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

InterOffice Memo

To: File

From: Edward Wiener & Kassahun Sellassie

Date: May 20, 2015

Subject: 1997 8-Hour RACT Analysis for Veolia Energy – Schuylkill Station.

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 Philadelphia - Schuylkill Station (Veolia – Schuylkill) owns and operates a steam generating facility in 2600 Christian Street, Philadelphia, PA 19146. Equipment used at the facility includes three (3) boilers. The facility was named Trigen Philadelphia Energy Company, but adopted the name of its parent company Veolia Energy Philadelphia in December 2000.

Applicability for NOx and VOC RACT:

In addition to owning Veolia – Schuylkill, Veolia is part owner of the Veolia Energy Efficiency PA (LLC), a steam generating facility, and Grays Ferry Cogeneration Partnership (GFCP), an electric generating facility, all facilities adjacently located at 2600 Christian Street, Philadelphia, PA 19146. The three facilities have been determined a single source since Plan Approval Application No. 10277 was submitted for the new Veolia Energy Efficiency boilers on October 25, 2010. The three facilities as a single source are major for 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. The three facilities as a single source are not major for 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 Schuylkill is subject to 1-hour ozone RACT, as approved into the SIP by EPA on December 15, 2000 (65 FR 78418), and is being evaluated for 1997 8-hour ozone RACT as documented in this memo. RACT determinations for GFCP and Veolia Energy Efficiency have been provided in separate memos.

Process Descriptions:

Veolia - Schuylkill Station currently has two (2) tangential-fired boilers rated 795 MMBTU/hr (CU02 and CU01-Boilers No. 23 and No. 24) and one (1) front wall-fired boiler rated 761 MMBTU/hr (CU05-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.

These boilers do not operate at maximum capacity for 365 days per year. The boilers at Schuylkill Station operate seasonally and predominately supply district steam heat as such the boilers operate at peak capacity in the non-ozone season and operate minimally or not at all during ozone season**.** See emissions inventories in Appendix.

NOx RACT Evaluation:

Veolia Schuylkill's three boilers, Boiler #23, #24, and 26, are subject to 1-hour RACT. As a result of AMS case-by-case-RACT determination, the facility is subject to a RACT Plan Approval (PA Permit Number 51-04942) issued on December 1, 1999 and approved into the SIP by EPA on December 15, 2000 (65 FR 78418).
In the 1-hour RACT Plan Approval, the boilers were given a combined No. 6 oil limit of 65,526,316 gallons per rolling 12-month period and a combined NOx emissions limit of 1,646 tons in any rolling 12-month period. Also, Boilers No. 23 and No. 24 each were given NOx emission limits of 0.35 pounds per MMBTU. Boiler No. 26 was required to have low NOx burners (LNB) installed and was given a NOx emission limit of 0.36 pounds per MMBTU on a 30-day rolling average.

Boiler No. 24 was shut down in January 2014 as part of Plan Approval No. 10277 and thus is not being re-evaluated for RACT.

The following were considered possible NOx controls for Boilers #23 and #26: (1) Selective Catalytic Reduction (SCR), (2) Ultra Low-NOx Burners and switch to natural gas (ULNB with NG), (3) Selective Non-Catalytic Reduction (SNCR), (4) Flue Gas Recirculation (FGR), (5) Low NOx Burner (LNB) without switching fuel type, (6) Ultra Low NOx Burners (ULNB), and (7) Burners Out of Service (BOOS) and other combustion modifications.

The following were determined technologically infeasible for all boilers: 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.

ULNB are burners designed to create a larger, lower temperature flame. They would reduce NOx emissions by around 30% for Boiler #23 and around 12.3% for Boiler #26 (the reduction for Boiler #26 is lower because it was modified with Low-NOx Burners as a result of the 1 hr case-by-case RACT).

LNB are burners designed to create a larger, lower temperature flame. They would reduce NOx emissions by around 20% for Boiler #23. Boiler #26 was modified with Low-NOx Burners as a result of the 1 hr case-by-case RACT.

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. FGR is determined technologically infeasible for Boiler No. 23 due to space limitations. NOx emissions from Boiler No. 26 are expected to be reduced by around 40 % with this technology.

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 Boiler #23 and around 34.4% for Boiler #26 (the reduction is greater than ULNB alone due to the switch from oil to lower emitting natural gas, Boiler #26 has a lower reduction because it has Low-NOx Burners from the 1 hr case-by-case RACT).

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%. SCR is determined technologically infeasible for Boiler No. 23 due to space limitations.

Boiler No. 23 has a NOx emission limit of 0.35 lbs/MMBTU from the 1-hour RACT determination. This limit is being reduced to 0.34 lb/MMBTU, based on stack test data. ,
Additionally, under the facility's Title V/State Operating Permit No. V11-014 issued May 24, 2012 (Section D. 2 (b)(3)), the boiler is restricted to operate up to 30% of its hourly heat input capacity on an annual basis. This heat input limit is Federally enforceable and thus considered in this RACT analysis.

The following NOx controls were determined technologically feasible for Boilers No. 23 and No. 26. A summary of cost effectiveness is provided below. The RACT baseline NOx emissions for Boiler No. 23 are 355.15 tons per year based on the applicable capacity factor of 30% and revised NOx emissions rate[795 mmbtu/hr *8760 hr/yr * 0.34 lb/mmbtu *0.3= 355.15 tons per year]. The RACT baseline emissions for Boiler No. 26 are 1199.9 tons per year and was determined based on the rated capacity of 761 MMBTU/hr, 8,760 hours per year, and the 0.36 lbs/MMBTU NOx emission limit from the 1-hour RACT determination.

For more detailed calculations, please see the Appendix.

Source	Control Technology	Baseline NOx Emissions (tons per year)	NOx Reduction (%)	NOx Reduction (tpy)	Total Annualized Cost ($/year)	Cost Effectiveness ($/Ton)
Schuylkill Boiler #23	ULNB	355.15	30	106.54	1,049,236	9,848
	LNB	355.15	20	71.03	986,193	13,884
	ULNB with NG	315.15	57.2	203.14	1,972,937	9,712
Schuylkill Boiler #26	ULNB	1199.9	12.3	147.59	653,905	4,431
	ULNB with NG	1199.9	34.4	412.77	1,552,809	3,762
	FGR	1199.9	40	479.96	1,357,452	2,828
	SCR	1199.9	80	959.92	3,342,088	3,482

All of these control options have been determined economically unreasonable. Additionally, these boilers seldom operate during the ozone season, as noted in the Appendix. Actual NOx emissions for each boiler are a fraction of the potential emissions listed above.

Although no additional RACT controls are reasonable for Boiler #23, the existing 30% capacity factor limit is more stringent than the current SIP-approved RACT limit on an annual basis. Thus, to further reduce NOx emissions AMS is proposing to incorporate as RACT 355.15 tons per 12-month rolling NOx emissions limit based on the 30% capacity factor for Boilers # 23. Additionally, after evaluating public comments, the boiler is being given an additional 270.30 lbs/hr limit, which corresponds to the lbs/MMBTU limit and capacity.

Currently allowed RACT emissions for Boiler #23: 1,183.8 tons per rolling of 12 months
Proposed allowed RACT emissions for Boiler #23: 355.15 tons per rolling of 12 months

AMS finds that the existing RACT limits for Boiler No. 26 continue to represent RACT. After evaluating public comments, Boiler No 26 is being given additional 0.41 lbs/MMBTU and 312.01 lbs/hr limits, both on an hourly basis, so there are additional shorter-term limits. AMS determined the boiler could achieve these shorter term limits under existing technology based on CEM data.

By taking the heat input restriction on Boiler #23, the total potential emissions from Boilers #23 and #26 (1,555.1 tons per year) are less than the 1-hour RACT combined emissions limit of 1,646 tons in any rolling 12-month period. AMS is proposing to remove the 1,646 tons per year limit.

With the removal of Boiler #24 and the 30% capacity factor restriction on Boiler #23, the combined potential #6 oil usage for Boilers #23 and #26 is 58,370,800 gallons per rolling 12-month period (based on the rated capacities, 8,760 hrs/yr, 0.15 MMBTU/gal of No. 6 oil, and a 30% capacity factor for Boiler #23). Since this is lower than the existing combined No. 6 oil limit of 65,526,316 gallons per rolling 12-month period, the existing limit is being removed.

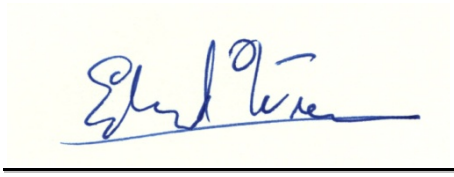
Conclusions and Recommendations:

AMS is determining the 365.6 tons of NOx per rolling 12-month period emission limit for Boiler #23 as an additional RACT requirement. AMS requests this limit to be approved into the SIP. Also, AMS requests to remove the combined NOx emissions limit and the combined No. 6 oil usage limit for Boilers 23 and 26. AMS recommends that these updates to the NOx RACT requirements currently approved in the SIP for the 1-hour ozone standard represent NOx RACT for the 1997 8-hour ozone standard for Veolia Schuylkill.

The following requirements are recommended as RACT:

- Boiler No. 23 NOx emission shall not exceed 0.34 pounds per MMBTU and 355.15 tons of NOx per rolling 12-month period.
- Boiler No. 26 is required to have low NOx burners (LNB). Its NOx emissions shall not exceed 0.36 pounds per MMBTU on a 30-day rolling average. Boiler No 26 was given the additional NOx limits of 0.41 lbs/MMBTU on an hourly basis and 312.01 lbs/hr on an hourly basis.
- Compliance shall be monitored and recorded based on annual NOx stack tests for each boiler and NOx CEMS for Boiler #26.

- Compliance shall be monitored and recorded based on annual NOx stack tests for each boiler and NOx CEMS for Boiler#26. The facility shall monitor and record compliance with them based on daily hours of operation, fuel type, fuel usage, fuel sulfur content for each boiler, and NOX CEMs for boiler #26 and annual stack test for Boiler #23 compliance with them based on fuel usage and the annual NOx stack tests



5/20/15

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

Appendix

Ozone Season Emission Inventory for Veolia Schuylkill Boiler #26 & Boiler 23 combined that indicated that during ozone season the emissions are zero (0) and yearly emissions combined two boilers #23 & #26 is 5.36 tpy in April, 2013. Based on emission data, the boiler #26 which has LNB doesn't need to install SCR or other control device.

Year of Inventory	Month of Inventory	NOx Emissions (tons)
2011	April	17.85
2011	May	0.00
2011	June	0.10
2011	July	0.00
2011	August	0.00
2011	September	0.35
2011	October	12.24
2012	April	9.32
2012	May	0.00
2012	June	0.00
2012	July	0.39
2012	August	0.00
2012	September	1.09
2012	October	0.05
2013	April	5.36
2013	May	0.00
2013	June	0.05
2013	July	0.00
2013	August	0.00
2013	September	0.00
2013	October	0.00

Detailed Calculations Summary

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

- Total Capital Investment (TCI)
- NOx Emission Reduction (tons/yr)
- Cost Effectiveness ($/ton)
- **Capital Recovery** = Convert from P (present) to A(Annual amount), A=P(A/P,i%,n),

$$CR = \frac{i(1+i)^n}{(1+i)^n - 1}$$ 20% interest and 10 yrs = A/P=0.2385; Annual Cost = TCI x CRF

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

$$SFF = \frac{i}{(1+i)^n - 1}$$ 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

Ammonia Cost

$2NH_3 + 2NO + 1/2O_2 \longrightarrow 2N_2 + 3H_2O$

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

NH_3 = Ammonia, NO = Nitric Oxide; O_2 = Oxygen; H_2O = Water; 1.05= Ammonia slip and excess ammonia

Veolia - Schuylkill Boiler #23

Table 1 Detail Calculations for Veolia - Schuylkill Boiler for ULNB with NG

Veolia SCH Boiler # 23			Factors used CF=30% Summer time no NOx emission or very low NOx <1 tpy
Boiler Capacity 795 MMBTU/hr			
Total capital Cost			
Total Capital Investment Cost (TCI)	$6,585,800		TCI from 1 hour RACT Proposal plus inflation adjustment. Original TCI includes equipment and installation cost estimates from ABB Power Plan Service Sales and JACA Corp[4].
Capital Recovery	$1,570,713	0.2385	10 yrs @20% from 1 hr RACT; A/P=0.2385
Annual Operating Costs			
Direct Annual Cost			
Electricity Cost[2]	$70,080		100kw @ $0.08/kwh, 8760 hrs/yr
Operator[3]	$16,425		0.5hr/shift, 3 shift/day, $30/hr
Supervisor[3]	$2,463.75		15% of Operator
Maintenance[3]	$19,162.50		0.5hr/shift, 3 shift/day, $35/hr
Material[3]	$19,162.50		100% of Maintenance
Total Direct Annual Cost	$127,294		
Indirect Annual Cost			
Overhead[3]	$11,498		60% of maintenance-OAQPS[1]
Administrative Charge	$131,716		2% of TCI-OAQPS[1]
Property Taxes[3]	$65,858		1% of TCI-OAQPS[1]
Insurance[3]	$65,858		1% of TCI-OAQPS[1]
Total Indirect Annual Cost	$274,930		
Total Annual Operating Costs	$1,972,937		
NOx Baseline Emissions (TPY)	355.15		Based on 795 mmbtu/hr, 8760 hr/yr , 0.34 lb/mmbtu RACT limit, and 0.3 capacity factor
NOx Emission Reduction (TPY)	203.14		Based on 57.2 % of NOx removed.

Cost Effectiveness ($/ton NOx removed)	$9,712		

Table 2 Detail Calculations for Veolia Schuylkill Boiler ULNB

Veolia SCH Boiler # 23			Factors used CF=30% Summer time no NOx emission or very low NOx <1 tpy
Boiler Capacity 795 mmbtu/hr			
Total capital Cost			
Total Capital Investment Cost (TCI)	$3,269,100		TCI from 1 hr RACT proposal plus inflation adjustment. Original TCI includes equipment and installation cost estimates from ABB Power Plan Service Sales and JACA Corp.
Capital Recovery	$779,680	0.2385	10 yrs @20% -from 1-hr RACT ; A/P=0.2385
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	$11,498		60% of maintenance-OAQPS
Administrative Charge	$65,382		2% of TCI-OAQPS[1]
Property Taxes	$32,691		1% of TCI-OAQPS[1]
Insurance	$32,691		1% of TCI-OAQPS[1]
Total Indirect Annual Cost	$142,262		
Total Annual Operating Costs	$1,049,236		
NOx Baseline Emissions (TPY)	355.15		Based on 795 mmbtu/hr, 8760 hr/yr , 0.34 lb/mmbtu RACT limit, and 0.3 capacity factor
NOx Emission Reduction (TPY)	106.54		Based on 30 % of NOx removed.
Cost Effectiveness ($/ton NOx removed)	$9,848		

Table 3 Detail Calculations for Veolia Schuylkill Boiler LNB

Veolia SCH Boiler # 23			Factors used CF=30% Summer time no NOx emission or very low NOx <1 tpy
Boiler #23 Capacity 795 MMBTU/hr			
Total capital Cost			
			LNB is 2-5% less in TCI than ULNB EPA 454/R-94-0022; NOx Control report, Northeast States for Coordinated Air Use Management, Dec 2000(NESCAUM)
Total Capital Investment Cost (TCI)	$3,105,645		TCI from 1-hr 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.
Capital Recovery	$740,696	0.2385	10 yrs @20% -from 1 hr RACT
Annual Operating Costs			
Direct Annual Cost			
Electricity Cost	$52,560		75kw @ $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	$109,774		
Indirect Annual Cost			
Overhead	$11,498		60% of maintenance-OAQPS[1]
Administrative Charge	$62,113		2% of TCI-OAQPS[1]
Property Taxes	$31,056		1% of TCI-OAQPS[1]
Insurance	$31,056		1% of TCI-OAQPS[1]
Total Indirect Annual Cost	$135,723		
Total Annual Operating Costs	$986,193		
NOx Baseline Emissions (TPY)	355.15		Based on 795 mmbtu/hr, 8760 hr/yr , 0.34 lb/mmbtu RACT limit, and 0.3 capacity factor
NOx Emission Reduction (TPY)	71.03		Based on 20 % of NOx removed.
Cost Effectiveness ($/ton NOx removed)	$13,884		

Veolia - Schuylkill Boiler #26

Table 4 Detail Calculations for Veolia - Schuylkill Boiler for SCR

Grays ferry			Factors used
761 MMBTU/hr			
Total capital Cost			
Total Capital Investment Cost (TCI)	**$6,385,200**		Based EPA Cost Control Manual of $6000/MMBTU/Hr. Escalate 1997 $ using the Marshall and swift Index.
Capital Recovery	**$1,020,355**	0.1598	20 yrs @15% -from 1-hr RACT
Annual Operating Costs			
Direct Annual Cost			
Electricity Cost[2]	$70,080		100kw @ $0.08/kwh, 8760 hrs/yr (PA DEP RACT State Implementation Plan (SIP) revision, Sep, 2006, page 18)
Maintenance[3]	$95,778.00		1.5%x TCI
Catalyst cost[3]	$190,000	0.1638	$190,000 total catalyst from litrature and vendors
Sinking Fund Factor			year 5, interest10%= A/F=0.1638
Total catalyst Replacement Cost[3]	$31,122		
Ammonia cost [3]	$453,709		(17/30 * 1.05 * 2 mole NH3/2 mole NO *NOx emission (1199.9tpy) *$410/ton*5yr*1.55
Total Direct Annual Cost	**$650,689**		
Indirect Annual Cost[3]	$1,020,355		Capital Recovery
Total Annual Cost	**$1,671,044**		
Total Annual Operating Costs	**$3,342,088**		
NOx Emission Reduction (TPY)	959.92		
Cost Effectiveness ($/ton NOx removed)	**$3,482**		

Table 5 Detail Calculations for Veolia Schuylkill Boiler FGR

Veolia SCH Boiler # 26			No Factors used but Summer time no NOx emission or very low NOx <1 tpy
Boiler Capacity 761 MMBTU/hr			
Total capital Cost			
Total Capital Investment Cost (TCI)	$4,375,800		TCI from 1 hr RACT proposal plus inflation adjustment. Original TCI includes equipment and installation cost estimates from Sierra Environmental Engineering, Inc.
Capital Recovery	$1,043,628	0.2385	10 yrs @20% -from 1-hr RACT; ; A/P=0.2385
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	$11,498		60% of maintenance-OAQPS[1]
Administrative Charge	$87,516		2% of TCI-OAQPS[1]
Property Taxes	$43,758		1% of TCI-OAQPS[1]
Insurance	$43,758		1% of TCI-OAQPS[1]
Total Indirect Annual Cost	$186,530		
Total Annual Operating Costs	$1,357,452		761 mmbtu/hr *8760 hr/yr * 0.36 lb/mmbtu
NOx Baseline Emissions (TPY)	1199.9		Based on 761 mmbtu/hr, 8760 hr/yr, and 0.36 lb/mmbtu RACT limit
NOx Emission Reduction (TPY)	479.96		Based on 40 % of NOx removed.
Cost Effectiveness ($/ton NOx removed)	2,828		

Table 6 Detail Calculations for Veolia Schuylkill Boiler ULNB with NG

Veolia SCH Boiler # 26			No Factors used but Summer time no NOx emission or very low NOx <1 tpy
Boiler Capacity 761 MMBTU/hr			
Total capital Cost			
Total Capital Investment Cost (TCI)	$5,077,264		TCI from 1 hr RACT proposal plus inflation adjustment. Original TCI includes equipment and installation cost estimates from Sierra Environmental Engineering, Inc.; A/P=0.2385
Capital Recovery	$1,210,927	0.2385	10 yrs @20% -from 1-hr RACT
Annual Operating Costs			
Direct Annual Cost			
Electricity Cost	$70,080		75kw @ $0.08/kwh, 8760 hrs/
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	$101,545		2% of TCI-OAQPS[1]
Property Taxes	$50,773		1% of TCI-OAQPS[1]
Insurance	$50,773		1% of TCI-OAQPS[1]
Total Indirect Annual Cost	$214,588		
Total Annual Operating Costs	$1,552,809		
NOx Baseline Emissions (TPY)	1199.9		Based on 761 mmbtu/hr, 8760 hr/yr, and 0.36 lb/mmbtu RACT limit
NOx Emission Reduction (TPY)	412.77		Based on 34.4 % of NOx removed.
Cost Effectiveness ($/ton NOx removed)	$3,762		

Table 7 Detail Calculations for Veolia Schuylkill Boiler ULNB

Veolia SCH Boiler # 26			No Factors used but Summer time no NOx emission or very low NOx <1 tpy
Boiler Capacity 761 MMBTU/hr			
Total capital Cost			
Total Capital Investment Cost (TCI)	$1,849,600		TCI from 1 hr 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	$70,080		75kw @ $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	$11,498		60% of maintenance-OAQPS[1]
Administrative Charge	$36,992		2% of TCI-OAQPS[1]
Property Taxes	$18,496		1% of TCI-OAQPS[1]
Insurance	$18,496		1% of TCI-OAQPS[1]
Capital Recovery	$441,130	0.2385	10 yrs @20% -from 1-hr RACT
Total Indirect Annual Cost	$526,611		
Total Annual Operating Costs	$653,905		
NOx Baseline Emissions (TPY)	1199.9		Based on 761 mmbtu/hr, 8760 hr/yr, and 0.36 lb/mmbtu RACT limit
NOx Emission Reduction (TPY)	147.59		Based on 12.3 % of NOx removed.
Cost Effectiveness ($/ton NOx removed)	$4,431		

References

1. Office of Air Quality Planning and standards (OAQPS) Environmental Protection Agency (EPA) Air Pollution Control Manual, Six Edition, EPA/452/B-02-001, January 2002.
2. Electricity cost: EPA cost calculation, Appendix A-NOx Control Analysis
3. North East States for Coordinated Air Use Management (NESCAUM)
4. http://new.abb.com/power-generation