Table 1. AERMOD Model Results: NO_2 Concentration Impacts due to the Wheelabrator Facility

Metric	Concentration µg/m³	Concentration ppb	Location (UTMx, UTMy, m)
Using 2005-2009 Meteorological Data:			
Maximum 1-hour average NO_2 Concentration	68.9	36.6	(360602, 4347851) 1.26 km E
Maximum 8th-high 1-hour average NO_2 Concentration	63.9	34.0	(360602, 4347951) 1.25 km E
1-hour NAAQS Design Value Concentration	52.7	28.0	(360702, 4347851) 1.36 km E
Annual Average Design Value Concentration	2.26	1.20	(360652, 4347901) 1.30 km E
Using 2006-2010 Meteorological Data:			
Maximum 1-hour average NO_2 Concentration	60.3	32.1	(359252, 4349151) 1.15 km N
Maximum 8th-high 1-hour average NO_2 Concentration	56.8	30.2	(358852, 4349151) 1.25 km NNW
1-hour NAAQS Design Value Concentration	53.1	28.2	(360502, 4348301) 1.19 km ENE
Annual Average Design Value Concentration	2.56	1.36	(360652, 4348001) 1.30 km E

Appendix A includes a number of maps and contour plots, showing the spatial extent of the modeled maximum 1-hour average NO_2 concentrations (during the 2005-2009 period; corresponding to the first row of data in Table 1). The area in which the modeled maximum 1-hour average NO_2 concentration exceeded 40 $\mu g/m^3$ is shown in Figures A.3 and A.4, and 50 $\mu g/m^3$ in Figures A.6 and A.7. Figures A.5 and A.8 show 3-D and 2-D contours of the same maximum hourly average NO_2 concentration model results (using different concentration cutoffs).

The AERMOD model was also run using a regional background concentration which varied by the season and hour of the day, as shown in Figure 2.[14] Hourly background NO_2 concentrations, ranging from 21 to 88 $\mu g/m^3$ (11 to 47 ppb) were added to each of the modeled 1-hour average concentrations (due to Wheelabrator) at every receptor. The modeled peak NO_2 concentrations including background are shown in Table 2 (using the same metrics as in Table 1).

[14] The variable background concentration data were identical to the background data used in the Energy Answers AERMOD modeling, and represent an upwind regional background concentration level. The modeled background NO_2 concentration does not include the impacts of other nearby NO_X sources, including transportation sources (automobiles, trucks, buses, and trains), industrial equipment, and other large point sources of NO_X in the area.

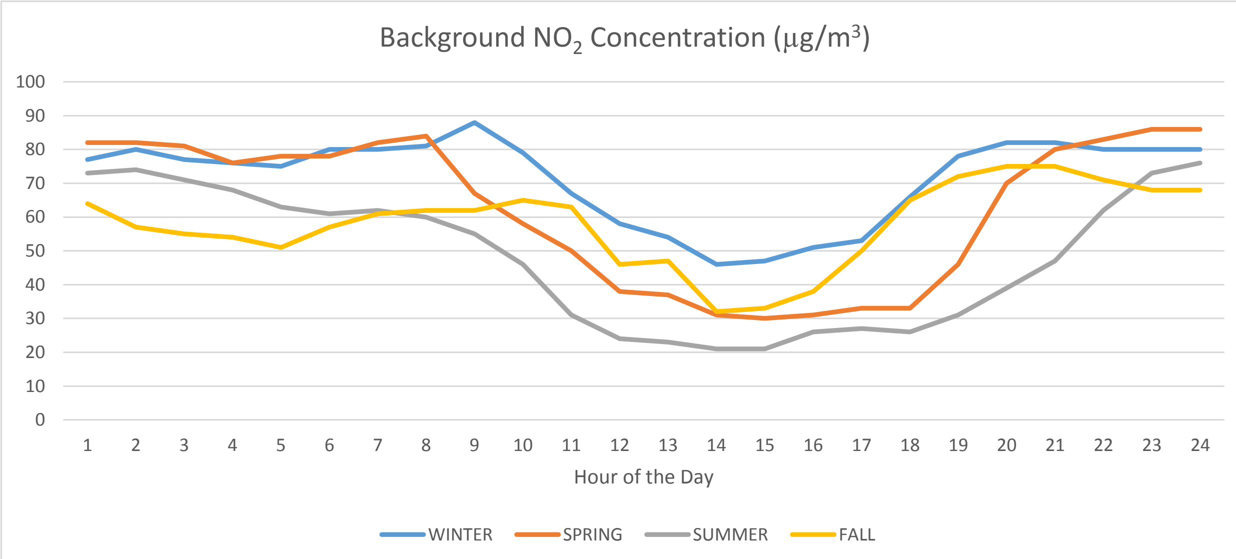

Figure 2. Modeled Background NO_2 Concentration

Table 2. AERMOD Model Results: NO_2 Concentration Impacts due to the Wheelabrator Facility, including Background Concentration

Metric	Concentration µg/m^3	Concentration ppb	Location (UTMx, UTMy, m)
Using 2005-2009 Meteorological Data:			
Maximum 1-hour average NO_2 Concentration	152.5	81.1	(360702, 4347851) 1.36 km E
Maximum 8th-high 1-hour average NO_2 Concentration	143.8	76.5	(360602, 4347851) 1.26 km E
1-hour NAAQS Design Value Concentration	129.8	69.0	(360752, 4347901) 1.40 km E
Annual Average Design Value Concentration	62.3	33.1	(360652, 4347901) 1.30 km E
Using 2006-2010 Meteorological Data:			
Maximum 1-hour average NO_2 Concentration	143.5	76.3	(360602, 4347851) 1.26 km E
Maximum 8th-high 1-hour average NO_2 Concentration	136.3	72.5	(360502, 4348151) 1.16 km E
1-hour NAAQS Design Value Concentration	130.5	69.4	(360602, 4348201) 1.27 km E
Annual Average Design Value Concentration	62.6	33.3	(360652, 4348001) 1.30 km E

According to the model results, the emissions from the Wheelabrator facility, together with the regional background NO_2 concentration, would not cause a violation of either the 1-hour or annual NO_2 NAAQS.[15] However all local sources of NO_X were not included in the modeling, including transportation sources and other large point sources.[16] Although the modeled design value does not violate the 1-hour NO_2 NAAQS, the model results (Table 1) indicate that the Wheelabrator facility, on its own, contributes more than one-fourth (28 percent) of the allowable 1-hour NAAQS design value for the cumulative impact from all sources in the community (which includes regional background).

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[15] For the 1-hour NO_2 NAAQS, the design value must be below 100 ppb = 188 $\mu g/m^3$. The annual NO_2 NAAQS is violated when the design value exceeds 53 pbb = 100 $\mu g/m^3$.
[16] To properly assess whether there would likely be a violation of the 1-hour NO_2 NAAQS, a modeling study would need to include all local sources of NO_X, including transportation sources (automobiles, trucks, buses, and trains), industrial equipment, and other large point sources of NO_X in the area. In addition, the Wheelabrator facility would need to be modeled using maximum daily emission rates to determine potential peak impacts, rather than the average emission rates used in this modeling study.

Regional-scale Nitrogen Deposition Impacts

The CALPUFF air quality dispersion model (v5.8.5) was used to estimate the deposition of nitrogen to a number of sensitive receptor areas, including the Chesapeake Bay Watershed and other regions within the Chesapeake Bay Watershed. The CALPUFF model was used to simulate the emissions of NO_X and SO_2, and the subsequent transport and atmospheric chemical transformation (into nitric acid and particulate nitrate) for an entire year. Meteorological data from previous CALPUFF modeling[17] of regional sources were used in the current modeling of the Wheelabrator facility. The CALPUFF inputs, options, and model results are described below.

Source Data

Emission data for the Wheelabrator facility were obtained from EPA's National Emissions Inventory (NEI) for the year 2011.[18] According to EPA's NEI, the Wheelabrator facility emitted 1,133.54 tons (32.6 g/s) of NO_X and 261.30 tons of SO_2 (7.5 g/s) in 2011.[19] The NEI 2011 NO_X and SO_2 emission rates for the Wheelabrator facility were used for the current CALPUFF modeling.[20] Although there are three boilers at the Wheelabrator facility, they are all emitted from the same stack (with identical stack properties), so the entire facility was modeled as a single emission unit.

MDE's recent AERMOD modeling included stack parameter data for the Wheelabrator facility, which were also used in the current CALPUFF modeling. The Wheelabrator emissions from the three boilers are exhausted from a stack that is 96.01 m (315 ft) high, from three identical ports, each with a diameter of 2.13 m (7 ft). The exhaust temperature was assumed to be 415F (485.93K), and the exhaust velocity was assumed to be 74 fps (22.55 m/s).

Modeling Domain and Receptor Data

The CALPUFF simulation was conducted within the 792 km x 828 km rectangular modeling domain shown in Figure 3, below. The CALPUFF computational grid consisted of 8,096 (88 x 92) modeled receptor locations, spaced every 9 km within the

[17] See (1) Gray, H.A., The Deposition of Airborne Mercury within the Chesapeake Bay Region from Coal-fired Power Plant Emissions in Pennsylvania (March 2007), (2) Gray, H.A., Deposition in the Chesapeake Bay Region (February 2009), and (3) Gray, H.A., Cypress Creek Power Plant Modeling: Pollutant Deposition to the Chesapeake Bay and Sensitive Watersheds within the Commonwealth of Virginia, report prepared for the Chesapeake Bay Foundation (August 2009).

[18] https://www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei

[19] MDE's recent (2016) modeling used an "allowable" SO_2 emission rate for Wheelabrator of 12.6 g/s = 438 tpy. Energy Answers also modeled the Wheelabrator facility as part of their AERMOD modeling exercise (performed in late 2012). Their modeled NOx emission rate for Wheelabrator was 37.55 g/s, which is about 15 percent higher than the 2011 NEI total (1133.54 tpy = 32.61 g/s).

[20] The NOx emission rate (1,133.54 tpy) used for the CALPUFF modeling was the same as the NO_X emission rate used in the AERMOD modeling described earlier in this report.

modeling domain. Terrain (elevation) data and surface characteristics data (land-use data, necessary for meteorological data development) were prepared for the gridded modeling domain using the recommended CALPUFF preprocessors.[21]

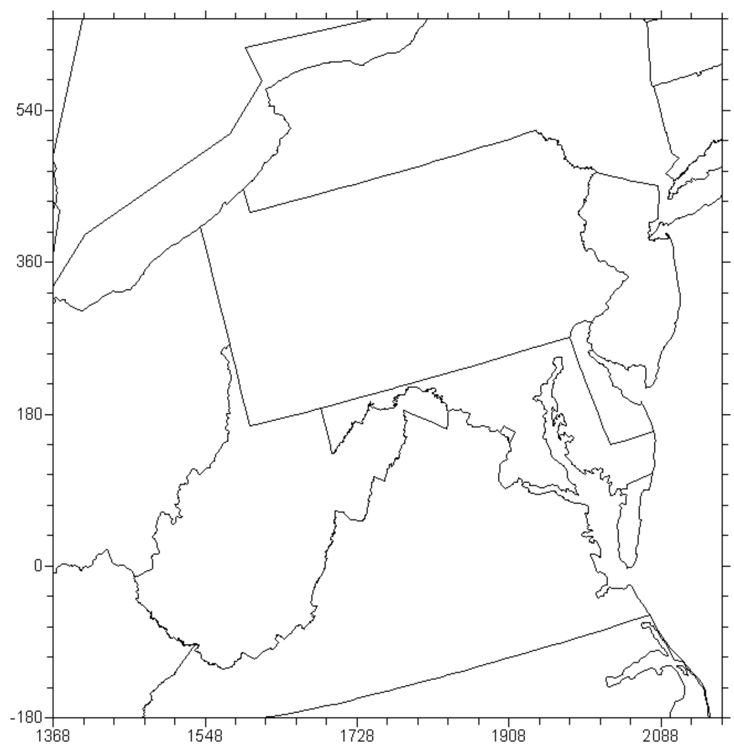

Figure 3. CALPUFF Modeling Domain

There were a number of “sensitive receptor areas” within the modeling domain in which the gridded modeled nitrogen deposition was summed to determine Wheelabrator’s overall impact to each area. These receptor areas are described below:

Chesapeake Bay Watershed. The Chesapeake Bay Watershed includes all the land surrounding the streams and tributaries that ultimately flow into the bay, and all the waters of the Chesapeake Bay.[22] The watershed extends through six states and the District of Columbia, from Virginia northward into New York, encompassing an area of approximately 170,000 km^2, as shown in Figure 4. A number of major and secondary rivers empty into the Chesapeake Bay, including the James, York, Rappahannock,

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[21] The preparation of the required geophysical data for use in the CALPUFF modeling is described in Appendix A of Gray, H.A., Cypress Creek Power Plant Modeling: Pollutant Deposition to the Chesapeake Bay and Sensitive Watersheds within the Commonwealth of Virginia, report prepared for the Chesapeake Bay Foundation (August 2009).

[22] A watershed, or drainage basin, is defined as the bounded area of land (including both land and water) that drains all the streams and rainfall to a common outlet.

Potomac, Patuxent, and Patapsco to the west, the Gunpowder, Bush, Susquehanna, Northeast, Elk, and Sassafras to the north, and the Chester, Choptank, Nanticoke, Wicomico, and Pocomoke to the east.

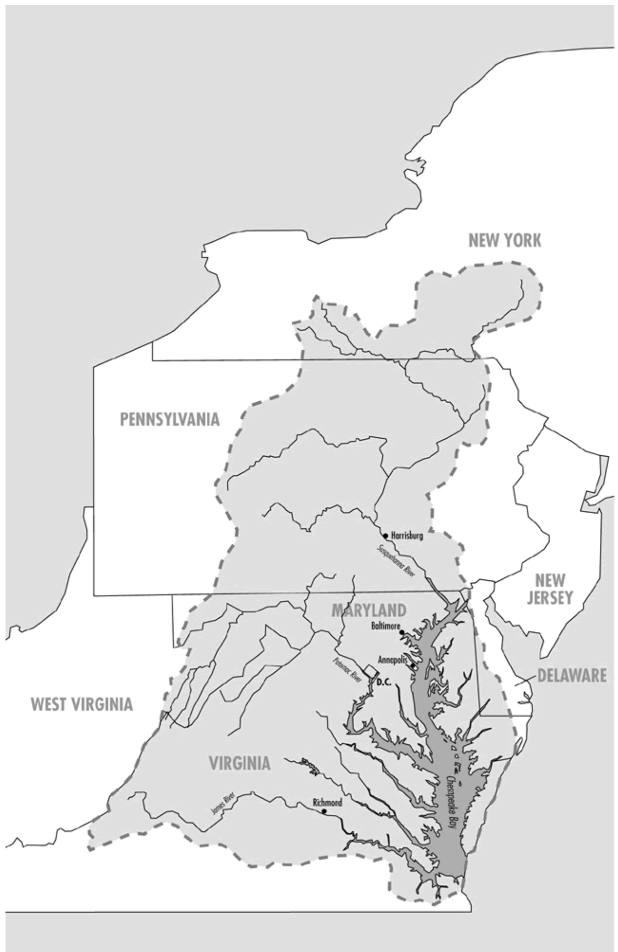

Figure 4. Chesapeake Bay Watershed

Chesapeake Bay. The Chesapeake Bay is the largest estuary in the United States, with an approximate area of 11,600 km^2, as shown in Figure 5. The bay and its shoreline (total shoreline: 18,800 km) are home to a diverse ecosystem of vegetation, fish, and other wildlife. The bay is quite shallow in many places; about one quarter of the area of the bay is less than 2m in depth. The CALPUFF model was used to estimate the deposition of nitrogen directly to the water surface of the Chesapeake Bay, that originated from the Wheelabrator facility.[23]

[23] The modeled deposition to the entire Chesapeake Bay Watershed includes the deposition to the waters of the Chesapeake Bay itself.

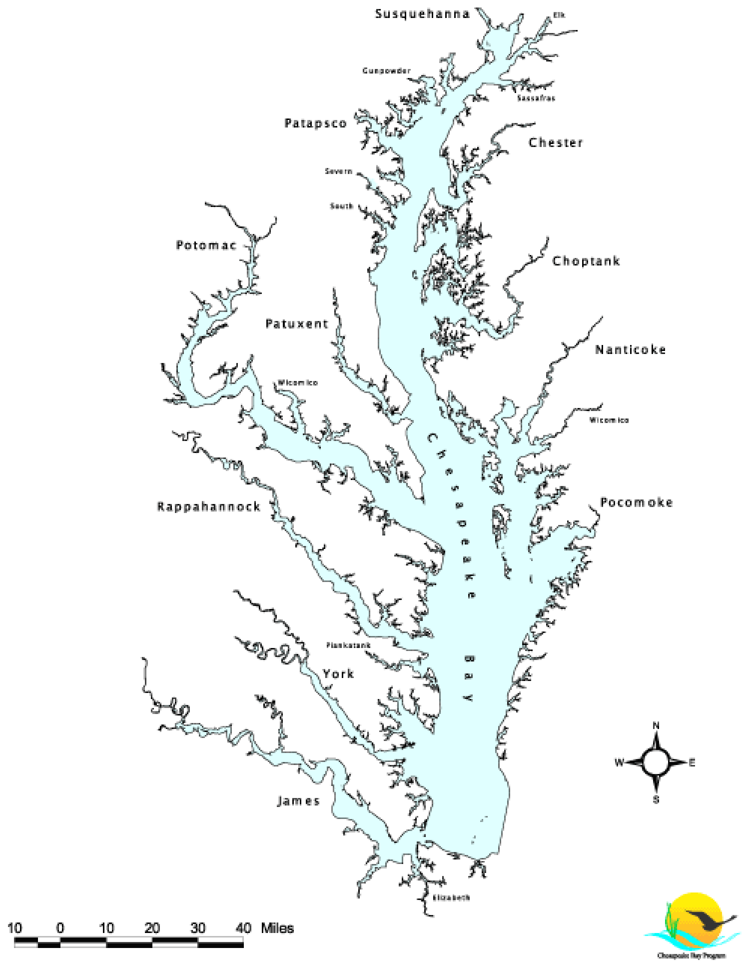

Figure 5. Chesapeake Bay

James River Basin Watershed. The James River Basin Watershed (Figure 6) consists of the region in which precipitation will ultimately drain into the Chesapeake Bay via the James River. The James River Basin Watershed is Virginia's largest river basin; it accounts for almost one-fourth the area of the Commonwealth of Virginia. The watershed includes about 4 percent open water and includes a population of about 2.5 million people. Over 65 percent of the watershed is forested, with 19 percent in cropland and pasture. The remaining 12 percent is considered urban. The James River Basin (USGS accounting unit 020802; area = 26,418 km^2) is made up of eight smaller watersheds: Upper James (USGS cataloging unit 02080201), Maury

(02080202), Middle James-Buffalo (02080203), Rivanna (02080204), Middle James-Willis (02080205), Lower James (02080206), Appomattox (02080207), and Hampton Roads (02080208), as shown in Figure 7.

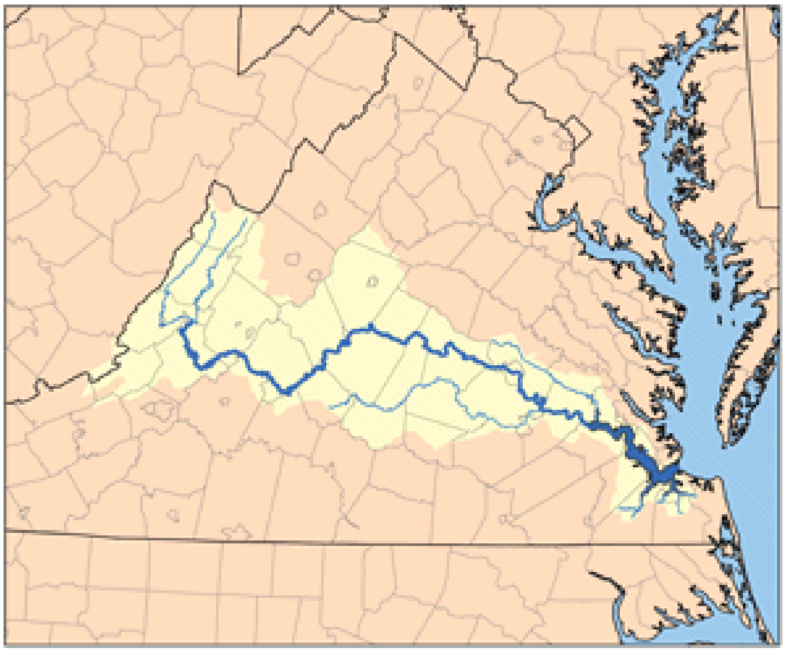

Figure 6. James River Basin Watershed

Including its Jackson River source, the James River is over 400 miles long. It is the twelfth longest river in the United States that remains entirely within one state. The James River forms in the Allegheny Mountains, near Iron Gate on the border between Alleghany and Botetourt counties from the confluence of the Cowpasture and Jackson Rivers, and flows into the Chesapeake Bay at Hampton Roads. Tidal waters extend west to Richmond at its fall line (the head of navigation). Larger tributaries draining to the tidal portion include the Appomattox River, Chickahominy River, Warwick River, Pagan River, and the Nansemond River. The James contributes about 12 percent of the streamflow from the non-tidal part of Chesapeake Bay Basin, making it the third largest streamflow source after the Susquehanna and the Potomac Rivers.

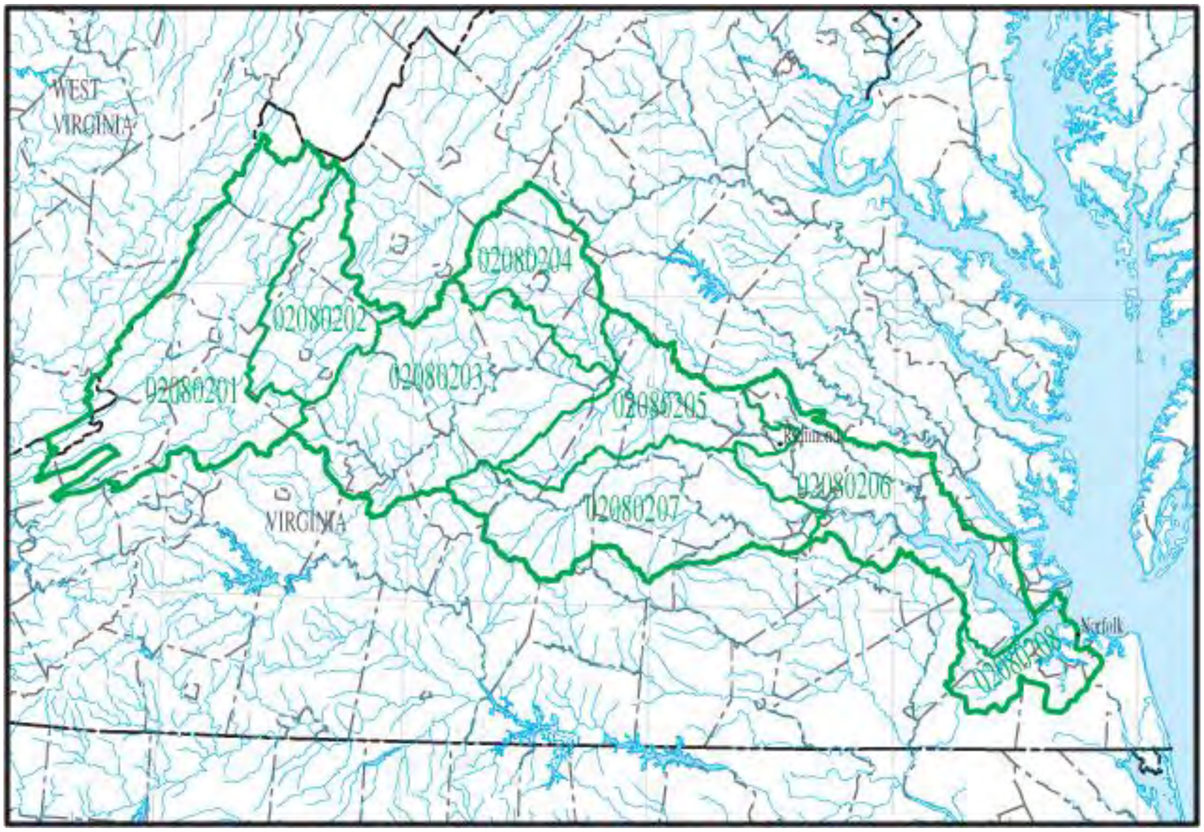

Figure 7. James River Drainage Basin (with USGS Cataloguing Units)

<u>Meteorological Data</u>

The meteorological data that were input to the CALPUFF dispersion model for modeling of the Wheelabrator facility were identical to the meteorological data that were developed for use in previous CALPUFF modeling assessments of numerous sources in the Chesapeake Bay area.[24] Detailed meteorological data for 1996 were obtained from the Penn State/NCAR Mesoscale Modeling System, Version 5 (MM5), a prognostic model with four-dimensional data assimilation. The 36 km MM5 data were augmented by ambient surface meteorological measurements, including wind speed and direction, temperature, and precipitation data. The resulting CALMET-derived data set for 1996 represents a typical annual cycle of meteorology and was used to estimate the long-term deposition impacts due to emissions from the Wheelabrator facility.[25]

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[24] Gray, H.A., Deposition in the Chesapeake Bay Region (Feb. 2009)
[25] A detailed description of the meteorological modeling can be found in Appendix A of Gray, H.A., Cypress Creek Power Plant Modeling: Pollutant Deposition to the Chesapeake Bay and Sensitive Watersheds within the Commonwealth of Virginia, report prepared for the Chesapeake Bay Foundation (August 2009).

Model Options

The CALPUFF model was used to account for the hourly emissions of NO_X and SO_2, and the subsequent transport, chemical transformation (into nitric acid, nitrate, and sulfate), and deposition of all modeled species.[26] The dry deposition rates for gases and particles are computed within CALPUFF as a function of geophysical parameters and meteorological conditions using a multi-layer resistance model. The rate of deposition to the surface depends on properties of the depositing material (particle size and density for particles; molecular diffusivity, solubility and reactivity for gases), the characteristics of the surface (surface roughness, and vegetation), and atmospheric variables (stability, turbulence intensity). An empirical scavenging coefficient approach is used to compute wet deposition fluxes for gases and particles during precipitation. Pollutant depletion is a function of the hourly precipitation rate and an empirically-derived pollutant-specific scavenging coefficient, which is based on characteristics of the pollutant species (reactivity and solubility) and precipitation type (liquid or frozen).[27]

Model Results

The CALPUFF model was used to estimate the nitrogen deposition at every gridded receptor location within the modeling domain for every hour of the annual simulation. The gridded data were then used to determine annual average rates of nitrogen deposition within each of the sensitive receptor areas described above (Chesapeake Bay Watershed, Chesapeake Bay, and James River Watershed), as shown in Table 3. The annual average modeled nitrogen deposition rates within the entire states of Maryland, Virginia, and Pennsylvania were also computed (see Table 3).

The Wheelabrator facility was modeled assuming the 2011 NO_X and SO_2 NEI emission rates.[28] The CALPUFF model results (annual nitrogen deposition) shown in Table 3 can be (approximately) scaled in proportion to the NO_X emission rate in order to estimate nitrogen deposition impacts for a different assumed emission rate.

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[26] The CALPUFF modeling for the Wheelabrator facility employed the same modeling procedures, CALPUFF modeling options, ozone input data, and POSTUTIL and CALPOST postprocessing procedures as was followed in previous CALPUFF modeling assessments. For details of the modeling protocol, see Appendix A of Gray, H.A. Cypress Creek Power Plant Modeling: Pollutant Deposition to the Chesapeake Bay and Sensitive Watersheds within the Commonwealth of Virginia, report prepared for the Chesapeake Bay Foundation (August 2009).
[27] For further details, see Scire, *et al*., A User's Guide for the CALPUFF Dispersion Model (Version 5). Earth Tech, Inc., Concord, MA, 2000. http://src.com/calpuff/download/CALPUFF_UsersGuide.pdf
[28] Including SO_2 and sulfate in the CALPUFF modeling was necessary to provide the appropriate balance between nitric acid and nitrate formation.

Table 3. CALPUFF Model Results: Annual Nitrogen Deposition due to the Wheelabrator Facility

Receptor Area	Annual Nitrogen Deposition (kg/yr)
Chesapeake Bay Watershed	42,719
Chesapeake Bay	2,171
Maryland	18,585
Virginia	9,361
Pennsylvania	23,185
James River Basin Watershed	1,911

The annual deposition of nitrogen to the Chesapeake Bay Watershed due to Wheelabrator's emissions was estimated by the CALPUFF model to be almost 43 metric tons, which equates to more than 117 kg of nitrogen deposition each day. The estimated 43 metric tons of nitrogen deposited within the Chesapeake Bay Watershed accounts for about 14 percent of Wheelabrator's annual nitrogen emissions (emitted as NO_X).

* * *

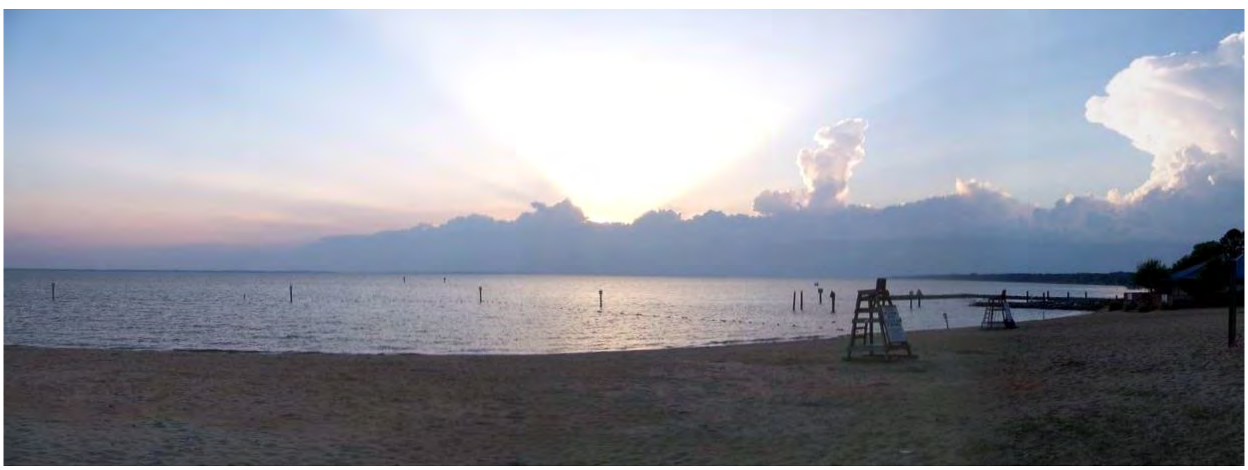


Figure 8. Huntington Park Beach on the James River

APPENDIX A: AERMOD Modeling Results

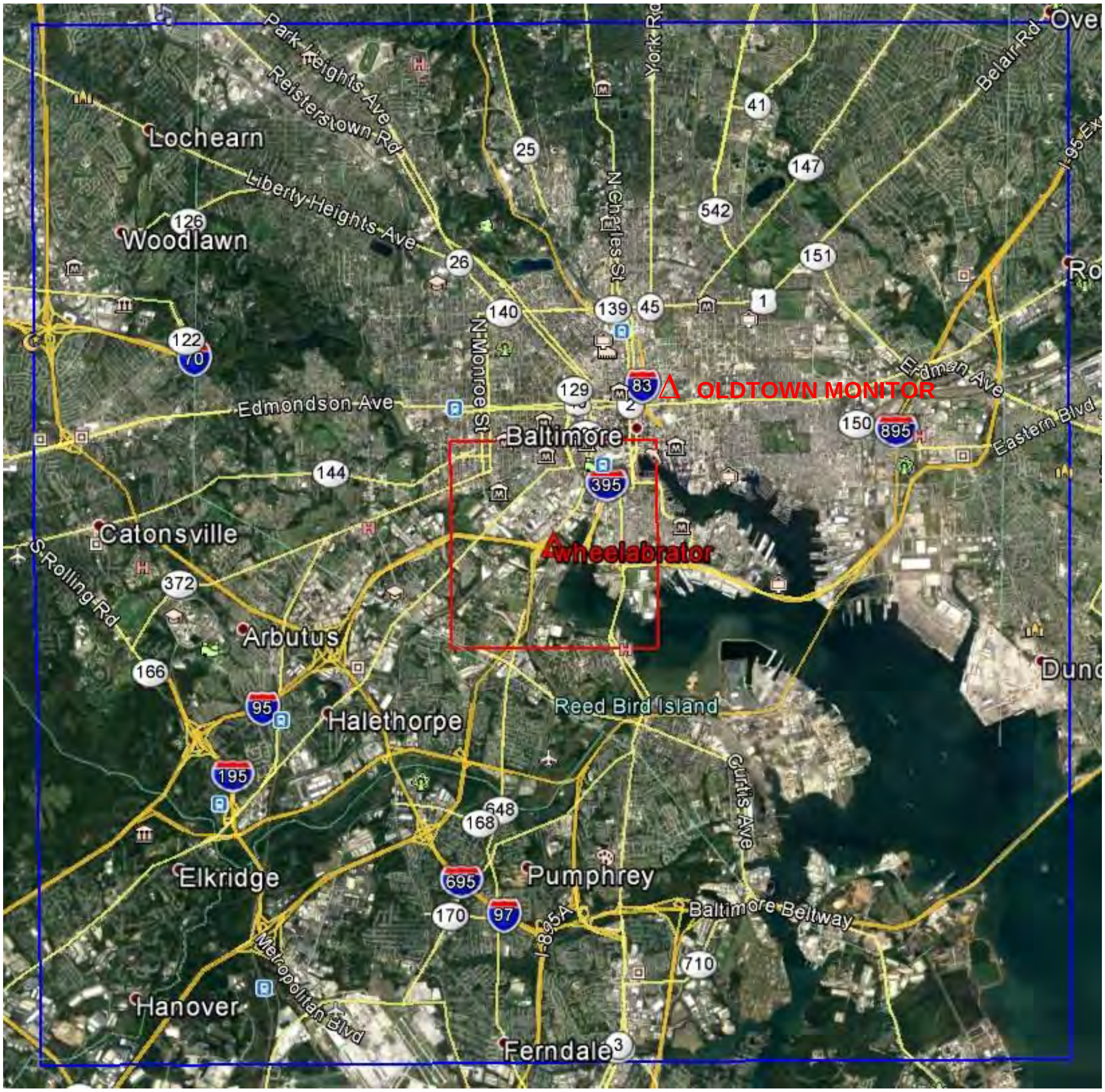


Figure A.1. Fine grid (red; 4x4 km) and coarse grid (blue: 20x20 km)

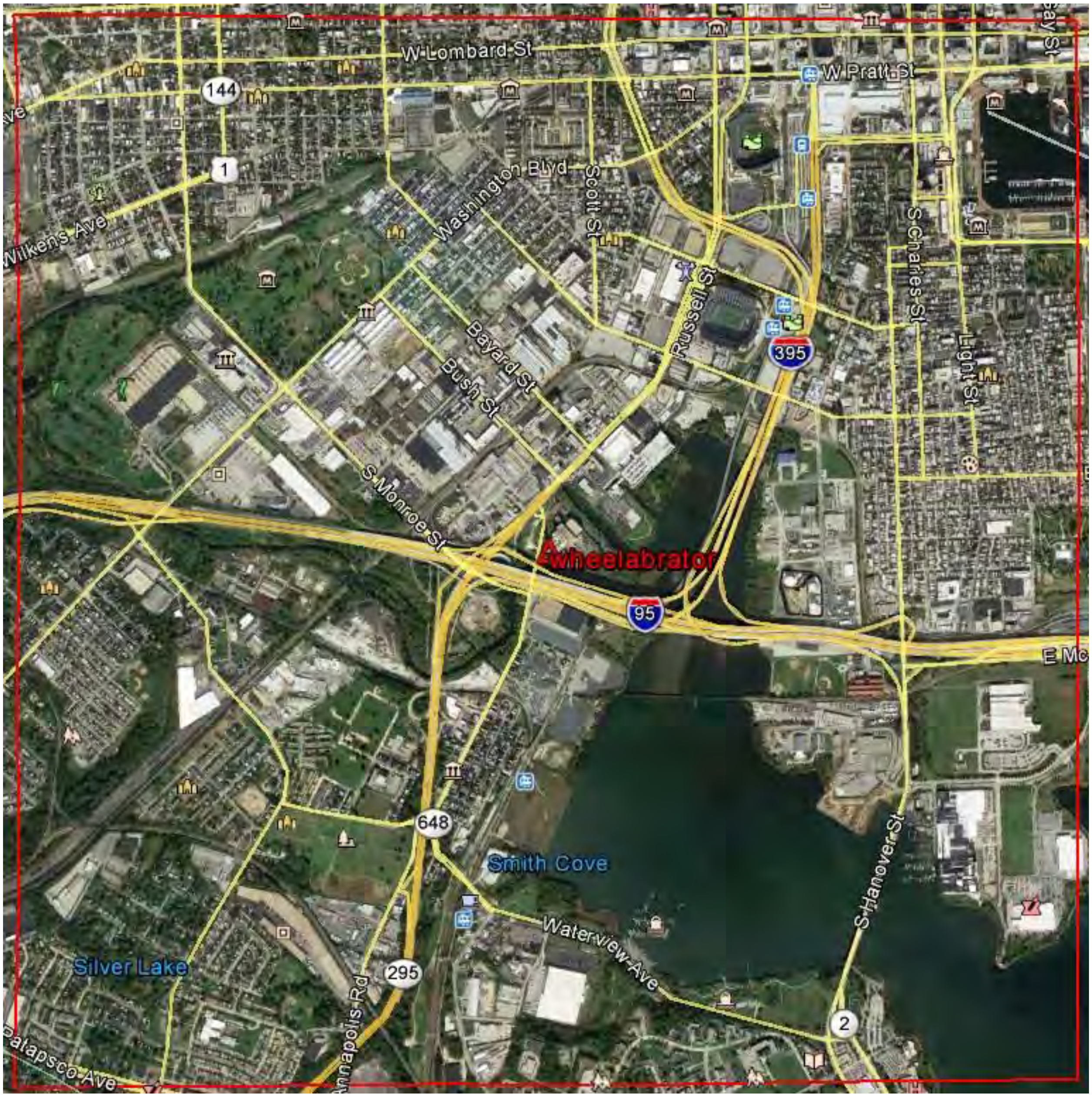


Figure A.2. Fine grid (4x4 km)

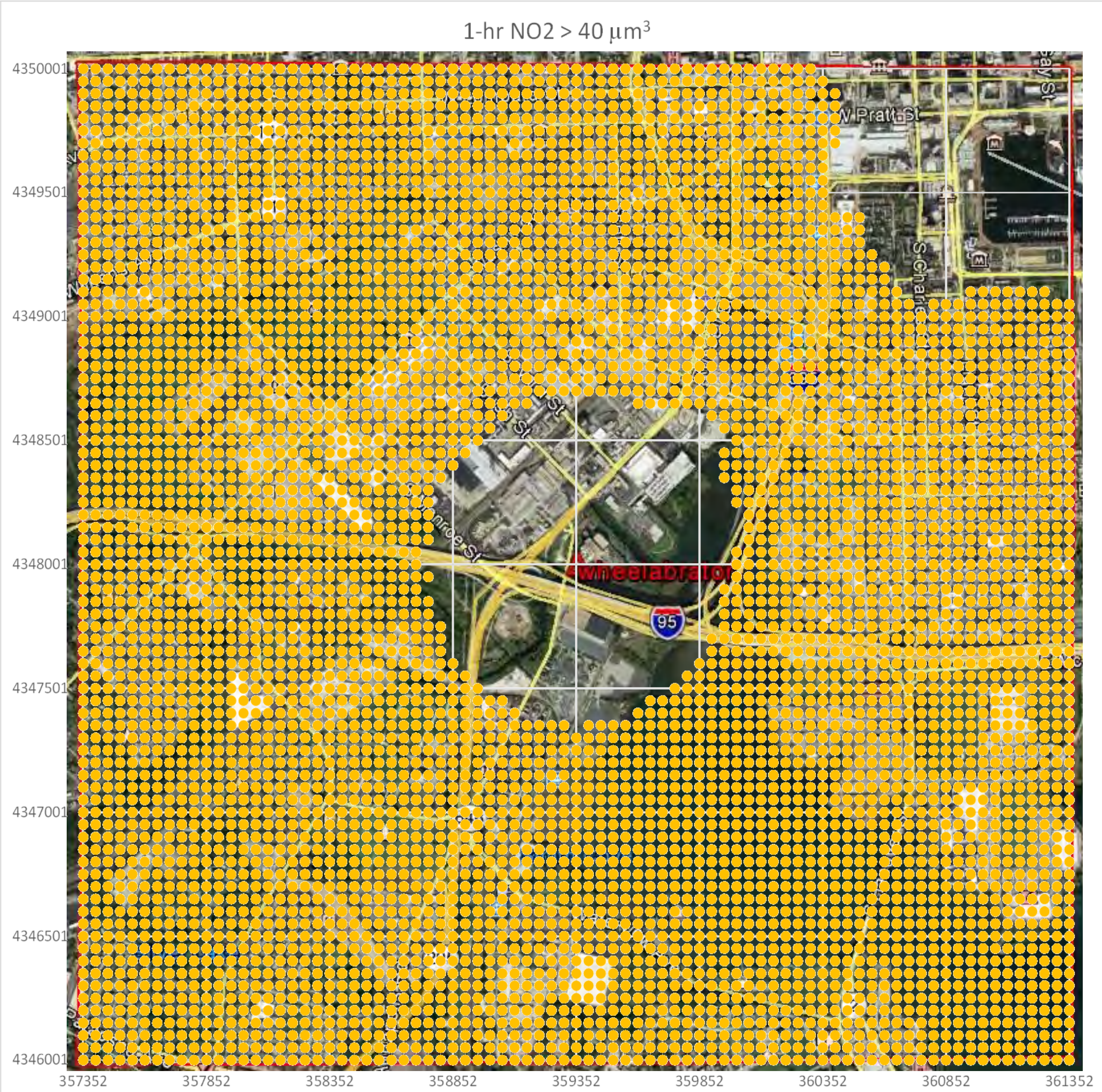


Figure A.3 Fine grid: modeled max 1-hr-NO_2 concentrations exceeding 40 $\mu g/m^3$

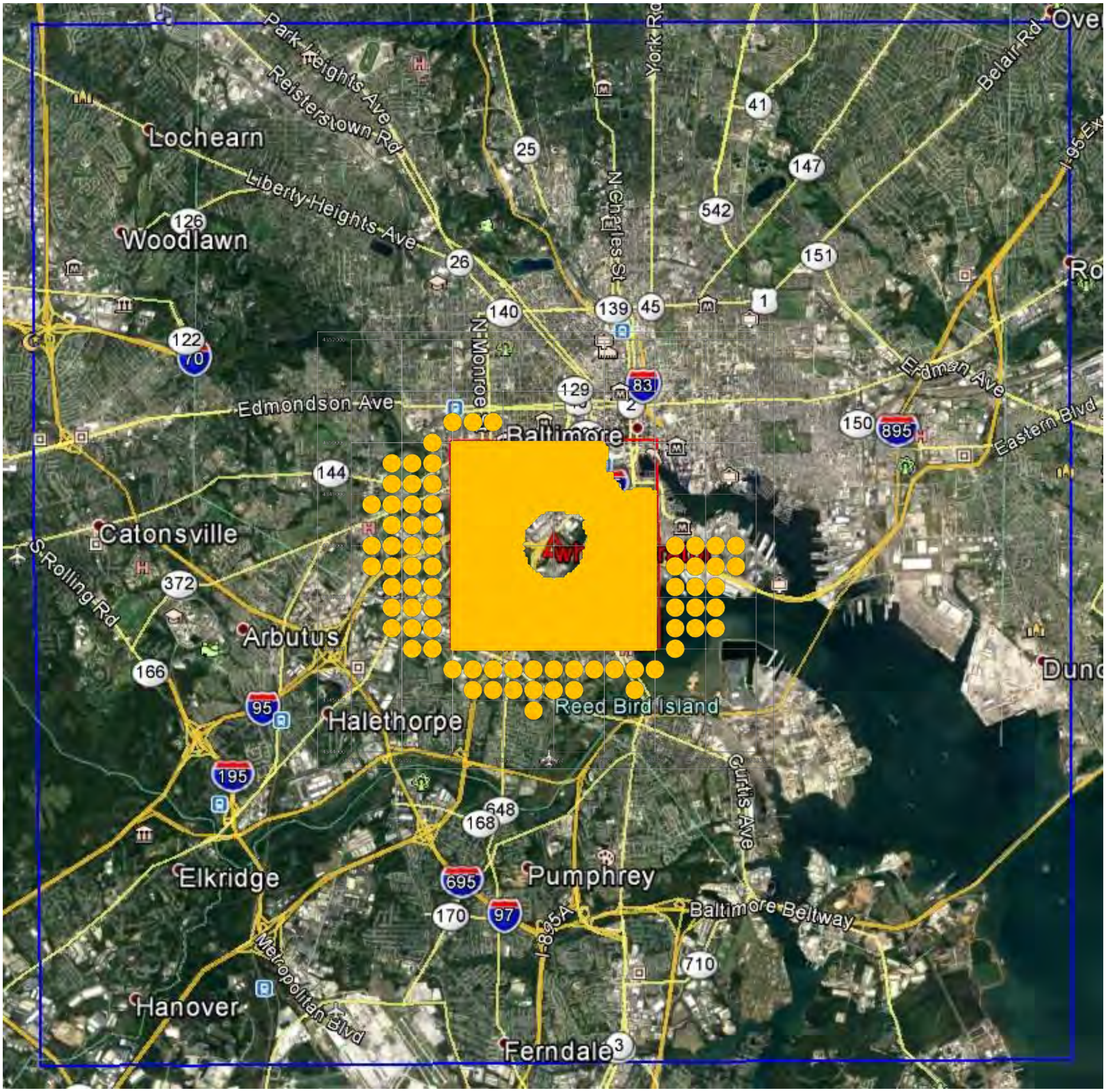


Figure A.4. Fine and coarse grids: modeled max 1-hr-NO_2 concentrations exceeding 40 $\mu g/m^3$

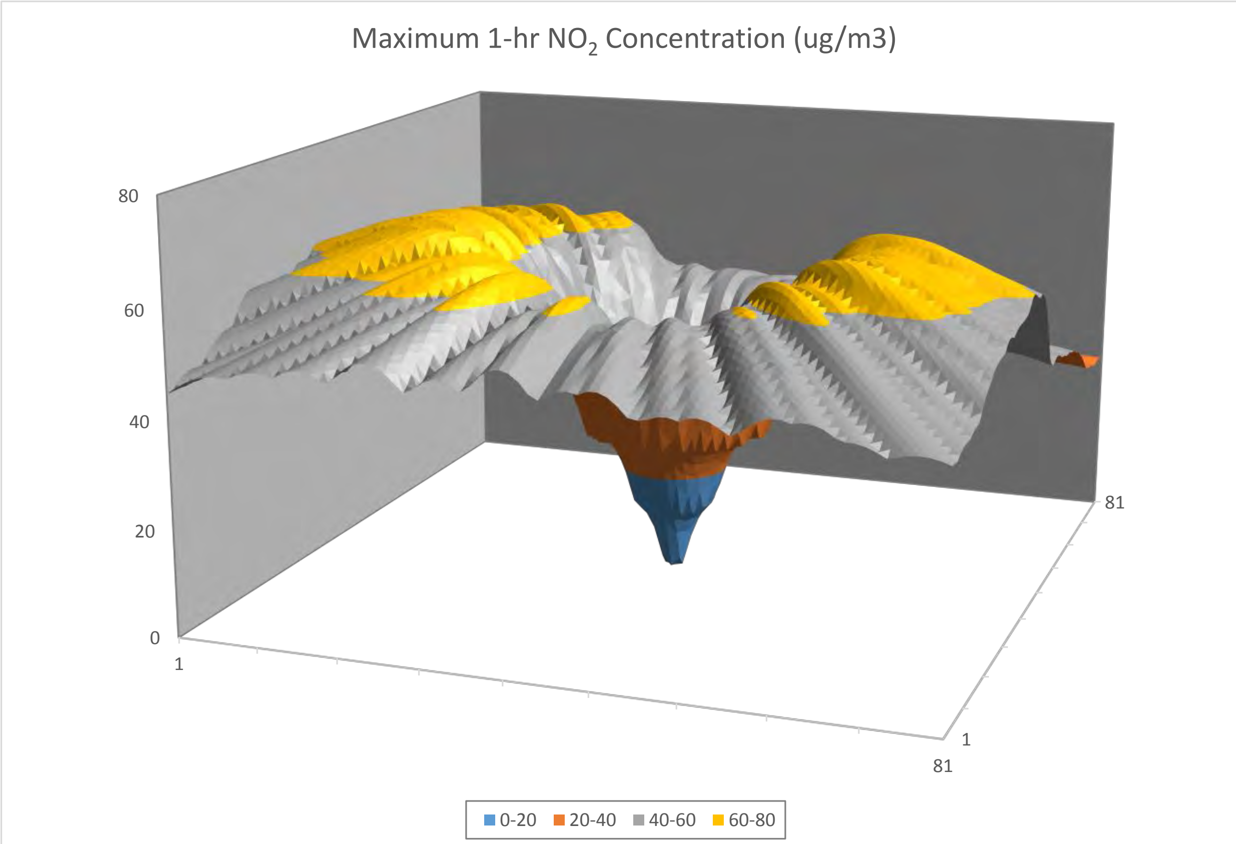
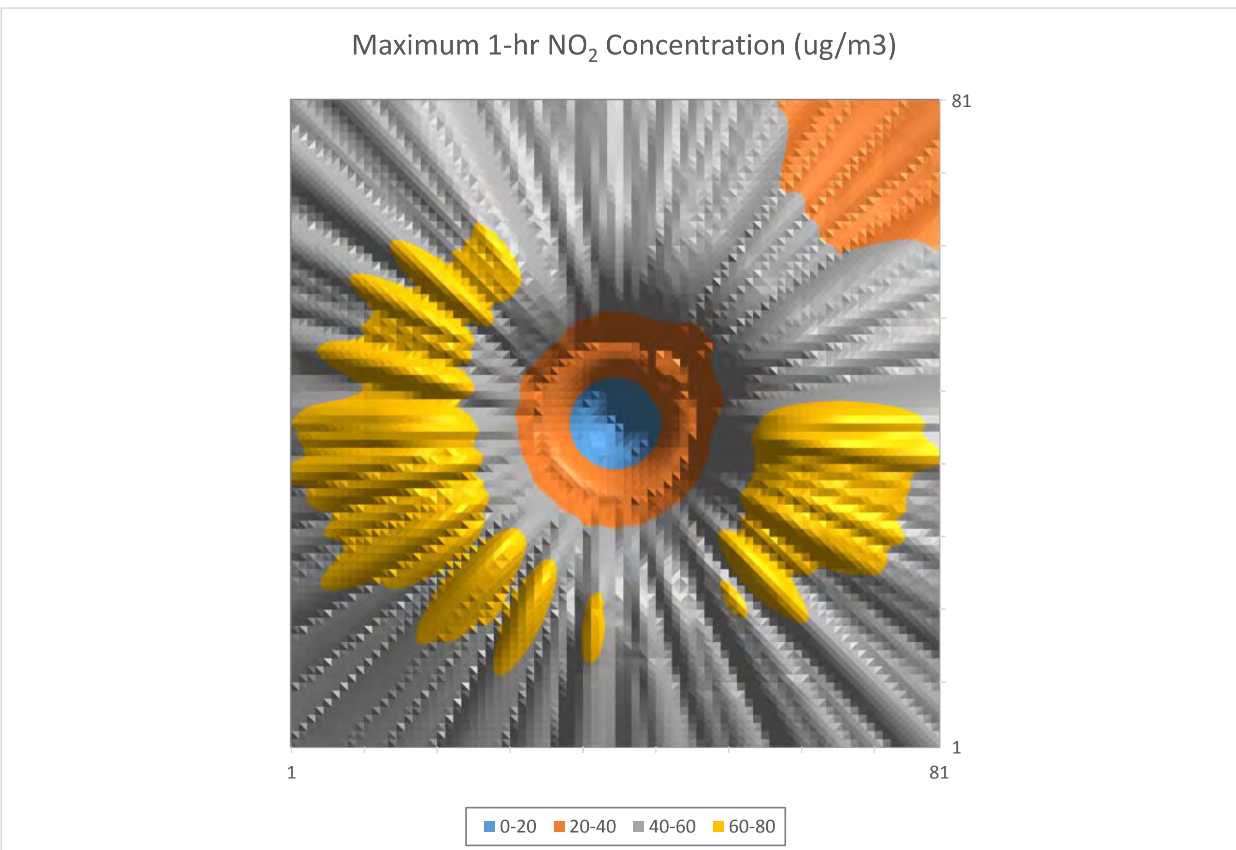


Figure A.5(a and b). Fine grid: modeled maximum 1-hr-NO_2 concentrations



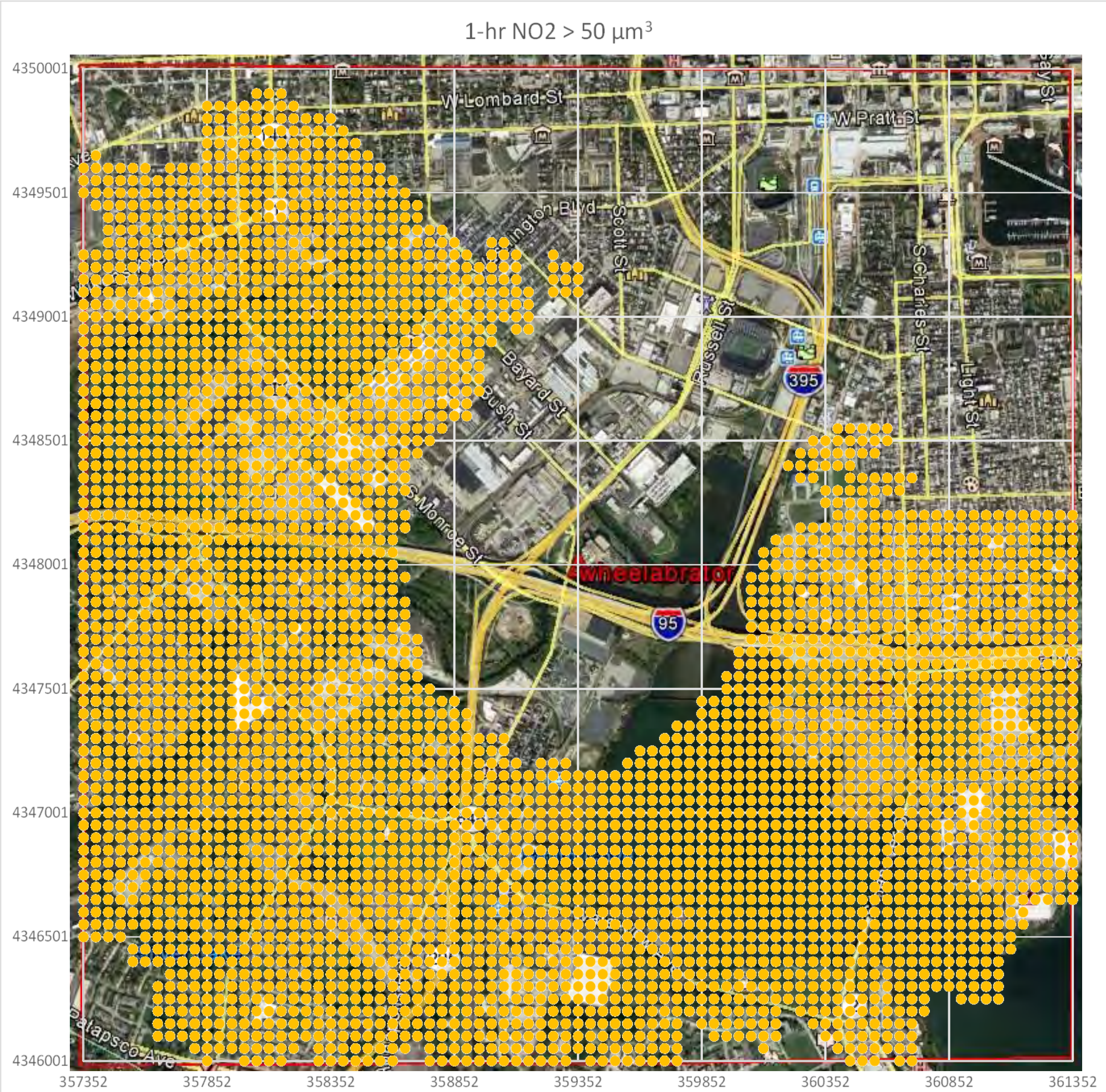


Figure A.6. Fine grid: modeled max 1-hr-NO_2 concentrations exceeding 50 $\mu g/m^3$

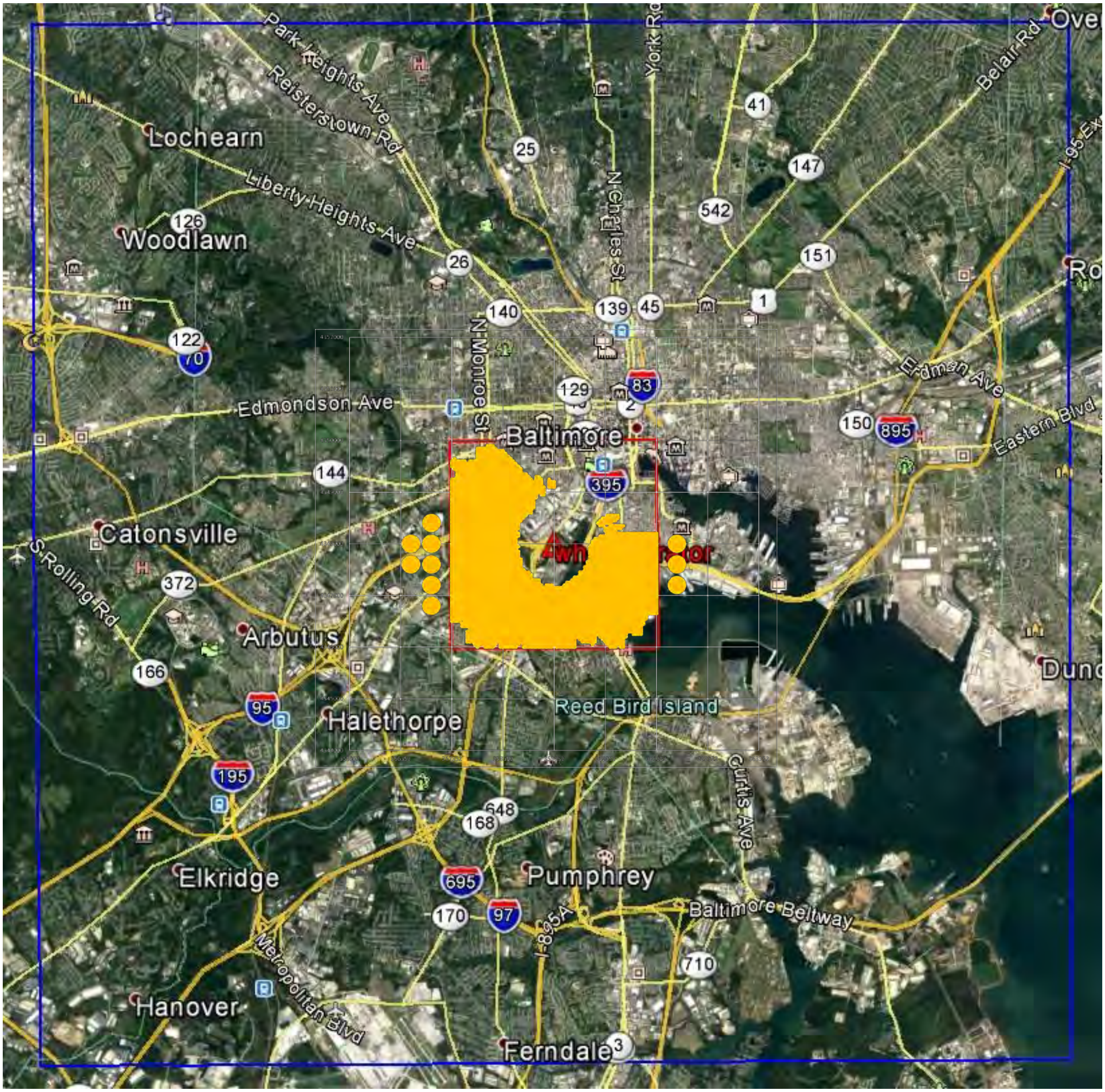


Figure A.7 Fine and coarse grids: modeled max 1-hr-NO_2 concentrations exceeding 50 $\mu g/m^3$

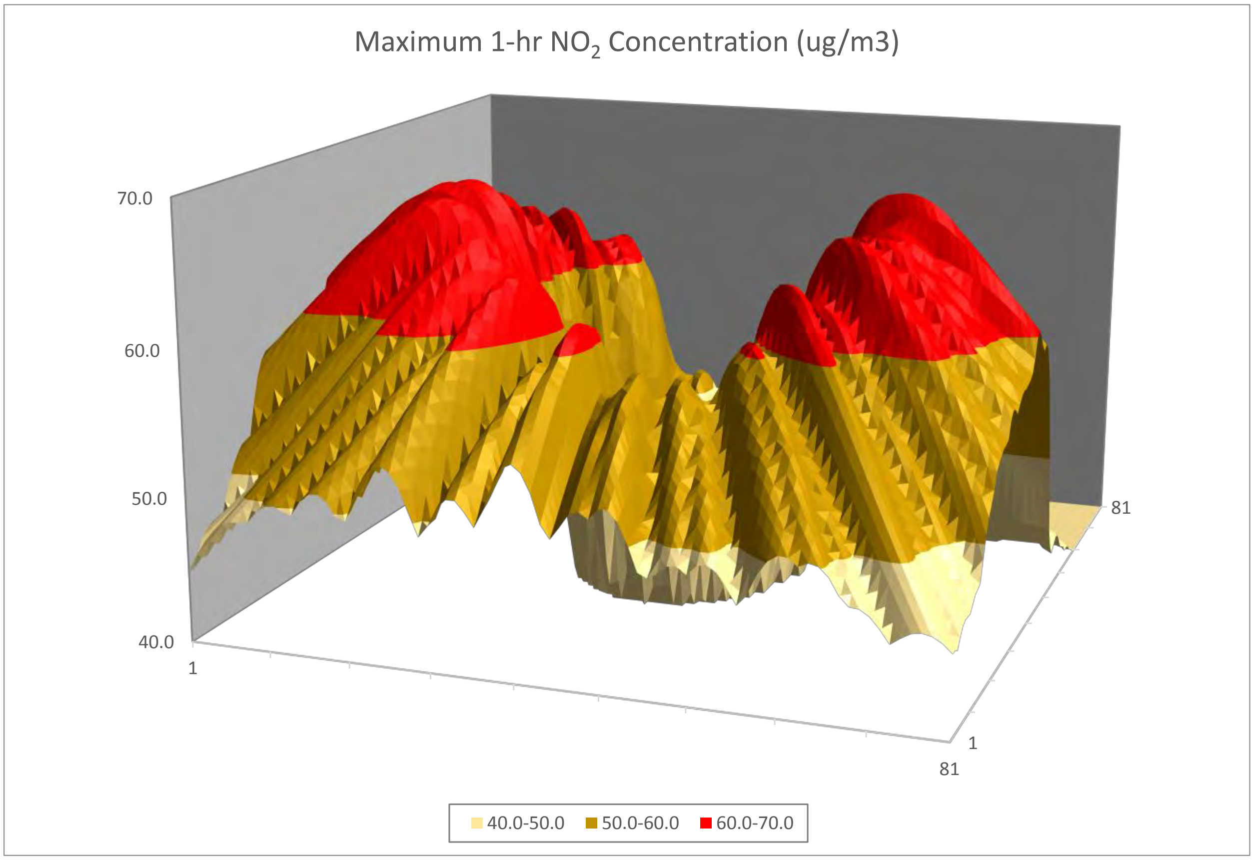
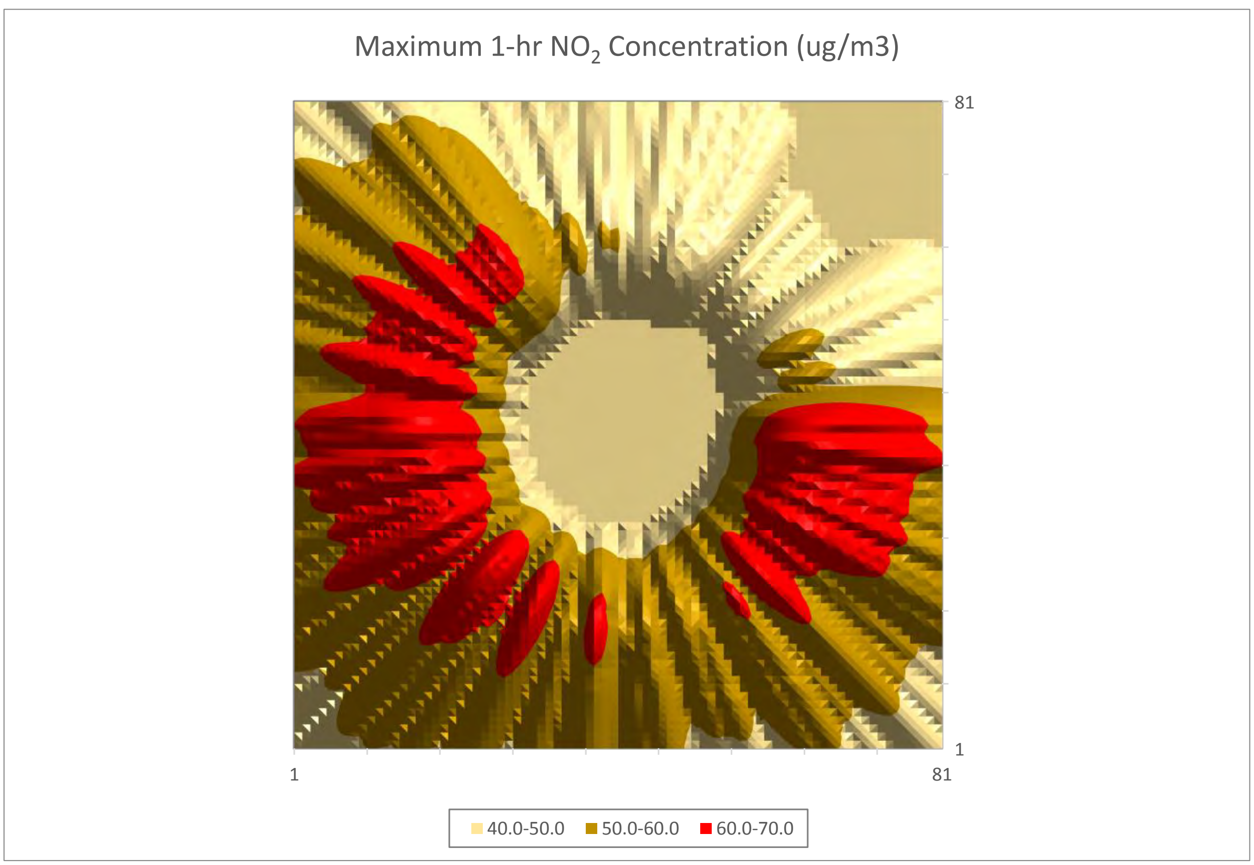


Figure A.8(a and b). Fine grid: modeled maximum 1-hr-NO_2 concentrations



ATTACHMENT B

EXPERT REPORT

On

NOx Emissions from the Wheelabrator Baltimore Municipal Waste Incinerator in Baltimore City, owned and operated by Wheelabrator Baltimore, L.P. ("Wheelabrator")

By

Dr. Ranajit (Ron) Sahu, Consultant[1]

May 5, 2017

I have prepared this report based on my review of the documents provided by the Maryland Department of the Environment (MDE), a telephone discussion held with MDE staff, and all of the publicly available materials relating to NOx emissions from the three incinerator boilers at the Wheelabrator facility. I have carefully reviewed Wheelabrator's suggestion regarding what the NOx RACT limit should be for these boilers and I have also carefully reviewed the NOx optimization and other studies that have been conducted by Wheelabrator since mid-2016 for which only partial and incomplete information is available. Lastly, I have carefully reviewed MDE discussions regarding RACT for this facility based on a review of various e-mails, both internal to MDE as well as between MDE and Wheelabrator.

Based on all of this, my observations are as follows.

Data Gaps for Understanding NOx Generation

The available information regarding NOx emissions generation and subsequent control at each of the three Wheelabrator boilers is incomplete due to the presence of significant data gaps. Notwithstanding the passage of time over which this issue has been under study and review by both the MDE and Wheelabrator, it is nonetheless clear that fundamental data gaps remain with regards to NOx generation and control, and therefore the resultant NOx emissions – which ultimately affect how the level corresponding to RACT should be determined.[2] The following are the more noteworthy data gaps:

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[1] Resume available upon request.

[2] For the purposes of this discussion, we will assume that the form of the NOx RACT standard will be X ppm at 7% oxygen in the exhaust flue gas that is emitted from the atmosphere. I will further assume that the standard includes a 24-hour averaging period. I do not necessarily agree with either of these as being the proper form of the RACT standard, even though I recognize that other jurisdictions have used NOx emission standards from incinerators along similar lines. At least two states, New Hampshire and Pennsylvania, use a mass-based standard (lb/MMBtu). *See* Ozone Transport Commission, White Paper on Control Technologies and OTC State Regulations for Nitrogen Oxides (NOx) Emissions from Eight Source Categories, at Appendix D: Municipal Waste Combustors in Ozone Transport Region (Feb. 10, 2017), http://www.otcair.org/upload/Documents/Reports/OTC_White_Paper_NOx_Controls_Regs_Eight_Sources_Final_Draft_02152017.pdf.

(a) Almost nothing is known about the nitrogen content of the waste that is burned at the incinerators. Given that the relatively low temperature combustion process used in the incinerators (in contrast to say, the temperatures in a coal-fired boiler), substantial portions of the NOx generated at the combustion process itself are by the so-called fuel-NOx pathway, as opposed to the more common thermal-NOx pathway in higher temperature processes. It is likely that a disproportionate amount of the NOx generated in the boilers is due to the combustion of that portion of the waste which is relatively high in nitrogen. Without understanding this NOx generation step in greater detail, it is improper to simply focus on the probable or possible NOx control options. Thus, MDE must require better characterization of the chemical composition of the waste fuel – especially with regards to its nitrogen content, including the forms of nitrogen present in the fuels. Since little is available in the record regarding fuel composition and nitrogen content, the MDE should require that representative samples of the fuel be analyzed and the results be made available to the public.

(b) Similar to the above, almost nothing is known about other fuel composition aspects, such as its as-burned moisture content and its oxygen content, which can affect the NOx generation levels at the furnace grate. Like the request above, I ask that the MDE require complete and representative analyses of these additional compositional parameters of the fuel as well.

(c) A detailed description of the combustion process, in particular the air-fuel ratio management that occurs at the furnace grate – as the fuel travels through the furnace – is not available in the public record. Wheelabrator should provide far more detail to describe how it controls the combustion process and what the critical control parameters are. What are the target set-points for these critical parameters so that one can understand the trade-offs being made in combustion controls at Wheelabrator? How does the operator decide to modulate the air fuel ratio across the grate and above the combustion zone – i.e., based on what parametric feedback?

All of the above is essential to understand the NOx generation step in each boiler and to identify the key parameters that affect the generation of NOx at the combustion grate itself or its immediate vicinity.

<u>Issues with the Optimization Study</u>

Wheelabrator conducted a short optimization study ("Quinapoxet Study" or "optimization study") of its existing Selective Non-Catalytic Reduction (SNCR) NOx control system in order to improve the NOx control capability of that system from its current performance. I have reviewed the Quinapoxet Study report, "Final Report NOx Control System Optimization at the Wheelabrator Baltimore WTE Facility, Quinapoxet Solutions, (undated, 2016)." The review, however, raised

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It would be much more preferable to have a mass-based (and not a concentration-based) standard along the lines of X lbs. NOx/ton trash burned. With regards to the averaging time, while a 24-hour standard has its uses, a secondary standard limiting NOx emissions over a shorter time period, such as one hour, is also desirable – both to conform the RACT standard to short-term NAAQS for NOx and also to put the onus on the operator, Wheelabrator, to address both average as well as peak NOx emissions.

numerous questions that need to be addressed to allow for a better understanding of the findings of that study and to assess its usefulness. I address some of the issues below.

It is not clear how flows inside the furnaces and flow distributions were measured during the study. The report states that "it was confirmed that furnace gas flows favored the rear wall at the urea injection level." But the basis for this statement is not clear. Relatedly, the support for Figure 6, "Typical Boiler Furnace Flow," is not clear.

To the extent that computational fluid dynamics (CFD) modeling or similar flow testing has been done on the boilers, there is no publicly available documentation. If no CFD modeling has been conducted at each boiler (since the optimization study confirms fairly distinct boiler to boiler variations in NOx emission rates), then Wheelabrator should be asked to do such modeling. It is simply premature to attempt to "optimize" NOx emissions from such boilers without a basic understanding of NOx generation and distribution as well as the effect of SNCR, which can only be obtained from properly conducted CFD modeling analyses.

The Quinapoxet Study report does not discuss any temperature profiling vertically in either boiler #1 or #2. It is not clear if any vertical temperature profiling was done at either of these boilers as part of the optimization study or otherwise. This is a critical issue. It is not clear how the plane at which the SNCR reagent is being injected could have been determined without doing such vertical temperature profiling.

In some of the discussions leading up to the optimization study, Wheelabrator identified, rightly so, that gallons/mass of urea injection was an important variable and they wanted to increase the mixing of the urea and gases, and the relevant variables are droplet size and droplet size distribution. In a later version, the focus is on injection pressure and dilution of water, but not segregated in gallons per hour, and there are no further discussions on droplet size or droplet size distribution. The final study report does not report the injection pressure, droplet size distribution, or similar important variables that directly affect urea/gas mixing. Thus, the degree to which gas/urea mixing was improved during the optimization study is unclear.

The study report indicates that gas temperature measurements were obtained using the GasTemp instrument. However, GasTemp does not provide a spatially resolved measurement because it provides a line-of-sight integrated measurement. It is not clear, therefore, why this path-integrated temperature measurement would be more useful when the goal should be to obtain the spatial temperature mapping inside the boiler.

These and several additional questions pertaining to the Quinapoxet Study were submitted to the MDE on April 4, 2017 and are enclosed here as Attachment C.

Ammonia Slip

One of the drawbacks for using SNCR as a NOx control strategy is the likelihood (or almost certainty) that there will be a significant amount of excess ammonia, which would result in a consequently large amount of "ammonia slip" emissions into the ambient from the stack. In addition to the obvious waste of resources, this slip is undesirable given that ammonia is a toxic air compound. Regardless of the point I will make next regarding considering hybrid SNCR/SCR as a NOx control measure – which would reduce ammonia slip – MDE should regulate the amount of ammonia allowed to be emitted as slip. MDE's position on the lack of such a limit and/or how compliance with such a limit can be assessed is confusing. In discussions with MDE staff, it appears that there is some confusion regarding the ability to continuously measure ammonia at the stack. I note that ammonia CEMS are widely available.[3] I also note that EPA's performance specification for ammonia CEMS dates back to 2004.[4]

Hybrid SNCR/SCR as a NOx Control Option

It is clear from discussions with the MDE staff that neither the MDE nor Wheelabrator has evaluated whether a hybrid combination of SNCR followed by one or more layers of SCR catalyst placed at the appropriate locations in the current gas path (i.e., where the temperatures are proper for the SCR reactions to take place) can work at the Wheelabrator boilers.

Given the significant NOx emissions from Wheelabrator (well over 1,000 tons/year) and given the very modest reductions in NOx that are under consideration via optimization of the existing SNCR control (in the range of around 100 tons/year or even less), I believe that a thorough technical feasibility evaluation of the hybrid SNCR/SCR option is worthwhile. The advantage of such systems is that the opportunistically placed in-duct SCR catalyst can take advantage of the ammonia/urea slip from the SNCR and effect significant additional NOx reductions (i.e., around 50-75%) in the catalyst layer(s), leading to substantially lower NOx at the stack than SNCR alone. Of course, as mentioned above, utilizing the ammonia slip from the SNCR in the downstream SCR will also reduce ammonia emissions to the atmosphere as well. The cost of placing the SCR catalyst within the duct is typically far lower than installing a stand-alone SCR system. Of course, engineering evaluations to assess the feasibility of a hybrid SNCR/SCR system need to be done before rejecting this approach. I encourage MDE to require Wheelabrator to do so. As I note, if this system is technically feasible, its cost would be far lower than a SCR system and NOx reductions would be significant (i.e., 50-75%) as opposed to the 10% or so NOx reduction under consideration as RACT for these boilers.

It is important to note that the SCR catalyst does not particularly care where the NOx originates from – it only acts on the local gas composition, which should be fully known and characterized at the current boilers. Thus, it is moot whether such hybrid systems have been used at other incinerators or not. To date, they have mostly been used at coal-fired boilers – which are fairly challenging applications. As examples and background, I am providing two Exhibits (from two different vendors) relating to hybrid SNCR/SCR systems.

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[3] See, for example, http://www.horiba.com/us/en/process-environmental/products/combustion/cems-stack-gas-emission/details/stack-gas-analyzer-enda-7000-series-23329/.

[4] https://www3.epa.gov/ttn/emc/prelim/pps-001.pdf

RACT Statistical Calculations

In my review of the documents provided by MDE, I saw that Wheelabrator has used a "MACT-type" 99 percentile upper confidence level (UCL) to arrive at what it believes should be the appropriate RACT NOx level for the Wheelabrator incinerators. However, this raises two issues.

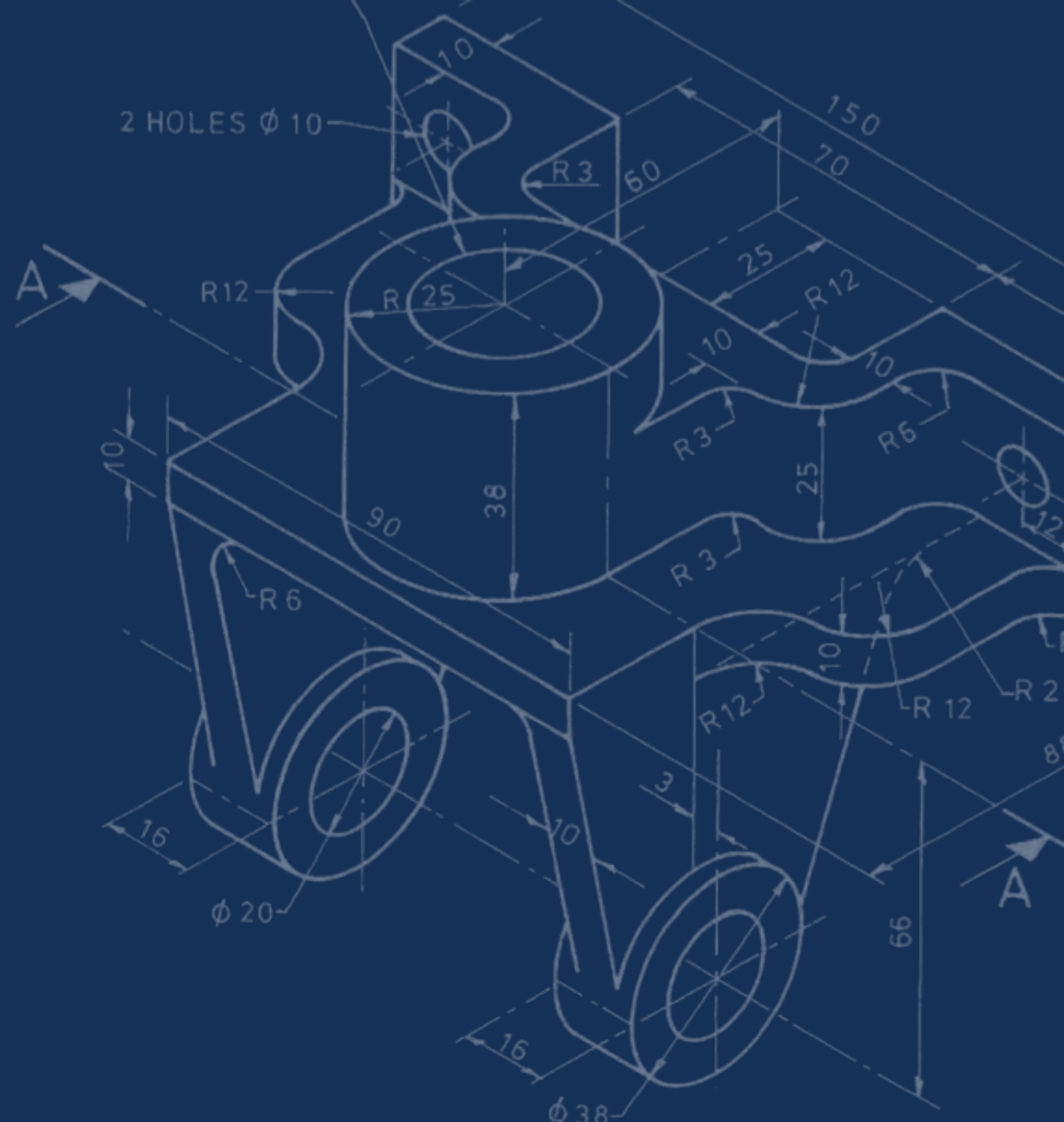
First, the actual NOx dataset which was used by Wheelabrator to conduct the statistical computations is not publicly available. Without this, it is not clear whether only the NOx data collected from the short-term Quinapoxet Study were included or if additional NOx data collected by Wheelabrator since that Study were also included (or should be included).

Second, from a policy standpoint it is not clear whether the MDE should be bound by the statistical approach suggested by Wheelabrator. MDE should provide a proper rationale for the statistical (or other) basis that will be used to determine NOx RACT for the Wheelabrator boilers. In doing so, MDE should address the form of the RACT limit, i.e., the issue raised earlier in footnote 2 in this report.

EXHIBITS 1 & 2 – HYBRID SNCR/SCR

Hybrid DeNOx

A Cost-Effective NOx Reduction Solution for Small & Medium Boilers



George Grgich, VP of Sales
george.grgich@lpamina.com

LP AMINA | Energy and Environmental

LP AMINA WAS ESTABLISHED WITH A MISSION TO SERVE AS AN INTEGRATED PLATFORM TO DEVELOP AND DEPLOY CLEAN COAL SOLUTIONS GLOBALLY

125+
Full time employees, on 3 continents

8
Locations worldwide, with activities in the US, Europe and Asia

10+
Patents, focused on coal / biomass conversion and pollution control

40+
Projects completed in last 5 years

15
Provinces and municipalities in China served to date

10GW
Of power plants retrofitted with pollution controls

Strategic partnership with Bayer to develop coal utilization technologies

The State of Wyoming co-funded LP Amina's Coal to Chemicals technology

West Virginia University participates in the research of LP Amina's CtC technology

LP Amina is a founding member and co-chair of the US-China Energy Cooperation Program (ECP)

LP Amina is a founding member of the US-China Clean Energy Research Center (CERC)

LP AMINA | Energy and Environmental

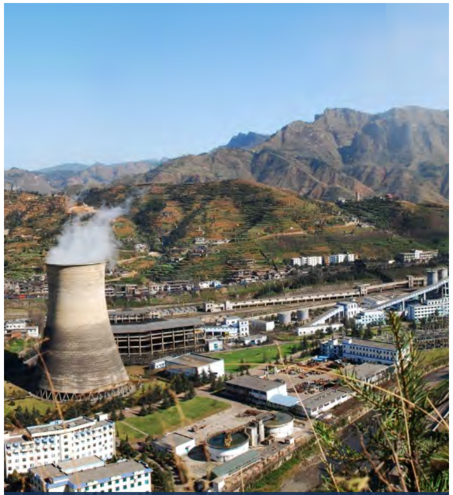
LP AMINA OFFERS A RANGE OF SOLUTIONS FOCUSED ON NOx REDUCTION FOR COAL AND GAS POWER AS WELL AS ADVANCED COAL UTILIZATION (COAL TO CHEMICALS)

Low NOx Burners

Shajiao Power Plant, Shenzhen

- LP Amina is **market leader** in pre-combustion De-NOx solutions via in-furnace optimization in China
- **25+ Projects** at major Chinese clients including China Huaneng Group, Guangzhou Yuedian Group, Datang Group

Hybrid LNB/SNCR/SCR



Yixing Power, Jiangsu

- **Proprietary technology** developed by LP Amina
- Combines benefits of several De-NOx technologies and brings **superior De-NOx** results at affordable price
- Installed at multiple units at Yixing Power in Jiangsu with **80% NOx reduction**

Direct Injection SCR

Jingfeng Power, Beijing

- **Proprietary technology** developed by LP Amina
- LP Amina was able to reduce NOx by **over 80%** with slip below 2 ppm
- More efficient, direct injection SCR uses significantly **less energy** and is cheaper to build

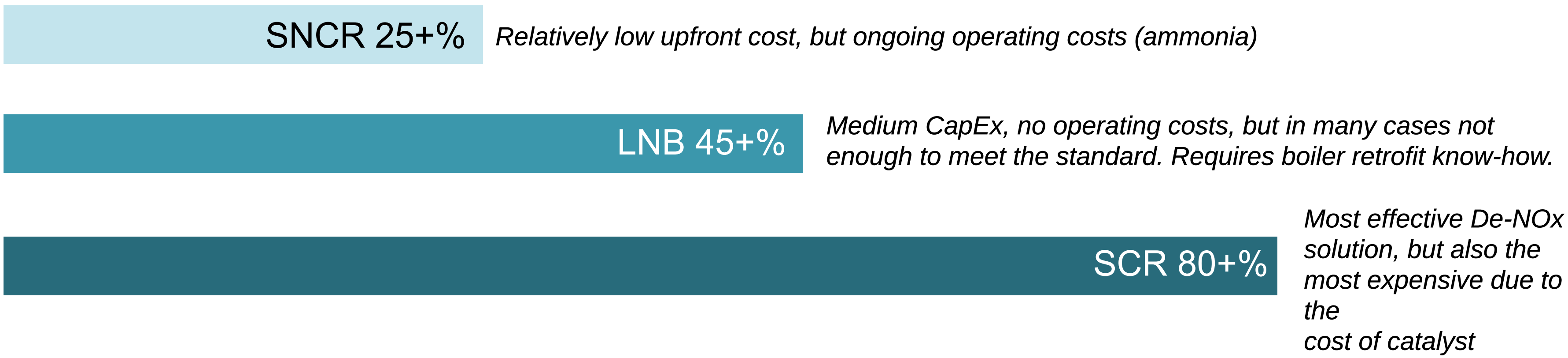
Advanced Coal Tech.

Hepo Facility, Shanxi

- Innovative process to **co-produce** electric power and high-value chemicals
- Extraordinary **economics** and **environmental im-pact improvement** from systems perspective
- Piloted in Shanxi, China; to be fully operational Q4 ‘14

LP AMINA'S PROPRIETARY DE-NOX HYBRID: COMBINES BENEFITS OF LNB, SNCR, AND SCR TECHNOLOGIES TO BRING SUPERIOR DE-NOX RESULTS AT AFFORDABLE PRICE

Average NOx Reduction by Each Technology (%)



Gradual NOx Reduction in LP Amina's Hybrid Approach (%)

The core idea behind LP Amina's Hybrid De-NOx Technology is to combine strengths of LNB, SNCR and SCR technologies, leveraging relative advantages of each

LP AMINA'S FIRST HYBRID TECHNOLOGY WAS INSTALLED ON YIXING UNION'S UNITS 5/6 IN CHINA'S JIANGSU PROVINCE, TOTAL 80% OF THE NOX REDUCTION WAS ACHIEVED

Yixing Union Units 5 and 6 Project Overview

Units Overview:

- Power generation capacity: 2 x 50 MW
- Combustion type: T-Fired
- Fuel: Bituminous coal

Scope:

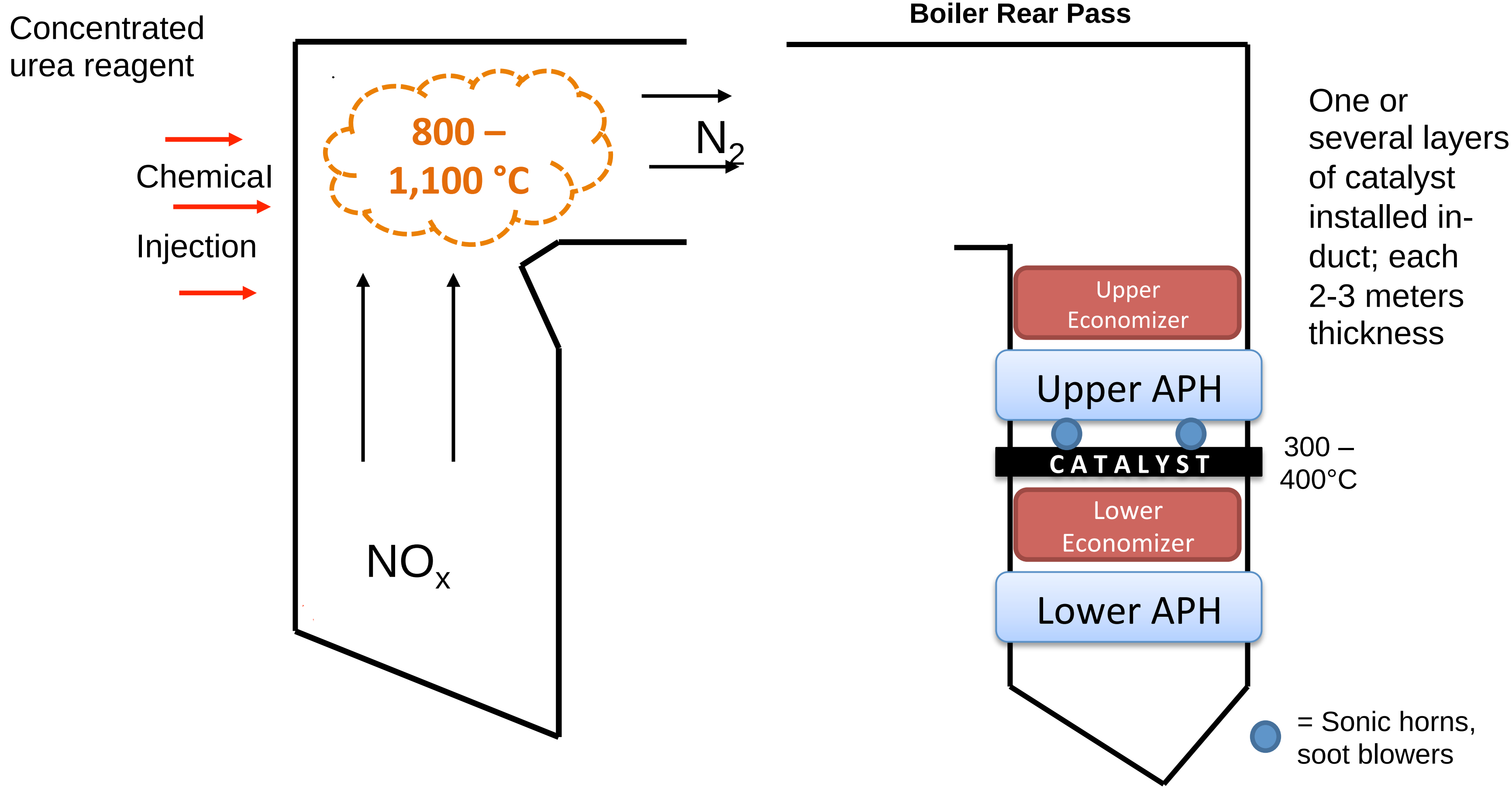
- SOFA and Low NOx Firing Systems
- Proprietary SNCR/SCR Hybrid
- Patented coal classifiers

Results:

- NOx reduced from 0.44 to 0.08 lb/MMBTu
- LOI below 1.5%
- Expanded fuel flexibility
- Increased unit efficiency
- Significant cost reduction due to the large savings in ammonia and catalysts
- Currently working on few more units for Yixing

IN HYBRID ARRANGEMENT, AMMONIA INJECTORS ARE INSTALLED IN UPPER FURNACE, AND ONE (OR MORE) IN-DUCT CATALYST INSTALLED IN BOILER REAR PASS

Schematical Arrangement of In-Duct SNCR & SCR



IN HYBRID ARRANGEMENT, AMMONIA INJECTORS ARE INSTALLED IN UPPER FURNACE, AND ONE (OR MORE) IN-DUCT CATALYST INSTALLED IN BOILER REAR PASS

Advantages

- Can achieve **significant NOx reduction**, especially when combined with LNB
- **Lower capital** cost than SCR (smaller catalyst volume, installed in-duct)
- **No significant slip** issues because catalyst cleans up excess ammonia

Constraints

- Boilers require adequate **in-duct space** for catalyst installation
- Requires **EPC with know-how** of all three technologies: LNB, SNCR, SCR

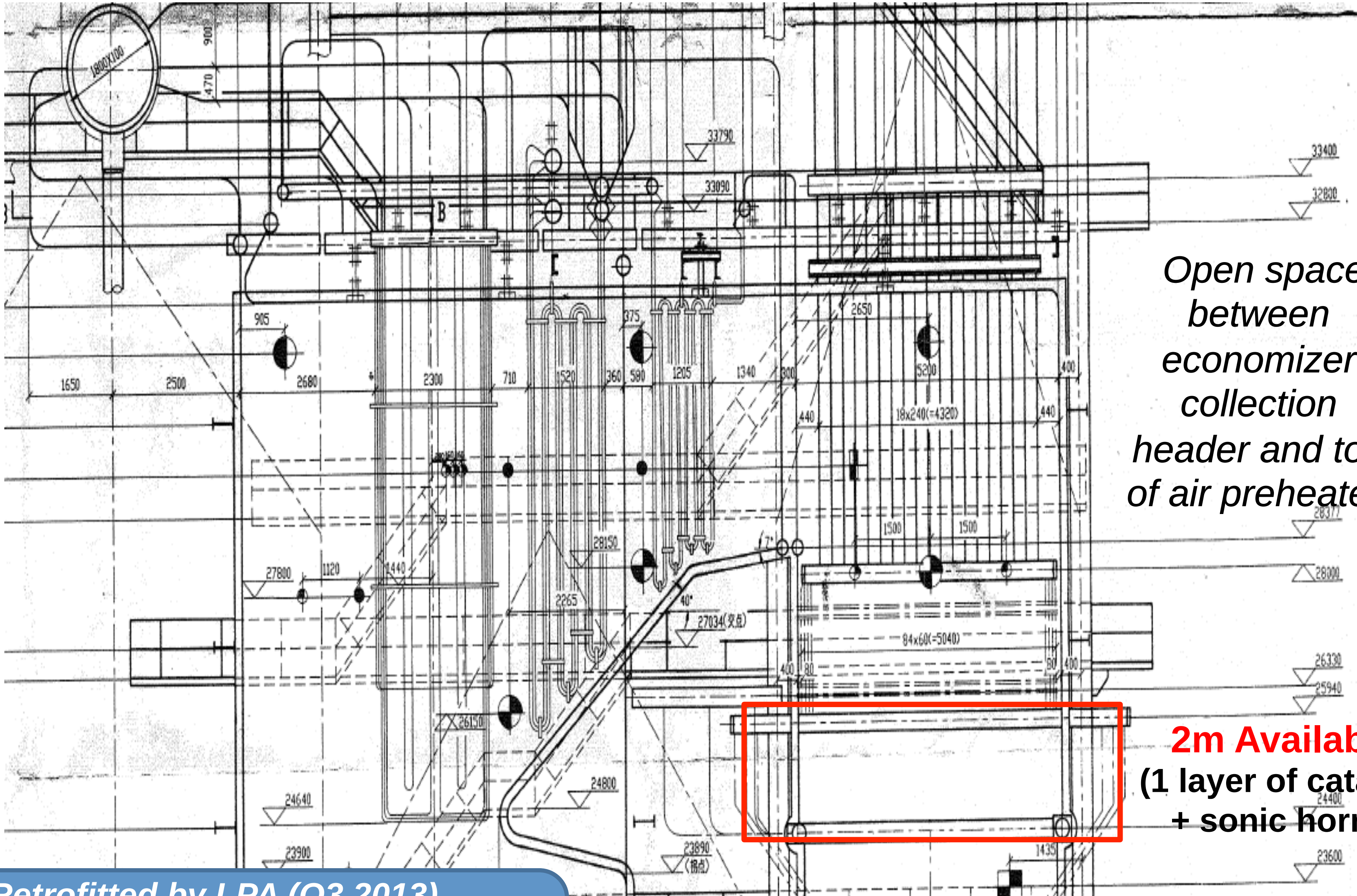
Applicability

Small Units	Medium Units (50-300 MW)	Large Units

- Smaller units utilize LNB and (S)OFA, *but still need additional NOx reduction*
  - SCR too expensive/ too large for some units
  - SNCR might not provide effective NOx reduction without large amount of slip

Large Units:

- LNB
- SCR



Open space between economizer collection header and top of air preheater.

2m Available

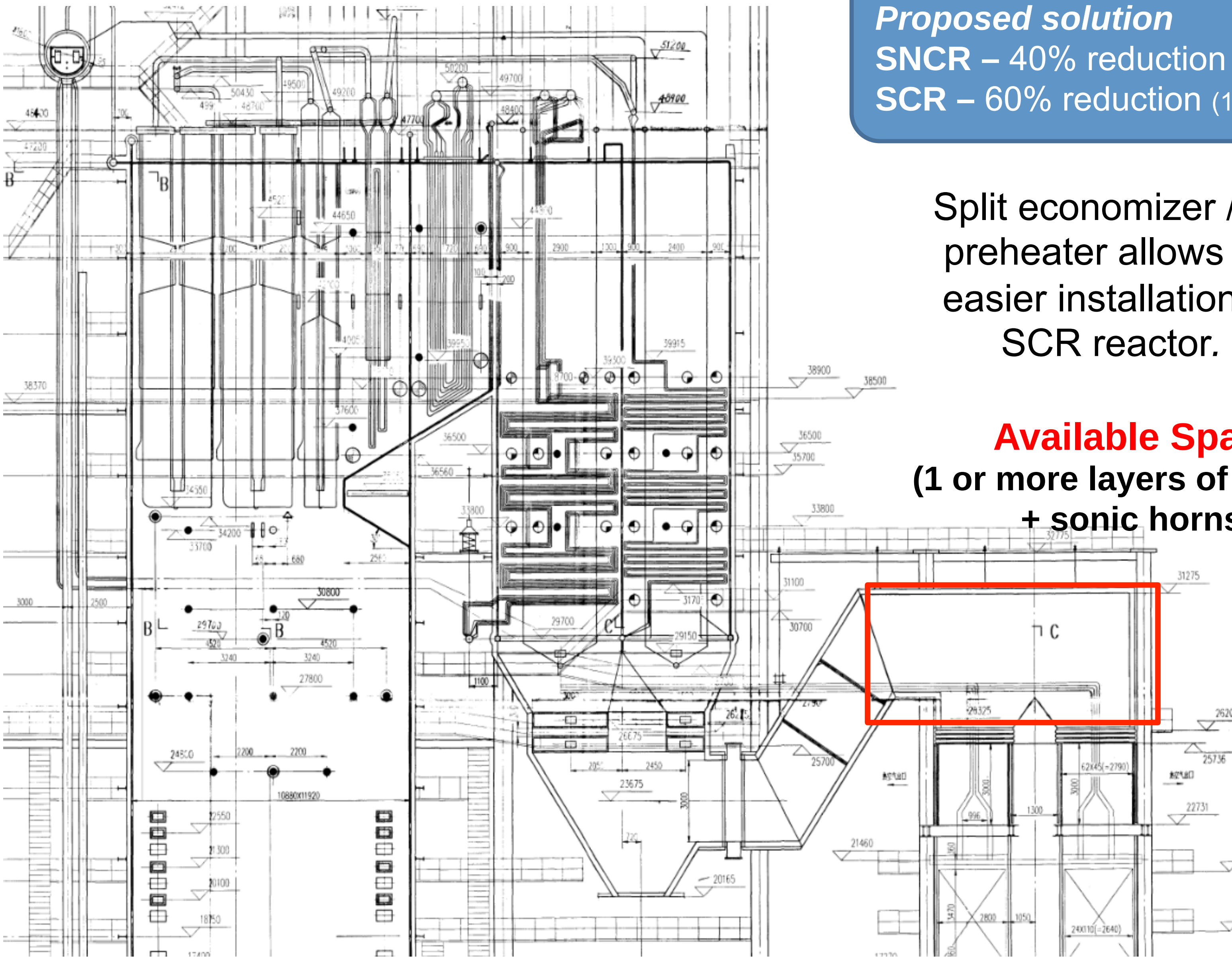
(1 layer of catalyst + sonic horns)

Retrofitted by LPA (Q3 2013)

***LNB* – 40% reduction** (200 mg/Nm^3)

SNCR – 30% reduction (200 mg/Nm^3)

SCR – 50% reduction (100 mg/Nm^3)

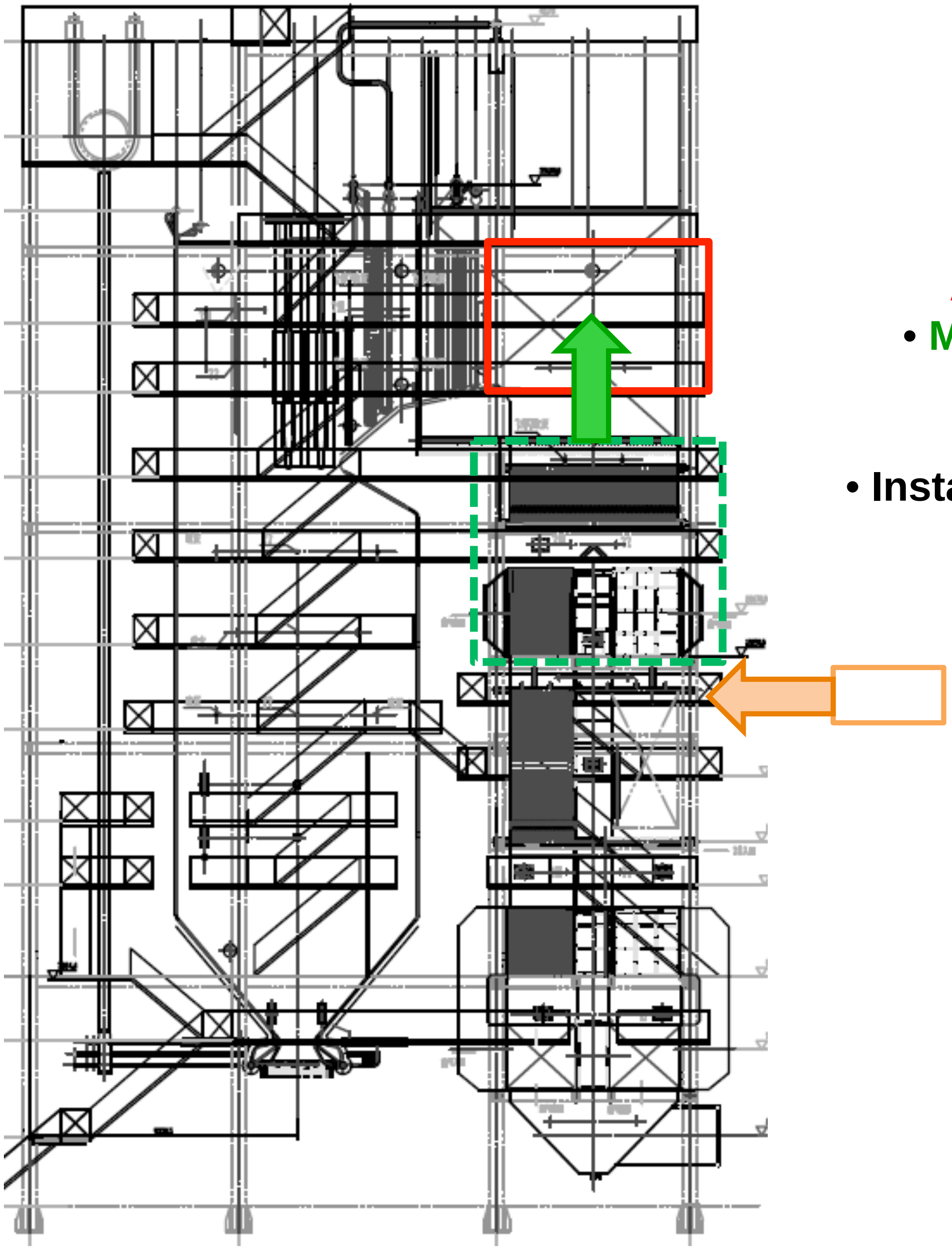


Proposed solution

SNCR – 40% reduction (250 mg/Nm³)

SCR – 60% reduction (100 mg/Nm³)

Split economizer / air preheater allows for easier installation of SCR reactor.

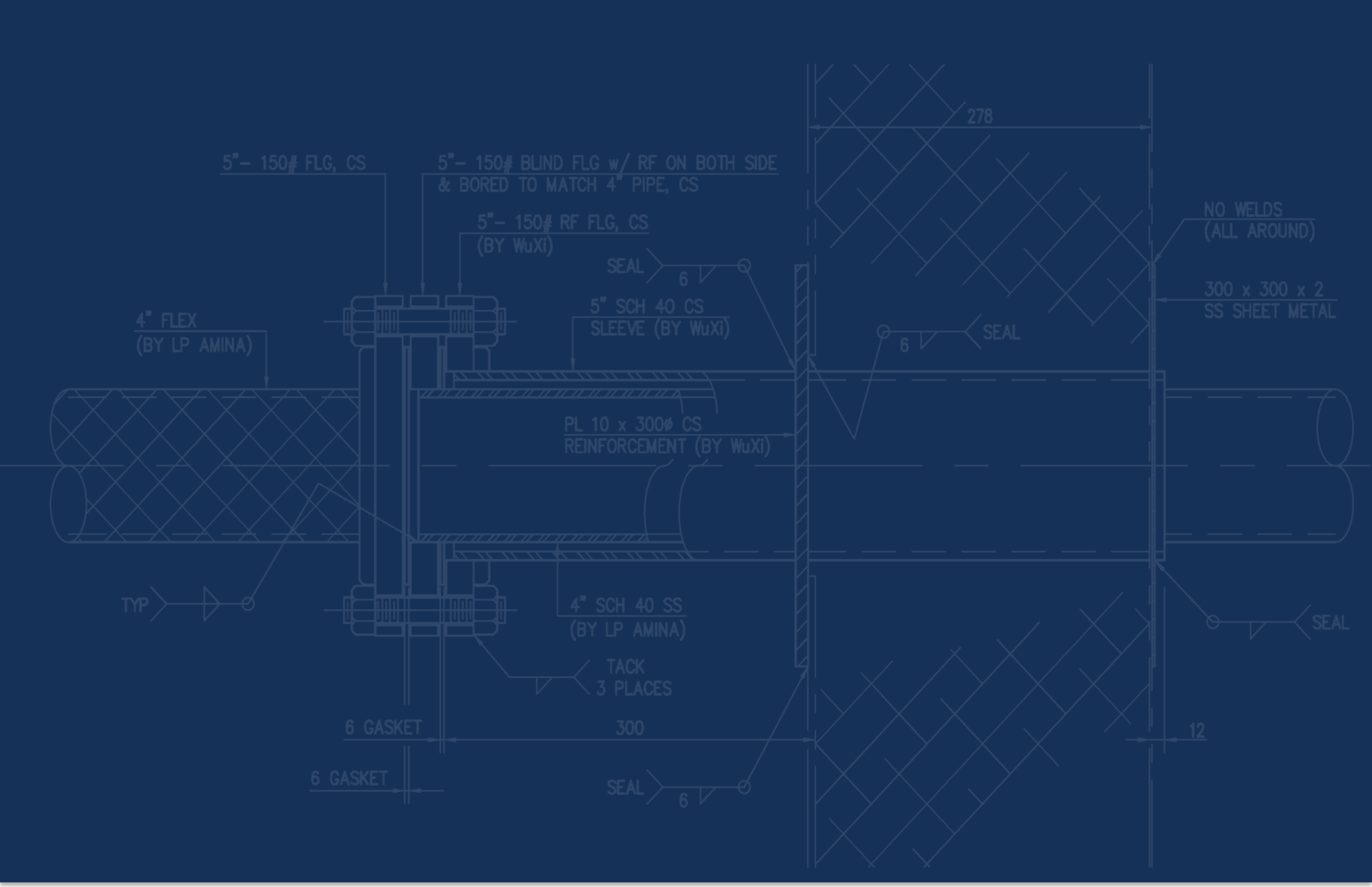


Proposed solution
SNCR – 40% reduction (166 mg/Nm³)
SCR – 40% reduction (100 mg/Nm³)

Available Space TOO HOT

- **Move economizer, APH upwards.**
- **Create new space below in correct temperature zone.**
- **Install 1 layer of catalyst + sonic horns**

Harder installation than other examples because of lack of space in correct temperature zone.



LP AMINA | Energy and Environmental

Hybrid SNCR/In-Duct SCR System

Dale Pfaff

FUEL TECH, INC.

Batavia, IL

Rich Abrams

BABCOCK POWER ENVIRONMENTAL

Worcester, MA

Environmental Controls Conference – Pittsburgh, PA

May 16 – 18, 2006

Agenda

- Hybrid Defined
- SNCR
  - Traditional
  - Re-Designed
- Compact SCR Design
  - Tools
- Hybrid Goals
- Real Life Examples
- Costs

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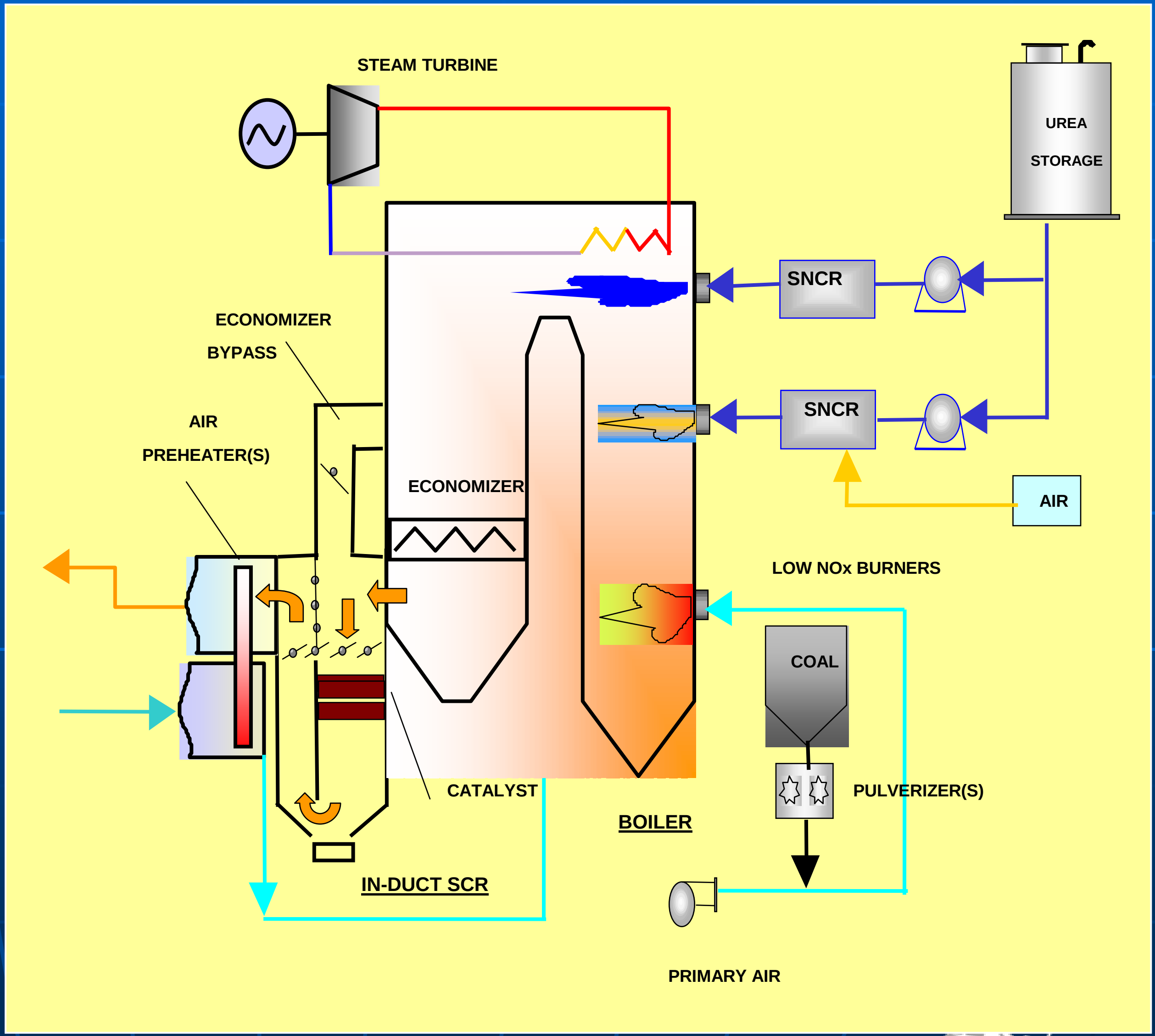
Technology for a renewed environment™

Hybrid NO_x Control System "Cascade®"

- **Redesigned** SNCR System with SCR (using urea)
- Higher NO_x Reduction and Utilization than SNCR
- NH_3 slip consumed in SCR
- Low SO_2 to SO_3 Conversion Rates
- 50 - 75% overall NO_x reduction
- Low capital costs



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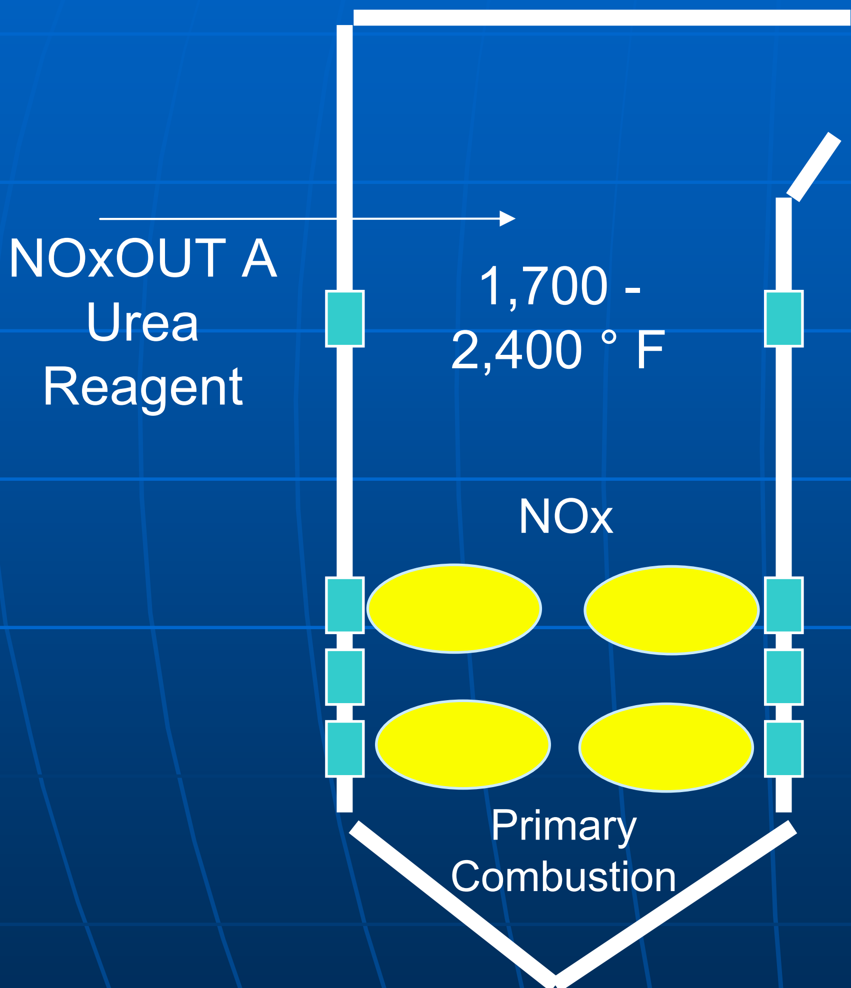
Traditional Urea Based Selective Non-Catalytic Reduction (SNCR) of NOx



- Post Combustion
- Gas Phase Reaction
- Furnace is the Reactor
- Typical Combustion Products
- Process Parameters
  - Time
  - Temperature and Species
  - Distribution
- Widely Applicable

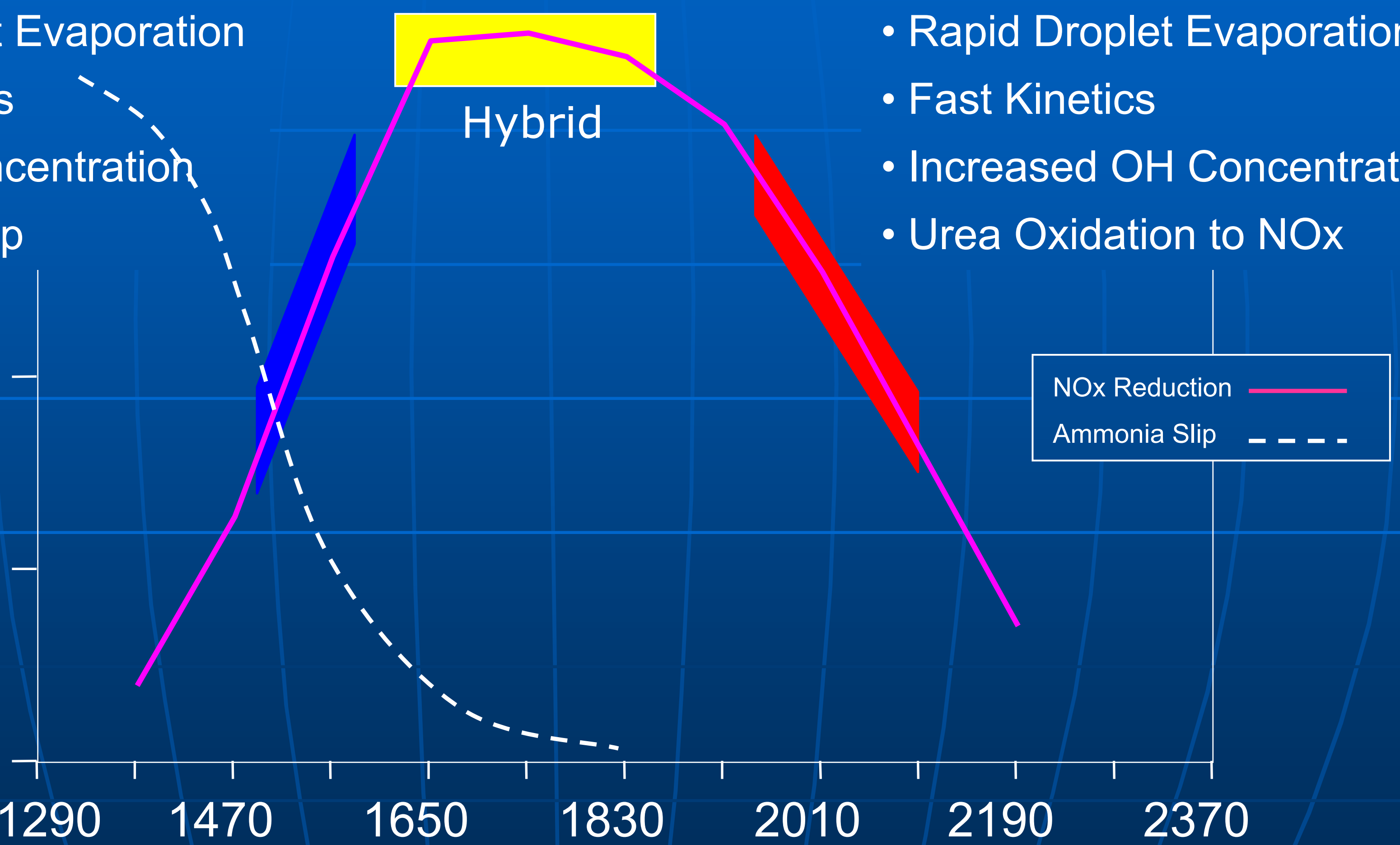
"Right Side of the Slope" Injection

Low Temperatures

- Slow Droplet Evaporation
- Slow Kinetics
- Low OH Concentration
- Ammonia Slip

High Temperatures

- Rapid Droplet Evaporation
- Fast Kinetics
- Increased OH Concentration
- Urea Oxidation to NOx



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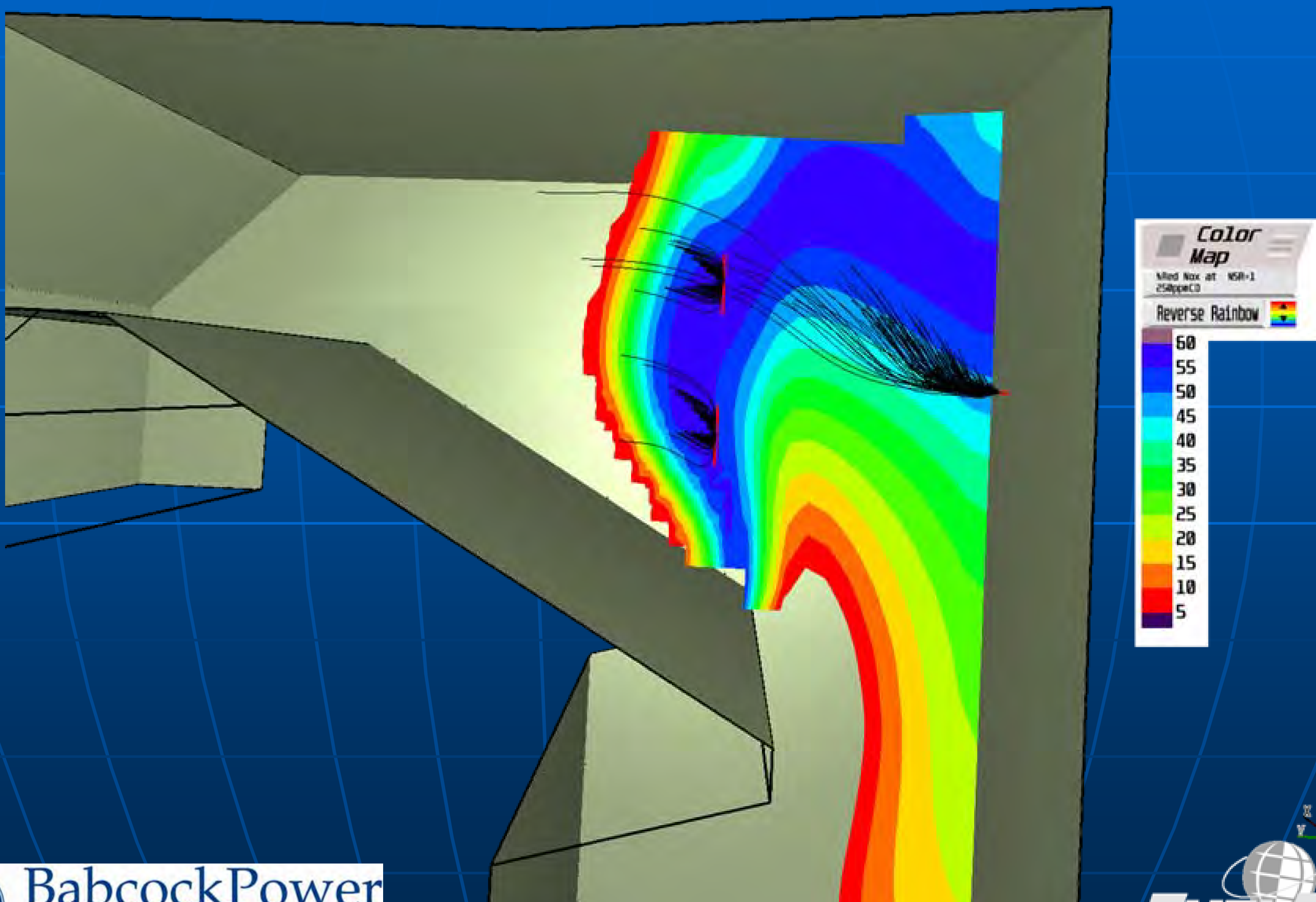
Hybrid SNCR Injection



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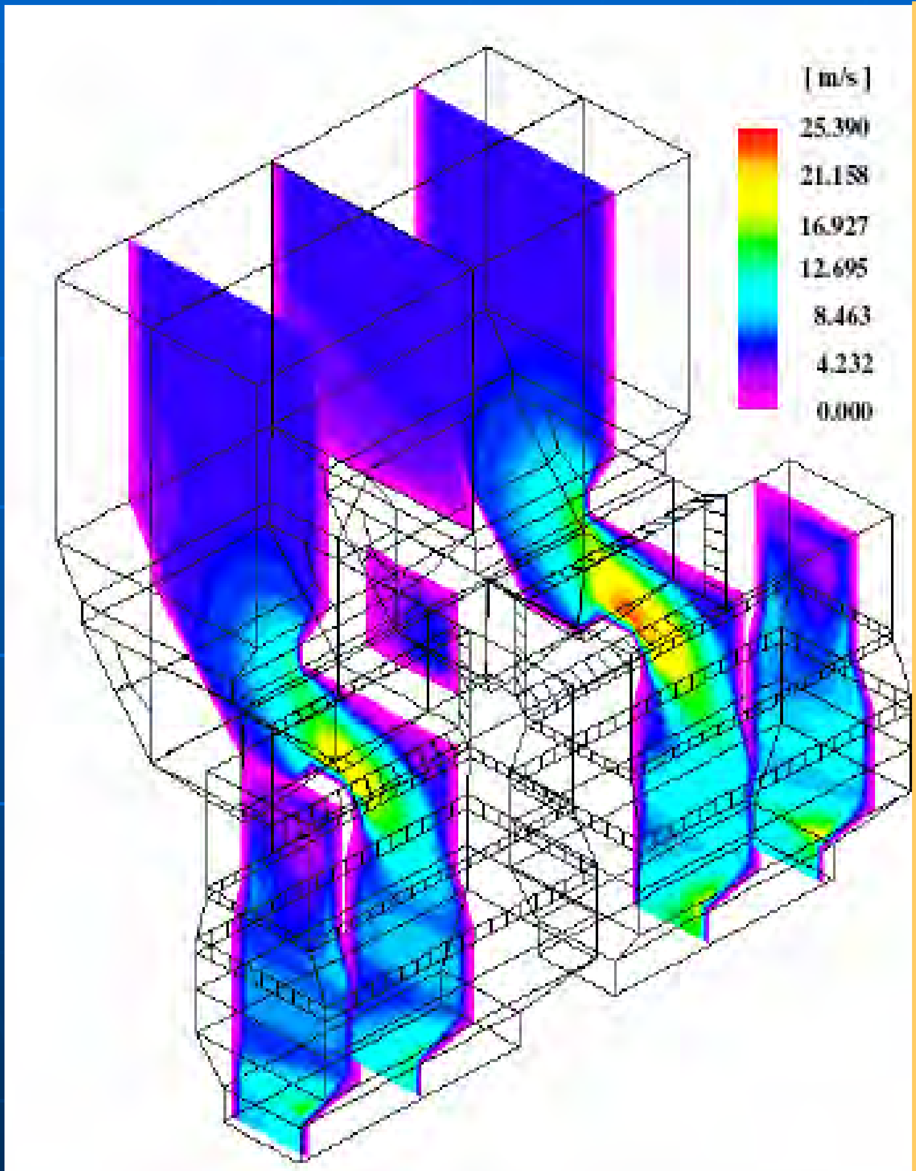
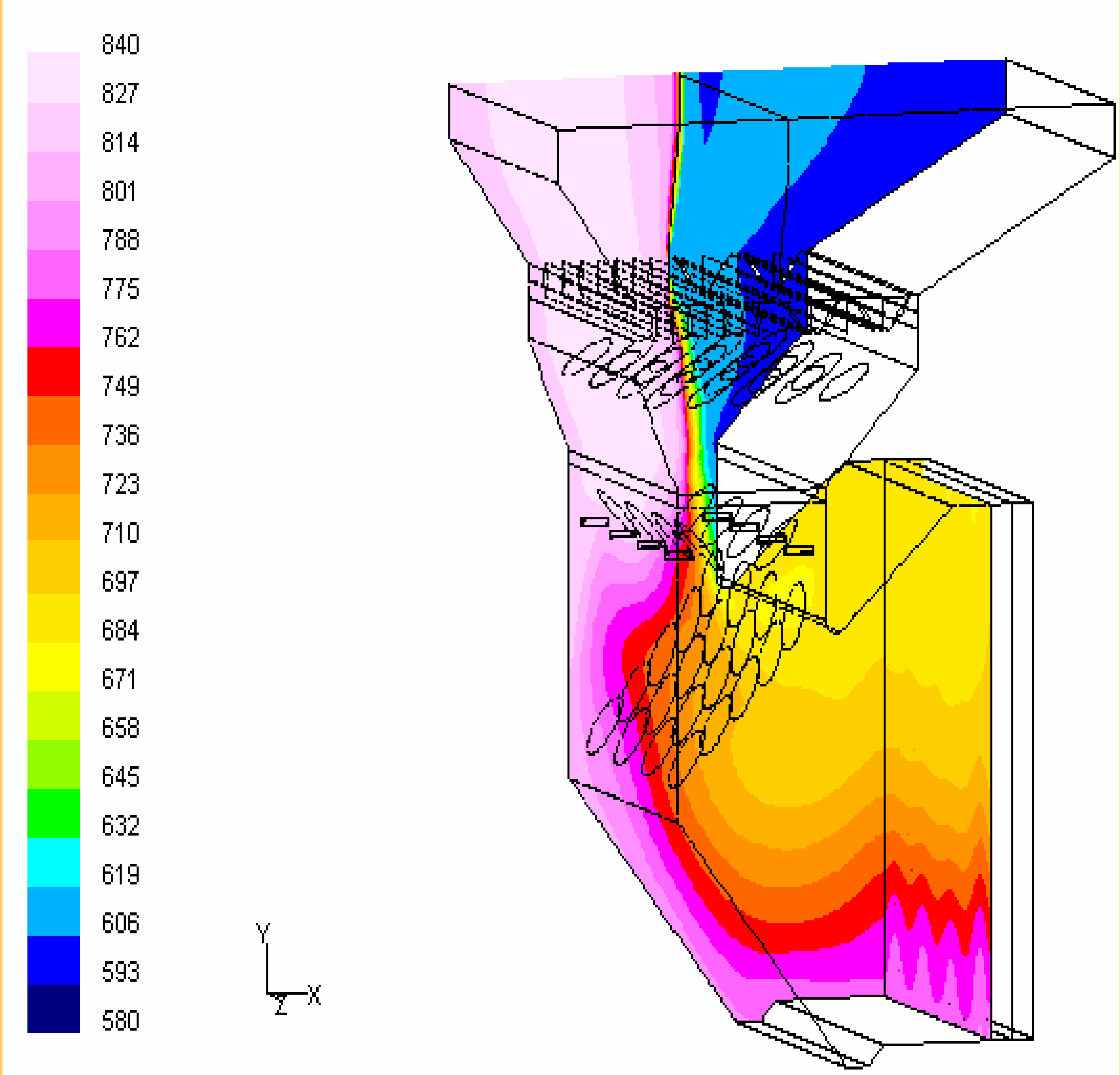
Hybrid In-Duct

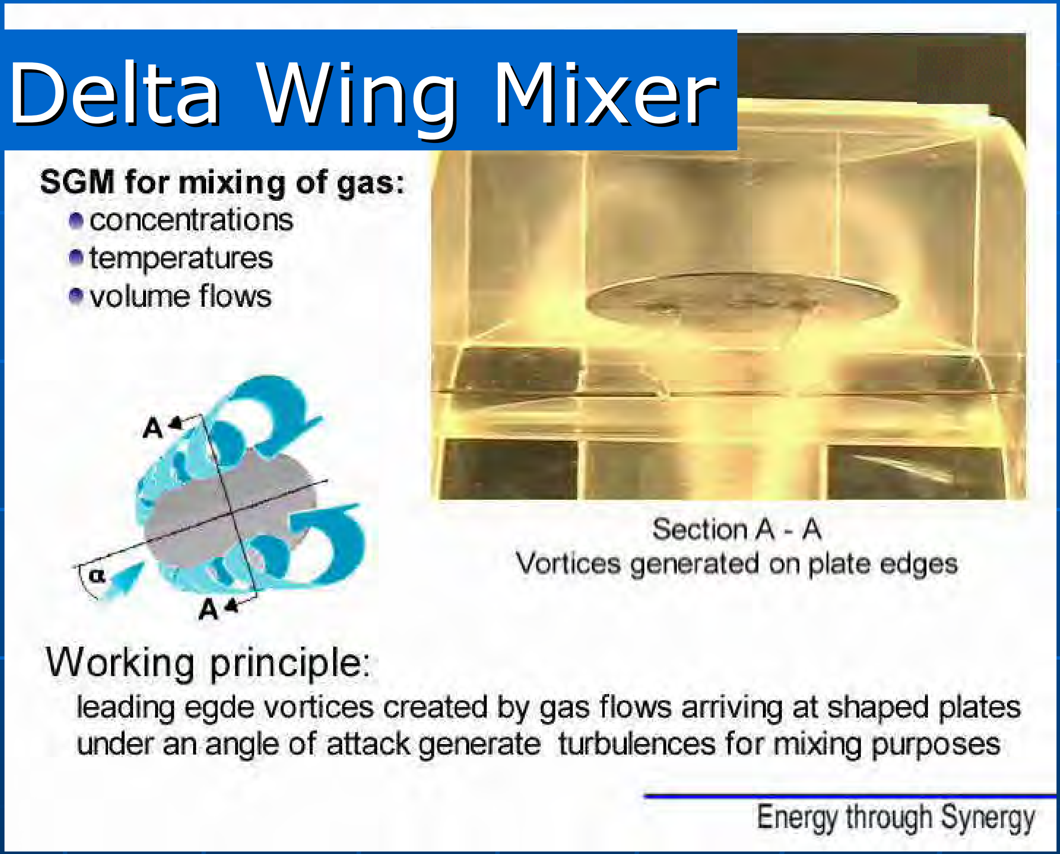




Exelon Handley 3 SCR @ MCR: Ammonia Mixers Away from Walls. Inlet & Outlet Crossmixer Stages, Geo 7
Contours of Temperature (F) on Catalyst Inlet & Reactor Centerline

Cold Flow Models and Flue Gas Mixing

- **1:40 scale flow model**



BPI makes extensive use of flow modeling to guide designs and to ensure proper distribution

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Typical Hybrid Process Goals

- Multiple Levels of SNCR Injection for Load Following Capabilities
- 50 - 75% Overall NOx Reduction, 2 - 5 ppm NH_3 Slip
- One Catalyst Layer at 1.3 m Depth
- SCR Inlet Temp = 650 °F Norm / 800 °F Max
- No Ammonia Injection Grid
- Efficient Mixing to Achieve Uniform Distribution
- SO_2 to SO_3 Conversion < 0.5 %
- Fits within the Physical Space Limitations

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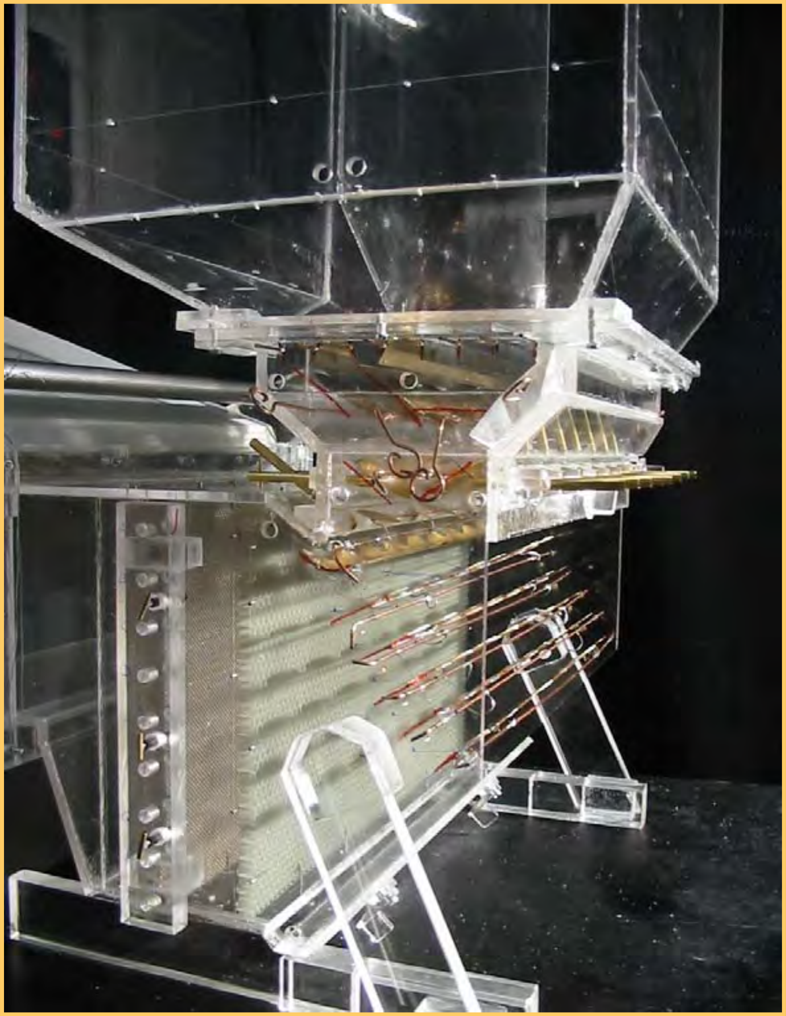
Commercial Compact SCR and Hybrid (SNCR/SCR) Examples

Example 1: Compact In-Duct SCR
Exelon Handley Unit 3

- Turbo Boiler – Gas Fired
- 94% NOx Removal SCR
- In-duct Reactor
- Delta Wing Mixing System
- Honeycomb Catalyst



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BPI - Handley Test Results

- Full load and low load NOx outlet concentrations achieved at 0.02 and 0.01 lbs/Mmbtu respectively
- NOx removal efficiencies of >94%
- Stack ammonia slip <3 ppm measured
- SCR system pressure loss as predicted
- NH3/NOx ratios < 6% RMS, per design
- Optimization of unit in six operating days

Example 2: Fuel Tech
Seward Station - 147 MWg, Coal

- T-fired CE furnace: 1990 BL of 0.78 lb/MMBTU
- Furnace and convective pass injection

Design Case:
42% reduction, 0.45 #/MMBtu, <5 ppm NH_3 slip

Operational Case:
35% reduction, 0.50 #/MMBtu, <2 ppm NH_3 slip
Less than 10 % in convective pass

High Ammonia Slip Case
54% reduction, 0.36 #/MMBtu, ≈10 ppm NH_3 slip
Short-term testing

- Increased chemical in convective pass

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SCR Expanded-duct Reactor Design

- Required <u>NH_3 Reduction</u> from 20 ppm to 2 ppm
- Rapid Flue Gas Mixing
- Minimum SO_3 production (Ammonium Salts)
- Minimum pressure drop
- Withstand coal fired gas stream

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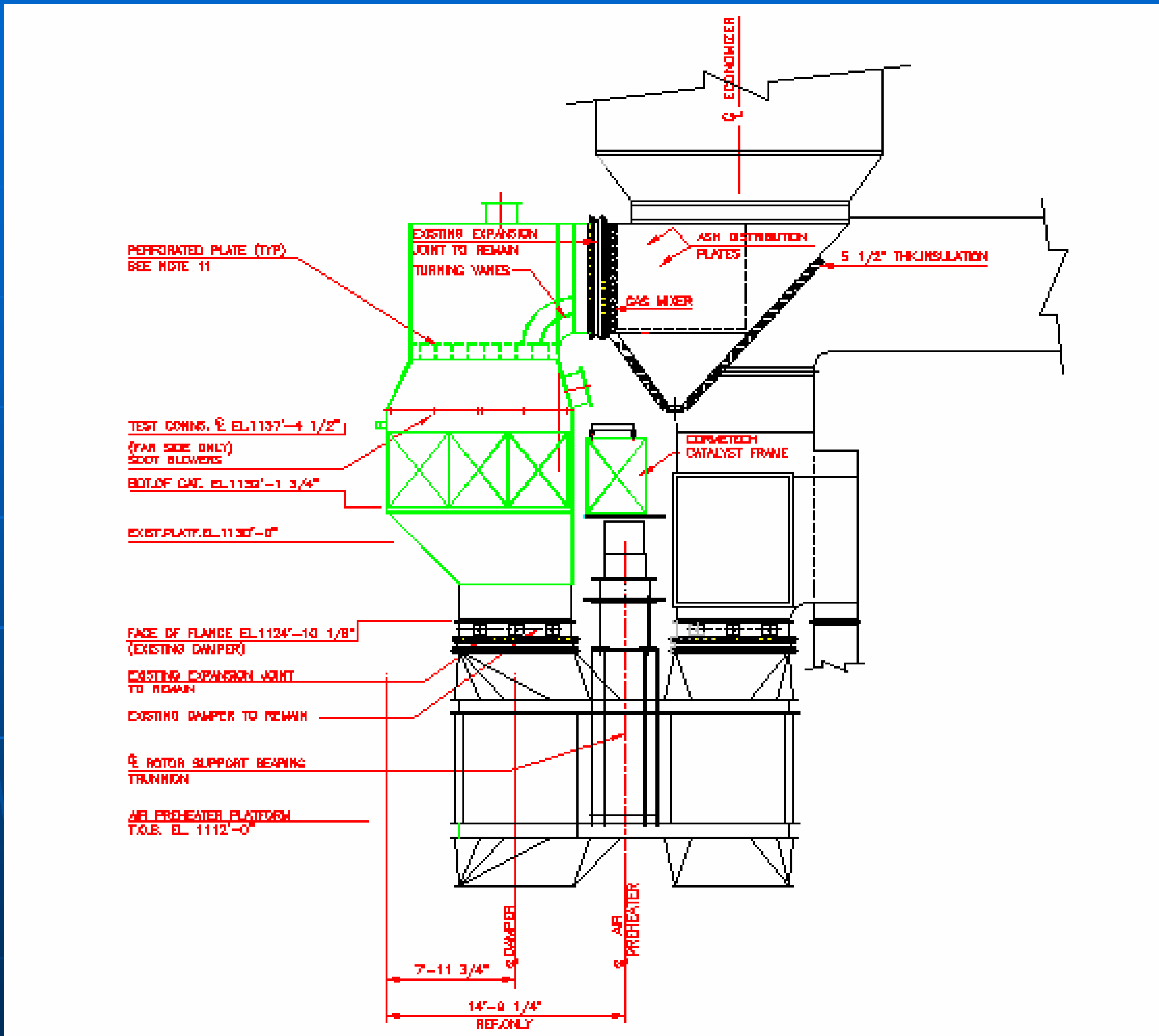

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Hybrid SNCR/SCR Performance

- Maximum Reduction Achieved (>50%)
  - System Tuned to 2, 10, or 20 ppm slip
  - Low-Load Operation at 2 ppm Slip.
- Increased Chemical Utilization
- Less than 2 ppm ammonia slip at SCR Outlet
- Hybrid SNCR/SCR Operated for more than 5 years

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Example 3; High Load (320MWe) Hybrid Results

Fuel	NOx Control System	NSR	SNCR Reduction	SNCR Utilization	SCR Reduction	Total Reduction	Overall Utilization
Coal	Standard SNCR	1.19	37.0%	31.1%	-	37.0%	31.1%
Coal	Hybrid	0.79	41.1%	59.2%	16.3%	50.7%	64.2%
Coal	Hybrid	1.15	36.9%	45.7%	54.2%	71.1%	61.8%
Gas	Hybrid	1.44	36.1%	38.6%	78.9%	86.5%	60.1%
Gas	Hybrid	1.56	39.0%	37.1%	83.6%	90.0%	57.7%

- Ammonia Slip at 10 ppm or less

Example 4; AES Greenidge Application Hybrid System

- 115 MW Coal Fired Unit, 2.9% S Bituminous coal
- Two levels of SNCR
- In-duct reactor; single layer of catalyst
- Short distance between economizer and reactor
- SNCR provides ~ 40% reduction
- SCR provides balance
- Overall system provides ~ 66% reduction

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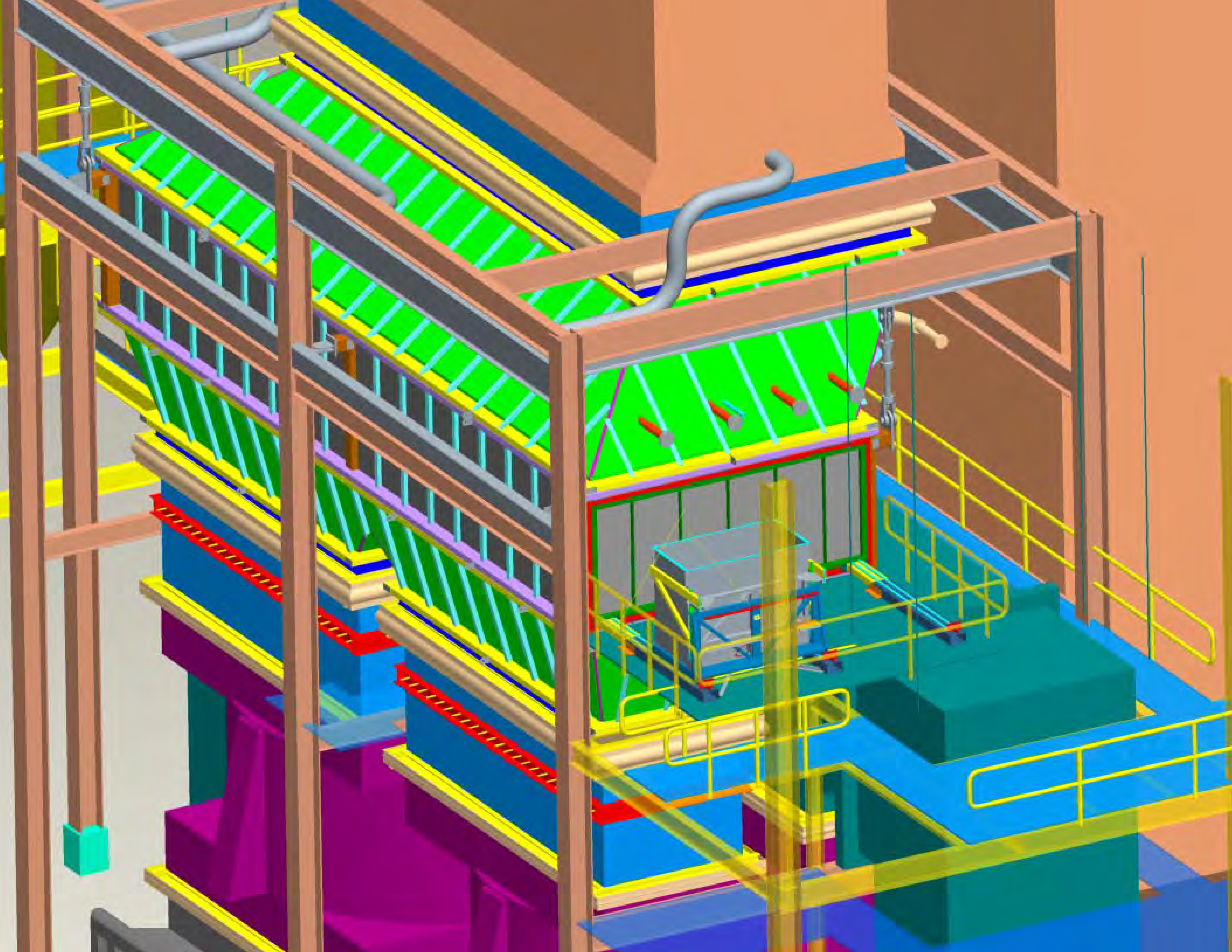

All-In Capital Cost vs. NOx Reduction

SCR	$70 - +$200?/KW	80 - 90%
SNCR	$10 - $30/KW	20 - 35%
Hybrid	$35 - $80/KW	50 - 75%

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Conclusions

- Hybrid combines redesigned SNCR with SCR
- Control Flexibility: Operating vs. Capital Costs
- Hybrid can control slip and improve utilization
- 50% and 75% NOx Reduction with significantly reduced SCR retrofit capital
- Each Unit Must Be Evaluated to Determine Feasibility for placement of an IN-DUCT or COMPACT SCR.
- 2 Utility and 3 Industrial Hybrid Applications

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ATTACHMENT C

<u>Questions Submitted via Email to Randy Mosier (MDE) from Leah Kelly (EIP) on April 4, 2017</u>

In response to Public Information Act ("PIA") request #2017-00093 relating to the Wheelabrator BRESCO incinerator in Baltimore, we received a NO_x Control System Optimization Final Report compiled by Quinapoxet Solutions for tests run in February and March of 2016 at Wheelabrator Baltimore (hereinafter "Final Report"). We have a few questions relating to this report and hope that MDE is willing to consider these.

We still intend to submit a longer set of comments later this month as stakeholders in the NOx RACT for Large MWCs process, which will address additional issues, but we wanted to get these inquiries in as soon as possible.

1. **What analyses did Wheelabrator conduct to measure or model the furnace gas flows?**

In the Final Report, Quinapoxet Solutions states that "it was confirmed that furnace gas flows favored the rear wall at the urea injection level." However, it was unclear within the report what tests were conducted to confirm this assertion, as the report refers to "Typical Boiler Furnace Flow" in Figure 6 to support its assertions. Is MDE aware of whether a computational fluid dynamics model or similar flow testing has been done on the Wheelabrator Boiler Furnaces?

2. **Has Wheelabrator conducted temperature measurements at varying heights within the furnaces to verify that the 4th floor is the optimal location for the SNCR Injector?**

Wheelabrator's presentation at the 1/17/17 NOx stakeholder meeting indicated that adequate residence time may be a concern for the single-pass boiler, and additional vertical testing could inform additional or modified urea injection at varying heights or angles within the furnace.

3. **Is the GasTemp pyrometer (line of sight average) appropriate for temperature profiling?**

When determining placement of injection locations, more detailed spatial data may be required. Using an instrument that gives you the average along a line is valuable in some contexts, much more granular data should be obtained to identify exact placement of urea injection.

4. **Could there be the opportunity to further optimize baseline combustion controls?**

The Final Report attributes the higher baseline concentration within Boiler 2 to be due to the higher operating temperature required in a "fouled" boiler. However, due to the relatively low operating temperatures of the boilers, it is unlikely that thermal NOx would cause the 20 ppm difference between the two baselines. We are curious whether additional factors, such as fuel composition or boiler operation, are contributing to these observed differences, and whether better standardization or optimization could reduce baseline emissions before SNCR treatment.

5. **If possible, can MDE provide the urea flow for *each* injector during testing in addition to total flow?**

6. **Have the injection locations identified within the optimization study or the urea injection rates been implemented, and do they continue to be utilized currently?**

7. **Was the optimization study protocol approved by MDE?**

ENVIRONMENTAL INTEGRITY PROJECT

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May 9, 2017

Via E-mail
George (Tad) Aburn
Director
Air & Radiation Management Administration
Maryland Department of the Environment
1800 Washington Boulevard
Baltimore, MD 21230
george.aburn@maryland.gov

RE: Public Stakeholder Process for Setting Reasonably Available Control Technology Limits for Nitrogen Oxides Emissions from Large Municipal Waste Combustors

Dear Mr. Aburn:

The Environmental Integrity Project ("EIP") submits the following comments as part of the public stakeholder process on the Maryland Department of the Environment's ("MDE's") development of new Reasonably Available Control Technology ("RACT") limits for the pollutant nitrogen oxides ("NO_x") from Maryland's two large municipal waste combustors ("incinerators"). Time constraints prevented us from sending these comments to the environmental, health, and community groups that signed onto EIP's October 26, 2017 letter regarding this rulemaking. However, we expect that these groups will adopt this set of comments, or similar comments, in the future. We know that our partner groups remain very concerned about the emissions from the Baltimore Resource Energy Systems Company ("BRESCO") incinerator operated by Wheelabrator Baltimore, L.P. and committed to participating in this rulemaking process.

The NO_x emissions from the BRESCO incinerator are extremely high for the amount of energy and steam that is produced by this plant. EIP is concerned about the health impacts of these emissions, discussed in more detail below, on residents living in the area immediately surrounding the incinerator and elsewhere in the Baltimore area. It is critical that MDE require significant NO_x reductions at this facility. At MDE's January 17, 2017 stakeholder meeting, Wheelabrator proposed to reduce its short-term (24-hour) emissions limit to 170 ppm,[1] which would reduce its NO_x pollution by a paltry 60 tons per year.[2] In 2016, this plant emitted 1,146 tons of NOx, and a reduction of 60 tons from this level is woefully inadequate.

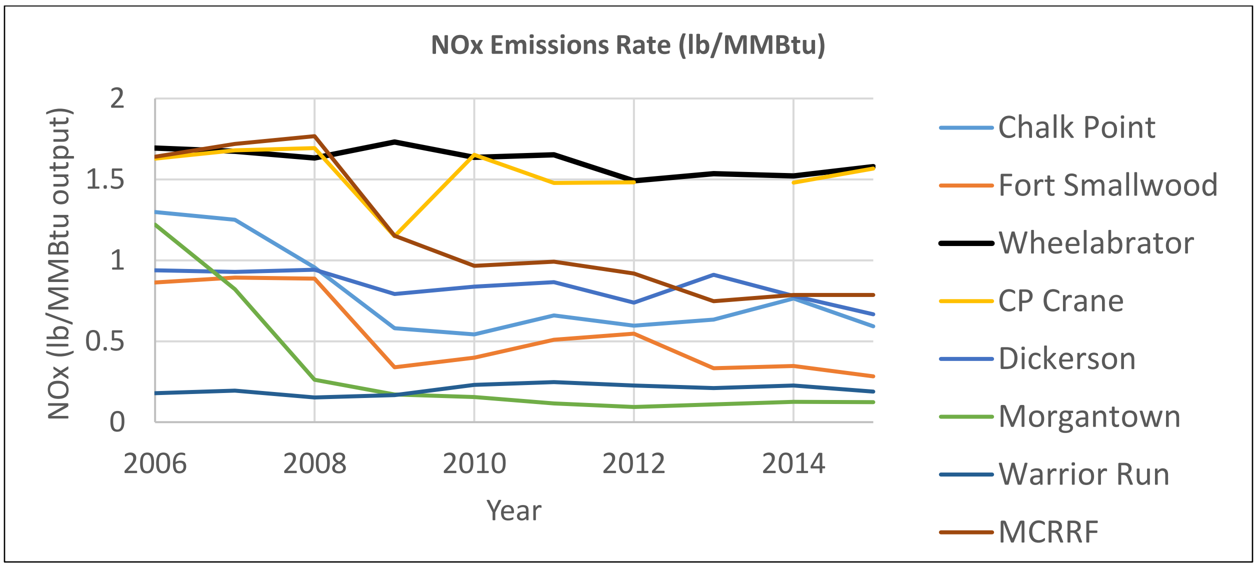
[1] In these comments, "ppm" is used as shorthand for parts per million by volume dry at 7% oxygen.
[2] MDE PowerPoint Presentation, NOx RACT for Municipal Waste Combustors (MWCs), Stakeholder Meeting - January 17, 2017, p. 26 *at* http://www.mde.state.md.us/programs/regulations/air/Documents/SHMeetings/MunicipalWasteCombustors/MWCNOxRACTPresentation.pdf

As discussed in more detail below, Connecticut and New Jersey have each adopted a short-term NO_x RACT limit for incinerators of 150 ppm, and Wheelabrator incinerators in those states that are very similar to the Baltimore plant are subject that limit. However, a 150 ppm limit would reduce annual emissions by only about 200 tons per year at the Baltimore incinerator, which still falls short of what MDE should be seeking. MDE should set a much lower 24-hour limit, using its legal authority to require reductions beyond the RACT standard if necessary.

I. **Introduction**

In 2015, the BRESCO incinerator was the sixth highest NO_x-emitting facility in the State of Maryland, and it emitted more NO_x per useful output (energy plus steam) that year than any of the other large power plants in the state. As shown in Figure 1 below, [3] the BRESCO facility is also one of only three large power plants in Maryland that has *not* significantly reduced its NO_x emissions over the last decade (one of the three – the Warrior Run coal plant - started out with relatively low NO_x rates and simply maintained them).

Figure 1: NOx Emissions Per Unit of Useful Output (energy + steam) from Maryland's top 7 electrical generating stations: 2006-2015



[3] EIP calculated Wheelabrator's NOx rate per unit useful output in order to account for the value of the steam that the facility provides for heating nearby buildings. If we had calculated this rate based on NOx per unit of energy produced, Wheelabrator's NOx rate would have been even higher compared to that of the other electrical generators in Maryland. NOx emissions data were taken from the Maryland Emissions inventory, expressed in tons per year. For a typical electrical generating unit (EGU), Net Generation (in MWH) was taken from the U.S. Energy Information Administration (EIA) Form 923 data, and converted to MMBtu using the conversion factor of 1 MWH=3.412 MMBtu. For combined heat and power (CHP) facilities, total output (combination of electric generation and useful thermal output) was estimated using EIA CHP efficiency factors, which represent the ratio of total output to total input, multiplied by Total Fuel Consumption (MMBtu). Annual NOx emissions were then divided by total output (net generation for EGU, combination of electric and useful thermal output for CHP) to produce a ton NOx/total output value.

In addition, BRESCO emitted 1,146 tons of NO_x in 2016, according to the PowerPoint presentation given on January 17, 2017 by Wheelabrator,[4] which is actually an increase from its 2015 emissions of 1,123 tons of NO_x. These high NO_x rates are especially troubling in light of the fact that the Wheelabrator incinerator is treated as a Tier 1 source of renewable energy under Maryland's Renewable Portfolio Standard ("RPS"), which ostensibly encourages the use of clean, non-polluting energy. In fact, according to data provided in the most recent report on the RPS released by the Maryland Public Service Commission ("PSC"), it appears that Wheelabrator received about $3.5 million in 2015 for its Tier 1 renewable energy credits.[5] If the company did, in fact, receive this amount of money for producing "clean" energy, it is imperative that it invest in pollution control upgrades to protect the lungs of the ratepayers who subsidize these renewable energy credits.

A. Health Impacts of BRESCO's NO_x Emissions

i. Nitrogen dioxide (NO_2)

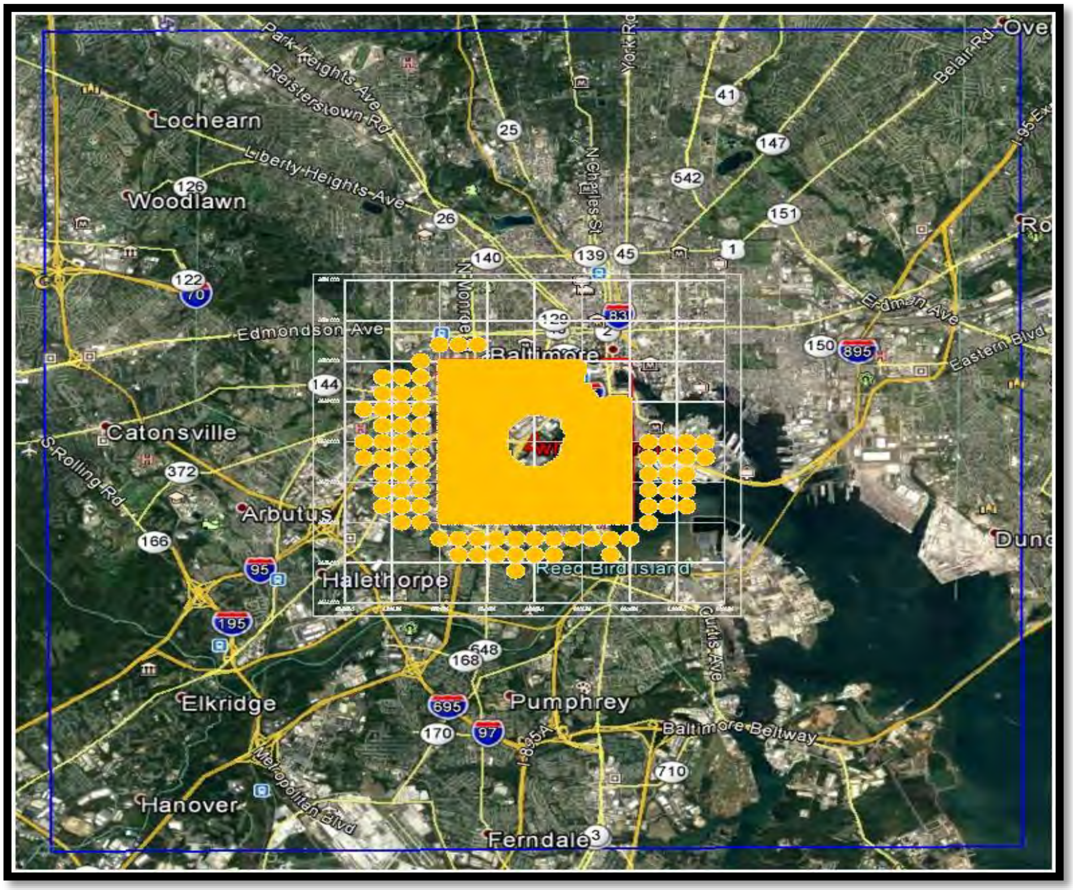
As discussed in detail in the report of Dr. H. Andrew Gray of Gray Sky Solutions dated May 9, 2017 (hereinafter "Gray Modeling Report")[6], modeling has been performed of the impact of BRESCO's NO_x emissions on levels of nitrogen dioxide (NO_2) in the ambient (outdoor) air. A full description of the methodology and data used in the report, as well as all findings, can be found in that report, and one of the maps produced by Dr. Gray is reproduced as Figure 2 below.

[4]Timothy Porter, Director Air Quality Management, Wheelabrator Baltimore NOx RACT Review PowerPoint Presentation (hereinafter "Wheelabrator Jan. 17 PowerPoint Presentation") (Jan. 17, 2017), p.13 *at* http://mde.maryland.gov/programs/regulations/air/Documents/SHMeetings/MunicipalWasteCombustors/MWCWheelabratorNOxRACTPresentation.pdf.

[5] In 2015, 248,377 Tier 1 renewable energy credits were retired from Wheelabrator, and the average cost of a non-solar Tier 1 credit was $13.87, indicating that Wheelabrator likely received around $3.5 million that year for its renewable credits. Public Service Commission of Maryland, Renewable Energy Portfolio Standard Report, With Data for Calendar Year 2015 (January 2017), pp. 7, 19, *at* http://www.psc.state.md.us/wp-content/uploads/RPS-Report-2017.pdf.

[6] The Gray Modeling Report is Attachment A to the May 9, 2017 comments submitted by the Chesapeake Bay Foundation on MDE's MWC NO_x RACT rulemaking.

Figure 2. Maximum 1-Hour NO2 Concentrations from BRESCO above 40 µg/m3 (21.3 ppb)
Modeled concentrations – fine grid + course grid



Dr. Gray modeled and mapped concentrations of nitrogen dioxide (NO_2) in the ambient air using two metrics: (1) NO_2 concentrations caused solely by BRESCO's NO_x emissions and (2) NO_2 concentrations caused by BRESCO's emissions added to regional background NO_2 concentrations. NO_2 is a pollutant for which short-term exposure can cause serious adverse respiratory effects, including increased risk of hospitalization due to asthma. To limit these effects, the U.S. EPA has set a federal health-based standard to limit exposure to NO_2 on a 1-hour basis. EPA's 1-hour limit is 100 parts per billion ("ppb"), measured based on the 98th percentile of hourly readings each year averaged over three years.[7]

However, studies have shown that adverse respiratory impacts can occur even in concentrations below the EPA standard. Increases of 30 ppb (which is the same as 56.4 micrograms per cubic meter ("µg/m^3")) using 1-hour maximum values[8] "indicate[d] a 2–20% increase in risks for emergency department visits and hospital admissions and higher risks for respiratory symptoms" in "effect estimates from epidemiologic studies conducted in the United

[7] EPA, National Ambient Air Quality Standards, at https://www.epa.gov/criteria-air-pollutants/naaqs-table.
[8] Values were standardized to 30 ppb for 1-hour maximum readings or 20 ppb over 24 hours.

States and Canada," according to EPA. [9] For example, one study conducted in Atlanta, Georgia from 1992 to 2000, found that an increase of 30 ppb in 1-hour maximum NO_2 concentrations was associated with a 2.4 % increase in respiratory emergency department visits and "4.1% increase in asthma visits in individuals 2 to 18 years of age."[10]

Dr. Gray modeled emissions from BRESCO using two different sets of meteorological data, one from 2005-2009 and one from 2006-2010. Under each scenario, the model estimated that BRESCO's emissions alone caused peak 1-hour concentrations over 30 ppb.[11] In addition, the model "predicted that elevated peak concentrations [of NO_2] occur over a large area surrounding the Wheelabrator facility."[12] For the 2005-2009 meteorological data, the model estimated that BRESCO's emissions alone (without the addition of background concentrations) resulted in maximum 1-hour ambient NO_2 levels of over 21.3 ppb (40 $\mu g/m^3$) across about 26 square kilometers (10 square miles) near the facility. This is illustrated above in Figure 2. BRESCO's emissions alone also caused modeled ambient NO_2 concentrations of over 26.6 ppb (50 $\mu g/m^3$) in the ambient air over 11.4 square kilometers (about 5.5 miles) near the plant, again looking at maximum 1-hour NO_2 levels.

While these maximum modeled impacts extend across a fairly sizeable geographic area, it is noteworthy that they do not reach the location of MDE's NO_2 monitor located in downtown Baltimore (the Oldtown site at 1100 Hillen Street, Baltimore, MD 21202).[13] Thus, it appears entirely possible that MDE's NO_2 monitor, which has not measured any exceedance of EPA's 1-hour air quality standard for NO_2 for many years, is not capturing the maximum NO_2 levels caused by BRESCO. As stated in Dr. Gray's report, his modeling also did not estimate any exceedances of EPA's 1-hour air quality standard (100 ppb). However, Dr. Gray modeled only (1) ambient NO_2 levels caused solely by BRESCO; and (2) ambient NO_2 levels caused by BRESCO plus background NO_2 concentrations. The background concentrations did not include

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[9] EPA, Proposed Rule for Primary National Ambient Air Quality Standard for Nitrogen Dioxide, 74 Fed. Reg. 34404, 33413 (July 15, 2009), available at https://www.gpo.gov/fdsys/pkg/FR-2009-07-15/pdf/E9-15944.pdf. This is based on a robust set of literature. EPA states:

> Temporal associations between respiratory emergency department visits or hospital admissions and ambient levels of NO2 have been the subject of over 50 peer-reviewed research publications since the review of the NO2 NAAQS that was completed in 1996. These studies have examined morbidity in different age groups and have often utilized multi-pollutant models to evaluate potential confounding effects of co-pollutants. Associations are particularly consistent among children (< 14 years) and older adults (> 65 years) when all respiratory outcomes are analyzed together . . . . and among children and subjects of all ages for asthma admissions . . . . When examined with copollutant models, associations of NO2 with respiratory emergency department visits and hospital admissions were generally robust and independent of the effects of co-pollutants (i.e., magnitude of effect estimates remained relatively unchanged) . . . . The plausibility and coherence of these effects are supported by experimental (i.e., toxicologic and controlled human exposure) studies that evaluate host defense and immune system changes, airway inflammation, and airway responsiveness . . . .

Id. (internal citations omitted).

[10] *Id.*

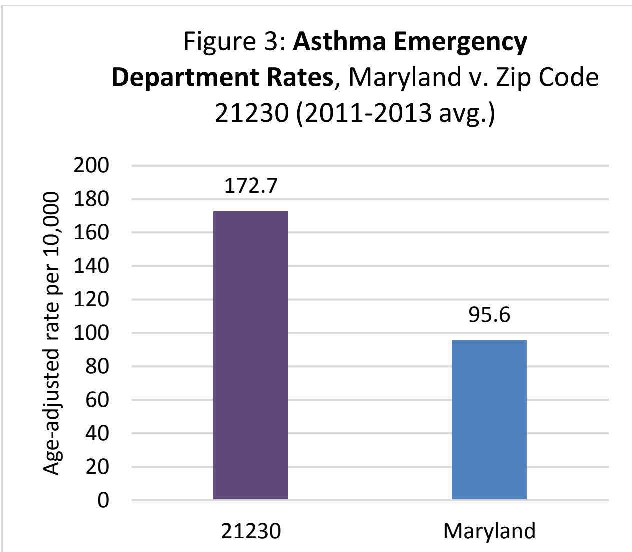
[11] Gray Modeling Report p. 5.

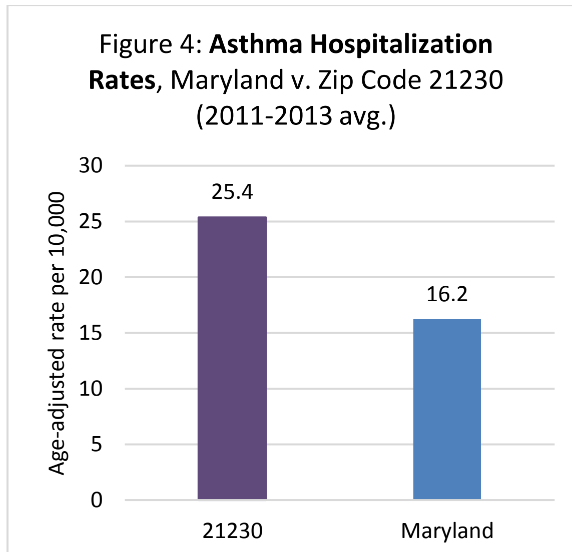
[12] Gray Modeling Report p. 4.

[13] The fact that this monitor is outside of the modeling receptor grid is shown in the first map in Appendix A to the Gray Modeling Report.

nearby industrial facilities or emissions from local road traffic, which is likely the greater contributor in South Baltimore.[14] Thus, it is possible that exceedances of EPA's 1-hour NO_2 standard are occurring and are not being captured by MDE's Oldtown monitor.

Lastly, it is important to reiterate that adverse health (respiratory) impacts can be caused by NO_2 at levels significantly below 100 ppb. The areas immediately around BRESCO, which have the highest modeled ambient NO_2 contributions from the incinerator, all have high asthma rates compared to Maryland as a whole. Air pollution is likely not the main contributor to asthma rates in these areas and traffic emissions also contribute to ambient NO_2 levels. Nevertheless, a dramatic reduction in BRESCO's NO_x emissions could have significant benefits for these communities.





Figures 3 and 4 above compare asthma rates– using different measures of acute asthma events –in Maryland as a whole to asthma rates in zip code 21230, which is the zip code most affected by BRESCO's emissions according to Dr. Gray's modeling.[15] Using an average over 2011-2013 (the most recent three years for which data is available), the asthma emergency room visit rate in zip code 21230 is about 80% higher than the state-wide rate, and the asthma hospitalization rate in zip code 21230 is approximately 57% higher the state rate.[16] Again, air pollution is likely not the main driver of these rates, but significantly reducing NO_x emissions from BRESCO could help to reduce acute asthma events in these communities.

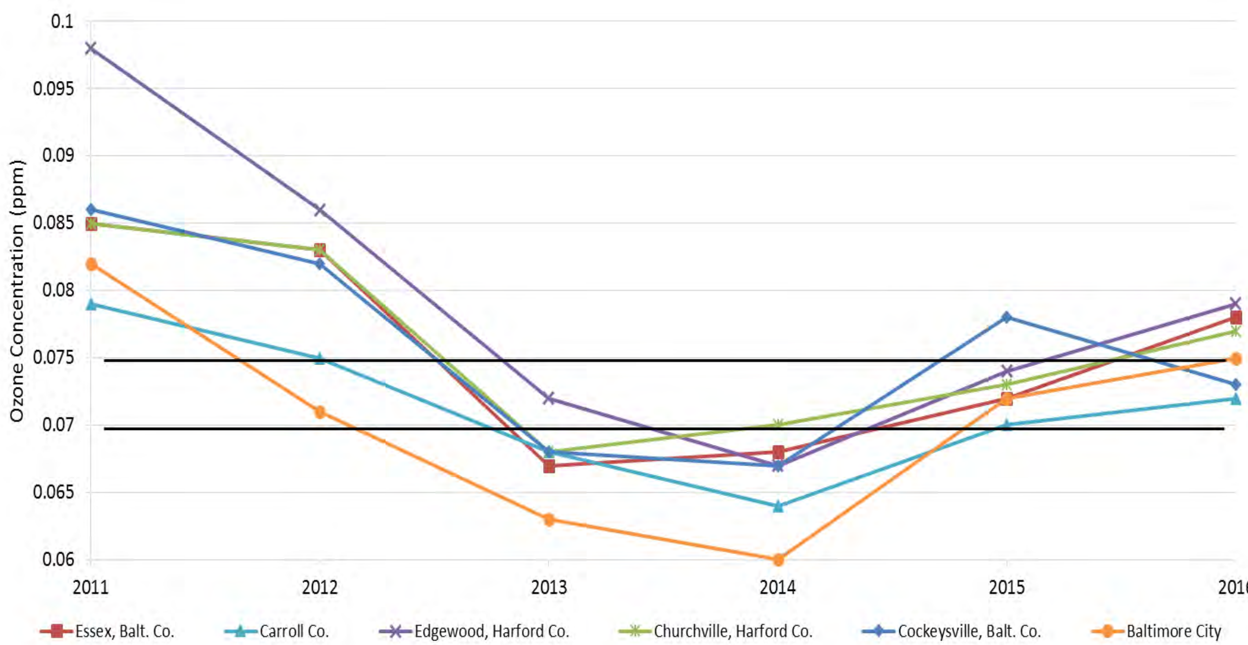
[14] Gray Modeling Report p. 7.
[15] These rates are based on age-adjusted rates per 10,000 people provided by the Maryland Department of Health and Mental Hygiene's ("DHMH's") Environmental Public Health Tracking service, at https://maps.dhmh.maryland.gov/epht/query.aspx (last visited May 7, 2017).
[16] Asthma hospitalization rates accounts for discharges of persons who are admitted to the hospital (inpatients) for asthma including those admitted through the hospital emergency department. It does not cover persons who visit the emergency department for asthma and are treated and released (outpatients). Emergency room visits cover all persons who visit the emergency room for asthma but not those who are admitted to a hospital in other ways, such as through physician appointments.

ii. Ozone

NO_x is also the primary pollutant that contributes to the formation of ground-level ozone, which has been shown to worsen the effects of asthma. A study of children ages 5-17 in New York City between 2005 and 2011 found that an increase of 13 ppb in ground-level ozone concentrations was associated with an increased risk of 2.9-8.4% of asthma emergency department visits for boys and 5.4-6.5% for girls. For girls, the same increase in ozone concentrations was also associated with an 8.2% increase in risk of asthma hospitalizations.[17]

We were not able to obtain modeling of the impacts of BRESCO's NO_x emissions on ozone levels in the Baltimore area because ozone is not emitted directly but rather forms in the ambient air when NO_x and volatile organic compounds (VOCs) combine with heat and sunlight. Ozone monitoring in the Baltimore area has historically shown the highest ozone levels in Harford and Baltimore Counties, although the one monitor located in Baltimore City has been increasing relative to other monitors, as show in Figure 5 below.

Figure 5: Baltimore Area Ozone Trends by Year (4th Highest 8-Hour Max for Each Year)[18]



The most recent monitoring data available shows that the Baltimore area does not meet EPA's 2015 health-based air quality standard for ozone (70 ppb) and that ozone levels have been increasing in the Baltimore area between 2014 and 2016. This is because the summers of 2013 and 2014 were atypically cool and ozone forms in the greatest amounts in hot, sunny weather.

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[17] Sheffield et al., Ambient ozone exposure and children's acute asthma in New York City: a case-crossover analysis, *Environmental Health* (2015) 14:25 DOI 10.1186/s12940-015-0010-2, p. 1.

[18] Data used from EPA's Monitor Values Reports *at* https://www.epa.gov/outdoor-air-quality-data/monitor-values-report. Compliance with EPA's ozone standards is assessed by looking at the 4th highest maximum 8-hour reading at each monitor averaged over three years. This chart, which does not show a 3-year average, is presented for the purpose of showing trends.

In addition, recent research by MDE and the University of Maryland College Park indicates that an increase of 100 tons per day of NO_x is associated with a 0.5 to 1.0 ppb increase in ambient ozone levels. In other words, large reductions in NO_x emission are necessary to address Baltimore's ozone problem.[19]

II. Argument: MDE Must Set a NO_x Standard for BRESCO That is No Higher Than 150 ppm and Should Set a Limit That is Much Lower than 150 ppm

MDE must set a new limit for NOx emissions from the BRESCO incinerator that is no higher than 150 ppm under the Reasonably Available Control Technology ("RACT") standard. Other states have adopted a 150 ppm limit for NO_x RACT, and Wheelabrator incinerators similar to the Baltimore plant are subject to that limit. A limit of 150 ppm will result in NO_x reductions from the facility of about only 200 tons per year, allowing the incinerator to continue emitting about 940 tons per year of NO_x, a high amount especially when compared with Maryland's other incinerator. For this reason, it is criticacl that MDE require significant additional reductions at the Baltimore incinerator and that it use legal authority to go beyond the RACT standard if necessary to obtain such reductions. In addition, MDE should require Wheelabrator to provide important additional information by (1) responding to EIP's questions about the analysis performed in 2016 of the incinerator's current controls; and (2) conducting computational fluid dynamics modeling of NO_x generation in the incinerator's boilers.

A. MDE Must Set a RACT Limit No Higher Than 150 ppm on a 24-hour average

MDE must set a RACT limit for the BRESCO incinerator that is no higher than 150 ppm on a 24-hour basis. A 150 ppm RACT standard on a 24-hour basis has been adopted by other states in the Ozone Control Region, and Wheelabrator incinerators similar to the Baltimore plant are subject to this limit. RACT is defined as "the lowest emissions limit that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility."[20] EPA has described this standard as "technology forcing" and stated that "[i]n determining RACT for an individual source or group of sources, the control agency, using the available guidance, should select the best available

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[19] Specifically, MDE has stated the following relating to research conducted for a 2014 white paper:

> Based on data obtained from the NASA DISCOVER-AQ field campaign over Maryland, it was observed that there was 4 to 8 ppb O3 produced per ppb NOx consumed, well within the range of 24 1-20 for other observations over the continental US (Jacob, 2004). This means that for each 100 tons/d increase in NOx emissions we can expect ~0.5 to 1.0 ppb increase in ozone [He et al., 2013a; He et al., 2013b].

MDE, Technical Support Document for COMAR 26.11.38 - Control of NOx Emissions from Coal-Fired Electric Generating Units p. 23 (May 25, 2015) *at* http://mde.maryland.gov/programs/Regulations/air/Documents/TSD_Phase1_with_Appendix.pdf.

[20] COMAR 26.11.01.01.B(40); *accord* U.S. EPA, State Implementation Plans; Nitrogen Oxides Supplement to the General Preamble for the Implementation of Title I of the Clean Air Act Amendments of 1990, 57 Fed. Reg. 55,620, 55,624 (Nov. 25, 1992).

controls, deviating from those controls only where local conditions are such that they cannot be applied there and imposing even tougher controls where conditions allow."[21]

i. Other states have adopted 150 ppm as RACT for NOx emissions from large municipal waste combustors (MWCs)

New Jersey, Connecticut, and Massachusetts have all either adopted or proposed adoption of a 150 ppm standard for NO_x RACT for incinerators like the BRESCO facility. In 2016, Connecticut adopted a 150 ppm limit for mass burn waterwall combustors on a 24-hour daily average. [22] New Jersey adopted a 150 ppm limit for all municipal solid waste incinerators in the state, which became effective in 2009 or 2011, depending on the facility, although the regulations allow incinerators to seek an exception to this rule. [23] Based on a white paper released in February 2017 by the Ozone Transport Commission ("OTC") (hereinafter "OTC NO_x Control White Paper") it appears that all large MWCs in the state are subject to the 150 ppm (no exceptions appear to have been granted).[24] Lastly, in 2013, Massachusetts, proposed a NO_x RACT limit of 150 ppm for mass burn waterwall combustors, but the rule has not been finalized.[25]

ii. Other Wheelabrator incinerators that are similar to the BRESCO plant are subject to a 150 ppm RACT limit

In addition, there are three Wheelabrator incinerators that appear very similar to BRESCO located in other states that are subject to 150 ppm RACT limits for NO_x or may be soon. Those facilities, and their similarities to the BRESCO plant, are described in more detail below.

Facility: Wheelabrator Bridgeport, L.P. (CT)[26]

- Details: 69.5 MW Steam Generation (Combined Heat and Power)

[21] Memorandum from Roger Strelow, Assistant Admin., Air and Waste Management, U.S. EPA, *Guidance for determining Acceptability of SIP Regulations in Non-attainment Areas*, to Regional Administrators, Regions I-X (Dec. 9, 1976), *available at* https://www3.epa.gov/ttn/naaqs/aqmguide/collection/cp2/19761209_strelow_ract.pdf .
[22] Regs. Conn. State Agencies § 22a-174-38(c)(8) Table 32-a.
[23] New Jersey's regulations require compliance by 2009 "if compliance is achieved by optimizing the existing NOx air pollution control system without modifying the . . . incinerator" and by 2011 "if compliance is achieved by installing a new NOx air pollution control system on an existing . . . incinerator or by physical modifying an existing . . . incinerator." New Jersey Department of Environmental Protection ("NJ DEP"), N.J.A.C. 7:27-19.12.
[24] Ozone Transport Commission (OTC) Stationary & Area Sources Committee, *White Paper on Control Technologies and OTC State Regulations for Nitrogen Oxides (NOx) Emissions from Eight Source Categories*, (hereinafter "OTC NO_x Control White Paper"), Appendix D, pp. 1-2 (Feb. 10, 2017, *at* http://www.otcair.org/upload/Documents/Reports/OTC_White_Paper_NOx_Controls_Regs_Eight_Sources_Final_Draft_02152017.pdf. The OTC NOx White Paper is attached hereto as Appendix A.
[25] Massachusetts Department of Environmental Protection, Proposed Amendments to the Clean Air Act Section 111(d), Including the Municipal Waste Combustor Regulation 310 CMR 7.08(2) (May 2013) *at* http://www.mass.gov/eea/docs/dep/service/regulations/310cmr07.pdf.
[26] Connecticut Department of Energy & Environmental Protection ("CT DEEP"), Title V Operating Permit: Wheelabrator Bridgeport, L.P. Permit No. 015-0219-TV (issued Dec. 3, 2014) (hereinafter "Wheelabrator Bridgeport Title V Permit") *at* http://www.ct.gov/deep/lib/deep/air/permits/titlev/wheelabarator_bridgeport/p_015-0219-tv.pdf.

- Installation Year: 1988
- Specifications: Three 750 ton per day Babcock & Wilcox/Von Roll Reciprocating Grate Waterwall Furnaces. Boiler MCR of 325 MMBtu/hr and 196,800 lb/hr of steam.
- NOx Controls: SNCR-NOx Control (urea), with injection rate from 0-35 gal/hr
- Ammonia slip limit: 20 ppm

The design and operation of Wheelabrator Bridgeport appear to be very similar to the BRESCO incinerator in Baltimore, with many of the furnace specifications being identical to the Maryland facility. Both plants use three 750 ton per day Babcock & Wilcox/Von Roll Reciprocating Grate Waterwall Furnaces, which produce steam for heating or for electricity generation. Each combustor has a maximum heat input rate of 325 MMBtu/hr, and similar design steam flow rate (193,600 lb/hr steam for Wheelabrator Baltimore).[27] The air emission controls at both facilities use urea-based SNCR, spray dryer absorbers, and activated carbon injection, while Wheelabrator Bridgeport uses a baghouse instead of an electrostatic precipitator (ESP).

Prior to Connecticut's 2016 adoption of a 150 ppm NO_x RACT limit, the Wheelabrator Bridgeport facility was subject to a NOx limit of 200 ppm.[28] In October 2016, Wheelabrator Bridgeport received a permit modification that allows it to install a flue gas recirculation ("FGR") system by August 1, 2017 to improve SNCR performance.[29]

Facility: Wheelabrator Gloucester County Resource Recovery Facility (NJ)[30]

- Details: 14 MW[31] Electric Generating Unit
- Installation Year: 1990
- Specifications: Two 287.5 ton per day mass burn waterwall MSW combustors, rated at 108 MMBtu/hr with a maximum steam production of 286,664 lbs for any 4-hour block period.
- NOx Controls: SNCR-NOx Control (urea)
- Ammonia slip limit: 20 ppm

Wheelabrator Gloucester operates mass burn waterwall combustors, controlled by urea-based SNCR, spray dryer absorbers, activated carbon injection, and particulate baghouses. According to a permit modification, Wheelabrator met New Jersey's updated NO_x RACT standard of 150 ppm by installing a minimum of four additional SNCR injector ports in each

[27] Wheelabrator Jan. 17 PowerPoint Presentation, *supra* note 4.
[28] Wheelabrator Bridgeport Title V Permit, *supra* note 26.
[29]CT DEEP, New Source Review Permit: Wheelabrator Bridgeport, L.P. Permit No. 015-0097 (hereinafter "Wheelabrator Bridgeport NSR Permit"),p. 4, Oct. 21, 2016 *at* http://www.ct.gov/deep/lib/deep/air/permits/titlev/wheelabarator_bridgeport/p_015-0097.pdf. This permit is attached hereto as Appendix B.
[30]NJ DEP, Minor Modification Permit: Wheelabrator Gloucester Company, L.P. BOP090001 (Oct. 16, 2009) (hereinafter "Wheelabrator Gloucester Modification"). Excerpts from this permit are attached hereto as Appendix C.
[31] Wheelabrator Technologies, Wheelabrator Gloucester *at* https://www.wtienergy.com/plant-locations/energy-from-waste/wheelabrator-gloucester (last visited May 5, 2017).

furnace at this plant, and increasing SNCR system control via system optimization and temperature profiling.[32]

Facility: Wheelabrator Falls (PA)

- Details: 53 MW Electric Generating Unit
- Installation Year: 1994
- Specifications: Two 750 ton per day Babcock and Wilcox/Von Roll Reciprocating Grate Waterwall Furnaces.
- NOx Controls: SNCR-NOx Control

Wheelabrator Falls appears to have a very similar furnace design to both Wheelabrator Bridgeport and Wheelabrator Baltimore, utilizing 750 ton per day Babcock and Wilcox/Von Roll Reciprocating Grate waterwall furnaces. While Wheelabrator Falls is not in a state that has a 150 ppm RACT limit, MDE has identified that the facility is seeking to reduce its emissions to this level by optimizing its existing SNCR in order to receive renewable energy credits in New Jersey.[33] This facility uses carbon injection, spray dryer absorbers, and fabric filters (baghouses) for pollution control.[34]

The OTC NO_x Control White Paper also identifies two incinerators that are not owned or operated by Wheelabrator, one in New York and one in Pennsylvania, that appear similar to the BRESCO incinerator and are subject to a 150 ppm NO_x limit.[35]

Facility Name	Year Opened	Capacity (TPD)	NOx Limit (ppmvd)	Equipment/Facility Info
Susquehanna Resource Harrisburg (PA)	2005	800	150 (24 hr)	3x 267 TPD mass burn waterwall. Ammonia slip limit of 12 ppmvd.
Covanta Babylon (NY)	1988	750	150 (24 hr)	2x 375 TPD water wall furnaces with Martin reverse-reciprocating grate

32 Wheelabrator Gloucester Modification, *supra* note 30.
33 Email from Husain Waheed, MDE Engineer (Feb 2, 2017) received in response to request under the Maryland Public Information Act ("PIA").
34 Pennsylvania Department of Environmental Protection ("PADEP"), E-Facts, Wheelabrator Falls Major Facility Operating Permit, (Permit No. 09-00013), Authorization Search Details *at* http://www.ahs.dep.pa.gov/eFACTSWeb/searchResults_singleAuth.aspx?AuthID=1093955 (last visited May 7, 2017).
35 OTC NOx Control White Paper, *supra* note 24, Appendix D, pps 2-3.

iii. ***Wheelabrator should not avoid a RACT limit of 150 ppm simply because of the possibility of ammonia slip from its NOx controls***

The most significant apparent difference between the BRESCO incinerator in Baltimore and each of the three Wheelabrator incinerators described above is that each of the other incinerators has baghouses installed for control of particulate pollution. A baghouse is one of the most, if not *the* most, effective technologies for control of particulate pollution. BRESCO, on the other hand, is equipped with an electrostatic precipitator ("ESP").[36]

Although a baghouse is used primarily for the control of particulates, it appears that installation of baghouses may be necessary to achieve adequate control of NO_x at the BRESCO facility. Wheelabrator has claimed that it cannot use its current pollution controls– Selective Non-Catalytic Reduction ("SNCR") –to comply with a NO_x limit below 170 ppm because increasing the effectiveness of SNCR requires increasing the use of urea. Wheelabrator maintains that this causes ammonia slip, which could cause a violation of the visible emissions limit to which the incinerator is subject. Wheelabrator has stated that "excessive [ammonia] slip cannot be reduced in [an] ESP as in [a] baghouse."[37]

If excess ammonia slip is a problem when additional urea is injected in the SNCR at the BRESCO incinerator, it appears that there are ways to reduce ammonia slip. Some possibilities are:

(1) According to the OTC NO_x White Paper, when ammonia slip from selective catalytic reduction ("SCR") (a more effective form of NOx control than the SNCR currently installed on the BRESCO incinerator) is a problem, "[a[mmonia cleanup catalysts can be installed behind the SCR catalyst to collect any excess ammonia that slips through (converting it into nitrogen and water)."[38]

(2) Installation of the hybrid SNCR/SCR control technology described in detail in the expert report of Dr. Ranajit Sahu dated May 5, 2017, which includes an "opportunistically placed in-duct SCR catalyst [that] can take advantage of the ammonia/urea slip from the SNCR and effect significant additional NOx reductions (i.e., around 50-75%) in the catalyst layer(s), leading to substantially lower NOx at the stack than SNCR alone."[39]

(3) MDE should require that ammonia slip be measured at BRESCO from now on. According to the Sahu Report, continuous emissions monitoring systems ("CEMS") for ammonia are widely available and "EPA's performance specification for ammonia CEMS dates back to 2004."[40] The proposed Energy Answers incinerator, which

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[36] Part 70 Operating Permit Fact Sheet, Wheelabrator Baltimore, L.P., Permit No. 24-510-01186 (2013) p. 1.
[37] Wheelabrator Jan. 17 PowerPoint Presentation*, supra* note 4, p. 7.
[38] OTC NO_x Control White Paper, *supra* note 24, p. 15
[39] The Expert Report on NOx Emissions from the Wheelabrator Baltimore Municipal Waste Incinerator in Baltimore City, owned and operated by Wheelabrator Baltimore, L.P. ("Wheelabrator") by Dr. Ranajit (Ron) Sahu, Consultant, p. 4, May 5, 2017 (hereinafter "Sahu Report"). This report is Attachment B to the May 9, 2017 comments submitted by the Chesapeake Bay Foundation on MDE's MWC NO_x RACT rulemaking.
[40] *Id.*

would have been located in South Baltimore,[41] was permitted to use a continuous ammonia monitor to measure its ammonia slip upon approval by MDE's Air and Management Administration ("ARMA").[42] MDE has full legal authority to require use of ammonia CEMS at BRESCO.[43]

In addition, if Wheelabrator maintains that there is no other way to achieve a 150 ppm NO_x limit while avoiding excessive ammonia slip, MDE should require installation of baghouses on each of the BRESCO combustor units. All three of the Wheelabrator incinerators described in the section above (Bridgeport, Gloucester, and Wheelabrator Falls) are equipped with baghouses, all are subject (or appear soon to be subject) to a NO_x limit of 150 ppm, and the Bridgeport and Gloucester facilities are subject to an ammonia limit of 20 ppm.

In addition, the proposed Energy Answers incinerator in Baltimore, which was subject to the same visible emissions limit that applies to BRESCO, also had an ammonia slip limit of 20 ppm.[44] Thus, if BRESCO can meet a 20 ppm ammonia slip limit, then it should be able to comply with its visible emission limit, and baghouses should allow the BRESCO facility to meet this ammonia slip limit. It appears that many incinerators can meet such a limit for ammonia. Connecticut requires that all MWCs in the state that use SNCR for NO_x control must comply with a 20 ppm limit on ammonia.[45] According to the OTC NO_x Control White Paper, all of the large MWC units in New Jersey are subject to ammonia slip limits of 20 ppm or 50 ppm.[46]

The fact that all three of the out-of-state Wheelabrator incinerators described above have installed baghouses indicates that it is both technically and economically feasible for Wheelabrator to do so at its Baltimore facility. In the event that Wheelabrator maintains that installation of baghouses is not economically feasible, MDE should consider using authority to require emissions reductions that go beyond the RACT standard in order to ensure that NO_x from the BRESCO incinerator is substantially reduced. Wheelabrator should not be permitted to emit higher rates of NO_x in Baltimore City than at its New Jersey and Connecticut plants simply because it has failed to install particulate controls in Baltimore that are as good as those installed at the Bridgeport, CT and Gloucester, NJ incinerators.

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41 Energy Answers Certificate of Public Convenience and Necessity ("CPCN"), Condition A-22(b). An excerpt from the Energy Answers CPCN is attached as Appendix D hereto. The Energy Answers CPCN was revoked by the Maryland Public Service Commission in 2016.
42 *Id*.
43 COMAR 26.11.01.04(B)(1) states:

> The Department or the control officer may require a person responsible for any installation to install, use, and maintain monitoring equipment or employ other methods as specified by the Department or the control officer to determine the quantity or quality, or both, of emissions discharged into the atmosphere and to maintain records and make reports on these emissions to the Department or the control officer in a manner and on a schedule approved by the Department or the control officer.

44 Energy Answers CPCN, Condition A-22(a). Energy Answers would also have installed baghouses and Regenerative SCR. Energy Answers CPCN Condition A-3.
45 Regs. Conn. State Agencies § 22a-174-38(c)(16).
46 OTC NOx Control White Paper, *supra* note 24, Appendix D, p. 1.

B. MDE Should Require Wheelabrator to Analyze whether BRESCO Can Achieve a NOx Limit Lower Than 150 ppm by Installing Hybrid SCR/SNCR Technology

As noted above, a hybrid SCR/SNCR control technology exists that could substantially reduce NO_x at the BRESCO incinerator at a reduced price compared to an SCR system. This hybrid technology is described in detail in the Sahu Report and the exhibits thereto. Dr. Sahu notes that this technology could reduce emissions from their current levels by 50-75%. The NO_x emission rates that could be achieved with this range of efficiencies, and corresponding estimated limits, are provided below in Table 1 below.

Table 1: NOx Emissions, Reductions, and Limits zAssociated with Hybrid SCR/SNCR

	Average 24-hr NOx (ppm)[47]	Annual NOx (tpy)[48]	NOx Reduction (tpy)[49]
Hybrid SCR/SNCR (75%)	**56**	**377.5**	**768.5**
Hybrid SCR/SNCR (60%)	**89.6**	**604**	**542**
Hybrid SCR/SNCR (50%)	**112**	**755**	**391**

MDE should require Wheelabrator to analyze the feasibility of installing this system on the BRESCO incinerator as RACT.

C. MDE Should Set a NO_x Limit Well Below 150 ppm and Should Use its Legal Authority to go Beyond RACT if Necessary

MDE is not constrained by the RACT standard and is fully authorized to set a NO_x limit for the BRESCO incinerator that is lower and more protective than the limit required under RACT.[50] Wheelabrator should be required to meet an emission limit that is much lower than 150 ppm because 150 ppm would reduce annual emissions by only about 200 tons per year, achieving an annual emissions level of about 940 tons per year.

[47] Average ppm calculated by applying reduction efficiency to 2016 average 24-hour NOx rate of 170 ppm, according to Wheelabrator Jan. 17 PowerPoint Presentation, *supra* note 4, p. 12.
[48]Annual NOx emissions were calculated by applying the proportion of average ppm after additional emissions control to 2016 levels (170 ppmvd)and multiplying by the annual NOx emissions in tons per year (1146 tons per year in 2016).
[49] Measured from 2016 actual emissions of 1146.
[50] EPA has stated that "a state has discretion to require beyond-RACT reductions from any source, and has an obligation to demonstrate attainment as expeditiously as practicable. Thus, states may require VOC and NOX reductions that are 'beyond RACT' if such reductions are needed in order to provide for timely attainment of the ozone NAAQS." EPA, Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements, 80 Fed. Reg. 12264,12279 (March 6, 2015).

As discussed in EIP's October 26, 2017 letter to MDE, the Montgomery County Resource Recovery Facility in Maryland reduced its NO_x emissions by 494 tons a year (about 49%) around 2009 by installing "Low NO_x" technology. The hybrid SCR/SNCR technology discussed above may be capable of reducing NO_x emissions at BRESCO from current levels by 390-770 tons per year. If baghouses or an ammonia catalyst are installed, the current SNCR controls at BRESCO might be capable of achieving much higher reduction efficiencies without contributing to excess ammonia slip. In addition, the Wheelabrator Bridgeport facility in Connecticut appears to be using a flue gas recirculation ("FGR") system to improve SNCR performance.[51]

If any of these controls is capable of reducing NO_x by a substantial amount and does not satisfy every element of the RACT standard, then MDE should use its legal authority to require "beyond RACT" NO_x reductions at the Baltimore incinerator.

D. MDE Should Require Wheelabrator to Conduct Computational Fluid Dynamics Modeling of the Incinerator's NO_x Generation and MDE has Full Legal Authority to Require Such an Analysis

The SNCR optimization analysis performed by Wheelabrator in early 2016 leaves many information gaps, as described in the Sahu Report.[52] EIP submitted questions to MDE requesting more information about this analysis by email dated April 4, 2017.[53] MDE should require Wheelabrator to respond to all of these questions. MDE should also require Wheelabrator to conduct computational fluid dynamics ("CFD") modeling of the NO_x generation in each of the three boilers at the facility in order to provide "a basic understanding of NO_x generation and distribution as well as the effect of SNCR," as described in the Sahu Report.[54] This will provide information that is critical and much more useful than the SNCR optimization assessment.

MDE has full legal authority to require Wheelabrator to provide additional information about the SNCR optimization tests and to perform a CFD and to submit a written report thereon. Under COMAR 26.11.01.05(A), MDE may "require a person who owns or operates an installation or source to establish and maintain records sufficient to provide the information necessary to . . . [a]ssist the Department in the development of an implementation plan, air emissions standard, equipment performance standard, or material formulation standard." MDE may also

> require a person responsible for any installation to install, use, and maintain monitoring equipment *or employ other methods as specified by the Department* to determine the quantity or quality or both, of emissions discharged into the atmosphere and to maintain records and make reports on these emissions to the

[51] Wheelabrator Bridgeport NSR Permit, *supra* note 29.
[52] Sahu Report pp. 2-3.
[53] Email from Leah Kelly, EIP Attorney, to Randy Mosier, Division Chief, Air Quality Regulations Division, MDE ARMA, dated April 4, 2017. The questions in this email are reproduced in Appendix E hereto.
[54] Sahu Report p. 4.

Department or the control officer in a manner and on a schedule approved by the Department or the control officer.[55]

Thank you for your consideration of these comments.

Sincerely,

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[55] COMAR 26.11.01.04(B)(1) (emphasis added).

Appendix A

Ozone Transport Commission (OTC)
Stationary & Area Sources Committee

White Paper on Control Technologies and OTC State Regulations for Nitrogen Oxides (NOx) Emissions from Eight Source Categories

Executive Summary

Purpose

This white paper identifies current emission limits and regulations for nitrogen oxides (NOx) emissions from eight source categories within the member states of the Ozone Transport Commission (OTC), in partial fulfilment of item 4 of the November 5, 2015 Charge to the OTC's Stationary and Area Sources (SAS) Committee. That Charge reads as follows:

> "To provide each state with a common base of information, a workgroup will develop a listing of emissions rates in each state within the Ozone Transport Region (OTR) for source categories responsible for significant NOx and VOC emissions and identify a range of emissions rates that the respective state has determined to be RACT. Some of the source categories that should be included in the listing include electrical generating units, turbines, boilers, engines and municipal waste combustors."

The white paper focuses on eight NOx source categories, which together account for 95% of the annual NOx emissions from non-(large) electric generating unit (EGU) stationary sources within the OTR, based on the 2014 EPA National Emissions Inventory, version 1.

The range of NOx emission rates is available in the source category-specific tables provided in this Executive Summary and in the Appendices to the white paper. Because of variation in the expression of NOx emission rates in the states (e.g., units, averaging times), a simple range is not provided.

A separate OTC workgroup (the CP/AIM workgroup) is currently working on a Technical Support Document for seven current OTC VOC model rules covering the period from about 2010 to 2014. The Technical Support Document could be used in revising and updating this white paper.

Note that this white paper states the emission rates required in the OTC states as of the date of this paper. The OTC states will be required to perform a RACT review for the 2015 ozone national ambient air quality standard (NAAQS), which may result in revisions to the emission rates provided here.

NOx RACT Background

The Environmental Protection Agency (EPA) defines RACT as "the lowest emission limitation that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility" (44 FR 53762, September 17, 1979).

Sections 182(f) and 184(b)(2) of the Clean Air Act (CAA) require states with ozone non-attainment areas, classified as moderate, serious, severe, and extreme--as well as all areas in the OTR--to implement RACT for existing major stationary sources of NOx.

NOx RACT Applicability

Section 302 of the CAA defines a major stationary source as any facility which has the potential to emit of 100 tons per year (tpy) of any air pollutant. Section 182 of the CAA reduces the major stationary source potential to emit threshold for certain ozone nonattainment classifications: 50 tpy for serious areas; 25 tpy for severe areas; and 10 tpy for extreme areas. The anti-backsliding provisions of the CAA require an area to continue to apply the area's historical most stringent major source threshold. Current and historical area classifications may be found in the EPA Green Book online at https://www3.epa.gov/airquality/greenbook/index.html.

NOx Emission Control Technologies and Strategies

The following NOx emissions control technologies and strategies are described in this whitepaper:

- Combustion Modification
  - Low Excess Air (LEA) or Reducing O_2 levels
  - Lean Combustion
  - Staged Combustion
  - Low Nitrogen Fuel Oil
  - Flue Gas Recirculation (FGR)
  - Low-NOx Burner (LNB) and Overfire Air (OFA)
  - Wet controls
- Post-Combustion Modifications
  - Gas Reburn
  - Non-Selective Catalytic Reduction (NSCR)
  - Selective Catalytic Reduction (SCR)
  - Selective Non-Catalytic Reduction (SNCR)
- Other Control Strategies
  - Combustion Tuning and Optimization
  - Use of Preheated Cullet

Current NOx regulations and emission limits for source categories in the Ozone Transport Region (OTR)

1. Industrial/Commercial/Institutional (ICI) Boilers in OTR

Results of a recent survey of the NOx emission limits and regulations for ICI Boilers in the OTR found in **Appendix A** of the white paper are summarized below:

NOx limit based on boiler capacity and fuel type

Capacity (mmBtu/hr)	NOx Limit (lbs/mmBtu)			
			Oil	
	Coal	Nat. Gas	Distillate	Residual
50 – 100	0.28 – 0.50	0.05 – 0.43	0.08 – 0.43	0.20 -0.50
100 – 250	0.08 – 1.00	0.06 – 0.43	0.10 – 0.43	0.20 -0.50
>250	0.08 – 1.40	0.10 – 0.70	0.10 – 0.43	0.15 -0.50

2. Stationary Gas (Combustion) Turbine Engines in OTR

Results of a recent survey of the NOx emission limits and regulations for Combustion Turbines (>25 MW capacity) in the OTR found in **Appendix B** of the white paper are summarized below:

TURBINE ENGINES (>25 MW)	Simple Cycle		Combined Cycle	
	Gas-fired	Oil-fired	Gas-fired	Oil-fired
State	NOx Limit (ppmvd @15% O_2)			
CT - Statewide	258 (42 - 0.9 lb/MMBtu)[a] 42 – 55[b]; 40[c]	240 (40 - 0.9 lb/mmBtu)[a] 40 – 75[b]; 40 – 50[c]	258 (42 - 0.9 lb/MMBtu)[a] 42[b]; 25[c]	240 (40 - 0.9 lb/mmBtu)[a] 40 – 65[b]; 40 – 42[c]
DC (If ≥100 mmBTU/hr)	NA	75	NA	NA
DE - Statewide	42	88	42	88
MA - Statewide	65	100	42	65
MD - Select Counties	42	65	42	65
ME - Statewide	NA	NA	3.5 – 9.0	42
NH - Statewide	25 (55 for pre-1999)	75	42	65
NJ – Statewide (≥15 MW)	25 (1.00 lb/MWh)	42 (1.60 lb/MWh)	25 (0.75 lb/MWh)	42 (1.20 lb/MWh)
NY - Statewide	50	100	42	65
PA - Statewide	>1,000 bhp & <6,000 bhp (150); >6000 BHP (42)	>1,000 bhp and <6,000 bhp (150); >6000 BHP (96)	1,000 bhp and <180 MW (42); >180 MW (4)	1,000 bhp and <180 MW (96); >180 MW (8) F42
RI - Statewide	No RACT Sources (new only)	No RACT Sources (new only)	No RACT Sources (new only)	No RACT Sources (new only)
VA - OTR jurisdiction	42	65 - 77	42	65 - 77
VT - Statewide	NA			

Notes:
- CT: [a]Existing RCSA Sec. 22a-174-22 (to be repealed as of June 1, 2018); [b]RCSA Sec. 22a-174-22e starting June 1, 2018; [c]RCSA Sec. 22a-174-22e starting June 1, 2023.
- NJ: lb/mmBtu limit converted to ppmvd @15% O_2 based on Part 75 Eq-F5 and F-factors of 8710 for natural gas and 9190 for oil; lb/MWh limit converted to ppmvd@15% O_2 based on New Jersey technical support document; 25 ppm ≈ 1.0 lb/MWh for simple cycle gas; 42 ppm ≈ 1.60 lbs/hr for simple cycle oil. (NJ Proposal Number: PRN 2008-260).
- NA = Not Applicable

3. Stationary Reciprocating Internal Combustion (IC) Engines in OTR

Results of a recent survey of the emission limits and regulations for IC Engines (>500 hp) in the OTR presented in **Appendix C** of the white paper are summarized below:

IC ENGINES >500 hp	**NOx Limit (g/hp-hr)**			
State	**Gas-fired, Lean Burn**	**Gas-fired, Rich Burn**	**Diesel**	**Dual Fuel**
CT - Statewide	2.5*; 1.5 - 2.0**	2.5*; 1.5 - 2.0**	8.0*; 1.5 - 2.3**	Multi-fuel provisions*;**
DC	NA	NA	NA	NA
DE - Statewide	Technology Stds.	Technology Stds.	Technology Stds.	Technology Stds.
MA - Statewide	3.0	1.5	9.0	9.0
MD - Select Counties	150 ppmvd @ 15% O_2 (Approx. 1.7 g/hp-hr)*	110 ppmvd @ 15% O_2 (Approx. 1.6 g/hp-hr)*	175 ppmvd @ 15% O_2	125 ppmvd @ 15% O_2
ME - Statewide	NA	NA	3.7 (Source-specific RACT)	NA
NH - Statewide	2.5	1.5	8.0	8.0
NJ - Statewide	1.5	1.5	2.3	2.3
NY - Statewide	1.5	1.5	2.3	2.3
PA - Statewide	3.0	2.0	8.0	8.0
RI - Statewide	2.5	1.5	9.0	No specified in Regulation, no sources.
VA - OTR Jurisdiction	Source-specific RACT	Source-specific RACT	Source-specific RACT	Source-specific RACT
VT - Statewide	4.8	4.8	4.8	4.8

Notes:
- CT - * existing RCSA section 22a-174-22 (to be repealed as of June 1, 2018) and RCSA section 22a-174-22e starting June 1, 2018); **RCSA section 22a-174-22e starting June 1, 2023.
- MD - * Conversion factors from ppmv @ 15% O_2 to g/hp-hr from EPA ACT, July 1993 EPA453-R-93-032
- NJ: For an engine ≥37 kW and that has been modified on or after March 7, 2007, 0.90 grams/bhp-hr or an emission rate which is equivalent to a 90% NOx reduction from the uncontrolled NOx emission level
- NA = Not Applicable

4. Municipal Waste Combustors (MWCs) in OTR

Results of a recent survey of the emission limits and regulations for MWCs in the OTR presented in **Appendix D** of the white paper are summarized below:

- There are no MWCs in DC, DE, RI, and VT.
- The unit level capacity of MWCs ranges from 50 - 2,700 tpd of MSW.
- The types of combustors include: mass burn units (waterwall, refractory, stationary grate, reciprocating grate, single chamber), two types of rotary incinerators, and refuse-derived fuel incinerators.
- The types on NOx controls employed include FGR and SNCR with the majority of the units controlled with SNCR.
- The NOx emission limits vary within the OTR by state and by combustor technology.
    - 372 ppmvd NOx @ 7% O_2, 1-hour average (control technology not specified)
    - 185 - 200 ppmvd NOx @ 7% O_2, 3-hour average (with SNCR)
    - 120 - 250 ppmvd NOx @ 7% O_2, 24-hour average (control technology not specified)
    - 150 ppmvd NOx @ 7% O_2, calendar-day average (with SNCR)
    - 0.35 - 0.53 lb NOx/MMBtu, calendar-day average (with SNCR)
    - 135 ppmvd NOx @ 7% O_2, annual average (with no controls)

5. Cement kilns in OTR

Results of a recent survey of the emission limits and regulations for cement kilns in the OTR are presented below:

- There are no cement kilns in CT, DC, DE, MA, NH, NJ, RI, and VT.
- Depending on the type of kilns (wet or dry, with or without pre-calciner), the NOx emission limits range from 2.33 - 6.0 lbs/ton clinker in the existing state rules.

State	NOx Limit (lbs/ton clinker)				Regulations
	Long Dry	Long Wet	Pre-heater	Pre-calciner	
MD	5.1 3.4*	6.0 NA*	2.8 2.4*	2.8 2.4*	COMAR 26.11.30: http://www.dsd.state.md.us/comar/SubtitleSearch.aspx?search=26.11.30.
ME	2.33	-	-	-	EPA Consent Agreement (Docket 01-2013-0053, Sept 2013)
PA	3.44	3.88	2.36	2.36	Final RACT 2 Rule (46 Pa.B. 2036, April 23, 2016): http://www.pabulletin.com/secure/data/vol46/46-17/694.html
NY	2.88 (using SNCR) (SCC: 3-05-006-06)	5.2(SCC: 3-05-007-06)			Subpart 220-1 - Effective: 7/11/2010 Submitted: 8/19/2010; Final: 77 FR 13974, 78 Fr 41846: https://www3.epa.gov/region02/air/sip/ny_reg.htm
VA - OTR jurisdiction	No Limits				

Notes:

- MD: *After 04/01/2017

6. Hot Mix Asphalt Production Plants in OTR

Results of a recent survey of state regulations for Asphalt Production Plants in the OTR found in **Appendix E** of the white paper are summarized below.

State	Hot Mix Asphalt Production Plants – Regulations	State Contacts
CT	RCSA section 22a-174-22 will be replaced with RCSA section 22a-174-22e (RCSA section 22a-174-22 will be repealed as of June 1, 2018). Note: Neither section includes a limit that specifically applies to "asphalt production plants" but the fuel-burning equipment is regulated. http://www.ct.gov/deep/lib/deep/air/regulations/mainregs/sec22.pdf https://eregulations.ct.gov/eRegsPortal/Search/getDocument?guid=%7bE2C443EB-00E6-46AF-A260-65881DD13319%7d	Merrily Gere, 860 424 3416, Merrily.Gere@ct.gov;
DC	150 ppmvd @ 7% O_2 is the NOx RACT standard for major sources (25 TPY) of NOx only (two of the three HMA facilities in DC). No NOx RACT standard is specified for minor sources of NOx. The third HMA facility, a 225 TPH continuous drum-mix asphalt plant, has NOx limits of 12.4 lb/hr and 22.0 tons per 12-month rolling period to emit keeping NOx below the major source threshold. 20 DCMR § 805.6, RACT for Major Stationary Sources of Oxides of Nitrogen: http://www.dcregs.dc.gov/Gateway/RuleHome.aspx?RuleNumber=20-805;	Alexandra Catena, 202 535-2989, alexandra.catena@dc.gov
DE	Specific emissions limitations in lb/HMA are determined on a facility by facility basis. http://regulations.delaware.gov/AdminCode/title7/1000/1100/1112.shtml	Mark Prettyman 302-739-9402 mark.prettyman@state.de.us
MA	No specific NOx RACT emission limits for this source category in state NOx RACT regulations; BACT determination for Benevento Asphalt: 0.044 lb/MMBtu (Nat Gas), 0.113 lb/MMBtu (#2 Oil and other fuel types)	Marc Cohen 617.292.5873 Marc.Cohen@MassMail.State.MA.US
MD	Search Title 26, Chapter 11; http://www.dsd.state.md.us/COMAR/SearchTitle.aspx?scope=26	Randy Mosier, 410 537 4488, Randy.Mosier@maryland.gov
ME	NOx Limit: 0.12 lb/ton asphalt for all fuel types; http://www.maine.gov/dep/air/rules/;	Jeff Crawford, 207 287 7647, jeff.s.crawford@maine.gov
NH	NOx Limit: 0.12 lbs/ton asphalt for all fuel types; NH Administrative Rule Env-A 1300 *NOx RACT* (Part Env-A 1308 *Asphalt Plant Rotary Dryers*) http://des.nh.gov/organization/commissioner/legal/rules/documents/env-a1300.pdf	Gary Milbury 603 271-2630, gary.milbury@des.nh.gov
NJ	NOx Limit (ppmvd @7% O_2): 75 (Natural Gas), 100 (No. 2 Oil), 125 (No. 4 or heavier fuel oil or on-spec used oil or mixture of these three); N.J.A.C. 7:27-19.9, based on OTC ADDENDUM TO RESOLUTION 06-02 http://www.state.nj.us/dep/aqm/Sub19.pdf	Peg Gardner, 609 292 7095 Margaret.Gardner@dep.nj.gov
NY	Hot mix asphalt plants cap out of Title V. www.dec.ny.gov/regs/2492.html	John Barnes, 518 402 8396, john.barnes@dec.ny.gov; Robert Bielawa, robert.bielawa@dec.ny.gov

PA	Additional RACT Requirements for Major Sources of NOx and VOCs. Sections 129.96 - 129.100. Control of NOX from Major Sources of NOx and VOC; Effective April 23, 2016. Federal Register -TBD Case by Case; http://www.pacode.com/secure/data/025/articleICIII_toc.html	Susan Hoyle, shoyle@pa.gov Randy Bordner, ranbordner@pa.gov Susan Foster, sufoster@pa.gov Sean Wenrich, sewenrich@pa.gov
VA - OTR jurisdiction	All of ~15 plants have federally enforceable limits on their PTE of NOx and VOC to make them minor sources (<100 tpy NOX, <50 TPY VOC). None of them trigger the major stationary RACT source definition under 9 VAC 5 Chapter 40 Article 51 at this time.	Doris McLeod doris.mcleod@deq.virginia.gov
VT	No specific regulatory emission limits for Hot Mix Asphalt Production Plants, but most permits contain 0.06 lb/ton asphalt limit based on application submittal; http://dec.vermont.gov/air-quality/laws	Doug Elliott, 802 377 5939, Doug.Elliott@vermont.gov

Notes:

- No RACT Sources in RI;

7. Glass Furnaces in OTR

Results of a recent survey of Glass Furnaces in the OTR found in **Appendix F** of the white paper are presented below.

State	Glass Furnaces – Regulations	State Contacts
MA	Global consent decree for Ardagh Glass Inc. (formerly Saint Gobain Containers), Milford; Emission limit (lbs NOx/ton glass) = 1.3 *, 30 day rolling average, oxyfuel furnaces; https://www.epa.gov/enforcement/consent-decree-saint-gobain-containers-inc	Marc Cohen 617.292.5873 Marc.Cohen@MassMail.State.MA.US
MD	COMAR 26.11.09.08I, Search Title 26, Chapter 11; http://www.dsd.state.md.us/COMAR/SearchTitle.aspx?scope=26	Randy Mosier (410) 537-4488 Randy.Mosier@maryland.gov
NJ	Emission limit (lbs NOx/ton glass) = 9.2 (for flat glass); 4.0 (for others), Oxyfiring installed at rebricking; N.J.A.C. 7:27-19.10, based on OTC ADDENDUM TO RESOLUTION 06-02 http://www.state.nj.us/dep/aqm/Sub19.pdf	Peg Gardner, 609 292 7095 Margaret.Gardner@dep.nj.gov
NY	Emission limit (lbs NOx/ton glass) = 1.89 - 4.49; Subpart 220-2 - Effective: 7/11/2010 Submitted: 8/19/2010; Final: 77 FR 13974, 78 Fr 41846; www.dec.ny.gov/regs/2492.html	John Barnes (518) 402-8396 john.barnes@dec.ny.gov Robert Bielawa robert.bielawa@dec.ny.gov
PA	Emission limit (lbs NOx/ton glass) = 4.0 (container and fiberglass furnaces); 7.0 (pressed or blown, and flat glass furnaces); 6.0 (all other glass melting furnaces); Control of NOx Emissions From Glass Melting Furnaces. Sections 129.301 - 129.310. The rule limits the emissions of NOx from glass melting furnaces on an annual basis. Effective September 21, 2011. 08/22/2011; 76 Federal Register 52283 http://www.pacode.com/secure/data/025/articleICIII_toc.html	Susan Hoyle shoyle@pa.gov Randy Bordner ranbordner@pa.gov Susan Foster, sufoster@pa.gov Sean Wenrich sewenrich@pa.gov
VA - OTR jurisdiction	No glass plants trigger the major stationary source RACT threshold in 9 VAC 5 Chapter 40 Article 51 at this time that are located in the OTR portions of Virginia	Doris McLeod doris.mcleod@deq.virginia.gov

Notes:

- No Sources in CT, DC, DE, ME, NH, RI, and VT;
- MA: * excludes Abnormally Low Production Rate Days; Furnace Startup, Malfunction of the Furnace, and Maintenance of the Furnace.

8. Natural Gas Pipeline Compressor Prime Movers in OTR

Results of a recent survey of regulations for Natural Gas Pipeline Compressor Primer Movers in the OTR found in **Appendix G** of the white paper are presented below.

State	Natural Gas Pipeline Compressor Prime Movers – Regulations	State Contacts
CT	RCSA section 22a-174-22 (to be repealed as of June 1, 2018). Will be replaced with RCSA section 22a-174-22e. Note: Does not specifically apply to "natural gas pipelines" but fuel-burning equipment such as compressors is regulated; http://www.ct.gov/deep/lib/deep/air/regulations/mainregs/sec22.pdf https://eregulations.ct.gov/eRegsPortal/Search/getDocument?guid=%7bE2C443EB-00E6-46AF-A260-65881DD13319%7d	Merrily Gere, 860 424-3416, Merrily.Gere@ct.gov
DE	http://regulations.delaware.gov/AdminCode/title7/1000/1100/1112.shtml http://regulations.delaware.gov/AdminCode/title7/1000/1100/1144.shtml *	Mark Prettyman 302-739-9402 mark.prettyman@state.de.us
MA	310 CMR 7.19(7) NOx RACT simple cycle turbine existing emission limit of 65 ppm @ 15% O_2, proposed for more stringent standard of 40 ppm in 2017. A BACT determination in 2006 for a replacement of a 53.8 MMBtu/hr; Allison turbine at Tennessee Gas Pipeline Charlton station with two 50-6200LS Solar Centaur split shaft gas turbine compressor sets equipped with Solar's pre-combustion SoLoNOx technology each rated at 6,037 hp with a maximum heat input = 53.52 MMBtu/hr at ISO conditions): 15 ppm @ 15% O_2 (or alternatively 3.22 lbs/hr)	Marc Cohen, 617.292.5873, Marc.Cohen@MassMail.State.MA.US
MD	COMAR 26.11.29; Search Title 26, Chapter 11; http://www.dsd.state.md.us/COMAR/SearchTitle.aspx?scope=26	Randy Mosier, 410 537 4488, Randy.Mosier@maryland.gov
ME	Source specific BACT	Jane Gilbert, (207) 287-2455, jane.gilbert@maine.gov
NH	Regulated under Part Env-A 1306 *Combustion Turbines* (no separate rule for compressor stations): http://des.nh.gov/organization/commissioner/legal/rules/documents/env-a1300.pdf	Gary Milbury, 603 271 2630, Gary.milbury@des.nh.gov
NJ	N.J.A.C. 7:27-19.5 and 19.8, amendments in progress (applicable to turbines and engines at natural gas compressor stations) based on draft OTC white paper. http://www.state.nj.us/dep/aqm/Sub19.pdf	Peg Gardner, 609 292 7095 Margaret.Gardner@dep.nj.gov
NY	Covered under NOx RACT Rule (Subpart 227-2) Effective: 7/8/2010, Submitted: 8/19/2010, Final: 77 FR 13974, 78 Fr 41846; www.dec.ny.gov/regs/2492.html	John Barnes, 518 402 8396, john.barnes@dec.ny.gov Robert Bielawa, robert.bielawa@dec.ny.gov
PA	Additional RACT Requirements for Major Sources of NOx and VOCs. Sections 129.96 - 129.100. Control of NOx from Major Sources of NOx and VOC. Effective April 23, 2016. Federal Register - TBD (No Distinction) http://www.pacode.com/secure/data/025/articleICIII_toc.html	Susan Hoyle, shoyle@pa.gov Randy Bordner ranbordner@pa.gov Susan Foster, sufoster@pa.gov Sean Wenrich, sewenrich@pa.gov

RI	One source; Source specific RACT for engines at compressor station	Laurie Grandchamp, 401 222 2808, laurie.grandchamp@dem.ri.gov
VA - OTR jurisdiction	9 VAC 5 Chapter 40 Article 51, case by case RACT	Doris McLeod doris.mcleod@deq.virginia.gov

Notes:

- *DE: Reg. 1144 only applies to stationary generators, and not all engines.

The OTC identified natural gas pipeline compressor prime movers as a potential category for emission control strategies at its November, 2010 meeting and tasked the SAS Committee to explore the issue. In 2011 a SAS workgroup prepared a white paper to describe the issue and recommend potential Commission action, e.g., adopt a model rule drafted by the SAS to achieve NOx emissions reductions from this emission source and assist the OTC states in achieving the National Ambient Air Quality Standards (NAAQS) for ozone.

Within the OTR, natural gas pipeline compressor prime movers fueled by natural gas are used in several phases of natural gas supply: 1) gathering the natural gas from the well field and transporting it to the main transportation pipeline system; 2) moving natural gas through the main pipeline system to distribution points and end users; and 3) injecting and extracting natural gas from gas storage facilities. These natural gas pipeline compressor prime movers, mostly driven by internal combustion (IC) reciprocating engines and combustion turbines, are a significant source of nitrogen oxide (NOx) emissions year-round. Data sources indicate that nine OTR states have large natural gas compressor facilities (CT, MA, MD, ME, NJ, NY, PA, RI, VA); three OTR states contain a number of natural gas well field compressors (MD, NY, PA); and two OTR states have natural gas underground storage facilities (PA, NY).

The SAS Committee examined other areas of natural gas production (beyond the natural gas pipeline compressor prime movers addressed by the white paper) and concluded that potentially significant NOx reductions may be possible from the "upstream" activities of well drilling, well completion, and well head and field gathering natural gas compressor prime movers. Preliminary information indicates that NOx emissions from these sources may greatly exceed those of the pipeline and underground storage compression sources. This is more evident in the expansion of natural gas production due to shale gas activities.

Only limited data were available regarding the population of natural gas pipeline compressor prime movers fueled by natural gas in the OTR at the time that this white paper was written. The most comprehensive data that were available at that time was the 2007 emissions inventory (including a MARAMA point source emissions inventory for that year); therefore, 2007 was the base year used for analysis.[1] The 2007 data indicate that there are a multitude of natural gas compressor facilities in the OTR (including 150 classified as "major emissions sources") including 2-stroke lean-burn internal

[1] OTC Nat Gas Compressor Prime Mover Inventory Rev 092711 from BC 092513.xlsx.

combustion (IC) reciprocating engines, 4-stroke lean-burn IC reciprocating engines, 4-stroke rich-burn IC reciprocating engines, and combustion turbines. The 2007 data showed:

- At least 409 reciprocating engine prime movers with ratings of 200 - 4300 hp, which includes a large number of makes and models
- At least 125 combustion turbine prime movers with ratings of 1000 - 20,000 hp, which includes a moderate number of makes and models.

Many of these prime movers may be >40 years old. The MARAMA point source emissions inventory data indicates that in 2007 this population of natural gas prime movers emitted ~11,000 tons of NOx in the OTR annually (~30 tpd on average).

Ozone Transport Commission (OTC)

Stationary & Area Sources Committee

Draft White Paper on Control Technologies and OTC State Regulations for Nitrogen Oxides (NOx) Emissions from Eight Source Categories

Executive Summary

Purpose

This white paper identifies current emission limits and regulations for nitrogen oxides (NOx) emissions from eight source categories within the member states of the Ozone Transport Commission (OTC), in partial fulfilment of item 4 of the November 5, 2015 Charge to the OTC's Stationary and Area Sources (SAS) Committee. That Charge reads as follows:

> "To provide each state with a common base of information, a workgroup will develop a listing of emissions rates in each state within the Ozone Transport Region (OTR) for source categories responsible for significant NOx and VOC emissions and identify a range of emissions rates that the respective state has determined to be RACT. Some of the source categories that should be included in the listing include electrical generating units, turbines, boilers, engines and municipal waste combustors."

The white paper focuses on eight NOx source categories, which together account for 95% of the annual NOx emissions from non-(large) electric generating unit (EGU) stationary sources within the OTR, based on the 2014 EPA National Emissions Inventory, version 1.

The range of NOx emission rates is available in the source category-specific tables provided in this Executive Summary and in the Appendices to the white paper. Because of variation in the expression of NOx emission rates in the states (e.g., units, averaging times), a simple range is not provided.

A separate OTC workgroup (the CP/AIM workgroup) is currently working on a Technical Support Document for seven current OTC VOC model rules covering the period from about 2010 to 2014. The Technical Support Document could be used in revising and updating this white paper.

Note that this white paper states the emission rates required in the OTC states as of the date of this paper. The OTC states will be required to perform a RACT review for the 2015 ozone national ambient air quality standard (NAAQS), which may result in revisions to the emission rates provided here.

NOx RACT Background

The Environmental Protection Agency (EPA) defines RACT as "the lowest emission limitation that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility" (44 FR 53762, September 17, 1979).

Sections 182(f) and 184(b)(2) of the Clean Air Act (CAA) require states with ozone non-attainment areas, classified as moderate, serious, severe, and extreme--as well as all areas in the OTR--to implement RACT for existing major stationary sources of NOx.

NOx RACT Applicability

Section 302 of the CAA defines a major stationary source as any facility which has the potential to emit of 100 tons per year (tpy) of any air pollutant. Section 182 of the CAA reduces the major stationary source potential to emit threshold for certain ozone nonattainment classifications: 50 tpy for serious areas; 25 tpy for severe areas; and 10 tpy for extreme areas. The anti-backsliding provisions of the CAA require an area to continue to apply the area's historical most stringent major source threshold. Current and historical area classifications may be found in the EPA Green Book online at https://www3.epa.gov/airquality/greenbook/index.html.

NOx Emission Control Technologies and Strategies

The following NOx emissions control technologies and strategies are described in this whitepaper:

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  - Low Excess Air (LEA) or Reducing O_2 levels
  - Lean Combustion
  - Staged Combustion
  - Low Nitrogen Fuel Oil
  - Flue Gas Recirculation (FGR)
  - Low-NOx Burner (LNB) and Overfire Air (OFA)
  - Wet controls
- Post-Combustion Modifications
  - Gas Reburn
  - Non-Selective Catalytic Reduction (NSCR)
  - Selective Catalytic Reduction (SCR)
  - Selective Non-Catalytic Reduction (SNCR)
- Other Control Strategies
  - Combustion Tuning and Optimization
  - Use of Preheated Cullet

Current NOx regulations and emission limits for source categories in the Ozone Transport Region (OTR)

1. Industrial/Commercial/Institutional (ICI) Boilers in OTR

Results of a recent survey of the NOx emission limits and regulations for ICI Boilers in the OTR found in **Appendix A** of the white paper are summarized below:

NOx limit based on boiler capacity and fuel type

Capacity (mmBtu/hr)	NOx Limit (lbs/mmBtu)			
			Oil	
	Coal	Nat. Gas	Distillate	Residual
50 – 100	0.28 – 0.50	0.05 – 0.43	0.08 – 0.43	0.20 -0.50
100 – 250	0.08 – 1.00	0.06 – 0.43	0.10 – 0.43	0.20 -0.50
>250	0.08 – 1.40	0.10 – 0.70	0.10 – 0.43	0.15 -0.50

2. Stationary Gas (Combustion) Turbine Engines in OTR

Results of a recent survey of the NOx emission limits and regulations for Combustion Turbines (>25 MW capacity) in the OTR found in **Appendix B** of the white paper are summarized below:

TURBINE ENGINES (>25 MW)	Simple Cycle		Combined Cycle	
	Gas-fired	Oil-fired	Gas-fired	Oil-fired
State	**NOx Limit (ppmvd @15% O_2)**			
CT - Statewide	258 (42 - 0.9 lb/MMBtu)[a] 42 – 55[b]; 40[c]	240 (40 - 0.9 lb/mmBtu)[a] 40 – 75[b]; 40 – 50[c]	258 (42 - 0.9 lb/MMBtu)[a] 42[b]; 25[c]	240 (40 - 0.9 lb/mmBtu)[a] 40 – 65[b]; 40 – 42[c]
DC (If ≥100 mmBTU/hr)	NA	75	NA	NA
DE - Statewide	42	88	42	88
MA - Statewide	65	100	42	65
MD - Select Counties	42	65	42	65
ME - Statewide	NA	NA	3.5 – 9.0	42
NH - Statewide	25 (55 for pre-1999)	75	42	65
NJ – Statewide (≥15 MW)	25 (1.00 lb/MWh)	42 (1.60 lb/MWh)	25 (0.75 lb/MWh)	42 (1.20 lb/MWh)
NY - Statewide	50	100	42	65
PA - Statewide	>1,000 bhp & <6,000 bhp (150); >6000 BHP (42)	>1,000 bhp and <6,000 bhp (150); >6000 BHP (96)	1,000 bhp and <180 MW (42); >180 MW (4)	1,000 bhp and <180 MW (96); >180 MW (8) F42
RI - Statewide	No RACT Sources (new only)	No RACT Sources (new only)	No RACT Sources (new only)	No RACT Sources (new only)
VA - OTR jurisdiction	42	65 - 77	42	65 - 77
VT - Statewide	NA			

Notes:

- CT: [a]Existing RCSA Sec. 22a-174-22 (to be repealed as of June 1, 2018); [b]RCSA Sec. 22a-174-22e starting June 1, 2018; [c]-RCSA Sec. 22a-174-22e starting June 1, 2023.
- NJ: lb/mmBtu limit converted to ppmvd @15% O_2 based on Part 75 Eq-F5 and F-factors of 8710 for natural gas and 9190 for oil; lb/MWh limit converted to ppmvd@15% O_2 based on New Jersey technical support document; 25 ppm ≈ 1.0 lb/MWh for simple cycle gas; 42 ppm ≈ 1.60 lbs/hr for simple cycle oil. (NJ Proposal Number: PRN 2008-260).
- NA = Not Applicable

3. Stationary Reciprocating Internal Combustion (IC) Engines in OTR

Results of a recent survey of the emission limits and regulations for IC Engines (>500 hp) in the OTR presented in **Appendix C** of the white paper are summarized below:

IC ENGINES >500 hp	NOx Limit (g/hp-hr)			
State	**Gas-fired, Lean Burn**	**Gas-fired, Rich Burn**	**Diesel**	**Dual Fuel**
CT - Statewide	2.5*; 1.5 - 2.0**	2.5*; 1.5 - 2.0**	8.0*; 1.5 - 2.3**	Multi-fuel provisions*;**
DC	NA	NA	NA	NA
DE - Statewide	Technology Stds.	Technology Stds.	Technology Stds.	Technology Stds.
MA - Statewide	3.0	1.5	9.0	9.0
MD - Select Counties	150 ppmvd @ 15% O_2 (Approx. 1.7 g/hp-hr)*	110 ppmvd @ 15% O_2 (Approx. 1.6 g/hp-hr)*	175 ppmvd @ 15% O_2	125 ppmvd @ 15% O_2
ME - Statewide	NA	NA	3.7 (Source-specific RACT)	NA
NH - Statewide	2.5	1.5	8.0	8.0
NJ - Statewide	1.5	1.5	2.3	2.3
NY - Statewide	1.5	1.5	2.3	2.3
PA - Statewide	3.0	2.0	8.0	8.0
RI - Statewide	2.5	1.5	9.0	No specified in Regulation, no sources.
VA - OTR Jurisdiction	Source-specific RACT	Source-specific RACT	Source-specific RACT	Source-specific RACT
VT - Statewide	4.8	4.8	4.8	4.8

Notes:

- CT - * existing RCSA section 22a-174-22 (to be repealed as of June 1, 2018) and RCSA section 22a-174-22e starting June 1, 2018); **RCSA section 22a-174-22e starting June 1, 2023.
- MD - * Conversion factors from ppmv @ 15% O_2 to g/hp-hr from EPA ACT, July 1993 EPA453-R-93-032
- NJ: For an engine ≥37 kW and that has been modified on or after March 7, 2007, 0.90 grams/bhp-hr or an emission rate which is equivalent to a 90% NOx reduction from the uncontrolled NOx emission level
- NA = Not Applicable

4. Municipal Waste Combustors (MWCs) in OTR

Results of a recent survey of the emission limits and regulations for MWCs in the OTR presented in **Appendix D** of the white paper are summarized below:

- There are no MWCs in DC, DE, RI, and VT.
- The unit level capacity of MWCs ranges from 50 - 2,700 tpd of MSW.
- The types of combustors include: mass burn units (waterwall, refractory, stationary grate, reciprocating grate, single chamber), two types of rotary incinerators, and refuse-derived fuel incinerators.
- The types on NOx controls employed include FGR and SNCR with the majority of the units controlled with SNCR.
- The NOx emission limits vary within the OTR by state and by combustor technology.
  - 372 ppmvd NOx @ 7% O_2, 1-hour average (control technology not specified)
  - 185 - 200 ppmvd NOx @ 7% O_2, 3-hour average (with SNCR)
  - 120 - 250 ppmvd NOx @ 7% O_2, 24-hour average (control technology not specified)
  - 150 ppmvd NOx @ 7% O_2, calendar-day average (with SNCR)
  - 0.35 - 0.53 lb NOx/MMBtu, calendar-day average (with SNCR)
  - 135 ppmvd NOx @ 7% O_2, annual average (with no controls)

5. Cement kilns in OTR

Results of a recent survey of the emission limits and regulations for cement kilns in the OTR are presented below:

- There are no cement kilns in CT, DC, DE, MA, NH, NJ, RI, and VT.
- Depending on the type of kilns (wet or dry, with or without pre-calciner), the NOx emission limits range from 2.33 - 6.0 lbs/ton clinker in the existing state rules.

State	NOx Limit (lbs/ton clinker)				Regulations
	Long Dry	Long Wet	Pre-heater	Pre-calciner	
MD	5.1 3.4*	6.0 NA*	2.8 2.4*	2.8 2.4*	COMAR 26.11.30: http://www.dsd.state.md.us/comar/SubtitleSearch.aspx?search=26.11.30.
ME	2.33	-	-	-	EPA Consent Agreement (Docket 01-2013-0053, Sept 2013)
PA	3.44	3.88	2.36	2.36	Final RACT 2 Rule (46 Pa.B. 2036, April 23, 2016): http://www.pabulletin.com/secure/data/vol46/46-17/694.html
NY	2.88 (using SNCR) (SCC: 3-05-006-06)	5.2(SCC: 3-05-007-06)			Subpart 220-1 - Effective: 7/11/2010 Submitted: 8/19/2010; Final: 77 FR 13974, 78 Fr 41846: https://www3.epa.gov/region02/air/sip/ny_reg.htm
VA - OTR jurisdiction	No Limits				

Notes:
- MD: *After 04/01/2017

6. Hot Mix Asphalt Production Plants in OTR

Results of a recent survey of state regulations for Asphalt Production Plants in the OTR found in **Appendix E** of the white paper are summarized below.

State	Hot Mix Asphalt Production Plants – Regulations	State Contacts
CT	RCSA section 22a-174-22 will be replaced with RCSA section 22a-174-22e (RCSA section 22a-174-22 will be repealed as of June 1, 2018). Note: Neither section includes a limit that specifically applies to "asphalt production plants" but the fuel-burning equipment is regulated. http://www.ct.gov/deep/lib/deep/air/regulations/mainregs/sec22.pdf https://eregulations.ct.gov/eRegsPortal/Search/getDocument?guid=%7bE2C443EB-00E6-46AF-A260-65881DD13319%7d	Merrily Gere, 860 424 3416, Merrily.Gere@ct.gov;
DC	150 ppmvd @ 7% O_2 is the NOx RACT standard for major sources (25 TPY) of NOx only (two of the three HMA facilities in DC). No NOx RACT standard is specified for minor sources of NOx. The third HMA facility, a 225 TPH continuous drum-mix asphalt plant, has NOx limits of 12.4 lb/hr and 22.0 tons per 12-month rolling period to emit keeping NOx below the major source threshold. 20 DCMR § 805.6, RACT for Major Stationary Sources of Oxides of Nitrogen: http://www.dcregs.dc.gov/Gateway/RuleHome.aspx?RuleNumber=20-805;	Alexandra Catena, 202 535-2989, alexandra.catena@dc.gov
DE	Specific emissions limitations in lb/HMA are determined on a facility by facility basis. http://regulations.delaware.gov/AdminCode/title7/1000/1100/1112.shtml	Mark Prettyman 302-739-9402 mark.prettyman@state.de.us
MA	No specific NOx RACT emission limits for this source category in state NOx RACT regulations; BACT determination for Benevento Asphalt: 0.044 lb/MMBtu (Nat Gas), 0.113 lb/MMBtu (#2 Oil and other fuel types)	Marc Cohen 617.292.5873 Marc.Cohen@MassMail.State.MA.US
MD	Search Title 26, Chapter 11; http://www.dsd.state.md.us/COMAR/SearchTitle.aspx?scope=26	Randy Mosier, 410 537 4488, Randy.Mosier@maryland.gov
ME	NOx Limit: 0.12 lb/ton asphalt for all fuel types; http://www.maine.gov/dep/air/rules/;	Jeff Crawford, 207 287 7647, jeff.s.crawford@maine.gov
NH	NOx Limit: 0.12 lbs/ton asphalt for all fuel types; NH Administrative Rule Env-A 1300 *NOx RACT* (Part Env-A 1308 *Asphalt Plant Rotary Dryers*) http://des.nh.gov/organization/commissioner/legal/rules/documents/env-a1300.pdf	Gary Milbury 603 271-2630, gary.milbury@des.nh.gov
NJ	NOx Limit (ppmvd @7% O_2): 75 (Natural Gas), 100 (No. 2 Oil), 125 (No. 4 or heavier fuel oil or on-spec used oil or mixture of these three); N.J.A.C. 7:27-19.9, based on OTC ADDENDUM TO RESOLUTION 06-02 http://www.state.nj.us/dep/aqm/Sub19.pdf	Peg Gardner, 609 292 7095 Margaret.Gardner@dep.nj.gov
NY	Hot mix asphalt plants cap out of Title V. www.dec.ny.gov/regs/2492.html	John Barnes, 518 402 8396, john.barnes@dec.ny.gov; Robert Bielawa, robert.bielawa@dec.ny.gov

PA	Additional RACT Requirements for Major Sources of NOx and VOCs. Sections 129.96 - 129.100. Control of NOX from Major Sources of NOx and VOC; Effective April 23, 2016. Federal Register -TBD Case by Case; http://www.pacode.com/secure/data/025/articleICIII_toc.html	Susan Hoyle, shoyle@pa.gov Randy Bordner, ranbordner@pa.gov Susan Foster, sufoster@pa.gov Sean Wenrich, sewenrich@pa.gov
VA - OTR jurisdiction	All of ~15 plants have federally enforceable limits on their PTE of NOx and VOC to make them minor sources (<100 tpy NOX, <50 TPY VOC). None of them trigger the major stationary RACT source definition under 9 VAC 5 Chapter 40 Article 51 at this time.	Doris McLeod doris.mcleod@deq.virginia.gov
VT	No specific regulatory emission limits for Hot Mix Asphalt Production Plants, but most permits contain 0.06 lb/ton asphalt limit based on application submittal; http://dec.vermont.gov/air-quality/laws	Doug Elliott, 802 377 5939, Doug.Elliott@vermont.gov

Notes:

- No RACT Sources in RI;

7. Glass Furnaces in OTR

Results of a recent survey of Glass Furnaces in the OTR found in **Appendix F** of the white paper are presented below.

State	Glass Furnaces – Regulations	State Contacts
MA	Global consent decree for Ardagh Glass Inc. (formerly Saint Gobain Containers), Milford; Emission limit (lbs NOx/ton glass) = 1.3 *, 30 day rolling average, oxyfuel furnaces; https://www.epa.gov/enforcement/consent-decree-saint-gobain-containers-inc	Marc Cohen 617.292.5873 Marc.Cohen@MassMail.State.MA.US
MD	COMAR 26.11.09.08I, Search Title 26, Chapter 11; http://www.dsd.state.md.us/COMAR/SearchTitle.aspx?scope=26	Randy Mosier (410) 537-4488 Randy.Mosier@maryland.gov
NJ	Emission limit (lbs NOx/ton glass) = 9.2 (for flat glass); 4.0 (for others), Oxyfiring installed at rebricking; N.J.A.C. 7:27-19.10, based on OTC ADDENDUM TO RESOLUTION 06-02 http://www.state.nj.us/dep/aqm/Sub19.pdf	Peg Gardner, 609 292 7095 Margaret.Gardner@dep.nj.gov
NY	Emission limit (lbs NOx/ton glass) = 1.89 - 4.49; Subpart 220-2 - Effective: 7/11/2010 Submitted: 8/19/2010; Final: 77 FR 13974, 78 Fr 41846; www.dec.ny.gov/regs/2492.html	John Barnes (518) 402-8396 john.barnes@dec.ny.gov Robert Bielawa robert.bielawa@dec.ny.gov
PA	Emission limit (lbs NOx/ton glass) = 4.0 (container and fiberglass furnaces); 7.0 (pressed or blown, and flat glass furnaces); 6.0 (all other glass melting furnaces); Control of NOx Emissions From Glass Melting Furnaces. Sections 129.301 - 129.310. The rule limits the emissions of NOx from glass melting furnaces on an annual basis. Effective September 21, 2011. 08/22/2011; 76 Federal Register 52283 http://www.pacode.com/secure/data/025/articleICIII_toc.html	Susan Hoyle shoyle@pa.gov Randy Bordner ranbordner@pa.gov Susan Foster, sufoster@pa.gov Sean Wenrich sewenrich@pa.gov
VA - OTR jurisdiction	No glass plants trigger the major stationary source RACT threshold in 9 VAC 5 Chapter 40 Article 51 at this time that are located in the OTR portions of Virginia	Doris McLeod doris.mcleod@deq.virginia.gov

Notes:

- No Sources in CT, DC, DE, ME, NH, RI, and VT;
- MA: * excludes Abnormally Low Production Rate Days; Furnace Startup, Malfunction of the Furnace, and Maintenance of the Furnace.

8. Natural Gas Pipeline Compressor Prime Movers in OTR

Results of a recent survey of regulations for Natural Gas Pipeline Compressor Primer Movers in the OTR found in **Appendix G** of the white paper are presented below.

State	Natural Gas Pipeline Compressor Prime Movers – Regulations	State Contacts
CT	RCSA section 22a-174-22 (to be repealed as of June 1, 2018). Will be replaced with RCSA section 22a-174-22e. Note: Does not specifically apply to "natural gas pipelines" but fuel-burning equipment such as compressors is regulated; http://www.ct.gov/deep/lib/deep/air/regulations/mainregs/sec22.pdf https://eregulations.ct.gov/eRegsPortal/Search/getDocument?guid=%7bE2C443EB-00E6-46AF-A260-65881DD13319%7d	Merrily Gere, 860 424-3416, Merrily.Gere@ct.gov
DE	http://regulations.delaware.gov/AdminCode/title7/1000/1100/1112.shtml http://regulations.delaware.gov/AdminCode/title7/1000/1100/1144.shtml *	Mark Prettyman 302-739-9402 mark.prettyman@state.de.us
MA	310 CMR 7.19(7) NOx RACT simple cycle turbine existing emission limit of 65 ppm @ 15% O_2, proposed for more stringent standard of 40 ppm in 2017. A BACT determination in 2006 for a replacement of a 53.8 MMBtu/hr; Allison turbine at Tennessee Gas Pipeline Charlton station with two 50-6200LS Solar Centaur split shaft gas turbine compressor sets equipped with Solar's pre-combustion SoLoNOx technology each rated at 6,037 hp with a maximum heat input = 53.52 MMBtu/hr at ISO conditions): 15 ppm @ 15% O_2 (or alternatively 3.22 lbs/hr)	Marc Cohen, 617.292.5873, Marc.Cohen@MassMail.State.MA.US
MD	COMAR 26.11.29; Search Title 26, Chapter 11; http://www.dsd.state.md.us/COMAR/SearchTitle.aspx?scope=26	Randy Mosier, 410 537 4488, Randy.Mosier@maryland.gov
ME	Source specific BACT	Jane Gilbert, (207) 287-2455, jane.gilbert@maine.gov
NH	Regulated under Part Env-A 1306 *Combustion Turbines* (no separate rule for compressor stations): http://des.nh.gov/organization/commissioner/legal/rules/documents/env-a1300.pdf	Gary Milbury, 603 271 2630, Gary.milbury@des.nh.gov
NJ	N.J.A.C. 7:27-19.5 and 19.8, amendments in progress (applicable to turbines and engines at natural gas compressor stations) based on draft OTC white paper. http://www.state.nj.us/dep/aqm/Sub19.pdf	Peg Gardner, 609 292 7095 Margaret.Gardner@dep.nj.gov
NY	Covered under NOx RACT Rule (Subpart 227-2) Effective: 7/8/2010, Submitted: 8/19/2010, Final: 77 FR 13974, 78 Fr 41846; www.dec.ny.gov/regs/2492.html	John Barnes, 518 402 8396, john.barnes@dec.ny.gov Robert Bielawa, robert.bielawa@dec.ny.gov
PA	Additional RACT Requirements for Major Sources of NOx and VOCs. Sections 129.96 - 129.100. Control of NOx from Major Sources of NOx and VOC. Effective April 23, 2016. Federal Register - TBD (No Distinction) http://www.pacode.com/secure/data/025/articleICIII_toc.html	Susan Hoyle, shoyle@pa.gov Randy Bordner ranbordner@pa.gov Susan Foster, sufoster@pa.gov Sean Wenrich, sewenrich@pa.gov

RI	One source; Source specific RACT for engines at compressor station	Laurie Grandchamp, 401 222 2808, laurie.grandchamp@dem.ri.gov
VA - OTR jurisdiction	9 VAC 5 Chapter 40 Article 51, case by case RACT	Doris McLeod doris.mcleod@deq.virginia.gov

Notes:

- *DE: Reg. 1144 only applies to stationary generators, and not all engines.

The OTC identified natural gas pipeline compressor prime movers as a potential category for emission control strategies at its November, 2010 meeting and tasked the SAS Committee to explore the issue. In 2011 a SAS workgroup prepared a white paper to describe the issue and recommend potential Commission action, e.g., adopt a model rule drafted by the SAS to achieve NOx emissions reductions from this emission source and assist the OTC states in achieving the National Ambient Air Quality Standards (NAAQS) for ozone.

Within the OTR, natural gas pipeline compressor prime movers fueled by natural gas are used in several phases of natural gas supply: 1) gathering the natural gas from the well field and transporting it to the main transportation pipeline system; 2) moving natural gas through the main pipeline system to distribution points and end users; and 3) injecting and extracting natural gas from gas storage facilities. These natural gas pipeline compressor prime movers, mostly driven by internal combustion (IC) reciprocating engines and combustion turbines, are a significant source of nitrogen oxide (NOx) emissions year-round. Data sources indicate that nine OTR states have large natural gas compressor facilities (CT, MA, MD, ME, NJ, NY, PA, RI, VA); three OTR states contain a number of natural gas well field compressors (MD, NY, PA); and two OTR states have natural gas underground storage facilities (PA, NY).

The SAS Committee examined other areas of natural gas production (beyond the natural gas pipeline compressor prime movers addressed by the white paper) and concluded that potentially significant NOx reductions may be possible from the “upstream” activities of well drilling, well completion, and well head and field gathering natural gas compressor prime movers. Preliminary information indicates that NOx emissions from these sources may greatly exceed those of the pipeline and underground storage compression sources. This is more evident in the expansion of natural gas production due to shale gas activities.

Only limited data were available regarding the population of natural gas pipeline compressor prime movers fueled by natural gas in the OTR at the time that this white paper was written. The most comprehensive data that were available at that time was the 2007 emissions inventory (including a MARAMA point source emissions inventory for that year); therefore, 2007 was the base year used for analysis.[1] The 2007 data indicate that there are a multitude of natural gas compressor facilities in the OTR (including 150 classified as “major emissions sources”) including 2-stroke lean-burn internal

[1] OTC Nat Gas Compressor Prime Mover Inventory Rev 092711 from BC 092513.xlsx.

combustion (IC) reciprocating engines, 4-stroke lean-burn IC reciprocating engines, 4-stroke rich-burn IC reciprocating engines, and combustion turbines. The 2007 data showed:

- At least 409 reciprocating engine prime movers with ratings of 200 - 4300 hp, which includes a large number of makes and models
- At least 125 combustion turbine prime movers with ratings of 1000 - 20,000 hp, which includes a moderate number of makes and models.

Many of these prime movers may be >40 years old. The MARAMA point source emissions inventory data indicates that in 2007 this population of natural gas prime movers emitted ~11,000 tons of NOx in the OTR annually (~30 tpd on average).

OZONE TRANSPORT COMMISSION

White Paper on Control Technologies and OTC State Regulations for Nitrogen Oxides (NOx) Emissions from Eight Source Categories

STATIONARY AREA SOURCES COMMITTEE

2/10/2017

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ABBREVIATIONS

I. Introduction

A. Purpose

This white paper identifies current emission limits and regulations for nitrogen oxides (NOx) emissions from eight source categories within the member states of the Ozone Transport Commission (OTC), in partial fulfilment of item 4 of the November 5, 2015 Charge to OTC's Stationary and Area Sources (SAS) Committee which reads as follows:

> "To provide each state with a common base of information, a workgroup will develop a listing of emissions rates in each state within the Ozone Transport Region (OTR) for source categories responsible for significant NOx and VOC emissions and identify a range of emissions rates that the respective state has determined to be RACT. Some of the source categories that should be included in the listing include electrical generating units, turbines, boilers, engines and municipal waste combustors."

B. NOx RACT Background

The Environmental Protection Agency (EPA) defines RACT as "the lowest emission limitation that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility" (44 FR 53762, September 17, 1979).

Sections 182(f) and 184(b)(2) of the Clean Air Act (CAA) require states with ozone non-attainment areas, classified as moderate, serious, severe, and extreme--as well as all areas in the Ozone Transport Region (OTR)--to implement RACT for existing major stationary sources of NOx.

C. NOx RACT Applicability

Section 302 of the CAA defines a major stationary source as any facility which has the potential to emit of 100 tons per year (tpy) of any air pollutant (Table 1). Section 182 of the CAA reduces the major stationary source potential to emit threshold for certain ozone nonattainment classifications: 50 tpy for serious areas; 25 tpy for severe areas; and 10 tpy for extreme areas.

The anti-backsliding provisions of the CAA require an area to continue to apply their historical most stringent major source threshold. Current and historical area classifications may be found in the EPA Green Book online at https://www3.epa.gov/airquality/greenbook/index.html.

Table 1 RACT Major Stationary Source Thresholds (lowest historical value generally applies)

Area	NOx Emissions (potential to emit; tpy)
Ozone Transport Region	100
Moderate ozone nonattainment	
Serious ozone nonattainment	50
Severe ozone nonattainment	25
Extreme ozone nonattainment	10

II. NOx Emission Control Technologies and Strategies

The formation of nitrogen oxides (nitrous oxide, nitric oxide, dinitrogen dioxide, dinitrogen trioxide, nitrogen dioxide, dinitrogen tetroxide, dinitrogen pentoxide) collectively known as NOx[1] is strongly dependent on temperature of combustion and occurs by three fundamentally different mechanisms:

Thermal NOx: is the result of oxidation of nitrogen (N_2) to NOx through reactions that involve oxygen (O_2), hydrogen and hydroxyl radicals[2] at temperatures at or above 1,300ºC (2,370ºF)[3] It also arises directly from the thermal dissociation and subsequent reaction of molar amounts of N_2 and O_2 in the combustion air and is the principal mechanism of NOx emission in turbines firing natural gas or distillate oil fuel. Most thermal NOx is formed at a slightly fuel-lean mixture (because of excess oxygen available for reaction) in high temperature stoichiometric flame pockets downstream of the fuel injectors where combustion air has mixed sufficiently with the fuel to produce the peak temperature fuel/air interface.[4] "Avoiding local high flame temperatures, high residence times, recirculation patterns and excess air can reduce the formation of thermal NOx."[5] (Table 2)

Prompt NOx: forms within the flame from early reactions of N_2 molecules in the combustion air and hydrocarbon radicals (such as the Intermediate Hydrogen Cyanide or HCN) in the fuel. Prompt NOx formation is favored by excess hydrocarbons, and "is less temperature dependent than thermal NOx and the reactions are relatively faster".[6] The amount of prompt NOx is usually negligible compared to thermal NOx.[7] "Avoiding local excess of unburned hydrocarbons and keeping the flame lean of fuel can reduce the formation of prompt NOx."[8]

Fuel NOx: stems from the evolution and reaction of fuel-bound nitrogen compounds (such as in coal) with O_2. Chemically-bound nitrogen is negligible in natural gas fuel (although some N_2 is present) and is found in low levels in distillate oils. Fuel NOx from distillate oil-fired turbines may become significant in turbines equipped with a high degree of thermal NOx controls.

Combustion and post-combustion control technologies are commonly used to reduce emissions of thermal NOx and fuel NOx[9] (Table 3).

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[1] EPA-456/F-99-006R: Nitrogen Oxides (NOx), Why and How They Are Controlled. 11/1999. https://www3.epa.gov/ttncatc1/dir1/fnoxdoc.pdf
[2] S. Barendregt, L.Risseeuw, and F. Waterreus. Applying ultra-low-NOx burners. 2006. Petrochemicals & Gas Processing. Technip Benelux PTQ Q2. https://www.johnzink.com/wp-content/uploads/ultra-low-nox-burners.pdf
[3] https://www3.epa.gov/ttncatc1/dir1/fnoxdoc.pdf
[4] EPA-453/R-94-037. Alternative Control Techniques Document – NOx Emissions from Glass Manufacturing. 06/1994. https://www3.epa.gov/ttncatc1/dir1/glassact.pdf
[5] https://www.johnzink.com/wp-content/uploads/ultra-low-nox-burners.pdf
[6] https://www.johnzink.com/wp-content/uploads/ultra-low-nox-burners.pdf
[7] https://www3.epa.gov/ttncatc1/dir1/glassact.pdf
[8] https://www.johnzink.com/wp-content/uploads/ultra-low-nox-burners.pdf
[9] https://www3.epa.gov/ttncatc1/dir1/glassact.pdf

Table 2 NOx Control Methods[10]

Abatement or Emission Control Principle or Method	Successful Technologies	Pollution Prevention Method (P2) or Add-on Technology (A)
1. Reducing peak temperature	Flue Gas Recirculation (FGR) Natural Gas Reburning Low NOx Burners (LNB) Combustion Optimization Burners Out Of Service (BOOS) Less Excess Air (LEA) Inject Water or Steam Over Fire Air (OFA) Air Staging Reduced Air Preheat Catalytic Combustion	P2 P2 P2 P2 P2 P2 P2 P2 P2 P2 P2
2. Reducing residence time at peak temperature	Inject Air Inject Fuel Inject Steam	P2 P2 P2
3. Chemical reduction of NOx	Fuel Reburning (FR) Low NOx Burners (LNB) Selective Catalytic Reduction (SCR) Selective Non-Catalytic Reduction (SNCR)	P2 P2 A A
4. Oxidation of NOx with subsequent absorption	Non-Thermal Plasma Reactor Inject Oxidant	A A
5. Removal of nitrogen	Oxygen Instead Of Air Ultra-Low Nitrogen Fuel	P2 P2
6. Using a sorbent	Sorbent In Combustion Chambers Sorbent In Ducts	A A
7. Combinations of these Methods	All Commercial Products	P2 and A

A. Combustion Modifications

"Maximum reduction of thermal NOx can be achieved by controlling both the combustion temperature (i.e. reducing the temperature below the adiabatic flame temperature, for a given stoichiometry) and the stoichiometry of air to fuel (O_2:N_2)."[11]

Combustion control technologies control the temperature or O_2 to reduce NOx formation (Table 4). Combustion controls could be dry controls which use advanced combustion design to suppress NOx formation and/or promote CO burnout, or wet controls which use water to lower combustion temperature. "Since thermal NOx is a function of both temperature (exponentially) and time (linearly), dry controls either lower the combustion temperature

[10] https://www3.epa.gov/ttncatc1/dir1/fnoxdoc.pdf
[11] AP-42, Vol. I, 3.1: Stationary Gas Turbines. https://www3.epa.gov/ttnchie1/ap42/ch03/final/c03s01.pdf

using lean mixtures of air and/or fuel staging, or decrease their residence time in the combustor."[12] A combination of the dry control methods described below may be used to reduce NOx emissions:

1. Low Excess Air (LEA) or Reducing O_2 levels

In LEA systems, NOx formation is reduced by decreasing the amount of O_2 that is available to react with N_2 in the combustion air. This is achieved through the use of oxygen trim controls (e.g. a combustion analyzer) which "measure the stack O_2 concentration and automatically adjust the inlet air at the burner" for optimal fuel and air mixture resulting in a ~ 1% thermal efficiency[13]. "This method can reduce the level of NOx produced by up to 10%, but may increase the emissions of CO very significantly." This method is widely used in many processes that employ rich burn engines.[14]

2. Lean combustion

Lean combustion (two stage lean/lean combustion) involves "increasing the air-to-fuel (A/F) ratio of the mixture so that the peak and average temperatures within the combustor will be less than that of the stoichiometric mixture, thus suppressing thermal NOx formation. Introducing excess air not only creates a leaner mixture but it also can reduce residence time at peak temperatures."[15] While a rich-burn engine is characterized by excess fuel which results in an exhaust O_2 content of about 0.5%, a lean-burn engine is characterized by excess air with an exhaust O_2 content typically >8%.[16]

"In lean premixed combustion the fuel is typically premixed with >50% theoretical air resulting in lower flame temperatures thus suppressing thermal NOx formation. Operation at excess air levels and at high pressures increases the influence of inlet humidity, temperature, and pressure leading to variations in emissions of ≥30%. For a given fuel firing rate, lower ambient temperatures lower the peak temperature in the flame, lowering thermal NOx significantly. Similarly, turbine operating loads affect NOx emissions with higher emissions expected for higher loads due to higher peak temperature in the flame zone."[17]

3. Staged Combustion

In staged combustion, the amount of underfire air (air supplied below the combustion grate) is reduced, which generates a starved-air region reducing thermal NOx formation. In this method, "only a portion of the fuel is burned in the main chamber" greatly

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[12] https://www3.epa.gov/ttnchie1/ap42/ch03/final/c03s01.pdf
[13] https://www.epa.gov/sites/production/files/2015-12/documents/iciboilers.pdf
[14] Combustion Training: NOx Reduction Methods. http://www.e-inst.com/combustion/nox-reduction
[15] https://www3.epa.gov/ttnchie1/ap42/ch03/final/c03s01.pdf
[16] Manufacturers of Emission Controls Association (MECA), 05/2015. Emission Control Technology for Stationary Internal Combustion Engines. http://www.meca.org/resources/MECA_stationary_IC_engine_report_0515_final.pdf
[17] https://www3.epa.gov/ttnchie1/ap42/ch03/final/c03s01.pdf

reducing the temperature in the main chamber thereby reducing the amount of thermal NOx. "All of the fuel is eventually burned, producing the same amount of energy."[18]

"Two-stage lean/lean combustors are essentially fuel-staged, premixed combustors which allow the turbine to operate with an extremely lean mixture burned at each stage while ensuring a stable flame. A small stoichiometric pilot flame which ignites the premixed gas and provides flame stability has insignificant NOx emissions. Low NOx emission levels are achieved by this combustor design through cooler flame temperatures associated with lean combustion and avoidance of localized "hot spots" by premixing the fuel and air."[19]

"Two stage rich/lean combustors are essentially air-staged, premixed combustors in which the primary zone is operated fuel rich and the secondary zone is operated fuel lean. The rich mixture produces lower temperatures (compared to stoichiometric), higher concentrations of CO and H_2 because of incomplete combustion, and also decreases the amount of oxygen available for NOx generation. Before entering the secondary zone, the exhaust of the primary zone is quenched (to extinguish the flame) by large amounts of air and a lean mixture is created. The lean mixture is pre-ignited and the combustion completed in the secondary zone where the lower temperature environment minimizes NOx formation."[20]

4. Low Nitrogen Fuel Oil

"The use of low nitrogen oils, which can contain up to 15 - 20 times less fuel-bound nitrogen than standard No. 2 oil, can greatly reduce NOx emissions as fuel-bound nitrogen can contribute 20-50% of total NOx levels."[21]

5. Flue Gas Recirculation (FGR)

FGR lowers the temperature of the flame thereby reducing thermal NOx. "In FGR, cooled flue gas and ambient air are mixed to become the combustion air. This mixing reduces the O_2 content of the combustion air supply and lowers combustion temperatures."[22] "A portion of the exhaust gas is re-circulated into the combustion process, cooling the area. This process may be either external or induced, depending on the method used to move the exhaust gas. FGR may also minimize CO levels while reducing NOx levels."[23]

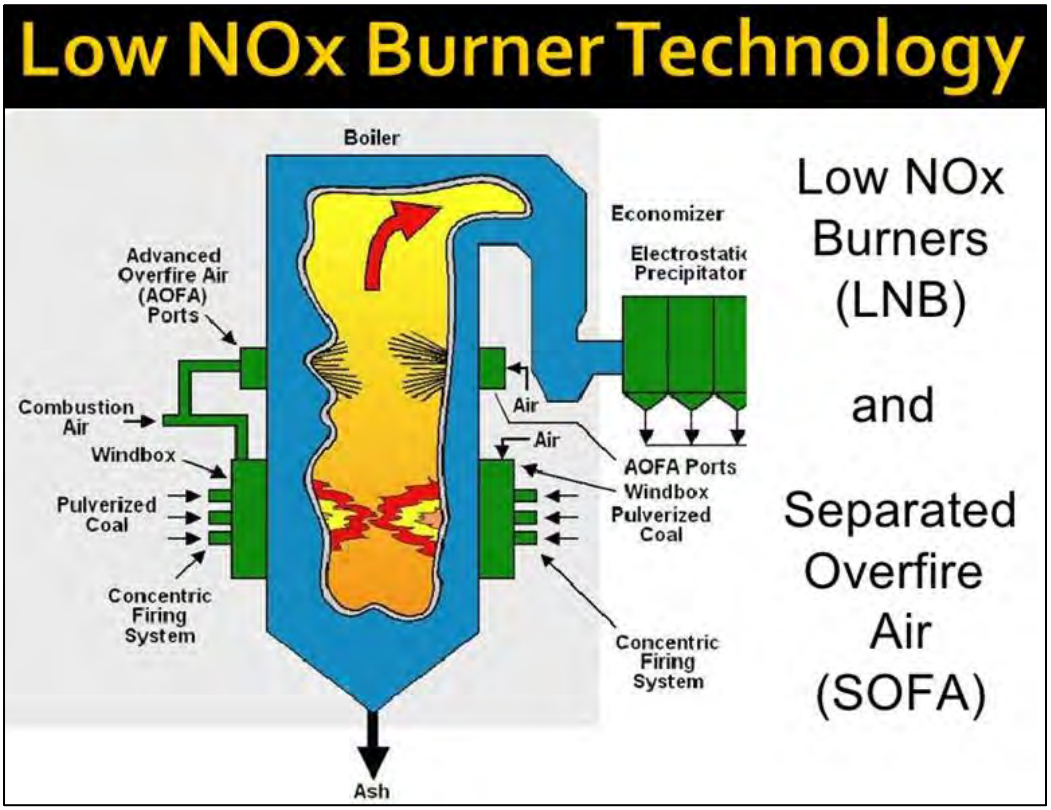
6. Low-NOx Burner (LNB) and Overfire Air (OFA)

LNB and OFA (air supplied above the combustion grate) (Fig. 1) can be used separately or as a system, and can reduce NOx emissions by 40 - 60%.[24] LNBs are applicable to

[18] http://www.e-inst.com/combustion/nox-reduction
[19] https://www3.epa.gov/ttnchie1/ap42/ch03/final/c03s01.pdf
[20] https://www3.epa.gov/ttnchie1/ap42/ch03/final/c03s01.pdf
[21] http://www.e-inst.com/combustion/nox-reduction
[22] AP-42, Vol. I, CH 2.1: Refuse Combustion: https://www3.epa.gov/ttnchie1/ap42/ch02/final/c02s01.pdf
[23] http://www.e-inst.com/combustion/nox-reduction
[24] Northeast States for Coordinated Air Use Management (NESCAUM) Report, 01/2009. Applicability and Feasibility of NOx, SO_2, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers.

most ICI boiler types, and are being increasingly used at ICI boilers <10 MMBtu/hr. These technologies require site-specific suitability analyses since several parameters can have substantial impact on their performance or even retrofit feasibility.[25] LNBs use gas, distillate or residual oil, and coal, and can be coupled with FGR or Selective Non-Catalytic Reduction (SNCR) for additional reductions.[26]

Figure 1 Schematic of Low NO_x Burner Technology[27]



Ultra Low NOx Burner (ULNB) can achieve NOx emission levels in the order of single digits in ppm.[28]

7. Wet controls

Wet controls use steam or water injection to reduce combustion temperatures and thermal NOx formation. The injected water-steam "increases the thermal mass by dilution" and also acts as a heat sink absorbing the latent heat of vaporization from the flame zone thereby reducing combustion peak temperatures in the flame zone and decreasing thermal NOx.[29] Water or steam is typically injected into turbine inlet air at a water-to-fuel weight ratio of <1.0 and depending on the initial NOx levels, such

[25] NESCAUM Report
[26] A. M. Bodnarik
[27] NGS Emissions and Air Quality Compliance http://www.slideshare.net/en3pro/ngs-emissions-and-air-quality-compliance
[28] NESCAUM Report
[29] https://www3.epa.gov/ttnchie1/ap42/ch03/final/c03s01.pdf

injections may reduce NOx by ≥60%. "Water or steam injection is usually accompanied by an efficiency penalty (typically 2-3%) and "excess amounts of condensation may form." An increase in power output (typically 5-6%) results from "the increased mass flow required to maintain turbine inlet temperature at manufacturer's specifications. Both CO and VOC emissions are increased by water injection depending on the amount of water injection".[30]

B. Post-Combustion Modifications

Post-combustion controls or add-on controls include natural gas re-burning or catalytic controls (e.g. catalytic converters) which selectively reduce NOx and/or oxidize CO exhaust emissions through a series of chemical reactions without itself being changed or consumed[31] (Table 5). Catalytic control devices are used to lower the emissions of combustion processes in varied sources including stationary engines, boilers, heaters and internal combustion engines. Catalytic converters break down nitrogen oxides into separate nitrogen and oxygen particles. Some catalytic converters are also used to reduce the high CO levels produced when reducing NOx, as low CO levels are important to ensuring complete combustion.

"An emission control catalyst system consists of a steel housing (its size being dependent on the size of the engine for which it is being used) that contains a metal or ceramic structure which acts as a catalyst support or substrate. There are no moving parts, just acres of interior surfaces on the substrate coated with either base or precious catalytic metals, such as platinum (Pt), rhodium (Rh), palladium (Pd), or vanadium (V), depending on targeted pollutants. Catalysts transform pollutants into harmless gases through chemical reactions in the exhaust stream depending on the technology being used, and also depending on whether the engine is operating rich or lean."[32]

1. Gas Reburn

"Natural gas reburning involves limiting combustion air to produce an LEA zone. Recirculated flue gas and natural gas are then added to this LEA zone to produce a fuel-rich zone that inhibits NOx formation and promotes reduction of NOx to N_2."[33]
Gas reburn has been used only in large EGU applications, but is an option for larger watertube-type boilers including stokers. Reburn may yield 35 - 60% reductions in NOx emissions but requires appropriate technical and economic analyses to determine suitability.[34] "Economic benefit of reburning depends on available steam demand,

[30] https://www3.epa.gov/ttnchie1/ap42/ch03/final/c03s01.pdf
[31] http://www.meca.org/resources/MECA_stationary_IC_engine_report_0515_final.pdf
[32] http://www.meca.org/resources/MECA_stationary_IC_engine_report_0515_final.pdf
[33] https://www3.epa.gov/ttnchie1/ap42/ch02/final/c02s01.pdf
[34] NESCAUM Report

natural gas and electricity costs, and the ability to operate the system at higher than designed heat input."[35]

2. Non-Selective Catalytic Reduction (NSCR)

"NSCR is an effective NOx-reduction technology for rich-burn, spark-ignited stationary gas engines. NSCR is currently the most economical and accepted emission control method for rich-burn engines. This same catalyst technology is referred to as a three-way catalyst when the engine is operated at the stoichiometric point where not only is NOx reduced but so are CO and non-methane hydrocarbons (NMHC). Conversely, lean NOx catalyst systems and oxidation catalysts provide little, if any, emission control in a rich-burn environment. However, in a lean-burn environment, oxidation catalysts provide significant reductions in both CO and NMHC, and lean NOx catalyst systems provide reductions in NOx, CO, and NMHC."[36]

"NSCR systems are similar in design to three-way catalytic converters used on most modern cars and light-duty trucks. Exhaust from the engine is passed through a metallic or ceramic honeycomb covered with a platinum group metal catalyst. The catalyst promotes the low temperature (approximately 850°F) reduction of NOx into N_2, the oxidation of CO into CO_2, and the oxidation of HCs into water vapor."[37]

An NSCR system has three simultaneous reactions[38]:

1. Reduction of nitrogen oxides to nitrogen and oxygen:
   $2NOx \rightarrow XO_2 + N_2$
2. Oxidation of carbon monoxide to carbon dioxide:
   $2CO + O_2 \rightarrow 2CO_2$
3. Oxidation of unburnt hydrocarbons to carbon dioxide and water:
   $C_xH_{2x+2} + [(3X+1)/2]O_2 \rightarrow XCO_2 + (X+1)H_2O$

"NSCR catalyst efficiency is directly related to the air/fuel mixture and temperature of the exhaust. Efficient operation of the catalyst typically requires the engine exhaust gases contain no more than 0.5% oxygen. In order to obtain the proper exhaust gas O_2 across the operating range, an A/F ratio controller is installed that measures the oxygen concentration in the exhaust and adjusts the inlet A/F ratio to meet the proper 0.5% O_2 exhaust requirement for varying engine load conditions, engine speed conditions, and ambient conditions."[39]

"Lean NOx Catalyst (LNC) technology 'has demonstrated NOx emission reductions from stationary diesel and lean-burn gas engines. LNCs control NOx emissions by injecting a small amount of diesel fuel or other hydrocarbon reductant into the exhaust upstream

[35] C. A. Penterson, H. Abbasi, M. J. Khinkis, Y. Wakamura, and D. G. Linz. Natural gas reburning technology for NOx reduction from MSW combustion systems. http://www.seas.columbia.edu/earth/wtert/sofos/nawtec/1990-National-Waste-Processing-Conference/1990-National-Waste-Processing-Conference-20.pdf

[36] http://www.meca.org/resources/MECA_stationary_IC_engine_report_0515_final.pdf

[37] http://www.meca.org/resources/MECA_stationary_IC_engine_report_0515_final.pdf

[38] http://www.meca.org/resources/MECA_stationary_IC_engine_report_0515_final.pdf

[39] http://www.meca.org/resources/MECA_stationary_IC_engine_report_0515_final.pdf

of a catalyst. The fuel or other hydrocarbon reductant serves as a reducing agent for the catalytic conversion of NOx to N_2. Because the mechanism is analogous to SCR but uses a different reductant, LNC technology is sometimes referred to as hydrocarbon selective catalytic reduction, or HC-SCR. Other systems operate passively without any added reductant at reduced NOx conversion rates.

The typical LNC is constructed of a porous material made of zeolite (a micro-porous material with a highly ordered channel structure), along with either a precious metal or base metal catalyst. The zeolites provide microscopic sites that attract hydrocarbons and facilitate NOx reduction reactions. Without the added fuel and catalyst, reduction reactions that convert NOx to N_2 would not take place because of excess oxygen present in the exhaust. For diesel engines over transient cycles, peak NOx conversion efficiencies are typically 25 - 40% (at reasonable levels of diesel fuel consumption), although higher NOx conversion efficiencies have been observed on specially designed HC-SCR catalysts that employ an ethanol-based reductant.

For stationary lean-burn gas engines, two types of lean NOx catalyst formulations have emerged: a low temperature catalyst based on platinum and a high temperature catalyst utilizing base metals (usually copper). Each catalyst is capable of controlling NOx over a narrow temperature range. A copper-exchange zeolite-based catalyst is active at temperatures between 350 - 450°C, resulting in 60% NOx conversion, while a platinum catalyst is active at lower temperatures of approximately 200 - 300˚C, with 50% NOx conversion capability.”[40]

3. Selective Catalytic Reduction (SCR)

“SCR systems selectively reduce NOx emissions using a three-way catalyst in a low-oxygen environment by injecting a reducing agent into lean-burn exhaust gas stream upstream of a catalyst which reacts with NOx, and O_2 to form N_2 and H_2O.

Pure anhydrous ammonia (NH_3), aqueous ammonia (NH_4OH), or urea ($CO(NH_2)_2$) can be used as the reductant, is stored on site or injected into the exhaust stream upstream of the catalyst, but, in stationary gas engine applications, urea is most common because of its ease of use. As it hydrolyzes, each mole of urea decomposes into two moles of NH_3. The NH_3 then reacts with the NOx to convert it into N_2 and H_2O.”[41]

The chemical equation for a stoichiometric reaction using either anhydrous or aqueous ammonia for a selective catalytic reduction process is:

1. $4NO + 4NH_3 + O_2 \rightarrow 4N_2 + 6H_2O$
2. $2NO_2 + 4NH_3 + O_2 \rightarrow 3N_2 + 6H_2O$
3. $NO + NO_2 + 2NH_3 \rightarrow 2N_2 + 3H_2O$

The reaction for urea instead of either anhydrous or aqueous ammonia is:

$$4NO + 2(NH_2)_2CO + O_2 \rightarrow 4N_2 + 4H_2O + 2CO_2$$

[40] http://www.meca.org/resources/MECA_stationary_IC_engine_report_0515_final.pdf
[41] http://www.meca.org/resources/MECA_stationary_IC_engine_report_0515_final.pdf

"An oxidation catalyst must be added to the SCR design if hydrocarbons and CO need to be controlled in addition to NOx on a lean-burn engine. The oxidation catalyst first oxidizes the exhaust stream to convert CO to CO_2 and hydrocarbons to CO_2 and water. The CO_2, water, and NOx then enter the SCR catalyst where the NOx reacts with the NH_3. The exhaust gas must contain a minimum amount of O_2 and be within a particular temperature range (typically 450 - 850°F) for the SCR system to operate properly. Exhaust gas temperatures greater than the upper limit (850°F) cause NOx and NH_3 to pass through the catalyst unreacted. The temperature range is dictated by the catalyst material which is typically made from noble metal oxides such as vanadium and titanium, or zeolite-based material.

Catalyst selection is somewhat based on the expected temperature range of the engine exhaust and is sized to achieve the desired amount of NOx reduction. Both precious metal and base metal catalysts have been used in SCR systems. Base metal catalysts, typically vanadium and titanium, are used for exhaust gas temperatures between 450 - 800°F. For higher temperatures (675 - 1100°F), zeolite catalysts may be used. Precious metal SCR catalysts are also useful for low temperatures (350 - 550°F). The catalyst can be supported on either ceramic or metallic substrate materials (e.g., cordierite or metal foil) constructed in a honeycomb configuration. In some designs, the catalyst material is extruded directly into the shape of a honeycomb structure. Most catalysts are configured in a parallel-plate, "honeycomb" design to maximize the surface area-to-volume ratio of the catalyst. The reagent injection system is comprised of a storage tank, reagent injector(s), reagent pump, pressure regulator, and electronic controls to accurately meter the quantity of reagent injected as a function of engine load, speed, temperature, and NOx emissions to be achieved.

Ammonia emissions, called "ammonia slip", may be a consideration when specifying an SCR system.[42] "SCR systems can attain NOx conversion efficiencies of 95% or greater, but ammonia/urea requirements tend to increase with higher NOx conversion efficiencies, creating the potential to slip more ammonia. Ammonia cleanup catalysts can be installed behind the SCR catalyst to collect any excess ammonia that slips through (converting it into nitrogen and water). The ideal ratio of ammonia to NOx is 1:1 based on having ammonia available for reaction of all of the exhaust NOx without ammonia slip. However, SCR efficiency can be less than ideal at low temperatures (potential low SCR activity) and at higher temperatures with high exhaust flow rates (high space velocities). Optimizing the ammonia to NOx ratio is shown to lead to potential improvements in overall NOx conversion efficiency with little additional ammonia slip."[43]

"Although an SCR system can operate alone, it is typically used in conjunction with water-steam injection systems or lean-premix system to reduce NOx emissions to their lowest levels (<10 ppm at 15% O_2 for SCR and wet injection systems). The SCR system for landfill or digester gas-fired turbines requires a substantial fuel gas pretreatment to

[42] https://www3.epa.gov/ttnchie1/ap42/ch03/final/c03s01.pdf

[43] http://www.meca.org/resources/MECA_stationary_IC_engine_report_0515_final.pdf

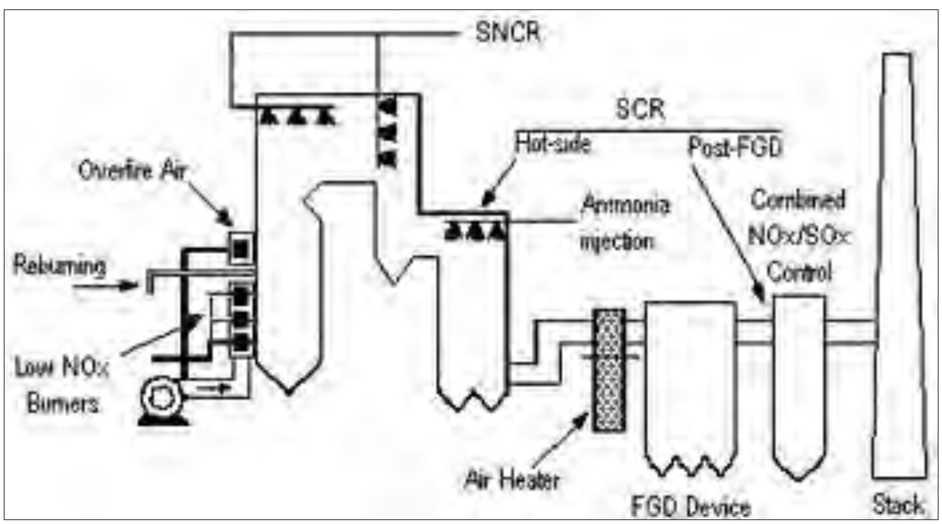
remove trace contaminants that can poison the catalyst. Therefore, SCR and other catalytic treatments may be inappropriate control technologies for landfill or digester gas-fired turbines. The catalyst and catalyst housing used in SCR systems tend to be very large and dense (in terms of surface area to volume ratio) because of the high exhaust flow rates and long residence times required for NOx, O_2, and NH_3 to react on the catalyst. Some SCR installations incorporate CO catalytic oxidation modules along with the NOx reduction catalyst for simultaneous CO/NOx control."[44]

4. Selective Non-Catalytic Reduction (SNCR)

"SNCR is a process that involves a reductant, usually urea, being added to the top of the furnace and going through a very long reaction at approximately 1400 - 1600°F. This method is more difficult to apply to boilers due to the specific temperature needs, but it can reduce NOx emissions by 70%."[45] "With SNCR, NH_3 or urea is injected into the furnace along with chemical additives to reduce NOx to N_2 without the use of catalysts. Based on analyses of data from U. S. MWCs equipped with SNCR, NOx reductions of 45% are achievable (Fig. 2)"[45]

SNCR systems are "commercially installed on a wide range of boiler configurations including dry bottom wall fired and tangentially fired units, wet bottom units, stokers and fluidized bed units. These units fire a variety of fuels such as coal, oil, gas, biomass, and waste. Other applications include thermal incinerators, municipal and hazardous solid waste combustion units, cement kilns, process heaters, and glass furnaces."[46]

Figure 2 Schematic of Selective Catalytic and Non-Catalytic Reduction[47]



[44] http://www.meca.org/resources/MECA_stationary_IC_engine_report_0515_final.pdf
[45] http://www.e-inst.com/combustion/nox-reduction
[46] EPA-452/F-03-031: Air Pollution Control Technology (Selective Non-Catalytic Reduction (SNCR) Fact Sheet. https://www3.epa.gov/ttncatc1/dir1/fsncr.pdf
[47] http://www.e-inst.com/combustion/nox-reduction

C. Other Control Strategies

1. Combustion Tuning and Optimization

Combustion Tuning may be required to minimize NOx emissions especially since "the combustion system may drift over time from its optimum setting or certain controls (e.g., dampers) may not be operational due to wear."[48] Tuning of the combustion system may involve a simple visual check by an experienced boiler or stationary engineer, or parametric testing involving "changes in the key control variables of the combustion system and observation of key parameters" such as flue gas outlet (stack) temperature, and NOx emissions.[49]

Combustion optimization can be accomplished "based on parametric testing, analysis of the results, and estimating optimum operating parameters" based on specific objectives such as combustion efficiency (measure of completeness of fuel oxidation), NOx emissions, boiler efficiency ("net energy output/energy input" ratio), plant efficiency, or a combination of these goals.

Based on their size, periodic testing and manual tuning are adequate for most ICI boilers. Economic considerations and/or specific requirements (such as maximizing boiler efficiency or minimizing NOx emissions) may warrant the installation of digital optimization systems or instrumentation (temperature sensors, oxygen monitors to help avoid incomplete combustion and maintain a stable flame, etc.) for larger boilers particularly those with frequently changing operating conditions such as load.[50] However, there are "no fixed requirements for instrumentation" since "very little instrumentation is essential to operate the boiler safely".[51]

"One process control measure that has been used for ICI boilers is the use of oxygen trim controls" which "measure the stack O_2 concentration and automatically adjust the inlet air at the burner for optimum efficiency" (a gain of ~1%).[52] While tuning, optimization, and instrumentation and controls (I&C) are applicable to all boilers, optimization and I&C may be economical and justified for only the larger coal or biomass fired boilers "because their operating parameters (e.g., fuel quality) may be variable and difficult to control". "Implementing these measures may be technically straightforward and would require raising the awareness of facility staff and management regarding the potential cost savings and importance of tuning/optimization."[53]
Combustion Tuning and Optimization efforts can yield NOx reductions of 5-15% or more.[54]

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[48] https://www.epa.gov/sites/production/files/2015-12/documents/iciboilers.pdf
[49] https://www.epa.gov/sites/production/files/2015-12/documents/iciboilers.pdf
[50] https://www.epa.gov/sites/production/files/2015-12/documents/iciboilers.pdf
[51] https://www.epa.gov/sites/production/files/2015-12/documents/iciboilers.pdf
[52] https://www.epa.gov/sites/production/files/2015-12/documents/iciboilers.pdf
[53] https://www.epa.gov/sites/production/files/2015-12/documents/iciboilers.pdf
[54] NESCAUM Report

Back to TOC

2. Use of Preheated Cullet

The use of cullet (recycled, broken, or waste glass) in container glass manufacturing reduces NOx emissions besides saving costs on raw material, fuel, and energy. Cullet melts at a lower temperature than raw materials resulting in lowered thermal NOx emissions from the furnace and avoiding NOx emissions associated with raw materials besides reducing energy demands, lowering production costs, reducing the wear and tear of the furnace, and ultimately lowering maintenance costs and prolonging furnace life.[55]

Preheating cullet through a direct heat transfer from furnace exhaust to a cullet layer or passing the cullet through a vertical funnel surrounded by hollow chambers that is heated externally by the furnace exhaust helps achieve additional energy savings. Once preheated, the cullet is released from the base of the funnel for transport to the batch charger. Direct preheating reduces furnace energy by up to 12% for cullet contents of 50% or greater while indirect heat transfer systems can reduce furnace energy by up to 20%.
After leaving the hollow chambers, the furnace exhaust passes through a conventional filter system and is released to the atmosphere. [56]

“Every 10% increase in the amount of cullet used reduces melting energy by ~2.5%” depending on the preheat temperature and the amount of cullet (thickness) used. Studies show that to achieve notable savings, the cullet must be preheated to at least 650 °F but if temperature exceeds ~1025°F, it will begin to soften and become difficult to transport.[57]

Given that a container glass manufacturing furnace is capable of producing from 100 - 400 tons of glass per day, the reduction in NOx emissions can be substantial. Technical issues such as the design and implementation of the preheating unit, and monitoring of the preheating temperature should be evaluated with the over-all system configuration and carefully reviewed prior to the implementation. [58]

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[55] CWC BP-GL3-01-04: Best Practices in Glass Recycling 06/1996. http://www.cwc.org/gl_bp/3-01-04.pdf
[56] http://www.cwc.org/gl_bp/3-01-04.pdf
[57] http://www.cwc.org/gl_bp/3-01-04.pdf
[58] http://www.cwc.org/gl_bp/3-01-04.pdf

III. Current NOx RACT rules and emission limits for source categories in the Ozone Transport Region (OTR)

A. INDUSTRIAL/COMMERCIAL/INSTITUTIONAL (ICI) BOILERS

1. ICI Boilers in OTR

Results of a recent survey of the NOx emission limits and RACT regulations for ICI Boilers in the OTR are found in **Appendix A** and are summarized below in Table 3:

Table 3 NOx limits based on ICI boiler capacity and fuel type in OTR

	NOx Limit (lbs/mmBtu)			
Capacity			Oil	
(mmBtu/hr)	Coal	Nat. Gas	Distillate	Residual
50 – 100	0.28 – 0.45	0.05 – 0.43	0.08 – 0.43	0.20 -0.43
100 – 250	0.08 – 1.00	0.06 – 0.43	0.10 – 0.43	0.20 -0.43
>250	0.08 – 1.00	0.10 – 0.70	0.10 – 0.43	0.15 -0.43

2. Background

Industrial boilers "are used by heavy industry (e.g. paper products, chemical, food, and petroleum industries) to produce heat or electricity to run processes or machinery. Most of these boilers have a capacity of 10 - 250 million British thermal units per hour (MMBtu/hr)".[59]

Commercial boilers "are used by wholesale and retail trade establishments, office buildings, hotels, restaurants, and airports to supply steam and hot water for space heating." These boilers are generally smaller than the industrial units with heat input capacities generally of <10 MMBtu/hr.[60]

Institutional boilers are used in educational facilities such as medical centers, universities and schools, and also in government buildings, and military installations to provide steam and hot water used for space heating and/or electricity. These boilers have heat input capacities generally <10 MMBtu/hr.[61]

"The complete boiler system includes the furnace and combustion system, the heat exchange medium where combustion heat is transferred to the water, and the exhaust system."[62] There are four major boiler configurations based on their heat transfer configuration: watertube, firetube, cast iron, and tubeless.[63]

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[59] Combustion Portal - ICI Boilers http://www.combustionportal.org/boilerregulations.cfm

[60] http://www.combustionportal.org/boilerregulations.cfm

[61] http://www.combustionportal.org/boilerregulations.cfm

[62] EPA-453/R-94-022: Alternative Control Techniques Document—NOx Emissions from Industrial/Commercial/Institutional (ICI) Boilers. https://www3.epa.gov/ttncatc1/dir1/icboiler.pdf

[63] https://www3.epa.gov/ttncatc1/dir1/icboiler.pdf

The ICI Boilers burn a variety of fuels including coal (crushed and pulverized forms of bituminous, sub-bituminous, anthracite and lignite), distillate and residual fuel oils, natural gas, biomass (wood residue and bagasse), liquefied petroleum gas, refinery gas, and a variety of process gases and waste materials to produce steam for generating electricity, providing heat, and for other uses.[64,65] Boilers fired with coal, wood, or process byproducts are larger, i.e. >100 MMBtu/hr in capacity, while natural gas- and oil-fired boilers tend to be <20 MMBtu/hr on average.[66] For smaller industrial and commercial units <50 MMBtu/hr capacity, coal is not preferred "because of the high capital cost of coal handling equipment relative to the costs of the boilers."[67]

3. Emissions Control

Based on the type of boiler, firing, fuel combusted, combustion modification, fuel treatment, and/or post-combustion processes[68], combinations of the following methods and technologies are frequently used to control ICI boiler NOx emissions: boiler tuning or optimization, LNB (applicable to most ICI boiler types, and increasingly used at ICI boilers <10 MMBtu/hr) and OFA, ULNB, gas reburn (used only in large EGU applications, but is an option for larger watertube-type boilers including stokers), SCR, and SNCR.[69]

B. COMBUSTION TURBINES

1. Combustion Turbine Engines in OTR

Results of a recent survey of the NOx emission limits and RACT regulations for Combustion Turbines (>25 MW capacity) in the OTR are found in **Appendix B.**

2. Background[70]

Gas turbines, also referred to as "combustion turbines" are used in multiple applications including electric power generation, cogeneration, natural gas transmission, and various processes. They operate differently from traditional coal-fired electricity generating units in that they use the expansion of air when heated, instead of steam, to drive turbines (Fig. 3). Combustion turbines are available with power outputs ranging from 300 horsepower (hp) to >268,000 hp using natural gas and distillate (No. 2 low sulfur) fuel oil as primary fuels.[71]

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[64] Final reconsideration of the air toxics standards for industrial, commercial, and institutional boilers and process heaters at major source facilities. 11/05/2015. https://www3.epa.gov/airquality/combustion/docs/20151105fs.pdf

[65] Fact Sheet: https://www3.epa.gov/airquality/combustion/docs/20121221_sum_overview_boiler_ciswi_fs.pdf

[66] Applicability and Feasibility of NOx, SO_2, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers.

[67] https://www3.epa.gov/ttncatc1/dir1/icboiler.pdf

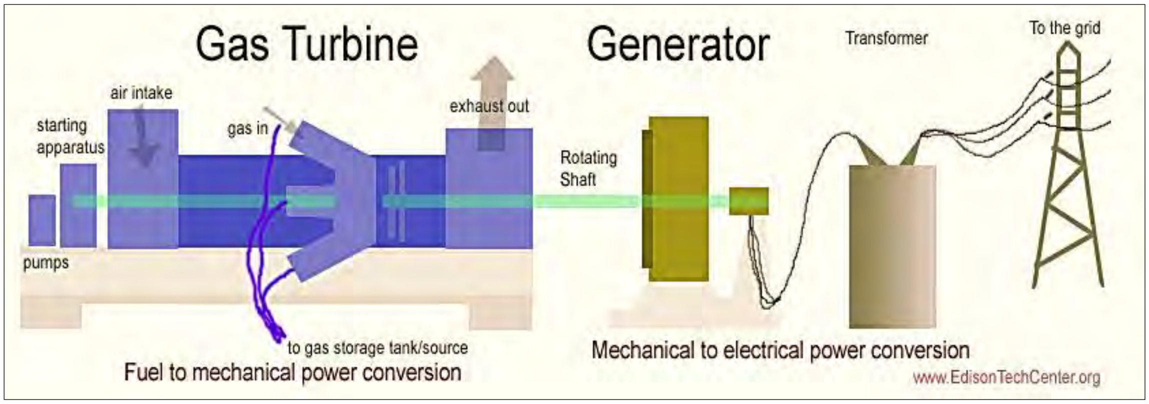
[68] A. M. Bodnarik, 09/03/2009. ICI Boiler NOx & SO_2 - Control Cost Estimates Control Cost Estimates; http://otcair.org/upload/Documents/Meeting%20Materials/ICI%20Boiler%20Control%20Cost%20presentation%20090309%20long%20version.pdf

[69] NESCAUM Report

[70] https://www3.epa.gov/ttnchie1/ap42/ch03/final/c03s01.pdf

[71] https://www3.epa.gov/ttnchie1/ap42/ch03/final/c03s01.pdf

Figure 3 Schematic of Power Generation using Gas Turbines[72]



In electric power generation, combustion turbine units referred to as peaking units are used infrequently for short periods to supplement power supply during peak demand periods when electricity use is highest although they are also capable of operating for extended periods.[73] Combustion turbine units can operate together or independently. Peaking units have much lower capacity factors than baseload units (which are nearly always operating when available) or intermediate load units (which typically run very little at night but have higher capacity factors during the day).

Natural gas is the marginal fuel for power generation in both Texas and the northeastern United States and marginal units are those that set the price for electricity. Natural gas combustion turbines are usually dispatched in response to price signals, i.e. real-time wholesale hourly electricity prices.[74] Although these turbines are more expensive to operate than other types of power plants, since they can respond quickly when needed (like hydroelectric stations), they tend to be used to meet short-term increases in electricity demand related to ramping or when loads (and therefore prices) are higher.[75]

Combustion (gas) turbines are complex machines but essentially involve three main components[76]:
Compressor: draws in ambient air, compresses it ~30 times ambient pressure, and feeds it to the combustion chamber at speeds of hundreds of miles per hour.[77,78]

Combustion system: where fuel is introduced, ignited, and burned, is typically a ring of fuel injectors that inject a steady stream of burning fuel (low sulfur fuel oil or natural gas) into combustion chambers where it mixes with the compressed air and is ignited at

[72] Edison Tech Center. Gas Turbines: Learn about the history and development of the gas turbine. http://www.edisontechcenter.org/gasturbines.html
[73] https://www.duke-energy.com/about-energy/generating-electricity/oil-gas-fired-intro.asp
[74] October 1, 2013, Natural gas-fired combustion turbines are generally used to meet peak electricity load. http://www.eia.gov/todayinenergy/detail.cfm?id=13191
[75] http://www.eia.gov/todayinenergy/detail.cfm?id=13191
[76] HOW GAS TURBINE POWER PLANTS WORK. http://energy.gov/fe/how-gas-turbine-power-plants-work
[77] https://www3.epa.gov/ttnchie1/ap42/ch03/final/c03s01.pdf
[78] http://energy.gov/fe/how-gas-turbine-power-plants-work

temperatures >2000°F. The resulting combustion develops a 300,000 hp gas stream that enters and expands through the turbine section.[79]

The combustion process can be classified as:

- Diffusion flame combustion: In this process, the fuel/air mixing and combustion take place simultaneously in the primary combustion zone generating regions of near-stoichiometric fuel/air mixtures where the temperatures are very high.[80]
- Lean premix staged combustion: Here, the fuel and air are thoroughly mixed in an initial stage resulting in a uniform, lean, unburned fuel/air mixture which is delivered to a secondary stage where the combustion reaction takes place. The majority of gas turbines currently manufactured are lean-premix staged combustion turbines also referred to as Dry Low NOx combustors. Manufacturers use different types of fuel/air staging, including fuel staging, air staging, or both applying the same staged, lean-premix principle.[81]

There are three types of Combustors:

- annular combustor: "is a doughnut-shaped, single, continuous chamber that encircles the turbine in a plane perpendicular to the air flow".[82]
- can-annular combustor: is similar to the annular but incorporates "several can-shaped combustion chambers rather than a single continuous chamber". "Annular and can-annular combustors are based on aircraft turbine technology and are typically used for smaller scale applications".[83]
- silo (frame-type) combustor: "has one or more combustion chambers mounted external to the gas turbine body. These are typically larger than annular or can-annular combustors used for larger scale applications".[84]

Turbine: "A gas turbine is an internal combustion engine that operates with rotary rather than reciprocating motion."[85] It is an "intricate array of alternate stationary and rotating aerofoil-section blades" similar to propeller blades. As hot combustion gas expands through the turbine, it spins the rotating blades which perform dual functions: "they drive the compressor to draw more pressurized air into the combustion section", and "they spin a generator to produce electricity" much like steam does in a steam-electric station. Two-thirds of the energy generated rotates the air-compressor turbine while the remaining horsepower spins the electric generator.[86,87]

Land based gas turbines are of two types:

- Heavy Frame engines: are characterized by lower (typically <20) pressure ratios (compressor discharge pressure/inlet air pressure) and tend to be physically large.

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[79] http://energy.gov/fe/how-gas-turbine-power-plants-work
[80] https://www3.epa.gov/ttnchie1/ap42/ch03/final/c03s01.pdf
[81] https://www3.epa.gov/ttnchie1/ap42/ch03/final/c03s01.pdf
[82] https://www3.epa.gov/ttnchie1/ap42/ch03/final/c03s01.pdf
[83] https://www3.epa.gov/ttnchie1/ap42/ch03/final/c03s01.pdf
[84] https://www3.epa.gov/ttnchie1/ap42/ch03/final/c03s01.pdf
[85] http://energy.gov/fe/how-gas-turbine-power-plants-work
[86] http://energy.gov/fe/how-gas-turbine-power-plants-work
[87] https://www.duke-energy.com/about-energy/generating-electricity/oil-gas-fired-how.asp

They have higher power outputs and consequently produce larger amounts of polluting emissions like NOx.[88]

- Aeroderivative engines: are derived from jet engines and operate at very high (typically >30) compression ratios. These engines tend to be very compact and used for smaller power outputs.[89]

The temperature at which a turbine operates is key to its fuel-to-power efficiency with higher temperatures corresponding to higher efficiencies, which can translate to more economical operation. While the gas flowing through a typical power plant turbine reach 2300^{o}F, some of the critical metals in the turbine can withstand only 1500 - 1700^{o}F. So the air from the compressor might be used for cooling key turbine components thereby reducing ultimate thermal efficiency. The advanced turbines are able to boost turbine inlet temperatures up to 2600^{o}F thereby achieving efficiencies of ~60%.[90]

"Energy from the hot exhaust gases, which expand in the power turbine section, are recovered in the form of shaft horsepower."[91] More than 50% of the shaft horsepower is needed to drive the internal compressor and the remainder is available to drive an external load. "Gas turbines may have one, two, or three shafts to transmit power between the inlet air compression turbine, the power turbine, and the exhaust turbine." The gas turbine is used to provide shaft horsepower for oil and gas production and transmission.

The heat content of the exhaust gases exiting the turbine is either discarded or recovered for further use in the following process cycles:

Simple Cycle: is the most basic operating cycle of gas turbines in which there is no exhaust heat recovery. Simple cycle gas turbines are typically used for shaft horsepower applications e.g. by utilities for backup power generation during emergencies or peak electric demand periods (<5,000 hp) and by the petroleum industry (300-20,000 hp units). Simple cycle turbines operate with a thermal efficiency (ratio of useful shaft energy to fuel energy input) of 15-42%.[92]

Regenerative Cycle: uses heat exchangers to recover the heat of turbine exhaust gases to preheat the air entering the combustor thereby reducing the amount of fuel required to reach combustor temperatures. Thermal efficiency of this cycle is ~35%.[93]

Cogeneration: uses the hot exhaust gases in a heat recovery steam generator (HRSG) to raise process steam, with or without supplementary firing. The steam generated by the HRSG can be delivered at a variety of pressures and temperatures to other thermal processes on site. A supplementary burner or duct burner can be placed in

[88] http://energy.gov/fe/how-gas-turbine-power-plants-work
[89] http://energy.gov/fe/how-gas-turbine-power-plants-work
[90] http://energy.gov/fe/how-gas-turbine-power-plants-work
[91] https://www3.epa.gov/ttnchie1/ap42/ch03/final/c03s01.pdf
[92] https://www3.epa.gov/ttnchie1/ap42/ch03/final/c03s01.pdf
[93] https://www3.epa.gov/ttnchie1/ap42/ch03/final/c03s01.pdf

the exhaust duct stream of the HRSG for additional steam generation. A cogeneration cycle operates at ~84% thermal efficiency.[94]

Combined Cycle or Repowering: recovers exhaust heat to raise steam for a steam turbine Rankine cycle, with or without supplementary firing. In a combined cycle, the gas turbine drives an electric generator, and the steam from the HRSG drives a steam turbine which also drives an electric generator. A supplementary-fired boiler can be used to increase the steam production. This cycle is used in various applications in gas and oil industry, emergency power generation facilities, independent electric power producers, electric utilities, etc. The thermal efficiency of this cycle is 38-60%.[95]

3. Emissions Control

"Gas turbines operate with high overall excess air because they use combustion air dilution as the means to maintain turbine inlet temperature below design limits. In older gas turbine models, where combustion is in the form of a diffusion flame, most of the dilution takes place downstream of the primary flame, which does not minimize peak temperature in the flame and suppress thermal NOx formation. Diffusion flames are characterized by regions of near-stoichiometric fuel/air mixtures where temperatures are very high leading to significant thermal NOx formation."[96]

"Newer model gas turbines use lean premixed combustion where the fuel is typically premixed with more than 50% theoretical air resulting in lower flame temperatures thus suppressing thermal NOx formation." Operation at excess air levels and at high pressures increases the influence of inlet humidity, temperature, and pressure leading to variations in emissions of ≥30%. For a given fuel firing rate, lower ambient temperatures lower the peak temperature in the flame, lowering thermal NOx significantly. "Similarly, turbine operating loads affect NOx emissions with higher emissions expected for higher loads due to higher peak temperature in the flame zone."[97]

Emission controls for gas turbines include wet controls that use water (to lower combustion temperature thereby reducing thermal NOx formation), and a combination of dry combustion control methods e.g. lean combustion, staged combustion, etc. and post-combustion catalytic controls such as SCR.

C. INTERNAL COMBUSTION ENGINES (ICEs)

1. IC Engines in OTR

Results of a recent survey of the emission limits and RACT regulations for IC Engines (>500 hp) in the OTR are found in **Appendix C.**

[94] https://www3.epa.gov/ttnchie1/ap42/ch03/final/c03s01.pdf
[95] https://www3.epa.gov/ttnchie1/ap42/ch03/final/c03s01.pdf
[96] https://www3.epa.gov/ttnchie1/ap42/ch03/final/c03s01.pdf
[97] https://www3.epa.gov/ttnchie1/ap42/ch03/final/c03s01.pdf

2. Background

A stationary engine is a large reciprocating engine with an immobile framework and could be a steam engine or an internal combustion engine (ICE).[98]

An ICE consists of a fixed cylinder and a moving piston and the ignition and combustion of the fuel occur within the engine itself.[99] The expanding combustion gases push the piston which alternatively moves back and forth to convert pressure into rotating motion. Based on the number of piston strokes needed to complete a cycle, ICE can be classified as two stroke or four stroke engines. The cycle includes four distinct processes: intake, compression, combustion and power stroke, and exhaust[100] (Fig. 4). An ICE can use a wide range of fuels including gasoline, diesel, natural gas, propane, biodiesel, or ethanol, and could be “"rich burn" (burning with a higher amount of fuel as compared to air) or "lean burn" (less fuel compared to air) engines.”[101] ICE are “commonly used at power and manufacturing plants to generate electricity and to power pumps and compressors. They are also used in emergencies to produce electricity and pump water for flood and fire control.”[102]

“Reciprocating internal combustion engines (RICE) are used in a variety of stationary applications, including gas compression, pumping, power generation, cogeneration, irrigation, and inert gas production.”[103]

[98] Stationary Internal Combustion Engines https://www3.epa.gov/airtoxics/icengines/

[99] Internal Combustion Engine Basics. 11/22/2013. http://www.energy.gov/eere/energybasics/articles/internal-combustion-engine-basics

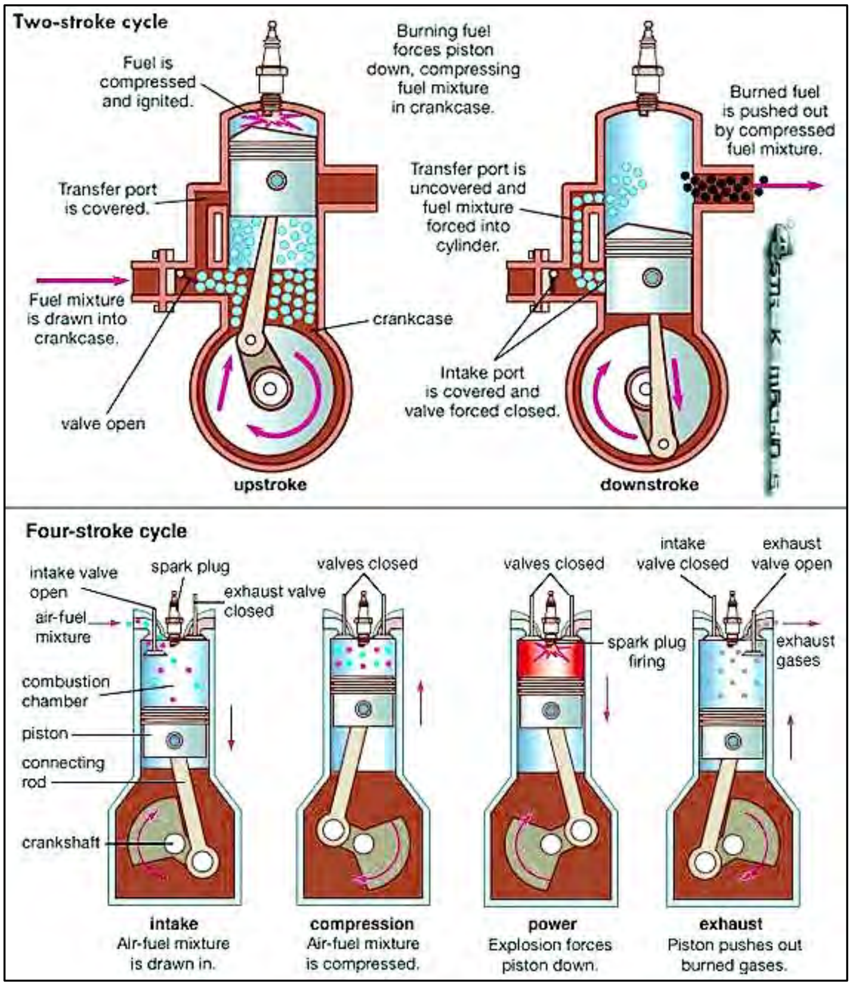
[100] http://www.energy.gov/eere/energybasics/articles/internal-combustion-engine-basics

[101] Reciprocating Internal Combustion Engines (RICE) https://www3.epa.gov/region1/rice/

[102] Reciprocating Internal Combustion Engines (RICE) https://www3.epa.gov/region1/rice/

[103] http://www.meca.org/resources/MECA_stationary_IC_engine_report_0515_final.pdf

Figure 4 Schematic of the workings of Two-Stroke and Four-Stroke Engines[104]



"Based on combustion chemistry and air pollution, stationary internal combustion engines are classified into 1. reciprocating piston engines in which combustion is performed periodically in a chamber of changing volume; 2. Steady flow engines in which combustion takes place continuously in a chamber of constant volume."[105]
The stationary RICE can be further classified into spark ignition gasoline engines, or compression ignition diesel engine[106] based on "how they supply and ignite the fuel"[107].

Spark Ignition (SI) engines: "In SI engines, the fuel is evaporated and mixed with the oxidizing agent before the ignition takes place."[108] Here, "the fuel (natural gas, propane or liquefied petroleum gas (LPG), or gasoline) is mixed with air and then inducted into the cylinder during the intake process. After the piston compresses the fuel-air mixture,

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[104] http://www.crazyengineers.com/threads/difference-2-stroke-engine-4-stroke-engine.69275/
[105] G. St. Cholakov. Control of exhaust emissions from internal combustion engine vehicles. Pollution control technologies v. III. Encyclopedia of Life Support Systems. http://www.eolss.net/sample-chapters/c09/e4-14-05-01.pdf
[106] http://www.eolss.net/sample-chapters/c09/e4-14-05-01.pdf
[107] http://www.energy.gov/eere/energybasics/articles/internal-combustion-engine-basics
[108] http://www.eolss.net/sample-chapters/c09/e4-14-05-01.pdf

the spark ignites it, causing combustion. The expansion of the combustion gases pushes the piston during the power stroke."[109]

"Modern SI engines used in passenger and freight vehicles are four stroke" while two-stroke engines are used in small motorcycles, as outboard motors and other small power equipment because of their lower weight, and cost per unit of power input". "Two-stroke engines emit 20-50% fuel unburned in the exhaust and also considerable oil". Two stroke engines with "advanced fuel injection, lubrication and combustion systems achieve lower higher fuel efficiency and lower emissions". The main pollutants from four-stroke gasoline engines are hydrocarbons, CO and NOx found in their exhaust emissions. [110]

"Stationary gas engines, typically fueled by natural gas or propane, are widely used for prime power and for gas compression. In gas compression, the types of engines are either rich burn or lean-burn i.e. use different air-to-fuel (A/F) ratios in the combustion chamber during combustion." "For gas production or gas gathering, the engines can be either rich or lean whereas for gas transmission, the engines are typically all lean-burning. Gas engines are used for prime power applications, especially where it is convenient to connect a natural gas line to the engine. Both rich-burn and lean-burn engines are used for decentralized power or distributed generation, cogeneration, and combined heat and power (CHP) applications. Depending on the application, stationary IC engines range in size from relatively small (~50 hp) for agricultural irrigation purposes to (>1000 hp) used in parallel to meet the load requirements."[111]

Compression Ignited (CI) engines use diesel as fuel. "In a diesel engine, only air is inducted into the engine and then compressed. These engines then spray the fuel into the hot compressed air at a suitable, measured rate, causing it to ignite."[112]
CI engines could be classified as:

Direct CI engines: Here, the fuel is sprayed directly into compressed heated air whereupon it evaporates and ignites. These engines provide higher power output and better efficiency than engines with indirect ignition but are noisier. Examples of Direct CI engines: jet engines which may use a gas turbine, liquid fuel, air as oxidizing agent and a turbo compressor (aircraft jet engines); rocket jet engines which have chemical agents as fuels and oxidizers.[113]

Indirect CI engines: Here combustion takes place in a pre-chamber often by a glow-spark and the combustion then spreads to the main chamber. Examples of Indirect CI engines include passenger cars.[114]

"Compared to the typical SI engines, both light duty (LD) and heavy duty (HD) diesel CI engines have considerably higher compression ratios and better fuel efficiency leading

[109] http://www.energy.gov/eere/energybasics/articles/internal-combustion-engine-basics
[110] http://www.eolss.net/sample-chapters/c09/e4-14-05-01.pdf
[111] http://www.meca.org/resources/MECA_stationary_IC_engine_report_0515_final.pdf
[112] http://www.energy.gov/eere/energybasics/articles/internal-combustion-engine-basics
[113] http://www.eolss.net/sample-chapters/c09/e4-14-05-01.pdf
[114] http://www.eolss.net/sample-chapters/c09/e4-14-05-01.pdf

to lower hydrocarbon and CO emissions; LD vehicles emit less NOx than comparable gasoline engines but those from HD are higher."[115]

"Diesel engines inherently operate lean mode of operation, i.e. use excess air-to-fuel ratios in the combustion chamber during combustion. Stationary diesel engines are widely used in emergency backup generators and for water pumping, especially when the electrical grid is down. In places where an electrical grid is not accessible or available, diesel engines can be used to generate prime power as a distributed generating source."[116]

3. Emissions Control

Different emission control technologies such as SCR and NSCR are used to control emissions from stationary IC engines. The choice of control depends on the engine's A/F ratio, since the exhaust gas composition differs depending on whether the engine is operated in a rich, lean, or stoichiometric burn condition, and on the engine operating mode (speed and load) as it affects the exhaust gas temperature.[117]

NSCR is currently the most economical and accepted NOx emission control method for rich-burn, spark-ignited stationary gas engines, while SCR is used to reduce NOx emissions from diesel and lean-burn gas engines. For stationary lean-burn gas engines, two types of lean NOx catalyst formulations each of which controls NOx over a narrow temperature range (a low temperature catalyst based on Pt, and a high temperature catalyst utilizing base metals (usually Cu)) are used.

D.MUNICIPAL SOLID WASTE COMBUSTORS (MWCs)

1. MWCs in OTR

Results of a recent survey of the emission limits and RACT regulations for MWCs in the OTR are found in **Appendix D** and are summarized below:

- There are no MWCs located in DE, DC, RI and VT.
- The unit level capacity of MWCs ranges from 50 - 2,700 tpd of MSW.
- The types of combustors include: mass burn units (waterwall, refractory, stationary grate, reciprocating grate, single chamber), two types of rotary incinerators, and refuse-derived fuel incinerators.
- The types on NOx controls employed include FGR and SNCR with the majority of the units controlled with SNCR
- The NOx emission limits vary within the OTR:
  - 372 ppmvd NOx @ 7% O_2, 1-hour average
  - 185 - 200 ppmvd NOx @ 7% O_2, 3-hour average
  - 120 - 250 ppmvd NOx @ 7% O_2, 24-hour average
  - 150 ppmvd NOx @ 7% O_2, calendar-day average
  - 0.35 - 0.53 lb NOx/MMBtu, calendar-day average

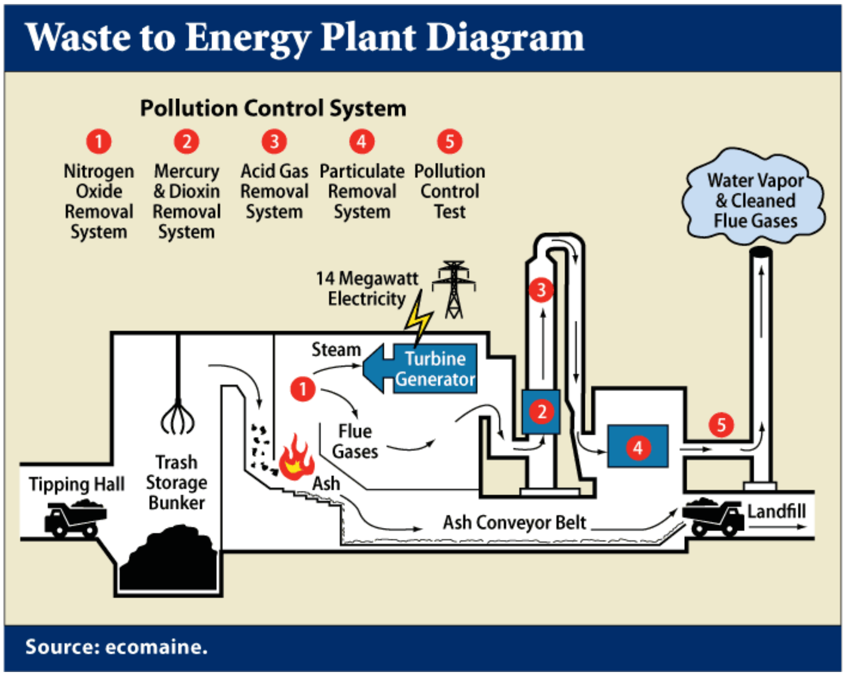
[115] http://www.eolss.net/sample-chapters/c09/e4-14-05-01.pdf
[116] http://www.meca.org/resources/MECA_stationary_IC_engine_report_0515_final.pdf
[117] http://www.meca.org/resources/MECA_stationary_IC_engine_report_0515_final.pdf

- 135 ppmvd NOx @ 7% O_2, annual average

2. Background

Refuse combustion involves the burning of garbage and other nonhazardous solids, collectively referred to as municipal solid waste (MSW), to generate electric power (Fig. 5). Types of municipal solid waste combustion devices commonly used include single chamber units, multiple chamber units, and trench incinerators.[118]

Figure 5 Schematic of Energy Generation from Municipal Waste[119]



There are 3 main classes of technologies used in MWCs:

- Mass Burn (MB): These units combust do not require any preprocessing of MSW other than the removal of items too large to go through the feed system. The MSW is placed on a grate that moves through the MB combustor where combustion air in excess of stoichiometric amounts is supplied both as underfire and overfire air. MB combustors are usually erected at the site (as opposed to being prefabricated and transported from another location), and have an MSW throughput of 46-900 megagrams/day (Mg/day) (50-1,000 tpd) per unit.[120]

  The MB combustor category has 3 designs[121]:

  1) waterwall (WW) – these designs have water-filled tubes in the furnace walls that are used to recover heat for production of steam and/or electricity;

[118] https://www3.epa.gov/ttnchie1/ap42/ch02/final/c02s01.pdf
[119] Waste To Energy – Incineration Vs. Gasification. 08/31/2014. https://ecoandsustainable.com/2014/08/31/waste-to-energy/
[120] https://www3.epa.gov/ttnchie1/ap42/ch02/final/c02s01.pdf
[121] https://www3.epa.gov/ttnchie1/ap42/ch02/final/c02s01.pdf

2) rotary combustion waterwall (RC) – this design uses a rotary combustion chamber constructed of water-filled tubes followed by a waterwall furnace;
3) refractory wall - these designs are older and typically do not include any heat recovery.

- Refuse-Derived Fuel (RDF): These combustors burn MSW that has been processed such as removing non-combustibles and shredding which generally raises the heating value and provides a finely divided and more uniform fuel suitable for co-firing with pulverized coal. The type of RDF used depends on the boiler design. Most boilers designed to burn RDF use spreader stokers and fire fluff RDF in a semi-suspension model. A subset of the RDF technology is fluidized bed combustors (FBC). RDFs have an MSW throughput capacity of 290-1,300 Mg/day (320-1,400 tpd).[122]
- Modular Combustors (MOD): These are similar to MB combustors in that they burn waste that has not been pre-processed, but they are typically shop fabricated with an MSW throughput capacity of 4-130 Mg/day (5-140 tpd). One of the most common types of MOD is the starved air (SA) or controlled air type combustor which incorporates two combustion chambers. Air is supplied to the primary chamber at sub-stoichiometric levels and the resultant incomplete combustion products (CO and organic compounds) pass into the secondary combustion chamber where combustion is completed with the additional air. Another MOD design is the excess air (EA) combustor which like the SA also consists of 2 chambers, but is functionally similar to MB units in its use of excess air in the primary chamber.[123]

3. Emissions Control

Nitrogen oxides in the MWCs are formed primarily during combustion through the oxidation of nitrogen-containing compounds in the waste at relatively low temperatures (<1,090^{o}C or 2,000^{o}F), and negligibly through the fixation of atmospheric nitrogen which occurs at much higher temperatures. Because of the kind of fuel MWCs use and the relatively low temperatures at which they operate, 70–80% of NOx formed in MSW incineration is associated with nitrogen in the MSW.[124]

A variety of technologies are used to control NOx emissions from MWC including combustion controls such as staged combustion, LEA, and FGR, and post-combustion add-on controls like SCR, SNCR, and natural gas re-burning.

E. CEMENT KILNS

1. Cement kilns in OTR

Results of a recent survey of the emission limits and RACT regulations for cement kilns in the OTR are presented below in Table 4:

- There are no cement kilns in CT, DE, MA, NJ, VT, DC, NH, RI

[122] https://www3.epa.gov/ttnchie1/ap42/ch02/final/c02s01.pdf
[123] https://www3.epa.gov/ttnchie1/ap42/ch02/final/c02s01.pdf
[124] https://www3.epa.gov/ttnchie1/ap42/ch02/final/c02s01.pdf

- Depending on the type of kilns (wet or dry, with or without pre-calciner), the NOx emission limits range from 2.33 - 6.0 lbs/ton clinker in the existing state rules.

Table 4 Cement Kiln Emissions Ranges and Regulations in OTC States

State	NOx Limit (lbs/ton clinker)				RACT Regulations
	Long Dry	Long Wet	Pre-heater	Pre-calciner	
MD	5.1 3.4*	6.0 NA*	2.8 2.4*	2.8 2.4*	COMAR 26.11.30: http://www.dsd.state.md.us/comar/SubtitleSearch.aspx?search=26.11.30.
ME	2.33	-	-	-	EPA Consent Agreement (Docket 01-2013-0053, Sept 2013)
PA	3.44	3.88	2.36	2.36	Final RACT 2 Rule (46 Pa.B. 2036, April 23, 2016): http://www.pabulletin.com/secure/data/vol46/46-17/694.html
NY	2.88 (using SNCR) (SCC: 3-05-006-06)	5.2 (SCC: 3-05-007-06)			Subpart 220-1 - Effective: 7/11/2010 Submitted: 8/19/2010; Final: 77 FR 13974, 78 Fr 41846: https://www3.epa.gov/region02/air/sip/ny_reg.htm
VA (OTR jurisdiction)	No Limits				

*After 04/01/2017

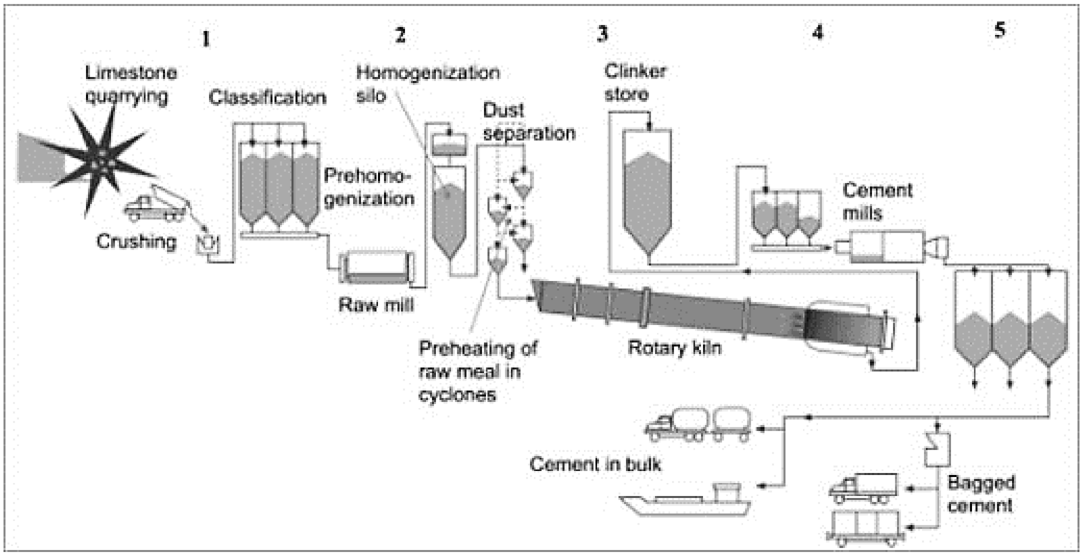
2. Background

Portland cement manufacturing is an "energy-intensive process that grinds and heats a mixture of raw materials such as limestone, clay, sand and iron ore in a rotary kiln" into a product called clinker which "is cooled, ground and then mixed with a small amount of gypsum to produce cement"[125] (Fig. 6).

"The main source of air toxics emissions from a Portland cement plant is the kiln." Emissions of a variety of pollutants originate in the kiln from "the burning of fuels and heating of raw feed materials", and "from the grinding, cooling, and materials handling steps in the manufacturing process".[126]

[125] https://www3.epa.gov/ttn/caaa/t3/fact_sheets/cement_amend_fs_120806.html
[126] Ibid 13 https://www3.epa.gov/ttn/caaa/t3/fact_sheets/cement_amend_fs_120806.html

Figure 6 Schematic of a Cement Kiln Operation[127]



There are essentially two types of cement kilns:

<u>Wet process kilns</u>: The original rotary cement kilns were called 'wet process' kilns since the raw meal used was in the form of a slurry with ~40% water at ambient temperature. Evaporating this water to dry out the slurry is an energy-intensive process and “various developments of the wet process (such as the 'filter press') were aimed at reducing the water content of the raw meal”.[128] The wet process still continues today because many raw materials are suited to blending as a slurry.[129]

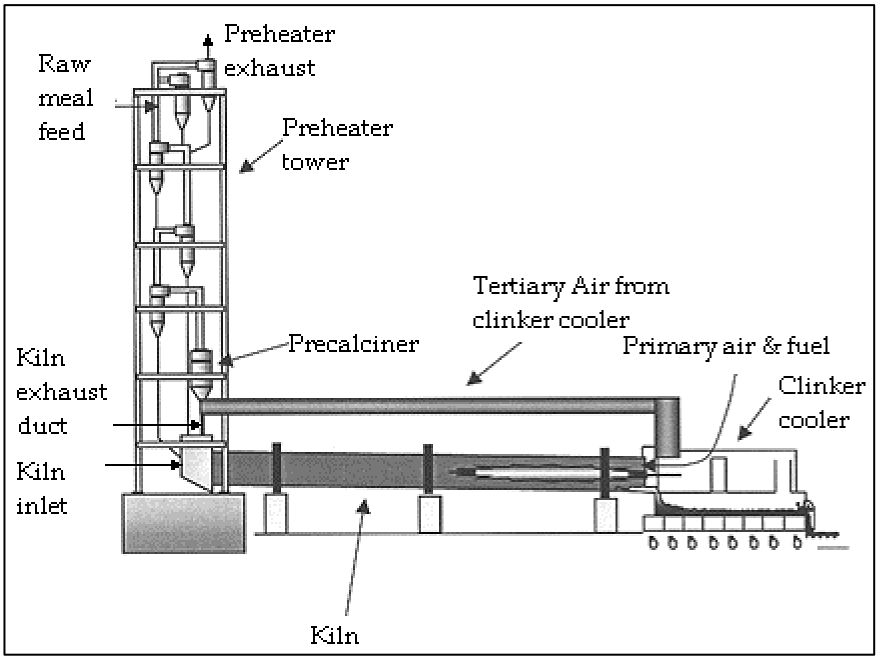
<u>Dry process kilns</u>: The basic dry process system consists of the kiln and a suspension preheater. Raw materials such as limestone and shale are ground finely and blended to produce the raw meal which is fed in at the top of the “suspension preheater” tower. This tower has a series of cyclones through which fast-moving hot gases from the kiln and, often, hot air from the clinker cooler are blown to keep the meal powder suspended in air until it reaches the same temperature as the gas. So the raw meal is heated before it enters the kiln.[130]

“The dry process is much more thermally efficient than the wet process” because the meal is a dry powder with little or no water to be evaporated, and the heat transfer from the hot gases to the raw meal is efficient because of the very high surface area-to-size ratio of meal particles and the large temperature differential between the hot gas and the cooler meal. Typically, 30-40% of the meal is decarbonated before entering the kiln.[131]

[127] Introduction to cement production line: http://m.great-wall.co/solutions/turnkey-plant/cement-production-line.html
[128] Manufacturing - the cement kiln http://www.understanding-cement.com/kiln.html
[129] http://www.understanding-cement.com/kiln.html
[130] http://www.understanding-cement.com/kiln.html
[131] http://www.understanding-cement.com/kiln.html

Most new cement plants are of the 'dry process' type and use 'precalciner' kilns which operate on a similar principle to that of preheater system but with the major addition of another burner called precalciner (Fig. 7). With this additional heat, about 85-95% of the meal is decarbonated before it enters the kiln. "Whenever economically feasible a wet process kiln can be converted to a state-of-the art dry process production facility" that includes a multi-stage preheater with or without a pre-calciner.[132]

Figure 7 Components of a Dry Process Precalciner Cement Kiln[133]



3. Emissions Control

Thermal NOx is the primary form of NOx emissions in cement manufacturing because of the high temperatures and oxidizing conditions required for fuel combustion and clinker formation.[134] The NOx controls employed in cement plants include LNBs, mid-kiln system firing, staged combustion in the calciner (SCC), SNCR, SCR[135] or approved Alternative Control Techniques (ACT - EPA-453/R-07-006) during the ozone season.

[132] http://ietd.iipnetwork.org/content/dry-kilns-multistage-pre-heaters-and-pre-calcination
[133] M. P.M. Chinyama, August 9, 2011. Chapter 11. Alternative Fuels in Cement Manufacturing. http://www.intechopen.com/books/alternative-fuel/alternative-fuels-in-cement-manufacturing
[133] https://www3.epa.gov/ttncatc1/dir1/cement_updt_1107.pdf
[134] https://www3.epa.gov/ttncatc1/dir1/cement_updt_1107.pdf
[135] S. Barna. 02/28/2007. Identification and Evaluation of Candidate Control Measures Final Technical Support Document. http://www.nj.gov/dep/baqp/2008%20Regional%20Haze/Appendix%20F-3.pdf

F. HOT MIX ASPHALT PRODUCTION PLANTS

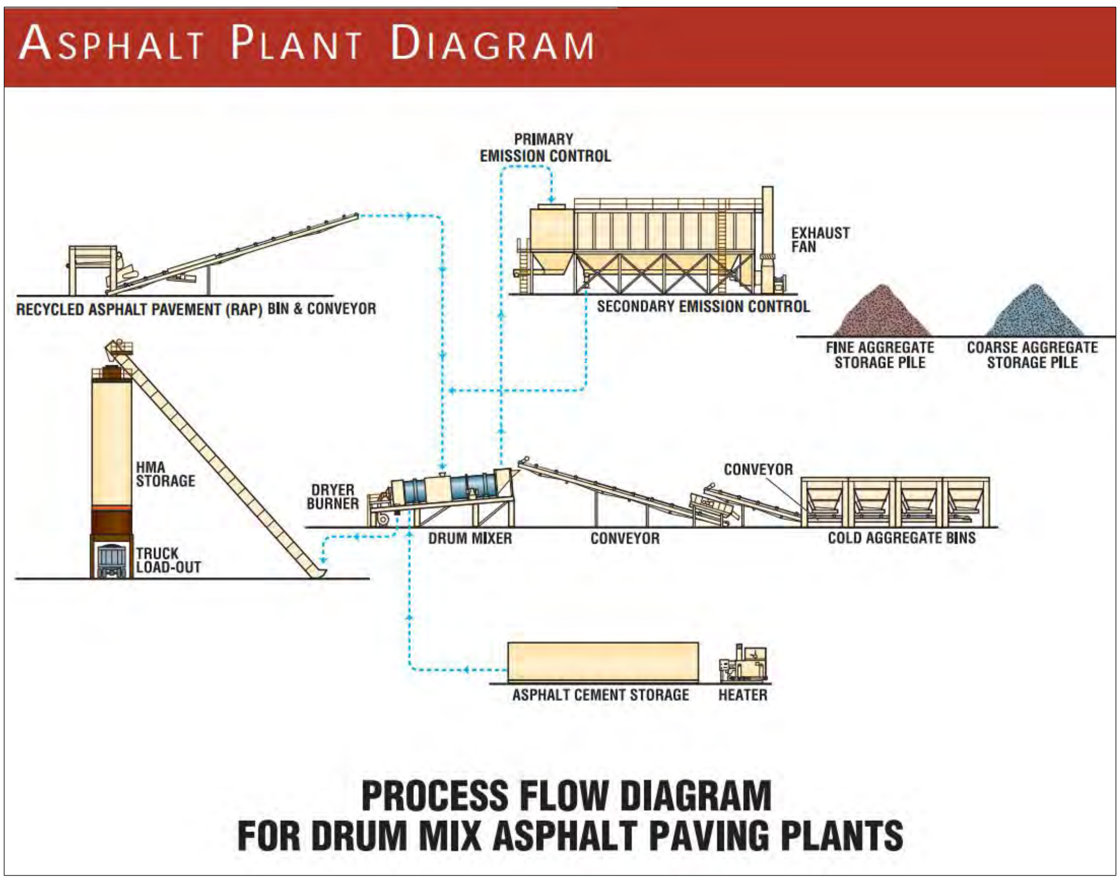
1. Hot Mix Asphalt Production Plants in OTR

Results of a recent survey of the RACT regulations for Asphalt Production Plants in the OTR are found in **Appendix E.**

2. Background

An asphalt production plant, typically a batch type asphalt plant or drum mix asphalt plant, is operated to manufacture asphalt pavement (Fig. 8). Hot mix asphalt (HMA) paving material is produced by mixing measured quantities of size-graded, high quality aggregate including any reclaimed asphalt pavement (RAP) and heated liquid asphalt cement.[136] HMA characteristics are determined by the amount and grade of asphalt cement, and the relative amounts and types of aggregate and RAP used. Aggregate and RAP (if used) constitute over 92% by weight of the total mixture. Specific percentage of fine aggregate (<74 micrometers [µm] in physical diameter) is required for the production of good quality HMA.[137]

Figure 8 Schematic of a Hot Mix Asphalt Production Plant[138]



136 AP-42, Vol. I: Section 11.1 Hot Mix Asphalt Plants https://www3.epa.gov/ttnchie1/ap42/ch11/final/c11s01.pdf
137 https://www3.epa.gov/ttnchie1/ap42/ch11/final/c11s01.pdf
138 http://www.carolinaasphalt.org/aws/CAPA/asset_manager/get_file/35278?ver=14654

"In the reclamation process, old asphalt pavement is removed from the road base. This material is then transported to the plant, and is crushed and screened to the appropriate size for further processing. The paving material is then heated and mixed with new aggregate (if applicable), and the proper amount of new asphalt cement is added to produce HMA that meets the required quality specifications."[139]

"Hot mix asphalt paving materials can be manufactured by: (1) batch mix plants, (2) continuous mix (mix outside dryer drum) plants, (3) parallel flow drum mix plants, and (4) counterflow drum mix plants. This order of listing generally reflects the chronological order of development and use within the HMA industry."[140] Nearly all plants being manufactured today are able to use gaseous fuels (natural gas) or fuel oil to dry and heat the aggregate, and also have RAP processing capability. "An HMA plant can be constructed as a permanent plant, a skid-mounted (easily relocated) plant, or a portable plant."[141]

3. Emissions Control

"The primary emission sources associated with HMA production are the dryers, hot bins, and mixers, which emit PM and a variety of gaseous pollutants." Among other emission sources found at HMA plants are hot oil heaters used to heat the asphalt storage tanks. Fugitive emissions include gaseous pollutants and PM resulting from process and open sources.[142]

"As with most facilities in the mineral products industry, batch mix HMA plants have two major categories of emissions: ducted sources, and fugitive sources. The most significant ducted source of emissions of most pollutants from batch mix, parallel flow drum mix and counterflow drum mix plants HMA plants is the rotary drum dryer." "As with any combustion process, the design, operation, and maintenance of the burner provides opportunities to minimize emissions of NOx, CO, and organic compounds."[143]

Of these pollutants, stack test results show that NOx emissions, whether generated from drum-type or batch-type dryers, depend on fuel type and size, larger dryers being higher NOx emitters. NOx emissions reductions of at least 35% can be achieved by installing low NOx burners, fluid gas recirculation, water injection, and by implementing best management practices and/or other NOx reduction measures[144,145].

Wet aggregate requires longer processing time in a dryer and results in higher NOx emissions. Reducing aggregate moisture can be achieved by following best management practices such as covering the aggregate stockpile to prevent high water content due to rain; or designing and operating stockpiles for better water drainage; and removing sand

139 https://www3.epa.gov/ttnchie1/ap42/ch11/final/c11s01.pdf
140 https://www3.epa.gov/ttnchie1/ap42/ch11/final/c11s01.pdf
141 https://www3.epa.gov/ttnchie1/ap42/ch11/final/c11s01.pdf
142 https://www3.epa.gov/ttnchie1/ap42/ch11/related/ea-report.pdf
143 AP-42, Vol. I: Section 11.1 Hot Mix Asphalt Plants https://www3.epa.gov/ttnchie1/ap42/ch11/final/c11s01.pdf
144 http://www.nj.gov/dep/rules/proposals/080408a.pdf
145 http://www.otcair.org/upload/Documents/Meeting%20Materials/RES%2006-02_Concerning%20Coordination%20and%20Implementation%20of%20Control%20Strategies_061115.pdf

and aggregate from piles at a sufficient height above the base to avoid charging wet mix to the dryer.[146]

G. GLASS FURNACES

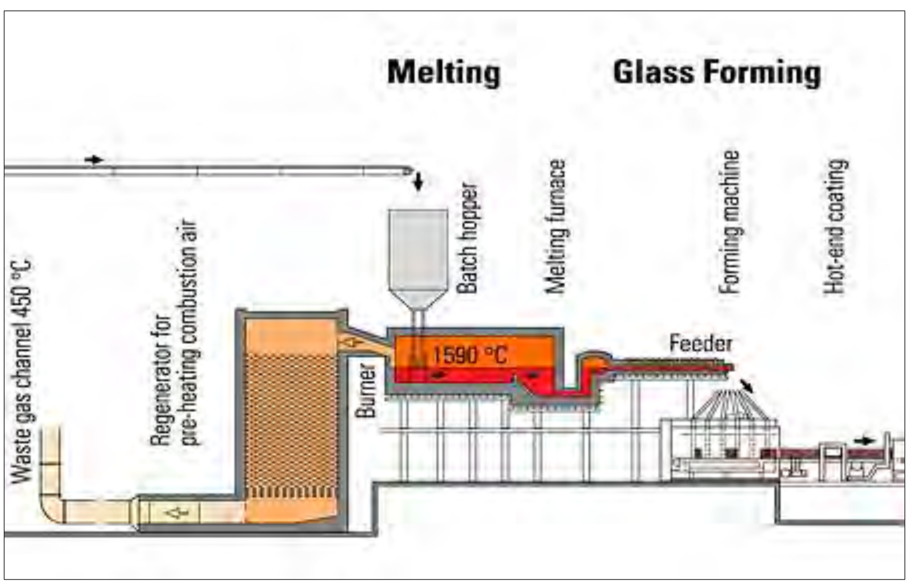
1. Glass Furnaces in OTR

Results of a recent survey of Glass Furnaces in the OTR are found in **Appendix F**.

2. Background

Glass manufacturing involves the mixing of raw materials and then melting the mixture in a furnace, a process in which dry ingredients are first mixed in a batch (Fig. 9). The batch is fed in a semi-continuous way to one end of the melting furnace where chemical reactions take place between the batch ingredients and glass is formed by cooling in such a way that the components do not crystallize but are viscous at high temperatures. Silica compounds are the most common materials used in glass production because of their ability to cool without crystallizing. Melting and fabrication of glass occurs in furnaces which vary in furnace geometry, firing pattern, heat recovery techniques, and specific temperatures depending on the type of glass produced. In principle, the production processes in the manufacture of various types of glass are essentially identical through the melting step. Each of these operations uses vastly different machinery and processes, though each shares the need for controlled heating/forming/cooling steps. All glass furnaces operate at temperatures where NOx formation takes place.[147]

Figure 9 Schematic of Glass Production[148]



[146] http://www.state.nj.us/dep/aqm/Sub19.pdf
[147] https://www3.epa.gov/ttncatc1/dir1/glassact.pdf
[148] Forming Glass: http://de.verallia.com/en/about-glass/glass-production

There are 3 categories of commercial glass produced in the US:

Container glass: In a typical system downstream of the melter consists of so-called individual section (I-S) machines in which molten glass "gobs" are fed into molds and containers are then formed by blowing the molten glass into the mold. The containers are then carefully cooled in the annealing section to relieve stresses introduced in the molding process to form the final products which are then inspected in machines to ensure proper dimension, and packed.[149]

Flat glass: Here, the molten glass from the fining section is poured onto a bath of molten tin and as it flows over this bath, it is gradually cooled. Then it enters an annealing section after which it is cut, packed, and either sold or further processed, generally at a separate facility.[150]

Pressed/blown glass: This production uses an extremely wide range of operations downstream of the furnace to produce items such as tableware, light bulbs, glass tubing, and other products. Unlike the other two types of glass, production of pressed/blown glass does not generally use regenerators to recover heat from the flue gas leading to its higher energy use.[151]

The heat for these reactions is usually supplied by natural gas burners that are fired over the glass melt. Heat is transferred primarily by radiation from the flame to the surface of the melt in a furnace which is designed in essentially two configurations:

End-port furnaces: These are smaller than the side-port furnaces, generally used in the container and pressed/blown industries, and limited to <175 tpd. In these furnaces, the flames travel in a U-shape over the melt from one side and flue gases exit the other.[152]

Side-port furnaces: In these furnaces which tend to provide more even heating essential for the high quality necessary for flat glass and some containers, the flames travel from one side of the furnace to the other. These furnaces are also larger with some >800 tpd.[153]

"The cycle of air flow from one checker to the other is reversed about every 15 - 30 minutes in both the end-port and side-port furnaces. In both cases, refractory-lined flues are used to recover the energy of the hot flue gas exiting the furnace to heat the refractory material called a checker. After the checker has reached a certain temperature, the gas flow is reversed and the firing begins on the other side (or end) of the furnace. The combustion air is then preheated in the hot checker and mixed with the gas to produce the flame. The combustion air preheat temperatures in flat glass furnaces can reach 1260°C (2300°F) and substantial NOx can be formed in the checkers.

149 https://www3.epa.gov/ttncatc1/dir1/glassact.pdf
150 https://www3.epa.gov/ttncatc1/dir1/glassact.pdf
151 https://www3.epa.gov/ttncatc1/dir1/glassact.pdf
152 https://www3.epa.gov/ttncatc1/dir1/glassact.pdf
153 https://www3.epa.gov/ttncatc1/dir1/glassact.pdf

Lower preheat temperatures are used in container glass, and NOx contributions there are apparently negligible."[154]

Cullet is extensively used in both container and flat glass industries where the batch components and cullet react in the melting chamber to form glass. Cullet may consist of internally recycled glass from waste in downstream operations such as cutting and forming, or it may be externally recycled from glass returned in recycle operations. Because the chemical reactions necessary to form glass have already taken place in the cullet, about half the energy is needed to melt the cullet compared to virgin batch ingredients. Because of the high quality requirements, external or "foreign" cullet is not used in flat glass production but is used in container glass production.[155]

3. Emissions Control

Potential sources of NOx formation in glass melting furnaces in glass plants include thermal NOx and the evolution of NO_x from the heating of glass raw materials containing nitrate compounds ("niter") used in certain glass formulations.[156]

"Uncontrolled NOx emissions depend primarily on various process parameters including fuel firing rate, furnace geometry, fuels used, and raw materials, and can vary significantly from site to site and from furnace to furnace. Uncontrolled thermal NOx emissions range from 8 - 10 lb NOx/ton glass produced from regenerative container glass furnaces, and will vary considerably depending on furnace age, electric boost (which substitutes electrical energy for thermal energy in container glass furnaces), batch/cullet ratio, and from site to site even for nominally similar furnaces. Assuming a heat requirement of 6MM Btu/ton glass, these emissions would correspond to 1.3 - 1.7 lb NOx/MM Btu. As a general rule, NOx emissions from large flat glass furnaces are lower and from smaller pressed/blown furnaces would be higher. NO from nitrates is of the order of 0.36 lb NO per lb niter (as $NaNO_3$) in the batch formulation."[157]

H. NATURAL GAS PIPELINES

1. Natural Gas Pipeline Compressor Prime Movers in OTR

Results of a recent survey of RACT regulations for Natural Gas Pipeline Compressor Prime Movers in the OTR are found in **Appendix 8**.

Previous Analysis by OTC SAS Committee

The OTC identified natural gas pipeline compressor prime movers as a potential category for emission control strategies at its November, 2010 meeting and tasked the SAS Committee to explore the issue. In 2011 a SAS workgroup prepared a white paper to describe the issue and recommend potential Commission action, e.g., adopt a model rule drafted by the SAS to achieve NOx emissions reductions from this emission source

[154] https://www3.epa.gov/ttncatc1/dir1/glassact.pdf
[155] https://www3.epa.gov/ttncatc1/dir1/glassact.pdf
[156] https://www3.epa.gov/ttncatc1/dir1/glassact.pdf
[157] https://www3.epa.gov/ttncatc1/dir1/glassact.pdf

and assist the OTC states in achieving the National Ambient Air Quality Standards (NAAQS) for ozone.

Within the OTR, natural gas pipeline compressor prime movers fueled by natural gas are used in several phases of natural gas supply: 1) gathering the natural gas from the well field and transporting it to the main transportation pipeline system; 2) moving natural gas through the main pipeline system to distribution points and end users; and 3) injecting and extracting natural gas from gas storage facilities. These natural gas pipeline compressor prime movers, mostly driven by internal combustion (IC) reciprocating engines and combustion turbines, are a significant source of nitrogen oxide (NOx) emissions year-round. Data sources indicate that nine OTR states have large natural gas compressor facilities (CT, MA, MD, ME, NJ, NY, PA, RI, VA); three OTR states contain a number of natural gas well field compressors (MD, NY, PA); and two OTR states have natural gas underground storage facilities (PA, NY).

The SAS Committee examined other areas of natural gas production (beyond the natural gas pipeline compressor prime movers addressed by the white paper) and concluded that potentially significant NOx reductions may be possible from the "upstream" activities of well drilling, well completion, and well head and field gathering natural gas compressor prime movers. Preliminary information indicates that NOx emissions from these sources may greatly exceed those of the pipeline and underground storage compression sources. This is more evident in the expansion of natural gas production due to shale gas activities.

Only limited data were available regarding the population of natural gas pipeline compressor prime movers fueled by natural gas in the OTR at the time that this white paper was written. The most comprehensive data that were available at that time was the 2007 emissions inventory (including a MARAMA point source emissions inventory for that year); therefore, 2007 was the base year used for analysis.[158] The 2007 data indicate that there are a multitude of natural gas compressor facilities in the OTR (including 150 classified as "major emissions sources") including 2-stroke lean-burn internal combustion (IC) reciprocating engines, 4-stroke lean-burn IC reciprocating engines, 4-stroke rich-burn IC reciprocating engines, and combustion turbines. The 2007 data showed:

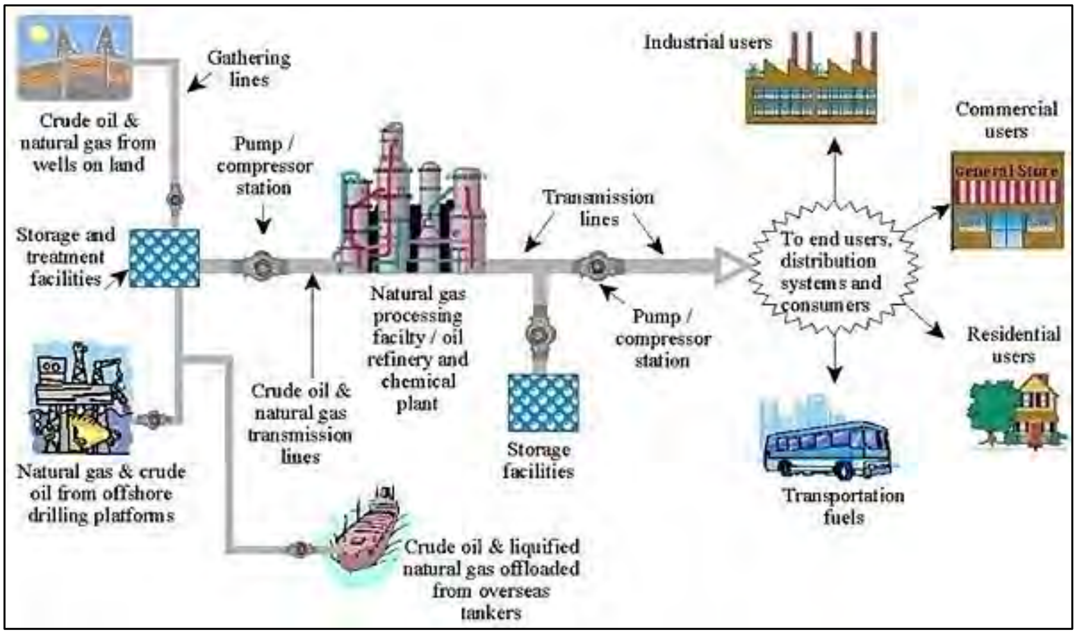
- At least 409 reciprocating engine prime movers with ratings of 200 - 4300 hp, which includes a large number of makes and models
- At least 125 combustion turbine prime movers with ratings of 1000 - 20,000 hp, which includes a moderate number of makes and models.

Many of these prime movers may be >40 years old. The MARAMA point source emissions inventory data indicates that in 2007 this population of natural gas prime movers emitted ~11,000 tons of NOx in the OTR annually (~30 tpd on average).

[158] OTC Nat Gas Compressor Prime Mover Inventory Rev 092711 from BC 092513.xlsx.

2. Background

Figure 3 Oil and Gas Pipeline System Overview[159,160]



Pumps and compressors are important components of fuel (such as unrefined petroleum, petroleum products, and liquefied natural gas) transport systems working on the same operating principle with the former being used for liquids and the latter for gas.[161] Pumps and compressor stations are used to convey these products through pipelines over long distances to their final destination for distribution to refineries and for end-use by consumers or rerouting into storage areas during periods of low demand (Fig. 10). Gases and liquids are moved through impellers in the compressor, or pump. This increases the pressure at the outlet of the component. To keep the Natural gas flowing through the pipelines, it is compressed into a liquid state by applying pressure through compressors and at lowered temperature and avoid "friction losses" in the pipe.[162]

The number of compressor station facilities located along a natural gas pipeline vary (one every 40-100 miles)[163], and the amount of pressure they generate (200-1,500 pounds per square inch (psi))[164], vary depending on the topography of the area across the pipelines traverse (those on hilly terrain require more frequent pressure increases

[159] Department of Transportation, Fact Sheet: Pump and Compressor Stations; https://primis.phmsa.dot.gov/comm/FactSheets/FSPumpStations.htm
[160] https://primis.phmsa.dot.gov/comm/FactSheets/FSPumpStations.htm
[161] https://primis.phmsa.dot.gov/comm/FactSheets/FSPumpStations.htm
[162] https://primis.phmsa.dot.gov/comm/FactSheets/FSPumpStations.htm
[163] https://primis.phmsa.dot.gov/comm/FactSheets/FSPumpStations.htm
[164] Compressor Stations: What They Do, How They Work, and Why They Are Important. 01/21/2014. http://setxind.com/midstream/compressor-stations-what-how-why/

than on flat terrain), the pipeline length and diameter, the product being moved, design characteristics of the compressor or pump.
"Supply and demand can also be a factor at times in the level of compression required for the flow of the natural gas."[165] Pumps are positioned approximately every 20-100 miles.[166]

Compressor stations include several key component parts:

Compressor Unit –is the primary equipment "which actually compresses the gas". "Some compressor stations may have multiple compressor units depending on the needs of the pipeline."[167] The compressor unit is a large engine which could be one of the three following types[168]:

- Turbines with Centrifugal Compressors – These units use turbines for compression fueled by natural gas from the pipeline itself.
- Electric Motors with Centrifugal Compressors – These are also centrifugal compressors but are powered by high voltage electric motors.
- Reciprocating Engine with Reciprocating Compressor – These compressors use large engines "to crank reciprocating pistons located within cylindrical cases on the side of the unit" to compress the gas, and are fueled by natural gas.[169]

Filters, Scrubbers, Strainers: remove liquids (e.g. water, hydrocarbons), dirt, particles, and other impurities from the natural gas, which though considered "dry" as it passes through the pipeline, water and other hydrocarbons may condense out of the gas as it travels.[170]

Gas Cooling Systems – offset the heat generated when natural gas is compressed and return it to temperatures that will not damage the pipeline.[171]

Mufflers – installed to reduce the noise level at compressor stations which is especially important near residential or other inhabited areas.[172]

Pigs[173] - cylindrical or spherical bullet shaped devices inserted into pipelines to perform multiple functions: for physical separation of different batches of a product or different types of product; for cleaning and maintenance of the pipeline by scraping away buildup/debris thus improving the efficiency and flow of the pipeline and also help prevent corrosive damage; for inspection (by Smart PIGs) of pipeline problems like welding defects, cracks, pitting, etc. using magnetic flux leakage (MFL), ultrasonics or other technologies; for positioning and monitoring (by Smart Pigs) by gathering data about the location and position of specific defects or

[165] http://setxind.com/midstream/compressor-stations-what-how-why/
[166] https://primis.phmsa.dot.gov/comm/FactSheets/FSPumpStations.htm
[167] http://setxind.com/midstream/compressor-stations-what-how-why/
[168] http://setxind.com/midstream/compressor-stations-what-how-why/
[169] http://setxind.com/midstream/compressor-stations-what-how-why/
[170] http://setxind.com/midstream/compressor-stations-what-how-why/
[171] http://setxind.com/midstream/compressor-stations-what-how-why/
[172] http://setxind.com/midstream/compressor-stations-what-how-why/
[173] What are PIG's, PIG Launchers, and PIG Receivers and Why Are They Important? http://setxind.com/midstream/what-are-pig-launchers-and-receivers/

problems in the pipeline thus helping avoid unnecessary digging up of the non-damaged parts of the pipeline or replacing while allowing regular close monitoring of problem sections to track damage progression. Caliper PIGs are used to provide estimates of the internal geometry of the pipeline.[174]

Many modern compressor stations can be completely monitored and operated remotely.

Pumps and compressors in transmission lines are regulated by the Office of Pipeline Safety and state regulators under 49 CFR Parts 192 and 195.[175]

3. Emissions Control

Reduction of NOx emissions from natural gas pipeline compressor stations and transmission facilities involve the use of combustion-based technologies including low emissions combustion (LEC) strategies like enhanced A/F mixing, use of operational controls such as ignition timing, A/F ratios, and other (non-LEC) technologies like exhaust gas recirculation and SCR for lean burn reciprocating engines, and NSCR for rich burn reciprocating engines.[176]

IV. Appendices

A. Industrial/Commercial/Institutional (ICI) Boilers in OTR

B. Combustion Turbines in OTR

C. Internal Combustion Engines (ICEs in OTR

D. Municipal Waste Combustors (MWCs in OTR

E. Asphalt Production Plants in OTR

F. Glass Furnaces in OTR

G. Natural Gas Pipelines in OTR

[174] http://setxind.com/midstream/what-are-pig-launchers-and-receivers/

[175] https://primis.phmsa.dot.gov/comm/FactSheets/FSPumpStations.htm

[176] Availability and Limitations of NOx Emission Control Resources for Natural Gas-Fired Reciprocating Engine Prime Movers Used in the Interstate Natural Gas Transmission Industry. http://www.ingaa.org/File.aspx?id=22780

APPENDIX A. INDUSTRIAL/COMMERCIAL/INSTITUTIONAL BOILERS IN OZONE TRANSPORT REGION

(Data as of 01/18/2017)

1. COAL-FIRED BOILERS	Boiler capacity (mmBtu/hr)		
	50 - 100	100 - 250	>250
State	NOx Limit (lbs/mmBtu)		
CT - Statewide	0.29 - 0.43[a]; 0.28[b] 0.12[c]	0.15 - 0.43[a]; 0.15 - 0.28[b] 0.12[c]	0.15 - 0.43[a]; 0.15 - 0.28[b] 0.12[c]
DC - District-wide	>20 mmBTU/hr, adjust combustion process	0.43	0.43
DE - Statewide	LEA, Low NOx, FGR	0.38 - 0.43	0.38 - 0.43
MA - Statewide	0.43	0.33 - 0.45	0.33 - 0.45
MD - Select counties	No limits	0.70	0.65
ME - Statewide	0.38 (firing biomass and coal)	0.38 (firing biomass and coal)	0.38 (firing biomass and coal)
NH - Statewide	0.30 - 0.50	0.30 - 1.00	0.30 - 1.40
NY - Statewide	No limits	0.08 - 0.20	0.08 - 0.20
PA - Statewide	0.45 Refinery gas unit 0.25	0.45 Refinery gas unit 0.25	Coal with SCR temp >600^{o}F (0.12); CFB (0.16); Tangential (0.35); Refinery gas unit (0.25); Other (0.40)
VA - OTR jurisdiction	0.38 - 1.0	0.38 - 1.00	0.38 - 1.00
VT - Statewide	No limits	No limits	0.70

2. NATURAL GAS-FIRED BOILERS	Boiler capacity (mmBtu/hr)		
	50 - 100	100 - 250	>250
State	NOx Limit (lbs/mmBtu)		
CT - Statewide	0.20 - 0.43[a]; 0.20 - 0.30[b]; 0.05 - 0.10[c]	0.15 - 0.43[a]; 0.10 - 0.30[b]; 0.10[c]	0.15 - 0.43[a]; 0.10 - 0.30[b]; 0.10[c]
DC - District-wide	>20 mmBTU/hr, adjust combustion process	0.20	0.20
DE - Statewide	LEA, Low NOx, FGR	0.20	0.20
MA - Statewide	0.10	0.20	0.20
MD - Select counties	Tune-up	0.20	0.70
ME - Statewide	Tune-up (20-50 MMBtu/hr)	No limits	No limits
NH - Statewide	0.10 - 0.20	0.10 - 0.25	0.10 - 0.25
NJ - Statewide	0.05	0.10	0.10
NY - Statewide	No limits	0.08 – 0.20	0.08 – 0.20
PA - Statewide	0.10	0.10	0.10
RI - Statewide	0.10	0.10	0.20
VA - OTR jurisdiction	0.20	0.20	0.20
VT - Statewide	No limits	No limits	0.20

3. OIL-FIRED BOILERS	Boiler capacity (mmBtu/hr)					
	50 – 100		100 – 250		>250	
	NOx Limit (lbs/mmBtu)					
State	**Distillate**	**Residual**	**Distillate**	**Residual**	**Distillate**	**Residual**
CT - Statewide	0.20 - 0.43[a] 0.20 - 0.43[b] 0.10[c]	0.25 - 0.43[a] 0.25 - 0.43[b] 0.20[c]	0.15 - 0.43[a] 0.10 - 0.43[b] 0.10 - 0.15[c]	0.15 - 0.43[a] 0.15 - 0.43[b] 0.15 - 0.20[c]	0.15 - 0.43[a] 0.10 - 0.43[b] 0.10 - 0.15[c]	0.15 - 0.43[a] 0.15 - 0.43[b] 0.15 - 0.20[c]
DC - District-wide	0.30	Banned	0.25	Banned	0.25	Banned
DE - Statewide	LEA, LNB, FGR		0.38 - 0.43		0.38 - 0.43	
MA - Statewide	Tune-up		0.30	0.40	0.25 - 0.28	
MD - Select Counties	No limits		0.25		0.70	
ME - Statewide	0.30	0.30	0.30	0.30	0.30	0.30
NH - Statewide	0.12	0.30 - 0.50	0.12	0.30 - 0.50	0.12	0.30 - 0.50
NJ - Statewide	0.08	0.20	0.10	0.20	0.10	0.20
NY - Statewide	0.08 - 0.20		0.15		0.15 - 0.20	
PA - Statewide	0.12	0.20	0.12	0.20	0.12	0.20
RI - Statewide	0.12	LNB & FGR	0.12	LNB & FGR	0.25	LNB & FGR
VA - OTR jurisdiction	0.25 - 0.43		0.25 - 0.43		0.25 - 0.43	
VT - Statewide	No limits		No limits		0.30	

Notes:

- No Coal-Fired Boilers in NJ and RI; no coal-only fired boilers in ME
- In Tables 1-3: CT: [a]Existing RCSA Sec. 22a-174-22 (to be repealed as of June 1, 2018); [b]RCSA Sec. 22a-174-22e starting June 1, 2018; [c]RCSA Sec. 22a-174-22e starting June 1, 2023;
- In Tables 2-3: NJ: NOx limits apply to ICI boilers rated 25 - 100 MMBtu/hr
- LEA = Low Excess Air; FGR = Flue Gas Recirculation; LNB = Low Nox Burner;

State	4. ICI Boilers - Regulations	State Contacts
CT	Revising RCSA section 22a-174-22. Will be replaced with RCSA section 22a-174-22e (anticipate finalizing by 2017). http://www.ct.gov/deep/lib/deep/air/regulations/mainregs/sec22.pdf https://eregulations.ct.gov/eRegsPortal/Search/getDocument?guid=%7bE2C443EB-00E6-46AF-A260-65881DD13319%7d	Merrily Gere, 860 424 3416, Merrily.Gere@ct.gov
DC	20 DCMR § 805.5, RACT for Major Stationary Sources of Oxides of Nitrogen: http://www.dcregs.dc.gov/Gateway/RuleHome.aspx?RuleNumber=20-805; 20 DCMR § 801, includes a ban on No. 5 fuel oil and heavier as of July 1, 2016: http://www.dcregs.dc.gov/Gateway/RuleHome.aspx?RuleNumber=20-801	Alexandra Catena, 202 535-2989, alexandra.catena@dc.gov
DE	7 DE Admin Code 1112, Control of Nitrogen Oxides Emissions: http://regulations.delaware.gov/AdminCode/title7/1000/1100/1112.shtml 7 DE Admin Code 1142, Specific Emission Control Requirements: http://regulations.delaware.gov/AdminCode/title7/1000/1100/1142.shtml#TopOfPage http://www.dnrec.delaware.gov/dwhs/Info/Regs/Documents/Reg1142_S1_Recoded_v1.pdf	Mark Prettyman 302-739-9402 mark.prettyman@state.de.us
MA	MassDEP proposed amendments to NOx RACT affecting emission limits for Large Boilers, turbines, and engines and solicited public comment till September 26, 2016. MassDEP is currently preparing the final regulations and Response to Comments.	Marc Cohen, 617.292.5873, Marc.Cohen@MassMail.State.MA.US
MD	COMAR 26.11.09.08 B, E, F & J - Evaluating potential need for changes; http://www.dsd.state.md.us/COMAR/SearchTitle.aspx?scope=26	Randy Mosier, 410 537 4488, Randy.Mosier@maryland.gov
ME	*Reasonably Available Control Technology For Facilities that Emit Nitrogen Oxides (NOx-RACT)*, 06-096 C.M.R. ch. 138: http://www.maine.gov/dep/air/rules/index.html	Jeff Crawford, (207) 287-7647, jeff.s.crawford@maine.gov
NH	NH Administrative Rule Env-A 1300 *NOx RACT* http://des.nh.gov/organization/commissioner/legal/rules/documents/env-a1300.pdf Parts Env-A 1303 through Env-A 1305	Gary Milbury, 603 271-2630 Gary.Milbury@des.nh.gov
NJ	N.J.A.C. 7:27 19.7, based on OTC ADDENDUM TO RESOLUTION 06-02 http://www.state.nj.us/dep/aqm/Sub19.pdf	Peg Gardner, 609 292 7095, Margaret.Gardner@dep.nj.gov
NY	Subpart 227-2, Effective: 7/8/2010, Submitted: 8/19/2010, Final: 77 FR 13974, 78 Fr 41846; https://www.federalregister.gov/articles/2013/07/12/2013-16493/approval-and-promulgation-of-implementation-plans-new-york-state-ozone-implementation-plan-revision	John Barnes, 518 402 8396, john.barnes@dec.ny.gov; Robert Bielawa, robert.bielawa@dec.ny.gov
PA	Additional RACT Requirements for Major Sources of NOx and VOCs. Sections 129.96 - 129.100. Control of NOX from Major Sources of NOx and VOC. Effective April 23, 2016. Federal Register –TBD; Final RACT 2 Rule (46 Pa.B. 2036, April 23, 2016). http://www.pabulletin.com/secure/data/vol46/46-17/694.html	Susan Hoyle, shoyle@pa.gov Randy Bordner, ranbordner@pa.gov Susan Foster, sufoster@pa.gov Sean Wenrich, sewenrich@pa.gov
RI	Air Pollution Control Regulation Number 27, Control of Nitrogen Oxide Emissions	Laurie Grandchamp, 401 222 2808, laurie.grandchamp@dem.ri.gov
VA	9 VAC 5 Chapter 40 Article 51; http://www.deq.virginia.gov/Portals/0/DEQ/Air/Regulations/451.pdf	Doris McLeod, 804-698-4197, doris.mcleod@deq.virginia.gov
VT	No action to date; http://dec.vermont.gov/air-quality/laws	Doug Elliott, 802 377 5939, Doug.Elliott@vermont.gov

APPENDIX B. COMBUSTION GAS TURBINE ENGINES IN OZONE TRANSPORT REGION

(Data as of 01/18/2017)

1. TURBINE ENGINES (>25 MW)	Simple Cycle		Combined Cycle	
	Gas-fired	Oil-fired	Gas-fired	Oil-fired
State	**NOx Limit (ppmvd @15% O_2)**			
CT - Statewide	258 (42 - 0.9 lb/MMBtu)[a] 42 – 55[b]; 40[c]	240 (40 - 0.9 lb/mmBtu)[a] 40 – 75[b]; 40 – 50[c]	258 (42 - 0.9 lb/MMBtu)[a] 42[b]; 25[c]	240 (40 - 0.9 lb/mmBtu)[a] 40 – 65[b]; 40 – 42[c]
DC - District-wide (If ≥100 mmBTU/hr)	NA	75	NA	NA
DE - Statewide	42	88	42	88
MA - Statewide	65	100	42	65
MD - Select Counties	42	65	42	65
ME - Statewide	NA	NA	3.5 – 9.0	42
NH - Statewide	25 (55 for pre-1999)	75	42	65
NJ - Statewide (≥15 MW)	25 (1.00 lb/MWh)	42 (1.60 lb/MWh)	25 (0.75 lb/MWh)	42 (1.20 lb/MWh)
NY - Statewide	50	100	42	65
PA - Statewide	>1,000 bhp & <6,000 bhp (150); >6000 BHP (42)	>1,000 bhp and <6,000 bhp (150); >6000 BHP (96)	1,000 bhp and <180 MW (42); >180 MW (4)	1,000 bhp and <180 MW (96); >180 MW (8) F42
RI - Statewide	No RACT Sources (new only)	No RACT Sources (new only)	No RACT Sources (new only)	No RACT Sources (new only)
VA - OTR jurisdiction	42	65 - 77	42	65 - 77
VT - Statewide	NA			

Notes:

- CT: [a]Existing RCSA Sec. 22a-174-22 (to be repealed as of June 1, 2018); [b]RCSA Sec. 22a-174-22e starting June 1, 2018; [c]RCSA Sec. 22a-174-22e starting June 1, 2023.
- NJ: lb/mmBtu limit converted to ppmvd @15% O_2 based on Part 75 Eq-F5 and F-factors of 8710 for natural gas and 9190 for oil; lb/MWh limit converted to ppmvd@15% O_2 based on New Jersey technical support document; 25 ppm ≈ 1.0 lb/MWh for simple cycle gas; 42 ppm ≈ 1.60 lbs/hr for simple cycle oil. (NJ Proposal Number: PRN 2008-260).
- NA = Not Applicable

State	2. Combustion Gas Turbine Engines – Regulations	State Contacts
CT	RCSA section 22a-174-22 will be repealed as of June 1, 2018 and will be replaced with RCSA section 22a-174-22e (finalized December 22, 2016). http://www.ct.gov/deep/lib/deep/air/regulations/mainregs/sec22.pdf https://eregulations.ct.gov/eRegsPortal/Search/getDocument?guid=%7bE2C443EB-00E6-46AF-A260-65881DD13319%7d	Merrily Gere, 860 424 3416, Merrily.Gere@ct.gov
DC	20 DCMR § 805.4, RACT for Major Stationary Sources of Oxides of Nitrogen: http://www.dcregs.dc.gov/Gateway/RuleHome.aspx?RuleNumber=20-805;	Alexandra Catena, 202 535-2989, alexandra.catena@dc.gov
DE	7 DE Admin Code 1112, Control of Nitrogen Oxides Emissions: http://regulations.delaware.gov/AdminCode/title7/1000/1100/1112.shtml 7 DE Admin Code 1148, Control of Stationary Combustion Turbine Electric Generating Unit Emissions: http://regulations.delaware.gov/AdminCode/title7/1000/1100/1148.shtml	Mark Prettyman, 302-739-9402, mark.prettyman@state.de.us Bob Clausen, 302-739-9402, robert.clausen@state.de.us
MA	MassDEP proposed amendments to NOx RACT affecting emission limits for Large Boilers, turbines, and engines and solicited public comment till September 26, 2016. MassDEP is currently preparing the final regulations and Response to Comments.	Marc Cohen, 617.292.5873, Marc.Cohen@MassMail.State.MA.US
MD	COMAR 26.11.09.08 G Greater than 15% capacity and less than 15% capacity; https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=0ahUKEwia9K6f2ZbOAhUI2T4KHVLHDmAQFggiMAE&url=http%3A%2F%2Fwww.mde.state.md.us%2Fprograms%2FAir%2FAirQualityPlanning%2FDocuments%2FOzone_ISIP_2012.pdf&usg=AFQjCNHMy94YhR5yKcchTc-CzzC7-pPeXA	Randy Mosier, 410 537 4488, Randy.Mosier@maryland.gov
ME	No action to date; http://www.maine.gov/dep/air/rules/index.html	Jeff Crawford, (207) 287-7647, jeff.s.crawford@maine.gov
NH	NH Administrative Rule Env-A 1300 *NOx RACT* (Part Env-A 1306 *Combustion Turbines*) http://des.nh.gov/organization/commissioner/legal/rules/documents/env-a1300.pdf	Gary Milbury 603 271-2630, gary.milbury@des.nh.gov
NJ	N.J.A.C. 7:27-19.5 http://www.state.nj.us/dep/aqm/Sub19.pdf	Peg Gardner, 609 292 7095, Margaret.Gardner@dep.nj.gov
NY	Under Development; https://www.federalregister.gov/articles/2013/07/12/2013-16493/approval-and-promulgation-of-implementation-plans-new-york-state-ozone-implementation-plan-revision	John Barnes, 518 402 8396, john.barnes@dec.ny.gov; Robert Bielawa robert.bielawa@dec.ny.gov
PA	PA's RACT Rule covers Combustion Turbines. Additional RACT Requirements for Major Sources of NOx and VOCs: Sections 129.96 - 129.100. Control of NOx from Major Sources of NOx and VOC. Effective April 23, 2016. Federal Register –TBD; https://www.portal.state.pa.us/portal/server.pt/document/1613671/1_ract_2_final_exec_summary_pdf	Susan Hoyle, shoyle@pa.gov Randy Bordner, ranbordner@pa.gov Susan Foster, sufoster@pa.gov Sean Wenrich, sewenrich@pa.gov
RI	Evaluating potential need for changes	Laurie Grandchamp, 401 222 2808, laurie.grandchamp@dem.ri.gov
VA	9 VAC 5 Chapter 40 Article 51: http://www.deq.virginia.gov/Portals/0/DEQ/Air/Regulations/451.pdf	Doris McLeod, doris.mcleod@deq.virginia.gov

VT	No action to date; http://dec.vermont.gov/air-quality/laws	Doug Elliott, 802 377 5939, Doug.Elliott@vermont.gov

APPENDIX C. INTERNAL COMBUSTION ENGINES (STATIONARY GENERATORS) IN OZONE TRANSPORT REGION

(Data as of 01/18/2017)

1. IC ENGINES >500 hp	NOx Limit (g/hp-hr)			
State	**Gas-fired, Lean Burn**	**Gas-fired, Rich Burn**	**Diesel**	**Dual Fuel**
CT - Statewide	2.5*; 1.5 - 2.0**	2.5*; 1.5 - 2.0**	8.0*; 1.5 - 2.3**	Multi-fuel provisions*;**
DC - Districtwide	NA			
DE - Statewide	Technology Stds.	Technology Stds.	Technology Stds.	Technology Stds.
MA - Statewide	3.0	1.5	9.0	9.0
MD - Select Counties	150 ppmvd @ 15% O_2 (Approx. 1.7 g/hp-hr)*	110 ppmvd @ 15% O_2 (Approx. 1.6 g/hp-hr)*	175 ppmvd @ 15% O_2	125 ppmvd @ 15% O_2
ME - Statewide	NA	NA	3.7 (Source-specific RACT)	NA
NH - Statewide	2.5	1.5	8.0	8.0
NJ - Statewide	1.5	1.5	2.3	2.3
NY - Statewide	1.5	1.5	2.3	2.3
PA - Statewide	3.0	2.0	8.0	8.0
RI - Statewide	2.5	1.5	9.0	Not specified in Regulation, no sources.
VA - OTR Jurisdiction	Source-specific RACT			
VT - Statewide	4.8	4.8	4.8	4.8

Notes:

- CT: * existing RCSA section 22a-174-22 (to be repealed as of June 1, 2018); ** RCSA section 22a-174-22e starting June 1, 2023
- MD: * Conversion factors from ppmv @ 15% O_2 to g/hp-hr from EPA ACT, July 1993 EPA453-R-93-032
- NJ: For an engine ≥37 kW and that has been modified on or after March 7, 2007, 0.90 grams/bhp-hr or an emission rate which is equivalent to a 90% NOx reduction from the uncontrolled NOx emission level
- NA = Not Applicable

State	2. IC ENGINES >500 hp – Regulations	State Contacts
CT	RCSA section 22a-174-22 will be repealed as of June 1, 2018 and will be replaced with RCSA section 22a-174-22e (finalized December 22, 2016). http://www.ct.gov/deep/lib/deep/air/regulations/mainregs/sec22.pdf https://eregulations.ct.gov/eRegsPortal/Search/getDocument?guid=%7bE2C443EB-00E6-46AF-A260-65881DD13319%7d	Merrily Gere, 860 424 3416, Merrily.Gere@ct.gov
DC	NA	Alexandra Catena, 202 535-2989, alexandra.catena@dc.gov
DE	7 DE Admin Code 1112, Control of Nitrogen Oxides Emissions http://regulations.delaware.gov/AdminCode/title7/1000/1100/1112.shtml#TopOfPage 7 DE Admin Code 1144, Control of Stationary Generator Emissions http://regulations.delaware.gov/AdminCode/title7/1000/1100/1144.shtml#TopOfPage	Mark Prettyman, 302-739-9402, mark.prettyman@state.de.us
MA	MassDEP proposed amendments to NOx RACT affecting emission limits for Large Boilers, turbines, and engines and solicited public comment till September 26, 2016. MassDEP is currently preparing the final regulations and Response to Comments.	Marc Cohen, 617.292.5873, Marc.Cohen@MassMail.State.MA.US
MD	COMAR 26.11.36	Randy Mosier, 410 537 4488, Randy.Mosier@maryland.gov
ME	Source-specific RACT per Title V license	Jane Gilbert (207) 287-2455, jane.gilbert@maine.gov
NH	NH Administrative Rule Env-A 1300 *NOx RACT* (Part Env-A 1307 *Stationary Internal Combustion Engines*) http://des.nh.gov/organization/commissioner/legal/rules/documents/env-a1300.pdf	Gary Milbury 603 271-2630, gary.milbury@des.nh.gov
NJ	N.J.A.C. 7:27-19.8 http://www.state.nj.us/dep/aqm/Sub19.pdf	Peg Gardner, 609 292 7095, Margaret.Gardner@dep.nj.gov
NY	Part 222, In Progress	John Barnes, 518 402 8396, john.barnes@dec.ny.gov; Robert Bielawa, robert.bielawa@dec.ny.gov
PA	Additional RACT Requirements for Major Sources of NOx and VOCs. Sections 129.96 - 129.100. Control of NOx from Major Sources of NOx and VOC. Effective April 23, 2016. Federal Register -TBD	Susan Hoyle, shoyle@pa.gov Randy Bordner, ranbordner@pa.gov Susan Foster, sufoster@pa.gov Sean Wenrich, sewenrich@pa.gov
RI	Air Pollution Control Regulation Number 27, Control of Nitrogen Oxide Emissions	Laurie Grandchamp, 401 222 2808, laurie.grandchamp@dem.ri.gov
VA	9 VAC 5 Chapter 40 Article 51; http://www.deq.virginia.gov/Portals/0/DEQ/Air/Regulations/451.pdf	Doris McLeod, doris.mcleod@deq.virginia.gov
VT	VT Regulation 5-271	Doug Elliott, 802 377 5939, Doug.Elliott@vermont.gov

APPENDIX D. MUNICIPAL WASTE COMBUSTORS IN OZONE TRANSPORT REGION

(Data as of 01/18/2017)

State	Municipal Waste Combustor (MWC) Facility	Unit # - Capacity (tons/day)	NOx Standard (ppmvd @7% O_2)	Ammonia Slip Limit (ppmvd @7% O_2)	Averaging Time	Control Technology	Type of System	Date of Installation - Startup
CT	Covanta Southeastern CT (Preston)	1, 2 - 344.5 each	150 for all[a]	20[a]	24 hr daily av.	SNCR	MB - WW	12-4-1991
	Wheelabrator Bridgeport	1, 2, 3 - 750 each	150 for all[a]	20[a]	24 hr daily av.	SNCR	MB - WW	1-13-1988
	Covanta Bristol	1, 2 - 358 each	150 for all[a]	20[a]	24 hr daily av.	SNCR	MB - WW	10-23-1987
	Wheelabrator Lisbon	1, 2 - 562.4 each	150 for all[a]	20[a]	24 hr daily av.	SNCR	MB - WW	10-19-1995
	MIRA (Hartford)	1, 2, 3 - 675 each	146 for all	20[a]	24 hr daily av.	SNCR	Processed MWC	9-4-1987
MA	SEMASS	1, 2 - 1000 each	250 for all	10 - default	24 hr		RDF Stoker	1-1-1988
	SEMASS	3 - 1000	180		24 hr	SNCR	RDF stoker	
	Wheelabrator N. Andover	1, 2 - 750 each	205 for all		24 hr	SNCR	MB - WW	3-1/4-1-1985
	Wheelabrator Saugus	1, 2 - 750 each	205 for all		24 hr	SNCR	MB - WW	6-30-1975
	Wheelabrator Millbury	1, 2 - 750 each	205 for all		24 hr	SNCR	MB - WW	9-17-1987
	Covanta Haverhill	1, 2 - 825 each	205 for all		24 hr	SNCR	MB - WW	4-1-1989
	Covanta Springfield	1,2,3 - 136 each	167 for all		24 hr	FGR	MB - REF	5-1-1988
	Covanta Pittsfield	1,2,3 - 120 each	192 for all		24 hr	FGR	MB - REF	6-1-1981
MD	Wheelabrator	3 - 750	205	None	24-hr	SNCR	MB - grate	1985
	Mont. Covanta	3 - 600	205	None	24-hr	SNCR	MB - grate	1995
ME	Eco Maine - Portland	1,2 - 275 each	180	10	24-hr daily av.	SNCR	MB-WW	1988
	Mid Maine Waste Action Corp	1,2 - 125 each	315 (summer) 350 (winter)	NA	24-hr daily av.	NA	MB - oscillating 210°	1992
	Penobscot Energy Recovery Co	1,2 – 360.5 each	230	NA	24-hr daily av	NA	RDF Stoker	1988
NH	Wheelabrator – Concord	1,2 - 287.53 each	0.53 lb/MMBtu (RACT) 0.35 (MWC Std)	20	calendar day avg.	SNCR	MB	1988
	Wheelabrator – Claremont	1,2 – 115 each	0.53 lb/MMBtu	20	calendar day avg.	SNCR	MB	1986
NJ	Essex CRRF (PI 07736)	1,2,3 – 2700 each	150 for all	50	calendar day	SNCR	MB	3-1988
	Warren CRRF (PI 85455)	1,2 – 438 each	150 for all	50	calendar day	SNCR	MB	7-31-1986
	Camden CRRF (PI 51614)	1,2,3 – 1236 each	150 for all	20	calendar day	SNCR	MB	12-7-1988
	Union CRRF (PI 41814)	1,2,3 – 1540 each	150 for all	50	calendar day	SNCR	MB	12-30-1991

	Gloucester CRRF (PI 55793)	1,2 – 575 each	150 for all	20	calendar day	SNCR	MB	6-9-1988

State	Municipal Waste Combustor (MWC) Facility	Unit # - Capacity (tons/day)	NOx Standard (ppmvd @7% O_2)	Ammonia Slip Limit (ppmvd @7% O_2)	Averaging Time	Control Technology	Type of System	Date of Installation-Startup
NY	Babylon RRF	1, 2 - 375 each	150 for all	None	24 hr	SNCR	MB - SC	1988
	Hempstead RRF	1, 2, 3 - 773 each	185 for all	None	365 days rolling av.	Part 231		1989
	Huntington RRF	1, 2, 3 - 250 each	185 for all	50	3 hr rolling	SNCR	MB - WW	1991
	MacArthur RRF	1, 2 - 242.5 each	170 for all	None	24 hr		MB - RC	1989
	Dutchess Co RRF	1, 2 - 228 each	170 for all	None	24 hr		MB - RC	1989
	Wheelabrator Westchester	1, 2 - 750 each	184 for all	None	24 hr		MB - SC	1984
	Wheelabrator Hudson Falls	1, 2 - 275 each	372 for all	None	1 hr		MB - WW	1991
	Onondaga County RRF	1, 2, 3 - 330 each	200 for all	50	3 hr	SNCR	MB - REF	1994
	Oswego County RRF	1, 2, 3, 4 - 50 each	none	None		none	RDF incinerator	1984
	Covanta Niagara	1, 2 - 1097.5 each	205 for all	50	24 hr	SNCR	MB - SC	1996
PA	Covanta Delaware Valley	1 - 585	180	NA	24 hr	None	MB - RC	3-1-1991
			88.56 lb/hr		Unknown			
			0.42 lb/MMBtu		Unknown			
		2 - 585	180		24 hr	None	MB - RC	3-1-1991
			88.56 lb/hr		Unknown			
			0.42 lb/MMBtu		Unknown			
		3 - 585	180		24 hr	None	MB - RC	3-1-1991
			88.56 lb/hr		Unknown			
			0.42 lb/MMBtu		Unknown			
		4 - 585	180		24 hr	None	MB - RC	4-18-1991
			88.56 lb/hr		Unknown			
			0.42 lb/MMBtu		Unknown			
		5 - 585	180		24 hr	None	MB - RC	4-23-1991
			88.56 lb/hr		Unknown			
			0.42 lb/MMBtu		Unknown			
		6 - 585	180		24 hr	None	MB - RC	6-8-1991
			88.56 lb/hr		Unknown			
			0.42 lb/MMBtu		Unknown			
	Covanta Plymouth	1 - 608	205	10	Unknown	SNCR	RG - WW	1-1-1991
			109 lb/hr		Unknown			

State	Municipal Waste Combustor (MWC) Facility	Unit # - Capacity (tons/day)	NOx Standard (ppmvd @7% O_2)	Ammonia Slip Limit (ppmvd @7% O_2)	Averaging Time	Control Technology	Type of System	Date of Installation-Startup
PA		2 - 608	205		Unknown	SNCR	RG - WW	1-1-1991
			109 lb/hr		Unknown			
	Municipal Waste Combustor (MWC) Facility	**Unit # - Capacity (tons/day)**	**NOx Standard (ppmvd @7% O_2)**	**Ammonia Slip Limit (ppmvd @7% O_2)**	**Averaging Time**	**Control Technology**	**Type of System**	**Date of Installation-Startup**
	Wheelabrator Falls Twp	1 - 800	180	No Limit	24 hr	SNCR	MB - WW	5-1-1994
			102.6 lb/hr		Unknown			
		2 - 800	180		24 hr	SNCR	MB - WW	5-1-1994
			102.6 lb/hr		Unknown			
	Lancaster Co. Resource Recovery	1 - 400	180	No Limit	24 hr	SNCR	RG - WW	12-1-1990
		2 - 400	180		24 hr	SNCR	RG - WW	12-1-1990
		3 - 400	180		24 hr	SNCR	RG - WW	12-1-1990
	York Co. Resource Recovery	1 - 450	165	NA	24 hr	None	RC	10-23-1989
			135		Annual			
		2 - 450	165		24 hr	None	RC	10-23-1989
			135		Annual			
		3 - 450	165		24 hr	None	RC	10-23-1989
			135		Annual			
	Susquehanna Resource Harrisburg	1 - 267	150	12	24 hr	SNCR	MB - WW	12-30-2005
			135		24 hr			
		2 - 267	150		24 hr	SNCR	MB - WW	2-1-2006
			135		24 hr			
		3 - 267	150		24 hr	SNCR	MB - WW	3-1-2006
			135		24 hr			
VA - OTR jurisdiction	Covanta Fairfax, Inc (Reg # 71920)	001 - 750	205 ppm, 206.3 lbs/hr, 716.2 tpy[VA1]	NA	24 hr	SNCR	RG-WW	1987
		002 - 750	205 ppm, 206.3 lbs/hr, 716.2 tpy[VA1]		24 hr	SNCR	RG-WW	1987
		003 - 750	205 ppm, 206.3 lbs/hr, 716.2 tpy[VA1]		24 hr	SNCR	RG-WW	1987
		004 - 750	205 ppm, 206.3 lbs/hr, 716.2 tpy[VA1]		24 hr	SNCR	RG-WW	1987
	Covanta Alexandria/Arlington (Reg # 71895)	001-325	205 ppm [VA2]	NA	24 hr	SNCR	RG-WW	1988
		002-325	205 ppm [VA2]		24 hr	SNCR	RG-WW	1988

		002-325	205 ppm [VA2]		24 hr	SNCR	RG-WW	1988

Notes:

- No MWCs in DE, DC, RI, & VT;
- CT: [a]Current Standard as of 08/02/16;
- ME: Maine Energy Recovery Co (RDF Stoker) installed in 1987 closed permanently in 2012
- VA: [VA1]Final 2008 O_3 NAAQS RACT standard for Covanta Fairfax units has not yet been determined. Review/analysis is ongoing; [VA2]Final 2008 O_3 NAAQS RACT standard for Covanta Alexandria/Arlington units has not yet been determined. Review/analysis is ongoing.
- Abbreviations: mass burn = MB; waterwall = WW; rotary waterwall = RC; refractory wall = REF; refuse-derived fuel = RDF; reciprocating grate waterwall = RG – WW; mass burn - single chamber = MB – SC; NA = Not Applicable.

State	MWC - Regulations	State Inspectors/Contacts
CT	Revised RCSA section 22a-174-38 (finalized 8/2/16) http://eregulations.ct.gov/eRegsPortal/Search/RMRView/PR2015-192	Merrily Gere, 860 424 3416, Merrily.Gere@CT.gov
MA	310 CMR 7.08(2): http://www.mass.gov/courts/docs/lawlib/300-399cmr/310cmr7.pdf Covanta Springfield and Covanta Pittsfield - permit	SEMASS: Dan Disalvio, 508 946 2878, dan.disalvio@state.ma.us; Wheelabrator (N. Andover & Saugus) & Covanta Haverhill: Joseph Su, 978 694 3283, joseph.su@state.ma.us; Wheelabrator Millbury: Paul Dwiggins, 508 767 2760, paul.dwiggins@state.ma.us; Covanta (Springfield & Pittsfield): Todd Wheeler, 413 755 2297, todd.wheeler@state.ma.us
MD	COMAR 26.11.08.08; COMAR 26.11.08.07 & 26.11.08.08 - Revising NOx RACT for Large MWCs; planned proposal June 2016: http://www.dsd.state.md.us/comar/SubtitleSearch.aspx?search=26.11.08.* http://www.dsd.state.md.us/comar/SubtitleSearch.aspx?search=26.11.09.*	Wheelabrator: Ariane Kouamou-Nouba, 410 537 4233, ariane.kouamou-nouba@maryland.gov Mont. Covanta: Mitchell Greger, 410 537 3235, mitchell.greger@maryalnd.gov
ME	http://www.maine.gov/dep/air/rules/	Jeff Crawford, 207 287 7647, jeff.s.crawford@maine.gov
NH	Env-A 1309 (RACT) Env-A 3300 (NH MWC Std); Evaluating comments from draft RACT submittal; http://des.nh.gov/organization/commissioner/legal/rulemaking/documents/env-a3300-adpt-pstd.pdf	Gary Milbury, 603 271 2630, gary.milbury@des.nh.gov
NJ	N.J.A.C. 7:27-19.12 - basis for OTC draft MSW white paper	Essex CRRF (PI 07736): Scott Michenfelder, 609 439 2432, Scott.Michenfelder@dep.nj.gov; Warren CRRF (PI 85455): Douglas Bannon, 973 656 4444, Douglas.Bannon@dep.nj.gov Camden CRRF (PI 51614): Matthew Zehr, 609 439 9406, Matthew.Zehr@dep.nj.gov; Union CRRF (PI 41814): Robin Jones, 609 439 9418, Robin.Jones@dep.nj.gov; Gloucester CRRF (PI 55793): Vince Garbarino, 609 439 9396, Vince.Garbarino@dep.nj.gov
NY	Babylon - RRF Subpart 219-2; Hempstead - RRF Part 231; Huntington - RRF 40 CFR 52.21; MacArthur RRF - 40 CFR 60.1705(a)(1); Dutchess Co RRF - 40 CFR 60.1705(a)(1); Wheelabrator Westchester - 40 CFR 52.21(j); Wheelabrator Hudson Falls - 40 CFR 52.21(j)(2); Onondaga County RRF- 40 CFR 52.21(j); Covanta Niagara - 40 CFR 60.33(b); Part 219, Effective 12/31/1988	John Barnes, 518 402 8396, john.barnes@dec.ny.gov
PA	Covanta Delaware Valley - 25 Pa. Code §127.12 (BAT) and 25 Pa. Code §129.91 (RACT); Covanta Plymouth, Wheelabrator Falls Twp - 25 Pa. Code §127.12 (BAT) and 40 CFR Part 60, Subpart Cb; Lancaster Co. Resource Recovery - 25 Pa. Code §127.12 (BAT); York Co. Resource Recovery - 25 Pa. Code §127.12 (BAT), 25 Pa. Code §129.91 (RACT); Susquehanna Resource Harrisburg - 40 CFR Part 60, Subpart Eb, 25 Pa. Code §127.12 (BAT); Voluntary limit for netting purposes; Additional RACT Requirements for Major Sources of NOx and VOCs. Sections 129.96 - 129.100. Control of NOX from Major Sources of NOx and VOC. Effective April 23, 2016. Federal Register –TBD; http://www.pacode.com/secure/data/025/articleICIII_toc.html	Susan Hoyle shoyle@pa.gov Randy Bordner ranbordner@pa.gov Susan Foster sufoster@pa.gov Sean Wenrich sewenrich@pa.gov
VA	9 VAC 5 Chapter 40 Article 51 http://www.deq.virginia.gov/Portals/0/DEQ/Air/Regulations/451.pdf	Doris Mcleod, doris.mcleod@deq.virginia.gov

APPENDIX E. HOT MIX ASPHALT PRODUCTION PLANTS IN OZONE TRANSPORT REGION

(Data as of 01/18/2017)

State	NOx Limit (ppmvd @ 7% O_2)		
	Natural Gas	**No. 2 Oil**	**Other Fuels**
CT	No specific emission limits for Hot Mix Asphalt Production Plants		
DC	150	150	150
DE	No specific emission limits for Hot Mix Asphalt Production Plants		
MA	BACT determination for Benevento Asphalt:		
	0.044 lb/MMBtu	0.113 lb/MMBtu	0.113 lb/MMBtu
MD			
ME	0.12 lb/ton asphalt	0.12 lb/ton asphalt	0.12 lb/ton asphalt
NH	0.12 lb/ton asphalt	0.12 lb/ton asphalt	0.12 lb/ton asphalt
NJ	75	100	125*
NY	No specific emission limits for Hot Mix Asphalt Production Plants		
PA			
VA - OTR jurisdiction	NA		
VT	No specific regulatory emission limits for Hot Mix Asphalt Production Plants, but most permits contain 0.06 lb/ton asphalt limit based on application submittal.		

Notes:

- No Sources in RI;
- NJ: ***** No. 4 or heavier fuel oil or on-spec used oil or mixture of these three
- VA – OTR jurisdiction: All of ~15 plants have federally enforceable limits on their PTE of NOx and VOC to make them minor sources (<100 tpy NOX, <50 TPY VOC)
- DE: Specific emissions limitations in lb/HMA are determined on a facility by facility basis.
- DC: 150 ppmvd @ 7% O_2 is the NO_x RACT standard for major sources (25 TPY) of NO_x only (two of the three HMA facilities in DC). No NO_x RACT standard is specified for minor sources of NO_x. The third HMA facility, a 225 TPH continuous drum-mix asphalt plant, has limits on potential to emit keeping NO_x below the major source threshold. Its NO_x limits are 12.4 lb/hr and 22.0 tons per 12-month rolling period.

State	Hot Mix Asphalt Production Plants – Regulations	State Contacts
CT	RCSA section 22a-174-22 will be repealed as of June 1, 2018 and will be replaced with RCSA section 22a-174-22e (finalized December 22, 2016). Note: Neither section includes a limit that specifically applies to "asphalt production plants" but the fuel-burning equipment is regulated: http://www.ct.gov/deep/lib/deep/air/regulations/mainregs/sec22.pdf https://eregulations.ct.gov/eRegsPortal/Search/getDocument?guid=%7bE2C443EB-00E6-46AF-A260-65881DD13319%7d	Merrily Gere, 860 424 3416, Merrily.Gere@ct.gov
DC	20 DCMR § 805.6, RACT for Major Stationary Sources of Oxides of Nitrogen: http://www.dcregs.dc.gov/Gateway/RuleHome.aspx?RuleNumber=20-805	Alexandra Catena, 202 535-2989, alexandra.catena@dc.gov
DE	http://regulations.delaware.gov/AdminCode/title7/1000/1100/1112.shtml	Mark Prettyman 302-739-9402, mark.prettyman@state.de.us
MA	No specific NOx RACT emission limits for this source category in state NOx RACT regulations.	Marc Cohen 617.292.5873, Marc.Cohen@MassMail.State.MA.US
MD	Search Title 26, Chapter 11; http://www.dsd.state.md.us/COMAR/SearchTitle.aspx?scope=26	Randy Mosier, 410 537 4488, Randy.Mosier@maryland.gov
ME	http://www.maine.gov/dep/air/rules/	Jeff Crawford, 207 287 7647, jeff.s.crawford@maine.gov
NH	NH Administrative Rule Env-A 1300 *NOx RACT* (Part Env-A 1308 *Asphalt Plant Rotary Dryers*) http://des.nh.gov/organization/commissioner/legal/rules/documents/env-a1300.pdf	Gary Milbury 603 271-2630, gary.milbury@des.nh.gov
NJ	N.J.A.C. 7:27-19.9, based on OTC ADDENDUM TO RESOLUTION 06-02 http://www.state.nj.us/dep/aqm/Sub19.pdf	Peg Gardner, 609 292 7095, Margaret.Gardner@dep.nj.gov
NY	Hot mix asphalt plants cap out of Title V www.dec.ny.gov/regs/2492.html	John Barnes, 518 402 8396, john.barnes@dec.ny.gov; Robert Bielawa, robert.bielawa@dec.ny.gov
PA	Additional RACT Requirements for Major Sources of NOx and VOCs. Sections 129.96 - 129.100. Control of NOX from Major Sources of NOx and VOC; Effective April 23, 2016. Federal Register -TBD Case by Case; http://www.pacode.com/secure/data/025/articleICIII_toc.html	Susan Hoyle, shoyle@pa.gov Randy Bordner, ranbordner@pa.gov Susan Foster, sufoster@pa.gov Sean Wenrich, sewenrich@pa.gov
VA - OTR jurisdiction	No asphalt plants trigger the major stationary RACT source definition under 9 VAC 5 Chapter 40 Article 51 at this time.	Doris McLeod, doris.mcleod@deq.virginia.gov
VT	No action to date; http://dec.vermont.gov/air-quality/laws	Doug Elliott, 802 377 5939, Doug.Elliott@vermont.gov

APPENDIX F. GLASS FURNACES IN OZONE TRANSPORT REGION

(Data as of 01/18/2017)

State	Facility	Emission rate (lb NOx/ ton of glass)	Averaging Time	Technology
MD				
MA	Ardagh Glass Inc. (formerly known as Saint Gobain Containers), Milford	1.3*	30 day rolling	Oxy-fuel combustion furnaces
NJ	Statewide	9.2 (flat glass); 4.0 (except flat glass)		Oxyfiring installed at rebricking
NY	Statewide	1.89 - 4.49		
PA	Statewide	4.0 (container and fiberglass furnaces); 7.0 (pressed or blown, and flat glass furnaces); 6.0 (all other glass melting furnaces)		

Notes:

- No Sources in CT, DC, DE, ME, NH, RI, VA (OTR Jurisdiction), and VT;
- MA: ***** this excludes Abnormally Low Production Rate Days, Furnace Startup, Malfunction of the Furnace, and Maintenance of the Furnace;
- NJ: Applicability depends on type of glass manufacturing , maximum production rate , PTE NOx >10tpy

State	Glass Furnaces - Regulations	State Contacts
MA	Global consent decree for Ardagh Glass Inc. (formerly Saint Gobain Containers), Milford; https://www.epa.gov/enforcement/consent-decree-saint-gobain-containers-inc	Marc Cohen, 617.292.5873, Marc.Cohen@MassMail.State.MA.US
MD	COMAR 26.11.09.08I, Search Title 26, Chapter 11; http://www.dsd.state.md.us/COMAR/SearchTitle.aspx?scope=26	Randy Mosier, 410 537-4488, Randy.Mosier@maryland.gov
NJ	N.J.A.C. 7:27-19.10, based on OTC ADDENDUM TO RESOLUTION 06-02 http://www.state.nj.us/dep/aqm/Sub19.pdf	Peg Gardner, 609 292 7095, Margaret.Gardner@dep.nj.gov
NY	Subpart 220-2 - Effective: 7/11/2010 Submitted: 8/19/2010; Final: 77 FR 13974, 78 Fr 41846; www.dec.ny.gov/regs/2492.html	John Barnes, 518 402-8396, john.barnes@dec.ny.gov; Robert Bielawa robert.bielawa@dec.ny.gov
PA	Control of NOx Emissions From Glass Melting Furnaces. Sections 129.301 - 129.310. The rule limits the emissions of NOx from glass melting furnaces on an annual basis. Effective September 21, 2011. 08/22/2011, 76 Federal Register 52283 http://www.pacode.com/secure/data/025/articleICIII_toc.html	Susan Hoyle, shoyle@pa.gov Randy Bordner, ranbordner@pa.gov Susan Foster, sufoster@pa.gov Sean Wenrich, sewenrich@pa.gov

APPENDIX G. NATURAL GAS PIPELINE COMPRESSORS IN OZONE TRANSPORT REGION

(Data as of 01/18/2017)

State	Natural Gas Pipeline Compressors – Regulations	State Contacts
CT	RCSA section 22a-174-22 will be repealed as of June 1, 2018 and will be replaced with RCSA section 22a-174-22e (finalized December 22, 2016). Note: Does not specifically apply to "natural gas pipelines" but fuel-burning equipment such as compressors is regulated; http://www.ct.gov/deep/lib/deep/air/regulations/mainregs/sec22.pdf https://eregulations.ct.gov/eRegsPortal/Search/getDocument?guid=%7bE2C443EB-00E6-46AF-A260-65881DD13319%7d	Merrily Gere, 860 424 3416, Merrily.Gere@ct.gov
DE	http://regulations.delaware.gov/AdminCode/title7/1000/1100/1112.shtml http://regulations.delaware.gov/AdminCode/title7/1000/1100/1144.shtml *	Mark Prettyman, 302-739-9402, mark.prettyman@state.de.us
MA	310 CMR 7.19(7) NOx RACT simple cycle turbine existing emission limit of 65 ppm @ 15% O_2, proposed for more stringent standard of 40 ppm in 2017. A BACT determination in 2006 for a replacement of a 53.8 MMBtu/hr Allison turbine at Tennessee Gas Pipeline Charlton station with two 50-6200LS Solar Centaur split shaft gas turbine compressor sets equipped with Solar's pre-combustion SoLoNOx technology each rated at 6,037 hp with a maximum heat input = 53.52 MMBtu/hr at ISO conditions): 15 ppm @ 15% O_2 (or alternatively 3.22 lbs/hr)	Marc Cohen, 617.292.5873, Marc.Cohen@MassMail.State.MA.US
MD	COMAR 26.11.29; Search Title 26, Chapter 11; http://www.dsd.state.md.us/COMAR/SearchTitle.aspx?scope=26	Randy Mosier, 410 537 4488, Randy.Mosier@maryland.gov
ME	Source specific BACT	Jane Gilbert, (207) 287-2455, jane.gilbert@maine.gov
NH	Regulated under Part Env-A 1306 *Combustion Turbines* (no separate rule for compressor stations)*:* http://des.nh.gov/organization/commissioner/legal/rules/documents/env-a1300.pdf	Gary Milbury, 603 271 2630, Gary.milbury@des.nh.gov
NJ	N.J.A.C. 7:27-19.5 and 19.8, amendments in progress (applicable to turbines and engines at natural gas compressor stations) based on draft OTC white paper. http://www.state.nj.us/dep/aqm/Sub19.pdf	Peg Gardner, 609 292 7095, Margaret.Gardner@dep.nj.gov
NY	Covered under NOx RACT Rule (Subpart 227-2) Effective: 7/8/2010, Submitted: 8/19/2010, Final: 77 FR 13974, 78 Fr 41846; www.dec.ny.gov/regs/2492.html	John Barnes, 518 402 8396, john.barnes@dec.ny.gov; Robert Bielawa, robert.bielawa@dec.ny.gov
PA	Additional RACT Requirements for Major Sources of NOx and VOCs. Sections 129.96 - 129.100. Control of NOx from Major Sources of NOx and VOC. Effective April 23, 2016. Federal Register - TBD (No Distinction) http://www.pacode.com/secure/data/025/articleICIII_toc.html	Susan Hoyle, shoyle@pa.gov Randy Bordner, ranbordner@pa.gov Susan Foster, sufoster@pa.gov Sean Wenrich, sewenrich@pa.gov
RI	One source; Source specific RACT for engines at compressor station	Laurie Grandchamp, 401 222 2808,

		laurie.grandchamp@dem.ri.gov
VA - OTR jurisdiction	9 VAC 5 Chapter 40 Article 51, case by case RACT	Doris McLeod, doris.mcleod@deq.virginia.gov

Notes:

- No Sources in DC and VT;
- DE: * Reg. 1144 only applies to stationary generators, and not all engines.

APPENDIX A. INDUSTRIAL/COMMERCIAL/INSTITUTIONAL BOILERS IN OZONE TRANSPORT REGION

(Data as of 01/18/2017)

1. COAL-FIRED BOILERS	Boiler capacity (mmBtu/hr)		
	50 - 100	100 - 250	>250
State	NOx Limit (lbs/mmBtu)		
CT - Statewide	0.29 - 0.43[a]; 0.28[b] 0.12[c]	0.15 - 0.43[a]; 0.15 - 0.28[b] 0.12[c]	0.15 - 0.43[a]; 0.15 - 0.28[b] 0.12[c]
DC - District-wide	>20 mmBTU/hr, adjust combustion process	0.43	0.43
DE - Statewide	LEA, Low NOx, FGR	0.38 - 0.43	0.38 - 0.43
MA - Statewide	0.43	0.33 - 0.45	0.33 - 0.45
MD - Select counties	No limits	0.70	0.65
ME - Statewide	0.38 (firing biomass and coal)	0.38 (firing biomass and coal)	0.38 (firing biomass and coal)
NH - Statewide	0.30 - 0.50	0.30 - 1.00	0.30 - 1.40
NY - Statewide	No limits	0.08 - 0.20	0.08 - 0.20
PA - Statewide	0.45 Refinery gas unit 0.25	0.45 Refinery gas unit 0.25	Coal with SCR temp >600^{o}F (0.12); CFB (0.16); Tangential (0.35); Refinery gas unit (0.25); Other (0.40)
VA - OTR jurisdiction	0.38 - 1.0	0.38 - 1.00	0.38 - 1.00
VT - Statewide	No limits	No limits	0.70

2. NATURAL GAS-FIRED BOILERS	Boiler capacity (mmBtu/hr)		
	50 - 100	100 - 250	>250
State	NOx Limit (lbs/mmBtu)		
CT - Statewide	0.20 - 0.43[a]; 0.20 - 0.30[b]; 0.05 - 0.10[c]	0.15 - 0.43[a]; 0.10 - 0.30[b]; 0.10[c]	0.15 - 0.43[a]; 0.10 - 0.30[b]; 0.10[c]
DC - District-wide	>20 mmBTU/hr, adjust combustion process	0.20	0.20
DE - Statewide	LEA, Low NOx, FGR	0.20	0.20
MA - Statewide	0.10	0.20	0.20
MD - Select counties	Tune-up	0.20	0.70
ME - Statewide	Tune-up (20-50 MMBtu/hr)	No limits	No limits
NH - Statewide	0.10 - 0.20	0.10 - 0.25	0.10 - 0.25
NJ - Statewide	0.05	0.10	0.10
NY - Statewide	No limits	0.08 – 0.20	0.08 – 0.20
PA - Statewide	0.10	0.10	0.10
RI - Statewide	0.10	0.10	0.20
VA - OTR jurisdiction	0.20	0.20	0.20
VT - Statewide	No limits	No limits	0.20

3. OIL-FIRED BOILERS	Boiler capacity (mmBtu/hr)					
	50 – 100		100 – 250		>250	
	NOx Limit (lbs/mmBtu)					
State	**Distillate**	**Residual**	**Distillate**	**Residual**	**Distillate**	**Residual**
CT - Statewide	0.20 - 0.43[a] 0.20 - 0.43[b] 0.10[c]	0.25 - 0.43[a] 0.25 - 0.43[b] 0.20[c]	0.15 - 0.43[a] 0.10 - 0.43[b] 0.10 - 0.15[c]	0.15 - 0.43[a] 0.15 - 0.43[b] 0.15 - 0.20[c]	0.15 - 0.43[a] 0.10 - 0.43[b] 0.10 - 0.15[c]	0.15 - 0.43[a] 0.15 - 0.43[b] 0.15 - 0.20[c]
DC - District-wide	0.30	Banned	0.25	Banned	0.25	Banned
DE - Statewide	LEA, LNB, FGR		0.38 - 0.43		0.38 - 0.43	
MA - Statewide	Tune-up		0.30	0.40	0.25 - 0.28	
MD - Select Counties	No limits		0.25		0.70	
ME - Statewide	0.30	0.30	0.30	0.30	0.30	0.30
NH - Statewide	0.12	0.30 - 0.50	0.12	0.30 - 0.50	0.12	0.30 - 0.50
NJ - Statewide	0.08	0.20	0.10	0.20	0.10	0.20
NY - Statewide	0.08 - 0.20		0.15		0.15 - 0.20	
PA - Statewide	0.12	0.20	0.12	0.20	0.12	0.20
RI - Statewide	0.12	LNB & FGR	0.12	LNB & FGR	0.25	LNB & FGR
VA - OTR jurisdiction	0.25 - 0.43		0.25 - 0.43		0.25 - 0.43	
VT - Statewide	No limits		No limits		0.30	

Notes:

- No Coal-Fired Boilers in NJ and RI; no coal-only fired boilers in ME
- In Tables 1-3: CT: [a]Existing RCSA Sec. 22a-174-22 (to be repealed as of June 1, 2018); [b]RCSA Sec. 22a-174-22e starting June 1, 2018; [c]RCSA Sec. 22a-174-22e starting June 1, 2023;
- In Tables 2-3: NJ: NOx limits apply to ICI boilers rated 25 - 100 MMBtu/hr
- LEA = Low Excess Air; FGR = Flue Gas Recirculation; LNB = Low Nox Burner;

State	4. ICI Boilers - Regulations	State Contacts
CT	Revising RCSA section 22a-174-22. Will be replaced with RCSA section 22a-174-22e (anticipate finalizing by 2017). http://www.ct.gov/deep/lib/deep/air/regulations/mainregs/sec22.pdf https://eregulations.ct.gov/eRegsPortal/Search/getDocument?guid=%7bE2C443EB-00E6-46AF-A260-65881DD13319%7d	Merrily Gere, 860 424 3416, Merrily.Gere@ct.gov
DC	20 DCMR § 805.5, RACT for Major Stationary Sources of Oxides of Nitrogen: http://www.dcregs.dc.gov/Gateway/RuleHome.aspx?RuleNumber=20-805; 20 DCMR § 801, includes a ban on No. 5 fuel oil and heavier as of July 1, 2016: http://www.dcregs.dc.gov/Gateway/RuleHome.aspx?RuleNumber=20-801	Alexandra Catena, 202 535-2989, alexandra.catena@dc.gov
DE	7 DE Admin Code 1112, Control of Nitrogen Oxides Emissions: http://regulations.delaware.gov/AdminCode/title7/1000/1100/1112.shtml 7 DE Admin Code 1142, Specific Emission Control Requirements: http://regulations.delaware.gov/AdminCode/title7/1000/1100/1142.shtml#TopOfPage http://www.dnrec.delaware.gov/dwhs/Info/Regs/Documents/Reg1142_S1_Recoded_v1.pdf	Mark Prettyman 302-739-9402 mark.prettyman@state.de.us
MA	MassDEP proposed amendments to NOx RACT affecting emission limits for Large Boilers, turbines, and engines and solicited public comment till September 26, 2016. MassDEP is currently preparing the final regulations and Response to Comments.	Marc Cohen, 617.292.5873, Marc.Cohen@MassMail.State.MA.US
MD	COMAR 26.11.09.08 B, E, F & J - Evaluating potential need for changes; http://www.dsd.state.md.us/COMAR/SearchTitle.aspx?scope=26	Randy Mosier, 410 537 4488, Randy.Mosier@maryland.gov
ME	*Reasonably Available Control Technology For Facilities that Emit Nitrogen Oxides (NOx-RACT)*, 06-096 C.M.R. ch. 138: http://www.maine.gov/dep/air/rules/index.html	Jeff Crawford, (207) 287-7647, jeff.s.crawford@maine.gov
NH	NH Administrative Rule Env-A 1300 *NOx RACT* http://des.nh.gov/organization/commissioner/legal/rules/documents/env-a1300.pdf Parts Env-A 1303 through Env-A 1305	Gary Milbury, 603 271-2630 Gary.Milbury@des.nh.gov
NJ	N.J.A.C. 7:27 19.7, based on OTC ADDENDUM TO RESOLUTION 06-02 http://www.state.nj.us/dep/aqm/Sub19.pdf	Peg Gardner, 609 292 7095, Margaret.Gardner@dep.nj.gov
NY	Subpart 227-2, Effective: 7/8/2010, Submitted: 8/19/2010, Final: 77 FR 13974, 78 Fr 41846; https://www.federalregister.gov/articles/2013/07/12/2013-16493/approval-and-promulgation-of-implementation-plans-new-york-state-ozone-implementation-plan-revision	John Barnes, 518 402 8396, john.barnes@dec.ny.gov; Robert Bielawa, robert.bielawa@dec.ny.gov
PA	Additional RACT Requirements for Major Sources of NOx and VOCs. Sections 129.96 - 129.100. Control of NOX from Major Sources of NOx and VOC. Effective April 23, 2016. Federal Register –TBD; Final RACT 2 Rule (46 Pa.B. 2036, April 23, 2016). http://www.pabulletin.com/secure/data/vol46/46-17/694.html	Susan Hoyle, shoyle@pa.gov Randy Bordner, ranbordner@pa.gov Susan Foster, sufoster@pa.gov Sean Wenrich, sewenrich@pa.gov
RI	Air Pollution Control Regulation Number 27, Control of Nitrogen Oxide Emissions	Laurie Grandchamp, 401 222 2808, laurie.grandchamp@dem.ri.gov
VA	9 VAC 5 Chapter 40 Article 51; http://www.deq.virginia.gov/Portals/0/DEQ/Air/Regulations/451.pdf	Doris McLeod, 804-698-4197, doris.mcleod@deq.virginia.gov
VT	No action to date; http://dec.vermont.gov/air-quality/laws	Doug Elliott, 802 377 5939, Doug.Elliott@vermont.gov

APPENDIX B. COMBUSTION GAS TURBINE ENGINES IN OZONE TRANSPORT REGION

(Data as of 01/18/2017)

1. TURBINE ENGINES (>25 MW)	Simple Cycle		Combined Cycle	
	Gas-fired	Oil-fired	Gas-fired	Oil-fired
State	NOx Limit (ppmvd @15% O_2)			
CT - Statewide	258 (42 - 0.9 lb/MMBtu)[a] 42 – 55[b]; 40[c]	240 (40 - 0.9 lb/mmBtu)[a] 40 – 75[b]; 40 – 50[c]	258 (42 - 0.9 lb/MMBtu)[a] 42[b]; 25[c]	240 (40 - 0.9 lb/mmBtu)[a] 40 – 65[b]; 40 – 42[c]
DC - District-wide (If ≥100 mmBTU/hr)	NA	75	NA	NA
DE - Statewide	42	88	42	88
MA - Statewide	65	100	42	65
MD - Select Counties	42	65	42	65
ME - Statewide	NA	NA	3.5 – 9.0	42
NH - Statewide	25 (55 for pre-1999)	75	42	65
NJ - Statewide (≥15 MW)	25 (1.00 lb/MWh)	42 (1.60 lb/MWh)	25 (0.75 lb/MWh)	42 (1.20 lb/MWh)
NY - Statewide	50	100	42	65
PA - Statewide	>1,000 bhp & <6,000 bhp (150); >6000 BHP (42)	>1,000 bhp and <6,000 bhp (150); >6000 BHP (96)	1,000 bhp and <180 MW (42); >180 MW (4)	1,000 bhp and <180 MW (96); >180 MW (8) F42
RI - Statewide	No RACT Sources (new only)	No RACT Sources (new only)	No RACT Sources (new only)	No RACT Sources (new only)
VA - OTR jurisdiction	42	65 - 77	42	65 - 77
VT - Statewide	NA			

Notes:

- CT: [a]Existing RCSA Sec. 22a-174-22 (to be repealed as of June 1, 2018); [b]RCSA Sec. 22a-174-22e starting June 1, 2018; [c]RCSA Sec. 22a-174-22e starting June 1, 2023.
- NJ: lb/mmBtu limit converted to ppmvd @15% O_2 based on Part 75 Eq-F5 and F-factors of 8710 for natural gas and 9190 for oil; lb/MWh limit converted to ppmvd@15% O_2 based on New Jersey technical support document; 25 ppm ≈ 1.0 lb/MWh for simple cycle gas; 42 ppm ≈ 1.60 lbs/hr for simple cycle oil. (NJ Proposal Number: PRN 2008-260).
- NA = Not Applicable

State	2. Combustion Gas Turbine Engines – Regulations	State Contacts
CT	RCSA section 22a-174-22 will be repealed as of June 1, 2018 and will be replaced with RCSA section 22a-174-22e (finalized December 22, 2016). http://www.ct.gov/deep/lib/deep/air/regulations/mainregs/sec22.pdf https://eregulations.ct.gov/eRegsPortal/Search/getDocument?guid=%7bE2C443EB-00E6-46AF-A260-65881DD13319%7d	Merrily Gere, 860 424 3416, Merrily.Gere@ct.gov
DC	20 DCMR § 805.4, RACT for Major Stationary Sources of Oxides of Nitrogen: http://www.dcregs.dc.gov/Gateway/RuleHome.aspx?RuleNumber=20-805;	Alexandra Catena, 202 535-2989, alexandra.catena@dc.gov
DE	7 DE Admin Code 1112, Control of Nitrogen Oxides Emissions: http://regulations.delaware.gov/AdminCode/title7/1000/1100/1112.shtml 7 DE Admin Code 1148, Control of Stationary Combustion Turbine Electric Generating Unit Emissions: http://regulations.delaware.gov/AdminCode/title7/1000/1100/1148.shtml	Mark Prettyman, 302-739-9402, mark.prettyman@state.de.us Bob Clausen, 302-739-9402, robert.clausen@state.de.us
MA	MassDEP proposed amendments to NOx RACT affecting emission limits for Large Boilers, turbines, and engines and solicited public comment till September 26, 2016. MassDEP is currently preparing the final regulations and Response to Comments.	Marc Cohen, 617.292.5873, Marc.Cohen@MassMail.State.MA.US
MD	COMAR 26.11.09.08 G Greater than 15% capacity and less than 15% capacity; https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=0ahUKEwia9K6f2ZbOAhUI2T4KHVLHDmAQFggiMAE&url=http%3A%2F%2Fwww.mde.state.md.us%2Fprograms%2FAir%2FAirQualityPlanning%2FDocuments%2FOzone_ISIP_2012.pdf&usg=AFQjCNHMy94YhR5yKcchTc-CzzC7-pPeXA	Randy Mosier, 410 537 4488, Randy.Mosier@maryland.gov
ME	No action to date; http://www.maine.gov/dep/air/rules/index.html	Jeff Crawford, (207) 287-7647, jeff.s.crawford@maine.gov
NH	NH Administrative Rule Env-A 1300 *NOx RACT* (Part Env-A 1306 *Combustion Turbines*) http://des.nh.gov/organization/commissioner/legal/rules/documents/env-a1300.pdf	Gary Milbury 603 271-2630, gary.milbury@des.nh.gov
NJ	N.J.A.C. 7:27-19.5 http://www.state.nj.us/dep/aqm/Sub19.pdf	Peg Gardner, 609 292 7095, Margaret.Gardner@dep.nj.gov
NY	Under Development; https://www.federalregister.gov/articles/2013/07/12/2013-16493/approval-and-promulgation-of-implementation-plans-new-york-state-ozone-implementation-plan-revision	John Barnes, 518 402 8396, john.barnes@dec.ny.gov; Robert Bielawa robert.bielawa@dec.ny.gov
PA	PA's RACT Rule covers Combustion Turbines. Additional RACT Requirements for Major Sources of NOx and VOCs: Sections 129.96 - 129.100. Control of NOx from Major Sources of NOx and VOC. Effective April 23, 2016. Federal Register –TBD; https://www.portal.state.pa.us/portal/server.pt/document/1613671/1_ract_2_final_exec_summary_pdf	Susan Hoyle, shoyle@pa.gov Randy Bordner, ranbordner@pa.gov Susan Foster, sufoster@pa.gov Sean Wenrich, sewenrich@pa.gov
RI	Evaluating potential need for changes	Laurie Grandchamp, 401 222 2808, laurie.grandchamp@dem.ri.gov
VA	9 VAC 5 Chapter 40 Article 51: http://www.deq.virginia.gov/Portals/0/DEQ/Air/Regulations/451.pdf	Doris McLeod, doris.mcleod@deq.virginia.gov

VT	No action to date; http://dec.vermont.gov/air-quality/laws	Doug Elliott, 802 377 5939, Doug.Elliott@vermont.gov

APPENDIX C. INTERNAL COMBUSTION ENGINES (STATIONARY GENERATORS) IN OZONE TRANSPORT REGION

(Data as of 01/18/2017)

1. IC ENGINES >500 hp	**NOx Limit (g/hp-hr)**			
State	**Gas-fired, Lean Burn**	**Gas-fired, Rich Burn**	**Diesel**	**Dual Fuel**
CT - Statewide	2.5*; 1.5 - 2.0**	2.5*; 1.5 - 2.0**	8.0*; 1.5 - 2.3**	Multi-fuel provisions*;**
DC - Districtwide	NA			
DE - Statewide	Technology Stds.	Technology Stds.	Technology Stds.	Technology Stds.
MA - Statewide	3.0	1.5	9.0	9.0
MD - Select Counties	150 ppmvd @ 15% O_2 (Approx. 1.7 g/hp-hr)*	110 ppmvd @ 15% O_2 (Approx. 1.6 g/hp-hr)*	175 ppmvd @ 15% O_2	125 ppmvd @ 15% O_2
ME - Statewide	NA	NA	3.7 (Source-specific RACT)	NA
NH - Statewide	2.5	1.5	8.0	8.0
NJ - Statewide	1.5	1.5	2.3	2.3
NY - Statewide	1.5	1.5	2.3	2.3
PA - Statewide	3.0	2.0	8.0	8.0
RI - Statewide	2.5	1.5	9.0	Not specified in Regulation, no sources.
VA - OTR Jurisdiction	Source-specific RACT			
VT - Statewide	4.8	4.8	4.8	4.8

Notes:

- CT: * existing RCSA section 22a-174-22 (to be repealed as of June 1, 2018); ** RCSA section 22a-174-22e starting June 1, 2023
- MD: * Conversion factors from ppmv @ 15% O_2 to g/hp-hr from EPA ACT, July 1993 EPA453-R-93-032
- NJ: For an engine ≥37 kW and that has been modified on or after March 7, 2007, 0.90 grams/bhp-hr or an emission rate which is equivalent to a 90% NOx reduction from the uncontrolled NOx emission level
- NA = Not Applicable

State	2. IC ENGINES >500 hp – Regulations	State Contacts
CT	RCSA section 22a-174-22 will be repealed as of June 1, 2018 and will be replaced with RCSA section 22a-174-22e (finalized December 22, 2016). http://www.ct.gov/deep/lib/deep/air/regulations/mainregs/sec22.pdf https://eregulations.ct.gov/eRegsPortal/Search/getDocument?guid=%7bE2C443EB-00E6-46AF-A260-65881DD13319%7d	Merrily Gere, 860 424 3416, Merrily.Gere@ct.gov
DC	NA	Alexandra Catena, 202 535-2989, alexandra.catena@dc.gov
DE	7 DE Admin Code 1112, Control of Nitrogen Oxides Emissions http://regulations.delaware.gov/AdminCode/title7/1000/1100/1112.shtml#TopOfPage 7 DE Admin Code 1144, Control of Stationary Generator Emissions http://regulations.delaware.gov/AdminCode/title7/1000/1100/1144.shtml#TopOfPage	Mark Prettyman, 302-739-9402, mark.prettyman@state.de.us
MA	MassDEP proposed amendments to NOx RACT affecting emission limits for Large Boilers, turbines, and engines and solicited public comment till September 26, 2016. MassDEP is currently preparing the final regulations and Response to Comments.	Marc Cohen, 617.292.5873, Marc.Cohen@MassMail.State.MA.US
MD	COMAR 26.11.36	Randy Mosier, 410 537 4488, Randy.Mosier@maryland.gov
ME	Source-specific RACT per Title V license	Jane Gilbert (207) 287-2455, jane.gilbert@maine.gov
NH	NH Administrative Rule Env-A 1300 *NOx RACT* (Part Env-A 1307 *Stationary Internal Combustion Engines*) http://des.nh.gov/organization/commissioner/legal/rules/documents/env-a1300.pdf	Gary Milbury 603 271-2630, gary.milbury@des.nh.gov
NJ	N.J.A.C. 7:27-19.8 http://www.state.nj.us/dep/aqm/Sub19.pdf	Peg Gardner, 609 292 7095, Margaret.Gardner@dep.nj.gov
NY	Part 222, In Progress	John Barnes, 518 402 8396, john.barnes@dec.ny.gov; Robert Bielawa, robert.bielawa@dec.ny.gov
PA	Additional RACT Requirements for Major Sources of NOx and VOCs. Sections 129.96 - 129.100. Control of NOx from Major Sources of NOx and VOC. Effective April 23, 2016. Federal Register -TBD	Susan Hoyle, shoyle@pa.gov Randy Bordner, ranbordner@pa.gov Susan Foster, sufoster@pa.gov Sean Wenrich, sewenrich@pa.gov
RI	Air Pollution Control Regulation Number 27, Control of Nitrogen Oxide Emissions	Laurie Grandchamp, 401 222 2808, laurie.grandchamp@dem.ri.gov
VA	9 VAC 5 Chapter 40 Article 51; http://www.deq.virginia.gov/Portals/0/DEQ/Air/Regulations/451.pdf	Doris McLeod, doris.mcleod@deq.virginia.gov
VT	VT Regulation 5-271	Doug Elliott, 802 377 5939, Doug.Elliott@vermont.gov

APPENDIX D. MUNICIPAL WASTE COMBUSTORS IN OZONE TRANSPORT REGION

(Data as of 01/18/2017)

State	Municipal Waste Combustor (MWC) Facility	Unit # - Capacity (tons/day)	NOx Standard (ppmvd @7% O_2)	Ammonia Slip Limit (ppmvd @7% O_2)	Averaging Time	Control Technology	Type of System	Date of Installation - Startup
CT	Covanta Southeastern CT (Preston)	1, 2 - 344.5 each	150 for all[a]	20[a]	24 hr daily av.	SNCR	MB - WW	12-4-1991
	Wheelabrator Bridgeport	1, 2, 3 - 750 each	150 for all[a]	20[a]	24 hr daily av.	SNCR	MB - WW	1-13-1988
	Covanta Bristol	1, 2 - 358 each	150 for all[a]	20[a]	24 hr daily av.	SNCR	MB - WW	10-23-1987
	Wheelabrator Lisbon	1, 2 - 562.4 each	150 for all[a]	20[a]	24 hr daily av.	SNCR	MB - WW	10-19-1995
	MIRA (Hartford)	1, 2, 3 - 675 each	146 for all	20[a]	24 hr daily av.	SNCR	Processed MWC	9-4-1987
MA	SEMASS	1, 2 - 1000 each	250 for all	10 - default	24 hr		RDF Stoker	1-1-1988
	SEMASS	3 - 1000	180		24 hr	SNCR	RDF stoker	
	Wheelabrator N. Andover	1, 2 - 750 each	205 for all		24 hr	SNCR	MB - WW	3-1/4-1-1985
	Wheelabrator Saugus	1, 2 - 750 each	205 for all		24 hr	SNCR	MB - WW	6-30-1975
	Wheelabrator Millbury	1, 2 - 750 each	205 for all		24 hr	SNCR	MB - WW	9-17-1987
	Covanta Haverhill	1, 2 - 825 each	205 for all		24 hr	SNCR	MB - WW	4-1-1989
	Covanta Springfield	1,2,3 - 136 each	167 for all		24 hr	FGR	MB - REF	5-1-1988
	Covanta Pittsfield	1,2,3 - 120 each	192 for all		24 hr	FGR	MB - REF	6-1-1981
MD	Wheelabrator	3 - 750	205	None	24-hr	SNCR	MB - grate	1985
	Mont. Covanta	3 - 600	205	None	24-hr	SNCR	MB - grate	1995
ME	Eco Maine - Portland	1,2 - 275 each	180	10	24-hr daily av.	SNCR	MB-WW	1988
	Mid Maine Waste Action Corp	1,2 - 125 each	315 (summer) 350 (winter)	NA	24-hr daily av.	NA	MB - oscillating 210°	1992
	Penobscot Energy Recovery Co	1,2 – 360.5 each	230	NA	24-hr daily av	NA	RDF Stoker	1988
NH	Wheelabrator – Concord	1,2 - 287.53 each	0.53 lb/MMBtu (RACT) 0.35 (MWC Std)	20	calendar day avg.	SNCR	MB	1988
	Wheelabrator – Claremont	1,2 – 115 each	0.53 lb/MMBtu	20	calendar day avg.	SNCR	MB	1986
NJ	Essex CRRF (PI 07736)	1,2,3 – 2700 each	150 for all	50	calendar day	SNCR	MB	3-1988
	Warren CRRF (PI 85455)	1,2 – 438 each	150 for all	50	calendar day	SNCR	MB	7-31-1986
	Camden CRRF (PI 51614)	1,2,3 – 1236 each	150 for all	20	calendar day	SNCR	MB	12-7-1988
	Union CRRF (PI 41814)	1,2,3 – 1540 each	150 for all	50	calendar day	SNCR	MB	12-30-1991

	Gloucester CRRF (PI 55793)	1,2 – 575 each	150 for all	20	calendar day	SNCR	MB	6-9-1988

State	Municipal Waste Combustor (MWC) Facility	Unit # - Capacity (tons/day)	NOx Standard (ppmvd @7% O_2)	Ammonia Slip Limit (ppmvd @7% O_2)	Averaging Time	Control Technology	Type of System	Date of Installation-Startup
NY	Babylon RRF	1, 2 - 375 each	150 for all	None	24 hr	SNCR	MB - SC	1988
	Hempstead RRF	1, 2, 3 - 773 each	185 for all	None	365 days rolling av.	Part 231		1989
	Huntington RRF	1, 2, 3 - 250 each	185 for all	50	3 hr rolling	SNCR	MB - WW	1991
	MacArthur RRF	1, 2 - 242.5 each	170 for all	None	24 hr		MB - RC	1989
	Dutchess Co RRF	1, 2 - 228 each	170 for all	None	24 hr		MB - RC	1989
	Wheelabrator Westchester	1, 2 - 750 each	184 for all	None	24 hr		MB - SC	1984
	Wheelabrator Hudson Falls	1, 2 - 275 each	372 for all	None	1 hr		MB - WW	1991
	Onondaga County RRF	1, 2, 3 - 330 each	200 for all	50	3 hr	SNCR	MB - REF	1994
	Oswego County RRF	1, 2, 3, 4 - 50 each	none	None		none	RDF incinerator	1984
	Covanta Niagara	1, 2 - 1097.5 each	205 for all	50	24 hr	SNCR	MB - SC	1996
PA	Covanta Delaware Valley	1 - 585	180	NA	24 hr	None	MB - RC	3-1-1991
			88.56 lb/hr		Unknown			
			0.42 lb/MMBtu		Unknown			
		2 - 585	180		24 hr	None	MB - RC	3-1-1991
			88.56 lb/hr		Unknown			
			0.42 lb/MMBtu		Unknown			
		3 - 585	180		24 hr	None	MB - RC	3-1-1991
			88.56 lb/hr		Unknown			
			0.42 lb/MMBtu		Unknown			
		4 - 585	180		24 hr	None	MB - RC	4-18-1991
			88.56 lb/hr		Unknown			
			0.42 lb/MMBtu		Unknown			
		5 - 585	180		24 hr	None	MB - RC	4-23-1991
			88.56 lb/hr		Unknown			
			0.42 lb/MMBtu		Unknown			
		6 - 585	180		24 hr	None	MB - RC	6-8-1991
			88.56 lb/hr		Unknown			
			0.42 lb/MMBtu		Unknown			
	Covanta Plymouth	1 - 608	205	10	Unknown	SNCR	RG - WW	1-1-1991
			109 lb/hr		Unknown			

PA		2 - 608	205		Unknown	SNCR	RG - WW	1-1-1991
			109 lb/hr		Unknown			
	Municipal Waste Combustor (MWC) Facility	**Unit # - Capacity (tons/day)**	**NOx Standard (ppmvd @7% O_2)**	**Ammonia Slip Limit (ppmvd @7% O_2)**	**Averaging Time**	**Control Technology**	**Type of System**	**Date of Installation-Startup**
	Wheelabrator Falls Twp	1 - 800	180	No Limit	24 hr	SNCR	MB - WW	5-1-1994
			102.6 lb/hr		Unknown			
		2 - 800	180		24 hr	SNCR	MB - WW	5-1-1994
			102.6 lb/hr		Unknown			
	Lancaster Co. Resource Recovery	1 - 400	180	No Limit	24 hr	SNCR	RG - WW	12-1-1990
		2 - 400	180		24 hr	SNCR	RG - WW	12-1-1990
		3 - 400	180		24 hr	SNCR	RG - WW	12-1-1990
	York Co. Resource Recovery	1 - 450	165	NA	24 hr	None	RC	10-23-1989
			135		Annual			
		2 - 450	165		24 hr	None	RC	10-23-1989
			135		Annual			
		3 - 450	165		24 hr	None	RC	10-23-1989
			135		Annual			
	Susquehanna Resource Harrisburg	1 - 267	150	12	24 hr	SNCR	MB - WW	12-30-2005
			135		24 hr			
		2 - 267	150		24 hr	SNCR	MB - WW	2-1-2006
			135		24 hr			
		3 - 267	150		24 hr	SNCR	MB - WW	3-1-2006
			135		24 hr			
VA - OTR jurisdiction	Covanta Fairfax, Inc (Reg # 71920)	001 - 750	205 ppm, 206.3 lbs/hr, 716.2 tpy[VA1]	NA	24 hr	SNCR	RG-WW	1987
		002 - 750	205 ppm, 206.3 lbs/hr, 716.2 tpy[VA1]		24 hr	SNCR	RG-WW	1987
		003 - 750	205 ppm, 206.3 lbs/hr, 716.2 tpy[VA1]		24 hr	SNCR	RG-WW	1987
		004 - 750	205 ppm, 206.3 lbs/hr, 716.2 tpy[VA1]		24 hr	SNCR	RG-WW	1987
	Covanta Alexandria/Arlington (Reg # 71895)	001-325	205 ppm [VA2]	NA	24 hr	SNCR	RG-WW	1988
		002-325	205 ppm [VA2]		24 hr	SNCR	RG-WW	1988

		002-325	205 ppm [VA2]		24 hr	SNCR	RG-WW	1988

<u>Notes</u>:

- No MWCs in DE, DC, RI, & VT;
- CT: [a]Current Standard as of 08/02/16;
- ME: Maine Energy Recovery Co (RDF Stoker) installed in 1987 closed permanently in 2012
- VA: [VA1]Final 2008 O_3 NAAQS RACT standard for Covanta Fairfax units has not yet been determined. Review/analysis is ongoing; [VA2]Final 2008 O_3 NAAQS RACT standard for Covanta Alexandria/Arlington units has not yet been determined. Review/analysis is ongoing.
- Abbreviations: mass burn = MB; waterwall = WW; rotary waterwall = RC; refractory wall = REF; refuse-derived fuel = RDF; reciprocating grate waterwall = RG – WW; mass burn - single chamber = MB – SC; NA = Not Applicable.

State	MWC - Regulations	State Inspectors/Contacts
CT	Revised RCSA section 22a-174-38 (finalized 8/2/16) http://eregulations.ct.gov/eRegsPortal/Search/RMRView/PR2015-192	Merrily Gere, 860 424 3416, Merrily.Gere@CT.gov
MA	310 CMR 7.08(2): http://www.mass.gov/courts/docs/lawlib/300-399cmr/310cmr7.pdf Covanta Springfield and Covanta Pittsfield - permit	SEMASS: Dan Disalvio, 508 946 2878, dan.disalvio@state.ma.us; Wheelabrator (N. Andover & Saugus) & Covanta Haverhill: Joseph Su, 978 694 3283, joseph.su@state.ma.us; Wheelabrator Millbury: Paul Dwiggins, 508 767 2760, paul.dwiggins@state.ma.us; Covanta (Springfield & Pittsfield): Todd Wheeler, 413 755 2297, todd.wheeler@state.ma.us
MD	COMAR 26.11.08.08; COMAR 26.11.08.07 & 26.11.08.08 - Revising NOx RACT for Large MWCs; planned proposal June 2016: http://www.dsd.state.md.us/comar/SubtitleSearch.aspx?search=26.11.08.* http://www.dsd.state.md.us/comar/SubtitleSearch.aspx?search=26.11.09.*	Wheelabrator: Ariane Kouamou-Nouba, 410 537 4233, ariane.kouamou-nouba@maryland.gov Mont. Covanta: Mitchell Greger, 410 537 3235, mitchell.greger@maryalnd.gov
ME	http://www.maine.gov/dep/air/rules/	Jeff Crawford, 207 287 7647, jeff.s.crawford@maine.gov
NH	Env-A 1309 (RACT) Env-A 3300 (NH MWC Std); Evaluating comments from draft RACT submittal; http://des.nh.gov/organization/commissioner/legal/rulemaking/documents/env-a3300-adpt-pstd.pdf	Gary Milbury, 603 271 2630, gary.milbury@des.nh.gov
NJ	N.J.A.C. 7:27-19.12 - basis for OTC draft MSW white paper	Essex CRRF (PI 07736): Scott Michenfelder, 609 439 2432, Scott.Michenfelder@dep.nj.gov; Warren CRRF (PI 85455): Douglas Bannon, 973 656 4444, Douglas.Bannon@dep.nj.gov Camden CRRF (PI 51614): Matthew Zehr, 609 439 9406, Matthew.Zehr@dep.nj.gov; Union CRRF (PI 41814): Robin Jones, 609 439 9418, Robin.Jones@dep.nj.gov; Gloucester CRRF (PI 55793): Vince Garbarino, 609 439 9396, Vince.Garbarino@dep.nj.gov
NY	Babylon - RRF Subpart 219-2; Hempstead - RRF Part 231; Huntington - RRF 40 CFR 52.21; MacArthur RRF - 40 CFR 60.1705(a)(1); Dutchess Co RRF - 40 CFR 60.1705(a)(1); Wheelabrator Westchester - 40 CFR 52.21(j); Wheelabrator Hudson Falls - 40 CFR 52.21(j)(2); Onondaga County RRF- 40 CFR 52.21(j); Covanta Niagara - 40 CFR 60.33(b); Part 219, Effective 12/31/1988	John Barnes, 518 402 8396, john.barnes@dec.ny.gov
PA	Covanta Delaware Valley - 25 Pa. Code §127.12 (BAT) and 25 Pa. Code §129.91 (RACT); Covanta Plymouth, Wheelabrator Falls Twp - 25 Pa. Code §127.12 (BAT) and 40 CFR Part 60, Subpart Cb; Lancaster Co. Resource Recovery - 25 Pa. Code §127.12 (BAT); York Co. Resource Recovery - 25 Pa. Code §127.12 (BAT), 25 Pa. Code §129.91 (RACT); Susquehanna Resource Harrisburg - 40 CFR Part 60, Subpart Eb, 25 Pa. Code §127.12 (BAT); Voluntary limit for netting purposes; Additional RACT Requirements for Major Sources of NOx and VOCs. Sections 129.96 - 129.100. Control of NOX from Major Sources of NOx and VOC. Effective April 23, 2016. Federal Register –TBD; http://www.pacode.com/secure/data/025/articleICIII_toc.html	Susan Hoyle shoyle@pa.gov Randy Bordner ranbordner@pa.gov Susan Foster sufoster@pa.gov Sean Wenrich sewenrich@pa.gov
VA	9 VAC 5 Chapter 40 Article 51 http://www.deq.virginia.gov/Portals/0/DEQ/Air/Regulations/451.pdf	Doris Mcleod, doris.mcleod@deq.virginia.gov

APPENDIX E. HOT MIX ASPHALT PRODUCTION PLANTS IN OZONE TRANSPORT REGION

(Data as of 01/18/2017)

State	NOx Limit (ppmvd @ 7% O_2)		
	Natural Gas	No. 2 Oil	Other Fuels
CT	No specific emission limits for Hot Mix Asphalt Production Plants		
DC	150	150	150
DE	No specific emission limits for Hot Mix Asphalt Production Plants		
MA	BACT determination for Benevento Asphalt:		
	0.044 lb/MMBtu	0.113 lb/MMBtu	0.113 lb/MMBtu
MD			
ME	0.12 lb/ton asphalt	0.12 lb/ton asphalt	0.12 lb/ton asphalt
NH	0.12 lb/ton asphalt	0.12 lb/ton asphalt	0.12 lb/ton asphalt
NJ	75	100	125*
NY	No specific emission limits for Hot Mix Asphalt Production Plants		
PA			
VA - OTR jurisdiction	NA		
VT	No specific regulatory emission limits for Hot Mix Asphalt Production Plants, but most permits contain 0.06 lb/ton asphalt limit based on application submittal.		

Notes:

- No Sources in RI;
- NJ: * No. 4 or heavier fuel oil or on-spec used oil or mixture of these three
- VA – OTR jurisdiction: All of ~15 plants have federally enforceable limits on their PTE of NOx and VOC to make them minor sources (<100 tpy NOX, <50 TPY VOC)
- DE: Specific emissions limitations in lb/HMA are determined on a facility by facility basis.
- DC: 150 ppmvd @ 7% O_2 is the NO_x RACT standard for major sources (25 TPY) of NO_x only (two of the three HMA facilities in DC). No NO_x RACT standard is specified for minor sources of NO_x. The third HMA facility, a 225 TPH continuous drum-mix asphalt plant, has limits on potential to emit keeping NO_x below the major source threshold. Its NO_x limits are 12.4 lb/hr and 22.0 tons per 12-month rolling period.

State	Hot Mix Asphalt Production Plants – Regulations	State Contacts
CT	RCSA section 22a-174-22 will be repealed as of June 1, 2018 and will be replaced with RCSA section 22a-174-22e (finalized December 22, 2016). Note: Neither section includes a limit that specifically applies to "asphalt production plants" but the fuel-burning equipment is regulated: http://www.ct.gov/deep/lib/deep/air/regulations/mainregs/sec22.pdf https://eregulations.ct.gov/eRegsPortal/Search/getDocument?guid=%7bE2C443EB-00E6-46AF-A260-65881DD13319%7d	Merrily Gere, 860 424 3416, Merrily.Gere@ct.gov
DC	20 DCMR § 805.6, RACT for Major Stationary Sources of Oxides of Nitrogen: http://www.dcregs.dc.gov/Gateway/RuleHome.aspx?RuleNumber=20-805	Alexandra Catena, 202 535-2989, alexandra.catena@dc.gov
DE	http://regulations.delaware.gov/AdminCode/title7/1000/1100/1112.shtml	Mark Prettyman 302-739-9402, mark.prettyman@state.de.us
MA	No specific NOx RACT emission limits for this source category in state NOx RACT regulations.	Marc Cohen 617.292.5873, Marc.Cohen@MassMail.State.MA.US
MD	Search Title 26, Chapter 11; http://www.dsd.state.md.us/COMAR/SearchTitle.aspx?scope=26	Randy Mosier, 410 537 4488, Randy.Mosier@maryland.gov
ME	http://www.maine.gov/dep/air/rules/	Jeff Crawford, 207 287 7647, jeff.s.crawford@maine.gov
NH	NH Administrative Rule Env-A 1300 *NOx RACT* (Part Env-A 1308 *Asphalt Plant Rotary Dryers*) http://des.nh.gov/organization/commissioner/legal/rules/documents/env-a1300.pdf	Gary Milbury 603 271-2630, gary.milbury@des.nh.gov
NJ	N.J.A.C. 7:27-19.9, based on OTC ADDENDUM TO RESOLUTION 06-02 http://www.state.nj.us/dep/aqm/Sub19.pdf	Peg Gardner, 609 292 7095, Margaret.Gardner@dep.nj.gov
NY	Hot mix asphalt plants cap out of Title V www.dec.ny.gov/regs/2492.html	John Barnes, 518 402 8396, john.barnes@dec.ny.gov; Robert Bielawa, robert.bielawa@dec.ny.gov
PA	Additional RACT Requirements for Major Sources of NOx and VOCs. Sections 129.96 - 129.100. Control of NOX from Major Sources of NOx and VOC; Effective April 23, 2016. Federal Register -TBD Case by Case; http://www.pacode.com/secure/data/025/articleICIII_toc.html	Susan Hoyle, shoyle@pa.gov Randy Bordner, ranbordner@pa.gov Susan Foster, sufoster@pa.gov Sean Wenrich, sewenrich@pa.gov
VA - OTR jurisdiction	No asphalt plants trigger the major stationary RACT source definition under 9 VAC 5 Chapter 40 Article 51 at this time.	Doris McLeod, doris.mcleod@deq.virginia.gov
VT	No action to date; http://dec.vermont.gov/air-quality/laws	Doug Elliott, 802 377 5939, Doug.Elliott@vermont.gov

APPENDIX F. GLASS FURNACES IN OZONE TRANSPORT REGION

(Data as of 01/18/2017)

State	Facility	Emission rate (lb NOx/ ton of glass)	Averaging Time	Technology
MD				
MA	Ardagh Glass Inc. (formerly known as Saint Gobain Containers), Milford	1.3*	30 day rolling	Oxy-fuel combustion furnaces
NJ	Statewide	9.2 (flat glass); 4.0 (except flat glass)		Oxyfiring installed at rebricking
NY	Statewide	1.89 - 4.49		
PA	Statewide	4.0 (container and fiberglass furnaces); 7.0 (pressed or blown, and flat glass furnaces); 6.0 (all other glass melting furnaces)		

Notes:

- No Sources in CT, DC, DE, ME, NH, RI, VA (OTR Jurisdiction), and VT;
- MA: ***** this excludes Abnormally Low Production Rate Days, Furnace Startup, Malfunction of the Furnace, and Maintenance of the Furnace;
- NJ: Applicability depends on type of glass manufacturing , maximum production rate , PTE NOx >10tpy

State	Glass Furnaces - Regulations	State Contacts
MA	Global consent decree for Ardagh Glass Inc. (formerly Saint Gobain Containers), Milford; https://www.epa.gov/enforcement/consent-decree-saint-gobain-containers-inc	Marc Cohen, 617.292.5873, Marc.Cohen@MassMail.State.MA.US
MD	COMAR 26.11.09.08I, Search Title 26, Chapter 11; http://www.dsd.state.md.us/COMAR/SearchTitle.aspx?scope=26	Randy Mosier, 410 537-4488, Randy.Mosier@maryland.gov
NJ	N.J.A.C. 7:27-19.10, based on OTC ADDENDUM TO RESOLUTION 06-02 http://www.state.nj.us/dep/aqm/Sub19.pdf	Peg Gardner, 609 292 7095, Margaret.Gardner@dep.nj.gov
NY	Subpart 220-2 - Effective: 7/11/2010 Submitted: 8/19/2010; Final: 77 FR 13974, 78 Fr 41846; www.dec.ny.gov/regs/2492.html	John Barnes, 518 402-8396, john.barnes@dec.ny.gov; Robert Bielawa robert.bielawa@dec.ny.gov
PA	Control of NOx Emissions From Glass Melting Furnaces. Sections 129.301 - 129.310. The rule limits the emissions of NOx from glass melting furnaces on an annual basis. Effective September 21, 2011. 08/22/2011, 76 Federal Register 52283 http://www.pacode.com/secure/data/025/articleICIII_toc.html	Susan Hoyle, shoyle@pa.gov Randy Bordner, ranbordner@pa.gov Susan Foster, sufoster@pa.gov Sean Wenrich, sewenrich@pa.gov

APPENDIX G. NATURAL GAS PIPELINE COMPRESSORS IN OZONE TRANSPORT REGION

(Data as of 01/18/2017)

State	Natural Gas Pipeline Compressors – Regulations	State Contacts
CT	RCSA section 22a-174-22 will be repealed as of June 1, 2018 and will be replaced with RCSA section 22a-174-22e (finalized December 22, 2016). Note: Does not specifically apply to "natural gas pipelines" but fuel-burning equipment such as compressors is regulated; http://www.ct.gov/deep/lib/deep/air/regulations/mainregs/sec22.pdf https://eregulations.ct.gov/eRegsPortal/Search/getDocument?guid=%7bE2C443EB-00E6-46AF-A260-65881DD13319%7d	Merrily Gere, 860 424 3416, Merrily.Gere@ct.gov
DE	http://regulations.delaware.gov/AdminCode/title7/1000/1100/1112.shtml http://regulations.delaware.gov/AdminCode/title7/1000/1100/1144.shtml *	Mark Prettyman, 302-739-9402, mark.prettyman@state.de.us
MA	310 CMR 7.19(7) NOx RACT simple cycle turbine existing emission limit of 65 ppm @ 15% O_2, proposed for more stringent standard of 40 ppm in 2017. A BACT determination in 2006 for a replacement of a 53.8 MMBtu/hr Allison turbine at Tennessee Gas Pipeline Charlton station with two 50-6200LS Solar Centaur split shaft gas turbine compressor sets equipped with Solar's pre-combustion SoLoNOx technology each rated at 6,037 hp with a maximum heat input = 53.52 MMBtu/hr at ISO conditions): 15 ppm @ 15% O_2 (or alternatively 3.22 lbs/hr)	Marc Cohen, 617.292.5873, Marc.Cohen@MassMail.State.MA.US
MD	COMAR 26.11.29; Search Title 26, Chapter 11; http://www.dsd.state.md.us/COMAR/SearchTitle.aspx?scope=26	Randy Mosier, 410 537 4488, Randy.Mosier@maryland.gov
ME	Source specific BACT	Jane Gilbert, (207) 287-2455, jane.gilbert@maine.gov
NH	Regulated under Part Env-A 1306 *Combustion Turbines* (no separate rule for compressor stations): http://des.nh.gov/organization/commissioner/legal/rules/documents/env-a1300.pdf	Gary Milbury, 603 271 2630, Gary.milbury@des.nh.gov
NJ	N.J.A.C. 7:27-19.5 and 19.8, amendments in progress (applicable to turbines and engines at natural gas compressor stations) based on draft OTC white paper. http://www.state.nj.us/dep/aqm/Sub19.pdf	Peg Gardner, 609 292 7095, Margaret.Gardner@dep.nj.gov
NY	Covered under NOx RACT Rule (Subpart 227-2) Effective: 7/8/2010, Submitted: 8/19/2010, Final: 77 FR 13974, 78 Fr 41846; www.dec.ny.gov/regs/2492.html	John Barnes, 518 402 8396, john.barnes@dec.ny.gov; Robert Bielawa, robert.bielawa@dec.ny.gov
PA	Additional RACT Requirements for Major Sources of NOx and VOCs. Sections 129.96 - 129.100. Control of NOx from Major Sources of NOx and VOC. Effective April 23, 2016. Federal Register - TBD (No Distinction) http://www.pacode.com/secure/data/025/articleICIII_toc.html	Susan Hoyle, shoyle@pa.gov Randy Bordner, ranbordner@pa.gov Susan Foster, sufoster@pa.gov Sean Wenrich, sewenrich@pa.gov
RI	One source; Source specific RACT for engines at compressor station	Laurie Grandchamp, 401 222 2808,

		laurie.grandchamp@dem.ri.gov
VA - OTR jurisdiction	9 VAC 5 Chapter 40 Article 51, case by case RACT	Doris McLeod, doris.mcleod@deq.virginia.gov

Notes:

- No Sources in DC and VT;
- DE: * Reg. 1144 only applies to stationary generators, and not all engines.

Appendix B

Connecticut Department of

ENERGY &
ENVIRONMENTAL
PROTECTION

BUREAU OF AIR MANAGEMENT
NEW SOURCE REVIEW PERMIT
TO CONSTRUCT AND OPERATE A STATIONARY SOURCE

Issued pursuant to Title 22a of the Connecticut General Statutes (CGS) and Section 22a-174-3a of the Regulations of Connecticut State Agencies (RCSA).

Owner/Operator	Wheelabrator Bridgeport, L.P.
Address	6 Howard Avenue, Bridgeport, CT 06605
Equipment Location	6 Howard Avenue, Bridgeport, CT 06605
Equipment Description	Babcock & Wilcox/Von Roll Reciprocating Grate, Waterwall Furnace, Watertube Boiler No. 1
Town-Permit Numbers	015-0097
Premises Number	0765
Stack Number	010
Prior Permit Issue Dates	October 23, 1985 (Permit to Construct) February 15, 1990 (Original Permit to Operate) October 31, 1997 (Revision) February 11, 2002 (Revision) August 9, 2004 (Modification) November 27, 2013 (Modification)
Modification Issue Date	October 21, 2016
Expiration Date	None

/s/ Anne Gobin for
Robert J. Klee
Commissioner

October 21, 2016
Date

This permit specifies necessary terms and conditions for the operation of this equipment to comply with state and federal air quality standards. The Permittee shall at all times comply with the terms and conditions stated herein.

PART I. DESIGN SPECIFICATIONS

A. General Description

Wheelabrator Bridgeport, L.P. operates a resource recovery facility. The facility has three Babcock & Wilcox waterwall furnace/watertube boiler systems which combust municipal solid waste (MSW) and special waste to produce steam. The steam produced is in turn sold, used for heating, or used by the steam turbine to produce electricity. Natural gas is used for startup and flame stabilization. Each municipal waste combustor (MWC) is equipped with a spray dryer absorber for acid gas control, a fabric filter for particulate matter control, a powdered activated carbon injection system for control of mercury and a selective non-catalytic reduction system for control of NO_x emissions. Each MWC is also equipped with continuous emission monitors to monitor opacity, SO_2, NO_x and CO.

B. Equipment Design Specifications

1. Municipal Waste Combustor

   a. Design Maximum Charging Rate: 750 ton/day of MSW based on a design higher heating value of 5,200 BTU/lb
   b. Maximum Heat Input Rate: 325 MMBTU/hr
   c. Design Steam Flow Rate: 196,800 lb/hr @ 900 psig and 830°F

2. Auxiliary Burner System: This furnace/boiler shall be equipped with an auxiliary burner system that shall have the capability of raising combustion gas temperatures to 1800°F for a combustion gas residence time of at least one second, except during periods of start-up, shutdown, and malfunction. Such system shall be capable of maintaining a minimum combustion gas temperature of 1500°F after secondary air injections for at least one second. The combustion gas temperature when firing MSW, at all times, shall be at a minimum of 1800°F for a minimum of one second residence time, measured at the one second plane. Measurement of the superheater outlet temperature is a surrogate for the furnace/ combustion gas temperature and residence time based on the time-temperature test.[1]

   a. Number of Burners: two
   b. Burner Manufacturer/Model No: Babcock & Wilcox
   c. Maximum Auxiliary Fuel Firing Rate: 70 MCF/hr each burner
   d. Maximum Gross Heat Input : 70 MMBTU/hr each burner

3. Nominal Output: 69.5 MW total plant

4. Overfire and underfire air will be maintained to obtain optimum combustion.

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[1] Superheater outlet temperature is monitored and converted to furnace or combustion gas temperature at the one second plane based on the time-temperature test results, in order to determine compliance with the1800°F for a minimum of one second residence time requirement.

5. This furnace/boiler shall be equipped with automatic controls for the regulation of combustion; for example, air distribution and combustion gas temperature controls.

C. Control Equipment Design Specifications

The following specifications need not be verified on a continuous basis; however, if requested by the Commissioner, demonstration shall be shown.

1. Fabric Filter: 10 compartments @ 8280 ft^2 each - a minimum of 8 compartments shall be in service when the unit is operating.

   a. Make and Model: Wheelabrator-Frye
   b. Air/Cloth Ratio: 2.28:1 (with 10 compartments) and 2.85:1 (with 8 compartments)
   c. Bag Material: fiberglass with acid resistant finish or fiberglass with ePFTE membrane
   d. Cleaning Method: Automatic
   e. Pressure Drop Across Each Compartment: 3.5-15 in H_2O
   f. Pressure Drop Across Baghouse: 3.5-15 in H_2O
   g. Inlet Temperature: Not to exceed 17°C (30°F), based on a 4-hour arithmetic average, above the maximum demonstrated particulate matter control device inlet temperature (RCSA §22a-174-38(g)(1))
   h. Design Removal Efficiency: 99% +

2. Spray Dryer Absorber

   a. Make and Model: Wheelabrator-Frye
   b. Lime Usage: 0-1400 lb/hr
   c. Water Usage: 0-45 gal/min
   d. Inlet Gas Temperature: 400-550°F

3. Selective NonCatalytic Reduction (SNCR)

   a. Make and Model: Halcyon Mechanical Services
   b. Control Reagent: Urea
   c. Reagent Injection Rate: 0-35 gal/hr
   d. Temperature Range: 1600-2100°F
   e. Furnace Mixing Time: minimum 0.5 sec

4. Powdered Activated Carbon Injection System: Operational parameters required to achieve maximum mercury reduction are established by stack test results:

   a. Make and Model: Halcyon Technologies PACIS
   b. Control Reagent: Powdered Activated Carbon
   c. Reagent Injection Rate: 0-50 lb/hr
   d. Design Removal Efficiency: 85%

D. Stack Parameters

1. Minimum Stack Height: 295 ft above grade

2. Minimum Exhaust Gas Flow Rate: 189,000 acfm @ 250°F

3. Normal Stack Exit Temperature, Range: 250-350°F

4. Minimum Distance from Stack to Property Line: 104 ft

PART II. OPERATIONAL CONDITIONS

A. Operational Parameters

1. Municipal Waste Combustor

   a. Material(s) Charged:
      i. Municipal solid waste, as defined and restricted under CGS §22a-207 et seq. and any applicable Bureau of Materials Management and Compliance Assurance permit.
      ii. Special waste as defined in RCSA §22a-209-1 and in accordance with the Permittee's most recently DEEP approved Special Waste Disposal Plan issued pursuant to CGS §22a-208y.

   b. Maximum Allowable Daily Charging Rate
      i. The Maximum Allowable Daily Charging Rate for MSW is based upon the maximum allowable heat input rate to the furnace/boiler of 325 MMBTU/hr in accordance with the chart in Appendix G of this permit setting forth the maximum allowable daily MSW charging rate (ton/day) as a function of the MSW higher heating value (BTU/lb).
      ii. The Permittee shall combust no more than 180 tons per day of Special Waste in total for the three municipal waste combustor units at this facility.
      iii. Medical waste, or waste that originated as medical waste, shall not be combusted in this unit, unless it is done in compliance with II.A.1.b.ii of this permit.

   c. Maximum Steam Flow Rate: 216,480 lb/hr

   d. Maximum Hours of Operation: Daily: 24; over any consecutive 12-month period: 8760

2. Auxiliary Burner System

   a. Fuel Type: Natural Gas

   b. Annual Capacity Factor, as defined in 40 CFR §60.41b, shall not exceed 10%, in accordance with 40 CFR §60.44b(d).

3. The Permittee may install no later than August 1, 2017, a Flue Gas Recirculation (FGR) system to improve SNCR performance. Installation and operation of the FGR system shall not preclude the Permittee from complying with all other conditions listed in this permit.

4. The Permittee shall not cause or allow such unit to operate at a temperature, measured at each particulate control device inlet, more than 17 degrees centigrade, based on a 4-hour arithmetic average, above the maximum demonstrated particulate control device temperature measured during the most recent performance test for dioxin/furan emissions for which compliance with the dioxin/furan emissions limit was achieved.
   [RCSA §22a-174-38(g)(1)]

5. The Permittee shall not cause or allow such unit to operate at a municipal waste combustor unit load greater than 110% of the maximum demonstrated 4-hour average municipal waste combustor unit load, based on a 4-hour arithmetic average, measured during the most recent performance test for dioxin/furan emissions for which compliance with the dioxin/furan emissions limit was achieved. Municipal waste combustor unit load shall be measured by a steam flow meter. [RCSA §22a-174-38(g)(2)]

PART III. CONTINUOUS EMISSION MONITORING REQUIREMENTS AND ASSOCIATED EMISSION LIMITS

The Permittee shall comply with the CEM requirements as set forth in RCSA §22a-174-4. CEM shall be required for the following pollutant/operational parameters and enforced on the following basis:

Pollutant/Operational Parameter	Averaging Times	Emission Limit	Units
Opacity	6-minute block	10%	
SO_2	24-hour daily geometric average	29[2]	ppmvd @7% O_2
NO_x[3]	24-hour block	200 (Prior to August 2, 2017) 150 (On or after August 2, 2017)	ppmvd @7% O_2
CO	4-hour block	100	ppmvd @7% O_2
O_2	1-hour		
Unit Load	4-hour block		lb/hr
Total Combined Overfire and Underfire Air			acfm
Furnace Temperature	4-hour block		°F
Pressure Drop Across the Baghouse			in H_2O
Baghouse Inlet Temperature	4-hour block		°C or °F
Activated Carbon Injection Rate	8-hour block		lb/hr

A. The Permittee shall install and operate CEM equipment to monitor and record opacity, sulfur dioxide (SO_2), nitrogen oxides as nitrogen dioxide (NO_2), carbon monoxide (CO) and oxygen (O_2).

B. The Permittee shall also install and operate continuous monitoring systems for measuring and recording unit load (i.e., steam flow meter), total combined overfire and underfire air, furnace temperature as measured at the superheater outlet, pressure drop across the baghouse, baghouse inlet temperature, and powdered activated carbon injection rate .

C. This furnace shall be equipped to measure the required combustion temperatures and associated required residence times.

D. The Permittee shall install and use dedicated CEM analyzers. Each furnace flue exhaust shall have its own set of CEM analyzers and there shall be no shared analyzers.

E. The Permittee shall review all recorded CEM data daily and notify the Commissioner in writing, on forms prescribed by the Commissioner, of any deviation from an emissions or parametric limitation, and shall identify the cause or likely cause of such deviation, all corrective actions and preventive measures taken with respect thereto, and the dates of such actions and measures as follows: (1) For any hazardous air pollutant, no later than 24 hours after such deviation commenced; and (2) For any other regulated air pollutant or parameter, no later than ten days after such deviation commenced.

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[2] Or a 75% reduction by weight or volume, whichever is less stringent.

[3] Pursuant to RCSA §22a-174-38(c)(8), prior to August 2, 2017, the Permittee shall not cause or allow the emission of NO_x in excess of 200 ppmvd @7% O_2. On or after August 2, 2017, the Permittee shall not cause or allow the emission of NO_x in excess of 150 ppmvd @7% O_2.

F. Continuous monitors and recorders required by this permit shall be installed, calibrated, tested and operated to measure and record the emissions and parameters in a manner that demonstrates compliance with siting, performance and quality assurance specifications stated in 40 CFR Part 60 Appendices B and F, RCSA §22a-174-38(j) and RCSA §22a-174-4.

G. The Permittee shall report all CEM data to the Commissioner on a quarterly basis, in accordance with RCSA §22a-174-38(l)(2).

PART IV. MONITORING, RECORD KEEPING AND REPORTING REQUIREMENTS

A. Monitoring and Record Keeping Requirements

1. The Permittee shall make and keep records summarizing:

   a. the monthly quantity of MSW combusted for the facility. The monthly quantity of MSW combusted for the facility shall be determined by summing the truck scale house weight data for the month minus the refuse pit inventory. The pit inventory will be measured on the Sunday nearest to the end of the month and pro-rated for the full month.
   b. the combined monthly total quantity of Special Waste received by the facility in accordance with the most recently DEEP approved Special Waste Disposal Plan. These records shall identify the categories of Special Waste received by the facility each month and the corresponding monthly totals for each of these categories.
   c. the monthly quantity of natural gas combusted by the furnace/boiler, using either fuel purchase receipts or a non-resettable totalizing fuel meter.

2. The Permittee shall monitor and record the Special Waste daily charging rate for each of the three municipal solid waste combustors and the combined daily total for the facility.

3. The Permittee shall calculate and record the consecutive 12-month quantity of MSW and Special Waste combusted at the facility by adding the current month's MSW and Special Waste combusted to that of the previous 11 months. The Permittee shall make these calculations within 30 days of the end of each month.

4. The Permittee shall calculate and record the consecutive 12-month natural gas consumption by adding the current month's fuel consumed to that of the previous 11 months. The Permittee shall make these calculations within 30 days of the end of each month.

5. The Permittee shall calculate and record the annual capacity factor for natural gas for each calendar quarter. The annual capacity factor is determined on a 12-month rolling average basis with a new annual capacity factor calculated at the end of each calendar month. [40 CFR 60.49b(d)]

6. The Permittee shall keep sufficient records to determine compliance with the required combustion temperatures and associated required residence times. These records shall include the time-temperature test results, monitoring records of furnace temperature as measured at the superheater outlet, and a sample calculation identifying the superheater outlet temperature corresponding to a combustion gas temperature of 1800°F for a minimum of one second residence time, measured at the one second plane.

7. The Permittee shall make and keep records of the dates and time periods for startup and shutdown events for each furnace/boiler. [RCSA §22a-174-38(k)(13)]

8. The Permittee shall keep records of the occurrence and duration of any malfunction in the operation of each furnace/boiler and/or associated pollution control equipment.

9. The Permittee shall make and keep records summarizing all CEM data required in Part III of this permit. [RCSA §22a-174-38(k)(3)]

10. The Permittee shall make and keep records of all annual performance tests conducted to determine compliance with the particulate matter, dioxin/furan, cadmium, lead, mercury and ammonia emission limits.

11. The Permittee shall make and keep records of all performance tests conducted to determine compliance with any pollutant emission rate or operational parameter, if such tests are required by the Commissioner.

12. The Permittee shall calculate and record the monthly and consecutive 12-month PM, SO_2, NO_x, VOC, CO, Pb, HCL and ammonia emissions in units of tons. The consecutive 12-month emissions shall be determined by adding (for each pollutant) the current month's emissions to that of the previous 11 months. Such records shall include a sample calculation for each pollutant. The Permittee shall make these calculations within 30 days of the end of the previous month.

13. The Permittee shall make and keep records of the ASC and MASC for the pollutants listed in RCSA §22a-174-29 and emitted by this equipment.

14. The Permittee shall make and keep records of the date, the time of the shift, the name of the operator of that shift and the operator's certification. [RCSA §22a-174-38(h)(1)]

15. The Permittee shall make and keep records of the name of each person that has reviewed the operating manual, the date of initial review and the date of the annual review. [RCSA §22a-174-38(h)(5)]

16. The Permittee shall make and keep records of operator training and certification in accordance with RCSA §22a-174-38(k)(2).

17. The Permittee shall make and keep records for the carbon injection system in accordance with RCSA §22a-174-38(k)(11).

18. The Permittee shall make and keep for each municipal waste combustor unit, the following records of air pollution control device operation [RCSA §22a-174-38(k)(12)]:

    a. For each reagent, the feed rate to the air pollution control device, measured in kilograms per hour or pounds per hour, during the annual particulate emissions performance tests, with supporting calculations;
    b. For each reagent, the feed rate to the air pollution control device, measure in kilograms per hour or pounds per hour, for each hour of operation, with supporting calculations; and
    c. For each calendar quarter, total reagent usage for each municipal waste combustor unit in kilograms or pounds for each calendar quarter.

19. The Permittee shall keep all records required by this permit on premises for a period of no less than five years and shall submit such records to the Commissioner upon request.

B. Reporting

1. The Permittee shall provide written notification to the Commissioner within 72 hours of the time at which the Permittee receives information regarding performance test results indicating that any particulate matter, opacity, cadmium, lead, mercury, ammonia, dioxin/furan, hydrogen chloride or fugitive ash emission levels exceed the applicable pollutant emission limits or standards defined in RCSA §22a-174-38.

2. The Permittee shall submit reports to the Commissioner of all required performance tests.

3. The Permittee shall submit a quarterly report to the Commissioner within 30 days following the end of each calendar quarter. Each quarterly report shall include the information required in RCSA §22a-174-38(l)(2).

4. The Permittee shall submit an annual report to the Commissioner no later than January 30 of each year following the calendar year in which the data were collected. Each annual report shall include the information required in RCSA §22a-174-38(l)(3).

5. The Permittee shall submit all RCSA §22a-174-38 applicable reports in accordance with RCSA §§22a-174-38(l)(7) through 22a-174-38(l)(9).

6. The Permittee shall notify the Commissioner, in writing, no later than August 1, 2017 of the installation and operation of a FGR system. In the event that the Permittee opts not to install a FGR system, the Permittee shall notify the Commissioner of this decision, in writing, no later than August 1, 2017.

PART V. OPERATION AND MAINTENANCE REQUIREMENTS

A. The Permittee shall not cause or allow the plant to be operated at any time unless a certified chief operator or shift operator is physically present at the plant. [RCSA §22a-174-38(h)(1)] Operators shall be certified by the Commissioner under RCSA §22a-231-1. [RCSA §22a-174-38(h)(2)] Not later than six months after the date of employment, all chief operators and shift operators must satisfactorily complete an operator training course conducted by the commissioner. [RCSA §22a-174-38(h)(3)] The equipment operators shall be trained in the operation and maintenance of both the fuel burning and pollution control equipment.

B. The Permittee shall maintain an Operating and Maintenance (O&M) Manual in accordance with RCSA §22a-174-38(h)(4). This manual shall be updated on a yearly basis. Any revision to this manual which conflicts or may conflict with any condition of this permit shall be reviewed by the Commissioner and shall receive the Commissioner's written approval prior to incorporating such revision in the O&M Manual.

C. The Permittee shall establish a training program to review the O&M Manual with each person who has responsibilities affecting the operation of the plant. The training program shall be repeated on an annual basis for each person. [RCSA §22a-174-38(h)(5)]

PART VI. ALLOWABLE EMISSION LIMITS

The Permittee shall not cause or allow this equipment to exceed the emission limits stated herein at any time.

Table 1 - Pollutant Limits

Criteria Pollutants	lb/hr	lb/MMBtu	ppmvd @ 12% CO_2	TPY
PM	7.9	0.0243		34.6
SO_x[4]	104.0	0.32		455.6
NO_x	114.4	0.352		501.1
VOC	14.9	0.046	70	65.3
CO	34.1	0.105		149.5
Pb	0.13	0.0004		0.56

Non-Criteria Pollutants	lb/hr	lb/MMBtu	ppmvd @ 7% O_2	TPY
Ammonia	3.717		18	16.3
Sulfuric Acid (H_2SO_4)	15.275	0.047		69.9
HCl	12.675			55.5

Table 2 - RCSA §22a-174-38 Emission Limits

Pollutant	mg/dscm @ 7% O_2	ppmvd @ 7% O_2
PM	25	
SO_2		29[5]
NO_x		200[3,6] (Prior to August 2, 2017)
		150[3,6] (On or after August 2, 2017)
CO		100[7]
HCl		29[8]
Pb	0.400	
Cadmium	0.035	
Mercury	0.028[9]	
Dioxins/Furans	0.000030	

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4 At 29 ppmvd, the SO_x emission limit is 22.6 lb/hr and 98.8 TPY.

5 Based on a 24-hour daily geometric average or 75% reduction by weight or volume, whichever is less stringent.

6 Based on a 24-hour daily average.

7 Based on a 4-hour block average.

8 Or 95% reduction by weight or volume, whichever is less stringent.

9 Or 85% reduction by weight, whichever is less stringent.

A. The emission limits from RCSA §22a-174-38(c), as specified in Table 2 above, shall apply at all times except during periods of startup (including any warm-up period when firing natural gas only), shutdown, or malfunction as specified in RCSA §22a-174-38(c)(11):

- For determining compliance with an applicable carbon monoxide emissions limit, if a loss of boiler water level control or a loss of combustion air control is determined to be a malfunction, the duration of the malfunction period shall be limited to 15 hours per occurrence. Otherwise, the duration of each startup, shutdown or malfunction period shall be limited to three hours per occurrence;
- For the purpose of compliance with the opacity emission limits, during each period of startup, shutdown or malfunction, the opacity limits shall not be exceeded during more than five 6-minute arithmetic average measurements; and;
- During periods of startup, shutdown, or malfunction, monitoring data shall be excluded from calculations of compliance with the Table 2 emission limits but shall be recorded and reported in accordance with subsections (k) and (l) of RCSA §22a-174-38.

In the event that particulate matter, cadmium, lead, mercury, dioxin/furan, hydrogen chloride or ammonia emissions from this furnace/boiler exceed the respective emission limits, as determined through stack testing compliance data, the Permittee shall immediately initiate corrective action to re-attain compliance with this limit and shall report to the Commissioner as required under Part IV.B.1 of this permit.

In the event that SO_2, NO_x or CO emissions from this furnace/boiler exceed the respective emission limits, as determined through CEM compliance data, the Permittee shall immediately initiate corrective action to re-attain compliance with this limit and shall report to the Commissioner as required under Part III.E of this permit.

B. Hazardous Air Pollutants

This equipment shall not cause an exceedance of the Maximum Allowable Stack Concentration (MASC) for any hazardous air pollutant (HAP) emitted and listed in RCSA §22a-174-29. [STATE ONLY REQUIREMENT]

C. Demonstration of compliance with the above emission limits shall be determined by calculating the emission rates from the following monitoring requirements:

- PM, hydrogen chloride, cadmium, lead, mercury, dioxin/furan, ammonia: Annual Stack Test, Reference Part VII of this permit
- SO_x, NO_x, CO: Continuous Emission Monitoring, Reference Part III of this permit
- VOC, All Other HAPs: Initial Stack Test

1. Particulate Matter (PM)

    a. The Permittee shall not emit PM in excess of 25 mg/dscm corrected to 7% O_2 (dry basis). Compliance shall be determined annually based on an arithmetic average determined using all data generated in three test runs, in accordance with RCSA §22a-174-38(i)(4)(A). In the event that the PM emission rate exceeds 0.020 gr/dscf corrected to 12% CO_2 (dry basis), as determined through stack testing compliance data, the Permittee shall cease operation of this furnace. The furnace will be permitted to restart only after the Permittee demonstrates to the Commissioner's satisfaction that sufficient corrective action has been taken. Within three days after restarting operation under this circumstance, the Permittee shall demonstrating in writing to the Commissioner's satisfaction that it is in compliance with the particulate emission limit.

b. Maximum Allowable Opacity: 10 percent based on a 6-minute block average

2. Sulfur Dioxide (SO_2)

The Permittee shall not emit SO_2 in excess of 29 ppmvd corrected to 7% O_2 (dry basis) based on a 24-hour daily geometric average or a 75% reduction by weight or volume, whichever is less stringent.

3. Nitrogen Oxides (NO_x)

Effective August 2, 2017, the Permittee shall not emit NO_x in excess of 150 ppmvd corrected to 7% O_2 (dry basis) based on a 24-hour block average. Prior to August 2, 2017, the Permittee shall not emit NO_x in excess of 200 ppmvd corrected to 7% O_2 (dry basis) based on a 24-hour block average.

4. Carbon Monoxide (CO)

The Permittee shall not emit CO in excess of 100 ppmvd corrected to 7% O_2 (dry basis) based on a 4-hour block average.

5. Cadmium (Cd)

The Permittee shall not emit Cadmium in excess of 0.035 mg/dscm corrected to 7% O_2 (dry basis). Compliance shall be determined annually based on an arithmetic average determined using all data generated in three test runs, in accordance with RCSA §22a-174-38(i)(4)(B).

6. Lead (Pb)

The Permittee shall not emit Lead in excess of 0.400 mg/dscm corrected to 7% O_2 (dry basis). Compliance shall be determined annually based on an arithmetic average determined using all data generated in three test runs, in accordance with RCSA §22a-174-38(i)(4)(B).

7. Mercury (Hg)

The Permittee shall not emit Mercury in excess of 0.028 mg/dscm corrected to 7% O_2 (dry basis), or an 85% reduction by weight, whichever is less stringent. Compliance shall be determined annually based on an arithmetic average of emission concentrations or percent reductions determined using all data generated in a minimum of at least three test runs, in accordance with RCSA §22a-174-38(i)(4)(C).

8. Hydrogen Chloride (HCl)

The Permittee shall not emit HCl in excess of 29 ppmvd corrected to 7% O_2 (dry basis) or a 95% reduction by weight or volume, whichever is less stringent. Compliance shall be determined annually based on an arithmetic average of emission concentrations or percent reductions determined using all data generated in three test runs, in accordance with RCSA §22a-174-38(i)(4)(G).

9. Dioxin/Furan

The Permittee shall not emit Dioxin/Furan in excess of 0.000030 mg/dscm corrected to 7%

O_2 (dry basis), total mass (total tetra through octa-dibenzo-p-dioxins and dibenzofurans). Compliance shall be determined annually based on an arithmetic average determined using all data generated in three test runs, in accordance with RCSA §§22a-174-38(i)(3) and 22a-174-38(i)(4)(H).

10. Ammonia

The Permittee shall not emit Ammonia in excess of 18 ppmvd corrected to 7% O_2 (dry basis). Compliance shall be determined annually based on an arithmetic average determined using all data generated in three test runs, in accordance with RCSA §22a-174-38(i)(4)(L).

11. Hazardous Air Pollutants

In the event that any MASC exceedance occurs for any hazardous air pollutant emitted and listed in RCSA §22a-174-29, the Permittee shall take corrective action to achieve the regulatory limit. Additionally, the Permittee shall provide written notification to the Commissioner within three working days of the time at which the Permittee receives information regarding performance test results indicating an exceedance of any hazardous air pollutant listed in Part VII.A of this permit.

PART VII. STACK EMISSION TEST REQUIREMENTS

Stack emission testing shall be performed in accordance with the Emission Test Guidelines available on the DEEP website.

Annual stack testing shall be required for the following pollutant(s):

☒ PM ☐ PM_{10} ☐ $PM_{2.5}$ ☐ SO_2 ☐ NO_x ☐ CO
☐ VOC ☐ Opacity ☒ Other: See A below

Annual Stack Testing Requirements

A. The Permittee shall conduct an annual performance test for dioxin/furan, particulate matter, hydrogen chloride, cadmium, lead and mercury in accordance with RCSA §22a-174-38(i). The Permittee shall also conduct an annual performance test for ammonia using Modified EPA Method 26A and in accordance with RCSA §22a-174-38(i).

B. The Permittee shall complete and submit to the Commissioner an Intent to Test (ITT) form and complete test package no less than 90 days before annual emission testing is scheduled. The Permittee shall submit written notice to the Commissioner three business days before conducting annual emission testing. The ITT shall address the compliance testing of all air pollutants listed in Part VII.A of this permit.

All methods and procedures listed in the ITT shall be consistent with the requirements of the DEEP (pursuant to RCSA §22a-174-38) or equivalent methods approved by DEEP. This ITT shall include provisions for measurement of any and all operational parameters necessary to verify compliance with the terms of this permit. In addition, additional non-criteria pollutant emission rates shall be confirmed during testing, if requested by DEEP.

C. During the test program the emissions and operating parameters of this equipment shall be measured, monitored and recorded. The operating parameters that shall be recorded during the test program shall include, at a minimum, unit load, furnace temperature as measured at the superheater outlet and pressure, feedwater temperature, furnace draft, total underfire and overfire air, soot-blowing frequency, auxiliary fuel firing rate, reagent stoichiometry, lime slurry flow rate and application pressure, dilution water flow rate, pressure drop across the baghouses, baghouse inlet temperature, fabric filter cleaning cycle mode, and MSW charging rate, if requested by DEEP.

D. The compliance tests shall be carried out with the furnace/boiler operating at approximately 100% of the maximum unit load (i.e., maximum rated capacity).

E. The Permittee shall comply with all applicable notification, testing, and record keeping provisions of RCSA §22a-174-38.

F. The Commissioner may require the Permittee to conduct additional performance tests if any pollutant emission rate or operational parameter is identified as not being in compliance with any permit condition.

PART VIII. CONTROL EQUIPMENT MALFUNCTION

In addition to complying with the requirements of RCSA §22a-174-7, the Permittee shall also comply with the following conditions:

A. Except as otherwise provided in this part, the Permittee shall only be allowed to operate this furnace/boiler during shutdown of air pollution control equipment when there is a malfunction of such air pollution control equipment and as allowed under RCSA §22a-174-7(b). In the event of the malfunction of air pollution control equipment that cannot be corrected within three hours, the Permittee shall immediately institute a furnace shutdown procedure in accordance with the O&M Plan. The period for which the facility will be allowed to operate during shutdown of the air pollution control equipment shall not exceed the burnout of the unit's charge at the time of the shutdown of the air pollution control equipment. No MSW may be charged into the hopper following a shutdown of the air pollution control equipment until after the air pollution control equipment has been put back on-line.

B. The Commissioner retains authority to take enforcement actions including, but not limited to, requiring shutdown of the facility if the source consistently (as determined by the Commissioner) violates any pollutant emission limit or permit condition.

C. None of the conditions in this part shall exempt the Permittee from compliance with any other condition of this permit, with any emission limit established in this permit, or with any applicable state or federal regulation.

PART IX. PREMISES REQUIREMENTS

A. (State Enforceable Only) The Permittee shall comply with the state odor regulations, as set forth in RCSA §22a-174-23.

B. (State Enforceable Only) The Permittee shall comply with the state noise control regulations, as set forth in RCSA §§22a-69-1 through 22a-69-7.4.

C. The Permittee shall institute and comply with the following conditions at all times:

1. Sufficient wind-sheltered storage capacity for refuse, residual particulates and bottom ash on site and provision for landfill disposal of same must be provided for, in the event of strike,

malfunction of air pollution control equipment, or other interruption.

2. Vehicular traffic areas shall be paved and adequately swept at the plant site.

3. Ensure that all trucks when loaded with municipal solid waste or any material likely to become airborne are covered at all times while outside the tipping building.

4. Transfer, storage and transportation at and from the plant site, of materials collected from the furnace grates and air pollution control equipment shall be transferred in a covered container or other method equally effective in preventing the material from becoming airborne during storage and transfer.

5. The Permittee shall implement a clean up program on the plant site whereby any refuse, MSW or other materials will be collected.

6. The Permittee shall be subject at all times to the requirements of RCSA §22a-174-18(c), requirements which pertain to the control of fugitive dust emissions.

7. The public shall not have uncontrolled access to any portion of this premises.

PART X. ENFORCEMENT CONSIDERATIONS

A. CEM data, stack testing data and the results of any monitoring and testing of source parameters and emission rates shall, unless otherwise specified in this permit, be used to determine compliance with this permit.

B. The Permittee shall comply with any and all applicable requirements of the Clean Air Act as amended in 1990 as such requirements become applicable to this facility.

C. Pursuant to RCSA §22a-6b-602, the Permittee is hereby advised of its liability for assessment of civil penalties for any violation of this permit.

D. Notwithstanding any other provision of this permit, for the purpose of determining compliance or establishing whether a permittee has violated or is in violation of any permit condition, nothing in this permit shall preclude the use, including the exclusive use, of any credible evidence or information.

PART XI. ADDITIONAL TERMS AND CONDITIONS

A. This permit does not relieve the Permittee of the responsibility to conduct, maintain and operate the regulated activity in compliance with all applicable requirements of any federal, municipal or other state agency. Nothing in this permit shall relieve the Permittee of other obligations under applicable federal, state and local law.

B. Any representative of the DEEP may enter the Permittee's site in accordance with constitutional limitations at all reasonable times without prior notice, for the purposes of inspecting, monitoring and enforcing the terms and conditions of this permit and applicable state law.

C. This permit may be revoked, suspended, modified or transferred in accordance with applicable law.

D. This permit is subject to and in no way derogates from any present or future property rights or other rights or powers of the State of Connecticut and conveys no property rights in real estate or material, nor any exclusive privileges, and is further subject to any and all public and private rights and to any federal, state or local laws or regulations pertinent to the facility or regulated activity affected thereby. This permit shall neither create nor affect any rights of persons or municipalities who are not parties to this permit.

E. Any document, including any notice, which is required to be submitted to the Commissioner under this permit shall be signed by a duly authorized representative of the Permittee and by the person who is responsible for actually preparing such document, each of whom shall certify in writing as follows: "I have personally examined and am familiar with the information submitted in this document and all attachments thereto, and I certify that based on reasonable investigation, including my inquiry of those individuals responsible for obtaining the information, the submitted information is true, accurate and complete to the best of my knowledge and belief. I understand that any false statement made in the submitted information may be punishable as a criminal offense under section 22a-175 of the Connecticut General Statutes, under section 53a-157b of the Connecticut General Statutes, and in accordance with any applicable statute."

F. Nothing in this permit shall affect the Commissioner's authority to institute any proceeding or take any other action to prevent or abate violations of law, prevent or abate pollution, recover costs and natural resource damages, and to impose penalties for violations of law, including but not limited to violations of this or any other permit issued to the Permittee by the Commissioner.

G. Within 15 days of the date the Permittee becomes aware of a change in any information submitted to the Commissioner under this permit, or that any such information was inaccurate or misleading or that any relevant information was omitted, the Permittee shall submit the correct or omitted information to the Commissioner.

H. The date of submission to the Commissioner of any document required by this permit shall be the date such document is received by the Commissioner. The date of any notice by the Commissioner under this permit, including but not limited to notice of approval or disapproval of any document or other action, shall be the date such notice is personally delivered or the date three days after it is mailed by the Commissioner, whichever is earlier. Except as otherwise specified in this permit, the word "day" means calendar day. Any document or action which is required by this permit to be submitted or performed by a date which falls on a Saturday, Sunday or legal holiday shall be submitted or performed by the next business day thereafter.

I. Any document required to be submitted to the Commissioner under this permit shall, unless otherwise specified in writing by the Commissioner, be directed to: Office of Director; Engineering & Enforcement Division; Bureau of Air Management; Department of Energy and Environmental Protection; 79 Elm Street, 5th Floor; Hartford, Connecticut 06106-5127.

Appendix C

State of New Jersey

Jon S. Corzine
Governor

DEPARTMENT of ENVIRONMENTAL PROTECTION

Mark N. Mauriello
Acting Commissioner

Environmental Regulation
Bureau of Air Permits
401 E. State Street, 2nd floor, P.O. Box 27
Trenton, NJ 08625-0027

Air Pollution Control Operating Permit
Minor Modification and Preconstruction Approval

Permit Activity Number: BOP090001 **Program Interest Number: 55793**

Mailing Address	Plant Location
Michael Kissel, Plant Mgr WHEELABRATOR GLOUCESTER CO LP 600 RT 130 West Deptford Twp, NJ 08093	WHEELABRATOR GLOUCESTER COMPANY L P 600 Us Rt 130 Westville Boro Gloucester County

Initial Operating Permit Approval Date: **December 13, 2003**

Minor Modification Approval Date: **October 16, 2009**

Operating Permit Renewal Expiration Date: **December 11, 2013**

This minor modification is approved and issued under the authority of Chapter 106, P.L. 1967 (N.J.S.A. 26:2C-9.2). The equipment at the facility must be operated in accordance with the requirements of this permit.

This approval, in response to your application, merges the provisions of the previously approved operating permit and the changes from this minor modification into a single comprehensive permit that replaces the one previously issued. This modification is for the proposed enhancement of the existing SNCR system through the installation of a minimum of four additional SNCR injector ports in the furnace membrane walls and additional SNCR system control through system optimization and temperature profiling to comply with the new NOx limitations for municipal solid waste incinerators.

Equipment at the facility referenced by this minor modification **is not covered by** the permit shield, pursuant to the provisions of N.J.A.C. 7:27-22.17. Pursuant to N.J.A.C. 7:27-22.33(e), this minor modification consists of both a preconstruction approval and operating permit approval. This operating permit does not include compliance schedules as part of the approved compliance plan.

The permittee shall submit to the Department and to the EPA on forms provided by the Department, at the addresses given below, a periodic compliance certification, in accordance with N.J.A.C. 7:27-22.19 and the schedule for compliance certifications set forth in the compliance plan in this operating permit. The annual compliance certification reporting period will cover the calendar year ending December 31. **The annual compliance certification is due to the Department and the EPA within 60 days after the end of each calendar year during which this permit was in effect.** Forms provided by the Department can be found on the Department's website at: http://www.nj.gov/dep/enforcement/compliancecertsair.htm.

The annual compliance certification report may also be considered as your six month deviation report for the period from July 1 through December 31 which is due by January 30 of each year, as required by paragraph 13 in Section F, *General Provisions and Authorities*, of this permit, if the annual compliance certification is submitted by January 30.

New Jersey Department of Environmental Protection
Air & Environmental Quality Compliance & Enforcement
401 East State Street, P. O. Box 422
Trenton, New Jersey 08625-0422

United States Environmental Protection Agency, Region II
Air Compliance Branch
290 Broadway
New York, New York 10007-1866

Air and Environmental Quality Compliance & Enforcement
Southern Regional Enforcement Office
One Port Center, 2 Riverside Drive, Suite 201
Camden, NJ 08102
Air and Environmental Quality Compliance & Enforcement

We are including two electronic files, PDF and RADIUS. The PDF file contains the complete operating permit for your facility. The RADIUS file contains the Facility Name, Location, and Contact Information; the Facility Specific Requirements (Compliance Plan) and Inventories; and any Compliance Schedules (if needed). Upon importing this information into your personal computer with RADIUS software, you will have up-to-date information in RADIUS format. RADIUS software, instructions, and help are available at the Department's website at www.state.nj.us/dep/aqpp. We also have an Operating Permit Help Line available from 9:00 AM to 4:00 PM daily, where you may speak to someone about any questions you may have. The Operating Permit Help Line number is 609-633-8248.

If, in your judgment, the Department is imposing any unreasonable condition of approval in this permit modification action, you may contest the Department's decision on the modification and request an adjudicatory hearing pursuant to N.J.S.A. 52:14b-1 et seq. and N.J.A.C. 7:27-22.32(a). All requests for an adjudicatory hearing must be received in writing by the Department within 20 calendar days of the date you receive this letter. The request must contain the information requested in N.J.A.C. 7:27-1.32 and the information on the enclosed Administrative Hearing Request Checklist and Tracking Form.

The permittee is responsible for submitting a timely and administratively complete operating permit renewal application. The application is considered timely if it is received at least 12 months before the expiration date of the operating permit. To be deemed administratively complete, an application for renewal of the operating permit shall include all of the information required by the application form for the renewal and the information required pursuant to N.J.A.C. 7:27-22.30(d). However, consistent with N.J.A.C. 7:27-22.30(c), the permittee is encouraged to submit the renewal application at least 15 months prior to expiration of the operating permit, so that the Department can notify the applicant of any deficiencies in the application. This will allow the permittee to correct any deficiencies, and to better ensure that the application is administratively complete by the renewal deadline. Only applications which are timely and administratively complete will be eligible for coverage by an application shield. The renewal application can be found at our website, http://www.state.nj.us/dep/aqpp/downloads/forms/OPRenewal.PDF.

Permittees that are subject to Compliance Assurance Monitoring (CAM), pursuant to 40 CFR 64, shall develop a CAM Plan for modified equipment as well as existing sources. Details of the rule and guidance on how to prepare a plan can be found at EPA's website: www.epa.gov/ttn/emc/cam.html. In addition, CAM Plans must be included as part of the permit renewal application. Permittees that do not submit a CAM Plan may have their modification applications denied, pursuant to N.J.A.C. 7:27-22.3.

If you have any questions regarding this permit approval, please call your permit writer, Harry Baist, at (609) 633-8235.

Approved by:

Yaso Sivaganesh
Bureau of Air Permits

Enclosure
CC: S. Riva, USEPA Region II (CD containing final permit)
R. Wormley SRO (Signature Page Only)

Section A

Facility Name: WHEELABRATOR GLOUCESTER COMPANY L P
Program Interest Number: 55793
Permit Activity Number: BOP090001

REASON FOR PERMIT

The reason for issuance of this permit is to comply with the air pollution control permit provisions of Title V of the federal Clean Air Act, federal rules promulgated at 40 CFR 70, and state regulations promulgated at N.J.A.C. 7:27-22, which requires the state to issue operating permits to major facilities and minor facilities that are in certain designated source categories. This is the operating permit for the facility listed on the cover page, which includes a minor modification for the enhancement of the existing SNCR system through the installation of a minimum of four additional SNCR injector ports in the furnace membrane walls and additional SNCR system control through system optimization and temperature profiling to comply with the new NOx limitations for municipal solid waste incinerators.

New Jersey has elected to integrate its Title I New Source Review (NSR) preconstruction permits with the new Title V operating permits instead of issuing separate permits. Consequently, the existing preconstruction permit provisions that were previously approved for this facility have been consolidated into this permit. This permit may also include applicable requirements for grandfathered sources.

This permit action consolidates previously approved permit terms and conditions into one single permit for the facility. The New Jersey Department of Environmental Protection (Department) issues this operating permit authorizing the facility to operate equipment and air pollution control devices. In the operating permit application, the facility represented that it meets all applicable requirements of the federal Clean Air Act and the New Jersey Air Pollution Control Act codified at N.J.S.A. 26:2C. Based on an evaluation of the data contained in the facility’s application, the Department has approved this operating permit.

This permit allows this facility to operate the equipment and air pollution control devices specified in this permit and emit up to a level specified for each source operation. The signatories named in the application are responsible for ensuring that the facility is operated in a manner consistent with this permit, its conditions, and applicable rules.

New Jersey Department of Environmental Protection
Facility Specific Requirements

Ref.#	Applicable Requirement	Monitoring Requirement	Recordkeeping Requirement	Submittal/Action Requirement
23	Any person responsible for the use of an incinerator shall when ordered by the Department, provide the facilities and necessary equipment for determining the density of smoke being discharged from a stack or chimney and shall conduct such smoke tests using methods approved by the Department. [N.J.A.C. 7:27-11.3(e)1]	None.	Other: All smoke test data shall be recorded in a permanent log at such time intervals as specified by the Department. Data shall be maintained for a period of not less than one year and shall be available for review by the Department.[N.J.A.C. 7:27-11.3(e)1].	None.
24	Any person responsible for the use of an existing incinerator shall upon request of the Department provide such sampling facilities and testing facilities exclusive of instruments and sensing devices as may be necessary for the Department to determine the nature and quantity of emissions from such incinerators and shall during such testing operate the incinerator at a charging rate of waste no less than the designed capacity of the incinerator using materials representative of the types of wastes normally burned. [N.J.A.C. 7:27-11.3(e)]	None.	None.	None.
25	No person shall use or cause to be used any incinerator unless all components connected, or attached to, or serving the incinerator, including control apparatus are functioning properly and are in use, in accordance with this permit. [N.J.A.C. 7:27-11.5(c)]	None.	None.	None.
26	VOC (Total) <= 3.5 lb/hr. Maximum uncontrolled emission rate from each municipal solid waste combuster, based on the Table 16A at N.J.A.C. 16.16. This limit applies at all times, including startup and shutdown. [N.J.A.C. 7:27-16.16(d)]	Other: Refer to VOC stack testing requirement in U1 OS0, except that compliance with this requirement is based on any 60-minute period (worst case run).[N.J.A.C. 7:27-16.16(g)1ii].	Other: Refer to VOC stack testing requirement in U1 OS0.[N.J.A.C. 7:27-16.16(g)1ii].	None.
27	Nitrogen oxides (NOx) <= 150 ppmvd @ 7% O2 by May 1, 2011, from BOP090001. [N.J.A.C. 7:27-19.12(a)2]	Nitrogen oxides (NOx): Monitored by continuous emission monitoring system continuously, based on one calendar day [N.J.A.C. 7:27-19.12 &. [N.J.A.C. 7:27-19.15(a)]	Nitrogen oxides: Recordkeeping by data acquisition system (DAS) / electronic data storage continuously. [N.J.A.C. 7:27-19.19(a)]	None.

WHEELABRATOR GLOUCESTER COMPANY L P (55793)
BOP090001

Date: 10/19/200

New Jersey Department of Environmental Protection
Reason for Application

Permit Being Modified

Permit Class: BOP **Number:** 70001

Description of Modifications:	This modification is for the proposed enhancement of the existing SNCR system through the installation of a minimum of four additional SNCR injector ports in the furnace membrane walls and additional SNCR system control through system optimization and temperature profiling to comply with the new NOx limitations for municipal solid waste incinerators.

New Jersey Department of Environmental Protection
Equipment Inventory

Equip. NJID	Facility's Designation	Equipment Description	Equipment Type	Certificate Number	Install Date	Grand-Fathered	Last Mod. (Since 1968)	Equip. Set ID
E1	Boiler No. 1	287.5 Tons Per Day Municipal Solid Waste Combustor	Boiler	PCP000001	1/1/1990	No	1/1/1996	
E2	Boiler No. 2	287.5 Tons Per Day Municipal Solid Waste Combustor	Boiler	PCP000001	1/1/1990	No	1/1/1996	
E3	Ash Handling	Metals Truck Loadout	Manufacturing and Materials Handling Equipment	BOP990001	1/1/1990	No	3/9/1998	
E4	Lime Silo	Lime Silo for Pebble Lime Storage	Manufacturing and Materials Handling Equipment	091943	1/1/1990	No	1/1/1990	
E5	Headsproket	Head Sprocket	Manufacturing and Materials Handling Equipment	01-98-0805	5/5/1998	No	3/9/1998	
E6	Fire pump	1.7 MMBTU/hr fire pump	Fuel Combustion Equipment (Other)	093884	1/10/1990	No		
E7	Ash Handling	Ash Truck Loadout	Manufacturing and Materials Handling Equipment	082610	1/1/1990	No	3/9/1998	
E8	Ash Handling	Ash Conditioner	Manufacturing and Materials Handling Equipment	082610	1/1/1990	No	3/9/1998	

New Jersey Department of Environmental Protection
Control Device Inventory

CD NJID	Facility's Designation	Description	CD Type	Install Date	Grand-Fathered	Last Mod. (Since 1968)	CD Set ID
CD1	B1 SDA	Boiler No. 1 Spray Dryer Absorber	Scrubber (Other)	1/1/1990	No	1/1/1990	
CD2	B1 FF	Boiler No. 1 Fabric Filter	Particulate Filter (Baghouse)	1/1/1990	No	1/1/1990	
CD3	B1 CI	Boiler No. 1 Carbon Injection System	Other	1/1/1996	No	1/1/1996	
CD4	B2 SDA	Boiler No. 2 Spray Dryer Absorber	Scrubber (Other)	1/1/1990	No	1/1/1990	
CD5	B2 FF	Boiler No. 2 Fabric Filter	Particulate Filter (Baghouse)	1/1/1990	No	1/1/1990	
CD6	B2 CI	Boiler No. 2 Carbon Injection System	Other	1/1/1996	No	1/1/1996	
CD7	Lime Silo	Lime Silo Baghouse	Particulate Filter (Baghouse)	1/1/1990	No	1/1/1990	
CD9	B1 SNCR	Boiler No. 1 SNCR	Selective Non-Catalytic Reduction		No		
CD10	B2 SNCR	Boiler No. 2 SNCR	Selective Non-Catalytic Reduction		No		
CD11	Scrubber#1	Ash Conditioning Area Wet Scrubber	Scrubber (Other)	2/5/2007			
CD12	Scrubber #2	Loadout Building Wet Scrubber	Scrubber (Other)	2/5/2007			

WHEELABRATOR GLOUCESTER COMPANY L P (55793)
BOP090001

Date: 10/19/2009

New Jersey Department of Environmental Protection
Emission Unit/Batch Process Inventory

U 1 MSW combust. Two 287.5 Ton Per Day, 108 MMBTU/hr Municipal Solid Waste (MSW) Fired Combustors (E1 and E2)

UOS NJID	Facility's Designation	UOS Description	Operation Type	Signif. Equip.	Control Device(s)	Emission Point(s)	SCC(s)	Annual Oper. Hours Min.	Annual Oper. Hours Max.	VOC Range	Flow (acfm) Min.	Flow (acfm) Max.	Temp. (deg F) Min.	Temp. (deg F) Max.
OS1	Boiler No. 1	Boiler No. 1 - Burning Municipal Solid Waste (E1), Controlled by Scrubber CD1, Baghouse CD2, and Carbon Injection System CD3	Normal - Steady State	E1	CD1 (P) CD2 (P) CD3 (P)	PT1	1-01-012-01	0.0	8,760.0		18,000.0	80,000.0	200.0	500.0
OS2	Boiler No. 2	Boiler No. 2 - Burning Municipal Solid Waste (E2), Controlled by Scrubber CD4, Baghouse CD5, and Carbon Injection System CD6	Normal - Steady State	E2	CD4 (P) CD5 (P) CD6 (P)	PT1	1-01-006-01	0.0	8,760.0		18,000.0	80,000.0	200.0	500.0
OS3	Blr 1-Emer M	Boiler No. 1 - Emergency malfunction	Malfunction	E1	CD1 (P) CD2 (P) CD3 (P)									
OS4	Blr 2-Emer M	Boiler No. 2 - Emergency malfunction	Malfunction	E2	CD4 (P) CD5 (P) CD6 (P)									

Appendix D

GENERAL CONDITIONS

G-1. Except as otherwise provided for in the following provisions, the application for the Certificate of Public Convenience and Necessity (CPCN) is considered to be part of this CPCN for the Energy Answers Baltimore, LLC (EA) Fairfield Renewable Energy Project (the "Fairfield Project" or "Project"). The application consists of the original application received by the Maryland Public Service Commission (PSC) in May 2009, the revised application received by the PSC in October 2009, and the Motion to Amend and technical amendment received by the PSC in January 2012. In the application, estimates of dimensions, volumes, emission rates, operating rates, feed rates and hours of operation are not deemed to constitute enforceable numeric limits except to the extent that they are necessary to make a determination of applicable regulations. Construction of the facility shall be undertaken in accordance with the CPCN application and subsequent amendments approved by the Commission. If there are any inconsistencies between the conditions specified below and the application, the conditions in this CPCN shall take precedence. If CPCN conditions incorporate federal or state laws through paraphrased language, where there is any inconsistency between the paraphrased language and the actual state or federal laws being paraphrased, the applicable federal or state laws shall take precedence.

G-2. If any provision of this CPCN shall be held invalid for any reason, the remaining provisions shall remain in full force and effect and such invalid provision shall be considered severed and deleted from this CPCN.

G-3. Representatives of the Maryland PSC shall be afforded access to the Fairfield Renewable Energy Project facility at any reasonable time to conduct inspections and evaluations necessary to assure compliance with the CPCN. EA shall provide such assistance as may be necessary to conduct such inspections and evaluations by representatives of the PSC effectively and safely.

G-4. Representatives of the Maryland Department of the Environment (MDE) and the Baltimore City Health Department shall be afforded access to the Fairfield Renewable Energy Project facility at any reasonable time to conduct inspections and evaluations necessary to assure compliance with the CPCN requirements. EA shall provide such assistance as reasonably may be necessary to conduct such inspections and evaluations effectively and safely, which may include but need not be limited to the following:

a) Inspecting construction authorized under this CPCN;

b) Sampling any materials stored or processed on site, or any waste or discharge into the environment;

c) Inspecting any monitoring or recording equipment required by this CPCN or applicable regulations;

d) Having access to or copying any records required to be kept by EA pursuant to this CPCN or applicable regulations;

e) Obtaining any photographic documentation and evidence; and

f) Determining compliance with the conditions and regulations specified in the CPCN.

G-5. Informational copies of the reports and notifications as described in Conditions A-2, A-8, A-13, A-15, A-20b, A-21 b-d, A-41, A-44, A-46, A-53, A-56, A-57, A-58, A-61, F-4, and E-7 shall be sent to the Maryland Power Plant Research Program (PPRP) at:

Power Plant Assessment Division
Department of Natural Resources
Tawes State Office Building, B-3
580 Taylor Avenue
Annapolis, Maryland 21401

AIR QUALITY REQUIREMENTS

General Air Quality Requirements

A-1. MDE Air and Radiation Management Administration (MDE-ARMA) shall have concurrent jurisdiction with the PSC to enforce the air quality conditions of this CPCN.

A-2. The CPCN serves as the Prevention of Significant Deterioration (PSD) approval, Nonattainment New Source Review (NA-NSR) approval, and air quality construction permit for the Fairfield Renewable Energy Project and does not constitute the permit to construct or approvals until such time as EA has provided documentation demonstrating that nitrogen oxides (NO_x) emission offsets totaling at least 781 tons, volatile organic compound (VOC) emission offsets totaling at least 125 tons, particulate matter less than 2.5 micrograms (PM2.5) emission offsets totaling at least 156 tons, and SO_2 (as a PM2.5 precursor) emission offsets totaling at least 446 tons have been obtained and approved by the MDE-ARMA and are federally enforceable. Should the PM2.5 Lowest Achievable Emissions Rate (LAER) limit be determined to be greater than the provisional LAER limit for PM2.5 in Condition 21(b) of 22 milligrams per dry standard cubic meter (mg/dscm) @ 7% O_2, EA shall be required to obtain additional PM2.5 offsets for the difference between the provisional and final LAER limit at a ratio of 1:1 within 180 days of the final PM2.5 limit having been imposed by MDE-ARMA.

A-3. For air permitting purposes, the facility shall be comprised of the following equipment:

a) Four spreader-stoker boilers ("combustors") each designed to operate at 450 million British thermal units per hour (MMBtu/hr), and each designed to combust an average of 1,000 tons per day (tpd) of Waste-derived Fuel to generate electricity and steam. High pressure steam from the boilers will drive one, nominal, 157-megawatt (MW) turbine generator. Each boiler shall be equipped with three, 150-million Btu per hour (MMBtu/hr) natural burners. Each boiler shall be equipped with the following air pollution control systems: regenerative selective catalytic reduction (RSCR) to control NO_x emissions; an activated carbon injection system to control mercury and dioxin/furan emissions; a Turbosorp® (or equivalent) humidifying circulating bed scrubber with dry lime injection to neutralize acid gases; fabric filters (baghouses) to capture particulate matter; and an oxidation catalyst to control CO emissions;

b) Two four-celled water-cooled condenser cooling towers;

c) One diesel fuel-fired emergency generator, model year 2010 or later, with a power output of up to 500 kilowatts (kW));

d) Two diesel fuel-fired emergency fire water pumps, model year 2010 or later, with a power output of up to 100 kW;

e) Bottom ash handling system; and

f) Fly ash handling system.

A-4. Definitions:

a) "Automotive Shredder Residue" ("ASR") is defined as shredded interior plastic trim, upholstery fabric and filler, insulation and padding of end-of-life vehicles (ELV). ASR may consist of rubber, paper, hard plastic, vinyl, glass, and some aluminum and plated metals from the scrap, as well as rocks and dirt, the amount of which depends on scrap handling procedures.

b) "Malfunction" is defined as any sudden, infrequent, and not reasonably preventable failure of air pollution control equipment, process equipment, or a process that operates in an abnormal or unusual manner. Failures that are caused in part by poor maintenance or careless operation are not malfunctions. Periods of malfunction shall not exceed 3 hours per occurrence, except if a loss of boiler water level control or combustion air control is determined to be a malfunction, the duration of the malfunction period is limited to 15 hours per occurrence [40 CFR 60.58b(a)(1) and 40 CFR 60.58b(a)(1)(iii)].

c) "Processed Refuse Fuel" ("PRF") is shredded municipal solid waste, commercial waste, and non-hazardous industrial wastes, after a portion of the ferrous metals is removed.

d) "Processed Urban Wood Waste" is wood fuel derived from both green and dried wood waste materials, and may include sawn lumber, pruned branches, stumps, and whole trees from street and park maintenance, shipping pallets, wood debris segregated from construction and demolition and land clearing and grubbing activities;

e) "Shutdown" is defined as that period of time that the combustor temperature is lowered, following cessation of the charging of Waste-derived Fuel to the combustor, and beginning at the point at which the temperature drops below 1,500°F and combustion firing with natural gas commences, and continuing until natural gas stops flowing. Shutdown shall not exceed 3 hours per occurrence [40 CFR 60.58b(a)(1)];

f) "Startup" commences when a Fairfield combustor begins the continuous burning of Waste-derived Fuel and does not include any warmup period when that combustor is combusting fossil fuel, and no Waste-derived Fuel is being fed to the combustor [40 CFR 60.58b(a)(1)(i)]. Startup shall not exceed 3 hours per occurrence [40 CFR 60.58b(a)(1)] following which operation of the continuous burning of Waste-derived Fuel shall begin;

g) "Tire Derived Fuel" ("TDF") is a processed (ground) material made primarily from scrap tires that are no longer usable for their original intended purpose because of wear, damage, or defect;

h) "Warmup" is defined as the period of time from initiation of combustion firing with natural gas until the combustor's temperature can be maintained at or above 1,500°F for a period of at least one second after secondary air injection, and before any Waste-derived Fuel is introduced into the combustor;

i) "Waste-derived Fuel" shall consist of PRF, ASR, TDF, and Processed Urban Wood Waste. Other non-hazardous Waste-derived Fuel may only be combusted upon written approval from MDE-ARMA.

A-5. EA shall construct exhaust stacks for the Fairfield combustors at a minimum height of 295 feet above ground level.

A-6. In accordance with COMAR 26.11.02.04B, the air quality provisions expire if, as determined by MDE-ARMA:

a) Construction is not commenced within 36 months after the August 6, 2010 effective date of the CPCN issued in Case 9199;

b) Construction is substantially discontinued for a period of 18 months or more after it has commenced; or

c) Construction is not completed within a reasonable period of time after the issuance of a final CPCN.

A-7. At least 60 days prior to the anticipated date of initial startup of the facility, EA shall submit to MDE-ARMA an application for a temporary permit to operate.

A-8. All requirements pertaining to air quality that apply to EA shall apply to all subsequent owners and/or operators of the facility. In the event of any change in control or ownership, EA shall notify the succeeding owner/operator of the existence of the requirements of this CPCN pertaining to air quality by letter and shall send a copy of that letter to the PSC and MDE-ARMA.

Plant-wide Air Requirements

A-9. The Fairfield Project is subject to all applicable federally enforceable air quality requirements including, but not limited to, the following regulations:

A-25. EA shall develop and update, at least each calendar year, a site-specific operating manual that shall, at a minimum, address the elements of municipal waste combustor unit operations specified in 40 CFR 60.53b(e). EA shall maintain the manual on site and make it available to MDE-ARMA upon request.

A-26. EA shall not cause the combustors to operate at a temperature, measured at the particulate matter control device inlet, exceeding 17°C above the maximum demonstrated particulate matter control device temperature defined in 40 CFR 60.51b, except during certain specified types of testing [40 CFR 60.53b(c)].

A-27. EA shall comply with the operator training and certification requirements outlined in 40 CFR 60.54b.

A-28. EA shall use the procedures in 40 CFR 60.58b(i) to determine compliance with applicable operating requirements.

A-29. Warmup on Waste-derived Fuel is prohibited. During warmup, auxiliary fuel (natural gas) shall be used to achieve combustion chamber operating temperature.

Emissions and Operational Requirements for Emergency Diesel Generator and Firewater Pump Engines

A-30. The emergency diesel generator and the two firewater pump engines are each subject to all applicable federally enforceable air quality requirements including, but not limited to, the following regulations:

a) *Visible Emissions*—Prohibits EA from causing or permitting the discharge of emissions from any fuel burning equipment, other than water in an uncombined form, which is visible to human observers. [COMAR 26.11.09.05A(2)]. This limitation does not apply to emissions during load changing, soot blowing, startup, or adjustments or occasional cleaning of control equipment if [COMAR 26.11.09.05A(3)]:

i) The visible emissions are not greater than 40 percent opacity; and

ii) The visible emissions do not occur for more than 6 consecutive minutes in any 60-minute period.

b) *Visible Emissions Stationary Internal Combustion Engine Powered Equipment*—Prohibits EA from causing or permitting the discharge of emissions from any engine [COMAR 26.11.09.05B(2)-(4)]:

i) Operating at idle at an opacity greater than 10 percent; or

ii) At conditions other than idle at an opacity greater than 40 percent.

c) *Control of Sulfur Oxides from Fuel Burning Equipment*—Prohibits EA from burning, selling or making available for sale any fuel with a sulfur content by weight in excess of or which otherwise exceeds 0.3 percent for distillate fuel oils [COMAR 26.11.09.07A(2)(c)]; and operational experience. Within 90 days following the completion of two full years of commercial operation, EA shall submit to MDE-ARMA a technical analysis, based on emissions and operating data compiled during the first two years of operation, demonstrating whether or not new, more stringent LAER emission limits for SO_2 and NO_x are technically appropriate without modification of design or operation, and in any case, the appropriate numerical values for the limits that would preserve an adequate margin of safety between actual performance and any revised LAER limit.

d) At least 120 days prior to initial startup of any combustor unit, EA shall submit to MDE-ARMA for review and approval, an Emission Limit Optimization Plan that describes the specific emissions and operating data that will be collected and recorded over the course of the initial two years of operation, to serve as the technical basis for developing potentially more stringent emission limits for NO_x, SO_2 and PM2.5. EA shall also propose in the Emission Limit Optimization Plan the statistical and other analyses to be undertaken for developing the potentially more stringent emission limits.

A-22. EA shall limit emissions of ammonia resulting from unreacted ammonia ("ammonia slip") emitted from the RSCR to 20 parts per million by volume, dry basis, corrected to 7 percent oxygen. Compliance with the ammonia slip limit shall be determined based on a 24-hour block average basis.

a) Compliance with the ammonia slip limit shall be demonstrated by using the following calculation procedure: ammonia slip ppmvd@7% oxygen = ((a-(bxc/1,000,000)) x 1,000,000/b) x d

where:
a = aqueous ammonia injection rate (lb/hr)/17 (lb/lb-mole),
b = dry exhaust gas flow rate (lb/hr)/29 (lb/lb-mole),
c = change in measured NO_x concentration ppmv, dry at 7% oxygen across catalyst, and
d = correction factor.

The correction factor shall be derived during compliance testing by comparing the measured and calculated ammonia slip.

b) Alternatively, EA may request permission from MDE-ARMA to utilize a continuous in-stack ammonia monitor acceptable to MDE-ARMA to monitor ammonia emissions.

A-23. EA shall not operate the combustors at a unit load level greater than 110% of the maximum demonstrated municipal waste combustor unit load [40 CFR 60.53b(a)], except for testing purposes, as specified in 40 CFR 60.53b(b). Unit load means the steam load of the municipal waste combustor as specified in 40 CFR 60.58b(i)(6). Maximum demonstrated municipal combustor load means the load as defined in 40 CFR 60.51b.

A-24. Municipal waste combustor unit capacity shall be calculated using the procedures in 40 CFR 60.58b(j).

Appendix E

Questions Submitted to MDE by EIP Attorney Leah Kelly via email on April 4, 2017

In response to Public Information Act ("PIA") request #2017-00093 relating to the Wheelabrator BRESCO incinerator in Baltimore, we received a NO_x Control System Optimization Final Report compiled by Quinapoxet Solutions for tests run in February and March of 2016 at Wheelabrator Baltimore (hereinafter "Final Report"). We have a few questions relating to this report and hope that MDE is willing to consider these.

1. **What analyses did Wheelabrator conduct to measure or model the furnace gas flows?**

In the Final Report, Quinapoxet Solutions states that "it was confirmed that furnace gas flows favored the rear wall at the urea injection level." However, it was unclear within the report what tests were conducted to confirm this assertion, as the report refers to "Typical Boiler Furnace Flow" in Figure 6 to support its assertions. Is MDE aware of whether a computational fluid dynamics model or similar flow testing has been done on the Wheelabrator Boiler Furnaces?

2. **Has Wheelabrator conducted temperature measurements at varying heights within the furnaces to verify that the 4th floor is the optimal location for the SNCR Injector?**

Wheelabrator's presentation at the 1/17/17 NOx stakeholder meeting indicated that adequate residence time may be a concern for the single-pass boiler, and additional vertical testing could inform additional or modified urea injection at varying heights or angles within the furnace.

3. **Is the GasTemp pyrometer (line of sight average) appropriate for temperature profiling?**

When determining placement of injection locations, more detailed spatial data may be required. Using an instrument that gives you the average along a line is valuable in some contexts, much more granular data should be obtained to identify exact placement of urea injection.

4. **Could there be the opportunity to further optimize baseline combustion controls?**

The Final Report attributes the higher baseline concentration within Boiler 2 to be due to the higher operating temperature required in a "fouled" boiler. However, due to the relatively low operating temperatures of the boilers, it is unlikely that thermal NOx would cause the 20 ppm difference between the two baselines. We are curious whether additional factors, such as fuel composition or boiler operation, are contributing to these observed differences, and whether better standardization or optimization could reduce baseline emissions before SNCR treatment.

5. **If possible, can MDE provide the urea flow for *each* injector during testing in addition to total flow?**

6. **Have the injection locations identified within the optimization study or the urea injection rates been implemented, and do they continue to be utilized currently?**

7. **Was the optimization study protocol approved by MDE?**

Northeast
Maryland
Waste
Disposal
Authority

September 29, 2017

Mr. Randy Mosier
Division Chief, Air Quality Regulations Division
Maryland Department of the Environment
Air Quality Planning Program
1800 Washington Boulevard, Suite 730
Baltimore, Maryland 21230

Subject: Comments on Draft NOx RACT Regulations for MWC

Dear Mr. Mosier:

I am writing to provide comments and questions on the proposed NOx RACT regulations for Municipal Waste Combustors as distributed in your September 18, 2017 email.

1. Consistency of terminology:

   a. Definition of Operating day includes the time an installation operates, consumes fuel, or causes emissions. It appears that the original definition applied only to medical waste incinerators. What is the intent of including that definition in this section? This new definition is very broad (especially the use of the term 'operates' to define 'operating day'). Recommend that the definition of 'operating day' follow the definition used in the Portland Cement NSPS (40 CFR §60.61). *Note that language in brackets replaces the words 'produces clinker'*: "*Operating day* means a 24-hour period beginning at 12:00 midnight during which [the facility is combusting MSW]. For calculating 30 day rolling average emissions, an *operating day* does not include the hours of operation during startup or shutdown".
   b. Definition of shutdown (3-hour duration) should include all of the periods allowed for by the federal rules (40 CFR 60.58b(a)(1)). Use of different shutdown parameters for NOx emissions vs other emissions (specifically CO) may lead to unnecessary confusion on the part of operators and MDE staff.
   c. Definition of 24-hr block average emission rate. Note that the MCRRF already calculates NOx emissions on a 24-hour basis. Use of a different 24-hour block definition for NOx during startup/shutdown and normal operation may lead to unnecessary confusion on the part of operators and MDE staff. Recommend that the definition be consistent with 40 CFR 60.51b: "*Twenty-four hour daily average* or *24-hour daily average* means either the arithmetic mean or geometric mean (as specified) of all hourly emission concentrations when the affected facility is operating and combusting municipal solid waste measured over a 24-hour period between 12:00 midnight and the following midnight." Also, note that our current methodology for calculating 24-hour block averages is based on 1-hour block data (which is derived from valid minute data and 15-minute blocks).

410.333.2730 / 410.333.2721 fax / authority@nmwda.org
nmwda.org / Business-to-Business Recycling: mdrecycles.org
Tower II - Suite 402, 100 S. Charles Street, Baltimore, MD 21201-2705

2. Submittal of Plan. Section H requires submittal of a plan within 45 days after the effective date of the regulation. Note that the MCRRF will achieve compliance with the regulation through the continued use of its optimized Low NOx (LN) technology in combination with SNCR. The MCRRF has previously submitted emission data to MDE for various operational periods. Is additional information required to be submitted to MDE?

3. Submission of quarterly reports. Section I contains a requirement for submission of a new quarterly report. We recommend that the data requirements for this quarterly report be included as an attachment to the existing Semiannual Monitoring Report (i.e., SixMon Report) currently being submitted to MDE on a semi-annual basis.

4. Calculation of mass rate emissions. Section L specifies mass loading limits for startup and shutdown periods. Pursuant to its Title V permit, the MCRRF currently calculates mass emission rates for periods of startup, shutdown and malfunction (including for NOx). The calculation of mass emissions utilizes stack flow rates using flow monitors installed in each unit. We recommend that the language of Section L reflect the use of stack flows from flow monitors in the calculation of mass emissions.

We thank you in advance for your review and response to these questions and comments and look forward to seeing the language that is "Under Consideration" in Sections E and F.

Sincerely,

Chris Skaggs
Executive Director

cc: Bill Broglie, Montgomery County
Bill Davidson, Montgomery County
Joe Walsh, Covanta
Dave Blackmore, Covanta

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MARYLAND

Randy Mosier -MDE- <randy.mosier@maryland.gov>

REQUEST FOR COMMENTS - MWC NOx RACT stakeholder meeting - September 22, 2017

Timothy Porter <tporter@wtienergy.com>
To: Randy Mosier -MDE- <randy.mosier@maryland.gov>

Wed, Oct 4, 2017 at 2:11 PM

Mr. Randy Mosier

Division Chief Air Quality Regulation Division

Maryland Department of the Environment

Air Quality Planning Program

Dear Randy,

Please find our comments to the draft NOx RACT regulation presented at the September 22, 2017 stakeholder meeting. The attachment is a markup of the draft regulation reflecting our comments below.

1. Shutdown definition needs to be modified slightly. The Baltimore MWC facility does not have the ability to close the chute but relies on MSW in the chute to provide the air seal to the furnace. As such shutdown should commence 30 minutes after the chute to loading hopper is closed <u>or after MSW feed to loading hopper has ceased</u>.

2. Along with startup and shutdown periods unavoidable or unpreventable malfunction periods meeting the malfunction definition in 26.11.08.01 must also be excluded from the 30 day rolling and 24 hour averages. As with startups and shutdowns the NOx RACT limits for our MWC facility did not address NOx emission variability that may occur during unavoidable malfunctions. Consistent with the Large MWC requirements under 40 CFR 60 Subparts Eb/Cb as adopted in COMAR 26.11.08.08, the duration of a malfunction would be limited to three hours in duration. Conversely malfunction periods <u>*would be included*</u> in the 24 hour block average facility mass emission rate specified in the Startup, Shutdown <u>and Malfunction</u> Limitations in 26.11.08.10 D (3). Inclusion of malfunctions with startups and shutdowns in the mass emission limitation is consistent with USEPA's SSM Policy as it establishes a legally and practically enforceable limit for malfunctions.

3. The effective date of the emission limitations specified in Paragraph D should be tied to 1 year after the effective date of the regulation or May 1, 2019 whichever is later and 2 years after effective date of the regulation or May 1, 2020 whichever is later. It is unknown at this time when regulation will become effective. If there is a delay in finalizing the regulation, 1 or 2 year period after effective date of regulation would provide sufficient time for to meet final limits and associated requirements, given the planning and scheduling required to make necessary upgrades and installation of equipment to meet the limits. Other states have adopted this concept for implementing final RACT regulations.

4. The 24 hour block average period must include a minimum data availability requirement to ensure there is sufficient data to calculate representative daily NOx concentration averages. We recommend that a valid 24 hour average consist of a minimum of 18 hours of valid CEM data. This will ensure on short operating days due

to scheduled or unscheduled outage or during times when CEMs are being maintained, calibrated or repaired will not lead to unwarranted exceedances of the 24 our concentration limit.

5. We believe the "compliance" plan required under Paragraph H is a little ambiguous and should be clarified. Plan should include CEM calculations used to demonstrate compliance with applicable limits including mass based emission rate limits inclusive of SSM periods. This would put the CEM calculations and monitoring approach upfront and subject to MDE review and comment before finalizing. In addition such calculations would not have be repeated in every quarterly report. The compliance plan would also address malfunctions.

6. Quarterly reports under Paragraph F should only include dates times and information for any exceedance of the NOx RACT limits and for any startup, shutdown or malfunction period when data was excluded from the 24 hour or 30 day rolling average. This is the most important information and aligns reporting with existing quarterly reporting requirements. This could be done in part by referencing quarterly reporting requirements under COMAR 26.11.01.11E (2)(c) aligning NOx RACT limit reporting requirements with existing reporting requirements, simplify preparation of reports and allow for quick and timely review of reports by MDE.

7. Finally, we agree with the concept that a feasibility study be conducted by an independent third party to evaluate the ability of the facility to cost effectively achieve further NOx reductions as may be needed for MDE to achieve attainment with relevant ambient air quality standards in the future.

We trust the above comments and attachment will assist MDE in developing the final NOx RACT regulations. If you have questions or need further information, please let me know.

Sincerely,

Timothy Porter

Wheelabrator
TECHNOLOGIES

Timothy Porter

Director Air Quality Management

Wheelabrator Technologies

100 Arboretum Drive | Suite 310,

Portsmouth, NH 03801

Tel 603-929-3375 | Cell 603-498-2134

www.wtienergy.com | Twitter @WTIEnergy

From: Randy Mosier -MDE- [mailto:randy.mosier@maryland.gov**]**
Sent: Friday, September 22, 2017 2:57 PM
To: Ariane Kouamou-Nouba; Barbara Einzig; Bill Davidson; Bill Paul -MDE-; Bradley Keller; Carolyn A Jones; Chris

Cripps; Chris Skaggs; Dave Blackmore; David Jones; Dawn Harmon; Director Tad Aburn; Doris McLeod; Edward Reisinger; Fern Shen; George Ikhinmwin; Husain Waheed; Jeffrey Fretwell; John Quinn; Joseph Walsh; Karen Irons; Ken Jackson; Kim Mcintyre; Mario Cora -MDE-; Mary Pat Clarke; Megan Ulrich -MDE-; Mitchell Greger -MDE-; Neil Seldman; Randy Mosier; Rhonda Wolf; Stephen Groenke; Steve Blake; Steven Lang -MDE-; Susan Nash -MDE-; Timothy Porter; Abel Russ; Ariel Solaski; Ben Kunstman; Charles Graham III; Chris Yoder; Craig Flamm; Dante Swinton; Deron Lovaas; Destiny Watford; Diana Dascalu-Joffe; Donna McDowell; Doreen Cantor Paster; Emily Scarr; Eric Schaeffer; Greg Sawtell; Jennifer Kunze; Joanna Diamond; Jon Kenney; Jon Mueller; Josh Tulkin; Joshua Berman; Kevin Kriescher; Leah Kelly; Lee Epstein; Mike Ewall; Mike Tidwell; Patton Dycus; Rebecca Rehr; Rebecca Ruggles; Rich Reis; Seth Bush; Taylor Smith-Hams; Tim Whitehouse; Trisko, Gene; Mary Jane Rutkowski -MDE-; Horacio Tablada
Subject: REQUEST FOR COMMENTS - MWC NOx RACT stakeholder meeting - September 22, 2017

Dear stakeholders,

[Quoted text hidden]

Click here to complete a three question customer experience survey.

Wheelbrator Markups to Draft MWC NOx RACT Regulations.pdf
122K

Markup of Draft Large MWC NOx RACT Regulation

.01 Definitions.

(28) "Malfunction" is defined at 40 CFR §60.51c. For large Municipal Waste Combustors the malfunction shall not exceed a period of three hours in duration.

(54) Shutdown.

(a) —(d) (text unchanged)

(e) "Shutdown" for a Large MWC commences thirty minutes after the chute to the loading hopper of the combustion train is closed or feeding to loading hopper has ceased, and continues for a period of time not to exceed three hours.

(61) "30-day rolling average emission rate" means a value of NOx emissions in ppmv, corrected to 7 percent oxygen, calculated by:

(a) Summing the total hourly ppmv of NOx emitted from the unit during the current operating day and the previous 29 operating days, excluding periods of ~~startup~~ startup,~~and~~ shutdown and malfunction; and

(b) Dividing the total hourly ppmv of NOx emitted from the unit during the 30 operating days summed in Regulation .01B(61)(a) of this Chapter by 30.

(62) "24-hour block average emission rate" means a value of NOx emissions in ppmv, corrected to 7 percent oxygen, calculated by:

(a) Summing the hourly average ppmv of NOx emitted from the unit during 24 hours between midnight of one day and ending the following midnight, excluding periods of startup, ~~and~~ shutdown and malfunction; and

(b) Dividing the total sum of hourly NOx ppmv values emitted during 24 hours between midnight of one day and ending the following midnight by the 24 hours between midnight of one day and ending the following midnight.

(c)A valid 24-hour average shall have a minimum of 18 hours of CEM data.

.10 NOx Requirements for Large Municipal Waste Combustors.

A. The owner and operator of a Large MWC shall minimize NOx emissions by operating and optimizing the use of all installed pollution control technology and combustion controls consistent with the technological limitations, manufacturers' specifications, good engineering and maintenance practices, and good air pollution control practices for minimizing emissions (as defined in 40 CFR §60.11(d)) for such equipment and the unit at all times the unit is in operation, including periods of startup, ~~and~~ shutdown and malfunction.

D. ~~Startup~~ Startup, ~~and~~ Shutdown and Malfunction NOx Emission Limitations.

(1) As of May 1, 2019~~,~~ or 1 year after effective date of this regulation whichever is later, the requirements of §B of this Regulation shall be met at all times, except for periods of startup, ~~and~~ shutdown and malfunction.

(2) As of May 1, 2020 or 2 years after the effective date of this regulation, the requirements of §§B and C of this Regulation shall be met at all times, except for periods of startup, ~~and~~ shutdown and malfunction.

(3) During periods of startup, ~~and~~ shutdown and malfunctions the following emission limitations shall apply:

(a) For Montgomery County Resource Recovery Facility, a facility wide NOx emission limit of 202 lbs/hr timed average mass loading over a 24-hour block period.

E. No later than December 1, 2020, Wheelabrator Baltimore, Inc. shall submit a study to the Department that identifies additional feasible NOx reduction strategies to meet the Department's air quality goals.

H. Not later than 45 days after the effective date of this Regulation, the owner or operator of a Large MWC shall submit a compliance plan to the Department for approval that demonstrates how the Large MWC will operate installed NOx ~~pollution~~ control technology and combustion controls to meet the requirements of §A of this Regulation. The plan shall summarize the data that will be collected and CEM calculations used to demonstrate compliance with §A of this Regulation. The plan shall cover ~~all modes of operation, including but not limited to~~ normal operations, startup, ~~and~~ shutdown and malfunction.~~.~~

I. Beginning July 1, 2019, the owner or operator of a Large MWC shall submit a quarterly report to the Department in accordance with COMAR 26.11.01.11E(2)(c) containing:

(1) Date time, reason and corrective action taken and preventative measures implemented for any exceedance of the~~Data, information, and calculations which demonstrate compliance with the~~ NOx 24-hour block average emission rate as required in §§B ~~and F(2)(f) of this Regulation, as applicable~~; and
(2) ~~Documented actions taken during p~~Periods of ~~startup~~ startup, ~~and~~ shutdown and malfunction when data was excluded from the 24 hour average including corrective actions to minimize emissions. ~~in signed, contemporaneous operating logs.~~
I. Beginning July 1, 2020, the owner or operator of a Large MWC shall submit a quarterly report to the Department in accordance with COMAR 26.11.01.11E(2)(c) ~~containing~~ when ~~data, information, and calculations which demonstrat~~e compliance with the NOx 30-day rolling average emission rate was not achieved or when data was excluded during startups, shutdowns or malfunctions ~~as required~~ in §§C ~~and F(2)(f) of this Regulation, as applicable.~~including reasons, corrective actions and preventative measure adopted.

L. Compliance with the NOx mass loading emission limitation for periods of startup and shutdown in §§D E(2) and F(2)(f) of this Regulation shall be demonstrated by calculating the 24-hr block averages of all hourly average NOx emission concentrations for all the hours during the 24-hour period that the affected facility is operating, including periods of startup and shutdown~~.~~ The method for calculating mass emission loading shall be included in the compliance plan required under Paragraph H above.

ENVIRONMENTAL INTEGRITY PROJECT

CHESAPEAKE BAY FOUNDATION
Saving a National Treasure

October 6, 2017

Via E-mail
George (Tad) Aburn
Director
Air & Radiation Management Administration
Maryland Department of the Environment
1800 Washington Boulevard
Baltimore, MD 21230
george.aburn@maryland.gov

RE: Public Stakeholder Process for Setting Reasonably Available Control Technology Limits for Nitrogen Oxides Emissions from Large Municipal Waste Combustors

Dear Mr. Aburn:

The Environmental Integrity Project ("EIP") and the Chesapeake Bay Foundation ("CBF") (collectively, "Commenters") respectfully submit this initial set of comments on the Maryland Department of the Environment's ("MDE's") September 18, 2017 draft proposed regulation for changes to Chapter 8 (Control of Incinerators) and Chapter 9 of Subtitle 11 (Air Quality) of Title 26 (Department of the Environment) of the Code of Maryland Regulations (hereinafter "9/18/17 Draft Rule").

Commenters appreciate the opportunity to participate in the public stakeholder process as MDE develops new requirements for limiting emissions of nitrogen oxides (NOx) from Maryland's two large municipal waste combustors ("MWCs") in accordance with federal requirements for reducing concentrations of ground-level ozone. In this set of comments, we provide initial feedback on the 9/18/17 Draft Rule and initial input on MDE's undrafted proposal, announced at the September 22, 2017 public stakeholder meeting, to set a second set of NOx limits for the Wheelabrator incinerator to take effect in 2022 after submission of a feasibility study in 2020. In accordance with MDE's request, we are submitting these comments by October 6, 2017. However, we are not able to fully analyze the 9/18/17 Draft Rule or the proposed 2020 and 2022 requirements without more time and more information. Thus, we expect to submit further comments in this proceeding, particularly after a written draft of regulations is available relating to the proposed 2020 and 2022 requirements and after we are able to review the information in the Technical Support Document.

I. Background

MDE commenced the stakeholder process on Large MWC NOx Reasonably Available Control Technology ("RACT") rulemaking in August 2016. The new RACT limits are being set in order to comply with federally-mandated planning requirements for moving Maryland toward compliance with federal air quality standards for ground-level ozone. Ozone is a persistent problem in Maryland, and the Baltimore area is one of the regions in the state that is most adversely affected by ozone. The U.S. EPA sets air quality standards for ozone based on a three-year average of the fourth-highest eight-hour measurement at a monitor during a given year. The 2008 federal ozone standard is 75 parts per billion ("ppb") and, in 2015, the U.S. EPA set a stronger limit of 70 ppb.

Ozone levels have been increasing in Baltimore starting in 2015. The highest ozone levels in the Baltimore nonattainment area over the last several years have been measured at the Edgewood monitor in Harford County.[1] The most recent three years of data for that monitor that are publicly available via EPA's online Monitor Values Report tool are shown in Table 1 below.[2] Commenters expect that the final monitor value for year 2017 will be higher than 73 ppb as the data available online appears to be current only through 2nd quarter 2017 (the end of June) and the highest values during the summer were likely measured during the hotter months of July or August. Thus, it appears that the three-year average for the Edgewood monitor could be over 75 ppb when the final 2017 value is added and that Baltimore area could be out of attainment with EPA's 2008 standard.

Table 1: 4th-highest 8-hour Ozone Values at Edgewood monitor (in ppb)	
2015	74
2016	77[3]
2017*	73
3-Year Average	74.7

*Data appears current through 2nd Quarter 2017

The 73 ppb ozone concentration measured in 2017 at the Edgewood monitor is only 1 ppb lower than the highest reading that has been measured (so far) in the state, 74 ppb measured at the Fairhill monitor in Cecil County. Commenters are particularly concerned about the 2017 ozone levels because ARMA Director Tad Aburn stated at the September 22, 2017 stakeholder meeting that Maryland ozone levels in 2017 were higher than in 2016, though we understand that this may not be specific to Baltimore.

In addition, while Commenters are very appreciative of Maryland's critical efforts to curb NOx pollution from dirty out-of-state coal-fired electrical generating units (EGUs), which significantly contribute to Baltimore's ozone nonattainment,[4] it is clear that substantial additional

[1] This is excluding a monitor installed in 2016 identified on EPA's website as being located in the Essex area of Baltimore County, but which MDE has told us is actually located on Hart-Miller Island in the Chesapeake Bay. Email from David Krask, Program Manager, MDE ARMA Air Monitoring Program, to Leah Kelly, Senior Attorney, EIP, dated March 21, 2017.

[2] EPA, Outdoor Air Quality Data, Monitor Values Reports, at https://www.epa.gov/outdoor-air-quality-data/monitor-values-report

[3] Excludes values claimed as exceptional events. With exceptional events included, this value would be 79.

[4] *See* Maryland Clean Air Act 126 Petition (Nov. 16, 2016); *see also*, Maryland v. Pruitt, *et al*., 1:17-cv-02873 (D. Md. filed Sep. 27, 2017).e

reductions in NOx emissions are also required. Table 2 below shows an estimate from MDE's recent petition to EPA under Section 126 of the Clean Air Act regarding maximum reductions to ozone levels that would be achieved by curbing NOx emissions from certain out-of-state units using data from July 2011. The ozone reductions estimated at the Edgewood monitor are the lowest of any monitor in the state. Thus, we agree with MDE that these out-of-state plants must curb their air pollution under the requirements of the Clean Air Act. However, it is also important that the Wheelabrator/BRESCO trash incinerator in Baltimore City – which, in 2016, was the third largest NOx polluter in the Baltimore nonattainment area after the Fort Smallwood coal plant complex in Anne Arundel and Lehigh Cement facility in Carroll County[5] – substantially reduce its annual NOx emissions.

Table 2: Maximum Ozone Reduction if 126 Petition Power Plants had Run Their SCR/SNCR Controls (Table D-3 from Appendix D of Maryland's Section 126 Petition to EPA)

Maryland Monitor	Reduction (ppb)
Davidsonville	2.22
Padonia	2.32
Essex	1.79
Calvert	2.55
South Carroll	2.95
Fairhill	1.85
Southern Maryland	2.60
Blackwater NWR	2.25
Frederick Airport	3.05
Piney Run	6.06
Edgewood	1.66
Aldino	1.80
Millington	1.79
Rockville	2.23
HU-Beltsville	2.24
PG Equest Center	2.50
Beltsville	2.20
Hagerstown	2.96
Furley	1.73

Lastly, Commenters think it is important to note that the NOx emissions from the BRESCO incinerator are a matter of significant and widespread public concern for Baltimore

[5] MDE PowerPoint Presentation, NOx RACT for Municipal Waste Combustors (MWCs), Stakeholder Meeting – September 22, 2017, p. 13 *at* http://mde.maryland.gov/programs/Regulations/air/Documents/SHMeetings/MunicipalWasteCombustors/MWCStakeholder09222017.pdf.

City residents and officials. On September 28, 2017, the Housing and Urban Affairs Committee of the Baltimore City Council approved a resolution that, as amended during the hearing, requests that MDE set a limit of 45 ppmvd @ 7% O2 (hereinafter "ppm") for BRESCO[6], which is the limit that would likely have to be met by a new incinerator located in Maryland.[7]

II. Comments on the 9/18/17 Draft Rule

As stated above, Commenters have not had sufficient time and do not have sufficient information to fully analyze the 9/18/17 Draft Rule. In particular, our analysis is dependent on certain information that we expect will be provided in the Technical Support Document. We have done our best to provide initial feedback below and to identify, in these comments, the additional information that we will need to evaluate certain pieces of this draft rule.

A. 2019 and 2020 NOx RACT Limits for BRESCO

Commenters have expressed in the past that MDE must set a NOx RACT limit that is no higher than 150 ppm on a 24-hour basis for the Wheelabrator/BRESCO plant. We appreciate that the 9/18/17 Draft Rule requires that BRESCO meet this limit by May 1, 2019. We also note that a representative of Wheelabrator appeared at the September 28, 2017 hearing in front of the Baltimore City Council and repeatedly stated that the company supports the 150 ppm limit. Thus, we expect that this limit will be in the final version of the rule and will not be weakened in any subsequent drafts.

With respect to the 145 ppm limit for BRESCO over a 30-day period, we are missing the information necessary to evaluate the limit. Specifically, we do not know on what basis this limit was set, though we believe that it was based on emission levels at similar incinerators in other states. In addition, we would like to know MDE's numerical estimate – in pounds or tons per year – for the NOx reductions that this limit will achieve beyond the reductions provided by the 24-hour 150 ppm limit.

B. Startup Shutdown and Malfunction Events

Commenters have not had a chance to fully analyze how the startup and shutdown sections of the 9/18/17 Draft Rule measure up against EPA's requirements for addressing such events as set forth in the Final SSM SIP Call.[8] We have also not had a chance to draft comments on whether the startup, shutdown, and malfunction provisions of 40 C.F.R. § 60.58b, which we expect MDE may try to harmonize with the startup and shutdown provisions of the 9/18/17 Draft Rule, meet these requirements. Commenters expect to address these issues – possibly in substantial detail – in future comments. For now, we offer the following limited comments on this issue:

[6] The resolution and amendment are attached as Exhibits A and B respectively.

[7] This was the NOx limit set forth in the final permits for the proposed incinerator in Frederick County and the proposed Energy Answers incinerator in Baltimore City. Neither facility has been built.

[8] 80 Fed. Reg. 33840 (June 12, 2015).

- Commenters expect that Wheelabrator and Covanta may request that MDE remove the mass-based limits (in lbs/hour) that apply under the 9/18/17 Draft Rule during startup and shutdown events and may also seek a revision allowing an exemption during malfunction events of up to three hours based on the argument that this is allowed under 40 C.F.R. § 60.58b. Commenters' initial research indicates that such exemptions may not allowed as part of this rule, and we would object to unlimited exemptions during periods of startup and shutdown.

- In general, Commenters appreciate MDE's approach of requiring mass-based limits that correspond with concentration-based 24-hour NOx RACT limits during startup and shutdown events of no more than 3 hours each. However, Commenters request the Department consider startup and shutdown mass loading limits averaged over the duration of startup and shutdown periods, rather than on a 24-hour block period as proposed in 9/18/17 Draft COMAR 26.11.08.10L. Commenters propose these changes to clarify that mass-based emission averages should be calculated only during the period of startup or shutdown, and should not be averaged along with normal operations data. Because the proposed alternative emission limits are based on worst case actual NO_x emissions, changing the averaging time to only apply to the period of startup and shutdown is more stringent than applying over a 24-hour block period. This change to the alternative emission limits would ensure that the emissions during startup and shutdown are no higher than worst case actual NO_x emissions from normal operations.

- The final rule should state that NOx Continuous Emissions Monitoring System ("CEMS") data and flow data measured during periods of startup and shutdown must be reported to MDE as part of the quarterly reporting requirements imposed after the 2019 and 2020 NOx limits take effect.

C. Compliance Demonstration and Reporting

The 9/18/17 Draft Rule provision that would be codified in COMAR 26.11.08.10I, [9] requires that "[b]eginning July 1, 2019, the owner or operator of [an incinerator] shall submit a quarterly report to [MDE] containing: (1) Data, information, and calculations which demonstrate compliance with the NOx 24-hour block average emissions rate" required for each facility as well as certain records of actions taken during startup and shutdown events.

Commenters do not consider this condition to set forth with sufficient specificity the information necessary to demonstrate compliance. As discussed below in Section IIIA, Commenters are requesting that MDE order Wheelabrator to immediately begin submitting 1-hour NOx CEMS data in order to provide essential data for the feasibility study. Our preference would be that this 1-hour data would continue to be submitted and that these datasets would be part of the compliance demonstration requirements. However, at minimum, MDE should require that 24-hour block NOx CEMS data should be submitted on a quarterly basis to MDE after the 2019 limit goes into effect in order to ensure compliance with the 24-hour limits and the subsequent 30-day limits. This is particularly important for the BRESCO facility, which has not

[9] The first section I as there are two in the draft.

– based on the most recent data made available – been achieving emission levels close to its 24-hour NOx limit (150 ppm) and less important for the Montgomery County Resource Recovery Facility, which appears to be achieving emission levels significantly below its proposed 24-hour limit of 140 ppm. Further, to reduce paperwork and the burden on MDE, the companies should be required to report this CEMS data electronically in a spreadsheet using Microsoft Excel or a similar format.

D. Absence of Ammonia Slip Limit and Ammonia CEMS Monitoring Requirement

Commenters are very concerned about the absence of a limit for ammonia slip in the 9/18/17 Draft Rule, especially as Connecticut includes such a limit in its incinerator NOx RACT regulations, which also includes a 24-hour limit of 150 ppm for mass burn waterwall combustors. EIP also provided two examples in its May 9, 2017 comments of similar Wheelabrator incinerators in other states that are subject to a NOx limit of 150 ppm on a 24-hour basis and an ammonia slip limit of 20 ppm.

Wheelabrator has argued in the past that it will have difficulty meeting the 150 ppm NOx limit without increasing its ammonia slip, which the company has stated could cause it to violate its emissions limit. Visible emissions, or opacity, is used as a proxy to measure particulate matter, which, in its smallest fraction (PM2.5), can pose the risk of premature death due from heart and lung disease. MDE should revise the 9/18/17 Draft Rule to include an ammonia slip limit of no higher than 20 ppm and should also require that ammonia CEMS be installed to monitor ammonia slip, as also discussed in EIP's May 9, 2017 comments and Attachment B to CBF's May 9, 2017 comments.

III. Comments on 2020 Feasibility Study and 2022 "Beyond RACT" NOx Limit

At the September 22, 2017 stakeholder meeting, MDE announced that it is seeking input on a new section of the rule, for which a written draft has not been made available to the public, which would require Wheelabrator to meet a lower NOx limit in 2022 and to submit a feasibility study in 2020. Commenters appreciate that MDE has proposed to go beyond the 150 ppm limit as that limit, while appropriate for the RACT legal standard, is not sufficient to achieve the ozone reductions necessary to move toward protecting public health in the Baltimore area. In addition, MDE clearly has the legal authority to require a stronger limit as "a state has discretion to require beyond-RACT reductions from any source, and has an obligation to demonstrate attainment as expeditiously as practicable. Thus, states may require . . . NOx reductions that are 'beyond RACT' if such reductions are needed in order to provide for timely attainment of the ozone [federal air quality standards]."[10]

Commenters appreciate that MDE has taken the important step of proposing a beyond-RACT set of requirements in the regulation. However, we are concerned that the proposed feasibility study is the end result of unacceptable foot-dragging on the part of Wheelabrator. In our view, much of the information that will be produced by this study is information that should have been submitted by Wheelabrator to MDE early in the NOx RACT rulemaking process,

[10] EPA, Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements, 80 Fed. Reg. 12264,12279 (March 6, 2015).

likely in 2015 (before the public stakeholder process commenced). Nevertheless, as we consider it essential to have more information about the BRESCO facility, Commenters support the collection of additional information and are providing our initial thoughts below with respect to this proposed approach.

A. MDE Should Order Wheelabrator to Start Submitting Certain Information Necessary for the Feasibility Study Immediately, Especially NOx CEMS Data

Certain additional detailed data is necessary in order to develop an adequate set of information regarding the facility operations as a basis for the feasibility study. MDE should require Wheelabrator to start reporting this immediately, at least in the case of NOx CEMS data, or as soon as possible.

It appears that Wheelabrator is not submitting any NOx CEMS data to MDE with regularity other than the short amount of annual data provided in the annual Emissions Certification Reports ("ECR"). (By contrast, Commenters note that the Montgomery County plant makes its 24-hour CEMS data available online where any member of the public can see it.)[11] This data is essential for MDE's engineers and the public[12] to assess facility performance claims regarding demonstration of the feasibility of various controls.

In addition to its general legal authority to require regulated air pollution sources in Maryland to submit information and perform analyses,[13] MDE also has specific legal authority to review and/or require the submission of this data under applicable federal regulations for Large MWCs and under COMAR's provisions relating to CEMS data. Through its Title V permit conditions and COMAR,[14] the BRESCO plant is subject to federal regulations for Large MWCs set forth in 40 C.F.R. § 60.59b. Under that regulation, an owner/operator of an incinerator is required to maintain data for 1-hour and 24-hour average NOx emission concentrations on site for 5 years and to make it available "for submittal to the Administrator or review on site by an EPA or State inspector." 40 C.F.R. § 60.59b(d)(2)(i). In addition, COMAR 26.11.01.11E(2)(c)(vii) requires facilities to submit certain data in quarterly CEMS, including "[o]ther information required by [MDE] that is determined to be necessary to evaluate the data, to ensure that compliance is achieved, or to determine the applicability of this regulation."

MDE should begin collecting the following data from Wheelabrator now or as soon as possible, no later than upon the effective date of the regulation:

- NOx and ammonia[15] CEMS data reported on a 1-hour average, provided electronically by Wheelabrator on a semiannual basis.

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[11] Montgomery County Maryland Department of Environmental Protection, Resource Recovery Facility Emissions Data at https://www.montgomerycountymd.gov/sws/facilities/rrf/cem-detail.html.
[12]Commenters would expect to review the NOx CEMS data themselves. We have submitted requests under the Maryland Public Information Act ("PIA") that would have produced NOx CEMS data if it were being submitted to MDE.
[13] *See* COMAR 26.11.01.05(A), COMAR 26.11.01.04(B)(1).
[14] Wheelabrator Baltimore, LP Title V Permit pages 41-42; COMAR 26.11.08.08(C).
[15] As stated above, Commenters recognizes that ammonia monitoring is not currently required at the facility, but it should be required.

- Temporal Fuel/waste composition data, provided in a quarterly report.[16]

- Quarterly gas composition sample collected as a 12-hour integrated sample at the first practical location after leaving the boiler. Sample shall be sent to accredited lab and will be analyzed for:
    - O_2, CO, CO_2, NO, NO_2, NH_3, SO_2 and total reduced sulfur.
    - Organics and toxics included within EPA Method TO-15
    - Alkaline Metals (sodium, potassium)
    - Heavy Metals
    - Arsenic

- Detailed temperature profile and model of gas flow path, including vertical profiling within boiler and along the gas path after it leaves the boiler to the stack.

B. Feasibility Study

Commenters consider it critical that the entity performing the feasibility study and creating a report thereon be a truly independent third party that does not consider itself beholden financially or in any other way to Wheelabrator. For this reason, we request that MDE ensure that Wheelabrator submit the funding for the study to the state but that the study be performed by internal state engineers or an independent consultant managed by staff from MDE and/or the Power Plant Research Program ("PPRP") within the Maryland Department of Natural Resources.

i. Technologies that must be considered

Commenters have compiled the following list of technologies that should be considered within the feasibility analysis *at minimum*:

- Optimized SNCR, including analysis of ammonia versus urea injection
- Flue Gas Recirculation
- Fuel nitrogen content reduction strategy
- In-duct Hybrid SNCR/SCR[17]
- Regenerative SCR (RSCR)[18]
- Advanced Natural Gas Injection
- Injection or Combustion Optimization

[16] At the 9/22/17 meeting, Tim Porter stated that Wheelabrator had conducted a study regarding fuel NO_x going back to regulation development in the mid-90's, and found that there was limiting yard waste had no measurable effect on NO_x reductions. Commenters request the referenced study, and maintain that tracking nitrogen within the fuel is an important component within the optimization study.
[17] Wheelabrator Representative Tim Porter gave initial feedback on in-duct hybrid SNCR/SCR technology within 9/22/17 NOx RACT stakeholder meeting, stating his concerns about catalyst interference and poisoning at the Wheelabrator Baltimore facility. Commenters believe additional engineering analysis and gas composition data is needed to assess the feasibility of this technology, and request that the analysis include potential strategies to address concerns of catalyst interference or poisoning.
[18] Commenters had previously presented RSCR as a control option within the 1/17/17 stakeholder meeting, and request that RSCR be included within beyond RACT feasibility analysis.

    - Additional temperature and flow profiling to inform injector height, positions, injection rates, and injector technology
    - Additional flow modeling (in boiler and ducts) and optimization of combustion practices
- Replacement of ESP with Baghouses
- Boiler modification to accommodate Covanta Low-NO_x or similar technology
- Boiler replacement

ii. *Cost benefit analysis*

Any cost-benefit analysis performed as part of the feasibility study must include the costs of Wheelabrator's pollution to the public. Baltimore residents already suffer from the highest asthma rates in Maryland and are consistently exposed to some of the highest levels of harmful ozone. Wheelabrator's emissions contribute to this persistent public health problem. Accordingly, the cost-benefit analysis should include the human health costs to Baltimore and Maryland residents that are caused by Wheelabrator's emissions. CBF has been working with a human health expert to estimate the annual cost of human health impacts caused by air pollution emissions from the Wheelabrator Baltimore incinerator. Preliminary results show that human health impacts from Wheelabrator's emissions in Maryland cost over $20 million annually. This estimate includes costs related to bronchitis, asthma, heart attacks, emergency room visits, and lost work days. CBF plans to share a more comprehensive report with these results in the coming weeks and will submit a copy to MDE. Ultimately, the feasibility analysis for Wheelabrator must account for the significant health costs imposed upon the community by the air pollution from the incinerator.

iii. *Relationship to 2022 limit*

Finally, as discussed below, Commenters think that MDE must set an emissions limit for the 2022 time frame as part of this rulemaking and should, under no circumstances, delay the promulgation of such a limit. The purpose of the feasibility study should be to determine how the facility will meet the limit. If Wheelabrator selects the option of retiring the facility, then the study should focus on how the facility should transition to retirement.

C. 2022 Limits

Commenters believe that there have been repeated and unacceptable efforts by Wheelabrator to delay imposition of new NOx limits by MDE. Thus, we would strongly oppose any suggestion by Wheelabrator that the stronger, "beyond RACT" limits should take effect after 2022. For this reason, we do not consider "Option 2" of the two options for the 2022 limits, as presented in MDE's September 22, 2017 Powerpoint presentation, to be a sufficient approach. Option 2 contemplates the initiation of future rulemaking in 2020 or 2021. Future rulemaking only invites further delay and Commenters believe, along with members of the public and local elected officials, that Wheelabrator must reduce its emissions substantially and quickly.[19]

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[19] *See* Fern Shen, *City Council blasts State's NOx rule for BRESCO*, Baltimore Brew, September 29, 2017, at

Option 1 for the 2022 limit, as set forth in MDE's September 22, 2017 Powerpoint presentation contemplates establishing the limit as part of the current rulemaking. MDE provides two choices for the form of the limit: either a Presumptive limit or "'Alternative Limit' if supported by the 2020 feasibility study - Alternative limit would need to go through full public comment and hearing process required by Maryland law." It is unclear to Commenters why an alternative limit – one that allows compliance based on meeting one of 3 or 4 options set forth in a rule – would need to go through a *separate* comment and hearing process, if this is what is meant by MDE's presentation. If the alternative limit is established as part of the current rulemaking, as opposed to future rulemaking (which would make it fall under Option 2), then it will have to go through public comment and hearing. This should be sufficient for promulgation of a regulation establishing the 2022 limit.

MDE has already set such an alternative limit for some of the worst-performing coal plant units in the state as part of its recent NOx reduction rule for coal plants. COMAR 26.11.38.04B requires that operators of these seven coal plant boilers (units) shall choose from the following:

(1) Not later than June 1, 2020:

(a) Install and operate a selective catalytic reduction (SCR) control system; and

(b) Meet a NO_x emission rate of 0.09 lbs/MMBtu, as determined on a 30-day rolling average during the ozone season;

(2) Not later than June 1, 2020, permanently retire the unit

(3) Not later than June 1, 2020, permanently switch fuel from coal to natural gas for the unit;

(4) Not later than June 1, 2020, meet either a NO_x emission rate of 0.13 lbs/MMBtu as determined on a 24-hour system-wide block average or a system-wide NO_x tonnage cap of 21 tons per day during the ozone season.

MDE should set a similar kind of limit for Wheelabrator. Based on our initial analysis, we would suggest that such a limit would allow the plant to meet one of the following options:

(1) Not later than May 1, 2022:

a. Install and operate a selective catalytic reduction (SCR) control or Regenerative Selective Catalytic Reduction (RSCR) system; and
b. Meet a NOx emission rate of 45 ppm on a 24-hour basis; OR

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https://baltimorebrew.com/2017/09/29/city-council-hearing-blasts-states-nox-rules-for-bresco/ (Councilwoman Mary Pat Clarke stating to a Wheelabrator representative that, with respect to NOx reductions: "We need you to go real low, real fast.")

(2) Not later than May 1, 2022, permanently retire the source; OR

(3) Not later than May 1, 2022, based on a method identified during the feasibility study, meet a limit of 87 ppm on a 30-day average and a limit of [numerical value to be determined] on a 24-hour average. [20]

Thank you for your consideration of these comments.

Sincerely,

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[20] The basis for the limits in part 3 would be NOx emission levels at the Montgomery County Resource Recovery Facility. Commenters have not had a chance to fully review the 24-hour CEMS data for that plant so we are not able, at this time, to suggest a value for the 24-hour standard. However, the final rule must have a numerical limit in it for the 24-hour value. In addition, Commenters understand that the 87 ppm limit on a 30-day value suggested is lower than the 105 ppm limit on a 30-day average that MDE has proposed on the 9/18/17 Draft Rule. However, the proposed 105 ppm limit appears more lenient than is necessary given that the 9/22/17 MDE Presentation shows that the 4-year average from 2013-2016 and the annual 24-hour block average for 2016 were 87 ppm at the Montgomery County incinerator.

EXHIBIT A

City of Baltimore
Council Bill 17-0034R
(Resolution)

Introduced by: Councilmembers Reisinger, Clarke, Henry, Pinkett, Scott, Costello, President Young, Councilmembers Cohen, Middleton, Stokes, Dorsey, Burnett, Sneed, Bullock
Introduced and read first time: July 17, 2017
Assigned to: Housing and Urban Affairs Committee

REFERRED TO THE FOLLOWING AGENCIES: City Solicitor, Department of Housing and Community Development, Department of Public Works, Health Department

A RESOLUTION ENTITLED

A COUNCIL RESOLUTION concerning

Request for State Action – Set a Strong Nitrogen Oxides Limit for the Wheelabrator Baltimore Incinerator

FOR the purpose of urging the Maryland Department of the Environment to set a nitrogen oxides pollution limit for the Wheelabrator Baltimore incinerator that is no higher than the 150 ppm standard on a 24-hour average that has been adopted by Connecticut and New Jersey and proposed in Massachusetts, or, if at all possible, significantly lower than 150 ppm in order to provide maximum air quality benefits to residents of Baltimore.

Recitals

Emissions of nitrogen oxides (NOx) contribute to the formation of three pollutants in the ambient (outdoor) air: ground-level ozone, nitrogen dioxide, and fine particulate matter. Each of these pollutants can have adverse effects on human health, including worsening symptoms of asthma in people who already have the condition. Baltimore City has substantially higher rates of asthma hospitalizations and emergency room visits due to asthma than the rest of the State of Maryland.

The Baltimore area, which includes Baltimore City and five additional counties, is designated as a nonattainment area for ground-level ozone by the U.S. EPA, meaning that the area does not meet federal air quality standards for ozone. NOx is the primary pollutant that contributes to the formation of ground-level ozone.

Many factors contribute to Baltimore's ozone problem, including pollution from power plants located in other states. Locally, the municipal solid waste incinerator operated by Wheelebrator Baltimore, L.P. and located in South Baltimore is a major source of NOx emissions.

In 2015, the Baltimore incinerator emitted 1,123 tons of NOx, making it the sixth largest emitter of NOx in the State of Maryland that year. The Baltimore incinerator also emitted more NOx per unit of energy generated in 2015 than any other large power plant in Maryland.

The Maryland Department of the Environment is in the process of developing regulations that will establish new NOx emission limits for Maryland's two municipal solid waste incinerators, including the Wheelabrator incinerator in Baltimore. These regulations are part of an air quality

EXPLANATION: Underlining indicates matter added by amendment.
~~Strike out~~ indicates matter deleted by amendment.

plan that Maryland must submit to the EPA under the federal Clean Air Act to show that the state is making progress toward attaining federal ozone standards.

The new NOx limits established under this rulemaking must, at minimum, meet a standard called Reasonably Available Control Technology ("RACT"). The RACT standard is defined as "the lowest emissions limit that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility."

MDE may not set NOx emission limits that are weaker and less health-protective than the RACT standard. However, MDE has the authority to set NOx emission limits that are stronger and more protective of health than the RACT standard.

Short-term emission limits for incinerators are expressed in parts per million by volume dry at 7% oxygen (hereinafter "ppm"). The limit is frequently assessed based on a 24-hour average. A NOx limit of 150 ppm on a 24-hour basis has been adopted as the RACT standard for municipal solid waste incinerators by the states of Connecticut and New Jersey and has been proposed for adoption in Massachusetts. New Jersey allows facility operators to seek an exception in the form of an alternate limit.

Around 2009, the operator of Maryland's second municipal solid waste incinerator, the Montgomery County Resource Recovery Facility ("MCRRF"), voluntarily installed new NOx pollution controls on that incinerator that reduced its NOx emissions by about half. From 2013 through 2015, MCRRF's annual average NOx emissions were about 85 to 89 ppm on a 24-hour basis.

The Wheelabrator Baltimore's annual average NOx emissions from 2013 through 2015 were 162 to169 ppm on a 24-hour basis. Its current NOx emissions limit is 205 ppm. Wheelabrator Baltimore, L.P. has proposed that Maryland set a new NOx emissions limit of 170 ppm for the Baltimore incinerator. According to the most recent calculations by the Maryland Department of the Environment, this would reduce annual NOx emissions from the Baltimore incinerator by 60 tons per year.

The Baltimore incinerator receives financial benefits because it is treated as a Tier 1 source of renewable energy under Maryland's Renewable Portfolio Standard. Under this program, Marylanders are supposed to reap benefits from renewable energy resources that include long-term decreased emissions and a healthier environment.

NOW, THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL OF BALTIMORE, That the Council urges the Maryland Department of the Environment to set a nitrogen oxides pollution limit for the Wheelabrator Baltimore incinerator that is no higher than the 150 ppm standard on a 24-hour average that has been adopted by Connecticut and New Jersey and proposed in Massachusetts, or, if at all possible, significantly lower than 150 ppm in order to provide maximum air quality benefits to residents of Baltimore.

AND BE IT FURTHER RESOLVED, That a copy of this Resolution be sent to the Governor, the Secretary of the Maryland Department of the Environment, the Director of the Air and Radiation Management Administration, the Division Chief of the Air Quality Regulations Division, the Mayor, and the Mayor's Legislative Liaison to the City Council.

EXHIBIT B

 DLR DRAFT I 27SEP17

AMENDMENTS TO COUNCIL BILL 17-0034R
(1st Reader Copy)

By:
{To be offered to the Housing and Urban Affairs Committee}

Amendment No. 1

On page 2, after line 27, insert:

"The Council requests that the Maryland Department of the Environment use its legal authority to go beyond the RACT standard in order to set a nitrogen oxides limit of 45 ppm on a 24-hour basis, which is the limit that would likely be set for a new incinerator.".

October 20, 2017

Via E-mail
George (Tad) Aburn
Director
Air & Radiation Management Administration
Maryland Department of the Environment
1800 Washington Boulevard
Baltimore, MD 21230
george.aburn@maryland.gov

RE: Rulemaking for Limits on Nitrogen Oxides (NOx) Emissions from Large Municipal Waste Combustors (MWCs)

Dear Mr. Aburn:

United Workers, Chesapeake Physicians for Social Responsibility ("CPSR"), Clean Water Action, Chesapeake Climate Action Network ("CCAN"), and Sierra Club submit the brief comments below regarding the draft regulation in the above-referenced proceeding that the Maryland Department of the Environment ("MDE") shared with public stakeholders on September 18, 2017 and on MDE's undrafted proposal, announced at the September 22, 2017 public stakeholder meeting, to set another set of NOx limits for the Wheelabrator Baltimore incinerator to take effect in 2022 after submission of a feasibility study in 2020.

Our groups remain very concerned about the human health and environmental impacts of trash incinerators in Maryland, especially the largest of the state's two incinerators, which is located in Baltimore City and operated by Wheelabrator Baltimore, L.P. (often referred to as the BRESCO incinerator). Nitrogen oxides ("NOx") and ozone pollution negatively impact the health of Baltimore residents, and ozone levels have been increasing in the Baltimore area since 2015. We request that MDE act to reduce the human health costs of air pollution from this incinerator as quickly and as much as possible.

Our groups appreciate the time and effort that MDE has put into its development of this regulation. We thank MDE for using its authority, under the Reasonably Available Control Technology ("RACT") legal standard, to propose a 24-hour limit of 150 ppmvd @ 7% O2 ("ppm") for the Wheelabrator incinerator, which would take effect in May 2019, and a second limit of 145 ppm on a 30-day basis that would take effect in May 2020. However, we also feel very strongly that these limits, which allow the Wheelabrator incinerator to continue emitting about 900 tons per year of NOx, are not low enough to protect public health and sufficiently improve air quality in the Baltimore area. We urge MDE to use its authority to require substantial additional reductions quickly.

We do not think that this goal – significant reductions achieved quickly - will be accomplished if the development of additional more stringent emission reductions is kicked down the road and picked up again in a rulemaking that commences in 2020 or 2021. This option – future rulemaking – is presented as Option 2 in the Powerpoint presentation that MDE made at the September 22, 2017 stakeholder meeting.[1] We feel strongly that MDE must set the more stringent NOx emission limits as part of this rulemaking and should not wait until 2020 or 2021 to commence a separate rulemaking in order to establish those limits.

We thank MDE for considering these comments and look forward to continuing to participate in this stakeholder process.

Sincerely,

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[1] MDE PowerPoint Presentation, NOx RACT for Municipal Waste Combustors (MWCs), Stakeholder Meeting – September 22, 2017, p. 30 *at* http://mde.maryland.gov/programs/Regulations/air/Documents/SHMeetings/MunicipalWasteCombustors/MWCStakeholder09222017.pdf.

Cc: *Via E-mail*

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October 27, 2016

Via E-mail and First Class Mail
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RE: Public Stakeholder Process for Setting Reasonably Available Control Technology Limits for Nitrogen Oxides Emissions from Large Municipal Waste Combustors

Dear Mr. Aburn:

I am writing on behalf of the Environmental Integrity Project ("EIP"), Clean Water Action, Chesapeake Physicians for Social Responsibility, United Workers, Free Your Voice, Maryland Environmental Health Network, and the Sierra Club (collectively, "Commenters"). We write with regard to the public stakeholder process that the Maryland Department of the Environment ("MDE") is conducting to set Reasonably Available Control Technology ("RACT") limits for nitrogen oxides ("NO_x") emissions from Maryland's two large municipal waste combustors ("MWCs" or "incinerators"). MDE held an initial public stakeholder meeting on August 30, 2016. As far as we know, MDE has not scheduled any additional meetings that will allow stakeholders to participate in this process. We respectfully request that MDE:

(1) Schedule two more stakeholder meetings to allow additional concerned members of the public to attend and participate in this discussion, particularly as it pertains to NO_x limits for the Baltimore Refuse Energy Systems Company ("BRESCO") incinerator in Baltimore City; and
(2) Address at these meetings the different control technology options available, described in more detail below, for reducing NO_x at BRESCO in the context of the RACT rulemaking.

Each of our groups is extremely concerned about the effects of air pollution from the BRESCO plant on Baltimoreans, particularly vulnerable populations such as children, the elderly, and individuals with asthma. We wish to participate and provide input in this rulemaking process, which requires an opportunity for us to become fully informed about the options for controlling NO_x emissions at the plant as well as the emissions tests currently being run at BRESCO and the data produced by these tests. We thank MDE for initiating the public stakeholder process on this very important set of regulations, and we strongly urge the agency to set a final rule that requires Wheelabrator Baltimore, LP ("Wheelabrator"), the plant's owner and operator, to do its part to protect human health in Baltimore by more effectively controlling its emissions.

We appreciate MDE's hard work over the years to help reduce ozone levels in Maryland, and recognize that progress has been made. We think that the present RACT rulemaking presents an important opportunity to make further progress.

Background

Health Effects of Nitrogen Oxides (NO_x)

Nitrogen oxides (NO_x) emissions can affect human health in multiple ways. NO_x is the primary contributor to ground-level ozone, a pollutant that can cause airway constriction and chronic obstructive pulmonary disease and can aggravate cases of asthma.[1] Although not relevant to the legal standard at issue (which is for ozone), NO_x is also a precursor to fine particulate matter ($PM_{2.5}$), a pollutant that can cause premature mortality due to heart and lung disease,[2] aggravate asthma,[3] and increase the risk of adverse birth outcomes, including low birth weight and preterm birth.[4] $PM_{2.5}$ can cause adverse health effects even at levels below federal air quality standards, and experts who study this issue agree that there is no evidence of a "threshold" below which $PM_{2.5}$ is safe.[5] Children, older adults, and people with existing respiratory conditions, such as asthma, are at the greatest risk of suffering adverse effects from exposure to ozone and/or $PM_{2.5}$.[6] As MDE is aware, this puts Baltimore City residents at increased risk from exposure to these pollutants due to the extremely high rates of existing asthma in the city.[7]

Baltimore Ozone Levels

The Baltimore area has long been designated by the U.S. EPA as a "nonattainment area" for ground-level ozone, meaning that it does not meet federal air quality standards for this pollutant.[8] While ozone levels declined in 2013 and 2014 in the Baltimore area, in part because

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[1] U.S. EPA, Health Effects of Ozone Pollution, https://www.epa.gov/ozone-pollution/health-effects-ozone-pollution

[2] *See* Laden, F. et al., Reduction in Fine Particulate Air Pollution and Mortality: Extended Follow-Up of the Harvard Six Cities Study, 173 Am. J. Respir. Crit. Care Med. 667 (2006); Pope, C.A. et al., Lung Cancer, Cardiopulmonary Mortality, and Long-term Exposure to Fine Particulate Air Pollution, 287 JAMA 1132 (2002).

[3] U.S. EPA, Health and Environmental Effects of Particulate Matter (PM) https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm.

[4] R. Nachman, et. al., Intrauterine Inflammation and Maternal Exposure to Ambient PM2.5 during Preconception and Specific Periods of Pregnancy: The Boston Birth Cohort, Environ. Health Perspect., Advanced Publication, DOI:10.1289/EHP243: 4.

[5] *See generally*, U.S. EPA, Summary of Expert Opinions on the Existence of a Threshold in the Concentration-Response Function for PM2.5-related Mortality, Technical Support Document (June 2010), available at: http://www3.epa.gov/ttnecas1/regdata/Benefits/thresholdstsd.pdf.

[6] U.S. EPA, *supra* notes 1,3.

[7] Data recently released by the Maryland Department of Health and Mental Hygiene ("DHMH") shows that, in 2013, Baltimore City's asthma hospitalization rate was almost three times the state rate and the city's rate was almost twice that of the next-highest Maryland county (Dorchester County). DHMH Environmental Public Health Tracking website at http://phpa.dhmh.maryland.gov/OEHFP/EH/tracking/Pages/Home.aspx.

[8] The Baltimore ozone nonattainment area consists of Baltimore City and the following counties: Anne Arundel, Baltimore, Carroll, Harford, and Howard.

of cooler summers, they rose again in 2015 and 2016.[9] Commenters do not yet have access to ozone data from July through September of 2016, which will almost certainly include the highest ozone levels recorded in 2016 due to the fact that ozone formation is greatest in hot, sunny weather. Even without that data, however, it is clear that, during the 2014-2016 period,[10] Baltimore's ozone levels exceeded the federal air quality standard of 70 parts per billion ("ppb") that was finalized in 2015. The Padonia Elementary School monitor, located in Baltimore County, registered a design value of 72.3 ppb over the period from 2014 through 2016 (again, without including what are likely the highest values of the year) and the Aldino Road monitor in Harford County registered a value of 72 ppb. It is possible that, when the more recent data is included, other monitors will exceed the 70 ppb standard or even the older, more relaxed standard of 75 ppb that was passed by EPA in 2008 and is still in effect.

Legal Standard

Section 182 of the federal Clean Air Act requires states to adopt Reasonably Available Control Technology ("RACT") requirements for major sources of NO_x. RACT is defined as "the lowest emissions limit that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility."[11] EPA has described this standard as "technology forcing" and stated that "[i]n determining RACT for an individual source or group of sources, the control agency, using the available guidance, should select the best available controls, deviating from those controls only where local conditions are such that they cannot be applied there and imposing even tougher controls were conditions allow."[12]

Maryland Incinerator NO_x Controls

Maryland has two large municipal waste combustors that are subject to the current NO_x rulemaking: the Montgomery County Resource Recovery Facility ("MCRRF") and the Baltimore Refuse Energy Systems Company ("BRESCO") incinerator in Baltimore City. NO_x is controlled at both facilities using a technology called Selective Non-Catalytic Reduction. However, in 2008-2010, additional controls, referred to as "Low NO_x" were installed at MCRRF and this addition cut the facility's NO_x emissions by almost half. As shown in Table 1 below, this reduction in NO_x emissions was achieved while plant operations remained relatively constant.

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[9] The U.S. EPA makes ozone monitoring data available on its Airdata site at https://www.epa.gov/outdoor-air-quality-data. As of October 6, 2016, it appears that the 2016 Baltimore ozone data available on the Airdata site is from first and second quarters but that third quarter data has not yet been posted. EIP has also submitted a public records request to MDE for this data.

[10] The federal air quality standard for ozone is based on the fourth highest 8-hour ozone level recorded each year, averaged over a three-year period. U.S. EPA, National Ambient Air Quality Standards (NAAQS) table, at https://www.epa.gov/criteria-air-pollutants/naaqs-table.

[11] COMAR 26.11.01.01.B(40); *accord* U.S. EPA, State Implementation Plans; Nitrogen Oxides Supplement to the General Preamble for the Implementation of Title I of the Clean Air Act Amendments of 1990, 57 Fed. Reg. 55,620, 55,624 (Nov. 25, 1992).

[12] Memorandum from Roger Strelow, Assistant Admin., Air and Waste Management, U.S. EPA, *Guidance for determining Acceptability of SIP Regulations in Non-attainment Areas*, to Regional Administrators, Regions I-X (Dec. 9, 1976), *available at* https://www3.epa.gov/ttn/naaqs/aqmguide/collection/cp2/19761209_strelow_ract.pdf .

Table 1: MCRRF NO_x Emissions and Operating Data 2006-2015[13]				
Year	**NO_x emissions** (tons)	**Waste processed** (tons)	**% capacity** (waste burning)	**Power generated** (megawatt hours)
2006	1,041	620,666	94%	371,971
2007	1,009	578,804	88%	343,955
2008	998	573,293	87%	331,055
2009	554	527,623	80%	282,170
2010	499	551,670	84%	303,075
2011	512	556,266	85%	308,150
2012	479	544,647	83%	310,008
2013	388	555,716	85%	312,539
2014	427	Not available	Not available	315,450
2015	441	599,250	91%	Not available

MCRRF's annual average NO_x emissions from 2006-2008 were 1,016 tons per year. After the installation of the new Low NO_x controls, during the period from 2009 through 2011, average NO_x emissions were 522 tons per year. This is an average reduction of 494 tons per year or 48.6% of emissions. According to the U.S. EPA, the reduction at the plant was "equivalent to . . . the annual emissions of about 50,000 passenger cars."[14]

As shown in Table 2 below, the BRESCO incinerator, which lacks the Low NO_x controls installed at MCRRF currently emits NO_x in levels very similar to those that were produced by MCRRF before it installed the Low NO_x technology.

[13] Emissions data from Maryland Emissions Inventory. Capacity and power generation data from Northeast Maryland Power Waste Disposal Authority ("NMWDA") website at http://nmwda.org/montgomery-county/ ,except for 2014 power generation data from U.S. Energy Information Administration ("EIA") and 2015 waste processing data from MDE PowerPoint presentation dated August 30, 2016 on NOx RACT for Large MWCs.
[14] U.S. EPA, Clean Air Excellence Award Recipients: Year 2014 at 1, https://www.epa.gov/sites/production/files/2015-06/documents/clean_air_excellence_award_recipients_year_2014.pdf .

Table 2: BRESCO Emissions and Waste Processing 2006-2015[15]		
Year	**NO_x emissions** (tons)	**Waste processed** (tons)
2006	1,107	670,989
2007	1,065	657,404
2008	1,094	688,800
2009	1,159	688,489
2010	1,077	676,400
2011	1,133	701,636
2012	1,012	697,078
2013	1,067	713,410
2014	1,076	Not available
2015	1,124	730,150

While BRESCO is a bigger facility that burns more waste per year, the difference in its waste burning capacity does not account for its substantially increased NO_x emissions relative to MCRRF. Following MCRRF's installation of Low NO_x, it combusted an average of 555,862 tons of waste per year and emitted an average of 479 tons of NO_x per year (using data from years 2009-2015, excluding 2014 for consistency). BRESCO, by contrast, combusted an average of 701,194 tons of waste per year, 26.1% more than MCRRF, during those years but emitted an average of 1,095 tons of NO_x per year, 129% more than MCRRF. Thus, BRESCO is emitting a great deal more NO_x than MCRRF even when its increased burning capability is accounted for, and it appears that NO_x emissions from BRESCO could be substantially reduced from their current levels.

MDE Should Provide Additional Information to the Public Regarding NO_x Control Options for the BRESCO Incinerator

Commenters respectfully request that MDE schedule additional stakeholder meetings so that MDE, and Wheelabrator if necessary, can present information about options available for reducing NO_x emissions from the BRESCO incinerator. At minimum, we request that such a presentation address the following options:

(1) Selective Catalytic Reduction

Selective Catalytic Reduction ("SCR") is widely recognized as the most effective technology for controlling NO_x emissions from a variety of combustion sources, including

[15] Emissions data from Maryland Emissions Inventory. Waste data from NMWDA website at http://nmwda.org/baltimore-resco/, except for 2014 power generation data from U.S. Energy Information Administration ("EIA") and 2015 waste processing data from MDE NOx RACT PowerPoint presentation dated August 30, 2016.

municipal solid waste ("MSW") incinerators. SCR can achieve NO_x removal efficiencies of 90% at coal plants. According to the State of Maryland's own technical analysis, SCR can provide control efficiencies of 75% or greater at MSW incinerators.[16]

While we understand that MDE may determine that SCR does not meet the "economic feasibility" prong of the definition of Reasonably Available Control Technology, we request that MDE or Wheelabrator provide information about this option and explain why it is not economically feasible, if this is position of the agency or the company.

(2) Regenerative Selective Catalytic Reduction

Regenerative Selective Catalytic Reduction ("RSCR") is described by the State of Maryland's Power Plant Research Program ("PPRP") as "a variation of SCR that is far more energy efficient than standard SCR" which "substantially improves the cost-effectiveness of applying SCR to [municipal waste combustor] units."[17] PPRP explains further:

> With RSCR, supplemental fuel, such as natural gas, is combusted to re-heat the flue gas to the catalyst operating temperature, as with traditional SCR, However, with RSCR, over 95 percent of that heat is recovered using heat exchangers, and is then re-introduced back into the flue gas. This results in far less use of natural gas than with traditional SCR, and much lower, associated fuel costs.[18]

RSCR is the control technology that would have been used on the Energy Answers incinerator proposed for the Fairfield area of Baltimore City. According to PPRP, "the supplier of the RSCR technology [for that project], Babcock Power Environmental, anticipate[d] that a minimum 80 percent removal efficiency for NO_x" could be achieved at the MSW combustion units involved.[19] While the Energy Answers plant would have been a refuse-derived fuel incinerator utilizing spreader-stoker boilers, RSCR was also determined to be technically feasible for the proposed Frederick/Carroll County Renewable Waste-to-Energy Facility ("FCCRWTE"), which would have used mass burn waterwall combustors like the BRESCO plant.[20] This determination was made in a permit application for the FCCRWTE project submitted by Wheelabrator and NMWDA.

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[16] Maryland Power Plant Research Program ("PPRP"), Supplemental Environmental Review Document, Motion by Energy Answers Baltimore, LLC, to Amend the Construction Commencement Deadline in its Certificate of Public Convenience and Necessity, Maryland Public Service Commission Docket No. 9199 (June 2012) at 6-6 (Excerpt attached hereto as Attachment A).

[17] *Id.*at 6-6 to 6-7 (Attachment A).

[18] *Id.*

[19] Commenters understand that the Energy Answer project would have utilized different kinds of boilers than the BRESCO plant and would have shredded the MSW before combustion. However, these things should not affect the control efficiency of the NOx pollution controls.

[20] Frederick/Carroll County Renewable Waste-to-Energy Facility, Prevention of Significant Deterioration/Air Construction Permit Application, Prepared for NMWDA and Wheelabrator Technologies, Inc. by Environmental Consulting & Technology, Inc., Last Revised: October 2012, at 4-6, 6-12 (Excerpts attached here to as Attachment B).

We respectfully request that MDE or Wheelabrator address in a presentation the option of requiring the installation of RSCR at the BRESCO incinerator.

(3) Low NO_x Controls

As discussed in detail above, the MCRRF incinerator in Montgomery County installed in 2008-2010 a set of controls referred to as "Low NO_x," which reduced its NO_x emissions, already controlled at the time with Selective Non-Catalytic Reduction technology, by about 50%. Low NO_x is described in a recent MDE PowerPoint presentation as "a unique combustion system design, including modifications to combustion air flow, reagent injection and control systems logic."[21] MDE also states that system was installed at a capital cost of $6.7 million and the average operating costs over the last three years has been $566,000 per year.

There are a number of reasons to believe that installation of this system on the BRESCO plant would have a similar emissions reduction effect. BRESCO and MCRRF employ the same boiler technology (mass burn waterwall boilers) and both use Selective Non-Catalytic Reduction as the primary NO_x control. In addition, BRESCO's current NO_x emissions rate (per heat generation) is similar to MCRRF's rates in the years before it installed Low NO_x. BRESCO's average NO_x rate in the most recent three years for which we have data, 2012-2014, is 1.79 lbs/Mmbtu.[22] MCRRF's average NO_x rate from 2006-2008 was 1.71 lbs/Mmbtu.

For all of these reasons, it appears that installation of Low NO_x controls in the BRESCO incinerator would be extremely effective at reducing NO_x emissions in Baltimore as well as being technologically and economically feasible. We respectfully request that MDE address this option in a public presentation and we strongly urge MDE to consider setting an emissions limit that, at minimum, requires installation and operation of these controls

(4) Apparent Poor Performance of BRESCO's Existing Pollution Controls

Lastly, we request that MDE, or Wheelabrator, explain at a public stakeholder meeting why it appears that the existing NO_x controls at BRESCO are functioning poorly and below what would be expected of the kind of control technology. The controls currently installed at BRESCO are Selective Non-Catalytic Reduction ("SNCR"). According to the Maryland PPRP's analysis, when applied to MSW incinerators, SNCR "typically achieves minimum control efficiencies in the general range of 50 to 60 percent."[23]

However, according to the PowerPoint presentation made by MDE at its August 30, 2016 stakeholder meeting, BRESCO is achieving removal efficiencies of 14-21% under its original configuration and 25% with optimized operation of the system (based on increased urea utilization).[24] It is not clear from the presentation whether these numbers are total NO_x removal efficiency numbers or whether this is some subset of NO_x reductions. However, if BRESCO's

[21] MDE PowerPoint presentation dated August 30, 2016 on NOx RACT for Large MWCs.
[22] We are using pounds per mmbtu instead of pounds per megawatt hour in order to ensure an "apples to apples" comparison, as BRESCO generates both steam and electricity and MCRRF produces only electricity.
[23] Maryland PPRP, *supra*, note 15 at 6-7 (Attachment A).
[24] MDE PowerPoint presentation dated August 30, 2016 on NOx RACT for Large MWCs.

total NO_x control efficiency is, indeed, hovering between 14 and 25% when SNCR is supposed to be capable of 50-60% removal, we respectfully request that MDE explain, or require Wheelabrator to explain, why BRESCO's controls are performing so poorly. We also request that MDE make available to the public the raw emissions data that has been produced by the NO_x control optimization tests being run at BRESCO.

Conclusion

The groups listed below appreciate that MDE has initiated this rulemaking as a public stakeholder process. We collectively desire meaningful input into this set of regulations and share the goal of obtaining final emission limits for BRESCO that will result in a healthier Baltimore with reduced symptoms of asthma and other conditions that are worsened by exposure to air pollution. For these reasons, we respectfully ask that MDE schedule additional public stakeholder meetings at which MDE and/or Wheelabrator provide information about each of the topics described above.

Sincerely,

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MARYLAND DEPARTMENT OF NATURAL RESOURCES

DRAFT

PPRP

Motion by Energy Answers Baltimore, LLC, to Amend the Construction Commencement Deadline in its Certificate of Public Convenience and Necessity

Supplemental Environmental Review Document

June 2012

MARYLAND POWER PLANT RESEARCH PROGRAM

- Emissions from the cooling tower will be controlled by the operation of high efficiency drift eliminators.

6.1.2 LAER Determinations For MWC Units

PPRP, in conjunction with MDE-ARMA, conducted an independent LAER assessment. The following sections summarize the State's determination of LAER for the proposed EA Fairfield project.

EA's proposed LAER determinations for the MWC units are summarized in Table 6-1.

Table 6-1 EA's Proposed LAER for Fairfield Project MWC Units

Pollutant	Control Technology [1]	Proposed LAER Limit (averaging period)	Originally Licensed Limit (Case 9199 Conditions Oct 2010)
NO_x	RSCR, GCPs	45 ppmdv @ 7% O_2 (24-hr daily arith. avg w/CEMS)	45 ppmdv @ 7% O_2 (24-hr daily arith. avg w/CEMS)
VOCs	GCPs	7 ppmdv @ 7% O_2 (avg of 3 tests)	18 mg/dscm @ 7% O_2 (avg of 3 tests)
PM2.5 (filterable and condensable)	Semi-dry scrubber, FF	22 mg/dscm @ 7% O_2 (avg of 3, 1-hr tests) Provisional limit [2]	24 mg/dscm @ 7% O_2 (avg of 3, 1-hr tests) Provisional limit [2]
SO_2	Semi-dry scrubber, FF	24 ppmdv @ 7% O_2 (24-hr daily geom. avg of hourly arith. avg w/CEMS)	24 ppmdv @ 7% O_2 (24-hr daily geom. avg of hourly arith. avg w/CEMS)

[1] RSCR = regenerative selective catalytic reduction; ppmdv = parts per million by volume on dry weight basis; GCP = good combustion practices; FF = fabric filter

[2] PM2.5 limit, inclusive of filterable and condensable fractions, is provisional and will be reviewed based on future stack tests to verify or refine the limit

6.1.2.1 NO_x

6.1.2.1.1 LAER for NOx from the MWC Units

A LAER analysis is required for emissions of NO_x as a precursor to the nonattainment pollutant, ozone. NO_x emissions are a product of combustion processes and there are two formative mechanisms for NO_x. The first is "thermal NO_x" formation, in which NO_x is formed from the high-temperature oxidation of nitrogen that is present in the combustion air. The second is "fuel NO_x" which forms when nitrogen and nitrogen compounds that are present in the fuel are oxidized during combustion.

MWC units combust fuel at a high temperature, with a substantial amount of ambient air ("excess air") being introduced to the combustion zone. Because emissions of thermal NO_x are determined principally by the percentage of excess air and the temperature, thermal NO_x production is normally greater at MWC units than fuel NO_x production. Fuel NO_x production is governed by the nitrogen content of the fuel, as well as by the combustion conditions, specifically temperature and amount of combustion air. Lower combustion temperatures, as well as good mixing of the fuel with the combustion air, reduce the opportunity for localized areas of high temperature spikes and excessive oxygen levels to develop in the combustion zone (i.e., the conditions that promote NO_x formation).

NO_x emissions from MWC units can be reduced by three methods: 1) lowering the nitrogen content of the fuel by source separation, where feasible, 2) managing the combustion conditions to minimize NO_x formation, and 3) applying an add-on control technology to remove NO_x.

Materials Separation

Because most constituents of solid waste (and fuels derived from it) contain nitrogen, source separation of nitrogen-bearing constituents of solid waste is generally not a feasible means for achieving NO_x emissions abatement. However, one exception is yard waste/leaves, which are generated in substantial amounts and are naturally high in nitrogen content. MWC operators prefer that yard waste/leaves in large quantities be diverted from combustion, with the preferred alternative disposition being municipal/county composting programs.

Combustion Control and Combustion Modifications

The generation of NO_x emissions in the combustion process can be minimized by the same MWC unit design and operating practices, referred to as GCPs, that were determined to be BACT for the control of CO emissions. In the BACT analysis for CO, it was explained that the combustion factors that minimize CO emissions (i.e., high temperature and abundant oxygen) will increase the formation and emissions of NO_x. Accordingly, GCPs for the control of NO_x entail ensuring that combustion occurs at sufficient temperature and with sufficient oxygen to keep CO emissions low, while preventing localized hot spots and pockets of high oxygen levels that can result in excessive production of NO_x. GCPs for NO_x control are achieved by:

- Maintaining a uniform distribution of primary (underfire) air to control the flame temperature and to prevent regions of high excess air;
- Promoting adequate mixing of the combustion gases; and

- Using secondary (overfire) air, with active control of the underfire-to-overfire air ratio, to ensure complete combustion and low CO formation, while preventing temperature and oxygen spikes that create excessive NO_x. The underfire-to-overfire ratio is adjusted and optimized, based on values of control parameters, such as combustion temperature, steam demand, CO concentration, and oxygen concentration.

GCPs are well demonstrated at MWC units to prevent excessive formation of NO_x. GCPs alone, however, are not sufficient to meet BACT or LAER requirements for MWC units. Further control is potentially achievable with the combustion modifications discussed below, and is achievable with add-on controls discussed subsequently.

Aside from combustion control discussed above, there are combustion modifications that could be considered for further reduction of NO_x emissions; i.e., flue gas recirculation (FGR) and gas re-burning. In FGR, a portion of the cooled flue gas (typically 20 – 30 percent) is recirculated back to the MWC unit to replace part of the MWC unit's secondary air supply. By diluting the secondary air with recirculated flue gas, the net oxygen content of the secondary air is lowered. Reducing the oxygen content lowers the peak flame temperature during combustion, suppressing the production of thermal NO_x. FGR can reduce NO_x emissions by approximately 10 – 25 percent. Experience with FGR at MWC units in the U.S. is limited to date.

With gas reburning, combustion is modified by injecting natural gas above the combustion grate, thereby creating a fuel-rich zone that suppresses NO_x formation. Air is introduced above the fuel-rich zone to complete combustion and ensure CO emissions remain low. This combustion modification requires substantial quantities of natural gas fueling, which is not energy efficient and, hence, is not utilized or demonstrated on MWC units in the U.S.

Combustion modification techniques such as FGR and gas reburning are not considered further as LAER for NO_x control, because there are add-on control techniques, to be evaluated below, that are demonstrated to afford substantially greater control of NO_x emissions from MWC units.

Add-On Controls

Two add-on control techniques are available for the control of NO_x, namely selective catalytic reduction (SCR) and non-selective catalytic reduction (SNCR). As SCR provides the more stringent level of control for NO_x, it is evaluated first.

With SCR, an ammonia-based reagent (aqueous ammonia or urea) is injected into the flue gas, where it mixes with nitrogen oxide (NO), the predominant compound of NO_x emanating from the combustion process. The mixture of NO and ammonia passes through a catalyst bed, using a catalyst material comprised of one of several metals, or zeolite (synthetic silica compound), or a ceramic material (molecular sieve). The catalyst chemically reduces the NO to nitrogen. Without the catalyst, this reaction would only occur efficiently at combustion temperatures, typically 1,600ºF to 1,800ºF. The catalyst, however, enables the reaction to occur at a much lower temperature, typically required to be in the range of 500ºF to 700ºF. This operating temperature requirement has important implications for SCR when applied to MWC units that combust fuel derived from MSW and other biomass fuels. This is because, when combusting such fuels, the SCR cannot be placed in the location where the flue gas temperature is in the proper temperature range; i.e., at the MWC unit exit, prior to the semi-dry scrubber. When combusting such fuels, the PM present in the flue gas exiting the MWC units contains sulfur compounds, alkaline compounds, and trace heavy metals that can chemically de-activate the catalyst. Accordingly, at MWC units, the SCR catalyst must be placed downstream of the emission control devices for acid gases and PM. At that location, however, the flue gas temperature has typically cooled to below 300ºF, and hence, must be re-heated to the operating temperature of the catalyst.

SCR applied to MWC units can provide a 75 percent or greater control efficiency for NO_x emissions. Of all available NO_x control methods demonstrated for MWC units, SCR provides the most stringent control efficiency.

SCR is routinely used today to control NO_x emissions from natural gas combustion turbines and boilers. SCR is also used on some coal-fueled power plants. SCR has been implemented effectively at MWC units in Europe and on one MWC unit in Canada. While SCR technology has been recently proposed in the U.S. for several planned new MWC units, it has not yet been demonstrated to date on a MWC unit in the U.S. The reason that SCR, while technically feasible for MWC units, has not yet been applied to MWC units in the U.S. is principally economic. For MWC units, traditional SCR has not met the cost-effectiveness criterion required for it to serve as the basis for setting a BACT emission limit. The reason that traditional SCR has been cost-ineffective to date is the need to re-heat the flue gas to the required operating temperature, which in turn, requires substantial, supplemental fuel combustion (e.g., natural gas), which would normally be cost-prohibitive.

A variation of SCR that is far more energy efficient than standard SCR, regenerative SCR (RSCR), is now available for application to MWC units, and accordingly, substantially improves the cost-effectiveness of applying

SCR to MWC units. With RSCR, supplemental fuel, such as natural gas, is combusted to re-heat the flue gas to the catalyst operating temperature, as with traditional SCR. However, with RSCR, over 95 percent of that heat is recovered using heat exchangers, and is then re-introduced back into the flue gas. This results in far less use of natural gas than with traditional SCR, and much lower, associated fuel costs. The RSCR uses cycling beds of ceramic media to recover, store, and transfer the heat. This same heat recovery and transfer technology has been used commercially for decades in regenerative thermal oxidizers (RTO). The RSCR technology has operated successfully on several biomass power plants fueled with wood in the U.S. since the mid-2000s, achieving NO_x removal efficiencies exceeding the nominal design values of 70 to 75 percent for those plants, according to the RSCR equipment supplier.

While RSCR has been demonstrated at biomass-fueled boilers in the U.S., it has not as yet been demonstrated at a MWC unit. RSCR is proposed for meeting LAER requirements for NO_x at the EA Fairfield MWC units, and this proposed application of RSCR would be among the first such application to a MWC unit. The supplier of the RSCR technology, Babcock Power Environmental, anticipates that a minimum 80 percent removal efficiency for NO_x can achieved at the Fairfield MWC units.

The second type of add-on control demonstrated for NO_x abatement at MWC units is SNCR. SNCR is the add-on NO_x control technology used at virtually all MWC units operating today in the U.S. Like SCR, SNCR reduces NO_x by injecting an ammonia based reagent (aqueous ammonia, urea) to convert NO present in the post-combustion gases to nitrogen via chemical reduction. However, unlike SCR, SNCR does not use a catalyst and its associated process chemistry is more complex. Because a catalyst is not used with SNCR, the required reaction temperature for NO_x reduction is much higher, with the desired reaction occurring most efficiently within a specific temperature range of approximately 1,700 to 1,850ºF. However, special reagent formulations are now available that can extend that range downward to approximately 1,300ºF. As reaction temperature is critical, SNCR requires the reagent to be injected into the combustion gases where the boiler temperatures are within the required range. This is typically a location within the combustion zone, or immediately following it. When applied to MWC units, SNCR typically achieves minimum control efficiencies in the general range of 50 to 60 percent. By comparison, SCR, again, can achieve a minimum 75 percent control.

6.1.2.1.2 *LAER for NOx from the MWC Units*

The 2010 CPCN had imposed a LAER emissions limit on NO_x emissions from each of the four MWC units of 45 ppmdv @7% O_2, as the 24-hour daily arithmetic average of hourly concentrations, with compliance to be demonstrated by means of a CEMS. That limit is substantially more stringent than the emission standards imposed by the NSPS for large MWC units (40 CFR 60, Subpart Eb) of 150 ppmdv @7% O_2, with 180 ppmdv allowed during the first year of operation. In its 2012 Motion to Amend, EA had proposed the same emission limit as LAER, with compliance to be demonstrated on the same basis. PPRP has independently evaluated the proposed LAER emission limitation, based on a review of the following:

- Recent permitting precedents for MWC units summarized by U.S. EPA in its national RBLC;
- Permits issued recently for MWC units that are not yet reflected in the RBLC database; and
- Proposed permit conditions for MWC project developments in progress of which PPRP is aware. (Note: Such proposed permit limits can serve as relevant benchmarks in a BACT/LAER analysis, but until the reference permit is issued, those proposed limits are not formal BACT/LAER precedents.)

The RBLC search revealed no permit with more stringent limits than that proposed for the EA Fairfield facility. PPRP identified no new MWC projects for which permits were recently issued, but are not yet reflected in the RBLC. However, three WTE projects currently in development were identified for which some information was available regarding proposed emissions limits. Those projects include a new WTE facility under development by EA in Puerto Rico, a new WTE facility under development in Frederick County, Maryland, and a WTE facility being re-developed in Harrisburg, Pennsylvania. The proposed LAER limit for the Frederick County project and the proposed BACT limit for the EA Puerto Rico project were the same as the LAER limit proposed for the EA Fairfield facility, 45 ppmdv @7% O_2, as the 24-hour daily arithmetic average of hourly concentrations. The BACT limit for NO_x proposed for the Harrisburg project was 135 ppmdv @7% O_2, as the 24-hour daily arithmetic average of hourly concentrations, which is less stringent than the LAER limit proposed for the EA Fairfield facility. The reference materials (i.e., RBLC listings, permits) reviewed by PPRP for this LAER analysis are included in Appendix D.

The combination of GCPs and RSCR is proposed for control of NO_x emissions from the Fairfield MWC units. GCPs are well demonstrated at MWC units nationally to prevent excessive NO_x generation. While SCR has been demonstrated on MWC units in Europe and Canada, the proposed application to the Fairfield MWC unit would be among the first in the U.S. SCR, including the proposed RSCR, is recognized to provide the most stringent level of control of flue gas NO_x emissions, including NO_x emissions from MWC units. The RSCR technology supplier anticipates NO_x emissions reductions from the Fairfield MWC units will exceed 80 percent. The emission limit proposed as LAER for each of the Fairfield MWC units is 45 ppmdv @ 7% O_2, as the 24-hour daily arithmetic average of hourly concentrations, with compliance to be demonstrated by means of a CEMS. This proposed limit is substantially more stringent than the emission standards imposed by the applicable NSPS for large MWC units (40 CFR 60, Subpart Eb) of 150 ppmdv @ 7% O_2, with 180 ppmdv allowed during first year of operation. The proposed limit is also more stringent than the limit imposed to date on any MWC unit in the U.S., and is as stringent as the most stringent limits proposed for MWC projects presently undergoing permitting review in the U.S. Accordingly, PPRP and MDE-ARMA concur that the proposed emission limit of 45 ppmdv @ 7% O_2, as the 24-hour daily arithmetic average of hourly concentrations, is LAER for NO_x, with compliance to be demonstrated by means of a CEMS. This LAER emission limit can be achieved through the application of emission controls consisting of the combination of RSCR and GCPs.

6.1.2.2 VOCs

6.1.2.2.1 LAER Evaluation for VOC Emissions from the MWC Units

A LAER analysis is required for emissions of VOC as a precursor to the nonattainment pollutant, ozone. As discussed below, emissions of VOCs are controlled by using good combustion design and operating practices, referred to as GCPs. VOC emissions can be further reduced by applying add-on controls.

Good Combustion Practices (GCP)

Emissions of VOCs result from the incomplete combustion of compounds containing carbon. The same factors related to poor combustion efficiency that create excessive emissions of CO are also responsible for excessive emissions of VOCs (i.e., insufficient oxygen and/or insufficient temperature during combustion of the fuel). As was explained previously, the best combustion efficiency, and hence the lowest VOC emission rates, results from higher combustion temperatures and greater amounts of combustion air (excess air). However, high temperatures and excess air levels also have the undesirable attribute of promoting the formation of excessive NO_x emissions. Accordingly, the combustion design and operating practices for a MWC unit must be optimized to enable the lowest possible emissions of CO and VOCs, without creating excessive emissions of NO_x. The specific design and operating factors required to optimize emissions of CO, NO_x, and also VOCs are referred to

Appendix B – Baltimore City Council Resolution

Introduced by: Councilmembers Reisinger and Clarke, Henry, Pinkett, Costello, Young, Cohen, Middleton, Stokes, Dorsey, Burnett, Sneed, Bullock

Prepared by: Department of Legislative Reference **Date:** July 11, 2017

Referred to: HOUSING AND URBAN AFFAIRS ____ Committee

Also referred for recommendation and report to municipal agencies listed on reverse.

CITY COUNCIL 17-0034R

A RESOLUTION ENTITLED

A COUNCIL RESOLUTION concerning

Request for State Action – Set a Strong Nitrogen Oxides Limit for the Wheelabrator Baltimore Incinerator

FOR the purpose of urging the Maryland Department of the Environment to set a nitrogen oxides pollution limit for the Wheelabrator Baltimore incinerator that is no higher than the 150 ppm standard on a 24-hour average that has been adopted by Connecticut and New Jersey and proposed in Massachusetts, or, if at all possible, significantly lower than 150 ppm in order to provide maximum air quality benefits to residents of Baltimore.

****The introduction of an Ordinance or Resolution by Councilmembers at the request of any person, firm or organization is a courtesy extended by the Councilmembers and not an indication of their position.**

Agencies

- [ ] Baltimore City Public School System
- [ ] Baltimore Development Corporation
- [x] City Solicitor
- [ ] Comptroller's Office
- [ ] Department of Audits
- [ ] Department of Finance
- [ ] Department of General Services
- [x] Department of Housing and Community Development
- [ ] Department of Human Resources
- [ ] Department of Planning
- [ ] Other:______________________
- [ ] Other:______________________
- [ ] Other:______________________
- [x] Department of Public Works
- [ ] Department of Real Estate
- [ ] Department of Recreation and Parks
- [ ] Department of Transportation
- [ ] Fire Department
- [x] Health Department
- [ ] Mayor's Office of Employment Development
- [ ] Mayor's Office of Human Services
- [ ] Mayor's Office of Information Technology
- [ ] Office of the Mayor
- [ ] Police Department
- [ ] Other:______________________
- [ ] Other:______________________

Boards and Commissions

- [ ] Board of Estimates
- [ ] Board of Ethics
- [ ] Board of Municipal and Zoning Appeals
- [ ] Comm. for Historical and Architectural Preservation
- [ ] Commission on Sustainability
- [ ] Employees' Retirement System
- [ ] Other:______________________
- [ ] Other:______________________
- [ ] Other:______________________
- [ ] Environmental Control Board
- [ ] Fire & Police Employees' Retirement System
- [ ] Labor Commissioner
- [ ] Parking Authority Board
- [ ] Planning Commission
- [ ] Wage Commission
- [ ] Other:______________________
- [ ] Other:______________________
- [ ] Other:______________________

CITY OF BALTIMORE
COUNCIL BILL 17-0034R
(Resolution)

Introduced by: Councilmembers Reisinger, Clarke, Henry, Pinkett, Scott, Costello, President Young, Councilmembers Cohen, Middleton, Stokes, Dorsey, Burnett, Sneed, Bullock
Introduced and read first time: July 17, 2017
Assigned to: Housing and Urban Affairs Committee

Committee Report: Favorable with amendments
Adopted: October 16, 2017

A COUNCIL RESOLUTION CONCERNING

Request for State Action – Set a Strong Nitrogen Oxides Limit for the Wheelabrator Baltimore Incinerator

FOR the purpose of urging the Maryland Department of the Environment to set a nitrogen oxides pollution limit for the Wheelabrator Baltimore incinerator that is no higher than the 150 ppm standard on a 24-hour average that has been adopted by Connecticut and New Jersey and proposed in Massachusetts, or, if at all possible, significantly lower than 150 ppm in order to provide maximum air quality benefits to residents of Baltimore.

Recitals

Emissions of nitrogen oxides (NOx) contribute to the formation of three pollutants in the ambient (outdoor) air: ground-level ozone, nitrogen dioxide, and fine particulate matter. Each of these pollutants can have adverse effects on human health, including worsening symptoms of asthma in people who already have the condition. Baltimore City has substantially higher rates of asthma hospitalizations and emergency room visits due to asthma than the rest of the State of Maryland.

The Baltimore area, which includes Baltimore City and five additional counties, is designated as a nonattainment area for ground-level ozone by the U.S. EPA, meaning that the area does not meet federal air quality standards for ozone. NOx is the primary pollutant that contributes to the formation of ground-level ozone.

Many factors contribute to Baltimore's ozone problem, including pollution from power plants located in other states. Locally, the municipal solid waste incinerator operated by Wheelebrator Baltimore, L.P. and located in South Baltimore is a major source of NOx emissions.

In 2015, the Baltimore incinerator emitted 1,123 tons of NOx, making it the sixth largest emitter of NOx in the State of Maryland that year. The Baltimore incinerator also emitted more NOx per unit of energy generated in 2015 than any other large power plant in Maryland.

EXPLANATION: Underlining indicates matter added by amendment.
~~Strike out~~ indicates matter stricken by amendment.

The Maryland Department of the Environment is in the process of developing regulations that will establish new NOx emission limits for Maryland's two municipal solid waste incinerators, including the Wheelabrator incinerator in Baltimore. These regulations are part of an air quality plan that Maryland must submit to the EPA under the federal Clean Air Act to show that the state is making progress toward attaining federal ozone standards.

The new NOx limits established under this rulemaking must, at minimum, meet a standard called Reasonably Available Control Technology ("RACT"). The RACT standard is defined as "the lowest emissions limit that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility."

MDE may not set NOx emission limits that are weaker and less health-protective than the RACT standard. However, MDE has the authority to set NOx emission limits that are stronger and more protective of health than the RACT standard.

Short-term emission limits for incinerators are expressed in parts per million by volume dry at 7% oxygen (hereinafter "ppm"). The limit is frequently assessed based on a 24-hour average. A NOx limit of 150 ppm on a 24-hour basis has been adopted as the RACT standard for municipal solid waste incinerators by the states of Connecticut and New Jersey and has been proposed for adoption in Massachusetts. New Jersey allows facility operators to seek an exception in the form of an alternate limit.

Around 2009, the operator of Maryland's second municipal solid waste incinerator, the Montgomery County Resource Recovery Facility ("MCRRF"), voluntarily installed new NOx pollution controls on that incinerator that reduced its NOx emissions by about half. From 2013 through 2015, MCRRF's annual average NOx emissions were about 85 to 89 ppm on a 24-hour basis.

The Wheelabrator Baltimore's annual average NOx emissions from 2013 through 2015 were 162 to169 ppm on a 24-hour basis. Its current NOx emissions limit is 205 ppm. Wheelabrator Baltimore, L.P. has proposed that Maryland set a new NOx emissions limit of 170 ppm for the Baltimore incinerator. According to the most recent calculations by the Maryland Department of the Environment, this would reduce annual NOx emissions from the Baltimore incinerator by 60 tons per year.

<u>The Council requests that the Maryland Department of the Environment use its legal authority to go beyond the RACT standard in order to set a nitrogen oxides limit of 45 ppm on a 24-hour basis, which is the limit that would likely be set for a new incinerator.</u>

The Baltimore incinerator receives financial benefits because it is treated as a Tier 1 source of renewable energy under Maryland's Renewable Portfolio Standard. Under this program, Marylanders are supposed to reap benefits from renewable energy resources that include long-term decreased emissions and a healthier environment.

NOW, THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL OF BALTIMORE, That the Council urges the Maryland Department of the Environment to set a nitrogen oxides pollution limit for the Wheelabrator Baltimore incinerator that is no higher than the 150 ppm standard on a 24-hour average that has been adopted by Connecticut and New Jersey and proposed in

Massachusetts, or, if at all possible, significantly lower than 150 ppm in order to provide maximum air quality benefits to residents of Baltimore.

AND BE IT FURTHER RESOLVED, That a copy of this Resolution be sent to the Governor, the Secretary of the Maryland Department of the Environment, the Director of the Air and Radiation Management Administration, the Division Chief of the Air Quality Regulations Division, the Mayor, and the Mayor's Legislative Liaison to the City Council.

AMENDMENTS TO COUNCIL BILL 17-0034R
(1st Reader Copy)

By: The Housing and Urban Affairs Committee
{To be offered on the Council Floor}

Amendment No. 1

On page 2, after line 27, insert:

"The Council requests that the Maryland Department of the Environment use its legal authority to go beyond the RACT standard in order to set a nitrogen oxides limit of 45 ppm on a 24-hour basis, which is the limit that would likely be set for a new incinerator.".

ADOPTED

BALTIMORE CITY COUNCIL
Housing And Urban Affairs Committee
VOTING RECORD

DATE: 9-28-17

BILL#CC: 17- 0034R BILL TITLE: Resolution – Request for State Action – Set a Strong Nitrogen Oxides Limit for the Wheelabrator Baltimore Incinerator

MOTION BY: Henry **SECONDED BY:** Dorsey

☐ **FAVORABLE** ☒ **FAVORABLE WITH AMENDMENTS**

☐ **UNFAVORABLE** ☐ **WITHOUT RECOMMENDATION**

NAME	YEAS	NAYS	ABSENT	ABSTAIN
Bullock, J. Chair	☒	☐	☐	☐
Schleifer, I. Vice Chair	☒	☐	☐	☐
Burnett, K.	☒	☐	☐	☐
Henry, B.	☒	☐	☐	☐
Sneed ,S.	☒	☐	☐	☐
Cohen, Z	☒	☐	☐	☐
Dorsey, R.	☒	☐	☐	☐
*	☐	☐	☐	☐
*	☐	☐	☐	☐
*	☐	☐	☐	☐
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TOTALS	7	0		

CHAIRPERSON: [signature]

COMMITTEE STAFF: Richard G. Krummerich, Initials: RK

The Baltimore City Department of
HOUSING & COMMUNITY
DEVELOPMENT

MEMORANDUM

To: The Honorable President and Members of the Baltimore City Council
c/o Natawna Austin, Executive Secretary

From: Michael Braverman, Housing Commissioner MB

Date: September 21, 2017

Re: **City Council Bill 17-0034R - for Request for State Action – Set a Strong Nitrogen Oxides Limit for the Wheelabrator Baltimore Incinerator**

The Department of Housing and Community Development (HCD) has reviewed City Council Bill 17-0034R, for the purpose of urging the Maryland Department of the Environment to set a nitrogen oxides pollution limit for the Wheelabrator Baltimore incinerator that is no higher than the 150 ppm standard on a 24-hour average that has been adopted by Connecticut and New Jersey and proposed in Massachusetts, or, if at all possible, significantly lower than 150 ppm in order to provide maximum air quality benefits to residents of Baltimore.

If enacted, the City would request that the Maryland Department of the Environment set pollution limits on nitrogen oxides from the Baltimore incinerator to assist with improving air quality.

The Department of Housing and Community Development supports the passage of City Council Bill 17-0034R.

MB:sd

cc: Ms. Karen Stokes, *Mayor's Office of Government Relations*
Mr. Kyron Banks, *Mayor's Office of Government Relations*

RECEIVED
SEP 25 2017
BALTIMORE CITY COUNCIL
PRESIDENT'S OFFICE

F R O M	Name & Title	Dr. Leana Wen	Health Department	
	Agency Name & Address	Health Department 1001 E. Fayette Street Baltimore, Maryland 21201	MEMO	
	Subject	17-0034R – Request for State Action – Set a Strong Nitrogen Oxides Limit for the Wheelabrator Baltimore Incinerator		

To: President and Members
of the City Council
c/o 409 City Hall

Sept. 21, 2017

The Baltimore City Health Department (BCHD) is pleased to have the opportunity to review 17-0034R – Request for State Action – Set a Strong Nitrogen Oxides Limit for the Wheelabrator Baltimore Incinerator. The purpose of this resolution is to call upon the Maryland Department of the Environment (MDE) to set stronger limits for the emissions of nitrogen oxide (NO2) for the Wheelabrator.

The resolution will not impact BCHD operations, as BCHD does not enforce the standards being recommended for reduction. The positive impact of MDE reducing allowable NO2 emissions for those living in the immediate area is difficult to measure. However, the Environmental Protection Agency's (EPA) recent Integrated Science Assessment (ISA) for Oxides of Nitrogen – Health Criteria (Final Report, 2016) serves to strengthen the cumulative body of evidence that indicates that short-term exposure to NO2 can cause respiratory effects. In particular, these effects are related to asthma exacerbation, a disease that impacts Baltimore's children disproportionately.

Baltimore City suffers from high rates of asthma. The state Department of Health and Mental Hygiene reports 12.4% of Baltimore City adults have asthma, four points higher than the statewide average. Moreover, 1 in 5 children under the age of 18 in Baltimore City suffer from asthma, double the national average. These high rates lead to large losses of productivity through missed school and work days. Reduced air pollution realized through a Zero Waste plan could help the city lower its asthma rates.

BCHD appreciates the opportunity to review issues connected to NO2 emissions at this informational hearings, and to provide information on the potential health benefits of lower emissions.

Leana S. Wen, M.D., M.Sc.
Commissioner of Health
Baltimore City

RECEIVED
SEP 22 2017
BALTIMORE CITY COUNCIL
PRESIDENT'S OFFICE

comments

CITY OF BALTIMORE

CATHERINE E. PUGH, Mayor

DEPARTMENT OF LAW

101 City Hall
Baltimore, Maryland 21202

July 27, 2017

The Honorable President and Members
of the Baltimore City Council
Attn: Executive Secretary
Room 409, City Hall
100 N. Holliday Street
Baltimore, Maryland 21202

Re: City Council Bill 17-0034R – Request for State Action – Set a Strong Nitrogen Oxides Limit for the Wheelabrator Baltimore Incinerator

Dear President and City Council Members:

The Law Department has reviewed City Council Bill 17-0034R for form and legal sufficiency. This resolution calls on the Maryland Department of the Environment to set certain limits for Nitrogen Oxides at the Baltimore Incinerator.

A resolution is an appropriate way for the City Council of Baltimore to request action from a state agency. *See, e.g., Inlet Assocs. v. Assateague House Condominium,* 313 Md. 413, 428 (1988). Therefore, the Law Department approves this Resolution for form and legal sufficiency.

Very truly yours,

Hilary Ruley
Chief Solicitor

cc: David E. Ralph, Acting City Solicitor
Karen Stokes, Director, Mayor's Office of Government Relations
Kyron Banks, Mayor's Legislative Liaison
Elena DiPietro, Chief Solicitor, General Counsel Division
Victor Tervala, Chief Solicitor
Jennifer Landis, Assistant Solicitor

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JUL 28 2017
BALTIMORE CITY COUNCIL
PRESIDENT'S OFFICE

F

CITY OF BALTIMORE

CATHERINE E. PUGH, Mayor

OFFICE OF COUNCIL SERVICES

LARRY E. GREENE, Director
415 City Hall, 100 N. Holliday Street
Baltimore, Maryland 21202
410-396-7215 / Fax: 410-545-7596
email: larry.greene@baltimorecity.gov

HEARING NOTES

City Council Resolution: CC–17-0034R

Request for State Action - Set a Strong Nitrogen Oxide Limit for the Wheelabrator Baltimore Incinerator

Committee: Housing and Urban Affairs
Chaired By: Councilmember John Bullock

Hearing Date: September 28, 2017
Time (Beginning): 2:15 PM
Time (Ending): 4:20 PM
Location: Clarence "Du" Burns Chamber
Total Attendance: 70
Committee Members in Attendance:
John Bullock Zeke Cohen
Isaac "Yitzy" Schleifer Ryan Dorsey
Kristerfer Burnett
Bill Henry
Sharon Sneed

Bill Synopsis in the file?	☒ yes	☐ no	☐ n/a
Attendance sheet in the file?	☒ yes	☐ no	☐ n/a
Agency reports read?	☒ yes	☐ no	☐ n/a
Hearing televised or audio-digitally recorded?	☐ yes	☐ no	☒ n/a
Certification of advertising/posting notices in the file?	☐ yes	☐ no	☒ n/a
Evidence of notification to property owners?	☐ yes	☐ no	☒ n/a
Final vote taken at this hearing?	☒ yes	☐ no	☐ n/a

Motioned by: .... **Councilmember** Henry
Seconded by: .... **Councilmember** Dorsey
Final Vote: .... **Fav. with Amendments**

Major Speakers

(This <u>is not</u> an attendance record.)

- Marcia Collins -Department of Public Works
- Gwen DuBois - Physicians for Social Responsibility
- Michael Dougherty - Wheelabrator

Major Issues Discussed

1. Chair Bullock continued the 2:00 PM Hearing

2. Environmental activists believe that the Wheelabrator Incinerator is harmful to public health of Baltimore, and want the State of Maryland to enforce much stricter standards on emissions.

3. Representatives from Wheelabrator testified that the Company is constantly improving its operation and is voluntarily adopting stricter emission standards.

4. The Resolution was amended and adopted on a 7-0 vote

Further Study

Was further study requested? ☐ **Yes** ☒ **No**

If yes, describe.

Committee Vote:

J. Bullock:.. **Yea**
I. Schleifer: .... **Yea**
K. Burnett: .... **Yea**
B. Henry: .... **Yea**
S. Sneed:.. **Yea**
Z. Cohen:... **Yea**
R. Dorsey:.. **Yea**
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Richard G. Krummerich, Committee Staff Date: 9-29-17
cc: Bill File
OCS Chrono File

CITY OF BALTI

CITY COUNCIL HEARING AT

Committee: * Housing and Urban Affairs	
Date: September 28, 2017	Time:2:15 PM
Subject: * - Resolution – Request for State Action – Set a Strong Nitrogen Ox Incinerator	

PLEASE PRINT

IF YOU WANT TO TESTIFY PLEA

FIRST NAME	LAST NAME	ST. #	ADDRESS/ORGANIZATION N
John	Doe	100	North Charles Street
Gwen	DuBois		Physicians for Soc Res
Dante ~~Swinton~~	Swinton		Energy Justice Net
Rodette ~~Jones~~	Jones		United Workers
Taylor	Smith-Hams		Chesapeake Climate A N
Jennifer	Kunze		Clean Water Act
Kevin	Kriescher		Sierra Club
Andy	Hinz	4427 Ave	Citizen
Neil	Seldman		Inst for Local Se
Michael	Dougherty		Wheelabrator
Maria	Collins		3920

CITY OF BALTIMORE
CATHERINE E. PUGH, Mayor

OFFICE OF COUNCIL SERVICES
LARRY E. GREENE, Director
415 City Hall, 100 N. Holliday Street
Baltimore, Maryland 21202
410-396-7215 / Fax: 410-545-7596
email: larry.greene@baltimorecity.gov

BILL SYNOPSIS

Committee: Housing and Urban Affairs

City Council Resolution CC 17-0034R

Request for State Action – Set a Strong Nitrogen Oxides Limit for the Wheelabrator Baltimore Incinerator

Sponsor: *Councilmember Reisinger, et al*
Introduced: *July 17, 2017*

Purpose:

For the purpose of urging the Maryland Department of the Environment to set a nitrogen oxides pollution limit for the Wheelabrator Baltimore incinerator that is no higher than the 150 ppm standard on a 24 hour average that has been adopted by Connecticut and New Jersey and proposed in Massachusetts, or, if at all possible, significantly lower than 150 ppm in order to provide maximum air quality benefits to residents of Baltimore.

Effective: Upon enactment

Hearing Date/Time/Location: September 28, 2017 at 2:15 PM in the Council Chambers

Agency Reports

Department of Law	Favorable
Health Department	Comments
Department of Housing and Community Development	Favorable
Department of Public Works	

Analysis

Current Law

None

Background

The Wheelabrator Incinerator is located at 1801 Annapolis Road in the Westport neighborhood in the Southern Portion of Baltimore City. It was constructed in 1985 and has been operated by several owners. It has a primary function of converting trash to energy.

The facility produces nitrogen oxides (NOx) which are considered by many authorities to be a major health hazard.

State Regulations limit NOx emissions to 205 Parts per million (ppm). In inspections between 2013 and 2015 the facility showed emissions 162-169 ppm. Recent literature suggests this is an unhealthy level.

CC 17-0034R calls on The Maryland Department of the Environment to set a limit on NOx emissions at no more than 150 ppm.

Additional Information

Fiscal Note: Not Available

Information Source(s): Bill File

Analysis by: Richard G. Krummerich Direct Inquiries to: 410-396-1266
Analysis Date: 9-26-17

CITY OF BALTIMORE
COUNCIL BILL 17-0034R
(Resolution)

Introduced by: Councilmembers Reisinger, Clarke, Henry, Pinkett, Scott, Costello, President Young, Councilmembers Cohen, Middleton, Stokes, Dorsey, Burnett, Sneed, Bullock
Introduced and read first time: July 17, 2017
Assigned to: Housing and Urban Affairs Committee

REFERRED TO THE FOLLOWING AGENCIES: City Solicitor, Department of Housing and Community Development, Department of Public Works, Health Department

A RESOLUTION ENTITLED

A COUNCIL RESOLUTION concerning

Request for State Action – Set a Strong Nitrogen Oxides Limit for the Wheelabrator Baltimore Incinerator

FOR the purpose of urging the Maryland Department of the Environment to set a nitrogen oxides pollution limit for the Wheelabrator Baltimore incinerator that is no higher than the 150 ppm standard on a 24-hour average that has been adopted by Connecticut and New Jersey and proposed in Massachusetts, or, if at all possible, significantly lower than 150 ppm in order to provide maximum air quality benefits to residents of Baltimore.

Recitals

Emissions of nitrogen oxides (NOx) contribute to the formation of three pollutants in the ambient (outdoor) air: ground-level ozone, nitrogen dioxide, and fine particulate matter. Each of these pollutants can have adverse effects on human health, including worsening symptoms of asthma in people who already have the condition. Baltimore City has substantially higher rates of asthma hospitalizations and emergency room visits due to asthma than the rest of the State of Maryland.

The Baltimore area, which includes Baltimore City and five additional counties, is designated as a nonattainment area for ground-level ozone by the U.S. EPA, meaning that the area does not meet federal air quality standards for ozone. NOx is the primary pollutant that contributes to the formation of ground-level ozone.

Many factors contribute to Baltimore's ozone problem, including pollution from power plants located in other states. Locally, the municipal solid waste incinerator operated by Wheelebrator Baltimore, L.P. and located in South Baltimore is a major source of NOx emissions.

In 2015, the Baltimore incinerator emitted 1,123 tons of NOx, making it the sixth largest emitter of NOx in the State of Maryland that year. The Baltimore incinerator also emitted more NOx per unit of energy generated in 2015 than any other large power plant in Maryland.

The Maryland Department of the Environment is in the process of developing regulations that will establish new NOx emission limits for Maryland's two municipal solid waste incinerators, including the Wheelabrator incinerator in Baltimore. These regulations are part of an air quality

EXPLANATION: Underlining indicates matter added by amendment.
~~Strike out~~ indicates matter deleted by amendment.

plan that Maryland must submit to the EPA under the federal Clean Air Act to show that the state is making progress toward attaining federal ozone standards.

The new NOx limits established under this rulemaking must, at minimum, meet a standard called Reasonably Available Control Technology ("RACT"). The RACT standard is defined as "the lowest emissions limit that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility."

MDE may not set NOx emission limits that are weaker and less health-protective than the RACT standard. However, MDE has the authority to set NOx emission limits that are stronger and more protective of health than the RACT standard.

Short-term emission limits for incinerators are expressed in parts per million by volume dry at 7% oxygen (hereinafter "ppm"). The limit is frequently assessed based on a 24-hour average. A NOx limit of 150 ppm on a 24-hour basis has been adopted as the RACT standard for municipal solid waste incinerators by the states of Connecticut and New Jersey and has been proposed for adoption in Massachusetts. New Jersey allows facility operators to seek an exception in the form of an alternate limit.

Around 2009, the operator of Maryland's second municipal solid waste incinerator, the Montgomery County Resource Recovery Facility ("MCRRF"), voluntarily installed new NOx pollution controls on that incinerator that reduced its NOx emissions by about half. From 2013 through 2015, MCRRF's annual average NOx emissions were about 85 to 89 ppm on a 24-hour basis.

The Wheelabrator Baltimore's annual average NOx emissions from 2013 through 2015 were 162 to169 ppm on a 24-hour basis. Its current NOx emissions limit is 205 ppm. Wheelabrator Baltimore, L.P. has proposed that Maryland set a new NOx emissions limit of 170 ppm for the Baltimore incinerator. According to the most recent calculations by the Maryland Department of the Environment, this would reduce annual NOx emissions from the Baltimore incinerator by 60 tons per year.

The Baltimore incinerator receives financial benefits because it is treated as a Tier 1 source of renewable energy under Maryland's Renewable Portfolio Standard. Under this program, Marylanders are supposed to reap benefits from renewable energy resources that include long-term decreased emissions and a healthier environment.

NOW, THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL OF BALTIMORE, That the Council urges the Maryland Department of the Environment to set a nitrogen oxides pollution limit for the Wheelabrator Baltimore incinerator that is no higher than the 150 ppm standard on a 24-hour average that has been adopted by Connecticut and New Jersey and proposed in Massachusetts, or, if at all possible, significantly lower than 150 ppm in order to provide maximum air quality benefits to residents of Baltimore.

AND BE IT FURTHER RESOLVED, That a copy of this Resolution be sent to the Governor, the Secretary of the Maryland Department of the Environment, the Director of the Air and Radiation Management Administration, the Division Chief of the Air Quality Regulations Division, the Mayor, and the Mayor's Legislative Liaison to the City Council.

INTRODUCTORY*

CITY OF BALTIMORE
COUNCIL BILL ____R
(Resolution)

Introduced by: Councilmembers Reisinger and Clarke

A RESOLUTION ENTITLED

A COUNCIL RESOLUTION concerning

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AND BE IT FURTHER RESOLVED, That a copy of this Resolution be sent to the Governor, the Secretary of the Maryland Department of the Environment, the Director of the Air and Radiation Management Administration, the Division Chief of the Air Quality Regulations Division, the Mayor, and the Mayor's Legislative Liaison to the City Council.

ACTION BY THE CITY COUNCIL

JUL 17 2017

FIRST READING (INTRODUCTION) ______________________ 20 ____

PUBLIC HEARING HELD ON 9-28 ______________________ 20 17

COMMITTEE REPORT AS OF 10-16 ______________________ 20 17

____ FAVORABLE ____ UNFAVORABLE __X__ FAVORABLE AS AMENDED ____ WITHOUT RECOMMENDATION

[signature] ______________________ Chair

COMMITTEE MEMBERS: ______________________

COMMITTEE MEMBERS: ______________________

SECOND READING: The Council's action being favorable (unfavorable), this City Council bill was (was not) ordered printed for Third Reading on:

OCT 16 2017 ______________________ 20 ____

__✓__ Amendments were read and adopted (defeated) as indicated on the copy attached to this blue backing.

THIRD READING ______________________ 20 ____

____ Amendments were read and adopted (defeated) as indicated on the copy attached to this blue backing.

THIRD READING (ENROLLED) ______________________ 20 ____

____ Amendments were read and adopted (defeated) as indicated on the copy attached to this blue backing.

THIRD READING (RE-ENROLLED) ______________________ 20 ____

WITHDRAWAL ______________________ 20 ____

There being no objections to the request for withdrawal, it was so ordered that this City Council Ordinance be withdrawn from the files of the City Council.

______________________ President

______________________ Chief Clerk

1050-10-2

City of Baltimore
Council Bill 17-0034R
(Resolution)

Introduced by: Councilmembers Reisinger, Clarke, Henry, Pinkett, Scott, Costello, President Young, Councilmembers Cohen, Middleton, Stokes, Dorsey, Burnett, Sneed, Bullock
Introduced and read first time: July 17, 2017
Assigned to: Housing and Urban Affairs Committee

Committee Report: Favorable with amendments
Adopted: October 16, 2017

A Council Resolution Concerning

Request for State Action – Set a Strong Nitrogen Oxides Limit for the Wheelabrator Baltimore Incinerator

FOR the purpose of urging the Maryland Department of the Environment to set a nitrogen oxides pollution limit for the Wheelabrator Baltimore incinerator that is no higher than the 150 ppm standard on a 24-hour average that has been adopted by Connecticut and New Jersey and proposed in Massachusetts, or, if at all possible, significantly lower than 150 ppm in order to provide maximum air quality benefits to residents of Baltimore.

Recitals

Emissions of nitrogen oxides (NOx) contribute to the formation of three pollutants in the ambient (outdoor) air: ground-level ozone, nitrogen dioxide, and fine particulate matter. Each of these pollutants can have adverse effects on human health, including worsening symptoms of asthma in people who already have the condition. Baltimore City has substantially higher rates of asthma hospitalizations and emergency room visits due to asthma than the rest of the State of Maryland.

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Many factors contribute to Baltimore's ozone problem, including pollution from power plants located in other states. Locally, the municipal solid waste incinerator operated by Wheelabrator Baltimore, L.P. and located in South Baltimore is a major source of NOx emissions.

In 2015, the Baltimore incinerator emitted 1,123 tons of NOx, making it the sixth largest emitter of NOx in the State of Maryland that year. The Baltimore incinerator also emitted more NOx per unit of energy generated in 2015 than any other large power plant in Maryland.

EXPLANATION: Underlining indicates matter added by amendment.
~~Strike out~~ indicates matter stricken by amendment.

The Maryland Department of the Environment is in the process of developing regulations that will establish new NOx emission limits for Maryland's two municipal solid waste incinerators, including the Wheelabrator incinerator in Baltimore. These regulations are part of an air quality plan that Maryland must submit to the EPA under the federal Clean Air Act to show that the state is making progress toward attaining federal ozone standards.

The new NOx limits established under this rulemaking must, at minimum, meet a standard called Reasonably Available Control Technology ("RACT"). The RACT standard is defined as "the lowest emissions limit that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility."

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The Council requests that the Maryland Department of the Environment use its legal authority to go beyond the RACT standard in order to set a nitrogen oxides limit of 45 ppm on a 24-hour basis, which is the limit that would likely be set for a new incinerator.

The Baltimore incinerator receives financial benefits because it is treated as a Tier 1 source of renewable energy under Maryland's Renewable Portfolio Standard. Under this program, Marylanders are supposed to reap benefits from renewable energy resources that include long-term decreased emissions and a healthier environment.

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AND BE IT FURTHER RESOLVED, That a copy of this Resolution be sent to the Governor, the Secretary of the Maryland Department of the Environment, the Director of the Air and Radiation Management Administration, the Division Chief of the Air Quality Regulations Division, the Mayor, and the Mayor's Legislative Liaison to the City Council.

City of Baltimore
Council Bill 17-0034R
(Resolution)

Introduced by: Councilmembers Reisinger, Clarke, Henry, Pinkett, Scott, Costello, President Young, Councilmembers Cohen, Middleton, Stokes, Dorsey, Burnett, Sneed, Bullock
Introduced and read first time: July 17, 2017
Assigned to: Housing and Urban Affairs Committee

REFERRED TO THE FOLLOWING AGENCIES: City Solicitor, Department of Housing and Community Development, Department of Public Works, Health Department

A Resolution Entitled

A Council Resolution concerning

Request for State Action – Set a Strong Nitrogen Oxides Limit for the Wheelabrator Baltimore Incinerator

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plan that Maryland must submit to the EPA under the federal Clean Air Act to show that the state is making progress toward attaining federal ozone standards.

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AND BE IT FURTHER RESOLVED, That a copy of this Resolution be sent to the Governor, the Secretary of the Maryland Department of the Environment, the Director of the Air and Radiation Management Administration, the Division Chief of the Air Quality Regulations Division, the Mayor, and the Mayor's Legislative Liaison to the City Council.

The Baltimore City Department of
HOUSING & COMMUNITY
DEVELOPMENT

MEMORANDUM

To: The Honorable President and Members of the Baltimore City Council
c/o Natawna Austin, Executive Secretary

From: Michael Braverman, Housing Commissioner

Date: September 21, 2017

Re: **City Council Bill 17-0034R - for Request for State Action – Set a Strong Nitrogen Oxides Limit for the Wheelabrator Baltimore Incinerator**

The Department of Housing and Community Development (HCD) has reviewed City Council Bill 17-0034R, for the purpose of urging the Maryland Department of the Environment to set a nitrogen oxides pollution limit for the Wheelabrator Baltimore incinerator that is no higher than the 150 ppm standard on a 24-hour average that has been adopted by Connecticut and New Jersey and proposed in Massachusetts, or, if at all possible, significantly lower than 150 ppm in order to provide maximum air quality benefits to residents of Baltimore.

If enacted, the City would request that the Maryland Department of the Environment set pollution limits on nitrogen oxides from the Baltimore incinerator to assist with improving air quality.

The Department of Housing and Community Development supports the passage of City Council Bill 17-0034R.

MB:sd

cc: Ms. Karen Stokes, *Mayor's Office of Government Relations*
Mr. Kyron Banks, *Mayor's Office of Government Relations*

RECEIVED
SEP 25 2017
BALTIMORE CITY COUNCIL
PRESIDENT'S OFFICE

F R O M	Name & Title	Dr. Leana Wen	Health Department MEMO	
	Agency Name & Address	Health Department 1001 E. Fayette Street Baltimore, Maryland 21201		HEALTH DEPARTMENT BALTIMORE MARYLAND
	Subject	17-0034R – Request for State Action – Set a Strong Nitrogen Oxides Limit for the Wheelabrator Baltimore Incinerator		

To: President and Members
of the City Council
c/o 409 City Hall

Sept. 21, 2017

The Baltimore City Health Department (BCHD) is pleased to have the opportunity to review 17-0034R – Request for State Action – Set a Strong Nitrogen Oxides Limit for the Wheelabrator Baltimore Incinerator. The purpose of this resolution is to call upon the Maryland Department of the Environment (MDE) to set stronger limits for the emissions of nitrogen oxide (NO2) for the Wheelabrator.

The resolution will not impact BCHD operations, as BCHD does not enforce the standards being recommended for reduction. The positive impact of MDE reducing allowable NO2 emissions for those living in the immediate area is difficult to measure. However, the Environmental Protection Agency's (EPA) recent Integrated Science Assessment (ISA) for Oxides of Nitrogen – Health Criteria (Final Report, 2016) serves to strengthen the cumulative body of evidence that indicates that short-term exposure to NO2 can cause respiratory effects. In particular, these effects are related to asthma exacerbation, a disease that impacts Baltimore's children disproportionately.

Baltimore City suffers from high rates of asthma. The state Department of Health and Mental Hygiene reports 12.4% of Baltimore City adults have asthma, four points higher than the statewide average. Moreover, 1 in 5 children under the age of 18 in Baltimore City suffer from asthma, double the national average. These high rates lead to large losses of productivity through missed school and work days. Reduced air pollution realized through a Zero Waste plan could help the city lower its asthma rates.

BCHD appreciates the opportunity to review issues connected to NO2 emissions at this informational hearings, and to provide information on the potential health benefits of lower emissions.

Leana S. Wen, M.D., M.Sc.
Commissioner of Health
Baltimore City

RECEIVED
SEP 22 2017
BALTIMORE CITY COUNCIL
PRESIDENT'S OFFICE

comments

CITY OF BALTIMORE
CATHERINE E. PUGH, Mayor

DEPARTMENT OF LAW
101 City Hall
Baltimore, Maryland 21202

July 27, 2017

The Honorable President and Members
of the Baltimore City Council
Attn: Executive Secretary
Room 409, City Hall
100 N. Holliday Street
Baltimore, Maryland 21202

Re: City Council Bill 17-0034R – Request for State Action – Set a Strong Nitrogen Oxides Limit for the Wheelabrator Baltimore Incinerator

Dear President and City Council Members:

The Law Department has reviewed City Council Bill 17-0034R for form and legal sufficiency. This resolution calls on the Maryland Department of the Environment to set certain limits for Nitrogen Oxides at the Baltimore Incinerator.

A resolution is an appropriate way for the City Council of Baltimore to request action from a state agency. *See, e.g., Inlet Assocs. v. Assateague House Condominium*, 313 Md. 413, 428 (1988). Therefore, the Law Department approves this Resolution for form and legal sufficiency.

Very truly yours,

Hilary Ruley
Chief Solicitor

cc: David E. Ralph, Acting City Solicitor
Karen Stokes, Director, Mayor's Office of Government Relations
Kyron Banks, Mayor's Legislative Liaison
Elena DiPietro, Chief Solicitor, General Counsel Division
Victor Tervala, Chief Solicitor
Jennifer Landis, Assistant Solicitor

F

RECEIVED
JUL 28 2017
BALTIMORE CITY COUNCIL
PRESIDENT'S OFFICE

INTRODUCTORY*

CITY OF BALTIMORE
COUNCIL BILL ____R
(Resolution)

17-0034R

APPROVED FOR FORM STYLE, AND TEXTUAL SUFFICIENCY
TW 7.11.17
DEP'T LEGISLATIVE REFERENCE

Introduced by: Councilmembers Reisinger and Clarke

A RESOLUTION ENTITLED

A COUNCIL RESOLUTION concerning

Request for State Action – Set a Strong Nitrogen Oxides Limit for the Wheelabrator Baltimore Incinerator

HUA
Law
Health
HCD
DPW

FOR the purpose of urging the Maryland Department of the Environment to set a nitrogen oxides pollution limit for the Wheelabrator Baltimore incinerator that is no higher than the 150 ppm standard on a 24-hour average that has been adopted by Connecticut and New Jersey and proposed in Massachusetts, or, if at all possible, significantly lower than 150 ppm in order to provide maximum air quality benefits to residents of Baltimore.

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* WARNING: THIS IS AN UNOFFICIAL, INTRODUCTORY COPY OF THE BILL.
THE OFFICIAL COPY CONSIDERED BY THE CITY COUNCIL IS THE FIRST READER COPY.

dlr17-0103(3)~intro/11Jul17
ccres/RSANOx/lk:tw

The new NOx limits established under this rulemaking must, at minimum, meet a standard called Reasonably Available Control Technology ("RACT"). The RACT standard is defined as "the lowest emissions limit that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility."

MDE may not set NOx emission limits that are weaker and less health-protective than the RACT standard. However, MDE has the authority to set NOx emission limits that are stronger and more protective of health than the RACT standard.

Short-term emission limits for incinerators are expressed in parts per million by volume dry at 7% oxygen (hereinafter "ppm"). The limit is frequently assessed based on a 24-hour average. A NOx limit of 150 ppm on a 24-hour basis has been adopted as the RACT standard for municipal solid waste incinerators by the states of Connecticut and New Jersey and has been proposed for adoption in Massachusetts. New Jersey allows facility operators to seek an exception in the form of an alternate limit.

Around 2009, the operator of Maryland's second municipal solid waste incinerator, the Montgomery County Resource Recovery Facility ("MCRRF"), voluntarily installed new NOx pollution controls on that incinerator that reduced its NOx emissions by about half. From 2013 through 2015, MCRRF's annual average NOx emissions were about 85 to 89 ppm on a 24-hour basis.

The Wheelabrator Baltimore's annual average NOx emissions from 2013 through 2015 were 162 to169 ppm on a 24-hour basis. Its current NOx emissions limit is 205 ppm. Wheelabrator Baltimore, L.P. has proposed that Maryland set a new NOx emissions limit of 170 ppm for the Baltimore incinerator. According to the most recent calculations by the Maryland Department of the Environment, this would reduce annual NOx emissions from the Baltimore incinerator by 60 tons per year.

The Baltimore incinerator receives financial benefits because it is treated as a Tier 1 source of renewable energy under Maryland's Renewable Portfolio Standard. Under this program, Marylanders are supposed to reap benefits from renewable energy resources that include long-term decreased emissions and a healthier environment.

NOW, THEREFORE, BE IT RESOLVED BY THE CITY COUNCIL OF BALTIMORE, That the Council urges the Maryland Department of the Environment to set a nitrogen oxides pollution limit for the Wheelabrator Baltimore incinerator that is no higher than the 150 ppm standard on a 24-hour average that has been adopted by Connecticut and New Jersey and proposed in Massachusetts, or, if at all possible, significantly lower than 150 ppm in order to provide maximum air quality benefits to residents of Baltimore.

AND BE IT FURTHER RESOLVED, That a copy of this Resolution be sent to the Governor, the Secretary of the Maryland Department of the Environment, the Director of the Air and Radiation Management Administration, the Division Chief of the Air Quality Regulations Division, the Mayor, and the Mayor's Legislative Liaison to the City Council.

Judiciary and Legislative Investigations Informational Hearing on Request for State Action – Set a Strong Nitrogen Oxides Limit for the Wheelabrator Baltimore Incinerator
Thursday – September 28, 2017

Panelists

Destiny Watford, 2016 Goldman Environmental Prize winner

Mike Ewall, Founder and Director Energy Justice Network

James Alston, Westport Resident and leader within the Westport Community Development Corporation

Dr. Laalitha Surapaneni, Hospitalist at Bayview and public health graduate

Leah Kelly, Environmental Integrity Project

Neil Seldman, co-founder of the Institute for Local Self-Reliance and is a member of ILSR's Board of Directors. (Zero Waste)

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Neil Seldman, co-founder of the Institute for Local Self-Reliance and is a member of ILSR's Board of Directors. (Zero Waste)

Krummerich, Richard

From: Gayle Killen <killchar@gmail.com>
Sent: Wednesday, September 20, 2017 12:35 PM
To: Bullock, John; Schleifer, Isaac; Burnett, Kristerfer; Henry, Bill (email); Sneed, Shannon; Cohen, Zeke; Dorsey, Ryan; Krummerich, Richard
Subject: Bresco Incinerator and Baltimore Air Quality

Greetings, and thank you for your care and concern over citizen health.

I ask you to emphatically urge the Maryland Department of the Environment to set a nitrogen oxides pollution limit for the Wheelabrator Baltimore incinerator that is no higher than the 150 ppm standard on a 24-hour average that has been adopted by Connecticut and New Jersey and proposed in Massachusetts, or, if at all possible, significantly lower than 150 ppm in order to provide maximum air quality benefits to residents of Baltimore.

Sincere Gratitude,
Gayle Killen
Ellicott City, MD

--
Every great advance in natural knowledge has involved the absolute rejection of authority.
~Thomas H. Huxley

Dear Chairman and Council Members,

Thank you for the opportunity to share scientific evidence on the toxic effects of NOx on all of our health. I am a practicing Internal Medicine physician at Johns Hopkins Bayview representing Physicians for Social Responsibility. I am here to speak on behalf of my patients who suffer from Asthma, COPD Heart Disease and Lung Cancer. Everyday I see these patients, struggling with their diseases, taking newer, more expensive medications, sick, in the hospital, missing work and time spent with their families. All of these illnesses have been linked to air pollution and NOx in particular.

Exposure to NOx is associated with higher risk for asthma related hospital visits [1,2], especially in children.[3] NOx also stunts the growth of lungs in children.[4] Unfortunately, medications via Inhalers do not seem to completely counter the effects of air pollution[5]. Studies done worldwide show that exposure to NOx increases fatalities, (*with a study showing that for every 10 microgram per m3 increase in No2, chance of mortality from a cardiovascular cause increases by 13%*)[6]. A study done right here in Baltimore shows that NOx disproportionately increases mortality in patients on dialysis[7]

NOx also acts as a source to generate other more dangerous pollutants like ground level ozone and Particulate matter. Higher levels of Ozone were associated with a 3 time higher likelihood of developing asthma in children playing outside for a longer time[8]. Particulate matter is shown to cause increased deaths from cardiovascular causes and is associated with increased heart attacks[9], strokes[10], kidney disease[11], diabetes[12], infertility stillbirths[13], and death from cardiovascular disease[14].

As I appeal to you today, it does not escape me that the air I breathe as a physician living in an upscale walk able neighborhood with green spaces is quite different from the air some of my patients breathe. Studies show that NOx and its co-pollutants **disproportionally** affect our vulnerable populations- children, elderly[15], people suffering from pre-existing conditions, racial minorities[16] and city residents living in poverty.[17]

21230 is the area affected most by BRESCO's emissions according to Dr. Gray's modeling report[18]. The asthma emergency room visit rate in zip code 21230 is about 80% higher than the statewide rate. According to the state health data from 2009, we in Baltimore City spend around 23million dollars per year on asthma hospitalizations, 72% of which is paid by public insurance[19]. We do not know that this burden falls entirely on NOx. However, we maintain that decreasing NOx emissions will improve health outcomes for some of these residents and save taxpayer dollars.

The good news is that there is evidence that decreases in NOx levels are translated to health benefits in real time. 2 studies done in California showed decreasing NOx and ozone levels in communities improve lung function in children[20] and reduce bronchitis episodes in children[21]. This improved lung function translates into adulthood and prevents premature deaths. Studies from Europe show decline in mortality from decreased NOx levels.[22] Studies in the United States also show that decrease in particulate matter increases life expectancy[23]

Today you have the power to save lives. As you enact this set of nitrogen dioxide related regulations, to prevent some Maryland children from missing school from their asthma, to prevent a young never-smoker from getting lung cancer. [24]Because of what you do to set a RACT limit for the BRESCO incinerator that is much lower than 150 ppm on a 24-hour basis, someone's grandma in Maryland will live longer and someone's dad will not have a heart attack. Please take this opportunity to save lives and make Maryland a better place for everyone to live, work and raise a family.

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Krummerich, Richard

From:	Bullock, John
Sent:	Wednesday, September 27, 2017 11:22 AM
To:	Elizabeth L. Engleman
Subject:	RE: Hearing calling on the Maryland Department of the Environment (MDE) to Lower Nitrogen Oxides Limits

Good Morning,

Thank you for sharing your perspective. We will add this to the record.

Best Regards,

Dr. John Bullock
Councilman, 9th District
100 Holliday Street, Room 516
Baltimore, MD 21202
410-396-4815
john.bullock@baltimorecity.gov

From: Elizabeth L. Engleman [vSe304@hotmail.com]
Sent: Wednesday, September 27, 2017 11:00 AM
To: Bullock, John; Schleifer, Isaac; Burnett, Kristerfer; Henry, Bill (email); Sneed, Shannon; Cohen, Zeke; Dorsey, Ryan
Cc: Clarke, Mary Pat; Jennifer Kunze; Reisinger, Edward; Pinkett, Leon; Scott, Brandon; Costello, Eric; City Council President; Middleton, Sharon; Stokes, Robert; Stephen Cleghorn
Subject: Hearing calling on the Maryland Department of the Environment (MDE) to Lower Nitrogen Oxides Limits

DATE: September 27, 2017

TO: Housing and Urban Affairs Committee

Baltimore City Council

RE 17-0034R Request for State Action - Set a Strong Nitrogen Oxides Limit for the Wheelabrator Baltimore Incinerator
For the purpose of urging the Maryland Department of the Environment to set a nitrogen oxides pollution limit for the Wheelabrator Baltimore incinerator that is no higher than the 150 ppm standard on a 24-hour average that has been adopted by Connecticut and New Jersey and proposed in Massachusetts, or, if at all possible, significantly lower than 150 ppm in order to provide maximum air quality benefits to residents of Baltimore.

FROM: Elizabeth Engleman
4000 N Charles ST, Suite 1610
Baltimore, MD 21218
Cell 863 632 3075

Dear Councilmembers:

This is written in support of efforts to set a stricter limit on the BRESCO trash burning incinerator's nitrogen oxide (NOx) pollution limits. NOx mixed with sunlight creates unacceptable ground level ozone. From this, NOx contributes to the region's hazy air, its oxygen-gobbling algal blooms in the Chesapeake Bay and ozone and fine airborne particles that cause asthma and other respiratory disease.

I serve as Co-chair of Peace and Justice Ministry-Environmental Justice Steering Committee for First Unitarian Church of Baltimore. We are a vibrant urban congregation in celebration of our historic Bicentennial year.

Our brief ***Mission Statement*** provides the context in which I write:

-Transforming spirits,
-Celebrating diversity,
-Supporting each other,
-Building a better Baltimore

To be clearer, I shall cite two mandates from our **Mission**:

- We partner with Baltimore communities to mutually transform
- We challenge injustice, brutality and ignorance with compassion, love and understanding.

This is our **Vision,** " We bring hope as we work with our Baltimore neighbors to heal the wounds of racism, poverty and injustice."

Our Change-for-Change partner, Clean Water Action-Maryland, states our concern in this way, "The BRESCO trash incinerator is the largest air polluter in Baltimore, wastes what could be a valuable resource for local businesses using zero waste practices, and connects with a system of steam pipes that put residents and visitors at risk."

Even though the "waste to energy" industry often touts trash incineration as a source of "green" energy, it's far from that - BRESCO generated more NOx pollution per unit of energy than any power plant in Maryland.

Variable winds provide long term health risks to our members, friends and neighbors. At greatest risk are neighbors who are particularly vulnerable populations such as children, the elderly and individuals with asthma. Although the odor is unbearable at times, that is not the gravest threat.

'In addition to BRESCO's NOx releases, its sulfur dioxide, formaldehyde, mercury and hydrochloric acid emissions are also the highest of any industrial source in the city", according to Michael Ewall, of Energy Justice Network, who reviewed the most recent Environmental Protection Agency data.

"At 3 million pounds annually, the incinerator accounts for more than 37% of all the stationary (non-car) emissions in Baltimore", Ewall said.

Chesapeake Bay Foundation and Environmental Integrity Project has said about BRESCO: "They're getting a fair amount of money for producing ostensibly clean energy...(and) Some of that ought to be reinvested in good pollution controls to protect the lungs of the ratepayers who are subsidizing that."

I concur that **17-0034R** is a good start to **Request for State Action - Set a Strong Nitrogen Oxides Limit for the Wheelabrator Baltimore Incinerator** *For the purpose of urging the Maryland Department of the Environment to set a nitrogen oxides pollution limit for the Wheelabrator Baltimore incinerator that is no higher than the 150 ppm standard on a 24-hour average that has been adopted by Connecticut and New Jersey and proposed in Massachusetts, or, if at all possible, significantly lower than 150 ppm in order to provide maximum air quality benefits to residents of Baltimore.*

However, I am mandated to ask that no citation of "unbearable cost" be allowed to let BRESCO continue operations as usual. The technology exists to remedy for Nitrogen Oxide limits of 150ppm (standard on a 24-hour average) or less. Life and health emergencies of our members and neighbors demand we should make sure it's polluting as little as possible - and that's a whole lot less than it's polluting now.

I stand with Destiny Watford, student activist, who points to a 2013 Massachusetts Institute of Technology study that found Baltimore has the highest emissions-related mortality rate of all the large cities in the country. Of every 100,000 residents in the city, the study found that 130 were likely to die prematurely each year of causes related to air pollution. This is unacceptable now!

With respect and hope,

Elizabeth Engleman

Krummerich, Richard

From: Thomas Reilly <tmtreilly@gmail.com>
Sent: Thursday, September 28, 2017 8:26 AM
To: Bullock, John; Schleifer, Isaac; Burnett, Kristerfer; Henry, Bill (email); Sneed, Shannon; Cohen, Zeke; Dorsey, Ryan
Cc: Krummerich, Richard
Subject: Bresco Incinerator

Hello all,
I work in the solid waste industry in Anne Arundel County, but live in Baltimore City. I am a registered Professional Engineer (PE) and Board Certified Environmental Engineer (BCEE). I am also a concerned citizen when it comes to our air quality.

I urge you to pressure MDE to set stricter limits on the NOx pollution that is currently escaping the BRESCO incinerator. Some of the harmful effects of NOx pollution (from the EPA website):

- Breathing air with a high concentration of NO2 can irritate airways in the human respiratory system. Such exposures over short periods can aggravate respiratory diseases, particularly asthma, leading to respiratory symptoms (such as coughing, wheezing or difficulty breathing).
- NO2 along with other NOx reacts with other chemicals in the air to form both particulate matter and ozone. Both of these are also harmful when inhaled due to effects on the respiratory system.
- NO2 and other NOx interact with water, oxygen and other chemicals in the atmosphere to form acid rain. Acid rain harms sensitive ecosystems such as lakes and forests.
- The nitrate particles that result from NOx make the air hazy and difficult to see though. This affects the many national parks that we visit for the view.

Let's make Baltimore a healthier place to live AND become a shining example for other cities regarding how to manage our pollution.

Thank you for your time.

-Thomas Reilly, P.E., BCEE

AMENDMENTS TO COUNCIL BILL 17-0034R
(1st Reader Copy)

By: The Housing and Urban Affairs Committee
{To be offered on the Council Floor}

Amendment No. 1

On page 2, after line 27, insert:

"The Council requests that the Maryland Department of the Environment use its legal authority to go beyond the RACT standard in order to set a nitrogen oxides limit of 45 ppm on a 24-hour basis, which is the limit that would likely be set for a new incinerator.".

Maryland
Department of
the Environment

Larry Hogan
Governor

Boyd Rutherford
Lieutenant Governor

Ben Grumbles
Secretary

August 30, 2017

The Honorable Bernard C. "Jack" Young
Council President, Baltimore City Council
100 Holliday Street, Suite 400
Baltimore, Maryland 21202

Re: Council Resolution concerning Request for State Action – Set a Strong Nitrogen Oxides (NOx) Limit for the Wheelabrator Baltimore Incinerator

Dear Council President Young and Baltimore City Council Members:

The Maryland Department of the Environment (MDE or the Department) understands that the Council is considering a resolution "urging the Maryland Department of the Environment to set a NOx pollution limit for the Wheelabrator Baltimore incinerator that is no higher than the 150 ppm standard on a 24-hour average…or, if at all possible, significantly lower than 150 ppm in order to provide maximum air quality benefits to residents of Baltimore." The Department shares in your interest and concern for the health of our citizens and the protection of our environment.

As the Council is aware, the municipal waste combustor operated by Wheelabrator Baltimore, Inc. incinerates over two thousand tons of municipal solid waste per day and also provides steam that is used as a source of power for residents and businesses of the city. Over the past year, the Department has been working with stakeholders comprised of representatives from affected facilities, environmental organizations and the local community. The Department is now in the process of developing regulations that update the NOx Reasonably Available Control Technology (RACT) emissions limitations for the Wheelabrator Baltimore facility that incorporate concerns and comments received from stakeholders. This new NOx RACT limit for Wheelabrator will reduce emissions from the facility and be more protective of public health.

The Department appreciates the City Council's attention to this matter. At their request, Council Members Edward Reisinger and Mary Pat Clarke have already been added to the Department's stakeholder list for this topic. The Department welcomes all members to attend a stakeholder meeting regarding the proposed regulations on September 22, 2017 at 10:00 a.m. at the Maryland Department of the Environment (First Floor Conference Rooms), 1800 Washington Boulevard, Baltimore, Maryland 21230.

Sincerely,

George (Tad) S. Aburn, Jr., Director
Air and Radiation Administration

Appendix C – Air Quality Control Advisory Council

NOx RACT for Municipal Waste Combustors (MWCs)

AQCAC Briefing – June 6, 2016

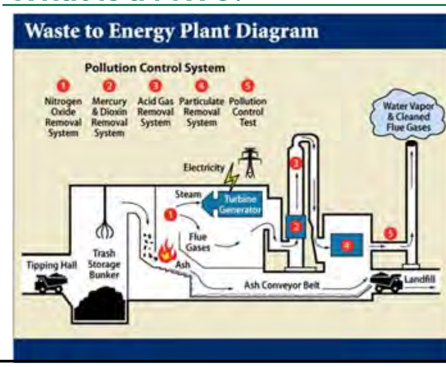
Topics Covered

- MD NOx RACT Review for Large MWCs
- MD MWC Sources
- Federal NOx RACT Requirements
- Federal MWC Requirements
- MD Existing NOx RACT for MWCs
- Regional and MDE NOx RACT Updates
- Emission Reductions
- Regulation Timeline

MD NOx RACT Review for Large MWCs

- The purpose of this review is to establish new NO_x RACT standards and requirements for large municipal waste combustors (MWCs) with a capacity greater than 250 tons per day.
- There are two large MWCs in Maryland; Wheelabrator Baltimore, L.P. and Montgomery County Resource Recovery Facility (MCRRF).
- The Department has engaged in an active stakeholder process with affected sources and EPA

What is a MWC?



Wheelabrator Facts

2,250 Tons of Waste Processed per day

730,150 Tons of Waste Processed Last Year

64 MW Energy Generation Capacity

40,000 Homes Powered

1985 Began Operations

Wheelabrator 2014 NOx Emissions

2014 Top 15 NOx Emission Sources in MD

No.	FACILITY	NOx Emissions(tpy)*
1	NRG Chalk Point Generating Station	3,877
2	Fort Smallwood Road Complex	3,638
3	Lehigh Cement Company LLC	2,902
4	Luke Paper Company	2,696
5	NRG Dickerson Generating Station	1,688
6	NRG Morgantown Generating Station	1,323
7	C. P. Crane LLC	1,247
8	Holcim (US), Inc	1,173
9	**Wheelabrator Baltimore, LP**	**1,076**
10	AES Warrior Run Inc	552
11	MCRRF	427
12	Harford County Resource Recovery Facility	284
13	Constellation Power - Perryman Generating Station	215
14	Mettiki Coal, LLC	125
15	Brandywine Power Facility	118

* Facility-wide NOx emissions

MCRRF Facts

1,800
Tons of Waste Processed per day

599,250
Tons of Waste Processed Last Year

52 MW
Energy Generation Capacity

37,000
Homes Powered

1995
Began Operations

MCRRF 2014 NOx Emissions

2014 Top 15 NOx Emission Sources in MD

No.	FACILITY	NOx Emissions(tpy)*
1	NRG Chalk Point Generating Station	3,877
2	Fort Smallwood Road Complex	3,638
3	Lehigh Cement Company LLC	2,902
4	Luke Paper Company	2,696
5	NRG Dickerson Generating Station	1,688
6	NRG Morgantown Generating Station	1,323
7	C. P. Crane LLC	1,247
8	Holcim (US), Inc	1,173
9	Wheelabrator Baltimore, LP	1,076
10	AES Warrior Run Inc	552
11	**MCRRF**	**427**
12	Harford County Resource Recovery Facility	284
13	Constellation Power - Perryman Generating Station	215
14	Mettiki Coal, LLC	125
15	Brandywine Power Facility	118

* Facility-wide NOx emissions

Federal NOx RACT Requirements

- Under the Clean Air Act (CAA), 42 U.S.C. § 7401 et seq., sources in ozone nonattainment areas classified as moderate and above are subject to a NOx Reasonably Available Control Technology (RACT) requirement.
- Section 182 of the CAA requires States to review and revise NOx RACT requirements as necessary to achieve compliance with ambient air quality standards.
- EPA defines RACT as the lowest emissions limitation (e.g., on a part per million or pound per million Btu basis) that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility.

MDE NOx RACT Review

- MDE considers technological advances, the stringency of the revised ozone standard and whether new sources subject to RACT requirements are present in the nonattainment area.
- MDE also reviews regional RACT SIPs for existing sources to determine if meeting new standards or installing control technologies are economically and technically feasible.

Federal Requirements for MWCs

- On December 19, 1995, EPA adopted standards for new MWC plants in 40 CFR 60 Subpart Eb and Emission Guidelines (EG) for existing MWCs Subpart Cb as part of an action under Section 111(d) and 129 of the CAA.
- On November 17, 1997, the Department adopted these regulations in COMAR 26.11.08.08 which, in part, established a **NOx emission standard of 205 ppmv** (parts per million by volume) based on a 24 hour average.

111(d) and 129 Requirements

- Section 111(d) establishes technology-based emission standards for major sources of dangerous air pollutants that are not tied to an air quality value or an ambient standard.
  - There are section 111(d) pollutants, and emission standards by source are set and approved through a "State Plan".
- Section 129 requires plans for solid waste incinerators and establishes emission guidelines for both traditional criteria pollutants and non-criteria pollutants.

Maryland NOx RACT for MWCs

- On October 18, 1999, the Department adopted source specific RACT limitations for a variety of major NOx emission sources, including MWCs, under COMAR 26.11.09.08.
- The NOx RACT for Large MWC sources required that NOx emissions may not exceed the NOx emission standards in COMAR 26.11.08.08 or applicable Prevention of Significant Deterioration limits, whichever is more restrictive.

Regional Updates to MWC NOx RACT

- Region-wide, several states have proposed or revised NOx RACT standards for large MWCs.
- On April 20, 2009, New Jersey established a NOx RACT emission rate of 150 ppmvd.
  - Includes alternative compliance option allowing MWCs to apply for an alternative NOx emission rate.
- In May of 2013, Massachusetts proposed a NOx RACT of 150 ppmvd for MWCs equivalent to the type of large MWC plants operating in Maryland.
  - To date, Massachusetts proposal has not moved forward for adoption.
- Most recently, on April 23, 2016, Pennsylvania updated their RACT requirements and established a NOx emission rate of 180 ppmvd for MWCs.

MDE Updates to MWC NOx RACT

- Based upon regional RACT amendments and source optimization studies conducted by Maryland sources, the Department has concluded that the NOx RACT standards for MWCs can be improved upon based on the design of the combustor and year of installation.
- Maryland MWCs have demonstrated the potential to reduce NOx emissions through analysis and optimization of existing controls.
- Updating NOx RACT for MWCs in Maryland will result in reductions in NOx emissions from these sources, which are needed to attain and maintain compliance with federal ozone standards.

Regulation Timeline

- Stakeholder Meetings
  - July 21, 2015
  - January 13, 2016
  - TBD Summer 2016
  - Numerous emails and conference calls with individual sources and EPA
- AQCAC Briefing
  - June 6, 2016
- AQCAC Action Item
  - September 19, 2016
- Regulation Adoption
  - NPA – December 2016
  - Public Hearing – January 2017
  - NFA – March 2017
- Compliant Effective Date
  - May 1, 2017

Questions and Discussion

Additional Slides

NOx RACT for Municipal Waste Combustors (MWCs)

AQCAC Meeting – December 11, 2017

Topics Covered

- Municipal Waste Combustors (MWCs) in Maryland
  - Purpose of NOx RACT review
  - Stakeholder process
  - MWC overview
- MDE NOx RACT update
  - Proposed NOx RACT regulation
- Additional NOx Emission Control Requirements beyond 2020
- Timeline

MD NOx RACT for Large MWCs

- The purpose of this action is to establish new NO_x RACT (Reasonably Available Control Technology) requirements for large MWCs with a capacity greater than 250 tons per day
- There are two large MWCs in Maryland;
  - Wheelabrator Baltimore, Inc. and
  - Montgomery County Resource Recovery Facility (MCRRF)
- The Department has been meeting with affected sources and EPA since 2015 to discuss MWC operations, emissions data and NOx RACT proposals
- June 6, 2016 – AQCAC briefing
- August 30, 2016 – 1st Stakeholder Meeting
  - October 27, 2016 – Stakeholder comments received
- January 17, 2017 – 2nd Stakeholder Meeting
  - May 9, 2017 - Stakeholder comments received
- September 22, 2017 – 3rd Stakeholder Meeting
  - October 6-20, 2017 - Stakeholder comments received

Key Stakeholder Comments

- MDE must set NOx RACT limits that are consistent with limits in other leadership states … at or below 150 ppm on a 24-hour basis
  - Consider even more stringent limits
- RACT requirements are intended to acknowledge the different design and age of equipment at existing MWCs and to require "reasonable" controls
  - New units are subject to BACT
- Requirements for SSM are important
  - Mass based versus rate based requirement

MWC NOx RACT - Other States

State	24-hour Limit	30-day Limit	Additional 2020 Requirements?
MD	150 ppmv at Wheelabrator 140 ppmv at MCRFF	145 ppmv at Wheelabrator 105 ppmv at MCRFF	Yes at Wheelabrator No at MCRRF
PA	180 ppmv	NA	NA
CT	150 ppmv	NA	NA
NJ	150 ppmv	NA	NA
MA	150 ppmv *	NA	NA
VA	Under development - Stringent limits under consideration		

* Proposed May of 2013

NOx Emissions: 2015/2016
Top 15 Stationary Sources

No.	2016 Top 15 NOx Emissions Sources in MD	NOx Emissions (Tons Per Year)* 2016	NOx Emissions (Tons Per Year) * 2015
1	Lehigh Cement Company LLC	2,781	2,936
2	Raven Power Fort Smallwood LLC	2,569	3,102
3	NRG Chalk Point Generating Station	2,326	2,126
4	Luke Paper Company	1,927	1,887
5	**Wheelabrator Baltimore, LP**	**1,141**	**1,123**
6	NRG Dickerson Generating Station	987	987
7	NRG Morgantown Generating Station	949	897
8	C P Crane Generating Station	661	1,078
9	**Montgomery County Resource Recovery Facility (MCRRF)**	**418**	**441**
10	AES Warrior Run Inc	359	445
11	Holcim (US), Inc **	331	1,225
12	Constellation Power - Westport	195	65
13	Constellation Power - Perryman Generating Station	150	190
14	Rock Springs Generation Facility	141	127
15	KMC Thermo-Brandywine Power Facility	137	144
Total Mobile Source NOx Emissions in MD - 2014		88,568 tons per year	

* Facility-wide NOx emissions
* * Company converted to preheater/precalciner kiln process, operating hours and NOx emissions were lower – operated for 153 days

Wheelabrator

2,250
Tons of Waste Processed per day

722,789
Tons of Waste Processed Last Year

64 MW
Energy Generation Capacity

40,000
Homes Powered

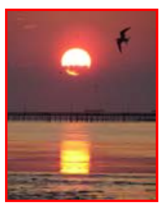
1985
Began Operations

Wheelabrator NOx Emissions

Year	NOx Tons	Long Term (Annual) Average NOx 24-Hr Block Concentration
2013	1067	169 ppm
2014	1076	162 ppm
2015	1123	168 ppm
2016	1141	169 ppm
Average	**1102**	**167 ppm**

Wheelabrator NOx Control Technology

- Wheelabrator operates an SNCR for NOx Control (urea based)
- Optimized existing SNCR systems to target proposed NOx RACT limits
  - Injector locations, number of injectors, fuel-tip design, urea injection rate, operating parameters (dilution water flow, air pressure)
- Conducted long-term analysis of optimized system to ensure system capabilities
- The optimized control system and SNCR result in lowering the NOx emission rate range from 167 ppmv to below 150 ppmv



Montgomery County Resource Recovery Facility

1,800
Tons of Waste Processed per day

599,250
Tons of Waste Processed Last Year

52 MW
Energy Generation Capacity

37,000
Homes Powered

1995
Began Operations

MCRRF NOx Emissions

Year	NOx Tons	Long Term (Annual) Average NOx 24-Hr Block Concentration
2013	387.7	85 ppm
2014	426.7	88 ppm
2015	441.2	89 ppm
2016	418	87 ppm
Average	**418**	**87 ppm**

MCRRF NOx Control Technology

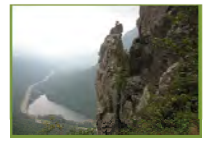
- An SNCR system is integrated to a combustion Low NOx (LN™) system with modifications to the location of the injectors
- The Covanta LN™ technology employs a unique combustion system design, including modifications to combustion air flows, reagent injection and control systems logic
- The LN™ control system and SNCR result in lowering the NOx emission rate range to 85-89 ppm long-term (annual average) basis
- Approximate 47 percent reduction on long term basis, but subject to high variability on daily basis, lesser can be assured on a short-term basis
- The LN™ control system installation started in 2008 and was completed in 2010 at a capital cost of $6.7 million and the average operating costs over the last three years has been $566,000 per year

MDE Updates to MWC NOx RACT

- Based upon:
  - regional RACT amendments in other states
  - review of MWC NOx emissions data analysis of optimization studies
  - recent combustion upgrades at Wheelabrator
- The Department has concluded that the NOx RACT standards for MWCs can be strengthened within the definition of RACT
- MDE proposing to pair daily (24-hour) limits with longer (30-day rolling average) limits

MDE Proposed NOx RACT

- Three key elements:
  - Requirement to optimize control technologies to minimize NOx emissions each day of operation
  - Daily, 24-hour block average limits to ensure peak daily emissions are addressed
  - Longer term, 30-day rolling average limits to ensure that even lower limits are met throughout the year



Maryland Department of the Environment

Requirement to Minimize NOx Emissions Every Day

- .10A - The owner and operator of a Large MWC shall minimize NOx emissions by operating and optimizing the use of all installed pollution control technology at all times the unit is in operation, including periods of startup and shutdown
  - Ensures NOx control technologies are operated in the best possible manner to minimize emissions
  - Satisfies part of EPA's SSM policy (more on that later)
- .10G – Not later than 45 days after effective date of regulation, a plan is due to the Department demonstrating how Large MWCs will operate controls during all modes of operation including but not limited to normal operations, startup and shutdown

Daily and Longer Term Limits

- .10B and C – NOx emission rates
- 24-hour block average rates effective May 1, 2019
- 30-day rolling average rates effective May 1, 2020
  - Allows time to ensure more stringent, long-term rates can be met on a consistent basis

Unit	24 Hour Block Average Rate	30 Day Rolling Average Rate
Wheelabrator	150 ppmv	145 ppmv
MCRRF	140 ppmv	105 ppmv

ppmv = parts per million volume

Reporting Requirements

- .10H and I – Reporting Requirements
- Beginning July 1, 2019, the owner or operator of a Large MWC shall submit a quarterly report to the Department containing:
  - (1) Data, information, and calculations which demonstrate compliance with the NOx 24-hour block average emission rates;
  - (2) NOx continuous emission monitoring data and stack flow data, which demonstrate compliance with the startup and shutdown mass NOx emission limits;
  - (3) Flagging of periods of startup and shutdown and exceedances of emission rates;
  - (4) NO_x continuous emission monitoring data and total urea flow rate to the boiler averaged over a 1-hour period, in a Microsoft Excel format; and
  - (5) Documented actions taken during periods of startup and shutdown in signed, contemporaneous operating logs.
- Beginning July 1, 2020, the owner or operator of a Large MWC shall submit a quarterly report to the Department containing data, information, and calculations which demonstrate compliance with the NO_x 30-day rolling average emission rate

Monitoring and Compliance

- .10F, K and L – Monitoring and Compliance
- The owner or operator of a Large MWC shall continuously monitor NOx emissions with a continuous emission monitoring system in accordance with COMAR 26.11.01.11 - Continuous Emission Monitoring (CEM) Requirements
- Compliance with NOx emission standards to be demonstrated with a CEM
- Compliance with NOx mass loading limits for periods of startup and shutdown demonstrated by calculating the 24-hr average of all hourly average NOx emission concentrations from continuous emission monitoring systems, utilizing stack flow rates derived from flow monitors, for all the hours during the startup or shutdown period

EPA SSM Policy – June 12, 2015

- Provides a mechanism for facilities to meet alternative emission limits during periods of startup/shutdown
- EPA requires seven specific criteria be met when developing SS limits
- MDE addressing SS criteria directly in proposed regulation and within Technical Support Documents

Startup/Shutdown Limits

- .10D – Startup and Shutdown NOx Emission Limitations
- Higher volumes of air are present in furnace during SS events & adjustment to 7% oxygen does not represent actual NOx emissions
- Mass based emission standards take into account the design flue gas flow rate & represent the worst case actual NOx emissions
  - Applied facility wide on a 24-hour period
  - When the unit is in periods of startup and shutdown, the NOx 24-hour block average emission rate will apply for the 24-hour period after startup and before shutdown
- Mass based calculations based upon 24 hour block average NOx RACT limits

Unit	24 Hour Block Average Rate	Mass Loading NOx Limit
Wheelabrator	150 ppmv	252 lbs/hr
MCRRF	140 ppmv	202 lbs/hr

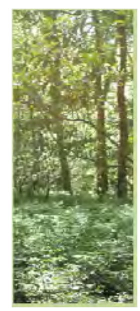
ppmv = parts per million volume

Additional NOx Emission Control Requirements

- .10E - Additional NOx Emission Control Requirements
- Requires feasibility analysis to be submitted by Wheelabrator by January 1, 2020
- Based upon the results of the feasibility analysis, Wheelabrator to propose new NOx emissions limits for consideration by the Department
- Two steps:
  - Feasibility analysis due January 1, 2020
  - MDE to initiate rulemaking after submittal of feasibility analysis

The Feasibility Analysis

- Step 1 - Feasibility Analysis
  - In 2020, Wheelabrator would submit a feasibility analysis describing options for achieving lower NOx emissions based upon results of third-party study. Would include information like:
    - A written narrative and schematics detailing existing facility operations, boiler design, NOx control technologies, and relevant emission performance
    - A written narrative and schematics detailing state of the art NOx control technologies for achieving additional NOx reductions from existing MWCs in consideration of the current boiler configuration at Wheelabrator
    - A feasibility analysis of whether each identified NOx control could be implemented at Wheelabrator
    - A cost-benefit analysis
    - An estimated timeline for implementation
    - Any other information MDE deems necessary to evaluate the review



Process for Establishing New NOx Limits

- Step 2 – Proposal and Promulgation
  - Not later than January 1, 2020, based upon the results of the feasibility analysis, Wheelabrator shall propose new NOx emission limits for approval by the Department
  - MDE to initiate rulemaking to adopt new NOx limits for the Wheelabrator facility after approval of feasibility analysis
    - The additional NOx emission control requirements would need to go through full public comment and hearing process as required by Maryland law

Timeline

- Stakeholder Meetings
  - August 30, 2016
  - January 17, 2017
  - September 22, 2017
- AQCAC
  - December 11, 2017
- Regulation Adoption
  - NPA – May 2018
  - Public Hearing – June 2018
  - NFA – August 2018
- Effective Date
  - September 2018

Appendix D – Montgomery County Resource Recovery Facility

Montgomery County Resource Recovery Facility

NO_x Optimization

May 18, 2016

Contents

Tables

Figures

1 Executive Summary

The Montgomery County Resource Recovery Facility (MCRRF) is an energy from waste facility operated by Covanta Montgomery, Inc. (Covanta) on behalf of the Northeast Maryland Waste Disposal Authority (NMWDA) and Montgomery County (County). The MCRRF is currently operating under a permit which limits the nitrogen oxides (NO_x) emissions to 180 parts per million (ppm) at 7% O_2 for a 24-hour block average except during periods of startup, shutdown, or malfunction (SSM), during which periods the NO_x emission limit is based on facility-wide mass emission rates as follows: 176 lb/hr 1-hour block average, 87.9 lb/hr 4-hour block average, and 44.0 lb/hr 24-hour block average.

In 2009 Covanta, under an Agreement with the NMWDA and the County, completed work on environmental improvements at the MCRRF which included the installation of Covanta's proprietary Low NO_x (LN™) combustion system upgrade, a conversion of the anhydrous ammonia based Selective Non-Catalytic Reduction (SNCR) system to an aqueous ammonia SNCR system, and upgrades to the boiler first pass refractory, tile, and inconel overlay.

The Maryland Department of the Environment (MDE) has requested information in support of its NO_x RACT review. HDR was retained by the NMWDA and County to provide the following:

- A description of the 2009 boiler modifications undertaken to incorporate Covanta's proprietary LN™ System;
- A description of the modifications undertaken to retrofit the facility's SNCR system from Anhydrous ammonia injection to 19% Aqueous ammonia injection;
- A discussion on the testing that was performed during the 2009 commissioning of the new LN™/SNCR systems to determine target operating conditions;
- A summary of the operating data for the years 2009 through 2014 relative to NOx control; and
- An opinion as to whether or not the proposed 24-hour block average, individual boiler unit, of 140 ppm for NOx (adjusted to 7% O2) is a reasonable RACT limit for the Montgomery County Facility.

Based on the available information, the equipment installed to date, the operating conditions of the boiler, and the contractual relationship between NMWDA and Covanta, HDR is of the opinion that the proposed 24-hour block average, individual boiler unit limit of 140 ppm for NOx (adjusted to 7% O2) is a reasonable RACT limit for the Montgomery County Facility.

2 Facility Description

The Montgomery County Resource Recovery Facility (MCRRF) is an energy from waste facility operated by Covanta Montgomery, Inc. on behalf of the Northeast Maryland

Waste Disposal Authority (NMWDA) and Montgomery County. The facility is located in Dickerson, (Montgomery County) Maryland and is comprised of three (3), 600 ton per day waterwall furnaces with Martin reverse reciprocating grates. Each boiler generates approximately 171,000 pounds per hour of steam at 865 pounds per square inch (psig) and 830°F. The steam is used to generate approximately 63 MW of electricity in a GE turbine.

The air pollution control system for each of the boilers includes hydrated lime injection into the boiler for initial acid gas control, a powdered activated carbon injection system for mercury and dioxin reduction, a semi-dry scrubber for acid gas control, a baghouse for particulate control, and, prior to 2009, an anhydrous ammonia Selective Non Catalytic Reduction (SNCR) system to control emissions of NO_x,

In August of 2008, Montgomery County and NMWDA issued a change order for environmental improvements at the Montgomery County Resource Recovery Facility. The environmental improvements were designed to reduce NO_x emissions below the permitted level of 180 ppmdv at 7% O2 (24-hour block average). The improvements included the installation of Covanta's proprietary and patented LN™ system in each of the boilers, replacement of the anhydrous ammonia based SNCR system with an aqueous ammonia SNCR system, application of Inconel 625 alloy to a significant portion of the boiler waterwall surface to protect the boiler tubes from the elevated temperatures resulting from LN™ operation, and refractory upgrades to protect the lower furnace area. The project was completed and operational on all three Units by October of 2009.

3 NO_x Control Systems

3.1 Low NO_x Combustion (LN™) System

Covanta began investigations into NO_x reductions for its new and existing facilities starting in 2005. By early 2006 Covanta began collecting data and designing a system in cooperation with Martin GmbH, to be installed in one of the boilers at the Bristol Resource Recovery Facility. One variation of the system that was being investigated was the LN™ system. The primary concept behind Covanta's LN™ system is to reduce the amount of combustion air in the furnace combustion zone to a level closer to stoichiometric conditions. By limiting the amount of oxygen in this region, the formation of NO_x is reduced. Combustion air in this region can be reduced by either reducing primary air (also called underfire or undergrate air), or secondary air (overfire air). The Martin boilers typically operate at a split of approximately 60% Primary Air and 40% secondary air. This ratio will vary slightly based on fuel conditions. However, simply reducing the air to this zone would result in incomplete combustion, high carbon monoxide (CO) emissions, and other operational problems.

The LN™ system includes additional combustion air ports that are installed in the upper furnace to provide combustion air (Tertiary Air) to complete combustion of the flue gases. The LN™ system shifts a portion of the Secondary Air from the overfire air ports to the Tertiary Air ports and the total air to the boiler is maintained relatively constant. In boilers retrofitted with the LN™ systems, the flue gas flow to the boiler is relatively unchanged and the boiler operation is only slightly impacted. There are some changes to the heat transfer in the boiler first pass which result in lower flue gas temperatures to the balance of the boiler. This has the potential effect of reducing the superheated steam temperature.

After the successful demonstration of the LN™ system at the Bristol, CT facility, Covanta installed a LN™ systems on boilers at Hempstead, NY (1 of 3 boilers retrofitted), Essex, NJ (1 of 3 boilers retrofitted), Hennepin, MN (both boilers retrofitted), and Haverhill, MA (1 of the 2 boilers retrofitted). Montgomery County entered into the change order in 2009 for Environmental Improvements after these successful retrofits.

3.1.1 LN™ System Installation

Figure 1 roughly shows the MCRRF boiler and the location of the new Tertiary Air ports and ammonia injection.

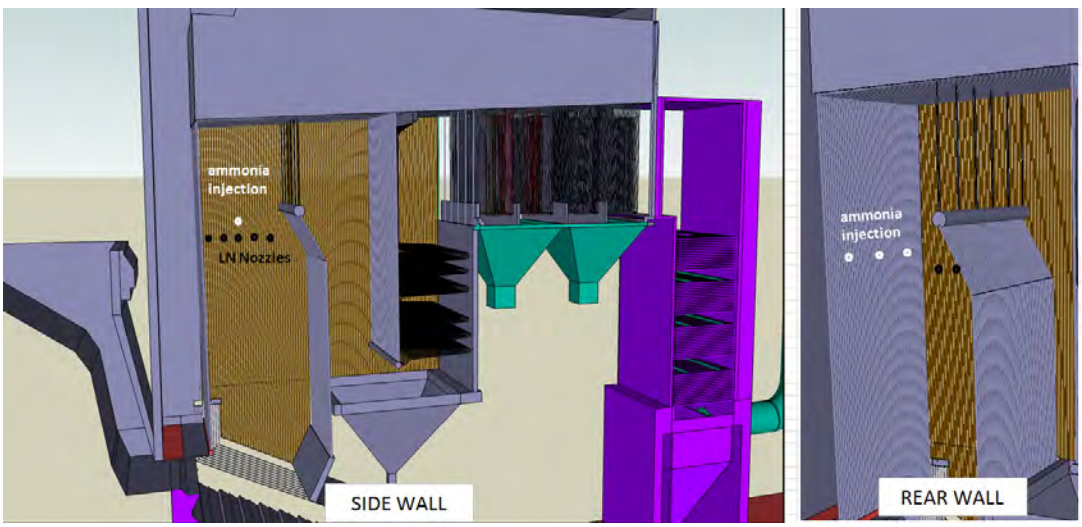


Figure 1. LN™ and SNCR Ports

The installation of the LN™ system required the design and installation of new ducting to divert a portion of the Secondary Air to these new Tertiary Air ports. This new ducting was tied into the Secondary Air fan discharge ducting. The Tertiary Air duct included pressure and flow meters and a damper for flow control. The existing dampers for the front and rear overfire air dampers were replaced due to the age and style of the original dampers. The ducting was connected to headers on the two sides of the boiler, and five downcommers were tied into the header to direct Tertiary Air to the Tertiary Air ports. (Figure 2). A header was run along the front wall of the boiler to connect the sidewall headers. (Figure 3). No Tertiary Air ports were installed along the boiler front or rear walls.

Figure 2. Tertiary Air Side Wall Header

Figure 3. Tertiary Air Front Wall Duct

To accommodate the five inch diameter Tertiary Air ports, bent tubes with shop applied spiral wound Inconel were installed in the boiler sidewalls. The following photos show the bent tubes, removed waterwall sections, installed bent tubes and exterior packing box.

Figure 4. Waterwall Tube Modifications for Tertiary Air Nozzles

Figure 5 shows the final installation, with refractory installed.

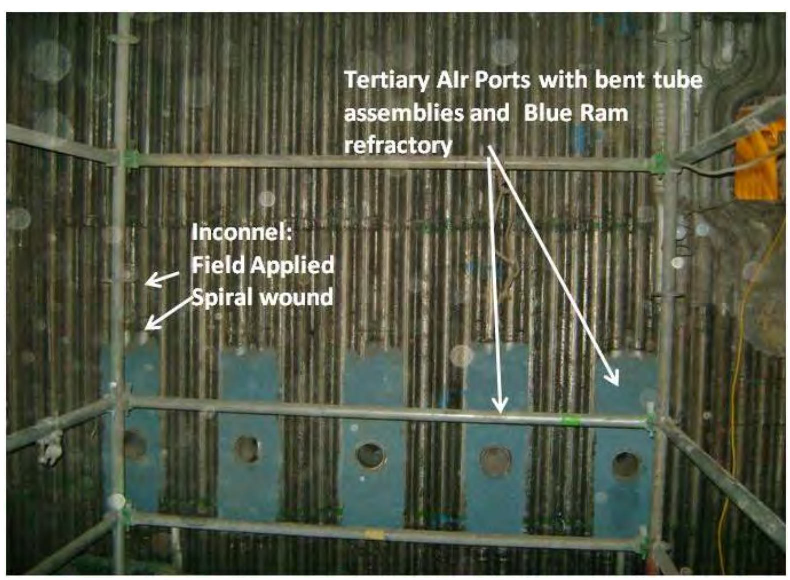


Figure 5. Final Installation – Boiler Sidewalls

3.2 SNCR System

In the SNCR systems, either aqueous or anhydrous ammonia (NH_3) is injected into the upper elevation in the first pass of the boiler. Ammonia and NO_x react according to the following basic reactions:

$4\ NO + 4\ NH_3 + O2 \rightarrow 4\ N_2 + 6\ H_20$

$4\ NH_3 + 5\ O_2 \rightarrow 4\ NO + 6\ H_20$

Temperature of the flue gas at the injection level is a critical parameter in the design of the LN™ system. The following are key temperature considerations:

- At a temperature range of 1,600°F to 1,800°F, the first reaction is the primary reaction and NO_x is reduced to N_2.
- At temperatures above 2,000°F, the second reaction dominates and some of the NH_3 is oxidized to NO.
- At temperatures below 1,600°F, a fraction of the NH_3 remains unreacted and passes through the boiler, resulting in ammonia slip.

As part of the Environmental Improvements, Covanta replaced the anhydrous ammonia injection system with an aqueous ammonia injection system using 19 percent ammonia. The system incorporates five injection ports at a single elevation. Compared to the anhydrous ammonia system, the aqueous ammonia system provides for a system that is safer to operate and eliminates certain additional requirements of the EPA's Accidental Release Prevention Management Program. The replacement required the installation of a new containment dike and ammonia storage tank, valves, controls, and instrumentation for the ammonia pumping station, purge air system and carrier water system, ammonia leak detection and interlocks, new eye wash and shower stations, and the decommissioning and removal of the existing anhydrous ammonia storage tank and carrier air system.

Each of the five injection nozzles are rated at 15.4 gallons per hour (gph) of diluted ammonia solution at 10 psig, resulting in a total flow of 77 gph (1.3 gpm) to each boiler. Ammonia flow to the nozzles is controlled by the LN™ control system and the carrier water is controlled by a pressure control loop to maintain a constant 10 psig at the nozzles. This constant pressure maintains a consistent spray pattern under all ammonia injection rates. Three nozzles are located across the boiler front wall and one nozzle is installed in each sidewall. The spray pattern and droplet size is ideally designed such that the droplet evaporates as it is dispersed into the center of the boiler, and the droplets are fully evaporated before they can contact any boiler surface.

3.3 Inconel Installation and Refractory Upgrades

Prior to the environmental improvements, Covanta had overlaid some of the boiler tubes with Inconel, an austenite nickel-chromium-based overlay material that is welded onto the boiler waterwalls and membranes. Inconel is applied to portions of the boiler first and second pass waterwalls at waste-to-energy facilities to protect against corrosion in these high exposure areas. The MCRRF boilers are fitted with a division wall in the second pass that was also overlayed with Inconel. One side effect of the LN™ system is an increased temperature in the lower furnace section of the boiler and an increase to corrosion rates. As part of the environmental improvements, additional Inconel was added in the first and second pass of the boilers.

In the lower furnace, the waterwalls are covered with refractory. With the installation of the LN™ system, the lower furnace refractory is subjected to higher temperatures and the life of the refractory is reduced. Improved refractory life in this harsh environment is enhanced with the installation of double fired, back-cast tiles. Tiles are installed on the boiler walls and held in place by a clip that is attached to the wall membrane. A refractory is mixed and poured between the tile and the waterwall. This increases the heat transfer through the tile and into the waterwall tubes, reducing the temperature of the tile and increasing tile life.

4 LN™/SNCR Optimization

The LN™ and ammonia injection control is based on an integrated control scheme that incorporates a signal from the NO_x emissions analyzer at the stack, ammonia flow to the SNCR system, and combustion air flow to the new LN™ system (Tertiary Air). The system operates as follows:

- The operator selects the Stack NO_x setpoint, which through a proportional–integral–derivative (PID) controller determines the ammonia flow rate necessary to maintain that NO_x level.
- The operator also selects a "desired" ammonia flow rate, which is compared to the actual ammonia flow rate in the primary PID control.
- As the actual ammonia flow rate deviates above the desired flow rate, a positive output signal is generated, which sends an increasing (open) signal to the Tertiary Air damper.
- The increased air flow through the Tertiary Air damper increases the total overfire air flow. This increase in total overfire air flow is negated by another controller, which shuts the secondary air dampers sufficiently to maintain a constant total overfire air flow.
- If the actual ammonia flow rate were to drop below the desired setpoint, the Tertiary Air damper will close, and the secondary air dampers will open to accommodate the change.

An automatic control damper in the Tertiary Air header is modulated to control the static pressure and flow in the downstream header. During the initial testing, the Tertiary Air pressure was controlled from approximately 1 inch water gauge ("w.g.) at 0% LN™ output to 18 "w.g. at full output. A minimum pressure of 1" H2O is required to protect the ducting and nozzles from overheating. The 18" "w.g. in the Tertiary Air header setting resulted in a flow of approximately 81 thousand pounds per hour (klb/hr) or 18,000 standard cubic feet per minute (scfm) of air to the LN™ nozzles. Expressed as a percentage of total combustion air flow, full flow to the Tertiary Air nozzles represented approximately 23 percent of the combustion air to the Tertiary Air ports. Covanta has found that this amount of Tertiary Air is sufficient and that the higher rates will increase temperature and accelerate damage to the lower furnace. Damage to the tile and inconel in the first pass increases maintenance requirements and costs during planned outages and can cause increased forced boiler outages.

During commissioning and testing, to demonstrate that the LN™ and ammonia systems were fully functional and performing as designed, a series of short-term tests were carried out at different SNCR and LN™ signal settings to verify the system's overall performance and operation. The testing consisted of operating the boilers at full load while varying the Tertiary Air and aqueous ammonia flow to observe the impacts on NO_x reduction.

To obtain more data for system operation analysis, additional temporary test instrumentation was installed on Unit 2. An ammonia slip analyzer was installed at the outlet of the boiler (prior to the scrubber) to monitor and record unreacted ammonia, and a furnace IR thermometer (InfraView) was installed in the furnace above the Tertiary Air ports. Both of these instruments were wired into the DCS for data logging purposes. An additional IR thermometer was installed during a portion of the testing in the lower part of the furnace with a portable computer for local data collection. The lower IR thermometer was mainly used to observe how the lower furnace temperature is affected with the increase of Tertiary Air and the reduction of secondary air.

The installation locations of the additional test equipment as well as level of ammonia and Tertiary Air injection nozzles are shown in Figure 6. Boiler access ports and openings available for test instrumentation in the MCRRF boilers are very limited and the data obtained from this test program was not necessarily representative of bulk average conditions. As shown on Figure 6 both temporary IR thermometers were installed near the rear wall of the boiler.

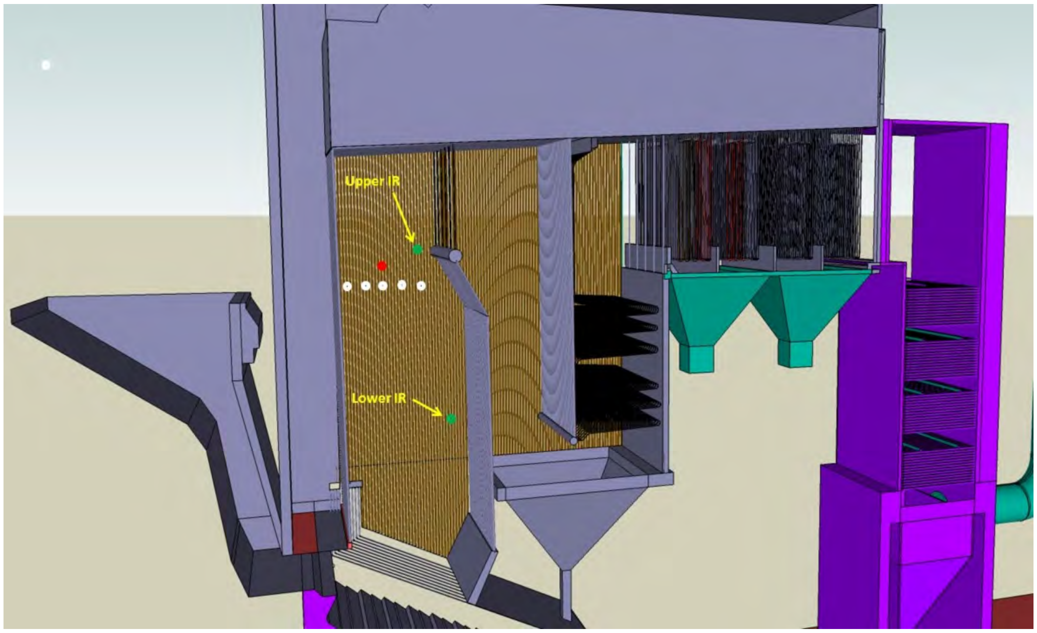


Figure 6. IR Locations

Testing consisted of running 15 minute tests at various ammonia flows and LN™ settings. In addition, tests of one hour duration were performed to better observe the affect of Tertiary Air on NO_x reduction and the unabated NO_x emissions.

During the testing, the facility was operated for periods of time with 0% LN™ and no ammonia flow. These test conditions represent the fully unabated condition. At these settings a minimum amount of combustion air is admitted to the Tertiary Air ports to provide nozzle cooling. During these periods of time the NO_x emissions ranged between roughly 280 ppm and 340 ppm and averaged approximately 310 ppm. For purpose of analysis, an estimate of fully unabated NO_x emissions of 320 ppm is assumed to account for the slight reduction resulting from the Tertiary Air required for cooling. The initial target for the LN™ system was a 50% reduction in NO_x formation, or 150-170 ppm

4.1 LN™ Performance

During the initial tuning of the control system, the range for the Tertiary Air flow was controlled to a range from 20 to 70 klb/hr. Flows above this range will lead to higher temperatures in the lower furnace and will increase wastage. To demonstrate the ability of the LN™ system to reduce the formation of NO_x to the 150 ppm to 170 ppm range, a series of tests were performed with no ammonia flow to the nozzles. During the testing, the LN™ signal was varied in increments of 25%. Table 1 shows the results of operating the Number 2 boiler at various LN™ settings with no ammonia flow. As shown in Table 1, the LN™ system is capable of reducing the formation of NO_x by 50% with a Tertiary Air flow of 70 klb/hr. The Table also shows that the largest incremental gains are between 0 and 25%, and between 75% and 100% LN™ signal. Tertiary Air ranges from 7% of the total combustion air at 0% LN™ to 22% of the combustion air at 100% output.

Table 1. LN™ Operation with No SNCR

LN Signal	%	0	25	50	75	100
NH3 GPH	gph	0	0	0	0	0
Steam Flow	Klb/Hr	167	176	172	171	168
NOx	ppm	320	236	234	211	159
NOx Reduction	%	0%	26%	27%	34%	50%
CO	ppm	20	18	17	21	15
Tertiary Pressure	inwc	1.7	5.7	9.6	13.5	17.1
Upper Furnace IR Temp	Deg F	1792	1867	1778	1811	1975
Roof Average Temp	Deg F	1666	1672	1667	1640	1638
Lower Furnace IR Temp	Deg F	1692	1731	1773	1808	1921
Tertiary Air Flow	Klb/Hr	22.6	48.25	58.02	67.96	70.4
UFA Flow	Klb/Hr	196.9	196.39	195.47	193.51	193.72
OFA Flow	Klb/Hr	121.71	109.26	96.69	78.61	58.98
Total Comb Air Flow	Klb/Hr	341.21	353.9	350.18	340.08	323.1
Tertiary Air % of Total	%	7%	14%	17%	20%	22%

The flue gas temperatures in the lower furnace are a primary concern with increasing tertiary flows. As seen in Table 1 above, the lower furnace temperature measured by the IR thermometer increased significantly at Tertiary Air flows above 67 klb/hr, suggesting that the limit for ideal LN™ operation would be NO_x controlled to approximately 210 ppm by the LN™ system. Since this was a short term test and test conditions varied, some of the data does not directly trend. For example, the upper IR temperature was higher at the 25% setting than at 50% setting. However, the steam flow was also higher during the 25% testing, which indicates that there may have been a fluctuation in combustion parameters.

4.2 SNCR Performance

After the LN™ system demonstrated NO_x emissions were reduced from unabated values of 280-340 ppm to levels in the range of 150 ppm to 170 ppm, the SNCR system was operated to further reduce the NO_x.

To determine the efficiency of the SNCR system it is assumed that nearly all of the NO_x is present as NO and the following equation is assumed to be the primary reaction for the NO and ammonia in the boiler.

$$4NH_3 + 4NO + O_2 \rightarrow 4N_2 + 6\ H_2O$$

This equation shows that one mole of NH3 is required to remove one mole of NO. Making assumptions for boiler efficiency and incorporating the steam flow and enthalpy gain, a heat input to the boiler (Million BTU/hr) can be calculated. The flue gas flow can then be estimated by using a Fuel F-Factor for MSW of 14389 (dry standard cubic feet of flue gas at 7% O_2 per million BTU of heat input). This information and the NO_x ppm can be used to calculate the pounds of NO_x emissions.

For a given LN™ setting, the ammonia flow was adjusted incrementally to observe the impact on NO_x emissions. The NO_x reduction and the ammonia flow are converted to moles and a ratio of the moles of NH_3 consumed per mole of NO_x removed can be calculated. This molar ratio is known as the Normalized Stoichiometric Ratio (NSR). Operating at an NSR of one, there is sufficient NH_3 to theoretically remove all of the NO_x in the flue gas. Since this is not the only reaction path taken by all of the NH_3, some NH_3 passes through without reacting and some "burns" to create NO, removing all of the NO_x at an NSR of 1 is not possible. Industry data to date indicates that at an NSR of 1, a reduction of 50% can be anticipated. Figure 7, from an EPA paper prepared by Radian Corporation "*NO_x Control Technologies Applicable to Municipal Waste Combustion*" shows the relationship of NSR to % NO_x removal for a number of WTE facilities. Typically, as the NSR increases above 2, the incremental gain in NO_x reduction does not justify the additional ammonia. Additionally, ammonia slip will typically increase when operating at the higher NSR.

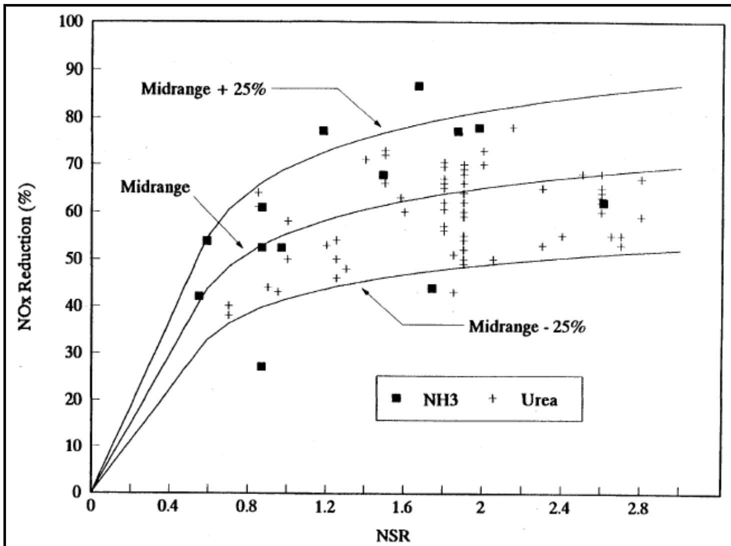


Figure 3-4. Effect of Reagent Feedrate on SNCR Performance

Figure 7. NSR For Other Waste-to-Energy Plants

The following Table 2 provides the results of the SNCR testing at various LN™ settings at the Montgomery facility. The Table also shows the steam flow and key operating temperatures.

Table 2. LN™ Operation With SNCR

TEST COMBINATION			Temperatures (°F)						Reduction		Combustion Air Flow		
		Steam Flow	R Temperature		Thermocouples		NOx	NH3 Slip	Total	SNCR	UFA	OFA	Tert
LN %	NH3 GPH	Klb/Hr	Upper	Lower	Sidewall	Roof	ppm	ppm	%	%	Klb/Hr	Klb/Hr	Klb/Hr
0	**0**	167	1792		1641	1627	300	2.23		0%	197	122	23
0	**10**	172	1721		1624	1624	225	1.58	25%	25%	194	124	23
0	**20**	171	1894	1882	1660	1637	170	1.75	43%	43%	191	123	27
0	**30**	162	1701		1601	1612	156	1.91	48%	48%	190	118	23
0	**40**	171	1707		1608	1636	142	2.37	53%	53%	193	122	25
25	**0**	176	1867		1682	1642	236	1.58	21%	0%	196	109	48
25	**20**	173	2023	1779	1718	1617	174	1.83	42%	26%	193	107	51
25	**30**	174	1828		1639	1667	113	2.74	62%	52%	188	110	48
25	**40**	173	1661		1668	1596	96	2.05	68%	59%	190	108	50
50	**0**	172	1778		1775	1640	234	1.61	22%	0%	195	97	58
50	**10**	169	1621		1753	1583	208	1.41	31%	11%	195	96	57
50	**20**	169	1760	1687	1749	1581	171	1.89	43%	27%	191	97	57
50	**30**	172	1640		1751	1595	154	1.83	49%	34%	189	97	58
75	**0**	171	1811	1808	1768	1610	211	1.47	30%	0%	194	79	68
75	**10**	167	1825	1849	1778	1608	152	1.49	49%	28%	196	78	67
75	**20**	165	1930	1755	1739	1594	117	1.42	61%	45%	197	76	66
75	**30**	171	1882	1780	1771	1606	92	1.70	69%	56%	195	79	67
75	**40**	170	1844	1817	1739	1567	66	2.16	78%	69%	193	80	66
100	**0**	168	1975	1921	1755	1612	159	1.69	47%	0%	194	59	70
100	**10**	170	1976	1998	1743	1601	128	1.51	57%	19%	191	61	71
100	**20**	171	1999	2177	1760	1619	96	1.52	68%	40%	192	61	71
100	**30**	172	2052	2197	1771	1636	77	3.05	74%	52%	192	61	71
100	**40**	168	1978	2071	1771	1634	50	7.48	83%	69%	191	61	70

The data representing the SNCR performance is presented in Figures 8 and 9. These graphs show that a 50% reduction of the NO_x produced at each of the LN™ settings is achievable at an NSR between 1 and 1.5. It appears that a higher NSR is required for increased LN™ settings. This may be a function of the lower baseline NO_x for the higher LN™ settings (LN™ reducing the formation of NO_x). The data set collected at the 50% LN™ setting did not appear to be consistent with the balance of the test data.

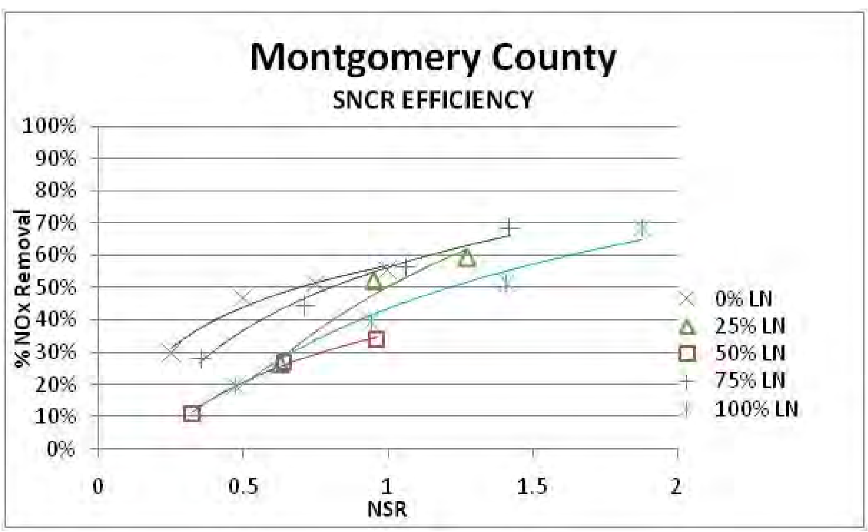


Figure 8. SNCR Efficiency at Various LN™ Settings

The following Figure shows that a 50% reduction in the remaining NO_x is achievable under nearly all LN™ settings with an ammonia flow in the 30-40 gpm range.

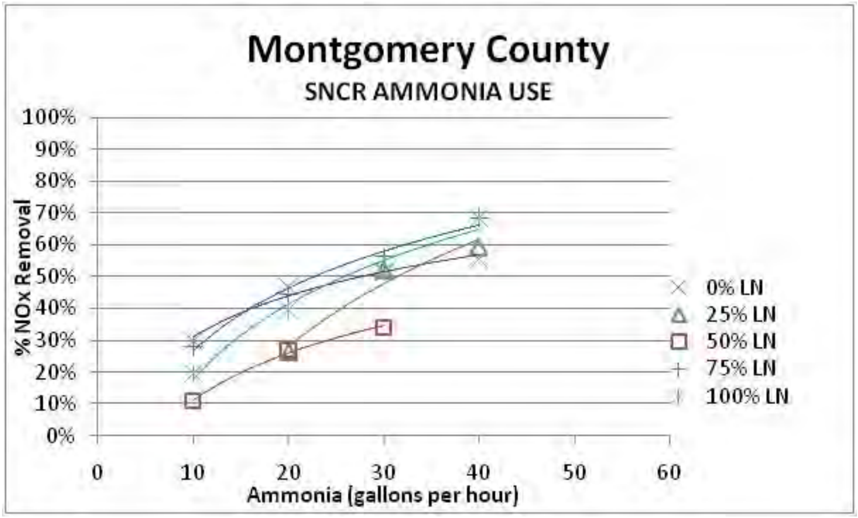


Figure 9. SNCR Ammonia Consumption

Based on an unabated NO_x of 320 ppm, a 55% to 60% total NO_x reduction is required to achieve the proposed140 ppm permit limit. The figures suggest that a 60% reduction of NO_x could be possible with LN™ settings as low as 25% setting. For LN™ settings under that value, the data did not demonstrate the capability to achieve the desired reduction without additional ammonia. It is important to note that variations in unabated NOx conditions were not quantified, and these variations cannot be controlled.

Figures 10 and 11 are provided to show the overall NO_x removal efficiency of the combined LN™/SNCR systems. The unabated NO_x levels used in these calculations and graphs use the data that was recorded during the limited unabated testing that was performed in October 2009.

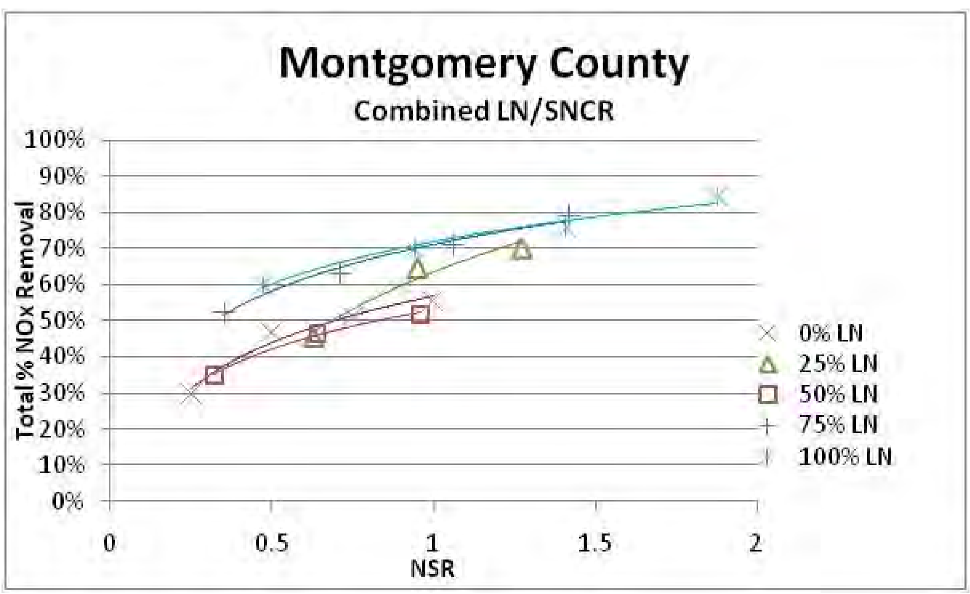


Figure 10. Combined Performance LN™/SNCR - NSR

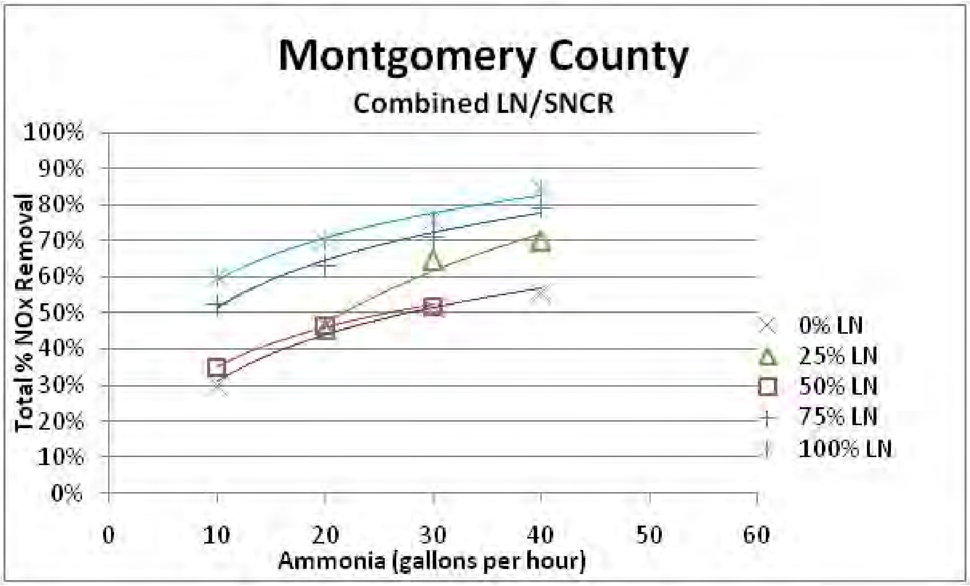


Figure 11. Combined Performance LN™/SNCR - Consumption

There are a number of factors that affect the performance and operation of SNCR systems. These factors include:

- **Variations in the unabated NO_x levels -** With other factors held constant, at higher unabated NO_x levels, more ammonia will be required to achieve a NO_x setpoint.
- **Temperature at injection elevation.** The optimum temperature "window" for ammonia injection is between 1,600°F and 1,800°F.
- **Reagent distribution within the flue gas.** Typically, improved distribution of the reagent within the flue gas results in increased the removal efficiency. Distribution can be affected by the number of injection nozzles, spray patterns and spray penetration. The 5 lances at the Montgomery facility appear sufficient.
- **Droplet size.** The size of the droplet will impact the rate the droplet evaporates and how far the droplet penetrates and mixes with the flue gas. Droplet size is determined by nozzle selection and operating pressures.
- **Spray Impingement**. If the spray pattern allows the ammonia to impinge on boiler tubes due to insufficient pressure (tubes in close proximity to the nozzle) or high pressure (tubes on opposite wall) corrosion can be accelerated and the ammonia may not be used effectively.

- **Residence time after injection (>.5 seconds**). If the ammonia is injected into an area where there is insufficient flue gas residence time at the elevated temperatures the reaction efficiency will be reduced.

- **Flue gas composition (O2 and CO).** Low Oxygen concentrations, as well as high CO concentrations in the flue gas have the potential to impact the performance of the SNCR system.

- **Variations in heat release rates and steam flows.** Variability in waste fed to the boiler will result in fluctuation in heat release on the grate and steam flows. These variations will also impact the formation of NO_x and the temperature and flue gas flow patterns at the injection elevation.

- **Access limitations**. The nozzles should be inspected and replaced on a routine basis. Access to the nozzles, clearance to pull and inspect the nozzles, and operator safety, need to be considered when selecting nozzle placement.

The LN™ system is scaled to operate in the range of Tertiary Air flows from 20 to 81 klb/hr, or approximately 7% to 22% of the total Combustion Air flow. Increasing this flow or percentage will reduce the formation of NO_x to levels below 150 ppm and will reduce the amount of ammonia required in the SNCR system. However, at Tertiary Air flows above 20% of the total combustion air flow, the temperature in the lower furnace increases and the inconel and refractory life will be reduced, increasing operations and maintenance costs and potentially resulting in unscheduled outages.

5 Historical Data

The plant has been operating in the combined LN™/SNCR Mode for the past 6 years. The following graph depicts the 24-hour block average NO_x emissions for the period of January 2010 through December 2015.

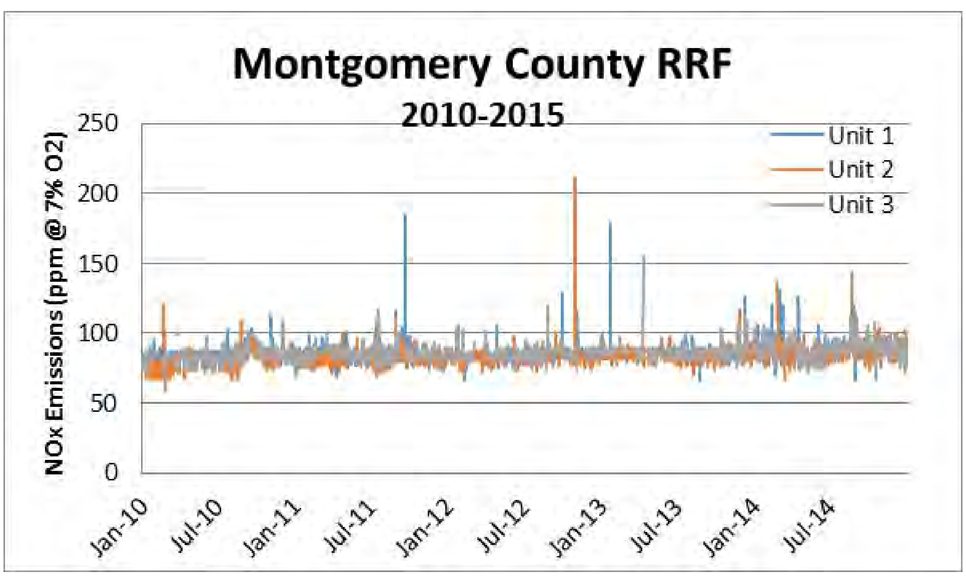


Figure 12. 5-Year Operating Data

During this period the boilers have typically been controlled to 24-hour block average NO_x levels less than 100 ppm. However, there have been spikes above this level. Removing periods of startup and shutdown from the data set does remove many of the spikes; however, some high NO_x values remain after taking out these periods. These are generally attributable to variations in uncontrolled NO_x, and/or other variations beyond the control of the operators.

It has been proposed that a new 24-hour block average NO_x emission limit of 140 ppm at 7% O2 be imposed on the Facility. Based on the historical data since 2009, and the preliminary optimization testing performed in 2009, this 140 ppm level would be achievable by the Facility and would provide sufficient latitude for uncontrollable conditions. In the event that an ammonia analyzer is required by new regulation in the future, and if a continuous NH_3 permit limit is imposed, it could impact the ability of the Facility to achieve a NO_x limit below the 140 ppm while simultaneously meeting any newly imposed ammonia limit.

6 Conclusion

The Montgomery County Facility has preemptively installed an aggressive NO_x control system consisting of a LN™ system to reduce the formation of NO_x and the installation of an SNCR system to reduce the NO_x that is formed. A new limit of 140 ppm (at 7% Oxygen), measured as a 24-hour block average, is a reasonable target and should be considered for the new RACT limit. While the Facility has demonstrated satisfactory operation for extended period of time at levels in the 110-120 ppm range, individual unit spikes are unavoidable. Reducing the permit limit from 180 ppm to a level lower than 140 ppm (measured as a 24-hr block average) could result in increased O&M costs and the potential for excess emissions that may not be representative of normal operation of the MCRRF.

7 References

US Environmental Protection Agency, US Department of Energy Efficiency, Conservation and Renewable Energy- NO_x Control Technologies Applicable to Waste Combustion, prepared by D.M. White, K.L. Nebel, M. Gundappa, and K.R. Ferry, Radian Corporation, Research Triangle Park, NC. December 1994.

KEEP PERMIT AT SITE

CONTROL NO. B- 04209

State of Maryland

Martin O'Malley
Governor

Robert M. Summers, PhD
Secretary

DEPARTMENT OF THE ENVIRONMENT

Air and Radiation Management Administration
1800 Washington Boulevard, Suite 720
Baltimore, MD 21230

[ ] Construction Permit

[X] Part 70 Operating Permit

PERMIT NO.	24-031-01718	DATE ISSUED	March 1, 2014
PERMIT FEE	To be paid in accordance with COMAR 26.11.02.19B(b)	EXPIRATION DATE	October 31, 2018

LEGAL OWNER & ADDRESS

Northeast Maryland Waste Disposal Authority
100 S. Charles Street, Tower II, Suite 402
Baltimore, MD 21201
Attn: Steve Blake, Project Manager

SITE

Montgomery Co. Resource Recovery Facility
21204 Martinsburg Road
Dickerson, MD 20842
Montgomery County
AI#17118

SOURCE DESCRIPTION

The facility consists of three (3) furnaces, each with a separate air pollution control system, storage silos, hydrated lime and dolomitic lime.

This source is subject to the conditions described on the attached pages.

Program Manager

Director, Air and Radiation Management Administration

MDE/ARMA/PER.009 (Rev. 10-08-03)

(NOT TRANSFERABLE)

TABLE B: **Emission Standards; Facility Wide Performance Requirements Applicable during Startup, Shutdown and Malfunction Periods**

Pollutant/ Parameter	*Emission Standard for a Large MWC*	*Performance Requirements*
SO_2 (Sulfur Dioxide)	60.3 lbs/hr timed average mass loading over a 3-hour period on a facility wide basis beginning with a start-up, shutdown and/or malfunction operation period. **Authority:** PSD Approval (2-14-92, amended 6-18-2013)	CEMS. Methods and procedures as specified in 40 CFR 60.58b(e). **Authority:** 111(d) plan-COMAR 26.11.08.08A(2)
NOx (Oxides of Nitrogen)	260 lbs/hr timed average mass loading over a 24-hour period on a facility wide basis beginning with a start-up, shutdown and/or malfunction operation period. **Authority:** PSD Approval (2-14-92, amended 6-18-2013)	CEMS. Methods and procedures as specified in 40 CFR 60.58b(h). **Authority:** 111(d) plan-COMAR 26.11.08.08A(2)
CO (Carbon Monoxide)	A. 176 lbs/hr timed average mass loading over a 1-hour period on a facility wide basis beginning with a start-up, shutdown and/or malfunction operation period B. 87.9 lbs/hr timed average mass loading over a 4-hour period on a facility wide basis beginning with a start-up, shutdown and/or malfunction operation period C. 44.0 lbs/hr timed average mass loading over a 24-hour period on a facility wide basis beginning with a start-up, shutdown and/or malfunction operation period **Authority:** PSD Approval (2-14-92, amended 6-18-2013)	CEMS. Methods and procedures as specified in 40 CFR 60.58b(b) and 40 CFR 60.58b(i)(1) - (5). **Authority:** 111(d) plan-COMAR 26.11.08.08A(2)

Appendix E – Wheelabrator Baltimore, Inc.

KEEP PERMIT AT SITE

CONTROL NO. B- 04297

State of Maryland

Martin O'Malley
Governor

Robert M. Summers, Ph.D.
Secretary

DEPARTMENT OF THE ENVIRONMENT

Air and Radiation Management Administration
1800 Washington Boulevard, Suite 720
Baltimore, MD 21230

[ ] Construction Permit

[X] Revised Part 70 Operating Permit

PERMIT NO. 24-510-01886 A

DATE ISSUED April 1, 2014

PERMIT FEE To be paid in accordance with COMAR 26.11.02.19B(b)

EXPIRATION DATE August 31, 2019

LEGAL OWNER & ADDRESS
Wheelabrator Baltimore, L.P.
1801 Annapolis Road
Baltimore, MD 21230
Attn: Mr. David Jones, Plant Manager

SITE
Same

Baltimore City
AI#472

SOURCE DESCRIPTION

Municipal waste combustor.

This source is subject to the conditions described on the attached pages.

Program Manager

Director, Air and Radiation Management Administration

MDE/ARMA/PER.009 (Rev. 10-08-03)

(NOT TRANSFERABLE)

Table IV – 1

(i) Combustion theory;

(j) Air pollution control technology;

(k) Continuous emission monitors and their calibration, and quality assurance requirements [**Authority:** COMAR 26.11.08.09D(1)].

3. For the operator of any municipal waste combustor (MWC), completing a training course means:

   (a) Completing an initial training course approved by the Department of at least 5 days (40 hours) duration; and

   (b) Passing a written test approved by the Department. [**Authority:** COMAR 26.11.08.09D(2)]

4. The certified operator shall, after initial training, complete and pass an annual review course approved by the Department of at least 1-day (8 hours) duration [**Authority:** COMAR 26.11.08.09D(4)].

5. Operations and Maintenance Manual.

   (a) The owner or operator of a large MWC shall develop and maintain on-site, an operations and maintenance manual that contains, at a minimum, all of the course content requirements in COMAR 26.11.08.09D(1) and in 40 CFR §60.54b(e).

   (b) The operations and maintenance manual shall be updated annually. [**Authority:** COMAR 26.11.08.09H(1)&(2)]

C. PSD Approval 83-01 (Feb. 21, 1986)

1. The Permittee shall not exceed the facility-wide (MWC Units #1, 2 & 3) emissions limitations specified below [**Authority:** PSD Approval 83-01, Part I, Condition (1)]:

SO_2:	375 lbs./hr. and 1,478 tons/year
CO:	121 lbs./hr. and 477 tons/year
NOx:	298 lbs./hr. and 1,176 tons/year
Fluorides:	12 lbs./hr. and 47 tons/year

   (a) Compliance with the facility wide lbs./hr PSD emission limit shall be determined as follows [**Authority:** COMAR 26.11.02.02H]:

      - SO_2, CO and NOx: 8 hour block average. A valid facility eight hour block average is based on a minimum of 6 hours of total facility hourly data.

Table IV – 1	
	• Fluorides: the average of three test runs using EPA Reference Method 13B, 26A, or equivalent • All emissions associated with startup, shutdown, and malfunction episodes are included in the pounds per hour standard (b) The tons per year PSD emission limits are a 12-month composite (rolling monthly) and includes all emissions associated with startup, shutdown, and malfunction episodes [**Authority:** COMAR 26.11.02.02H]. 2. The Permittee shall develop and submit to the Department for approval, procedures to ensure that only acceptable wastes as defined in Appendix A of the PSD application are incinerated [**Authority:** PSD Approval 83-01 Part I, Condition (4)]. 3. The start-up fuel for the incinerator shall be natural gas. The incinerator shall not exceed a fuel consumption rate of 2.7 x 10^7 $ft.^3$ of natural gas in any one-year period [**Authority**: PSD Approval 83-01 Part I, Condition (5)]. **D. NSINA Approval No. 83-01 (Feb. 21, 1986)** Each furnace shall be equipped with electrostatic precipitators that shall be operated such that the particulate grain loading at the outlet ends of the ESP complies with the 0.017 gr/dscf particulate matter emission standard for large MWCs [**Authority:** NSINA Approval 83-01 Condition (3)]. Note: compliance with the existing Large MWC particulate emission limit of 25 mg/dscm (0.01093 gr/dscf) and testing, recordkeeping and monitoring requirements under COMAR 26.11.08.08A(2) assures compliance with the NSINA limit. **E. Visible Emissions** No emissions, other than water in an uncombined form, visible to human observers. The no visible emission requirement does not apply to emissions during start-up, or adjustments, or occasional cleaning of control equipment, if: (1) the visible emissions are not greater than 40 percent opacity; and (2) the visible emissions do not occur for more than 6 consecutive minutes in any 60 minute period **[Authority: COMAR 26.11.08.04B&C]**.
1.2	**<u>Testing Requirements</u>:** **A. Existing Large MWC Emission Limits** The Permittee shall comply with the testing requirements for the emissions and operational parameters in accordance with the test methods and specified frequencies referenced in **Table IV-1A** for existing large MWCs no less than 9 months and no more than 15 months following the previous test [**Authority:** COMAR 26.11.08.08A(2)].

Final Report

NO_x Control System Optimization

at the Wheelabrator Baltimore WTE Facility

1 Executive Summary

Quinapoxet Solutions has completed a NOx emission-control system optimization program at Wheelabrator Baltimore on Boiler 1 and 2. The program involved conducting furnace temperature profiles and adjusting SNCR NOx-control system parameters to achieve the lowest sustainable emission level. The two boilers selected represented "clean" (Boiler 1) and "dirty" (Boiler 2) heat transfer surfaces and therefore would encompass the full range of expected furnace temperatures for which the SNCR systems would have to operate.

Furnace temperature profiling verified that furnace temperatures at the fourth floor furnace elevation were not imposing any limitations on the NOx control system as furnace temperatures seldom deviated from the ideal range for effective NOx control. However, it was confirmed that furnace gas flows favored the rear wall at the urea injection level. With the as-found configuration of using injectors mounted in each corner of the furnace on the 4th floor, NOx could be controlled to meet existing limits but further NOx reductions would be hard to achieve and maintain. During the optimization tests, doubling or even tripling reagent flow rates using the existing four corner injectors only reduced NOx emissions from an average of 185 ppm (7% O2) down to about 175 ppm (7% O2) on either boiler and is consistent with typical long term SNCR system performance.

When the two front furnace corner injectors were moved to the side walls toward the rear of furnace, additional NOx reduction capability was demonstrated. Boiler 1 achieved about 155 ppm and Boiler 2 achieved around 165 ppm at the same urea flow rates used with the original four corner injector configuration. The difference in performance between the two boilers is attributed to difference in furnace temperature with Boiler 2 being hotter than Boiler 1. Since these optimization results only encompass a couple of days of operation, longer term evaluation is required to determine if these NOx levels can be continuously achieved and if ammonia slip may be generated under some operating conditions.

2 Introduction

Emissions of nitrogen oxides are controlled using a combination of good combustion practice (low excess air/modified staged combustion) and selective non-catalytic reduction (SNCR). Combustion adjustments are made periodically to minimize CO emissions, ensure good fuel burnout and maintain gas temperature at the superheater inlet below the temperature which leads to accelerated corrosion of superheater tubes and premature superheater failure.

Over the years, Quinapoxet Solutions has helped the Wheelabrator Baltimore plant to optimize NOx emissions and boiler performance by measuring furnace temperatures at the elevation where urea is being injected. Temperature is critical for SNCR performance since NOx is only reduced effectively within a narrow range of 1800 to 2100 °F. Equally important, the urea causes ammonia slip emissions if injected at temperatures below 1600° F and forms more NOx than it reduces at temperatures above 2400 °F. Furnace temperatures may change with fuel composition and furnace fouling or slagging, but the plant has been able to compensate by adjusting urea flow rates to maintain compliance with both PSD and MWC NOx limits.

This SNCR evaluation/optimization program was performed to help Wheelabrator determine a source-specific 24-hour average NOx RACT limit that can be continuously achieved through optimization of the existing SNCR system.

Specific objectives of the optimization program were:

- Conduct furnace temperature profiling to verify optimum SNCR temperature window for the range of boiler/furnace conditions
- Evaluate SNCR injector configurations that could maximize NOx removal and urea utilization rate to minimize potential for encountering periods of excess ammonia (NH_3) slip for long term representative boiler operating conditions.
- Provide insight into how temperature and urea distribution affect NO_x control so Plant is better prepared to achieve NOx RACT limit through full range of fuel, furnace and boiler operating conditions throughout the year.

3 Test Approach:

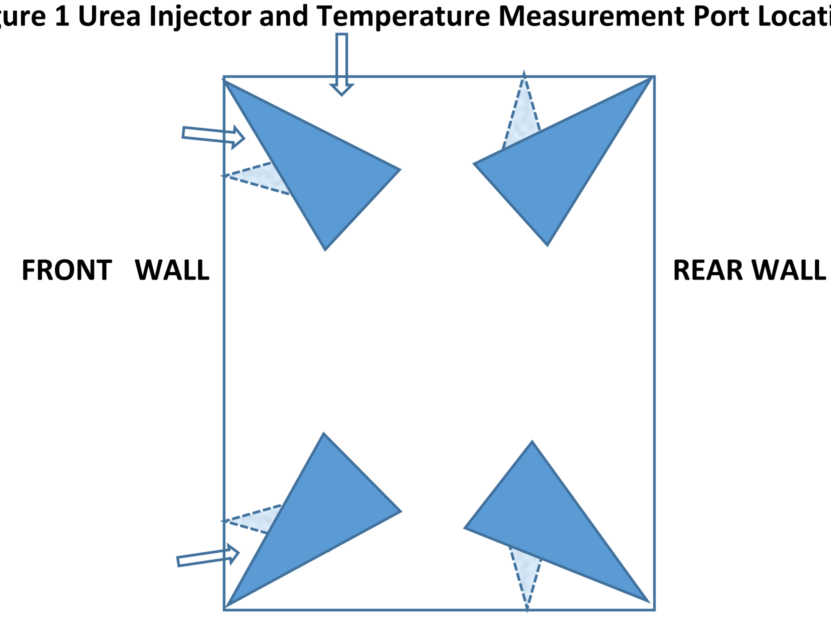
Furnace temperature measurements were made during the week using a unique optical pyrometer called GasTemp. Unlike most optical pyrometers that detect infrared radiation given off by CO2 in the gas stream, the GasTemp measures the intensity of light given off ash particles in the visible part of the spectrum. Whereas infrared CO2 based optical pyrometers have a characteristic focal length leading to a “point” or short path average temperature reading, ash particles radiate as a cloud such that the measured temperature is more of a line of sight average across the full width of the furnace. This average “full width” temperature is more representative of the entire furnace gas stream and has proven more appropriate for SNCR system optimization.

At Baltimore, furnace temperature readings were obtained by inserting the GasTemp into existing furnace access ports on the 4th Floor. One port is located on the side wall of the boiler directly opposite the gas burner at nearly the same furnace elevation as the four (4) large corner urea injectors currently used for NO_x control. As such the furnace temperatures at this port should directly relate to SNCR operating conditions for the side wall injectors. Two other access ports located on the front wall near the corners were also used. These ports were expected to yield slightly lower temperatures characteristic of the front wall corner injector location given that the flue gas flow path favors the rear furnace wall and lower furnace temperature would be expected near the front of the furnace.

NO_x optimization was performed by changing injector configurations. Urea flow rates were then varied with the different injector configurations from 5 gallons per hour to 15 gallons per hour. Baseline NOx data was obtained periodically by shutting off the urea for brief periods.

Figure 1 below shows the available urea injectors that can be used on all three boilers to control NOx emissions. Each boiler has four large injectors located in the four (4) furnace corners (dark blue cones) and four small injectors (light blue cones) that can be utilized in front and side walls. The small injectors have flow capacity of approximately 1/3 of the large injectors. The four large corner injectors is the base line injector configuration used on all three boilers for the past several years and represents the starting point for the NOx optimization program. The use of smaller injectors in side walls was also included in the evaluation.

Figure 1 Urea Injector and Temperature Measurement Port Locations



4 Test Results

4.1 Preliminary NOx Data Analysis:

The Plant collected preliminary data on SNCR performance in the weeks leading up to the proposed optimization program by increasing urea flow rates incrementally while looking at the NO_x reduction and signs of possible ammonia slip.

- **Boiler 1:** In February, an injection rate of 9 GPH resulted in a daily average NOx emission reduction of 22 % from 194 ppm down to 151 ppm.
- **Boiler 2:** In February, 6 GPH reduced NOx from 205 ppm to 171 ppm (17 %), and 9 GPH took the NOx down to 157 ppm (23 %).

No signs of ammonia slip (ash odor or detached stack plume) were noted during these tests. Though uncontrolled NOx emissions were different on the two boilers, emission reduction percentages were comparable. We decided to use these test conditions as the starting point for the optimization work described below.

4.2 Furnace Temperature Profiling:

For maximum urea utilization and minimal ammonia slip, urea must be injected within the middle of this optimal range (1800-2100 °F). Table 1 summarizes a statistical analysis (mean temperature plus or minus one standard deviation) of the temperature data obtained during the tests. The figures that follow illustrate how these temperatures fluctuate within the optimum temperature range for effective NOx reduction.

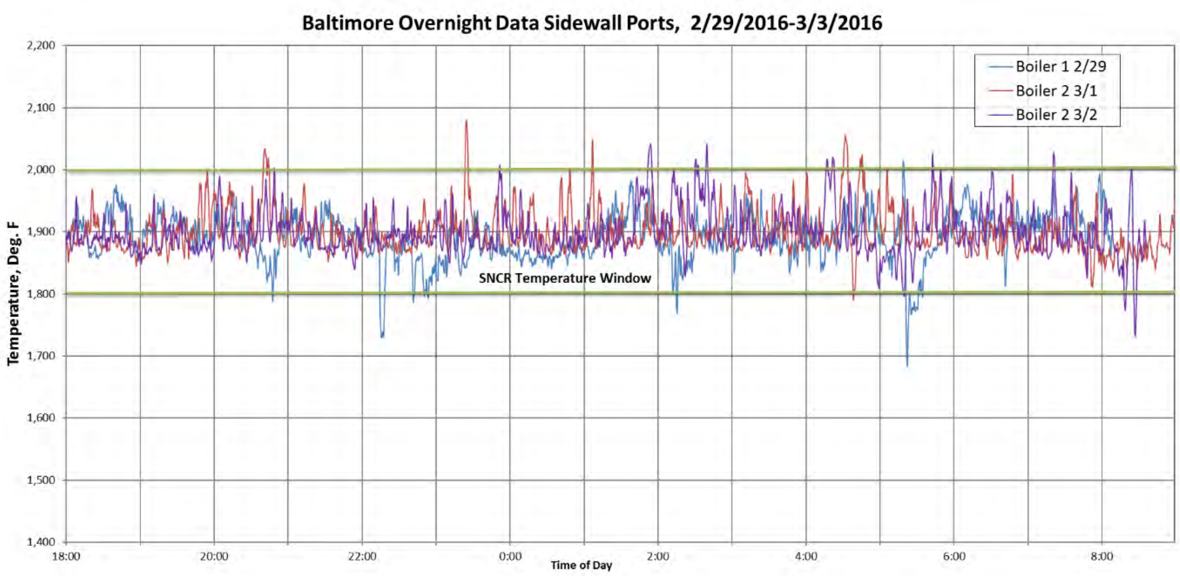
Table 1. Furnace Temperature Summary

Boiler	Date	Port	Temperature, °F	Comments
1	2/29	Side	1891 ± 37	Over night
1	3/1	Left front	1796 ± 35	
1	3/1	Right front	1818 ± 45	
1	3/3	Side	1917 ± 40	195 klb/h steam flow
2	3/1	Side	1899 ± 34	Over night
2	3/2	Side	1900 ± 36	Over night
2	3/2	Left front	1856 ± 22	
2	3/2	Right front	1874 ± 26	

Boiler 2 temperatures were expected to be higher than Boiler 1 temperatures since Boiler 1 had just come back on line after an outage and should have had cleaner tube surfaces. However, Boiler 2 was only slightly hotter when both Boilers were producing the same steam flow of 192,000 lb/h as shown in Table 1. Boiler 1 temperature increased about 30 F when steam flow was increased to 195,000 lbs/hour.

Figure 2 below compares the temperature fluctuations in each boiler as measured at full load overnight. Boiler 1 was monitored on February 29 and March 2 while Boiler 2 was monitored on March 1. This figure shows that even though the average temperatures were similar, Boiler 1 had more temperature excursions below 1800 F while Boiler 2 had more excursions above 2000 F. However, for the vast majority of the time both Boilers were operating in the middle of the effective SNCR window confirming that current injector locations on 4th floor are optimum for effective SNCR operation.

Figure 2 Temperature Comparisons for Boilers 1 and 2



Temperatures measured through the front wall ports in Boiler 1 were not as favorable for effective SNCR performance. Figure 3 shows that temperature fluctuations below 1800 F were fairly frequent in the front corners of Boiler 1. Based on temperatures alone, the rear side wall urea injectors should be more effective than the front corner injectors currently in use. Since this was not the case for Boiler 2 (see Figure 4), the difference was presumed to be that Boiler was had cleaner furnace walls with more effective heat transfer.

Figure 3 Boiler 1 Temperatures Front Corner Ports

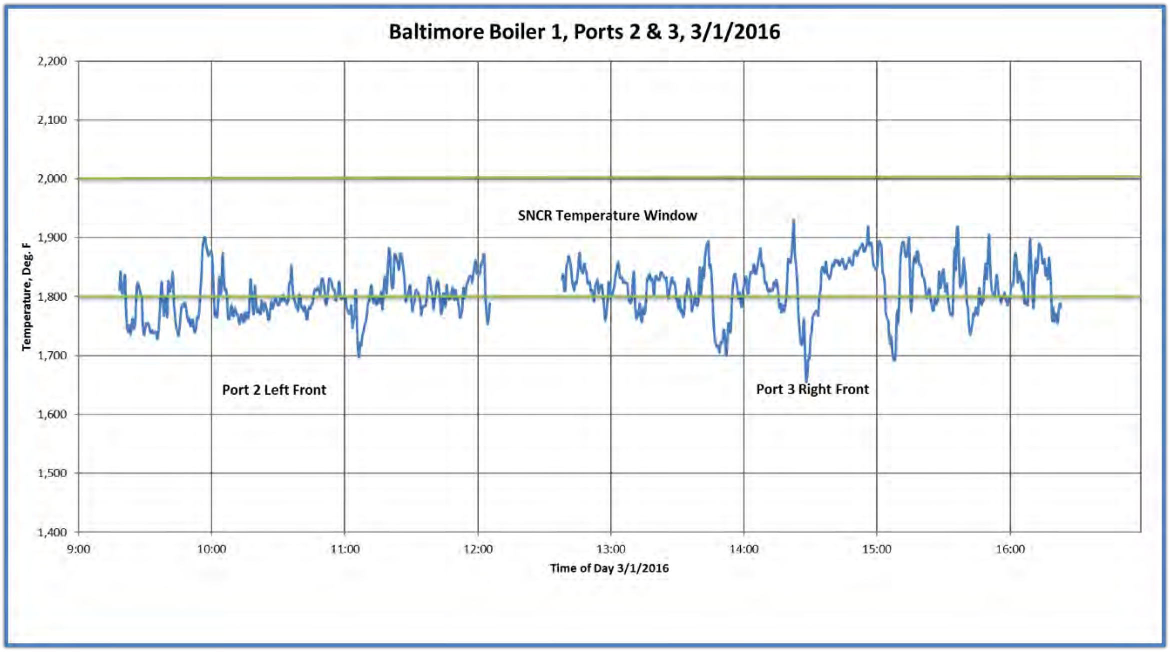
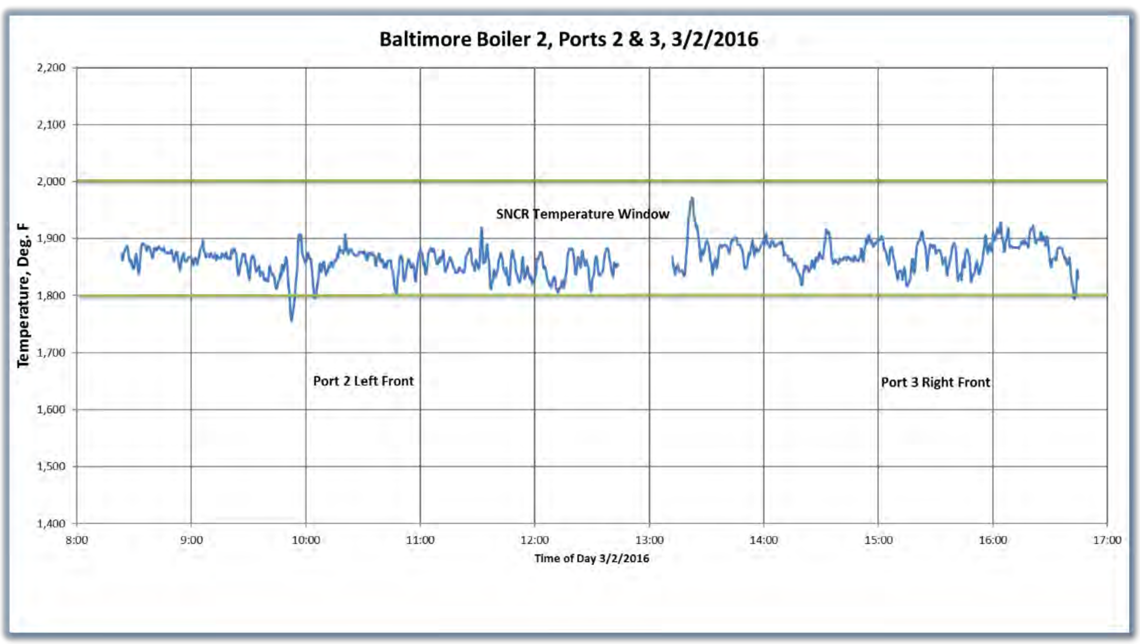
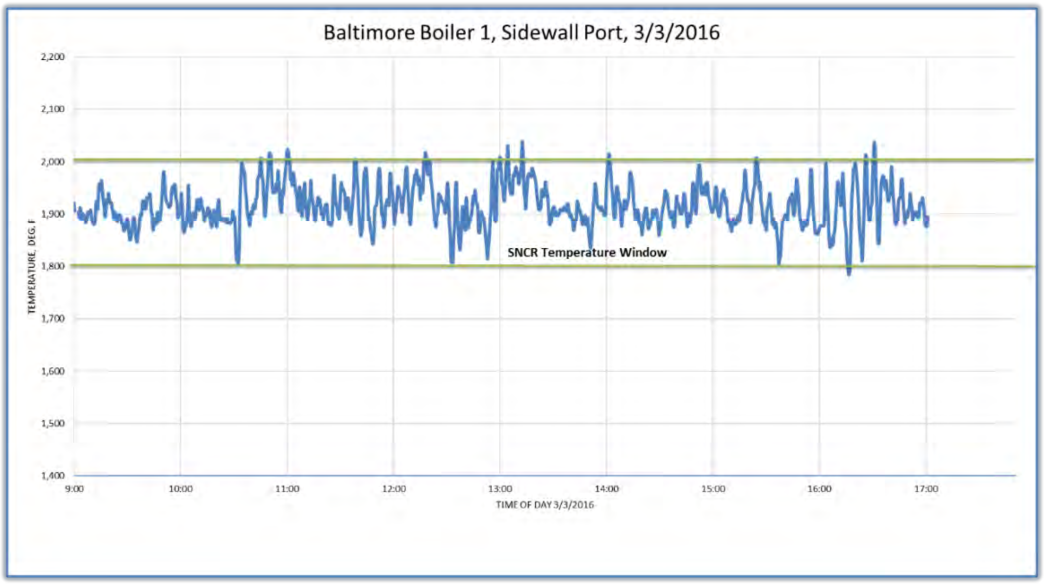


Figure 4 Boiler 2 Temperatures Front Corner Ports



As mentioned above, slightly higher temperatures were measured in Boiler 1 on March 3 when the NOx optimization was taking place. The temperature fluctuations as measured in the side wall port by the GasTemp are shown on Figure 5. These temperatures are still in the range required for SNCR to be effective.

Figure 5 Boiler 1 Temperatures during NOx Tuning



4.2 NO_x Optimization Results:

Tuning the SNCR system takes three factors into consideration:

- Temperature: injecting the urea reagent at 1800-2100 °F,
- Mixing: maximizing the coverage to insure contact between the reagent and NOx,
- Time: providing enough residence time at temperature after mixing to achieve reaction.

Figure 6 shows typical furnace gas flow and temperature profiles for the Baltimore boilers. It can be seen that much of the gas flow favors the rear half of the furnace at the 4th floor elevation where the SNCR injectors are located. The temperature measurements and furnace flow patterns suggested that urea injection from the furnace side walls toward the rear of furnace wall would be more effective than from the front wall corner ports. Subsequent optimization testing showed the following results as summarized in Table 2. Detailed results are provided in Table 3 at end of report.

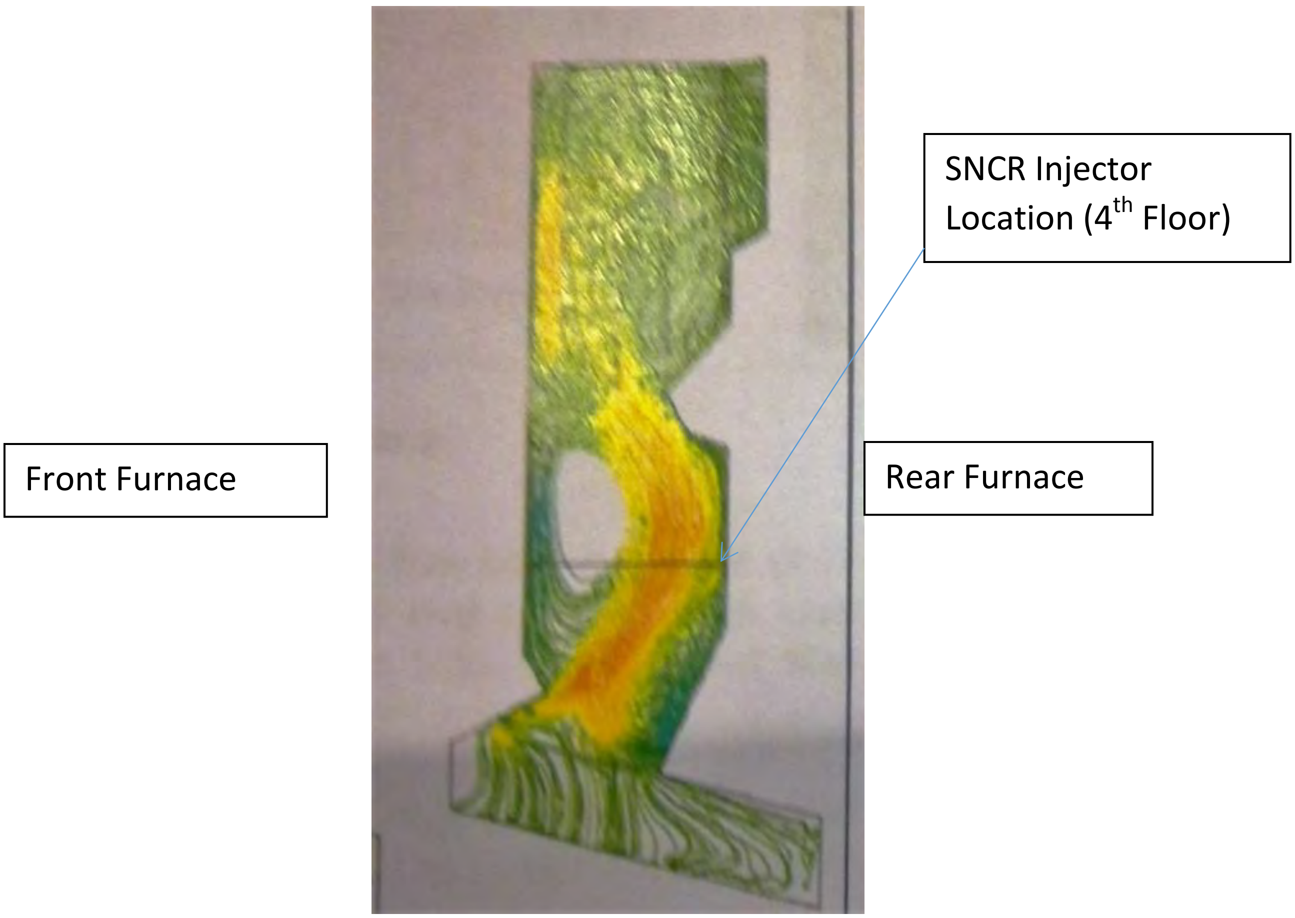


Figure 6 Typical Boiler Furnace Flow

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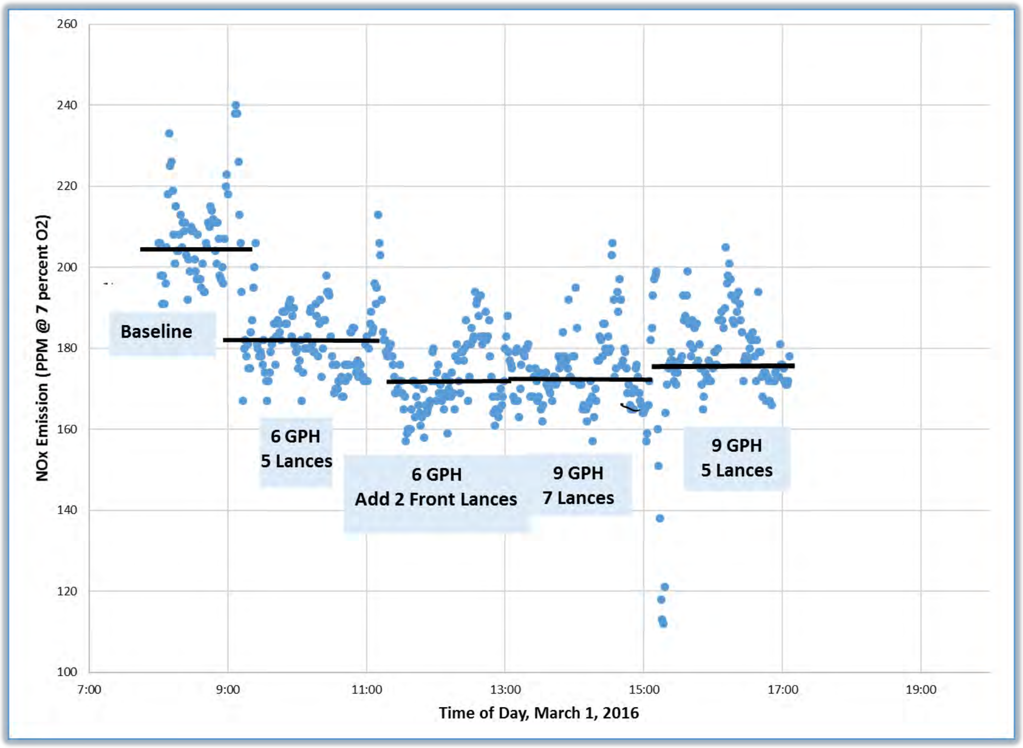
Table 2 NOx Optimization Results Summary

Date	Boiler	Urea Flow, GPH	NOx, PPM	NOx Reduction, %	Utilization, %	Comments
3/1/16	1	0	206	n/a	n/a	Baseline
3/1/16	1	6	182	11.7	30	4 injectors in corners, 1 on side (normal or as found)
3/1/16	1	6	173	16.0	42	4 injectors in corners, 1 on side, 2 on front
3/1/16	1	9	174	15.5	27	4 injectors in corners, 1 on side, 2 on front
3/1/16	1	9	177	14.1	24	4 injectors in corners, 1 on side
3/2/16	2	0	224	n/a	n/a	Baseline
3/2/16	2	9	193	13.8	26	4 injectors in corners (normal or as found)
3/2/16	2	9	192	14.3	27	4 injectors in corners, 1 on each side
3/2/16	2	12	177	21.0	30	4 injectors in corners, 1 on each side
3/2/16	2	12	167	25.4	36	2 rear side wall, 2 rear corners
3/3/16	2	12	157	29.9	42	2 rear side wall, 2 rear corners (overnight avg)
3/3/16	1	0	203	n/a	n/a	Baseline
3/3/16	1	5	165	18.7	57	2 rear side wall, 2 rear corners
3/3/16	1	10	150	26.1	40	2 rear side wall, 2 rear corners
3/3/16	1	15	144	29.1	30	2 rear side wall, 2 rear corners
3/3/16	1	15	150	26.1	27	2 rear side walls only

Initial Boiler 1 Results: Starting on the morning of March 1, the as-found injector configuration on Boiler 1 was evaluated. The baseline or normal injector configuration on Boiler 1 was injection of 6 GPH of urea using the large injectors located in the four corners with one of the smaller injectors was used in the left side wall. The baseline configuration showed a NO reduction of only 11.7%. To improve urea dispersion, two of the smaller injectors were added to the front wall ports and NOx removal increased to 16.0% at the same 6 GPM urea flow rate while utilization increased to 42%. Increasing the urea flow to 9 gpm with this injector configuration did not improve NOx reduction however urea utilization decreased from about 42% to 27%, indicating that the additional urea did not react with NOx and could likely lead to NH3 slip. The NOx results from Boiler 1 preliminary tests are shown in Figure 7.

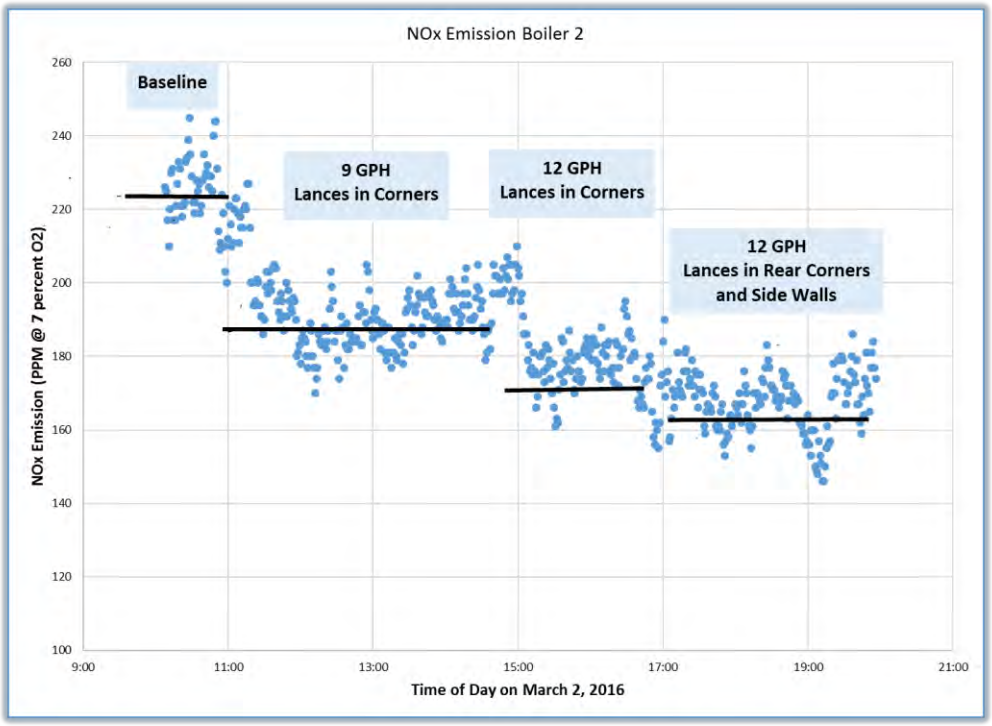
Figure 7 NOx Optimization Results for Boiler 1 on March 1, 2016



<u>Boiler 2 Results</u>: On March 2, optimization testing switched to Boiler 2 while Boiler 1 was down to repair a small economizer tube leak. Using the large injectors in the four furnace corners achieved similar NOx removal as Boiler 1 (14%) at same 9 GPH urea injection rate. Since Boiler 2 uncontrolled NOx was about 20 ppm higher than Boiler 1 resulting controlled NOx was approximately 20 ppm higher (193 ppm) than Boiler 1. Increasing the reagent flow rate from 9 GPH to 12 GPH improved NOx removal from 14% to 21% and reduced NOx to 177 pm, with a slight increase in urea utilization to about 30% indicating some urea was ineffective.

The largest improvement in Boiler 2 NOx removal was achieved by moving the two large injectors from the front corner ports (where there is less gas flow and cooler temperatures) to the furnace side walls about 7 feet from the rear wall. This new injector configuration increased NOx removal to 25 % with an increase in urea utilization to 36% at the same 12 GPH urea feed rate. This injector arrangement was evaluated overnight at 12 GPH urea rate and NOx averaged 157 ppm, with NOx removal at 30 %. The moving of the front corner injectors to furnace rear side walls proved very effective as urea utilization increased from 25% to 36-42%. Boiler 2 results are shown in Figure 8 below.

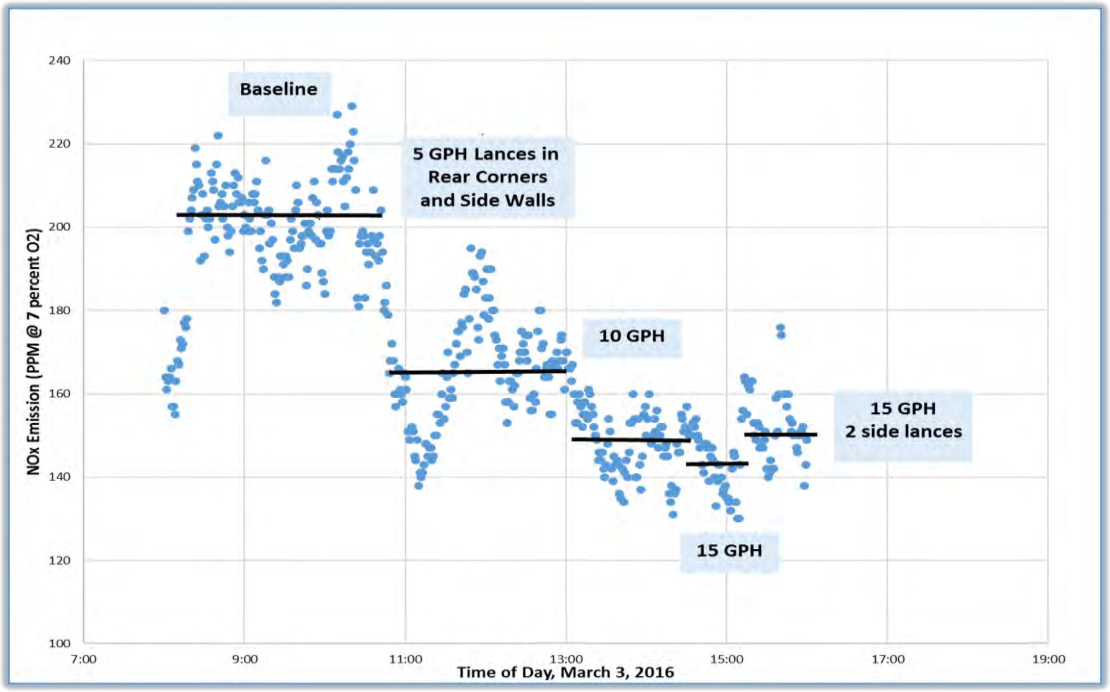
Figure 8 NOx Optimization Results for Boiler 2



<u>Boiler 1 Additional Results</u>: When Boiler 1 came back on line on March 3 further optimization testing was conducted. Based on the Boiler 2 SNCR performance improvement achieved when the two large front furnace corner injectors were moved to the rear furnace side walls, Boiler 1 injectors were configured the same way and urea flow rates of 5, 10, and 15 GPH were evaluated. This new injector configuration also significantly improved Boiler 1 SNCR performance.

At 5 GPH urea feed rate, NOx dropped from 177 ppm to 165 ppm, NOx removal increased from 12% to 19% while urea utilization increased significantly from 30 to 57% compared to the original four corner injector configuration. This improvement demonstrated that the new injector configuration of using 2 rear corner port and 2 rear side wall ports was optimum. Further, at urea flow of 10 GPH, utilization increased to 40% compared to 25% at 9 GPH with old 4 corner injector configuration. Increasing urea flow to 15 GPH dropped utilization from 40% to 30% but provided only a slight increase in NOx removal from 26% to 29% and would not be considered as efficient as 10 GPH urea rate. Finally the two side wall injectors were evaluated at 15 GPH urea flow without the rear corner injectors, but results were not as good as the 4-injector configuration most likely as result of the reduction in urea dispersion in furnace. The additional Boiler 1 results are shown on Figure 9.

Figure 9 NOx Optimization Results Boiler 1 March 3

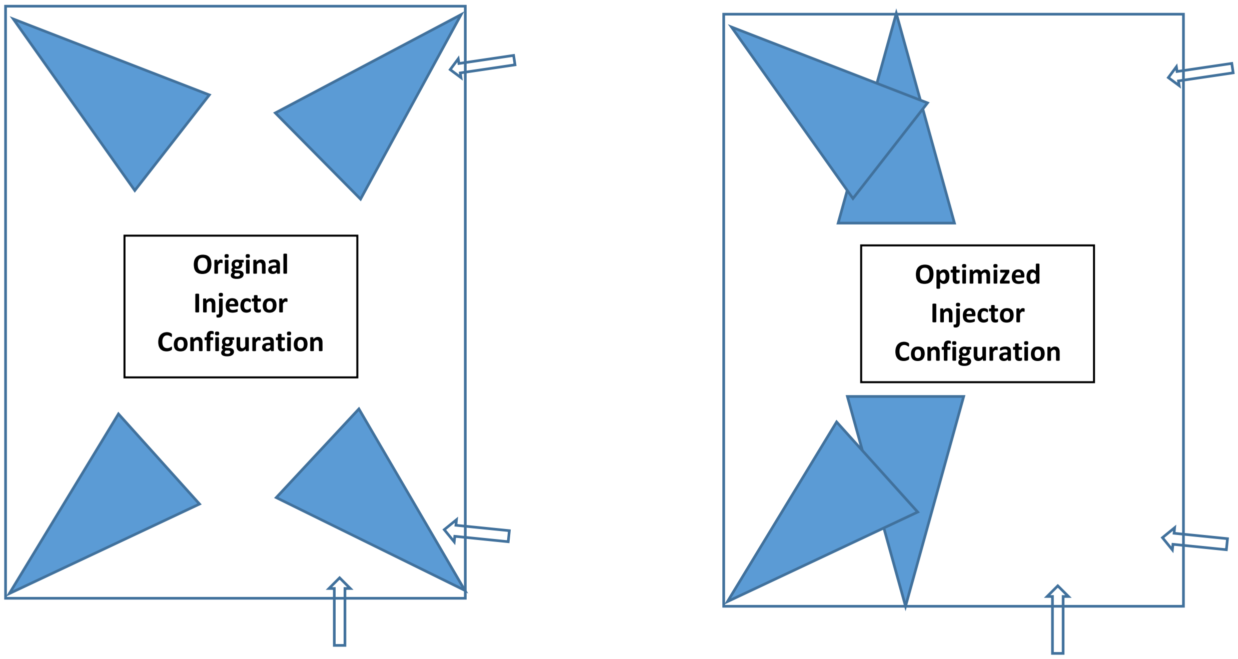


5. **Conclusion**

At full load (around 192 k lb/hour steam flow), furnace temperatures for both boilers at the fourth floor elevation are within the optimum temperature range for effective SNCR operation using urea reagent. Further, even with the normal temperature fluctuations associated with combustion of heterogeneous MSW fuel, furnace temperature fluctuations were neither too high nor too low for effective SNCR NOx control. As expected, Boiler 2 had slightly higher furnace temperatures than Boiler 1 since Boiler 2 had thicker ash deposits on tube surfaces or was more "fouled" as the boiler approached the end of a 6-month run. Comparatively, Boiler 1 was only two weeks into a new run after furnace/boiler cleaning and the more efficient heat transfer would provide for slightly cooler furnace. A more "fouled" boiler with higher temperature will generally produce slightly higher NOx emissions (Boiler 2 uncontrolled NOx was 20 ppm higher than Boiler 1 uncontrolled NOx), but should not change the NOx reduction achievable with SNCR as furnace temperatures at the injector location generally will remain within the SNCR operating range.

The optimization tests demonstrated that urea injection biased toward the rear of the furnace using the 2 rear corner and 2 rear side wall injectors, as shown in Figure 10 below, provided the best improvement in NOx reduction and urea utilization over all other injector configurations.

Figure 10 SNCR Injector Configuration Changes



With the as-found original injector configuration using 4 corner urea injectors, NOx averaged around 175 ppm, NOx removal ranged from 14-21% with urea utilization around 25%. This configuration was sufficient to maintain compliance the PSD permit equivalent limit of about 185 ppm.

Moving the existing front corner large injectors to the rear side walls location significantly improved SNCR system performance at comparable urea injection rates. With this new injector configuration, NOx was reduced to the 150-165 ppm range, NOx removal increased to over 25% and importantly urea utilization increased significantly and approached 40%, which in our experience is close to the practical limit of SNCR performance. Given that any future NOx RACT limit has to be achieved throughout the full range of boiler conditions (cleaned to fouled boiler) The Boiler 2 optimization results would be considered more limiting and therefore would be the basis for long term performance evaluation. As such a NOx ppm setpoint of 165 ppm would be the initial starting NOx RACT limit to be evaluated for long term performance using the new injector configuration.

6. **Recommendations:**

- Continue to operate with reagent injection biased toward the rear of the furnace using the 2 rear corner and 2 rear side wall injectors so that longer term trends in NOx variability and reagent utilization can be developed.
- Urea flow rates should be adjusted to try to achieve the 165 ppm set point for several days on each boiler to account for full range of combustion and operating conditions with clean and fouled boiler.

Summary of SNCR Optimization Program Results

Unit	Date	Steam Flow klbs/hr	Flue Gas dscfm at 7%	Base NOx ppm7%	Cont NOx ppm7%	NOx REM %	Urea gph	Urea lb/hr	NH3 Moles/hr	Baseline NOx lbs/hr	Baseline NOx Moles/hr	NSR	Urea Utili-zation	Comments
Unit 1	3/1/2016	192.0	76804	206	182	11.7%	6.0	28.5	0.95	113.3	2.46	0.39	30%	Test 1: As-Found
Unit 1	3/1/2016	192.0	76804	206	173	16.0%	6.0	28.5	0.95	113.3	2.46	0.39	42%	Test 2: As-Found + 2 front lances
Unit 1	3/1/2016	192.0	76804	206	174	15.5%	9.0	42.8	1.43	113.3	2.46	0.58	27%	Test 3: Same as Above with increased urea
Unit 1	3/1/2016	192.0	76804	206	177	14.1%	9.0	42.8	1.43	113.3	2.46	0.58	24%	Test 4: As-Found with increased urea
Unit 2	3/2/2016	192.0	76804	224	193	13.8%	9.0	42.8	1.43	123.3	2.68	0.53	26%	Test 5: As-Found, increased urea flow
Unit 2	3/2/2016	192.0	76804	224	192	14.3%	9.0	42.8	1.43	123.3	2.68	0.53	27%	Test 6: Add side lances
Unit 2	3/2/2016	192.0	76804	224	177	21.0%	12.0	57.0	1.90	123.3	2.68	0.71	30%	Test 7: Increase urea flow
Unit 2	3/2/2016	192.0	76804	224	167	25.4%	12.0	57.0	1.90	123.3	2.68	0.71	36%	Test 8: Put front lances in side ports
Unit 2	3/2/2016	192.0	76804	224	157	29.9%	12.0	57.0	1.90	123.3	2.68	0.71	42%	Test 9: overnight operation with above lances
Unit 1	3/3/2016	192.0	76804	203	165	18.7%	5.0	23.8	0.79	111.7	2.43	0.33	57%	Test 10: Lances in side ports and rear corners
Unit 1	3/3/2016	192.0	76804	203	150	26.1%	10.0	47.5	1.58	111.7	2.43	0.65	40%	Test 11: increase urea flow
Unit 1	3/3/2016	192.0	76804	203	144	29.1%	15.0	71.3	2.38	111.7	2.43	0.98	30%	Test 12: increase ure flow again
Unit 1	3/3/2016	192.0	76804	203	150	26.1%	15.0	71.3	2.38	111.7	2.43	0.98	27%	Test 13: 2 side lances only

From 2015 Stack Tests

Units	Steam flow klbs/hr	Airflow dscfm7%
1	192	76221
2	192	77797
3	192	76394
Avg	**192**	**76804**

Urea gal	[Urea] %	Urea lb	Urea moles	NH3 moles
1	50.0%	4.75	0.079	0.16

NSR = Ratio of NH3 moles to Uncontrolled or Baseline NOx Moles

Utilization % Moles NH3 reacting with NOx or utilized to Total Moles NH3 injected or

Moles NOx removed divided by Moles NH3 injected x 100

30 Hickory Lane, Windham, NH 03087 (603) 560-1463

Wheelabrator Baltimore NOx RACT Evaluation Report

1.) Overview:

This report is a summary of Wheelabrator Baltimore's efforts to evaluate and determine facility specific NOx RACT emission limits that would be included in the state's 2008 ozone attainment state implementation plan (SIP). Final NOx RACT limits proposed s result of these efforts include both a steady state limit based on 24 hour daily average that could be continuously achieved and an alternative limit that would apply during startups and shutdowns. It is understood both limits would be subject to MDE and USEPA approval. Development of the NOx RACT limits consisted of the following:

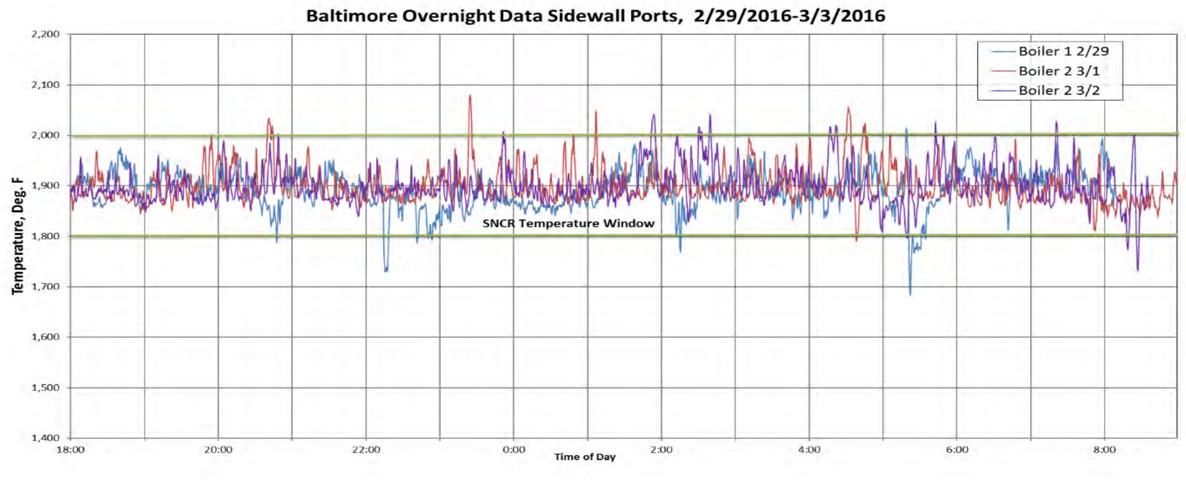
- Optimization testing of the existing Selective Non-Catalytic Reduction (SNCR) NOx control system to determine an initial steady state target NOx RACT limit. Optimization testing included furnace temperature profiling to verify optimum SNCR operating temperature location in furnace,
- Conducting a longer term SNCR system performance evaluation at the initial target steady state limit determined during optimization testing including verification of ammonia (NH_3) slip levels,
- Determining an appropriate alternative NOx limit for startups/shutdowns in accordance with recent USEPA startup and shutdown policy regarding SIP emission limitations.

2.) SNCR NOx Control System Optimization Testing:

Optimization testing of existing SNCR system was conducted by Quinapoxhet Solutions on waste to energy (WTE) Boilers 1 & 2 February 29-March 4, 2016. Testing was conducted in accordance with the "Baltimore NOx Optimization Program for NOx RACT Determination 2-22-2016" submitted to MDE on 2-23-2016. Boiler 1 represented a "clean" boiler with minimum furnace slagging and ash deposits on furnace walls while Boiler 2 represented a "fouled" boiler with furnace slagging and heavier furnace wall ash deposits. Conducting furnace temperature profiling would verify that urea injector location were within the effective SNCR temperature range on boilers throughout full range of expected boiler/furnace conditions. Temperature profiling and optimization testing was conducted with both boilers generally operating within the normal steam flow range of 190-195 klbs./hour. The complete Quinapoxhet Solution optimization test report is provided as an attachment to this report.

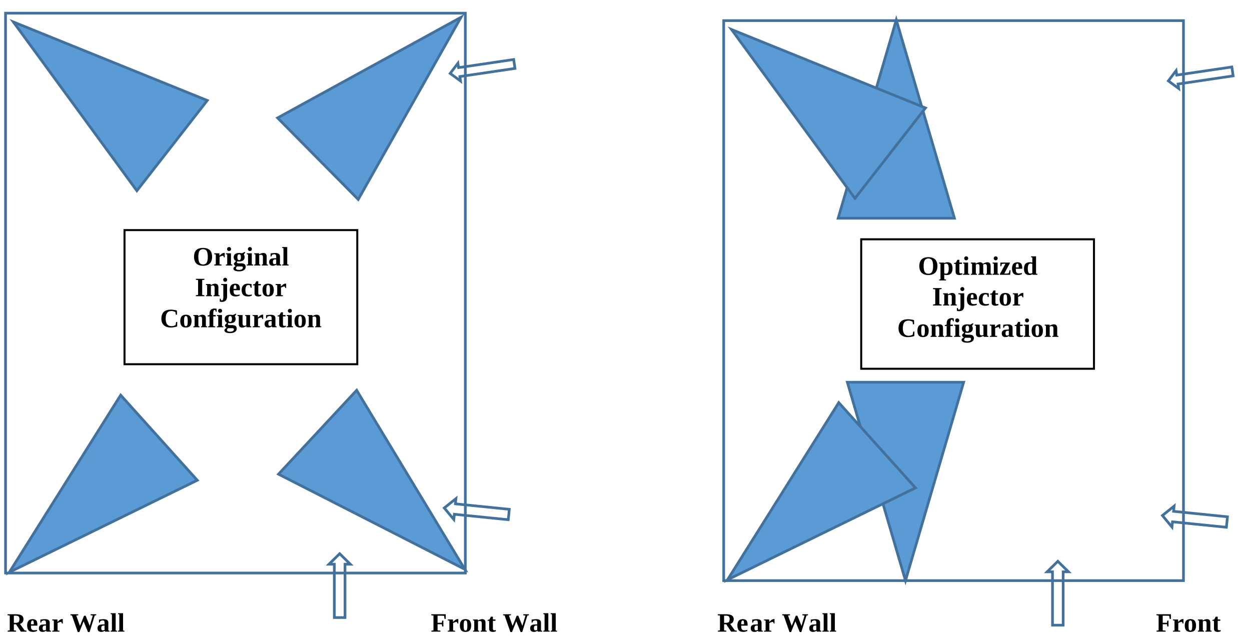
<u>Furnace Temperature Profiling Results</u>: Furnace temperature profiling results confirmed that the existing SNCR system injectors were located within the optimum SNCR operating temperature window of 1800-2000 deg F over the full range of expected furnace/boiler fouling conditions as shown in the summary graph below.

Furnace Temperature Summary for Boilers 1 and 2



<u>SNCR System Optimization Test Results:</u> Optimization testing was performed by evaluating different injector configurations (number of injectors and furnace locations) and varying urea injection rates. Optimization testing found that urea injection biased more toward the rear of the furnace using the 2 rear corner and 2 rear side wall injectors, as shown in the figure below, provided the best improvement in NOx reduction and urea utilization over all other injector configurations.

<u>Optimized SNCR Injector Configuration</u>



Rear Wall **Front Wall** **Rear Wall** **Front**
Wall

With the as-found original injector configuration using 4 injectors located in furnace corners, NOx averaged around 175 ppm while NOx removal ranged from 14-21% with urea utilization around 25%. Moving the existing front corner injectors to the rear side walls appeared to improve SNCR system performance at comparable urea injection rates as NOx was reduced to the 150-165 ppm range, NOx removal increased to over 25% and urea utilization approached 40%, close to the practical limit of SNCR performance. Higher urea utilization rate reduces the potential for excessive ammonium slip generation. The results from the optimum SNCR system injector configuration are summarized below. Boiler 2 optimization results would be considered limiting since a steady state NOx RACT limit must be continuously achieved throughout the full range operating conditions (cleaned to fouled boiler) of all three boilers. As such, the initial target NOx RACT limit was determined to be in the range of 160-165 ppm7%O2 for longer term evaluation and ammonia slip testing.

Optimized SNCR System Configuration Summary

Unit	Test No.	Date	Steam Flow klbs/hr	Baseline NOx ppm7%	Controlled NOx ppm7%	NOx REM %	Urea gph	Urea Utilization	SNCR System Configuration
2	8	3/2/2016	192	224	167	25%	12	36%	2 rear corner injectors + 2 rear side wall injectors
2	9	3/2/2016	192	224	157	30%	12	42%	Overnight:2 rear corner injectors + 2 rear side wall injectors
			Avg	**224**	**162**	**28%**	**12**	**39%**	
1	10	3/3/2016	192	203	165	19%	5	57%	2 rear corner injectors + 2 rear side wall injectors
1	11	3/3/2016	192	203	150	26%	10	40%	2 rear corner injectors + 2 rear side wall injectors
1	12	3/3/2016	192	203	144	29%	15	30%	2 rear corner injectors + 2 rear side wall injectors
			Avg	**203**	**153**	**25%**	**10**	**42%**	

Long Term Evaluation Results: The objective of the long term evaluation was to demonstrate that a 160-165 ppm target NOx RACT range could be continuously achieved on a 24 hour average basis on all three boilers over a period of several days. NOx setpoints of 160 and 165 ppm were evaluated for 3 different times from the period of March 29 to May 4. The intermittent periods were necessary to accommodate a Boiler 3 outage, allow time to review data and make SNCR system adjustment and cover a longer boiler operating period. NOx baselines were taken for approximately 30 minutes at the beginning of each 24 hour period to estimate NOx removal and urea utilization rate. During the evaluation periods, the plant operator monitored NOx levels and made urea feed rate adjustments to try and maintain the 24 hour average at or less than the target NOx setpoint. The optimum injector configuration identified during optimization testing (2 rear corner injectors and 2 rear side wall injectors) was used throughout the long term evaluation period on all three boilers.

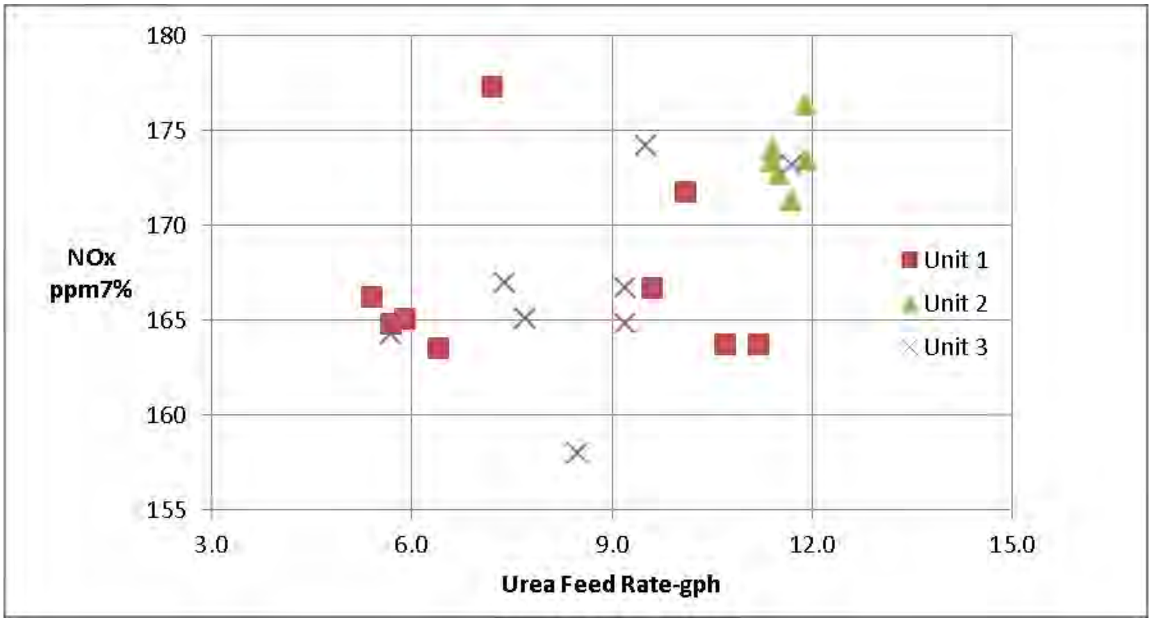
A total of twenty-three (23)-24 hour averages combined for all three boilers were obtained during the long term evaluation. Results are presented in the summary table and graph below. During short term optimization testing Unit 2 achieved an average NOx level of 162 ppm with the optimum injector configuration. However, as indicated in the summary table and graph, Unit 2 was not able to achieve a 24 hour average below 170 ppm regardless of the urea feed rate while Units 1 and 3 generally were able to achieve 24 hour averages close to 165 ppm. The Unit 1 long term results approximated the short term optimization test results. The difference in the SNCR system performance between Units 1 and 3 and Unit 2 would reflect inherent performance differences that can exist between identical boiler units.

Long Term Performance Evaluation Results

Boiler	Date	NOx Set Point ppm7%	Steam Load klb/hr	Baseline NOx ppm7%	Controlled NOx Avg ppm7%	NOx %RE	Urea Rate gph	Urea Utilization
#1	5/5/2016	165	195	200	167	17%	10	26%
	5/6/2016	165	195	200	172	14%	10	21%
	5/7/2016	165	192	200	164	18%	11	24%
#1	4/15/2016	165	195	178	166	7%	5	17%
	4/16/2016	165	195	177	164	8%	6	16%
	4/17/2016	160	195	194	164	16%	11	22%
#1	3/30/2016	165	195	193	165	15%	6	38%
	3/31/2016	165	195	189	165	13%	6	31%
	4/1/2016	160	194	183	177	3%	7	6%
#2	4/15/2016	165	192	219	176	19%	12	27%
	4/16/2016	165	191	208	171	18%	12	23%
	4/17/2016	160	192	208	174	17%	12	22%
#2	3/30/2016	165	192	196	173	12%	12	15%
	3/31/2016	165	191	193	174	10%	11	12%
	4/1/2016	160	192	198	173	12%	11	16%
#3	5/5/2016	165	184	191	158	17%	9	28%
	5/6/2016	165	192	222	174	22%	10	38%
	5/7/2016	165	192	219	173	21%	12	29%
#3	4/15/2016	165	192	179	164	8%	6	19%
	4/16/2016	165	192	192	165	14%	8	26%
	4/17/2016	160	170	186	165	11%	9	15%
#3	3/30/2016	165	192	200	167	17%	9	27%
	3/31/2016	165	190	192	167	13%	7	25%

Average	164	191	196	169	14%	9	23%
Median	165	192	194	167	14%	10	23%
Std Dev				5.1			

<u>**Long Term Evaluation-24 Hour Average Summary Graph**</u>



<u>Ammonia Slip Testing</u>: The long term evaluation phase ended with ammonia slip testing conducted during the annual stack tests the week of May 17-19, 2016. Ammonia slip was measured during HCl testing using EPA Test Method 26A. (Ammonia slip results are included in annual stack test report) This is the same ammonia slip test method approved for use at Wheelabrator MWC facilities in CT and MA where ammonia slip testing is a Title V permit requirement. Ammonia slip results were promising in that at NOx emission levels around 165 ppm, ammonia slip was below 4 ppm. Target ammonia slip levels for well-designed and optimized SNCR systems is 10 ppm or less. The relatively low ammonia slip results are indicative of good urea utilization. Importantly the low slip results reduce the potential of detached visible ammonium chloride plume episodes considered by MDE to be violation of the no visible emission limitation under COMAR 26.11.08.04B.

<u>**Ammonia Slip Results**</u>

Unit	Date	Time	Steamflow klb/hr	Urea Feed gph	Outlet NOx ppm7%	NH3 slip ppm7%
1	5/17/2016	0829-0928	192.7	5.4	153	3.0
	5/17/2016	1130-1229	192.0	5.0	163	1.2
	5/17/2016	1435-1534	190.5	5.0	162	3.3
		Average	**191.7**	**5.1**	**159**	**2.5**
2	5/18/2016	1105-1204	191.7	14.0	162	2.0
	5/19/2016	1415-1514	191.1	11.0	172	1.6
	5/20/2016	1557-1656	193.1	11.0	182	1.3
		Average	**192.0**	**12.0**	**172**	**1.6**
3	5/18/2016	1105-1212	191.6	15.0	165	4.0
	5/19/2016	1421-1520	192.6	15.0	178	1.3
	5/20/2016	1718-1817	192.4	14.9	166	3.3
		Average	**192.2**	**15.0**	**170**	**2.9**

Determination of Achievable Steady State NOx RACT Limit: Given the difference in SNCR system performance between boilers, a steady state NOx RACT limit that can be continuously achieved should be based on combined results from all three boilers. A statistical analysis including calculated upper confidence limits of the combined long term evaluation results is provided in the table below. The analysis indicates that while it is possible that an average 24 hour NOx concentration of 165 ppm7% may be achieved over several days, any NOx limit must be continuously achieved by all three boilers for each 24 hour daily period throughout the full range of boiler operating conditions, fuel mix, and inherent performance differences that exist between identical boilers. The appropriate way to account for the variability in 24 hour averages is to calculate Upper Confidence Limits (UCLs) using the mean and standard deviation of the combined results. The resulting UCLs would be considered representative of a range of achievable 24 hour average NOx RACT limits at different probabilities.

Long Term 24 Hour Average Upper Confidence Limits			
One Tail Upper limit	0.95	0.975	0.99
Student-t Value	1.714	2.069	2.5
Average ppm7%	169	169	169
Standard Deviation	5.1	5.1	5.1
Upper Confidence Limit ppm7%	**178**	**180**	**182**

Recognizing that some additional improvement to long SNCR system performance may be possible, the proposed steady state NOx RACT limit that could be continuously achieved based on optimization testing and long term evaluation would be based on the more restrictive 95% upper confidence level or 178 ppm 7% O2.

3.) Alternative Startup and Shutdown Limit:

The Title V permit incorporates a facility wide short term NOx limit of 298 lbs/hour based on an eight (8) hour block average derived directly from the PSD construction permit (PSD Approval 83-01). In response to a USEPA order that resolved a citizen's petition to EPA for the 2009 TV operating permit renewal, an 8 hour block average was established for the facility wide NOx limit in addition to requiring that emissions during startup, shutdowns and malfunctions be included for determining compliance with the limit.(TV Permit, Table IV-1, Section 1.1 C) The limit is subject to continuous monitoring in accordance monitoring requirements specified in Table IV-1, Section 1.3.

This short term facility wide NOx limit, combined with the facilities standard startup and shutdown procedures should be sufficient to limit NOx emissions during startup, shutdown and malfunction periods.

4.) Startup and Shutdown Procedures:

In general all emissions controls including carbon system, SNCR system and SDA are put in service before refuse combustion begins. Emission controls remain in service during shutdown until refuse combustion is completed on the grates. During startups boiler and furnace are brought up to initial temperature required for refuse combustion using use the auxiliary natural gas burners and allows emission control systems to be put into service prior to refuse combustion. During shutdowns, gas burners are fired as needed to maintain furnace temperature until refuse combustion is completed and only ash remains on the grates. Completion of all startup and shutdown procedures are documented and initialized by person responsible for each task. Startup/shutdown records are maintained on site for 5 years. Excerpts from facility startup and shutdown procedures confirming emission control startup and shutdown sequencing are provided below.

Startup Procedure- Emission Controls

1. Ensure Feed Hopper Net has been removed and warning lights are removed.
2. 3 hours after Gas fire has been established. Shut down Ram and Grates. Turn off Feed Hopper warning lights. Instruct crane operator to feed dry refuse or trash into feed hopper.
3. When the feed hopper is sealed with refuse the furnace pressure will rapidly drop. Place ID fan in auto at -.25 in H2O to maintain furnace draft.
4. Start Secondary Air Fan (SAF) with Fan Damper at -5%.
5. Place SAF header pressure in auto at 14 inches H2O. *Note: Since ID Fan is now in Auto maintain boiler Temp/Pressure parameters by changing SAF header pressure and or Gas Burner set point.*
6. Place Carbon system, SNCR system and SDA in service. *Note: SDA might have already been in service for temperature control to ESP. Ensure Carbon is in service before any Refuse is ignited!*

Shutdown Procedure- Emission Controls

1. When the 2nd Zone Grates are empty, shut 2nd Zone Primary Air Dampers, place 3rd Zone Grates at 105%.
2. When the 3rd Zone Grates are empty, shut 3rd Zone Primary Air Dampers, place 4th Zone Grates at 105%.
3. When the 4th Zone Grates are empty, shut 4th Zone Primary Air Dampers, place 5th Zone Grates at 105%.
4. When the 5th Zone Grates are empty, place 5th Zone Grates at 105%.
5. Place Primary Air Fan Damper at -5%, then shutdown Primary Air Fan & secure SCAH's.
6. Place 1st through 5th Zone Primary Air Dampers at 105%.

When no fire is visible on Grates:

   a. Shutdown Carbon feed.
   b. Place Urea System (SNCR) in Flush for at least 15 minutes.
   c. Shutdown Spray Dryer Absorber when outlet temperature permits or SDA automatically shuts off on low temperature. Adjust lime slurry recirculation pressure to prevent over injection to on line boilers.

Technologies to enable clean efficient energy

NOx Optimization Project

Wheelabrator Baltimore Inc.

Baltimore, Maryland

Units 1, 2 & 3

Project: 459S

Author: Michael Bisnett

June 5-9. 2017

Table of Contents:

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1. Executive Summary

Fuel Tech Inc. (FTI) was contracted by Wheelabrator to conduct SNCR system optimization testing at their Waste to Energy (WTE) facility located in Baltimore, Maryland. The objective was to obtain provide further optimization of the SNCR system to reduce NOx levels below 150 ppmdc (corrected to 7%O2) while minimizing ammonia slip and the potential for unreacted urea/ammonia to impinge on the furnace waterwall platens given the close proximity of the platens above the SNCR urea injector locations.

For this optimization program, additional changes were made to the existing SNCR equipment to allow for more flexibility for enhancing NOx removal. These changes primarily included installation of new NOx injector tips with 30 deg up angle cone spray and use of alternate rear furnace wall injector ports. The use of the additional rear wall injector ports and modified injector tips enhanced the coverage of the injectors allowed for more flexibility to optimize the SNCR system to control NOx below the 150 ppmdc (corrected to 7% O2) target while simultaneously maintaining low ammonia slip levels. Longer term testing needs to be conducted to ensure that the 150 ppmdc target can be sustained while WTE units are operating throughout the normal range of fuel variations and boiler maintenance cycles.

2. Introduction

Wheelabrator operates 3 mass burn municipal solid waste-to-energy (WTE) units in Baltimore, Maryland. This NOx reduction/SNCR system optimization project was to determine if the existing SNCR system can be further optimized to improve NOx reduction and achieve a target limit of 150 ppmdc. Because this project was focused on all 3 WTE units within a three-day testing period, the short term results are only a small sample of the performance of the modified SNCR system. Longer term data collection using the new injector tips, injector locations and operating parameters (dilution water flow, air pressure) under the normal variations in fuel and unit operation should be done to confirm the target level can be achieved without producing a visible plume or impacting boiler reliability via impingement of urea/ammonia on platen waterwall surfaces.

FTI's optimization test objective was to achieve NOx levels consistently below 150 ppmdc with low ammonia slip, without producing a visible plume at the stack and to minimize impact of SNCR operation on waterwall platens.

3. Methodology

3.1 Single Level SNCR

The SNCR systems on all 3 units use multiple injectors located at a single level in furnace. The number of injectors varies but up to 8 injectors can be used at any one time. All of the injectors were located on the 4th floor at Approx. Elevation 97': 2 rear corner, 2 side wall, 2 front corner, and 2 rear wall.

FTI standard flow injectors have been used the past several years. These injectors have a larger diameter and allow for more liquid flow than earlier version of injectors used when the SNCR system was first installed. In addition, the FTI injectors allow for the installation of various new injectors tips that can help direct the urea droplets to an optimum release area within the furnace.

This set of optimization tests was done using the same existing injection ports but included the installation of new injector tips that provided a 30 degree upward angle cone spray to increase urea dispersion in optimum furnace temperature range. The rear wall injectors had been recently installed based on prior optimization testing that indicated the rear furnace wall could be a more optimum location. Prior optimization testing also indicated that the two front corner injectors may not contribute much to SNCR performance and could be removed without impacting performance.

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3.2 Ammonia Slip Measurement

Measuring the ammonia slip, a by-product of the SNCR process, is a very important part of evaluating SNCR performance in any application. Excessive ammonia slip can result in the formation of a detached visible ammonium chloride plume above the stack. As such, keeping the slip as low as possible is always a priority but increasing the NOx reduction efficiency is also as important. Finding the optimum balance between minimizing slip and achieving desired NOx reduction or emission levels is the key in getting the most out of the SNCR process.

The ammonia slip measurements that were taken on all 3 units were done using a modified EPA wet extraction method. This method is used exclusively by FTI to get a quick measurement of the slip. On all 3 units the slip samples were taken before the SDA to ensure that the measured slip was representative of the actual slip coming after the SNCR process. The samples were taken using a single glass lined and heated probe. During testing the plant was also monitoring the possible presence of a visible plume and at no time during the 3 days of testing and while running the units at the 150 ppmdc NOx set point was a detached plume visible. Ammonia slip results during the week registered the highest slip at 10 ppm but most of the tests were less than 5 ppm.

3.3 SNCR Process and Ammonia Slip

Ammonia slip needs to be determined given its importance in determining the effectiveness of the SNCR process. Basically, if the urea is being released into a hotter area of the furnace near the maximum SNCR temperature range, the resultant NOx reduction could be good and the ammonia slip would remain low as there is more reaction/mixing time in the optimum SNCR temperature range for the SNCR reaction to occur. In contrast if the urea is released in a cooler area of the furnace near lower optimum temperature range, NOx reduction may also be very good but the ammonia slip would be much higher given the shorter residence time within optimum temperature range. The furnace temperature and other factors including furnace spatial coverage of urea spray are the driving force that dictates the pathway that the NOx/urea interactions take place. Trying to find the optimum release point and dispersion pattern in any operating unit is the goal and that goal can be difficult to reach.

During this project the ammonia slip was measured at the inlet to the SDA. Only one sample taken exceeded 10 ppm, most were below 5 ppm and most were closer to 1-2 ppm.

Overall the previous optimization tests indicated that the urea was being released in an area that was on the hotter side as evidenced in that increasing the urea feed to 20 gph, did not increase ammonia slip significantly. While some of the additional urea was used to increase NOx reduction, the remaining urea was consumed or oxidized in the hotter area of the furnace.

3.4 Temperature Measurement

A SpectraTemp infrared imaging camera was placed at the 4th Floor injection level to provide continuous measurement of furnace gas temperature at the urea injection level. During testing the furnace temperature measured by the Spectra-Temp was recorded throughout the day. The average temperature for Unit 1 was 2051 F degrees, Unit 2 was 2053 F degrees and Unit 3 was 2011 F degrees. The temperature varied from a low of 1992 F on Unit 3 to a high of 2090 F on Unit 2.

In this case it seems that the variations in the furnace temperatures were not significant and overall furnace temperature were toward the higher side of the SNCR optimum temperature range.

3.5 Baseline NOx

Baseline NOx values on all 3 units were close to previous optimization testing levels of around 200+ ppmdc. Overall the during this testing period the baseline varied in the range of 190 to 220 ppmdc It appeared that earlier in the day the baseline was lower and increased during the day. The plant confirmed that the NOx would increase at times and but the mechanism or its consistency was not understood.

The uncontrolled or baseline NOx concentration is used to calculate the NSR (normalized stoichiometric ratio) or molar ratio of ammonia (urea converts to ammonia) to baseline NOx. The NSR is used as a way to compare urea usage based on the actual demand or uncontrolled NOx levels. NSR is also used to calculate the utilization of urea on a percent basis. Utilization is equal to the NSR/ (% NOx reduction). The utilization rate is a measure of how efficiently/effectively the urea is being used.

3.6 As Found SNCR System Configuration

The as found SNCR configuration at start of optimization test was as follows:

- 2 Rear wall FTI injectors with normal tips
- 2 Rear corner FTI injectors with normal tips
- 2 Side wall FTI injectors with normal tips
- 2 Front wall FTI injectors with normal tips
- Approximately 1.33gpm of mixed chemical/water flow to each injector
- 50 psig of atomizing air pressure to each injector
- SNCR system in automatic control

The atomizing air pressures and mixed chemical flow to each injector can be varied within reason. Note that too much mixed chemical flow to the injectors or atomizing air pressures approaching 30 psig could cause droplet impingement on the water wall platen and superheater pendant tubes given the larger diameter of the droplets.

4. Test Program Narrative

4.1 June 5 (Initial Unit 1 testing)

The intent was to start the testing series on Unit 1 and continue onto the other two units during the next 3 days. An understanding of current SNCR operation was picked up by talking with operators, supervisors and managers at the plant. It was clear that the boiler operating conditions were "as normal" as can be expected and probably represented an average day. The uncontrolled NOx (baseline) was recorded at 200 ppmdc and then the SNCR system was placed in automatic control with a NOx set point of 170 ppmdc. Subsequently ammonia slip was measured using the modified EPA wet chemistry method with a result of 1.8 ppm. The average urea injection rate was 15 gph, dilution water flow rate was 1.33 gpm per injector and all 8 injectors were in service. In this initial testing the NSR was found to be 0.91 and the utilization rate was 36.5%.

4.2 June 6 (Unit 3 Testing)

The test equipment was moved from unit 1 to unit 3 and Unit 3 testing began with a verification of the ammonia slip using the current SNCR injector configuration of 8 injectors. While maintaining an average NOx of 173 ppmdc, the urea injection rate was 10 gph, dilution water rate 0.88 gpm/injector, NSR= 0.76. Ammonia slip was measured at 1.8 ppmdc with a urea utilization rate of 19.2%.

The testing on Unit 3 was used to initially test various injector configurations, angled tips, and adjustments to water flow and injector atomizing air pressure that would then be used as the basis for the testing on the other units

An uncontrolled NOx baseline was obtained with a value of 198 ppmdc. This value was lower than expected but considering the variability of the fuel, the NOx baseline is expected to vary to some degree. The 19.2% utilization rate and low ammonia slip result was an indication that the urea release temperature was at the higher end or rate with low ammonia slip was an indication the urea injection of the of the SNCR optimum temperature range as urea/ammonia was oxidized in the hotter areas before it could react with NOx.

For the next test the NSR was increased to 1.14 by increasing the urea feed rate to 15 gph without changing any of the other SNCR parameters. Dilution water remained the same at 0.88 gpm per injector. This test was done to determine if the higher NSR would increase ammonia slip. Increasing the NSR from 0.76 to 1.14 increased the NOx reduction, from 15 to 25% from original baseline of 198 ppmdc while urea utilization increased to 21.9%. With the increased urea dosage it would have been expected that ammonia slip would have increased as well but it remained around 1.4 ppm. At the higher urea dosage NOx dropped from 173 ppmdc in the initial test to 145 ppmdc. While increasing the NSR improved NOx control, the relatively small increase in urea utilization and continued low ammonia slip was indication that urea release point was still in the upper end of the optimum SNCR temperature range.

Changing the physical size of the injected droplets is another way to affect the performance of the SNCR system. The next test reduced the atomizing air pressure from 50 to 40 psig. The reduction in air pressure increased the individual droplet size and decreased the kinetic energy of the droplet. The effective difference is that the droplets will carry higher into the furnace and release urea in a different temperature zone. One important caveat regarding increasing the droplet size is the potential that the droplets could get large enough to impinge on heat transfer surfaces in the furnace. Therefore being conservative with the droplet size is always a consideration.

Decreasing the atomizing air from 50 to 40 psig had a negative impact on NOx reduction, ammonia slip and utilization rate. NOx increased to 155 ppmdc, NOx reduction percentage decreased to 14.6% and the slip increased significantly, from 1.4 to 10.6 ppm. These results indicated that the urea was not being used efficiently and was now being released into an area that is too cool, resulting in poor NOx reduction with higher slip. The lower atomizing air pressure resulted in larger droplets that carried urea into a cooler region of the furnace before it was available to react with NOx.

Figure 1: Unit 3 Initial Injector Locations

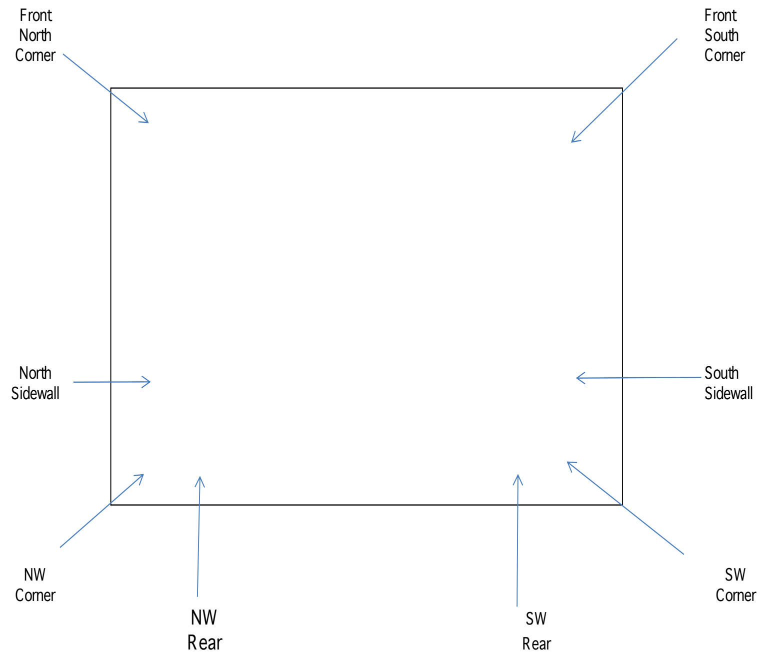
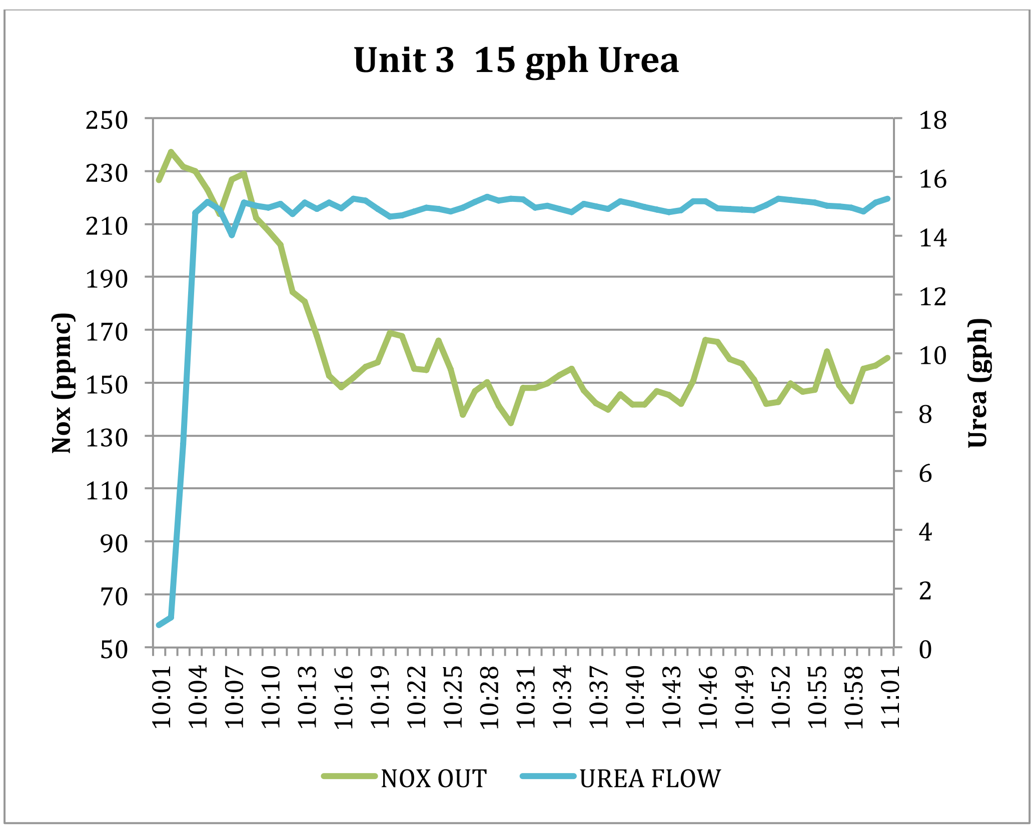


Figure 2: Unit 3 NOx at 15 gph Urea



4.3 Removing the front corner injectors

Based on discussions with plant personnel it was theorized that the front 2 corner injectors were not very effective or contributing much to NOx control.

When the front two corner injectors were removed (Figure 3) and side wall and rear furnace injectors left in place, SNCR system performance improved. The NOx reduction increased from 17 to 37% and the ammonia slip decreased from 10.6 to 1.1 ppm. The comparison was with the test using the same urea dosage, atomizing air pressure and injector water flow. The only difference was the 2 front corner injectors were taken out of service. Making this simple change supported the theory that the front corner port injectors were not contributing to NOx control. After removing the front injectors, the NOx dropped back to 149 ppmdc and slip to 1.1 ppm. NOx reduction and utilization increased to, 37.5% and 32.9% respectively. The reason the controlled NOx value stayed about the same was because the baseline NOx had increased over the testing period from 198 ppmdc to 212 ppmdc.

A baseline NOx value was obtained after this set of tests to ensure it had not changed much and to allow for the installation of the new 30 degree cone tips (angled vertically up) for the next test run.

Figure 3: Unit 3 Injector locations after front wall injectors removed

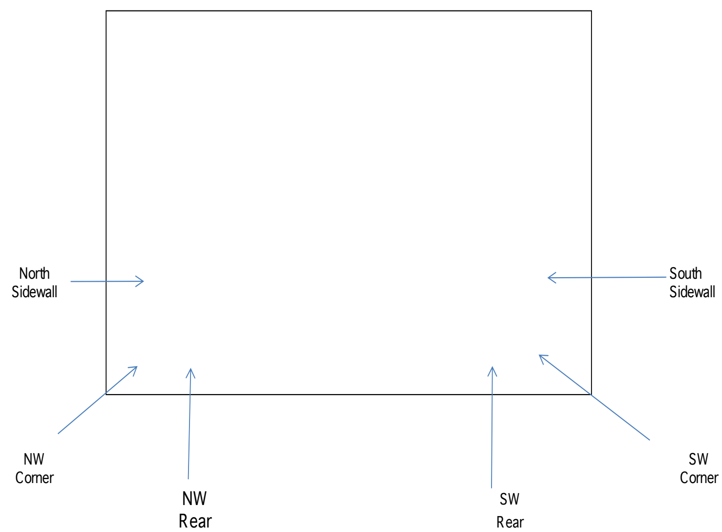
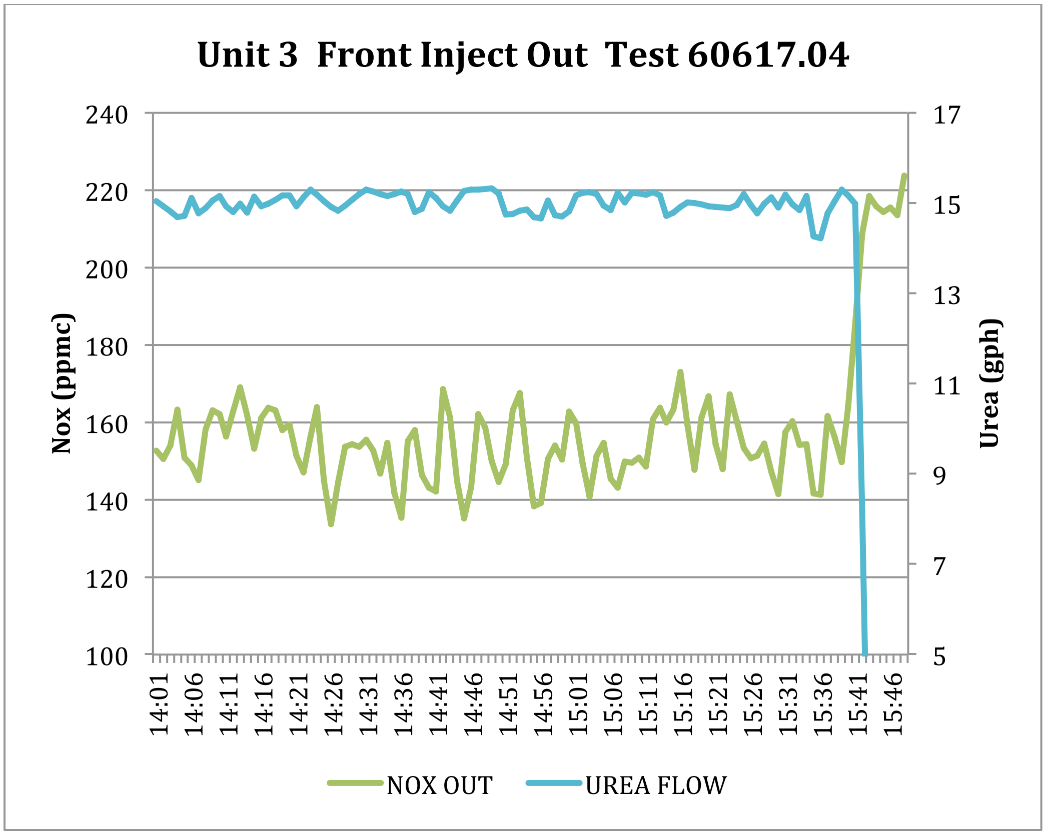


Figure 4: Unit 3 results after front wall injectors removed



4.4 Installing the angled tips

Moving onto the next phase required that the current straight cone spray tips be replaced with cone tips that are angled up at 30 degrees. This purpose of the angled up tips is to give the droplets direction and help to drive the majority of the liquid to a more optimum temperature location in the furnace. Using these tips allows for better placement of the urea without increasing the droplet size too much. The six injectors were fitted with the 30 deg up angled tips: two sidewall, two rear wall and two rear corners.

The results were very good. Using the same urea dosage of 15 gph, with an NSR of 1.14, the NOx reduction increased from 37.5 to 42.7%, utilization increased from 32.9% to 37.4% and the NOx dropped to 130 ppmdc. Individual injector water flow was 1.33 gpm at an air pressure of 40 psig. The measured ammonia slip increased slightly to 3.3 ppm from 1.1 ppm and stack observation indicated there was no visible plume. Making the change to the angled up tips showed that releasing the urea higher in the furnace with the right injector configuration was very beneficial.

The initial Unit 3 optimization results were very positive and predictable and, as such, were used as the starting point for further optimization of the other 2 units.

Figure 5: 30 degree angled tips, angled upwards

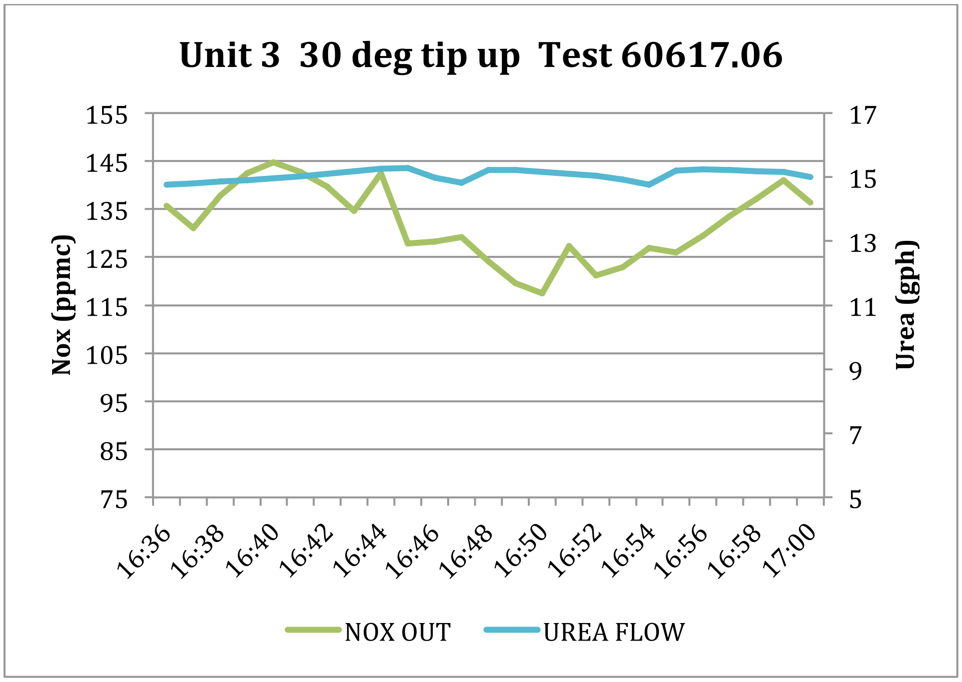


Figure 6: Unit 3 Daily Summary

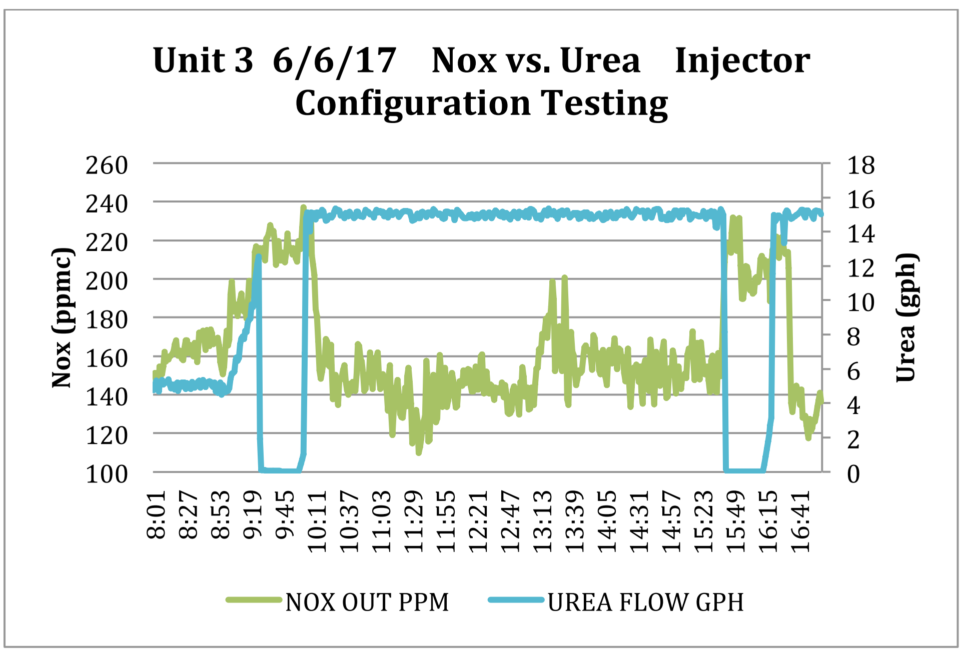


Figure7: Unit 3 Test Results

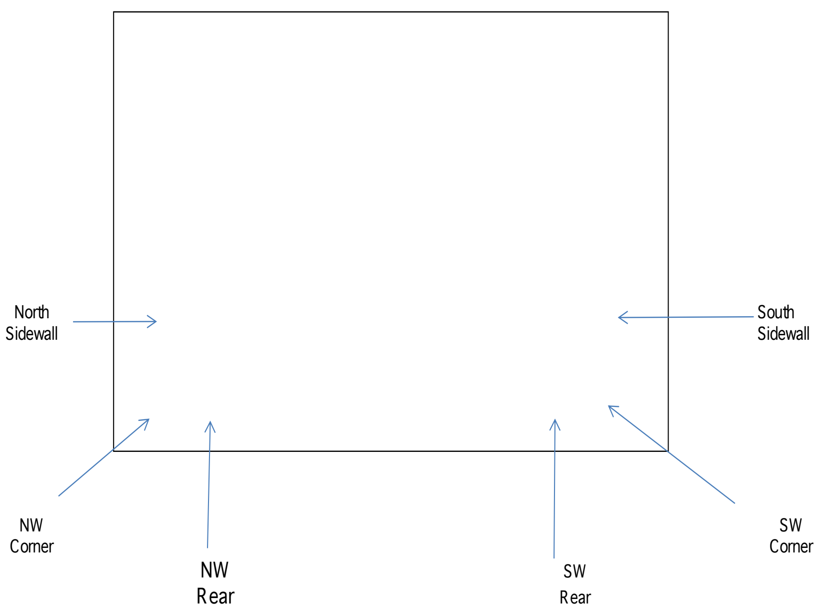
Test No.	Test Type	Test Time	Stm Load KPPH	Load MMBtu per hr	Econ O2	# of inj's	Tip Type	Flow [gpm]	Flow / inj [gpm]	Liquid P [psig]	Air P [psig]	"A" @ Flow [gph]	50% NSR	Nox ppmvc	Spectra Temp deg F	NH3 ppm	BL NOx lbs/hr	NOx lbs/hr	Summary of Results Total NSR	% Red	% Util
60617.00	High load	8:00	190	300	10.5	8	Cone	7.0	0.88	75	50	10.0	0.76	173	1992	1.8	96.000	82.000	0.76	14.6%	19.2%
60617.01	Baseline	9:00	193	300	11.2	8	Cone	7.0	0.88	75	50	0.0	0.00	198	1992		96.000	96.000	0.00	0.0%	0.0%
60617.02	Test 1 Incr NSR	10:00	192	306	11.0	8	Cone	7.0	0.88	75	50	15.0	1.14	145	1992	1.4	96.000	72.000	1.14	25.0%	21.9%
60617.03	Air 40 psig	11:30	190	304	10.5	8	Cone	7.0	0.88	75	40	15.0	1.14	155	1992	10.6	96.000	80.000	1.14	16.7%	14.6%
60617.04	Front N/S inj out	14:00	192	306	9.0	6	Cone	8.0	1.33	80	40	15.0	1.14	149	2050	1.1	96.000	60.000	1.14	37.5%	32.9%
60617.05	Baseline	15:45	192	306	9.3	6	Cone 30 up	8.0	1.33	80	40	0.0	0.00	212	2036		96.000	96.000	0.00	0.0%	0.0%
60617.06	6 inj, 30 deg cone up	16:50	192	304	9.6	6	Cone 30 up	8.0	1.33	80	40	15.0	1.14	130	2021	3.3	96.000	55.000	1.14	42.7%	37.4%

5. June 7 (Unit 1 Testing)

5.1 Duplicated Injector Configuration from Unit 3

On June 7th the injector configuration was changed on Unit 1 to duplicate the final optimized injector configuration used on Unit 3. The new configuration included 2 rear wall, 2 rear corner and 2 side wall injectors with each injector having a 30 degree angled up conical tip (Figure 8).

Figure 8: Unit 1 Injector locations



A baseline NOx value was obtained prior to the first test. For the 1st test NOx was kept close to 140 ppmdc with 15 gph of urea and a measured slip of 1.7 ppm (Figure 10) and utilization rate of 36.5%. This proved that the final configuration from Unit 3 carried over successfully to Unit 1 as SNCR performance was very good. (Figure 9) Given the successful duplication of results on Unit 1, further optimization was done to this configuration to evaluate impact on SNCR performance

Total liquid flow to each injector was reduced from 1.33 to 1.00 gpm to determine if the change would affect the NOx reduction performance. (Figure 11) The smaller droplets that are formed at the lower injector flow could reduce the potential impingement issues on the adjacent water wall platen tubes. While lowering the total water flow reduced NOx removal slightly it was not considered significant and therefore keeping the droplets smaller would result in nearly identical performance but decrease the likelihood of tube impingement.

Increasing the urea dosage (Figure 12) from 15 to 20 gph was done to determine if there is a point where increasing the urea dosage will not lead to a reasonable increase in the NOx reduction with the 6 injector configuration and essentially determining a point of diminishing returns. Increasing to 20 gph of urea reduced NOx to 130 ppmdc but the utilization dropped from 34.7 to 32.9% while ammonia slip increased slightly from 1.7 to 2.7 ppm evidence that a urea rates above 20 gph, ammonia slip would increase very quickly. The results indicate that there is some inherent SNCR operational flexibility or “buffering” potential to maintain NOx below 150 ppmdc to accommodate combustion and process variability associated with MSW combustion.

Since the front corner injectors were found to be ineffective and not providing much NOx reduction the next test removed the two side injectors to see how if they were effective or not. Removing the side injectors did not impact SNCR performance negatively or positively compared to 6 injector operation at 15 gph urea feed rate and therefore may not be needed to achieve 150 ppmdc. (Figure 13) The advantage of using 4 injectors instead of 6 is a lower potential for impingement on the pendant tubes.

Figure 9: Unit 1 Front and side wall injectors removed

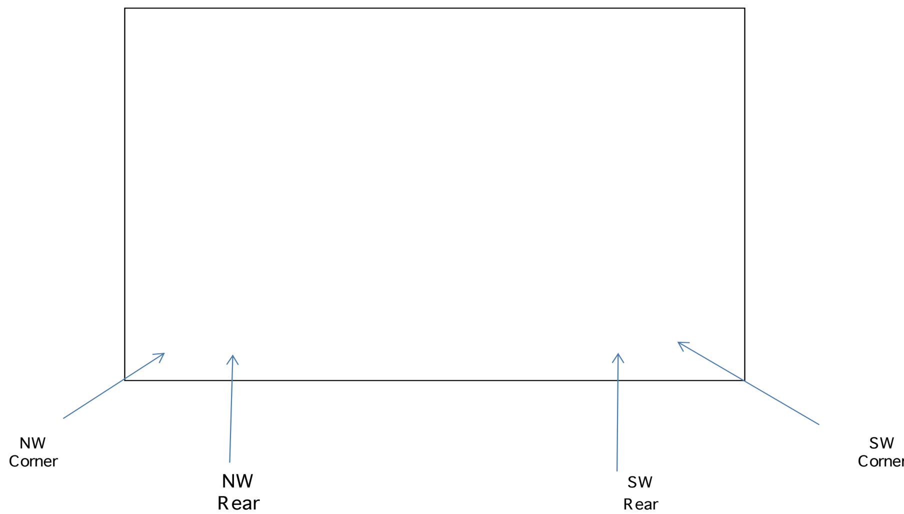


Figure 10: Unit 1 Initial Test

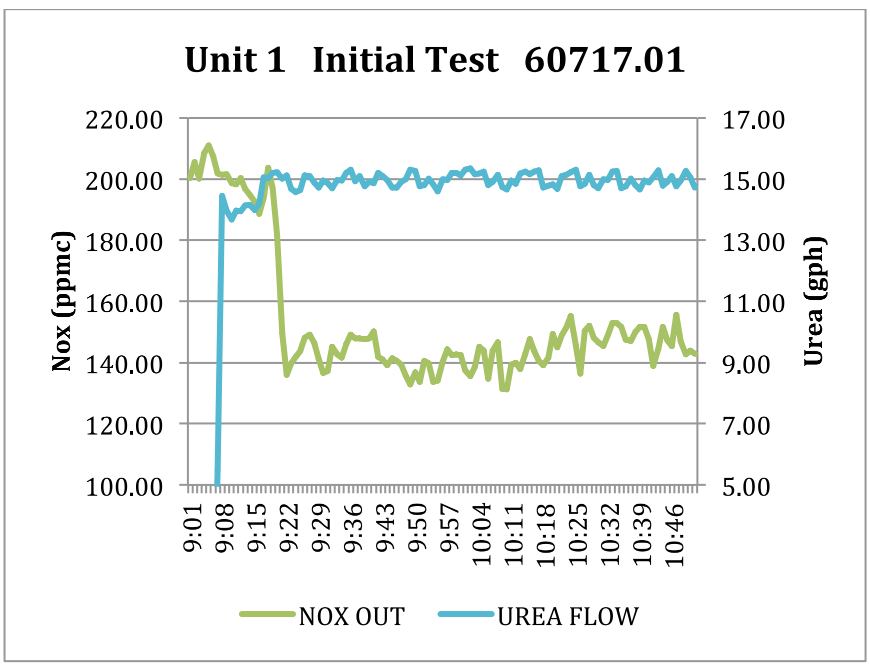


Figure 11: Mixed Chemical Flow Reduced

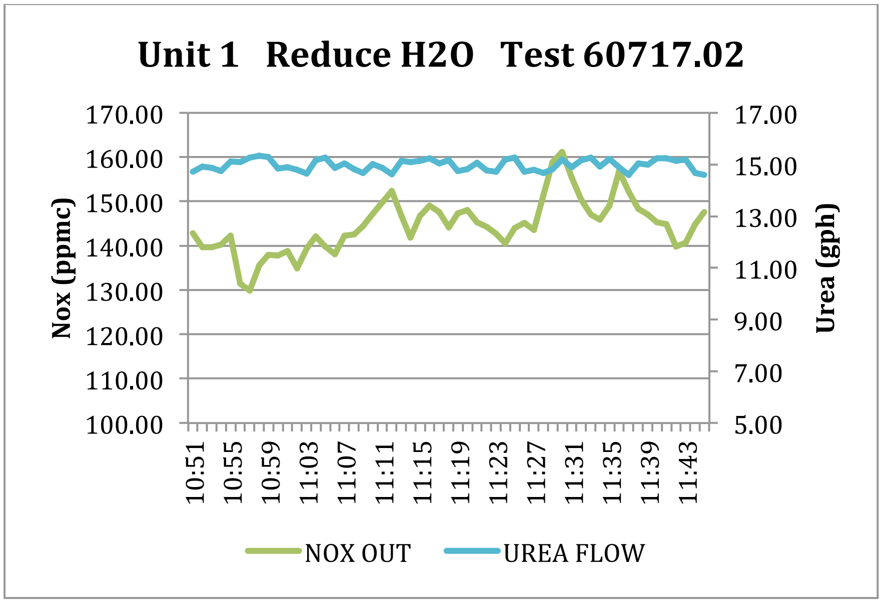


Figure 12: Increased Urea Flow

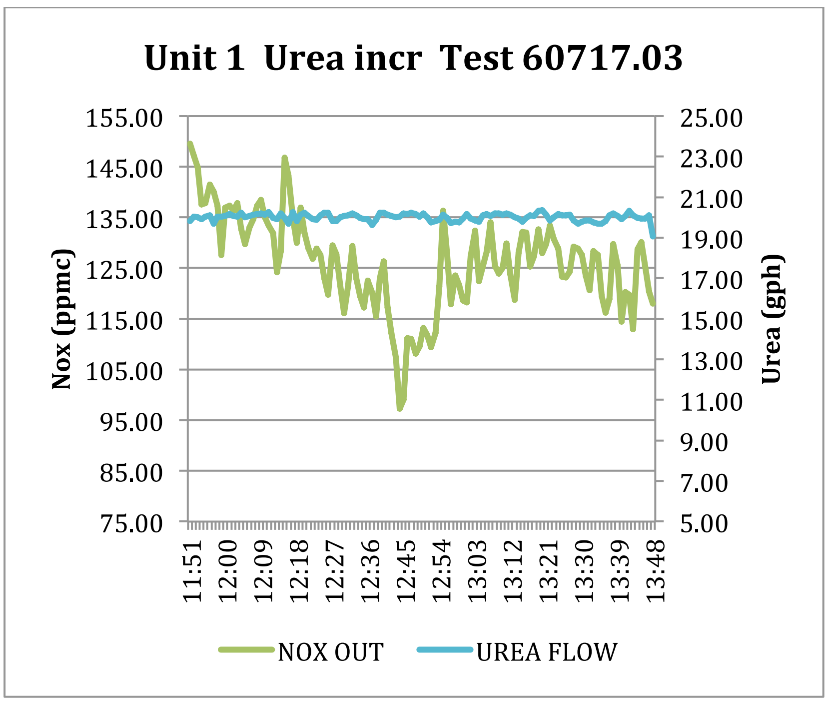


Figure 13: Side Wall Injectors removed

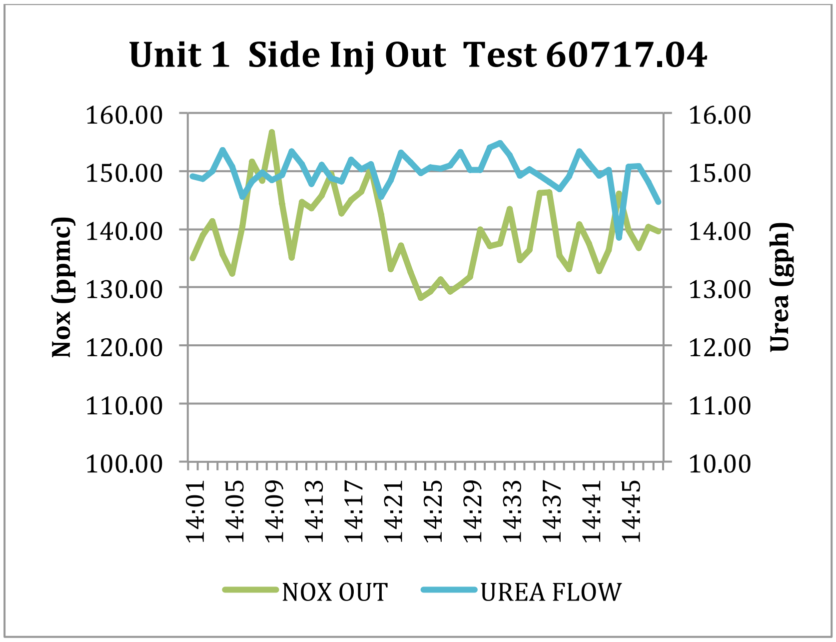


Figure 14: Unit 1 Testing Summary

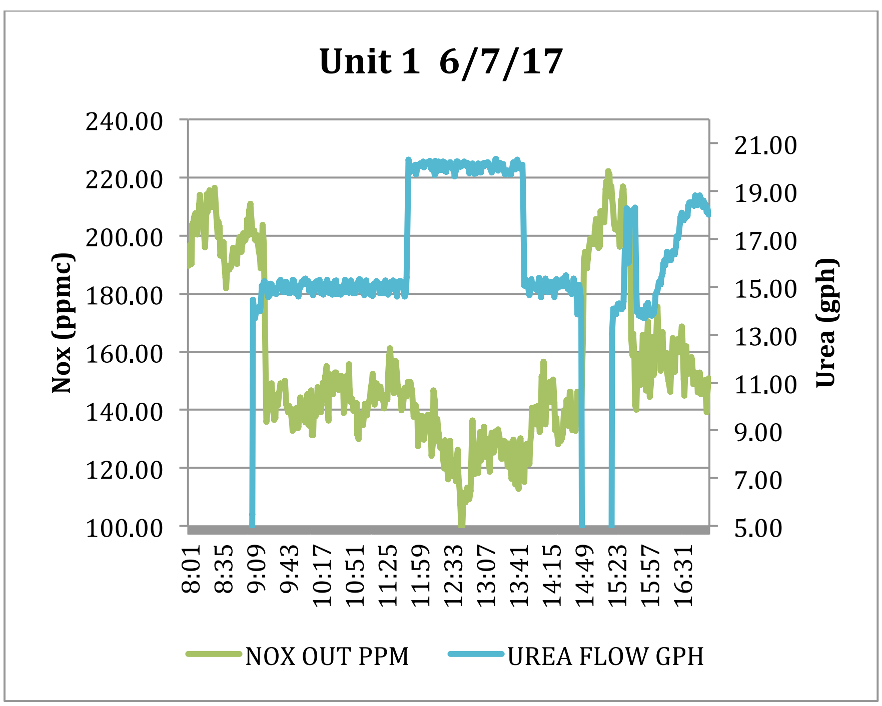


Figure 15: Unit 1 Testing Summary

Unit 1 Test No.	Test Type	Test Time	Stm Load KPPH	# of Inj's	Tip Type	Flow / inj [gpm]	Liquid P [psig]	Air P [psig]	"A" @ Flow [gph]	50% NSR	O2 % dry	NOx ppmvc	Spectra Temp deg F	NH3 ppm	BL NOx lbs/hr	NOx lbs/hr	Total NSR	% Red	% Util
60717.00	Baseline	8:00	192	6	Cone 30 up	1.33	80	40	0.0	0.00	10.4	200	2050		120.000	120.000	0.00	0.0%	0.0%
60717.01	Duplicate Unit 3	9:00	194	6	Cone 30 up	1.33	80	40	15.0	0.91	9.4	140	2060	1.7	120.000	80.000	0.91	33.3%	36.5%
60717.02	Reduce liq 1gpm/inj	10:50	192	6	Cone 30 up	1.00	80	40	15.0	0.91	9.2	147	2040		120.000	82.000	0.91	31.7%	34.7%
60717.03	Incr NSR 20 gph	11:50	191	6	Cone 30 up	1.00	80	40	20.0	1.22	9.5	130	2035	2.7	120.000	72.000	1.22	40.0%	32.9%
60717.04	Decr urea, side inj out	14:00	193	4	Cone 30 up	1.00	80	40	15.0	0.91	9.4	144	2055	2.0	120.000	80.000	0.91	33.3%	36.5%
60717.05	Baseline	2:50	190	4	Cone 30 up	1.00	80	40	0.0	0.00	10.3	200	2067		120.000	120.000	0.00	0.0%	0.0%

5.2 Automatic Control on Unit 1 and 3

Overnight the controls for the Unit 1 and 3 SNCR systems were set to automatic and a NOx set point was set at 150 ppmdc. Reviewing the NOx and urea usage data for overnight operation confirmed that the SNCR system was able to control the NOx below 150 ppmdc most of the time with the urea flow around 5-10 gph. However, there were times the urea feed increased to as high as 20 gph to meet the NOx to 150 ppmdc setpoint.

The cause for the high periods of urea consumption is more than likely due to an increase in the baseline NOx from combustion variability or a change in the combustion/furnace temperature profile that affects SNCR performance. Increasing combustion temperatures could contribute to increased thermal NOx production and/or increase in conversion of fuel bound nitrogen to NOx as both are impacted by combustion temperature and the amount of O2 present in the active combustion zone. Changing combustion could also contribute to a variation in the furnace temperature profile and also impact the SNCR performance.

6. June 8 (Unit 2 Testing)

Unit 2 was the last unit to be tested. The Unit 2 SNCR system was configured to the same as Units 1 and 3 based on the positive results using the 2 rear corner and 2 rear wall injectors with 30 degree angled up tips with atomizing air pressure at 40 psig, 1 gpm of total dilution water flow per injector and urea flows between 5 and 20 gph. A baseline NOx value of 195 ppmdc was obtained in the morning. Again as on Units 1 and 3, Unit 2 baseline NOx tended was lower at the beginning of the day and increased as the day progressed.

Starting up the SNCR system for the first set of tests went without incident and the NOx was reduced to 140 ppmdc. (Figure 17) This was achieved with 4 injectors at 1 gpm water flow, 15 gph urea flow and 40 psig air pressure. NOx levels were about 140 ppmdc and ammonia slip was 2.9 ppm.

Increasing the urea from 15 to 20 gph reduced NOx to about 135 ppmdc but the slip increases to 3.9 ppm. (Figure 18) After testing was completed the system was left in full automatic control with a NOx set point of 150 ppmdc.

Figure 16: Unit 2 Injector locations

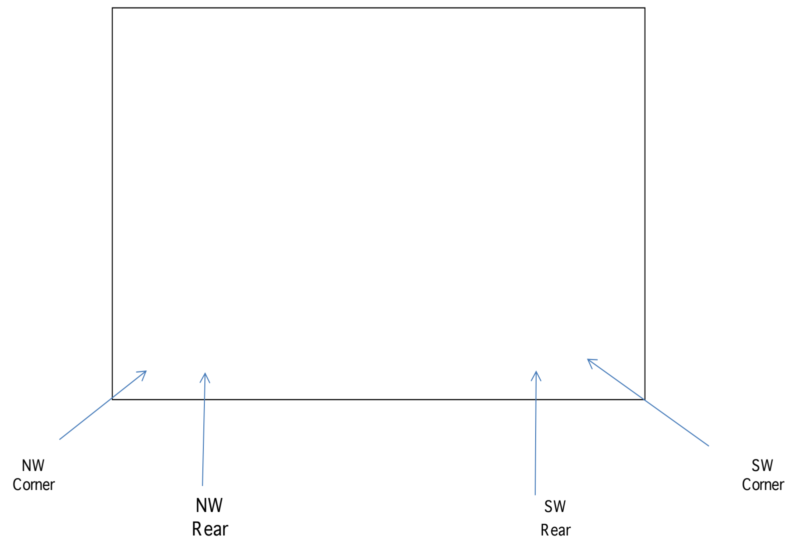


Figure 17: Unit 2 Initial Test

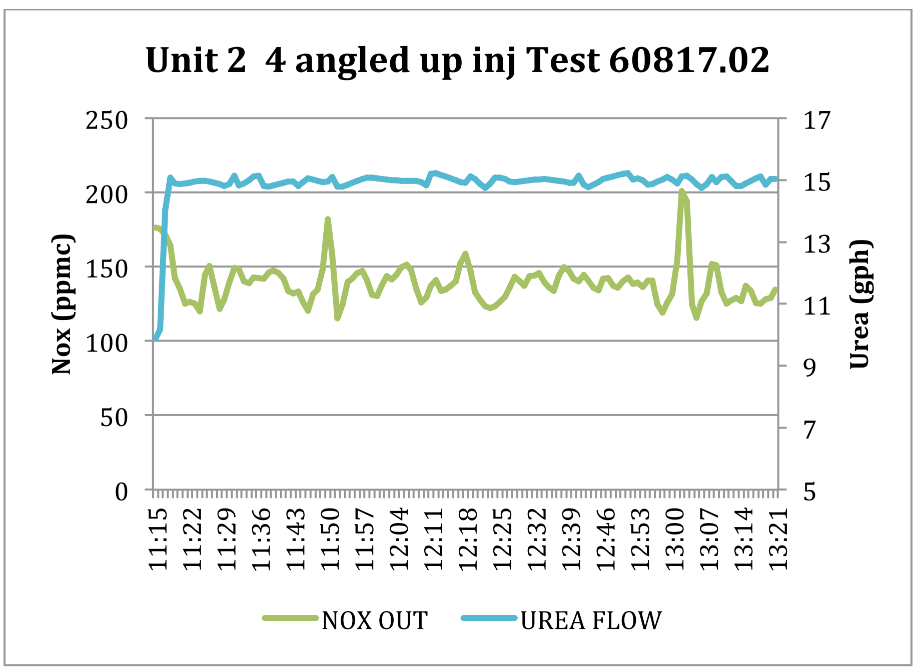


Figure 18: Urea Flow Increased to 20 gph

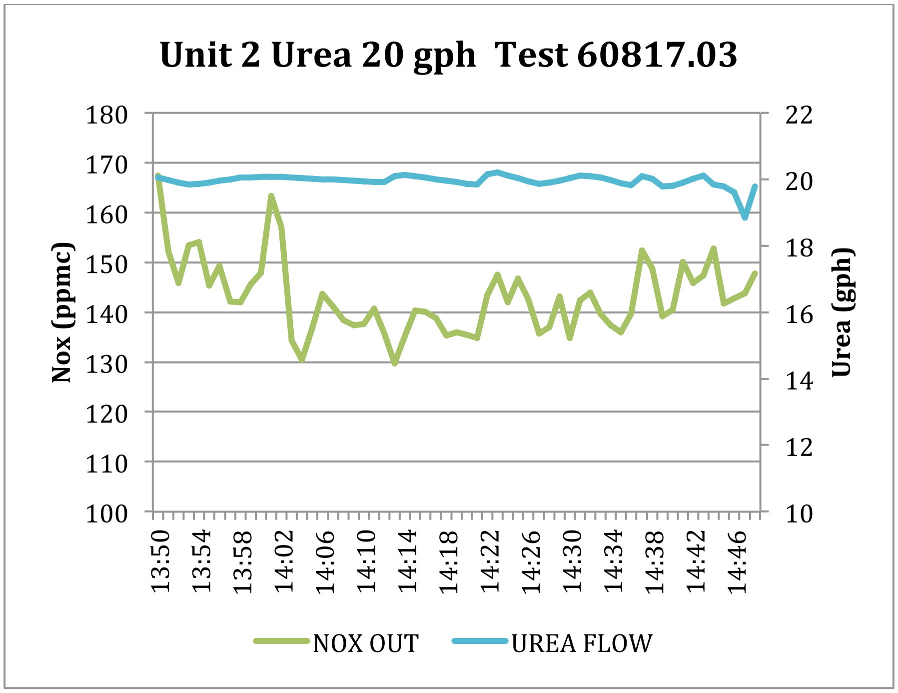


Figure 19: Baseline NOx Changes during day

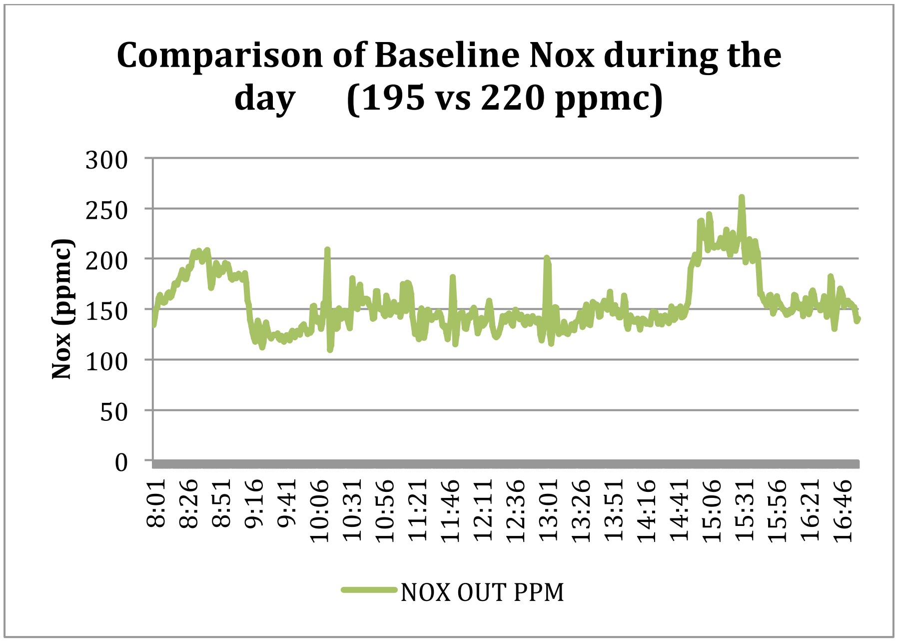


Figure 20: Unit 2 Daily Summary

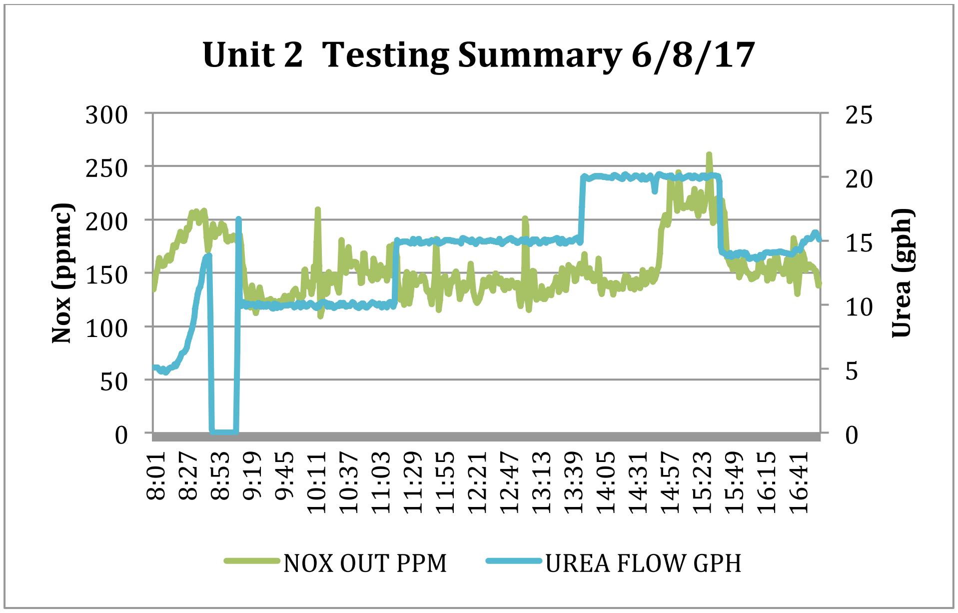


Figure 17: Unit 2 Testing Summary

Unit 2			Stm	# of		Flow	Liquid	Air	"A" @	50%			Spectra			BL				
Test	Test	Test	Load	Inj's	Tip	/ inj	P	P	Flow		O2	NOx	Temp	Red	NH3	NOx	NOx	Total	%	%
No.	Type	Time	KPPH		Type	[gpm]	[psig]	[psig]	[gph]	NSR	% dry	ppmvc	deg F	%	ppm	lbs/hr	lbs/hr	NSR	Red	Util
60817.00	Baseline	8:00	192	4	Cone 30 up	1.00	80	40	0.0	0.00	10.4	195	2090	100.0%		110.000	110.000	0.00	0.0%	0.0%
60817.01	Test stopped	9:15	193	4	Cone 30 up	1.00	80	40	10.0	0.66	10.0	160	2065	80.0%	1.6	110.000	88.000	0.66	20.0%	30.1%
60817.02	4 inj, angled up	11:15	189	4	Cone 30 up	1.00	80	40	15.0	1.00	9.9	140	2078	68.2%	2.9	110.000	75.000	1.00	31.8%	32.0%
60817.03	Urea up 20gph	13:50	190	4	Cone 30 up	1.00	80	40	20.0	1.22	9.9	136	2035	59.2%	3.9	120.000	71.000	1.22	40.8%	33.6%
60817.04	Baseline	14:50	192	4	Cone 30 up	1.00	80	40	0.0	0.00	9.2	220	1995	100.0%		120.000	120.000	0.00	0.0%	0.0%

7. Conclusions

The results of FTI's short term SNCR optimization testing indicated that use of 30 deg up angled injector tips and injector total liquid flow of 1 gpm provided additional capability for SNCR systems to achieve and maintain NOx emission level of 150 ppmdc with minimal ammonia slip. The target NOx could be maintained with urea flow rates of approximately 15 gph and ammonia slip of less than 5ppm. Assuming an average baseline NOx of 210ppm, this equates to an NSR of approximately 1 with 28.6% utilization.

The optimized SNCR system configuration for the all three units based on the test results are as follows:

- 2 Rear Wall FTI Standard Injectors with 30^o up angled tips
- 2 Rear Corner Wall FTI Standard injectors with 30^o up angled tips
- 1 gpm total liquid flow per injector
- 40 psig atomizing air pressure per injector

Longer term testing for 2-3 week period needs to be performed with SNCR systems in automatic control at setpoint of 145 ppmdc to maintain the targeted NOx level of 150 ppmdc on 24 hour average. Daily and hourly NOx and urea variability should be evaluated at the completion of this longer testing period to provide additional insight on the ability of the SNCR system to achieve 150 ppmdc. This longer term testing, may require some further SNCR system adjustments as needed including using more injectors, increasing total liquid flow to injectors or changing atomizing air pressure to maintain NOx below 150 ppmdc.

A summary of the testing program for all three units is provided below:

All Unit Testing Summary

Unit 1 Test No.	Test Type	Test Time	Steam Load (kpph)	Econ O2 (%)	No. of Inj.	Tip Type	Flow per Inj (gpm)	Liquid Press (psig)	Air Press (psig)	"A" @ Flow (gph)	50% NSR	NOx (ppmvc)	Spectra Temp (°F)	Reduction (%)	NH3 Slip (ppm)	BL NOx (lb/hr)	Controlled NOx (lb/hr)	Total NSR	NOx Reduction (%)	Utilization (%)
60717.00	Baseline	8:00	192	9.9	6	Cone 30 up	1.33	80	40	0.0	0.00	205	2050	100.0%		120.000	120.000	0.00	0.0%	0.0%
60717.01	Duplicate Unit 3	9:00	194	9.9	6	Cone 30 up	1.33	80	40	15.0	0.91	140	2060	66.7%	1.7	120.000	80.000	0.91	33.3%	36.5%
60717.02	Reduce liq 1gpm/inj	10:50	192	9.2	6	Cone 30 up	1.00	80	40	15.0	0.91	147	2040	68.3%		120.000	82.000	0.91	31.7%	34.7%
60717.03	Incr NSR 20 gph	11:50	191	9.5	6	Cone 30 up	1.00	80	40	20.0	1.22	132	2035	60.0%	2.7	120.000	72.000	1.22	40.0%	32.9%
60717.04	Decr urea, side inj out	14:00	193	10.3	4	Cone 30 up	1.00	80	40	15.0	0.91	144	2055	66.7%	2.0	120.000	80.000	0.91	33.3%	36.5%
60717.05	Baseline	2:50	190	10.3	4	Cone 30 up	1.00	80	40	0.0	0.00		2067	100.0%		120.000	120.000	0.00	0.0%	0.0%

Unit 2 Test No.	Test Type	Test Time	Steam Load (kpph)	Econ O2 (%)	No. of Inj.	Tip Type	Flow per Inj (gpm)	Liquid Press (psig)	Air Press (psig)	"A" @ Flow (gph)	50% NSR	NOx (ppmvc)	Spectra Temp (°F)	Reduction (%)	NH3 Slip (ppm)	BL NOx (lb/hr)	Controlled NOx (lb/hr)	Total NSR	NOx Reduction (%)	Utilization (%)
60817.00	Baseline	8:00	192	9.9	4	Cone 30 up	1.00	80	40	0.0	0.00	205	2090	100.0%		110.000	110.000	0.00	0.0%	0.0%
60817.01	Test stopped	9:15	193	9.9	4	Cone 30 up	1.00	80	40	10.0	0.66	140	2065	80.0%	1.6	110.000	88.000	0.66	20.0%	30.1%
60817.02	4 inj, angled up	11:15	189	9.2	4	Cone 30 up	1.00	80	40	15.0	1.00	147	2078	68.2%	2.9	110.000	75.000	1.00	31.8%	32.0%
60817.03	Urea up 20gph	13:50	190	9.5	4	Cone 30 up	1.00	80	40	20.0	1.22	132	2035	59.2%	3.9	120.000	71.000	1.22	40.8%	33.6%
60817.04	Baseline	14:50	192	10.3	4	Cone 30 up	1.00	80	40	0.0	0.00	144	1995	100.0%		120.000	120.000	0.00	0.0%	0.0%

Unit 3 Test No.	Test Type	Test Time	Steam Load (kpph)	Econ O2 (%)	No. of Inj.	Tip Type	Flow per Inj (gpm)	Liquid Press (psig)	Air Press (psig)	"A" @ Flow (gph)	50% NSR	NOx (ppmvc)	Spectra Temp (°F)	Reduction (%)	NH3 Slip (ppm)	BL NOx (lb/hr)	Controlled NOx (lb/hr)	Total NSR	NOx Reduction (%)	Utilization (%)
60617.00	High load	8:00	190	10.5	8	Cone	0.88	75	50	10.0	0.76	173	1992	85.4%	1.8	96.000	82.000	0.76	14.6%	19.2%
60617.01	Baseline	9:00	193	11.2	8	Cone	0.88	75	50	0.0	0.00	198	1992	100.0%		96.000	96.000	0.00	0.0%	0.0%
60617.02	Test 1 Incr NSR	10:00	192	11.0	8	Cone	0.88	75	50	15.0	1.14	145	1992	75.0%	1.4	96.000	72.000	1.14	25.0%	21.9%
60617.03	Air 40 psig	11:30	190	10.5	8	Cone	0.88	75	40	15.0	1.14	155	1992	83.3%	10.6	96.000	80.000	1.14	16.7%	14.6%
60617.04	Front N/S inj out	14:00	192	9.0	6	Cone	1.33	80	40	15.0	1.14	149	2050	62.5%	1.1	96.000	60.000	1.14	37.5%	32.9%
60617.05	Baseline	15:45	192	9.3	6	30 up	1.33	80	40	0.0	0.00	212	2036	100.0%		96.000	96.000	0.00	0.0%	0.0%
60617.06	6 inj, 30 deg cone up	16:50	192	9.6	6	30 up	1.33	80	40	15.0	1.14	130	2021	57.3%	3.3	96.000	55.000	1.14	42.7%	37.4%

	#1 Boiler						#2 Boiler						#3 Boiler					
	STM FLOW	DRY O2 IN	DRY O2 OUT	NOX OUT	UREA FLOW	SNCR WTR	STM FLOW	DRY O2 IN	DRY O2 OUT	NOX OUT	UREA FLOW	SNCR WTR	STM FLOW	DRY O2 IN	DRY O2 OUT	NOX OUT	UREA FLOW	SNCR WTR
Date	KLB/HR	%	%	PPM	GPH	GPM	KLB/HR	%		PPM	GPH	GPM	KLB/HR	%		PPM	GPH	GPM
6/12/17	191.5	10.4	11.6	150	17	3	185.5	10.0	10.7	147	13	4	185.1	9.6	11.6	144	8	6
6/13/17	191.8	9.7	10.9	147	17	4	192.0	10.0	10.8	145	14	4	191.6	9.6	11.6	145	11	6
6/14/17	191.5	9.8	11.0	155	18	4	192.0	9.8	10.6	148	18	3	191.8	9.9	11.9	146	14	6
6/20/17	194.9	9.9	10.9	147	16	4	193.4	9.9	10.8	157	19	4	195.2	9.1	11.3	150	18	5
6/21/17	191.9	10.0	11.1	145	16	5	191.9	9.9	10.7	154	19	4	192.0	9.1	11.4	145	17	6
6/22/17	191.6	10.2	11.2	145	13	5	191.5	10.1	10.9	150	18	4	191.4	9.4	11.0	140	9	7
6/23/17	188.7	10.4	11.5	145	12	6	191.6	10.1	10.9	145	17	6	191.8	9.6	11.8	146	13	9
6/24/17	191.5	10.4	11.4	145	15	6	191.2	10.2	11.0	147	16	6	191.5	9.3	11.6	145	13	9
6/25/17	191.8	14.2	11.5	145	17	6	191.8	10.1	11.0	147	18	5	191.9	9.2	11.5	145	15	9
6/26/17	189.8	15.6	11.7	145	15	6	190.9	10.7	11.5	146	16	6	191.3	9.9	12.3	145	12	9
6/27/17	192.0	10.1	11.2	145	14	6	192.0	10.2	11.0	147	16	6	191.3	9.8	12.0	146	13	9
6/28/17	191.4	9.7	10.9	145	11	6	191.9	10.2	10.9	144	10	6	192.0	9.8	11.9	143	9	8
6/29/17	191.9	9.6	10.8	145	12	6	190.6	10.2	10.9	145	11	6	192.0	9.6	11.7	144	6	9

Summary ppm7%	
Averagae NOx	146
Max Value	157
Min Value	140
Std Dev	3

Summary	ppm7%
Hourly Count	984
Averagae NOx	146
Max Value	187
Min Value	115
Std Dev	6
Hours > 150	168

		#1 Boiler						#2 Boiler						#3 Boiler					
		STM FLOW	DRY O2 IN	DRY O2 OUT	NOX OUT	UREA FLOW	SNCR WTR	STM FLOW	DRY O2 IN	DRY O2 OUT	NOX OUT	UREA FLOW	SNCR WTR	STM FLOW	DRY O2 IN	DRY O2 OUT	NOX OUT	UREA FLOW	SNCR WTR
		KLB/HR	%		PPM	GPH	GPM	KLB/HR	%		PPM	GPH	GPM	KLB/HR	%		PPM	GPH	GPM
6/12/17 0:00	6/12/17 1:00	192.4	10.1	11.3	161	15	4	192.5	10.0	10.8	163	10	4	191.9	9.2	11.1	142	5	6
6/12/17 1:00	6/12/17 2:00	192.6	10.2	11.4	154	19	3	191.7	9.7	10.5	149	16	4	191.9	9.0	11.0	148	7	6
6/12/17 2:00	6/12/17 3:00	190.7	10.5	11.7	145	19	3	192.3	9.8	10.6	149	19	4	191.9	9.2	11.2	142	6	6
6/12/17 3:00	6/12/17 4:00	192.0	9.9	11.2	150	19	3	191.4	10.0	10.8	150	16	4	192.1	9.0	10.9	143	6	6
6/12/17 4:00	6/12/17 5:00	191.0	10.7	11.8	139	18	3	189.8	10.7	10.1	138	15	4	189.8	9.5	11.6	142	6	6
6/12/17 5:00	6/12/17 6:00	190.2	11.1	12.1	149	14	3	192.6	10.3	10.6	145	10	4	191.4	9.8	11.9	141	5	6
6/12/17 6:00	6/12/17 7:00	192.1	10.9	12.0	142	15	3	192.4	10.5	11.2	151	13	4	191.7	10.1	12.3	146	7	6
6/12/17 7:00	6/12/17 8:00	189.1	10.9	12.1	148	15	3	184.5	10.3	11.0	144	14	4	183.5	10.6	12.7	147	6	6
6/12/17 8:00	6/12/17 9:00	190.2	10.6	11.7	142	15	3	152.0	9.7	10.7	129	9	4	151.2	11.4	13.3	141	7	6
6/12/17 9:00	6/12/17 10:00	192.0	11.1	12.1	149	15	3	149.9	9.7	10.5	134	5	4	153.2	9.2	11.1	135	5	6
6/12/17 10:00	6/12/17 11:00	191.5	10.9	12.0	150	18	3	150.7	9.7	10.5	138	5	4	149.9	9.5	11.3	132	5	6
6/12/17 11:00	6/12/17 12:00	192.5	10.2	11.4	155	20	3	172.7	9.6	10.6	162	12	4	171.2	8.8	10.6	143	5	6
6/12/17 12:00	6/12/17 13:00	192.9	10.1	11.4	171	20	3	191.3	9.1	10.0	155	20	4	189.8	8.6	10.6	154	9	6
6/12/17 13:00	6/12/17 14:00	192.0	10.1	11.3	161	20	3	192.0	9.4	10.3	150	20	4	192.6	8.9	11.1	135	12	6
6/12/17 14:00	6/12/17 15:00	191.0	10.3	11.4	149	19	3	191.4	10.0	10.7	144	18	4	191.2	9.1	11.4	149	7	6
6/12/17 15:00	6/12/17 16:00	192.8	10.0	11.2	158	13	3	191.5	9.6	10.4	151	13	4	191.6	9.3	11.4	134	6	6
6/12/17 16:00	6/12/17 17:00	192.1	9.7	11.0	148	16	3	191.8	10.0	10.7	139	12	4	186.7	9.9	12.0	149	7	6
6/12/17 17:00	6/12/17 18:00	191.8	9.7	11.0	144	18	3	192.1	10.0	10.7	152	10	4	192.5	8.9	11.0	146	9	6
6/12/17 18:00	6/12/17 19:00	191.3	10.2	11.4	150	18	3	191.4	10.2	10.9	146	15	4	191.7	9.2	11.5	147	11	6
6/12/17 19:00	6/12/17 20:00	192.1	10.5	11.7	149	17	3	192.7	10.4	11.2	149	13	4	192.3	9.4	11.5	147	8	6
6/12/17 20:00	6/12/17 21:00	191.3	10.7	11.9	146	17	4	191.4	10.2	10.9	143	18	4	192.3	10.0	11.6	152	10	6
6/12/17 21:00	6/12/17 22:00	191.3	10.4	11.7	144	15	4	190.4	10.7	11.4	147	12	4	188.0	10.1	12.0	153	12	6
6/12/17 22:00	6/12/17 23:00	192.5	10.5	11.6	146	16	4	192.1	10.3	11.1	146	14	4	191.5	10.1	12.1	138	9	6
6/12/17 23:00	6/13/17 0:00	188.6	10.9	12.0	143	16	4	191.4	10.4	11.3	145	12	4	191.6	10.4	12.3	157	13	6
6/13/17 0:00	6/13/17 1:00	190.6	10.9	12.0	148	16	4	192.6	9.9	10.8	145	16	4	192.6	9.8	11.9	147	17	6
6/13/17 1:00	6/13/17 2:00	192.8	9.9	11.2	152	20	3	191.8	10.4	11.2	146	14	4	191.2	10.2	12.1	147	19	6
6/13/17 2:00	6/13/17 3:00	189.7	10.8	11.9	141	18	3	191.8	10.8	11.6	138	12	4	188.9	10.2	12.1	146	19	6
6/13/17 3:00	6/13/17 4:00	191.5	10.3	11.7	144	16	3	190.7	11.1	11.8	147	9	4	187.9	11.2	12.9	143	16	6
6/13/17 4:00	6/13/17 5:00	193.0	9.9	11.2	152	17	3	193.0	10.9	11.8	149	10	4	191.3	10.0	12.0	132	7	6
6/13/17 5:00	6/13/17 6:00	191.9	9.5	10.8	152	20	3	192.3	10.3	11.0	146	14	4	191.8	9.8	11.6	142	9	6
6/13/17 6:00	6/13/17 7:00	190.9	10.5	11.7	145	19	3	191.6	10.2	11.1	141	14	4	191.2	9.5	11.5	148	9	6
6/13/17 7:00	6/13/17 8:00	193.5	8.8	10.1	154	20	3	192.7	9.9	10.8	151	14	4	192.3	9.2	11.1	146	9	6
6/13/17 8:00	6/13/17 9:00	191.7	8.7	10.2	156	20	3	191.9	9.9	10.8	143	16	4	191.9	9.3	11.4	143	10	6
6/13/17 9:00	6/13/17 10:00	191.8	9.3	10.6	154	20	3	192.2	9.7	10.5	141	13	4	191.5	10.0	12.1	140	6	6
6/13/17 10:00	6/13/17 11:00	191.8	9.0	10.3	149	20	4	192.0	9.4	10.3	149	15	4	192.7	9.5	11.7	151	8	6
6/13/17 11:00	6/13/17 12:00	191.7	9.6	10.8	137	15	4	191.8	9.9	10.7	142	13	4	192.1	9.4	11.5	144	9	6
6/13/17 12:00	6/13/17 13:00	191.5	9.8	11.1	148	13	4	192.1	9.4	10.3	150	13	4	192.0	9.0	11.3	152	11	6
6/13/17 13:00	6/13/17 14:00	192.9	9.2	10.6	149	17	5	191.5	9.7	10.5	145	17	4	192.2	9.0	11.2	142	13	6
6/13/17 14:00	6/13/17 15:00	191.6	9.5	10.7	140	17	5	191.8	10.1	10.9	142	16	3	192.4	8.9	11.0	145	12	6
6/13/17 15:00	6/13/17 16:00	192.0	9.7	10.9	142	14	5	191.7	10.3	11.0	142	14	3	190.7	9.6	11.7	144	13	6
6/13/17 16:00	6/13/17 17:00	192.0	9.2	10.6	142	10	4	192.5	9.7	10.6	143	12	3	192.7	9.0	11.1	137	9	6
6/13/17 17:00	6/13/17 18:00	191.7	9.5	10.7	150	12	5	192.3	9.3	10.1	145	10	4	192.1	9.4	11.5	149	6	6
6/13/17 18:00	6/13/17 19:00	191.7	9.2	10.4	145	13	5	191.5	9.6	10.4	149	13	4	191.3	9.5	11.7	150	10	6
6/13/17 19:00	6/13/17 20:00	191.9	9.5	10.8	150	17	5	191.9	9.5	10.3	149	16	4	192.3	9.5	11.6	147	14	6
6/13/17 20:00	6/13/17 21:00	192.2	9.6	10.8	143	19	4	191.6	9.5	10.4	149	19	4	192.2	9.4	11.5	142	14	6
6/13/17 21:00	6/13/17 22:00	192.1	9.6	10.8	145	17	4	191.9	9.7	10.5	143	19	4	191.6	9.7	11.8	143	11	6
6/13/17 22:00	6/13/17 23:00	192.5	9.5	10.7	147	19	4	191.9	10.3	11.0	137	14	3	192.4	9.3	11.5	146	10	6
6/13/17 23:00	6/14/17 0:00	190.4	10.3	11.3	139	15	4	192.0	10.2	11.0	149	12	3	191.8	9.5	11.5	145	11	6
6/14/17 0:00	6/14/17 1:00	192.5	9.6	10.9	146	12	4	192.6	9.2	10.1	149	17	3	192.5	9.0	11.0	142	9	6
6/14/17 1:00	6/14/17 2:00	192.4	9.6	10.8	151	17	4	192.0	9.1	9.9	154	20	3	191.3	9.7	11.8	150	11	6
6/14/17 2:00	6/14/17 3:00	191.5	9.8	11.1	142	18	4	192.8	9.0	9.8	145	19	3	192.4	9.5	11.8	143	11	6
6/14/17 3:00	6/14/17 4:00	192.3	9.9	10.9	150	19	4	191.3	9.2	9.9	148	19	3	191.4	9.8	12.0	150	14	6
6/14/17 4:00	6/14/17 5:00	191.5	10.2	11.2	142	17	4	192.2	8.9	9.9	152	20	3	193.4	9.3	11.6	150	16	6
6/14/17 5:00	6/14/17 6:00	191.3	10.5	11.6	143	16	4	191.7	8.7	9.7	155	20	3	191.6	9.2	11.2	139	14	6
6/14/17 6:00	6/14/17 7:00	191.9	10.7	11.8	143	15	4	192.5	9.0	9.9	149	20	3	192.2	8.8	11.0	144	14	6
6/14/17 7:00	6/14/17 8:00	191.9	10.6	11.7	145	15	4	191.9	9.4	10.3	153	20	3	191.2	9.6	11.7	142	11	6
6/14/17 8:00	6/14/17 9:00	192.4	10.3	11.4	145	14	4	190.7	9.9	10.8	147	20	3	191.5	10.4	12.5	143	9	6
6/14/17 9:00	6/14/17 10:00	190.0	10.6	11.7	157	18	4	192.3	10.8	11.6	144	14	3	191.4	10.5	12.5	147	9	6
6/14/17 10:00	6/14/17 11:00	188.7	11.1	12.2	182	20	4	192.4	9.9	10.8	150	19	3	191.0	10.3	12.3	156	17	6
6/14/17 11:00	6/14/17 12:00	185.5	9.8	11.0	154	19	4	191.3	10.5	11.3	142	16	3	191.7	10.5	12.4	147	19	5
6/14/17 12:00	6/14/17 13:00	191.0	9.2	10.4	152	20	4	192.1	10.2	11.0	145	18	3	192.7	10.1	12.0	152	19	5
6/14/17 13:00	6/14/17 14:00	191.8	9.1	10.4	155	20	4	191.8	10.3	11.1	146	18	3	192.5	9.9	11.9	151	19	5
6/14/17 14:00	6/14/17 15:00	191.3	9.7	11.0	187	20	4	191.8	10.3	11.1	138	16	3	190.2	10.6	12.6	146	18	6
6/14/17 15:00	6/14/17 16:00	191.5	10.1	11.4	185	20	4	191.4	10.7	11.5	150	14	3	191.0	10.7	12.7	144	18	6
6/14/17 16:00	6/14/17 17:00	192.6	10.4	11.5	170	20	4	192.2	10.4	11.3	144	16	3	192.2	10.4	12.4	145	19	5
6/14/17 17:00	6/14/17 18:00	191.9	9.8	10.9	150	19	4	192.0	10.4	11.3	145	16	3	191.3	10.5	12.5	139	12	6
6/14/17 18:00	6/14/17 19:00	191.9	9.9	11.0	147	20	4	191.7	10.8	11.5	143	14	3	191.2	10.4	12.5	149	10	6

6/14/17 19:00	6/14/17 20:00	192.6	9.2	10.4	159	20	4	192.4	10.0	10.8	155	18	3	192.5	9.6	11.7	147	13	6
6/14/17 20:00	6/14/17 21:00	192.2	9.0	10.3	155	20	4	192.1	9.4	10.3	157	20	3	191.4	9.6	11.6	150	15	6
6/14/17 21:00	6/14/17 22:00	192.2	8.9	10.2	148	20	4	192.0	9.4	10.3	153	20	3	192.5	9.4	11.4	141	16	6
6/14/17 22:00	6/14/17 23:00	191.8	9.2	10.4	159	20	4	191.4	10.1	10.9	142	18	3	192.4	9.7	11.8	145	13	6
6/14/17 23:00	6/15/17 0:00	192.4	8.6	9.8	144	19	4	192.3	9.6	10.5	144	14	3	192.2	9.5	11.5	139	11	6
6/15/17 0:00	6/15/17 1:00	192.0	8.4	9.6	150	19	4	192.2	9.3	10.2	140	16	3	192.6	9.0	11.1	146	10	6
6/15/17 1:00	6/15/17 2:00	191.9	8.6	9.9	157	20	4	191.8	9.7	10.6	154	16	3	191.2	9.4	11.4	152	11	6
6/15/17 2:00	6/15/17 3:00	192.3	8.5	9.8	158	20	4	192.5	9.1	10.0	150	20	3	192.8	9.3	11.3	146	17	6
6/15/17 3:00	6/15/17 4:00	191.5	9.5	10.6	146	20	4	191.3	9.9	10.8	140	16	3	191.2	10.3	12.3	133	9	6
6/15/17 4:00	6/15/17 5:00	191.3	9.8	10.7	137	13	4	192.3	9.9	10.6	143	12	3	186.4	10.6	12.7	151	8	6
6/15/17 5:00	6/15/17 6:00	192.8	9.3	10.5	148	14	4	192.4	9.5	10.4	140	10	3	191.4	9.7	11.3	129	6	6
6/15/17 6:00	6/15/17 7:00	191.7	9.7	10.7	147	14	4	191.5	9.5	10.4	153	11	3	192.2	9.4	11.3	153	9	6
6/15/17 7:00	6/15/17 8:00	192.1	8.9	10.1	150	19	3	191.6	9.4	10.3	155	19	3	192.3	9.0	11.0	147	14	6
6/15/17 8:00	6/15/17 9:00	191.4	9.3	10.5	150	20	3	191.9	9.3	10.2	151	20	3	191.6	9.1	11.1	145	14	6
6/15/17 9:00	6/15/17 10:00	191.9	9.2	10.3	145	19	3	192.6	9.2	10.1	148	20	3	193.2	9.5	11.5	141	14	6
6/15/17 10:00	6/15/17 11:00	191.7	9.3	10.5	158	20	3	191.9	10.0	10.8	148	20	3	190.9	10.0	12.0	148	12	6
6/15/17 11:00	6/15/17 12:00	192.1	9.4	10.5	153	20	3	192.0	9.6	10.4	152	20	3	190.8	10.1	12.1	143	13	6
6/15/17 12:00	6/15/17 13:00	191.8	9.1	10.2	151	20	3	192.0	9.4	10.3	151	20	3	192.0	10.2	12.2	140	11	6
6/15/17 13:00	6/15/17 14:00	185.4	9.1	10.3	137	17	3	192.0	9.7	10.6	147	20	3	192.7	10.0	12.0	151	10	6
6/15/17 14:00	6/15/17 15:00	189.8	10.1	11.0	158	17	3	191.0	10.1	10.8	152	20	3	191.5	10.1	12.3	147	14	6
6/15/17 15:00	6/15/17 16:00	191.9	9.6	10.6	146	19	3	192.1	10.1	10.9	145	18	3	189.2	10.7	12.8	143	14	6
6/20/17 0:00	6/20/17 1:00	193.0	10.9	11.8	159	11	4	191.6	10.5	11.4	158	14	4	192.6	9.6	11.6	159	11	4
6/20/17 1:00	6/20/17 2:00	192.6	9.6	10.7	148	15	4	193.2	9.7	10.7	160	19	4	192.5	8.7	10.4	158	17	4
6/20/17 2:00	6/20/17 3:00	191.6	10.2	11.2	145	17	4	190.6	10.1	11.1	156	20	4	192.2	9.1	11.1	163	20	4
6/20/17 3:00	6/20/17 4:00	192.6	10.8	11.8	145	15	4	191.8	10.3	11.3	146	19	4	194.5	9.7	11.6	145	18	4
6/20/17 4:00	6/20/17 5:00	190.7	10.8	11.6	140	13	4	191.0	10.8	11.9	139	16	4	191.2	10.0	12.1	147	18	4
6/20/17 5:00	6/20/17 6:00	192.0	9.8	10.9	153	16	4	194.9	9.6	10.7	163	19	4	197.0	9.1	11.1	154	19	4
6/20/17 6:00	6/20/17 7:00	192.3	9.4	10.4	139	17	4	193.1	9.2	10.2	168	20	4	192.4	8.4	10.6	155	20	4
6/20/17 7:00	6/20/17 8:00	197.3	9.3	10.4	146	15	4	191.9	9.3	10.4	166	20	4	196.0	9.0	10.9	144	18	4
6/20/17 8:00	6/20/17 9:00	204.5	9.5	10.5	145	16	4	194.7	9.4	10.4	175	20	4	205.0	8.7	11.0	162	19	4
6/20/17 9:00	6/20/17 10:00	205.5	9.3	10.4	151	19	4	198.5	9.6	10.5	173	20	4	204.3	9.4	11.8	151	20	5
6/20/17 10:00	6/20/17 11:00	203.9	10.4	11.2	140	16	4	198.8	10.6	11.4	154	20	4	204.3	9.8	12.2	140	17	6
6/20/17 11:00	6/20/17 12:00	204.9	9.6	10.6	155	16	4	200.5	9.5	10.4	158	20	4	206.4	8.1	10.6	157	18	6
6/20/17 12:00	6/20/17 13:00	205.9	8.5	9.7	163	20	4	200.0	9.2	10.2	168	20	4	204.5	8.5	11.0	158	20	6
6/20/17 13:00	6/20/17 14:00	191.8	10.2	11.2	141	18	4	192.0	10.1	10.9	155	20	4	192.9	9.0	11.3	145	19	6
6/20/17 14:00	6/20/17 15:00	191.8	10.2	11.1	143	15	4	191.4	10.2	11.0	152	20	4	192.4	8.9	11.3	150	20	6
6/20/17 15:00	6/20/17 16:00	191.9	10.2	11.1	144	12	4	192.6	9.8	10.7	150	19	4	191.7	9.1	11.4	144	18	6
6/20/17 16:00	6/20/17 17:00	191.9	10.1	11.0	144	14	4	191.8	9.9	10.9	151	20	4	191.6	9.1	11.6	141	17	6
6/20/17 17:00	6/20/17 18:00	192.4	9.9	10.9	148	14	4	192.0	9.9	10.8	158	20	4	192.4	9.3	11.6	148	15	6
6/20/17 18:00	6/20/17 19:00	191.3	9.6	10.7	144	16	4	192.1	9.7	10.6	152	20	4	191.7	9.2	11.4	144	17	6
6/20/17 19:00	6/20/17 20:00	192.3	9.5	10.6	149	17	4	191.2	10.0	10.8	149	20	4	192.2	9.0	11.2	146	16	6
6/20/17 20:00	6/20/17 21:00	191.1	9.9	11.0	143	16	4	192.5	9.9	10.8	151	20	4	191.8	8.9	11.1	148	18	6
6/20/17 21:00	6/20/17 22:00	192.3	9.9	11.0	145	18	4	192.2	9.6	10.5	162	20	4	191.6	9.5	11.7	140	16	6
6/20/17 22:00	6/20/17 23:00	191.3	10.5	11.4	145	15	4	191.6	10.0	10.9	150	19	4	191.4	9.6	12.0	145	15	6
6/20/17 23:00	6/21/17 0:00	193.2	9.7	10.7	151	18	4	191.9	9.7	10.7	158	20	4	192.8	9.2	11.4	147	17	6
6/21/17 0:00	6/21/17 1:00	191.2	9.9	10.9	147	20	4	192.6	9.4	10.3	156	20	4	192.0	9.3	11.5	142	15	6
6/21/17 1:00	6/21/17 2:00	192.4	10.0	11.0	143	18	4	191.8	9.5	10.4	159	20	4	192.7	9.1	11.3	151	16	6
6/21/17 2:00	6/21/17 3:00	190.6	10.8	11.7	142	16	4	191.7	9.4	10.4	163	20	4	191.5	9.4	11.6	143	19	6
6/21/17 3:00	6/21/17 4:00	191.7	11.2	11.7	144	12	4	191.7	10.3	11.1	146	19	4	192.6	9.4	11.7	153	19	6
6/21/17 4:00	6/21/17 5:00	192.1	11.0	11.9	149	14	4	191.4	10.4	11.3	147	18	4	191.7	9.8	12.1	147	18	6
6/21/17 5:00	6/21/17 6:00	192.3	10.4	11.4	142	16	4	192.3	10.1	10.9	151	20	4	192.7	8.9	11.5	142	18	6
6/21/17 6:00	6/21/17 7:00	192.0	10.2	11.3	142	14	4	190.6	10.5	11.4	143	17	4	192.1	8.3	10.5	145	16	6
6/21/17 7:00	6/21/17 8:00	192.7	9.8	10.9	149	14	4	193.6	9.8	10.7	154	19	4	192.6	8.6	10.7	150	18	6
6/21/17 8:00	6/21/17 9:00	192.2	9.6	10.7	146	18	4	190.4	10.1	10.8	156	20	4	192.0	8.4	10.3	150	20	6
6/21/17 9:00	6/21/17 10:00	191.7	9.6	10.7	147	18	4	192.6	9.3	10.3	155	20	4	191.3	8.9	11.0	137	17	6
6/21/17 10:00	6/21/17 11:00	191.4	9.9	10.9	146	18	4	191.6	9.5	10.4	145	19	4	192.3	9.0	11.3	150	16	6
6/21/17 11:00	6/21/17 12:00	191.8	9.6	10.7	147	18	6	191.4	10.2	11.0	154	20	5	191.4	9.4	11.8	147	18	6
6/21/17 12:00	6/21/17 13:00	193.0	9.2	10.4	145	19	6	193.0	9.7	10.6	163	20	5	192.2	9.3	11.6	148	19	5
6/21/17 13:00	6/21/17 14:00	190.8	10.3	11.2	141	16	6	191.0	9.1	10.1	166	20	5	191.6	9.3	11.7	146	18	5
6/21/17 14:00	6/21/17 15:00	190.3	10.7	11.6	145	15	6	192.4	9.8	10.7	153	20	5	189.9	9.5	11.9	141	18	6
6/21/17 15:00	6/21/17 16:00	193.5	10.1	11.1	143	14	6	191.5	10.3	11.0	156	20	5	191.4	9.4	11.9	142	14	6
6/21/17 16:00	6/21/17 17:00	192.4	9.8	10.9	146	15	6	192.9	9.7	10.7	159	20	5	192.6	8.9	11.3	152	16	6
6/21/17 17:00	6/21/17 18:00	191.8	9.9	10.8	140	14	6	191.3	10.3	11.1	151	20	5	191.9	9.2	11.6	142	16	6
6/21/17 18:00	6/21/17 19:00	192.0	10.3	11.2	144	8	6	191.9	9.9	10.8	140	13	5	191.9	9.2	11.6	149	18	5
6/21/17 19:00	6/21/17 20:00	192.4	10.0	10.9	152	14	6	192.3	9.8	10.7	154	18	5	192.0	9.4	11.6	148	19	5
6/21/17 20:00	6/21/17 21:00	191.4	9.9	10.9	142	14	5	191.7	10.3	11.1	153	20	4	191.6	8.9	11.2	144	19	6
6/21/17 21:00	6/21/17 22:00	192.3	9.9	10.9	147	15	5	192.8	9.9	10.8	159	20	4	192.8	9.1	11.3	144	16	6
6/21/17 22:00	6/21/17 23:00	192.0	9.6	10.6	146	15	5	191.6	9.9	10.8	158	20	4	191.0	9.3	11.5	140	15	6
6/21/17 23:00	6/22/17 0:00	192.2	9.7	10.8	149	17	5	192.9	9.3	10.3	166	20	4	193.1	9.2	11.4	134	12	6
6/22/17 0:00	6/22/17 1:00	191.4	9.6	10.6	140	15	5	191.3	9.3	10.2	162	20	4	191.4	9.2	11.2	152	7	6
6/22/17 1:00	6/22/17 2:00	190.2	10.0	11.0	152	17	5	191.4	9.4	10.2	164	20	4	191.8	8.9	11.0	150	16	6
6/22/17 2:00	6/22/17 3:00	187.9	10.4	11.4	142	18	5	191.9	9.6	10.6	159	20	4	191.9	9.2	11.3	141	14	6
6/22/17 3:00	6/22/17 4:00	192.5	10.2	11.4	143	16	5	187.6	10.9	11.6	141	18	4	191.4	9.8	12.1	141	11	6
6/22/17 4:00	6/22/17 5:00	191.0	11.0	11.9	140	13	5	186.1	11.2	11.8	140	14	4	181.5	10.8	13.0	150	12	6
6/22/17 5:00	6/22/17 6:00	192.8	10.8	11.7	146	11	5	193.0	10.5	11.2	149	13	4	191.1	9.5	11.9	142	12	6
6/22/17 6:00	6/22/17 7:00	193.4	9.8	10.8	139	9	5	191.4	10.0	10.8	150	18	4	191.0	10.4	12.6	133	6	6
6/22/17 7:00	6/22/17 8:00	191.3	10.0	11.0	148	9	5	192.9	10.0	10.8	146	19	4	193.7	9.5	11.1	131	7	6
6/22/17 8:00	6/22/17 9:00	191.4	10.3	11.2	148	10	5	190.4	9.8	10.6	139	19	4	191.3	9.1	10.3	125	5	6
6/22/17 9:00	6/22/17 10:00	191.3	10.3	11.4	150	13	5	192.9	9.9	10.7	149	17	4	192.5	8.9	9.9	139	5	6

6/22/17 10:00	6/22/17 11:00	192.3	9.9	11.1	143	13	5	192.4	9.9	10.8	150	18	4	192.0	8.6	9.2	130	5	7
6/22/17 11:00	6/22/17 12:00	192.0	9.7	10.8	144	14	5	192.1	9.5	10.4	156	20	4	192.2	9.2	9.0	127	5	9
6/22/17 12:00	6/22/17 13:00	192.6	9.7	10.8	150	15	5	192.3	9.2	10.1	155	20	4	191.6	8.4	10.1	144	6	9
6/22/17 13:00	6/22/17 14:00	191.7	9.7	10.7	143	16	5	190.8	10.4	11.1	141	19	4	191.6	9.0	9.4	137	5	9
6/22/17 14:00	6/22/17 15:00	190.9	10.6	11.5	146	14	5	192.4	10.3	11.1	153	17	4	192.2	9.3	7.9	115	5	9
6/22/17 15:00	6/22/17 16:00	191.6	10.2	11.2	142	14	5	191.4	9.8	10.6	160	20	4	192.1	9.6	10.3	145	9	9
6/22/17 16:00	6/22/17 17:00	191.5	10.2	11.1	144	13	5	192.6	9.6	10.5	161	20	4	191.9	9.1	11.2	142	12	8
6/22/17 17:00	6/22/17 18:00	192.9	9.3	10.4	143	13	5	191.4	9.9	10.7	153	20	4	191.7	9.6	11.7	143	9	9
6/22/17 18:00	6/22/17 19:00	191.1	10.6	11.5	147	11	5	191.4	10.3	11.2	145	20	4	192.1	9.4	11.6	150	12	8
6/22/17 19:00	6/22/17 20:00	191.5	10.6	11.5	141	11	5	192.3	10.8	11.5	145	17	4	192.2	9.8	11.7	140	9	9
6/22/17 20:00	6/22/17 21:00	192.4	10.5	11.5	149	11	5	190.8	10.8	11.5	143	17	4	191.1	10.0	12.0	148	10	8
6/22/17 21:00	6/22/17 22:00	192.4	10.1	11.1	146	14	5	191.7	10.8	11.5	145	17	4	192.9	9.4	11.5	147	12	8
6/22/17 22:00	6/22/17 23:00	191.2	10.7	11.6	143	12	5	192.1	11.0	11.7	147	18	4	191.4	9.8	12.0	141	11	8
6/22/17 23:00	6/23/17 0:00	192.3	9.9	11.0	146	13	5	193.0	10.2	11.1	148	18	4	191.8	9.5	11.7	144	9	8
6/23/17 0:00	6/23/17 1:00	191.9	10.1	11.1	145	12	6	192.1	9.8	10.6	149	20	5	192.0	9.8	11.9	146	9	9
6/23/17 1:00	6/23/17 2:00	192.2	10.3	11.3	145	13	6	192.1	10.1	10.9	147	20	6	193.5	9.1	11.3	142	10	10
6/23/17 2:00	6/23/17 3:00	191.7	10.3	11.3	144	12	6	191.4	10.2	11.1	142	19	6	185.2	9.9	12.1	148	10	10
6/23/17 3:00	6/23/17 4:00	193.2	9.2	10.6	146	12	6	192.3	9.9	10.8	144	16	6	192.6	9.3	11.5	143	8	10
6/23/17 4:00	6/23/17 5:00	190.1	10.3	11.3	140	11	7	191.8	10.4	11.2	141	16	6	191.4	9.1	11.0	145	9	9
6/23/17 5:00	6/23/17 6:00	192.3	10.4	11.4	146	8	6	191.8	10.3	11.0	145	13	6	192.6	9.7	11.6	139	6	9
6/23/17 6:00	6/23/17 7:00	190.8	10.8	11.7	146	8	6	192.2	10.5	11.2	144	10	6	190.5	10.0	12.1	144	6	9
6/23/17 7:00	6/23/17 8:00	191.8	11.1	11.9	146	11	6	192.1	10.6	11.3	148	13	6	192.4	10.4	12.4	147	8	9
6/23/17 8:00	6/23/17 9:00	192.9	10.4	11.3	143	10	6	191.8	10.1	10.9	148	16	6	192.7	9.2	11.4	146	10	9
6/23/17 9:00	6/23/17 10:00	177.5	10.8	11.9	149	12	7	191.6	9.8	10.7	148	18	6	192.1	9.5	11.5	151	11	9
6/23/17 10:00	6/23/17 11:00	182.8	10.7	11.6	147	13	6	191.8	10.5	11.3	144	18	6	191.4	9.7	11.9	142	12	9
6/23/17 11:00	6/23/17 12:00	190.8	10.9	11.8	147	13	6	192.8	10.1	10.9	142	16	6	192.2	9.6	11.7	146	10	9
6/23/17 12:00	6/23/17 13:00	193.0	9.9	11.0	145	15	6	190.7	10.2	11.0	144	14	6	192.4	9.1	11.3	147	12	9
6/23/17 13:00	6/23/17 14:00	191.6	10.3	11.2	139	12	6	188.0	10.9	11.6	145	14	6	192.0	9.2	11.3	143	13	9
6/23/17 14:00	6/23/17 15:00	191.6	10.6	11.4	144	11	6	187.8	10.9	11.6	147	15	6	191.3	9.7	11.9	146	13	9
6/23/17 15:00	6/23/17 16:00	191.9	10.7	11.6	150	12	6	192.2	10.3	11.0	150	17	6	192.3	9.6	11.7	155	15	9
6/23/17 16:00	6/23/17 17:00	163.1	11.1	12.1	149	16	6	192.7	10.1	11.0	145	18	6	192.7	9.3	11.4	139	17	9
6/23/17 17:00	6/23/17 18:00	169.4	11.0	12.0	144	9	6	192.3	9.4	10.2	145	19	6	191.8	9.8	12.1	151	17	9
6/23/17 18:00	6/23/17 19:00	190.3	10.5	11.6	149	12	6	192.5	9.4	10.3	145	19	6	191.8	10.0	12.1	142	17	9
6/23/17 19:00	6/23/17 20:00	190.7	10.4	11.5	145	13	6	190.9	9.9	10.8	142	18	6	191.3	10.2	12.3	145	18	9
6/23/17 20:00	6/23/17 21:00	192.7	10.6	11.7	147	14	6	192.3	10.0	10.8	147	17	6	192.3	9.8	12.0	150	19	9
6/23/17 21:00	6/23/17 22:00	191.2	10.1	11.2	143	14	6	191.6	10.0	10.8	143	18	5	191.7	10.2	12.4	145	19	9
6/23/17 22:00	6/23/17 23:00	192.2	10.3	11.4	146	14	6	192.9	9.6	10.4	149	18	5	193.0	9.7	11.9	149	19	9
6/23/17 23:00	6/24/17 0:00	192.6	9.7	11.0	147	16	6	190.8	9.6	10.4	144	19	6	191.8	9.5	11.7	145	19	9
6/24/17 0:00	6/24/17 1:00	191.8	9.7	10.9	143	15	6	192.4	9.3	10.3	148	19	6	192.0	8.8	11.0	140	14	9
6/24/17 1:00	6/24/17 2:00	191.1	10.2	11.3	144	15	6	192.1	9.3	10.2	153	20	6	192.1	9.3	11.4	145	12	9
6/24/17 2:00	6/24/17 3:00	191.9	10.6	11.6	147	15	6	191.1	9.9	10.8	141	19	6	191.9	8.8	11.1	148	14	9
6/24/17 3:00	6/24/17 4:00	190.5	10.3	11.5	141	14	6	191.5	10.5	11.2	143	15	6	191.4	9.1	11.2	141	14	8
6/24/17 4:00	6/24/17 5:00	191.4	10.3	11.3	148	14	6	192.4	10.8	11.4	148	15	6	192.7	9.0	11.1	143	9	8
6/24/17 5:00	6/24/17 6:00	186.6	10.5	11.5	146	17	6	187.6	10.4	11.0	143	16	6	187.9	9.2	11.4	145	11	9
6/24/17 6:00	6/24/17 7:00	191.5	10.7	11.7	142	14	6	191.3	10.7	11.4	142	15	6	192.3	9.4	11.7	150	11	9
6/24/17 7:00	6/24/17 8:00	191.9	10.4	11.4	144	13	6	185.1	11.0	11.7	148	13	6	191.5	9.2	11.5	144	14	9
6/24/17 8:00	6/24/17 9:00	192.4	10.4	11.5	149	13	6	190.7	10.2	11.0	147	15	6	192.4	9.5	11.9	142	11	9
6/24/17 9:00	6/24/17 10:00	192.0	10.0	11.1	145	15	6	191.9	10.0	10.9	147	18	6	191.5	9.7	12.0	145	10	9
6/24/17 10:00	6/24/17 11:00	191.8	10.1	11.1	146	16	6	192.5	9.9	10.6	136	15	6	192.7	9.4	11.8	145	10	9
6/24/17 11:00	6/24/17 12:00	191.0	10.6	11.6	143	17	6	191.4	10.4	11.1	150	13	6	189.0	10.6	12.6	146	13	9
6/24/17 12:00	6/24/17 13:00	192.3	10.8	11.8	147	15	6	192.2	10.5	11.3	146	15	6	192.3	9.5	11.7	144	11	9
6/24/17 13:00	6/24/17 14:00	192.7	10.1	11.2	145	17	6	192.1	10.5	11.2	145	15	6	190.9	9.5	12.0	145	11	9
6/24/17 14:00	6/24/17 15:00	190.2	11.1	12.0	139	15	6	190.6	10.6	11.3	137	12	6	191.3	9.8	12.3	145	10	9
6/24/17 15:00	6/24/17 16:00	192.7	11.0	11.9	144	11	6	193.3	10.5	11.2	149	10	6	190.0	9.9	12.0	147	12	9
6/24/17 16:00	6/24/17 17:00	192.4	10.5	11.5	145	11	6	191.1	10.9	11.5	144	12	6	189.1	9.7	12.0	141	12	9
6/24/17 17:00	6/24/17 18:00	193.0	10.2	11.2	145	12	6	188.4	10.8	11.5	152	13	6	192.2	9.5	11.8	149	11	9
6/24/17 18:00	6/24/17 19:00	192.1	9.9	11.0	149	12	6	192.5	9.6	10.4	154	19	6	192.0	9.0	11.4	143	13	9
6/24/17 19:00	6/24/17 20:00	190.8	10.3	11.3	145	14	6	191.0	10.3	10.9	142	19	6	191.9	9.3	11.7	149	13	9
6/24/17 20:00	6/24/17 21:00	191.3	10.5	11.5	148	16	6	192.1	10.1	10.9	145	17	6	191.8	8.9	11.2	144	14	9
6/24/17 21:00	6/24/17 22:00	192.6	10.0	11.1	144	17	6	192.3	9.8	10.7	151	19	6	193.2	8.6	10.9	146	15	9
6/24/17 22:00	6/24/17 23:00	191.4	10.3	11.4	149	17	6	192.1	9.3	10.2	158	20	6	191.5	8.6	10.8	152	16	9
6/24/17 23:00	6/25/17 0:00	191.5	10.3	11.5	145	19	6	190.9	10.1	10.9	150	20	5	191.7	8.7	11.0	146	19	8
6/25/17 0:00	6/25/17 1:00	191.3	10.2	11.7	142	16	6	192.5	9.6	10.5	154	20	5	192.2	8.7	11.0	151	20	8
6/25/17 1:00	6/25/17 2:00	191.0	9.4	11.1	151	19	6	190.4	10.1	11.0	145	19	5	191.3	8.9	11.2	142	18	9
6/25/17 2:00	6/25/17 3:00	192.2	9.6	11.1	143	19	6	193.1	10.2	11.0	147	17	5	192.8	8.8	10.7	142	16	9
6/25/17 3:00	6/25/17 4:00	191.8	8.5	11.2	148	19	6	191.9	10.2	11.0	142	17	5	191.8	8.9	11.1	144	13	9
6/25/17 4:00	6/25/17 5:00	191.7	9.4	11.2	144	19	6	191.4	10.0	10.7	150	17	5	192.0	8.8	11.0	149	15	9
6/25/17 5:00	6/25/17 6:00	191.6	9.0	10.9	142	19	6	192.5	9.9	10.7	146	19	5	192.0	8.9	11.1	146	17	9
6/25/17 6:00	6/25/17 7:00	192.3	9.9	11.5	147	17	6	192.1	9.8	10.8	145	19	5	191.8	9.0	11.3	139	14	9
6/25/17 7:00	6/25/17 8:00	191.8	9.3	11.3	147	19	6	191.8	9.9	10.8	153	20	5	192.1	9.3	11.6	144	11	9
6/25/17 8:00	6/25/17 9:00	191.1	9.2	11.5	142	16	6	192.0	10.0	10.8	147	20	5	191.0	9.5	11.8	148	13	9
6/25/17 9:00	6/25/17 10:00	192.8	9.2	11.5	145	17	6	191.8	10.3	11.1	142	17	5	192.0	9.5	11.7	148	14	9
6/25/17 10:00	6/25/17 11:00	191.1	9.3	11.4	144	16	6	192.2	9.8	10.6	150	19	5	191.4	9.9	12.1	144	16	9
6/25/17 11:00	6/25/17 12:00	191.8	11.4	11.4	146	17	6	191.5	9.9	10.9	147	19	5	193.1	9.3	11.5	145	16	9
6/25/17 12:00	6/25/17 13:00	192.3	19.0	11.8	145	16	6	191.9	10.1	10.9	148	19	5	191.4	10.0	12.3	143	14	9
6/25/17 13:00	6/25/17 14:00	191.6	19.0	11.3	144	16	6	192.7	9.6	10.5	156	20	5	192.1	9.4	11.8	142	13	9
6/25/17 14:00	6/25/17 15:00	191.8	19.0	11.6	147	18	6	190.9	10.4	11.3	140	17	5	192.5	9.2	11.6	149	14	9
6/25/17 15:00	6/25/17 16:00	191.2	19.0	11.8	144	19	6	192.4	10.1	10.9	147	16	5	192.0	9.4	11.7	142	15	9
6/25/17 16:00	6/25/17 17:00	190.8	19.0	11.9	147	17	6	190.9	10.6	11.4	142	17	5	189.9	10.2	12.5	137	10	9

6/25/17 17:00	6/25/17 18:00	191.8	19.0	11.9	141	17	6	192.8	10.1	11.0	148	17	5	192.9	9.1	11.2	145	6	9
6/25/17 18:00	6/25/17 19:00	192.4	19.0	11.6	145	14	6	191.5	10.2	11.1	143	16	5	192.6	8.3	10.6	158	14	9
6/25/17 19:00	6/25/17 20:00	191.4	19.0	11.6	146	16	6	192.1	10.6	11.4	145	14	5	191.3	8.5	10.8	150	19	9
6/25/17 20:00	6/25/17 21:00	192.9	19.0	11.4	149	18	6	192.4	10.3	11.1	147	16	5	191.6	9.4	11.7	143	18	9
6/25/17 21:00	6/25/17 22:00	191.2	19.0	11.7	145	18	6	191.5	10.5	11.4	146	17	5	192.4	9.0	11.2	146	19	8
6/25/17 22:00	6/25/17 23:00	191.9	19.0	11.7	139	17	6	192.6	9.6	10.5	151	20	5	192.4	8.9	11.2	138	15	9
6/25/17 23:00	6/26/17 0:00	192.0	19.0	11.4	150	16	6	188.4	10.5	11.4	142	18	5	191.1	9.7	12.1	144	12	9
6/26/17 0:00	6/26/17 1:00	191.8	19.0	11.7	142	17	6	191.9	10.2	11.1	146	18	5	192.4	8.6	10.9	145	13	9
6/26/17 1:00	6/26/17 2:00	193.2	19.0	11.1	146	16	6	192.5	10.1	11.1	147	19	5	192.2	8.9	11.2	145	14	9
6/26/17 2:00	6/26/17 3:00	190.8	19.0	11.7	146	16	6	191.9	10.0	10.9	149	20	5	192.0	8.7	11.1	151	17	9
6/26/17 3:00	6/26/17 4:00	192.3	19.0	11.2	142	16	6	192.4	10.0	11.0	149	20	5	190.6	9.6	12.0	141	16	9
6/26/17 4:00	6/26/17 5:00	190.0	19.0	11.5	145	13	6	191.5	10.1	11.1	151	20	5	192.1	9.6	12.0	143	12	9
6/26/17 5:00	6/26/17 6:00	192.8	19.0	11.6	145	16	6	192.6	10.1	11.0	143	16	5	192.6	9.6	11.9	145	11	9
6/26/17 6:00	6/26/17 7:00	181.8	19.0	12.4	153	15	6	188.5	10.5	11.3	142	18	5	190.5	10.2	12.5	144	11	9
6/26/17 7:00	6/26/17 8:00	181.7	19.0	12.0	143	15	6	185.0	11.1	11.8	148	16	5	192.0	10.4	12.8	142	12	9
6/26/17 8:00	6/26/17 9:00	187.6	19.0	12.4	146	15	6	180.4	11.5	12.2	136	13	5	192.1	10.2	12.6	144	6	9
6/26/17 9:00	6/26/17 10:00	179.0	19.0	12.7	144	18	6	190.5	11.0	11.8	151	15	6	192.0	9.9	12.3	153	14	9
6/26/17 10:00	6/26/17 11:00	192.0	19.0	12.0	145	17	6	192.8	10.5	11.3	149	16	6	190.7	10.7	13.2	136	15	9
6/26/17 11:00	6/26/17 12:00	192.3	19.0	11.7	138	14	6	191.9	10.5	11.2	140	18	6	184.7	10.4	12.8	144	12	9
6/26/17 12:00	6/26/17 13:00	190.9	19.0	12.0	148	12	6	191.8	10.7	11.6	143	14	6	189.9	10.6	13.0	143	9	9
6/26/17 13:00	6/26/17 14:00	186.7	13.2	12.4	150	16	6	191.8	10.7	11.5	145	14	6	192.0	10.6	13.0	147	9	9
6/26/17 14:00	6/26/17 15:00	192.8	12.9	12.1	141	18	6	191.5	11.1	11.9	147	16	6	188.3	11.1	13.4	149	13	9
6/26/17 15:00	6/26/17 16:00	191.9	12.9	12.0	142	12	6	191.3	11.1	11.9	142	13	6	192.7	9.6	12.3	139	13	9
6/26/17 16:00	6/26/17 17:00	192.2	12.9	11.6	147	12	6	190.0	11.0	11.8	143	12	6	190.4	10.5	12.9	142	8	9
6/26/17 17:00	6/26/17 18:00	186.4	14.9	12.1	148	14	6	189.5	11.1	11.9	149	12	6	191.2	10.5	12.9	150	12	9
6/26/17 18:00	6/26/17 19:00	192.0	10.3	11.2	144	15	6	191.7	10.5	11.4	147	15	6	192.5	9.8	12.0	145	11	9
6/26/17 19:00	6/26/17 20:00	192.8	9.8	10.8	150	17	6	192.1	10.6	11.4	146	16	6	192.2	9.5	11.7	148	11	9
6/26/17 20:00	6/26/17 21:00	189.7	10.4	11.3	141	16	6	192.4	11.0	11.7	144	16	6	191.0	10.3	12.4	142	11	9
6/26/17 21:00	6/26/17 22:00	191.6	10.4	11.3	146	17	6	192.6	11.0	11.8	145	15	6	192.7	10.3	12.4	144	9	9
6/26/17 22:00	6/26/17 23:00	192.7	10.5	11.4	145	17	6	192.1	10.9	11.6	146	15	6	192.0	9.6	11.7	144	8	9
6/26/17 23:00	6/27/17 0:00	190.6	10.7	11.5	143	15	6	192.2	10.6	11.4	147	16	6	192.6	8.8	11.1	149	11	9
6/27/17 0:00	6/27/17 1:00	192.5	10.4	11.4	147	17	6	191.8	10.1	11.0	151	19	6	192.7	8.6	10.9	151	15	9
6/27/17 1:00	6/27/17 2:00	192.0	10.3	11.3	147	18	6	193.0	9.6	10.5	158	20	6	191.6	8.9	11.1	148	16	9
6/27/17 2:00	6/27/17 3:00	191.5	10.5	11.5	145	19	6	191.5	9.9	10.7	152	20	6	192.1	9.0	11.2	142	19	8
6/27/17 3:00	6/27/17 4:00	191.6	10.5	11.5	142	18	6	192.1	10.0	10.8	150	20	6	191.7	9.6	11.8	145	16	9
6/27/17 4:00	6/27/17 5:00	192.5	10.5	11.5	142	14	6	192.1	9.5	10.4	163	20	6	191.3	9.6	11.7	140	16	9
6/27/17 5:00	6/27/17 6:00	191.0	10.7	11.6	144	13	6	191.4	10.2	11.1	145	19	6	192.1	9.5	11.7	147	14	9
6/27/17 6:00	6/27/17 7:00	192.7	10.8	11.7	140	11	6	191.2	10.2	11.0	141	16	6	191.7	9.6	11.8	141	14	9
6/27/17 7:00	6/27/17 8:00	192.3	10.5	11.6	144	8	6	192.6	10.5	11.3	145	12	6	192.9	9.2	11.5	147	14	9
6/27/17 8:00	6/27/17 9:00	192.2	10.3	11.3	152	9	6	191.3	9.9	10.8	144	14	6	191.7	8.8	10.7	144	11	9
6/27/17 9:00	6/27/17 10:00	191.9	9.9	10.9	146	13	6	192.2	10.5	11.3	149	14	6	192.2	9.2	11.4	145	13	9
6/27/17 10:00	6/27/17 11:00	191.8	10.0	11.0	147	15	6	192.1	10.5	11.2	144	16	6	189.7	10.3	12.5	140	10	9
6/27/17 11:00	6/27/17 12:00	192.2	9.7	11.0	145	15	6	191.3	10.6	11.4	142	14	6	193.4	10.3	12.5	146	9	9
6/27/17 12:00	6/27/17 13:00	191.5	9.8	10.9	145	18	6	190.6	11.0	11.7	145	13	6	191.3	10.2	12.4	148	10	9
6/27/17 13:00	6/27/17 14:00	191.3	10.1	11.2	145	17	6	192.9	10.7	11.4	146	15	6	192.5	10.1	12.5	143	10	9
6/27/17 14:00	6/27/17 15:00	191.5	10.3	11.3	142	16	6	192.7	10.4	11.2	148	16	6	189.4	10.5	12.7	147	11	9
6/27/17 15:00	6/27/17 16:00	192.9	10.2	11.2	144	11	6	192.3	10.2	11.0	147	17	6	183.6	10.4	12.6	144	10	9
6/27/17 16:00	6/27/17 17:00	191.4	9.9	10.9	143	12	6	192.3	10.0	10.7	144	19	6	184.7	10.6	12.8	142	7	9
6/27/17 17:00	6/27/17 18:00	192.9	9.9	11.0	145	12	6	193.4	9.6	10.3	139	14	6	192.3	10.3	12.5	148	9	9
6/27/17 18:00	6/27/17 19:00	191.4	10.0	11.0	148	12	6	189.8	10.1	10.8	149	13	6	192.2	9.7	11.9	147	9	9
6/27/17 19:00	6/27/17 20:00	192.2	9.7	10.8	140	12	6	192.9	10.2	10.9	148	15	6	192.0	10.1	12.3	152	12	9
6/27/17 20:00	6/27/17 21:00	192.0	9.8	10.9	150	13	6	192.4	9.4	10.3	144	17	6	192.8	10.5	12.6	146	17	9
6/27/17 21:00	6/27/17 22:00	192.2	9.6	10.8	145	13	6	191.5	9.9	10.7	144	14	6	191.6	10.3	12.5	145	17	9
6/27/17 22:00	6/27/17 23:00	191.8	9.6	10.9	148	13	6	191.3	10.7	11.5	143	14	6	192.5	10.4	12.6	156	19	8
6/27/17 23:00	6/28/17 0:00	192.1	9.2	10.5	137	14	6	193.3	9.8	10.7	145	14	6	192.1	10.0	12.1	140	16	9
6/28/17 0:00	6/28/17 1:00	192.0	9.6	10.8	135	6	6	192.1	9.8	10.6	138	11	6	191.2	10.2	12.3	135	8	9
6/28/17 1:00	6/28/17 2:00	191.7	10.0	11.0	149	7	6	191.2	9.9	10.7	150	9	6	192.5	9.8	11.9	145	6	9
6/28/17 2:00	6/28/17 3:00	192.9	9.4	10.6	142	7	6	194.1	9.1	9.9	138	9	6	191.9	10.1	12.3	146	6	9
6/28/17 3:00	6/28/17 4:00	190.6	10.0	11.1	145	6	6	190.5	9.8	10.5	149	7	6	191.9	10.1	12.3	142	7	9
6/28/17 4:00	6/28/17 5:00	192.8	9.7	11.0	147	7	6	193.6	9.4	10.0	144	8	6	192.2	10.0	12.1	144	6	9
6/28/17 5:00	6/28/17 6:00	191.0	10.1	11.2	143	8	6	190.0	10.0	10.7	141	7	6	191.8	9.9	12.2	147	8	9
6/28/17 6:00	6/28/17 7:00	191.3	10.0	11.2	148	9	6	191.7	9.9	10.6	152	8	6	191.5	10.1	12.2	144	9	9
6/28/17 7:00	6/28/17 8:00	192.4	10.0	11.2	149	11	6	191.9	9.8	10.5	151	13	6	192.6	9.6	11.7	146	8	9
6/28/17 8:00	6/28/17 9:00	192.1	9.7	10.9	145	14	6	190.2	10.8	11.4	140	13	6	191.5	9.8	12.0	149	11	8
6/28/17 9:00	6/28/17 10:00	192.5	9.3	10.6	144	12	6	193.0	10.4	11.1	144	10	6	191.8	10.1	12.4	141	12	8
6/28/17 10:00	6/28/17 11:00	191.2	10.0	11.2	144	11	6	191.1	10.8	11.5	144	10	6	192.0	10.1	12.4	146	10	8
6/28/17 11:00	6/28/17 12:00	192.5	9.3	10.6	152	16	6	192.3	10.4	11.1	149	11	6	192.3	9.6	11.8	148	10	8
6/28/17 12:00	6/28/17 13:00	191.6	9.9	11.1	139	15	6	191.8	10.8	11.4	144	12	6	192.2	9.5	11.9	149	15	8
6/28/17 13:00	6/28/17 14:00	191.2	10.1	11.2	143	13	6	191.6	10.5	11.2	145	12	6	192.2	9.5	11.7	142	14	8
6/28/17 14:00	6/28/17 15:00	181.3	10.5	11.7	150	14	6	192.4	10.6	11.3	147	13	6	191.3	9.8	12.0	143	12	8
6/28/17 15:00	6/28/17 16:00	191.0	9.8	11.1	138	12	6	192.3	10.5	11.1	146	15	6	192.1	9.8	12.0	143	13	8
6/28/17 16:00	6/28/17 17:00	192.1	9.6	10.9	154	13	6	191.1	10.6	11.2	144	15	6	192.6	9.6	11.7	148	12	8
6/28/17 17:00	6/28/17 18:00	191.7	9.3	10.6	139	16	6	192.1	10.6	11.2	144	14	6	192.0	9.3	11.5	145	14	8
6/28/17 18:00	6/28/17 19:00	192.2	9.4	10.8	153	16	6	192.5	10.6	11.2	142	12	6	192.3	9.4	11.5	141	11	8
6/28/17 19:00	6/28/17 20:00	192.2	9.4	10.7	138	15	6	192.1	10.4	11.0	141	11	6	192.5	9.6	11.5	142	10	8
6/28/17 20:00	6/28/17 21:00	191.6	9.6	10.9	140	10	6	191.8	10.4	11.1	139	6	6	191.7	10.0	11.9	134	6	8
6/28/17 21:00	6/28/17 22:00	192.8	9.3	10.5	139	7	6	192.7	10.4	11.1	147	6	6	191.9	9.7	11.7	128	5	8
6/28/17 22:00	6/28/17 23:00	191.4	9.4	10.7	148	7	6	191.8	10.3	11.1	148	9	6	192.0	9.5	11.6	144	5	8
6/28/17 23:00	6/29/17 0:00	192.4	9.4	10.6	146	11	6	191.9	10.0	10.8	143	10	6	192.8	9.7	11.9	142	6	8

6/29/17 0:00	6/29/17 1:00	191.4	9.6	10.8	144	9	6	191.6	10.4	11.1	143	6	6	190.5	9.8	11.9	141	5	8
6/29/17 1:00	6/29/17 2:00	190.8	9.7	10.9	144	9	6	191.3	10.6	11.3	149	9	6	191.9	10.5	12.7	142	5	8
6/29/17 2:00	6/29/17 3:00	193.1	9.3	10.6	143	7	6	192.9	10.2	11.0	144	10	6	192.5	10.0	12.2	142	5	8
6/29/17 3:00	6/29/17 4:00	192.3	9.2	10.4	149	10	6	191.2	10.8	11.4	146	10	6	190.8	10.5	12.6	145	7	8
6/29/17 4:00	6/29/17 5:00	190.6	9.9	11.1	148	12	6	192.0	10.5	11.3	150	11	6	192.7	10.3	12.6	140	6	8
6/29/17 5:00	6/29/17 6:00	191.7	9.6	10.8	141	11	6	192.3	10.4	11.2	139	10	6	191.9	9.9	12.1	147	6	8
6/29/17 6:00	6/29/17 7:00	192.7	9.4	10.7	144	10	6	191.5	10.5	11.2	149	10	6	192.5	9.7	11.9	143	6	8
6/29/17 7:00	6/29/17 8:00	192.2	9.4	10.6	144	8	6	192.4	10.2	10.9	140	10	6	192.4	9.3	11.6	149	7	8
6/29/17 8:00	6/29/17 9:00	191.1	10.0	11.3	147	7	6	191.1	9.8	10.6	148	9	6	191.9	9.5	11.7	144	8	8
6/29/17 9:00	6/29/17 10:00	191.7	9.6	10.9	150	13	6	190.9	9.9	10.6	149	13	6	191.2	9.8	12.0	145	8	8
6/29/17 10:00	6/29/17 11:00	192.5	9.2	10.6	145	15	6	181.3	11.5	12.0	145	15	6	191.4	10.0	12.2	146	7	9
6/29/17 11:00	6/29/17 12:00	191.7	9.5	10.8	147	16	6	178.2	10.6	11.2	139	12	6	193.0	9.9	12.1	144	8	9
6/29/17 12:00	6/29/17 13:00	192.2	9.3	10.7	146	18	6	191.5	9.6	10.4	149	12	6	192.1	9.6	11.7	144	7	9
6/29/17 13:00	6/29/17 14:00	191.7	9.6	10.9	143	15	6	189.4	9.7	10.5	143	13	6	191.5	9.7	11.7	145	6	9
6/29/17 14:00	6/29/17 15:00	191.8	9.9	11.1	141	14	6	191.1	10.2	10.9	142	10	6	192.2	9.8	11.9	145	6	9
6/29/17 15:00	6/29/17 16:00	191.8	10.5	11.6	144	12	6	191.8	9.9	10.7	147	11	6	192.3	9.3	11.4	143	7	9
6/29/17 16:00	6/29/17 17:00	192.3	9.6	10.9	148	13	6	191.4	10.2	10.8	143	10	6	191.7	9.1	11.1	147	6	9
6/29/17 17:00	6/29/17 18:00	190.7	9.7	10.9	143	13	6	191.8	9.8	10.5	151	12	6	192.2	8.6	10.6	144	7	9
6/29/17 18:00	6/29/17 19:00	192.8	9.6	10.9	144	12	6	191.8	10.1	10.8	141	14	6	191.8	8.9	10.9	139	5	9
6/29/17 19:00	6/29/17 20:00	191.7	9.7	11.0	141	9	6	192.7	10.2	10.9	145	11	6	192.4	8.8	10.9	137	5	9
6/29/17 20:00	6/29/17 21:00	192.6	9.4	10.7	156	10	6	191.6	9.9	10.6	146	11	6	191.2	9.6	11.7	139	5	9
6/29/17 21:00	6/29/17 22:00	192.3	9.2	10.5	144	16	6	192.1	9.9	10.7	144	11	6	192.0	9.1	11.2	147	6	9
6/29/17 22:00	6/29/17 23:00	191.7	9.0	10.3	140	13	6	192.2	10.1	10.8	144	10	6	192.2	9.0	11.1	145	8	9
6/29/17 23:00	6/30/17 0:00	192.1	9.5	10.7	147	12	6	190.6	10.0	10.7	144	10	6	192.8	9.2	11.2	146	8	9

Appendix F – Operating Procedures for Large MWCs

Appendix F – Operating Procedures for Large MWCs

Appendix F contains unofficial, draft operating procedures for the Montgomery County Resource Recovery Facility and Wheelabrator Baltimore, Inc. Final operating procedures for the affected Large Municipal Waste Combustors (MWCs) will be submitted to the Department not later than 45 days after the effective date of the proposed regulations.

Under COMAR 26.11.08.10G, the Department has proposed the following provision:

G. Not later than 45 days after the effective date of this regulation, the owner or operator of a Large MWC shall submit a plan to the Department and EPA for approval that demonstrates how the Large MWC will operate installed pollution control technology and combustion controls to meet the requirements of §A of this Regulation. The plan shall summarize the data that will be collected to demonstrate compliance with §A of this Regulation. The plan shall cover all modes of operation, including but not limited to normal operations, startup, and shutdown.

Compliance for Large MWCs will be dependent upon the facilities operating their units as specified in the approved plans during all modes of operation, including but not limited to normal operations, startup, and shutdown. The MWC facility will provide quarterly reports detailing that the emission limitations have been met.

Montgomery County Resource Recovery Facility Startup/Shutdown Procedures

BOILER STARTUP PROCEDURE
With at least one other boiler and the dump condenser online
Assumes all plant systems that are common to all boiler units are already operating normally

1. Perform standard walk down of unit, including but not limited to:
   Verify that all safety clearance have been properly released before preparing the unit for startup.
   Check that the feed chute, feed rams and table, grate surface, clinker rollers, ash pit, ash discharger, and boiler fans are clear of personnel, tools and debris, and are ready for service.
   Verify that over fire air nozzles in front and rear walls of furnace are clear of slag and ready for service.
   Verify feed chute cooling water system is full and ready for service. Check water supply and float switch.
   Check UFA zone hopper doors are closed.
   Check all access plates in feeder are closed and locked.
   Check stoker lubrication system, Fill grease pump as necessary.
   Check ash discharger and fly ash system doors closed and system ready for operation.
   Check discharger water level.
   Verify power to stoker panel.
   Check hydraulic system.
   Open drum vents, crossover drum vents, and all super heater vents and drains.
   Open 4" warm-up line at boiler, PV-28 valve at turbine level.
   Close Steam Header Valve, open steam stop and non-return valve.
   Verify all access doors closed on boiler, furnace, baghouse, Quench Reactor and flyash system.
   Line up feedwater station.
   Start grease pump.
   Verify Instrument Air to Stoker Hydraulic Cabinet.
   All Baghouse Isolation Dampers open. A and B modules in service.
   Start hydrated lime blower to prevent melting of hoses
   Check ammonia system line-up.

2. Start two hydraulic pumps. Test operation of:
   UFA dampers, feed chute damper, feeders, grates, clinker roll, ash discharger, OFA dampers including tertiary dampers.

3. Pre-set Martin panel as follows:
   FEEDERS: speed 25%, stroke 8.2" power OFF
   GRATES: speed 15%, power OFF
   Clinker Roll off
   OPTIMIZING CONTROLLER: set to short, power OFF

place in FURNACE TEMPERATURE CONTROL
OFA Dampers in manual and CLOSED
UFA Dampers in step 18

4. Commence filling boiler with feedwater to a level of -5 inches. Do not exceed 30k feed flow to prevent starving DA Tank. If the boiler is cold use demin fill system.

   NOTE: During a cold boiler start up, the combustion fan interlock trip circuit shall be tested. This test will be accomplished by attempting to start the UFA and OFA fans while the ID fan is not running. Before attempting this test, ensure that the electrical circuits are ready for a fan start. (Hardwired switches are in the reset position, breakers racked in, etc.) Attempt to start the UFA and OFA fans, if they do not start, the test is complete and should be entered in the control room log. If the fans start, have the interlocks repaired before continuing the start up.

5. Start ID fan, seal air fan and FD fan. Set furnace draft at -.10" in auto and the FD header pressure at 16.5" in auto. Blow down boiler to -7" drum level, monitor for fan trip. Line up air to furnace camera.

6. Refill boiler to -4" drum level. FD Fans. Put dampers in auto, and commence purge of burners.

7. Verify Ammonia system, Quench reactor, hydrated lime system, and carbon system are all ready for service.

8. Verify the following APC equipment:
   Verify Hydrated Lime Blower running
   Fly ash handling equipment available, tested then shutdown

9. When purge is complete, start both gas burners. Burners should be operated at approximately 20%-40%, do not ever exceed boiler warm-up curve of 100 degrees per hour. Of TIR-65A, B, C. TR-51 and TIR-13.

10. Constantly monitor boiler drum level to prevent LoLo Fan trips or HiHi Turbine trips. Blowdown as necessary.

11. Slowly close FD damper. Secure FD fan if desired.

12. At 25 psi drum pressure, close drum vent. Close all super heater vents and drains except last pass super heater vent.

13. When steam flow is established open or close PV-28 to keep pressure below 850 PSI. When fire is stable, start FD fan. Set header pressure to 17" W.G.

14. At 500 PSI superheat outlet line up ERV.

15. At approximately 330 - 350 degrees baghouse inlet temperature, line up quench reactor.

16. Attempt to approach a differential of no more than 100 degrees between boilers on gas fire prior to opening the boiler header isolation valve.

17. If unable to attain less than 100 degrees differential on burners, prepare unit for trash fire.

18. When temperature is close to starting trash fire, start up the following equipment:
    Line up remaining baghouse modules.
    If not already running, start up Quench Reactors.
    Start Hydrated Lime injection.
    Install ammonia nozzles and line up ammonia and carrier water.
    Start up Carbon Injection System.

19. Choose a grapple full of trash and spread it evenly in the hopper over the closed damper. Fill all the way across the feed chute hopper. Once hopper has a level across the damper, open the feed chute damper, allowing the trash to fall in. Continue feeding the hopper until a low level has cleared. This procedure limits ID Fan swings when the feed chute damper is opened. When seal is established at feed chute, maintain draft at -.25" W.G.

20. Log feed chute open on CEM.

21. In Temp mode the grate and feeder will run. Let the stoker stroke in some fuel. Watch and make sure you don’t over feed. Turn feeders off if necessary.

22. Monitor fire from martin viewport, relay information to control room until combustion controller can be placed in automatic.

23. Line up air preheaters, if needed.

24. Start OFA Fan, set dampers to auto, header at 20" W.G.

25. Start the Ash Discharger at approximately 60%, Clinker Roll at 12 stokes/hr, and the Riddling Flaps in short cycle.

26. Start Grates and Feeders. Monitor fires and bed continuously. In the event of a poor fire, periodically stop feeders and grates. This will allow a smooth fire to develop on the grates before being covered by new, wet refuse.

27. Adjust UFA setpoint to maintain 9-10% O2.

28. Adjust furnace temperature set point to maintain operation of feeders and grates. Use the air dampers to adjust steam flow by increasing air flow by 1-3 steps every five minutes.

29. As soon as temperature can be maintained above 750 degrees reliably, start to slowly open the boiler steam header valve. Maintain constant attention to boiler drum level during this operation. If the feed regulating valve is not already in automatic by this point, place it in three element control with a set point of -3”. As header valve comes open, start to close down of 4" warmup line until all steam is directed to the turbine. Once drum level is stable return feed regulating valve set point to 0”.

30. Begin to slowly lower the gas burner set point. Make small step decreases, ensuring that the combustion controller fuel picks up the pressure and temperature load as the burner is dropped. Pay particular attention to furnace temperature, CO levels, and super heater temperature.

31. Continue to monitor fire and bed as burner is gradually backed out. Use grate and feeder speed controls to establish a bed thickness of 2'.

32. When steam flow is established, shift over to steam flow control mode. Set point will match process variable. Use combustion controller fuel to increase steamflow set point to keep feeders and grates running as needed. Adjust steam flow at the fuel combustion controller at a rate not to exceed 2k every five minutes. After each adjustment, allow actual steamflow to reach set point before adjusting again.

33. Line up CBD and chemical feed system.

34. Increase steam flow set point in a step fashion, always following the stoker tables. With each steam flow adjustment, adjust under fire air set point as needed to maintain excess oxygen at 9-10%.

35. When burners are stepped down to 0%, secure burners.

36. Log boiler on-line on CEM.

37. Maintain 8-9% O2, and desired steamflow mode.

38. Utilize attemperation as needed.

39. When bed is all the way to clinker roll, start up clinker roll and ash dischargers.

40. When ash dischargers are pushing sufficient bottom ash, start fly ash system and dolo, begin cleaning baghouse modules.

Revision Date: December 2014

BOILER SHUTDOWN PROCEDURE

With at least one other boiler to be left running and the dump condenser online

Assumes all plant systems that are common to all boiler units are operating normally

NOTE: Prior to shutdown of boiler unit, ensure the boiler water chemistry is within co-ordinated phosphate block, and add one quart of oxygen scavenger to boiler.

1. Plan shutdown to close feed chute damper 15 to 30 minutes into the first hour of the 4 hour block if possible. Set grates, clinker roll, and discharger to 100% NI.
   Blow soot prior to shutdown.
   The electromatic relief valve shall be tested prior to a boiler semi-annual shutdown. Manually open the valve for 5 seconds to ensure proper operation. Log results in control room log. Prepare work order for repairs if valve fails to open.

2. Ensure riddlings are set to short during shutdown to ensure riddlings chutes are clear.

3. Inform PJM of impending load reduction. This may also be done after the unit is coded offline.

4. Notify crane operator to stop feeding the boiler to be secured and clean feed chute hopper.

5. Burners may be started at this time to ensure proper operation and to maintain furnace roof temperature and boiler emissions. Increase burner set point as needed to control CO.

6. Monitor level in the Feedchute and close the Feedchute Damper as soon as refuse level is below Damper level. Log the feed chute closed on the CEM. If the boiler is being shut down for maintenance, place the revolving yellow light on the feedchute to help remind operators the unit is down. Leave light in place until all work is completed.

7. If steam coil air heaters are in service, secure them.

8. Turn off optimizing controller. Feeder speed and stroke length may be increased in small increments as the steam flow begins to drop. Avoid overfeeding and clumping of garbage. The feeders may also be placed in NI at this time.

9. At 70K of steam flow (from garbage), secure the over fire air fan and manually close the front and rear over fire air damper headers. The grates and feeders should continue to operate despite the OFA fan being off.

10. Monitor drum level and steam temperature. The attemperators may need to be isolated at this time.

11. Maximize UFA to achieve total burnout. Control may be transferred from Steam Flow to Furnace Temp mode to control UFA flow by adjusting the steps. Operate burners to control CO and O2.

12. The feed table will need to be blown off at some point. This is usually done sometime during the second hour, but is dependant upon CO levels and bed conditions. The feeders may be turned off at this time. Ensure that the grates are kept on for the duration of the shutdown period.

13. Check fire at this time. Manual stroking of the clinker roll may be necessary to avoid a build-up in zones 4 and 5. Discharger water level must be maintained to help control air in leakage and unwanted CO.

14. When it is determined that sufficient burnout has occurred, begin backing out the burners and monitor the stack O2 and steam flow. If O2 drops or steam flow increases restore gas flow and extend shutdown. Burners may be completely secured once it is determined that >16% stack O2 or <50K steam flow has been achieved. Remember that shutdown time cannot exceed 3 hours or violations will count. Immediately open the super heater last pass drain after securing the burners. At no time should steam flow be allowed to drop to zero without first lining up last pass drain valve. Serious damage to super heater can result.

15. As soon as air is backed down to minimum, isolated 6 baghouse modules, usually leaving modules A and B lined up as sacrificial modules, protecting the others from cold temperatures. If a quick cool down is required more modules may be put in service. Secure cleaning cycles of the Baghouse and Reverse Air Fan.

16. When the boiler is coded offline:
Stop Ammonia Injection
Stop Hydrated Lime Injection, leave injection blower running
Stop Slurry feed to Quench Reactor. Maintain flow of water to the Quench Reactor until the inlet temperature drops to approximately 330 degrees F.
Stop Carbon Feed

Stop Grates unless it is desired to run them off some more
Isolate the Electromatic Relief Valve and turn off switch in control room

17. If it is desired to run off the grates, begin to increase grate speed and clinker roll speed. Ensure riddlings are clear and not alarming.

18. Secure chemical injection and CBD.

19. At approximately 400 psi drum pressure, blow down all water wall headers.

20. Approximately 1 hour after shutdown (or grates run off) shutdown:
Clinker Roll
Air to Furnace Camera (remove camera for outage).

21. Clean UFA intake screen, close Fan Inlet Damper and Secure fan.

25. Stop Seal Air Fan.

26. At 25 psi, open drum vent last pass vent and drain.

27. After approximately 8 hours, shutdown flyash handling system

28. Shutdown Ash Dischargers- Water to dischargers may be isolated after the unit has been coded off-line

29. Do not drain boiler unless boiler tube work or waterside internal work is to be performed. Ensure super heater temperature is below 500 degrees, then superheater section should be flooded until water comes out vents on steam drum and superheater.

*See boiler lay up Procedure

Revision Date: April 2015

BOILER EMERGENCY SHUTDOWN PROCEDURE
SEVERE RUPTURED TUBE OR LOSS OF DRUM LEVEL

INDICATIONS:

Rapid decrease in drum level

Increased Baghouse differential pressure

Rapid loss of steam pressure/steam flow

Drop in flue gas temperatures

Positive furnace pressure, high ID fan amps

DA level dropping

Low Low drum level trips on OFA and UFA fans

Dramatic increase in feed water flow/over amping of feed water pumps

IMMEDIATE ACTIONS

1. If rupture is too severe to maintain drum level, secure feed water to protect drum levels in unaffected boilers.

2. Code boiler off on CEM when steam flow is less than 50K or stack O2 is greater than 16%.

3. Verify that FD and OFA fans have tripped. Open ERV.

4. Close UFA dampers.

5. Protect ID Fan from tripping, or restart as necessary, control damper manually if necessary.

6. Ensure Crane Operator has stopped feeding affected unit.

7. Pass the word over radio and Com-Trol phone, verify safety of personnel in plant.

8. Isolate boiler, close steam header, secure soot blowers, close chemical injection and CBD. Open last pass super heater vent and drains.

9. Monitor DA level, start extra make-up pump as necessary.

10. Shut steam supply to steam coil air pre-heaters.

11. Advise crane operator to watch for feed chute fires.

COOLING BOILER AND CLEARING FEEDTABLE AND GRATES

1. Jumper Low Low trip.

2. Start up FD and OFA fans. Increase over fire air flow to decrease sidewall temp. Once temperatures are less than 600* carefully increase under fire air to maintain temperature of less than 600 degrees.

3. Slowly burn off grates and empty feed chute. Switching grates on and off and cycling under fire air will be necessary to control temperature.

4. After grates and feed chute are empty, perform a normal shutdown.

NOTES

Proceed without delay; refuse in the feed chute will ignite.

In case of an overflowing Feed chute water jacket, do not open any drain. If refuse in the chute must be sprayed with water, use as little as possible.

Sidewall temperatures above 600 degrees do serious damage to boiler tubes when water level is low, enormous repair costs and downtime for replacements are the consequences.

Revision Date: April 2015

Wheelabrator Baltimore, Inc. Startup/Shutdown Procedures

Excerpt of May 3, 2016 email from Wheelabrator Baltimore, Inc. to Maryland Department of the Environment that provides basic summary of startup and shutdown procedures for the facility:

"Not all startups and shutdowns require exclusion of hourly averages so the excluded hours will not match the number of shutdowns (SD) and startup (SU) indicated on the 24 hour average data sheets. Normal startup procedure requires turning the SNCR system on after the furnace is heated up to temperature using auxiliary gas burners and just before trash is dropped on the grate and trash combustion begins. For shutdowns the SNCR system remains on until MSW fire is out on the grate. We follow the NSPS definition of startup as defined in 40 CFR 60 Subpart Eb/Cb. Startup period begins when the grates are initially fed (continuously, semi-continuously or by batch) MSW and the MSW has ignited. The three (3) hour start up window (when data can be excluded from daily average) begins with initial combustion of MSW. The startup period does not include any warm-up period when the boiler is combusting only natural gas and there is no MSW being combusted."

Appendix G – EPA Startup, Shutdown, and Malfunction criteria

Maryland
Department of
the Environment

MWC NOx RACT Mass Loading Limits during Periods of Startup and Shutdown

August 8, 2018

Purpose

On June 12, 2015, the Environmental Protection Agency (EPA) published an updated startup, shutdown and malfunction (SSM) policy in the Federal Register, 80 Fed. Reg. 33840. The SSM Policy, in part, provides guidance to states for development of alternative emission limitations during SSM events. There are seven criteria that the guidance recommends states consider when setting an alternative emission limitation. The purpose of this document is to address those seven specific criteria as appropriate considerations for developing emission limitations in NOx RACT SIP provisions that apply during startup and shutdown for large municipal waste combustors (Large MWCs).

Section XI.D. of the SSM Policy provides recommendations for the development of alternative emission limitations applicable during startup and shutdown. *See* 80 Fed. Reg. at 33980. A state can develop special, alternative emission limitations that apply during startup or shutdown if the source cannot meet the otherwise applicable emission limitation in a State Implementation Plan (SIP). SIP provisions may include alternative emission limitations for startup and shutdown as part of a continuously applicable emission limitation when properly developed and otherwise consistent with Clean Air Act (CAA) requirements.

The EPA recommends that, in order to be approvable (*i.e.,* meet CAA requirements), alternative requirements applicable to the source during startup and shutdown should be narrowly tailored and take into account considerations such as the technological limitations of the specific source category and the control technology that is feasible during startup and shutdown.

EPA's Current Startup, Shutdown, Malfunction (SSM) Policy

EPA has revised prior guidance provided in the CFR with respect to startup, shutdown and malfunctions. Alternative emission limitations may be developed for startup, shutdown or other normal modes of operation, but no longer may be applied during periods of malfunction.

EPA's current SSM Policy states: "EPA is reiterating and clarifying its prior guidance concerning how states may elect to replace existing exemptions for excess emissions during SSM events with properly developed alternative emission limitations that apply to the affected sources during startup, shutdown or other normal modes of source operation (*i.e.,* that apply to excess emissions during those normal modes of operation as opposed to during malfunctions)." 80 Fed. Reg. at 33845.

"The EPA recognizes that…some sources may need to take steps to control emissions better so as to comply with emission limitations continuously, as required by the CAA, or to increase durability of components and monitoring systems to detect and manage malfunctions promptly." 80 Fed. Reg. at 33849.

EPA's SSM policy provides that in the event of a malfunction which causes excess emissions, consideration for enforcement discretion should be exercised, provided reasonable care to avoid malfunctions and good operating practices are being followed by the source operator: "The EPA emphasizes that the absence of an affirmative defense provision in a SIP, whether as a freestanding generally applicable provision or as a specific component of a particular emission limitation, does not mean that all exceedances of SIP emission limitations will automatically be subject to enforcement or automatically be subject to imposition of particular remedies. Pursuant to the CAA, all parties with authority to bring an enforcement action to enforce SIP provisions (*i.e.,* the state, the EPA or any parties who qualify under the citizen suit provision of section 304) have enforcement discretion that they may exercise as they deem appropriate in any given circumstances. For example, if the event that causes excess emissions is an actual malfunction that occurred despite reasonable care by the source operator to avoid malfunctions, then each of these parties may decide that no enforcement action is warranted." 80 Fed. Reg. at 33852.

Seven Criteria for Startup, Shutdown Events

The EPA identifies the following seven specific criteria as appropriate considerations for developing emission limitations in SIP provisions that apply during startup and shutdown (80 Fed. Reg. at 33912):

(1) The revision is limited to specific, narrowly defined source categories using specific control strategies (*e.g.,* cogeneration facilities burning natural gas and using selective catalytic reduction);
(2) Use of the control strategy for this source category is technically infeasible during startup or shutdown periods;

(3) The alternative emission limitation requires that the frequency and duration of operation in startup or shutdown mode are minimized to the greatest extent practicable;
(4) As part of its justification of the SIP revision, the state analyzes the potential worst-case emissions that could occur during startup and shutdown based on the applicable alternative emission limitation;
(5) The alternative emission limitation requires that all possible steps are taken to minimize the impact of emissions during startup and shutdown on ambient air quality;
(6) The alternative emission limitation requires that, at all times, the facility is operated in a manner consistent with good practice for minimizing emissions and the source uses best efforts regarding planning, design, and operating procedures; and
(7) The alternative emission limitation requires that the owner or operator's actions during startup and shutdown periods are documented by properly signed, contemporaneous operating logs or other relevant evidence.

The Department addressed these seven criteria for emission limitations that apply during startup and shutdown for Large MWCs in the following ways:

(1) The revision is limited to specific, narrowly defined source categories using specific control strategies (*e.g.,* cogeneration facilities burning natural gas and using selective catalytic reduction)

Under proposed COMAR 26.11.08.10D, the Department provides for alternative facility-wide, mass loading NOx emission limits averaged over a 24-hour period. These alternative limits only apply to Large MWCs that have a capacity greater than 250 tons per day. Specifically, these alternative Startup/Shutdown limits apply to the Montgomery County Resource Recovery Facility (MCRRF) and Wheelabrator Baltimore, Inc. (Wheelabrator).

MCRRF and Wheelabrator utilize selective non-catalytic reduction (SNCR) for control of NOx emissions. Therefore, MDE's alternative NOx emission limitations are limited to apply to Large MWCs that have a capacity greater than 250 tons per day and use SNCR for control of NOx emissions.

(2) Use of the control strategy for this source category is technically infeasible during startup or shutdown periods

COMAR 26.11.08.10B and .10C require updated NOx RACT limits for Large MWCs. In part, the proposed regulations set NOx 24-hour block average and 30-day rolling average emission rates to be met at all times except for periods of startup and shutdown. The 24-hour block average and 30-day rolling average emission rates are steady state (normal operation mode) emission limits in parts per million by volume (ppmv), which is a measure of concentration. This concentration measurement is calculated as mass of NOx emitted / volumetric gas flow rate from the stack.

The 24-hour block average and 30-day rolling average emission rates for Large MWCs are defined as a value of NO_x emissions in ppmv, corrected to 7 percent oxygen. Therefore, the 24-hour block average and 30-day rolling average emission rates are mathematically adjusted so that the volumetric gas flow rate from the stack is corrected to 7 percent oxygen.

Concentration-based emission limits are not practical during startup and shutdown because it is technically infeasible for Large MWCs to comply with the emission rates due to the “7 percent oxygen correction factor” that is required to be applied to the NOx 24-hour block average and 30-day rolling average emission rates. During periods of startup and shutdown, the volumetric gas flow rate from the stack is transient, as adjustments are made to the amount of air introduced into the furnace. The mathematical oxygen correction would result in an artificially high NOx “concentration reading”, even though the amount (mass) of actual NOx emissions would remain unchanged during startup or shutdown. Therefore, it is necessary to set alternative NOx emission limits based on mass of NOx emitted during periods of startup and shutdown (transient periods).

(3) The alternative emission limitation requires that the frequency and duration of operation in startup or shutdown mode are minimized to the greatest extent practicable

COMAR 26.11.08.01B(60)(c) defines ”Startup” for a Large MWC as commencing when the unit begins the continuous burning of municipal solid waste and continuing for a period of time not to exceed three hours; but does not include any warm-up period when the particular unit is combusting fossil fuel or other non-municipal solid waste fuel, and no municipal solid waste is being fed to the combustor.

Continuous burning begins once municipal solid waste is fed to the combustor. Once municipal solid waste is being fed to the combustor, the MWC operates continuously until a shutdown is initiated.

Maryland Department of the Environment

MWC NOx RACT Mass Loading Limits during Periods of Startup and Shutdown

COMAR 26.11.08.01B(54)(e) defines "Shutdown" for the MCRRF as commencing thirty minutes after the chute to the loading hopper of the combustion train is closed and ending no later than three hours thereafter.

COMAR 26.11.08.01B(54)(f) defines "Shutdown" for the Wheelabrator facility as commencing thirty minutes after municipal solid waste feed to the loading hopper has ceased and ending no later than three hours thereafter.

By definition the duration of startup and shutdown procedures for a Large MWC are not to exceed three hours per occurrence, which minimizes the duration of the startup or shutdown to the greatest extent practicable. The alternative 24-hour mass emission limits established by COMAR 26.11.08.10D, apply during these times.

(4) As part of its justification of the SIP revision, the state analyzes the potential worst-case emissions that could occur during startup and shutdown based on the applicable alternative emission limitation

Under COMAR 26.11.08.10D, the Department proposes facility-wide, mass loading NOx emission limits averaged over a 24-hour period to determine the NOx load to the ambient atmosphere on days where there is a startup or shutdown event. The mass loading limits include emissions during the startup or shutdown. In addition, on days where the unit experiences startup or shutdown, the concentration-based 24-hour block average emission rate in COMAR 26.11.08.10B will also apply for the 24-hour period after startup or the 24-hour period before shutdown, as applicable.

Mass NOx emission limits take into account the design flue gas flow rate and represent the worst case actual NOx emissions that could occur during periods of startup and shutdown. These mass NOx emission limits, applicable to each Large MWC, provide equivalent stringency to the concentration limits that apply at all other times. The 24-hour block average NOx emissions rates of COMAR 26.11.08.10B are part of the calculation used to derive the mass NOx emission limits of COMAR 26.11.08.10D. Mass emission limit calculations are derived utilizing 40 CFR 60.58b(h)(2) of subpart Eb (Concentration correction to 7 percent oxygen) or 40 CFR 60.45 (Conversion procedures to convert CEM data into applicable standards). EPA Method 19 may also be utilized to determine NOx emission rates based upon oxygen concentrations. Facility average flue gas flow rates are also utilized into the calculations. The calculation methodology for the mass emission limits is based upon the existing Prevention of Significant

Deterioration (PSD) Approval for each affected facility. Mass based emission calculations for each affected Large MWC are detailed below.

Wheelabrator Baltimore, Inc.

Mass based emission calculations for Wheelabrator utilize the facility average flue gas flow (106,336 dscf/min) and O2 (10.7%) values from the facility's 2017 stack test and the 150 ppmv NOx 24-hour block average emission rate from COMAR 26.11.08.10B.

150 ppm7% x (20.9-10.7)/13.9) x 1.194E-7 x 106,336 dscf/min x 60 min/hour x 3 boilers
= 252 lbs/hour

EPA Method 19-NOx ppm to lbs/dscf Conversion Factor:
1.194 E-7 = 46 lbs/lb-mole /385.3 dscf lb-mole/1,000,000

Montgomery County Resource Recovery Facility

Mass based emission calculations for Montgomery County Resource Recovery Facility utilize the facility average flue gas flow (91,204 dscf/min) and O2 (8.1%) values as provided by the facility based upon their Prevention of Significant Deterioration (PSD) Approval and the 140 ppmv NOx 24-hour block average emission rate from COMAR 26.11.08.10B.

$$\frac{46.01\,(lb/lb\text{-}mol) * (20.9-8.1)/(20.9-7.0) * 140.00\,(ppmdv) * 91{,}204\,(dscfm) * (1800/2250) * 60\,(m/h) * 3\text{ Boiler Units}}{3.853E+08\,(ft3/lb\text{-}mol)}$$

= 202 lbs/hr

(5) The alternative emission limitation requires that all possible steps are taken to minimize the impact of emissions during startup and shutdown on ambient air quality

The specific steps that each affected facility takes to operate and minimize the impact of emissions during startup and shutdown are listed in Appendix F - Operating Procedures for Large MWCs of this Technical Support Document, as provided by the facility.

Additionally, under COMAR 26.11.08.10A and G, the Department is proposing the following provisions. These provisions will apply at all times, including periods of startup and shutdown, and will minimize the impact of emissions on ambient air quality:

MWC NOx RACT Mass Loading Limits during Periods of Startup and Shutdown

A. The owner and operator of a Large MWC shall minimize NOx emissions by operating and optimizing the use of all installed pollution control technology and combustion controls consistent with the technological limitations, manufacturers' specifications, good engineering and maintenance practices, and good air pollution control practices for minimizing emissions (as defined in 40 CFR §60.11(d)) for such equipment and the unit at all times the unit is in operation, including periods of startup and shutdown.

G. Not later than 45 days after the effective date of this Regulation, the owner or operator of a Large MWC shall submit a plan to the Department and EPA for approval that demonstrates how the Large MWC will operate installed pollution control technology and combustion controls to meet the requirements of §A of this Regulation. The plan shall summarize the data that will be collected to demonstrate compliance with §A of this Regulation. The plan shall cover all modes of operation, including but not limited to normal operations, startup, and shutdown.

Compliance for Large MWCs will be dependent upon the facilities operating their units as specified in the approved plans during all modes of operation, including but not limited to normal operations, startup, and shutdown.

(6) The alternative emission limitation requires that, at all times, the facility is operated in a manner consistent with good practice for minimizing emissions and the source uses best efforts regarding planning, design, and operating procedures

Under COMAR 26.11.08.10A and G, the Department is proposing the following provisions. These provisions will apply at all times, including periods of startup and shutdown, and will minimize the impact of emissions on ambient air quality:

Under COMAR 26.11.08.10A, the Department is proposing the following provision:

A. The owner and operator of a Large MWC shall minimize NO_x emissions by operating and optimizing the use of all installed pollution control technology and combustion controls consistent with the technological limitations, manufacturers' specifications, good engineering and maintenance practices, and good air pollution control practices for minimizing emissions (as defined in 40 CFR §60.11(d)) for such equipment and the unit at all times the unit is in operation, including periods of startup and shutdown.

Under COMAR 26.11.08.10G, the Department is proposing the following provision:

MWC NOx RACT Mass Loading Limits during Periods of Startup and Shutdown

G. Not later than 45 days after the effective date of this regulation, the owner or operator of a Large MWC shall submit a plan to the Department and EPA for approval that demonstrates how the Large MWC will operate installed pollution control technology and combustion controls to meet the requirements of §A of this Regulation. The plan shall summarize the data that will be collected to demonstrate compliance with §A of this Regulation. The plan shall cover all modes of operation, including but not limited to normal operations, startup, and shutdown.

Compliance for Large MWCs will be dependent upon the facilities operating their units as specified in the approved plans during all modes of operation, including but not limited to normal operations, startup, and shutdown. The MWC facility will provide quarterly reports detailing that the emission limitations have been met.

(7) The alternative emission limitation requires that the owner or operator's actions during startup and shutdown periods are documented by properly signed, contemporaneous operating logs or other relevant evidence

Under COMAR 26.11.08.10H, the Department is proposing the following provisions:

Beginning July 1, 2019, the owner or operator of a Large MWC shall submit a quarterly report to the Department containing:
(1) Data, information, and calculations which demonstrate compliance with the NOx 24-hour block average emission rate as required in §B of this Regulation;
(2) Data, information, and calculations, including NOx continuous emission monitoring data and stack flow data, which demonstrate compliance with the startup and shutdown mass NOx emission limits as required in §D of this Regulation;
(3) Flagging of periods of startup and shutdown and exceedances of emission rates;
(4) NOx continuous emission monitoring data and total urea flow rate to the boiler averaged over a 1-hour period, in a Microsoft Excel format; and
(5) Documented actions taken during periods of startup and shutdown in signed, contemporaneous operating logs.

Under COMAR 26.11.08.10I, the Department is proposing the following provision:

Beginning July 1, 2020, the quarterly report to be submitted pursuant to §H of this Regulation shall also include data, information, and calculations which demonstrate compliance with the NOx 30-day rolling average emission rate as required in §C of this Regulation.

MWC NOx RACT Mass Loading Limits during Periods of Startup and Shutdown

Under COMAR 26.11.08.10L, the Department is proposing the following provision:

L. Compliance with the NOx mass loading emission limitation for periods of startup and shutdown in §D(1) of this Regulation shall be demonstrated by calculating the 24-hr average of all hourly average NOx emission concentrations from continuous emission monitoring systems, utilizing stack flow rates derived from flow monitors, for all the hours during the 3-hour startup or shutdown period and the remaining 21 hours of the 24-hour period.

Under COMAR 26.11.08.10M, the Department is proposing the following provision:

M. Compliance with the NOx mass loading emission limitation for periods of startup and shutdown in §D(2) of this Regulation shall be demonstrated by calculating the 24-hr average of all hourly average NOx emission concentrations from continuous emission monitoring systems, utilizing the applicable Prevention of Significant Deterioration calculation methodology, for all the hours during the 3-hour startup or shutdown period and the remaining 21 hours of the 24-hour period.