EXHIBIT C - 1

Maryland
Department of
the Environment

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TECHNICAL SUPPORT DOCUMENT

FOR

Amendments to COMAR 26.11.08 – Control of Incinerators

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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%

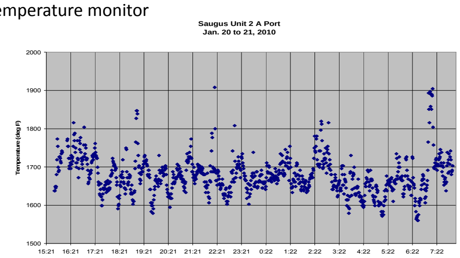
Wheelabrator NOx RACT Summary

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

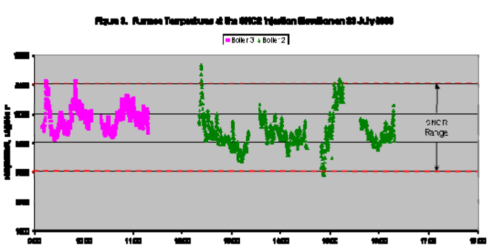
Baltimore NOx Summary

July 1- Dec 31, 2015 24 Hour Average Summary			
	NOXRPT_1 (PPMDC)	NOXRPT_2 (PPMDC)	NOXRPT_3 (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

Baltimore Furnace temperature profiling 2008-using continuous temperature monitor



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

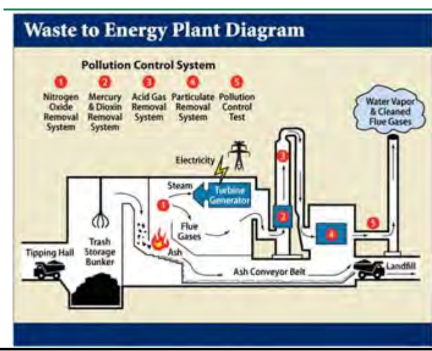
Why NOx?

- 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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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%

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1,800
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- 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

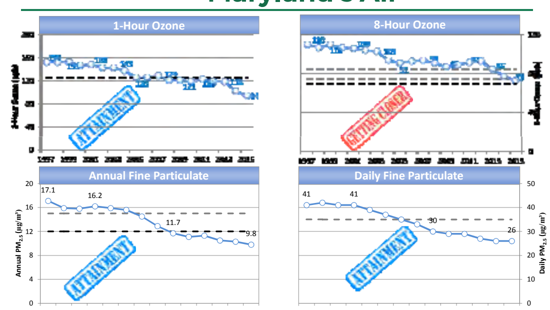
Topics Covered

- 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

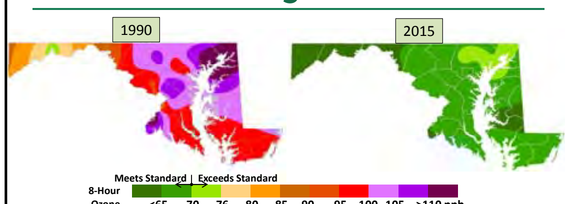
Progress in Cleaning Maryland's Air



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

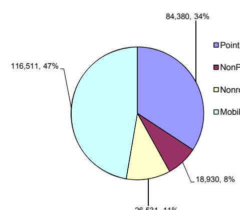
- Since around 2005, Maryland has implemented some of the countries most effective emission reduction programs
  - These efforts have worked
- Power Plants
- Cement Plants
- Cars and Trucks
- Consumer Products
- Area Source VOCs

2005 to 2017 Control Programs

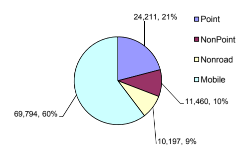
- Power Plants
  - The Maryland Healthy Air Act of 2006
  - 2015 NOx reductions for coal plants
- Portland Cement Plants
  - 2017 NOx RACT updates
- VOC Regulations
  - Architectural and Industrial Coatings
  - Consumer Products
  - Autobody Refinishing
- Mobile Sources
  - The Maryland Clean Cars Act 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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- October 27, 2016 – Stakeholder comments received

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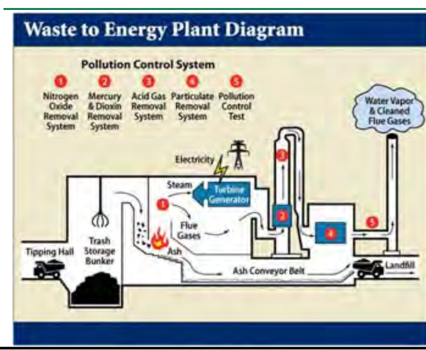

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RACT Cost Analysis – NOx Emissions Methodology

- 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

Discussion

Maryland

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.

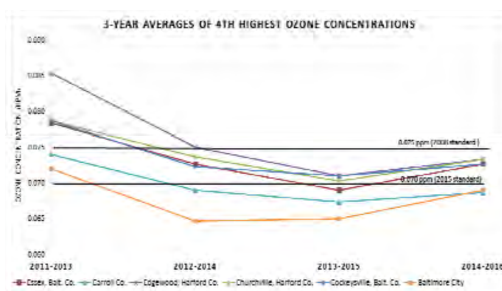
Source: *See generally*, U.S. EPA (2010) Summary of Expert Opinions on the Existence of a Threshold in the Concentration-Response Function for PM2.5-related Mortality, Technical Support Document, available at: http://www3.epa.gov/ttnecas1/regdata/Benefits/thresholdstsd.pdf,

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.

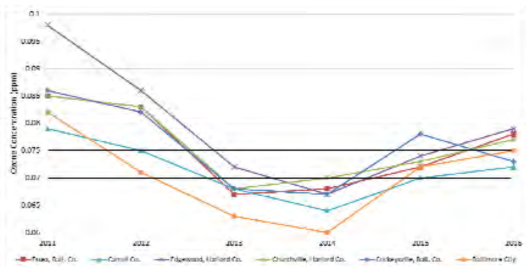
Source: EPA, Health Effects of Ozone Pollution, https://www.epa.gov/ozone-pollution/health-effects-ozone-pollution

Baltimore Area Ozone Trends – Meeting EPA Air Quality Standards



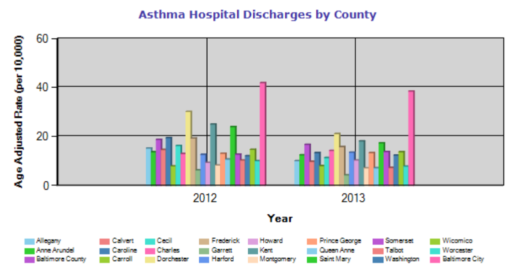
Source: EPA Airdata, https://www.epa.gov/outdoor-air-quality-data

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.aspx

NO_x Emissions from BRESCO

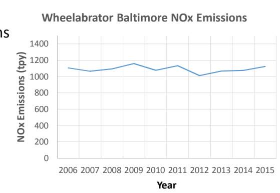
- 6th highest NOx emitter in Maryland in 2015

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

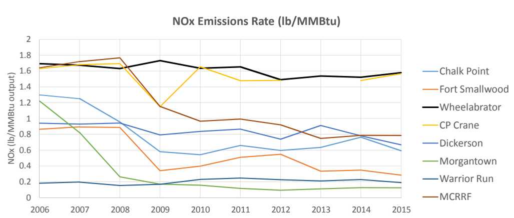
Wheelabrator Baltimore (BRESCO)

- 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.

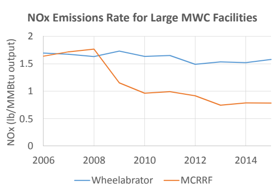
Treatment Technologies

- 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[TM] NOx Control Technology Feasibility

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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

3

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

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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

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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

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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

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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

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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 Utili-zation
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%

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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

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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**

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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

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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

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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

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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%

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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

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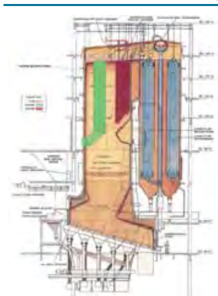
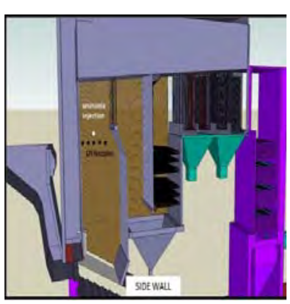
NOx RACT Review
LN^{TM} NOx Control Feasibility at Baltimore





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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)

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Wheelabrator Baltimore
NOx RACT Review

Timothy Porter
Director Air Quality Management

January 17, 2017

Wheelabrator
TECHNOLOGIES

Maryland Department of the Environment

NOx RACT for Municipal Waste Combustors (MWCs)

Stakeholder Meeting – September 22, 2017

Topics Covered

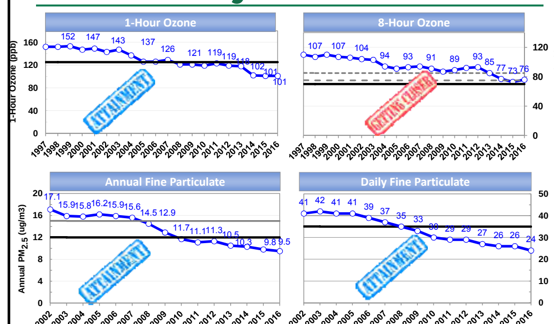
- Background Information
  - Air Quality Overview
  - MD Efforts to Reduce Pollution
- Municipal Waste Combustors (MWCs) in Maryland
  - Purpose of NOx RACT review
  - Stakeholder comments
  - MWC overview
- MDE NOx RACT update
  - Proposed NOx RACT regulation
- Optional SIP Strengthening requirements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

Maryland Department of the Environment

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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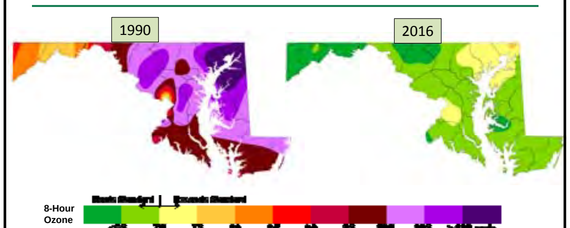
Clean Air Progress in Baltimore

- 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

MDE TSD 8/14/2018 034

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

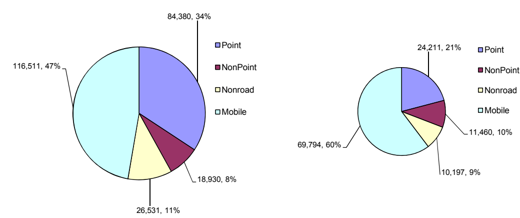
2005 to 2017 Control Programs

- 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

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**

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

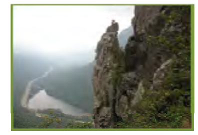
- An SNCR system is integrated to a combustion Low NOx (LN™) system with modifications to the location of the injectors
- The Covanta LN™ technology employs a unique combustion system design, including modifications to combustion air flows, reagent injection and control systems logic
- The LN™ control 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

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

Discussion

CHESAPEAKE BAY FOUNDATION
Saving a National Treasure

February 3, 2017

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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.

Background

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.

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[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
Director
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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:

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.

Background

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.

[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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CHESAPEAKE BAY FOUNDATION
Saving a National Treasure

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

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[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
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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:

<u>Source Data</u>

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

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[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]

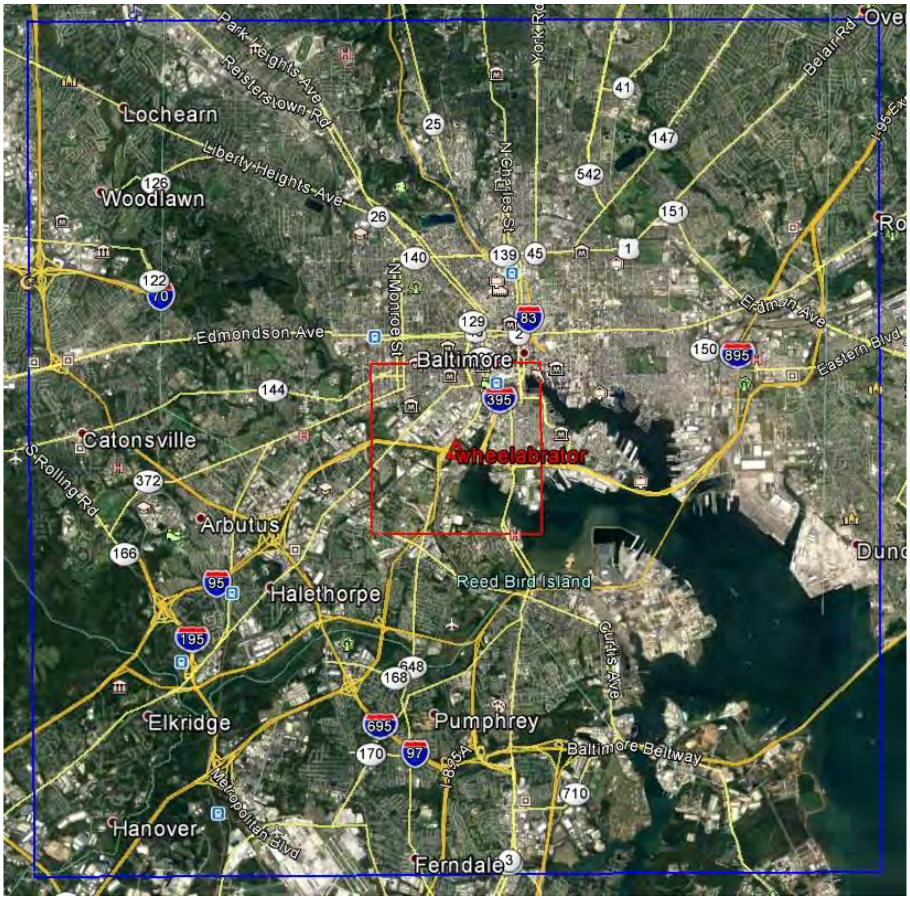

Figure 1. AERMOD Receptor Grids (red: fine 4x4 km 50m grid; blue: coarse 20x20 km 400m grid)

<u>Model Options</u>

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.

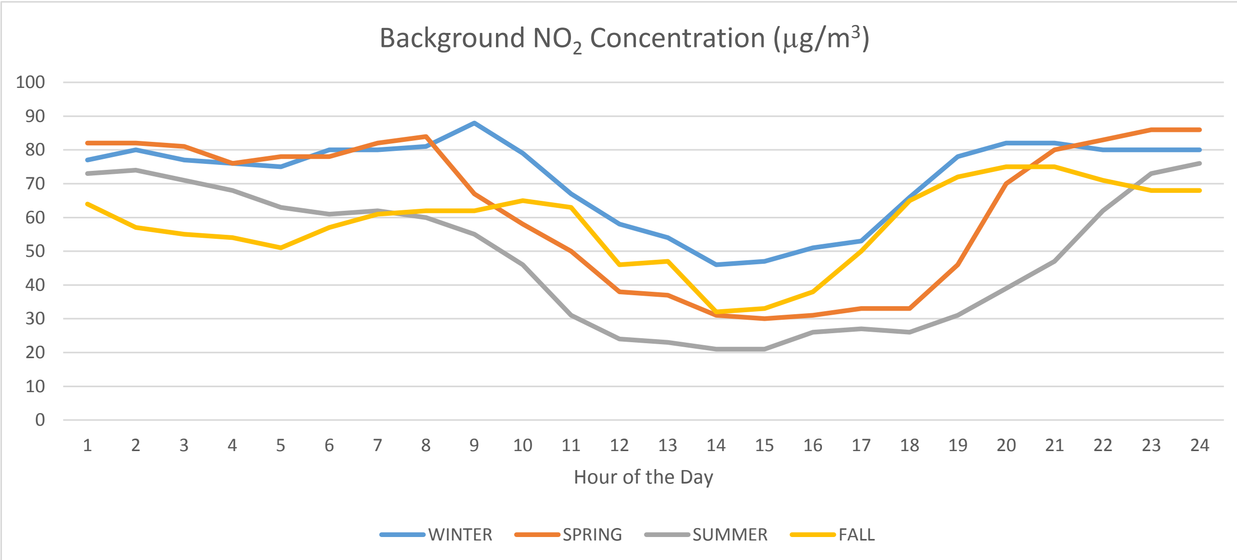

Figure 2. Modeled Background NO_2 Concentration

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

Metric	Concentration µg/m³	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).

[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

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[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]

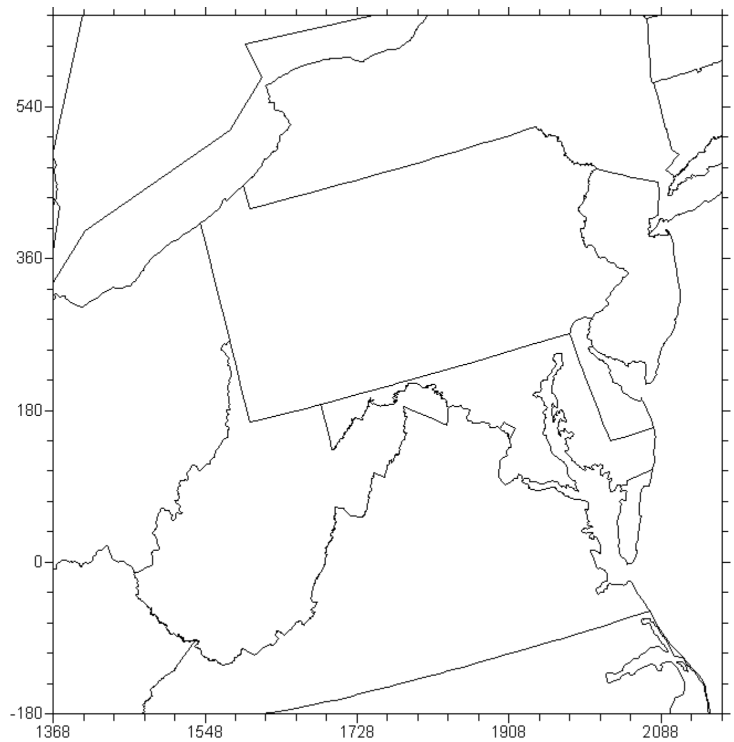

Figure 3. CALPUFF Modeling Domain

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,

[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.

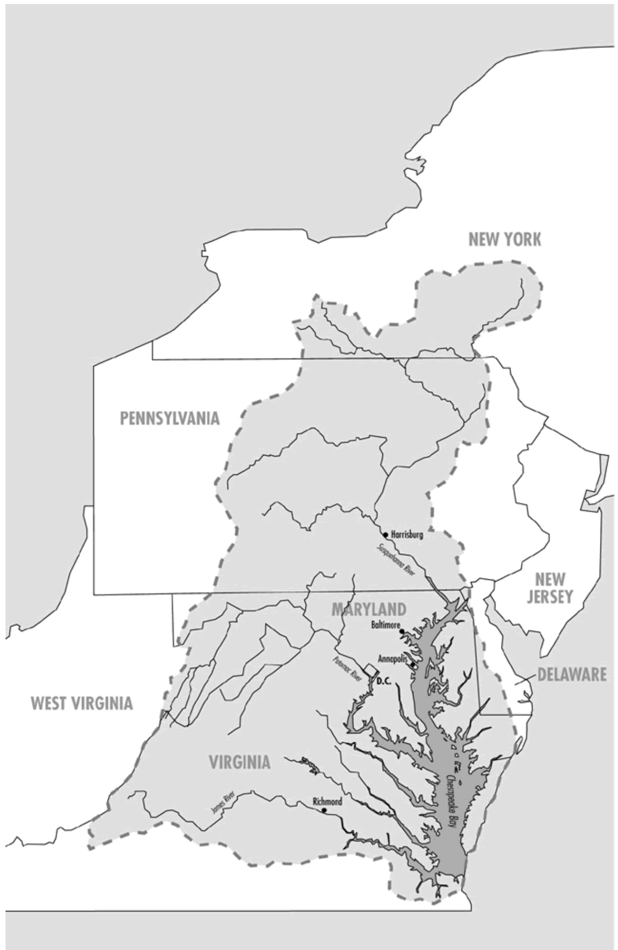

Figure 4. Chesapeake Bay Watershed

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.

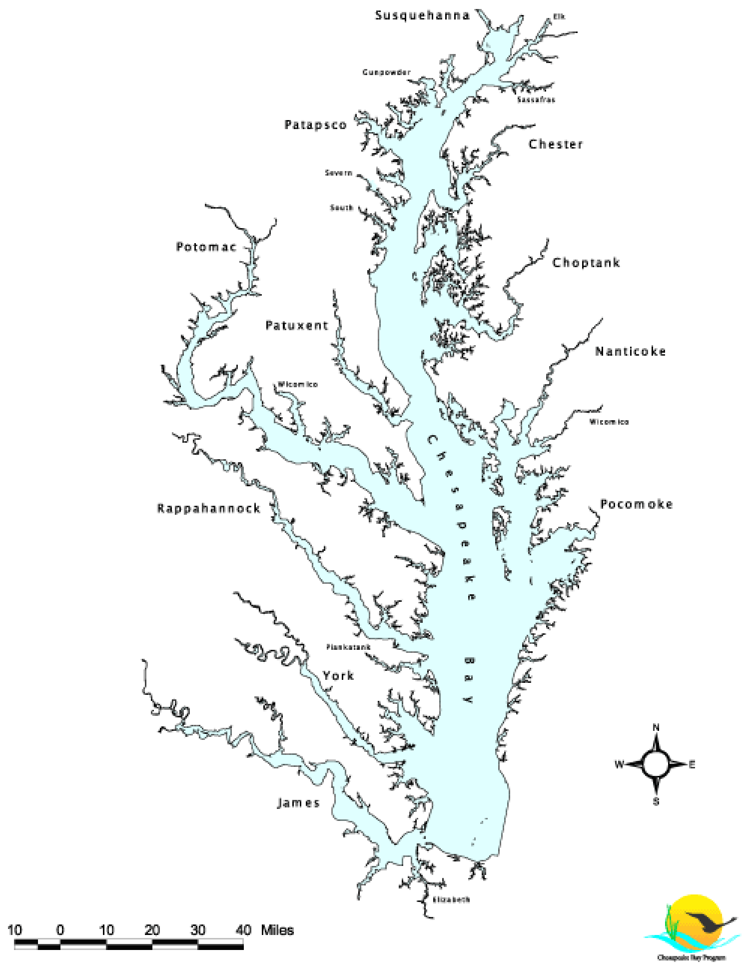

Figure 5. Chesapeake Bay

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.

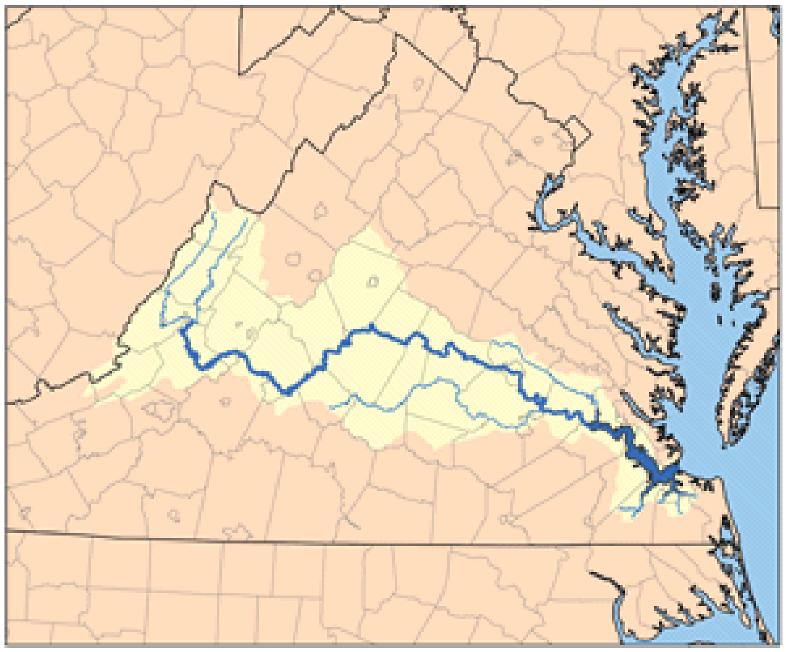

Figure 6. James River Basin Watershed

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.

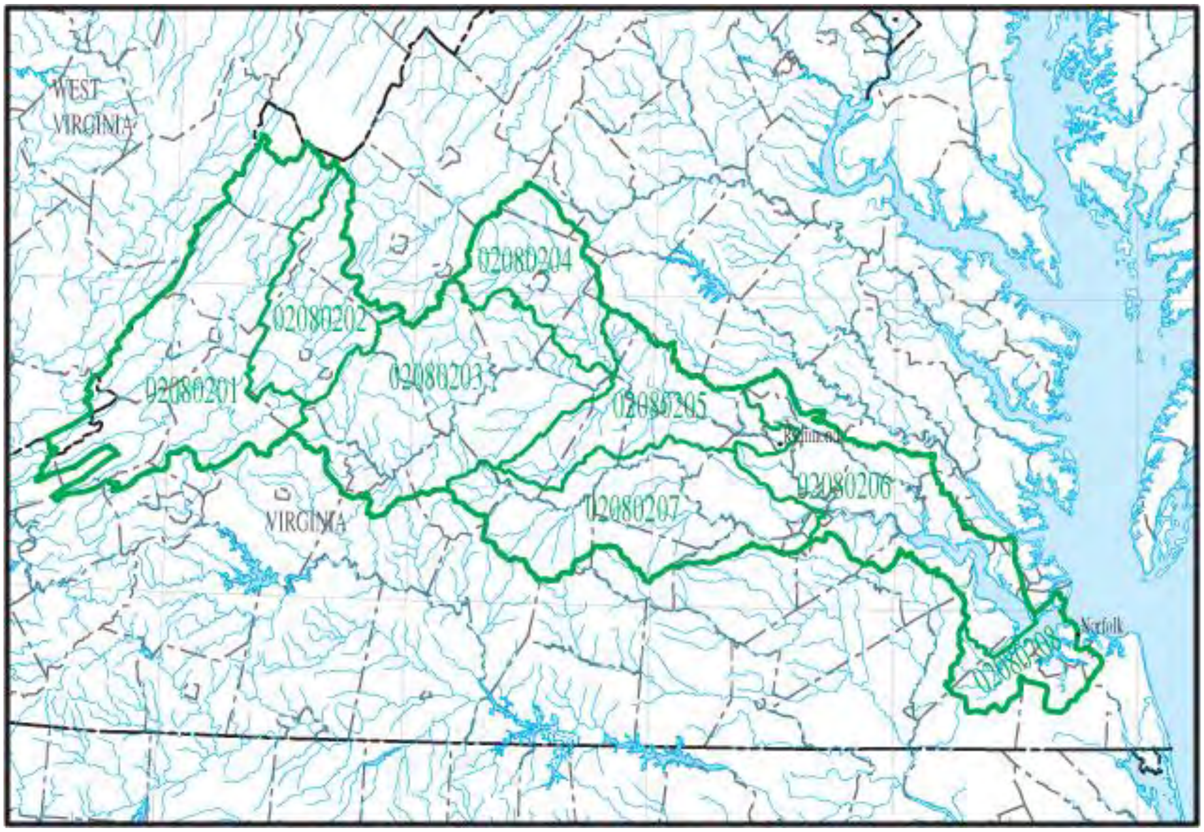

Figure 7. James River Drainage Basin (with USGS Cataloguing Units)

Meteorological Data

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]

[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).

* * *

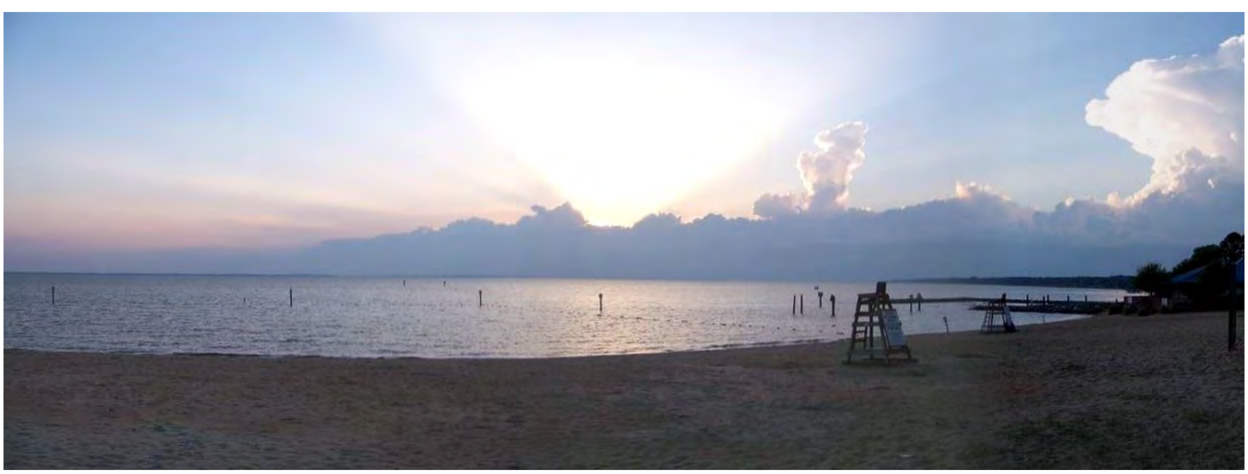


Figure 8. Huntington Park Beach on the James River

APPENDIX A: AERMOD Modeling Results

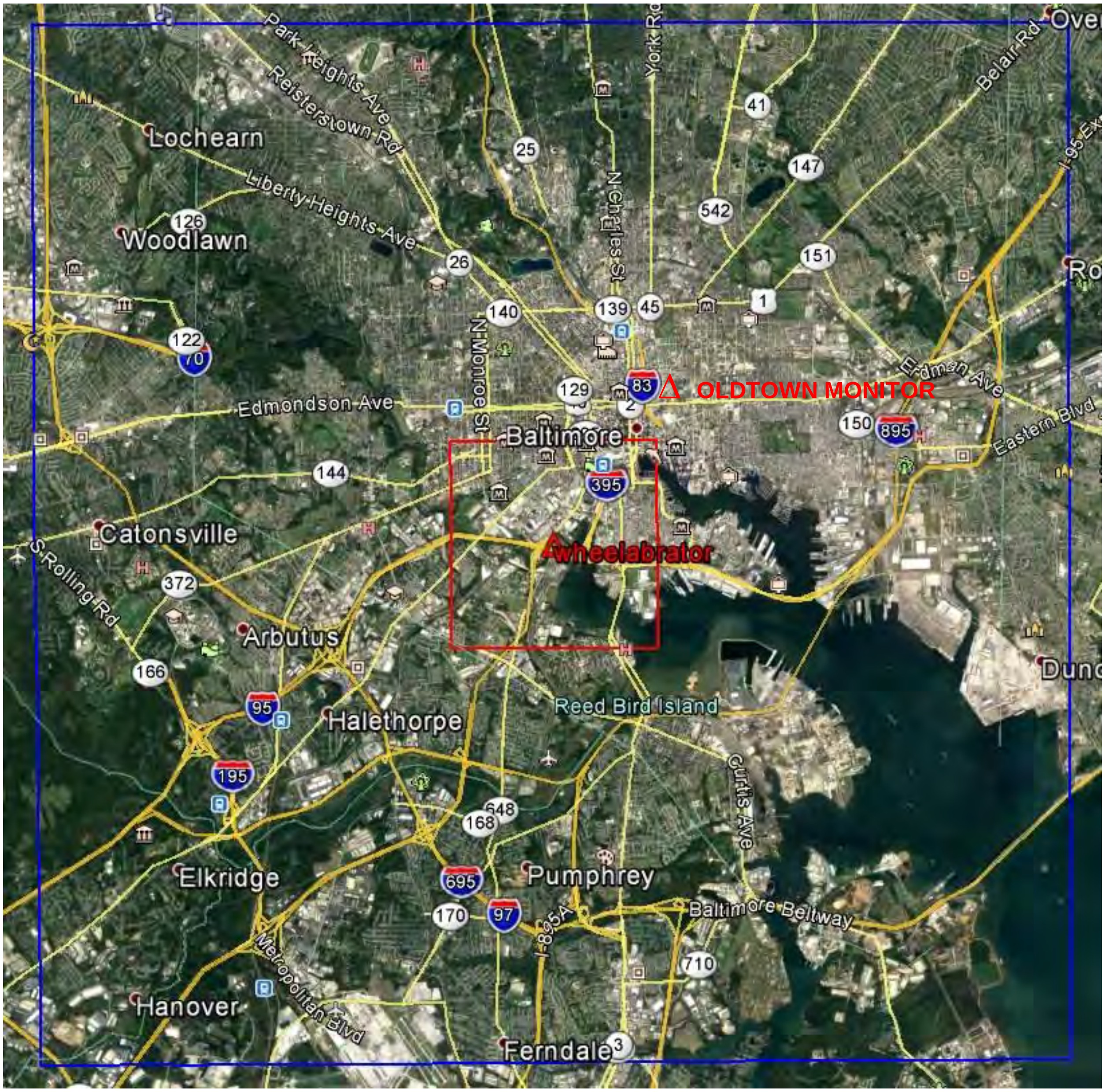


Figure A.1. Fine grid (red; 4x4 km) and coarse grid (blue: 20x20 km)

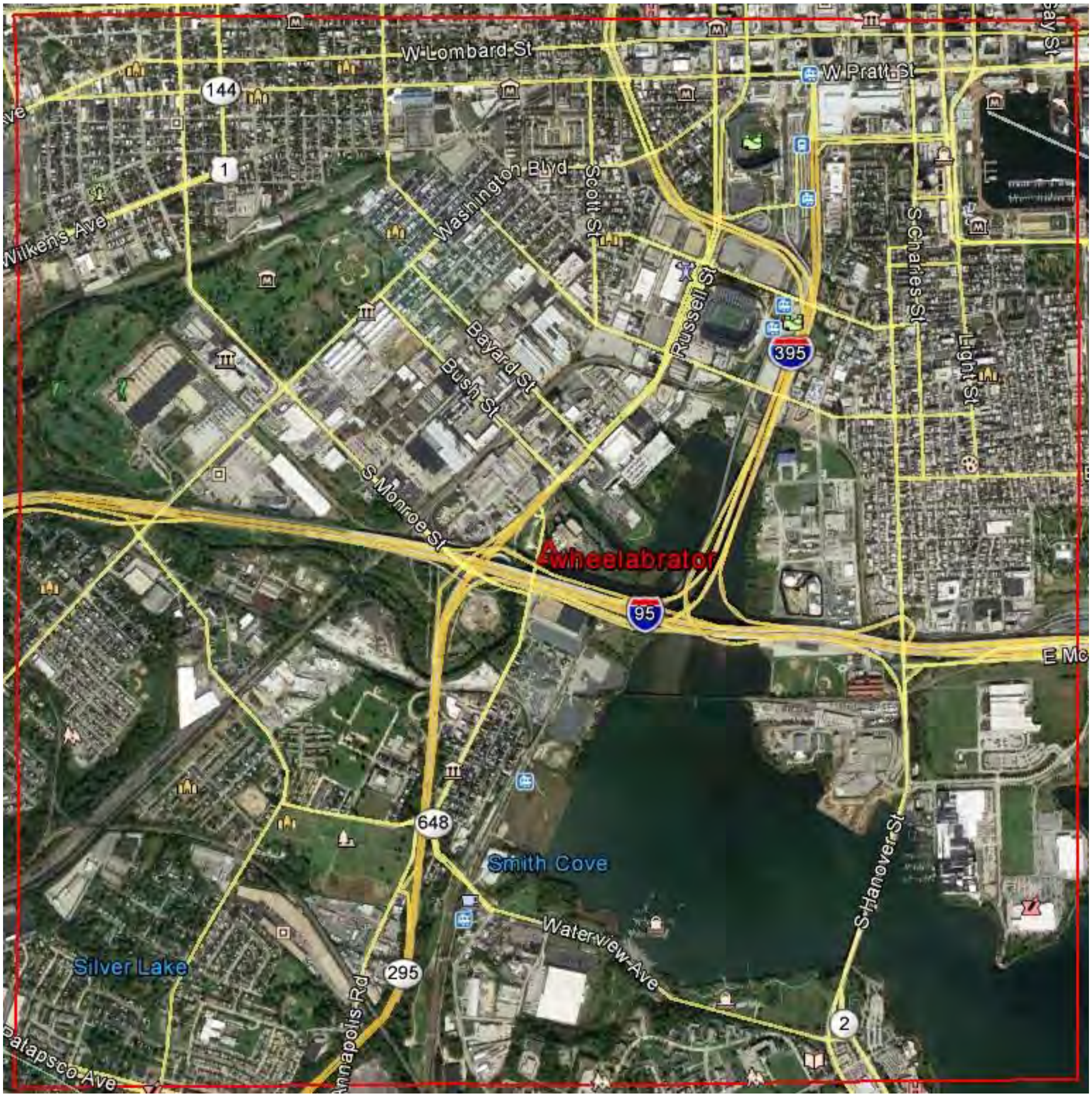


Figure A.2. Fine grid (4x4 km)

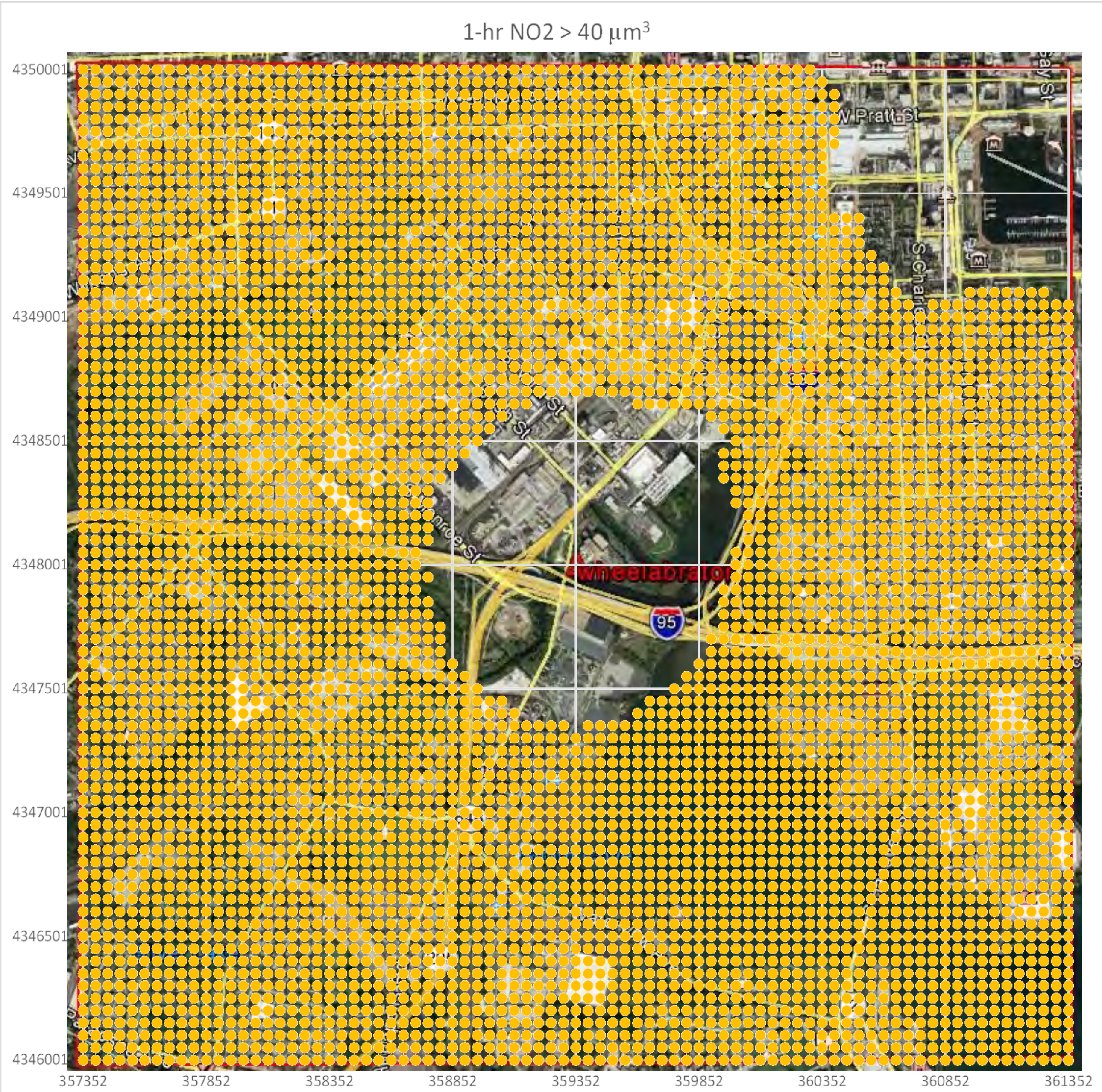


Figure A.3 Fine grid: modeled max 1-hr-NO_2 concentrations exceeding 40 µg/m^3

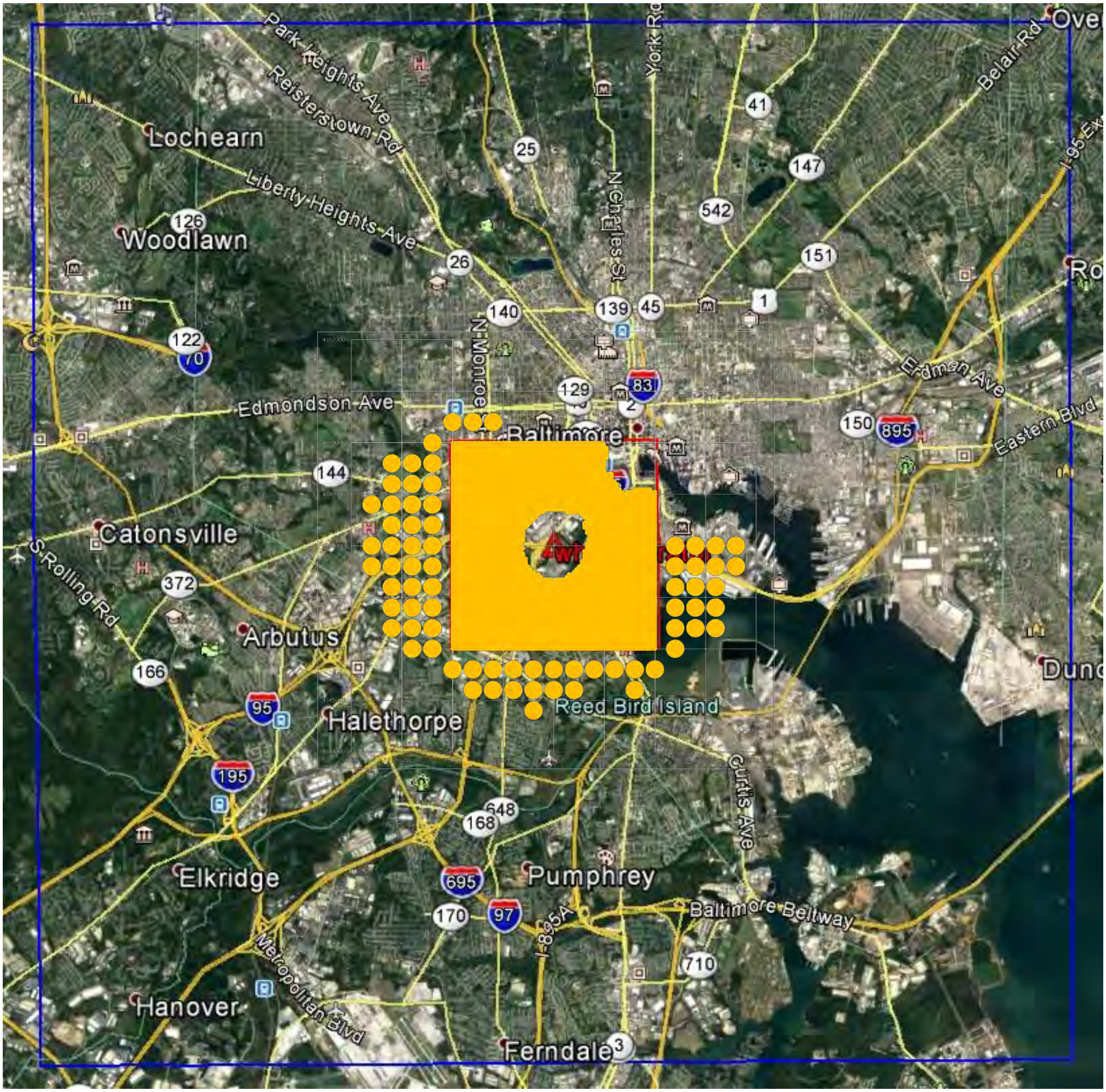


Figure A.4. Fine and coarse grids: modeled max 1-hr-NO_2 concentrations exceeding 40 $\mu g/m^3$

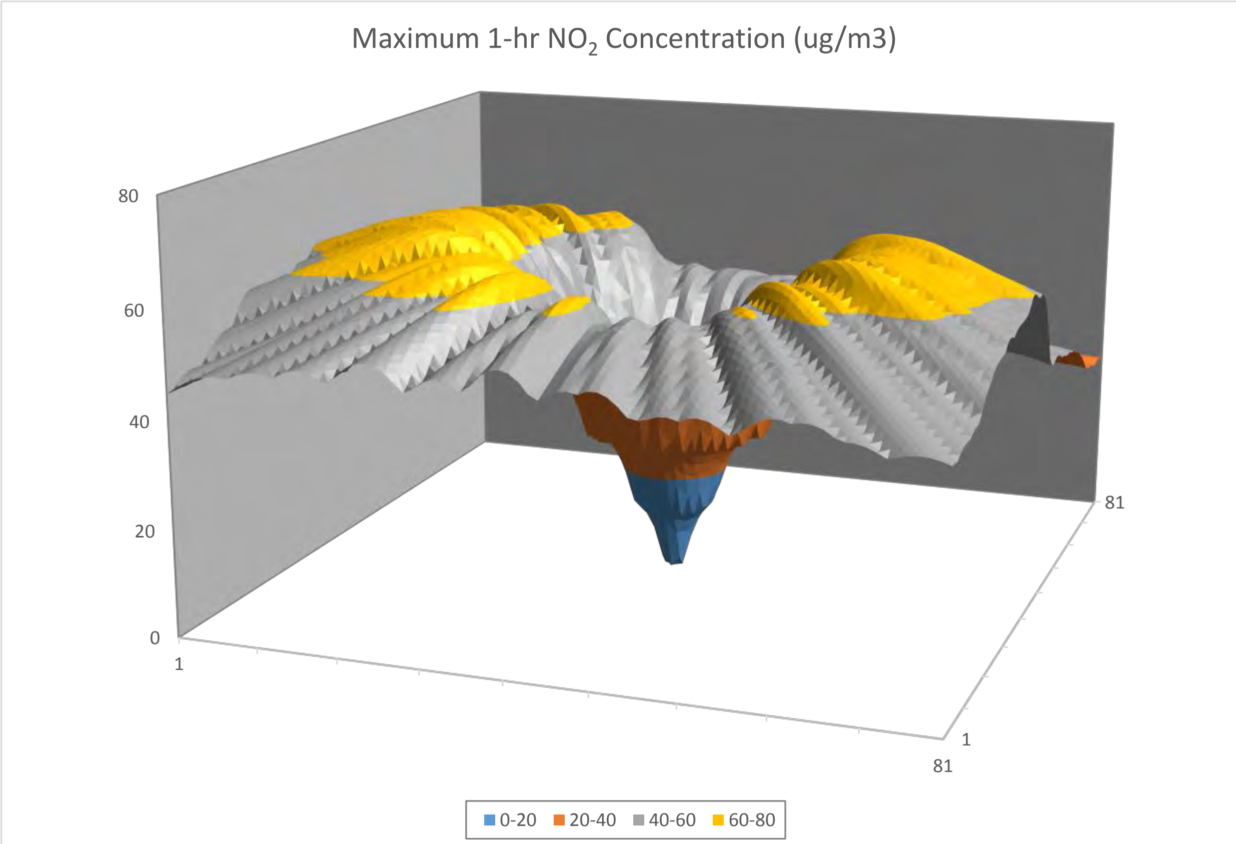
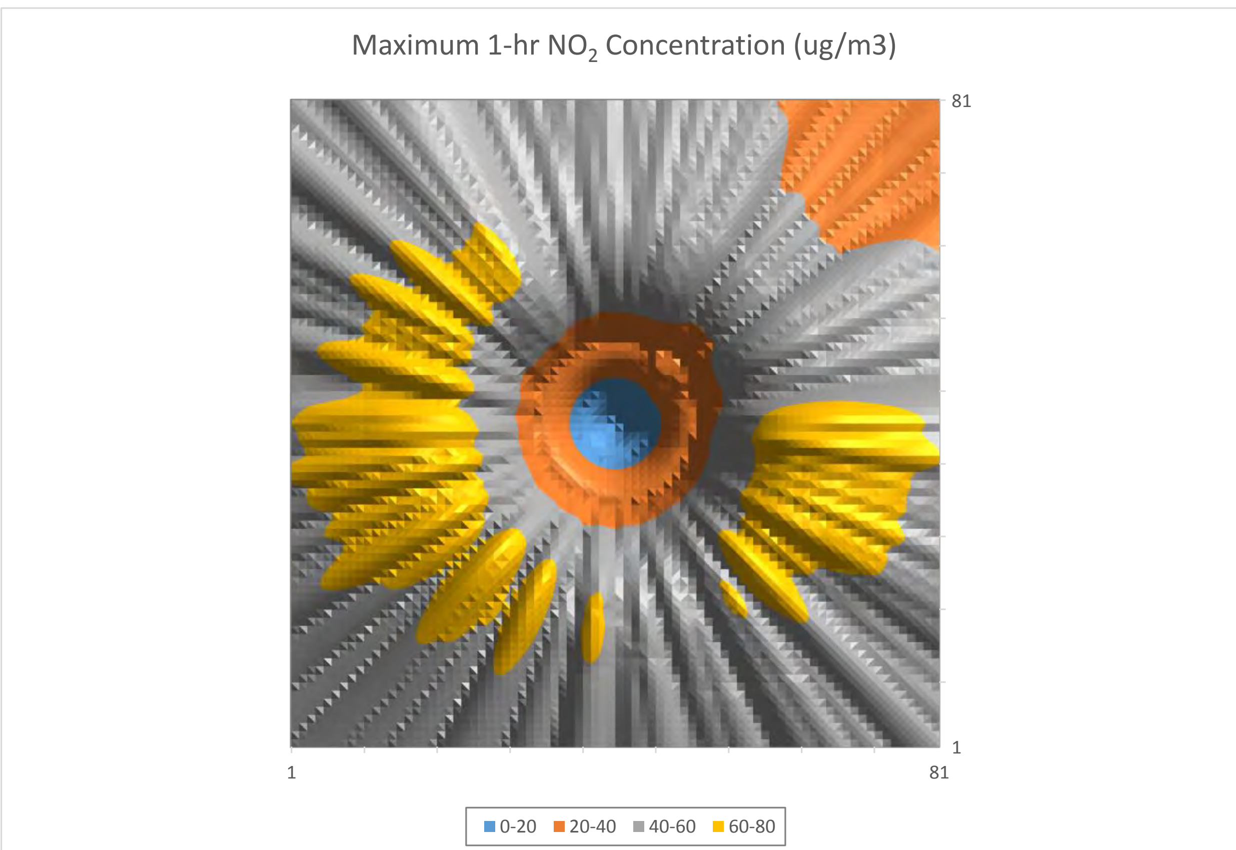


Figure A.5(a and b). Fine grid: modeled maximum 1-hr-NO_2 concentrations



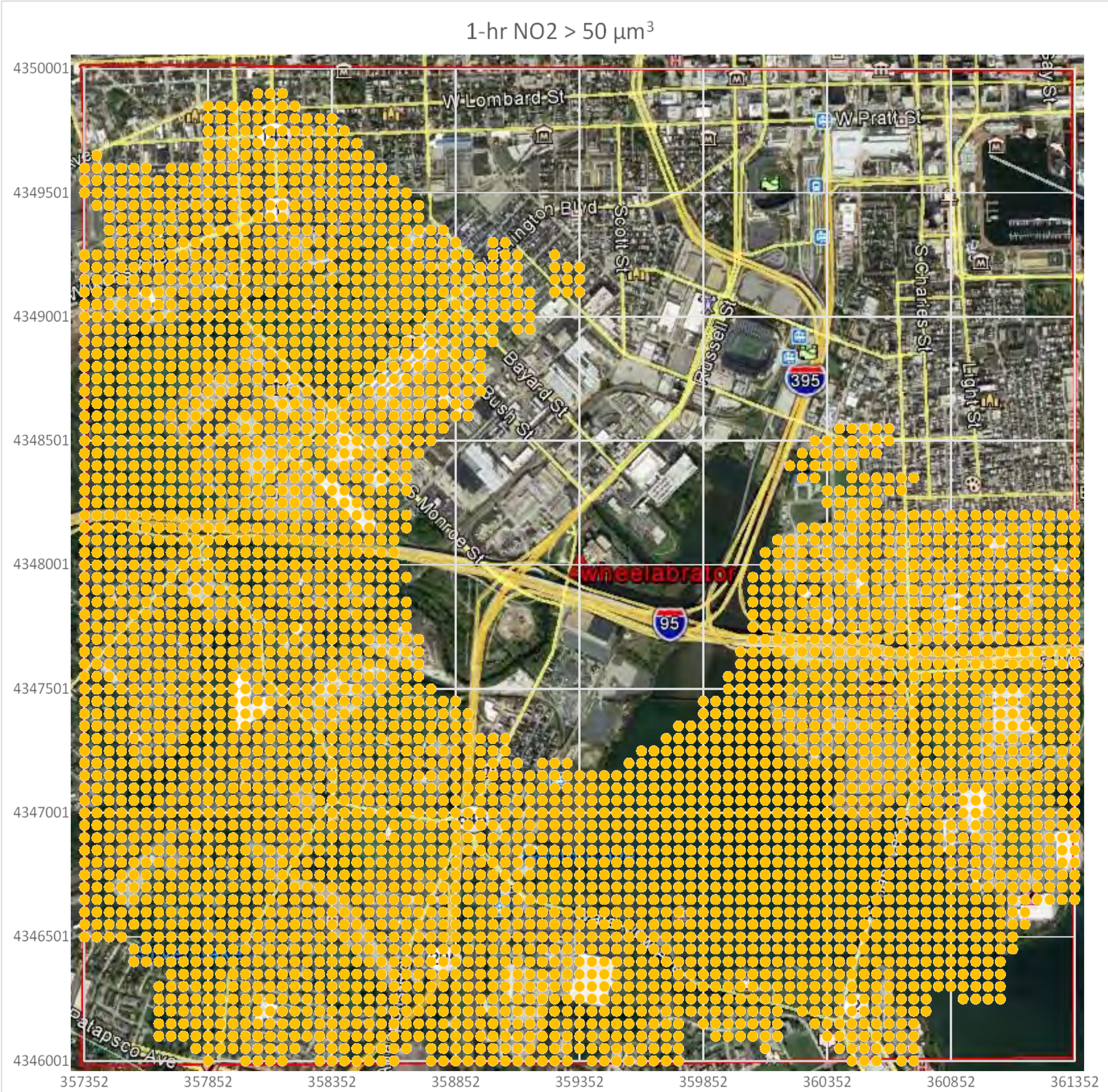


Figure A.6. Fine grid: modeled max 1-hr-NO_2 concentrations exceeding 50 $\mu g/m^3$

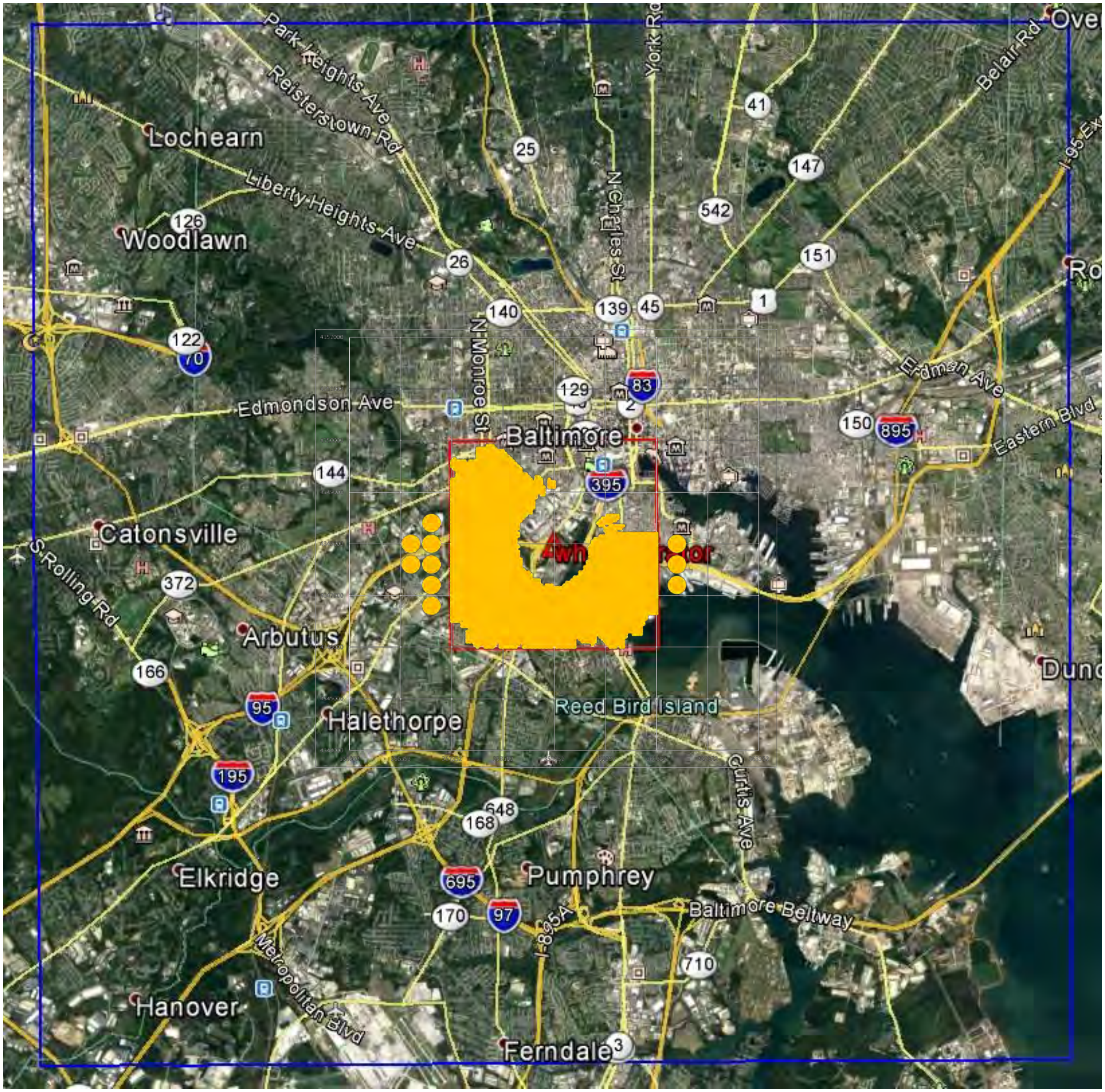


Figure A.7 Fine and coarse grids: modeled max 1-hr-NO_2 concentrations exceeding 50 $\mu g/m^3$

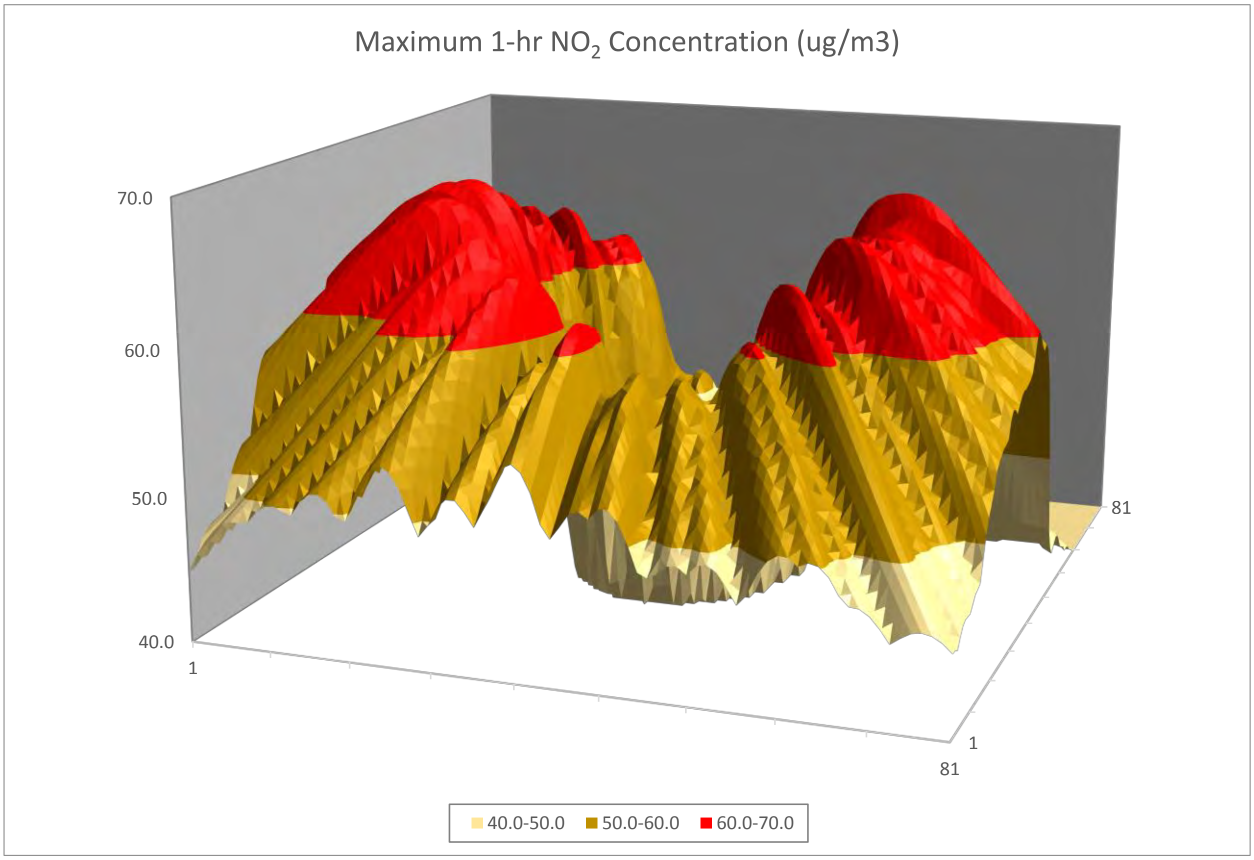
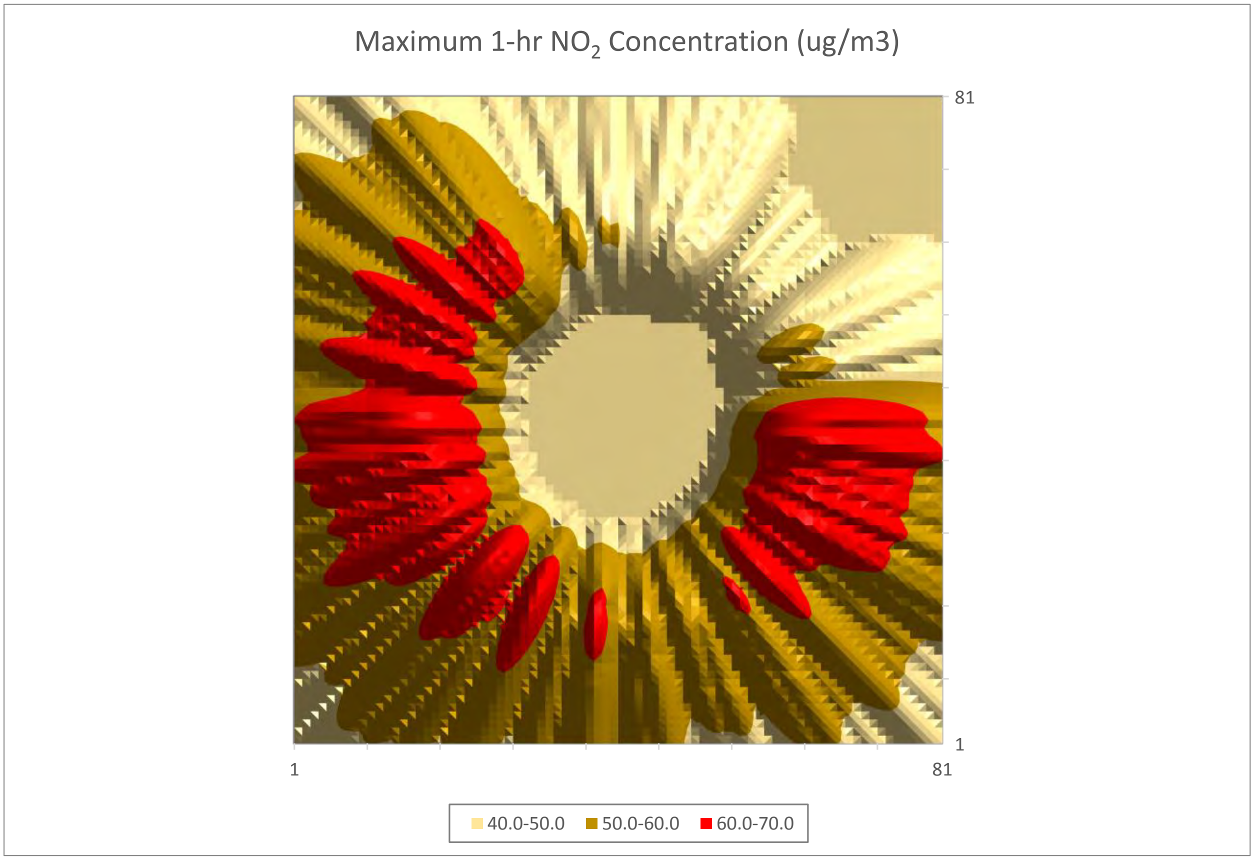


Figure A.8(a and b). Fine grid: modeled maximum 1-hr-NO_2 concentrations



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

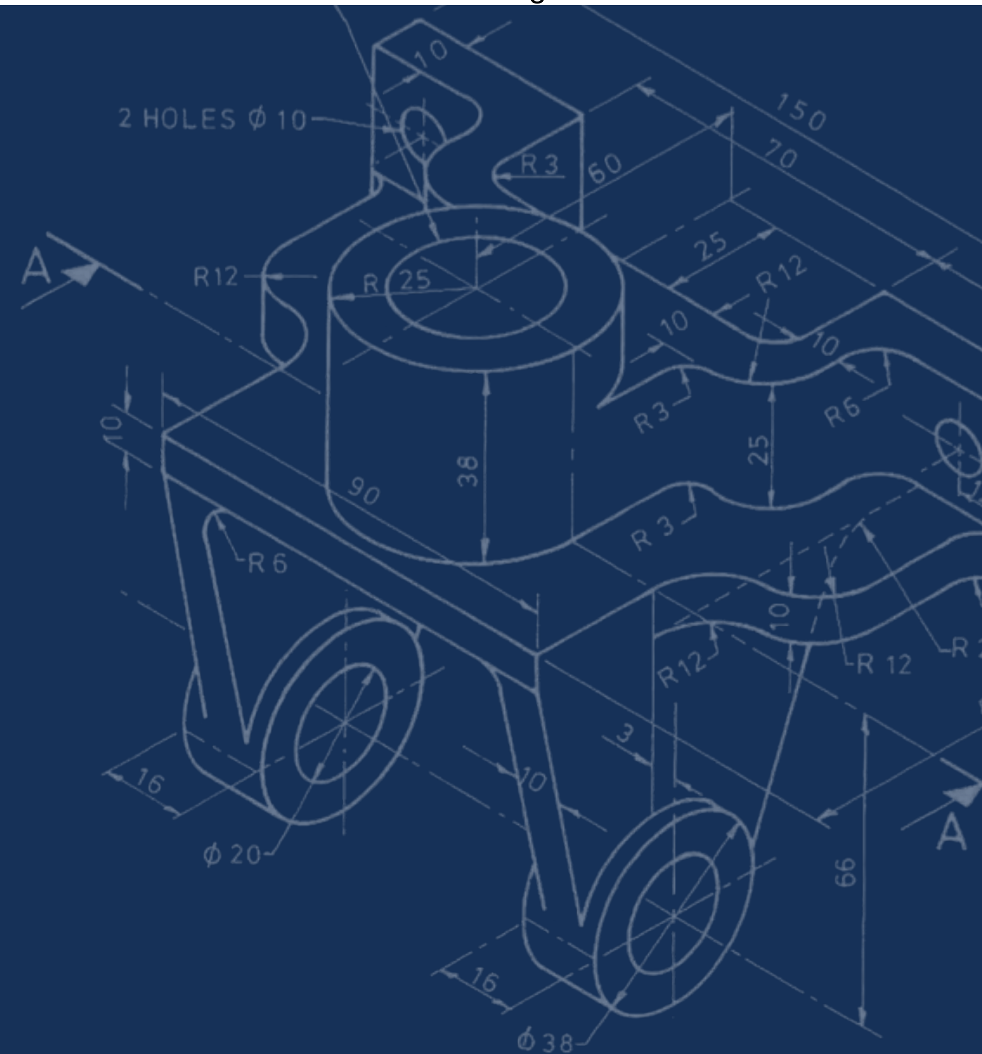
RACT Statistical Calculations

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 munici-palities 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 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

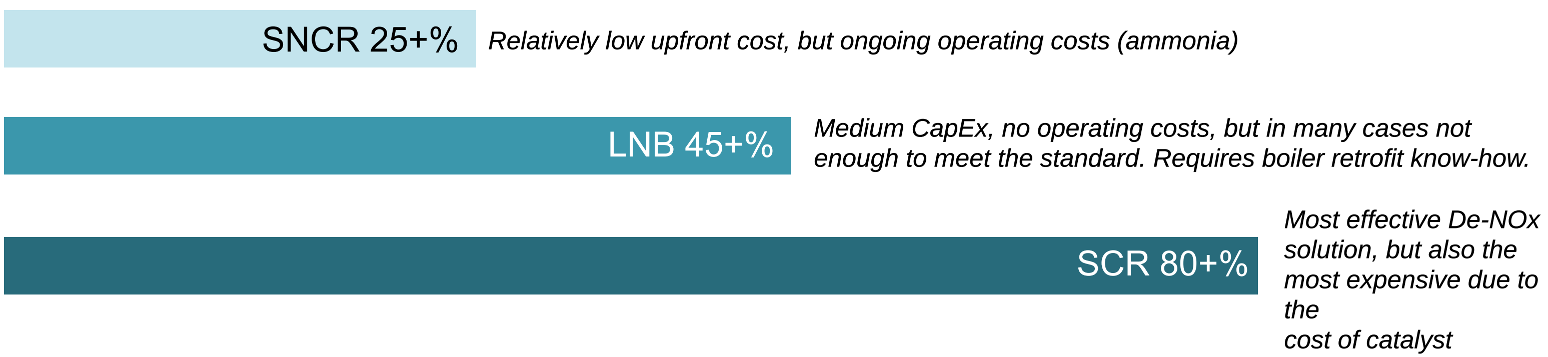
Advanced Coal Tech.

Hepo Facility, Shanxi

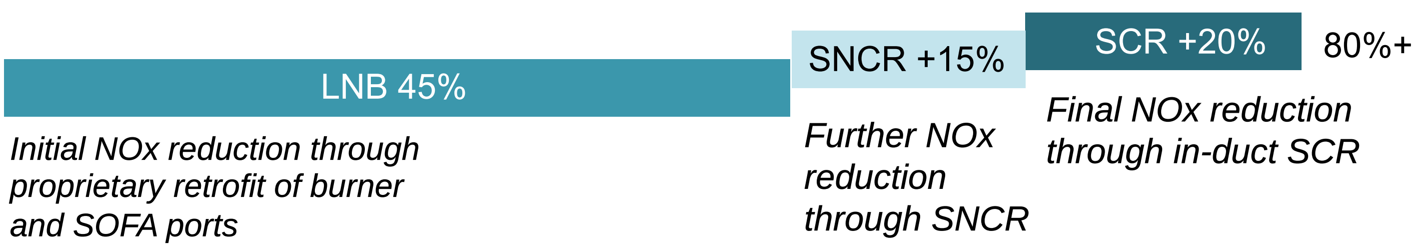
- Innovative process to **co-produce** electric power and high-value chemicals
- Extraordinary **economics** and **environmental impact improvement** from systems perspective
- Piloted in Shanxi, China; to be fully operational Q4 '14

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

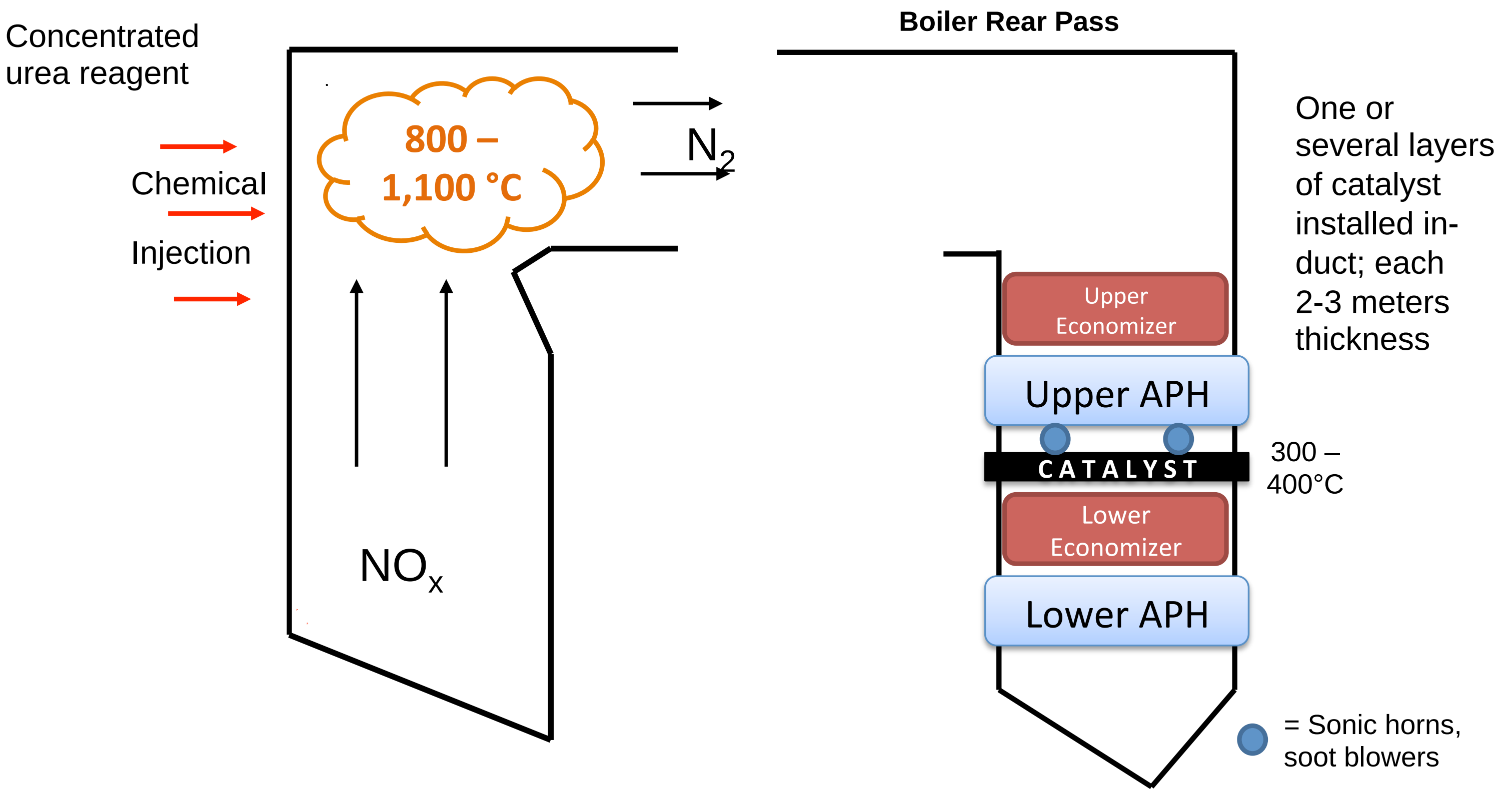
Units Overview:
- Power generation capacity: 2 x 50 MW
- Combustion type: T-Fired
- Fuel: Bituminous coal

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

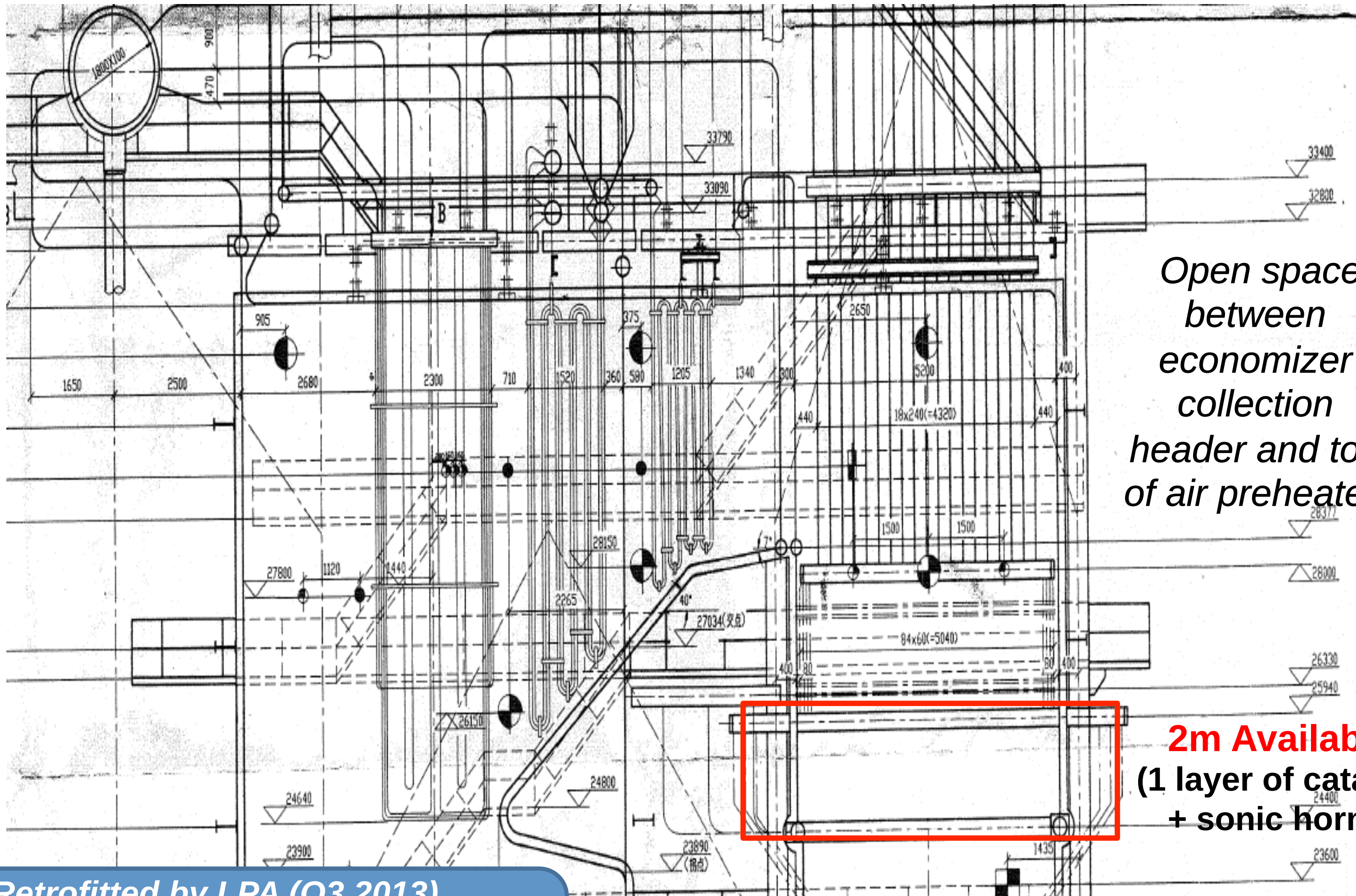
- Smaller units utilize LNB and (S)OFA, *but still need additional NOx reduction*
  - SCR too expensive/ too large for some units
  - SNCR might not provide effective NOx reduction without large amount of slip

Large Units:

- LNB
- SCR

Hybrid LNB / SNCR / SCR – Example 1

LP AMINA Energy and Environmental

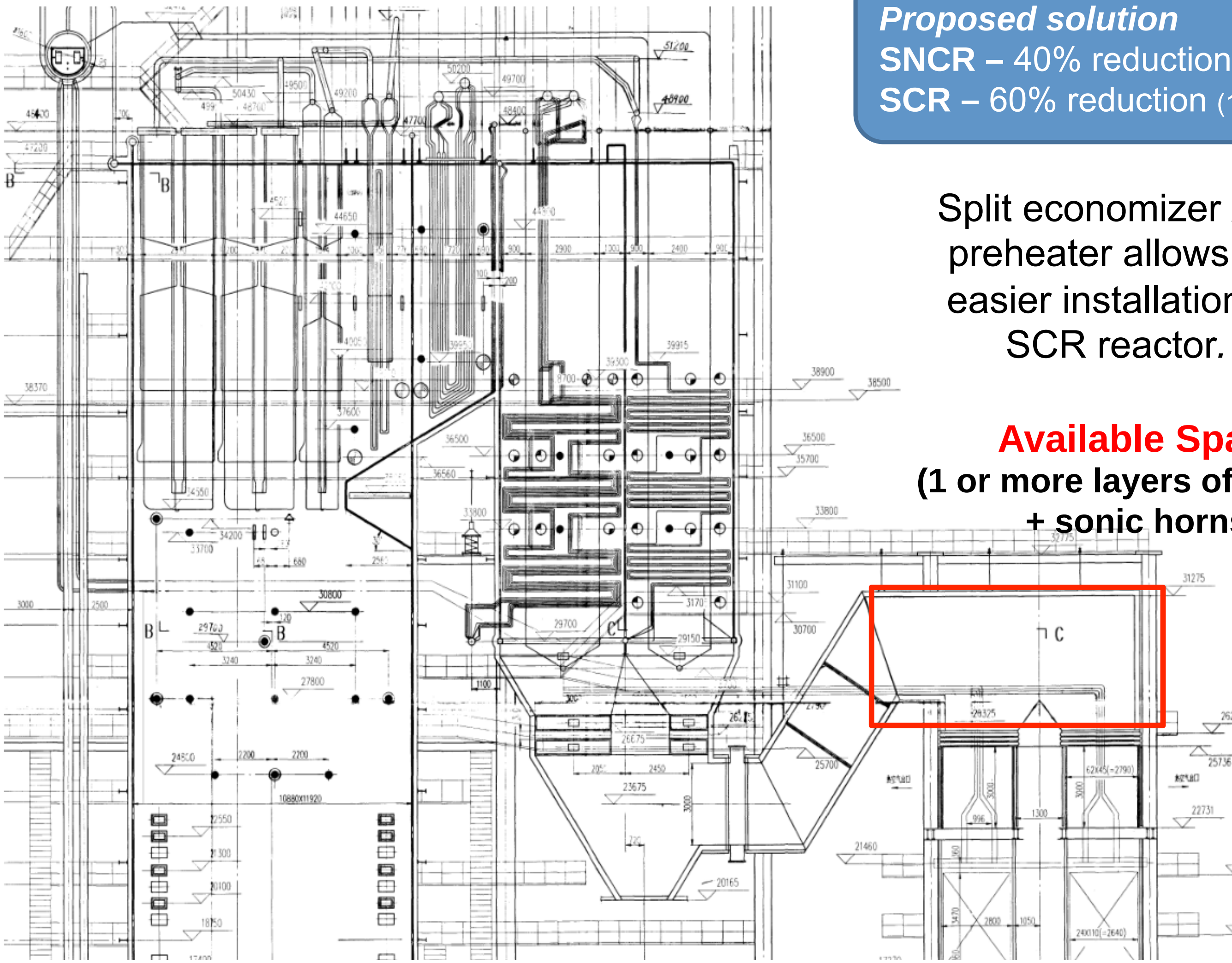


Open space between economizer collection header and top of air preheater.

2m Available
(1 layer of catalyst + sonic horns)

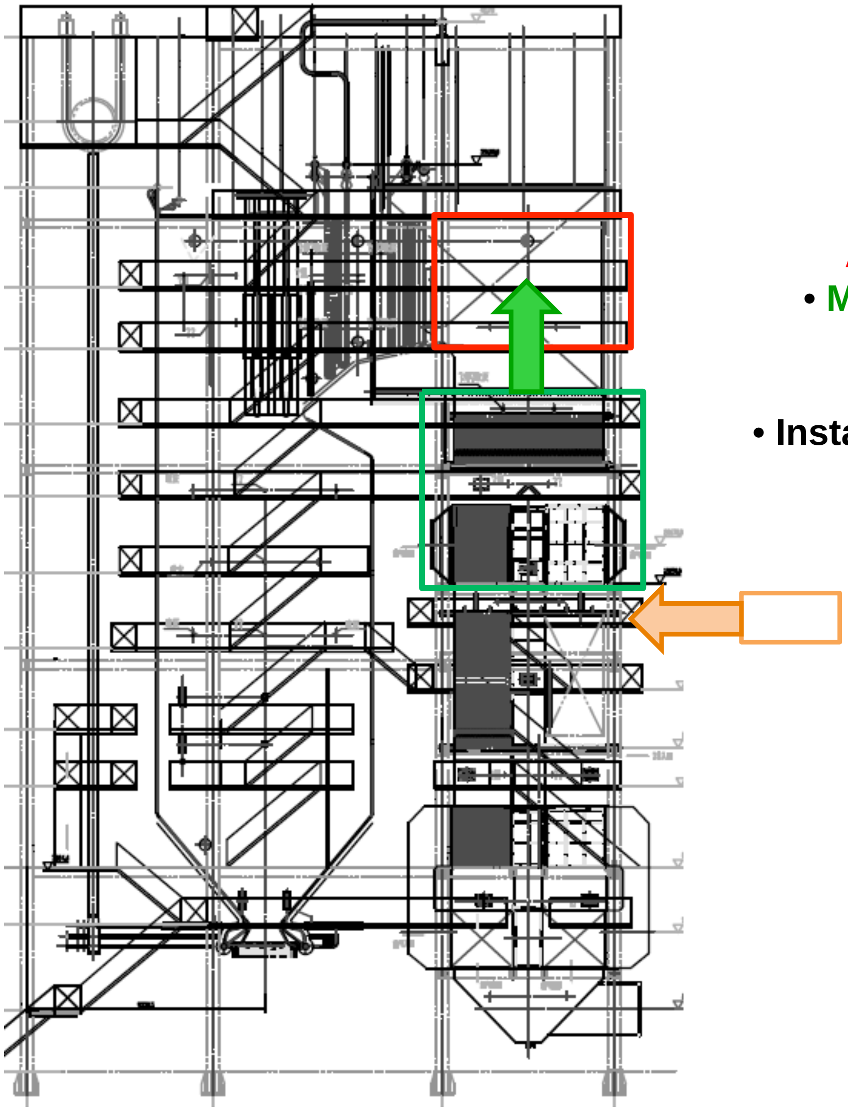
Retrofitted by LPA (Q3 2013)
LNB **–** 40% reduction (200 mg/Nm³)
SNCR – 30% reduction (200 mg/Nm³)
SCR – 50% reduction (100 mg/Nm³)

Proposed solution
SNCR – 40% reduction (250 mg/Nm^3)
SCR – 60% reduction (100 mg/Nm^3)



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

Available Space
(1 or more layers of catalyst + sonic horns)

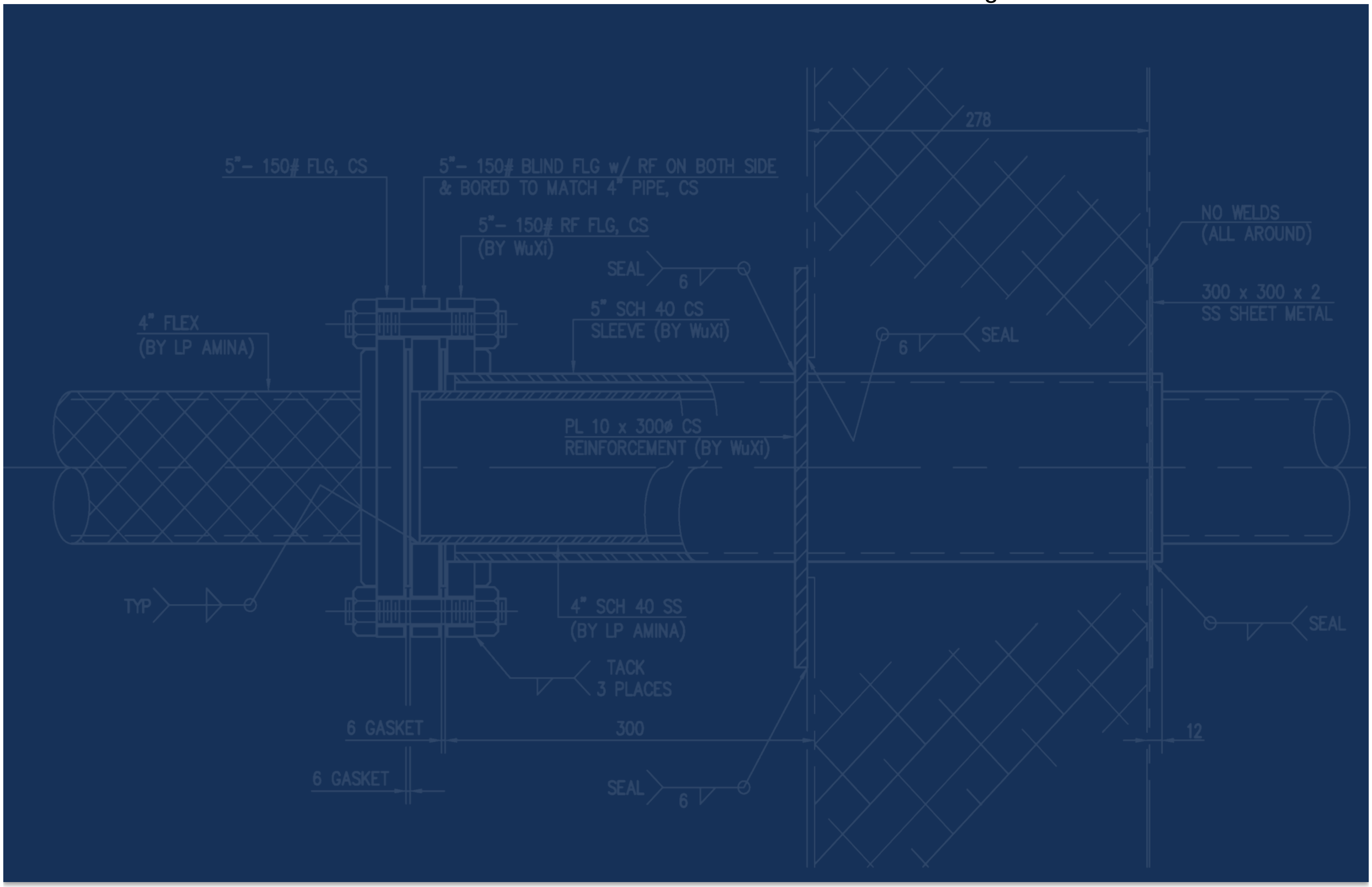


Proposed solution
SNCR – 40% reduction (166 mg/Nm³)
SCR – 40% reduction (100 mg/Nm³)

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

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Agenda

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

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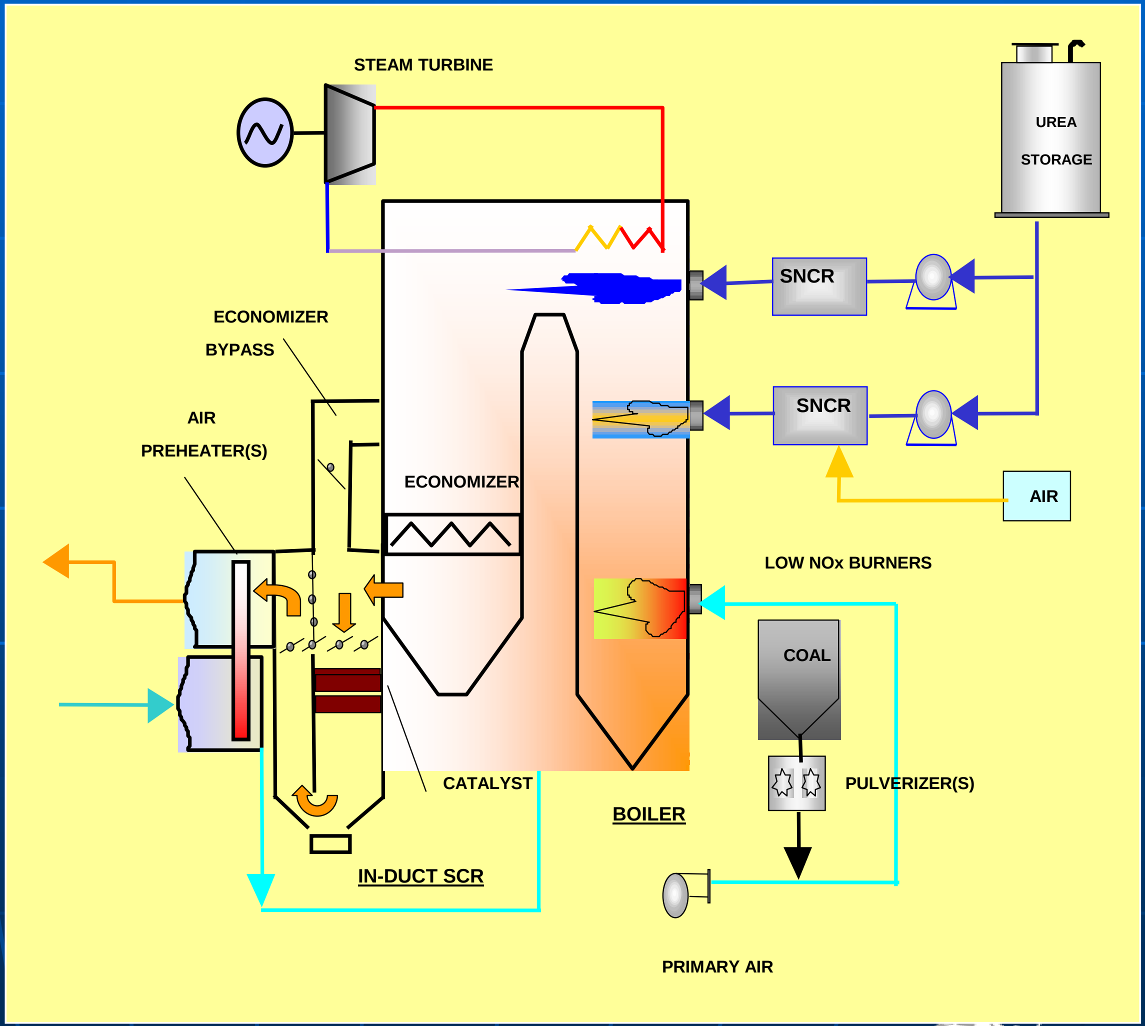
Hybrid NO_x Control System "Cascade®"

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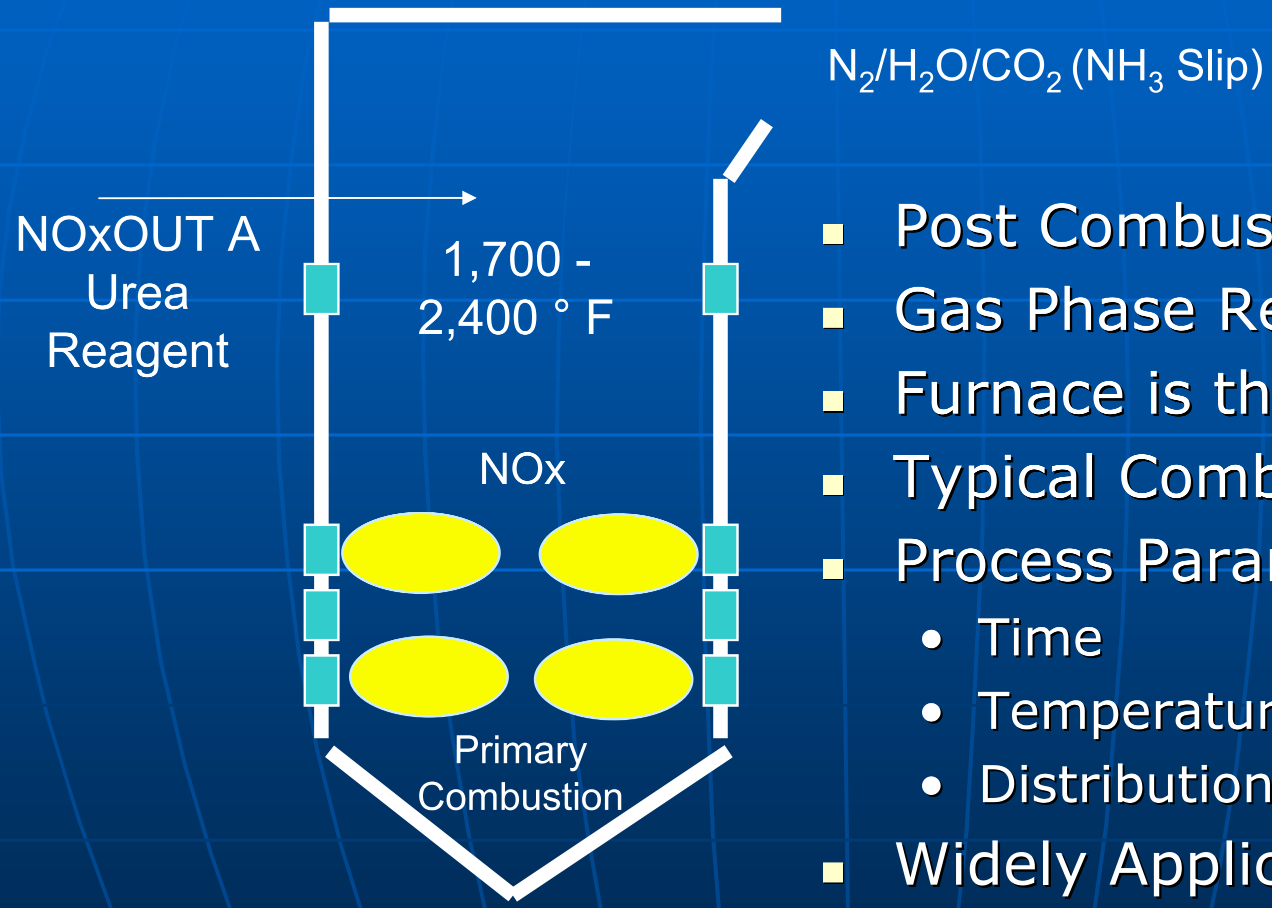
Traditional Urea Based Selective Non-Catalytic Reduction (SNCR) of NOx



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

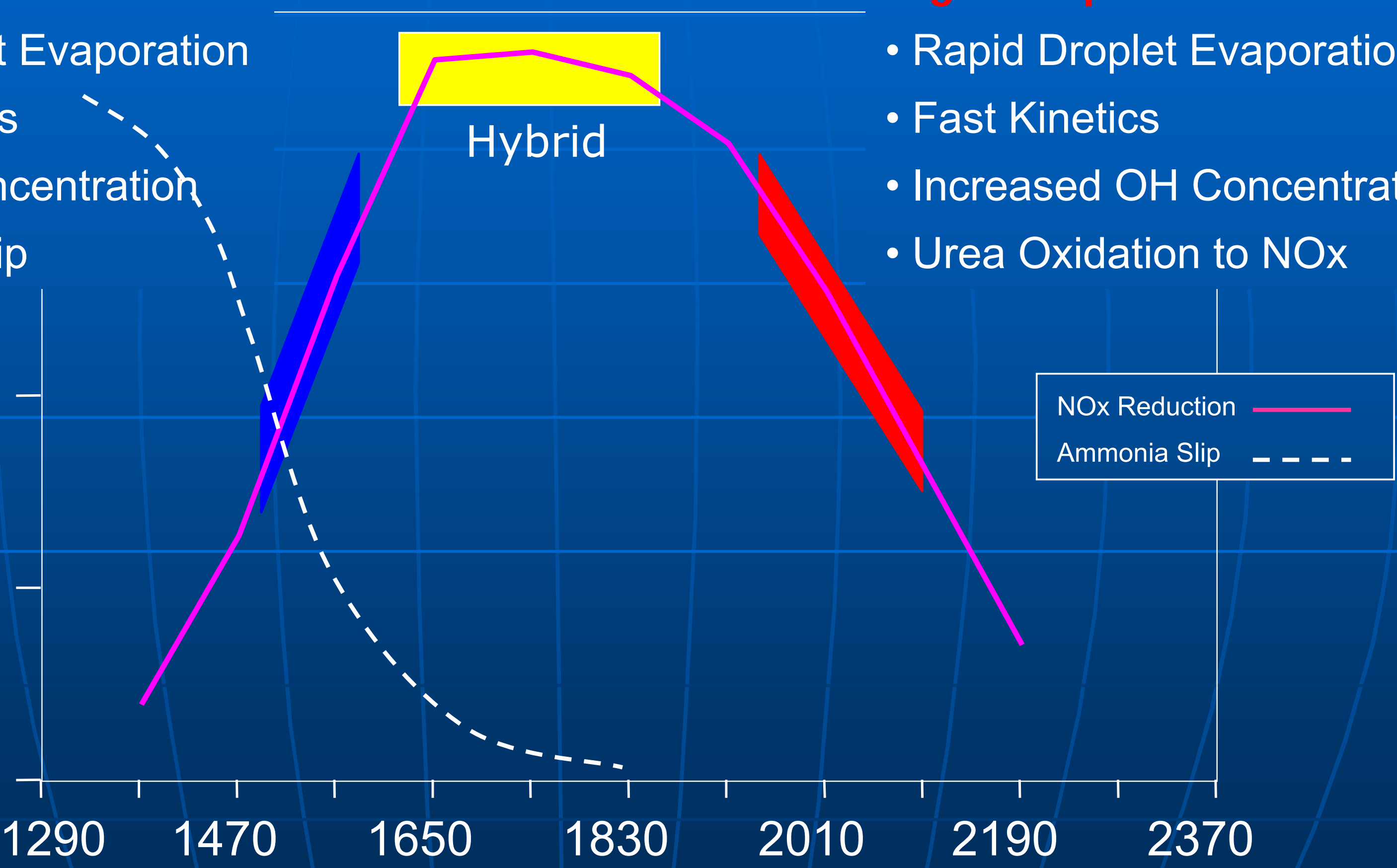
"Right Side of the Slope" Injection

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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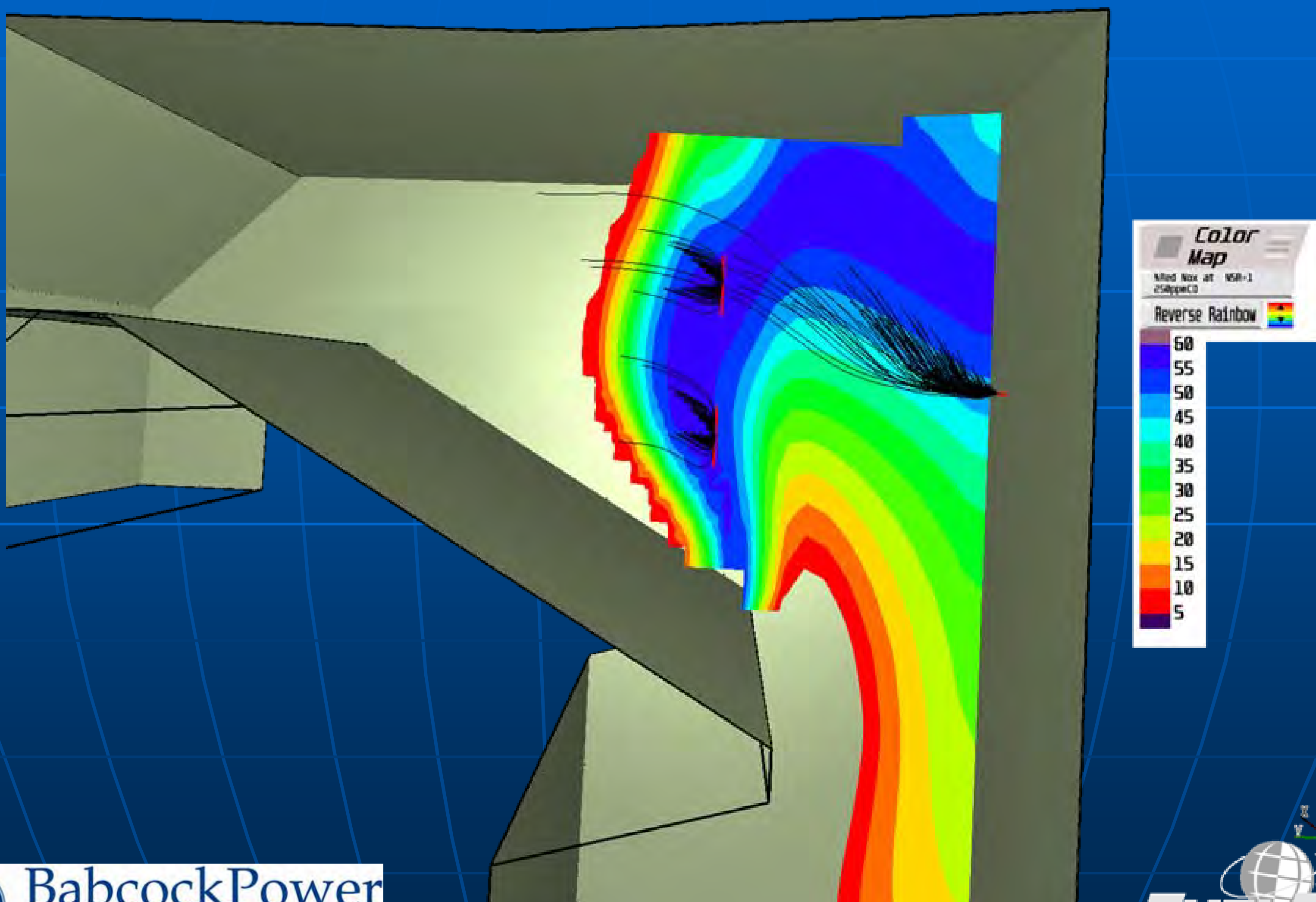
Hybrid SNCR Injection



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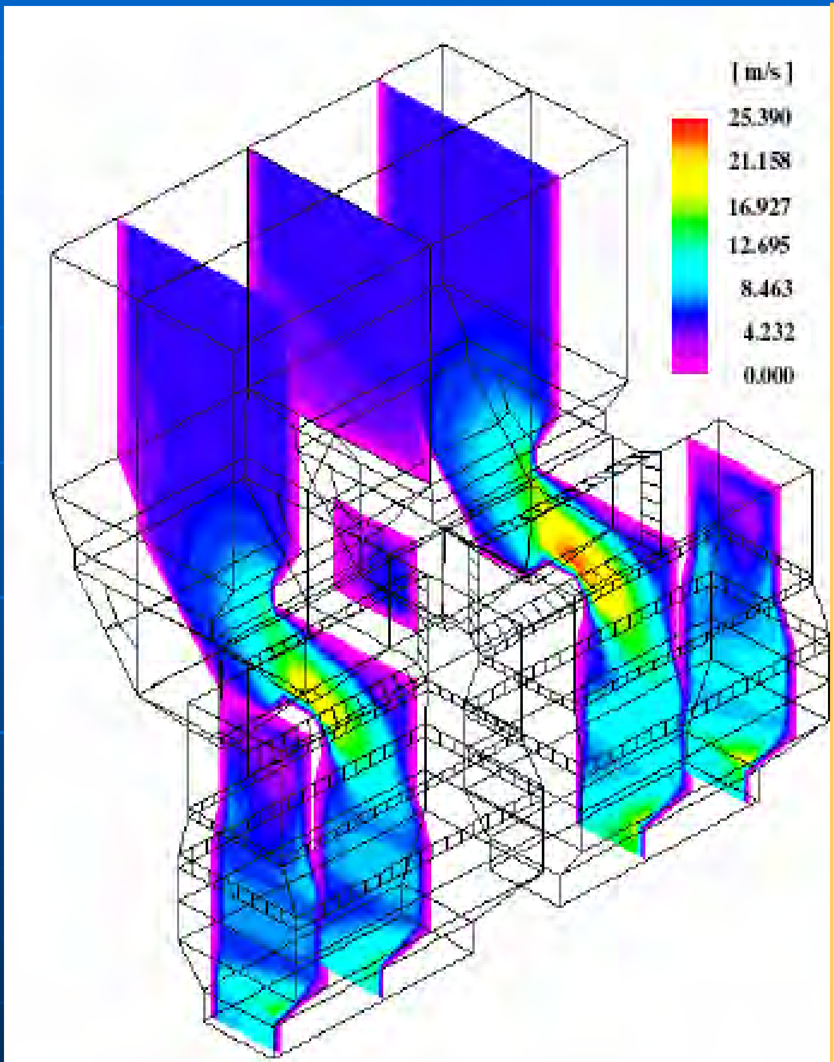
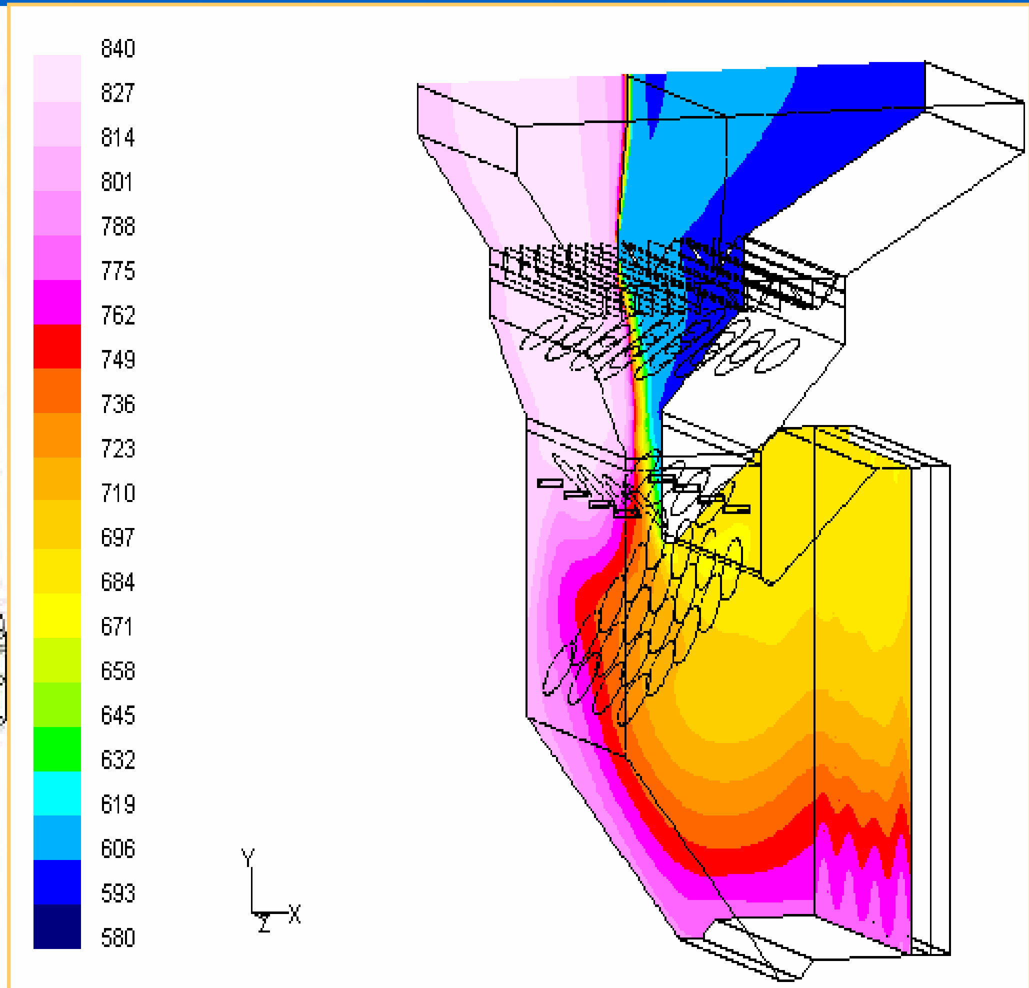
Hybrid In-Duct





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

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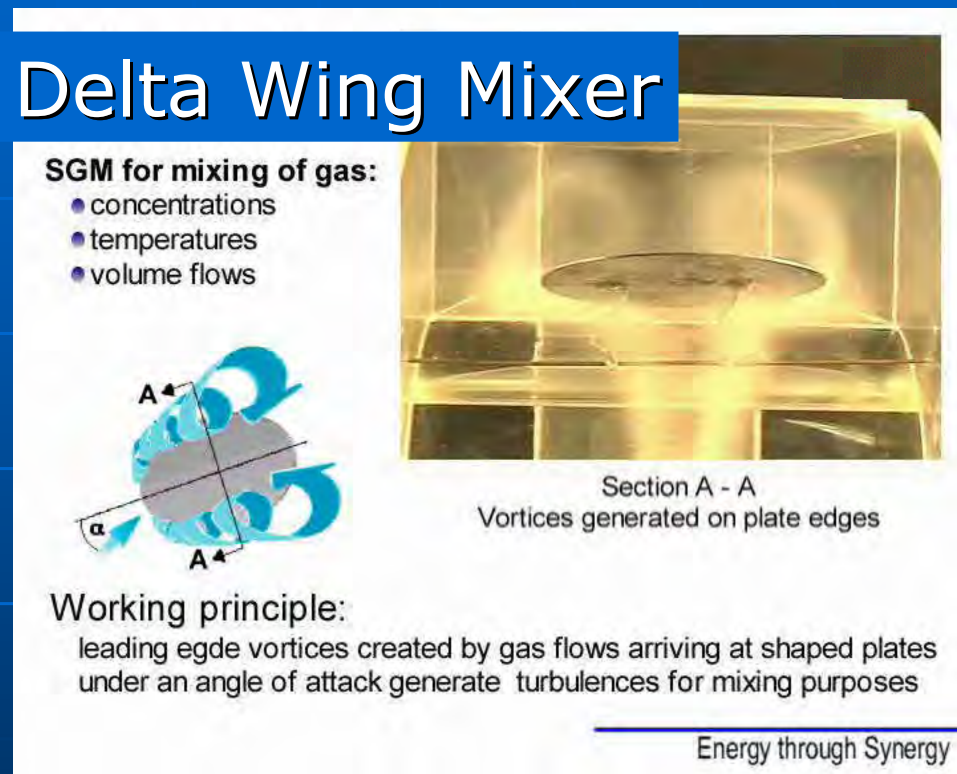
Cold Flow Models and Flue Gas Mixing

- **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

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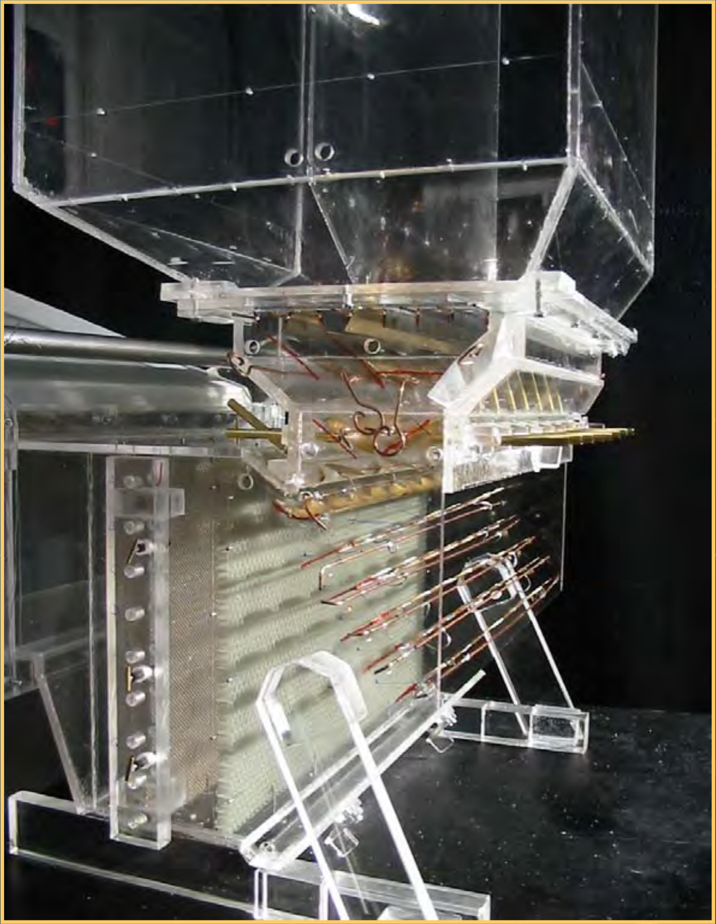
Example 1: Compact In-Duct SCR Exelon Handley Unit 3

- 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

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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

<u>Design Case:</u>

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

<u>Operational Case:</u>

35% reduction, 0.50 #/MMBtu, <2 ppm NH_3 slip

Less than 10 % in convective pass

<u>High Ammonia Slip Case</u>

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 NH_3 Reduction 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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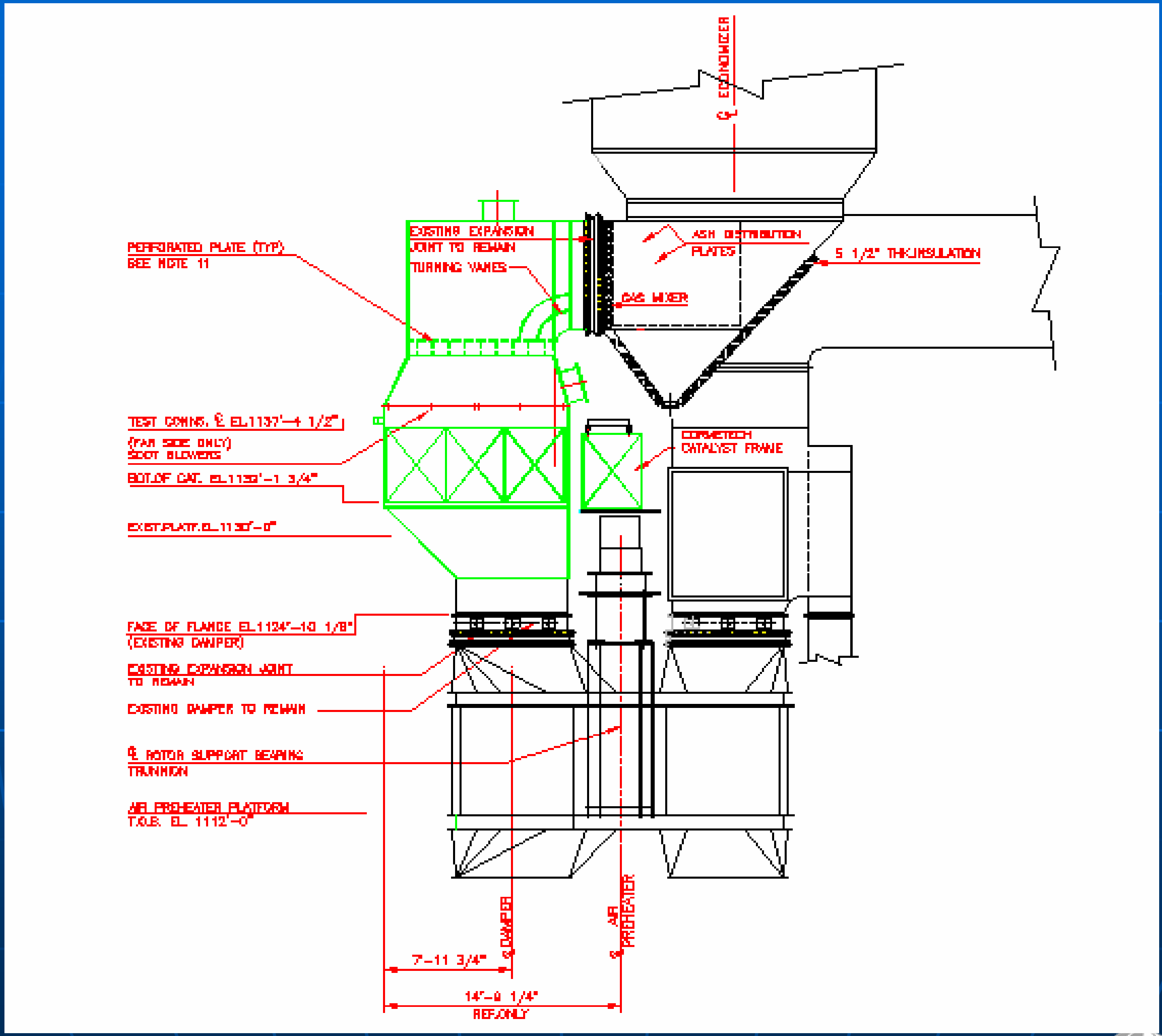

℄ ECONOMIZER
EXISTING EXPANSION JOINT TO REMAIN
TURNING VANES
ASH DISTRIBUTION PLATES
5 1/2" THK.INSULATION
GAS MIXER
PERFORATED PLATE (TYP) SEE NOTE 11
TEST CONNS. ℄ EL.1137'-4 1/2"
(FAR SIDE ONLY) SOOT BLOWERS
BOT.OF CAT. EL.1132'-1 3/4"
EXIST.PLATF.EL.1130'-0"
CORMETECH CATALYST FRAME
FACE OF FLANGE EL.1124'-10 1/8" (EXISTING DAMPER)
EXISTING EXPANSION JOINT TO REMAIN
EXISTING DAMPER TO REMAIN
℄ ROTOR SUPPORT BEARING TRUNNION
AIR PREHEATER PLATFORM T.O.B. EL. 1112'-0"
℄ DAMPER
℄ AIR PREHEATER
7'-11 3/4"
14'-9 1/4" REF.ONLY

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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

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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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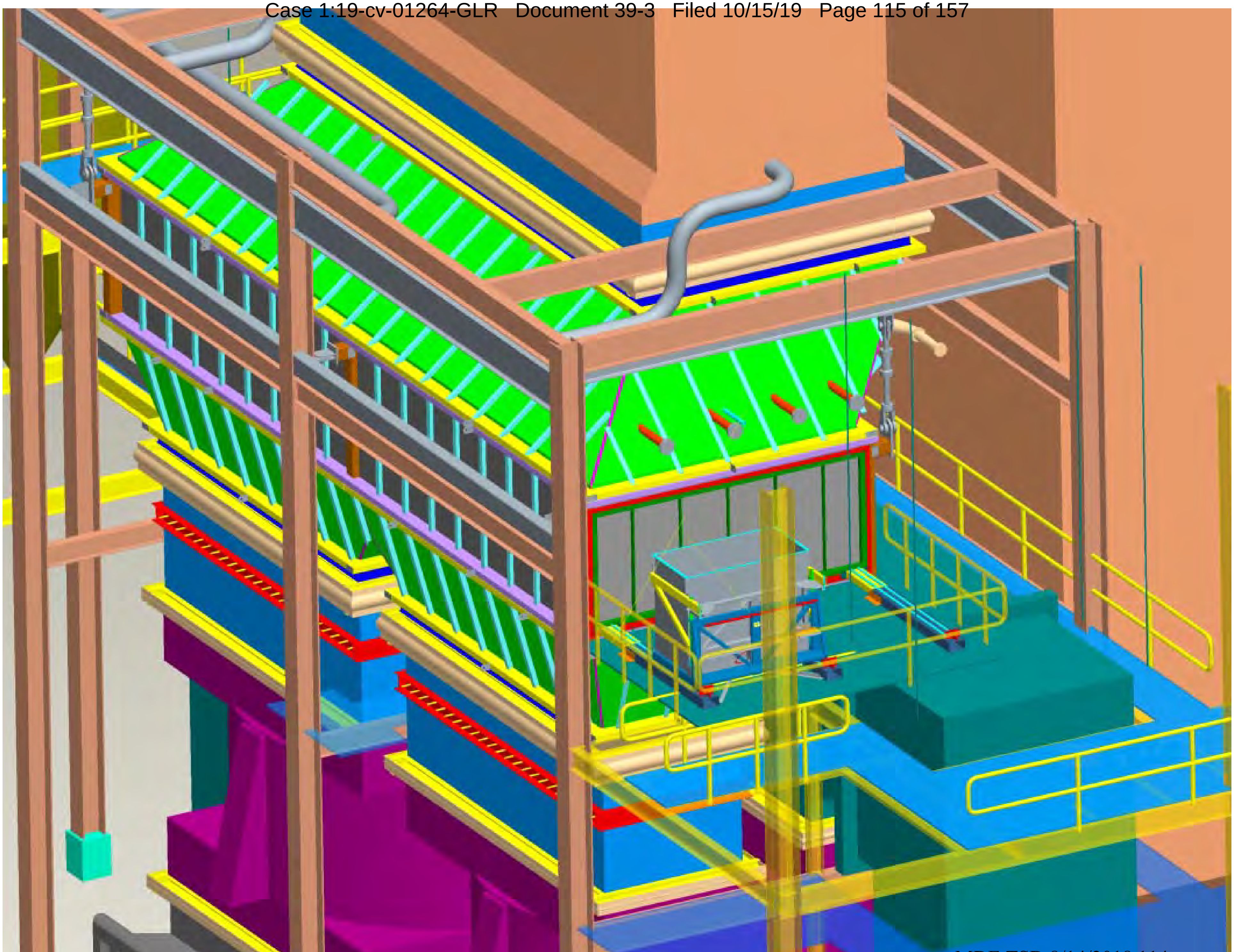

All-In Capital Cost vs. NOx Reduction

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

Questions Submitted via Email to Randy Mosier (MDE) from Leah Kelly (EIP) 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.

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?**

EIP ENVIRONMENTAL INTEGRITY PROJECT

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www.environmentalintegrity.org

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.

---

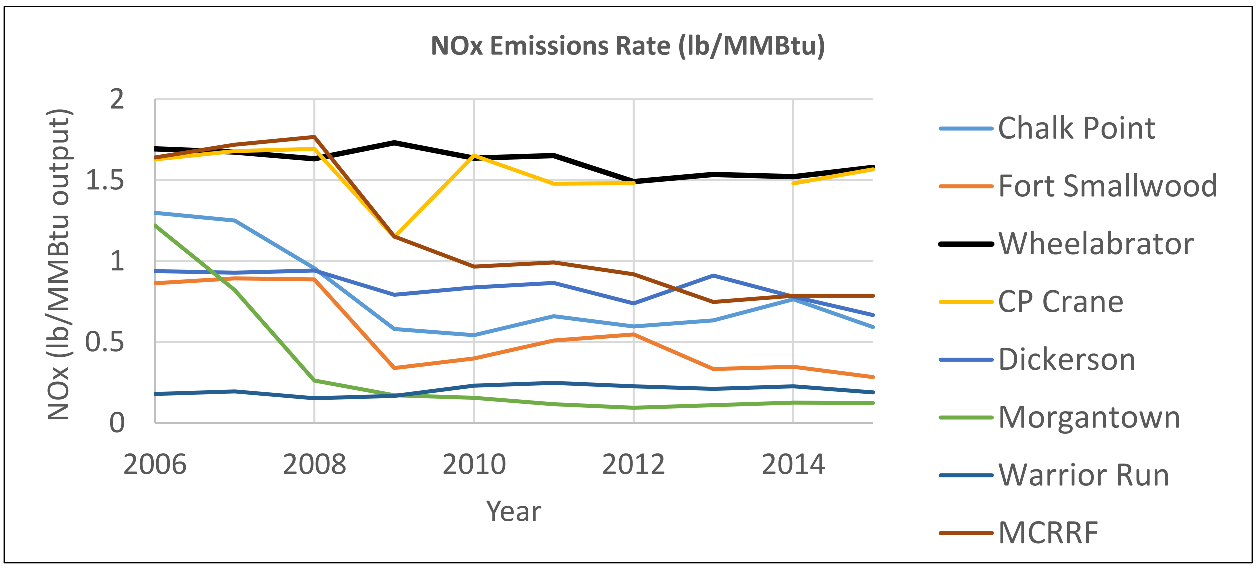
[1] In these comments, "ppm" is used as shorthand for parts per million by volume dry at 7% oxygen.
[2] MDE PowerPoint Presentation, NOx RACT for Municipal Waste Combustors (MWCs), Stakeholder Meeting - January 17, 2017, p. 26 *at* http://www.mde.state.md.us/programs/regulations/air/Documents/SHMeetings/MunicipalWasteCombustors/MWCNOxRACTPresentation.pdf

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.

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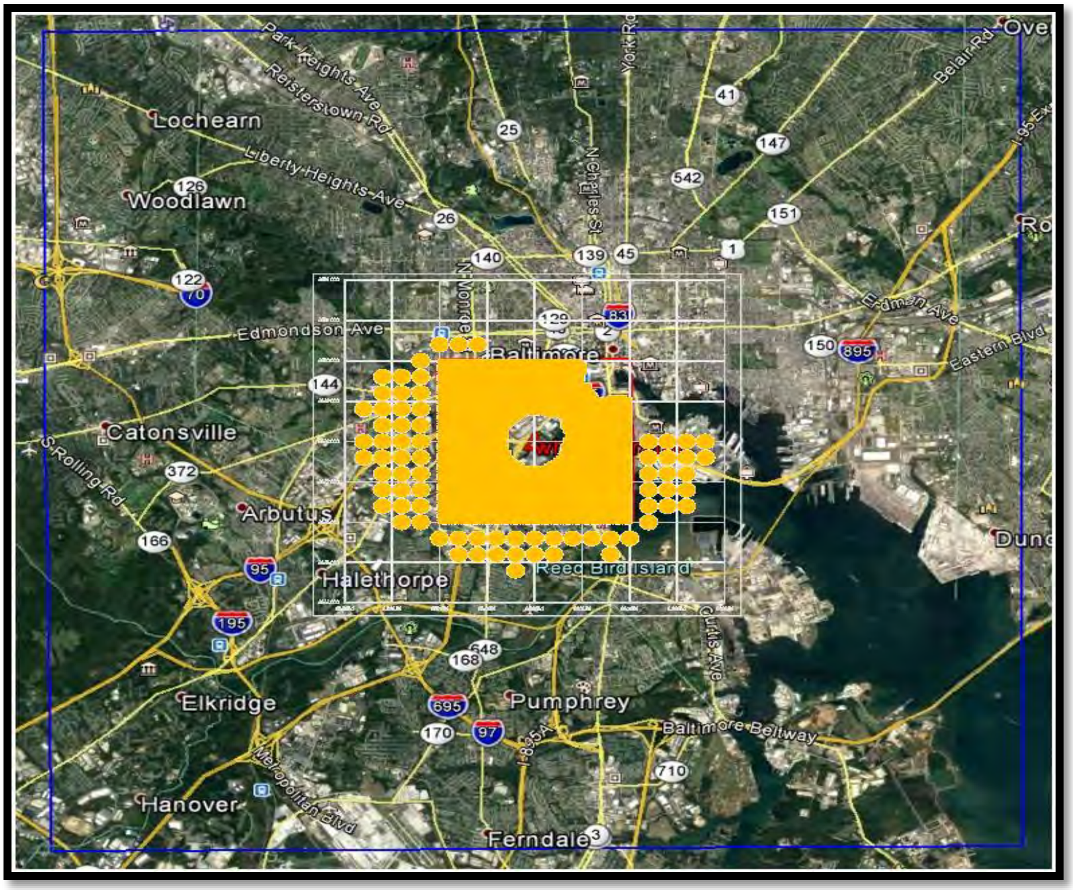
[4] Timothy Porter, Director Air Quality Management, Wheelabrator Baltimore NOx RACT Review PowerPoint Presentation (hereinafter "Wheelabrator Jan. 17 PowerPoint Presentation") (Jan. 17, 2017), p.13 *at* http://mde.maryland.gov/programs/regulations/air/Documents/SHMeetings/MunicipalWasteCombustors/MWCWheelabratorNOxRACTPresentation.pdf.

[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.

Figure 3: **Asthma Emergency Department Rates**, Maryland v. Zip Code 21230 (2011-2013 avg.)

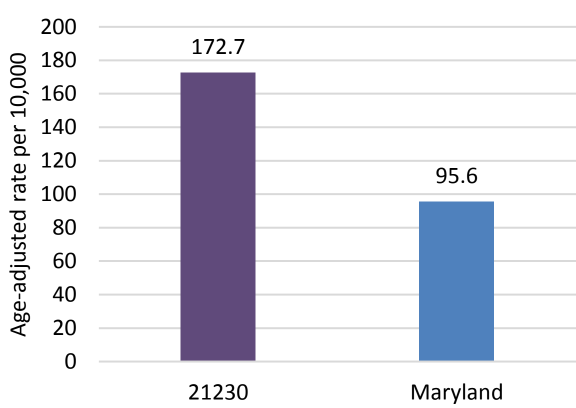
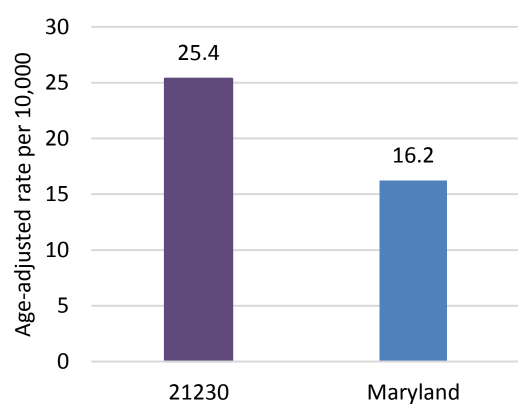


Figure 4: **Asthma Hospitalization Rates**, Maryland v. Zip Code 21230 (2011-2013 avg.)



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).

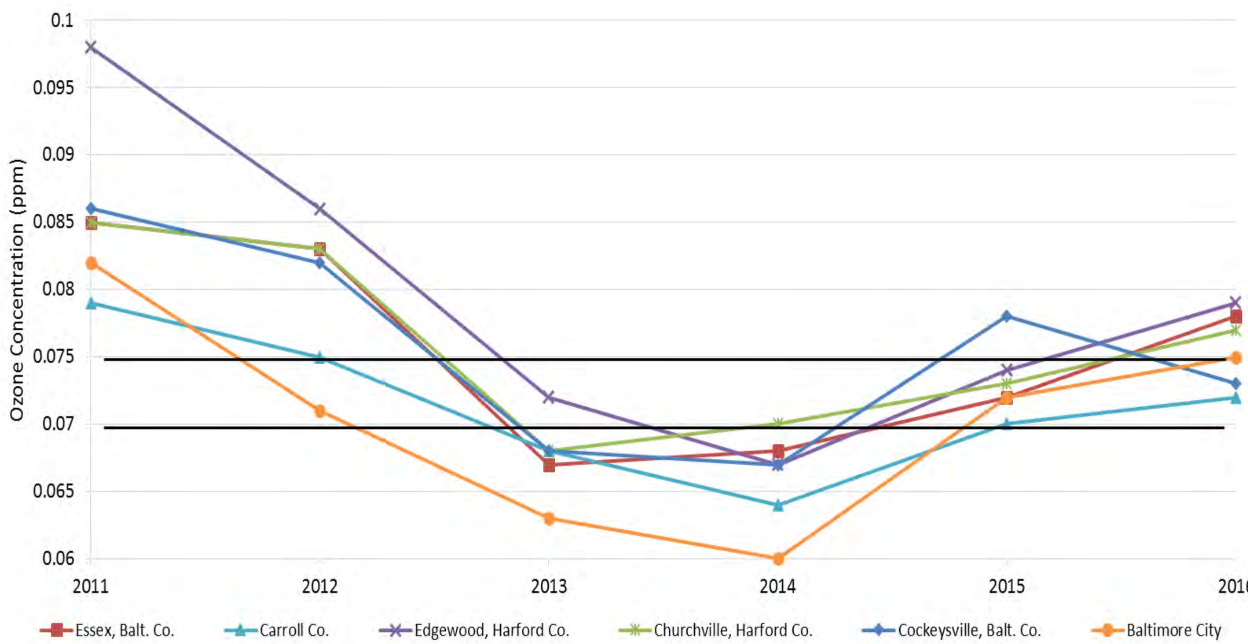
[16] Asthma hospitalization rates accounts for discharges of persons who are admitted to the hospital (inpatients) for asthma including those admitted through the hospital emergency department. It does not cover persons who visit the emergency department for asthma and are treated and released (outpatients). 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.

[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)

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[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

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[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

[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.

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[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,

Leah Kelly
Attorney
Environmental Integrity Project
1000 Vermont Ave. NW, Suite 1100
Washington, D.C. 20005
Phone: 202-263-4448
Email: lkelly@environmentalintegrity.org

Cc: *Via E-mail*

Randy E. Mosier
Division Chief, Air Quality Regulations Division
Maryland Department of the Environment
1800 Washington Boulevard, STE 730
Baltimore, Maryland 21230-1720
randy.mosier@maryland.gov

[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 NO_x 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:

- 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).