NSR

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UTAH DEPARTMENT OF ENVIRONMENTAL QUALITY

APR 27 2017

DIVISION OF AIR QUALITY

April 27, 2017

Martin D. Gray, Manager
New Source Review Section
Utah Division of Air Quality
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Document Date: 04/27/2017
DAQ-2017-005324

RE: Submittal of Best Available Control Technology Evaluation

Dear Mr. Gray:

As requested in your letter of January 23, 2017, Big West Oil, LLC have prepared a list of control technologies potentially applicable to the Big West Oil Refinery in North Salt Lake for the $PM_{2.5}$ State Implementation Plan (SIP) currently under development by UDAQ for the Salt Lake City Non-attainment Area. We understand this information may be used to determine the level of control technology that will satisfy the Best Available Control Technology (BACT) requirement for stationary point sources within the SIP.

This submittal consists of the *Best Available Control Technology Evaluation - Utah $PM_{2.5}$ State Implementation Plan* report in Attachment I which follows the U.S. Environmental Protection Agency (EPA) prescribed top down process for identification and evaluation of BACT. The report evaluates all technologies that would reduce $PM_{2.5}$ emissions and precursors of $PM_{2.5}$ emissions (SO_2, NO_x, VOC and ammonia) from all regulated sources within the refinery. The evaluation considers technical feasibility, estimates of actual emissions reductions and cost effectiveness for each technology or work practice identified.

While a very brief time was allotted by UDAQ for completion of this request, we believe the reports provides a comprehensive evaluation of potential control technologies and work practices utilizing reasonable assumptions and engineering judgment. Nonetheless, it should be recognized that BACT may not be uniform within a group of similar sources. Each facility will have specific physical and technical conditions that make a given control technology more (or less) applicable. We therefore encourage UDAQ to engage in dialogue with us and other industry representatives to better understand the applicability and limitations of this information before making final decisions with regard to BACT implementation in the $PM_{2.5}$ SIP.

Finally, we consider the financial and cost information included in the attached report to be Confidential Business Information (CBI) and request UDAQ to treat it accordingly.

Sincerely,

R. Stuart Smith

R. Stuart Smith
Environmental Manager
North Salt Lake Refinery
Big West Oil, LLC

cc: Bryce Bird
Michael Swanson

ATTACHMENT I

Best Available Control Technology Evaluation – Utah PM2.5 State Implementation Plan
April 2017

Best Available Control Technology Evaluation – Utah $PM_{2.5}$ State Implementation Plan

North Salt Lake City, Utah

April 2017

Prepared for:
Big West Oil Refinery

Environmental Resources Management
www.erm.com

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Best Available Control Technology Evaluation – Utah $PM_{2.5}$ State Implementation Plan

North Salt Lake City, Utah

April 2017

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LIST OF ACRONYMS AND ABBREVIATIONS

AEI	annual emission inventory
BAAQMD	Bay Area Air Quality Management District
BACT	Best Available Control Technology
BWO	Big West Oil
CFR	Code of Federal Regulations
DGS	dry gas scrubber
EF	emission factor
EFR	external floating roof
EPA	Environmental Protection Agency
ERM	ERM-West, Inc.
ESP	electrostatic precipitator
FCCU	Fluid Catalytic Cracking Unit
FGF	flue gas blowback filter
FGR	flue gas recirculation
H_2S	hydrogen sulfide
HDS	hydrodesulfurization
hp	horsepower
hr	hour
IFR	internal floating roof
LAER	lowest achievable emission rate
lb	pound
LDAR	Leak Detection and Repair Program
LLC	Limited Liability Company
LNB	low-NOx burner
MACT	maximum achievable control technology
mg	milligram
MMBtu	million British thermal units
MMSCF	million standard cubic feet
N	no
N/A	not applicable
NAAQS	National Ambient Air Quality Standards
NH3	ammonia
NOx	nitrogen oxides
NSPS	New Source Performance Standard
O_2	oxygen
$PM_{2.5}$	particulate matter 2.5 microns or less in diameter
ppm	parts per million
ppmv	parts per million volume
RACT	Reasonably Available Control Technology
RBLC	RACT/BACT/LAER Clearinghouse
RSR	Refinery Sector Rule (40 CFR 63 Subpart CC)
SBAPCD	Santa Barbara Air Pollution Control District
SCAQMD	South Coast Air Quality Management District
SCR	selective catalytic reduction
SIC	standard industrial classification
SIP	State Implementation Plan
SJUVAPCD	San Joaquin Unified Valley Air Pollution Control District
SNCR	selective non-catalytic reduction
SO_2	sulfur dioxide
SOx	sulfur oxides
SRP	Sulfur Recovery Plant
SWCAA	South West Clean Air Agency
SWS	sour water stripper
TGTU	Tail Gas Treatment Unit
tpy	tons per year
UDAQ	Utah Department of Environmental Quality, Division of Air Quality
UOP	company and brand name
VOC	volatile organic compound
ULNB	ultra-low NOx burner
VRU	vapor recovery unit
WAC	Washington Administrative Code
WGS	wet gas scrubber
Y	yes

EXECUTIVE SUMMARY

This Best Available Control Technology (BACT) Evaluation was completed in accordance with the Utah Department of Air Quality's 23 January 2017 letter requesting this analysis as part of the regulatory agency's fine particular matter (particulate matter 2.5 microns or less in diameter or $PM_{2.5}$) Serious Nonattainment State Implementation Plan (SIP) development process. The top-down BACT process was followed to identify BACT for each source and the following associated emission type: $PM_{2.5}$, sulfur dioxide (SO_2), nitrogen oxides (NOx), volatile organic compounds (VOC), and ammonia (NH_3).

The applicable sources at the Big West Oil, LLC North Salt Lake Refinery were identified as: Fluid Catalytic Cracking Unit (FCCU) regenerator vent, process heaters, boilers, flares, storage tanks, loading racks, standby fire pump, Sulfur Recovery Plant, valves, pumps, heat exchangers, cooling towers, and Wastewater Treatment System.

After completing the BACT evaluation process utilizing a BACT cost effectiveness threshold of $10,000 per ton removed per year, the addition of carbon canister controls at the wastewater treatment system was identified as a BACT project to be completed by the end of 2018. The other applicable sources all have current controls identified as BACT as described in Table 1.

As a part of the BACT process, other issues that could adversely impact the environment, safety and health, and energy demand were included in the evaluation. Any projects that are identified to be completed outside the normal refinery turnaround maintenance cycle would increase safety and health risks and energy demand as the refinery is not currently planned to have a turnaround until 2019. Additional costs would also be associated with taking a refinery shutdown out of sequence and those lost opportunity costs would need to be added to any projects that are considered as additional feasible measures or most stringent measures.

1.0 *INTRODUCTION*

On behalf of Big West Oil, LLC (BWO), ERM-West, Inc. (ERM) conducted a Best Available Control Technology (BACT) evaluation for the company's North Salt Lake Refinery. This report presents the BACT process and results for submittal to the Utah Department of Environmental Quality, Division of Air Quality (UDAQ). The BACT evaluation was completed in accordance with the UDAQ's 23 January 2017 letter requesting this analysis as part of the regulatory agency's fine particular matter (particulate matter 2.5 microns or less in diameter or $PM_{2.5}$) Serious Nonattainment State Implementation Plan (SIP) development process.

2.0 *APPROACH*

A top-down BACT analysis was completed for all technologies that would reduce $PM_{2.5}$ emissions and precursors of $PM_{2.5}$ emissions from all regulated sources within the BWO Refinery. The evaluation included assessing the Fluid Catalytic Cracking Unit (FCCU) Regenerator, heaters, boilers, flares, storage tanks, pumps, compressors, valves, engines, and the wastewater treatment process. All applicable emission control technologies were identified for the refinery emission sources, and they were screened for technical feasibility under the SIP requirements and schedule.

The SIP is designed to regulate and limit $PM_{2.5}$ and its precursors to below the National Ambient Air Quality Standards (NAAQS) based on data to be collected throughout year 2019. This means that control technology improvements will need to be in place before the end of year 2018 to support compliance with the SIP. Therefore, the evaluation and identification of BACT takes into account whether BWO can implement the new controls before the end of 2018.

In cases where BWO has determined that control technologies are technically feasible, except for the SIP schedule constraints, these controls are not considered BACT, but rather "Additional Feasible Measures" that could be implemented if more time were available. All technologies considered technically feasible as BACT or Additional Feasible Measures were ranked based on their potential emission reduction efficiencies. Energy, environmental, health and safety impacts, and other considerations were evaluated for the feasible technologies; the technologies that had the largest emissions reduction and most cost-effective with the least environmental, health, safety and energy impact were identified as BACT or Additional Feasible Measures for the applicable emission units.

2.1 BACT ANALYSIS PROCESS

The BACT analysis was organized into the following steps, which are described in the paragraphs that follow:

1. Identify control technologies.
2. Eliminate technically infeasible technologies.
3. Rank technologies by control effectiveness.
4. Evaluate controls for economic feasibility.
5. Recommend BACT.

2.1.1 Step 1 - Identify Control Technologies

BWO identified its emission sources for $PM_{2.5}$ and precursors, and then identified acceptable control technologies for these sources. The U.S. Environmental Protection Agency (EPA) established the Reasonably Available Control Technology/BACT/Lowest Achievable Emission Rate (RACT/BACT/LAER) Clearinghouse (RBLC) to provide a central database of air pollution technology information. BWO relied on the RBLC and other resources listed in Section 2.2, to identify potentially applicable control technologies. The emission sources and applicable technologies were documented using a BACT Matrix table for tracking and presentation of the results as presented in Section 3 and the attached tables.

2.1.2 Step 2 - Eliminate Technically Infeasible Technologies

BWO reviewed the technologies to determine whether they were technically feasible at the refinery based on site-specific (i.e., real estate) or operational constraints. The SIP time constraints were also taken into account relative to defining technically feasible BACT. Based on the UDAQ expectation that BACT be defined as control technologies that could be installed and made operational by the end of 2018, BWO has determined that only the carbon canisters installed on the Wastewater Treatment System can be installed and made operational by this deadline; the existing controls currently in place can be considered BACT for all other sources. However, if not for the time constraints of the SIP schedule, BWO believes other control technologies could be implemented, and these are identified on the BACT Matrix as Additional Feasible Measures.

2.1.3 *Task 3 - Rank Technologies by Control Effectiveness*

BWO calculated the baseline emissions from its sources using either current emissions (based on recent 2016 changes) or the prior 2-year-average emissions. The potential for additional emission reductions was evaluated for the applicable technologies using vendor or Environmental Protection Agency (EPA)-provided removal efficiencies. The amount of emissions reductions that could be achieved for the applicable technologies were calculated and the technologies were listed according to rank on the BACT Matrix.

2.1.4 *Task 4 - Evaluate Controls for Economic Feasibility*

BWO evaluated the controls for economic feasibility using capital and operating cost estimates provided by the EPA Cost Control Manual, vendor information, ERM experience, and potential project estimates from BWO. Energy consumption, environmental, and other impacts were considered for the feasible controls to account for all economic impacts. The economic feasibility of increased controls was evaluated using the ratio of the cost for the new controls compared with the incremental emission reductions achieved by the new controls verses the baseline (current) condition in terms of dollars per ton of emissions reduced. BWO considered the ratio of $10,000 per ton of emission reductions to represent economically feasible controls.

2.1.5 *Task 5 - Recommend BACT*

Based on the evaluation of control technologies, BWO is presenting in this report its analysis and conclusions regarding the controls it believes are technically and economically feasible, and those that can be considered BACT (including compliance with the UDAQ SIP schedule) or Additional Feasible Measures (if more time is permissible for technology implementation). Table 1 presents a summary of BACT selections for each pollutant by source.

2.2 *REGULATORY BACKGROUND*

The following BACT clearinghouses and guidelines were searched as part of Step 1 to identify potentially applicable control technologies for the BWO emission sources:

- U.S. EPA
- Bay Area Air Quality Management District (BAAQMD)
- South Coast Air Quality Management District (SCAQMD)

- San Joaquin Unified Valley Air Pollution Control District (SJUVAPCD)
- Santa Barbara Air Pollution Control District (SBAPCD)
- Texas Commission of Environmental Quality

2.3 BASIS AND STUDY LIMITATION

The current applicable standards, emission control methods, and technologies are considered Reasonable Achievable Control Technologies RACT by the facility. Only Flare Gas Minimization was included in the $PM_{2.5}$ Moderate State Implementation Plan (SIP) by the UDEQ.

The emissions from 2014 and 2015 were averaged to be the sources' baseline emissions. The exceptions are the flares' VOC emissions baseline that was estimated using the revised EPA emission factor and the FCCU's NH_3 emissions baseline value used was from the 2016 emissions inventory.

The cost effectiveness for BACT is typically $10,000 per ton removed or less. Big West Oil used that as the basis for determining new BACT selections for this evaluation.

The determination of technical feasibility had several criteria that needed to be met such as physical constraints, facility natural gas consumption, fired equipment configuration (natural draft), and proven on similar sources.

The cost effectiveness calculations utilized the facility estimation factor for capital projects and a 100 percent contingency factor due to limited vendor cost input. Published costs from earlier EPA or published studies were brought up to January 2017 costs by using the Bureau of Labor Statistic's inflation calculator.

3.0 BACT EVALUATION

The BACT Evaluation is summarized for each source in the following sections. Tables 2 through 6 also present the emission sources for direct $PM_{2.5}$ and its precursors (e.g., sulfur dioxide (SO_2), nitrogen oxides (NOx), volatile organic compounds (VOCs), and ammonia (NH_3)). For each source, these tables list the identified control technologies, if they are technically feasible, the baseline emissions, the estimated emissions reductions, and the cost effectiveness for applicable technologies.

3.1 *FCCU REGENERATOR*

The FCCU regenerator emits $PM_{2.5}$, SO_2, NOx, and NH_3 and each pollutant has different control technologies evaluated.

3.1.1 *$PM_{2.5}$*

BWO operates an FCCU regenerator that produces emissions for direct $PM_{2.5}$. The identified control technologies are listed in Table 2, including the currently implemented use of flue gas blowback filter and tertiary cyclones with fabric filter.

The BACT technology review identified potential additional control technologies for the FCCU regenerator, including ESP and a wet gas scrubber (WGS). However, the FCCU regenerator has insufficient space to install an ESP or WGS; and they are therefore technically infeasible.

Table 2 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. However, there are no additional controls classified as technically feasible for the FCCU regenerator. Therefore, the current controls are considered BACT for the FCCU regenerator (i.e., a flue gas blowback filter and tertiary cyclones with fabric filter).

3.1.2 *SO_2*

BWO operates an FCCU regenerator that produces emissions for SO_2. The identified control technologies are listed in Table 3, including the currently implemented sulfur oxides (SOx)-reducing catalyst additive.

The BACT technology review showed potential additional control technologies for the FCCU regenerator, including adding additional SOx-reducing catalyst additive, WGS, and cat feed hydrotreater. However, the FCCU regenerator has insufficient space to install a WGS and cat feed hydrotreater; therefore, they are technically infeasible.

Table 3 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation was unnecessary for the FCCU as no additional technologies were considered technically feasible. Therefore, the current controls are considered BACT for the FCCU regenerator (i.e., SOx-reducing catalyst additive).

3.1.3 *NOx*

BWO operates an FCCU regenerator that produces emissions for NOx. The identified control technologies are listed in Table 4, including the currently implemented NOx-reducing UOP high efficiency (low-NOx) combustor design, low-NOx combustion promoter, and good combustion practices.

The BACT technology review showed potential additional control technologies for the FCCU regenerator, including adding a NOx-reducing additive, selective non-catalytic reduction (SNCR), selective catalytic reduction (SCR), and cat feed hydrotreating. However, the FCCU regenerator has insufficient space to install the SCR or cat feed hydrotreater and the flow dynamics required for a SNCR could not be met due to the installed blowback filter; therefore, they are technically infeasible. The use of NOx reducing additive is potentially feasible and under consideration. The effectiveness has not been proven at this time.

Table 4 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation showed that control technologies determined to be technologically implementable were economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. Therefore, the current controls are considered BACT for the FCCU regenerator (i.e., UOP high efficiency (low-NOx) combustor design, low-NOx combustion promoter, and good combustion practices). Evaluation of the NOx reducing additive will be completed once the effectiveness has been verified.

3.1.4 NH_3

BWO operates an FCCU regenerator that emits ammonia from the coke burn-off phase. The identified control technologies are listed in Table 6. Ammonia emissions are typically estimated using emission factors derived by EPA from a limited number of source test data. BWO has recently performed a source test that demonstrated approximately 98 percent reduction from the emissions predicted by the EPA emission factor. Performing this source test on a regular basis is considered BACT.

The BACT technology review showed potential additional control technologies for the FCCU regenerator, including a wet gas scrubber. However, the FCCU has insufficient physical space for the wet gas scrubber at the FCCU Regenerator exhaust after the addition of the flue gas blowback filter; therefore, it is technically infeasible.

As no additional technologies were identified as technically feasible, no economic analysis was conducted. Therefore, the current controls are considered BACT for the FCCU (i.e., regular source testing).

3.2 HEATERS (REFORMER (H-621, H-622, H-624), CRUDE (H-404)) >40 MMBTU/HR

Process heaters greater than 40 million British thermal units (MMBtu) per hour design heating rate have been identified by EPA as sources that could add control devices to reduce emissions even if that combustion system utilizes natural draft air movement. All of these existing heaters already have low NOx or ultra-low NOx burners.

3.2.1 $PM_{2.5}$

BWO operates heaters with heat ratings greater than 40 MMBtu/hr. These sources produce emissions for direct $PM_{2.5}$. The identified control technologies for direct $PM_{2.5}$ are listed in Table 2, including the currently implemented use of only refinery fuel gas for combustion (i.e., no oil burning) and good combustion practices such as regular oxygen (O_2) monitoring.

The BACT technology review showed potential additional control technologies including ESP, WGS, dry gas scrubber (DGS), and an O_2 Trim System.

Table 2 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. Only one heater is shown as an example. The economic feasibility evaluation showed that control technologies determined to be technically implementable were economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. Therefore, the current controls are considered BACT for the heaters with heat ratings greater than 40 MMBtu/hr MMBtu/hr (i.e., only use of refinery fuel gas and good combustion practices).

3.2.2 SO_2

BWO operates heaters that produce emissions for SO_2. The identified control technologies for SO_2 are listed in Table 3, including the currently implemented use of only refinery fuel gas for combustion (i.e., no oil burning) and compliance with New Source Performance Standards (NSPS) Subparts J and J_a fuel gas standards.

The BACT technology review showed potential additional control technologies for the large heaters including WGSs.

Table 3 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. Only one heater is shown as an example. The economic feasibility evaluation showed that the WGS was economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. However, a caustic scrubber has been added to treat fuel gas during outages of the Amine and Sulfur Recovery units to maintain the fuel standards and prevent additional SO_2 emissions.

Therefore, the current controls are considered BACT for the large heaters (i.e., use of only refinery fuel gas and compliance with NSPS Subparts J and J_a fuel gas standards).

3.2.3 *NOx*

3.2.3.1 Reformer Heater (H-621, H-622, H-624)

BWO operates reformer heaters that produce emissions for NOx. The identified control technologies for NOx are listed in Table 4, including the currently implemented use of only refinery fuel gas for combustion (i.e., no oil burning) and a low-NOx burner (LNB).

The BACT technology review showed potential additional control technologies including a ultra-low NOx burners (ULNB) and a sorbent injection or pass-through. Ultra-low NOx burners are not technically feasible due to the physical constraints.

Table 4 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation showed that control technologies determined to be technically implementable were economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. Therefore, the current controls are considered BACT for the reformer heater (i.e., use of only refinery fuel gas and the LNB).

3.2.3.2 Crude Heater (H-404)

BWO operates a crude heater with a heating capacity greater than 40 MMBtu/hr that produces emissions for NOx. The identified control technologies for NOx are listed in Table 4, including the currently implemented use of only refinery fuel gas for combustion (i.e., no oil burning) and ULNB.

The BACT technology review showed potential additional control technologies including a Selective Catalytic Reduction unit and a sorbent injection or pass-through.

Table 4 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation showed that control technologies determined to be technically implementable were economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. Therefore, the current controls are considered BACT for the Crude Heater (i.e., use of only refinery fuel gas and good combustion practices and ULNB).

3.3 *BOILERS (1, 2, 6) >40 MMBTU/HR*

Industrial boilers greater than 40 MMBtu/hr design heating rate have been identified by EPA as sources that could add control devices to reduce emissions even if that combustion system utilizes natural draft air movement. The existing boilers already have ultra-low NOx burners.

3.3.1 *$PM_{2.5}$*

BWO operates three boilers that produce emissions for direct $PM_{2.5}$. The identified control technologies for direct $PM_{2.5}$ are listed in Table 2, including the currently implemented use of only refinery fuel gas for combustion (i.e., no oil burning) and good combustion practices such as regular O_2 monitoring.

The BACT technology review showed potential additional control technologies including ESP, WGS, DGS, and an O_2 Trim System. However, the boilers have insufficient space for installing ESP, WGS, or DGS; therefore, they are technically infeasible.

Table 2 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. Only one boiler is shown as an example. The economic feasibility evaluation showed that control technologies determined to be technically implementable were economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. Therefore, the current controls are considered BACT for the boilers (i.e., use of only refinery fuel gas and good combustion practices and ULNB).

3.3.2 *SO_2*

BWO operates three boilers that produce emissions for SO_2. The identified control technologies for SO_2 are listed in Table 3, including the currently implemented use of only refinery fuel gas for combustion (i.e., no oil burning) and compliance with New Source Performance Standards (NSPS) Subparts J and J_a fuel gas standards.

The BACT technology review showed potential additional control technologies for the large heaters including WGSs.

Table 3 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. Only one boiler is shown as an example. The economic feasibility evaluation showed that the WGS was economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. However, a caustic scrubber has been added to treat fuel gas during outages of the Amine and Sulfur Recovery units to maintain the fuel standards and prevent additional SO_2 emissions.

Therefore, the current controls are considered BACT for the large heaters (i.e., use of only refinery fuel gas that meets J_a fuel standards).

3.3.3 *NOx*

BWO operates heaters and boilers of various sizes. These sources produce emissions for NOx. The identified control technologies for NOx are listed in Table 4, including the currently implemented use of only refinery fuel gas for combustion (i.e., no oil burning) and a ULNB.

The BACT technology review showed potential additional control technologies including SCR, flue gas recirculation (FGR), WGS, and an SNCR. However, the boilers have insufficient space for installing SCR, FGR, WGS, or SNCR; therefore, they are technically infeasible.

As no additional technologies were identified as technically feasible, no economic analysis was conducted. Therefore, the current controls are considered BACT for the boilers (i.e., use of only refinery fuel gas and ULNB).

3.4 *HEATERS <40 MMBTU/HR*

Process heaters less than 40 MMBtu/hr design heating rate have been identified by EPA as sources that typically cannot add control devices to reduce emissions as most combustion system utilizes natural draft air movement. Most of the existing heaters already have low NOx burners. The heaters that do not have these types of burners cannot physically accommodate the flame path of these ultra-low NOx burners so these modifications are not technically feasible.

3.4.1 *$PM_{2.5}$*

BWO operates small heaters (<40 MMBtu/hr) that produce emissions for direct $PM_{2.5}$. The identified control technologies for direct $PM_{2.5}$ are listed in Table 2, including the currently implemented use of only refinery fuel gas for combustion (i.e., no oil burning) and good combustion practices such as regular O_2 monitoring.

The BACT technology review showed potential additional control technologies including ESP, WGS, DGS, and an O_2 Trim System. However, the small heaters (<40 MMBtu/hr) have insufficient space for installing ESP, WGS, or DGS; therefore, they are technically infeasible.

Table 2 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation showed that control technologies determined to be technically implementable were economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. Therefore, the current controls are considered BACT for the heaters <40 MMBtu/hr (i.e., use of only refinery fuel gas and good combustion practices).

3.4.2 *SO_2*

BWO operates small heaters (<40 MMBtu/hr) that produce emissions for SO_2. The identified control technologies for SO_2 are listed in Table 3, including the currently implemented use of only refinery fuel gas for combustion (i.e., no oil burning) and compliance with New Source Performance Standards (NSPS) Subparts J and J_a fuel gas standards.

The BACT technology review showed potential additional control technologies for the large heaters including WGSs.

Table 3 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. Only one heater is shown as an example. The economic feasibility evaluation showed that the WGS was economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. However, a caustic scrubber has been added to treat fuel gas during outages of the Amine and Sulfur Recovery units to maintain the fuel standards and prevent additional SO_2 emissions.

Therefore, the current controls are considered BACT for the large heaters (i.e., use of only refinery fuel gas and compliance with NSPS Subparts J and J_a fuel gas standards).

3.4.3 *NOx*

3.4.3.1 H-403 and H-101

BWO operates heaters that produce emissions for NOx. The identified control technologies for NOx are listed in Table 4, including the currently implemented use of only refinery fuel gas for combustions (i.e., no oil burning).

The BACT technology review showed potential additional control technologies, including LNB, ULNB, SCR, SNCR, FGR, WGS, and a sorbent injection or pass-through. However, these heaters have insufficient space for installing the ULNB, FGR and WGS. There is also insufficient heating temperature for the SNCR. Therefore, they are technically infeasible.

Table 4 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation showed that control technologies determined to be technically implementable were economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. Therefore, the current controls are considered BACT for the above-listed small heaters, i.e., use of only refinery fuel gas.

3.4.3.2 H-301, H-402, H-601, H-1001, H-1002, H-1003, and H-1102

BWO operates small heaters (<40 MMBtu/hr) that produce emissions for NOx. The identified control technologies for NOx are listed in Table 4, including the currently implemented use of only refinery fuel gas for combustions (i.e., no oil burning) and LNBs.

The BACT technology review showed potential additional control technologies, including ULNB, SCR, SNCR, FGR, WGS, and a sorbent injection or pass-through. However, these heaters have insufficient space for installing the FGR and WGS. For ULNB, each heater would need a burner study to determine if that technology is feasible. There is also insufficient heating temperature for the SNCR. Therefore, they are technically infeasible.

Table 4 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation showed that control technologies determined to be technically implementable were economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. Therefore, the current controls are considered BACT for the above-listed small heaters (i.e., use of only refinery fuel gas and the LNBs).

3.5 *REFINERY FLARES*

The refinery flares emit $PM_{2.5}$, SO_2, NOx, and VOCs, and each pollutant has different control technologies to be evaluated.

3.5.1 *$PM_{2.5}$*

BWO operates two refinery flares that produce emissions for direct $PM_{2.5}$. The identified control technologies are listed in Table 2, including the currently implemented direct $PM_{2.5}$ reduction by complying with NSPS Subpart J and J_a flaring provisions.

The BACT technology review showed potential additional control technologies for the refinery flares, including flare gas minimization and flare gas recovery. BWO is expecting to implement a flare gas minimization project by January 2019. However, the small annual natural gas usage demonstrates that there is no opportunity for recovered flare gas to be used in the fuel gas system; and therefore the flare gas recovery option is technically infeasible.

Table 2 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. However, there are no additional controls classified as technically feasible for the refinery flares. Therefore, the current controls are considered BACT for the refinery flares (i.e., compliance with NSPS Subparts J and J_a flaring provisions, and the pending control installation of a flare gas minimization project (January 2019)).

3.5.2 *SO_2*

BWO operates two refinery flares that produce emissions for SO_2. The identified control technologies are listed in Table 3, including the currently implemented SO_2 reduction by complying with NSPS Subpart J flaring provisions and NSPS Subpart J_a fuel gas standard (with fuel gas to flare).

The BACT technology review showed potential additional control technologies for the refinery flares, including flare gas minimization and H_2S scavenger. BWO is expecting to implement a flare gas minimization project by January 2019.

Table 3 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation showed that control technologies determined to be technologically implementable were economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. Therefore, the current controls (i.e., compliance with NSPS Subpart J flaring provisions and NSPS Subpart J_a fuel gas standard (with fuel gas to flare), and the pending control installation of a flare gas minimization project (January 2019)) are considered BACT for the refinery flares.

3.5.3 *NOx*

BWO operates two refinery flares that produce emissions for NO_X. The identified control technologies are listed in Table 4, including the currently implemented NO_X reduction by complying with NSPS Subpart J and J_a flaring provisions.

The BACT technology review showed potential additional control technologies for the refinery flares, including flare gas minimization. BWO is expecting to implement a flare gas minimization project by January 2019.

Table 4 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. However, no additional controls are classified as technically feasible for the refinery flares. Therefore, the current controls, i.e., compliance with NSPS Subparts J and J_a flaring provisions, and the pending control installation of a flare gas minimization project (January 2019) are considered BACT for the refinery flares.

3.5.4 *VOCs*

BWO operates two refinery flares that produce emissions for VOCs. The identified control technologies are listed in Table 5, including the currently implemented VOC reduction by complying with NSPS Subpart J and J_a flaring provisions.

The BACT technology review showed that additional control technologies were feasible for the refinery flares, including flare gas minimization, and compliance with Refinery Sector Rule flare operation requirements that ensure adequate combustion efficiency. BWO is expecting to implement a flare gas minimization project by January 2019.

Table 5 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation showed that control technologies determined to be technologically implementable were economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. Therefore, the current controls (i.e., compliance with NSPS Subpart J and J_a flaring provisions, and the pending control installation of a flare gas minimization project (January 2019)) are considered BACT for the refinery flares.

3.6 *SULFUR RECOVERY PLANT: SO_2*

BWO operates a Sulfur Recovery Plant (SRP) that has a tail gas incinerator and currently achieves the required 95 percent sulfur recovery. In addition, the refinery has added caustic scrubber to treat fuel gas during SRP outages. This has reduced SO_2 emissions by approximately 13 tons per year (tpy). The identified control technologies are listed in Table 3, including the currently implemented SO_2 reduction with the tail gas incinerator and caustic scrubber.

The BACT technology review showed that an additional Tail Gas Treatment Unit (TGTU) was feasible for the SRP.

Table 3 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation showed that the additional TGTU determined to be technologically implementable was economically infeasible with incremental cost effectiveness ratio exceeding $10,000 per ton. Therefore, the current controls are considered BACT for the SRP (i.e., the tail gas incinerator and caustic scrubber).

3.7 *STANDBY (EMERGENCY) FIRE PUMP*

3.7.1 *$PM_{2.5}$*

The BACT technology review showed potential additional control technologies for the Standby Fire Pump, including the currently implemented good combustion practices for Tier II engines. The Standby Fire Pump is classified as an emergency engine and therefore only operates during an emergency and for a limited number of maintenance hours per year. The BACT technology review showed that a particulate filter as a potential add-on control technology for direct $PM_{2.5}$ was feasible.

Table 2 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation showed that the control technology determined to be technically implementable was economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. Therefore, the current controls are considered BACT for emergency stationary engines (i.e., good combustion practices for Tier II engines).

3.7.2 SO_2

The identified control technologies for SO_2 are listed in Table 3. The BACT technology review identified a low sulfur fuel as the potential control for the emergency engine, which the refinery currently implements for the Standby Fire Pump engine.

As no additional technologies were identified as technically feasible, no economic analysis was conducted. Therefore, the current controls are considered BACT for SO_2 (i.e., the use of an ultra-low sulfur diesel fuel).

3.7.3 NOx

The BACT technology review showed that additional control technologies were feasible for the Standby Fire Pump, including the currently implemented good combustion practices for Tier II engines. The identified control technologies for NOx are listed in Table 4. The BACT technology review identified an SCR as a potential add-on control to reduce NOx emissions.

Table 4 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation.

The economic feasibility evaluation demonstrated that the SCR is economically infeasible with incremental cost effectiveness ratio exceeding $10,000 per ton. Therefore, the current controls are considered BACT for the Standby Fire Pump (i.e., good combustion practices for Tier II engines).

3.8 FUGITIVE EQUIPMENT: VOCS

The refinery equipment and piping components that contribute to the fugitive VOC emissions are currently monitored under a Leak Detection and Repair Program at the refinery. This program requires that when an allowable leak rate is exceeded, the component must be repaired or replaced to eliminate that leak. This program is considered to be RACT for refineries. Using a lower leak rate designation for new equipment as identified by the NSPS Subpart GGGa is considered to be BACT. The refinery currently complies with the NSPS standard for valves, pumps, and piping components. The refinery also complies with Refinery MACT for heat exchangers by monitoring cooling tower return water to the specific limit. These identified control technologies are listed in Table 5.

As no additional technologies were identified as technically feasible, no economic analysis was conducted. Therefore, the current controls are considered BACT for fugitive equipment (i.e., the Leak Detection and

Repair Program in compliance with NSPS subpart GGGa and monitoring cooling tower return water as described above).

3.9 *PRODUCT LOADING RACKS: VOCS*

The truck rack and railcar rack are used for product loading.

The BACT technology review identified vapor recovery and vapor combustors as potential control technologies. The refinery currently implements these technologies for product loading racks. The identified control technologies are listed in Table 5.

As no additional technologies were identified as technically feasible, no economic analysis was conducted. Therefore, the current controls are considered BACT for fugitive equipment (i.e., vapor recovery and vapor combustors).

3.10 *GROUP 1 STORAGE TANKS: VOCS*

BWO has both external and internal floating storage tanks that produce emissions for VOCs. The identified control technologies are listed in Table 5, including the currently implemented VOC emissions reduction by degassing to a vapor combustion device.

The BACT technology review showed potential additional control technologies for the storage tanks including a dome (external floating roof [EFR] only), vapor water scrubber, vapor dry scrubber, vapor recovery unit (internal floating roof [IFR] only), and vapor recovery and combustor. The dome for the EFR is considered technically infeasible as it would require a complete rebuild of the tanks.

Table 5 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation showed that control technologies determined to be technologically implementable were economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. Therefore, the current controls are considered BACT for the Group 1 storage tanks (i.e., degassing to a vapor combustion device before opening and venting to atmosphere for inspection and maintenance).

3.11 *GROUP 2 STORAGE TANKS: VOCS*

BWO has vertical fixed roof storage tanks that produce emissions for VOCs. The identified control technologies are listed in Table 5, including the current controls of pressure/vacuum relief valves.

The BACT technology review showed potential additional control technologies for the storage tanks including vapor water scrubber, vapor dry scrubber, vapor recovery unit, internal floating roof, and vapor recovery and combustor. The internal floating roof would require tank reconstruction and is therefore considered technically infeasible.

Table 5 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation showed that control technologies determined to be technologically implementable were economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. Therefore, the current controls are considered BACT for the Group 2 Storage Tanks (i.e., pressure/vacuum relief valves).

3.12 *WASTEWATER TREATMENT SYSTEM: VOCS*

BWO operates a Wastewater Treatment System that produces emissions for VOCs. The identified control technologies are listed in Table 5, including the currently implemented VOC reduction of a fixed cover on the API separator that controls emissions from the surfaces.

The BACT technology review showed potential additional control technologies for the system, including carbon canisters and thermal oxidizers as potential add-on controls.

Table 5 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation showed that the carbon canisters cost would be less than the $10,000 per ton removed threshold. The thermal oxidizer determined to be technologically implementable was not economically feasible as it exceeds that threshold and adds a safety risk to the refinery as it would located near the storage tank area. Therefore, the current controls (i.e., the API fixed cover) and carbon canister installations are considered BACT for the Wastewater Treatment System.

3.13 *COOLING TOWERS: VOCS*

BWO operates cooling towers that produce emissions for VOCs. The identified control technologies are listed in Table 5, including the currently implemented monitoring under the heat exchanger leak detection program and high efficiency drift eliminators that minimize any secondary particulate formation.

The BACT technology review did not identify any additional feasible control technologies.

As no additional technologies were identified as technically feasible, no economic analysis was conducted. Therefore, the current controls are considered BACT for the cooling towers (i.e., monitoring and high efficiency drift eliminators).

3.14 *ENERGY, ENVIRONMENTAL, HEALTH AND SAFETY, AND OTHER CONSIDERATIONS*

The BACT Evaluation must consider impacts to increased energy usage that increase direct and indirect emissions for the refinery. Some technologies like low NOx and ultra-low NOx burners result in slightly higher fuel gas consumption. New pumps for wet scrubbers, new controllers for oxygen trim systems, and new electrostatic precipitators all increase electricity consumption. Carbon canisters regeneration uses energy offsite but should be a consideration in the overall determination of BACT.

Environmental impacts were identified for the final disposal of the carbon used at the wastewater treatment plant, disposal of the SOx reducing catalyst, caustic scrubber wastewater disposal, and low NOx additives disposal.

Additional safety and health concerns of workers are the handling of the caustic and additives used by some of the control devices.

Other cost considerations include attempting to install add-on control devices within the refinery during out-of-sequence maintenance turnarounds. Turnaround planning is very detailed and ordering long-lead equipment items is part of the schedule. To shorten that schedule incurs large cost impacts to the refinery. This opportunity cost would need to be evaluated and added to any projects that are identified to be included in the $PM_{2.5}$ SIP.

Tables

Table 1: BACT Selection for each Pollutant by Source

Source	$PM_{2.5}$	SO_2	NOx	VOC	NH_3
FCC Unit Regenerator	Currently implemented: flue gas blowback filter and tertiary cyclones with fabric filter	Currently implemented: SO_X-reducing catalyst additive	Currently implemented: UOP high efficiency (low-NOx) combustor design, low-NOx combustion promoter, and good combustion practices		Currently implemented: source testing on a regular basis
Heaters (Reformer, Crude)/Boilers >40 MMBtu/hr					
Reformer Heaters (H-621, 622, 624)	Currently implemented: only use of refinery fuel gas and good combustion practices	Currently implemented: use of only refinery fuel gas and compliance with NSPS Subparts J and J_a fuel gas standards	Currently implemented: use of only refinery fuel gas and the LNB		
H-404 #1 Crude Heater with ULNB	Currently implemented: only use of refinery fuel gas and good combustion practices	Currently implemented: use of only refinery fuel gas and compliance with NSPS Subparts J and J_a fuel gas standards	Currently implemented: use of only refinery fuel gas, ULNB, and good combustion practices		
Boilers (1, 2, 6) >40 MMBtu/hr	Currently implemented: use of only refinery fuel gas and good combustion practices	Currently implemented: use of only refinery fuel gas and compliance with NSPS Subparts J and J_a fuel gas standards	Currently implemented: use of only refinery fuel gas and ULNB		
Heaters <40 MMBtu/hr					
H-101 FCC Heater	Currently implemented: use of only refinery fuel gas and good combustion practices	Currently implemented: use of only refinery fuel gas and compliance with NSPS Subparts J and J_a fuel gas standards	Currently implemented: use of only refinery fuel gas		
H-301 Alkylation Unit Deisobutanizer Reboiler Heater	Same as H-101	Same as H-101	Currently implemented: use of only refinery fuel gas and the LNBs		
H-402 #2 Crude Heater	Same as H-101	Same as H-101	Currently implemented: use of only refinery fuel gas and the LNBs		
H-403 Crude Preflash Heater	Same as H-101	Same as H-101	Currently implemented: use of only refinery fuel gas		
H-601 32.4 MMBtu/hr Unifiner Heater	Same as H-101	Same as H-101	Currently implemented: use of only refinery fuel gas and the LNBs		
H-1001 (MIDW) Heater	Same as H-101	Same as H-101	Currently implemented: use of only refinery fuel gas and the LNBs		
H-1002 Hydrodesulfuri	Same as H-101	Same as H-101	Currently implemented: use of		

Source	$PM_{2.5}$	SO_2	NOx	VOC	NH_3
zation (HDS) Reboiler			only refinery fuel gas and the LNBs		
H-1003 HDS Heater	Same as H-101	Same as H-101	Currently implemented: use of only refinery fuel gas and the LNBs		
H-1102 SRU and Tail Gas Incinerator	Same as H-101	Same as H-101	Currently implemented: use of only refinery fuel gas and the LNBs		
Refinery Flares	Currently implemented controls and the pending control installation of a flare gas minimization project (Jan. 2019)	Currently implemented controls and the pending control installation of a flare gas minimization project (Jan. 2019)	Currently implemented controls and the pending control installation of a flare gas minimization project (Jan. 2019)	Currently implemented controls and the pending control installation of a flare gas minimization project (Jan. 2019).	
Sulfur Recovery Plant		Currently implemented: tail gas incinerator and caustic scrubber			
Standby (Emergency) Fire Pump	Currently implemented: good combustion practices for Tier II engines	Currently implemented: ultra-low sulfur fuel	Currently implemented: good combustion practices for Tier II engines		
Fugitive Equipment				Currently implemented: Leak Detection and Repair Program in compliance with NSPS subpart GGGa and monitoring cooling tower return water	
Product Loading Racks				Currently implemented: vapor recovery and vapor combustors	
Storage Tanks, Group 1				Currently implemented: degassing to a vapor combustion device	
Storage Tanks, Group 2				Currently implemented: pressure vacuum relief valves	
Wastewater Treatment System				New carbon canister installations and currently	

Source	$PM_{2.5}$	SO_2	NOx	VOC	NH_3
				implemented API fixed cover.	
Cooling Towers				Currently implemented: leak detection program and drift eliminators	

Table 2: Potential BACT Technologies for Direct $PM_{2.5}$ – Particulate Matter

Source / Process Area	Control Technology	Rule / Emission Limit	Technically Feasible? (Y / N)	Baseline (TPY)	Incremental Emissions Reduction (TPY)	Incremental Cost Effectiveness ($/ton)
FCC Unit Regenerator	Tertiary Cyclones w/ Fabric Filter	40 CFR 63 UUU 1.0 lb/1000 lb coke burn	Yes	0.675	Baseline	N/A
	Flue Gas Blowback Filter (FGF)	40 CFR 63 UUU 0.5 lb/1000 lb coke burn	Yes	0.675	Baseline	N/A
	Electrostatic Precipitator (ESP)		No	0.675	-	-
	Wet Gas Scrubber (WGS)		No	0.675	-	-
Heaters (Reformer, Crude) >40 MMBtu/hr	Use only Refinery fuel gas for combustion -- no oil burning	current SIP	Yes	1.81	Baseline	N/A
	Good combustion practices -- regular O_2 monitoring	Subpart DDDDD	Yes	1.81	Baseline	N/A
	O_2 Trim System	Subpart DDDDD	Yes	1.81	0.04	$1,520,422
	Electrostatic Precipitator (ESP)		Yes	1.81	1.09	$9,878,250
	Wet Gas Scrubber (WGS)		Yes	1.81	1.45	$318,250
	Dry Gas Scrubber (DGS)		Yes	1.81	1.63	$1,443,653
Boilers (1, 2, 6) >40 MMBtu/hr	Use only Refinery fuel gas for combustion -- no oil burning	current SIP	Yes	0.96	Baseline	N/A
	Good combustion practices -- regular O_2 monitoring	Subpart DDDDD	Yes	0.96	Baseline	N/A
	O_2 Trim System	Subpart DDDDD	Yes	0.96	0.02	$2,875,615
	Electrostatic Precipitator (ESP)		No	-	-	-
	Wet Gas Scrubber (WGS)		No	-	-	-
	Dry Gas Scrubber (DGS)		No	-	-	-
Heaters <40 MMBtu/hr	Use only Refinery fuel gas for combustion -- no oil burning	current SIP	Yes	0.69	Baseline	N/A
	Good combustion practices -- regular O_2 monitoring	Subpart DDDDD	Yes	0.69	Baseline	N/A
	O_2 Trim System	Subpart DDDDD	Yes	0.69	0.01	$4,011,609
	Electrostatic Precipitator (ESP)		No	-	-	-

Source / Process Area	Control Technology	Rule / Emission Limit	Technically Feasible? (Y / N)	Baseline (TPY)	Incremental Emissions Reduction (TPY)	Incremental Cost Effectiveness ($/ton)
	Wet Gas Scrubber (WGS)		No	-	-	-
	Dry Gas Scrubber (DGS)		No	-	-	-
Refinery Flares	Compliance with NSPS Subpart J flaring provisions		Yes	1.12	Baseline	N/A
	Compliance with NSPS Subpart J_a flaring provisions	40 CFR 60.102a(g)(3) -- limit on flare gas rate during normal operations (except during periods of process upset or fuel gas imbalance)	Yes	1.12	Baseline	N/A
	Flare Gas Minimization		Yes	1.12	0.56	$3,209,001
	Flare Gas Recovery		No	-	-	-
Standby (Emergency) Fire Pump[1]	Particulate Filter		Yes	0.28	0.25	$382,130

1) AP42 PM10 EF for Diesel Engines 0.0022 lb/hp-hr and 500 hours for 500 hp engine.

Table 3: Potential BACT Technologies for SO_2 - Sulfur Dioxide

Source / Process Area	Control Technology	Rule / Emission Limit	Technically Feasible? (Y / N)	Baseline (TPY)	Incremental Emissions Reduction (TPY)	Incremental Cost Effectiveness ($/ton)
FCC Unit Regenerator	Low Sulfur Feedstocks	current SIP	Yes	21.2	Baseline	N/A
	SOx Reducing Catalyst Additive[1]	40 CFR 60.102a(b)(3) 25 ppmv annual average	Yes	21.2	Baseline	N/A
	Wet Gas Scrubber (WGS)	40 CFR 60.102a(b)(3) 25 ppmv annual average	No	-	-	-
	Cat Feed Hydrotreater	40 CFR 60.102a(b)(3) 25 ppmv annual average	No	-	-	-
Heaters (Reformer, Crude) >40 MMBtu/hr	Use only Refinery fuel gas for combustion -- no oil burning	current SIP	Yes	0.90	Baseline	N/A
The data shown are an example of a heater (Reformer)	Comply with NSPS Subpart J fuel gas standard	40 CFR 60.105(a)(4) 162 ppmv maximum H_2S in fuel gas	Yes	0.90	Baseline	N/A
	Comply with NSPS Subpart J_a fuel gas standard	40 CFR 60.102a(g)(1)(ii) 60 ppmv annual average H_2S in fuel gas	Yes	0.90	Baseline	N/A
	Wet Gas Scrubber (WGS)		Yes	0.90	0.72	$640,035
Boilers (1, 2, 6) >40 MMBtu/hr	Use only Refinery fuel gas for combustion -- no oil burning	current SIP	Yes	0.53	Baseline	N/A
The data shown is an example of a boiler (#6)	Comply with NSPS Subpart J fuel gas standard	40 CFR 60.105(a)(4) 162 ppmv maximum H_2S in fuel gas	Yes	0.53	Baseline	N/A
	Comply with NSPS Subpart J_a fuel gas standard	40 CFR 60.102a(g)(1)(ii) 60 ppmv annual average H_2S in fuel gas	Yes	0.53	Baseline	N/A
	Wet Gas Scrubber (WGS)		Yes	0.53	0.42	$1,086,853

Source / Process Area	Control Technology	Rule / Emission Limit	Technically Feasible? (Y / N)	Baseline (TPY)	Incremental Emissions Reduction (TPY)	Incremental Cost Effectiveness ($/ton)
Heaters <40 MMBtu/hr	Use only Refinery fuel gas for combustion -- no oil burning	Current SIP	Yes	0.38	Baseline	N/A
The data shown is an example of a heater (H-301)	Comply with NSPS Subpart J fuel gas standard	40 CFR 60.105(a)(4) 162 ppmv maximum H_2S in fuel gas	Yes	0.38	Baseline	N/A
	Comply with NSPS Subpart J_a fuel gas standard	40 CFR 60.102a(g)(1)(ii) 60 ppmv annual average H_2S in fuel gas	Yes	0.38	Baseline	N/A
	Wet Gas Scrubber (WGS)		Yes	0.38	0.30	$1,515,873
Refinery Flares	Compliance with NSPS Subpart J flaring provisions		Yes	0.59	Baseline	N/A
	Comply with NSPS Subpart J_a fuel gas standard (with fuel gas to flare)	40 CFR 60.102a(g)(1)(ii) 60 ppmv annual average H_2S in fuel gas	Yes	0.59	Baseline	N/A
	H_2S Scavenger		Yes	0.59	0.1475	$ 728,028
	Flare Gas Minimization		Yes	0.59	0.295	$6,091,664
Sulfur Recovery Plant	Single-train Claus unit with tail-gas incineration	Current SIP requires 95% sulfur recovery efficiency	Yes	3.62	Baseline	N/A
	Caustic Scrubbing of sour fuel gas and SWS storage during SRP outages	No acid gas flaring during planned or unplanned outages of SRP	Yes	3.62	Baseline	N/A
	Tail Gas Unit on SRP	95% => 98% sulfur recovery efficiency	Yes	3.62	3.5	$4,238,088
Standby (Emergency) Fire Pump[2]	Ultra-Low Sulfur Fuel			0.26	Baseline	N/A

1) Based on reduction to 25 ppm from 170 ppm baseline.
2) AP42 SOx EF for Diesel Engines 0.00205 lb/hp-hr and 500 hours for 500 hp engine.

Table 4: Potential BACT Technologies for NOx - Nitrogen Oxides

Source / Process Area	Control Technology	Rule / Emission Limit	Technically Feasible? (Y / N)	Baseline (TPY)	Incremental Emissions Reduction (TPY)	Incremental Cost Effectiveness ($/ton)
FCC Unit Regenerator	UOP High Efficiency (Low-NOx) Combustor Design		Yes	17.39	Baseline	N/A
	Low-NOx Combustion Promoter (non-platinum)	40 CFR 60.102a(b)(2) 80 ppmv 7-day rolling average	Yes	17.39	Baseline	N/A
	NOx Reducing Additive[1]		Potentially	17.39	4.35	$566,559
	Selective Non-Catalytic Reduction (SNCR)		No	-	-	-
	Selective Catalytic Reduction (SCR)		No	-	-	-
	Cat Feed Hydrotreating		No	-	-	-
Boilers (1, 2, 6)	Fuel Gas Only -- no oil burning	Current SIP	Yes	4.15	Baseline	N/A
The data shown is an example of a boiler (#6)	Ultra-Low NOx Burners (w/ FGR)	For > 40 MMBtu/hr 40 CFR 60.102a(g)(2) 40 ppmv 24-hour rolling average	Yes	4.15	Baseline	N/A
	Selective Catalytic Reduction (SCR)		Yes	4.15	3.11	$2,052,385
	Selective Non-Catalytic Reduction (SNCR)		No	-	-	-
	Flue Gas Recirculation		No	-	-	-
	Wet Gas Scrubber (WGS)		No	-	-	-
	Sorbent injection or pass through		Yes	4.15	1.04	$2,373,236
Permitted Heater List						
H-101 FCC Heater (140 lb/MMSCF)	Fuel Gas Only -- no oil burning		Yes	2.99	Baseline	N/A
	Low NOx Burners (staged)		Potentially	2.99	1.49	$635,335
	Ultra-Low NOx Burners (staged)		No	-	-	-
	Selective Catalytic Reduction (SCR)		Yes	2.99	2.69	$2,375,898
	Selective Non-Catalytic Reduction (SNCR)		No	-	-	-
	Flue Gas Recirculation		No	-	-	-

Source / Process Area	Control Technology	Rule / Emission Limit	Technically Feasible? (Y / N)	Baseline (TPY)	Incremental Emissions Reduction (TPY)	Incremental Cost Effectiveness ($/ton)
	Wet Gas Scrubber (WGS)		No	-	-	-
	Sorbent injection or pass through		Yes	2.99	0.75	$3,296,789
H-301 17.29 MMBtu/hr Alkylation Unit Deisobutanizer Reboiler Heater (140 lb/MMSCF)	Fuel Gas Only -- no oil burning		Yes	9.02	Baseline	N/A
	Low NOx Burners (staged)		Yes	9.02	Baseline	N/A
	Ultra-Low NOx Burners (staged)		Potentially	9.02	6.77	$135,383
	Selective Catalytic Reduction (SCR)		Yes	9.02	8.12	$786,897
	Selective Non-Catalytic Reduction (SNCR)		No	-	-	-
	Flue Gas Recirculation		No	-	-	-
	Wet Gas Scrubber (WGS)		No	-	-	-
	Sorbent injection or pass through		Yes	9.02	2.26	$1,091,896
H-402 #2 Crude Heater (80 lb/MMSCF)	Fuel Gas Only -- no oil burning		Yes	4.34	Baseline	N/A
	Low NOx Burners (staged)		Yes	4.34	Baseline	N/A
	Ultra-Low NOx Burners (staged)		Potentially	4.34	3.25	$281,676
	Selective Catalytic Reduction (SCR)		Yes	4.34	3.90	$1,637,209
	Selective Non-Catalytic Reduction (SNCR)		No	-	-	-
	Flue Gas Recirculation		No	-	-	-
	Wet Gas Scrubber (WGS)		No	-	-	-
	Sorbent injection or pass through		Yes	4.34	1.08	$2,271,787
H-403 Crude Preflash Heater (140 lb/MMSCF)	Fuel Gas Only -- no oil burning		Yes	4.82	Baseline	N/A
	Low NOx Burners (staged)		Potentially	4.82	2.41	$393,941
	Ultra-Low NOx Burners (staged)		Potentially	4.82	3.61	$253,456
	Selective Catalytic Reduction (SCR)		Yes	4.82	4.34	$1,473,183

Source / Process Area	Control Technology	Rule / Emission Limit	Technically Feasible? (Y / N)	Baseline (TPY)	Incremental Emissions Reduction (TPY)	Incremental Cost Effectiveness ($/ton)
	Selective Non-Catalytic Reduction (SNCR)		No	-	-	-
	Flue Gas Recirculation		No	-	-	-
	Wet Gas Scrubber (WGS)		No	-	-	-
	Sorbent injection or pass through		Yes	4.82	1.20	$2,044,184
H-404 #1 Crude Heater with Ultra-Low NOx Burners (ULNB) (21.06 lb/MMSCF)	Fuel Gas Only -- no oil burning		Yes	2.33	Baseline	N/A
	Ultra-Low NOx Burners (staged)		Yes	2.33	Baseline	N/A
	Selective Catalytic Reduction (SCR)		Yes	2.33	1.75	$3,658,975
	Selective Non-Catalytic Reduction (SNCR)		No	-	-	-
	Flue Gas Recirculation		No	-	-	-
	Wet Gas Scrubber (WGS)		No	-	-	-
	Sorbent injection or pass through		Yes	2.33	0.58	$4,230,986
H-601 32.4 MMBtu/hr Unifiner Heater (140 lb/MMSCF)	Fuel Gas Only -- no oil burning		Yes	3.73	Baseline	N/A
	Low NOx Burners (staged)		Yes	3.73	Baseline	N/A
	Ultra-Low NOx Burners (staged)		Potentially	3.73	2.80	$327,658
	Selective Catalytic Reduction (SCR)		Yes	3.73	3.36	$1,904,479
	Selective Non-Catalytic Reduction (SNCR)		No	-	-	-
	Flue Gas Recirculation		No	-	-	-
	Wet Gas Scrubber (WGS)		No	-	-	-
	Sorbent injection or pass through		Yes	3.73	0.93	$2,642,649
H-621, 622, 624 Reformer Heaters (140 lb/MMSCF)	Fuel Gas Only -- no oil burning		Yes	14.24	Baseline	N/A
	Low NOx Burners (staged)		Yes	14.24	Baseline	N/A

Source / Process Area	Control Technology	Rule / Emission Limit	Technically Feasible? (Y / N)	Baseline (TPY)	Incremental Emissions Reduction (TPY)	Incremental Cost Effectiveness ($/ton)
	Ultra-Low NOx Burners (staged)		Potentially	14.24	10.68	$85,799
	Selective Catalytic Reduction (SCR)		No	-	-	-
	Selective Non-Catalytic Reduction (SNCR)		No	-	-	-
	Flue Gas Recirculation		No	-	-	-
	Wet Gas Scrubber (WGS)		No	-	-	-
	Sorbent injection or pass through		Yes	14.24	3.56	$691,990
H-1001 (MIDW) Heater (80 lb/MMSCF)	Fuel Gas Only -- no oil burning		Yes	2.79	Baseline	N/A
	Low NOx Burners (staged)		Yes	2.79	Baseline	N/A
	Ultra-Low NOx Burners (staged)		Potentially	2.79	2.09	$437,416
	Selective Catalytic Reduction (SCR)		Yes	2.79	2.51	$2,542,430
	Selective Non-Catalytic Reduction (SNCR)		No	-	-	-
	Flue Gas Recirculation		No	-	-	-
	Wet Gas Scrubber (WGS)		No	-	-	-
	Sorbent injection or pass through		Yes	2.79	0.70	$3,527,869
H-1002 Hydrodesulfurization (HDS) Reboiler (80 lb/MMSCF)	Fuel Gas Only -- no oil burning		Yes	1.24	Baseline	N/A
	Low NOx Burners (staged)		Yes	1.24	Baseline	N/A
	Ultra-Low NOx Burners (staged)		Potentially	1.24	0.93	$981,495
	Selective Catalytic Reduction (SCR)		Yes	1.24	1.12	$5,704,829
	Selective Non-Catalytic Reduction (SNCR)		No	-	-	-
	Flue Gas Recirculation		No	-	-	-
	Wet Gas Scrubber (WGS)		No	-	-	-
	Sorbent injection or pass through		Yes	1.24	0.31	$7,916,003
H-1003 HDS Heater (80 lb/MMSCF)	Fuel Gas Only -- no oil burning		Yes	2.92	Baseline	N/A

Source / Process Area	Control Technology	Rule / Emission Limit	Technically Feasible? (Y / N)	Baseline (TPY)	Incremental Emissions Reduction (TPY)	Incremental Cost Effectiveness ($/ton)
	Low NOx Burners (staged)		Yes	2.92	Baseline	N/A
	Ultra-Low NOx Burners (staged)		Potentially	2.92	2.19	$418,318
	Selective Catalytic Reduction (SCR)		Yes	2.92	2.63	$2,431,426
	Selective Non-Catalytic Reduction (SNCR)		No	-	-	-
	Flue Gas Recirculation		No	-	-	-
	Wet Gas Scrubber (WGS)		No	-	-	-
	Sorbent injection or pass through		Yes	2.92	0.73	$3,373,840
H-1102 SRP and Tail Gas Incinerator (80 lb/MMSCF)	Fuel Gas Only -- no oil burning		Yes	0.67	Baseline	N/A
	Low NOx Burners (staged)		Yes	0.67	0.33	$2,838,114
	Ultra-Low NOx Burners (staged)		Potentially	0.67	0.50	$1,825,998
	Selective Catalytic Reduction (SCR)		Yes	0.67	0.60	$10,613,412
	Selective Non-Catalytic Reduction (SNCR)		No	-	-	-
	Sorbent injection or pass through		Yes	0.67	0.17	$14,727,138
Refinery Flares	Compliance with NSPS Subpart J flaring provisions		Yes	14.7	Baseline	N/A
	Compliance with NSPS Subpart J_a flaring provisions	40 CFR 60.102a(g)(3) -- limit on flare gas rate during normal operations (except during periods of process upset or fuel gas imbalance)	Yes	14.7	Baseline	N/A
	Flare Gas Minimization		Yes	14.7	7.35	$244,495
Standby (Emergency) Fire Pump[1]	Selective Catalytic Reduction		Yes	3.88	3.49	$1,832,354

1) AP42 NOx EF for Diesel Engines 0.031 lb/hp-hr and 500 hours for 500 hp engine.

Table 5: Potential BACT Technologies for VOCs – Volatile Organic Compounds

Source / Process Area	Control Technology	Rule / Emission Limit	Technically Feasible? (Y / N)	Baseline (TPY)	Incremental Emissions Reduction (TPY)	Incremental Cost Effectiveness ($/ton)
Refinery Flares	Compliance with NSPS Subpart J flaring *provisions*		Yes	80.33	Baseline	N/A
	Compliance with NSPS Subpart J_a flaring *provisions*	40 CFR 60.102a(g)(3) -- limit on flare gas rate during normal operations (except during periods of process upset or fuel gas imbalance)	Yes	80.33	Baseline	N/A
	Compliance with Refinery Sector Rule (RSR) flare operation requirements - ensure adequate combustion efficiency	Compliance with RSR (40 CFR 63.670)	Yes	80.33	16.1	$45,177.62
	Flare Gas Minimization		Yes	80.33	40.2	$44,741.47
	Flare Gas Recovery		No	-	-	-
Fugitive Equipment						
Fugitive Emissions -- Valves, Pumps, Cooling Towers	Comply with NSPS subpart GGGa leak definition for LDAR monitoring		Yes	124	Baseline	N/A
Fugitive Emissions -- Heat Exchangers	Monthly monitoring for Heat Exchanger leaks with Modified El Paso stripper method	Heat Exchanger MACT 6.2 ppm VOC at cooling water return	Yes	4.8	Baseline	N/A
Product Loading Racks						
Truck	Vapor Recovery Unit	Gasoline Distribution MACT 10 mg/liter	Yes	10.75	Baseline	N/A
Truck	Backup VRU	Gasoline Distribution MACT 10 mg/liter	Yes	10.75	Baseline	N/A
Railcar	Vapor Combustor Unit		Yes	0.11	Baseline	N/A
Storage Tanks		40 CFR 60 Subparts K, Ka, Kb, GGG, GGGa				
Group 1 Tanks (Floating Roof)	Degassing to a vapor combustion device	40 CFR 63.660	Yes	152	Baseline	N/A
EFR only	Dome		No	-	-	-
	Vapor water scrubber		Yes	152	91.2	$19,029

Source / Process Area	Control Technology	Rule / Emission Limit	Technically Feasible? (Y / N)	Baseline (TPY)	Incremental Emissions Reduction (TPY)	Incremental Cost Effectiveness ($/ton)
IFR only	Vapor dry scrubber (activated carbon)		Yes	152	129.2	$10,529
	Vapor recovery unit		Yes	152	150.48	$67,079
	Vapor recovery and combustor		Yes	152	150.48	$15,700
Group 2 Tanks (Fixed Roof)	Pressure vacuum relief valves		Yes	5.22	Baseline	N/A
	Vapor water scrubber		Yes	5.22	4.176	$415,574
	Internal Floating Roof		No	-	-	-
	Vapor dry scrubber (activated carbon)		Yes	5.22	4.959	$274,318
	Vapor recovery unit		Yes	5.22	5.1678	$1,953,271
	Vapor recovery and combustor		Yes	5.22	5.1678	$457,157
Wastewater Treatment System	API fixed cover		Yes	16.2	Baseline	N/A
	Carbon canisters		Yes	16.2	15.39	$7,586
	Thermal oxidizer		Yes	16.2	15.9	$74,405
Cooling Towers	Drift Eliminators		Yes	4.8	Baseline	N/A

1) Assumes prorated reduction from current leak definition of 10,000 ppm (2010 AEI).

Table 6: Potential BACT Technologies for NH_3 - Ammonia

Source / Process Area	Control Technology	Rule / Emission Limit	Technically Feasible? (Y / N)	Baseline (TPY)	Incremental Emissions Reduction (TPY)	Incremental Cost Effectiveness ($/ton)
FCC[1]	Source Test		Yes	0.15	Baseline	N/A
	Wet Scrubber		No	-	-	-

1) Baseline emissions based on 2016 emissions inventory.

Big West Oil LLC 333 W. Center Street • North Salt Lake Utah 84054 • 801.296.7700 • www.bigwestoil.com

UTAH DEPARTMENT OF ENVIRONMENTAL QUALITY

APR 27 2017

DIVISION OF AIR QUALITY

April 27, 2017

Martin D. Gray, Manager
New Source Review Section
Utah Division of Air Quality
P.O. Box 144820
195 North 1950 West
Salt Lake City, UT 84114-4820

RE: Submittal of Best Available Control Technology Evaluation

Dear Mr. Gray:

As requested in your letter of January 23, 2017, Big West Oil, LLC have prepared a list of control technologies potentially applicable to the Big West Oil Refinery in North Salt Lake for the $PM_{2.5}$ State Implementation Plan (SIP) currently under development by UDAQ for the Salt Lake City Non-attainment Area. We understand this information may be used to determine the level of control technology that will satisfy the Best Available Control Technology (BACT) requirement for stationary point sources within the SIP.

This submittal consists of the *Best Available Control Technology Evaluation - Utah $PM_{2.5}$ State Implementation Plan* report in Attachment I which follows the U.S. Environmental Protection Agency (EPA) prescribed top down process for identification and evaluation of BACT. The report evaluates all technologies that would reduce $PM_{2.5}$ emissions and precursors of $PM_{2.5}$ emissions (SO_2, NO_x, VOC and ammonia) from all regulated sources within the refinery. The evaluation considers technical feasibility, estimates of actual emissions reductions and cost effectiveness for each technology or work practice identified.

While a very brief time was allotted by UDAQ for completion of this request, we believe the reports provides a comprehensive evaluation of potential control technologies and work practices utilizing reasonable assumptions and engineering judgment. Nonetheless, it should be recognized that BACT may not be uniform within a group of similar sources. Each facility will have specific physical and technical conditions that make a given control technology more (or less) applicable. We therefore encourage UDAQ to engage in dialogue with us and other industry representatives to better understand the applicability and limitations of this information before making final decisions with regard to BACT implementation in the $PM_{2.5}$ SIP.

Finally, we consider the financial and cost information included in the attached report to be Confidential Business Information (CBI) and request UDAQ to treat it accordingly.

Sincerely,

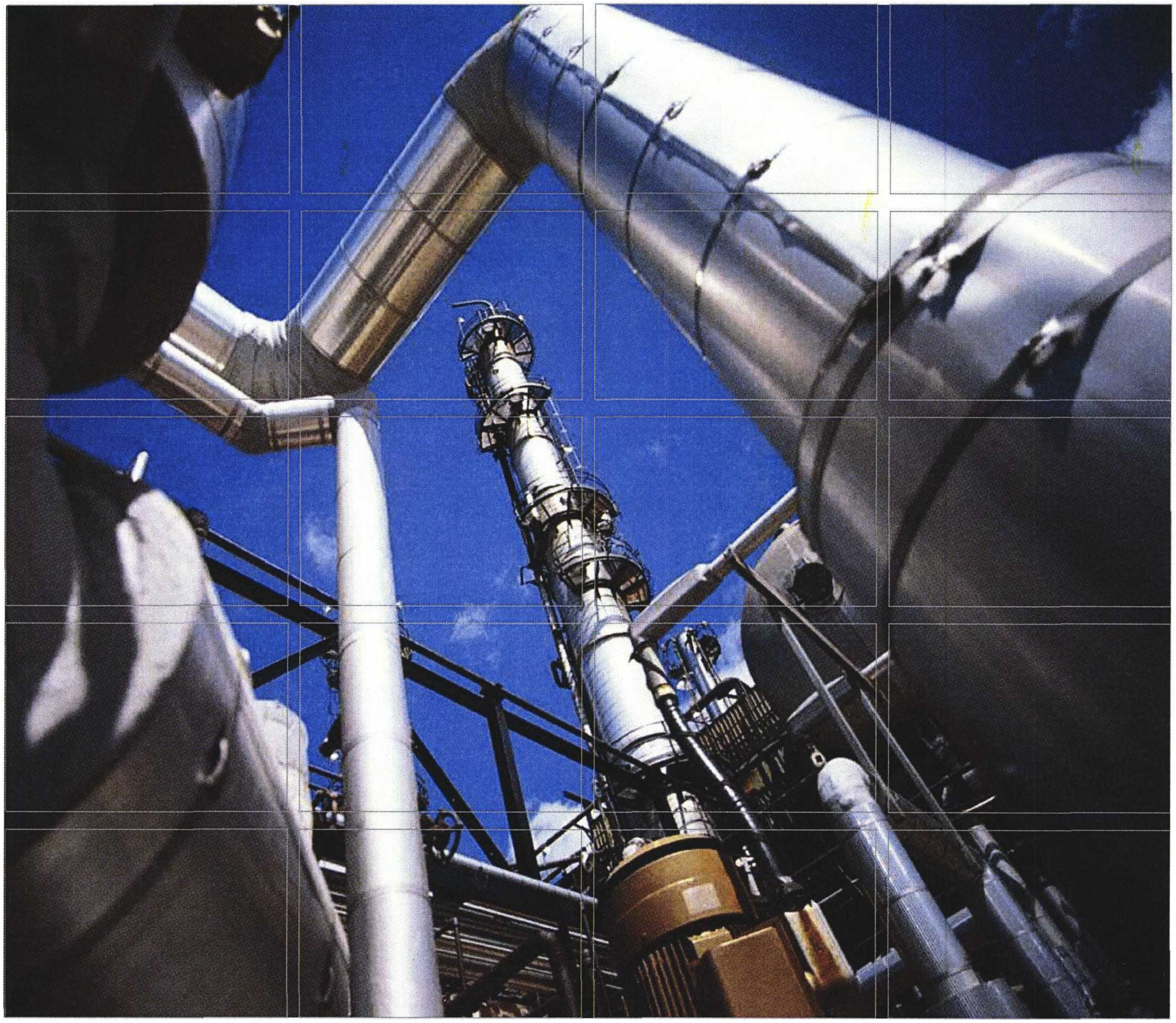
R. Stuart Smith

R. Stuart Smith
Environmental Manager
North Salt Lake Refinery
Big West Oil, LLC

cc: Bryce Bird
Michael Swanson

ATTACHMENT I

Best Available Control Technology Evaluation – Utah PM2.5 State Implementation Plan
April 2017



Best Available Control Technology Evaluation – Utah $PM_{2.5}$ State Implementation Plan

North Salt Lake City, Utah

April 2017

Prepared for:
Big West Oil Refinery

Environmental Resources Management
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Best Available Control Technology Evaluation – Utah $PM_{2.5}$ State Implementation Plan

North Salt Lake City, Utah

April 2017

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LIST OF ACRONYMS AND ABBREVIATIONS

AEI	annual emission inventory
BAAQMD	Bay Area Air Quality Management District
BACT	Best Available Control Technology
BWO	Big West Oil
CFR	Code of Federal Regulations
DGS	dry gas scrubber
EF	emission factor
EFR	external floating roof
EPA	Environmental Protection Agency
ERM	ERM-West, Inc.
ESP	electrostatic precipitator
FCCU	Fluid Catalytic Cracking Unit
FGF	flue gas blowback filter
FGR	flue gas recirculation
H_2S	hydrogen sulfide
HDS	hydrodesulfurization
hp	horsepower
hr	hour
IFR	internal floating roof
LAER	lowest achievable emission rate
lb	pound
LDAR	Leak Detection and Repair Program
LLC	Limited Liability Company
LNB	low-NOx burner
MACT	maximum achievable control technology
mg	milligram
MMBtu	million British thermal units
MMSCF	million standard cubic feet
N	no
N/A	not applicable
NAAQS	National Ambient Air Quality Standards
NH3	ammonia
NOx	nitrogen oxides
NSPS	New Source Performance Standard
O_2	oxygen
$PM_{2.5}$	particulate matter 2.5 microns or less in diameter
ppm	parts per million
ppmv	parts per million volume
RACT	Reasonably Available Control Technology
RBLC	RACT/BACT/LAER Clearinghouse
RSR	Refinery Sector Rule (40 CFR 63 Subpart CC)
SBAPCD	Santa Barbara Air Pollution Control District
SCAQMD	South Coast Air Quality Management District
SCR	selective catalytic reduction
SIC	standard industrial classification
SIP	State Implementation Plan
SJUVAPCD	San Joaquin Unified Valley Air Pollution Control District
SNCR	selective non-catalytic reduction
SO_2	sulfur dioxide
SOx	sulfur oxides
SRP	Sulfur Recovery Plant
SWCAA	South West Clean Air Agency
SWS	sour water stripper
TGTU	Tail Gas Treatment Unit
tpy	tons per year
UDAQ	Utah Department of Environmental Quality, Division of Air Quality
UOP	company and brand name
VOC	volatile organic compound
ULNB	ultra-low NOx burner
VRU	vapor recovery unit
WAC	Washington Administrative Code
WGS	wet gas scrubber
Y	yes

EXECUTIVE SUMMARY

This Best Available Control Technology (BACT) Evaluation was completed in accordance with the Utah Department of Air Quality's 23 January 2017 letter requesting this analysis as part of the regulatory agency's fine particular matter (particulate matter 2.5 microns or less in diameter or $PM_{2.5}$) Serious Nonattainment State Implementation Plan (SIP) development process. The top-down BACT process was followed to identify BACT for each source and the following associated emission type: $PM_{2.5}$, sulfur dioxide (SO_2), nitrogen oxides (NOx), volatile organic compounds (VOC), and ammonia (NH_3).

The applicable sources at the Big West Oil, LLC North Salt Lake Refinery were identified as: Fluid Catalytic Cracking Unit (FCCU) regenerator vent, process heaters, boilers, flares, storage tanks, loading racks, standby fire pump, Sulfur Recovery Plant, valves, pumps, heat exchangers, cooling towers, and Wastewater Treatment System.

After completing the BACT evaluation process utilizing a BACT cost effectiveness threshold of $10,000 per ton removed per year, the addition of carbon canister controls at the wastewater treatment system was identified as a BACT project to be completed by the end of 2018. The other applicable sources all have current controls identified as BACT as described in Table 1.

As a part of the BACT process, other issues that could adversely impact the environment, safety and health, and energy demand were included in the evaluation. Any projects that are identified to be completed outside the normal refinery turnaround maintenance cycle would increase safety and health risks and energy demand as the refinery is not currently planned to have a turnaround until 2019. Additional costs would also be associated with taking a refinery shutdown out of sequence and those lost opportunity costs would need to be added to any projects that are considered as additional feasible measures or most stringent measures.

1.0 INTRODUCTION

On behalf of Big West Oil, LLC (BWO), ERM-West, Inc. (ERM) conducted a Best Available Control Technology (BACT) evaluation for the company's North Salt Lake Refinery. This report presents the BACT process and results for submittal to the Utah Department of Environmental Quality, Division of Air Quality (UDAQ). The BACT evaluation was completed in accordance with the UDAQ's 23 January 2017 letter requesting this analysis as part of the regulatory agency's fine particular matter (particulate matter 2.5 microns or less in diameter or $PM_{2.5}$) Serious Nonattainment State Implementation Plan (SIP) development process.

2.0 APPROACH

A top-down BACT analysis was completed for all technologies that would reduce $PM_{2.5}$ emissions and precursors of $PM_{2.5}$ emissions from all regulated sources within the BWO Refinery. The evaluation included assessing the Fluid Catalytic Cracking Unit (FCCU) Regenerator, heaters, boilers, flares, storage tanks, pumps, compressors, valves, engines, and the wastewater treatment process. All applicable emission control technologies were identified for the refinery emission sources, and they were screened for technical feasibility under the SIP requirements and schedule.

The SIP is designed to regulate and limit $PM_{2.5}$ and its precursors to below the National Ambient Air Quality Standards (NAAQS) based on data to be collected throughout year 2019. This means that control technology improvements will need to be in place before the end of year 2018 to support compliance with the SIP. Therefore, the evaluation and identification of BACT takes into account whether BWO can implement the new controls before the end of 2018.

In cases where BWO has determined that control technologies are technically feasible, except for the SIP schedule constraints, these controls are not considered BACT, but rather "Additional Feasible Measures" that could be implemented if more time were available. All technologies considered technically feasible as BACT or Additional Feasible Measures were ranked based on their potential emission reduction efficiencies. Energy, environmental, health and safety impacts, and other considerations were evaluated for the feasible technologies; the technologies that had the largest emissions reduction and most cost-effective with the least environmental, health, safety and energy impact were identified as BACT or Additional Feasible Measures for the applicable emission units.

2.1 *BACT ANALYSIS PROCESS*

The BACT analysis was organized into the following steps, which are described in the paragraphs that follow:

1. Identify control technologies.
2. Eliminate technically infeasible technologies.
3. Rank technologies by control effectiveness.
4. Evaluate controls for economic feasibility.
5. Recommend BACT.

2.1.1 *Step 1 - Identify Control Technologies*

BWO identified its emission sources for $PM_{2.5}$ and precursors, and then identified acceptable control technologies for these sources. The U.S. Environmental Protection Agency (EPA) established the Reasonably Available Control Technology/BACT/Lowest Achievable Emission Rate (RACT/BACT/LAER) Clearinghouse (RBLC) to provide a central database of air pollution technology information. BWO relied on the RBLC and other resources listed in Section 2.2, to identify potentially applicable control technologies. The emission sources and applicable technologies were documented using a BACT Matrix table for tracking and presentation of the results as presented in Section 3 and the attached tables.

2.1.2 *Step 2 - Eliminate Technically Infeasible Technologies*

BWO reviewed the technologies to determine whether they were technically feasible at the refinery based on site-specific (i.e., real estate) or operational constraints. The SIP time constraints were also taken into account relative to defining technically feasible BACT. Based on the UDAQ expectation that BACT be defined as control technologies that could be installed and made operational by the end of 2018, BWO has determined that only the carbon canisters installed on the Wastewater Treatment System can be installed and made operational by this deadline; the existing controls currently in place can be considered BACT for all other sources. However, if not for the time constraints of the SIP schedule, BWO believes other control technologies could be implemented, and these are identified on the BACT Matrix as Additional Feasible Measures.

2.1.3 *Task 3 - Rank Technologies by Control Effectiveness*

BWO calculated the baseline emissions from its sources using either current emissions (based on recent 2016 changes) or the prior 2-year-average emissions. The potential for additional emission reductions was evaluated for the applicable technologies using vendor or Environmental Protection Agency (EPA)-provided removal efficiencies. The amount of emissions reductions that could be achieved for the applicable technologies were calculated and the technologies were listed according to rank on the BACT Matrix.

2.1.4 *Task 4 - Evaluate Controls for Economic Feasibility*

BWO evaluated the controls for economic feasibility using capital and operating cost estimates provided by the EPA Cost Control Manual, vendor information, ERM experience, and potential project estimates from BWO. Energy consumption, environmental, and other impacts were considered for the feasible controls to account for all economic impacts. The economic feasibility of increased controls was evaluated using the ratio of the cost for the new controls compared with the incremental emission reductions achieved by the new controls verses the baseline (current) condition in terms of dollars per ton of emissions reduced. BWO considered the ratio of $10,000 per ton of emission reductions to represent economically feasible controls.

2.1.5 *Task 5 - Recommend BACT*

Based on the evaluation of control technologies, BWO is presenting in this report its analysis and conclusions regarding the controls it believes are technically and economically feasible, and those that can be considered BACT (including compliance with the UDAQ SIP schedule) or Additional Feasible Measures (if more time is permissible for technology implementation). Table 1 presents a summary of BACT selections for each pollutant by source.

2.2 *REGULATORY BACKGROUND*

The following BACT clearinghouses and guidelines were searched as part of Step 1 to identify potentially applicable control technologies for the BWO emission sources:

- U.S. EPA
- Bay Area Air Quality Management District (BAAQMD)
- South Coast Air Quality Management District (SCAQMD)

- San Joaquin Unified Valley Air Pollution Control District (SJUVAPCD)
- Santa Barbara Air Pollution Control District (SBAPCD)
- Texas Commission of Environmental Quality

2.3 *BASIS AND STUDY LIMITATION*

The current applicable standards, emission control methods, and technologies are considered Reasonable Achievable Control Technologies RACT by the facility. Only Flare Gas Minimization was included in the $PM_{2.5}$ Moderate State Implementation Plan (SIP) by the UDEQ.

The emissions from 2014 and 2015 were averaged to be the sources' baseline emissions. The exceptions are the flares' VOC emissions baseline that was estimated using the revised EPA emission factor and the FCCU's NH_3 emissions baseline value used was from the 2016 emissions inventory.

The cost effectiveness for BACT is typically $10,000 per ton removed or less. Big West Oil used that as the basis for determining new BACT selections for this evaluation.

The determination of technical feasibility had several criteria that needed to be met such as physical constraints, facility natural gas consumption, fired equipment configuration (natural draft), and proven on similar sources.

The cost effectiveness calculations utilized the facility estimation factor for capital projects and a 100 percent contingency factor due to limited vendor cost input. Published costs from earlier EPA or published studies were brought up to January 2017 costs by using the Bureau of Labor Statistic's inflation calculator.

3.0 *BACT EVALUATION*

The BACT Evaluation is summarized for each source in the following sections. Tables 2 through 6 also present the emission sources for direct $PM_{2.5}$ and its precursors (e.g., sulfur dioxide (SO_2), nitrogen oxides (NO_x), volatile organic compounds (VOCs), and ammonia (NH_3)). For each source, these tables list the identified control technologies, if they are technically feasible, the baseline emissions, the estimated emissions reductions, and the cost effectiveness for applicable technologies.

3.1 *FCCU REGENERATOR*

The FCCU regenerator emits $PM_{2.5}$, SO_2, NOx, and NH_3 and each pollutant has different control technologies evaluated.

3.1.1 *$PM_{2.5}$*

BWO operates an FCCU regenerator that produces emissions for direct $PM_{2.5}$. The identified control technologies are listed in Table 2, including the currently implemented use of flue gas blowback filter and tertiary cyclones with fabric filter.

The BACT technology review identified potential additional control technologies for the FCCU regenerator, including ESP and a wet gas scrubber (WGS). However, the FCCU regenerator has insufficient space to install an ESP or WGS; and they are therefore technically infeasible.

Table 2 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. However, there are no additional controls classified as technically feasible for the FCCU regenerator. Therefore, the current controls are considered BACT for the FCCU regenerator (i.e., a flue gas blowback filter and tertiary cyclones with fabric filter).

3.1.2 *SO_2*

BWO operates an FCCU regenerator that produces emissions for SO_2. The identified control technologies are listed in Table 3, including the currently implemented sulfur oxides (SOx)-reducing catalyst additive.

The BACT technology review showed potential additional control technologies for the FCCU regenerator, including adding additional SOx-reducing catalyst additive, WGS, and cat feed hydrotreater. However, the FCCU regenerator has insufficient space to install a WGS and cat feed hydrotreater; therefore, they are technically infeasible.

Table 3 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation was unnecessary for the FCCU as no additional technologies were considered technically feasible. Therefore, the current controls are considered BACT for the FCCU regenerator (i.e., SO_X-reducing catalyst additive).

3.1.3 *NOx*

BWO operates an FCCU regenerator that produces emissions for NOx. The identified control technologies are listed in Table 4, including the currently implemented NOx-reducing UOP high efficiency (low-NOx) combustor design, low-NOx combustion promoter, and good combustion practices.

The BACT technology review showed potential additional control technologies for the FCCU regenerator, including adding a NOx-reducing additive, selective non-catalytic reduction (SNCR), selective catalytic reduction (SCR), and cat feed hydrotreating. However, the FCCU regenerator has insufficient space to install the SCR or cat feed hydrotreater and the flow dynamics required for a SNCR could not be met due to the installed blowback filter; therefore, they are technically infeasible. The use of NOx reducing additive is potentially feasible and under consideration. The effectiveness has not been proven at this time.

Table 4 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation showed that control technologies determined to be technologically implementable were economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. Therefore, the current controls are considered BACT for the FCCU regenerator (i.e., UOP high efficiency (low-NOx) combustor design, low-NOx combustion promoter, and good combustion practices). Evaluation of the NOx reducing additive will be completed once the effectiveness has been verified.

3.1.4 NH_3

BWO operates an FCCU regenerator that emits ammonia from the coke burn-off phase. The identified control technologies are listed in Table 6. Ammonia emissions are typically estimated using emission factors derived by EPA from a limited number of source test data. BWO has recently performed a source test that demonstrated approximately 98 percent reduction from the emissions predicted by the EPA emission factor. Performing this source test on a regular basis is considered BACT.

The BACT technology review showed potential additional control technologies for the FCCU regenerator, including a wet gas scrubber. However, the FCCU has insufficient physical space for the wet gas scrubber at the FCCU Regenerator exhaust after the addition of the flue gas blowback filter; therefore, it is technically infeasible.

As no additional technologies were identified as technically feasible, no economic analysis was conducted. Therefore, the current controls are considered BACT for the FCCU (i.e., regular source testing).

3.2 *HEATERS (REFORMER (H-621, H-622, H-624), CRUDE (H-404)) >40 MMBTU/HR*

Process heaters greater than 40 million British thermal units (MMBtu) per hour design heating rate have been identified by EPA as sources that could add control devices to reduce emissions even if that combustion system utilizes natural draft air movement. All of these existing heaters already have low NOx or ultra-low NOx burners.

3.2.1 *$PM_{2.5}$*

BWO operates heaters with heat ratings greater than 40 MMBtu/hr. These sources produce emissions for direct $PM_{2.5}$. The identified control technologies for direct $PM_{2.5}$ are listed in Table 2, including the currently implemented use of only refinery fuel gas for combustion (i.e., no oil burning) and good combustion practices such as regular oxygen (O_2) monitoring.

The BACT technology review showed potential additional control technologies including ESP, WGS, dry gas scrubber (DGS), and an O_2 Trim System.

Table 2 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. Only one heater is shown as an example. The economic feasibility evaluation showed that control technologies determined to be technically implementable were economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. Therefore, the current controls are considered BACT for the heaters with heat ratings greater than 40 MMBtu/hr MMBtu/hr (i.e., only use of refinery fuel gas and good combustion practices).

3.2.2 *SO_2*

BWO operates heaters that produce emissions for SO_2. The identified control technologies for SO_2 are listed in Table 3, including the currently implemented use of only refinery fuel gas for combustion (i.e., no oil burning) and compliance with New Source Performance Standards (NSPS) Subparts J and J_a fuel gas standards.

The BACT technology review showed potential additional control technologies for the large heaters including WGSs.

Table 3 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. Only one heater is shown as an example. The economic feasibility evaluation showed that the WGS was economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. However, a caustic scrubber has been added to treat fuel gas during outages of the Amine and Sulfur Recovery units to maintain the fuel standards and prevent additional SO_2 emissions.

Therefore, the current controls are considered BACT for the large heaters (i.e., use of only refinery fuel gas and compliance with NSPS Subparts J and J_a fuel gas standards).

3.2.3 *NOx*

3.2.3.1 Reformer Heater (H-621, H-622, H-624)

BWO operates reformer heaters that produce emissions for NOx. The identified control technologies for NOx are listed in Table 4, including the currently implemented use of only refinery fuel gas for combustion (i.e., no oil burning) and a low-NOx burner (LNB).

The BACT technology review showed potential additional control technologies including a ultra-low NOx burners (ULNB) and a sorbent injection or pass-through. Ultra-low NOx burners are not technically feasible due to the physical constraints.

Table 4 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation showed that control technologies determined to be technically implementable were economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. Therefore, the current controls are considered BACT for the reformer heater (i.e., use of only refinery fuel gas and the LNB).

3.2.3.2 Crude Heater (H-404)

BWO operates a crude heater with a heating capacity greater than 40 MMBtu/hr that produces emissions for NOx. The identified control technologies for NOx are listed in Table 4, including the currently implemented use of only refinery fuel gas for combustion (i.e., no oil burning) and ULNB.

The BACT technology review showed potential additional control technologies including a Selective Catalytic Reduction unit and a sorbent injection or pass-through.

Table 4 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation showed that control technologies determined to be technically implementable were economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. Therefore, the current controls are considered BACT for the Crude Heater (i.e., use of only refinery fuel gas and good combustion practices and ULNB).

3.3 *BOILERS (1, 2, 6) >40 MMBTU/HR*

Industrial boilers greater than 40 MMBtu/hr design heating rate have been identified by EPA as sources that could add control devices to reduce emissions even if that combustion system utilizes natural draft air movement. The existing boilers already have ultra-low NOx burners.

3.3.1 *$PM_{2.5}$*

BWO operates three boilers that produce emissions for direct $PM_{2.5}$. The identified control technologies for direct $PM_{2.5}$ are listed in Table 2, including the currently implemented use of only refinery fuel gas for combustion (i.e., no oil burning) and good combustion practices such as regular O_2 monitoring.

The BACT technology review showed potential additional control technologies including ESP, WGS, DGS, and an O_2 Trim System. However, the boilers have insufficient space for installing ESP, WGS, or DGS; therefore, they are technically infeasible.

Table 2 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. Only one boiler is shown as an example. The economic feasibility evaluation showed that control technologies determined to be technically implementable were economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. Therefore, the current controls are considered BACT for the boilers (i.e., use of only refinery fuel gas and good combustion practices and ULNB).

3.3.2 *SO_2*

BWO operates three boilers that produce emissions for SO_2. The identified control technologies for SO_2 are listed in Table 3, including the currently implemented use of only refinery fuel gas for combustion (i.e., no oil burning) and compliance with New Source Performance Standards (NSPS) Subparts J and J_a fuel gas standards.

The BACT technology review showed potential additional control technologies for the large heaters including WGSs.

Table 3 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. Only one boiler is shown as an example. The economic feasibility evaluation showed that the WGS was economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. However, a caustic scrubber has been added to treat fuel gas during outages of the Amine and Sulfur Recovery units to maintain the fuel standards and prevent additional SO_2 emissions.

Therefore, the current controls are considered BACT for the large heaters (i.e., use of only refinery fuel gas that meets J_a fuel standards).

3.3.3 *NOx*

BWO operates heaters and boilers of various sizes. These sources produce emissions for NOx. The identified control technologies for NOx are listed in Table 4, including the currently implemented use of only refinery fuel gas for combustion (i.e., no oil burning) and a ULNB.

The BACT technology review showed potential additional control technologies including SCR, flue gas recirculation (FGR), WGS, and an SNCR. However, the boilers have insufficient space for installing SCR, FGR, WGS, or SNCR; therefore, they are technically infeasible.

As no additional technologies were identified as technically feasible, no economic analysis was conducted. Therefore, the current controls are considered BACT for the boilers (i.e., use of only refinery fuel gas and ULNB).

3.4 *HEATERS <40 MMBTU/HR*

Process heaters less than 40 MMBtu/hr design heating rate have been identified by EPA as sources that typically cannot add control devices to reduce emissions as most combustion system utilizes natural draft air movement. Most of the existing heaters already have low NOx burners. The heaters that do not have these types of burners cannot physically accommodate the flame path of these ultra-low NOx burners so these modifications are not technically feasible.

3.4.1 *$PM_{2.5}$*

BWO operates small heaters (<40 MMBtu/hr) that produce emissions for direct $PM_{2.5}$. The identified control technologies for direct $PM_{2.5}$ are listed in Table 2, including the currently implemented use of only refinery fuel gas for combustion (i.e., no oil burning) and good combustion practices such as regular O_2 monitoring.

The BACT technology review showed potential additional control technologies including ESP, WGS, DGS, and an O_2 Trim System. However, the small heaters (<40 MMBtu/hr) have insufficient space for installing ESP, WGS, or DGS; therefore, they are technically infeasible.

Table 2 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation showed that control technologies determined to be technically implementable were economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. Therefore, the current controls are considered BACT for the heaters <40 MMBtu/hr (i.e., use of only refinery fuel gas and good combustion practices).

3.4.2 *SO_2*

BWO operates small heaters (<40 MMBtu/hr) that produce emissions for SO_2. The identified control technologies for SO_2 are listed in Table 3, including the currently implemented use of only refinery fuel gas for combustion (i.e., no oil burning) and compliance with New Source Performance Standards (NSPS) Subparts J and J_a fuel gas standards.

The BACT technology review showed potential additional control technologies for the large heaters including WGSs.

Table 3 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. Only one heater is shown as an example. The economic feasibility evaluation showed that the WGS was economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. However, a caustic scrubber has been added to treat fuel gas during outages of the Amine and Sulfur Recovery units to maintain the fuel standards and prevent additional SO_2 emissions.

Therefore, the current controls are considered BACT for the large heaters (i.e., use of only refinery fuel gas and compliance with NSPS Subparts J and J_a fuel gas standards).

3.4.3 *NOx*

3.4.3.1 H-403 and H-101

BWO operates heaters that produce emissions for NOx. The identified control technologies for NOx are listed in Table 4, including the currently implemented use of only refinery fuel gas for combustions (i.e., no oil burning).

The BACT technology review showed potential additional control technologies, including LNB, ULNB, SCR, SNCR, FGR, WGS, and a sorbent injection or pass-through. However, these heaters have insufficient space for installing the ULNB, FGR and WGS. There is also insufficient heating temperature for the SNCR. Therefore, they are technically infeasible.

Table 4 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation showed that control technologies determined to be technically implementable were economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. Therefore, the current controls are considered BACT for the above-listed small heaters, i.e., use of only refinery fuel gas.

3.4.3.2 H-301, H-402, H-601, H-1001, H-1002, H-1003, and H-1102

BWO operates small heaters (<40 MMBtu/hr) that produce emissions for NOx. The identified control technologies for NOx are listed in Table 4, including the currently implemented use of only refinery fuel gas for combustions (i.e., no oil burning) and LNBs.

The BACT technology review showed potential additional control technologies, including ULNB, SCR, SNCR, FGR, WGS, and a sorbent injection or pass-through. However, these heaters have insufficient space for installing the FGR and WGS. For ULNB, each heater would need a burner study to determine if that technology is feasible. There is also insufficient heating temperature for the SNCR. Therefore, they are technically infeasible.

Table 4 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation showed that control technologies determined to be technically implementable were economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. Therefore, the current controls are considered BACT for the above-listed small heaters (i.e., use of only refinery fuel gas and the LNBs).

3.5 *REFINERY FLARES*

The refinery flares emit $PM_{2.5}$, SO_2, NOx, and VOCs, and each pollutant has different control technologies to be evaluated.

3.5.1 *$PM_{2.5}$*

BWO operates two refinery flares that produce emissions for direct $PM_{2.5}$. The identified control technologies are listed in Table 2, including the currently implemented direct $PM_{2.5}$ reduction by complying with NSPS Subpart J and J_a flaring provisions.

The BACT technology review showed potential additional control technologies for the refinery flares, including flare gas minimization and flare gas recovery. BWO is expecting to implement a flare gas minimization project by January 2019. However, the small annual natural gas usage demonstrates that there is no opportunity for recovered flare gas to be used in the fuel gas system; and therefore the flare gas recovery option is technically infeasible.

Table 2 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. However, there are no additional controls classified as technically feasible for the refinery flares. Therefore, the current controls are considered BACT for the refinery flares (i.e., compliance with NSPS Subparts J and J_a flaring provisions, and the pending control installation of a flare gas minimization project (January 2019)).

3.5.2 *SO_2*

BWO operates two refinery flares that produce emissions for SO_2. The identified control technologies are listed in Table 3, including the currently implemented SO_2 reduction by complying with NSPS Subpart J flaring provisions and NSPS Subpart J_a fuel gas standard (with fuel gas to flare).

The BACT technology review showed potential additional control technologies for the refinery flares, including flare gas minimization and H_2S scavenger. BWO is expecting to implement a flare gas minimization project by January 2019.

Table 3 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation showed that control technologies determined to be technologically implementable were economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. Therefore, the current controls (i.e., compliance with NSPS Subpart J flaring provisions and NSPS Subpart J_a fuel gas standard (with fuel gas to flare), and the pending control installation of a flare gas minimization project (January 2019)) are considered BACT for the refinery flares.

3.5.3 *NOx*

BWO operates two refinery flares that produce emissions for NO_X. The identified control technologies are listed in Table 4, including the currently implemented NO_X reduction by complying with NSPS Subpart J and J_a flaring provisions.

The BACT technology review showed potential additional control technologies for the refinery flares, including flare gas minimization. BWO is expecting to implement a flare gas minimization project by January 2019.

Table 4 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. However, no additional controls are classified as technically feasible for the refinery flares. Therefore, the current controls, i.e., compliance with NSPS Subparts J and J_a flaring provisions, and the pending control installation of a flare gas minimization project (January 2019) are considered BACT for the refinery flares.

3.5.4 *VOCs*

BWO operates two refinery flares that produce emissions for VOCs. The identified control technologies are listed in Table 5, including the currently implemented VOC reduction by complying with NSPS Subpart J and J_a flaring provisions.

The BACT technology review showed that additional control technologies were feasible for the refinery flares, including flare gas minimization, and compliance with Refinery Sector Rule flare operation requirements that ensure adequate combustion efficiency. BWO is expecting to implement a flare gas minimization project by January 2019.

Table 5 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation showed that control technologies determined to be technologically implementable were economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. Therefore, the current controls (i.e., compliance with NSPS Subpart J and J_a flaring provisions, and the pending control installation of a flare gas minimization project (January 2019)) are considered BACT for the refinery flares.

3.6 *SULFUR RECOVERY PLANT: SO_2*

BWO operates a Sulfur Recovery Plant (SRP) that has a tail gas incinerator and currently achieves the required 95 percent sulfur recovery. In addition, the refinery has added caustic scrubber to treat fuel gas during SRP outages. This has reduced SO_2 emissions by approximately 13 tons per year (tpy). The identified control technologies are listed in Table 3, including the currently implemented SO_2 reduction with the tail gas incinerator and caustic scrubber.

The BACT technology review showed that an additional Tail Gas Treatment Unit (TGTU) was feasible for the SRP.

Table 3 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation showed that the additional TGTU determined to be technologically implementable was economically infeasible with incremental cost effectiveness ratio exceeding $10,000 per ton. Therefore, the current controls are considered BACT for the SRP (i.e., the tail gas incinerator and caustic scrubber).

3.7 *STANDBY (EMERGENCY) FIRE PUMP*

3.7.1 *$PM_{2.5}$*

The BACT technology review showed potential additional control technologies for the Standby Fire Pump, including the currently implemented good combustion practices for Tier II engines. The Standby Fire Pump is classified as an emergency engine and therefore only operates during an emergency and for a limited number of maintenance hours per year. The BACT technology review showed that a particulate filter as a potential add-on control technology for direct $PM_{2.5}$ was feasible.

Table 2 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation showed that the control technology determined to be technically implementable was economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. Therefore, the current controls are considered BACT for emergency stationary engines (i.e., good combustion practices for Tier II engines).

3.7.2 *SO_2*

The identified control technologies for SO_2 are listed in Table 3. The BACT technology review identified a low sulfur fuel as the potential control for the emergency engine, which the refinery currently implements for the Standby Fire Pump engine.

As no additional technologies were identified as technically feasible, no economic analysis was conducted. Therefore, the current controls are considered BACT for SO_2 (i.e., the use of an ultra-low sulfur diesel fuel).

3.7.3 *NOx*

The BACT technology review showed that additional control technologies were feasible for the Standby Fire Pump, including the currently implemented good combustion practices for Tier II engines. The identified control technologies for NOx are listed in Table 4. The BACT technology review identified an SCR as a potential add-on control to reduce NOx emissions.

Table 4 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation.

The economic feasibility evaluation demonstrated that the SCR is economically infeasible with incremental cost effectiveness ratio exceeding $10,000 per ton. Therefore, the current controls are considered BACT for the Standby Fire Pump (i.e., good combustion practices for Tier II engines).

3.8 *FUGITIVE EQUIPMENT: VOCS*

The refinery equipment and piping components that contribute to the fugitive VOC emissions are currently monitored under a Leak Detection and Repair Program at the refinery. This program requires that when an allowable leak rate is exceeded, the component must be repaired or replaced to eliminate that leak. This program is considered to be RACT for refineries. Using a lower leak rate designation for new equipment as identified by the NSPS Subpart GGGa is considered to be BACT. The refinery currently complies with the NSPS standard for valves, pumps, and piping components. The refinery also complies with Refinery MACT for heat exchangers by monitoring cooling tower return water to the specific limit. These identified control technologies are listed in Table 5.

As no additional technologies were identified as technically feasible, no economic analysis was conducted. Therefore, the current controls are considered BACT for fugitive equipment (i.e., the Leak Detection and

Repair Program in compliance with NSPS subpart GGGa and monitoring cooling tower return water as described above).

3.9 *PRODUCT LOADING RACKS: VOCS*

The truck rack and railcar rack are used for product loading.

The BACT technology review identified vapor recovery and vapor combustors as potential control technologies. The refinery currently implements these technologies for product loading racks. The identified control technologies are listed in Table 5.

As no additional technologies were identified as technically feasible, no economic analysis was conducted. Therefore, the current controls are considered BACT for fugitive equipment (i.e., vapor recovery and vapor combustors).

3.10 *GROUP 1 STORAGE TANKS: VOCS*

BWO has both external and internal floating storage tanks that produce emissions for VOCs. The identified control technologies are listed in Table 5, including the currently implemented VOC emissions reduction by degassing to a vapor combustion device.

The BACT technology review showed potential additional control technologies for the storage tanks including a dome (external floating roof [EFR] only), vapor water scrubber, vapor dry scrubber, vapor recovery unit (internal floating roof [IFR] only), and vapor recovery and combustor. The dome for the EFR is considered technically infeasible as it would require a complete rebuild of the tanks.

Table 5 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation showed that control technologies determined to be technologically implementable were economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. Therefore, the current controls are considered BACT for the Group 1 storage tanks (i.e., degassing to a vapor combustion device before opening and venting to atmosphere for inspection and maintenance).

3.11 *GROUP 2 STORAGE TANKS: VOCS*

BWO has vertical fixed roof storage tanks that produce emissions for VOCs. The identified control technologies are listed in Table 5, including the current controls of pressure/vacuum relief valves.

The BACT technology review showed potential additional control technologies for the storage tanks including vapor water scrubber, vapor dry scrubber, vapor recovery unit, internal floating roof, and vapor recovery and combustor. The internal floating roof would require tank reconstruction and is therefore considered technically infeasible.

Table 5 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation showed that control technologies determined to be technologically implementable were economically infeasible with incremental cost effectiveness ratios exceeding $10,000 per ton. Therefore, the current controls are considered BACT for the Group 2 Storage Tanks (i.e., pressure/vacuum relief valves).

3.12 *WASTEWATER TREATMENT SYSTEM: VOCS*

BWO operates a Wastewater Treatment System that produces emissions for VOCs. The identified control technologies are listed in Table 5, including the currently implemented VOC reduction of a fixed cover on the API separator that controls emissions from the surfaces.

The BACT technology review showed potential additional control technologies for the system, including carbon canisters and thermal oxidizers as potential add-on controls.

Table 5 ranks the technically feasible technologies according to reported achievable emission reductions, and shows their annualized costs to support the economic feasibility evaluation. The economic feasibility evaluation showed that the carbon canisters cost would be less than the $10,000 per ton removed threshold. The thermal oxidizer determined to be technologically implementable was not economically feasible as it exceeds that threshold and adds a safety risk to the refinery as it would located near the storage tank area. Therefore, the current controls (i.e., the API fixed cover) and carbon canister installations are considered BACT for the Wastewater Treatment System.

3.13 *COOLING TOWERS: VOCS*

BWO operates cooling towers that produce emissions for VOCs. The identified control technologies are listed in Table 5, including the currently implemented monitoring under the heat exchanger leak detection program and high efficiency drift eliminators that minimize any secondary particulate formation.

The BACT technology review did *not* identify any additional feasible control technologies.

As no additional technologies were identified as technically feasible, no economic analysis was conducted. Therefore, the current controls are considered BACT for the cooling towers (i.e., monitoring and high efficiency drift eliminators).

3.14 *ENERGY, ENVIRONMENTAL, HEALTH AND SAFETY, AND OTHER CONSIDERATIONS*

The BACT Evaluation must consider impacts to increased energy usage that increase direct and indirect emissions for the refinery. Some technologies like low NOx and ultra-low NOx burners result in slightly higher fuel gas consumption. New pumps for wet scrubbers, new controllers for oxygen trim systems, and new electrostatic precipitators all increase electricity consumption. Carbon canisters regeneration uses energy offsite but should be a consideration in the overall determination of BACT.

Environmental impacts were identified for the final disposal of the carbon used at the wastewater treatment plant, disposal of the SOx reducing catalyst, caustic scrubber wastewater disposal, and low NOx additives disposal.

Additional safety and health concerns of workers are the handling of the caustic and additives used by some of the control devices.

Other cost considerations include attempting to install add-on control devices within the refinery during out-of-sequence maintenance turnarounds. Turnaround planning is very detailed and ordering long-lead equipment items is part of the schedule. To shorten that schedule incurs large cost impacts to the refinery. This opportunity cost would need to be evaluated and added to any projects that are identified to be included in the $PM_{2.5}$ SIP.

Tables

Table 1: BACT Selection for each Pollutant by Source

Source	$PM_{2.5}$	SO_2	NOx	VOC	NH_3
FCC Unit Regenerator	Currently implemented: flue gas blowback filter and tertiary cyclones with fabric filter	Currently implemented: SO_X-reducing catalyst additive	Currently implemented: UOP high efficiency (low-NOx) combustor design, low-NOx combustion promoter, and good combustion practices		Currently implemented: source testing on a regular basis
Heaters (Reformer, Crude)/Boilers >40 MMBtu/hr					
Reformer Heaters (H-621, 622, 624)	Currently implemented: only use of refinery fuel gas and good combustion practices	Currently implemented: use of only refinery fuel gas and compliance with NSPS Subparts J and J_a fuel gas standards	Currently implemented: use of only refinery fuel gas and the LNB		
H-404 #1 Crude Heater with ULNB	Currently implemented: only use of refinery fuel gas and good combustion practices	Currently implemented: use of only refinery fuel gas and compliance with NSPS Subparts J and J_a fuel gas standards	Currently implemented: use of only refinery fuel gas, ULNB, and good combustion practices		
Boilers (1, 2, 6) >40 MMBtu/hr	Currently implemented: use of only refinery fuel gas and good combustion practices	Currently implemented: use of only refinery fuel gas and compliance with NSPS Subparts J and J_a fuel gas standards	Currently implemented: use of only refinery fuel gas and ULNB		
Heaters <40 MMBtu/hr					
H-101 FCC Heater	Currently implemented: use of only refinery fuel gas and good combustion practices	Currently implemented: use of only refinery fuel gas and compliance with NSPS Subparts J and J_a fuel gas standards	Currently implemented: use of only refinery fuel gas		
H-301 Alkylation Unit Deisobutanizer Reboiler Heater	Same as H-101	Same as H-101	Currently implemented: use of only refinery fuel gas and the LNBs		
H-402 #2 Crude Heater	Same as H-101	Same as H-101	Currently implemented: use of only refinery fuel gas and the LNBs		
H-403 Crude Preflash Heater	Same as H-101	Same as H-101	Currently implemented: use of only refinery fuel gas		
H-601 32.4 MMBtu/hr Unifiner Heater	Same as H-101	Same as H-101	Currently implemented: use of only refinery fuel gas and the LNBs		
H-1001 (MIDW) Heater	Same as H-101	Same as H-101	Currently implemented: use of only refinery fuel gas and the LNBs		
H-1002 Hydrodesulfuri	Same as H-101	Same as H-101	Currently implemented: use of		

Source	$PM_{2.5}$	SO_2	NOx	VOC	NH_3
zation (HDS) Reboiler			only refinery fuel gas and the LNBs		
H-1003 HDS Heater	Same as H-101	Same as H-101	Currently implemented: use of only refinery fuel gas and the LNBs		
H-1102 SRU and Tail Gas Incinerator	Same as H-101	Same as H-101	Currently implemented: use of only refinery fuel gas and the LNBs		
Refinery Flares	Currently implemented controls and the pending control installation of a flare gas minimization project (Jan. 2019)	Currently implemented controls and the pending control installation of a flare gas minimization project (Jan. 2019)	Currently implemented controls and the pending control installation of a flare gas minimization project (Jan. 2019)	Currently implemented controls and the pending control installation of a flare gas minimization project (Jan. 2019).	
Sulfur Recovery Plant		Currently implemented: tail gas incinerator and caustic scrubber			
Standby (Emergency) Fire Pump	Currently implemented: good combustion practices for Tier II engines	Currently implemented: ultra-low sulfur fuel	Currently implemented: good combustion practices for Tier II engines		
Fugitive Equipment				Currently implemented: Leak Detection and Repair Program in compliance with NSPS subpart GGGa and monitoring cooling tower return water	
Product Loading Racks				Currently implemented: vapor recovery and vapor combustors	
Storage Tanks, Group 1				Currently implemented: degassing to a vapor combustion device	
Storage Tanks, Group 2				Currently implemented: pressure vacuum relief valves	
Wastewater Treatment System				New carbon canister installations and currently	

Source	$PM_{2.5}$	SO_2	NOx	VOC	NH_3
				implemented API fixed cover.	
Cooling Towers				Currently implemented: leak detection program and drift eliminators	

Table 2: Potential BACT Technologies for Direct $PM_{2.5}$ – Particulate Matter

Source / Process Area	Control Technology	Rule / Emission Limit	Technically Feasible? (Y / N)	Baseline (TPY)	Incremental Emissions Reduction (TPY)	Incremental Cost Effectiveness ($/ton)
FCC Unit Regenerator	Tertiary Cyclones w/ Fabric Filter	40 CFR 63 UUU 1.0 lb/1000 lb coke burn	Yes	0.675	Baseline	N/A
	Flue Gas Blowback Filter (FGF)	40 CFR 63 UUU 0.5 lb/1000 lb coke burn	Yes	0.675	Baseline	N/A
	Electrostatic Precipitator (ESP)		No	0.675	-	-
	Wet Gas Scrubber (WGS)		No	0.675	-	-
Heaters (Reformer, Crude) >40 MMBtu/hr	Use only Refinery fuel gas for combustion -- no oil burning	current SIP	Yes	1.81	Baseline	N/A
	Good combustion practices -- regular O_2 monitoring	Subpart DDDDD	Yes	1.81	Baseline	N/A
	O_2 Trim System	Subpart DDDDD	Yes	1.81	0.04	$1,520,422
	Electrostatic Precipitator (ESP)		Yes	1.81	1.09	$9,878,250
	Wet Gas Scrubber (WGS)		Yes	1.81	1.45	$318,250
	Dry Gas Scrubber (DGS)		Yes	1.81	1.63	$1,443,653
Boilers (1, 2, 6) >40 MMBtu/hr	Use only Refinery fuel gas for combustion -- no oil burning	current SIP	Yes	0.96	Baseline	N/A
	Good combustion practices -- regular O_2 monitoring	Subpart DDDDD	Yes	0.96	Baseline	N/A
	O_2 Trim System	Subpart DDDDD	Yes	0.96	0.02	$2,875,615
	Electrostatic Precipitator (ESP)		No	-	-	-
	Wet Gas Scrubber (WGS)		No	-	-	-
	Dry Gas Scrubber (DGS)		No	-	-	-
Heaters <40 MMBtu/hr	Use only Refinery fuel gas for combustion -- no oil burning	current SIP	Yes	0.69	Baseline	N/A
	Good combustion practices -- regular O_2 monitoring	Subpart DDDDD	Yes	0.69	Baseline	N/A
	O_2 Trim System	Subpart DDDDD	Yes	0.69	0.01	$4,011,609
	Electrostatic Precipitator (ESP)		No	-	-	-

Source / Process Area	Control Technology	Rule / Emission Limit	Technically Feasible? (Y / N)	Baseline (TPY)	Incremental Emissions Reduction (TPY)	Incremental Cost Effectiveness ($/ton)
	Wet Gas Scrubber (WGS)		No	-	-	-
	Dry Gas Scrubber (DGS)		No	-	-	-
Refinery Flares	Compliance with NSPS Subpart J flaring provisions		Yes	1.12	Baseline	N/A
	Compliance with NSPS Subpart J_a flaring provisions	40 CFR 60.102a(g)(3) -- limit on flare gas rate during normal operations (except during periods of process upset or fuel gas imbalance)	Yes	1.12	Baseline	N/A
	Flare Gas Minimization		Yes	1.12	0.56	$3,209,001
	Flare Gas Recovery		No	-	-	-
Standby (Emergency) Fire Pump[1]	Particulate Filter		Yes	0.28	0.25	$382,130

1) AP42 PM10 EF for Diesel Engines 0.0022 lb/hp-hr and 500 hours for 500 hp engine.

Table 3: Potential BACT Technologies for SO_2 - Sulfur Dioxide

Source / Process Area	Control Technology	Rule / Emission Limit	Technically Feasible? (Y / N)	Baseline (TPY)	Incremental Emissions Reduction (TPY)	Incremental Cost Effectiveness ($/ton)
FCC Unit Regenerator	Low Sulfur Feedstocks	current SIP	Yes	21.2	Baseline	N/A
	SOx Reducing Catalyst Additive[1]	40 CFR 60.102a(b)(3) 25 ppmv annual average	Yes	21.2	Baseline	N/A
	Wet Gas Scrubber (WGS)	40 CFR 60.102a(b)(3) 25 ppmv annual average	No	-	-	-
	Cat Feed Hydrotreater	40 CFR 60.102a(b)(3) 25 ppmv annual average	No	-	-	-
Heaters (Reformer, Crude) >40 MMBtu/hr	Use only Refinery fuel gas for combustion -- no oil burning	current SIP	Yes	0.90	Baseline	N/A
The data shown are an example of a heater (Reformer)	Comply with NSPS Subpart J fuel gas standard	40 CFR 60.105(a)(4) 162 ppmv maximum H_2S in fuel gas	Yes	0.90	Baseline	N/A
	Comply with NSPS Subpart J_a fuel gas standard	40 CFR 60.102a(g)(1)(ii) 60 ppmv annual average H_2S in fuel gas	Yes	0.90	Baseline	N/A
	Wet Gas Scrubber (WGS)		Yes	0.90	0.72	$640,035
Boilers (1, 2, 6) >40 MMBtu/hr	Use only Refinery fuel gas for combustion -- no oil burning	current SIP	Yes	0.53	Baseline	N/A
The data shown is an example of a boiler (#6)	Comply with NSPS Subpart J fuel gas standard	40 CFR 60.105(a)(4) 162 ppmv maximum H_2S in fuel gas	Yes	0.53	Baseline	N/A
	Comply with NSPS *Subpart J_a fuel gas* standard	40 CFR 60.102a(g)(1)(ii) 60 ppmv annual average H_2S in fuel gas	Yes	0.53	Baseline	N/A
	Wet Gas Scrubber (WGS)		Yes	0.53	0.42	$1,086,853

Source / Process Area	Control Technology	Rule / Emission Limit	Technically Feasible? (Y / N)	Baseline (TPY)	Incremental Emissions Reduction (TPY)	Incremental Cost Effectiveness ($/ton)
Heaters <40 MMBtu/hr The data shown is an example of a heater (H-301)	Use only Refinery fuel gas for combustion -- no oil burning	Current SIP	Yes	0.38	Baseline	N/A
	Comply with NSPS Subpart J fuel gas standard	40 CFR 60.105(a)(4) 162 ppmv maximum H_2S in fuel gas	Yes	0.38	Baseline	N/A
	Comply with NSPS Subpart J_a fuel gas standard	40 CFR 60.102a(g)(1)(ii) 60 ppmv annual average H_2S in fuel gas	Yes	0.38	Baseline	N/A
	Wet Gas Scrubber (WGS)		Yes	0.38	0.30	$1,515,873
Refinery Flares	Compliance with NSPS Subpart J flaring provisions		Yes	0.59	Baseline	N/A
	Comply with NSPS Subpart J_a fuel gas standard (with fuel gas to flare)	40 CFR 60.102a(g)(1)(ii) 60 ppmv annual average H_2S in fuel gas	Yes	0.59	Baseline	N/A
	H_2S Scavenger		Yes	0.59	0.1475	$ 728,028
	Flare Gas Minimization		Yes	0.59	0.295	$6,091,664
Sulfur Recovery Plant	Single-train Claus unit with tail-gas incineration	Current SIP requires 95% sulfur recovery efficiency	Yes	3.62	Baseline	N/A
	Caustic Scrubbing of sour fuel gas and SWS storage during SRP outages	No acid gas flaring during planned or unplanned outages of SRP	Yes	3.62	Baseline	N/A
	Tail Gas Unit on SRP	95% => 98% sulfur recovery efficiency	Yes	3.62	3.5	$4,238,088
Standby (Emergency) Fire Pump[2]	Ultra-Low Sulfur Fuel			0.26	Baseline	N/A

1) Based on reduction to 25 ppm from 170 ppm baseline.
2) AP42 SOx EF for Diesel Engines 0.00205 lb/hp-hr and 500 hours for 500 hp engine.

Table 4: Potential BACT Technologies for NOx - Nitrogen Oxides

Source / Process Area	Control Technology	Rule / Emission Limit	Technically Feasible? (Y / N)	Baseline (TPY)	Incremental Emissions Reduction (TPY)	Incremental Cost Effectiveness ($/ton)
FCC Unit Regenerator	UOP High Efficiency (Low-NOx) Combustor Design		Yes	17.39	Baseline	N/A
	Low-NOx Combustion Promoter (non-platinum)	40 CFR 60.102a(b)(2) 80 ppmv 7-day rolling average	Yes	17.39	Baseline	N/A
	NOx Reducing Additive[1]		Potentially	17.39	4.35	$566,559
	Selective Non-Catalytic Reduction (SNCR)		No	-	-	-
	Selective Catalytic Reduction (SCR)		No	-	-	-
	Cat Feed Hydrotreating		No	-	-	-
Boilers (1, 2, 6)	Fuel Gas Only -- no oil burning	Current SIP	Yes	4.15	Baseline	N/A
The data shown is an example of a boiler (#6)	Ultra-Low NOx Burners (w/ FGR)	For > 40 MMBtu/hr 40 CFR 60.102a(g)(2) 40 ppmv 24-hour rolling average	Yes	4.15	Baseline	N/A
	Selective Catalytic Reduction (SCR)		Yes	4.15	3.11	$2,052,385
	Selective Non-Catalytic Reduction (SNCR)		No	-	-	-
	Flue Gas Recirculation		No	-	-	-
	Wet Gas Scrubber (WGS)		No	-	-	-
	Sorbent injection or pass through		Yes	4.15	1.04	$2,373,236
Permitted Heater List						
H-101 FCC Heater (140 lb/MMSCF)	Fuel Gas Only -- no oil burning		Yes	2.99	Baseline	N/A
	Low NOx Burners (staged)		Potentially	2.99	1.49	$635,335
	Ultra-Low NOx Burners (staged)		No	-	-	-
	Selective Catalytic Reduction (SCR)		Yes	2.99	2.69	$2,375,898
	Selective Non-Catalytic Reduction (SNCR)		No	-	-	-
	Flue Gas Recirculation		No	-	-	-

Source / Process Area	Control Technology	Rule / Emission Limit	Technically Feasible? (Y / N)	Baseline (TPY)	Incremental Emissions Reduction (TPY)	Incremental Cost Effectiveness ($/ton)
	Wet Gas Scrubber (WGS)		No	-	-	-
	Sorbent injection or pass through		Yes	2.99	0.75	$3,296,789
H-301 17.29 MMBtu/hr Alkylation Unit Deisobutanizer Reboiler Heater (140 lb/MMSCF)	Fuel Gas Only -- no oil burning		Yes	9.02	Baseline	N/A
	Low NOx Burners (staged)		Yes	9.02	Baseline	N/A
	Ultra-Low NOx Burners (staged)		Potentially	9.02	6.77	$135,383
	Selective Catalytic Reduction (SCR)		Yes	9.02	8.12	$786,897
	Selective Non-Catalytic Reduction (SNCR)		No	-	-	-
	Flue Gas Recirculation		No	-	-	-
	Wet Gas Scrubber (WGS)		No	-	-	-
	Sorbent injection or pass through		Yes	9.02	2.26	$1,091,896
H-402 #2 Crude Heater (80 lb/MMSCF)	Fuel Gas Only -- no oil burning		Yes	4.34	Baseline	N/A
	Low NOx Burners (staged)		Yes	4.34	Baseline	N/A
	Ultra-Low NOx Burners (staged)		Potentially	4.34	3.25	$281,676
	Selective Catalytic Reduction (SCR)		Yes	4.34	3.90	$1,637,209
	Selective Non-Catalytic Reduction (SNCR)		No	-	-	-
	Flue Gas Recirculation		No	-	-	-
	Wet Gas Scrubber (WGS)		No	-	-	-
	Sorbent injection or pass through		Yes	4.34	1.08	$2,271,787
H-403 Crude Preflash Heater (140 lb/MMSCF)	Fuel Gas Only -- no oil burning		Yes	4.82	Baseline	N/A
	Low NOx Burners (staged)		Potentially	4.82	2.41	$393,941
	Ultra-Low NOx Burners (staged)		Potentially	4.82	3.61	$253,456
	Selective Catalytic Reduction (SCR)		Yes	4.82	4.34	$1,473,183

Source / Process Area	Control Technology	Rule / Emission Limit	Technically Feasible? (Y / N)	Baseline (TPY)	Incremental Emissions Reduction (TPY)	Incremental Cost Effectiveness ($/ton)
	Selective Non-Catalytic Reduction (SNCR)		No	-	-	-
	Flue Gas Recirculation		No	-	-	-
	Wet Gas Scrubber (WGS)		No	-	-	-
	Sorbent injection or pass through		Yes	4.82	1.20	$2,044,184
H-404 #1 Crude Heater with Ultra-Low NOx Burners (ULNB) (21.06 lb/MMSCF)	Fuel Gas Only -- no oil burning		Yes	2.33	Baseline	N/A
	Ultra-Low NOx Burners (staged)		Yes	2.33	Baseline	N/A
	Selective Catalytic Reduction (SCR)		Yes	2.33	1.75	$3,658,975
	Selective Non-Catalytic Reduction (SNCR)		No	-	-	-
	Flue Gas Recirculation		No	-	-	-
	Wet Gas Scrubber (WGS)		No	-	-	-
	Sorbent injection or pass through		Yes	2.33	0.58	$4,230,986
H-601 32.4 MMBtu/hr Unifiner Heater (140 lb/MMSCF)	Fuel Gas Only -- no oil burning		Yes	3.73	Baseline	N/A
	Low NOx Burners (staged)		Yes	3.73	Baseline	N/A
	Ultra-Low NOx Burners (staged)		Potentially	3.73	2.80	$327,658
	Selective Catalytic Reduction (SCR)		Yes	3.73	3.36	$1,904,479
	Selective Non-Catalytic Reduction (SNCR)		No	-	-	-
	Flue Gas Recirculation		No	-	-	-
	Wet Gas Scrubber (WGS)		No	-	-	-
	Sorbent injection or pass through		Yes	3.73	0.93	$2,642,649
H-621, 622, 624 Reformer Heaters (140 lb/MMSCF)	Fuel Gas Only -- no oil burning		Yes	14.24	Baseline	N/A
	Low NOx Burners (staged)		Yes	14.24	Baseline	N/A

Source / Process Area	Control Technology	Rule / Emission Limit	Technically Feasible? (Y / N)	Baseline (TPY)	Incremental Emissions Reduction (TPY)	Incremental Cost Effectiveness ($/ton)
	Ultra-Low NOx Burners (staged)		Potentially	14.24	10.68	$85,799
	Selective Catalytic Reduction (SCR)		No	-	-	-
	Selective Non-Catalytic Reduction (SNCR)		No	-	-	-
	Flue Gas Recirculation		No	-	-	-
	Wet Gas Scrubber (WGS)		No	-	-	-
	Sorbent injection or pass through		Yes	14.24	3.56	$691,990
H-1001 (MIDW) Heater (80 lb/MMSCF)	Fuel Gas Only -- no oil burning		Yes	2.79	Baseline	N/A
	Low NOx Burners (staged)		Yes	2.79	Baseline	N/A
	Ultra-Low NOx Burners (staged)		Potentially	2.79	2.09	$437,416
	Selective Catalytic Reduction (SCR)		Yes	2.79	2.51	$2,542,430
	Selective Non-Catalytic Reduction (SNCR)		No	-	-	-
	Flue Gas Recirculation		No	-	-	-
	Wet Gas Scrubber (WGS)		No	-	-	-
	Sorbent injection or pass through		Yes	2.79	0.70	$3,527,869
H-1002 Hydrodesulfurization (HDS) Reboiler (80 lb/MMSCF)	Fuel Gas Only -- no oil burning		Yes	1.24	Baseline	N/A
	Low NOx Burners (staged)		Yes	1.24	Baseline	N/A
	Ultra-Low NOx Burners (staged)		Potentially	1.24	0.93	$981,495
	Selective Catalytic Reduction (SCR)		Yes	1.24	1.12	$5,704,829
	Selective Non-Catalytic Reduction (SNCR)		No	-	-	-
	Flue Gas Recirculation		No	-	-	-
	Wet Gas Scrubber (WGS)		No	-	-	-
	Sorbent injection or pass through		Yes	1.24	0.31	$7,916,003
H-1003 HDS Heater (80 lb/MMSCF)	Fuel Gas Only -- no oil burning		Yes	2.92	Baseline	N/A

Source / Process Area	Control Technology	Rule / Emission Limit	Technically Feasible? (Y / N)	Baseline (TPY)	Incremental Emissions Reduction (TPY)	Incremental Cost Effectiveness ($/ton)
	Low NOx Burners (staged)		Yes	2.92	Baseline	N/A
	Ultra-Low NOx Burners (staged)		Potentially	2.92	2.19	$418,318
	Selective Catalytic Reduction (SCR)		Yes	2.92	2.63	$2,431,426
	Selective Non-Catalytic Reduction (SNCR)		No	-	-	-
	Flue Gas Recirculation		No	-	-	-
	Wet Gas Scrubber (WGS)		No	-	-	-
	Sorbent injection or pass through		Yes	2.92	0.73	$3,373,840
H-1102 SRP and Tail Gas Incinerator (80 lb/MMSCF)	Fuel Gas Only -- no oil burning		Yes	0.67	Baseline	N/A
	Low NOx Burners (staged)		Yes	0.67	0.33	$2,838,114
	Ultra-Low NOx Burners (staged)		Potentially	0.67	0.50	$1,825,998
	Selective Catalytic Reduction (SCR)		Yes	0.67	0.60	$10,613,412
	Selective Non-Catalytic Reduction (SNCR)		No	-	-	-
	Sorbent injection or pass through		Yes	0.67	0.17	$14,727,138
Refinery Flares	Compliance with NSPS Subpart J flaring provisions		Yes	14.7	Baseline	N/A
	Compliance with NSPS Subpart J_a flaring provisions	40 CFR 60.102a(g)(3) -- limit on flare gas rate during normal operations (except during periods of process upset or fuel gas imbalance)	Yes	14.7	Baseline	N/A
	Flare Gas Minimization		Yes	14.7	7.35	$244,495
Standby (Emergency) Fire Pump[1]	Selective Catalytic Reduction		Yes	3.88	3.49	$1,832,354

1) AP42 NOx EF for Diesel Engines 0.031 lb/hp-hr and 500 hours for 500 hp engine.

Table 5: Potential BACT Technologies for VOCs - Volatile Organic Compounds

Source / Process Area	Control Technology	Rule / Emission Limit	Technically Feasible? (Y / N)	Baseline (TPY)	Incremental Emissions Reduction (TPY)	Incremental Cost Effectiveness ($/ton)
Refinery Flares	Compliance with NSPS Subpart J flaring provisions		Yes	80.33	Baseline	N/A
	Compliance with NSPS Subpart J_a flaring provisions	40 CFR 60.102a(g)(3) -- limit on flare gas rate during normal operations (except during periods of process upset or fuel gas imbalance)	Yes	80.33	Baseline	N/A
	Compliance with Refinery Sector Rule (RSR) flare operation requirements - ensure adequate combustion efficiency	Compliance with RSR (40 CFR 63.670)	Yes	80.33	16.1	$45,177.62
	Flare Gas Minimization		Yes	80.33	40.2	$44,741.47
	Flare Gas Recovery		No	-	-	-
Fugitive Equipment						
Fugitive Emissions -- Valves, Pumps, Cooling Towers	Comply with NSPS subpart GGGa leak definition for LDAR monitoring		Yes	124	Baseline	N/A
Fugitive Emissions -- Heat Exchangers	Monthly monitoring for Heat Exchanger leaks with Modified El Paso stripper method	Heat Exchanger MACT 6.2 ppm VOC at cooling water return	Yes	4.8	Baseline	N/A
Product Loading Racks						
Truck	Vapor Recovery Unit	Gasoline Distribution MACT 10 mg/liter	Yes	10.75	Baseline	N/A
Truck	Backup VRU	Gasoline Distribution MACT 10 mg/liter	Yes	10.75	Baseline	N/A
Railcar	Vapor Combustor Unit		Yes	0.11	Baseline	N/A
Storage Tanks		40 CFR 60 Subparts K, Ka, Kb, GGG, GGGa				
Group 1 Tanks (Floating Roof)	Degassing to a vapor combustion device	40 CFR 63.660	Yes	152	Baseline	N/A
EFR only	Dome		No	-	-	-
	Vapor water scrubber		Yes	152	91.2	$19,029

Source / Process Area	Control Technology	Rule / Emission Limit	Technically Feasible? (Y / N)	Baseline (TPY)	Incremental Emissions Reduction (TPY)	Incremental Cost Effectiveness ($/ton)
IFR only	Vapor dry scrubber (activated carbon)		Yes	152	129.2	$10,529
	Vapor recovery unit		Yes	152	150.48	$67,079
	Vapor recovery and combustor		Yes	152	150.48	$15,700
Group 2 Tanks (Fixed Roof)	Pressure vacuum relief valves		Yes	5.22	Baseline	N/A
	Vapor water scrubber		Yes	5.22	4.176	$415,574
	Internal Floating Roof		No	-	-	-
	Vapor dry scrubber (activated carbon)		Yes	5.22	4.959	$274,318
	Vapor recovery unit		Yes	5.22	5.1678	$1,953,271
	Vapor recovery and combustor		Yes	5.22	5.1678	$457,157
Wastewater Treatment System	API fixed cover		Yes	16.2	Baseline	N/A
	Carbon canisters		Yes	16.2	15.39	$7,586
	Thermal oxidizer		Yes	16.2	15.9	$74,405
Cooling Towers	Drift Eliminators		Yes	4.8	Baseline	N/A

1) Assumes prorated reduction from current leak definition of 10,000 ppm (2010 AEI).

Table 6: Potential BACT Technologies for NH_3 - Ammonia

Source / Process Area	Control Technology	Rule / Emission Limit	Technically Feasible? (Y / N)	Baseline (TPY)	Incremental Emissions Reduction (TPY)	Incremental Cost Effectiveness ($/ton)
FCC[1]	Source Test		Yes	0.15	Baseline	N/A
	Wet Scrubber		No	-	-	-

1) Baseline emissions based on 2016 emissions inventory.