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

InterOffice Memo

To: File

From: Kassahun Sellassie

Date: May 19, 2015

Subject: 1997 8-Hour RACT Analysis for Veolia-Energy Efficiency (PA) LLC

Introduction:

The Clean Air Act (CAA) requires that moderate (or worse) ozone nonattainment areas implement reasonably available control technology (RACT) controls on all major sources of Volatile Organic Compounds (VOC) and Nitrogen Oxides (NOx). Philadelphia County is part of the Philadelphia-Wilmington-Atlantic City moderate ozone nonattainment area for the 1997 8-hour ozone NAAQS. This document presents the findings of the reevaluation of NOx RACT for the 1997 8-hour ozone standard for this facility

Company Description:

Veolia Energy Efficiency PA (LLC), which owns and operates a steam generating facility at 2600 Christian Street, Philadelphia, PA 19146. The facility has two (2) new 297.91 MMBTU/hr boilers burning natural gas and No.2 fuel oil that were installed in 2013.

Applicability for NOx and VOC RACT:

Veolia –Schuylkill Station, Energy Efficiency is a major source of NOx due to having potential NOx emissions greater than 100 tons per year, the major source threshold in Philadelphia County that is applicable to NOx RACT for the 1997 8-hour ozone NAAQS. Veolia Energy Efficiency is also part owner of the adjacent Grays Ferry Cogeneration Partnership (GFCP) which owns and operates an electric generating unit facility at 2600 Christian Street, Philadelphia, PA 19146. GFCP started operating on July 27, 2000. Equipment used at GFCP includes one (1) front wall fired boiler, and one (1) combined cycle combustion turbine (CT). The RACT for GFCP has been evaluated in separate memo. They are not a major source of VOC, due to having potential VOC emissions not greater than 50 tons per year, the major source threshold in Philadelphia County that is applicable to NOx RACT for the 1997 8-hour ozone. Veolia Energy Efficiency is been evaluated for RACT for the first time.

RACT Evaluation:

The two 297.91 MMBTU/hr boilers burn natural gas and #2 oil. Each boiler is currently equipped with ULNB. Each boiler has the following NOx emission limits, Plan Approval No. 10277A, dated on Feb13, 2013, each on a rolling 30-day average: 0.01 lbs/MMBTU while burning gas and 0.08 lbs/MMBTU while burning oil. The boilers have a combined NOx emission limit of 52.31 tons per rolling 12-month period, also from Plan Approval No. 10277A.

The following were considered possible additional NOx controls as RACT for the boilers: (1) Selective Catalytic Reduction (SCR), (2) Ultra Low-NOx Burners (ULNB) and Overfire Air (ULNB with OFA), (3) Selective Non-Catalytic Reduction (SNCR), and (4) Low NOx Burners (LNB).

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% for Boilers #1 and #2.

ULNB with OFA reduce NOx emissions by around 70% for Boilers #1 and #2

SNCR reduce NOx emissions by around 55% for Boilers #1 and #2

LNB are burners designed to create a larger, lower temperature flame. They would reduce NOx emissions by around 50% for Boilers #1 and #2.

The NOx emissions for Boilers #1 and #2 were determined based on the rated capacity of 297.91 MMBTU/hr, 8,760 hours per year, and a 0.0.08 lbs/MMBTU NOx emission limit. The NOx emissions are 104.4 tons per year for Boilers #1 and #2

The following NOx controls were determined technologically feasible for Boilers #1 and #2.

Source	Control Tec	Baseline NOx Emissions (tpy)	NOx Reduction (%)	NOx Reduction (tpy)	Total Annualized Cost ($)	Cost Effectiveness ($/Ton)
Boiler # 1and #2 (each)	SCR	104.4	80	83.52	710,448	8,506
	OFA	104.4	45	46.98	196,775	4,188
	SNCR	104.4	55	57.42	539,579	9,397
	LNB	104.4	50	52.2	210,359	4,031

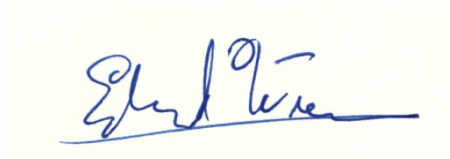
All of these control options have been determined economically unreasonable.

Because ULNB is currently installed on each boiler, it has been determined to be both technically and economically feasible for controlling NOx emissions of Boilers #1 and #2.

ULNB has been determined RACT for each boiler. The plan approval NOx emission limits of 0.01 lbs/MMBTU on a rolling 30-day average while burning gas and 0.08 lbs/MMBTU on a rolling 30-day average while burning oil have been determined RACT. The separate startup and shutdown emission limits are not on a rolling 30-day average, do not affect the rolling 30-day emission limits, and are not being carried into RACT.

Conclusions and Recommendations:

- AMS has determined that the existing controls for Boilers #1 and #2 (ULNB) is NOx RACT for the 1997 8-hour ozone standard for Veolia Energy Efficiency LLC. The emission limitations for Boilers #1 and #2 is 0.08 lbs of NOx/MMBTU on a rolling 30-day average when firing oil and 0.01 lb of NOx/MMBTU on a rolling 30-day average when firing gas. The facility shall monitor and record compliance based on NOx CEMs for Boilers #1 & #2.



5/19/15

Edward Wiener, Chief of Source Registration **Date**

RACT Calculations for Veolia-Energy Efficiency LLC- Boilers #1 and #2

Table 1- Detailed Calculations for SCR on Boilers #1 and #2

SCR, 297.91 MMBTU/hr Each			**Total capital Cost**
Total Capital Investment Cost (TCI)	$2,650,722		Based EPA Cost Control Manual of $6000/MMBTU/Hr. Escalate 1997 $ using the Marshall and swift Index (page 2-3)
Capital Recovery	$423,585	0.1598	20 yrs @15% CRF=0.1598[1]
Annual Operating Costs			
Direct Annual Cost[1]			
Electricity Cost[2]	$70,080		100kw @ $0.08/kwh, 8760 hrs/yr
Operator[1]	$16,425		0.5hr/shift, 3 shift/day, $30/hr
Supervisor[1]	$2,463.75		15% of Operator
Maintenance[1]	$19,162.50		0.5hr/shift, 3 shift/day, $35/hr
Material[1]	$19,162.50		100% of Maintenance
Ammonia	$39,476		Ammonia Cost=(17/30)*2/2moles*1.05*104.4*410*1.55
Annual Catalyst Replacement Cost[1]	$11,466		Catalyst Cost[1]= $70,000 Sinking Fund Factor = 0.1638 for 10% and 5 years
Total Direct Annual Cost	$169,337		
Indirect Annual Cost			
Overhead	$11,498		60% of maintenance-OAQPS[1]
Administrative Charge[3]	$53,014		2% of TCI-OAQPS[1]
Property Taxes[3]	$26,507		1% of TCI-OAQPS[1]
Insurance[3]	$26,507		1% of TCI-OAQPS[1]
Total Indirect Annual Cost	$117,526		
Total Annual Operating Costs	$710,448		
NOx Baseline Emissions (TPY)	104.4		Based on the rated capacity of 297.91MMBTU/hr, 8,760 hours per year, and a 0.08 lbs/MMBTU NOx emission

			limit.
NOx Emission Reduction (TPY)	83.52		Based on 80 % of NOx removed
Cost Effectiveness ($/ton NOx removed)	$8,506		

Table 2- Detailed Calculations for OFA on Boilers #1 and #2

Total Capital Investment Cost (TCI)	**$290,108**		TCI from original BART proposal from Veolia plus inflation adjustment .
Capital Recovery	$46,359	0.1598	20 yrs @15% CRF=0.1598[1]
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
Total Direct Annual Cost	$127,294		
Indirect Annual Cost			
Overhead	$11,498		60% of maintenance-OAQPS[1]
Administrative Charge	$5,802		2% of TCI-OAQPS[1]
Property Taxes	$2,901		1% of TCI-OAQPS[1]
Insurance	$2,901		1% of TCI-OAQPS[1]
Total Indirect Annual Cost	$23,102		
Total Annual Operating Costs	$196,775		
NOx Emission Reduction (TPY)	46.98		
Cost Effectiveness ($/ton NOx removed)	$4,188		

Table 3 Detailed Calculations for SNCR on Boilers #1 and #2

SNCR 297.91 each MMBTU/hr each			**Total capital Cost**
Direct Capital Cost	$1,558,993		Based EPA Cost Control Manual (($950/mmmbtu/hr)*Qb(MMBTU/hr)*(2375 MMBTU/hr/Qb)^0.557*(0.66 + 0.85 uNOx). Qb= bolier size (mmbtu/hr); n = NOx removal efficiency (page 1-31)
Indirect Capital Cost	311,799		Based on EPA Cost Manual page 2-6
Total Capital Investment Cost (TCI)	$1,870,792		
Capital Recovery (annual cost)	$298,953	0.1598	20 yrs @15% CRF=0.1598[1]
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
Ammonia	$39,476		Ammonia Cost=(17/30)*2/2moles*1.05*104.4*410*1.55
Total Direct Annual Cost	$166,769		
Indirect Annual Cost			
Overhead	$11,498		60% of maintenance-OAQPS[1]
Administrative Charge	$31,180		2% of TCI-OAQPS[1]
Property Taxes	$15,590		1% of TCI-OAQPS[1]
Insurance	$15,590		1% of TCI-OAQPS[1]
Total Indirect Annual Cost	$73,857		
Total Annual Operating Costs	$539,579		
NOx Emission Reduction (TPY)	57.42		
Cost Effectiveness ($/ton NOx removed)	$9,397		

Table 4 Detailed Calculations for LNB on Boilers #1 and #2

Total Capital Investment Cost (TCI)	$358,370		TCI from original BART proposal from Veolia plus inflation adjustment.
Capital Recovery	$57,268	0.1598	20 yrs @15% CRF=0.1598[1]
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
Total Direct Annual Cost	$127,294		
Indirect Annual Cost			
Overhead	$11,498		60% of maintenance-OAQPS[1]
Administrative Charge	$7,167		2% of TCI-OAQPS[1]
Property Taxes	$3,584		1% of TCI-OAQPS[1]
Insurance	$3,584		1% of TCI-OAQPS[1]
Total Indirect Annual Cost	$25,832		
Total Annual Operating Costs	$210,359		
NOx Emission Reduction (TPY)	52.2		
Cost Effectiveness ($/ton NOx removed)	$4,031		

References

1. Office of Air Quality Planning and standards (OAQPS), Environmental Protection Agency (EPA) Air Pollution Control Manual, Sixth Edition, EPA/452/B-02-001, January 2002.
2. Electricity cost: EPA cost manual, Appendix A-NOx Control Analysis
3. Capital Recovery = Convert from P (present) to A(Annual amount), A=P(A/P,i%,n),

   $CR = \frac{i(1+i)^n}{(1+i)^n - 1}$ 15% interest and 20 yrs = A/P=0.1598; Annual Cost =TCI * CFR
4. Catalyst Cost of SCR: The catalyst life is 5 years. The annual cost is given by the sinking fund factor (SFF). The SFF is the amount of money the facility will need to set aside each year to be able to replace the catalyst at the end of its life, based on the lifespan of the catalyst and the interest rate.

5. SFF = Convert from F (Future) to A(Annual amount), A=F(A/F,i%,n),

   $SFF = \frac{i}{(1+i)^n - 1}$ 10% interest and 5 yrs = A/F=0.1638

   Where i= Annual interest Rate (10%); n= catalyst system life (5 years);

   Catalyst Annual Cost = SFF x Catalyst Cost

6. Ammonia Cost:
   $2NH_3 + 2NO + 1/2O_2 \longrightarrow 2N_2 + 3H_2O$

   Annual Ammonia Cost = (17/30 * 2moles of NH_3/2 moles of NO *1.05 * NOx emission (tpy) *$410/ton yrs x 1.55)

   NH_3 = Ammonia, NO = Nitric Oxide; O_2 = Oxygen; H_2O = Water; 1.05= Ammonia slip and excess ammonia, 55% cost increament)