BEST AVAILABLE CONTROL TECHNOLOGY REVIEW

XTO Energy Inc. > Husky Central Delivery Point

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This report discusses the regulatory basis and approach used in completing the Best Available Control Technology (BACT) analysis for pollutants triggering this requirement for the XTO Energy Inc. (XTO) Husky Central Delivery Point (Husky). In addition, this report also documents the emission units for which the BACT analyses were performed.

The requirement to conduct a BACT analysis is set forth in the PSD regulations in 40 CFR §52.21(j)(2):

(j) Control Technology Review.

(2) A new major stationary source shall apply best available control technology for each regulated NSR pollutant that it would have the potential to emit in significant amounts.

BACT is defined in the PSD regulations 40 CFR §52.21(b)(12)(emphasis added) in relevant part as:

…<u>an emissions limitation</u> (including a visible emission standard) based on the maximum degree of reduction for <u>each pollutant</u> subject to regulation under Act which would be emitted from any <u>proposed</u> major stationary source or major modification which the Administrator, on a <u>case-by-case basis</u> taking into account energy, environmental, and economic impacts and other costs, determines is <u>achievable</u> for such a source or modification through application of <u>production processes</u> or <u>available</u> methods, systems, and techniques, including fuel cleaning or treatment or innovative fuel combustion techniques for control of such pollutant. In no event shall application of best available control technology result in emissions of any pollutant which would <u>exceed the emissions allowed by any applicable standard under 40 CFR parts 60 and 61</u>.

Although this definition was not changed by the Tailoring Rule, differences in the characteristics of criteria pollutant and GHG emissions from large industrial sources present several GHG-specific considerations under the BACT definition, which warrants further discussion. Those underlined terms in the BACT definition are addressed further below.

1.1. EMISSION LIMITATION

BACT is "an emission limitation," not an emission reduction rate or a specific technology. While BACT is prefaced upon the application of technologies reflecting the maximum reduction rate achievable, the final result of BACT is an emission limit. Typically, when quantifiable and measurable,[1] this limit would be expressed as an emission rate limit of a pollutant (e.g., lb/MMBtu, ppm, or lb/hr).[2] Furthermore, EPA's guidance on GHG BACT has indicated that GHG BACT limitations should be averaged over long-term timeframes such as 30- or 365-day rolling average.[3]

[1] The definition of BACT allows use of a work practice where emissions are not easily measured or enforceable. 40 CFR §52.21(b)(12).

[2] Emission limits can be broadly differentiated as "rate-based" or "mass-based." For a turbine, a rate-based limit would typically be in units of lb/MMBtu (mass emissions per heat input). In contrast, a typical mass-based limit would be in units of lb/hr (mass emissions per time).

[3] *PSD and Title V Permitting Guidance for Greenhouse Gases*. March 2011, page 46.

1.2. EACH POLLUTANT

Since BACT applies to "each pollutant subject to regulation under the Act," the BACT evaluation process is typically conducted for each regulated NSR pollutant individually and not for a combination of pollutants.[4] For PSD applicability assessments involving GHGs, the regulated NSR pollutant subject to regulation under the Clean Air Act (CAA) is the sum of six greenhouse gases and not a single pollutant.[5] In the final Tailoring Rule preamble, EPA went beyond applying this combined pollutant approach for GHGs to PSD applicability and made the following recommendations that suggest applicants should conduct a single GHG BACT evaluation on a CO_2e basis for emission sources that emit more than one GHG:

> *However, we disagree with the commenter's ultimate conclusion that BACT will be required for each constituent gas rather than for the regulated pollutant, which is defined as the combination of the six well-mixed GHGs. To the contrary, we believe that, in combination with the sum-of-six gases approach described above, the use of the CO_2e metric will enable the implementation of flexible approaches to design and implement mitigation and control strategies that look across all six of the constituent gases comprising the air pollutant (e.g., flexibility to account for the benefits of certain CH_4 control options, even though those options may increase CO_2). Moreover, we believe that the CO_2e metric is the best way to achieve this goal because it allows for tradeoffs among the constituent gases to be evaluated using a common currency.*[6]

For the proposed project, the GHG emissions are driven primarily by CO_2. CO_2 emissions represent more than 99% of the total CO_2e for the project as a whole. As such, the top-down GHG BACT analysis in the relevant sections should and will focus on CO_2.

1.3. BACT APPLIES TO THE PROPOSED SOURCE

BACT applies to the type of source proposed by the applicant. BACT does not redefine the source. The applicant defines the source (i.e., its goals, aims, and objectives). Although BACT is based on the type of source as proposed by the applicant, the scope of the applicant's ability to define the source is not absolute. A key task for the reviewing agency is to determine which parts of the proposed process are inherent to the applicant's purpose and which parts may be changed without changing that purpose. The proposed project is discussed in Form UA3, Section 3 and a process description has been included in Form UA3, Section 10 of this application to guide the technical reviewers in the areas of need and scope of this project and how BACT should be reviewed in light of this detailed information.

1.4. CASE-BY-CASE BASIS

Unlike many of the CAA programs, the PSD program's BACT evaluation is case-by-case. BACT permit limits are not simply the requirement for a control technology because of its application elsewhere or the direct transference of the lowest emission rate found in other permits for similar sources, applied to the proposed source. EPA has explained how the top-down BACT analysis process works on a case-by-case basis. To assist applicants and regulators with the case-by-case process, in 1990 EPA issued a Draft Manual on New Source Review permitting which included a "top-down" BACT analysis.

> *In brief, the top-down process provides that all available control technologies be ranked in descending order of control effectiveness. The PSD applicant first examines the most stringent--or "top"--alternative.*

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[4] 40 CFR §52.21(b)(12)

[5] 40 CFR § 52.21(b)(49)(i)

[6] 75 FR 31,531, Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule; Final Rule, June 3, 2010.

That alternative is established as BACT unless the applicant demonstrates, and the permitting authority in its informed judgment agrees, that technical considerations, or energy, environmental, or economic impacts justify a conclusion that the most stringent technology is not "achievable" in that case. If the most stringent technology is eliminated in this fashion, then the next most stringent alternative is considered, and so on.[7]

The five steps in a top-down BACT evaluation can be summarized as follows:

- Step 1. Identify all available control technologies;
- Step 2. Eliminate technically infeasible options;
- Step 3. Rank the technically feasible control technologies by control effectiveness;
- Step 4. Evaluate most effective controls; and
- Step 5. Select BACT.

Additionally, it is important to note that the top-down process is conducted on a unit-by-unit, pollutant-by-pollutant basis and only considers the portions of the facility that are considered "emission units" as defined under the PSD regulations.[8]

1.5. ACHIEVABLE

BACT is to be set at the lowest value that is "achievable." However, there is an important distinction between emission rates achieved at a specific time on a specific unit, and an emission limitation that a unit must be able to meet continuously over its operating life. As discussed by the DC Circuit Court of Appeals:

In National Lime Ass'n v. EPA, 627 F.2d 416, 431 n.46 (D.C. Cir. 1980), we said that where a statute requires that a standard be "achievable," it must be achievable" under most adverse circumstances which can reasonably be expected to recur."[9]

EPA has reached similar conclusions in prior determinations for PSD permits.

Agency guidance and our prior decisions recognize a distinction between, on the one hand, measured 'emissions rates,' which are necessarily data obtained from a particular facility at a specific time, and on the other hand, the 'emissions limitation' determined to be BACT and set forth in the permit, which the facility is required to continuously meet throughout the facility's life. Stated simply, if there is uncontrollable fluctuation or variability in the measured emission rate, then the lowest measured emission rate will necessarily be more stringent than the "emissions limitation" that is "achievable" for that pollution control method over the life of the facility. Accordingly, because the "emissions limitation" is applicable for the facility's life, it is wholly appropriate for the permit issuer to consider, as part of the BACT analysis, the

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[7] Draft NSR Manual at B-2. "The NSR Manual has been used as a guidance document in conjunction with new source review workshops and training, and as a simple guide for state and federal permitting officials with respect to PSD requirements and policy. Although it is not binding Agency regulation, the NSR Manual has been looked to be this Board as a statement of the Agency's thinking on certain PSD issues. E.g., *In re RockGen Energy Ctr*., 8 E.A.D. 536, 542 n. 10 (EAB 1999), *In re Knauf Fiber Glass*, *GmbH*, 8 E.A.D. 121, 129 n. 13 (EAB 1999)." *In re Prairie State Generating Company* 13 E.A.D. 1, 13 n 2 (2006)

[8] Pursuant to 40 CFR §52.21(a)(7), emission unit means any part of a stationary source that emits or would have the potential to emit any regulated NSR pollutant.

[9] As quoted in Sierra Club v. U.S. EPA (97-1686).

extent to which the available data demonstrate whether the emissions rate at issue has been achieved by other facilities over a long term.[10]

Thus, BACT must be set at the lowest feasible emission rate recognizing that the facility must be in compliance with that limit for the lifetime of the facility on a continuous basis. While viewing individual unit performance can be instructive in evaluating what BACT might be, any actual performance data must be viewed carefully, as rarely will the data be adequate to truly assess the performance that a unit will achieve during its entire operating life.

To assist in meeting the BACT limit, the source must consider production processes or available methods, systems or techniques, as long as those considerations do not redefine the source.

1.6. PRODUCTION PROCESS

The definition of BACT lists both production processes and control technologies as possible means for reducing emissions.

1.7. AVAILABLE

The term "available" in the definition of BACT is implemented through a feasibility analysis – a determination that the technology being evaluated is demonstrated or available and applicable.

1.8. FLOOR

For criteria pollutants, the least stringent emission rate allowable for BACT is any applicable limit under either New Source Performance Standards (NSPS – Part 60) or National Emission Standards for Hazardous Air Pollutants (NESHAP – Parts 61). Since no GHG limits have been incorporated into any existing NSPS or Part 61 NESHAPs, no floor for a GHG BACT analysis is available for consideration.

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[10] U.S. EPA Environmental Appeals Board decision, *In re: Newmont Nevada Energy Investment L.L.C.* PSD Appeal No. 05-04, decided December 21, 2005. Environmental Administrative Decisions, Volume 12, Page 442.

2. PROJECT DEFINITION

XTO is proposing to construct a natural gas processing and central delivery point located approximately 13.9 miles northeast of Loving, NM in Eddy County. The Husky Central Delivery Point (CDP) is a gas processing facility with oil and NGL stabilization and will produce sales gas, Y-grade NGL, and spec oil products. The Husky CDP will be built over multiple phases to reach a full processing capacity of 1.5 BCFD of natural gas, 200,000 BPD of oil stabilization and 190,000 BPD of NGL stabilization. The overall facility will be designed to accommodate three (3) cryogenic (cryo) trains. Additionally, XTO Energy is planning the construction of four (4) cogeneration turbines to provide power and auxiliary heat to the CDP. As discusses in Section 3 of the UA3, there are three (3) proposed operating scenarios: (1) Operation of the facility without cogeneration turbines and full heater buildout; (2) Operation of the facility with cogeneration turbines with reduced heater buildout; and (3) Combination of turbine and heater use during turbine downtime. For the purposes of this BACT Review, equipment from any of these three scenarios is included as detailed below:

- Twelve (12) Stabilization Hot Oil Heaters rated at 64.83 MMBtu/hr (Units SHTR1 through SHTR12);
- Three (3) Cryo Hot Oil Heaters rated at 103.99 MMBtu/hr (Units CHTR1 through CHTR3);
- Three (3) Regen Heaters rated at 39.14 MMBtu/hr (Units RHTR1 through RHTR3);
- Three (3) Dual-Tip Flares (Units FL1 through FL3);
- Four (4) 100,000 bbl Internal Floating Roof Tanks (Units IFR1 through IFR4);
- Six (6) 2,000 bbl Fixed Roof Oil Storage Tanks (Units OTK1 through OTK6);
- One (1) Vapor Combustor (Unit ECD1);
- Three (3) Thermal Oxidizers (Units TO1 through TO3);
- Facility Fugitives (Unit FUG);
- Storage Tank SSM Emissions (Unit SSM);
- Haul Road Fugitives (Unit ROAD);
- Two (2) 750 bbl Produced Water Tanks (Units PWTK1 through PWTK2);
- Produced Water Loading (Unit PWTL);
- Slop Oil Loading (Unit OTL);
- Three (3) Amine Units rated at 250 MMSCFD (Units AU1 through AU3);
- One (1) 1,000 bbl Gunbarrel Tank (Unit GBS1);
- One (1) 500 bbl Slop Oil Tank (Unit OTK7);
- Four (4) Natural Gas-Fired Turbines for Cogeneration (Units TUR1 through TUR4); and
- Eight (8) Natural Gas-Fired Emergency Generators rated at 2485 kW (Units GEN1 through GEN8).

BACT for the proposed project has been evaluated via a "top-down" approach which includes the steps outlined in the following subsections.

Additionally, EPA's March 2011 GHG Permitting Guidance generally directed that a BACT review for GHGs should be done in the same manner as it is done for any other regulated pollutant.[11] It should be noted that the scope of a BACT review was clarified in two ways with respect to GHGs:

- EPA stressed that applicants should clearly define the scope of the project being reviewed.[12] XTO has provided this information in Sections 1 and 2 (BACT Definition and Project Definition) of this review.
- EPA clarified that the scope of the BACT should focus on the project's largest contributors to CO_2e and may subject less significant contributors for CO_2e to less stringent BACT review.[13]

3.1. STEP 1 – IDENTIFY ALL AVAILABLE CONTROL TECHNOLOGIES

Available control technologies with the practical potential for application to the emission unit and regulated air pollutant in question are identified. Available control options include the application of alternate production processes and control methods, systems, and techniques including fuel cleaning and innovative fuel combustion, when applicable and consistent with the proposed project. The application of demonstrated control technologies in other similar source categories to the emission unit in question can also be considered. While identified technologies may be eliminated in subsequent steps in the analysis based on technical and economic infeasibility or environmental, energy, economic or other impacts, control technologies with potential application to the emission unit under review are identified in this step.

Under Step 1 of a criteria pollutant BACT analysis, the following resources are typically consulted when identifying potential technologies:

1. EPA's Reasonably Available Control Technology (RACT)/Best Available Control Technology (BACT)/Lowest Achievable Emission Reduction (LAER) Clearinghouse (RBLC) database;
2. Determinations of BACT by regulatory agencies for other similar sources or air permits and permit files from federal or state agencies;
3. Engineering experience with similar control applications;
4. Information provided by air pollution control equipment vendors with significant market share in the industry; and/or
5. Review of literature from industrial technical or trade organizations.

For GHGs, XTO will rely on items (2) through (5) and preliminary information from the EPA BACT GHG Workgroup for data to establish BACT.

EPA's "top-down" BACT analysis procedure also recommends the consideration of inherently lower emitting processes as available control options under Step 1.[14] For GHG BACT analyses, low-carbon intensity fuel selection is the primary control option that can be considered a lower emitting process. XTO proposes the use of

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[11] *PSD and Title V Permitting Guidance for Greenhouse Gases*. March 2011, page 17.

[12] Ibid, pages 22-23.

[13] Ibid, page 31.

[14] Ibid, page 24.

pipeline quality natural gas only for all combustion equipment associated with the proposed project. Table C-1 of 40 CFR Part 98 shows CO_2 emissions per unit heat input (MMBtu) for a wide variety of industrial fuel types. Only biogas (captured methane) and coke oven gas result in lower CO_2 emissions per unit heat input than natural gas, but these fuel types are not readily available for this project.

Additionally, EPA's GHG BACT guidance suggests that carbon capture and sequestration (CCS) be evaluated as an available control for substantial, large projects such as steel mills, refineries, and cement plants where CO_2e emissions levels are in the order of 1,000,000 tpy, or for industrial facilities with high-purity CO_2 streams.[15] However, EPA explained that "this does not necessarily mean CCS should be selected as BACT for such sources."

3.2. STEP 2 – ELIMINATE TECHNICALLY INFEASIBLE OPTIONS

After the available control technologies have been identified, each technology is evaluated with respect to its technical feasibility in controlling individual pollutant emissions from the source in question. The first question in determining whether a technology is feasible is whether it is demonstrated. Whether or not a control technology is demonstrated is a relatively straightforward determination, although a source may cite specific site-specific differences to eliminate a technology form consideration.

> Demonstrated "means that it has been installed and operated successfully elsewhere on a similar facility." *Prairie State*, slip op. at 45. "This step should be straightforward for control technologies that are demonstrated--if the control technology has been installed and operated successfully on the type of source under review, it is demonstrated, and it is technically feasible."[16]

An undemonstrated technology is only technically feasible if it is "available" and "applicable." A control technology or process is only considered available if it has reached the licensing and commercial sales phase of development and is "commercially available".[17] Control technologies in the R&D and pilot scale phases are not considered available. Based on EPA guidance, an available control technology is presumed to be applicable if it has been permitted or actually implemented by a similar source. Decisions about technical feasibility of a control option consider the physical or chemical properties of the emissions stream in comparison to emissions streams from similar sources successfully implementing the control alternative. The NSR Manual explains the concept of applicability as follows: "An available technology is "applicable" if it can reasonably be installed and operated on the source type under consideration."[18] Applicability of a technology is determined by technical judgment and consideration of the use of the technology on similar sources as described in the NSR Manual.

3.3. STEP 3 – RANK REMAINING CONTROL TECHNOLOGIES BY CONTROL EFFECTIVENESS

All remaining technically feasible control options are ranked based on their overall control effectiveness for the pollutant under review. For GHGs, this ranking may be based on energy efficiency and/or emission rate.

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[15] *PSD and Title V Permitting Guidance for Greenhouse Gases*. March 2011, pages 32-33.

[16] NSR Workshop Manual (Draft), Prevention of Significant Deterioration (PSD) and Nonattainment New Source Review (NNSR) Permitting, page B.17.

[17] Ibid, page B.18.

[18] Ibid, page B.18.

3.4. STEP 4 – EVALUATE MOST EFFECTIVE CONTROLS AND DOCUMENT RESULTS

After identifying and ranking available and technically feasible control technologies, the economic, environmental, and energy impacts are evaluated to select the best control option. If adverse collateral impacts do not disqualify the top-ranked option from consideration it is selected as the basis for the BACT limit. Alternatively, in the judgment of the permitting agency, if unreasonable adverse economic, environmental, or energy impacts are associated with the top control option, the next most stringent option is evaluated. This process continues until a control technology is identified. EPA recognized in its BACT guidance for GHGs that "[e]ven if not eliminated at Step 2 of the BACT analysis, on the basis of the current costs of CCS, we expect that CCS will often be eliminated from consideration in Step 4 of the BACT analysis, even in some cases where underground storage of the captured CO_2 near the power plant is feasible."[19]

The energy, environment, and economic impacts analysis under Step 4 of a GHG BACT assessment presents a unique challenge with respect to the evaluation of CO_2 and CH_4 emissions. The technologies that are most frequently used to control emissions of CH_4 in hydrocarbon-rich streams (e.g., flares, combustors and thermal oxidizers) actually convert CH_4 emissions to CO_2 emissions. Consequently, the reduction of one GHG (i.e., CH_4) results in a proportional increase in emissions of another GHG (i.e., CO_2). However, since the GWP of CH_4 is 21 times higher than CO_2, conversion of CH_4 emissions to CO_2 results in a net reduction of CO_2e emissions.

Permitting authorities have historically considered the effects of multiple pollutants in the application of BACT as part of the PSD review process, including the environmental impacts of collateral emissions resulting from the implementation of emission control technologies. To clarify the permitting agency's expectations with respect to the BACT evaluation process, states have sometimes prioritized the reduction of one pollutant above another. For example, technologies historically used to control NO_X emissions frequently caused increases in CO emissions. Accordingly, several states prioritized the reduction of NO_X emissions above the reduction of CO emissions, approving low NO_X control strategies as BACT that result in higher CO emissions relative to the uncontrolled emissions scenario.

3.5. STEP 5 – SELECT BACT

In the final step, the BACT emission limit is determined for each emission unit under review based on evaluations from the previous step.

Although the first four steps of the top-down BACT process involve technical and economic evaluations of potential control options (i.e., defining the appropriate technology), the selection of BACT in the fifth step involves an evaluation of emission rates achievable with the selected control technology. BACT is an emission limit unless technological or economic limitations of the measurement methodology would make the imposition of an emissions standard infeasible, in which case a work practice or operating standard can be imposed.

Establishing an appropriate averaging period for the BACT limit is a key consideration under Step 5 of the BACT process. Localized GHG emissions are not known to cause adverse public health or environmental impacts. Rather, EPA has determined that GHG emissions are anticipated to contribute to long-term environmental consequences on a global scale. Accordingly, EPA's Climate Change Workgroup has characterized the category of regulated GHGs as a "global pollutant." Given the global nature of impacts from GHG emissions, NAAQS are not established for GHGs in the Tailoring Rule and a dispersion modeling analysis for GHG emissions is not a required element of a PSD permit application for GHGs. Since localized short-term health and environmental effects from GHG emissions are not recognized, XTO proposes only an annual average GHG BACT limit.

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[19] *PSD and Title V Permitting Guidance for Greenhouse Gases*. March 2011, pages 42-43.

For the Husky CDP, the BACT requirement applies to each emission unit from which there are emissions increases of pollutants subject to PSD review. The proposed facility is subject to PSD permitting for CO, NO_X, VOC, PM_{10}, $PM_{2.5}$, H_2SO_4 and GHGs. Therefore, the proposed project is subject to BACT analysis for these pollutants.

Table 4-1 identifies the pollutants considered in the PSD BACT analysis for each emission unit.

Table 4-1. Pollutants Evaluated in the BACT Analysis for Each Emission Unit

Equipment	NO_X (Yes/No)	CO (Yes/No)	PM_{10}/$PM_{2.5}$ (Yes/No)	VOC (Yes/No)	H_2SO_4 (Yes/No)	GHG (Yes/No)
Natural Gas-Fired Turbines	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Emergency Natural Gas-Fired RICE	**Yes**	**Yes**	**Yes**	**Yes**	No	**Yes**
Heaters < 100 MMBtu/hr	**Yes**	**Yes**	**Yes**	**Yes**	No	**Yes**
Flares	**Yes**	**Yes**	**Yes**	**Yes**	No	**Yes**
VCD	**Yes**	**Yes**	**Yes**	**Yes**	No	**Yes**
Thermal Oxidizers	**Yes**	**Yes**	No	**Yes**	No	**Yes**
Produced Water Storage Tanks	No	No	No	**Yes**	No	No*
Slop Storage Tank	No	No	No	**Yes**	No	No*
Condensate Storage Tanks	No	No	No	**Yes**	No	No*
Gunbarrel Tank	No	No	No	**Yes**	No	No*
Internal Floating Roof (IFR) Tanks	No	No	No	**Yes**	No	No*
Fixed Roof Tank Cleanings	No	No	No	**Yes**	No	No*
IFR Tank Cleanings and Landings	No	No	No	**Yes**	No	No*
Truck Unloading of Condensate	No	No	No	**Yes**	No	No*
Truck Loading of Produced Water and Slop	No	No	No	**Yes**	No	No*
Process Fugitives	No	No	No	**Yes**	No	**Yes**
Amine Still Vents	No	No	No	**Yes**	No	**Yes**
Haul Roads	No	No	**Yes**	No	No	No*
Startup, Shutdown and Maintenance Activities	No	No	No	**Yes**	No	No*

* There are no methane or carbon dioxide fractions associated with these units; therefore, no GHG BACT is evaluated for this source.

The following sections provide detail on the BACT assessment methodology utilized in preparing the BACT analysis for the proposed Husky facility. The minimum control efficiency to be considered in a BACT assessment must result in an emission rate less than or equal to any applicable NSPS or NESHAP emission rate for the source.

4.1. IDENTIFICATION OF POTENTIAL CONTROL TECHNOLOGIES

Potentially applicable emission control technologies were identified by researching the U.S. EPA control technology database RACT/BACT/LAER Clearinghouse (RBLC), The Texas Commission on Environmental Quality's (TCEQ) BACT Guidelines, the California Air Resources Board's (CARB) Interim BACT Clearinghouse, technical literature, control equipment vendor information, state permitting authority files, and by using process knowledge and engineering experience. The RBLC, a database made available to the public through the U.S. EPA's Office of Air Quality Planning and Standards (OAQPS) Technology Transfer Network (TTN), lists technologies and corresponding emission limits that have been approved by regulatory agencies in major source permit actions. These technologies are grouped into industry categories and can be referenced in determining what emissions levels were proposed for similar types of emissions units.

A RBLC database search was performed in October 2019, to identify the emission control technologies and emission levels that were determined by permitting authorities as BACT within the past ten years for sources comparable to those proposed for Husky. The following categories were searched:

- Large Combined Cycle Combustion Turbines > 25MW (RBLC Code 15.210);
- Large Internal Combustion Engines > 500 hp (RBLC Code 17.130);
- Heaters > 100 MMBtu/hr (RBLC Code 12.310);
- Heaters < 100 MMBtu/hr (RBLC Code 13.310);
- Flares (RBLC Codes 19.330 and 19.390);
- Vapor Combustion (RBLC Codes 19.200 and 19.900);
- Fixed Roof Storage tanks (RBLC Codes 42.005 and 42.009);
- Internal Floating Roof Storage Tanks (RBLC Codes 42.006 and 42.009);
- Truck loading and unloading (RBLC Codes, 42.002, 42.010, 50.004 and 50.999);
- Fugitives (RBLC Code 50.007);
- Amine Units (RBLC Codes 50.002 and 50.006);
- Unpaved haul roads (RBLC Code 99.150); and
- SSM Activities (RBLC Codes 19.300, 42.004, 42.006 and 42.010)

Appendix A includes the RBLC search results. Since the RBLC database is still very limited in the number of entries for GHG emissions, XTO relied on items (2) through (5) and preliminary information from the EPA BACT GHG Workgroup for data to establish BACT.

Additionally, the following guidance documents were utilized as resources in completing the GHG BACT evaluation for the proposed project:

- *PSD and Title V Permitting Guidance for Greenhouse Gases (hereafter referred to as General GHG Permitting Guidance)*[20]
- *Available and Emerging Technologies for Reducing Greenhouse Gas Emissions from Industrial, Commercial, and Industrial Boilers (hereafter referred to as GHG BACT Guidance for Boilers)*[21]
- *Available and Emerging Technologies for Reducing Greenhouse Gas Emissions from the Petroleum Refining Industry (hereafter referred to as GHG BACT Guidance for Refineries)*[22]

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[20] U.S. EPA, Office of Air and Radiation, Office of Air Quality Planning and Standards, (Research Triangle Park, NC: March 2011). http://www.epa.gov/nsr/ghgdocs/ghgpermittingguidance.pdf

[21] U.S. EPA, Office of Air and Radiation, Office of Air Quality Planning and Standards, (Research Triangle Park, NC: October 2010). http://www.epa.gov/nsr/ghgdocs/iciboilers.pdf

[22] U.S. EPA, Office of Air and Radiation, Office of Air Quality Planning and Standards, (Research Triangle Park, NC: October 2010). http://www.epa.gov/nsr/ghgdocs/refineries.pdf

4.2. PROPOSED PRIMARY BACT LIMITS SUMMARY

Based on BACT assessment, XTO proposes the BACT limits shown in Table 4-2. A detailed discussion of the determination for each emission source is provided in the following Sections of this report.

Table 4-2. Proposed Primary BACT Limits Summary

Unit	Pollutant	Limit	Proposed BACT
>25 MW Natural Gas Fired Combined Cycle Turbine	NO_x	2 ppmv @ 15% O_2	Dry Low-NO_X combustion and SCR
	CO	2 ppmv @ 15% O_2	Catalytic oxidation and good combustion practices
	VOC	4.6 ppmv @ 15% O_2	Catalytic oxidation and good combustion practices
	$PM_{10}/PM_{2.5}$ (filterable)	0.00786 lb/MMBtu	Natural gas fuel and good combustion practices
	H_2SO_4	0.75 gr S/scf	Natural gas fuel and good combustion practices
	CO_2e	117 lb/MMBtu	Natural gas fuel, good combustion practices
Large Stationary Reciprocating Internal Combustion Engines (Emergency Generators)	NO_x	1.00 g/hp-hr	Clean burn technology and good combustion practices
	CO	1.50 g/hp-hr	Good combustion practices
	VOC	0.21 g/hp-hr	Good combustion practices
	$PM_{10}/PM_{2.5}$ (filterable)	7.71E-05 lb/MMBtu	Natural gas fuel and good combustion practices
	CO_2e	117 lb/MMBtu	Natural gas fuel and good combustion practices
Heaters < 100 MMBtu/hr	NO_x	0.0267 lb/MMBtu (Stab. & Regen)	Low NO_X burners and good combustion controls
	NO_x	0.034 lb/MMBtu (Cryo)	Low NO_X burners and good combustion controls
	CO	0.0163 lb/MMBtu	Good combustion controls
	VOC	0.0064 lb/MMBtu	Good combustion controls
	$PM_{10}/PM_{2.5}$ (filterable)	0.013 lb/MMBtu	Good combustion practices
	CO_2e	117 lb/MMBtu	Natural gas fuel and good combustion practices
Flare	NO_x, CO, VOC, $PM_{10}/PM_{2.5}$, CO_2e		Good flare design, good combustion, operating and maintenance practices and use of natural gas
VCD	NO_x, CO, VOC, $PM_{10}/PM_{2.5}$	0.138 (NO_X); 0.2755 (CO); 0.3966 (VOC) (lb/MMBtu)	Good combustor design, good combustion, operating and maintenance practices and use of natural gas

	CO_2e	0.25 lb/scf	Good combustor design, good combustion, operating and maintenance practices and use of natural gas
Thermal Oxidizer	NO_x	30 ppmv @ 3% O_2	Low NO_X burners and good combustion controls
	CO	50 ppmv @ 3% O_2	Good combustion controls
	VOC	Permitted Emission Rate	Good combustion controls
	CO_2e		Proper design, low carbon fuel selection, good combustion, operating and maintenance practices.
Fixed Roof Tanks	VOC	99% DRE	Routed to vapor combustion device.
Internal Floating Roof Tanks	VOC		Floating roof, white or aluminum. Primary and secondary seal.
Truck Loading and Unloading	VOC	99% DRE	Routed to vapor combustion device.
Fugitives	VOC		LDAR Program under 40 CFR 60 Subpart OOOOa
Amine Units	VOC	99% DRE	Good combustion design controls, good combustion, operating and maintenance practices. Vented to thermal oxidizers.
	CO_2e		Thermal incineration, condensers, flash gas recovery and proper design and operation.
Haul Roads	$PM_{10}/PM_{2.5}$	57% & 60% Reduction	Speed limit and base course, respectively.
SSM Activities	VOC	98% DRE	Good combustion design controls, good combustion, operating and maintenance practices. Vented to a control device.

4.3. OVERALL PROJECT EFFICIENCY CONSIDERATIONS

While the five-step BACT analysis is the EPA's preferred methodology with respect to selection of control technologies for pollutants, EPA has also indicated that an overarching evaluation of energy efficiency should take place as increases in energy efficiency will inherently reduce the total amount of GHG emissions produced by the source. As such, overall energy efficiency was a basic design criterion in the selection of technologies and processing alternatives to be installed at the proposed Husky Central Delivery Point.

The Husky Central Delivery Point will be designed and constructed using new or updated energy efficient equipment. The plant was designed with heat and process integration in mind for increased energy efficiency. Where feasible, the facility will utilize available process streams to transfer heat which reduces combustion heating requirements in the process. In addition, as provided in Section 3 of the application, XTO is proposing three operating scenarios: 1) Operation of the facility without cogeneration turbines and full heater buildout, 2) Operation of the facility with cogeneration turbines with reduced heater buildout, and 3) Combination of turbines and heater use during turbine downtime. The combustion turbines will also include steam recovery to generate additional electricity for the proposed plant as well as other XTO facilities. Equipment (vessels), piping, and components in hot service to will be designed to prevent heat loss to the atmosphere from equipment containing hot streams.

The facility will recycle the flash gas from the amine units to a control device. The recycling of this material will reduce the amount of natural gas required to fuel the facility's combustion sources and will avoid the formation of additional GHG from combusting this material in a control device.

Process control instrumentation and pneumatic components will be operated using compressed air rather than fuel gas or off-gas; therefore, no GHG emissions will be emitted to the atmosphere from these components. The plant will be built using new, state-of-the-art equipment and process instrumentation and controls. XTO operating and maintenance policies will maintain all equipment according to manufacturer specifications in order to keep all equipment operating efficiently.

Table 4-3. Summary of Proposed Good Combustion Practices [1]

Good Combustion Technique	Practice	Applicable Units	Standard
Operator practices	• Official documented operating procedures, updated as required for equipment or practice change • Procedures include startup, shutdown, malfunction • Operating logs/record keeping	All combustion units	• Maintain written site-specific operating procedures in accordance with GCPs, including startup, shutdown, and malfunction
Maintenance knowledge	• Training on applicable equipment & procedures	All combustion units	• Equipment maintained by personnel with training specific to equipment
Maintenance practices	• Official documented maintenance procedures, updated as required for equipment or practice change • Routinely scheduled evaluation, inspection, overhaul as appropriate for equipment involved • Maintenance logs/record keeping	All combustion units	• Maintain site specific procedures for best/optimum maintenance practices • Scheduled periodic evaluation, inspection, and overhaul as appropriate
Firebox (furnace) residence time, temperature, turbulence	• Supplemental stream injection into active flame zone • Residence time by design (incinerators) • Minimum combustion chamber temperature (incinerators)	Thermal Oxidizers and Flares	
Fuel quality analysis and fuel handling	• Monitor fuel quality • Periodic fuel sampling and analysis • Fuel handling practices • DBJVG will use clean and treated field gas as fuel	All combustion units	• Fuel analysis where composition could vary • Fuel handling procedures applicable to the fuel
Combustion air distribution	• Adjustment of air distribution system based on visual observations • Adjustment of air distribution based on continuous or periodic monitoring	All combustion units	• Routine & periodic adjustments & checks

[1] EPA Guidance document "Good Combustion Practices" available at: http://www.epa.gov/ttn/atw/iccr/dirss/gcp.pdf.

5. BACT EVALUATION FOR NATURAL GAS-FIRED COMBINED CYCLE TURBINES

The BACT evaluation for the proposed natural gas-fired combined cycle turbines (Units TUR1 through TUR4) for NO_X, CO, VOC, PM_{10}/$PM_{2.5}$, H_2SO_4 and GHG (as CO_2e) is provided in Sections 5.1 through 5.6. Appendix A provides a summary of RBLC and permit search results.

5.1. NO_X BACT

5.1.1. Background on Pollutant Formation

In combustion processes, NO_X is formed by two fundamentally different mechanisms known as “fuel NO_X“ and “thermal NO_X”. NO_X formation from natural gas combustion is primarily thermal NO_X.

“Fuel NO_X” forms when fuels containing nitrogen are burned. When these fuels are burned, the nitrogen bonds break and some of the resulting free nitrogen oxidizes to form NO_X. With excess air, the degree of fuel NO_X formation is primarily a function of the nitrogen content of the fuel. Therefore, since natural gas contains little or no fuel-bound nitrogen, fuel NO_X is not a major contributor to NO_X emissions from natural gas-fired turbines.[23]

Thermal NO_X is formed by a series of chemical reactions in which oxygen and nitrogen present in the combustion air dissociate and react to form NO_X. Prompt NO_X, a form of thermal NO_X, is formed in the proximity of the flame front as intermediate combustion products (e.g., HCN, N, and NH) are oxidized to form NO_X. In addition to prompt NO_X, thermal NO_X is formed through the Zeldovich mechanism. The amount of NO_X generated through this mechanism increases exponentially as a function of temperature and linearly as a function of residence time. The rate of NO_X generation decreases significantly at temperatures below 2,780 °F. Therefore, reducing combustion temperature is a common approach to reducing NO_X emissions.[24]

In lean premix combustion systems such as those to be used at Husky, atmospheric nitrogen acts as a diluent as fuel is mixed with air upstream of the combustor at fuel-lean conditions. The air-to-fuel ratio is maintained well below the ideal stoichiometric level to limit NO_X formation as lean conditions do not produce the high temperatures that create thermal NO_X. In addition, premixing prevents local “hot spots” within the combustor that can lead to significant NO_X formation. [25]

5.1.2. Identify All Available Control Technologies

NO_X reduction in natural gas-fired turbines can be accomplished by combustion control techniques and post-combustion control methods. Combustion control techniques incorporate fuel or air staging that affect the kinetics of NO_X formation (i.e., by reducing peak flame temperature) or introduce inerts (combustion products, for example) that limit initial NO_X formation, or both. Post-combustion NO_X control technologies employ various strategies to chemically reduce NO_X to elemental nitrogen (N_2) with or without the use of a catalyst.

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable NO_X control technologies for natural gas-fired combined cycle turbines were identified based on the

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[23] U.S. DOE, Office of Fossil Energy, National Technology Energy Laboratory, *The Gas Turbine Handbook*, 2006. http://www.netl.doe.gov/technologies/coalpower/turbines/refshelf/handbook/TableofContents.html

[24] Ibid.

[25] Ibid.

principles of control technology and engineering experience for general combustion units. Table 5-1 outlines the top down BACT analysis for NO_X emissions from the turbines.

5.1.3. Selection of BACT for NO_X

The most stringent RBLC and permit entries for NO_X control are provided in Appendix A. XTO has determined that NO_X BACT for normal operation is a limit of 2 ppmv @ 15% O_2 utilizing Selective Catalytic Reduction (SCR) and good combustion practices.

Table 5-1. BACT Analysis for Natural Gas-Fired Combined Cycle Turbines - NO_X

5.2. CO BACT

5.2.1. Background on Pollutant Formation

CO from natural gas-fired turbines is a by-product of incomplete combustion. Conditions leading to incomplete combustion include insufficient oxygen availability, poor fuel/air mixing, reduced combustion temperature, reduced combustion gas residence time, and load reduction.

5.2.2. Identify All Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable CO control technologies for combined cycle turbines were identified based on the principles of control technology and engineering experience for general combustion units. Table 5-2 outlines the top-down BACT analysis for CO emissions from the turbine.

5.2.3. Selection of BACT for CO

The most stringent RBLC and permit entries for CO control are provided in Appendix A. XTO has determined that CO BACT for normal operation is a limit of 2 ppmv @ 15% O_2 using catalytic oxidation and good combustion practices.

Table 5-2. BACT Analysis for Natural Gas-Fired Combined Cycle Turbines - CO

5.3. VOC BACT

5.3.1. Background on Pollutant Formation

The formation of VOC is the result of incomplete combustion. VOC results when there is insufficient residence time at high temperature to complete the final step in hydrocarbon oxidation.

5.3.2. Identify All Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable VOC control technologies for natural gas-fired turbines were identified based on the principles of control technology and engineering experience for general combustion units. Table 5-3 outlines the top-down BACT analysis for VOC emissions from the turbine. Generally, the control technologies for VOC are identical to those for CO.

5.3.3. Selection of BACT for VOC

The most stringent RBLC and permit entries for VOC control are provided in Appendix A. XTO has determined that VOC BACT for normal operation is a limit of 4.6 ppmv @ 15% O_2 using catalytic oxidation and good combustion practices.

Table 5-3. BACT Analysis for Natural Gas-Fired Combined Cycle Turbines - VOC

5.4. PM_{10}/$PM_{2.5}$ BACT

5.4.1. Background on Pollutant Formation

Filterable PM emissions from combustion are formed by ash and sulfur in the fuel. Combustion of natural gas generates low filterable PM emissions in comparison to other fuels due to its low ash and sulfur contents. Condensable particulate matter results from sulfur in the fuel and the resultant H_2SO_4 and NO_X being oxidized to nitric acid (HNO_3) and high molecular weight organics.

5.4.2. Identify All Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable particulate control technologies were identified based on the principles of control technology and engineering experience for general combustion units. Table 5-4 outlines the top-down BACT analysis for particulate emissions from the turbines.

5.4.3. Selection of BACT for PM_{10}/$PM_{2.5}$

Based on the review of the RBLC search and other permit review results, XTO has determined that the PM_{10}/$PM_{2.5}$ BACT limit is 0.00786 lb/MMBtu, which can be achieved by implementing good combustion practices and the use of only pipeline quality natural gas (fuel specifications).

Table 5-4. BACT Analysis for Natural Gas-Fired Combined Cycle Turbines – $PM_{10}/PM_{2.5}$

5.5. H_2SO_4 BACT

5.5.1. Background on Pollutant Formation

During normal operations, fuel sulfur oxidizes to form SO_2; however, a small portion of the sulfur may initially oxidize directly to SO_3. Additionally, a small portion of the fuel sulfur which initially oxidizes to form SO_2 may subsequently oxidize to form SO_3 prior to being emitted. SO_2 is expected to convert to SO_3 as it passes through both the oxidation catalyst and SCR system. This SO_3 then reacts with water vapor in the effluent gas to form H_2SO_4.

5.5.2. Identify All Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable control technologies were identified based on the principles of control technology and engineering experience for general combustion units. Table 5-5 outlines the top-down BACT analysis for H_2SO_4 emissions from the turbines.

5.5.3. Selection of BACT for H_2SO_4

Based on the review of the RBLC search and other permit review results, XTO has determined that the formation of sulfuric acid mist will be limited by limiting the fuel sulfur content of the natural gas. XTO has determined that the H_2SO_4 BACT limit is 0.75 gr S/scf, which can be achieved by implementing good combustion practices and the use of only pipeline quality natural gas (fuel specifications).

Table 5-5. BACT Analysis for Natural Gas-Fired Combined Cycle Turbines – H_2SO_4

5.6. GHG BACT

5.6.1. Background on Pollutant Formation

The combustion of natural gas in the generating units results in emissions of CO_2, CH_4, and N_2O. Nearly one-hundred percent of combustion-related GHG emissions are in the form of CO_2 on a mass basis, since each carbon atom combusted in the fuel stream results in nearly one molecule of CO_2 emissions.[26] CH_4 and N_2O form as the result of incomplete combustion and are formed in much lower quantities. Even when scaling CH_4 and N_2O by their relative global warming potentials (GWPs), these constituents combined contribute approximately one percent of the total GHG emissions (on CO_2e basis) resulting from the combustion of natural gas. Therefore, the BACT assessment for the CCCT generating units is focused on CO_2. In addition, using CO_2 as a surrogate for CO_2e BACT analysis is consistent with federal regulations.[27] The following section presents a GHG BACT evaluation for the proposed CCCT generating units. This section details the BACT steps versus using a tabular format similar to the other pollutants due to the extent of the carbon capture and sequestration (CCS) discussion.

5.6.2. Step 1 - Identification of Potential Control Technologies

The available control technologies for controlling GHG emissions from the generating units are:

- Carbon Capture and Sequestration (CCS)
- Efficient Turbine Design
- Fuel Selection
- Good Combustion Practices

5.6.2.1. Carbon Capture and Sequestration (CCS)

CCS for the generating units would involve post-combustion capture of CO_2 emissions. The emissions are sequestered in some fashion, decreasing emissions of CO_2 to the atmosphere. One option is to use the captured CO_2 for Enhanced Oil Recovery (EOR). Carbon capture can be achieved with low pressure scrubbing of CO_2 from the exhaust stream with either solvents (e.g., amines or ammonia), solid sorbents, or membranes. However, only solvents have been used to-date on a commercial scale while the others are in the research and development phase.

Since the majority of GHG emissions from a combustion turbine are in the form of CO_2, decreasing CO_2 emissions would decrease GHG emissions by nearly the same fraction.

5.6.2.2. Efficient Turbine Design

In general, turbines which operate at higher temperatures have highest efficiencies. Increasing the efficiency of the turbines directly decreases GHG emissions as less fuel is combusted per unit output.

5.6.2.3. Fuel Selection

Fuels containing less carbon have lower potential CO_2 and CH_4 emissions. Choosing a less carbonaceous fuel will decrease CO_2 and CH_4 emissions as fewer carbon atoms are available.

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[26] Although small fractions of fuel carbon convert to combustion byproducts such as CO and CH_4, the majority of carbon combusted in the fuel stream is converted to CO_2.

[27] 40 CFR § 52.21(b)(49)(i).

5.6.2.4. Good Combustion Practices

Good combustion and operating practices (GCPs) are a potential control option by improving the fuel efficiency of the generating units. GCPs also include proper maintenance and tune-up of the units as recommended by the manufacturer.

5.6.3. Step 2 - Elimination of Technically Infeasible Control Options

5.6.3.1. Carbon Capture and Sequestration (CCS)

CCS involves "capturing" and separating the CO_2 from the exhaust of the emission source, transporting the CO_2 to an appropriate injection site, and then storing CO_2 at a suitable sequestration site. The following sections describe the technical feasibility of each of the three steps necessary for the successful implementation of CCS. The CO_2 transfer options include both transfer to a pipeline or use in EOR.

CCS would involve post combustion capture of the CO_2 from the combustion turbines and sequestration of the CO_2 in some fashion; for example, in EOR. In theory, carbon capture could be accomplished with low pressure scrubbing of CO_2 from the exhaust stream with either solvents (e.g., amines and ammonia), solid sorbents, or membranes. [28]

The most commonly used solvent for CO_2 capture is monothanolamine (MEA). CO_2 from the flue gas is separated via absorption in an aqueous solution of MEA. CO_2 captured from this process can then be stored or used in EOR applications.

As part of the technical feasibility analysis, XTO reviewed developments in CCS technology and application for CCCTs around the world. Details are provided in this section.

Per the National Energy Technology Laboratory's (NETL) CCS Database, which includes a summary of world-wide development in the CCS technology as of April 2018, CO_2 capture using solvents, solid sorbents or membranes has been used on the coal-fired power plants and other industrial applications (e.g., food processing), which contain high concentrations of CO_2 in the flue gas (12 to 15 percent) compared to low-purity CO_2 resulting from the natural gas combined cycle (NGCC) units (approximately 3-4 percent). As presented in the NETL's database, none of the post-combustion CO_2 capture technologies have been demonstrated for full-scale, NGCC plants.[29]

The full-scale power plant CCS projects implemented are all coal-fired power plants.[30] While 2 full scale CCS projects for NGCC units were planned, one of these projects has been cancelled (Peterhead, Scotland, UK)[31] and the Masdar CCS Project in Abu Dhabi, United Arab Emirates is in the development phase. [32,33] Per the Masdar CCS Initiatives project website, the CO_2 would be captured for use in EOR operations.

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[28] Post Combustion CO_2 Capture: https://www.netl.doe.gov/coal/carbon-capture/post-combustion

[29] NETL CCS Database available at: https://www.netl.doe.gov/coal/carbon-storage/worldwide-ccs-database

[30] https://sequestration.mit.edu/tools/projects/index_capture.html

[31] https://sequestration.mit.edu/tools/projects/peterhead.html

[32] https://sequestration.mit.edu/tools/projects/taweelah.html

[33] http://www.zeroco2.no/projects/masdar-initiative-ccs-projects

While CO_2 capture has been demonstrated on a pilot scale by NET Power in La Porte, Texas, the plant uses oxy-combustion process, where fuel is burned with oxygen to greatly reduce the volume of flue gas that must be processed. The project has been implemented for a 50 MW power plant and this technology has not been demonstrated for full scale NGCC plants.[34]

In addition, in a recent study conducted by the Prairie Research Institute, which was initiated in March 2017 and completed in May 2019, feasibility of CCS was evaluated for fossil fuel-base power generation (i.e., coal), ethanol production, chemical fertilizer plants, and refineries (CarbonSAFE Illinois East Sub-Basin project).[35] As included in this report, CCS was evaluated for industries that produce high purity CO_2 streams and none included CO_2 emissions from CCCTs.

In order to be considered available as BACT, a technology must be demonstrated, and "**technologies in the pilot scale testing stages of development would not be considered available for BACT review.**"[36] In this case, CCS is still in the pilot stage with significant public funding for potential applications and has not been demonstrated for full-scale NGCC units.

The 2011 EPA GHG PSD Guidance also reiterated the challenges associated with CCS:

> *EPA recognizes the significant logistical hurdles that the installation and operation of a CCS system presents and that sets it apart from other add-on controls that are typically used to reduce emissions of other regulated pollutants and already have an existing reasonably accessible infrastructure in place to address waste disposal and other offsite needs. Logistical hurdles for CCS may include obtaining contracts for offsite land acquisition (including the availability of land), the need for funding (including, for example, government subsidies), timing of available transportation infrastructure, and developing a site for secure long-term storage. . . . Based on these considerations, a permitting authority may conclude that CCS is not applicable to a particular source, and consequently not technically feasible, even if the type of equipment needed to accomplish the compression, capture, and storage of GHGs are determined to be generally available from commercial vendors.*[37]

Although CCS has many hurdles for implementation at any source, EPA has stated specific technical concerns when applying CCS to natural gas-fired sources. On October 23, 2015, EPA published an NSPS proposal for emissions of carbon dioxide for new fossil fuel–fired electric generating units ("EGU"). As part of the development of the EGU NSPS EPA conducted a best system of emission reduction ("BSER") analysis for natural gas combined cycle turbines ("NGCC") with CCS. EPA again came to the conclusion that CCS was not technically feasible for natural gas-fired turbines, as follows:

[34] https://sequestration.mit.edu/tools/projects/net_power.html
[35] https://www.osti.gov/servlets/purl/1523190
[36] EPA, New Source Review Workshop Manual, B.18 (Oct. 1990).
[37] USEPA, *PSD and Title V Permitting Guidance for Greenhouse Gases*, EPA-457/B-11-001, March 2011, page 36.

NGCC with CCS is not a configuration that is being built today. The EPA considered whether NGCC with CCS could be identified as the BSER adequately demonstrated for new stationary combustion turbines, and we decided that it could not. At this time, CCS has not been implemented for NGCC units, and we believe there is insufficient information to make a determination regarding the technical feasibility of implementing CCS at these types of units.[38]

EPA's NSPS proposal for NGCC eliminates CCS as a technically feasible control technology for NGCC turbines. This conclusion also supports a technically infeasible determination for CCS applicability to the natural gas turbines at the proposed gas plant.

In particular for the proposed gas plant, an integrated CCS application is technically infeasible due to the short-term and long-term uncertainty and risks surrounding the design, installation and operation of a CCS project; the dependence upon a third party commercial contract for CO_2 disposition, *i.e*., enhanced oil recovery ("EOR"), for the life of the proposed power plant; and the absence of a regulatory infrastructure to oversee and regulate long-term CO_2 storage.

These risks are not unique to the proposed gas plant. The Interagency Task Force Report highlights the general short and long term CCS regulatory and market demand uncertainties:

- The existence of market failures, particularly the lack of a cohesive climate policy setting a price on carbon and encouraging emission reductions;
- The need for a legal and regulatory framework for CCS projects that facilitates project development, protects human health and the environment, and addresses public concerns whether CO_2 can be stored safely and securely;
- Improved industry confidence regarding the long-term liability for CO_2 storage, particularly regarding obligations for stewardship after closure and obligations to compensate parties for various types and forms of legally compensable losses or damages; and
- Integration of public information, education, and outreach throughout the CCS project lifecycle in order to foster public understanding and to build trust between communities and project developers.[39]

Large-scale (greater than 1 million metric tons CO_2 injected) projects using carbon sequestration are at the early stages of testing and development. It is still unclear, at this time, what the long-term outcome of these projects will be. The NETL, which is part of the Department of Energy (DOE)'s national laboratory system, is currently working on (and in some instances economically supporting) a number of large scale field tests in different geologic storage formations to confirm that CO_2 capture, transportation, injection, and storage can be achieved safely, permanently, and economically over extended periods of time.

Table 5-6 presents examples of current sequestration projects that are taking place in the United States and their respective states of development.

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[38] Federal Register 1430 & 1436 / Vol. 79, No. 5, January 8, 2014 - *Standards of Performance for Greenhouse Gas Emissions from New Stationary Sources: Electric Utility Generating Units*.

[39] CCS Task Force Report, August 2010, page 53.

Table 5-6. Recent (2010 and Later) CCS Projects in the United States

Project Name	Project Location	Reservoir	Approximate Distance to Storage Location	Sequestration Amount (tons per year)	Current State of Development
Century Plant	Pecos County, TX	Oil Field (EOR)	40-150 miles	8.4 million	Phase 1 CO_2 capture began in 2010 Phase 2 CO_2 capture began in 2012
Air Products Steam Methane Reformer EOR Project	Port Arthur, Texas	Oil Field (EOR)	12 miles to existing CO_2 pipeline	1 million	CO_2 capture began in January 2013
Coffeyville Gasification Plant	Coffeyville, Kansas	Pennsylvanian Burbank Sandstone	70 miles	1 million	CO_2 capture began in 2013
Lost Cabin Gas Plant	Fremont County, Wyoming	Oil Field (EOR)	232 miles	0.9 million	CO_2 capture began in 2013
Illinois Industrial Carbon Capture and Storage Project	Decatur, Illinois	Mount Simon Sandstone	On-site	1 million	CO_2 capture began in April 2017[1]
Petra Nova Carbon Capture Project	Thompsons, Texas	Oil Field (EOR)	82 miles	1.4 million	CO_2 capture began in January 2017
Kemper County Energy Facility	Kemper County, Mississippi	Oil Field (EOR)	61 miles	3 million	CO_2 capture estimated to begin in 2017
Texas Clean Energy Project	Penwell, Texas	Oil Field (EOR)	Not specified, CO_2 enters the Kinder Morgan pipeline system	3 million	CO_2 capture estimated to begin in 2021
Riley Ridge Gas Plant	Big Piney, Wyoming	Oil Field (EOR)	N/A	2.5 million	CO_2 capture estimated to begin in 2020

[1] http://www.agweb.com/article/major-adm-carbon-capture-project-underway-naa-associated-press/

Although a number of large-scale sequestration projects have begun the first steps (i.e., injection of CO_2) for demonstration of CO_2 sequestration technology since 2010, it has not yet been proven that these injection sites provide a permanent location for CO_2 storage. Before concluding that these field tests accomplish their goal of permanently capturing and storing CO_2, periodic monitoring (including tracking the CO_2 plume to ensure it stays within the intended containment zone) must demonstrate successful long-term containment.

In summary, carbon capture technology has not developed to the level that it can be considered feasible full-scale CCCT units, such as the proposed turbine. As such, XTO determined that CCS is technically infeasible control technology option and eliminates CCS from further review under this BACT analysis.

5.6.3.2. Efficient Turbine Design

Using highly efficient combustion turbines is technically feasible for minimizing GHG emissions. The proposed combustion turbine is comparable or more efficient than other potential combustion turbine models. The design base load heat rate on a "new and clean" basis, without duct firing at steady state is 9,165 Btu/kWh (LHV, net) for the proposed turbine.

The combustion turbine generating unit proposed by XTO are highly efficient. This method of reducing emissions is already included in the defined project and it is not technically feasible to significantly improve efficiency.

5.6.3.3. Fuel Selection

Selecting a low-carbon fuel is a technically feasible method of controlling GHG emissions from a CCCT generating unit. XTO is proposing to burn natural gas in the units. Natural gas has a relatively low carbon content compared to other possible fuels. Other typical fuels for use in a CCCT generating unit include fuel oil and synthetic natural gas (SNG). The combustion of fuel oil creates nearly 40 percent more CO_2 than combustion of natural gas, as well as 3 times and 6 times as much CH_4 and N_2O, respectively.[40] SNG is relatively equivalent to natural gas in terms of GHG emissions; however, natural gas is much more readily available near the proposed project site making natural gas a more logistically feasible option. Natural gas is already the best choice in terms of possible fuels for reducing GHG emissions and natural gas is also part of the defined project. Decreasing GHG emissions beyond the proposed design by switching fuels is not technically feasible as natural gas is already the fuel of choice.

5.6.4. Step 3 - Ranking of Remaining Control Technologies

As discussed above, CCS is deemed technically infeasible for control of GHG emissions from the combustion turbines. All other control technologies discussed above are technically feasible.

5.6.5. Step 4 - Evaluation of Most Stringent Controls

After identifying and ranking available and technically feasible control technologies, the economic, environmental, and energy impacts are evaluated to select the best control option. For all identified technically feasible control technologies, XTO has not identified any adverse energy, environmental, or economic impacts.

5.6.6. Selection of BACT (Step 5)

XTO proposes the following design elements and work practices as BACT for the combustion turbine generating units:

- Selection of efficient generating units;
- Use of pipeline natural gas as fuel; and
- Implementation of good combustion, operating, and maintenance practices.

[40] Based on emission factors for natural gas and No. 2 fuel oil in Tables C-1 and C-2 of Subpart C of 40 CFR 98.

As noted in Section 13, the proposed combustion turbines will not be subject to NSPS Subpart TTTT, since the power will not be sold to a utility system. XTO proposes a BACT limit of 117 lb of CO_2/MMBtu, for the CCCT generating unit. The proposed emission limit represents maximum emissions across all load conditions and ambient temperatures. The compliance with the proposed emission limits will be demonstrated on 12-operating month annual average basis.

5.7. TURBINE BACT SUMMARY

Based on the BACT analysis presented in the preceding subsections, Table 5-7 summarizes the BACT determinations for the turbine.

Table 5-7 Turbine BACT Summary

>25 MW Natural Gas Fired Combined Cycle Turbine	NO_x	2 ppmv @ 15% O_2	Dry Low-NO_X combustion and SCR
	CO	2 ppmv @ 15% O_2	Catalytic oxidation and good combustion practices
	VOC	4.6 ppmv @ 15% O_2	Catalytic oxidation and good combustion practices
	PM_{10}/$PM_{2.5}$ (filterable)	0.00786 lb/MMBtu	Natural gas fuel and good combustion practices
	H_2SO_4	0.75 gr S/scf	Natural gas fuel and good combustion practices
	CO_2e	117 lb/MMBtu	Natural gas fuel, good combustion practices

6. BACT EVALUATION FOR EMERGENCY ENGINES

XTO proposes to use eight (8) emergency engines (Units GEN1 through GEN8) to supply power during the loss of commercial power in emergency situations. These generators will use natural gas fuel and will be limited to less than 500 hours of operation per year. The BACT evaluation for combustion emissions from the proposed engines for NO_X, CO, VOC, PM_{10}/$PM_{2.5}$, and GHG (as CO_2e) are provided in this section. Appendix A provides a summary of RBLC and permit search results.

6.1. NO_X BACT

6.1.1. Background on Pollutant Formation

The formation of NO_X in engines and turbines follow the same mechanisms, and thermal NO_X is the dominant mechanism for both. Please refer to Section 5.1.1 for a detailed description of NO_X formation.

6.1.2. Identify All Available Control Technologies

NO_X reduction in natural gas-fired reciprocating internal combustion engines can be accomplished by combustion control techniques and post-combustion control methods. Combustion control techniques incorporate fuel or air staging that affect the kinetics of NO_X formation (i.e., reducing peak flame temperature) or introduce inerts (combustion products, for example) that limit initial NO_X formation, or both. Post-combustion NO_X control technologies employ various strategies to chemically reduce NO_X to elemental nitrogen (N_2).

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable NO_X control technologies for natural gas-fired reciprocating internal combustion engines were identified based on the principles of control technology and engineering experience for general combustion units. Table 6-1 outlines the top down BACT analysis for NO_X emissions from the engines.

6.1.3. Selection of BACT for NO_X

The most stringent RBLC and permit entries for NO_X control are provided in Appendix A. XTO has determined that NO_X BACT for normal operation is a limit of 1.0 g/hp-hr utilizing clean burn technology and combustion design controls.

Table 6-1. BACT Analysis for Natural Gas-Fired Reciprocating Internal Combustion Engines - NO_X

6.2. CO BACT

6.2.1. Background on Pollutant Formation

CO from natural gas-fired reciprocating internal combustion engines is a by-product of incomplete combustion. Conditions leading to incomplete combustion include insufficient oxygen availability, poor fuel/air mixing, reduced combustion temperature, reduced combustion gas residence time, and load reduction.

6.2.2. Identify All Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable CO control technologies for reciprocating internal combustion engines were identified based on the principles of control technology and engineering experience for general combustion units. Table 7-2 outlines the top-down BACT analysis for CO emissions from the engines.

6.2.3. Selection of BACT for CO

The most stringent RBLC and permit entries for CO control are provided in Appendix A. XTO has determined that CO BACT for normal operation is a limit of 1.5 g/hp-hr using good combustion practices.

Table 6-2. BACT Analysis for Natural Gas-Fired Reciprocating Internal Combustion Engines - CO

6.3. VOC BACT

6.3.1. Background on Pollutant Formation

The formation of VOC is the result of incomplete combustion. VOC results when there is insufficient residence time at high temperature to complete the final step in hydrocarbon oxidation.

6.3.2. Identify All Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable VOC control technologies for natural gas-fired reciprocating internal combustion engines were identified based on the principles of control technology and engineering experience for general combustion units. Table 6-3 outlines the top-down BACT analysis for VOC emissions from the engines. Generally, the control technologies for VOC are identical to those for CO.

6.3.3. Selection of BACT for VOC

The most stringent RBLC and permit entries for VOC control are provided in Appendix A. XTO has determined that VOC BACT for normal operation is a limit of 0.21 g/hp-hr using good combustion practices.

Table 6-3. BACT Analysis for Natural Gas-Fired Reciprocating Internal Combustion Engines - VOC

6.4. $PM_{10}/PM_{2.5}$ BACT

6.4.1. Background on Pollutant Formation

Filterable PM emissions from combustion are formed by ash and sulfur in the fuel. Combustion of natural gas generates low filterable PM emissions in comparison to other fuels due to its low ash and sulfur contents.

6.4.2. Identify All Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable particulate control technologies were identified based on the principles of control technology and engineering experience for general combustion units. Table 6-4 outlines the top-down BACT analysis for particulate emissions from the engines.

6.4.3. Selection of BACT for $PM_{10}/PM_{2.5}$

Based on the review of the RBLC search and other permit review results, XTO has determined that the $PM_{10}/PM_{2.5}$ BACT limit is 7.71E-05 lb/MMBtu (filterable) by implementing good combustion practices and use of pipeline quality natural gas (fuel specifications).

Table 6-4. BACT Analysis for Natural Gas-Fired Reciprocating Internal Combustion Engines – $PM_{10}/PM_{2.5}$

6.5. GHG BACT

6.5.1. Background on Pollutant formation

Emissions result from combustion of natural gas in the engines.

6.5.2. Step 1 - Identify All Available Control Technologies

The available GHG emission control strategies for the emergency engine combustion emissions include:

> Carbon Capture and Sequestration
> Efficient Engine Design
> Low Carbon Fuel Selection
> Good Combustion, Operating, and Maintenance Practices

6.5.2.1. *Carbon Capture and Sequestration*

A detailed discussion of CCS technology is provided in previous sections. Due to limited hours of operation and low CO_2 emissions from engines, CCS has not been implemented for emergency engines.

6.5.2.2. *Efficient Engine Design*

Good engine design can be employed to optimize combustion efficiency and meet the emergency requirements for the proposed plant.

6.5.2.3. *Low Carbon Fuel Selection*

The fuel for firing the proposed engines will be limited to natural gas fuel. Natural gas has the lowest carbon intensity of any available fuel for the engines.

6.5.2.4. *Good Combustion, Operating, and Maintenance Practices*

Good combustion and operating practices are a potential control option for maintaining the combustion efficiency of the emergency equipment. Good combustion practices include proper maintenance and tune-up of the engines per the manufacturer's specifications.

6.5.3. Step 2 - Eliminate Technically Infeasible Options

CCS is not considered an available control option for emergency equipment that operates on an intermittent basis and must be immediately available during plant emergencies without the constraint of starting up the CCS process. Therefore, CCS is not technically feasible for the emergency equipment. Therefore, it has been eliminated from further consideration in the remaining steps of the analysis.

All other control technologies are considered feasible.

6.5.4. Step 3 - Rank Remaining Control Technologies by Control Effectiveness

XTO will select all feasible control technologies to minimize GHG emissions from the engines.

6.5.5. Step 4 - Evaluate Most Effective Control Options

No significant adverse energy or environmental impacts (that would influence the GHG BACT selection process) associated with the above-mentioned technically feasible control options are expected.

6.5.6. Step 5 - Select BACT for the Emergency Engines

XTO proposes a BACT limit of 117 lb/MMBtu of CO_2 for the emergency engines. This limit will be achieved through the selection of fuel-efficient engines, use of natural gas fuel, and implementation of good combustion practices, including proper maintenance and operation.

The BACT evaluation for combustion emissions from the proposed heaters rated < 100 MMBtu/hr (Units SHTR1 through SHTR12, CHTR1 through CHTR3, and RHTR1 through RHTR3) for NO_X, CO, VOC, PM_{10}/$PM_{2.5}$, and GHG (as CO_2e) are provided in Sections 7.1 through 7.5. Appendix A provides a summary of RBLC and permit search results.

7.1. NO_X BACT

7.1.1. Background on Pollutant Formation

The formation of NO_X in heaters and turbines follow the same mechanisms, and thermal NO_X is the dominant mechanism. Please refer to Section 5.1.1 for a detailed description of NO_X formation.

7.1.2. Identify All Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable NO_X control technologies for heaters rated < 100 MMBtu/hr were identified. The cryo heaters are rated at 103.99 MMBtu/hr; and a RBLC search was completed for heaters between 100 MMBtu/hr and 250 MMBtu/hr. No significant differences in control technologies or BACT limits were found for the 103.99 MMBtu/hr heaters. Table 7-1 outlines the top-down BACT analysis for NO_X emissions from the heaters.

7.1.3. Selection of BACT for NO_x

The most stringent RBLC and permit entries for NO_X control are provided in Appendix A. XTO has determined that the NO_X BACT is utilizing low NO_x burners and good combustion controls with limits of 0.0267 lb/MMBtu for heaters less than 90 MMBtu/hr and 0.034 lb/MMBtu for heaters greater than 90 MMBtu/hr.

Table 7-1. BACT Analysis for Natural Gas-Fired Heaters – NO_X

7.2. CO BACT

7.2.1. Background on Pollutant Formation

CO from combustion sources is a by-product of incomplete combustion. Conditions leading to incomplete combustion include insufficient oxygen availability, poor fuel/air mixing, reduced combustion temperature, reduced combustion gas residence time, and load reduction.

7.2.2. Identify All Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable CO control technologies for the heaters were identified. Table 7-2 outlines the top-down BACT analysis for CO emissions from the heaters.

7.2.3. Selection of BACT for CO

Based on the review of the RBLC search and other permit review results, XTO has determined that the CO BACT is 0.0163 lb/MMBtu by utilizing good combustion practices and fuel selection.

Table 7-2. BACT Analysis for Natural Gas-Fired Heaters – CO

7.3. VOC BACT

7.3.1. Background on Pollutant Formation

The formation of VOC is the result of incompletion combustion from natural gas. VOC results when there is insufficient residence time at high temperature to complete the final step in hydrocarbon oxidation.

7.3.2. Identify All Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable VOC control technologies for the heaters were identified. Table 7-3 outlines the top-down BACT analysis for VOC emissions from the heaters.

7.3.3. Selection of BACT for VOC

Based on the review of the RBLC search and other permit review results, XTO has determined that the VOC BACT is 0.0064 lb/MMBtu by utilizing good combustion practices and fuel selection.

Table 7-3. BACT Analysis for Natural Gas-Fired Heaters – VOC

7.4. $PM_{10}/PM_{2.5}$ BACT

7.4.1. Background on Pollutant Formation

Filterable PM emissions from combustion are formed by ash and sulfur in the fuel. Combustion of natural gas generates low filterable PM emissions in comparison to other fuels due to its low ash and sulfur contents.

7.4.2. Identify All Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable $PM_{2.5}/PM_{10}$ control technologies for the heaters were identified. Table 7-4 outlines the top-down BACT analysis for $PM_{2.5}/PM_{10}$ emissions from the heaters.

7.4.3. Selection of BACT for $PM_{10}/PM_{2.5}$

Based on the review of the RBLC search and other permit review results, XTO has determined that the $PM_{10}/PM_{2.5}$ BACT is 0.0134 lb/MMBtu (filterable) by utilizing good combustion practices and use of pipeline quality natural gas.

Table 7-4. BACT Analysis for Natural Gas-Fired Heaters – PM_{10}/$PM_{2.5}$

7.5. GHG BACT

7.5.1. Background on Pollution Formation

The combustion of natural gas in the heater results in emissions of CO_2, CH_4, and N_2O. Nearly one-hundred percent of combustion-related GHG emissions are in the form of CO_2 on a mass basis, since each carbon atom combusted in the fuel stream results in nearly one molecule of CO_2 emissions.[41] CH_4 and N_2O form as the result of incomplete combustion and are formed in much lower quantities. Even when scaling CH_4 and N_2O by their relative global warming potentials (GWPs), these constituents combined contribute approximately one percent of the total GHG emissions (on CO_2e basis) resulting from the combustion of natural gas. Therefore, BACT assessment for the heaters is focused on CO_2. In addition, using CO_2 as a surrogate for a CO_2e BACT analysis is consistent with federal regulations.[42] The following section presents a GHG BACT evaluation for the proposed heaters.

7.5.2. Step 1 - Identification of Potential Control Technologies

The available GHG emission control strategies for the heaters are:

- Carbon Capture and Sequestration
- Efficient Heater Design
- Heat Integration
- Low Carbon Fuel Selection
- Good Combustion Practices

7.5.2.1. *Carbon Capture and Sequestration*

The contribution of CO_2e emissions from the heaters is a fraction of the scale for sources where CCS might ultimately be feasible. Although we believe that it is obvious that CCS is not BACT in this case, as directly supported in EPA's GHG BACT Guidance, a detailed rationale is provided to support this conclusion.

For the heaters, CCS would involve post combustion capture of the CO_2 from the heaters and sequestration of the CO_2 in some fashion. In general, carbon capture could be accomplished with low pressure scrubbing of CO_2 from the exhaust stream with solvents (e.g., amines and ammonia), solid sorbents, or membranes. However, only solvents have been used to-date on a commercial (yet slip stream) scale and solid sorbents and membranes are only in the research and development phase. A number of post-combustion carbon capture projects have taken place on slip streams at coal-fired power plants. Although these projects have demonstrated the technical feasibility of small-scale CO_2 capture on a slipstream of a power plant's emissions using various solvent based scrubbing processes, until these post-combustion technologies are installed fully on a power plant, they are not considered "available" in terms of BACT.

Larger scale CCS demonstration projects have been proposed through the DOE Clean Coal Power Initiative (CCPI); however, none of these facilities are operating, and, in fact, they have not yet been fully designed or constructed.[43] Additionally, these demonstration projects are for post-combustion capture on a pulverized coal (PC) plant using a slip stream versus the full exhaust stream. The exhaust from a PC plant would have a significantly higher concentration of CO_2 in the slipstream as compared to a more dilute stream from the

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[41] Although small fractions of fuel carbon convert to combustion byproducts such as CO and CH_4, the majority of carbon combusted in the fuel stream is converted to CO_2.

[42] 40 CFR § 52.21(b)(49)(i).

[43] Report of the Interagency Task Force on Carbon Capture & Storage, August 2010, p. 32.

combustion of natural gas.[44] Finally, the compression of the CO_2 would require additional power demand, resulting in additional fuel consumption (and CO_2 emissions).[45]

7.5.2.2. *Efficient Heater Design*

Efficient heater design and proper air-to-fuel ratio improve mixing of fuel and create more efficient heat transfer. Since XTO is proposing to install new heaters, these heaters will be designed to optimize combustion efficiency.

7.5.2.3. *Heat Integration*

The plant is equipped with multiple process-to-process cross heat exchangers for maximum heat integration and high efficiency mass transfer equipment to recover heat and reduce the overall energy use at the plant. The process-to-process cross heat exchangers minimize the size of the heaters to meet the process demands of the train.

7.5.2.4. *Low Carbon Fuel Selection*

Natural gas has the lowest carbon intensity of any available fuel for the heaters. The proposed heaters will be fired with only natural gas fuel.

7.5.2.5. *Good Combustion Practices*

Good combustion and operating practices are a potential control option by improving the fuel efficiency of the heaters. Good combustion practices also include proper maintenance and tune-up of the heaters at least annually per the manufacturer's specifications.

7.5.3. Step 2 - Elimination of Technically Infeasible Control Technologies

CCS is not feasible for small combustion units such as the <100 MMBtu/hr heaters proposed with this project. However, since the proposed project also includes large combustion sources (i.e., CCCTs), it is potentially feasible to capture and transfer CO_2 emissions from these smaller units and combine. As discussed in Section 5.6, CCS is eliminated as a control technology for the CCCT generating units. Therefore, this option is not evaluated in the subsequent analysis. In addition, the RBLC data does not include CCS as a control option for any of the listed sources.

All other control technologies are considered feasible.

7.5.4. Step 3 - Ranking of Remaining Control Technologies

XTO will select all other technically feasible controls to minimize GHG emissions. Therefore, no ranking is necessary.

7.5.5. Step 4 - Evaluation of Most Stringent Controls

No adverse energy, environmental, or economic impacts are associated with the above-mentioned technically feasible control options.

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[44] Report of the Interagency Task Force on Carbon Capture & Storage, August 2010, p. A-7.

[45] Report of the Interagency Task Force on Carbon Capture & Storage, August 2010, http://www.epa.gov/climatechange/downloads/CCS-Task-Force-Report-2010.pdf, p. 29

7.5.6. Step 5- Selection of BACT

Based on the selection of an efficient heaters, use of pipeline natural gas as fuel, heat integration, and implementing good combustion practices, XTO proposes a CO_2e BACT limit of 117 lb of CO_2e/MMBtu on a rolling 12-month basis. The RBLC data show an emission limit range of 117-120 lb CO_2e /MMBtu as well as annual emission limits based on hours of operation. Therefore, BACT is satisfied for the GHG emissions.

7.6. HEATERS BACT SUMMARY

Based on the BACT analysis presented in the preceding subsections, Table 7-55 summarizes the BACT determinations for the heaters.

Table 7-5 <100 MMBTU/hr Heaters BACT Summary

Heaters	NO_x	0.0267 lb/MMBtu (Stab. & Regen)	Low NO_X burners and good combustion controls
	NO_x	0.034 lb/MMBtu (Cryo)	Low NO_X burners and good combustion controls
	CO	0.0163 lb/MMBtu	Good combustion controls
	VOC	0.0064 lb/MMBtu	Good combustion controls
	PM_{10}/$PM_{2.5}$ (filterable)	0.013 lb/MMBtu	Good combustion practices
	CO_2e	117 lb/MMBtu	Natural gas fuel and good combustion practices

The plant flare and acid gas flare are used during maintenance or upset conditions. The BACT evaluation for fuel combustion emissions from the proposed flares (Units FL1 through FL3) for NO_X, CO, VOC, PM_{10}/$PM_{2.5}$ and CO_2e is provided in Section 8.1. Appendix A provides a summary of RBLC and permit search results.

8.1. BACT FOR VOC, CO, NO_X, PM_{10}/$PM_{2.5}$ AND SO_2

8.1.1. Background on Pollutant formation

Emissions result from the destruction of the off-gas produced during the emergency situations and during planned maintenance, startup, and shutdown activities. The flare is an example of a control device in which the control of certain pollutants causes the formation of collateral GHG emissions. Specifically, the control of CH_4 in the process gas at the flare results in the creation of additional CO_2 emissions. However, given the relative GWPs of CO_2 and CH_4 and the destruction of VOC, it is appropriate to apply combustion controls to CH_4 emissions even though it will form additional CO_2 emissions.

8.1.2. Identify all Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable control technologies for flares were identified. Table 8-1 outlines the top-down BACT analysis for criteria pollutant emissions from flares.

8.1.3. Selection of BACT for VOC, CO, NO_X, $PM_{2.5}$/PM_{10}

The flares will meet the minimum requirements set out in 40 CFR §60.18 (General control device and work practice requirements) with the following control efficiency requirements.

- Destruction efficiency of 98% for VOC, methane, and H_2S;
- No flaring of halogenated compounds allowed.

Based on the review of the RBLC search and other permit review results, XTO has determined that the BACT for flares is good flare design, good combustion, operating and maintenance practices and use of natural gas as fuel.

Table 8-1. BACT Analysis for Fuel Combustion Emissions from Flares – NO_X, CO, VOC and $PM_{10}/PM_{2.5}$

8.2. BACT FOR GHG

8.2.1. Background on Pollutant formation

Emissions result from the destruction of the off-gas produced during the emergency situations and during planned maintenance, startup and shutdown activities.

8.2.2. Step 1 - Identify All Available Control Technologies

The available GHG emission control strategies for the flare combustion emissions include:

- Carbon Capture and Sequestration;
- Low Carbon Fuel Selection;
- Flare Gas Recovery;
- Good Combustion, Operating, Maintenance Practices;
- Good Flare Design; and
- Limited vent gas releases to flare.

8.2.2.1. *Carbon Capture and Sequestration*

A detailed discussion of CCS technology is provided in previous sections. The emission unit evaluated in this step for the flare is the pilot for the flare.

8.2.2.2. *Fuel Selection*

The fuel for firing the proposed flare will be limited to natural gas fuel. Natural gas has the lowest carbon intensity of any available fuel for the Flare.

8.2.2.3. *Flare Gas Recovery*

Flaring can be reduced by installation of commercially available recovery systems, including recovery compressors and collection and storage tanks. The recovered gas is then utilized by introducing it into the fuel system as applicable.

8.2.2.4. *Good Combustion, Operating, and Maintenance Practices*

Good combustion and operating practices are a potential control option for improving the combustion efficiency of the flare. Good combustion practices include proper operation, maintenance, and tune-up of the flare at least annually per the manufacturer's specifications.

8.2.2.5. *Good Flare Design*

Good flare design can be employed to destroy large fractions of the flare gas. Much work has been done by flare and flare tip manufacturers to assure high reliability and destruction efficiencies. Good flare design includes pilot flame monitoring, flow measurement, and monitoring/control of waste gas heating value.

8.2.2.6. *Limited Vent Gas Releases to Flare*

Minimizing the number and duration of MSS activities and therefore limiting vent gases routed to the flare will help reduce emissions from MSS activities.

8.2.3. Step 2 - Eliminate Technically Infeasible Options

The technical infeasibility of CCS to control flare combustion emissions and flare gas recovery is discussed below. All other control technologies listed in Step 1 are considered technically feasible to control process emissions sent to the flare.

8.2.3.1. *Carbon Capture and Sequestration*

With no ability to collect exhaust gas from a flare other than using an enclosure, post combustion capture is technically infeasible and not an available control option.

8.2.3.2. *Flare Gas Recovery*

Flare gas recovery is deemed technically infeasible for control of GHG emissions from the flares. Specifically, the process gas sent to the flares is rich in CO_2 and cannot be used as fuel gas for the facility. The heat input of the process gas is so low, supplemental fuel will be mixed with the dehydrator waste streams to bring the heating value of combusted gas up to 300 Btu/scf as required by 40 CFR § 60.18.

The flares are also used for control of emissions from emergency situations and MSS activities. Due to the infrequent MSS activities and the amount of gas sent to the flares, it is technically infeasible to re-route the flare gas to a process fuel system and hence, the gas will be combusted by the flares for control. Therefore, flare gas recovery is not feasible for the control of MSS activities. For this project, flare gas recovery is technically infeasible and has been eliminated from further consideration in the remaining steps of the analysis.

8.2.4. Step 3 - Rank Remaining Control Technologies by Control Effectiveness

XTO will select all remaining feasible control technologies to minimize GHG emissions from the flares as listed in Step 1.

8.2.5. Step 4 - Evaluate Most Effective Control Options

No significant adverse energy or environmental impacts (that would influence the GHG BACT selection process) associated with the above-mentioned technically feasible control options are expected.

8.2.6. Step 5 - Select BACT for the Flare

XTO proposes the following design elements and work practices as BACT for the Flare:

- Low carbon fuel selection;
- Good combustion, operating, and maintenance practices;
- Good flare design; and
- Limited vent gas releases to flare.

The flare will meet the requirements of 40 CFR §60.18, and will be properly instrumented and controlled. Emission sources whose MSS emissions are routed to the flare will be operated in a manner to minimize the frequency and duration of such MSS activities and therefore, the amount of MSS vent gas released to the flare.

9. BACT EVALUATION FOR VAPOR COMBUSTION DEVICE

Emissions from the produced water, slop, and condensate storage tanks, the gunbarrel separator, and truck loading will be routed to a VCD (Unit ECD1). Emissions will be generated by the combustion of natural gas as well as the combustion of the vapors sent to the VCD. The BACT evaluation for the proposed VCD for NO_X, CO, VOC, and GHG (as CO_2e) is provided in Sections 9.1 through 9.5. Appendix A provides a summary of RBLC and permit search results.

9.1. NO_X BACT

9.1.1. Background on Pollutant Formation

The formation of NO_X in the VCD follows the same mechanisms as in engines, turbines, and heaters. Thermal NO_X is the dominant mechanism. Please refer to Section 5.1.1 for a detailed description of NO_X formation.

9.1.2. Identify all Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable NO_X control technologies for flares, which are similar to VCDs, were identified. Table 9-1 outlines the top-down BACT analysis for NO_X emissions from the VCD.

9.1.3. Selection of BACT for NO_X

Based on the review of the RBLC search and other permit review results, XTO has determined that NO_X BACT for the VCD is the permitted emission rate (0.138 lb/MMBtu), which is achievable by utilizing good combustion, operating, and maintenance practices as well as proper fuel selection.

9.2. CO BACT

9.2.1. Background on Pollutant Formation

CO from combustion sources is a by-product of incomplete combustion. Conditions leading to incomplete combustion include insufficient oxygen availability, poor fuel/air mixing, reduced combustion temperature, reduced combustion gas residence time, and load reduction.

9.2.2. Identify all Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable CO control technologies for flares, which are similar to VCDs, were identified. Table 9-1 outlines the top-down BACT analysis for CO emissions from the VCD.

9.2.3. Selection of BACT for CO

Based on the review of the RBLC search and other permit review results, XTO has determined that CO BACT for the VCD is the permitted emission rate (0.2755 lb/MMBtu), which is achievable by utilizing good combustion, operating, and maintenance practices as well as proper fuel selection.

9.3. VOC BACT

9.3.1. Background on Pollutant Formation

The formation of VOC is the result of incompletion combustion from natural gas. VOC results when there is insufficient residence time at high temperature to complete the final step in hydrocarbon oxidation. Additionally, the VCD is a unit that is used to control emissions of VOC from the glycol dehydrator still vent, condensate storage tanks, and truck loading operations. In addition to incomplete combustion emissions, additional emissions of VOC result from the un-destructed portion of these vent streams.

9.3.2. Identify all Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable VOC control technologies for flares, which are similar to VCDs, were identified. Table 9-1 outlines the top-down BACT analysis for VOC emissions from the VCD.

9.3.3. Selection of BACT for VOC

Based on the review of the RBLC search and other permit review results, XTO has determined that VOC BACT for the VCD is the permitted emission rate (0.3966 lb/MMBtu), which is achievable by utilizing good combustion, operating, and maintenance practices as well as proper fuel selection.

9.4. PM_{10}/$PM_{2.5}$ BACT

9.4.1. Background on Pollutant Formation

Filterable PM emissions from combustion are formed by ash and sulfur in the fuel and, in the case of the VCD, in the vent gases. Combustion of natural gas generates low filterable PM emissions in comparison to other fuels due to its low ash and sulfur contents.

9.4.2. Identify all Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable $PM_{2.5}$/PM_{10} control technologies for flares, which are similar to VCDs, were identified. Table 9-1 outlines the top-down BACT analysis for $PM_{2.5}$/PM_{10} emissions from the VCD.

9.4.3. Selection of BACT for PM_{10}/$PM_{2.5}$

Based on the review of the RBLC search and other permit review results, XTO has determined that $PM_{2.5}$/PM_{10} BACT for the VCD is the permitted emission rate, which is achievable by utilizing good combustion, operating, and maintenance practices as well as proper fuel selection.

Table 9-1. BACT Analysis for Vapor Combustion Device – NO_X, CO, VOC, and $PM_{10}/PM_{2.5}$

9.5. GHG BACT

9.5.1. Background on Pollutant Formation

Emissions from the produced water, slop, and condensate storage tanks, gunbarrel separator, and truck loading are routed to a VCD. GHG Emissions will be generated by the combustion of natural gas as well as the combustion of the vapors sent to the VCD.

The available GHG emission control strategies for the VCDs are:

- Carbon Capture and Sequestration;
- Proper Design;
- Low Carbon Fuel Selection; and
- Good Combustion, Operating, and Maintenance Practices.

9.5.1.1. *Carbon Capture and Sequestration*

A detailed discussion of CCS technology is provided in previous sections. The emission units evaluated in this step for the VCD are the burners on the VCD and CO_2 from combustion of the vapors routed to the VCD. The employment of CCS for the emissions from process units that vent through the heaters were deemed technically infeasible as discussed in Section 7.5.3. Therefore, controlling these minimal emissions generated from the VCD are not technically feasible.

9.5.1.2. *Proper Design*

Good VCD design can be employed to destroy any VOCs and CH_4 entrained in the waste gas from the tanks and loading operations. Good VCD design includes flow measurement and monitoring/control of waste gas heating values.

9.5.1.3. *Low Carbon Fuel Selection*

The fuel for firing the proposed VCD will be limited to natural gas fuel. Natural gas has the lowest carbon intensity of any available fuel for the VCD.

9.5.1.4. *Good Combustion, Operating, and Maintenance Practices*

Good combustion and operating practices are a potential control option by improving the fuel efficiency of the VCD. Good combustion practices also include proper maintenance and tune-up of the VCD at least annually per the manufacturer's specifications.

9.5.2. Step 2 - Elimination of Technically Infeasible Control Technologies

As discussed above in Section 7.5.3, the use of CCS is technically infeasible.

9.5.3. Step 3 - Ranking of Remaining Control Technologies

XTO will select all other technically feasible controls to minimize GHG emissions. Therefore, no ranking is necessary.

9.5.4. Step 4 - Evaluation of Most Stringent Controls

No adverse energy, environmental, or economic impacts are associated with the above-mentioned technically feasible control options.

9.5.5. Step 5 - Selection of BACT

Based on the selection of a properly designed VCD, use of pipeline natural gas as fuel, and implementing good combustion practices, XTO proposes a CO_2e BACT limit of 0.25 lb of CO_2e/scf of gas on a rolling 12-month basis.

9.6. VCD BACT SUMMARY

Based on the BACT analysis presented in the preceding subsections, Table 9-2 summarizes the BACT determinations for the VCD.

Table 9-2 VCD BACT Summary

VCD	NO_X, CO, VOC, PM_{10}/$PM_{2.5}$	0.138 (NO_X); 0.2755 (CO); 0.3966 (VOC) (lb/MMBtu)	Good combustor design, good combustion, operating and maintenance practices and use of natural gas
	CO_2e	0.25 lb/scf	Good combustor design, good combustion, operating and maintenance practices and use of natural gas

10. BACT EVALUATION FOR THERMAL OXIDIZERS

Emissions from the proposed amine units will be controlled by thermal oxidizers. The thermal oxidizers (TOs) utilize natural gas as fuel and thus result in combustion emissions from fuel as well as combustion of the vent gases. The BACT evaluation for fuel combustion emissions from the proposed thermal oxidizers (Units TO1 through TO3) for NO_X, CO, VOC, $PM_{10}/PM_{2.5}$, and CO_2e is provided in this section8.1. Appendix A provides a summary of RBLC and permit search results.

10.1. NO_X BACT

10.1.1. Background on Pollutant Formation

The formation of NO_X in thermal oxidizers follows a similar mechanism as in other combustion devices. Please refer to Section 5.1.1 for a detailed description of NO_X formation.

10.1.2. Identify All Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable NO_X control technologies for thermal oxidizers were identified. Table 10-1 outlines the top-down BACT analysis for NO_X emissions from the TOs.

10.1.3. Selection of BACT for NO_x

The most stringent RBLC and permit entries for NO_X control are provided in Appendix A. XTO has determined that the NO_X BACT is utilizing low NO_x burners and good combustion controls with a limit of 30 ppmvd @ 3% O_2.

Table 10-1. BACT Analysis for Thermal Oxidizers – NO_X

10.2. CO BACT

10.2.1. Background on Pollutant Formation

CO from combustion sources is a by-product of incomplete combustion. Conditions leading to incomplete combustion include insufficient oxygen availability, poor fuel/air mixing, reduced combustion temperature, reduced combustion gas residence time, and load reduction.

10.2.2. Identify All Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable CO control technologies for the TOs were identified. Table 10-2 outlines the top-down BACT analysis for CO emissions from the TOs.

10.2.3. Selection of BACT for CO

Based on the review of the RBLC search and other permit review results, XTO has determined that the CO BACT is 50 ppmv at 3% O_2 by utilizing good combustion practices.

Table 10-2. BACT Analysis for Thermal Oxidizers – CO

10.3. VOC BACT

10.3.1. Background on Pollutant Formation

The formation of VOC is the result of incompletion combustion from natural gas. VOC results when there is insufficient residence time at high temperature to complete the final step in hydrocarbon oxidation.

10.3.2. Identify All Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable VOC control technologies for the TOs were identified. Table 10-3 outlines the top-down BACT analysis for VOC emissions from the TOs.

10.3.3. Selection of BACT for VOC

Based on the review of the RBLC search and other permit review results, XTO has determined that the VOC BACT is the permitted emission rate, achievable by utilizing good combustion practices.

Table 10-3. BACT Analysis for Thermal Oxidizers – VOC

10.4. BACT FOR GHG

10.4.1. Background on Pollutant formation

Emissions result from combustion of natural gas as well as amine unit vent gases routed to the thermal oxidizers. The thermal oxidizer is an example of a control device in which the control of certain pollutants causes the formation of collateral GHG emissions. Specifically, the control of CH_4 in the process gas at the TO results in the creation of additional CO_2 emissions via the combustion reaction mechanism. However, given the relative GWPs of CO_2 and CH_4 and the destruction of VOCs and HAPs, it is appropriate to apply combustion controls to CH_4 emissions even though it will form additional CO_2 emissions.

10.4.2. Step 1 - Identify All Available Control Technologies

The available GHG emission control strategies for the thermal oxidizer combustion emissions include:

- Carbon Capture and Sequestration;
- Proper Design;
- Low Carbon Fuel Selection; and
- Good Combustion, Operating, and Maintenance Practices

10.4.2.1. *Carbon Capture and Sequestration*

A detailed discussion of CCS technology is provided in previous sections. The burners, which are the units of interest will have low CO_2 emissions, similar to the heaters.

10.4.2.2. *Proper Design*

Good thermal oxidizer design can be employed to destroy any VOCs and CH_4 entrained in the waste gas from the amine unit. Good thermal oxidizer design includes flow measurement and monitoring/control of waste gas heating values.

10.4.2.3. *Low Carbon Fuel Selection*

The fuel for firing the proposed thermal oxidizers will be limited to natural gas fuel. Natural gas has the lowest carbon intensity of any available fuel for the thermal oxidizers.

10.4.2.4. *Good Combustion, Operating, and Maintenance Practices*

Good combustion and operating practices are a potential control option by improving the fuel efficiency of the thermal oxidizers. Good combustion practices also include proper maintenance and tune-up of the thermal oxidizers at least annually per the manufacturer's specifications.

10.4.3. Step 2 - Eliminate Technically Infeasible Options

As discussed above, the burners are the unit of interest in this section; therefore, the use of CCS is technically infeasible as illustrated in Section 7.5.3 for heaters that use natural gas as fuel. All other control technologies listed in Step 1 are considered technically feasible.

10.4.4. Step 3 - Rank Remaining Control Technologies by Control Effectiveness

XTO will select all feasible control technologies to minimize GHG emissions from the thermal oxidizers.

10.4.5. Step 4 - Evaluate Most Effective Control Options

No significant adverse energy or environmental impacts (that would influence the GHG BACT selection process) associated with the above-mentioned technically feasible control options are expected.

10.4.6. Step 5 - Select BACT for the Thermal Oxidizers

XTO proposes the following design elements and work practices as BACT for the thermal oxidizers:

- Proper Design;
- Low Carbon Fuel Selection (natural gas as fuel); and
- Good combustion, Operating, and Maintenance Practices.

11. BACT EVALUATION FOR PRODUCED WATER STORAGE TANKS

The BACT evaluation for the proposed produced water storage tanks (Units PWTK1 through PWTK2) for VOC is provided in Section 11.1. Appendix A provides a summary of RBLC and permit search results. There are no CH_4 or CO_2 fractions in the produced water; therefore, no GHG BACT is evaluated for this source.

11.1. VOC BACT

11.1.1. Background on Pollutant Formation

VOC emissions from tanks are formed as a result of working and breathing losses. The produced water is processed through a stabilization process before entering the storage tanks. Stabilized produced water has no flashing losses.

11.1.2. Identify all Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable VOC control technologies were identified based on the principles of control technology and engineering experience for storage tanks. Table 11-1 outlines the top-down BACT analysis for VOC emissions from the produced water storage tanks.

11.1.3. Selection of BACT for VOC

The most stringent RBLC and permit entries for VOC control are provided in Appendix A. XTO has determined that VOC BACT is utilizing a VCD with 99% efficiency for the produced water storage tanks.

Table 11-1. BACT Analysis for Produced Water Storage Tanks – VOC

12. BACT EVALUATION FOR SLOP STORAGE TANK

The BACT evaluation for the proposed slop storage tank (Unit OTK7) for VOC is provided in Section 12.1. Appendix A provides a summary of RBLC and permit search results. There are no CH_4 or CO_2 fractions in the slop tank; therefore, no GHG BACT is evaluated for this source.

12.1. VOC BACT

12.1.1. Background on Pollutant Formation

VOC emissions from tanks are formed as a result of working and breathing losses. The slop is processed through a stabilization process before entering the storage tanks. Stabilized slop has no flashing losses.

12.1.2. Identify all Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable VOC control technologies were identified based on the principles of control technology and engineering experience for storage tanks. Table 12-1 outlines the top-down BACT analysis for VOC emissions from storage tanks.

12.1.3. Selection of BACT for VOC

The most stringent RBLC and permit entries for VOC control are provided in Appendix A. XTO has determined that VOC BACT is utilizing a VCD with 99% efficiency for the slop storage tank.

Table 12-1. BACT Analysis for Slop Storage Tank – VOC

13. BACT EVALUATION FOR CONDENSATE STORAGE TANKS

The BACT evaluation for the proposed condensate storage tanks (Units OTK1 through OTK6) for VOC is provided in Section 13.1 Appendix A provides a summary of RBLC and permit search results. There are no CH_4 or CO_2 fractions in the stabilized condensate; therefore, no GHG BACT is evaluated for this source.

13.1. VOC BACT

13.1.1. Background on Pollutant Formation

VOC emissions in tanks are formed as a result of working and breathing losses. The condensate is processed through a stabilization process before entering the storage tanks. Stabilized condensate has no flashing losses.

13.1.2. Identify all Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable VOC control technologies were identified based on the principles of control technology and engineering experience for storage tanks. Table 13-1 outlines the top-down BACT analysis for VOC emissions from storage tanks.

13.1.3. Selection of BACT for VOC

The most stringent RBLC and permit entries for VOC control are provided in Appendix A. XTO has determined that VOC BACT is utilizing a VCD with 99% efficiency for the condensate storage tanks.

Table 13-1. BACT Analysis for Condensate Storage Tanks – VOC

14. BACT EVALUATION FOR GUNBARREL SEPARATOR

The BACT evaluation for the proposed gunbarrel separator (Unit GBS1) for VOC is provided in Section 14.1. Appendix A provides a summary of RBLC and permit search results. There are no CH_4 or CO_2 fractions in the gunbarrel; therefore, no GHG BACT is evaluated for this source.

14.1. VOC BACT

14.1.1. Background on Pollutant Formation

VOC emissions in the gunbarrel separate are formed as a result of working and breathing losses. The product is processed through a stabilization process before entering the separator. The stabilized product has no flashing losses.

14.1.2. Identify all Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable VOC control technologies were identified based on the principles of control technology and engineering experience for separators. Table 14-1 outlines the top-down BACT analysis for VOC emissions from the gunbarrel separator.

14.1.3. Selection of BACT for VOC

The most stringent RBLC and permit entries for VOC control are provided in Appendix A. XTO has determined that the VOC BACT is utilizing a VCD with 99% efficiency for the gunbarrel separator.

Table 14-1. BACT Analysis for Gunbarrel Separator – VOC

15. BACT EVALUATION FOR INTERNAL FLOATING ROOF (IFR) TANKS

The BACT evaluation for the proposed IFR storage tanks (Units IFR1 through IFR4) for VOC is provided in Section 15.1. Appendix A provides a summary of RBLC and permit search results. There are no CH_4 or CO_2 fractions in the stabilized product; therefore, no GHG BACT is evaluated for this source.

15.1. VOC BACT

15.1.1. Background on Pollutant Formation

VOC emissions from tanks are formed as a result of working and breathing losses. The product is processed through a stabilization process before entering the storage tanks. The stabilized product has no flashing losses.

15.1.2. Identify all Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable VOC control technologies were identified based on the principles of control technology and engineering experience for storage tanks. Table 15-1 outlines the top-down BACT analysis for VOC emissions from storage tanks.

15.1.3. Selection of BACT for VOC

The most stringent RBLC and permit entries for VOC control are provided in Appendix A. XTO has determined that the VOC BACT is utilizing white or aluminum tanks with drain dry design, storing liquids with a TVP less than 11 psia, and utilizing primary and secondary seals for routine operations. Tank cleanings and landings for IFR tanks are considered in Section 17.1.

Table 15-1. BACT Analysis for IFR Tanks – VOC

16. BACT EVALUATION FOR FIXED ROOF TANK CLEANINGS

The BACT evaluation for the proposed fixed roof tank cleaning events (Unit SSM) for VOC is provided in Section 16.1. Appendix A provides a summary of RBLC and permit search results. No GHG BACT is evaluated for this source.

16.1. VOC BACT

16.1.1. Background on Pollutant Formation

VOC emissions are released during tank cleaning events as emissions are vented to the atmosphere during these maintenance activities.

16.1.2. Identify all Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable VOC control technologies were identified based on the principles of control technology and engineering experience for storage tanks. Table 11-1 outlines the top-down BACT analysis for VOC emissions during cleaning events from the fixed roof storage tanks.

16.1.3. Selection of BACT for VOC

The most stringent RBLC and permit entries for VOC control are provided in Appendix A. XTO has determined that VOC BACT is limiting the number of tank cleanings per any 12 consecutive month period to reduce emissions vented to the atmosphere.

Table 16-1. BACT Analysis for Fixed Roof Tank Cleanings – VOC

17. BACT EVALUATION FOR IFR TANK CLEANINGS AND LANDINGS

The BACT evaluation for the proposed IFR Tank cleanings and landings (Unit SSM) for VOC is provided in Section 17.1. Appendix A provides a summary of RBLC and permit search results. No GHG BACT is evaluated for this source.

17.1. VOC BACT

17.1.1. Background on Pollutant Formation

VOC emissions are formed during IFR landing and tank cleaning activities as emissions are released to the atmosphere.

17.1.2. Identify all Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable VOC control technologies were identified based on the principles of control technology and engineering experience for IFR tanks. Table 17-1 outlines the top-down BACT analysis for VOC emissions from maintenance events associated with the IFR tanks.

17.1.3. Selection of BACT for VOC

The most stringent RBLC and permit entries for VOC control are provided in Appendix A. XTO has determined that the VOC BACT is limiting the number of roof landings and tank cleanings per any 12 consecutive month period to reduce emissions vented to the atmosphere.

Table 17-1. BACT Analysis for IFR Tank Cleanings and Landings – VOC

18. BACT EVALUATION FOR TRUCK UNLOADING OF CONDENSATE

The BACT evaluation for the proposed condensate truck unloading for VOC is provided in Section 18.1. Appendix A provides a summary of RBLC and permit search results. There are no CH_4 or CO_2 fractions in the stabilized condensate; therefore, no GHG BACT is evaluated for this source.

18.1. VOC BACT

18.1.1. Background on Pollutant Formation

VOC emissions are formed as a result of evaporative losses of the condensate during unloading into tanks.

18.1.2. Identify all Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable VOC control technologies were identified based on the principles of control technology and engineering experience for unloading operations. Table 18-1 outlines the top-down BACT analysis for VOC emissions from truck unloading.

18.1.3. Selection of BACT for VOC

The most stringent RBLC and permit entries for VOC control are provided in Appendix A. XTO has chosen to use a VCD for VOC BACT with 99% efficiency for the unloading operations.

Table 18-1. BACT Analysis for Truck Unloading of Condensate – VOC

19. BACT EVALUATION FOR PRODUCED WATER AND SLOP LOADING

The BACT evaluation for the proposed produced water truck loading (Units PWTL and OTL) for VOC is provided in Section 19.1. Appendix A provides a summary of RBLC and permit search results. There are no CH_4 or CO_2 fractions in the stabilized product; therefore, no GHG BACT is evaluated for this source.

19.1. VOC BACT

19.1.1. Background on Pollutant Formation

VOC emissions are formed as a result of evaporative losses of the produced water and slop during loading on to trucks.

19.1.2. Identify all Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable VOC control technologies were identified based on the principles of control technology and engineering experience for loading operations. Table 19-1 outlines the top-down BACT analysis for VOC emissions from truck loading.

19.1.3. Selection of BACT for VOC

The most stringent RBLC and permit entries for VOC control are provided in Appendix A. XTO has chosen to use a VCD for VOC BACT with 99% efficiency for the loading operations.

Table 19-1. BACT Analysis for Produced Water and Slop Truck Loading – VOC

20.1. BACT FOR VOC AND GHG

The following sections present a BACT evaluation of fugitive VOC and GHG (CO_2 and CH_4) emissions (Unit FUG). It is anticipated that the fugitive emission controls presented in this analysis will provide similar levels of emission reduction for VOC, CO_2, and CH_4. Fugitive components included in the proposed facility include traditional components such as valves and flanges.

20.1.1. Step 1 - Identify All Available Control Technologies

In determining whether a technology is available for controlling VOC and GHG emissions from fugitive components, permits, permit applications, and EPA's RBLC were consulted. Based on these resources, the following available control technologies were identified and are discussed below:

- Installing leakless technology components to eliminate fugitive emission sources;
- Implementing various LDAR programs in accordance with applicable state and federal air regulations;
- Implementing an alternative monitoring program using a remote sensing technology such as infrared camera monitoring;
- Implementing an audio/visual/olfactory (AVO) monitoring program for odorous compounds; and
- Designing and constructing facilities with high quality components and materials of construction compatible with the process.

20.1.1.1. *Leakless Technology Components*

Leakless technology valves are available and currently in use, primarily where highly toxic or otherwise hazardous materials are used. These technologies are generally considered cost prohibitive except for specialized service. Some leakless technologies, such as bellows valves, if they fail, cannot be repaired without a unit shutdown, which often generates additional emissions.

20.1.1.2. *LDAR Programs*

LDAR programs have traditionally been implemented for the control of VOC emissions. BACT determinations related to control of VOC emissions rely on technical feasibility, economic reasonableness, reduction of potential environmental impacts, and regulatory requirements for these instrumented programs. Monitoring direct emissions of CO_2 is not feasible with the normally used instrumentation for fugitive emissions monitoring. However, instrumented monitoring is technically feasible for components in CH_4 service.

20.1.1.3. *Alternative Monitoring Program*

Alternate monitoring programs such as remote sensing technologies have been proven effective in leak detection and repair. The use of sensitive infrared camera technology has become widely accepted as a cost-effective means for identifying leaks of hydrocarbons.

20.1.1.4. *AVO Monitoring Program*

Leaking fugitive components can be identified through AVO methods. The gases and process fluids in the piping components are expected to have discernable odor, making them detectable by olfactory means. A large leak can be detected by sound (audio) and sight. The visual detection can be a direct viewing of leaking gases or a secondary indicator such as condensation around a leaking source due to cooling of the expanding gas as it leaves the leak interface. AVO programs are commonplace in the industry.

20.1.1.5. *High Quality Components*

A key element in the control of fugitive emissions is the use of high-quality equipment that is designed for the specific service in which it is employed. For example, a valve that has been manufactured under high quality conditions can be expected to have lower runout on the valve stem, and the valve stem is typically polished to a smoother surface. Both of these factors greatly reduce the likelihood of leaking.

20.1.2. Step 2 - Eliminate Technically Infeasible Options

Recognizing that leakless technologies have not been universally adopted as LAER or BACT, even for toxic or extremely hazardous services, it is reasonable to state that these technologies are impractical for control of VOC and GHG emissions whose impacts have not been quantified. Any further consideration of available leakless technologies for VOC and GHG controls is unwarranted.

All other control options are considered technically feasible.

20.1.3. Step 3 - Rank Remaining Control Technologies by Control Effectiveness

20.1.3.1. *LDAR Programs*

Instrumented monitoring is effective for identifying leaking VOC and CH_4, but may be wholly ineffective for finding leaks of CO_2. With CH_4 having a global warming potential greater than CO_2, instrumented monitoring of the fuel and feed systems for CH_4 would be an effective method for control of GHG emissions. Quarterly instrumented monitoring with a leak definition of 500 ppmv (2,000 ppmv for pumps and compressors), accompanied by intense directed maintenance, is generally assigned a control effectiveness of 97% (85% for pumps and compressors).[46]

20.1.3.2. *Alternative Monitoring Program*

Remote sensing using infrared imaging has proven effective for identification of leaks, including leaks of CO_2. The process has been the subject of EPA rulemaking as an alternative monitoring method to the EPA's Method 21. Effectiveness is likely comparable to EPA Method 21 when cost is included in the consideration.

20.1.3.3. *AVO Monitoring Program*

Audio/Visual/Olfactory means of identifying leaks owes its effectiveness to the frequency of observation opportunities. Those opportunities arise as operating technicians make rounds, inspecting equipment during those routine tours of the operating areas. This method cannot generally identify leaks at a low leak rates as instrumented reading can identify; however, low leak rates have lower potential impacts than do larger leaks. This method, due to frequency of observation is effective for identification of larger leaks.

20.1.3.4. *High Quality Components*

Use of high-quality components is effective in preventing emissions of VOC and GHG relative to use of lower quality components.

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[46] TCEQ published BACT guidelines for fugitive emissions in the document *Air Permit Technical Guidance for Chemical Sources: Equipment Leak Fugitives*, October 2000.

20.1.4. Step 4 - Evaluate Most Effective Control Options

No adverse energy, environmental, or economic impacts are associated with the above-mentioned technically feasible control options.

20.1.5. Step 5 - Select BACT for Fugitive Emissions

Monitoring will be conducted at the facility following the protocol established in 40 CFR 60 Subpart OOOOa. Any leaks discovered will be repaired as quickly as practical. The selected BACT for the fugitives was compared to the RBLC results. Several facilities proposed implementation of LDAR as BACT for fugitive emissions.

Since XTO is implementing the most effective control options available, additional analysis is not necessary. In addition, because fugitive VOC and GHG emissions are estimations only, XTO proposes no numerical BACT limit; but rather proposes to comply with the LDAR provisions detailed in 40 CFR 60 Subpart OOOOa.

Table 20-1. BACT Analysis for Fugitive Emissions – VOC and GHG

21. BACT EVALUATION FOR AMINE UNIT STILL VENTS

The BACT evaluation for the proposed amine unit still vents (Units AU1 through AU3) is provided in this section. Appendix A provides a summary of RBLC and permit search results.

21.1. VOC BACT

21.1.1. Background on Pollutant Formation

VOC emissions are formed as a result of removal of acidic contaminants from natural gas.

21.1.2. Step 1- Identify all Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable VOC control technologies were identified based on the principles of control technology and engineering experience for amine units. The available emission control options include:

- Best Practices; and
- Catalytic or thermal oxidation.

21.1.2.1. *Best Practices*

Best practices involve ensuring the amine system is maintained and operating with operational specifications.

21.1.2.2. *Operation and maintenance of the equipment in accordance with good air pollution control practices results in less VOC emissions. Thermal Incineration*

A high temperature control device is utilized for disposing the waste gas streams. This control option offers 99% control of VOC emissions.

21.1.3. Step 2 - Eliminate Technically Infeasible Options

The options in Step 1 are considered technically feasible for the amine unit still vents.

21.1.4. Step 3 - Rank the technically feasible control technologies by control effectiveness

Best practices is the base case. Thermal incineration provides 99% overall control technology and is technically feasible for this site.

21.1.5. Step 4 - Evaluate most effective controls

Thermal incineration results in 99% destruction efficiency of VOC and is selected as BACT.

21.1.6. Step 5 - Select BACT

XTO proposes thermal incineration as the control mechanism for the amine unit still vent stream. By controlling the acid gases from this stream, the VOC will also be controlled 99%.

21.2. GHG BACT

21.2.1. Background on Pollutant Formation

The amine units will be used to absorb CO_2 from a fractionated ethane gas stream to produce a treated gas stream with lower CO_2 content. Because the amine units are designed to remove CO_2 from the fractionated gas stream, the generation of CO_2 is inherent to the process, and a reduction of the CO_2 emissions by process changes would reduce the process efficiency. This would result in more CO_2 in the ethane and natural gas liquids that would eventually be emitted.

21.2.2. Step 1 - Identify all Available Control Technologies

The available GHG emission control options for the process emissions include:

- Carbon Capture and Sequestration;
- Flare;
- Thermal Oxidizer;
- Condenser;
- Proper Design and Operations; and
- Use of Tank Flash Gas Recovery System.

21.2.2.1. *Carbon Capture and Sequestration*

As CO_2 separation is one of the primary objectives of the amine unit, the amine regeneration unit produces a gas stream with a high CO_2 content. Accordingly, CCS is one possible option for control of GHG emissions from the amine regeneration unit. CCS has been shown to have a CO_2 control efficiency between 80-90%.

An effective CCS system would require three elements:

- Separation technology for the CO_2 exhaust stream (i.e., "carbon capture" technology),
- Transportation of CO_2 to a storage site, and
- A viable location for long-term storage of CO_2.

These three elements work in series. To execute a CCS program as BACT, all three elements must be available for this project. Geological sequestration of CO_2 can be achieved by one of three methods: (1) a well dedicated to CCS (i.e., a Class VI well) can be drilled and permitted, or (2) CO_2 can be used in Enhanced Oil Recovery (EOR) projects, or (3) CO_2 and other acid gases can be injected in an acid gas injection (AGI) Class II well.

<u>CCS and Class VI wells:</u>

XTO conducted research and analysis to determine the technical feasibility of CO_2 capture and transfer. Since most of the CO_2 emissions from the proposed project are generated from the amine unit, XTO evaluated potential options to capture and transfer the CO_2 from the amine unit still vent to an off-site facility for injection. The CO_2 portion of the amine unit still vent stream will need to be separated from the other components such as VOC from the stream in order to be routed to a CO_2 transfer pipeline.

Class VI wells are wells used for injection of CO_2 into underground subsurface rock formations for long-term storage. A Class VI well requires monitoring and testing to ensure the well is constructed and operated appropriately. The permitting requirements for Class VI wells are listed under 40 CFR 146 Subpart H promulgated pursuant to the Safe Drinking Water Act. The wells are designed to sequester only CO_2, and the requirements for these wells are considerable including the submittal of five specific project plans including the area of review and correction action, testing and monitoring, injection well plugging, post-injection site care and closure, and emergency and remedial response.[47]

Based on the results of these studies, capture and transfer of CO_2 from the amine treatment unit is technically feasible assuming that a Class VI well is available for injection of CO_2. In order to satisfy BACT requirements, this option is further evaluated for energy, environmental, and economic impacts assuming a Class VI injection well is available.

Enhanced Oil Recovery:

EOR technology enhances oil recovery rates by re-injecting CO_2 and hydrocarbon gases recovered from the well (and CO_2 from external sources, as needed) into the geologic formation to maintain well pressure. This technology also requires separation of CO_2 from the other components of the amine unit still vent such as VOC, which would require subsequent treatment prior to being released. CO_2 is a good choice for EOR because CO_2 is partially miscible in oil and lowers the viscosity and surface tension of the fluid for easy displacement.[48] EOR is designed to maintain pressure in an active well, rather than for the long-term sequestration of CO_2. Consequently, EOR projects are not designed with the same considerations for permanent CO_2 sequestration when compared to Class VI wells intended specifically for CCS.

Acid Gas Injection and Class II Wells:

XTO is assessing a third form of capture that can be achieved by AGI wells, specifically dry gas injection systems. AGI stores the acid gas in an isolated subsurface reservoir (Class II wells) that are regulated by New Mexico's Oil Conservation District pursuant to the New Mexico Administrative Code (NMAC) 19.15.26. There are a number of Class II injection wells in New Mexico that have been installed for H_2S injection.[49] However, no wells have been installed for CO_2-only injection. As opposed to Class VI wells that are specific to CO_2 injection, Class II wells are intended for all oil and gas related fluid injection. Specifically, acid gas injection wells are designed to accept CO_2 as well as other acid gases from sour gas processing streams, such as the amine still vent stream at the proposed Husky Plant. The additional processing required for injection into a Class VI well with regards to separating out the CO_2 portion is not required for a Class II well, which saves energy as well as reduces other pollutants such as VOC associated with the emission source.

The ideal reservoir for AGI wells should be located in areas that cannot be compromised by future exploration of oil and gas resources and are far enough below any potable water sources. Reliability of the sequestration depends on natural geologic features of the chosen reservoir such as faulting or fracturing that could allow the acid gas to escape from the reservoir.[50]

Since capture and transfer of CO_2 for off-site transfer is technically feasible for the proposed project, this option is further evaluated for energy, environmental, and economic impacts, in Section 21.2.5.1.

21.2.2.2. *Flare*

One option to reduce the GHGs emitted from the Husky Plant is to send stripped amine acid gases to a flare. The flare is an example of a control device in which the control of certain pollutants causes the formation of collateral GHG emissions. Controlling the amine vent streams with a flare would also require supplemental fuel to increase the heating value of the gas to the point that it can be effectively combusted in a flare at 300 Btu/ft^3.

[47] EPA Underground Injection Control Geologic Sequestration Rule Training Workshop: UIC GS Rule Elements http://water.epa.gov/type/groundwater/uic/class6/upload/module03permitinfo.pdf
[48] James P. Meyer PhD American Petroleum Institute, "Summary of Carbon Dioxide Enhanced Oil Recovery (CO_2 EOR) Injection Well Technology.
[49] http://water.epa.gov/type/groundwater/uic/upload/UIC-Well-Inventory_2010-2.pdf
[50] Dr. David T. Lescinsky. Acid Gas Injection in the Permian and San Juan Basins: Recent Case Studies from New Mexico. Chapter 1. August 31, 2010

This has collateral CO_2 and CH_4 emissions from the additional combustion of the fuel gas. However, given the relative GWPs of CO_2 and CH_4 and the destruction of VOCs and HAPs, it is appropriate to apply combustion controls to CH_4 emissions even though it will form additional CO_2 emissions. In general, flares have a destruction efficiency rate (DRE) of 98%, resulting in minor CH_4 emissions from the process flare due to incomplete combustion of CH_4. Additionally, the flare requires the use of a continuous pilot ignition system or equivalent that results in additional GHG emissions.

21.2.2.3. *Thermal Oxidizer*

Another option to reduce the GHGs emitted from the Husky Plant is to send stripped amine acid gases to a thermal oxidizer (TO). The TO is an example of a control device in which the control of certain pollutants causes the formation of collateral GHG emissions, the control of CH_4 in the process gas at the TO results in the creation of additional CO_2 emissions via the combustion reaction mechanism. However, given the relative GWPs of CO_2 and CH_4 and the destruction of VOCs and HAPs, it is appropriate to apply combustion controls to CH_4 emissions even though it will form additional CO_2 emissions. In general, TOs have a destruction efficiency rate (DRE) greater than of 99%, resulting in minor CH_4 emissions from the process flare due to incomplete combustion of CH_4.

21.2.2.4. *Condenser*

Condensers provide supplemental emissions control by reducing the temperature of the still column vent vapors on amine units to condense water and VOCs, including CH_4. The condensed liquids are then collected for further treatment or disposal. The reduction efficiency of the condensers is variable and depends on the type of condenser and the composition of the waste gas, ranging from 50-98% of the CH_4 emissions in the waste gas stream.

21.2.2.5. *Proper Design and Operations*

The amine units will be new equipment installed on site. New equipment has better energy efficiency, hence reducing the GHGs emitted during combustion. The new equipment will operate at a minimum circulation rate with consistent amine concentrations. By minimizing the circulation rate, the equipment avoids pulling out additional VOCs and GHGs in amine streams, which would increase VOC and GHG emissions into the atmosphere.

21.2.2.6. *Use of Tank Flash Gas Recovery Systems*

The amine units will be equipped with flash tanks. The flash tanks will be used to recycle off-gases formed as the pressure of the rich glycol/rich amine streams drops to remove lighter compounds in the stream prior to entering the reboiler. These off-gases are recycled back into the plant for reprocessing, instead of venting to the atmosphere or combustion device. The use of flash tanks increases the effectiveness of other downstream control devices.

21.2.3. **Step 2 - Eliminate Technically Infeasible Options**

All above options are considered technically feasible for the amine unit still vents.

21.2.4. **Step 3 - Rank the technically feasible control technologies by control effectiveness**

The control options for minimizing GHG emissions from the amine units are ranked below:

Table 21-1. GHG Reduction Efficiencies and Ranking

Rank	Control Technology	Estimated CO_2e Reduction	Reduction Details	Reference
1	Carbon Capture and Sequestration	80%	Reduction of all GHGs.	Available and Emerging Technologies for Reducing Greenhouse Gas Emissions from the Petroleum Refining Industry issued by EPA October 2010 Section 5.1.4 Carbon Capture. *(Also noted that industrial application of this technology is not expected to be available for 10 years.)*
2	Proper Design and Operation	1% - 10%	Reduction of all GHGs.	Available and Emerging Technologies for Reducing Greenhouse Gas Emissions from the Petroleum Refining Industry issued by EPA October 2010 Section 5.1.1.5 Improved Maintenance
3	Condenser	50-98% for CH_4	Reduction of CH_4 in acid gas	
4	Use of Tank Flash Gas Recovery Systems	< 0.25%	Reduction of CH_4 in flash gas only.	Hard piped back into the system
5	Thermal Oxidizer	--	Reduction in acid gas CH_4. Increase in CO_2 due to acid gas combustion and supplemental fuel	Vendor Data
6	Flare	--	Reduction in acid gas CH_4. Increase in CO_2 due to acid gas, supplemental fuel, and pilot gas combustion.	http://www.tceq.texas.gov/permitting/air/guidance/newsourcereview/flares/

21.2.5. Step 4 - Evaluate most effective controls

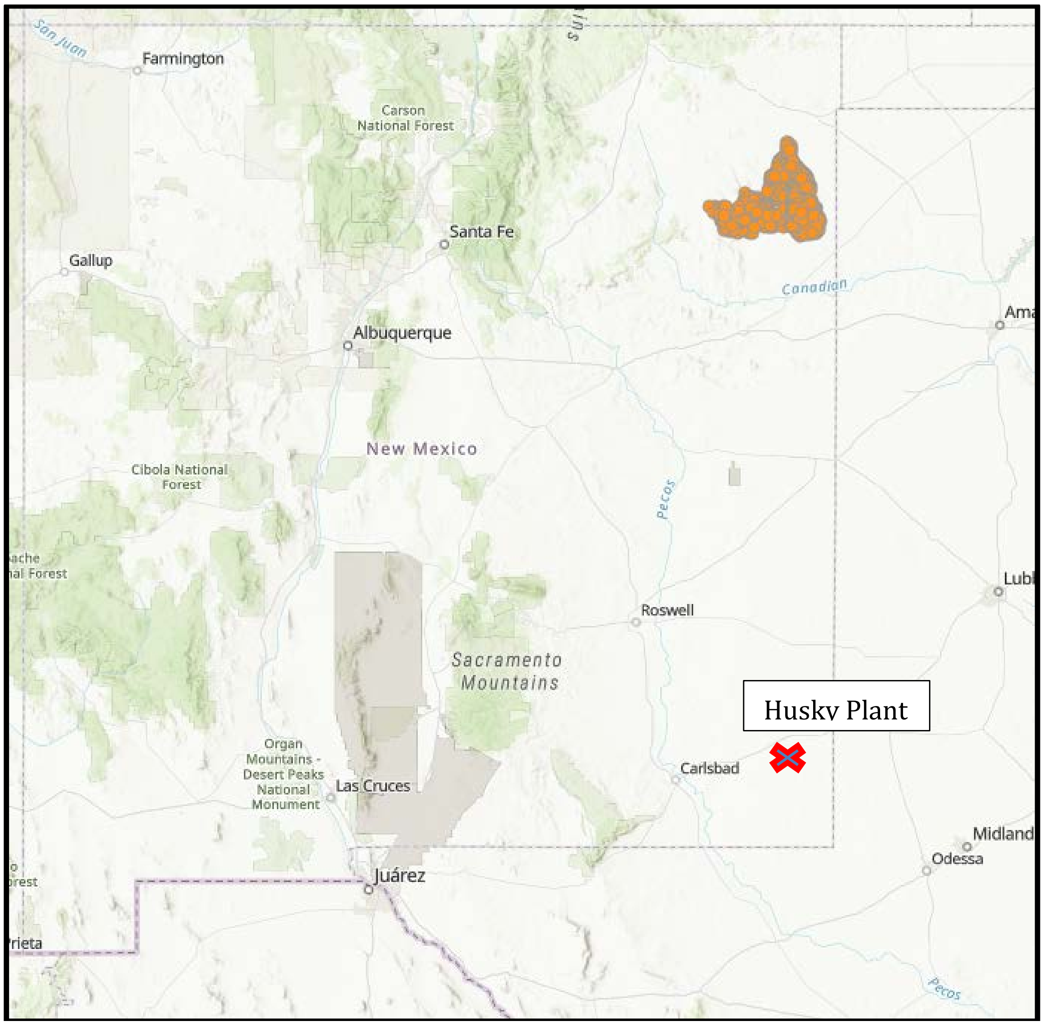
The only option that is technically feasible, but could have a significant adverse energy or environmental impacts (that would influence the GHG BACT selection process) is the use of CCS as discussed below. All other control technologies listed in Step 1 are considered technically feasible with no significant adverse energy or environmental impacts (that would influence the GHG BACT selection process).

21.2.5.1. *Carbon Capture and Sequestration*

While the amine acid gas stream routed to the TO is relatively high in CO_2 content, additional processing of the exhaust gas will be required to implement CCS. These include separation (removal of other pollutants from the combustion gases), capture, and compression of CO_2, transfer of the CO_2 stream and sequestration of the CO_2 stream. These processes require additional equipment to reduce the exhaust temperature, compress the gas, and transport the gas via pipelines. These units would require additional electricity and generate additional air emissions, of both criteria pollutants and GHG pollutants. This would result in negative environmental and energy impacts.

As part of the CO_2 transfer feasibility analysis, XTO reviewed currently active CO_2 injection wells identified on the ArcGIS website, which was compiled by the New Mexico Energy, Minerals, and Natural Resources Department.[51] This website provides the details of oil, gas, and CO_2 production wells as well as injection and salt water disposal wells in the State of New Mexico. Most of the wells are permitted to inject saltwater and not permitted for CO_2 injection. Therefore, XTO refined that search to identify CO_2 injection wells. Figure 21-1 shows a map of the location of the Husky Plant and the CO_2 injection wells, that are active. The nearest active CO_2 wells, operated by OXY USA Inc (Bravo Dome), are located approximately 200 miles from the proposed Husky Plant.[52]

Figure 21-1. Map of Husky Plant and Nearest CO_2 Injection Wells

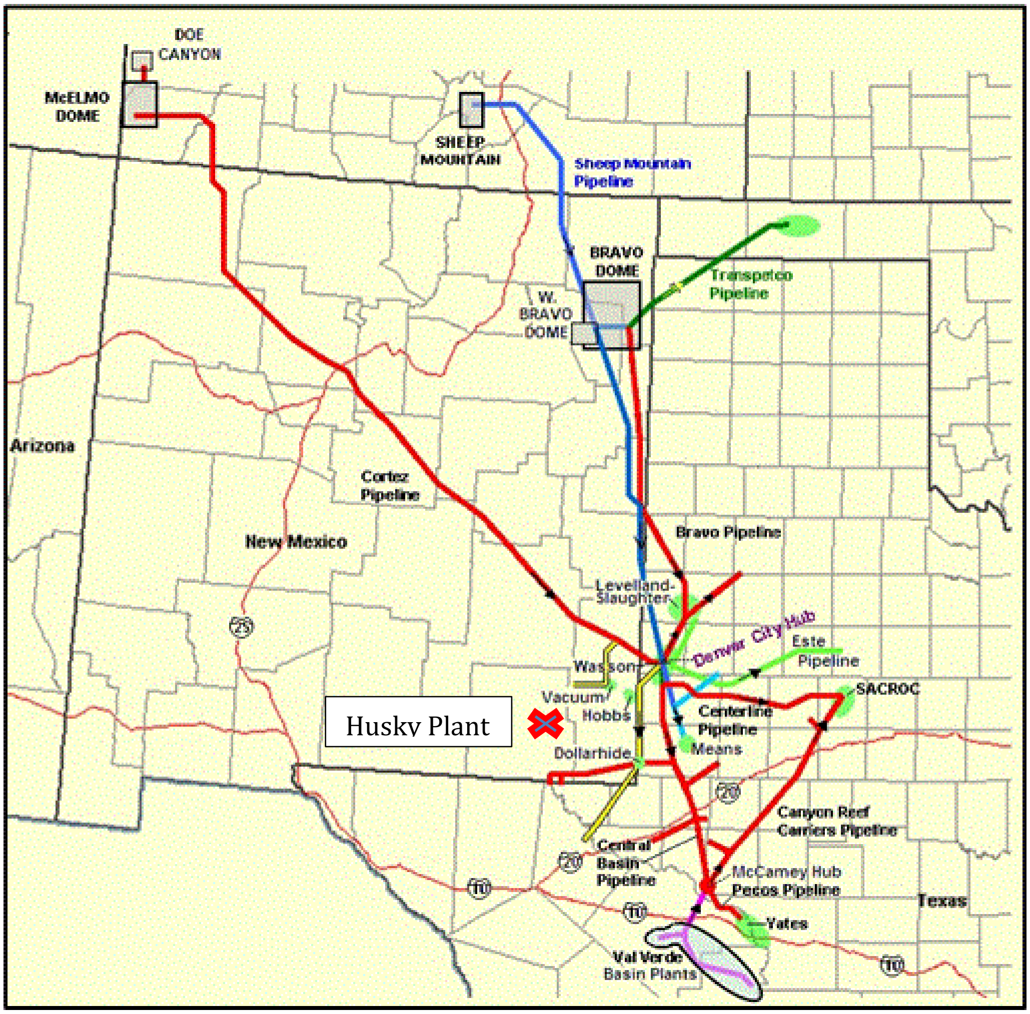


[51] Energy Production Wells, New Mexico, 2018 - NM_Wells_District_All_UTM_NAD83_Z13_SHP, available at: https://www.arcgis.com/home/item.html?id=8381d83488c749e19a20412ebc08edd1

[52] https://wwwapps.emnrd.state.nm.us/ocd/ocdpermitting/Data/WellDetails.aspx?api=30-021-20428

In addition, XTO reviewed CO_2 transfer pipelines available to transfer CO_2 to a nearby pipeline for EOR. An exhibit from the National Energy Technology Laboratory (NETL)'s publication "A Review of the CO_2 Pipeline Infrastructure in the U.S.", dated April 21, 2015 (DOE/NETL-2014/1681) shows the CO_2 pipelines in the Permian Basin. This is included in Figure 21-2 below.

Figure 21-2. CO_2 Pipelines in Permian Basin



The closest pipeline is approximately 29 miles, located on the south of the Husky Plant (near Texas and New Mexico border). Therefore, XTO estimated the cost of pipeline installation and operation to transfer the CO_2 from the Amine Vents. These costs were obtained from the National Energy Technology Laboratory (NETL)'s Document Quality Guidelines for Energy System Studies Estimating Carbon Dioxide Transport and Storage Costs DOE/NETL-2010/1447, dated March 2010.[53] Per this document, the pipeline costs include pipeline installation costs, other related capital costs, and operation and maintenance (O&M) costs.

[53] Quality Guidelines for Energy System Studies Estimating Carbon Dioxide Transport and Storage Costs DOE/NETL-2010/1447

Based on the total CO_2 emissions from the Amine Units, a 90% capture efficiency for CCS, and pipeline distance of 29 miles, the estimated cost of CO_2 pipeline installation and operation cost is $18.18 per ton of CO_2 removed, which is economically not viable. As such, XTO contends that CCS is an economically infeasible control technology option and eliminates CCS from further review under this BACT analysis. The cost analysis is provided at the end of this section.

Therefore, based on the comparison between the pipeline transfer cost and the project's annualized cost, although technically feasible, off-site transfer is not regarded as a viable or economically feasible CO_2 control option. Additionally, CO_2 capture and transfer would have negative environmental and energy impacts, as discussed above.

21.2.6. Step 5 - Select BACT

XTO proposes the use of thermal incineration, condensers, flash gas recovery, and proper design and operation as BACT for the amine units.

This section presents the BACT analysis for haul roads (Unit ROAD). Haul roads include roads where trucks travel either to unload condensate or load produced water and/or slop.

22.1.1. Background on Pollutant Formation

Haul roads have the potential to generate dust particles as vehicles traveling on the roads cause particles on the surface of the roads to become suspended in the atmosphere. The particle loading of the road surfaces is an indicator of the potential for vehicles traveling on the roads to generate these suspended dust particles. Unpaved haul roads have a higher potential for particle loading than paved haul roads, as vehicles traveling on unpaved roads can cause pulverization of the unpaved road surface, and the pulverized material contributes to the particle loading of the road.

The dust particles that are generated as vehicles travel on haul roads are filterable particulate matter. Therefore, the BACT evaluation for the haul roads addresses filterable particulate matter. The BACT analysis has been evaluated using the top down approach as shown in Table 22-1 .

22.1.2. Step 1 - Identify all Available Control Technologies

Control options for haul roads are designed to suppress or eliminate road dust. PM reduction options from haul roads include:

- Speed reduction and base course;
- Water application; and
- Paving.

22.1.3. Step 2 - Eliminate Technically Infeasible Options

Paving of roads is not feasible for industrial roads subject to very heavy vehicles. In addition, water application/sweeping is not technically feasible based on the very limited availability of water in the facility's proposed location as well as meteorological and climatological conditions at the proposed facility. Speed reduction and base course are the only technically feasible options remaining for control of PM from haul roads at Husky CDP.

22.1.4. Step 3 - Rank Remaining Control Technologies by Control Effectiveness

Speed reduction and base course are the remaining control technologies for reducing particulate matter from the surface of the roads.

22.1.5. Step 4 - Evaluate Most Effective Control Options

The particulate emissions from the haul roads are less than 5% of facility-wide PM totals. The impacts from this source are a small fraction of the proposed facility. Limiting the speed at the facility to 15 mph provides 57% control and base course provides a 60% reduction.[54] XTO has determined that these control options are sufficient for the low-emission source.

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[54] WRAP Fugitive Dust Handbook, Fugitive Dust Control Measures Applicable for the WRAP Region (September 7, 2006).

22.1.6. Step 5 - Select BACT for Haul Roads

XTO proposes to limit the speed of haul trucks to 15 mph by posting speed limit signs at regular intervals along the haul road. XTO will also apply an aggregate base course. These controls will result in a 57% and 60% control of the particulate matter emissions respectively.

Table 22-1. BACT Analysis for Haul Road Emissions – PM_{10}/$PM_{2.5}$

23. BACT EVALUATION FOR SSM ACTIVITIES

The BACT evaluation for the proposed SSM activities (Unit SSM) for VOC is provided in Section 23.1. Appendix A provides a summary of RBLC and permit search results. No GHG BACT is evaluated for the SSM activities.

23.1. VOC BACT

23.1.1. Background on Pollutant Formation

VOC emissions are formed as a result of startup, shutdown, and maintenance activities such as during plant turnarounds, pigging, purging, and other maintenance.

23.1.2. Identify all Available Control Technologies

Using the RBLC search and permit review results, as well as a review of technical literature, potentially applicable VOC control technologies were identified based on the principles of control technology and engineering experience for SSM activities. Table 23-1 outlines the top-down BACT analysis for VOC emissions from SSM activities.

23.1.3. Selection of BACT for VOC

The most stringent RBLC and permit entries for VOC control are provided in Appendix A. XTO has chosen to send SSM emissions to a flare for VOC BACT with a 98% DRE during plant turnarounds and will implement best practices for pigging, purging, and other maintenance activities.

Table 23-1. BACT Analysis for SSM Activities – VOC

APPENDIX A. RBLC TABLES