Amendment to
City of Philadelphia Department of Public Health
Air Management Services (AMS)
Reasonably Available Control Technology (RACT)
State Implementation Plan (SIP) Revision under the
8-Hour Ozone National Ambient Air Quality Standards (NAAQS)
(2013 revision)

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A.

Reasonably Available Control Technology (RACT) State Implementation Plan (SIP) Revision for the 8-hour Ozone National Ambient Air Quality Standard (NAAQS)

1. Introduction

Statutory Authority:

25 Pennsylvania Code Subpart C Article III

Philadelphia Air Management Code 3-301 of the Philadelphia Code

Background and Requirements:

The federal Clean Air Act (CAA) of 1990 gives the states primary responsibility for achieving the National Ambient Air Quality Standards (NAAQS). The NAAQSs are established by the U.S. Environmental Protection Agency (EPA) as the maximum concentrations in the atmosphere for specific air contaminants to protect public health and welfare. The principal mechanism at the state and local level for complying with the CAA is the State Implementation Plan (SIP). A SIP outlines the programs, actions, and commitments a state will carry out to implement its responsibilities under the CAA. Once approved by the EPA, a SIP is a legally binding document under both state and federal law.

In June 2004, EPA designated 126 areas of the country as "non-attainment" under the 8-hour ozone NAAQS. Among those non-attainment areas is the Philadelphia-Wilmington-Atlantic City Moderate Non-Attainment Area (NAA) that includes three counties in Delaware, five counties in eastern Pennsylvania and eight counties in southern New Jersey.

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According to the EPA's Final Rule to Implement the 8-Hour Ozone NAAQS (70 FR 71612, November 29, 2005), areas classified as moderate nonattainment or higher must submit a demonstration that their current rules fulfill 8-hour ozone RACT requirements for all CTG categories and all major, non-CTG sources as a revision to their SIPs. Such demonstrations can be made with either a new RACT determination or a certification that previously required RACT controls represent RACT for the 8-hour ozone standard.

On September 25, 2006, the Pennsylvania Department of Environmental Protection (PADEP) submitted to the U.S. Environmental Protection Agency (EPA) a SIP revision for Philadelphia County RACT plans for the 8-hour ozone standard.

On July 10, 2009, the D.C. Circuit Court decided states cannot rely on emissions reductions from cap-and-trade programs, such as the NOx SIP Call or the Clean Air Interstate Rule (CAIR), to demonstrate compliance of emissions sources with the RACT requirements.

Therefore, the City of Philadelphia, Department of Public Health, Air Management Services (AMS) is now amending the earlier SIP revision. This latest SIP revision makes the following changes to the 2006 submission:

1. AMS is revising Table 2, by removing references to the NOx SIP Call (removed items are marked in strikeout).
2. AMS is revising Section 3 “Negative Declaration List” by adding a negative declaration: Control of Volatile Organic Equipment Leaks from Natural Gas/Gasoline Processing Plants, EPA-450/2-83-007, December 1983.
3. AMS is revising Section 4 “Consistency With PADEP’s Negative Declaration List” by adding comments regarding removed items marked in strikeout.
4. AMS is adding Section 5 “Case-by-Case Evaluations” to address sources that needed new case-by-case RACT determinations due to the July 10, 2009, D.C. Circuit Court decision.

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Table 2. Philadelphia NOx RACT List and Certification under the 8-Hour Ozone NAAQS

PA Regulation Title 25. Environmental Protection, Chapter129 ~~& Chapter 145~~	**RACT Basis Document**	**SIP Revision Approved by EPA**	**RACT Rule Applicability and Requirements**	**Requirements at least as stringent as the 8-hour ozone RACT?**
STATIONARY SOURCES OF NO_x AND VOC Sections129.91-129.95 Control of major sources of NO_x and VOCs	NOx RACT, CAA Section 182(b)(2) and Section 182(f)	**07/20/01, 66 Federal Register 37908**	This section establishes provisions for case-by-case determinations of RACT for major NOx sources. In addition, it establishes requirements for case-by-case RACT determinations for certain major NOx sources and establishes presumptive RACT limitations for certain classes of combustion units: coal-fired combustion units rated equal or greater than 100 MMBtu, combustion units rated equal or greater than 20 MMBtu and less than 50 MMBtu.	Yes. This provision represents current NOx RACT control requirement under the 8-hour ozone NAAQS.
~~INTERSTATE POLLUTION TRANSPORT REDUCTION Subchapter A. Sections 145.1-145.100 NOX Budget Trading Program~~	~~These sections ensure that sources subject to the cap-and-trade program achieve RACT-level reductions because they meet the NOx SIP Call requirements.~~ ~~EPA believes that the SIP provisions for those sources subject to the State's emission cap-and-trade program where the cap-and-trade program has been adopted by the State that meets the NOx SIP Call requirements meet the ozone NOx RACT requirement (70 FR 71652).~~	~~**08/21/01, 66 Federal Register 43795**~~	~~This rule establishes a NOx budget and trading program for large sources of NOx, including electric generating units (EGUs), internal combustion engines, and cement kilns.~~	~~Yes.~~ ~~This provision represents current NOx RACT control requirement under the 8-hour ozone NAAQS.~~

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~~Subchapter B. Sections145.111-145.113 Emissions of NOx From Stationary Internal Combustion Engines~~	~~"RACT is considered met for cement kilns and stationary internal combustion engines that are subject to a SIP approved as meeting the NOX SIP Call obligation to install and operate controls that are expected to achieve at least a 30 percent and 82 percent reduction, respectively, from uncontrolled levels." (70 FR 71653).~~	~~**07/14/06, 71 Federal Register 40048**~~	~~This section establishes presumptive RACT limitations and standard requirements for certain stationary internal combustion engines: stationary internal combustion engine rated equal or greater than 2,400 brake horsepower, diesel stationary internal combustion engine rated equal or greater than 3,000 brake horsepower, and dual-fuel stationary internal combustion engine rated equal or greater than 4,000brake horsepower.~~	~~Yes.~~ ~~This provision represents current NOx RACT control requirement under the 8-hour ozone NAAQS.~~
~~Subchapter C. Sections145.141-145.144 Emissions of NOx From Cement Manufacturing~~	~~"RACT is considered met for cement kilns and stationary internal combustion engines that are subject to a SIP approved as meeting the NOX SIP Call obligation to install and operate controls that are expected to achieve at least a 30 percent and 82 percent reduction, respectively, from uncontrolled levels." (70 FR 71653).~~	~~**07/14/06, 71 Federal Register 40048**~~	~~This section establishes presumptive RACT limitations and standard requirements for certain (Portland) cement kilns..~~	~~Yes.~~ ~~This provision represents current NOx RACT control requirement under the 8-hour ozone NAAQS.~~

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3. NEGATIVE DECLARATION LIST

Philadelphia AMS found no emission sources that require this CTG requirement:

Control of Volatile Organic Emissions from Existing Stationary Sources, Volume VII: Factory Surface Coating of Flat Wood Paneling, EPA-450/2-78-032, June 1978.

Control of Volatile Organic Equipment Leaks from Natural Gas/Gasoline Processing Plants, EPA-450/2-83-007, December 1983.

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4. CONSISTENCY WITH PA DEP's NEGATIVE DECLARATION LIST

Philadelphia has sources that were included in the "**Pennsylvania Department of Environmental Protection Reasonably Available Control Technology (RACT) Proposed State Implementation Plan (SIP) Revision Under The 8-Hour Ozone National Ambient Air Quality Standard (NAAQS)"** Negative Declaration List. ~~These are sources that were evaluated through a Case-by-Case RACT determination.~~

~~In these cases it was reasonable and more cost-effective to establish a federally enforceable permit than promulgate a regulation. Each of these are as stringent as the guidance provided in the associated guidance documents.~~

~~The following list provides the facility name, permit number and associated guidance documents considered in establishing RACT:~~

~~Philadelphia Gas Works, Operating Permit No. V95-042 and Sunoco Philadelphia Refinery, Operating Permit No. V95-038~~
~~Control of Volatile Organic Equipment Leaks from Natural Gas/Gasoline Processing Plants, EPA-450/2-83-007, December 1983~~

~~Aker Philadelphia Shipyard, Operating Permit No. V01-006~~
~~Shipbuilding/Repair ACT (EPA 453/R-94-032, April 1994) and CTG, see 61 FR 44050, August 27, 1996~~

~~Sunoco Chemicals, Operating Permit No. V95-047~~
~~Control of Volatile Organic Compound Emissions from Air Oxidation Processes in Synthetic Organic Chemical Manufacturing Industry, EPA-450/3-84-015, December 1984~~

~~Sunoco Chemicals, Operating Permit No. V95-047~~
~~Control of Volatile Organic Compound Emissions from Reactor Processes and Distillation Operations Processes in the Synthetic Organic Chemical Manufacturing Industry, EPA-450/4-91-031, August 1993~~

On January 26, 2010, AMS sent a negative declaration to EPA regarding the following CTG: Control of Volatile Organic Equipment Leaks from Natural Gas/Gasoline Processing Plants, EPA-450/2-83-007, December 1983. It was determined that Philadelphia Gas Works and Sunoco Philadelphia Refinery (now PES) do not meet the definition of a natural gas processing plant in the CTG.

On April 26, 2010, AMS promulgated a regulation, AMR V: Section XV (Control of VOC from Marine Vessel Coating Operations) and Section XVI (Synthetic Organic Chemical Manufacturing Industry Air Oxidation, Distillation, and Reactor Processes), to address the following CTGs:

- Control of Volatile Organic Compound Emissions from Air Oxidation Processes in Synthetic Organic Chemical Manufacturing Industry, EPA-450/3-84-015, December 1984

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- Control of Volatile Organic Compound Emissions from Reactor Processes and Distillation Operations Processes in the Synthetic Organic Chemical Manufacturing Industry, EPA-450/4-91-031, August 1993
- Shipbuilding/Repair ACT (EPA 453/R-94-032, April 1994) and CTG, see 61 FR 44050, August 27, 1996

On June 3, 2010, AMS sent to PADEP, AMR V: Sections XV and XVI as SIP revision documents for submission to EPA. EPA is currently reviewing the revision.

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5. CASE-BY-CASE EVALUATIONS

On July 10, 2009, the D.C. Circuit Court determined that region-wide RACT-level reduction in emissions do not meet the Federal statutory requirement (section 172(c)(1) of the Clean Air Act) that such reductions be from existing sources in the nonattainment area (*National Resources Defense Council vs. EPA*, 571 F.3d 1245, 1256). As a result, states cannot rely on emissions reductions from cap-and-trade programs, such as the NOx SIP Call or the Clean Air Interstate Rule (CAIR), to demonstrate compliance of emissions sources with the RACT requirements. Accordingly, states must conduct for any air pollution source installed prior to the adoption of the 1997 8-hour ozone standard that was applicable to the NOx SIP Call and did not have to install any controls in the original case-by-case RACT, a new technical analysis to support that previously adopted RACT controls are based on the currently available, technically and economically feasible controls, and that they continue to represent RACT for the 8-hour ozone standard.

Five facilities were affected by the court decision:

1) Exelon – Delaware Station (1325 N. Beach Street, Philadelphia, PA 19125), with three 15.5 MW combustion turbines and one 17.5 MW combustion turbine;
2) Exelon – Richmond Station (3901 N. Delaware Avenue, Philadelphia, PA 19137), with two 66 MW combustion turbines;
3) Exelon – Schuylkill Station (2800 Christian Street, Philadelphia, PA 19146), with one 233 MMBTU/hr combustion turbine, one 284 MMBTU/hr combustion turbine, and one 2.75 MW emergency generator;
4) Veolia – Edison Station (908 Sansom Street, Philadelphia, PA 19107), with two 283 MMBTU/hr boilers and two 335 MMBTU/hr boilers;
5) Veolia – Schuylkill Station (2600 Christian Street, Philadelphia, PA 19146), with one 795 MMBTU/hr boiler and one 761 MMBTU/hr boiler.

For each of the above five facilities, AMS certifies that the RACT controls for the 8-hour ozone NAAQS are the same as the RACT controls approved by EPA under the 1-hour ozone NAAQS.

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CITY OF PHILADELPHIA
Department of Public Health
Environmental Protection Division
Air Management Services

InterOffice Memo

To: File

From: Edward Wiener

Date: March 1, 2012

Subject: 8-Hour RACT Analysis for Exelon Generating Company - Delaware Station

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Introduction:

On July 10, 2009, the D.C. Circuit Court determined that regionwide RACT-level reductions in emissions do not meet the Federal statutory requirement (section 172(c)(1) of the Clean Air Act) that such reductions be from existing sources in the nonattainment area, *National Resources Defense Council vs. EPA*, 571 F.3d 1245, 1256. As a result, states cannot rely on emissions reductions from cap-and-trade programs, such as the NOx SIP Call or the Clean Air Interstate Rule (CAIR), to demonstrate compliance of emissions sources with the RACT requirements. Accordingly, states must conduct for any air pollution source installed prior to the adoption of the 1997 8-hour ozone standard that was applicable to the NOx SIP Call and did not have to install any controls in the original 1-hour case-by-case RACT, a new technical analysis to support that previously adopted RACT controls are based on the currently available, technically and economically feasible controls, and that they continue to represent RACT for the 8-hour ozone standard. This document presents the findings of the reevaluation of NOx RACT for the 8-hour ozone standard for this facility.

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Company Description:

Exelon Generation Company - Delaware Station owns and operates an electric utility at 1325 North Beach Street, Philadelphia, PA, 19125. Equipment currently used at the facility includes four simple cycle combustion turbines. The facility was owned by PECO Energy Company at the time of the original RACT plan approval, but changed to ownership to Exelon in October 2000.

Applicability for NOx and VOC RACT:

Exelon - Delaware Station is a major source of Nitrogen Oxides (NOx) due to having potential NOx emissions greater than 25 tons per year, the major source threshold in Philadelphia County, and is applicable to NOx RACT (see the definition of “major facility” in 25 PA Code Section 121.1). The facility became a minor source of Volatile Organic Compounds (VOC) after taking capacity restrictions on processes as part of its original 1-hour RACT in the RACT Plan Approval (PA Permit Number 51-4901) dated July 11, 2001.

Process Descriptions:

Exelon - Delaware Station currently has four simple cycle combustion turbines, three rated 15.5 MW and one at 17.5 MW. All units burn #2 oil. These are the only NOx emission sources at the facility. The facility had three boilers and an emergency generator that were part of the original 1-hour RACT analysis for the facility, but since have shut down and are not listed in the current Title V operating permit for the facility (No. V11-038). Boilers No. 71 and 81 were shut down in 2004, the auxiliary boiler around 2005, and the emergency generator around 2006.

NOx RACT Analysis for the 8-hour Ozone Standard:

Each combustion turbine accepted a 5% annual capacity factor in the July 11, 2001 RACT plan approval (PA Permit Number 51-4901) and is covered under the presumptive RACT limitations of 25 PA Code Section 129.93(c)(5). Therefore, the only remaining significant NOx sources at the facility (the combustion turbines) are covered by Pennsylvania’s presumptive RACT. No further analysis is needed for 8-hour RACT.

Conclusions and Recommendations:

It is recommended that the 1-hour ozone RACT in the RACT Plan Approval (PA Permit Number 51-4901) dated July 11, 2001 still be considered to represent NOx RACT for the 8-hour ozone standard for the Exelon - Delaware Station.

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CITY OF PHILADELPHIA
Department of Public Health
Environmental Protection Division
Air Management Services

InterOffice Memo

To: File

From: Edward Wiener & Kassahun Sellassie

Date: March 4, 2013

Subject: 8-Hour RACT Analysis for Exelon Generating Company - Richmond Station

Introduction:

On July 10, 2009, the D.C. Circuit Court determined that regionwide RACT-level reductions in emissions do not meet the Federal statutory requirement (section 172(c)(1) of the Clean Air Act) that such reductions be from existing sources in the nonattainment area, *National Resources Defense Council vs. EPA*, 571 F.3d 1245, 1256. As a result, states cannot rely on emissions reductions from cap-and-trade programs, such as the NOx SIP Call or the Clean Air Interstate Rule (CAIR), to demonstrate compliance of emissions sources with the RACT requirements. Accordingly, states must conduct for any air pollution source installed prior to the adoption of the 1997 8-hour ozone standard that was applicable to the NOx SIP Call and did not have to install any controls in the original 1-hour case-by-case RACT, a new technical analysis to support that previously adopted RACT controls are based on the currently available, technically and economically feasible controls, and that they continue to represent RACT for the 8-hour ozone standard. This document presents the findings of the reevaluation of NOx RACT for the 8-hour ozone standard for this facility.

Company Description:

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Exelon Generation Company - Richmond Station owns and operates an electric utility at 3901 North Delaware Avenue, Philadelphia, PA, 19137. Equipment used at the facility includes two (2) simple cycle combustion turbines. The facility was owned by PECO Energy Company at the time of the original RACT plan approval, but changed to ownership to Exelon in October 2000.

Applicability for NOx and VOC RACT:

Exelon - Richmond Station is a major source of Nitrogen Oxides (NOx) due to having potential NOx emissions greater than 25 tons per year, the major source threshold in Philadelphia County, and is applicable to NOx RACT (see the definition of “major facility” in 25 PA Code Section 121.1). The facility became a minor source of Volatile Organic Compounds (VOC) after taking capacity restrictions on processes as part of its original 1-hour RACT in the RACT Plan Approval (PA Permit Number 51-4903) dated July 11, 2001.

Process Descriptions:

Exelon - Richmond Station currently has two simple cycle combustion turbines, each rated 66 MW. Each burns No. 2 oil.

The following were considered possible NOx controls for each combustion turbine: Water/Steam Injection, Selective Catalytic Reduction (SCR), and conversion to natural gas. Conversion to natural gas was determined technologically infeasible because the facility does not have access to natural gas at this time.

SCR injects ammonia upstream of a catalyst. NOx, ammonia (NH3), and oxygen (O2) react on the surface of the catalyst to form nitrogen (N2) and water (H20). NOx emissions are reduced by around 80%. Water/Steam Injection increases thermal mass by dilution which reduces peak temperatures in the flame zone. This reduces NOx emissions by around 60%.

Uncontrolled NOx emissions for each unit was determined based on an 838 MMBTU/hr capacity, 8,760 hours per year, a 0.7 lbs/MMBTU NOx emission limit from the original RACT Plan Approval (PA Permit Number 51-4903)

issued on July, 2001, and a 15% capacity factor limit from the same RACT plan approval. The 15% capacity factor means the unit can operate at 15% of its maximum capacity for the year. The maximum capacity is 838 MMBTU/hr for 8,760 hour per year. Uncontrolled emissions are 385.40 tons per year for each unit.

Source	Control Technologies	Uncontrolled NOx (tpy)	NOx Reduction (%)	NOx Reduction (tpy)	Total Annualized Cost	Cost Effectiveness ($/Ton)
Exelon Richmond	Water/Steam Injection	385.40	60	231.24	$725,492	3,137
	SCR	385.40	80	308.32	$2,913,987	9,451

Both of these technologies are determined economically unreasonable. Please see the Appendix for more details on the calculations.

NOx RACT Analysis for the 8-hour Ozone Standard:

Each combustion turbine was given a rolling 12-month capacity factor limit of less than 15% (based on net generation), a NOx emission limit of less than 0.7 pounds per MMBTU, and a requirement to install, maintain, and operate the unit in accordance with manufacturer's specifications in the original RACT Plan Approval (PA Permit Number 51-4903) issued on July, 2001. Therefore, the only remaining significant NOx sources at the facility (the combustion turbines) are covered by Pennsylvania's presumptive RACT. No further analysis is needed for 8-hour RACT.

Conclusions and Recommendations:

It is recommended that the 1-hour ozone RACT in the RACT Plan Approval (PA Permit Number 51-4903) dated July 11, 2001 still be considered to represent NOx RACT for the 8-hour ozone standard for the Exelon - Richmond Station.

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Appendix

Detail Calculations Summary **Estimating Approach and Basis**

Estimates of Total Capital Investment (TCI), annual costs, Potential emission reductions, and cost effectiveness are prepared for each of the feasible control technology cases above.

- EPA's Air Pollution Control Cost Estimate Manual, January 2002, 6th edition was used The following costs are calculated in order to evaluate the cost effectiveness of each emission control technology:
- Direct Capital Cost (DCC)
- Direct Installation Cost (DIC)
- Total Direct Capital Cost (TDC) = DCC + DIC
- Indirect Installation Cost (IIC)
- Project Contingency (PC) = 15% of (TDC + IIC)
- Preproduction Cost =2% of Total Plant Cost
- Total Capital Investment (TCI) = TDC + TIC
- Direct Annual Cost (DAC) ($/yr)
- NOx Emission Reduction (tons/yr)
- Cost Effectiveness ($/ton)

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Capital Recovery = Convert from P (present) to A(Annual amount), A=P(A/P,i%,n),

$CR = \frac{i(1+i)^n}{(1+i)^n - 1}$ 10% interest and 20 yrs = A/P=0.1175

Where i= Annual interest Rate
n= control system life

References

NESCAUM, EPA' s Office of Air Quality Planning and standards (OAQPS) edition 6, 2002; Cost analysis and engineering economics book (Michael R. Lindeburg) and PADEP Guidelines for RACT analysis.

Reference for Consumer Price Index CPI) is

1. From US Bureau of Labor Statics
2. EPA Cost Manual Appendix A.2.3

The big change is from 2004 through 2007 control equipment increase by 70%
For the Catalyst, The catalyst life is 5 years. The annual cost is given by the sinking fund factor (SFF)
Sinking Fund Factor (SFF) = Convert from F (Future) to A(Annual amount), A=F(A/F,i%,n),

$SFF = \frac{i}{(1+i)^n - 1}$ 8% interest and 3 yrs = A/F=0.1705

Where i= Annual interest Rate (8%)
n= catalyst system life (5 years)

EXELON RICHMOND

Table 1 Detail Calculations for Exelon Richmond Turbines SCR

Exelon Richmond Data			Factors used
Turbine Capacity	2 x 66 MW		15 % Capacity Factor
Total capital Cost			
Total Capital Investment Cost (TCI)	**$17,414,613**		TCI from original RACT proposal plus inflation adjustment. Original TCI includes equipment cost estimates from vendor-supplied estimates for similar units or industry data gathered for similar projects.
Annual Operating Costs			
Direct Annual Cost			
Electricity Cost	$70,080		100kw @ $0.08/kwh, 8760 hrs/yr (PA DEP RACT State Implementation Plan (SIP) revision, Sep, 2006, page 18)
Operator	$16,425		0.5hr/shift, 3 shift/day, $30/hr
Supervisor	$2,463.75		15% of Operator
Maintenance	$19,162.50		0.5hr/shift, 3 shift/day, $35/hr
Material	$19,162.50		100% of Maintenance
Catalyst cost			$190,000 total catalyst
Sinking Fund Factor	0.1705		
Total catalyst Replacement Cost	$32,395		
Total Direct Annual Cost	**$159,689**		
Indirect Annual Cost			
Overhead	$11,497		60% of maintenance-OAQPS
Administrative Charge	$348,292		2% of TCI-OAQPS
Property Taxes	$174,146		1% of TCI-OAQPS
Insurance	$174,146		1% of TCI-OAQPS
Capital Recovery	$2,046,217		20 yrs @10% -OAQPS
Total Indirect Annual Cost	**$2,754,298**		
Total Annual Operating Costs	**$2,913,987**		
NOx Emission Reduction (TPY)	308.32		
Cost Effectiveness ($/ton NOx removed)	$9,451		

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$$CRF = \frac{i(1+i)^n}{\left[(1+i)^n - 1\right]}$$

CFR=0.1175

I= interest rate 10%

n=equipment life = 20

Table 2 Detail Calculations for Exelon Richmond Turbines Water Injection

Exelon Richmond Data			Factors used
Turbine Capacity	2 x 66 MW		15 % Capacity Factor
Total capital Cost			

Total Capital Investment Cost (TCI)	**$3,725,099**		TCI from original RACT proposal plus inflation adjustment. Original TCI includes equipment cost estimates from vendor-supplied estimates for similar units or industry data gathered for similar projects.
Annual Operating Costs			
Direct Annual Cost			
Electricity Cost	$70,080		100kw @ $0.08/kwh, 8760 hrs/yr
Operator	$16,425		0.5hr/shift, 3 shift/day, $30/hr
Supervisor	$2,463.75		15% of Operator
Maintenance	$19,162.50		0.5hr/shift, 3 shift/day, $35/hr
Material	$19,162.50		100% of Maintenance
Total Direct Annual Cost	**$127,294**		
Indirect Annual Cost			
Overhead	$11,497		60% of maintenance-OAQPS
Administrative Charge	$74,501		2% of TCI-OAQPS
Property Taxes	$37,251		1% of TCI-OAQPS
Insurance	$37,251		1% of TCI-OAQPS
Capital Recovery	$437,699		20 yrs @10% -OAQPS
Total Indirect Annual Cost	**$598,198**		
Total Annual Operating Costs	**$725,492**		
NOx Emission Reduction (TPY)	231.24		
Cost Effectiveness ($/ton NOx removed)	$3,137		

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$$CRF = \frac{i(1+i)^n}{\left[(1+i)^n - 1\right]}$$ CFR=0.1175; I= interest rate 10% ; n=equipment life = 20

CITY OF PHILADELPHIA
Department of Public Health
Environmental Protection Division
Air Management Services

InterOffice Memo

To: File

From: Edward Wiener

Date: March 1, 2013

Subject: 8-Hour RACT Analysis for Exelon Generating Company - Schulkill Station

Introduction:

On July 10, 2009, the D.C. Circuit Court determined that regionwide RACT-level reductions in emissions do not meet the Federal statutory requirement (section 172(c)(1) of the Clean Air Act) that such reductions be from existing sources in the nonattainment area, *National Resources Defense Council vs. EPA*, 571 F.3d 1245, 1256. As a result, states cannot rely on emissions reductions from cap-and-trade programs, such as the NOx SIP Call or the Clean Air Interstate Rule (CAIR), to demonstrate compliance of emissions sources with the RACT requirements. Accordingly, states must conduct for any air pollution source installed prior to the adoption of the 1997 8-hour ozone standard that was applicable to the NOx SIP Call and did not have to install any controls in the original 1-hour case-by-case RACT, a new technical analysis to support that previously adopted RACT controls are based on the currently available, technically and economically feasible controls, and that they continue to represent RACT for the 8-hour ozone standard. This document presents the findings of the reevaluation of NOx RACT for the 8-hour ozone standard for this facility.

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Company Description:

Exelon Generation Company - Schuylkill Station owns and operates an electric utility in Philadelphia, Pennsylvania. Equipment used at the facility includes two (2) simple cycle combustion turbines and one (1) emergency generator. The facility was owned by PECO Energy Company at the time of the original RACT plan approval, but changed to ownership to Exelon in October 2000.

Applicability for NOx and VOC RACT:

Exelon - Schuylkill Station is a major source of Nitrogen Oxides (NOx) due to having potential NOx emissions greater than 25 tons per year, the major source threshold in Philadelphia County, and is applicable to NOx RACT (see the definition of “major facility” in 25 PA Code Section 121.1). The facility became a minor source of Volatile Organic Compounds (VOC) after taking capacity restrictions on processes as part of its original 1-hour RACT in the RACT Plan Approval (PA Permit Number 51-4904) dated July 11, 2001.

Process Descriptions:

Exelon - Schuylkill Station currently has two simple cycle combustion turbines and one emergency generator. One combustion turbine is rated 233 MMBTU/hr, one rated 284 MBTU/hr, both burn #2 oil and kerosene. The emergency generator is rated 2.75 MW and burns #2 oil or kerosene.

The facility had one boiler in the original RACT plan approval that was rated 1,530 MMBTU/hr and burned No. 6 oil as the primary fuel and No. 2 oil as the ignition fuel. This boiler was shutdown in 2012 and is expected to be permanently retired.

NOx RACT Analysis for the 8-hour Ozone Standard:

Each combustion turbine accepted a 5% annual capacity factor in the RACT Plan Approval (PA Permit Number 51-4904) dated July 11, 2001 and is covered under the presumptive RACT limitations of 25 PA Code Section 129.93(c)(5). The emergency generator was given an operating limit of less than 500 hours per rolling 12-month

period in the same RACT Plan Approval and is covered under the presumptive RACT requirements of 25 PA Code Section 129.93(c)(5). Therefore, the only remaining significant NOx sources at the facility (the combustion turbines and emergency generator) are covered by Pennsylvania's presumptive RACT. No further analysis is needed for 8-hour RACT.

Conclusions and Recommendations:

It is recommended that the 1-hour ozone RACT in the RACT Plan Approval (PA Permit Number 51-4904) dated July 11, 2001 still be considered to represent NOx RACT for the 8-hour ozone standard for the Exelon - Schuylkill Station.

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CITY OF PHILADELPHIA
Department of Public Health
Environmental Protection Division
Air Management Services

InterOffice Memo

To: File

From: Edward Wiener & Kassahun Sellassie

Date: March 4, 2013

Subject: 8-Hour RACT Analysis for Veolia Energy - Edison Station

Introduction:

On July 10, 2009, the D.C. Circuit Court determined that regionwide RACT-level reductions in emissions do not meet the Federal statutory requirement (section 172(c)(1) of the Clean Air Act) that such reductions be from existing sources in the nonattainment area, *National Resources Defense Council vs. EPA*, 571 F.3d 1245, 1256. As a result, states cannot rely on emissions reductions from cap-and-trade programs, such as the NOx SIP Call or the Clean Air Interstate Rule (CAIR), to demonstrate compliance of emissions sources with the RACT requirements. Accordingly, states must conduct for any air pollution source installed prior to the adoption of the 1997 8-hour ozone standard that was applicable to the NOx SIP Call and did not have to install any controls in the original 1-hour case-by-case RACT, a new technical analysis to support that previously adopted RACT controls are based on the currently available, technically and economically feasible controls, and that they continue to represent RACT for the 8-hour ozone standard. This document presents the findings of the reevaluation of NOx RACT for the 8-hour ozone standard for this facility.

Company Description:

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Veolia Energy Philadelphia - Edison Station owns and operates a steam generating facility at 908 Sansom Street, Philadelphia, PA 19107. Equipment used at the facility includes four (4) boilers. The facility was named Trigen Philadelphia Energy Company at the time of the original RACT plan approval, but adopted the name of its parent company Veolia Energy Philadelphia in December 2000.

Applicability for NOx and VOC RACT:

Veolia – Edison Station is a major source of Nitrogen Oxides (NOx) due to having potential NOx emissions greater than 25 tons per year, the major source threshold in Philadelphia County, and is applicable to NOx RACT (see the definition of "major facility" in 25 PA Code Section 121.1). The facility became a minor source of Volatile Organic Compounds (VOC) after taking fuel restrictions on the boilers in the RACT Plan Approval (PA Permit Number 51-4902) dated December 1, 1999.

Process Descriptions:

Veolia - Edison Station currently has two (2) boilers rated 283 MMBTU/hr (boilers No. 1 and No. 2) and two (2) boilers rated 335 MMBTU/hr (Boilers No. 3 and No. 4). Each boiler is front fired and burns No. 6 oil as the primary fuel and No. 2 oil as the ignition fuel. In the original RACT Plan Approval (PA Permit Number 51-4902) dated December 1, 1999, the boilers were given combined a combined No. 6 oil limit of 65,526,316 gallons per rolling 12-month period and given combined NOx emission limits of 0.50 pounds per MMBTU of heat input and 2,195 tons per rolling 12-month period.

The following were considered possible NOx controls for each boiler: Selective Catalytic Reduction (SCR), Ultra Low-NOx Burners and switch to natural gas (ULNB with NG), Selective Non-Catalytic Reduction (SNCR), Flue Gas Recirculation (FGR), Ultra Low NOx Burners without switching fuel type (ULNB), and Burners Out of Service (BOOS) and other combustion controls.

Burners-out-of-service and other combustion modifications were determined technologically infeasible because they would cause a reduction in boiler capacity, which could cause issues during peak periods. Selective Catalytic

Reduction was determined technologically infeasible for each boiler because of space limitations. Selective Non-Catalytic Reduction was determined to be technologically infeasible for each boiler because the boilers have frequent load changes and periods of low load operation.

ULNB are burners designed to create a larger, lower temperature flame. They reduce NOx emissions by around 30%.

FGR takes some of the exhaust gas from the stack and ducts it to the burner. It lowers peak flame temperatures and lowers the oxygen content of the air, reducing NOx emission by around 40%.

ULNB with NG are ULNB that are accompanied by a switch from oil to natural gas. They reduce NOx emissions by around 62%.

Uncontrolled NOx emissions for each unit were determined based on the rated capacity for each boiler (283 or 335 MMBTU/hr), 8,760 hours per year, a 0.50 lbs/MMBTU NOx emission limit from the original RACT Plan Approval (PA Permit Number 51-4902) dated December 1, 1999, and a 30% capacity limit initially established in Title V/State Operating Permit No. V95-001 issued December 18, 2001. The 30% capacity factor means each boiler can operate at 30% of its maximum capacity for the year. The maximum capacity is 283 or 335 MMBTU/hr (depending on the boiler) for 8,760 hour per year. Uncontrolled emissions are 185.9 tons per year each for Boilers No. 1 and No. 2 and 220.1 tons per year each for Boilers No. 3 and No. 4for each unit.

The following NOx controls were determined technologically feasible for Boilers No. 1 and No. 2. The calculations are for each boiler with each technology (the calculations are identical for each boiler).

Source	Control Technology	Uncontrolled NOx (tpy)	NOx Reduction (%)	NOx Reduction (tpy)	Total Annualized Cost	Cost Effectiveness ($/Ton)
Edison Boilers	ULNB	185.9	30	55.8	$963,957	17,275
	ULNB with NG	185.9	62	115.3	$1,047,758	9,087
	FGR	185.9	40	74.4	$1,106,984	14,879

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The following NOx controls were determined technologically feasible for Boilers No. 3 and No. 4. The calculations are for each boiler with each technology (the calculations are identical for each boiler).

Source	Control Technology	Uncontrolled NOx (tpy)	NOx Reduction (%)	NOx Reduction (tpy)	Total Annualized Cost	Cost Effectiveness ($/Ton)
Edison Boilers	ULNB	220.1	30	66.0	$963,957	14,605
	ULNB with NG	220.1	62	136.5	$1,047,758	7,676
	FGR	220.1	40	88.0	$1,106,984	12,579

Burners-out-of-service and other combustion modifications were determined technologically infeasible because they would cause a reduction in boiler capacity, which could cause issues during peak periods. Selective Catalytic Reduction was determined technologically infeasible for each boiler because of space limitations. Selective Non-Catalytic Reduction was determined to be technologically infeasible for each boiler because the boilers have frequent load changes and periods of low load operation.

These controls were determined economically unreasonable. For more detailed calculations, please see the Appendix.

Conclusions and Recommendations:

It is recommended that the 1-hour ozone RACT in the RACT Plan Approval (PA Permit Number 51-4902) dated December 1, 1999 still be considered to represent NOx RACT for the 8-hour ozone standard for the Veolia - Edison Station.

Appendix

Detail Calculations Summary

The following costs are calculated inorder to evaluate the cost effectiveness of each emission control technology:

- Direct Capital Cost (DCC)
- Direct Installation Cost (DIC)
- Total Direct Capital Cost (TDC) = DCC + DIC
- Indirect Installation Cost (IIC)
- Project Contigency (PC) = 15% of (TDC + IIC)
- Preproduction Cost =2% of Total Plant Cost
- Total Capital Investment (TCI) =
- Direct Annual Cost (DAC) ($/yr)
- NOx Emission Reduction (tons/yr)
- Cost Effectiveness ($/ton)
- Capital Recovery = Convert from P (present) to A(Annual amount), A=P(A/P,i%,n), $CR = \frac{i(1+i)^n}{(1+i)^n - 1}$

  18% interest and 10 yrs = A/P=0.23

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Reference for Consumer Price Index CPI) is

1. From US Bureau of Labor Statics
2. EPA Cost Manual Appendix A.2.3

VEOLIA EDISON

Table 1 Detail Calculations for Veolia-Edison Boilers (Boiler #1,2, 3, & 4) for ULNB

Veolia Edison Data			Factors used
Boilers Capacity	2 x 283 mmbtu/hr 2 x 335 mmbtu/hr		
Total capital Cost			
Direct Capital Cost			
Total Capital Investment Cost (TCI)	**$3,025,835**		TCI from original RACT proposal plus inflation adjustment. Original TCI includes equipment cost estimates from Riley Stoker Corp. and installation cost estimates from JACA Corp.
Annual Operating Costs			
Direct Annual Cost			
Electricity Cost	$52,560		75kw @ $0.08/kwh, 8760 hrs/yr (PA DEP

			RACT State Implementation Plan (SIP) revision, Sep, 2006, page 18)
Operator	$16,425		0.5hr/shift, 3 shift/day, $30/hr
Supervisor	$2,463.75		15% of Operator
Maintenance	$19,162.50		0.5hr/shift, 3 shift/day, $35/hr
Material	$19,162.50		100% of Maintenance
Total Direct Annual Cost	**$ 109,764**		
Indirect Annual Cost			
Overhead	$11,497		60% of maintenance-OAQPS
Administrative Charge	$60,517		2% of TCI-OAQPS
Property Taxes	$30,258		1% of TCI-OAQPS
Insurance	$30,258		1% of TCI-OAQPS
Capital Recovery	$721,662		10 yrs @18% -Original RACT Proposal
Total Indirect Annual Cost	**$854,193**		
Total Annual Operating Costs	**$963,957**		
NOx Emission Reduction (TPY)	**55.8 tpy** **66.0 tpy**		B#1 & 2 = 55.8 B#3 &4 = 66.0 tpy
Cost Effectiveness ($/ton NOx removed)	**$17,275** **$14,605**		

Table 2 Detail Calculations for Exelon Edison Boiler ULNB with NG

Veolia Edison Data			Factors used
Total Capital Investment Cost (TCI)	**$3,326,735**		TCI from original RACT proposal plus inflation adjustment. Original TCI includes equipment cost estimates from Riley Stoker Corp., installation cost estimates from JACA Corp., and gas line estimates from Phila. Gas Works.
Annual Operating Costs			
Direct Annual Cost			
Electricity Cost	$52,560		75kw @ $0.08/kwh, 8760 hrs/yr (PA DEP RACT State Implementation Plan (SIP) revision, Sep, 2006, page 18)
Operator	$16,425		0.5hr/shift, 3 shift/day, $30/hr
Supervisor	$2,463.75		15% of Operator
Maintenance	$19,162.50		0.5hr/shift, 3 shift/day, $35/hr
Material	$19,162.50		100% of Maintenance
Total Direct Annual Cost	**$ 109,764**		
Indirect Annual Cost			
Overhead	$11,497		60% of maintenance-OAQPS
Administrative Charge	$66,535		2% of TCI-OAQPS
Property Taxes	$33,267		1% of TCI-OAQPS
Insurance	$33,267		1% of TCI-OAQPS
Capital Recovery	$793,426		10 yrs @18% -Original RACT Proposal
Total Indirect Annual Cost	**$937,993**		
Total Annual Operating Costs	**$1,047,758**		

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NOx Emission Reduction (TPY)	**115.3 tpy** **136.5 tpy**		B#1 & 2 = 115.3 B#3 &4 = 136.5 tpy
Cost Effectiveness ($/ton NOx removed)	**$9,087** **$7,676**		

Table 3 Detail Calculations for Exelon Edison Boiler FGR

Veolia Edison Data			Factors used
Boilers Capacity	2 x 283 mmbtu/hr 2 x 335 mmbtu/hr		
Total capital Cost			
Total Capital Investment Cost (TCI)	**$3,539,400**		TCI from original RACT proposal plus inflation adjustment. Original TCI includes cost estimates from Riley Stoker Corp. and JACA Corp.
Annual Operating Costs			
Direct Annual Cost			
Electricity Cost	$52,560		75kw @ $0.08/kwh, 8760 hrs/yr (PA DEP RACT State Implementation Plan (SIP) revision, Sep, 2006, page 18)
Operator	$16,425		0.5hr/shift, 3 shift/day, $30/hr
Supervisor	$2,463.75		15% of Operator
Maintenance	$19,162.50		0.5hr/shift, 3 shift/day, $35/hr
Material	$19,162.50		100% of Maintenance
Total Direct Annual Cost	**$ 109,764**		
Indirect Annual Cost			
Overhead	$11,497		60% of maintenance-OAQPS
Administrative Charge	$70,788		2% of TCI-OAQPS
Property Taxes	$35,394		1% of TCI-OAQPS
Insurance	$35,394		1% of TCI-OAQPS
Capital Recovery	$844,147		10 yrs @18% -Original RACT Proposal
Total Indirect Annual Cost	**$997,220**		
Total Annual Operating Costs	**$1,106,984**		
NOx Emission Reduction (TPY)	**74.4 tpy** **88.0 tpy**		B#1 & 2 = 74.4 B#3 &4 = 88.0 tpy
Cost Effectiveness ($/ton NOx removed)	**$14,605** **$12,579**		

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CITY OF PHILADELPHIA
Department of Public Health
Environmental Protection Division
Air Management Services

InterOffice Memo

To: File

From: Edward Wiener & Kassahun Sellassie

Date: March 4, 2013

Subject: 8-Hour RACT Analysis for Veolia Energy – Schuylkill Station

Introduction:

On July 10, 2009, the D.C. Circuit Court determined that regionwide RACT-level reductions in emissions do not meet the Federal statutory requirement (section 172(c)(1) of the Clean Air Act) that such reductions be from existing sources in the nonattainment area, *National Resources Defense Council vs. EPA*, 571 F.3d 1245, 1256. As a result, states cannot rely on emissions reductions from cap-and-trade programs, such as the NOx SIP Call or the Clean Air Interstate Rule (CAIR), to demonstrate compliance of emissions sources with the RACT requirements. Accordingly, states must conduct for any air pollution source installed prior to the adoption of the 1997 8-hour ozone standard that was applicable to the NOx SIP Call and did not have to install any controls in the original 1-hour case-by-case RACT, a new technical analysis to support that previously adopted RACT controls are based on the currently available, technically and economically feasible controls, and that they continue to represent RACT for the 8-hour ozone standard. This document presents the findings of the reevaluation of NOx RACT for the 8-hour ozone standard for this facility.

Company Description:

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Veolia Energy Philadelphia - Schuylkill Station owns and operates a steam generating facility in Philadelphia, Pennsylvania. Equipment used at the facility includes three (3) boilers. The facility was named Trigen Philadelphia Energy Company at the time of the original RACT plan approval, but adopted the name of its parent company Veolia Energy Philadelphia in December 2000.

Applicability for NOx and VOC RACT:

Veolia – Schuylkill Station is a major source of Nitrogen Oxides (NOx) due to having potential NOx emissions greater than 25 tons per year, the major source threshold in Philadelphia County, and is applicable to NOx RACT (see the definition of "major facility" in 25 PA Code Section 121.1). The facility became a minor source of Volatile Organic Compounds (VOC) after taking fuel restrictions on the boilers in the RACT Plan Approval (PA Permit Number 51-4942) dated April 20, 1999.

Process Descriptions:

Veolia - Schuylkill Station currently has two (2) tangential-fired boilers rated 795 MMBTU/hr (Boilers No. 23 and No. 24) and one (1) front wall-fired boiler rated 761 MMBTU/hr (Boiler No. 26). Each boiler burns No. 6 oil as the primary fuel. Boilers No. 23 and No. 24 both burn No. 2 oil as the ignition fuel. In the original RACT plan approval issued April 20, 1999, the boilers were given combined a combined No. 6 oil limit of 65,526,316 gallons per rolling 12-month period and given a combined NOx emission limit of 1,646 tons per rolling 12-month period. Boilers No. 23 and No. 24 were given NOx emission limits of 0.35 pounds per MMBTU. Boiler No. 26 was required to have low NOx burners installed and was given a NOx emission limit of 0.36 pounds per MMBTU on a 30-day rolling average.

Boiler No. 24 is not being re-evaluated since it will be shut down as part of Plan Approval No. 10277 amended February 13, 2013 for a project to install new boilers at Grays Ferry Cogeneration Partnership (originally Boiler No. 23 was scheduled to be retired). The boiler is expected to be shut down this year. The analysis would be the same as Boiler No. 23.

The following were considered possible NOx controls for each boiler: Selective Catalytic Reduction (SCR), Ultra Low-NOx Burners and switch to natural gas (ULNB with NG), Selective Non-Catalytic Reduction (SNCR), Flue Gas Recirculation (FGR), Ultra Low NOx Burners without switching fuel type (ULNB), and Burners Out of Service (BOOS) and other combustion controls.

Burners-out-of-service and other combustion modifications were determined technologically infeasible for both boilers because they would cause a reduction in boiler capacity, which could cause issues during peak periods. Selective Non-Catalytic Reduction was determined to be technologically infeasible for both boilers because the boilers have frequent load changes and periods of low load operation. Flue gas recirculation and Selective Catalytic Reduction and Flue Gas Recirculation were determined technologically infeasible for Boiler No. 23 due to space limitations.

ULNB are burners designed to create a larger, lower temperature flame. They would reduce NOx emissions by around 30% for these boilers.

FGR takes some of the exhaust gas from the stack and ducts it to the burner. It lowers peak flame temperatures and lowers the oxygen content of the air, reducing NOx emission by around 40% for these boilers.

ULNB with NG are ULNB that are accompanied by a switch from oil to natural gas. They reduce NOx emissions by around 57.2% for these boilers.

SCR injects ammonia upstream of a catalyst. NOx, ammonia (NH3), and oxygen (O2) react on the surface of the catalyst to form nitrogen (N2) and water (H20). NOx emissions are reduced by around 80%.

Uncontrolled NOx emissions for Boiler No. 23 was determined based on the rated capacity of 795 MMBTU/hr), 8,760 hours per year, a 0.35 lbs/MMBTU NOx emission limit from the original RACT Plan Approval (PA Permit Number 51-4942) dated April 20, 1999, and a 30% capacity limit initially established in Title V/State Operating Permit No. V95-002 issued July 16, 2001. The 30% capacity factor means the boiler can operate at 30% of its maximum capacity for the year. The maximum capacity is 283 or 335 MMBTU/hr (depending on the boiler) for 8,760 hour per year. Uncontrolled emissions are 365.6 tons per year for Boiler No. 23.

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Uncontrolled NOx emissions for Boiler No. 26 are 1,150.8 tons per year. This is a NOx emission limit established in Plan Approval No. 10277 amended February 13, 2013 for Veolia – Schuylkill and the adjacent Grays Ferry Cogeneration facility (which includes a 1,119 MMBTU/hr Boiler No. 25, a 1,515 MMBTU/hr combustion turbine with a 366 MMBTU/hr heat recovery steam generator (CT/HRSG), and two 297.91 MMBTU/hr boilers to be installed under Plan Approval No. 10277). This limit is lower than the potential uncontrolled emissions for Boiler No. 26 by itself based on its rated capacity, a 0.36 lbs/MMBTU NOx limit from the original RACT plan approval, and 8,760 hours per year (1,199.9 tons/yr).

The following NOx controls were determined technologically feasible for Boilers No. 23 and No. 26.

Source	Control Tec	Uncontrolled NOx (tpy)	NOx Reduction (%)	NOx Reduction (tpy)	Total Annualized Cost	Cost Effectiveness ($/Ton)
Schuylkill Boiler #23	ULNB	365.6	30	109.7	$ 1,031,705	9,405
	ULNB with NG	365.6	57.2	209.1	$1,955,406	9,352
Schuylkill Boiler #26	ULNB	1150.8	12.3	141.6	$636,376	4,496
	ULNB with NG	1150.8	34.4	395.9	$1,535,279	3,878
	FGR	1150.8	40	460.3	$1,339,922	2,911
	SCR	1150.8	80	920.6	$1,899,540	2,075

Burners-out-of-service and other combustion modifications were determined technologically infeasible for both boilers because they would cause a reduction in boiler capacity, which could cause issues during peak periods. Selective Non-Catalytic Reduction was determined to be technologically infeasible for both boilers because the boilers have frequent load changes and periods of low load operation. Flue gas recirculation and Selective Catalytic Reduction and Flue Gas Recirculation were determined technologically infeasible for Boiler No. 23 due to space limitations.

These controls were determined economically unreasonable. Boiler No. 26 calculations were based on potential uncontrolled emissions that assume no other unit operates at the Veolia – Schuylkill or Grays Ferry Cogeneration facilities during the year (Boiler No. 26 uses the entire 1,150.8 tons/yr NOx limit itself), an unrealistically conservative assumption. Historically Boiler No. 23, Boiler No. 25, and the CT/HRSG combine for at least 200 tons of NOx emissions per year, plus there will be two new large boilers. If Boiler No. 26 uncontrolled NOx emissions were assumed 950.8 tons/yr (assuming at least 200 tons/yr for the other units), the cost effectiveness of FGR and SCR would be $3,523 and $2,511 per ton of NOx reduced, respectively. For more detailed calculations, please see the Appendix.

Conclusions and Recommendations:

It is determined that no changes to the original 1-hour RACT plan approval are required for the 8-hour RACT.

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Appendix

Detail Calculations Summary

The following costs are calculated inorder to evaluate the cost effectiveness of each emission control technology:

- Direct Capital Cost (DCC)
- Direct Installation Cost (DIC)
- Total Direct Capital Cost (TDC) = DCC + DIC
- Indirect Installation Cost (IIC)
- Project Contigency (PC) = 15% of (TDC + IIC)
- Preproduction Cost =2% of Total Plant Cost
- Total Capital Investment (TCI) =
- Direct Annual Cost (DAC) ($/yr)
- NOx Emission Reduction (tons/yr)
- Cost Effectiveness ($/ton)
- Capital Recovery = Convert from P (present) to A(Annual amount), A=P(A/P,i%,n), $CR = \frac{i(1+i)^n}{(1+i)^n - 1}$

  18% interest and 10 yrs = A/P=0.23

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Reference for Consumer Price Index CPI) is

1. From US Bureau of Labor Statics
2. EPA Cost Manual Appendix A.2.3

Veolia - Schuylkill Boiler #23

Table 4 Detail Calculations for Veolia - Schuylkill Boiler for ULNB with NG

			Factors used
Veolia - Schuylkill	795 mmbtu/hr		
Total capital Cost			
Total Capital Investment Cost (TCI)	**$6,585,800**		TCI from original RACT proposal plus inflation adjustment. Original TCI includes equipment and installation cost estimates from ABB Power Plan Service Sales and JACA Corp.
Annual Operating Costs			
Direct Annual Cost			
Electricity Cost	$52,560		75kw @ $0.08/kwh, 8760 hrs/yr (PA DEP RACT State Implementation Plan (SIP) revision, Sep, 2006, page 18)
Operator	$16,425		0.5hr/shift, 3 shift/day, $30/hr
Supervisor	$2,463.75		15% of Operator

Maintenance	$19,162.50		0.5hr/shift, 3 shift/day, $35/hr
Material	$19,162.50		100% of Maintenance
Total Direct Annual Cost	**$109,764**		
Indirect Annual Cost			
Overhead	$11,497		60% of maintenance-OAQPS
Administrative Charge	$131,716		2% of TCI-OAQPS
Property Taxes	$65,858		1% of TCI-OAQPS
Insurance	$65,858		1% of TCI-OAQPS
Capital Recovery	$1,570,713		10 yrs @18% -Original RACT Proposal
Total Indirect Annual Cost	**$1,845,642**		
Total Annual Operating Costs	**$1,955,406**		
NOx Emission Reduction (TPY)	**209.1**		
Cost Effectiveness ($/ton NOx removed)	**9,352**		

Table 5 Detail Calculations for Veolia Schuylkill Boiler ULNB

			Factors used
Veolia - Schuylkill	795 mmbtu/hr		
Total capital Cost			
Total Capital Investment Cost (TCI)	**$3,269,100**		TCI from original RACT proposal plus inflation adjustment. Original TCI includes equipment and installation cost estimates from ABB Power Plan Service Sales and JACA Corp.
Annual Operating Costs			
Direct Annual Cost			
Electricity Cost	$52,560		75kw @ $0.08/kwh, 8760 hrs/yr (PA DEP RACT State Implementation Plan (SIP) revision, Sep, 2006, page 18)
Operator	$16,425		0.5hr/shift, 3 shift/day, $30/hr
Supervisor	$2,463.75		15% of Operator
Maintenance	$19,162.50		0.5hr/shift, 3 shift/day, $35/hr
Material	$19,162.50		100% of Maintenance
Total Direct Annual Cost	**$109,764**		
Indirect Annual Cost			
Overhead	$11,497		60% of maintenance-OAQPS
Administrative Charge	$65,382		2% of TCI-OAQPS
Property Taxes	$32,691		1% of TCI-OAQPS
Insurance	$32,691		1% of TCI-OAQPS
Capital Recovery	$779,680		10 yrs @18%-Original RACT Proposal
Total Indirect Annual Cost	**$921,941**		
Total Annual Operating Costs	**$1,031,705**		
NOx Emission Reduction (TPY)	**109.7**		
Cost Effectiveness ($/ton NOx	**9,405**		

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Veolia - Schuylkill Boiler #26

Table 6 Detail Calculations for Veolia - Schuylkill Boiler for SCR

			Factors used
Veolia - Schuylkill	761 mmbtu/hr		
Total capital Cost			
Total Capital Investment Cost (TCI)	**$6,385,200**		TCI from original RACT proposal plus inflation adjustment. Original TCI includes equipment and installation cost estimates from Sierra Environmental Engineering, Inc.
Annual Operating Costs			
Direct Annual Cost			
Electricity Cost	$52,560		75kw @ $0.08/kwh, 8760 hrs/yr (PA DEP RACT State Implementation Plan (SIP) revision, Sep, 2006, page 18)
Operator	$16,425		0.5hr/shift, 3 shift/day, $30/hr
Supervisor	$2,463.75		15% of Operator
Maintenance	$19,162.50		0.5hr/shift, 3 shift/day, $35/hr
Material	$19,162.50		100% of Maintenance
Catalyst cost			$63,300 total catalyst
Sinking Fund Factor	0.1705		
Total catalyst Replacement Cost	$10,793		
Total Direct Annual Cost	**$120,557**		
Indirect Annual Cost			
Overhead	$11,498		60% of maintenance-OAQPS
Administrative Charge	$127,704		2% of TCI-OAQPS
Property Taxes	$63,852		1% of TCI-OAQPS
Insurance	$63,852		1% of TCI-OAQPS
Capital Recovery	$1,522,870		10 yrs @18% -OAQPS
Total Indirect Annual Cost	**$1,789,776**		
Total Annual Operating Costs	**$1,910,333**		
NOx Emission Reduction (TPY)	**920.6**		
Cost Effectiveness ($/ton NOx removed)	**2,075**		

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Table 7 Detail Calculations for Veolia Schuylkill Boiler FGR

			Factors used
Veolia - Schuylkill	761 mmbtu/hr		
Total capital Cost			
Total Capital Investment Cost (TCI)	**$4,375,800**		TCI from original RACT proposal plus inflation adjustment. Original TCI includes equipment and installation cost

			estimates from Riley Stoker Corp.
Annual Operating Costs			
Direct Annual Cost			
Electricity Cost	$52,560		75kw @ $0.08/kwh, 8760 hrs/yr (PA DEP RACT State Implementation Plan (SIP) revision, Sep, 2006, page 18)
Operator	$16,425		0.5hr/shift, 3 shift/day, $30/hr
Supervisor	$2,463.75		15% of Operator
Maintenance	$19,162.50		0.5hr/shift, 3 shift/day, $35/hr
Material	$19,162.50		100% of Maintenance
Total Direct Annual Cost	**$109,764**		
Indirect Annual Cost			
Overhead	$11,498		60% of maintenance-OAQPS
Administrative Charge	$87,516		2% of TCI-OAQPS
Property Taxes	$43,758		1% of TCI-OAQPS
Insurance	$43,758		1% of TCI-OAQPS
Capital Recovery	$1,043,628		10 yrs @18% -Original RACT Proposal
Total Indirect Annual Cost	**$1,230,158**		
Total Annual Operating Costs	**$1,339,922**		
NOx Emission Reduction (TPY)	**460.3**		
Cost Effectiveness ($/ton NOx removed)	**2,911**		

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Table 8 Detail Calculations for Veolia Schuylkill Boiler ULNB with NG

			Factors used
Veolia - Schuylkill	761 mmbtu/hr		
Total Capital Investment Cost (TCI)	**$5,077,264**		TCI from original RACT proposal plus inflation adjustment. Original TCI includes equipment and installation cost estimates from ABB Power Plan Service Sales and JACA Corp.
Annual Operating Costs			
Direct Annual Cost			
Electricity Cost	$52,560		75kw @ $0.08/kwh, 8760 hrs/yr (PA DEP RACT State Implementation Plan (SIP) revision, Sep, 2006, page 18)
Operator	$16,425		0.5hr/shift, 3 shift/day, $30/hr
Supervisor	$2,463.75		15% of Operator
Maintenance	$19,162.50		0.5hr/shift, 3 shift/day, $35/hr
Material	$19,162.50		100% of Maintenance
Total Direct Annual Cost	**$109,764**		
Indirect Annual Cost			
Overhead	$11,498		60% of maintenance-OAQPS
Administrative Charge	$101,545		2% of TCI-OAQPS
Property Taxes	$50,773		1% of TCI-OAQPS

Insurance	$50,773		1% of TCI-OAQPS
Capital Recovery	$1,210,927		10 yrs @18% -Original RACT Proposal
Total Indirect Annual Cost	**$1,425,515**		
Total Annual Operating Costs	**$1,535,279**		
NOx Emission Reduction (TPY)	**395.9**		
Cost Effectiveness ($/ton NOx removed)	**3,878**		

Table 9 Detail Calculations for Veolia Schuylkill Boiler ULNB

			Factors used
Veolia - Schuylkill	761 mmbtu/hr		
Total capital Cost			
Total Capital Investment Cost (TCI)	**$1,849,600**		TCI from original RACT proposal plus inflation adjustment. Original TCI includes equipment and installation cost estimates from ABB Power Plan Service Sales and JACA Corp.
Annual Operating Costs			
Direct Annual Cost			
Electricity Cost	$52,560		75kw @ $0.08/kwh, 8760 hrs/yr (PA DEP RACT State Implementation Plan (SIP) revision, Sep, 2006, page 18)
Operator	$16,425		0.5hr/shift, 3 shift/day, $30/hr
Supervisor	$2,463.75		15% of Operator
Maintenance	$19,162.50		0.5hr/shift, 3 shift/day, $35/hr
Material	$19,162.50		100% of Maintenance
Total Direct Annual Cost	**$109,764**		
Indirect Annual Cost			
Overhead	$11,498		60% of maintenance-OAQPS
Administrative Charge	$36,992		2% of TCI-OAQPS
Property Taxes	$18,496		1% of TCI-OAQPS
Insurance	$18,496		1% of TCI-OAQPS
Capital Recovery	$441,130		10 yrs @18% -Original RACT Proposal
Total Indirect Annual Cost	**$526,612**		
Total Annual Operating Costs	**$636,376**		
NOx Emission Reduction (TPY)	**141.6**		
Cost Effectiveness ($/ton NOx removed)	**4,496**		

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