Attachment A
Reasonably Achievable Control Technology (RACT) analysis

REASONABLY ACHIEVABLE CONTROL TECHNOLOGY ANALYSIS

PHILADELPHIA ENERGY SOLUTIONS

Philadelphia Energy Solutions Refining and Marketing, LLC. (PES).

Reasonably Achievable Control Technology Analysis for the Heater Firing Rate Increase

August 31, 2012 (Submittal)
September 6, 2012 (Completeness Determination)
September 2013 (Supplement)

Environmental Resources Management
75 Valley Stream Parkway
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1.0 *REASONABLY ACHIEVABLE CONTROL TECHNOLOGY ANALYSIS*

The Sunoco, Inc. (R&M)[1] Girard Point Processing Area and Point Breeze Processing Area RACT Plan Approval amended on October 7, 2002 was established for nitrogen oxides (NO_x) and volatile organic compounds (VOCs) and limits the firing rate on the heaters to comply with the RACT regulatory requirements codified in 25 Pa Code §129.91 through §129.95. This application addresses changes to certain NO_x RACT conditions[2]. No changes to VOC RACT conditions are requested. With this application, the Refinery proposes to remove the firing rate limits in the RACT Plan Approval for seven target heaters:

- Unit 231-B101 Heater;
- Unit 865-11H1 Heater;
- Unit 865-11H2 Heater;
- Unit 210-H101 Heater;
- Unit 210-H201 Heater;
- Unit 866-12H1 Heater; and
- Unit 868-8H101 Heater.

1.1 *RACT ANALYSIS REQUIREMENTS*

As described in 25 Pa Code §129.92(b), each RACT Analysis must include the requirements listed in Table 1-1 below.

[1] The Sunoco Philadelphia Refinery is now owned and operated by Philadelphia Energy Solutions Refining and Marketing, LLC (PES).

[2] The RACT Plan Approval revisions to the target heater firing rate or emission limits are not being requested by PES to comply with any requirements of Consent Decree No. 05-02866 (Fourth Amendment, dated August 17, 2012).

Table 1-1 25 Pa Code §129.92(b) RACT Requirements

25 Pa Code §129.92(b) Requirement	Discussion
A ranking of the available control options for the affected source in descending order of control effectiveness.[1]	• Ultra-low NO_x burners (ULNB) and Selective Catalytic Reduction (SCR) - 96% • Selective Catalytic Reduction - 85% • Ultra-low-NO_x burners - 66 to 76% • Low-NO_x burners and Selective Non-Catalytic Reduction (SNCR) - 70% • Low-NO_x burners (LNB) and Flue Gas Recirculation (FGR) - 55% • Selective Non-Catalytic Reduction - 40%
An evaluation of the technical feasibility of the available control options identified based on physical, chemical and engineering principles. A determination of technical infeasibility should identify technical difficulties restricting the successful use of the control option on the affected source.	• Unit 865-11H1 - The installation of SCR is not possible as there is not adequate plot space available; further, there is not adequate pressure to overcome the SCR pressure drop; therefore, SCR is infeasible. FGR installation would require the installation of mechanical draft burners, which is a major re-design of the unit; therefore FGR is infeasible. • Unit 210-H101 - FGR would not physically fit the plot space; therefore, it is infeasible. • Unit 210-H201 - The installation of SCR is not possible as there is not adequate plot space available; further, there is not adequate pressure to overcome the SCR pressure drop; therefore, SCR is infeasible. FGR installation would require the installation of mechanical draft burners, which is a major re-design of the unit; therefore FGR is infeasible.
A ranking of the technically feasible control options in order of overall control effectiveness for NO_x emissions.	The RACT summary in Appendix A for each target heater ranks the technically feasible controls options by listing them from highest to lowest control effectiveness.
The baseline emissions of NO_x before implementation of each control option ("pre-control emissions").	The "pre-control emissions" are listed in the "Potential Emissions (TPY)" column for each target heater in the RACT summary for each heater in Appendix A.
The estimated emission reduction potential or the estimated control efficiency of each control option.	The estimated emission reduction potential for each control option for each target heater is listed in the "Potential NO_x Reduced (TPY)" column in the RACT summary for each heater in Appendix A. These values based on design firing for each heater.
The estimated emissions after the application of each control option ("post-control emissions").	The "post-control emissions" are listed in the "Maximum Post Control Emissions @ Design Firing (TPY)" column for each target heater in the RACT summary for each heater in Appendix A.
An evaluation of cost effectiveness of each control option consistent with EPA's cost guidance manuals. The cost effectiveness shall be evaluated in terms of dollars per ton of NO_x emissions reduction.	See Appendix A for the RACT Cost Effectiveness Analysis.

[1] NO_x control effectiveness derived from Alternative Control Techniques Document - NO_x Emissions from Process Heaters (Revised) - EPA Emissions Standards Division - EPA-453/R-93-034 and Refinery process knowledge.

1.2 *RACT PLAN APPROVAL CHANGES*

PES is requesting changes to the RACT Plan Approval including updates to presumptive RACT sources and updates to previous RACT determinations on select heaters. For this RACT analysis and future RACT analyses, PES is requesting that the RACT determinations focus on identifying specific NO_x control technology requirements and pollutant emission rates (lb/MMBtu) as RACT. Previously the RACT determinations were identified as hourly firing rate limits (MMBtu/hr) and pollutant emission rates. The basis for the RACT analysis, provided here, now relies on design firing for all heaters.

A summary of requested RACT Plan Approval revisions are found in Table 1-4 at the end of this section.

1.2.1 *Presumptive RACT Revisions*

Three of the target heaters, Unit 865-11H2, Unit 866-12H1, and Unit 868-8H101, previously had firing rate limits less than 50 million British thermal units per hour (MMBtu/hr) and were therefore subject to presumptive RACT NO_x controls established under 25 Pa Code §129.93. Presumptive RACT required the use of combustion tuning rather than physical controls. Because these three heaters are seeking annual equivalent firing rate limits over 50 MMBtu/hr, PES has provided a Case-by-Case RACT analysis in Appendix A for these heaters as a part of this plan approval application along with the other target heaters.

1.2.2 *Modifications to Unit 231-B101 and Unit 865-11H1*

Ultra-low NO_x burners (ULNBs) are planned to be installed on Unit 231-B101 and Unit 865-11H1[3]. PES proposes that the RACT Plan Approval be revised to keep the current RACT limits for hourly firing limit (MMBtu/hr) and NO_x emission rate (lb/MMBtu) in place until the installation of the ULNBs are complete. A new permit condition should be included in Section 2 of the RACT Plan Approval to only allow the removal of the hourly firing limits for the Unit 231-B101 and Unit 865-11H1 heaters after the ULNBs have been successfully installed and stack test results show that the heaters meet the specified NO_x emission rate (0.03 lb/MMBtu). See the proposed RACT limits in Table 1-2 below.

[3] As part of a settlement agreement with the Clean Air Council, PES agreed voluntarily to install ultra-low NO_x burners on Unit 231-B101 Heater and Unit 865-11H1 Heater at the Refinery to further reduce emissions beyond the cuts achieved by the shut-down of the Marcus Hook Refinery.

Table 1-2 ***Proposed RACT Plan Approval Conditions for Unit 231-B101 and Unit 865-11H1***

Heater	Hourly Firing Limit (MMBtu/hr)	NO_x Emission Rate (lb/MMBtu)	RACT NO_x Control
RACT Plan Approval Conditions Pending ULNB Installation			
Unit 231-B101	91	0.122 (refinery fuel gas)	Combustion Tuning
Unit 865-11H1	72.2	0.113 (refinery fuel gas)/0.400 (refinery fuel oil)	Combustion Tuning
Proposed Conditions after ULNB Installation and Testing			
Unit 231-B101	---	0.03 (refinery fuel gas)	Combustion Tuning
Unit 865-11H1	---	0.03 (refinery fuel gas)	Combustion Tuning

1.2.3 *Cessation of Refinery Fuel Oil Firing*

As discussed under Section 110(l) of the Clean Air Act, while the changes to the RACT Plan Approval include removal of firing rates of seven heaters, the RACT Plan Approval will still provide reasonable further progress toward ozone attainment because PES is also requesting removal of the ability for fuel oil firing for five of the seven heaters. Typically refinery fuel oil firing NO_x emission rates are higher than gaseous fuel-firing NO_x emission rates.

Table 1-3 below shows the change in NO_x maximum emissions, based on the RACT limits for the target heaters based on the removal of the ability for fuel oil firing. The current oil firing NO_x emissions rate limits and hourly firing limits (MMBtu/hr) as well as the proposed gaseous fuel-firing NO_x emission rate limits and design firing (MMBtu/hr) for five of the target heaters were used to determine the total reduction in maximum NO_x emissions associated with the proposed RACT limit changes. This reduction in emissions provides reasonable further progress toward ozone attainment.

Table 1-3 NO_x Emissions Reductions from Cessation of Refinery Fuel Oil Firing

Target Heater	Existing Hourly Firing Limit (MMBtu/hr)	Oil Firing Emission Limit (lb NO_x/MMBtu)	Current RACT NO_x (TPY)	Design Firing (MMBtu/hr)	Gas Firing Proposed Emission Limit (lb NO_x/MMBtu)	Proposed RACT NO_x (TPY)	Change in NO_x (TPY)
Unit 865-11H1	72.2	0.400	126.5	87.3	0.030	11.5	-115.0
Unit 865-11H2 [1]	49.9	0.113	24.7	64.2	0.113	31.8	7.1
Unit 210-H101	183.0	0.400	320.6	192.0	0.089	74.8	-245.8
Unit 210-H201	242.0	0.400	424.0	254.0	0.030	33.4	-390.6
Unit 866-12H1 [1]	43.0	0.113	21.3	61.2	0.113	30.3	9.0
						Total Target Heater NO_x RACT Reduction (TPY)	-735.3

[1] Note that Unit 865-11H2 and Unit 866-12H1 are currently complying with the presumptive RACT limits and do not have oil firing NO_x emission limits. Conservatively, the proposed gas firing NO_x emission limit of 0.113 lb/MMBtu was assumed as the oil firing emission limit for this analysis.

Table 1-4 Summary of RACT Plan Approval Revisions

Section	Revisions Requested
Section 1.A(2)	Revise firing duty of Unit 231-B101 to 104.5 MMBtu/hr.
Section 1.A(11)	Revise firing duty of Unit 210-H101 to 192 MMBtu/hr. Revise firing duty of Unit 210-H201 to 254 MMBtu/hr. Revise the section to remove the firing of refinery fuel oil.
Section 1.A(15)	Revise firing duty of Unit 865-11H1 to 87.3 MMBtu/hr. Revise firing duty of Unit 865-11H2 to 64.2 MMBtu/hr. Revise the section to remove the firing of refinery fuel oil.
Section 1.A(16)	Revise firing duty of Unit 866-12H1 to 61.2 MMBtu/hr. Revise the section to remove the firing of refinery fuel oil.
Section 1.A(19)	Revise firing duty of Unit 868-8H101 to 60.0 MMBtu/hr.
Section 1.B(1)	Add control technology for Unit 210-H201 (ultra-low NO_x burners).
Section 2.A	Add description that ultra-low NO_x burners are planned to be installed on Unit 231-B101 and Unit 865-11H1. Installation will be completed after issuance of plan approval.
Section 2.B	Include combustion tuning as RACT for Unit 865-11H2 and Unit 868-8H101.
Section 2.C	Removal of the heat input caps (MMBtu/hr) for Unit 231-B101 and Unit 210-H201.
New paragraph in Section 2	Add control technologies for Unit 210-H101 (low NO_x burners) and Unit 210-H201 (ultra-low NO_x burners).
New paragraph in Section 3	Add description that original RACT limits apply until the installation of ultra-low NO_x burners on Unit 231-B101 and Unit 865-11H1.
Section 4.B	Add description that NO_x RACT emissions limit for Unit 210-H201 has been established using CEMS.
Section 4.C	Removal of Unit 231-B101 and Unit 865-11H1 Heaters from the table as compliance will be demonstrated through performance testing.
Section 4.C	Updates to add NO_x emission rate for Unit 865-11H2, Unit 866-12H1, and Unit 868-8H101.
Section 4.C	Updates to NO_x emission rate for Unit 210-H201 Heater and removing refinery fuel oil firing NO_x emission limitations for Unit 210-H101 and Unit 210-H201.

1.3 *RACT COST EFFECTIVENESS CALCULATIONS*

In this application, the cost effectiveness calculations for the RACT analyses were based on the EPA guidance document entitled *Alternative Control Techniques Document - NO_x Emissions from Process Heaters (Revised)* - EPA-453/R-93-034. PES also used cost information from past Refinery ULNB installations on two heaters (Unit 1332 H-400/H-401 Heater and Unit 137 F-3 Heater). These costs – capital and operation and maintenance (O&M) – were scaled up to 2012 dollar amounts using *Chemical*

Engineering cost indices. PES has also conducted the analysis at the current cost of borrowing capital.

As PES is a recently established company under new ownership in a private equity structure, the cost of borrowing capital (the minimum return that investors expect for providing capital to the company) is considered at a higher risk than many established companies. The cost effectiveness analysis reflects the current cost of capital for PES, which is 21.83%.

1.4 *RACT ANALYSIS RESULTS*

The RACT cost effectiveness for the subject heaters are calculated at approximately $6,700 to $163,000 per ton of NO_x emissions reductions for additional controls beyond those considered part of current heater design and operation. The RACT analysis leads to the following conclusions:

- The Unit 210-H101 Heater already has LNB installed[4]; however, the installation of current generation UNLB is not cost effective.
- Unit 210-H201 has NO_x control today at a permit limit of 0.03 lb/MMBtu, and no further control is deemed to be cost effective as indicated by the RACT analysis.
- With the planned installations of ULNBs on Unit 231-B101 and Unit 865-11H1, as indicated by the RACT analysis, no other control technologies are found to be cost effective.
- As illustrated in Appendix A, for the remaining heaters, additional retrofit NO_x control options beyond combustion tuning are not cost effective. Therefore, combustion tuning is RACT for these heaters.

[4] Burners were considered UNLB when installed, but referred to here as LNB to avoid confusion.

2.0 *RACT PLAN APPROVAL PROPOSED CONDITIONS*

Based on this RACT analysis, including the RACT cost effectiveness analysis completed in Appendix A, PES is proposing RACT for the seven target heaters as described below. Table 2-1 at the end of this section shows the existing and proposed RACT Plan Approval limits.

2.1 *RACT CONTROL EQUIPMENT REQUIREMENTS*

Combustion tuning will be RACT for the following heaters: Unit 231-B101 Heater, Unit 865-11H1 Heater, Unit 865-11H2 Heater; Unit 210-H101 Heater; Unit 210 H-201 Heater; Unit 866-12H1 Heater; and Unit 868-8H101 Heater as well as compliance with the RACT NO_x emission rate limit for each heater listed in Table 2-1.

2.2 *RACT IMPLEMENTATION SCHEDULE*

Sources in Table 2-1 below proposing combustion tuning to comply with RACT requirements of 25 PA Code 129.91(f) shall perform quarterly combustion tuning.

2.3 *RACT TESTING REQUIREMENTS AND STACK EMISSION LIMITATIONS*

After installation of the ULNB on the Unit 231-B101 and Unit 865-11H1 Heaters, PES shall conduct a one-time performance tests for NO_x. The results of these tests will be submitted to AMS.

The final NO_x RACT emission limits for the Unit 210-H201 Heater shall be established through the use of the Department-approved Continuous Emission Monitoring System (CEMS) currently installed. Compliance with the limitation listed in Table 2-1 below for Unit 210-H201 will be on a 365-day rolling average based on hourly averages of CEM data.

Compliance with emission limits for the Unit 210-H101, Unit 865-11H2, Unit 866-12H1, and Unit 868-8H101 Heaters shall be determined by quarterly stack sampling with a portable NO_x analyzer. After one year sampling, PES may petition AMS for semi-annual monitoring.

All annual combustion tuning shall at a minimum meet the requirements set forth in 25 PA Code 129.93 (b)(2) through (5).

At least thirty (30) days prior to a performance NO_x test, PES shall inform AMS of the date and time of the scheduled test.

2.4 *RACT RECORDKEEPING AND REPORTING REQUIREMENTS*

PES shall maintain a file containing all the records and other data that are required to be collected to demonstrate compliance with NO_x RACT requirements of 25 PA Code 129.91- 129.94.

The records shall provide sufficient data and calculations to clearly demonstrate that the requirements of §129.91-129.94 are met.

Data or information required to determine compliance shall be recorded and maintained in a time frame consistent with the averaging period of the requirement.

Records shall be retained for at least two years and shall be made available to the Department on request.

Table 2-1 RACT Plan Approval Existing and Proposed Limits

Unit	Existing Hourly Firing Limit (MMBtu/hr) [2]	Design Firing (MMBtu/hr)	Emission Rate Limit (lb NO_x/MMBtu)				RACT Control	
			Existing [3]		Proposed [4]		Existing	Proposed
			Gas	Oil	Gas	Oil		
Unit 231-B101	91	104.5	0.122	-	0.03	-	Tuning	Tuning [5]
Unit 865-11H1	72.2	87.3	0.113	0.400	0.03	-	Tuning	Tuning [5]
Unit 865-11H2 [1]	49.9	64.2	-	-	0.113	-	-	Tuning
Unit 210-H101	183	192.0	0.089	0.400	0.089	-	Tuning	Tuning [6]
Unit 210-H201	242	254.0	0.173	0.400	0.03	-	Tuning	Tuning [6]
Unit 866-12H1 [1]	43	61.2	-	-	0.113	-	-	Tuning
Unit 868-8H101 [1]	49.5	60.0	-	-	0.113	-	-	Tuning

1 Units are currently subject to PADEP's presumptive RACT and not subject to specific requirements in the RACT Plan Approval.
2 Compliance with limitation is based on the daily average heat input.
3 Compliance with limitation is based on quarterly stack sampling using a portable NO_x analyzer.
4 The Refinery is only proposing limits for firing natural gas at the target heaters. The Refinery no longer uses refinery fuel oil as a fuel for the Unit 865-11H1, Unit 210-H101, and Unit 210-H201 heaters and proposes to remove the capability to use refinery fuel oil as a fuel from the RACT Plan Approval. For Unit 210-H201, compliance with the emission rate limit will be through the use of Department-approved CEMS currently installed. For heaters other than Unit 210-H201, compliance with limitation is based on quarterly stack sampling using a portable NO_x analyzer.
5 PES is proposing that the current RACT Plan Approval conditions remain in place and the hourly firing rate limits can only be removed after the installation and testing of the ULNBs at Unit 231-B101 and Unit 865-11H1.
6 Control equipment is currently installed; however only combustion tuning is currently required as RACT control for these units in the RACT Plan Approval. The proposed emission rate limits also reflect the presence of control equipment.

CITY OF PHILADELPHIA
DEPARTMENT OF PUBLIC HEALTH
AIR MANAGEMENT SERVICES

RACT PLAN APPROVAL

Effective Date: August 1, 2000

Amended Date: October 7, 2002

Expiration Date: None

Replaces Permit No. None

These amendments will update RACT requirements for sources affected in the Heater Firing Rate Increase Plan Approval.

In accordance with provisions of the Air Pollution Control Act, the Act of January 8, 1960, P.L. 2119, as amended, and after due consideration of a Reasonably Available Control Technology (RACT) proposal received under the Pennsylvania Code, Title 25, Chapter 129.91 thru 129.95, of the rules and regulations of the Pennsylvania Department of Environmental Protection (PADEP), Air Management Services (AMS) amended the RACT Plan Approval of the Facility below for the source(s) listed in section 1.A. Emission Sources of the attached RACT Plan Approval.

Facility:	~~Sunoco, Inc. (R & M)~~
Owner:	~~Sunoco, Inc.~~
Location:	Girard Point Processing Area located at 3001 Penrose Ave Point Breeze Processing Area located at 3144 Passyunk Ave
Mailing Address:	3144 Passyunk Ave., Philadelphia, PA 19145
SIC Code(s):	2911
Plant ID:	1501 and 1517
Facility Contact:	~~Eric Schneider~~
Phone:	[redacted]
Permit Contact:	~~Eric Schneider~~
Phone:	[redacted]
Responsible Official:	~~Vincent J. Kelley~~
Title:	~~Refinery Manager~~

Edward Braun, Chief of Source Registration

10/7/02
Date

The RACT plan approval is subject to the following conditions:

1. The purpose of this Plan Approval is to establish Nitrogen Oxides (NOx)/Volatile Organic Compound (VOC) Reasonably Available Control Technology (RACT) for ~~Sunoco, Inc. (R&M)~~ Girard Point Processing Area and Point Breeze Processing Area. This includes the following emission sources and control equipment:

   A. Emission Sources

   (1) Process Heaters: Unit 137: F1 heater (415 MMBTU/hr)
   F2 heater (155 MMBTU/hr)
   F3 heater (60 MMBTU/hr)
   Process heaters F1 and F2 burn refinery fuel gas or refinery fuel oil. Heater F3 burns refinery fuel oil.

   (2) Process Heater: Unit 231: B-101 heater (~~91~~ MMBTU/hr) Heater fires refinery fuel gas.

   (3) Process Heater: Unit 433: H-1 heater (243 MMBTU/hr) Heater fires refinery fuel gas.

   (4) Process Heaters: Unit 1332: H-400 heater (186 MMBTU/hr)
   H-401 heater (233 MMBTU/hr)
   H-600 heater (21.3 MMBTU/hr)
   H-601 heater (48 MMBTU/hr)
   H-602 heater (49 MMBTU/hr)
   H-1 heater (45 MMBTU/hr)
   H-2 heater (60 MMBTU/hr)
   H-3 heater (43 MMBTU/hr)
   These heaters burn refinery fuel gas.

   (5) Process Heater: Unit 1232: B-104 heater (70 MMBTU/hr) Heater fires refinery fuel gas.

   (6) Boiler House #3: Boiler #37 (495 MMBTU/hr)
   Boiler #38 (495 MMBTU/hr)
   Boiler #39 (495 MMBTU/hr)
   Boiler #40 (660 MMBTU/hr)
   These boilers fire refinery fuel gas or refinery fuel oil.

   (7) Sludge Incinerator 8832: Unit was 44 MMBTU/hr and burned refinery fuel gas or refinery fuel oil.

   (8) Sulfur Recovery Unit 532: SO2 incinerator was 16 MMBTU/hr. Unit burned refinery fuel gas.

   (9) 1232 FCCU CO Boiler: CO waste gas combustion unit (580 MMBTU/hr) burns process waste gas, refinery fuel gas and refinery fuel oil.

   (10) Asphalt Heater: H1 (12.8 MMBTU/hr)
   H2 (12.8 MMBTU/hr)
   H3 (12.8 MMBTU/hr)
   H5 (12.8 MMBTU/hr)
   These heaters burned fire refinery fuel gas.

   (11) Crude Unit 210: Section A HTR H101 (~~183~~ MMBTU/hr)
   Section B HTR H201 (~~242~~ MMBTU/hr)
   Section C HTR 13H1 (235.4 MMBTU/hr)
   These heaters above fire refinery fuel gas ~~and refinery fuel oil~~.

(12) Hydrocracker Unit 859: HTR 1H1 (76 MMBTU/hr) Unit fires refinery fuel gas and refinery fuel oil.
HTR 1H2 (70 MMBTU/hr) Unit fires refinery fuel gas and refinery fuel oil.
HTR 1H3 (211 MMBTU/hr) Unit fires refinery fuel gas and refinery fuel oil.
HTR 1H4 (19 MMBTU/hr) Unit fires refinery fuel gas.

(13) Reformer Unit 864: HTR PH3 (80 MMBTU/hr)
HTR PH5 (90 MMBTU/hr)
HTR PH1 (80 MMBTU/hr)
HTR PH2 (45 MMBTU/hr)
HTR PH4 (57 MMBTU/hr)
HTR PH7 (45.5 MMBTU/hr)
HTR PH11 (74 MMBTU/hr)
HTR PH12 (85.1 MMBTU/hr)
These heaters fire refinery fuel gas and refinery fuel oil.

(14) Hydrogen Plant 861: HTR 3H1S (123 MMBTU/hr)
HTR 3H1N (125 MMBTU/hr)
These heaters burned refinery fuel gas.

(15) Distillate HDS Unit 865: HTR 11H1 (~~72.2~~ MMBTU/hr)
HTR 11H2 (~~49.9~~ MMBTU/hr)
These heaters fire refinery fuel gas ~~and refinery fuel oil~~.

(16) Gas Oil HDS Unit 866: HTR 12H1(~~43~~ MMBTU/hr) Heater fires refinery fuel gas ~~and refinery fuel oil~~.

(17) 22 Boiler House: Boiler #1 (169 MMBTU/hr)
Boiler #2 (169 MMBTU/hr)
Boiler #3 (203 MMBTU/hr)
These three boilers burn only refinery fuel gas or natural gas and are equipped with Ultra Low NOx Burners.

(18) Reformer Unit 860: HTR 2H3 (174.67 MMBTU/hr) Unit fires refinery fuel gas and refinery fuel oil.
HTR 2H5 (155 MMBTU/hr) Unit fires refinery fuel gas and refinery fuel oil.
HTR 2H1 (49 MMBTU/hr) Unit fires refinery fuel gas and refinery fuel oil.
HTR 2H2 (69.78 MMBTU/hr) Unit fires refinery fuel gas and refinery fuel oil.
HTR 2H4 (99.44 MMBTU/hr) Unit fires refinery fuel gas and refinery fuel oil.
HTR 2H6 (36.7 MMBTU/hr) Unit fires refinery fuel gas and refinery fuel oil.
HTR 2H7 (59 MMBTU/hr) Unit fires refinery fuel gas and refinery fuel oil.
HTR 2H8 (49.6 MMBTU/hr) Unit fires refinery fuel gas and refinery fuel oil.
Boiler 2H9 (165 MMBTU/hr) Unit fires refinery fuel gas or natural gas.

(19) 868 FCCU HTR 8H101 (~~47.92~~ MMBTU/hr) Unit fires refinery fuel gas.

(20) 868 FCCU Catalyst Regenerator

(21) 867 Sulfur Recovery Unit Incinerator

(22) Emergency Flares

(23) Cooling towers

(24) Fugitive leaks: valves, flanges, compressors, pumps, pipes.

B. Control Equipment

(1) Ultra-low NOx burner (ULNB) systems are installed on the following sources to control NOx emissions:
Unit 433 H-1 heater
Unit 1232 B-104 heater
#3 Boiler House boilers #37, #38, #39, and #40.
Unit 210-H201

2. This approval requires and authorizes:

A. The installation of the Ultra Low NOx Burners on 433 H-1 heater, 1232 B-104 heater, and #3 Boiler House boilers #37, #38, #39, and #40 to comply with RACT requirements. The installation of the burners has been completed.

B. ~~Sunoco will use~~ combustion tuning to comply with RACT requirements for the following heaters:

Add description that ultra-low NOx burners are planned to be installed on Unit 231-B101 and Unit 865-11H1. Installation will be completed after issuance of plan approval.

Unit 137: F1 heater, F2 heater, ~~F3 heater~~
Unit 231: B-101 heater
Unit 1332: H-400 heater, H-401 heater, H-2 heater
Crude Unit: 210A HTR H101, 210B HTR H201, 210C HTR 13H1
Hydrocracker Unit 859: HTR 1H1, HTR 1H2, HTR 1H3
Reformer Unit 864: HTR PH3, HTR PH5, HTR PH1, HTR PH2, ~~HTR PH4, HTR PH11, HTR PH12~~
Hydrogen Plant 861: HTR 3H1S, HTR 3H1N
Distillate HDS Unit 865: HTR 11H1
Reformer Unit 860: HTR 2H3, HTR 2H5, HTR 2H4, HTR 2H2, HTR 2H7
Gas Oil HDS Unit 866: ~~HTR 12H1(43 MMBTU/hr)~~
Distillate HDS Unit 865: HTR 11H2 and HDS Unit 868: HTR 8H101

C. All fuel burning sources will be capped at the heat input specified in the table below. If ~~Sunoco~~ desires to raise the cap, a RACT evaluation will have to be performed at that new heat input. The economic evaluation will be made using cost of living increases. Changes will require a resubmission as revision to the PA State Implementation Plan. The applicant shall bear the cost of public hearing and notification required for EPA approval as stipulated in 25 PA Code §129.9(h). Modifications or changes may require additional controls or more strict emission limits depending on the applicable regulation triggered as a result of the modification or change.

Process Unit	Source	Heat Input Cap (MMBTU/hr)
Unit 137:	F1 heater	415
	F2 heater	155
~~Unit 231:~~	~~B-101 heater~~	~~91~~
Unit 433:	H-1 heater	243
Unit 1332:	H-400 heater	186
Unit 1232:	B-104 heater	70
Boiler House #3:	Boilers #37, #38, #39	495
	Boiler #40	660
~~Crude Unit 210B:~~	~~HTR H201~~	~~242~~
Hydrocracker Unit 859:	HTR 1H1	76
	HTR 1H2	70
Reformer Unit 864:	HTR PH3	80
	HTR PH5	90
	HTR PH2	45
	HTR PH4	57
Hydrogen Plant 861:	HTR 3H1S	123
	HTR 3H1N	125

D. ~~Sunoco~~ shall monitor all fuel input to all heaters and boilers with BTU limitations on a daily basis to insure capacity limits are not exceeded or ~~sun~~ shall install fuel limiting devices on the heaters or boilers to keep capacities below allowable. The compliance method must be in place by June 30th 2000.

E. All fuel combustion sources with heat input equal to or greater than 20 MMBTU/hr and less than 50 MMBTU/hr shall comply with applicable presumptive RACT requirements of 25 PA Code 129.93(b)(2)-(5). All fuel combustion sources with heat input less than 20 MMBTU/hr shall comply with presumptive RACT requirements of 25 PA Code 129.93(c).

F. RACT for 22 Boiler House: Boiler #1, Boiler #2, and Boiler #3 is combustion tuning.

G. RACT for Reformer Unit 860 HTR 2H9 is combustion tuning.

H. The 868 FCCU NOx emissions shall be limited to 569 tons per year calculated on a 365 day rolling average basis. ~~Sun~~ shall follow good combustion practices controlling the level of excess oxygen and CO promoter in the regenerator to minimize NOx emissions from the regenerator.

J. ~~Sunoco~~ shall utilize an inspection and maintenance/monitoring program for VOC fugitive emissions from cooling towers.

K. ~~Sunoco~~ shall utilize a fugitive emissions leak detection and repair program (LDAR) for all valves, pumps, flanges, and compressors in VOC service. All applicable equipment shall be tagged by May 31, 1995. Monitoring of components shall begin by July 31, 1995 and shall be conducted on a quarterly basis (gaseous service) and an annual basis (liquid service) for all sources not covered under an existing LDAR program.

L. The 1232 FCCU CO Boiler: CO waste gas combustion unit (580 MMBTU/hr) shall comply with the presumptive RACT requirements of 25 PA Code 129.93(c)(4), which is installation, maintenance and operation of the source in accordance with manufacturers specifications.

Add control technologies for Unit 210-H101 (low NOx burners) and Unit 210-H201 (ultra-low NOx burners).

3. RACT Implementation Schedule

A. Upon issuance of this approval, ~~Sunoco, Inc. (R&M), Inc~~ shall begin immediate implementation of the measures necessary to comply with the approved RACT proposal.

B. Sources proposing combustion tuning to comply with RACT requirements of 25 PA Code 129.91(f) shall perform the annual combustion tuning by December 31st of each year not to exceed 12 months between tunings.

C. Sources applicable to presumptive RACT requirements of 25 PA Code 129.93(b)(2) shall complete the annual adjustment or tune-up by December 31st of each year not to exceed 12 months between tunings.

D. Sources proposing installing Ultra Low NOx Burners to comply with RACT requirements of 25 PA Code 129.91(f) shall perform combustion tuning annually by Decem

Add description that original RACT limits apply until the installation of ultra-low NOx burners on Unit 231-B101 and Unit 865-11H1.

4. Testing Requirements and Stack Emission Limitations

A. For units installing ULNB, ~~Sunoco~~ shall conduct performance tests for NOx. The results of these tests have been submitted to AMS.

B. The final NOx RACT emission limits for the #3 Boiler House boilers, 137 Unit F1 heater, #22 Boiler House boilers: #1, 2, & 3 and the 860 unit Boiler 2H9 have been established through the use of Department approved Continuous Emission Monitoring System (CEMS). Compliance with the limitation listed below will be on a 30 day rolling average based on hourly averages of CEM data.

Source	Limitation
Boiler House #3 – boilers #37, #38, #39, and #40	0.330 lbs. NOx/MMBTU
137 Unit F1 heater	0.230 lbs. NOx/MMBTU
Reformer Unit 860 Boiler 2H9	0.20 lbs. NOx/MMBTU
#22 Boiler House – boilers #1, #2, and #3	0.20 lbs. NOx/MMBTU

C. Compliance with emission limits for combustion sources listed below shall be determined by quarterly stack sampling with a portable NOx analyzer. After one year sampling, ~~Sunoco~~ may petition AMS for semi-annual monitoring. AMS may, at any time, require three one-hour stack tests per fuel type for each unit where fuels can be fired separately. AMS may, at any time, require three one-hour stack tests for dual-fuel type combustion sources where

Add description that NOx RACT emission limit for Unit 210-H201 has been established based on a rolling 365-day average using CEMS.

both fuels must be fired at the same time and compliance with emission limits will be through the use of one set of three one-hour stack tests.

	Limitation (lbs. NOx/MMBTU)	
Source	Gas	Oil
Process Heater Unit 433 ~~H-1 heater~~	0.060	N/A
Process Heater Unit 1332 H-400 heater	0.156	N/A
Process Heater Unit 1332 H-401 heater	0.156	N/A
Crude Unit 210A HTR H101	0.089	~~0.4~~
Crude Unit 210B HTR H201	~~0.173~~	~~0.4~~
Crude Unit 210C HTR 13H1	0.104	0.4
Hydrocracker Unit 859 HTR 1H3	0.134	0.4
Hydrogen Plant 861 HTR3H1S	0.133	N/A
Hydrogen Plant 861 HTR3H1N	0.133	N/A
F-2 @ 137 Unit	0.257	0.4
F-3 @ 137 Unit	N/A	0.4
~~B-101@ 231 Unit~~	~~0.122~~	~~N/A~~
H-2 @ 1332 Unit	0.300	N/A
B-104 @ 1232 Unit	0.177	N/A
1H-1 @ 859 Unit	0.123	0.4
1H-2 @ 859 Unit	0.123	0.4
PH-3 @ 864 Unit	0.284	0.4
PH-5 @ 864 Unit	0.283	0.4
PH-1 @ 864 Unit	0.167	0.4
PH-4 @ 864 Unit	0.102	0.4
PH-11 @ 864 Unit	0.145	0.4
PH-12 @ 864 Unit	0.119	0.4
~~1H-1 @ 865 Unit~~	~~0.113~~	~~0.4~~
2H-3 @ 860 Unit	0.163	0.4
2H-5 @ 860 Unit	0.163	0.4
2H-2 @ 860 Unit	0.350	0.4
2H-4 @ 860 Unit	0.270	0.4
2H-7 @ 860 Unit	0.157	0.4

Add NOx emission rate for Unit 865-11H2, Unit 866-12H1, and Unit 868-8H101

D. All annual combustion tuning shall at a minimum meet the requirements set forth in 129.93 (b)(2) through (5).

E. At least thirty (30) days prior to a performance NOx test, ~~Sunoco~~ shall inform AMS of the date and time of the scheduled test.

5. Recordkeeping and Reporting Requirements

A. The permittee shall maintain a file containing all the records and other data that are required to be collected to demonstrate compliance with NOx/VOC RACT requirements of 25 PA Code 129.91 - 129.94.

B. The records shall provide sufficient data and calculations to clearly demonstrate that the requirements of §129.91-129.94 are met.

C. Data or information required to determine compliance shall be recorded and maintained in a time frame consistent with the averaging period of the requirement.

D. Records shall be retained for at least two years and shall be made available to the Department on request.

6. The operation of the aforementioned sources shall not at any time result in the emission of visible air contaminants in excess of the limitations specified in Section 123.41, particulate matter in excess of the limitations specified in Section 123.11 or sulfur oxides in excess of the limitations specified in Section 123.22, all Sections of Chapter 123 of Article III of the Rules and Regulations of the Department of Environmental Resources, or in the emission of any of these or any

other type of air contaminant in excess of the limitations specified in, or established pursuant to, any other applicable rule or regulation contained in Article III.

7. The company shall not impose conditions upon or otherwise restrict the Department's access to the aforementioned source(s) and/or any associated air cleaning device(s) and shall allow the Department to have access at any time to said source(s) and associated air cleaning device(s) with such measuring and recording equipment, including equipment recording visual observations, as the Department deems necessary and proper for performing its duties and for the effective enforcement of the Air Pollution Control Act.

8. Revisions to any emission limitations incorporated in this RACT Approval will require resubmission as revision to the PA State Implementation Plan. The applicant shall bear the cost of public hearing and notification required for EPA approval as stipulated in 25 PA Code §129.9(h).

Appendix A
RACT Cost Effectiveness Analysis

NOx RACT Control Cost Effectiveness
Cost Effectiveness Summary

Control Option	Cost Effectiveness ($/Ton)						
	Unit 231-B101	Unit 865-11H1	Unit 865-11H2	Unit 210-H101	Unit 210-H201	Unit 866-12H1	Unit 868-8H101
ULNB & SCR	NA	NA	34,287	30,796	NA	34,831	35,060
SCR	102,243	NA	32,909	27,397	NA	33,524	33,782
ULNB	NA	NA	6,737	9,477	NA	6,737	6,737
LNB & SNCR	NA	NA	11,045	57,667	162,271	11,331	14,513
LNB & FGR	NA	NA	8,704	NA	NA	8,960	12,965
SNCR	39,924	42,874	13,132	10,825	28,098	13,379	13,482

Assumptions for all heaters:

Number of Years (n)	10
Interest Rate, % (i)	21.83
Annualized Cost Factor (ACF)	0.253

Based on 90% equity cost of the average Carlyle energy funds and 10% after tax debt cost.

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

EPA Air Pollution Control Cost Manual, Sixth Edition, EPA/452/B-02-001 - Equation 2.8a

Year	*Chemical Engineering* Cost Index
1986	318.4
1991	361
2012	582.2
Cost Escalation Factor for SCR[1]	1.83
Cost Escalation Factor for LNB, SNCR, and FGR[2]	1.61

[1] Cost data from *Alternative Control Techniques Document - NO_x Emissions from Process Heaters (Revised)* - EPA-453/R-93-034 scaled from 1986 to 2012 costs using the Cost Escalation Factor.

[2] Cost data from *Alternative Control Techniques Document - NO_x Emissions from Process Heaters (Revised)* - EPA-453/R-93-034 scaled from 1991 to 2012 costs using the Cost Escalation Factor.

Source		Control Efficiency	Comment
Ultra low-NO_x burners and Selective Catalytic Reduction	ULNB & SCR	96%	Combining both removal efficiencies of ULNB and SCR.
Selective Catalytic Reduction	SCR	85%	Based on Unit 1332 performance.
Ultra low-NO_x burners	ULNB	66 to 87%	Based on vendor experience at 0.03 lb/MMBtu.
Low-NO_x burners and Selective Non-Catalytic Reduction	LNB & SNCR	70%	Combining both removal efficiencies. Assumes 50% control efficiency for LNB and 40% control efficiency for SNCR. *Alternative Control Techniques Document - NO_x Emissions from Process Heaters (Revised)* - EPA-453/R-93-034.
Low-NO_x burners and Flue Gas Recirculation	LNB & FGR	55%	*Alternative Control Techniques Document - NO_x Emissions from Process Heaters (Revised)* - EPA-453/R-93-034.
Selective Non-Catalytic Reduction	SNCR	40%	Heater stack temperature below 700°F results in low NO_x removal efficiency. EPA Air Pollution Control Technology Fact Sheet - EPA-452/F-03-031.

Source Name	Design Capacity (MMBtu/hr)	NO_x Emission Rate (lb/MMBtu)	Number of Burners	Summary of Technical Infeasibilities for NO_x Control
Unit 231-B101	104.5	0.030	26	None.
Unit 865-11H1	87.3	0.030	8	SCR would not physically fit the plot space and there is not adequate pressure to overcome the SCR pressure drop; therefore, SCR is infeasible. FGR installation would require the installation of mechanical draft burners, which is a major re-design of the unit; therefore FGR is infeasible.
Unit 865-11H2	64.2	0.113	8	None.
Unit 210-H101	192.0	0.089	6	FGR would not physically fit the plot space; therefore, it is infeasible.
Unit 210-H201	254.0	0.030	8	SCR would not physically fit the plot space and there is not adequate pressure to overcome the SCR pressure drop; therefore, SCR is infeasible. FGR installation would require the installation of mechanical draft burners, which is a major re-design of the unit; therefore FGR is infeasible.
Unit 866-12H1	61.2	0.113	6	None.
Unit 868-8H101	60.0	0.113	4	None.

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NOx RACT Control Cost Effectiveness

Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034
All costs are scaled from 2012 U.S. dollars using the appropriate Cost Escalation Factor.

Capital Cost of Low NO_x Burners (page 6-4 and 6-5):

$$TCI = 30{,}000 + HQ[5{,}230 - (622 \times BQ) + (26.1 \times BQ^2)]$$

Where:
TCI = Total Capital Investment
HQ = heater capacity (GJ/hr)
BQ = burner heat release rate (GJ/hr)
BQ = HQ/NB x (1.158 + 8/HQ)
NB = number of burners

Capital Cost of Ultra-low NO_x Burners:
See the "Refinery ULNB Control Costs" tab for capital cost details for Ultra-low NO_x Burners

Capital Cost of Selective Non-Catalytic Reduction (page 6-7):

$$TCI = 31{,}850(HQ)^{0.6}$$

HQ = heater capacity (GJ/hr)

Operating Cost of Selective Non-Catalytic Reduction (page 6-8):

$$NH_3\ cost = Q \times (lb/MMBtu) \times \left(\frac{1\ mole\ NO_x}{46\ lb\ NO_x}\right) \times \left(\frac{17\ lb\ NH_3}{1\ mole\ NH_3}\right) \times \left(\frac{1\ mole\ NH_3}{1\ mole\ NO_x}\right) \times \left(\frac{\$0.125}{lb\ NH_3}\right) \times \left(8{,}760\frac{hours}{year}\right)$$

Where:
Q = heater capacity, MMBtu/hr

$$Electricty\ cost = \left(\frac{0.3\ kWh}{ton\ NH_3}\right) \times \left(\frac{ton\ NH_3}{year}\right) \times \left(\frac{\$0.06}{kWh}\right)$$

Where:

$$\frac{ton\ NH_3}{year} = Q \times (lb\ NO_x/MMBtu) \times \left(\frac{1\ mole\ NO_x}{46\ lb\ NO_x}\right) \times \left(\frac{17\ lb\ NH_3}{1\ mole\ NH_3}\right) \times \left(\frac{1\ mole\ NH_3}{1\ mole\ NO_x}\right) \times \left(\frac{ton}{2000\ lb}\right) \times \left(8{,}760\frac{hours}{year}\right)$$

Capital Cost of Selective Catalytic Reduction (page 6-8):

$$TCI = 1{,}373{,}000 \times \left(\frac{Q}{48.5}\right)^{0.6} + 49{,}000 \times \left(\frac{Q}{485}\right)$$

Where:
Q = heater capacity, MMBtu/hr

Operating Cost of Selective Catalytic Reduction (page 6-9):

$$NH_3\ cost = Q \times (lb/MMBtu) \times \left(\frac{1\ mole\ NO_x}{46\ lb\ NO_x}\right) \times \left(\frac{17\ lb\ NH_3}{1\ mole\ NH_3}\right) \times \left(\frac{1\ mole\ NH_3}{1\ mole\ NO_x}\right) \times \left(\frac{\$0.125}{lb\ NH_3}\right) \times \left(\frac{8{,}760\ hours}{year}\right)$$

Where:
Q = heater capacity, MMBtu/hr
Note the capacity factor has been assumed to be equal to 1; therefore, the capacity factor term has been omitted.

$$Catalyst\ Replacement\ Cost = 49{,}000 \times \frac{Q}{48.5}/5\ years$$

$$Electricty\ cost = \left(\frac{0.3\ kWh}{ton\ NH_3}\right) \times \left(\frac{ton\ NH_3}{year}\right) \times \left(\frac{\$0.06}{kWh}\right)$$

Where:

$$\frac{ton\ NH_3}{year} = Q \times (lb\ NO_x/MMBtu) \times \left(\frac{1\ mole\ NO_x}{46\ lb\ NO_x}\right) \times \left(\frac{17\ lb\ NH_3}{1\ mole\ NH_3}\right) \times \left(\frac{1\ mole\ NH_3}{1\ mole\ NO_x}\right) \times \left(\frac{ton}{2000\ lb}\right) \times \left(8{,}760\frac{hours}{year}\right)$$

Capital Cost of Flue Gas Recirculation (page 6-9):

$$TCI = 12{,}800(HQ)^{0.6}$$

Where:
HQ = heater capacity (GJ/hr)

Operating Cost of Flue Gas Recirculation (page 6-10):

$$Electricty\ cost = (motor\ hp) \times \left(\frac{0.75\ kW}{hp}\right) \times \left(\frac{8{,}760\ hours}{year}\right) \times \left(\frac{\$0.06}{kWh}\right)$$

Where:
motor hp = FGR fan motor horsepower, (1/5) x (Q)
Q = heater capacity, MMBtu/hr

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NOx RACT Control Cost Effectiveness

Ultra Low NO_x Burner Costs - from PES Refinery Project Experience

Economic Data	Heater Fired Duty (MMBtu/hr)	Number of Burners	Burner Heat Release (MMBtu/hr/burner)	Base Year ULNB Cost ($/burner)	Normalized Cost ($/MMBtu/hr)
1332 H-400/H-401 Heater	419	54	7.8	$50,000	$6,444
137 F-3 Heater	60	4	15	$80,500	$5,367
				Average	$5,905

Source Name	Design Capacity (MMBtu/hr)	ULNB Capital Cost Using ($/MMBtu/hr)	ULNB Total Capital Investment
Unit 231-B101	104.5	$617,103	NA
Unit 865-11H1	87.3	$515,532	NA
Unit 865-11H2	64.2	$379,120	$559,581
Unit 210-H101	192.0	$1,133,816	$1,673,512
Unit 210-H201	254.0	$1,499,944	NA
Unit 866-12H1	61.2	$361,404	$533,432
Unit 868-8H101	60.0	$354,317	$522,973

PES Refinery
Heater Firing Rate Increase Plan Approval
Unit 231-B101 RACT Cost Effectiveness Summary

	A	B	C	D	E	F	G	H	I	J
Control Option	Design Firing (MMBtu/hr)	Current Emission Rate (lb/MMBtu)[1]	Potential Emissions (TPY)	Control Efficiency (%)	Maximum Post Control Emissions @ Design Firing (TPY)	Potential NO_x Reduced (TPY)	2012 Total Capital Cost ($)	2012 O&M Cost ($)	2012 Annualized Cost[2] ($)	2012 Cost Effectiveness ($/Ton)
ULNB & SCR	104.5	0.03	13.7	96%	0.5	13.2	NA	NA	NA	NA
SCR	104.5	0.03	13.7	85%	2.1	11.7	4,118,447	149,357	1,193,342	102,243
LNB & SNCR	104.5	0.03	13.7	70%	4.1	9.6	NA	NA	NA	NA
LNB & FGR	104.5	0.03	13.7	55%	6.2	7.6	NA	NA	NA	NA
SNCR	104.5	0.03	13.7	40%	8.2	5.5	773,123	23,307	219,286	39,924
ULNB	104.5	0.03	13.7	0%	13.7	0.0	NA	NA	NA	NA
Calculation			= A * B * 8760 / 2000		= C * (1 - D)	= C - E			= (G * ACF) + H	= I / F

Notes:
[1] ULNB are planned to be installed on the Unit 231-B101 heater and the current emission rate is assumed to be 0.03 lb/MMBtu.
[2] See "RACT Cost Summary" tab for details on the Annualized Cost Factor (ACF).

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NOx RACT Control Cost Effectiveness

Source	**Unit 231-B101**	
Control	**SCR**	
Rated Heat Input	**104.5**	**MMBtu/hr**
Number of Burners	**26.0**	**Burners**
Baseline Actual Emissions	**13.73**	**tpy**
Current Emission Rate	**0.030**	**lb/MMBtu**
Control Efficiency	**85%**	
Heater Capacity	**110.3**	**GJ/hr**
Burner Heat Release Rate	**5.2**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

COST COMPONENT:	COST ($)
DIRECT COSTS	
Purchased Equipment Costs	
Equipment Cost (EC)	3,998,493
Instrumentation (Included in above costs)	- - -
Sales taxes (Included in above costs)	- - -
Freight (Included in above costs)	- - -
Subtotal - Purchased Equipment Costs (PEC)	**3,998,493**
Direct Installation Costs	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	- - -
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC)	**3,998,493**
INDIRECT INSTALLATION COSTS	
Engineering Costs (Included in above costs)	- - -
Construct. & Field Expenses (Included in above costs)	- - -
Contractor Fees (Included in above costs)	- - -
Start-up (Included in above costs)	- - -
Performance Test (Included in above costs)	- - -
Contingency (3% of PEC)	119,955
TOTAL INDIRECT COSTS, IC	**119,955**
TOTAL CAPITAL INVESTMENT (TCI)	**4,118,447**

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NOx RACT Control Cost Effectiveness

COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		113,257
		113,257
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
Ammonia Cost		2,046
Catalyst Replacement Cost		34,054
Electricity Cost		0.1
Subtotal - Utilities		**36,100**
TOTAL ANNUAL DIRECT COSTS[a]		**149,357**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**149,357**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		4,118,447
TOTAL ANNUAL CAPITAL REQUIREMENT		**1,043,985**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**1,193,342**

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NOx RACT Control Cost Effectiveness

Source	**Unit 231-B101**	
Control	**SNCR**	
Rated Heat Input	**104.5**	**MMBtu/hr**
Number of Burners	**26.0**	**Burners**
Baseline Actual Emissions	**13.73**	**tpy**
Current Emission Rate	**0.030**	**lb/MMBtu**
Control Efficiency	**40%**	
Heater Capacity	**110.3**	**GJ/hr**
Burner Heat Release Rate	**5.2**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

COST COMPONENT:	COST ($)
DIRECT COSTS	
Purchased Equipment Costs	
Equipment Cost (EC)	750,605
Instrumentation (Included in above costs)	- - -
Sales taxes (Included in above costs)	- - -
Freight (Included in above costs)	- - -
Subtotal - Purchased Equipment Costs (PEC)	**750,605**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	- - -
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC)	**750,605**
INDIRECT INSTALLATION COSTS	
Engineering Costs (Included in above costs)	- - -
Construct. & Field Expenses (Included in above costs)	- - -
Contractor Fees (Included in above costs)	- - -
Start-up (Included in above costs)	- - -
Performance Test (Included in above costs)	- - -
Contingency (3% of PEC)	22,518
TOTAL INDIRECT COSTS, IC	**22,518**
TOTAL CAPITAL INVESTMENT (TCI)	**773,123**

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COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		21,261
		21,261
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
Ammonia Cost		2,046
Electricity Cost		0.1
Subtotal - Utilities		**2,046**
TOTAL ANNUAL DIRECT COSTS[a]		**23,307**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**23,307**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		773,123
TOTAL ANNUAL CAPITAL REQUIREMENT		**195,979**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**219,286**

PES Refinery
Heater Firing Rate Increase Plan Approval
Unit 865-11H1 RACT Cost Effectiveness Summary

	A	B	C	D	E	F	G	H	I	J
Control Option	Design Firing (MMBtu/hr)	Current Emission Rate (lb/MMBtu)[1]	Potential Emissions (TPY)	Control Efficiency (%)	Maximum Post Control Emissions @ Design Firing (TPY)	Potential NO_x Reduced (TPY)	2012 Total Capital Cost ($)	2012 O&M Cost ($)	2012 Annualized Cost[2] ($)	2012 Cost Effectiveness ($/Ton)
ULNB & SCR	87.3	0.03	11.5	96%	0.5	11.0	NA	NA	NA	NA
SCR	87.3	0.03	11.5	85%	1.7	9.8	NA	NA	NA	NA
LNB & SNCR	87.3	0.03	11.5	70%	3.4	8.0	NA	NA	NA	NA
LNB & FGR	87.3	0.03	11.5	55%	5.2	6.3	NA	NA	NA	NA
SNCR	87.3	0.03	11.5	40%	6.9	4.6	694,045	20,796	196,729	42,874
ULNB	87.3	0.03	11.5	0%	11.5	0.0	NA	NA	NA	NA
Calculation			= A * B * 8760 / 2000		= C * (1 - D)	= C - E			= (G * ACF) + H	= I / F

Technical Infeasibilities:
SCR would not physically fit the plot space and there is not adequate pressure to overcome the SCR pressure drop; therefore, SCR is infeasible
FGR installation would require the installation of mechanical draft burners, which is a major re-design of the unit; therefore FGR is infeasible
Notes:
[1] ULNB are planned to be installed on the Unit 865-11H1 heater and the current emission rate is assumed to be 0.03 lb/MMBtu.
[2] See "RACT Cost Summary" tab for details on the Annualized Cost Factor (ACF).

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Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

Source	**Unit 865-11H1**	
Control	**SNCR**	
Rated Heat Input	**87.3**	**MMBtu/hr**
Number of Burners	**8.0**	**Burners**
Baseline Actual Emissions	**11.47**	**tpy**
Current Emission Rate	**0.030**	**lb/MMBtu**
Control Efficiency	**40%**	
Heater Capacity	**92.1**	**GJ/hr**
Burner Heat Release Rate	**14.3**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

COST COMPONENT:	COST ($)
DIRECT COSTS	
Purchased Equipment Costs	
Equipment Cost (EC)	673,830
Instrumentation (Included in above costs)	- - -
Sales taxes (Included in above costs)	- - -
Freight (Included in above costs)	- - -
Subtotal - Purchased Equipment Costs (PEC)	**673,830**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	- - -
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC)	**673,830**
INDIRECT INSTALLATION COSTS	
Engineering Costs (Included in above costs)	- - -
Construct. & Field Expenses (Included in above costs)	- - -
Contractor Fees (Included in above costs)	- - -
Start-up (Included in above costs)	- - -
Performance Test (Included in above costs)	- - -
Contingency (3% of PEC)	20,215
TOTAL INDIRECT COSTS, IC	**20,215**
TOTAL CAPITAL INVESTMENT (TCI)	**694,045**

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Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		19,086
		19,086
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
Ammonia Cost		1,709
Electricity Cost		0.1
Subtotal - Utilities		**1,709**
TOTAL ANNUAL DIRECT COSTS[a]		**20,796**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**20,796**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		694,045
TOTAL ANNUAL CAPITAL REQUIREMENT		**175,933**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**196,729**

PES Refinery
Heater Firing Rate Increase Plan Approval
Unit 865-11H2 RACT Cost Effectiveness Summary

	A	B	C	D	E	F	G	H	I	J
Control Option	Design Firing (MMBtu/hr)	Current Emission Rate (lb/MMBtu)[1]	Potential Emissions (TPY)	Control Efficiency (%)	Maximum Post Control Emissions @ Design Firing (TPY)	Potential NO_x Reduced (TPY)	2012 Total Capital Cost ($)	2012 O&M Cost ($)	2012 Annualized Cost[2] ($)	2012 Cost Effectiveness ($/Ton)
ULNB & SCR	64.2	0.113	31.8	96%	1.3	30.5	3,631,525	125,523	1,046,078	34,287
SCR	64.2	0.113	31.8	85%	4.8	27.0	3,071,944	110,135	888,841	32,909
ULNB	64.2	0.113	31.8	73%	8.4	23.3	559,581	15,388	157,237	6,737
LNB & SNCR	64.2	0.113	31.8	70%	9.5	22.2	857,483	28,316	245,679	11,045
LNB & FGR	64.2	0.113	31.8	55%	14.3	17.5	512,272	22,250	152,106	8,704
SNCR	64.2	0.113	31.8	40%	19.1	12.7	577,165	20,607	166,913	13,132
Calculation			= A * B * 8760 / 2000		= C * (1 - D)	= C - E			= (G * ACF) + H	= I / F

Notes:
[1] Unit 865-11H2 is projected to be above PADEP presumptive RACT firing limits and assumed NO_x emission rate limit of 0.113 lb/MMBtu is used.
[2] See "RACT Cost Summary" tab for details on the Annualized Cost Factor (ACF).

PES Refinery
Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

Source	**Unit 865-11H2**	
Control	**ULNB & SCR**	
Rated Heat Input	**64.2**	**MMBtu/hr**
Number of Burners	**8.0**	**Burners**
Baseline Actual Emissions	**31.78**	**tpy**
Current Emission Rate	**0.113**	**lb/MMBtu**
Control Efficiency	**96%**	
Heater Capacity	**67.7**	**GJ/hr**
Burner Heat Release Rate	**10.8**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

COST COMPONENT:	COST ($)
DIRECT COSTS - ULNB	
Purchased Equipment Costs	
Equipment Cost (EC)	379,120
Instrumentation (10% of EC)	37,912
Sales taxes (5% of EC)	18,956
Freight (8% of EC)	30,330
Subtotal - Purchased Equipment Costs (PEC)	**466,317**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	---
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC) - ULNB	**466,317**
INDIRECT INSTALLATION COSTS - ULNB	
Engineering Costs (5% of PEC)	23,316
Construct. & Field Expenses (Included in above costs)	---
Contractor Fees (10% of PEC)	46,632
Start-up (1% of PEC)	4,663
Performance Test (1% of PEC)	4,663
Contingency (3% of PEC)	13,990
TOTAL INDIRECT COSTS, IC - ULNB	**93,263**
DIRECT COSTS - SCR	
Purchased Equipment Costs	
Equipment Cost (EC)	2,982,470
Instrumentation (Included in above costs)	---
Sales taxes (Included in above costs)	---
Freight (Included in above costs)	---
Subtotal - Purchased Equipment Costs (PEC)	**2,982,470**
Direct Installation Costs	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	---
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC) - SCR	**2,982,470**
INDIRECT INSTALLATION COSTS - SCR	
Engineering Costs (Included in above costs)	---
Construct. & Field Expenses (Included in above costs)	---
Contractor Fees (Included in above costs)	---
Start-up (Included in above costs)	---
Performance Test (Included in above costs)	---
Contingency (3% of PEC)	89,474
TOTAL INDIRECT COSTS, IC - SCR	**89,474**
TOTAL CAPITAL INVESTMENT (TCI) - ULNB	**559,581**
TOTAL CAPITAL INVESTMENT (TCI) - SCR	**3,071,944**
TOTAL CAPITAL INVESTMENT (TCI)	**3,631,525**

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NOx RACT Control Cost Effectiveness

COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		99,867
		99,867
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
Ammonia Cost		4,735
Catalyst Replacement Cost		20,921
Electricity Cost		0.3
Subtotal - Utilities		**25,656**
TOTAL ANNUAL DIRECT COSTS		**125,523**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**125,523**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		3,631,525
TOTAL ANNUAL CAPITAL REQUIREMENT		**920,555**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**1,046,078**

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NOx RACT Control Cost Effectiveness

Source	**Unit 865-11H2**	
Control	**SCR**	
Rated Heat Input	**64.2**	**MMBtu/hr**
Number of Burners	**8.0**	**Burners**
Baseline Actual Emissions	**31.78**	**tpy**
Current Emission Rate	**0.113**	**lb/MMBtu**
Control Efficiency	**85%**	
Heater Capacity	**67.7**	**GJ/hr**
Burner Heat Release Rate	**10.8**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

COST COMPONENT:	COST ($)
DIRECT COSTS	
Purchased Equipment Costs	
Equipment Cost (EC)	2,982,470
Instrumentation (Included in above costs)	- - -
Sales taxes (Included in above costs)	- - -
Freight (Included in above costs)	- - -
Subtotal - Purchased Equipment Costs (PEC)	**2,982,470**
Direct Installation Costs	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	- - -
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC)	**2,982,470**
INDIRECT INSTALLATION COSTS	
Engineering Costs (Included in above costs)	- - -
Construct. & Field Expenses (Included in above costs)	- - -
Contractor Fees (Included in above costs)	- - -
Start-up (Included in above costs)	- - -
Performance Test (Included in above costs)	- - -
Contingency (3% of PEC)	89,474
TOTAL INDIRECT COSTS, IC	**89,474**
TOTAL CAPITAL INVESTMENT (TCI)	**3,071,944**

PES Refinery
Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		84,478
		84,478
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
Ammonia Cost		4,735
Catalyst Replacement Cost		20,921
Electricity Cost		0.3
Subtotal - Utilities		**25,656**
TOTAL ANNUAL DIRECT COSTS[a]		**110,135**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**110,135**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		3,071,944
TOTAL ANNUAL CAPITAL REQUIREMENT		**778,707**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**888,841**

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NOx RACT Control Cost Effectiveness

Source	**Unit 865-11H2**	
Control	**ULNB**	
Rated Heat Input	**64.2**	**MMBtu/hr**
Number of Burners	**8.0**	**Burners**
Baseline Actual Emissions	**31.78**	**tpy**
Current Emission Rate	**0.113**	**lb/MMBtu**
Control Efficiency	**73%**	
Heater Capacity	**67.7**	**GJ/hr**
Burner Heat Release Rate	**10.8**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

COST COMPONENT:	COST ($)
DIRECT COSTS	
Purchased Equipment Costs	
Equipment Cost (EC)	379,120
Instrumentation (10% of EC)	37,912
Sales taxes (5% of EC)	18,956
Freight (8% of EC)	30,330
Subtotal - Purchased Equipment Costs (PEC)	**466,317**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	- - -
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC)	**466,317**
INDIRECT INSTALLATION COSTS	
Engineering Costs (5% of PEC)	23,316
Construct. & Field Expenses (Included in above costs)	- - -
Contractor Fees (10% of PEC)	46,632
Start-up (1% of PEC)	4,663
Performance Test (1% of PEC)	4,663
Contingency (3% of PEC)	13,990
TOTAL INDIRECT COSTS, IC	**93,263**
TOTAL CAPITAL INVESTMENT (TCI)	**559,581**

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Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		15,388
		15,388
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
None		
Subtotal - Utilities		**0.0**
TOTAL ANNUAL DIRECT COSTS[a]		**15,388**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**15,388**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		559,581
TOTAL ANNUAL CAPITAL REQUIREMENT		**141,848**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**157,237**

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NOx RACT Control Cost Effectiveness

Source	**Unit 865-11H2**	
Control	**LNB & SNCR**	
Rated Heat Input	**64.2**	**MMBtu/hr**
Number of Burners	**8.0**	**Burners**
Baseline Actual Emissions	**31.78**	**tpy**
Current Emission Rate	**0.113**	**lb/MMBtu**
Control Efficiency	**70%**	
Heater Capacity	**67.7**	**GJ/hr**
Burner Heat Release Rate	**10.8**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

COST COMPONENT:	COST ($)
DIRECT COSTS - LNB	
Purchased Equipment Costs	
Equipment Cost (EC)	189,917
Instrumentation (10% of EC)	18,992
Sales taxes (5% of EC)	9,496
Freight (8% of EC)	15,193
Subtotal - Purchased Equipment Costs (PEC)	**233,598**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	---
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC) - LNB	**233,598**
INDIRECT INSTALLATION COSTS - LNB	
Engineering Costs (5% of PEC)	11,680
Construct. & Field Expenses (Included in above costs)	---
Contractor Fees (10% of PEC)	23,360
Start-up (1% of PEC)	2,336
Performance Test (1% of PEC)	2,336
Contingency (3% of PEC)	7,008
TOTAL INDIRECT COSTS, IC - LNB	**46,720**
DIRECT COSTS - SNCR	
Purchased Equipment Costs	
Equipment Cost (EC)	560,355
Instrumentation (Included in above costs)	---
Sales taxes (Included in above costs)	---
Freight (Included in above costs)	---
Subtotal - Purchased Equipment Costs (PEC)	**560,355**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	---
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC) - SNCR	**560,355**
INDIRECT INSTALLATION COSTS - SNCR	
Engineering Costs (Included in above costs)	---
Construct. & Field Expenses (Included in above costs)	---
Contractor Fees (Included in above costs)	---
Start-up (Included in above costs)	---
Performance Test (Included in above costs)	---
Contingency (3% of PEC)	16,811
TOTAL INDIRECT COSTS, IC - SNCR	**16,811**
TOTAL CAPITAL INVESTMENT (TCI) - LNB	**280,318**
TOTAL CAPITAL INVESTMENT (TCI) - SNCR	**577,165**
TOTAL CAPITAL INVESTMENT (TCI)	**857,483**

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NOx RACT Control Cost Effectiveness

COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		23,581
		23,581
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
Ammonia Cost		4,735
Electricity Cost		0.3
Subtotal - Utilities		**4,735**
TOTAL ANNUAL DIRECT COSTS*		**28,316**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**28,316**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		857,483
TOTAL ANNUAL CAPITAL REQUIREMENT		**217,363**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**245,679**

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Source	**Unit 865-11H2**	
Control	**LNB & FGR**	
Rated Heat Input	**64.2**	**MMBtu/hr**
Number of Burners	**8.0**	**Burners**
Baseline Actual Emissions	**31.78**	**tpy**
Current Emission Rate	**0.113**	**lb/MMBtu**
Control Efficiency	**55%**	
Heater Capacity	**67.7**	**GJ/hr**
Burner Heat Release Rate	**10.8**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

COST COMPONENT:	COST ($)
DIRECT COSTS - LNB	
Purchased Equipment Costs	
Equipment Cost (EC)	189,917
Instrumentation (10% of EC)	18,992
Sales taxes (5% of EC)	9,496
Freight (8% of EC)	15,193
Subtotal - Purchased Equipment Costs (PEC)	**233,598**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	- - -
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC) - LNB	**233,598**
INDIRECT INSTALLATION COSTS - LNB	
Engineering Costs (5% of PEC)	11,680
Construct. & Field Expenses (Included in above costs)	- - -
Contractor Fees (10% of PEC)	23,360
Start-up (1% of PEC)	2,336
Performance Test (1% of PEC)	2,336
Contingency (3% of PEC)	7,008
TOTAL INDIRECT COSTS, IC - LNB	**46,720**
DIRECT COSTS - FGR	
Purchased Equipment Costs	
Equipment Cost (EC)	225,197
Instrumentation (Included in above costs)	- - -
Sales taxes (Included in above costs)	- - -
Freight (Included in above costs)	- - -
Subtotal - Purchased Equipment Costs (PEC)	**225,197**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	- - -
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC) - FGR	**225,197**
INDIRECT INSTALLATION COSTS - FGR	
Engineering Costs (Included in above costs)	- - -
Construct. & Field Expenses (Included in above costs)	- - -
Contractor Fees (Included in above costs)	- - -
Start-up (Included in above costs)	- - -
Performance Test (Included in above costs)	- - -
Contingency (3% of PEC)	6,756
TOTAL INDIRECT COSTS, IC - FGR	**6,756**
TOTAL CAPITAL INVESTMENT (TCI) - LNB	**280,318**
TOTAL CAPITAL INVESTMENT (TCI) - FGR	**231,953**
TOTAL CAPITAL INVESTMENT (TCI)	**512,272**

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COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		14,087
		14,087
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
Electricity Cost		8,163
Subtotal - Utilities		**8,163**
TOTAL ANNUAL DIRECT COSTS*		**22,250**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**22,250**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		512,272
TOTAL ANNUAL CAPITAL REQUIREMENT		**129,856**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**152,106**

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Source	**Unit 865-11H2**	
Control	**SNCR**	
Rated Heat Input	**64.2**	**MMBtu/hr**
Number of Burners	**8.0**	**Burners**
Baseline Actual Emissions	**31.78**	**tpy**
Current Emission Rate	**0.113**	**lb/MMBtu**
Control Efficiency	**40%**	
Heater Capacity	**67.7**	**GJ/hr**
Burner Heat Release Rate	**10.8**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

COST COMPONENT:	COST ($)
DIRECT COSTS	
Purchased Equipment Costs	
Equipment Cost (EC)	560,355
Instrumentation (Included in above costs)	- - -
Sales taxes (Included in above costs)	- - -
Freight (Included in above costs)	- - -
Subtotal - Purchased Equipment Costs (PEC)	**560,355**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	- - -
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC)	**560,355**
INDIRECT INSTALLATION COSTS	
Engineering Costs (Included in above costs)	- - -
Construct. & Field Expenses (Included in above costs)	- - -
Contractor Fees (Included in above costs)	- - -
Start-up (Included in above costs)	- - -
Performance Test (Included in above costs)	- - -
Contingency (3% of PEC)	16,811
TOTAL INDIRECT COSTS, IC	**16,811**
TOTAL CAPITAL INVESTMENT (TCI)	**577,165**

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Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		15,872
		15,872
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
Ammonia Cost		4,735
Electricity Cost		0.3
Subtotal - Utilities		**4,735**
TOTAL ANNUAL DIRECT COSTS[a]		**20,607**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**20,607**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		577,165
TOTAL ANNUAL CAPITAL REQUIREMENT		**146,306**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**166,913**

PES Refinery
Heater Firing Rate Increase Plan Approval
Unit 210-H101 RACT Cost Effectiveness Summary

	A	B	C	D	E	F	G	H	I	J
Control Option	Design Firing (MMBtu/hr)	Current Emission Rate (lb/MMBtu)[1]	Potential Emissions (TPY)	Control Efficiency (%)	Maximum Post Control Emissions @ Design Firing (TPY)	Potential NO_x Reduced (TPY)	2012 Total Capital Cost ($)	2012 O&M Cost ($)	2012 Annualized Cost[2] ($)	2012 Cost Effectiveness ($/Ton)
ULNB & SCR	192	0.089	74.8	96%	3.0	71.9	7,613,995	283,106	2,213,176	30,796
SCR	192	0.089	74.8	85%	11.2	63.6	5,940,483	237,084	1,742,936	27,397
LNB & SNCR	192	0.089	74.8	70%	22.5	52.4	10,712,635	305,750	3,021,296	57,667
ULNB	192	0.089	74.8	66%	25.2	49.6	1,673,512	46,022	470,240	9,477
LNB & FGR	192	0.089	74.8	55%	33.7	41.2	NA	NA	NA	NA
SNCR	192	0.089	74.8	40%	44.9	29.9	1,113,678	41,779	324,085	10,825
Calculation			= A * B * 8760 / 2000		= C * (1 - D)	= C - E			= (G * ACF) + H	= I / F

Technical Infeasibilities:
FGR would not physically fit the plot space; therefore, it is infeasible.
Notes:
[1] Current generation UNLB is considered to be 0.03 lb/MMBtu, which represents a 66% reduction from 0.089 lb/MMBtu.
[2] See "RACT Cost Summary" tab for details on the Annualized Cost Factor (ACF).

PES Refinery
Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

Source	**Unit 210-H101**	
Control	**ULNB & SCR**	
Rated Heat Input	**192.0**	**MMBtu/hr**
Number of Burners	**6.0**	**Burners**
Baseline Actual Emissions	**74.85**	**tpy**
Current Emission Rate	**0.089**	**lb/MMBtu**
Control Efficiency	**96%**	
Heater Capacity	**202.6**	**GJ/hr**
Burner Heat Release Rate	**40.4**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

COST COMPONENT:	COST ($)
DIRECT COSTS - ULNB	
Purchased Equipment Costs	
Equipment Cost (EC)	1,133,816
Instrumentation (10% of EC)	113,382
Sales taxes (5% of EC)	56,691
Freight (8% of EC)	90,705
Subtotal - Purchased Equipment Costs (PEC)	**1,394,593**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	---
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC) - ULNB	**1,394,593**
INDIRECT INSTALLATION COSTS - ULNB	
Engineering Costs (5% of PEC)	69,730
Construct. & Field Expenses (Included in above costs)	---
Contractor Fees (10% of PEC)	139,459
Start-up (1% of PEC)	13,946
Performance Test (1% of PEC)	13,946
Contingency (3% of PEC)	41,838
TOTAL INDIRECT COSTS, IC - ULNB	**278,919**
DIRECT COSTS - SCR	
Purchased Equipment Costs	
Equipment Cost (EC)	5,767,459
Instrumentation (Included in above costs)	---
Sales taxes (Included in above costs)	---
Freight (Included in above costs)	---
Subtotal - Purchased Equipment Costs (PEC)	**5,767,459**
Direct Installation Costs	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	---
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC) - SCR	**5,767,459**
INDIRECT INSTALLATION COSTS - SCR	
Engineering Costs (Included in above costs)	---
Construct. & Field Expenses (Included in above costs)	---
Contractor Fees (Included in above costs)	---
Start-up (Included in above costs)	---
Performance Test (Included in above costs)	---
Contingency (3% of PEC)	173,024
TOTAL INDIRECT COSTS, IC - SCR	**173,024**
TOTAL CAPITAL INVESTMENT (TCI) - ULNB	**1,673,512**
TOTAL CAPITAL INVESTMENT (TCI) - SCR	**5,940,483**
TOTAL CAPITAL INVESTMENT (TCI)	**7,613,995**

PES Refinery
Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		209,385
		209,385
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
Ammonia Cost		11,152
Catalyst Replacement Cost		62,568
Electricity Cost		0.8
Subtotal - Utilities		**73,721**
TOTAL ANNUAL DIRECT COSTS		**283,106**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**283,106**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		7,613,995
TOTAL ANNUAL CAPITAL REQUIREMENT		**1,930,071**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**2,213,176**

PES Refinery
Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

Source	**Unit 210-H101**	
Control	**SCR**	
Rated Heat Input	**192.0**	**MMBtu/hr**
Number of Burners	**6.0**	**Burners**
Baseline Actual Emissions	**74.85**	**tpy**
Current Emission Rate	**0.089**	**lb/MMBtu**
Control Efficiency	**85%**	
Heater Capacity	**202.6**	**GJ/hr**
Burner Heat Release Rate	**40.4**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

COST COMPONENT:	COST ($)
DIRECT COSTS	
Purchased Equipment Costs	
Equipment Cost (EC)	5,767,459
Instrumentation (Included in above costs)	- - -
Sales taxes (Included in above costs)	- - -
Freight (Included in above costs)	- - -
Subtotal - Purchased Equipment Costs (PEC)	**5,767,459**
Direct Installation Costs	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	- - -
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC)	**5,767,459**
INDIRECT INSTALLATION COSTS	
Engineering Costs (Included in above costs)	- - -
Construct. & Field Expenses (Included in above costs)	- - -
Contractor Fees (Included in above costs)	- - -
Start-up (Included in above costs)	- - -
Performance Test (Included in above costs)	- - -
Contingency (3% of PEC)	173,024
TOTAL INDIRECT COSTS, IC	**173,024**
TOTAL CAPITAL INVESTMENT (TCI)	**5,940,483**

PES Refinery
Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		163,363
		163,363
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
Ammonia Cost		11,152
Catalyst Replacement Cost		62,568
Electricity Cost		0.8
Subtotal - Utilities		**73,721**
TOTAL ANNUAL DIRECT COSTS[a]		**237,084**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**237,084**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		5,940,483
TOTAL ANNUAL CAPITAL REQUIREMENT		**1,505,852**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**1,742,936**

PES Refinery
Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

Source	**Unit 210-H101**	
Control	**LNB & SNCR**	
Rated Heat Input	**192.0**	**MMBtu/hr**
Number of Burners	**6.0**	**Burners**
Baseline Actual Emissions	**74.85**	**tpy**
Current Emission Rate	**0.089**	**lb/MMBtu**
Control Efficiency	**70%**	
Heater Capacity	**202.6**	**GJ/hr**
Burner Heat Release Rate	**40.4**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

COST COMPONENT:	COST ($)
DIRECT COSTS - LNB	
Purchased Equipment Costs	
Equipment Cost (EC)	6,503,358
Instrumentation (10% of EC)	650,336
Sales taxes (5% of EC)	325,168
Freight (8% of EC)	520,269
Subtotal - Purchased Equipment Costs (PEC)	**7,999,131**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	---
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC) - LNB	**7,999,131**
INDIRECT INSTALLATION COSTS - LNB	
Engineering Costs (5% of PEC)	399,957
Construct. & Field Expenses (Included in above costs)	---
Contractor Fees (10% of PEC)	799,913
Start-up (1% of PEC)	79,991
Performance Test (1% of PEC)	79,991
Contingency (3% of PEC)	239,974
TOTAL INDIRECT COSTS, IC - LNB	**1,599,826**
DIRECT COSTS - SNCR	
Purchased Equipment Costs	
Equipment Cost (EC)	1,081,241
Instrumentation (Included in above costs)	---
Sales taxes (Included in above costs)	---
Freight (Included in above costs)	---
Subtotal - Purchased Equipment Costs (PEC)	**1,081,241**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	---
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC) - SNCR	**1,081,241**
INDIRECT INSTALLATION COSTS - SNCR	
Engineering Costs (Included in above costs)	---
Construct. & Field Expenses (Included in above costs)	---
Contractor Fees (Included in above costs)	---
Start-up (Included in above costs)	---
Performance Test (Included in above costs)	---
Contingency (3% of PEC)	32,437
TOTAL INDIRECT COSTS, IC - SNCR	**32,437**
TOTAL CAPITAL INVESTMENT (TCI) - LNB	**9,598,957**
TOTAL CAPITAL INVESTMENT (TCI) - SNCR	**1,113,678**
TOTAL CAPITAL INVESTMENT (TCI)	**10,712,635**

PES Refinery
Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		294,597
		294,597
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
Ammonia Cost		11,152
Electricity Cost		0.8
Subtotal - Utilities		**11,153**
TOTAL ANNUAL DIRECT COSTS[a]		**305,750**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**305,750**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		10,712,635
TOTAL ANNUAL CAPITAL REQUIREMENT		**2,715,545**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**3,021,296**

PES Refinery
Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

Source	**Unit 210-H101**	
Control	**ULNB**	
Rated Heat Input	**192.0**	**MMBtu/hr**
Number of Burners	**6.0**	**Burners**
Baseline Actual Emissions	**74.85**	**tpy**
Current Emission Rate	**0.089**	**lb/MMBtu**
Control Efficiency	**66%**	
Heater Capacity	**202.6**	**GJ/hr**
Burner Heat Release Rate	**40.4**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

COST COMPONENT:	COST ($)
DIRECT COSTS	
Purchased Equipment Costs	
Equipment Cost (EC)	1,133,816
Instrumentation (10% of EC)	113,382
Sales taxes (5% of EC)	56,691
Freight (8% of EC)	90,705
Subtotal - Purchased Equipment Costs (PEC)	**1,394,593**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	- - -
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC)	**1,394,593**
INDIRECT INSTALLATION COSTS	
Engineering Costs (5% of PEC)	69,730
Construct. & Field Expenses (Included in above costs)	- - -
Contractor Fees (10% of PEC)	139,459
Start-up (1% of PEC)	13,946
Performance Test (1% of PEC)	13,946
Contingency (3% of PEC)	41,838
TOTAL INDIRECT COSTS, IC	**278,919**
TOTAL CAPITAL INVESTMENT (TCI)	**1,673,512**

PES Refinery
Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		46,022
		46,022
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
None		
Subtotal - Utilities		**0.0**
TOTAL ANNUAL DIRECT COSTS[a]		**46,022**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**46,022**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		1,673,512
TOTAL ANNUAL CAPITAL REQUIREMENT		**424,218**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**470,240**

PES Refinery
Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

Source	**Unit 210-H101**	
Control	**SNCR**	
Rated Heat Input	**192.0**	**MMBtu/hr**
Number of Burners	**6.0**	**Burners**
Baseline Actual Emissions	**74.85**	**tpy**
Current Emission Rate	**0.089**	**lb/MMBtu**
Control Efficiency	**40%**	
Heater Capacity	**202.6**	**GJ/hr**
Burner Heat Release Rate	**40.4**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

COST COMPONENT:		COST ($)
DIRECT COSTS		
	Purchased Equipment Costs	
	Equipment Cost (EC)	1,081,241
	Instrumentation (Included in above costs)	---
	Sales taxes (Included in above costs)	---
	Freight (Included in above costs)	---
	Subtotal - Purchased Equipment Costs (PEC)	**1,081,241**
	Direct Installation Costs (Based on Vendor Discussion)	
	Foundations & supports; handling & erection; electrical; piping; etc.	0
	Site Preparation / Buildings- Included above	---
	Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC)		**1,081,241**
INDIRECT INSTALLATION COSTS		
	Engineering Costs (Included in above costs)	---
	Construct. & Field Expenses (Included in above costs)	---
	Contractor Fees (Included in above costs)	---
	Start-up (Included in above costs)	---
	Performance Test (Included in above costs)	---
	Contingency (3% of PEC)	32,437
TOTAL INDIRECT COSTS, IC		**32,437**
TOTAL CAPITAL INVESTMENT (TCI)		**1,113,678**

PES Refinery
Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		30,626
		30,626
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
Ammonia Cost		11,152
Electricity Cost		0.8
Subtotal - Utilities		**11,153**
TOTAL ANNUAL DIRECT COSTS[a]		**41,779**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**41,779**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		1,113,678
TOTAL ANNUAL CAPITAL REQUIREMENT		**282,306**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**324,085**

PES Refinery
Heater Firing Rate Increase Plan Approval
Unit 210-H201 RACT Cost Effectiveness Summary

	A	B	C	D	E	F	G	H	I	J
Control Option	Design Firing (MMBtu/hr)	Current Emission Rate (lb/MMBtu)[1]	Potential Emissions (TPY)	Control Efficiency (%)	Maximum Post Control Emissions @ Design Firing (TPY)	Potential NO_x Reduced (TPY)	2012 Total Capital Cost ($)	2012 O&M Cost ($)	2012 Annualized Cost[2] ($)	2012 Cost Effectiveness ($/Ton)
ULNB & SCR	254	0.03	33.4	96%	1.3	32.0	NA	NA	NA	NA
SCR	254	0.03	33.4	85%	5.0	28.4	NA	NA	NA	NA
LNB & SNCR	254	0.03	33.4	70%	10.0	23.4	13,474,367	375,519	3,791,135	162,271
LNB & FGR	254	0.03	33.4	55%	15.0	18.4	NA	NA	NA	NA
SNCR	254	0.03	33.4	40%	20.0	13.4	1,317,284	41,199	375,117	28,098
ULNB	254	0.03	33.4	0%	33.4	0.0	NA	NA	NA	NA
Calculation			= A * B * 8760 / 2000		= C * (1 - D)	= C - E			= (G * ACF) + H	= I / F

Technical Infeasibilities:
SCR would not physically fit the plot space and there is not adequate pressure to overcome the SCR pressure drop; therefore, SCR is infeasible.
FGR installation would require the installation of mechanical draft burners, which is a major re-design of the unit; therefore FGR is infeasible.
Notes:
[1] ULNB is already installed on the Unit 210-H201 heater.
[2] See "RACT Cost Summary" tab for details on the Annualized Cost Factor (ACF).

PES Refinery
Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

Source	**Unit 210-H201**	
Control	**LNB & SNCR**	
Rated Heat Input	**254.0**	**MMBtu/hr**
Number of Burners	**8.0**	**Burners**
Baseline Actual Emissions	**33.38**	**tpy**
Current Emission Rate	**0.030**	**lb/MMBtu**
Control Efficiency	**70%**	
Heater Capacity	**268.0**	**GJ/hr**
Burner Heat Release Rate	**39.8**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

COST COMPONENT:	COST ($)
DIRECT COSTS - LNB	
Purchased Equipment Costs	
Equipment Cost (EC)	8,236,506
Instrumentation (10% of EC)	823,651
Sales taxes (5% of EC)	411,825
Freight (8% of EC)	658,920
Subtotal - Purchased Equipment Costs (PEC)	**10,130,902**
Direct Installotion Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	- - -
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC) - LNB	**10,130,902**
INDIRECT INSTALLATION COSTS - LNB	
Engineering Costs (5% of PEC)	506,545
Construct. & Field Expenses (Included in above costs)	- - -
Contractor Fees (10% of PEC)	1,013,090
Start-up (1% of PEC)	101,309
Performance Test (1% of PEC)	101,309
Contingency (3% of PEC)	303,927
TOTAL INDIRECT COSTS, IC - LNB	**2,026,180**
DIRECT COSTS - SNCR	
Purchased Equipment Costs	
Equipment Cost (EC)	1,278,916
Instrumentation (Included in above costs)	- - -
Sales taxes (Included in above costs)	- - -
Freight (Included in above costs)	- - -
Subtotal - Purchased Equipment Costs (PEC)	**1,278,916**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	- - -
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC) - SNCR	**1,278,916**
INDIRECT INSTALLATION COSTS - SNCR	
Engineering Costs (Included in above costs)	- - -
Construct. & Field Expenses (Included in above costs)	- - -
Contractor Fees (Included in above costs)	- - -
Start-up (Included in above costs)	- - -
Performance Test (Included in above costs)	- - -
Contingency (3% of PEC)	38,367
TOTAL INDIRECT COSTS, IC - SNCR	**38,367**
TOTAL CAPITAL INVESTMENT (TCI) - LNB	**12,157,083**
TOTAL CAPITAL INVESTMENT (TCI) - SNCR	**1,317,284**
TOTAL CAPITAL INVESTMENT (TCI)	**13,474,367**

PES Refinery
Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		370,545
		370,545
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
Ammonia Cost		4,973
Electricity Cost		0.4
Subtotal - Utilities		**4,973**
TOTAL ANNUAL DIRECT COSTS[a]		**375,519**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**375,519**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		13,474,367
TOTAL ANNUAL CAPITAL REQUIREMENT		**3,415,616**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**3,791,135**

PES Refinery
Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

Source	**Unit 210-H201**	
Control	**SNCR**	
Rated Heat Input	**254.0**	**MMBtu/hr**
Number of Burners	**8.0**	**Burners**
Baseline Actual Emissions	**33.38**	**tpy**
Current Emission Rate	**0.030**	**lb/MMBtu**
Control Efficiency	**40%**	
Heater Capacity	**268.0**	**GJ/hr**
Burner Heat Release Rate	**39.8**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

COST COMPONENT:	COST ($)
DIRECT COSTS	
Purchased Equipment Costs	
Equipment Cost (EC)	1,278,916
Instrumentation (Included in above costs)	- - -
Sales taxes (Included in above costs)	- - -
Freight (Included in above costs)	- - -
Subtotal - Purchased Equipment Costs (PEC)	**1,278,916**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	- - -
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC)	**1,278,916**
INDIRECT INSTALLATION COSTS	
Engineering Costs (Included in above costs)	- - -
Construct. & Field Expenses (Included in above costs)	- - -
Contractor Fees (Included in above costs)	- - -
Start-up (Included in above costs)	- - -
Performance Test (Included in above costs)	- - -
Contingency (3% of PEC)	38,367
TOTAL INDIRECT COSTS, IC	**38,367**
TOTAL CAPITAL INVESTMENT (TCI)	**1,317,284**

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COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		36,225
		36,225
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
Ammonia Cost		4,973
Electricity Cost		0.4
Subtotal - Utilities		**4,973**
TOTAL ANNUAL DIRECT COSTS[a]		**41,199**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**41,199**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		1,317,284
TOTAL ANNUAL CAPITAL REQUIREMENT		**333,918**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**375,117**

PES Refinery
Heater Firing Rate Increase Plan Approval
Unit 866-12H1 RACT Cost Effectiveness Summary

	A	B	C	D	E	F	G	H	I	J
Control Option	Design Firing (MMBtu/hr)	Current Emission Rate (lb/MMBtu)[1]	Potential Emissions (TPY)	Control Efficiency (%)	Maximum Post Control Emissions @ Design Firing (TPY)	Potential NO_x Reduced (TPY)	2012 Total Capital Cost ($)	2012 O&M Cost ($)	2012 Annualized Cost[2] ($)	2012 Cost Effectiveness ($/Ton)
ULNB & SCR	61.2	0.113	30.3	96%	1.2	29.1	3,518,199	121,208	1,013,036	34,831
SCR	61.2	0.113	30.3	85%	4.5	25.7	2,984,767	106,538	863,147	33,524
ULNB	61.2	0.113	30.3	73%	8.0	22.2	533,432	14,669	149,889	6,737
LNB & SNCR	61.2	0.113	30.3	70%	9.1	21.2	838,966	27,585	240,255	11,331
LNB & FGR	61.2	0.113	30.3	55%	13.6	16.7	503,525	21,628	149,267	8,960
SNCR	61.2	0.113	30.3	40%	18.2	12.1	560,828	19,936	162,101	13,379
Calculation			= A * B * 8760 / 2000		= C * (1 - D)	= C - E			= (G * ACF) + H	= I / F

Notes:

[1] Unit 866-12H1 is projected to be above PADEP presumptive RACT firing limits and assumed NO_x emission rate limit of 0.113 lb/MMBtu is used.

[2] See "RACT Cost Summary" tab for details on the Annualized Cost Factor (ACF).

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Source	**Unit 866-12H1**	
Control	**ULNB & SCR**	
Rated Heat Input	**61.2**	**MMBtu/hr**
Number of Burners	**6.0**	**Burners**
Baseline Actual Emissions	**30.29**	**tpy**
Current Emission Rate	**0.113**	**lb/MMBtu**
Control Efficiency	**96%**	
Heater Capacity	**64.6**	**GJ/hr**
Burner Heat Release Rate	**13.8**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

COST COMPONENT:	COST ($)
DIRECT COSTS - ULNB	
Purchased Equipment Costs	
Equipment Cost (EC)	361,404
Instrumentation (10% of EC)	36,140
Sales taxes (5% of EC)	18,070
Freight (8% of EC)	28,912
Subtotal - Purchased Equipment Costs (PEC)	**444,527**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	---
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC) - ULNB	**444,527**
INDIRECT INSTALLATION COSTS - ULNB	
Engineering Costs (5% of PEC)	22,226
Construct. & Field Expenses (Included in above costs)	---
Contractor Fees (10% of PEC)	44,453
Start-up (1% of PEC)	4,445
Performance Test (1% of PEC)	4,445
Contingency (3% of PEC)	13,336
TOTAL INDIRECT COSTS, IC - ULNB	**88,905**
DIRECT COSTS - SCR	
Purchased Equipment Costs	
Equipment Cost (EC)	2,897,832
Instrumentation (Included in above costs)	---
Sales taxes (Included in above costs)	---
Freight (Included in above costs)	---
Subtotal - Purchased Equipment Costs (PEC)	**2,897,832**
Direct Installation Costs	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	---
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC) - SCR	**2,897,832**
INDIRECT INSTALLATION COSTS - SCR	
Engineering Costs (Included in above costs)	---
Construct. & Field Expenses (Included in above costs)	---
Contractor Fees (Included in above costs)	---
Start-up (Included in above costs)	---
Performance Test (Included in above costs)	---
Contingency (3% of PEC)	86,935
TOTAL INDIRECT COSTS, IC - SCR	**86,935**
TOTAL CAPITAL INVESTMENT (TCI) - ULNB	**533,432**
TOTAL CAPITAL INVESTMENT (TCI) - SCR	**2,984,767**
TOTAL CAPITAL INVESTMENT (TCI)	**3,518,199**

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COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		96,750
		96,750
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
Ammonia Cost		4,513
Catalyst Replacement Cost		19,943
Electricity Cost		0.3
Subtotal - Utilities		**24,457**
TOTAL ANNUAL DIRECT COSTS		**121,208**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**121,208**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		3,518,199
TOTAL ANNUAL CAPITAL REQUIREMENT		**891,828**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**1,013,036**

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Source	**Unit 866-12H1**	
Control	**SCR**	
Rated Heat Input	**61.2**	**MMBtu/hr**
Number of Burners	**6.0**	**Burners**
Baseline Actual Emissions	**30.29**	**tpy**
Current Emission Rate	**0.113**	**lb/MMBtu**
Control Efficiency	**85%**	
Heater Capacity	**64.6**	**GJ/hr**
Burner Heat Release Rate	**13.8**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

	COST COMPONENT:	**COST ($)**
DIRECT COSTS		
	Purchased Equipment Costs	
	Equipment Cost (EC)	2,897,832
	Instrumentation (Included in above costs)	- - -
	Sales taxes (Included in above costs)	- - -
	Freight (Included in above costs)	- - -
	Subtotal - Purchased Equipment Costs (PEC)	**2,897,832**
	Direct Installation Costs	
	Foundations & supports; handling & erection; electrical; piping; etc.	0
	Site Preparation / Buildings- Included above	- - -
	Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC)		**2,897,832**
INDIRECT INSTALLATION COSTS		
	Engineering Costs (Included in above costs)	- - -
	Construct. & Field Expenses (Included in above costs)	- - -
	Contractor Fees (Included in above costs)	- - -
	Start-up (Included in above costs)	- - -
	Performance Test (Included in above costs)	- - -
	Contingency (3% of PEC)	86,935
TOTAL INDIRECT COSTS, IC		**86,935**
TOTAL CAPITAL INVESTMENT (TCI)		**2,984,767**

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COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		82,081
		82,081
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
Ammonia Cost		4,513
Catalyst Replacement Cost		19,943
Electricity Cost		0.3
Subtotal - Utilities		**24,457**
TOTAL ANNUAL DIRECT COSTS[a]		**106,538**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**106,538**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		2,984,767
TOTAL ANNUAL CAPITAL REQUIREMENT		**756,608**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**863,147**

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Source	**Unit 866-12H1**	
Control	**ULNB**	
Rated Heat Input	**61.2**	**MMBtu/hr**
Number of Burners	**6.0**	**Burners**
Baseline Actual Emissions	**30.29**	**tpy**
Current Emission Rate	**0.113**	**lb/MMBtu**
Control Efficiency	**73%**	
Heater Capacity	**64.6**	**GJ/hr**
Burner Heat Release Rate	**13.8**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

COST COMPONENT:	COST ($)
DIRECT COSTS	
Purchased Equipment Costs	
Equipment Cost (EC)	361,404
Instrumentation (10% of EC)	36,140
Sales taxes (5% of EC)	18,070
Freight (8% of EC)	28,912
Subtotal - Purchased Equipment Costs (PEC)	**444,527**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	---
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC)	**444,527**
INDIRECT INSTALLATION COSTS	
Engineering Costs (5% of PEC)	22,226
Construct. & Field Expenses (Included in above costs)	---
Contractor Fees (10% of PEC)	44,453
Start-up (1% of PEC)	4,445
Performance Test (1% of PEC)	4,445
Contingency (3% of PEC)	13,336
TOTAL INDIRECT COSTS, IC	**88,905**
TOTAL CAPITAL INVESTMENT (TCI)	**533,432**

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COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		14,669
		14,669
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
None		
Subtotal - Utilities		**0.0**
TOTAL ANNUAL DIRECT COSTS[a]		**14,669**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**14,669**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		533,432
TOTAL ANNUAL CAPITAL REQUIREMENT		**135,220**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**149,889**

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Source	**Unit 866-12H1**	
Control	**LNB & SNCR**	
Rated Heat Input	**61.2**	**MMBtu/hr**
Number of Burners	**6.0**	**Burners**
Baseline Actual Emissions	**30.29**	**tpy**
Current Emission Rate	**0.113**	**lb/MMBtu**
Control Efficiency	**70%**	
Heater Capacity	**64.6**	**GJ/hr**
Burner Heat Release Rate	**13.8**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

COST COMPONENT:	COST ($)
DIRECT COSTS - LNB	
Purchased Equipment Costs	
Equipment Cost (EC)	188,440
Instrumentation (10% of EC)	18,844
Sales taxes (5% of EC)	9,422
Freight (8% of EC)	15,075
Subtotal - Purchased Equipment Costs (PEC)	**231,781**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	- - -
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC) - LNB	**231,781**
INDIRECT INSTALLATION COSTS - LNB	
Engineering Costs (5% of PEC)	11,589
Construct. & Field Expenses (Included in above costs)	- - -
Contractor Fees (10% of PEC)	23,178
Start-up (1% of PEC)	2,318
Performance Test (1% of PEC)	2,318
Contingency (3% of PEC)	6,953
TOTAL INDIRECT COSTS, IC - LNB	**46,356**
DIRECT COSTS - SNCR	
Purchased Equipment Costs	
Equipment Cost (EC)	544,494
Instrumentation (Included in above costs)	- - -
Sales taxes (Included in above costs)	- - -
Freight (Included in above costs)	- - -
Subtotal - Purchased Equipment Costs (PEC)	**544,494**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	- - -
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC) - SNCR	**544,494**
INDIRECT INSTALLATION COSTS - SNCR	
Engineering Costs (Included in above costs)	- - -
Construct. & Field Expenses (Included in above costs)	- - -
Contractor Fees (Included in above costs)	- - -
Start-up (Included in above costs)	- - -
Performance Test (Included in above costs)	- - -
Contingency (3% of PEC)	16,335
TOTAL INDIRECT COSTS, IC - SNCR	**16,335**
TOTAL CAPITAL INVESTMENT (TCI) - LNB	**278,137**
TOTAL CAPITAL INVESTMENT (TCI) - SNCR	**560,828**
TOTAL CAPITAL INVESTMENT (TCI)	**838,966**

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COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		23,072
		23,072
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
Ammonia Cost		4,513
Electricity Cost		0.3
Subtotal - Utilities		**4,514**
TOTAL ANNUAL DIRECT COSTS*		**27,585**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**27,585**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		838,966
TOTAL ANNUAL CAPITAL REQUIREMENT		**212,669**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**240,255**

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Source	**Unit 866-12H1**	
Control	**LNB & FGR**	
Rated Heat Input	**61.2**	**MMBtu/hr**
Number of Burners	**6.0**	**Burners**
Baseline Actual Emissions	**30.29**	**tpy**
Current Emission Rate	**0.113**	**lb/MMBtu**
Control Efficiency	**55%**	
Heater Capacity	**64.6**	**GJ/hr**
Burner Heat Release Rate	**13.8**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

COST COMPONENT:	COST ($)
DIRECT COSTS - LNB	
Purchased Equipment Costs	
Equipment Cost (EC)	188,440
Instrumentation (10% of EC)	18,844
Sales taxes (5% of EC)	9,422
Freight (8% of EC)	15,075
Subtotal - Purchased Equipment Costs (PEC)	**231,781**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	---
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC) - LNB	**231,781**
INDIRECT INSTALLATION COSTS - LNB	
Engineering Costs (5% of PEC)	11,589
Construct. & Field Expenses (Included in above costs)	---
Contractor Fees (10% of PEC)	23,178
Start-up (1% of PEC)	2,318
Performance Test (1% of PEC)	2,318
Contingency (3% of PEC)	6,953
TOTAL INDIRECT COSTS, IC - LNB	**46,356**
DIRECT COSTS - FGR	
Purchased Equipment Costs	
Equipment Cost (EC)	218,823
Instrumentation (Included in above costs)	---
Sales taxes (Included in above costs)	---
Freight (Included in above costs)	---
Subtotal - Purchased Equipment Costs (PEC)	**218,823**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	---
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC) - FGR	**218,823**
INDIRECT INSTALLATION COSTS - FGR	
Engineering Costs (Included in above costs)	---
Construct. & Field Expenses (Included in above costs)	---
Contractor Fees (Included in above costs)	---
Start-up (Included in above costs)	---
Performance Test (Included in above costs)	---
Contingency (3% of PEC)	6,565
TOTAL INDIRECT COSTS, IC - FGR	**6,565**
TOTAL CAPITAL INVESTMENT (TCI) - LNB	**278,137**
TOTAL CAPITAL INVESTMENT (TCI) - FGR	**225,388**
TOTAL CAPITAL INVESTMENT (TCI)	**503,525**

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COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		13,847
		13,847
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
Electricity Cost		7,781
Subtotal - Utilities		**7,781**
TOTAL ANNUAL DIRECT COSTS*		**21,628**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**21,628**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		503,525
TOTAL ANNUAL CAPITAL REQUIREMENT		**127,639**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**149,267**

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Source	**Unit 866-12H1**	
Control	**SNCR**	
Rated Heat Input	**61.2**	**MMBtu/hr**
Number of Burners	**6.0**	**Burners**
Baseline Actual Emissions	**30.29**	**tpy**
Current Emission Rate	**0.113**	**lb/MMBtu**
Control Efficiency	**40%**	
Heater Capacity	**64.6**	**GJ/hr**
Burner Heat Release Rate	**13.8**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

COST COMPONENT:	COST ($)
DIRECT COSTS	
Purchased Equipment Costs	
Equipment Cost (EC)	544,494
Instrumentation (Included in above costs)	- - -
Sales taxes (Included in above costs)	- - -
Freight (Included in above costs)	- - -
Subtotal - Purchased Equipment Costs (PEC)	**544,494**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	- - -
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC)	**544,494**
INDIRECT INSTALLATION COSTS	
Engineering Costs (Included in above costs)	- - -
Construct. & Field Expenses (Included in above costs)	- - -
Contractor Fees (Included in above costs)	- - -
Start-up (Included in above costs)	- - -
Performance Test (Included in above costs)	- - -
Contingency (3% of PEC)	16,335
TOTAL INDIRECT COSTS, IC	**16,335**
TOTAL CAPITAL INVESTMENT (TCI)	**560,828**

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COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		15,423
		15,423
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
Ammonia Cost		4,513
Electricity Cost		0.3
Subtotal - Utilities		**4,514**
TOTAL ANNUAL DIRECT COSTS[a]		**19,936**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**19,936**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		560,828
TOTAL ANNUAL CAPITAL REQUIREMENT		**142,164**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**162,101**

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Unit 868-8H101 RACT Cost Effectiveness Summary

	A	B	C	D	E	F	G	H	I	J
Control Option	Design Firing (MMBtu/hr)	Current Emission Rate (lb/MMBtu)[1]	Potential Emissions (TPY)	Control Efficiency (%)	Maximum Post Control Emissions @ Design Firing (TPY)	Potential NO_x Reduced (TPY)	2012 Total Capital Cost ($)	2012 O&M Cost ($)	2012 Annualized Cost[2] ($)	2012 Cost Effectiveness ($/Ton)
ULNB & SCR	60	0.113	29.7	96%	1.2	28.5	3,472,395	119,468	999,686	35,060
SCR	60	0.113	29.7	85%	4.5	25.2	2,949,422	105,087	852,736	33,782
ULNB	60	0.113	29.7	73%	7.9	21.8	522,973	14,382	146,950	6,737
LNB & SNCR	60	0.113	29.7	70%	8.9	20.8	1,057,946	33,519	301,697	14,513
LNB & FGR	60	0.113	29.7	55%	13.4	16.3	726,468	27,607	211,759	12,965
SNCR	60	0.113	29.7	40%	17.8	11.9	554,204	19,666	160,151	13,482
Calculation			= A * B * 8760 / 2000		= C * (1 - D)	= C - E			= (G * ACF) + H	= I / F

Notes:
[1] Unit 868-8H101 is projected to be above PADEP presumptive RACT firing limits and assumed NO_x emission rate limit of 0.113 lb/MMBtu is used.
[2] See "RACT Cost Summary" tab for details on the Annualized Cost Factor (ACF).

PES Refinery
Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

Source	**Unit 868-8H101**	
Control	**ULNB & SCR**	
Rated Heat Input	**60.0**	**MMBtu/hr**
Number of Burners	**4.0**	**Burners**
Baseline Actual Emissions	**29.70**	**tpy**
Current Emission Rate	**0.113**	**lb/MMBtu**
Control Efficiency	**96%**	
Heater Capacity	**63.3**	**GJ/hr**
Burner Heat Release Rate	**20.3**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

COST COMPONENT:	COST ($)
DIRECT COSTS - ULNB	
Purchased Equipment Costs	
Equipment Cost (EC)	354,317
Instrumentation (10% of EC)	35,432
Sales taxes (5% of EC)	17,716
Freight (8% of EC)	28,345
Subtotal - Purchased Equipment Costs (PEC)	**435,810**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	---
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC) - ULNB	**435,810**
INDIRECT INSTALLATION COSTS - ULNB	
Engineering Costs (5% of PEC)	21,791
Construct. & Field Expenses (Included in above costs)	---
Contractor Fees (10% of PEC)	43,581
Start-up (1% of PEC)	4,358
Performance Test (1% of PEC)	4,358
Contingency (3% of PEC)	13,074
TOTAL INDIRECT COSTS, IC - ULNB	**87,162**
DIRECT COSTS - SCR	
Purchased Equipment Costs	
Equipment Cost (EC)	2,863,517
Instrumentation (Included in above costs)	---
Sales taxes (Included in above costs)	---
Freight (Included in above costs)	---
Subtotal - Purchased Equipment Costs (PEC)	**2,863,517**
Direct Installation Costs	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	---
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC) - SCR	**2,863,517**
INDIRECT INSTALLATION COSTS - SCR	
Engineering Costs (Included in above costs)	---
Construct. & Field Expenses (Included in above costs)	---
Contractor Fees (Included in above costs)	---
Start-up (Included in above costs)	---
Performance Test (Included in above costs)	---
Contingency (3% of PEC)	85,906
TOTAL INDIRECT COSTS, IC - SCR	**85,906**
TOTAL CAPITAL INVESTMENT (TCI) - ULNB	**522,973**
TOTAL CAPITAL INVESTMENT (TCI) - SCR	**2,949,422**
TOTAL CAPITAL INVESTMENT (TCI)	**3,472,395**

PES Refinery
Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		95,491
		95,491
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
Ammonia Cost		4,425
Catalyst Replacement Cost		19,552
Electricity Cost		0.3
Subtotal - Utilities		**23,978**
TOTAL ANNUAL DIRECT COSTS		**119,468**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**119,468**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		3,472,395
TOTAL ANNUAL CAPITAL REQUIREMENT		**880,217**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**999,686**

PES Refinery
Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

Source	**Unit 868-8H101**	
Control	**SCR**	
Rated Heat Input	**60.0**	**MMBtu/hr**
Number of Burners	**4.0**	**Burners**
Baseline Actual Emissions	**29.70**	**tpy**
Current Emission Rate	**0.113**	**lb/MMBtu**
Control Efficiency	**85%**	
Heater Capacity	**63.3**	**GJ/hr**
Burner Heat Release Rate	**20.3**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

COST COMPONENT:	COST ($)
DIRECT COSTS	
Purchased Equipment Costs	
Equipment Cost (EC)	2,863,517
Instrumentation (Included in above costs)	---
Sales taxes (Included in above costs)	---
Freight (Included in above costs)	---
Subtotal - Purchased Equipment Costs (PEC)	**2,863,517**
Direct Installation Costs	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	---
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC)	**2,863,517**
INDIRECT INSTALLATION COSTS	
Engineering Costs (Included in above costs)	---
Construct. & Field Expenses (Included in above costs)	---
Contractor Fees (Included in above costs)	---
Start-up (Included in above costs)	---
Performance Test (Included in above costs)	---
Contingency (3% of PEC)	85,906
TOTAL INDIRECT COSTS, IC	**85,906**
TOTAL CAPITAL INVESTMENT (TCI)	**2,949,422**

PES Refinery
Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		81,109
		81,109
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
Ammonia Cost		4,425
Catalyst Replacement Cost		19,552
Electricity Cost		0.3
Subtotal - Utilities		**23,978**
TOTAL ANNUAL DIRECT COSTS[a]		**105,087**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**105,087**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		2,949,422
TOTAL ANNUAL CAPITAL REQUIREMENT		**747,649**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**852,736**

PES Refinery
Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

Source	**Unit 868-8H101**	
Control	**ULNB**	
Rated Heat Input	**60.0**	**MMBtu/hr**
Number of Burners	**4.0**	**Burners**
Baseline Actual Emissions	**29.70**	**tpy**
Current Emission Rate	**0.113**	**lb/MMBtu**
Control Efficiency	**73%**	
Heater Capacity	**63.3**	**GJ/hr**
Burner Heat Release Rate	**20.3**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

COST COMPONENT:	COST ($)
DIRECT COSTS	
Purchased Equipment Costs	
Equipment Cost (EC)	354,317
Instrumentation (10% of EC)	35,432
Sales taxes (5% of EC)	17,716
Freight (8% of EC)	28,345
Subtotal - Purchased Equipment Costs (PEC)	**435,810**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	- - -
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC)	**435,810**
INDIRECT INSTALLATION COSTS	
Engineering Costs (5% of PEC)	21,791
Construct. & Field Expenses (Included in above costs)	- - -
Contractor Fees (10% of PEC)	43,581
Start-up (1% of PEC)	4,358
Performance Test (1% of PEC)	4,358
Contingency (3% of PEC)	13,074
TOTAL INDIRECT COSTS, IC	**87,162**
TOTAL CAPITAL INVESTMENT (TCI)	**522,973**

PES Refinery
Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		14,382
		14,382
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
None		
Subtotal - Utilities		**0.0**
TOTAL ANNUAL DIRECT COSTS[a]		**14,382**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**14,382**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		522,973
TOTAL ANNUAL CAPITAL REQUIREMENT		**132,568**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**146,950**

PES Refinery
Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

Source	**Unit 868-8H101**	
Control	**LNB & SNCR**	
Rated Heat Input	**60.0**	**MMBtu/hr**
Number of Burners	**4.0**	**Burners**
Baseline Actual Emissions	**29.70**	**tpy**
Current Emission Rate	**0.113**	**lb/MMBtu**
Control Efficiency	**70%**	
Heater Capacity	**63.3**	**GJ/hr**
Burner Heat Release Rate	**20.3**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

COST COMPONENT:	COST ($)
DIRECT COSTS - LNB	
Purchased Equipment Costs	
Equipment Cost (EC)	341,289
Instrumentation (10% of EC)	34,129
Sales taxes (5% of EC)	17,064
Freight (8% of EC)	27,303
Subtotal - Purchased Equipment Costs (PEC)	**419,785**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	---
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC) - LNB	**419,785**
INDIRECT INSTALLATION COSTS - LNB	
Engineering Costs (5% of PEC)	20,989
Construct. & Field Expenses (Included in above costs)	---
Contractor Fees (10% of PEC)	41,979
Start-up (1% of PEC)	4,198
Performance Test (1% of PEC)	4,198
Contingency (3% of PEC)	12,594
TOTAL INDIRECT COSTS, IC - LNB	**83,957**
DIRECT COSTS - SNCR	
Purchased Equipment Costs	
Equipment Cost (EC)	538,062
Instrumentation (Included in above costs)	---
Sales taxes (Included in above costs)	---
Freight (Included in above costs)	---
Subtotal - Purchased Equipment Costs (PEC)	**538,062**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	---
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC) - SNCR	**538,062**
INDIRECT INSTALLATION COSTS - SNCR	
Engineering Costs (Included in above costs)	---
Construct. & Field Expenses (Included in above costs)	---
Contractor Fees (Included in above costs)	---
Start-up (Included in above costs)	---
Performance Test (Included in above costs)	---
Contingency (3% of PEC)	16,142
TOTAL INDIRECT COSTS, IC - SNCR	**16,142**
TOTAL CAPITAL INVESTMENT (TCI) - LNB	**503,742**
TOTAL CAPITAL INVESTMENT (TCI) - SNCR	**554,204**
TOTAL CAPITAL INVESTMENT (TCI)	**1,057,946**

PES Refinery
Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		29,094
		29,094
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
Ammonia Cost		4,425
Electricity Cost		0.3
Subtotal - Utilities		**4,425**
TOTAL ANNUAL DIRECT COSTS*		**33,519**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**33,519**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		1,057,946
TOTAL ANNUAL CAPITAL REQUIREMENT		**268,179**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**301,697**

PES Refinery
Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

Source	**Unit 868-8H101**	
Control	**LNB & FGR**	
Rated Heat Input	**60.0**	**MMBtu/hr**
Number of Burners	**4.0**	**Burners**
Baseline Actual Emissions	**29.70**	**tpy**
Current Emission Rate	**0.113**	**lb/MMBtu**
Control Efficiency	**55%**	
Heater Capacity	**63.3**	**GJ/hr**
Burner Heat Release Rate	**20.3**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

COST COMPONENT:	COST ($)
DIRECT COSTS - LNB	
Purchased Equipment Costs	
Equipment Cost (EC)	341,289
Instrumentation (10% of EC)	34,129
Sales taxes (5% of EC)	17,064
Freight (8% of EC)	27,303
Subtotal - Purchased Equipment Costs (PEC)	**419,785**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	---
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC) - LNB	**419,785**
INDIRECT INSTALLATION COSTS - LNB	
Engineering Costs (5% of PEC)	20,989
Construct. & Field Expenses (Included in above costs)	---
Contractor Fees (10% of PEC)	41,979
Start-up (1% of PEC)	4,198
Performance Test (1% of PEC)	4,198
Contingency (3% of PEC)	12,594
TOTAL INDIRECT COSTS, IC - LNB	**83,957**
DIRECT COSTS - FGR	
Purchased Equipment Costs	
Equipment Cost (EC)	216,239
Instrumentation (Included in above costs)	---
Sales taxes (Included in above costs)	---
Freight (Included in above costs)	---
Subtotal - Purchased Equipment Costs (PEC)	**216,239**
Direct Installation Costs (Based on Vendor Discussion)	
Foundations & supports; handling & erection; electrical; piping; etc.	0
Site Preparation / Buildings- Included above	---
Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC) - FGR	**216,239**
INDIRECT INSTALLATION COSTS - FGR	
Engineering Costs (Included in above costs)	---
Construct. & Field Expenses (Included in above costs)	---
Contractor Fees (Included in above costs)	---
Start-up (Included in above costs)	---
Performance Test (Included in above costs)	---
Contingency (3% of PEC)	6,487
TOTAL INDIRECT COSTS, IC - FGR	**6,487**
TOTAL CAPITAL INVESTMENT (TCI) - LNB	**503,742**
TOTAL CAPITAL INVESTMENT (TCI) - FGR	**222,726**
TOTAL CAPITAL INVESTMENT (TCI)	**726,468**

PES Refinery
Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		19,978
		19,978
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
Electricity Cost		7,629
Subtotal - Utilities		**7,629**
TOTAL ANNUAL DIRECT COSTS[a]		**27,607**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**27,607**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		726,468
TOTAL ANNUAL CAPITAL REQUIREMENT		**184,152**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**211,759**

PES Refinery
Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

Source	**Unit 868-8H101**	
Control	**SNCR**	
Rated Heat Input	**60.0**	**MMBtu/hr**
Number of Burners	**4.0**	**Burners**
Baseline Actual Emissions	**29.70**	**tpy**
Current Emission Rate	**0.113**	**lb/MMBtu**
Control Efficiency	**40%**	
Heater Capacity	**63.3**	**GJ/hr**
Burner Heat Release Rate	**20.3**	**GJ/hr**

Evaluated at New Firing Limit at 2012 Cost and Efficiencies
Costs derived from *Alternative Control Techniques Document - NOx Emissions from Process Heaters (Revised)* - EPA-453/R-93-034

	COST COMPONENT:	**COST ($)**
DIRECT COSTS		
	Purchased Equipment Costs	
	Equipment Cost (EC)	538,062
	Instrumentation (Included in above costs)	---
	Sales taxes (Included in above costs)	---
	Freight (Included in above costs)	---
	Subtotal - Purchased Equipment Costs (PEC)	**538,062**
	Direct Installation Costs (Based on Vendor Discussion)	
	Foundations & supports; handling & erection; electrical; piping; etc.	0
	Site Preparation / Buildings- Included above	---
	Subtotal - Direct Installation Costs	**0**
TOTAL DIRECT COSTS (TDC)		**538,062**
INDIRECT INSTALLATION COSTS		
	Engineering Costs (Included in above costs)	---
	Construct. & Field Expenses (Included in above costs)	---
	Contractor Fees (Included in above costs)	---
	Start-up (Included in above costs)	---
	Performance Test (Included in above costs)	---
	Contingency (3% of PEC)	16,142
TOTAL INDIRECT COSTS, IC		**16,142**
TOTAL CAPITAL INVESTMENT (TCI)		**554,204**

PES Refinery
Heater Firing Rate Increase Plan Approval
NOx RACT Control Cost Effectiveness

COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Maintenance Labor and Material (2.75% of TCI)		15,241
		15,241
Annualized Cost Factor		
Replacement Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
Replacement cost		
Subtotal - Operation and Maintenance Labor		
Utilities		
Ammonia Cost		4,425
Electricity Cost		0.3
Subtotal - Utilities		**4,425**
TOTAL ANNUAL DIRECT COSTS[a]		**19,666**

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**19,666**
Annualized Cost Factor		
Equipment Life (years) =	10	
Interest Rate (%) =	21.83	
Annualized Cost Factor		0.25
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT		554,204
TOTAL ANNUAL CAPITAL REQUIREMENT		**140,485**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**160,151**

Attachment B
AMS Plan Approval Application
Forms

CITY OF PHILADELPHIA

DEPARTMENT OF PUBLIC HEALTH
PUBLIC HEALTH SERVICES
AIR MANAGEMENT SERVICES

Air Management Services
321 University Avenue
Philadelphia PA 19104-4543
Phone: (215) 685-7572
FAX: (215) 685-7593

APPLICATION FOR PLAN APPROVAL TO CONSTRUCT, MODIFY OR REACTIVATE AN AIR CONTAMINATION SOURCE AND/OR AIR CLEANING DEVICE

(Prepare all information completely in print or type in triplicate)

SECTION A - APPLICATION INFORMATION

Location of source (Street Address) 3144 Passyunk Avenue	Facility Name PES Philadelphia Refinery	
Owner Philadelphia Energy Solutions Refining & Marketing, LLC		Tax ID No. [redacted]
Mailing Address 3144 Passyunk Avenue, Philadelphia, PA 19145	Telephone No. [redacted]	Fax No. [redacted]
Contact Person Charles D. Barksdale	Title Manager, Environmental Department	
Mailing Address 3144 Passyunk Avenue, Philadelphia, PA 19145	Telephone No. (215) [redacted]	Fax No (215) [redacted]

SECTION B - DESCRIPTION OF ACTIVITY

Application type ☐ New source ☐ Modification ☐ Replacement ☐ Reactivation ☐ Air cleaning device ☒ Other	SIC Code 2911	Completion Date On Approval
☐ NSPS ☐ NESHAP ☐ Case by Case MACT ☐ NSR ☐ PSD	Does Facility submit Compliance Review Form biannually ? ☒ Yes ☐ No If No attach Air Pollution Control Act Compliance Review Form with this application.	

Source Description: The Sunoco Philadelphia Refinery proposes to marginally increase the firing limitations of seven process heaters and to raise refinery crude feed and product rates by proportionate amounts. No physical modifications are required to either process units or monitoring systems. Emissions increases will be netted to insignificant levels by the application of coincident ERC's from shutdown units at the Sunoco Marcus Hook, Pa Refinery

SECTION C - PERMIT COORDINATION (ONLY REQUIRED FOR LAND DEVELOPMENT)

Question	YES	NO
1. Will the project involve construction activity that disturbs five or more acres of land?		X
2. Will the project involve discharge of industrial wastewater or stormwater to a dry swale, surface water, ground water or an existing sanitary sewer system?		X
3. Will the project involve the construction and operation of industrial waste treatment facility?		X
4. Is onsite sewage disposal proposed for your project?		X
5. Will the project involve construction of sewage treatment facilities, sanitary sewer, or sewage pumping station?		X
6. Is a stormwater collection and discharge system proposed for this project?		X
7. Will any work associated with this project take place in or near a stream, waterway, or wetland?		X
8. Does the project involve dredging or construction of any dam, pier, bridge or outfall pipe?		X
9. Will any solid waste or liquid wastes be generated as a result of the project?		X
10. Is a State Park located within two miles from your project?		X

SECTION D – CERTIFICATION

I certify that I have the authority to submit this Permit Application on behalf of the applicant named herein and that the information provided in this application is true and correct to the best of my knowledge and information.

Signature [signature] Date 9/6/13 Address 3144 Passyunk Avenue, Philadelphia, PA 19145

Name & Title Nithin Thaver, General Manager Phone [redacted] Fax (21[redacted]

SECTION E - OFFICIAL USE ONLY

Application No.	Plant ID	Health District	Census Tract	Fee	Date Received

Approved by	Date	Conformance by	Date

SECTION F 1 - GENERAL SOURCE INFORMATION

1. SOURCE						2. NORMAL PROCESS OPERATING SCHEDULE						
	A. Type Source (Describe)	B. Manufacturer of Source	C. Model No.	D. Rated Capacity (Specify units)	E. Type of Materials Processed	A. Amount Processed/yr. (Specify units)	B. Average hr/day	C. Total hr/yr	D. % Throughput/Quarter			
									1st	2nd	3rd	4th
1	**Target heaters**											
	See Attached Report for											
	Proposed Heater Firing											
	Changes											

3. ESTIMATED FUEL USAGE (Specify Units)							4. ANNUAL FUEL USAGE						
A. Used in Unit	B. Type Fuel	C. Average Hourly Rate	D. Maximum Hourly Rate	E. Percent Sulfur	F. Percent Ash	G. Heating Value	A. Annual Amounts	B. Average hr/day	C. Total hr/yr	D. % Throughput/Quarter			
										1st	2nd	3rd	4th
	See Attached Report for												
	Proposed Fired Htr. Duty												
	Changes												

5. IMPORTANT: **Attach on a separate sheet a flow diagram of process giving all (gaseous, liquid, and solid) flow rates. Also list raw materials charged to process equipment and the amounts charged (tons/hour, etc.) at rated capacity (give maximum, minimum and average charges describing fully expected variations in production rates). Indicate (on diagram) all points where contaminants are controlled (location of water sprays, hoods or other pickup points, etc.).**

SECTION F 1 - GENERAL SOURCE INFORMATION, CONTINUED
6. Describe process equipments in detail. **See Attached Report Sections**
7. Describe fully the methods used to monitor and record all operating conditions that may affect the emission of air contaminants. Provide detailed information to show that these methods provided are adequate. **No New Monitoring Equipment is Proposed or Required**
8. Describe modifications to process equipments in detail. **See Attached Report Sections**
9. Attach any and all additional information necessary to adequately describe the process equipment and to perform a thorough evaluation of the extent and nature of its emissions. **See Attached Report that includes a BAT/RACT analysis**

- PROVIDE EQUIPMENT INFORMATION ON THIS PAGE IF SOURCES DO NOT BELONG TO SPECIAL CATEGORIES IN F2 TO F8, OTHERWISE REMOVE THIS PAGE FROM THIS APPLICATION
- IF THERE ARE MORE EQUIPMENT, COPY THIS PAGE AND FILL IN THE INFORMATION AS INDICATED

SECTION F 2 - COMBUSTION UNITS INFORMATION

1. COMBUSTION UNITS **H101; H201; 11H1; 11H2; 12H1; 8H101; B101 - See Discussion Sections**

A. Manufacturer NA	B. Model No. NA	C. Unit No. NA
D. Rated heat input (Btu/hr) NA	E. Peak heat input (Btu/hr) NA	F. Use NA

G. Method firing

☐ Pulverized ☐ Spreader Stoker ☐ Cyclone ☐ Tangential ☐ Normal ☐ Fluidized bed ☐ Other _____

2. FUEL REQUIREMENTS

TYPE	*QUANTITY HOURLY*	*QUANTITY ANNUALLY*	*SULFUR*	*ASH*	*BTU CONTENT*
OIL NUMBER NA	NA	NA	NA	NA	NA
OTHER NA	NA	NA	NA	NA	NA

3. COMBUSTION AIDS, CONTROLS, AND MONITORS -- **(No New Equipment)**

☐ A. Overfire jets	Type	Number	Height above grate
☐ B. Draft controls	Type	Type	
☐ C. Oil preheat			
☐ D. Soot cleaning	Temperature (°F)	Frequency	
☐ E. Stack sprays	Method		
☐ F. Opacity monitoring device		Method	Cost
☐ G. Sulfur oxides monitoring device	Type	Method	Cost
☒ H. Nitrogen oxides monitoring device	Type	Method	Cost
☒ I. Fuel metering and/or recording devices	Type	Method	Cost
☐ J. Atomization interlocking device	Type	Method	Cost
☐ K. Collected flyash reentrainment preventative device	Type		

☐ L. Modulating controls ☐ Step ☐ Automatic

4. ☐ Flyash reinjection. (Describe operation)
N/A

5. Describe method of supplying make up air to the furnace room.
N/A

- USE THIS PAGE FOR COMBUSTION SOURCE, OTHERWISE REMOVE THIS PAGE FROM THIS APPLICATION.
- IF THERE ARE MORE THAN ONE UNIT, COPY THIS PAGE AND FILL IN THE INFORMATION AS INDICATED

SECTION F 2 - COMBUSTION UNITS INFORMATION, CONTINUED

6. OPERATING SCHEDULE

__ NA _____ hours/day _____ NA _____ days/week __ NA _____ weeks/year

7. SEASONAL PERIODS (MONTHS) N/A

Operating using primary fuel _____ Operating using secondary fuel _____

_____ to _____ _____ to _____

Non-operating

_____ to _____

8. If heat input is in excess of 250 x 10^6 Btu/hr., describe fully the methods used to record the following: rate of fuel burned; heating value, sulfur and ash content of fuels; smoke, sulfur oxides and nitrogen oxides emissions; and if electric generating plant, the average electrical output and the minimum and maximum hourly generation rate.

PES will continue to monitor, record, and report with applicable requirements found in the Philadelphia Refinery's existing Title V permit and the Consent Decree

9. Describe modifications to boiler in detail.

See Attached Report Sections

10. Type and method of disposal of all waste materials generated by this boiler.
(Is a Solid Waste Disposal Permit needed? ☐ Yes ☒ No)

11. Briefly describe the method of handling the waste water from this boiler and its associated air pollution control equipment.
(Is a Water quality Management Permit needed? ☐ Yes ☒ No)

12. Attach any and all additional information necessary to perform a thorough evaluation of this boiler.

See Attached Report Sections

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SECTION G - FLUE AND AIR CONTAMINANT EMISSION INFORMATION

1. STACK AND EXHAUSTER

This project does not involve any changes to existing stacks or emission points.

A. Outlet volume of exhaust gases

_____ CFM @_____ °F _____ % Moisture

B. Exhauster (attach fan curves)

_____ in w.g. _____ HP @ _____ RPM

C. Stack height above grade (ft) _____

Grade elevation (ft) _____

Distance from discharge to nearest property line(ft) _____

D. Stack diameter (ft) or Outlet duct area (sq. ft.)

E. Weather Cap

☐ YES ☐ NO

F. Indicate on an attached sheet the location of sampling ports with respect to exhaust fan, breeching, etc. Give all necessary dimensions.

2. POTENTIAL PROCESS EMISSIONS (OUTLET FROM PROCESS, BEFORE ANY CONTROL EQUIPMENT)

See Attached Report Sections

A. Particulate loading (lbs/hr or gr/DSCF)

B. Specific gravity of particulate (not bulk density)

C. Attached particle size distribution information

D. Specify gaseous contaminants and concentration

Contaminant		Concentration		VOC Contaminants		Concentration	
(1)	SO_x	_____ ppm (Vol.)	_____ lbs/hr	(4)	_____	_____ ppm (Vol.)	_____ lbs/hr
(2)	NO_x	_____ ppm (Vol.)	_____ lbs/hr	(5)	_____	_____ ppm (Vol.)	_____ lbs/hr
(3)	CO	_____ ppm (Vol.)	_____ lbs/hr	(6)	_____	_____ ppm (Vol.)	_____ lbs/hr

E. Does process vent through the control device ? ☐ YES ☐ NO

- If YES continue and fill out the appropriate SECTION H - CONTROL EQUIPMENT
- If NO skip to SECTION I - MISCELLANEOUS INFORMATION

F. Can the control equipment be bypassed: (If Yes, explain) ☐ YES ☐ NO

3. ATMOSPHERIC EMISSIONS

A. Particulate matter emissions (tons per year)

See Attached Report Sections

B. Gaseous contaminant emissions

Contaminants	Concentration		VOC Contaminants	Concentration
(1)	_____ (tpy)	(4)	_____	_____ (tpy)
(2)	_____ (tpy)	(5)	_____	_____ (tpy)
(3)	_____ (tpy)	(6)	_____	_____ (tpy)

See Attached Report Sections

SECTION H - CONTROL EQUIPMENT, CONTINUED

12. COSTS – **See Attached Report Sections**

A. List costs associated with control equipment. (List individual controls separately)

Control Equipment Cost:
Direct Cost:

Indirect Cost:

B. Estimated annual operating costs of control equipment only.

13. Describe modifications to control equipment in detail.

N/A

14. Describe in detail the method of dust removal from the air cleaning and methods of controlling fugitive emissions from dust removal, handling and disposal.

N/A

15. Does air cleaning device employ hopper heaters, hopper vibrators or hopper level detectors? If so, describe.

N/A

16. Attach manufacturer's performance guarantees and/or warranties for each of the major components of the control system (or complete system).

17. Attach the maintenance schedule for the control equipment and any part of the process equipment that if in disrepair would increase the air contaminant emissions. Periodic maintenance reports are to be submitted to the Department.

Maintenance will continue to be be provided as per the manufacturer's recommendations and the Title V Permit.

18. Attach any and all additional information necessary to thoroughly evaluate the control equipment.

See Attached Report Sections

SECTION I - MISCELLANEOUS INFORMATION

1. Specify monitoring and recording devices will be used for monitoring and recording of the emission of air contaminants. Provide detailed information to show that the facilities provided are adequate. Include cost and maintenance information.

☐ Opacity monitoring system	☐ SOx monitoring system	☒ NOx monitoring system
☐ CO monitoring system	☐ CO2 monitoring system	☒ Oxygen monitoring system
☐ HCL monitoring system	☐ TRS monitoring system	☐ H2S monitoring system
☐ Temperature monitoring system	☐ Stack flow monitoring system	☐ Other _____

If checked, provide manufacturer's name, model no. and pertinent technical specifications.

NO CHANGES PROPOSED FROM EXISTING MONITORING, AS OUTLINED IN EXISTING TITLE V PERMIT.

- PROVIDE CONTROL EQUIPMENT INFORMATION ON THIS PAGE IF IT PERTAINS TO THIS APPLICATION, OTHERWISE REMOVE THIS PAGE FROM THE APPLICATION.
- IF THERE ARE MORE OF THE SAME TYPE OF CONTROL EQUIPMENT, COPY THAT PAGE AND FILL IN THE INFORMATION AS INDICATED.
- CONTROL EQUIPMENT CAN BE FOUND FROM A MANUFACTURER CATALOGUE OR VENDORS.

2. Attach Air Pollution Episode Strategy (if applicable)

NA

3 If the source is subject to 25 Pa. Code Subchapter E, New Source Review requirements,

a. Demonstrate the availability of emission offset (if applicable)

b. Provide an analysis of alternate sites, sizes, production processes and environmental control techniques demonstrating that the benefits of the proposed source outweigh the environmental and social costs.

CO Dispersion modeling is required for PSD purposes. NSR for nonattainment pollutants is not applicable. See the attached Report Sections.

4. Attach calculations and any additional information necessary to thoroughly evaluate compliance with all the applicable requirements of Article III of the rules and regulations of Philadelphia Air Management, Pennsylvania Department of Environmental Protection and those requirements promulgated by the Administrator of the United States Environmental Protection Agency pursuant to the provisions of the Clean Air Act.

See Attached Report Sections

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