ExxonMobil Chemical Company
Mont Belvieu Plastics Plant
13330 Hatcherville Road
Mont Belvieu, Texas 77580-9532

ExxonMobil
Chemical

November 9, 2012

Mr. Carl Edlund, P.E.
Multimedia Planning and Permitting Division
United States Environmental Protection Agency Region 6
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733

Response to July 25, 2012
Completeness Determination Letter
Mount Belvieu Plastics Permit
Polyethylene Unit

Dear Mr. Edlund:

ExxonMobil Chemical Company (ExxonMobil) is hereby submitting this letter in response to your request received July 25, 2012 for additional information related to the application for a greenhouse gas permit for a polyethylene expansion unit to be located at ExxonMobil's Mont Belvieu Plastics Plant (MBPP) in Mont Belvieu, Chambers County, Texas.

Per your request, ExxonMobil understands that you need additional information to complete your review. The response to each of your requests is provided in the attachments. The USEPA items/questions contained in the request are presented below followed by ExxonMobil's responses in *italics*.

If you have any questions about the information provided, please contact Benjamin Hurst at benjamin.m.hurst@exxonmobil.com or (281) 834-6110.

Sincerely,

ExxonMobil Chemical Company

Benjamin M. Hurst
Air Advisor

Enclosures

cc: Manager, TCEQ Region 12 Air Program, Houston
Randy Parmley, P.E., Sage Environmental Consulting, L.P

ENCLOSURE

ExxonMobil Response to EPA Completeness Comments
Application for Greenhouse Gas Prevention of Significant Deterioration Permit
ExxonMobil Chemical Company – Mount Belvieu Plastics Plant (MBPP)

Process Description

1. On pages 2-1 and 2-2, of the permit application, it states that "no increase in GHG emissions are being requested" for the changes proposed at the Storage tank, Cooling Tower and Miscellaneous Vent Emissions. Please provide the PSD applicability calculations for these units to support the "no increase" in GHG emissions request.

   Response:

   PSD applicability calculations have been supplied for the storage tank, cooling tower, and miscellaneous vent emissions to demonstrate no increase in GHG emissions.

   Upon further detailed design, a new wastewater stream was evaluated for GHG emissions. The oily water separator is an existing unit at the polyethylene base plant. A new waste water stream will be generated from the proposed project and will be routed to the existing waste water treatment system via the oily water separator. This new stream will not contain GHG constituents and will not be a source of GHG emissions for the project.

   Refer to Attachment 1 to this letter for emission calculations for the proposed sources that do not have GHG emissions and a revised Table 3-1 Emission Point Summary.

2. Please supplement the process flow diagram by identifying all emission control point for GHG emissions for the Analyzer Vent (EPN: PEXANALZ).

   Response:

   Upon further detailed design, the total number of required analyzers has increased from 30 to 35 analyzers for the proposed project. Refer to Attachment 1 to this letter for revised Table 3-1 Emission Point Summary and emission calculations. Refer to Attachment 2 to this letter for the revised process flow diagram that includes emission control points for analyzer vents.

3. Is the "Area Fugitives" (EPN: NAGFUGEM) emission source that is identified on the process flow diagram, the same emission source presented in Section 3, Table 3-1 as "Fugitives" (EPN: PEXFUGEM) and also in the emission calculations presented in Appendix A? If so, please correct the emission point number for consistency. If not, please provide supplemental technical data on the additional stream.

Response:

See Attachment 2 to this letter for the revised process flow diagram that includes the corrected EPN PEXFUGEM.

4. On page 2-1 of the permit application, it indicates "a new profile flare (EPN:FUFLARE61) will control high volume, high concentration (HVHC) streams from the reactors, and low volume, low concentration (LVLC) streams from the reactors a small percent of the time when the incinerator is down." Also, on page 2-2 of the permit application the emissions from the Feed Purification Bed Regeneration and Shutdown Activities will be directed to the flare.

   A. Please provide supplemental technical data to the BACT analysis that discusses the design and operation of the low profile flare, i.e., percent combustion efficiency, percent emission reduction, proposed monitoring and recordkeeping strategy, maintenance schedule, total vent flow measurement, etc. Will it be computer controlled? If so, will there be manual overrides? Please provide benchmark comparison data of new flare system to similar or existing sources.

   Response:

   Upon further detailed design, the project has better definition of a vent collection system to control VOC emissions from the multiple vent streams resulting from routine continuous and intermittent operations. The Vent Collection System is comprised of two separate headers: a High Pressure (HP) Vent Header and a Low Pressure (LP) Vent Header. The Vent Collection System is designed to handle predominantly hydrocarbon streams in direct contact with the process (enclosed polymerization area) of the polyethylene (PE) unit. Attachment 2 contains a simplified schematic depicting the new control system for the vent collection system.

   Downstream of this section, where almost all the hydrocarbons have been purged from the product, there are trace amounts of hydrocarbons (ppmv range). The vents from this area are controlled with a regenerative thermal oxidizer (EPN: RUPK71); this vent collection system controls residual VOC emissions from the powder hopper bag filter, conveying air vents and extruder feed vents, all of which typically have less than 130 ppmv of residual hydrocarbons.

   <u>High Pressure Vent Header</u>

   The HP Vent Header is designed to receive high load, short duration vent streams, also referred to as the "high volume, high pressure" (HVHP) vent stream from the reactors and the high capacity feed supply depressure. The primary control device that controls VOC emissions on the HP Vent Header is a multi-point ground flare system, such as John Zink Company's LRGO multi-point flare system, or one that is comparable. The multi-point ground flare system (EPN: 3UFLARE63) has a principle application to the petroleum refining and chemical processing industries due to its internal staging system *that ensures short, smokeless flames maintained over the full operating range of the flare since burners are sequentially opened to maintain control.*

The multi-point ground flare is expected to achieve a DRE well above the 98 to 99% DRE accepted for assist-type flares. Multi-point ground flare vendor have indicated that available ground flare technology will achieve 99.5% to 99.8%+ DRE for hydrocarbons. In fact, John Zink Company performed testing on the LRGO burner design and submitted the data and results to USEPA[1]. The LRGO burner demonstrated 99.82% combustion efficiency when combusting a crude propylene stream. The composition of the HVHP vent stream routed to the proposed multi-point ground flare system is comparable to the crude propylene used in the John Zink test since it contains highly combustible components such as hexene, hexane, isopentane, butene, butane, and ethylene, resulting in a typical heating value in excess of 800 BTU per standard cubic foot (Btu/scf) of off gas. Furthermore, after reviewing the proposed streams to be combusted in the multi-point ground flare as part of this project, John Zink has provided a performance guarantee stating that the hydrocarbon destruction efficiency will be 99.8% or greater when the multi-point ground flare is operated in the following range:[2]

- *Burner operating pressure > 4 psig and*
- *Flare gas net heating value > 800 BTU/SCF.*

The operation of the multi-point ground flare system will be designed to meet the above requirements. Use of staging valves in this multi-header design allows the required minimum pressure of 4 psig to be maintained while the multi-point ground flare is operated. The HVHP vent stream that will be routed to the multi-point ground flare will consistently have a net heating value in excess of 800 Btu/scf. However, during the venting process, the stream may be diluted with nitrogen addition. In these instances, a computer control application will safely divert flow away from the multi-point ground flare and route it to the LP header. The two separate headers (HP and LP) are connected through a spill-over line with a HP to LP valve controlled by a computer control application which is used to direct the flow away from the HP header system. This may occur during defined periods of unit purging for shutdowns or startups when using nitrogen that dilutes the heat content (BTU/scf). This computer control application will also divert flow from the HP Vent Header to the LP Vent Header upon instances when the HVHP vent does not have adequate pressure above 4 psig. This computer control application ensures the multi-point ground flare is operated only at times when the HP Vent Header meets the design conditions to achieve good combustion efficiency.

The proposed multi-point ground flare system uses an array of high pressure burners to produce short, highly efficient flames. Pressure assisted burners utilize the flare gas pressure to ensure high exit velocity at the burner exit. The high velocity produces the energy required to promote high air entrainment and mixing in the combustion zone.

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[1] *See Attachment 3 to this letter for John Zink submittal to USEPA with supporting data.*

[2] *Per letter correspondence between Mr. Kevin Leary, John Zink and ExxonMobil on November 5, 2012. See Attachment 3.*

This entrainment / mixing energy in the combustion zone is the key to producing an efficient, smokeless flame. This energy level is created by a high velocity discharge without requiring supplemental energy such as steam or forced air blowers. The philosophy of the control system provides that when gas (energy) flow is low, the number of burners is reduced in order that there is sufficient fuel supply to each burner to maintain the required energy level for clean burning.

The multi-point ground flare system is provided with multiple headers, each header having multiple risers with burners. The burner is designed such that a number of small diameter ports eject high velocity gas, enhancing air entrainment and mixing for efficient and clean combustion. The aerodynamics of the burner provides air cooling and prevents flame recirculation, eliminating burner over-heating and internal coking. The staging control system, which can be either programmable logic controller (PLC) or distributed control system (DCS) based, will receive input from pressure transmitters and opens and closes staging valves according to waste gas pressure. Each stage is operated automatically with an actuated valve that opens or closes upon demand.

For the purposes of estimating GHG emissions, a flare combustion efficiency of 99.5% was applied since the pressure-assisted flare design has demonstrated higher efficiency when the total heating value of the flare stream is greater than 800 Btu/scf. The current multi-point ground flare design contains multiple runners and will contain pilots on each runner that will fire pipeline quality natural gas. A flow measurement system will be installed on the header to the multi-point ground flare. The pilots will be continuously monitored for presence of flame. The emissions calculations for the multi-point ground flare i.e., 3UFLARE63 Intermittent Flaring and 3UFLARE63 Pilot Gas are contained in Attachment 1 to this letter.

<u>Low Pressure Vent Header</u>

The LP Vent Header will receive routine continuous vent streams from the process, as well as routine intermittent vent streams. The streams are also referred to as "low volume, low pressure" (LVLP) streams, and were originally planned to be controlled by an incinerator. Upon further detailed design review, it was determined that greater VOC control efficiency can be achieved through the use of multiple flameless thermal oxidizers (FTOs) with an air-assisted elevated flare serving as a secondary disposition. Refer to the response to Item 7 for a full description of the FTOs and elevated flare operation, emission calculation methodologies, and BACT analyses.

The LP Vent Header is equipped with on-line analyzers that provide real time measurement of the heat content and speciation of vent streams to the LP Vent Header. Since the LP Vent Header is the primary collection header for routine continuous operation vent streams that include potential infrequent periods of low heating value streams, the heat content analyzer provides the signal to allow for supplemental natural gas injection, if required, to maintain minimum heating value content in the vent gas.

The primary control devices for the LP Vent Header are three FTOs (EPNs: 3UF61A/B/C), operated in parallel. Installing and operating three FTOs provides the *capacity to reliably control the expected routine vent stream flow within the LP Vent Header for VOC emissions abatement. An automatic feed control system shall be provided to the FTOs to ensure optimal operation over a wide range of plant operation. Excess flow beyond the capacity of the FTOs will be routed to the elevated flare through a liquid seal drum. This control scheme ensures flow from the LP vent header will preferentially be routed to the FTOs.*

The air-assisted elevated flare (EPN: 3UFLARE62) provides the additional capability necessary to control all vent streams during normal operation of the LP Vent Header and is the control device of least priority within the vent collection system due to: (1) the comparatively lower destruction efficiency (DRE of 99% for hydrocarbons with three or less carbon atoms and 98% for hydrocarbons with more than three carbon atoms) and (2) this device requires supplemental natural gas, during periods of low heating value content. Air blowers will be provided as part of the elevated flare system. Air flow measurement and controls will be provided to maintain combustion efficiency.

Flare[3] Monitoring and Operation

ExxonMobil proposes to install and operate a multi-point ground flare system and an air-assisted elevated flare system per the manufacturer's specifications that will achieve the requested DREs. ExxonMobil proposes to monitor and record the following parameters to demonstrate continuous compliance with flare systems' operating specifications required to achieve the stated DREs:

1. *Monitor and record the vent gas flow to the elevated flare through a flow monitoring system,*

2. *Maintain a minimum heating value and maximum exit velocity that meets 40 CFR § 60.18 requirements for the routine streams routed to the elevated flare,*

3. *Monitor and record the composition and heating value of the vent gas within the LP Vent Header,*

4. *Monitor and record the pressure of the HP Vent Header,*

5. *Monitor and record the composition of the vent gas within the HP Vent Header;*

6. *Monitor the pressure to the multi-point ground flare to demonstrate that flow routed to the multi-point ground flare system exceeds 4 psig; however, if a lower pressure can be demonstrated to achieve the same level of combustion efficiency, then this lower limit will be implemented,*

7. *Monitor and maintain a minimum heating value of 800 Btu/scf of the waste gas (adjusted for hydrogen) routed to the multi-point ground flare system to ensure the intermittent stream is combustible; however, if a lower heating value limit can be*

[3] *Refer to the response to Item 7 for monitoring and operation requirements for the FTOs.*

demonstrated to achieve the same level of combustion efficiency, then this lower limit will be implemented, and

8. *Monitor pilots for continuous presence of flame.*

The control system for the Vent Collection System will be designed to be computer controlled due to its complexity, and manual overrides of the control system will be utilized in the event of a failure of the computer control system to function properly. The system controls operation of the elevated flare and its assist air flow, operation of the multi-point ground flare, and operation of the spill-over valve between the HP and LP Vent Headers. The Vent Collection System does not contain bypass valves that prevent control of the vent streams through a control device, i.e., there are no valves that bypass a control device by routing the vent stream directly to atmosphere.

Refer to Attachment 1 to this letter for revised flare emission calculations and revised Table 3-1 Emission Point Summary. Refer to Attachment 4 to this letter for a summary of the proposed work practice standards and operating limits for the elevated and multi-point ground flare systems.

B. Was a flare gas recovery system considered for the proposed project? Please supplement the BACT analysis to support the elimination of a flare gas recovery system.

Response:

Vent gas recovery was evaluated by ExxonMobil for the proposed project. A compression system was specified with a total capacity to recover up to 1,800 pounds per hour of vent gas, which is equivalent to 1,000 pounds per hour of natural gas. This flow rate is based on the estimated amount of vent gas the boilers could reliably fire in place of natural gas. Since flare gas recovery is technically feasible, an economic analysis was performed to evaluate the economic feasibility of this control technology. Table 1 summarizes the economic analysis of flare gas recovery for the proposed project, which is estimated to avoid 11,541 tons of CO_2e per year. As shown in the table, flare gas recovery is estimated at a cost of $123.2 per ton of CO_2e avoided, which is an excessive cost to mitigate GHG emissions and renders flare gas recovery an economically infeasible control technology. Therefore, it is eliminated from consideration as a control technology for flare GHG emissions.

Table 1 Economic Analysis for Vent Gas Recovery

Item	Units	Value[4]	Comments
Vent Gas Recovery System Cost			
Capital Cost of VGR	\$ (millions)	7.0	Site-specific design
Amortized Capital Cost	\$ (millions)	1.4[5]	See Footnote
Operating and Maintenance Expenses	\$ (millions)	0.05	Site-specific design incorporating natural gas consumption reduction
Total Annual VGR Cost	**\$ (millions) / yr**	**1.4**	
Vent Gas Recovered			
Total Vent Gas Recovered	MMscf/yr	311.4	Based on estimate of 1,000 lb/hr of NG reduction
	MMBtu/yr	196,812	Higher heating value of 639 Btu/scf
Economics of Avoided CO_2e			
Annual Emissions from FTO Control of Vent Gas	tons CO_2e / yr	14,607	Oxidation emissions from unrecovered vent gas
Annual Emissions from Recovered Vent Gas to Boilers	tons CO_2e / yr	14,607	Firing recovered vent gas at the boilers
Annual Emissions from Natural Gas to Boilers	tons CO_2e / yr	11,541	Firing natural gas at the boilers
Tons of CO_2e Avoided	tpy	11,541[6]	
Cost per ton of CO_2e Avoided	\$ / ton CO_2e	123.2	

C. Will there be an analyzer on the vent flow to the flare? Is the "Off Gas to Flare" analysis results presented in Appendix A, representative of all vent streams directed to the multi-point ground flare?

Response:

Refer to the response to Item 4.A. for a description of analyzer applications. The "Off Gas to Flare" analysis presented in the application received May 22, 2012 has been revised. The representative case for annual emissions was derived using engineering analysis based on the annual vent gas composition. The flows expected to be routed to the multi-point ground flare are considered high volume, high pressure (HVHP) flows. Although the HVHP flows differ for the typical operating scenarios anticipated for the multi-point ground flare, the flows during each scenario do not vary excessively. HVHP vent streams anticipated to be controlled by the multi-point ground flare can be

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[4] *All monetary estimations have been calculated in 2016 dollars.*

[5] *A capital charge rate of 19% was assumed with an expected equipment life of 20 years.*

[6] *Tons of CO_2e avoided = Annual Emissions from FTO control of Vent Gas + Annual Emissions from Boiler Firing Natural Gas - Annual Emissions from Boiler Firing Recovered Vent Gas = 14,607 tpy + 11,541 tpy – 14,607 tpy = 11,541 tpy*

categorized as 'start-ups' (after shutdown, cleaning, and/or maintenance) and 'shutdowns' (operational transitions, catalyst change outs, grade changes, process safety releases, etc.). Refer to Attachment 1 to this letter for revised composition tables representative of the vent streams routed to control devices (previously referred to as "Off Gas to Flare").

D. Is the "MSS" (EPN: NAGMSS) emission source identified on the process flow diagram the same emissions that are discussed in the "Planned Maintenance, Start-Up, and Shutdown Activities" on page 2-2? In the discussion, it is indicated that these vent streams are directed to the low profile flare. Please supplement the process flow diagram to accurately depict where stream is vented. Are these emissions calculations included in the vent flow to the flare? If not, please provide supplemental calculations for this vent stream.

Response:

The EPN NAGMSS has been renamed to PEXMSS. Planned Maintenance, Start-Up, and Shutdown Activities have been updated as follows to reflect further detailed design:

<u>Incinerator Off-line</u>

This activity is no longer included since the incinerator has been removed from the scope of the project.

<u>Feed Purification Bed Regeneration Flaring</u>

During periods where feed purification beds undergo regeneration, the flameless thermal oxidizers will serve as the primary control device with the elevated flare controlling emissions from any excess capacity flow. These emissions are included in the EPNs 3UF61A/B/C.

<u>Reactor Shutdown and Start-up Activities</u>

Startup and shutdown emissions from the proposed project's startup and shutdown activities of the polymerization reactors will be controlled by the multi-point ground flare. These emissions are included in the EPN 3UFLARE63.

<u>Hexene Tank Maintenance</u>

This activity is no longer applicable to this permitting action. See the response to Item 6 for further details.

<u>PE Unit Start-up and Shutdown Activities</u>

Start-up and shutdown activities for equipment other than reactors will be controlled through the LP Vent Header. These emissions are included in the respective EPNs.

Boiler and FTO Start-up

The boilers and FTOs have estimated start-up emissions that have been included in the EPN PEXMSS.

Refer to Attachment 1 to this letter for revised MSS emission calculations and revised Table 3-1 Emission Point Summary. See Attachment 2 to this letter for the revised process flow diagram depicting MSS stream dispositions.

E. On page 3-3 of the permit application, it indicates "Emissions from the analyzer vents (EPN:PEXANALZ) are based on the estimated gas flow through each analyzer, vapor density, vapor speciation, and a 98% destruction efficiency." Please provide supplemental information on where the vent analyzers will be installed and what vent stream will it be analyzing. Please clarify if the 98% destruction efficiency applies to the flare, incinerator or regenerative thermal oxidizer (RTO)?

Response:

The destruction efficiency stated in the application applies to the destruction efficiency of the actual analyzer device since the vent stream is not routed to another control device. The proposed project design currently contains 35 analyzers distributed throughout the process equipment. These analyzers will contain TRACErase™ technology or similar technology to destroy the VOC emissions prior to release to the atmosphere. The focus of TRACErase™ technology is the use of a catalytic combustion process to oxidize vented samples while maintaining an atmospheric pressure reference. The TRACErase™ Hydrocarbon Emission Eliminator utilizes a continuous heat source to allow effective oxidation of intermittent fugitive emission streams as well as continuous source streams. Temperatures in excess of 100 °F indicate functioning of cartridge heater and in excess of 185° F indicate functioning of catalyst cartridge.

The proposed project will use a temperature sensor to alert personnel when the operating temperature is off target and the unit requires maintenance. Annual preventive maintenance to replace the catalyst cartridge will be performed, which is consistent with current MBPP practices. Refer to Attachment 1 to this letter for revised analyzer emission calculations and revised Table 3-1 Emission Point Summary. See Attachment 2 to this letter for the revised process flow diagram depicting analyzer vent locations. Refer to Attachment 4 to this letter for a summary of the proposed work practice standards and operating limits for the analyzers.

5. On page 3-3, of the permit application, it is stated that "A service factor of 0.55 is applied to the annual average fuel gas heat input since the boilers are projected to operate at an annual average of 55% of the design capacity." Please provide the rationale that indicates operating these boilers are 55% capacity if energy efficient as BACT.

Response:

Upon further detailed design, the capacity of the boilers has been increased to meet steam demand. Each boiler is sized to individually meet the steam demand of the proposed project for redundancy to ensure the plant is provided with adequate steam in the event of planned outages and unexpected shutdown of one boiler. In the event of an unexpected shutdown of one boiler, the operational boiler must rapidly increase its steam production, therefore both boilers must be operating at all times during normal plant operation. The boilers therefore operate in a reduced capacity mode where each boiler produces half of the normal steam demand. This is the typical operating mode for boilers. The service factor represents the estimated shared load of both boilers and accounts for the fact that each boiler operates during normal plant operation (with the exception of planned boiler maintenance), albeit at a reduced rate.

Based on ExxonMobil's operating history and the sizing of utilities including boilers, the design basis of the proposed boilers is to ensure an unexpected boiler shutdown will not cause a disruptive plant wide shut down. The actual sizing for the proposed project takes into account historical boiler reliability and provides redundant capacity to ensure availability of boiler generated steam does not restrict plant operation. Excess boiler capacity comes with an additional capital cost to the proposed project. The design of the boiler, however, ensures that even while operating at a reduced capacity (29% of capacity), there is a nominal impact on combustion efficiency (estimated at 3%) at the normal reduced rates that the boilers will operate.

6. EPA notes the "MSS Engine" (EPN: PEXENGINE) presented in the emissions calculations for this stream in Appendix A; however, it is not clear from the permit application what type of equipment is the "MSS Engine". Please provide supplemental technical data in the Process Description and the BACT Analysis sections with detailed information that includes, but not limited to, equipment type, fuel type, operating parameters, benchmark comparison of proposed equipment to similar sources, mode of operation, etc. Also, please identify the emission source on the process flow diagram.

Response:

Emission Point Number (EPN) PEXENGINE represents emissions from tank degassing of the proposed project's hexene tank roof landing and floating activities through the use of a portable combustion device owned and operated by a third party tank degassing contractor. The actual planned frequency of degassing activities is expected to be once every 10 years for an internal floating roof seal inspection required by environmental regulations, however, it is possible that the degassing activity could occur more than once in 10 years, for example, if repairs to the seal are necessary. The combustion device supplied by the tank degassing contractor for these infrequent activities can vary but in all cases will be portable.

Upon further review, because this engine meets the definition of a nonroad engine it does not qualify as a stationary source and is not subject to PSD review. The EPN PEXENGINE has *therefore been removed from Table 3-1 Emission Point Summary and the Process Flow Diagram (PFD).*

The Clean Air Act defines stationary source as "generally any source of an air pollutant except those emissions resulting directly from an internal combustion engine for transportation purposes or from a nonroad engine or nonroad vehicle as defined in section 7550 of this title." 42 U.S.C. 7602(z). Section 7550 of the CAA defines nonroad engine as "an internal combustion engine that is not used in a motor vehicle...or that is not subject to standards promulgated under section 7411 [relating to Standards of Performance for new Stationary Sources ("NSPS")]of this title.."). 42 U.S.C. Section 7550(10).

EPA has promulgated NSPS standards stationary internal combustion engines in 40 C.F.R. Subparts IIII and JJJJ. These NSPS standards specifically exclude non-road portable engines as defined in 40 C.F.R. Section 1068.30. See definition of "stationary internal combustion engine" in 40 CFR Sections 60.4219 and 4248. PEXENGINE meets the definition of nonroad engine in 40 CFR Section 1068.30 because it is portable (40 C.F.R.. Section 1068.30(1)(iii)) and will not remain at a location for more than 12 months (40 C.F.R. Section.1068.30(2)(iii).

7. On page 4-4 of the permit application, it states that "Incinerator efficiency will decrease over time; however, the rate of deterioration can be reduced by good operating and maintenance practices. Deterioration of incinerator efficiency results in higher heat rate, CO_2 emissions, and operating costs; in lower reliability; and in some cases, reduced output. Examples of good operation and maintenance practices include good air/fuel mixing in the combustion zone; sufficient residence time to completed combustion; proper fuel gas supply system operation in order to minimize fluctuations in fuel gas quality; good burner maintenance and operation; and overall excess oxygen levels high enough to safely complete combustion while maximizing thermal efficiency." Please address the following questions for the incinerator, RTO and the two boilers because the same "good operating and maintenance practices" are referenced in the BACT analysis for all of the proposed previously mentioned equipment.

Response:

Upon further detailed design, a more efficient control device was identified to control VOC emissions from the LP Vent Header (see response to Item 4.A. for a description of the LP Vent Header). The incinerator has therefore been removed from the scope of the proposed project and has been replaced by flameless thermal oxidizers (FTOs) (EPNs: 3UF61A/B/C) as the new primary control device for low volume, low pressure vent streams.

As discussed within the response to Item 4, the LP Vent Header is part of the Vent Collection System, which includes a separate high pressure (HP) Vent Header to route high volume, high pressure vent streams to the previously proposed multi-point ground flare (EPN: 3UFLFARE63) as the primary control device.

Since a computer control application manages the disposition of all vent streams using an integrated approach based on pressure, composition, and flow, the following discussion *includes a BACT analysis of the Vent Collection System, which also includes a new air-assisted elevated flare (EPN: 3UFLARE62) serving as the secondary disposition for the LP Vent Header and tertiary disposition for the HP Vent Header.*

Flameless Thermal Oxidizers

Flameless Thermal Oxidizers (FTOs) are state of the art technology to control VOC emissions by achieving a very high destruction efficiency (rated at 99.99% VOC DRE) over a wide range of stream compositions. An air blower on the LP Vent Header ensures the flow is preferentially directed to this high efficiency combustion device that requires virtually no supplemental fuel addition for combustion during normal operation.

The proposed FTO combusts natural gas during startup to achieve required operating temperature of the reaction bed. Once online, the FTO utilizes natural gas only when the control application determines the minimum heating value is not contained within the incoming vent stream, therefore supplemental fuel is required to maintain proper control device temperature and destruction efficiency. The process conditions for the LP Vent Header are such that the routine vent streams routed to the FTOs contain sufficient heating value to maintain proper operating temperature, therefore supplemental fuel is not required for operation, other than at times of exceptionally low flow rates, and as such, the control application works to utilize supplemental fuel only when required due to the absence of heating value in the incoming feed stream. An air blower with flow controls will be utilized to provide optimization of the excess oxygen present and bed temperature profile in the reactor. However, it must be noted that higher excess oxygen at stack does not necessarily indicate lower energy efficiency (unlike boilers) of the equipment when the feed stream has more than adequate heat content and no supplemental fuel firing is required.

The patented technology of the proposed FTO consists of a packed-bed, refractory-lined reactor filled with porous, inert ceramic media. Organic compounds are oxidized into CO_2 and water vapor. At startup, the ceramic packing in the oxidizer vessel is heated to the required operating temperature with a natural gas fired burner.

Unlike other packed-bed technologies, the reaction zone is stationary and continuous. This feature eliminates channeling or bypassing, allowing complete and efficient combustion while generating very low concentrations of NOx and carbon monoxide (CO).

The nature of the reactor is to establish a reaction zone. The reaction zone is maintained at proper operating temperature. All the gases fed to the system must pass through this reaction zone, i.e., there are no bypasses or shortcuts. As such, all the gases along with combustion air pass slowly through this zone, fully oxidizing the organic materials. This assures that the FTO meets and exceeds 99.99% destruction efficiency.

High level of destruction is applicable to CO as well. A typical indicator for incomplete combustion is the presence of CO; however, with mixing not being a problem in the FTO, the only time CO may be present is when there is insufficient air in the system. In this instance the stack oxygen measurement would adjust the system (increase air and/or reduce feed *stream flow), therefore, temperature and oxygen concentration are the parameters that demonstrate good combustion and control equipment operation to its optimum performance.*

Air-Assisted Elevated Flare

The air-assisted elevated flare (EPN: 3UFLARE62) will be designed to achieve a DRE of 99% for hydrocarbons with three or less carbon atoms and 98% for hydrocarbons with more than three carbon atoms with smokeless operation, however, for the purposes of estimating GHG emissions, an assumed flare combustion efficiency of 98% was applied since the total carbon content was the basis for emissions estimating, which does not segregate hydrocarbons.

The design of the elevated flare will be completed by an industry leader in flare technology and will incorporate industry-leading technology, including online flow and composition measurement and computer control. A flow measurement system will also be installed on the header to the elevated flare. The pilots will be fired by natural gas and will be continuously monitored for presence of flame.

Emissions Calculations

The emissions for the FTOs and the elevated flare are based on the anticipated gas flow, higher heating value, and carbon content of the LP Vent Header vent streams. FTO CO_2 emissions were calculated with Equation C-5 from 40 CFR 98 Subchapter C using Tier 3 calculation methodology. CH_4 and N_2O emissions from the FTOs were calculated based on the emission factor of 1×10^{-3} kg-CH_4/ MMBtu and 1×10^{-4} kg-N_2O / MMBtu (40 CFR 98 Subpart C Table C-2), respectively. Elevated flare CO_2 emissions were estimated according to Equation Y-1a from the Federal GHGMRR 40 CFR 98 Subpart Y. Elevated flare CH_4 and N_2O were calculated according to Equations Y-4 and Y-5, respectively, from the Federal GHGMRR 40 CFR 98 Subpart Y.

The emissions for the multi-point ground flare are estimated from representative off gas mass flow, stream speciation, and higher heating value of the vent streams to the HP Vent Header. CO_2 emissions from the multi-point ground flare were estimated according to Equation Y-1a from the Federal GHGMRR 40 CFR 98 Subpart Y. CH_4 and N_2O emissions from the multi-point ground flare were calculated according to Equations Y-4 and Y-5, respectively, from the Federal GHGMRR 40 CFR 98 Subpart Y.

The GWP values in Table A-1 of the GHG MRR Rule (40 CFR Part 98, Subpart A) were used to calculate CO_2e emissions from estimated emissions of CO_2, CH_4, and N_2O by multiplying the individual GHG pollutant rates by their applicable GWP.

Detailed calculations for this determination are provided in Attachment 1 to this letter. The proposed allowable emissions of CO_2, CH_4, and N_2O expressed as CO_2e for the FTO, elevated flare, and multi-point ground flare associated with the proposed project are presented in Table 3-1 Emission Point Summary in Attachment 1 to this letter.

BACT Analysis

The purpose of the Vent Collection System is to segregate and control VOC-containing vent streams from the process to the appropriate control device to maximize VOC destruction. Due to the integration of the computer control applications that manage the three control devices and operation of the Vent Collection System, this BACT analysis focuses on the combined Vent Collection System as a collective emission source. Additionally, since CO_2 accounts for over 99% of the total CO_2e emissions from these emission sources, this GHG BACT analysis is focused on controlling CO_2 emissions.

Step 1 – Identify Potential Control Technologies

The following technologies were identified as potential control options for the Vent Collection System based on available information and data sources:

- *Use of low carbon assist gas;*
    - *Fuels containing lower concentrations of carbon generate less CO_2 emissions than higher carbon fuels.*
- *Use of good operating and maintenance practices;*
    - *Appropriate maintenance of equipment (analyzers, flow measurement systems),*
    - *Operation at the designed temperature and oxygen concentration in the FTOs,*
    - *Operation based on recommended design velocity and heating value for the elevated flare, and*
    - *Operation based on recommended design pressure and heating value for the multi-point ground flare.*
- *Staged Operation;*
    - *The proposed project will install a Vent Collection System with staged operation. By segregating these low and high volume streams into different control device dispositions, the proposed project will optimize the amount of assist gas and air to hydrocarbon ratio required for good combustion. This will minimize the amount of CO_2 generated by destruction of vent streams.*
- *Energy Efficient Design;*
    - *Use of variable flow air blower with a computer control application.*
    - *Use of variable flow air blower with a computer control application to control the excess oxygen based on the incoming feed to the FTOs.*

- *Vent Gas Recovery (VGR);*
    - *Recover routine continuous vent streams prior to combustion in a control device and utilize the heat content to reduce natural gas consumption at the boilers thereby avoiding GHG emissions.*
- *Carbon Capture and Sequestration (CCS);*
    - *Refer to the response to Item 9 for a detailed description of CCS.*

Step 2 - Eliminate Technically Infeasible Options

Use of a low carbon fuel is technically feasible. Pipeline quality natural gas is the lowest carbon fuel commercially available at MBPP. Natural gas will be selected by the proposed project since it is the only fuel commercially available at MBPP.

The use of good operating and maintenance practices results in longer life of the equipment and more efficient operation. Therefore, such practices indirectly reduce GHG emissions by supporting operation as designed by the manufacturer. Use of good operating and maintenance practices and energy efficient design is technically feasible and will be incorporated into the proposed project.

The staged operation is integral to the design of the Vent Collection System, with three separate control devices for the various vent streams.

As discussed in the response to Item 9, CCS is considered technically, environmentally, and economically infeasible for the FTOs and boilers. CCS is eliminated as a potential control technology for GHG emissions.

As discussed in the response to Item 4.B., vent gas recovery (VGR) is considered economically infeasible for the Vent Collection System. VGR is eliminated as a potential control technology for GHG emissions.

Step 3 - Rank Remaining Control Technologies

The remaining feasible control technologies will be selected for the proposed project, therefore ranking is not required.

Step 4 - Evaluate the Most Effective Controls and Document Results

Step 4 is not applicable since all remaining control technologies will be selected.

Step 5 - Selection of BACT

As a result of these analyses, the use of a low carbon fuel, good operating and maintenance practices, staged operation, and energy efficient design are selected as BACT for the proposed Vent Collection System. The following work practice standards and operating limits are proposed to demonstrate BACT is met:

- *Use a low carbon fuel*
    - *Consume pipeline quality natural gas, or a fuel with a lower carbon content than pipeline quality natural gas, as supplemental fuel to the FTOs and Vent Headers.*
- *Use of good operating and maintenance practices;*
    - *LP Vent Header*
        - *Monitor the composition of the vent gas contained in the LP Vent Header through an online analyzer and record the heating value.*
    - *FTOs*
        - *Monitor and record the vent gas flow to FTO through a flow monitoring system.*
        - *Monitor the excess oxygen at the exhaust stack of the FTOs and maintain excess oxygen above the minimum demonstrated for the designated DRE during the performance test.*
        - *Monitor the temperature of the FTOs and maintain the temperature above the minimum demonstrated temperature or manufacturer recommended temperature.*
    - *Elevated Flare*
        - *Monitor and record the flow to the elevated flare through a flow monitoring system.*
        - *Maintain a minimum heating value and maximum exit velocity that meets 40 CFR § 60.18 requirements for the routine streams routed to the elevated flare including the assist air flow.*
    - *Multi-point ground Flare*
        - *Monitor the pressure to the multi-point ground flare to demonstrate that flow routed to the multi-point ground flare system exceeds 4 psig; however, if a lower pressure can be demonstrated to achieve the same level of combustion efficiency, then this lower limit will be implemented.*
        - *Monitor the heating value of the vent gas contained in the HP Vent Header through an online analyzer.*
        - *Monitor and maintain a minimum heating value of 800 Btu/scf of the off gas (adjusted for hydrogen) routed to the multi-point ground flare system to ensure the intermittent stream is combustible; however, if a lower*

heating value limit can be demonstrated to achieve the same level of combustion efficiency, then this lower limit will be implemented.

- *Energy Efficient Design*
    - *Use FTO variable flow air blowers with computer control application to control the excess oxygen based on the incoming feed.*
    - *Use computer control application to minimize assist gas firing in to the FTO*
    - *Use variable flow air blower for air-assist at elevated flare with computer control application.*
- *Staged Operation*
    - *Operation of the control applications to manage the disposition of the vent streams among the Vent Headers and the control devices.*
    - *Manual overrides and/or manual bypasses will be employed only during unexpected and unplanned failure of the computer control system to properly operate.*

A. Please provide comparative benchmark data on the percent efficiency of the burners selected by the applicant compared to existing or similar sources. Please provide details concerning the preventive maintenance on burners, frequency and recordkeeping schedule. How often will burners be inspected? How will this be ensured? What recordkeeping requirements are you proposing? What will alert on-site personnel to problems?

Response:

As discussed above, the incinerator is no longer included in the proposed project. The following response addresses burner technology for the boilers, RTO, and FTOs.

Boilers

The boilers will be equipped with SCR for NO_x control; therefore the focus for the burner design will be on combustion efficiency. The burner will be designed to maintain flame stabilization over a range of firing rates since the boilers will be required to operate at reduced firing rates during normal operation.

Good design principles and operating and maintenance practices proposed for this project include:

- *Manufacturer burner technology maximizes burner stability and performance over a large operating window of fuel gas pressure and composition. The burners for the proposed project will be designed to accommodate the fuel gas composition range and optimize the burner performance for the design operating window.*

- *The source of fuel gas is pipeline natural gas, which is free of liquids. This will mitigate the risk of burner fouling or damage, which reduces combustion efficiency resulting in increased CO emissions.*

- *A record will be maintained for any maintenance activity completed on the burner. The burners are inspected during routine scheduled maintenance periods and corrective measures are taken to ensure the highest quality of combustion and flame stability. Tip replacement is conducted, if required.*

RTO

The burners installed for the RTO operate to provide supplemental heat necessary for the RTO to maintain operating temperature. Although the RTO efficiently recovers heat required for oxidation, the heat content of the incoming feed is not sufficient to provide the heat required to maintain required temperature. The manufacturer uses a burner design that provides complete combustion of the natural gas fuel, in order to minimize assist gas consumption. This is standard industry practice and the highest efficiency level that can be achieved for a burner.

The burners will be visually inspected prior to startup (and during planned boiler maintenance shutdowns) to ensure proper performance per current practices at MBPP. On-site personnel will be alerted to problems through a low temperature alarm if the RTO reaches minimum operating temperature that was demonstrated during the performance test to establish DRE. As described in the above section for boilers, upon notification of an alarm, Operations will employ troubleshooting practices to identify and resolve the issue with appropriate support as needed.

FTOs

The burners installed for the FTOs operate during start-up only to provide the initial heat necessary for the FTOs to reach proper temperature. Once the operating temperature is reached, the FTOs maintain temperature through the exothermic oxidation reactions within the reactors. The manufacturer uses a burner design that provides complete combustion of the natural gas fuel, in order to minimize assist gas consumption. This is standard industry practice and the highest efficiency level that can be achieved for a burner.

Due to the infrequent nature of operation, the burners will be visually inspected prior to start-up to ensure proper performance per current startup practices at MBPP. On-site personnel will be alerted to problems if a FTO fails to reach operating temperature or excess oxygen at stack falls below a predetermined level.

Refer to Attachment 4 to this letter for a summary of the proposed work practice standards and operating limits for the boilers, FTOs, and RTO burners.

B. What will be the operating parameters utilized to ensure minimum excess air? Please include a discussion on how O_2 analyzers will be utilized at this proposed facility to determine optimum excess air to provide proper combustion.

Response:

As discussed above, the incinerator is no longer included in the proposed project. The following response addresses excess oxygen operation for the boilers, RTO, and FTOs.

Boilers

Proper combustion can be commercially achieved at low excess oxygen levels as measured by online analyzers during normal operation, which results in high boiler thermal efficiency and low GHG emissions. The excess oxygen at the burners is controlled and minimized via an application resetting the combustion air supply during normal operation. This application minimizes excess air to the extent complete combustion and maximum thermal efficiency is achieved yet safe operation is maintained. Air to fuel ratio control and low excess oxygen alarm in the DCS mitigate the risk of incomplete combustion due to lack of air. This alarm alerts the Operator that minimum excess oxygen has be detected so he/she may monitor the application controlling excess oxygen and correct the situation as necessary.

There may be times when the boiler will operate at higher excess oxygen than the minimum required level to achieve complete combustion. These times may include but are not limited to boiler turndown when extra air is necessary to achieve necessary mixing energy between combustion air and fuel gas.

FTOs

Excess oxygen is not an indicator for energy efficiency since supplemental fuel is only added to the FTOs during startup and when the incoming feed stream's heat content is too low to maintain FTO operating temperature. Refer to the response to Item 7 for a discussion of how the FTOs utilize excess oxygen control to maintain proper operation.

RTO

The RTO will ensure operation at adequately elevated temperature so that the DRE demonstrated through performance testing is achieved. As previously discussed, the RTO is utilized for vents containing residual levels of hydrocarbons from the powder hopper bag filter, conveying air vents and extruder feed vents due to the dilute VOC content, i.e. extremely low heat content, therefore supplemental fuel is utilized to achieve proper temperature. It is temperature and not excess oxygen that indicates proper operation, therefore temperature is the operating parameter that is continuously monitored and integrated into the control application for the RTO since the largest cost of operating a RTO is the supplemental fuel.

Refer to Attachment 4 to this letter for a summary of the proposed work practice standards and operating limits to manage excess oxygen for the boilers, FTOs, and RTO.

C. Please provide further discussion as to how good combustion efficiency will be ascertained from the incinerator, RTO and boilers operation parameters pertaining to, temperatures, pressures, and residence times. What is ExxonMobil's preferred monitoring method, recordkeeping requirements for this equipment (e.g., continuous or periodic)?

Response:

Good combustion practices for the boilers include appropriate maintenance of equipment (such as periodic burner tune-ups when required) and operating within the recommended combustion air and fuel ranges of the equipment as specified by its design, with the assistance of oxygen trim control. Good combustion practices for the FTOs and RTO include operating above the minimum temperature demonstrated during performance testing.

Although good combustion practices do not themselves necessarily directly reduce GHG emissions, using good combustion practices results in longer life of the equipment and more efficient operation. Therefore, such practices indirectly reduce GHG emissions by supporting operation as designed with consideration of other energy optimization practices incorporated into the proposed project, such as maintaining thermal efficiency. ExxonMobil will incorporate such combustion practices as recommended by its vendor and based on its extensive operating experience.

ExxonMobil proposes to monitor and record the temperature of the RTO and FTOs to demonstrate the level of DRE. Through continuous operation above the demonstrated and/or vendor specified temperature, the proposed project will ensure good combustion within the RTO and FTOs.

Refer to Attachment 4 to this letter for a summary of the proposed work practice standards and operating limits to ensure good combustion efficiency for the boilers, FTOs, and RTO.

D. Please submit a detailed description of the anticipated procedures that are proposed as part of the maintenance practices and include a proposed schedule for planned maintenance.

Response:

Operation and maintenance practices will be consistent with the current MBPP practices. Burner inspection and maintenance is typically performed on a planned basis during equipment maintenance down times to allow for entry requiring physical access to inspect/work on the individual components. Boiler inspections typically occur at least every 5 years but may be on a shorter frequency depending upon boiler performance. Inspection records are kept in the boiler equipment filing system. Key inspection steps include:

- *Check integrity of burner components (tips, tiles, surrounds),*
- *Inspect burner spuds for potential fouling,*
- *Inspect burner air doors and lubrication,*
- *Inspect all burners before closing main door to check for potential debris,*
- *Inspect combustion air ducting and dampers, and*
- *Check burner spud/orifice sizes.*

E. What will be ExxonMobil's method of monitoring and recordkeeping for the determination of fuel quality, i.e., continuous gas chromatograph, fuel meters, etc.

Response:

The fuel to the boilers will be pipeline natural gas; therefore the fuel will be sampled monthly per requirements set forth in 40 CFR 98 Subpart C. The vent streams to the FTOs will be continuously monitored and heat content recorded by means of an online analyzer. A control application will manage any additions of supplemental natural gas provided to the FTOs, therefore both the feed and fuel details will be known as both flows will be metered independently.

The fuel burned in the RTO burner for oxidation of vent gas supplied to the RTO is pipeline natural gas, same as what burned in the boiler, and the flow rate is continuously monitored. The feed stream to RTO is a very low concentration stream and is continuously monitored for flow rate. Refer to Attachment 4 to this letter for a summary of the proposed fuel quality monitoring and recordkeeping requirements for the boilers, FTOs, and RTO.

8. On page 4-4 of the permit application, it is indicated in the "Energy Efficient Design" section that "to maximize thermal efficiency, the incinerator will be equipped with heat recovery systems to produce an optimal amount of steam from waste heat for use throughout the plant. Specific technologies include: insulation of the incinerator to retain heat the improved process control."

    A. Please provide a comparison analysis of the "specific technologies" outlined for the incinerator that includes the anticipated increase in thermal efficiency compared to a similar source without the proposed thermal efficiency enhancements, (e.g., Design Feature: Heat Containment (Insulation), Improved Thermal Efficiency: 2% - 5%, etc.)

    Response:

    As discussed in previous responses, the incinerator as VOC control device has been removed from the project scope. Essentially, the FTOs have replaced the incinerator as the primary control device for low volume, low pressure vent streams. It must be noted that the FTOs are not typical stationary combustion sources that require an external heat source; therefore it is not appropriate to provide a response in quantitative terms for energy efficiency. However, one has been provided to address the efficiency concepts presented in this item for a qualitative response for the FTOs.

    The FTOs do not require supplemental fuel or heat to maintain optimum operation, unless the FTOs are operated a high turndown, i.e., essentially no flow is routed to the LP Vent Header, or the incoming feed stream does not have adequate heat content. As discussed in the response to Item 7, the FTOs are designed to maintain operating temperature through control applications that balance the excess oxygen levels based on feed forward control of the incoming feed stream. This feed stream, consisting of low volume, low pressure vents routed to the LP vent header, contains sufficient heat value such that supplemental fuel is not expected to be required during normal operation. FTOs are able to "burn" waste gasses at lower heating values than would be required *with direct fire burners. The device uses a thermal ceramic bed to allow oxidation to occur at much lower heat contents reducing supplemental fuel requirements. The vent stream therefore ensures the reactor is energy efficient by providing sufficient heat to maintain proper operating temperature.*

B. What operating parameters does ExxonMobil prefer to monitor to determine that the thermal efficiency in the plant is optimized, i.e., stack temperature, pressure, fuel usage, etc.?

Response:

ExxonMobil proposes to monitor and record the supplemental fuel flow to the FTOs to confirm energy efficient operation of the FTOs. Supplemental fuel is provided when the incoming heat content of the feed stream is typically below 45 Btu/scf and will be finalized during detail design. Refer to Attachment 4 to this letter for a summary of the proposed work practice standards and operating limits for the FTOs.

C. Provide any supporting data to substantiate operating and design improvements to the proposed "specific technologies" compared to the past operation and design, e.g., past energy consumed and what will be the difference compared to the new construction, comparative benchmark studies to similar operations. Please include any technical data that support your conclusions, as well as the associated decrease in GHG produced relative to heat input.

Response:

As discussed above, the Vent Collection System with staged operation delivers a high-level of performance for control of VOC emissions. In comparison to the initially proposed technology to control VOC emissions contained in low volume, low concentration vent streams, the FTOs and elevated flare will emit 27,496 tpy of CO_2e less than the initially proposed incinerator, which is a 23% reduction in emissions.

9. Beginning on page 4-5 of the permit application, the cost estimates provided for the Carbon Capture and Storage (CCS) appear to rely on the August 2010 report entitled, "Report of the Interagency Task Force on Carbon Capture and Storage." BACT is a case-by-case determination. Please provide site-specific facility data to evaluate the eliminate CCS from consideration for the following new equipment: incinerator, RTO and the two boilers. This material should contain detailed information on the quantity and concentration of CO_2 that is in the waste steam and the equipment for capture, storage and transportation. Please include cost construction, operation and maintenance, cost per pound of CO_2 removed by the technologies evaluated and include the feasibility and costs analysis for storage or transportation for these options. Please discuss in detail any site-specific safety or environmental impacts associated with such a removal system.

Response:

ExxonMobil is a leader in the research, development and application of CCS and related technologies, with over 30 years of extensive experience in technology that could be *transferable to CCS operations. ExxonMobil recognizes CCS is a promising technology for mitigating GHG emissions, but through our experience we also recognize that significant challenges must be overcome for wide-spread deployment across various industries. Challenges include high capture cost; first-of-a-kind (FOAK) technology deployments in new industrial sectors with unknown technology and process safety risks; and insufficient regulatory frameworks, including management of long-term responsibility, lack of transport infrastructure networks, long-term storage integrity confidence, and uncertain public acceptance of CCS projects. A number of large scale integrated projects have been cancelled over the past several years, both in the US and other parts of the world, generally citing all or a combination of the aforementioned challenges as barriers to the CCS project.*

CCS has been evaluated for the proposed project based on technological, environmental, and economic feasibility. In the guidance documents for GHG permitting, USEPA states[7]*:*

For the purpose of the BACT analysis for GHGs, EPA classifies CCS as an add-on pollution control technology that is "available" for facilities emitting CO_2 *in large amounts, including fossil fuel-fired power plants, and for industrial facilities with high-purity* CO_2 *streams (e.g., hydrogen production, ammonia production, natural gas processing, ethanol production, ethylene oxide production, cement production, and iron and steel manufacturing). For these types of facilities, CCS should be listed in Step 1 of the top-down BACT Analysis for GHGs.*

ExxonMobil does not agree with EPA's classification of CCS as "available" for any application other than processing produced natural gas. There are no global examples where capture of CO_2 *from a low pressure, low* CO_2 *concentration flue gas has been demonstrated at a scale and level of reliability necessary for application in a compliance-based scenario. The proposed project, with its numerous emission points and low* CO_2 *concentration, does not meet the criteria established in the above paragraph, nor does it meet any reasonable definition of BACT because CCS has not been demonstrated as an "available" and "applicable" technology for thermal oxidizers or a polyethylene unit or any similar applications. The proposed project is not analogous to a fossil fuel-fired power plant due to exhaust gas flow rate differences occurring from firing a power plant's turbine compared to controlling VOC emissions in a flameless thermal oxidizer. A fossil fuel-fired power plant stack volumetric flow rate is several orders of magnitude greater than a flameless thermal oxidizer represented in this permit application.*

Nor does the proposed project compare to an industrial facility with high-purity CO_2 *streams since the proposed project will construct several separate sources that will emit very low-purity* CO_2 *streams. The industrial facilities cited in the above USEPA example are similar to each other in that each has a limited number of stacks and the purity of the* CO_2 *for most is in the range of 65% (versus ~ 8 % for a boiler). A polyethylene unit is not a comparable process to hydrogen production, ammonia production, natural gas processing, ethanol production, ethylene oxide production, cement production, and iron and steel manufacturing*

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[7] *Office of Air Quality Planning and Standards, PSD and Title V Permitting Guidance for Greenhouse Gases, United States Environmental Protection Agency, Page 32, March 2011.*

by any measure, especially regarding the purity of the CO_2 in the stack, which is less than 8%. USEPA specifically cited CCS technology as "available" for the power plant and high-purity industrial facility streams simply because these are the applications that are either most impactful to reduce total US GHG emissions (in the case of fossil fuel-fired power plants) or may be best suited for CCS technology applications (in the case of hydrogen production, ammonia production, natural gas processing, ethanol production, ethylene oxide production, cement production, and iron and steel manufacturing) when only CO_2 source gas characteristics are evaluated. CCS is not applicable to polyethylene units because of the low purity CO_2-containing streams emitted from multiple stacks across the facility.

While specific component CCS technologies exist and have been in use for decades, integrated CCS facilities at the necessary scale for a polyethylene unit have not been demonstrated and do not currently exist at any scale. The following subsections describe the specific technologies comprising CCS and detail the specific barriers each pose to the proposed project and highlight why CCS is not an available or applicable technology for the proposed project.

Carbon Capture

While several technologies for the post-combustion capture of low-pressure, low-concentration CO_2 may be in development, none have been demonstrated at the scale of the proposed project nor for sources at natural gas fired facilities. Carbon capture for the proposed project would require FOAK technology application that is further complicated by the numerous emission points within the polyethylene unit. Any CCS technology will result in additional equipment, operating complexity, and increased energy consumption to operate the add-on equipment. Additional equipment would increase the energy and fuel demand and significantly increase the size of the power generation system, which would lead to more air pollution and wastewater generation at the site.

Further, as stated in the August 2010 Report of the Interagency Task Force on Carbon Capture and Storage[8]:

> *"Current technologies could be used to capture CO_2 from new and existing fossil energy power plants; however, they are not ready for widespread implementation primarily because they have not been demonstrated at the scale necessary to establish confidence for power plant application. Since the CO_2 capture capacities used in current industrial processes are generally much smaller than the capacity required for the purposes of GHG emissions mitigation at a typical power plant, there is considerable uncertainty associated with capacities at volumes necessary for commercial deployment."*

Recovery and purification of CO_2 from the FTOs and boilers flue gas would require significant additional processing to achieve the necessary CO_2 concentration for effective

[8] President Obama's Interagency Task Force on Carbon Capture and Storage, Report of the Interagency Task Force on Carbon Capture and Storage, August 2010, p. 50.

storage. The proposed project's exhaust streams are not high-purity streams, as recommended in USEPA's guidance. Instead, the exhausts contains less than eight (8) vol% CO_2 in the stack gas on an average annual basis, and would have to be purified and dried to a purity of over 98%. The stream would also require complex cooling systems prior to separation, compression, and transport. Therefore, the recovery and purification of CO_2 from the stack gases would necessitate significant additional processing, including energy and cooling water, and environmental/air quality penalties, to achieve the necessary CO_2 concentration for effective storage.

Once separated, the CO_2 must be compressed, requiring significant additional inputs of energy to accomplish compression of the low pressure CO_2 gas to a supercritical fluid, which is equivalent to a pressure increase of approximately 2,200 psia. This is a complicated process that requires complex equipment with numerous stages of compression integrated with heat removal.

Transport

Once the CO_2 is supercritical, it must be transported to a suitable site for storage or sequestration. Transport via pipeline is the only feasible transportation method for CO_2 recovered from MBPP due to the volumes involved. There is only one CO_2 pipeline located within a reasonable proximity to MBPP and it is owned and operated by Denbury Resources. The Denbury Green Pipeline is located approximately 20 miles from MBPP; however, there is no existing or planned pipeline that would connect the Denbury Green Pipeline to MBPP.

It is unknown at this time whether Denbury could or would accept CO_2 from the proposed project, if a pipeline were to be constructed, however, for the purposes of the economic analysis, it has been assumed that a contract would be secured from Denbury Resources and all recovered CO_2 from the proposed project would be accepted into the Green Pipeline.

Storage

Once the CO_2 is captured, it must be stored in a stable and secure reservoir or geologic formation that is not susceptible to acidic erosion. While a case specific evaluation has not been conducted, it is likely suitable storage reservoirs could be found within a reasonable proximity to MBPP. There are multiple mature oil and gas fields that could be suitable targets for enhanced oil recovery projects or that could have suitable brine formations either below or above know productions zones, that could serve as storage reservoirs. These sites however would require intensive evaluation and would very likely require substantial remedial work to provide the high degree of site and formation integrity necessary for secure storage. One of the biggest challenges that can be expected is the necessity of identifying old wells and ensuring they are securely plugged. Since a specific site has not been identified, estimating the technical feasibility and costs of this option is difficult and highly uncertain since a well that meets Class VI requirements under the UIC regulations would have to be identified and secured for the proposed project. Other potential storage sites that may be available are located in the Permian Basin, but are more than 470 miles from the proposed project site and there are no existing connecting CO_2 pipelines to this location from MBPP.

Economic Analysis

Although CCS is not technically or environmentally feasible for the proposed project, a site-specific CCS economic analysis was completed at the request of USEPA. A carbon capture and compression plant was specified with cost estimates by an ExxonMobil Research and Engineering Team specializing in CCS technologies. The Team determined that an amine absorber system with regeneration facilities and CO_2 compression would need to be located in a central location to the proposed project's sources and to the required utility plan, which would be required to meet the steam and power requirements for the CO_2 Capture Plant. This utility plant would generate its own GHG emissions. The CCS design therefore includes capture of CO_2 from the FTOs and boilers exhaust stacks as well as the additional CO_2 emissions generated by the utility plant. The system would be designed to achieve ~90% recovery of CO_2 from the exhaust gas. The CO_2 Capture Plant was specified to accept 226 tons of total FTO and boiler exhaust gas per hour to remove 20 total tons of CO_2 per hour due to the proposed project and 16 tons of total exhaust gas per hour to remove 2 tons of CO_2 per hour due to the dedicated utility plant. The additional power generated by this utility plant is exported as a credit to the operating cost of the utility plant.

The carbon capture and compression cost estimate represents the capital and operating expenses associated with the site-specific carbon capture plant. For purposes of the economic analysis below, it is assumed that a contract would be secured from Denbury Resources to accept CO_2 from MBPP, therefore, the transport costs are based on construction and operation and maintenance of a 20-mile pipeline that is eight inches in diameter. This represents an oversimplification of the complexities of the process that would be necessary to secure a long-term disposition for the captured CO_2. The cost estimates for transport and the liability estimate associated with storage were based on the Department of Energy's National Energy Technology Laboratory study "Estimating Carbon Dioxide Transport and Storage Costs", which was recently completed in 2010.

Note that the basis for the cost estimate for storage reflects an oversimplification of since it is a simple transfer of the recovered CO_2 to Denbury and does not estimate costs for items such as site screening and evaluation, injection well construction and equipment, pore space acquisition, and operating and maintenance costs, therefore this cost estimate is at the lowest possible level and may in fact be significantly underestimating the actual cost for storage if this technology were to be pursued. The cost represented for storage relates to liability, which was estimated at $5,000,000 per the DOE/NETL 2010 report.

As shown in Table 4-1, carbon capture for the proposed project is estimated to cost $366 per ton of CO_2 avoided or $50,800,000 annually to avoid ~90% of the CO_2 emissions from the sources and required utility plant. This cost includes operating and capital costs. The total cost for carbon capture is $208,300,000. This is an extraordinarily high cost and would render the proposed project economically unviable if selected.

Table 4-1 Economic Analysis for Carbon Capture and Compression

Cost Type	*Units[9]*	*Cost (millions $)*
Carbon Capture Plants - Capital and Operating Expense Estimation		
CO_2 Compressor and Intercoolers	*$ (millions)*	*32.9*
Amine Absorber System	*$ (millions)*	*61.3*
CO_2 Regeneration/Purification System	*$ (millions)*	*21.5*
Blower, Piping, and Ducting	*$ (millions)*	*14.8*
Utility Plant - Capital and Operating Expense Estimation		
New Utility Plant – Boiler, Boiler Feed Water Treatment and Blower	*$ (millions)*	*27.7*
Cooling Tower, Utilities Header and Piping	*$ (millions)*	*50.1*
Fuel, Utilities, Amine	*$ (millions) / yr*	*11.2*
Total Expense Estimation		
Operating Expense	*$ / Ton CO_2 Avoided*	*81*
Capital Expense	*$ / Ton CO_2 Avoided*	*285.1*
Total	***$ / Ton CO_2 Avoided***	***366.1***

[9] *All monetary estimations have been calculated in 2016 dollars.*

***Table 4-2 Economic Analysis for CO_2 Transport*[10]**

Cost Type	*Units*	*Cost Equation*	*Cost (millions)*
Pipeline Materials	*\$ Diameter (inches), Length (miles)*	$\$64,632 + \$1.85 \times L \times (330.5 \times D^2 + 686.7 \times D + 26,960)$	*2.0*
Pipeline Labor	*\$ Diameter (inches), Length (miles)*	$\$341,627 + \$1.85 \times L \times (343.2 \times D^2 + 2,074 \times D + 170,013)$	*8.1*
Pipeline Miscellaneous	*\$ Diameter (inches), Length (miles)*	$\$150,166 + \$1.58 \times L \times (8,417 \times D + 7,234)$	*2.5*
Pipeline Right of Way	*\$ Diameter (inches), Length (miles)*	$\$48,037 + \$1.20 \times L \times (577 \times D + 29,788)$	*0.9*
Pipeline Control System	*\$*		*0.11*
CO_2 Surge Tank	*\$*		*1.2*
Total Materials and Labor Estimation	*\$*		*14.8*
Operating and Maintenance Expense Estimation	*\$ / mile / year*	*\$8,632*	*3.5*
Total Expense Estimation	*\$*	.	*18.3*
Amortized Cost[11]	*\$/yr*		*3.6*
Total Cost per Ton of CO_2 Avoided			
Total Cost	*\$ / Ton CO_2 Avoided*	*25.9*	

The total estimated cost for CO_2 transport is \$3,600,000 per year or \$25.9 per ton of CO_2 avoided. This cost is for an eight-inch diameter pipeline 20 miles in length to transport supercritical CO_2 from MBPP to the Denbury Green Pipeline. The cost includes required materials and labor, equipment such as a surge tank and control system, right of way, construction, and operating and maintenance costs.

[10] *National Energy Technology Laboratory, Estimating Carbon Dioxide Transport and Storage Costs, United States Department of Energy, Page 5, DOE/NETL-2010/1447.*

[11] *A capital charge rate of 19% was assumed with an expected equipment life of 20 years.*

Table 4-3 Economic Analysis for CCS

CCS Technology for CO_2 Emissions	*Cost ($ per ton of CO_2 Avoided)*	*Tons of CO_2 Avoided per Year*[12]	***Total** Annualized Cost*[13] ***(Million $ per year)***
Capture and Compression	*$366.1*	*138,812*	*$50.8*
Transport	*$25.9*	*138,812*	*$3.6*
Storage	*$7.1*[14]	*138,812*	*$1.0*
Total CCS Cost	*$399.1*	*138,812*	*$55.4*

The total cost for capturing and compressing CO_2 generated by the proposed project, capturing and compressing CO_2 generated by the CO_2 capture equipment, transporting supercritical CO_2 20 miles, and providing liability coverage for storage of the project's CO_2 is estimated at $399.1 per ton of CO_2 avoided which equates to an annualized cost of $55,400,000 per year. An annualized CCS cost of $55.4 million dollars would render the proposed project unviable, even for this multi-million dollar investment proposed by ExxonMobil.

While CCS is a viable technology to mitigate CO_2 emissions within applicable industries, it is not an available or applicable technology for polyethylene units due to the low pressure, low CO_2 concentration streams that are distributed across multiple sources and the relatively small scale in comparison to a power plant. Based on the aforementioned technological and environmental challenges and the extraordinarily high annualized cost for capture, transport, and storage of CO_2, CCS as a combined technology is not considered technically, environmentally, or economically feasible for reducing GHG emissions from the proposed project. CCS is eliminated as a potential control option in the BACT analysis for CO_2 emissions from the proposed project.

10. On page 4-10 of the permit application, it is indicated that "energy efficiency is inherent in the operation of a RTO. Specific technologies include the following feed preheat, insulation of the RTO and improved process controls."

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[12] *This represents ~90% of the total CO_2 emissions from the proposed sources and utility plant.*

[13] *Total Annual Cost represents an amortized cost for the capital expenditure and operating and maintenance costs. A capital charge rate of 19% was assumed with an expected equipment life of 20 years.*

[14] *It is assumed that Denbury Resources will receive CO_2 from the proposed project and will incorporate the entire flow into its operations. Storage costs are therefore estimated to consist of liability, which is $5,000,000 per the DOE/NETL 2010 report.*

A. Please provide a comparison analysis of the proposed RTO's energy efficiency to similar or existing sources as previously mentioned in Comment 8A.

Response:

RTO is employed to ensure an absolute reduction in VOC released is achieved even in a low hydrocarbon content polyethylene unit product stream (~ 130 ppmv in residual hydrocarbon) as the resin is conveyed to the silos, after completing hydrocarbon purging in the process. The RTO was chosen to control this very lean hydrocarbon stream efficiently (achieve ~ 2 ppmv total hydrocarbon level in the exhaust from RTO). A regenerative thermal process is utilized whereby a cyclic heat recovery step is integrated into heating incoming feed gas with excess air to ensure complete and high efficiency combustion of the low hydrocarbon stream. This stream, in a typical Polymers plant would be vented to atmosphere without treatment. Thus deploying an RTO exceeds federal-level BACT for control of VOC.

The thermodynamic principle driving operation of the RTO is efficient heat transfer. As described in EPA's Air Pollution Control Technology Fact Sheet[15]:

> *RTOs use a high-density media such as a ceramic-packed bed still hot from a previous cycle to preheat an incoming VOC-laden waste gas stream. The preheated, partially oxidized gases then enter a combustion chamber where they are heated by auxiliary fuel (natural gas) combustion to a final oxidation temperature typically between 1,400 and 1,500 °F, and maintained at this temperature to achieve maximum destruction efficiency. The purified, hot gases exit this chamber and are directed to one or more different ceramic-packed beds cooled by an earlier cycle. Heat from the purified gases is absorbed by these beds before the gases are exhausted to the atmosphere. The reheated packed bed then begins a new cycle by heating a new incoming waste gas stream.*

The RTO designed for the proposed project includes the technologies described above by EPA:

> *The heat exchanger bed is comprised of separate sections, where alternately one part functions as cooling stage and the other as heating stage. The exhaust air passes vertically upward through the heat exchanger mass taking on the heat and raising the air temperature close to the oxidation of the pollutants at approximately 800 °C (1,472 °F). The hot purified gases pass downward through the other part of the heat exchanger mass transferring its energy back to the exchanger. This cools down the purified gases[16].*

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[15] *EPA website: http://www.epa.gov/ttn/catc/dir1/fregen.pdf accessed on October 24, 2012.*

Furthermore, the proposed RTO will be designed with a sophisticated air distribution system that will continuously control the alternating airflow through the individual heat exchanger sections. This replaces complicated damper mechanisms and eliminates difficulties with conventional design duct dampers. The benefits of the proposed RTO over other conventional RTOs include continuous air distribution instead of damper mechanisms, eliminates the need for compressed air, low wear and tear, and no pressure variations caused by switching operations. Although it cannot be quantified, a less complicated design with less moving parts and improved automation provides for a higher reliability and consistent operation of the RTO which results in improved energy efficiency. Also of note is that the alternative to this technology is incineration in order to achieve the high destruction efficiency for the low hydrocarbon content stream. Incineration is far more energy intensive than RTO, thereby generating more GHG emissions.

B. Please include a discussion on the automation of the RTO feed preheat system and operation parameters that will be monitored to ensure optimal heat transfer.

Response:

As described above, the proposed RTO will be designed with a sophisticated air distribution system that uses a rotating distributor to continuously control the alternating airflow through the individual heat exchanger sections. A computer control application manages the rotating distributor to ensure consistent operation. The operating parameter that will be monitored to ensure optimal heat transfer is temperature at the stack. Since supplemental fuel is required to maintain temperature at the reaction zone, the RTO will be managed such that temperature is maintained near its minimum during operation in order to minimize the amount of supplemental fuel required. In addition, exit temperature at stack shall be continuously monitored that shows the extent of heat recovery from exhaust gas. This optimization strategy will be integrated into the control application since supplemental fuel has an economic penalty associated with it.

C. Please provide supplemental data that will discuss the operating control parameters, i.e., oxygen monitors, air flow monitors, etc. Include a discussion on the control strategy that Exxon proposes for these operating parameters and how this strategy will translate to decreased CO_2 production. If possible, include comparison data to similarly operated sources.

Response:

Temperature is the key operating parameter that is monitored to indicate the performance of the RTO. A minimum operating temperature will be specified by vendor and/or by demonstration. The temperature will be continuously measured within the reactor and recorded. A computer control application will manage the operation of the RTO to ensure it operates within its performance targets. The control application optimizes the amount of supplemental fuel per the reaction zone temperature. It is not *economical or environmentally beneficial to operate the RTO at a higher temperature than required; therefore the control application optimizes the amount of supplemental fuel per the reaction zone temperature and maintains the temperature at the lowest temperature possible that ensures proper operation. In other words, the lower the temperature, the lower the supplemental fuel requirement and this is principle is that makes the RTO GHG efficient.*

ExxonMobil has extensive experience operating RTOs. For example, the Baton Rouge Chemical Plant operates a RTO that continually demonstrates a DRE of +99%. The computer control application manages the performance of the RTO to deliver optimized operation that meets all compliance requirements.

D. The RTO will control the residual VOC emissions from the powder hopper bag filter. On page 3-2 of the permit application, it is stated that "Annual emissions are based on 98% on-line reliability. When RTO is off-line, the vents will emit to atmosphere." Has this emission vent been considered in the GHG calculations? Please indicate the venting to atmosphere option on the process flow diagram for EPN: RUPK71.

Response:

The venting to atmosphere option was evaluated prior to application submittal and therefore included in the emission basis. This vent stream is only an emission source for GHG due to oxidation of VOC to CO_2. The vent stream does not contain any GHG constituents prior to oxidation. The RTO as a VOC control device achieves better than federal BACT emission reductions for VOC and is utilized due to the dilute nature of the vent stream.

Refer to Attachment 2 to this letter for a revised process flow diagram that includes the venting to atmosphere option.

11. On page 4-19 of the permit application, it states "the proposed project selects as-observed AVO as BACT for piping components in natural gas service and instrument LDAR for piping components in VOC service." Please supplement the 5-step BACT analysis with the LDAR programs that were evaluated for this project and a basis for the programs elimination. Please include the level of LDAR to be used.

Response:

Review of TCEQ's control efficiency table for applicable 28-series LDAR program shows that the 28LAER program has the highest overall control efficiency for components in VOC service. MBPP currently employs the 28VHP with CNQT program, which achieves 97% control efficiency for gas/vapor components in VOC service, which is equivalent to the most stringent program, 28LAER. Components in gas/vapor service would exclusively include components that may contain GHGs. The proposed project therefore ranks 28VHP with CNQT and 28LAER as LDAR programs that demonstrate the highest control efficiency for GHG-containing components. The instrument LDAR program chosen is 28VHP with CNQT since MBPP currently employs this LDAR program for components in VOC service.

An as-observed AVO program achieves a control efficiency equivalent to 28LAER; therefore, employing this program for components in non-VOC, natural gas service will meet or exceed BACT. Refer to Attachment 4 to this letter for a summary of the proposed work practice standards and operating limits for fugitive equipment components.

Additionally, the fugitive emission limits were removed from Table 3-1 Emission Point Summary since fugitive emissions are estimates only, are based on factors derived for a statistical sample, and are not specific to any single piping component or specifically for natural gas service; however, the TCEQ's 28VHP with CNQT and AVO LDAR programs are practically enforceable and are appropriate BACT requirements. Refer to Attachment 1 to this letter for the revised Table 3-1 Emission Point Summary and to Attachment 4 to this letter for a summary of the proposed work practice standards and operating limits for fugitive equipment components.

12. Being mindful of EPA's PSD and Title V Permitting Guidance for GHG data March, 2011 on page 17, which states the following:

    "The CAA and corresponding implementing regulations require that a permitting authority conduct a BACT analysis on a case-by-case basis, and the permitting authority must evaluate the amount of emissions reductions that each available emissions-reducing technology or technique would achieve, as well as the energy, environmental, economic and other costs associated with each technology or technique. Based on this assessment, the permitting authority must establish a numeric emissions limitation that reflects the maximum degree of reduction achievable for each pollutant subject to BACT through the application of the selected technology or technique. However, if the permitting authority determines that technical or economic limitations on the application of a measurement methodology would make a numerical emissions standard infeasible for one or more pollutants, it may establish design, equipment, work practices or operational standards to satisfy the BACT requirement."

    Please propose output based emission limitations or efficiency based limits for all PSD emission sources that are practically enforceable. Please provide an analysis that substantiates any reasons for infeasibility of a numerical emission limitation. For the emission sources where numerical emission limitations are infeasible, please propose an operating work practice standard that can be practically enforceable.

    Response:

    ExxonMobil has proposed annual numerical emission limits for each source in Table 3-1 Emission Point Summary contained in Attachment 1 to this letter. Table 3-2 located in Attachment 4 has been developed to summarize the proposed work practice standards and operating limits for the proposed project, which reflect appropriate short-term enforceable limits where feasible.

ATTACHMENT 1

- **Updated Table 3-1 Emission Point Summary**
- **Revised Fuel Compositions**
- **Emission Calculations**

Table 3-1
Emission Point Summary

Date:	November 2012	Permit No.:	TBD	Site Name:	Mt. Belvieu Plastics Plant
Company Name:	ExxonMobil Chemical Company			Project:	Polyethylene Unit

Air Contaminant Data					
Emission Point			Component or Air Contaminant Name	GHG Emission Rate (tons/yr)	CO_2e Emission Rate (ton/yr) [A]
EPN	FIN	Name			
3UF61A/B/C 3UFLARE62 3UFLARE63	3UF61A/B/C 3UFLARE62 3UFLARE63	Vent Collection System	CO_2	97,500	97,500
			N_2O	5	1,550
			CH_4	11	231
RUPK71	RUPK71	Regenerative Thermal Oxidizer	CO_2	2,221	2,221
			N_2O	1	310
			CH_4	1	21
PEXANALZ	PEXANALZ	Analyzers	CO_2	13	13
RUPK31/32	RUPK31/32	Boiler 31 / 32	CO_2	30,204	30,204
			N_2O	1	310
			CH_4	2	42
PEXFUGEM	PEXFUGEM	Fugitives	CO_2	2	2
			CH_4	17	357
PEXMSS	PEXMSS	Planned MSS	CO_2	19	19
			N_2O	1	310
			CH_4	1	21
Proposed Project Compliance Total			CO_2	129,959	129,959
			N_2O	8	2,480
			CH_4	32	672
			Total	129,999	133,111

[A] Air contaminant emission rates are contributions to the project CO_2e compliance total.

EPN = Emission Point Number
FIN = Facility Identification Number

ExxonMobil Chemical Company
Mt. Belvieu Plastics Plant
Vent Gas and Fuel Gas Heating Values and Compositions
Greenhouse Gas Emissions Calculations

REPRESENTATIVE VENT GAS TO FTO						
Constituent	Composition (mol%)	MW (lb/lbmol)	Composition (wt%)	HHV (Btu/lbmol)	HHV (Btu/scf)	Carbon Content (lb C / lb Constituent)
Hydrogen	0.1-1%	2.02	0.01-0.07%	123,364	320	0.00
Nitrogen	40-65%	28.01	35-61%	0	0	0.00
Methane	1-16%	16.04	1-8%	384,517	998	0.75
Ethene	28-30%	28.05	26-27%	574,308	1,490	0.86
Ethane	0.2-0.6%	30.07	0.2-0.6%	1,095,094	2,841	0.80
Butene	0.1-3%	56.11	0.1-4%	1,095,094	2,841	0.86
Butane	0.5-1%	58.12	1-3%	1,181,639	3,066	0.83
Isopentane	4-10%	72.15	9-21%	1,521,365	3,947	0.83
Hexane	0.1-0.2%	86.18	0.4-0.7%	1,807,569	4,690	0.84
Hexene Isomers	0.1-0.3%	84.16	0.3-0.9%	1,807,569	4,690	0.86
C8+	< 0.1%	114.23	< 0.01%	1,807,569	4,690	0.84
Tetrahydrofuran	< 0.2%	72.11	< 0.2%	1,089,075	2,826	0.67
Toluene	< 0.2%	92.13	< 0.2%	1,702,046	4,416	0.91
CO	0.00%	28.01	0.00%	122,225	317	0.43
CO2	0.00%	44.01	0.00%	0	0	0.27

REPRESENTATIVE VENT GAS TO ELEVATED FLARE						
Constituent	Composition (mol%)	MW (lb/lbmol)	Composition (wt%)	HHV (Btu/lbmol)	HHV (Btu/scf)	Carbon Content (lb C / lb Constituent)
Hydrogen	1%	2.02	0.11-0.12%	123,364	320	0.00
Nitrogen	39-50%	28.01	62-72%	0	0	0.00
Methane	1-15%	16.04	1-14%	384,517	998	0.75
Ethene	29-31%	28.05	45-47%	574,308	1,490	0.86
Ethane	0.2-0.4%	30.07	0-1%	1,095,094	2,841	0.80
Butene	2-2.1%	56.11	6-6.7%	1,095,094	2,841	0.86
Butane	1-1.6%	58.12	3-5%	1,181,639	3,066	0.83
Isopentane	10.6-11.4%	72.15	36-37%	1,521,365	3,947	0.83
Hexene	0.8-1%	84.16	4-5%	1,807,569	4,690	0.86
Hexane	0.2-0.4%	86.18	1-2%	1,807,569	4,690	0.84
Hexene Isomers	0.34-0.36%	84.16	1.59-1.61%	1,807,569	4,690	0.86
C8+	0%	114.23	0%	1,807,569	4,690	0.84
Tetrahydrofuran	0-0.1%	72.11	0-0.4%	1,089,075	2,826	0.67
Toluene	0-0.1%	92.13	0-0.4%	1,702,046	4,416	0.91

Note(s): The values represented in these tables are estimates only and are not values upon which compliance shall be based.

REPRESENTATIVE VENT GAS TO RTO INCLUDING ASSIST AND PILOT GAS						
Constituent	Composition (mol%)	MW (lb/lbmol)	Composition (wt%)	HHV (Btu/lbmol)	HHV (Btu/scf)	Carbon Content (lb C / lb Constituent)
Butene	< 0.01%	56.11	< 0.02%	1,170,631	3,037	0.86
Hexene	< 0.02%	84.16	< 0.1%	1,807,569	4,690	0.86
THF	< 0.002%	72.11	< 0.01%	1,164,557	3,021	0.67
Toluene	< 0.001%	92.13	< 0.01%	1,702,046	4,416	0.91
Oxygen	0-21%	32.00	0-23%	0	0	0.00
Nitrogen	0.3-79%	28.01	1-76%	0	0	0.00
Methane	0.5-96%	16.04	0.3-90%	384,517	998	0.75
C5+ (as Hexane)	0.001-0.1%	86.18	0.002-1%	1,807,569	4,690	0.84
Ethane	0.01-2%	30.07	0.01-3%	680,211	1,765	0.80
Ethylene	0%	28.05	0%	612,645	1,590	0.86
Propane	0.002-0.3%	44.10	0.003-1%	983,117	2,551	0.82
Butane	0.001-0.2%	58.12	0.002-1%	1,279,191	3,319	0.83
CO	0%	28.01	0%	122,225	317	0.43
CO2	0.01-2%	44.01	0.01-4%	0	0	0.27

REPRESENTATIVE VENT GAS TO MULTI-POINT GROUND FLARE						
Constituent	Composition (mol%)	MW (lb/lbmol)	Composition (wt%)	HHV (Btu/lbmol)	HHV (Btu/scf)	Carbon Content (lb C / lb Constituent)
Hydrogen	0-0.3%	2.02	0-5%	123,364	320	0.00
Nitrogen	12-26%	28.01	17-29%	0	0	0.00
Ethene	25-34%	28.05	30-47%	574,308	1,490	0.86
Ethane	0-0.3%	30.07	0-0.3%	1,095,094	2,841	0.80
Butene	0-26%	56.11	0-15%	1,095,094	2,841	0.86
Butane	6-12%	58.12	5-6%	1,181,639	3,066	0.83
Isopentane	31-43%	72.15	15-23%	1,521,365	3,947	0.83
Hexene	0-8%	84.16	0-4%	1,807,569	4,690	0.86
Hexane	0-3%	86.18	0-2%	1,807,569	4,690	0.84
Other C6+	0-3%	84.16	0-2%	1,807,569	4,690	0.86
C8+	0%	114.23	0%	1,807,569	4,690	0.84
Tetrahydrofuran	0-0.1%	72.11	0-0.03%	1,089,075	2,826	0.67
Toluene	0-0.1%	92.13	0-0.03%	1,702,046	4,416	0.91

REPRESENTATIVE NATURAL GAS						
Constituent	Composition (mol%)	MW (lb/lbmol)	Composition (wt%)	HHV (Btu/lbmol)	HHV (Btu/scf)	Carbon Content (lb C / lb Constituent)
Hydrogen	0.0%	2.02	0.0%	123,364	320	0.00
Methane	96%	16.04	90%	384,517	998	0.75
Ethane	1.8%	30.07	3.2%	680,211	1,765	0.80
Ethylene	0.0%	28.05	0.0%	612,645	1,590	0.86
Propane	0.3%	44.10	0.9%	983,117	2,551	0.82
n-Butane	0.2%	58.12	0.6%	1,279,191	3,319	0.83
C5+ (as Hexane)	0.1%	86.18	0.7%	1,807,569	4,690	0.84
Nitrogen	0.3%	28.01	0.5%	0	0	0.00
CO	0.0%	28.01	0.0%	122,225	317	0.43
CO_2	1.6%	44.01	4.2%	0	0	0.27

Note(s): The values represented in these tables are estimates only and are not values upon which compliance shall be based.

ExxonMobil Chemical Company
Mt. Belvieu Plastics Plant
Flameless Thermal Oxidizer
Greenhouse Gas Emissions Calculations

Parameter Name & Variable	Value & Units	Basis/Calculation/Notes
1. General Values and Calculations		
Standard Molar Volume V_{MS}	385 scf/lb-mol	Based on ideal gas law
Avg. Heat Value of Vent Gas HV_{AVG}	639 Btu/scf	Calculated from representative stream speciation
Total Vent Gas Heat Input to Flameless Thermal Oxidizer H	1,167,003 MMBtu/yr	$= Q_V * HV_{AVG}$
Total Flameless Thermal Oxidizer Vent Gas Volume Flow Q_V	1,826 MMscf/yr	Based on expected firing rate
Avg. Molecular Weight of Vent Gas M_V	30.0 lb/lb-mol	Calculated from representative stream speciation
Carbon Content of Vent Gas F_{cc}	0.33 lb_C/lb_{Gas}	Calculated from representative stream speciation
2. CO_2 Emission Rate Calculations		
CO_2 Annual Emission Rate =	**86,613 TPY**	$= MW_{CO2}/MW_{Carbon} * Q_V * 10^6 * F_{CC} * M_V / V_{MS}$ / 2000 lb/ton Equation C-5
3. N_2O Emission Rate Calculations		
N_2O Emission Factor F_{N2O}	6.0E-04 kg/MMBtu	40 CFR 98, Table C-2
N_2O Annual Emission Rate =	**1 TPY**	$= H * F_{N2O} * 2.205$ lb/kg / 2000 lb/ton Equation C-8b
4. CH_4 Emission Rate Calculations		
CH_4 Emission Factor F_{CH4}	3.0E-03 kg/MMBtu	40 CFR 98, Table C-2
CH_4 Annual Emission Rate =	**4 TPY**	$= H * F_{CH4} * 2.205$ lb/kg / 2000 lb/ton Equation C-8b
5. CO_2e Emission Rate Calculations		
CO_2 CO_2e Factor Fe_{CO2}	1 ton_{CO2}/ton_{CO2e}	40 CFR 98, Table A-1
N_2O CO_2e Factor Fe_{N2O}	310 ton_{N2O}/ton_{CO2e}	40 CFR 98, Table A-1
CH_4 CO_2e Factor Fe_{CH4}	21 ton_{CH4}/ton_{CO2e}	40 CFR 98, Table A-1
CO_2e Annual Emission Rate =	**87,007 TPY**	$= \Sigma (TPY * Fe_x)$

Note(s): The operational parameters are estimated variables that result in the worst-case maximum allowable emission rates.

ExxonMobil Chemical Company
Mt. Belvieu Plastics Plant
Total Elevated Flare
Greenhouse Gas Emissions Calcuations

Parameter Name & Variable		Value & Units	Basis/Calculation/Notes
1. CO_2 Emission Rate Calculations			
CO_2 Flaring Annual Emission Rate	=	**3,494 TPY**	
CO_2 Pilot Gas Annual Emission Rate	=	**169 TPY**	
CO_2 Annual Emission Rate	=	**3,663 TPY**	Sum of annual CO_2 emissions from all streams
2. N_2O Emission Rate Calculations			
N_2O Flaring Annual Emission Rate	=	**1 TPY**	
N_2O Pilot Gas Annual Emission Rate	=	**1 TPY**	
N_2O Annual Emission Rate	=	**2 TPY**	Sum of annual N_2O emissions from all streams
3. CH_4 Emission Rate Calculations			
CH_4 Flaring Annual Emission Rate	=	**1 TPY**	
CH_4 Pilot Gas Annual Emission Rate	=	**2 TPY**	
CH_4 Annual Emission Rate	=	**3 TPY**	Sum of annual CH_4 emissions from all streams
4. CO_2e Emission Rate Calculations			
CO_2 CO_2e Factor	Fe_{CO2}	1 ton_{CO2}/ton_{CO2e}	40 CFR 98, Table A-1
N_2O CO_2e Factor	Fe_{N2O}	310 ton_{N2O}/ton_{CO2e}	40 CFR 98, Table A-1
CH_4 CO_2e Factor	Fe_{CH4}	21 ton_{CH4}/ton_{CO2e}	40 CFR 98, Table A-1
CO_2e Annual Emission Rate	=	**4,346 TPY**	$= \Sigma$ (TPY * Fe_x)

Note(s): The operational parameters are estimated variables that result in the worst-case maximum allowable emission rates.

ExxonMobil Chemical Company
Mt. Belvieu Plastics Plant
Vent Gas to the Elevated Flare
Greenhouse Gas Emissions Calculations

Parameter Name & Variable		Value & Units	Basis/Calculation/Notes
1. General Values and Calculations			
Standard Molar Volume	V_{MS}	385 scf/lb-mol	Based on ideal gas law
Total Flare Vent Gas Volume Flow	Q_V	45 MMscf/yr	Based on expected flaring rate
Avg. Molecular Weight of Vent Gas	M_V	38.1 lb/lb-mol	Calculated from representative stream speciation
Avg. Carbon Content of Vent Gas	CC_{gas}	0.44 lb_C/lb_{gas}	Calculated from representative stream speciation
CO_2 Emission Factor	F_{CO2}	60 kg/MMBtu	40 CFR 98 Subpart Y
Flare Efficiency	Eff	98%	Based on process knowledge
Flare Efficiency Correction Factor	C_F	0.02	Calculated based on 40 CFR 98 Subpart Y
2. CO_2 Emission Rate Calculations			
CO_2 Annual Emission Rate	=	**3,494 TPY**	= Eff * MW_{CO2} / MW_C * Q_V * 10^6 * M_V / V_{MS} * CC_{gas} / 2000 lb/ton Equation Y-1a
3. N_2O Emission Rate Calculations			
N_2O Emission Factor	F_{N2O}	6.0E-04 kg/MMBtu	40 CFR 98 Subpart Y
N_2O Annual Emission Rate	=	**1 TPY**	= CO_2 TPY * F_{N2O} / F_{CO2} Equation Y-5
4. CH_4 Emission Rate Calculations			
CH_4 Emission Factor	F_{CH4}	3.0E-03 kg/MMBtu	40 CFR 98 Subpart Y
Wt. fraction of carbon in fuel gas from CH_4	f_{CH4}	7.53E-05	Calculated from representative stream speciation
CH_4 Annual Emission Rate	=	**1 TPY**	= (CO_2 TPY * F_{CH4} / F_{CO2}) + (CO_2 TPY * C_F * MW_{CH4}/MW_{CO2} * f_{CH4}) Equation Y-4
5. CO_2e Emission Rate Calculations			
CO_2 CO_2e Factor	Fe_{CO2}	1 ton_{CO2}/ton_{CO2e}	40 CFR 98, Table A-1
N_2O CO_2e Factor	Fe_{N2O}	310 ton_{N2O}/ton_{CO2e}	40 CFR 98, Table A-1
CH_4 CO_2e Factor	Fe_{CH4}	21 ton_{CH4}/ton_{CO2e}	40 CFR 98, Table A-1
CO_2e Annual Emission Rate	=	**3,825 TPY**	= Σ (TPY * Fe_x)

Note(s): The operational parameters are estimated variables that result in the worst-case maximum allowable emission rates.

ExxonMobil Chemical Company
Mt. Belvieu Plastics Plant
Pilot Gas to the Elevated Flare
Greenhouse Gas Emissions Calculations

Parameter Name & Variable	Value & Units	Basis/Calculation/Notes
1. General Values and Calculations		
Standard Molar Volume V_{MS}	385 scf/lb-mol	Based on ideal gas law
Total Flare Natural Gas Volume Flow Q_V	333 scf/hr	Design rate
Avg. Molecular Weight of Pilot Gas M_V	17.0 lb/lb-mol	Calculated from representative stream speciation
Avg. Carbon Content of Pilot Gas CC_{gas}	0.73 lb_C/lb_{gas}	Calculated from representative stream speciation
CO_2 Emission Factor F_{CO2}	60 kg/MMBtu	40 CFR 98 Subpart Y
Flare Efficiency Eff	98%	Based on process knowledge
Flare Efficiency Correction Factor C_F	0.02	Calculated based on 40 CFR 98 Subpart Y
Annual Period of Pilot Gas Flaring t	8,760 hr/yr	Based on expected normal firing hours
2. CO_2 Emission Rate Calculations		
CO_2 Annual Emission Rate =	**169 TPY**	= Eff * MW_{CO2} / MW_C * Q_V * t * M_V / V_{MS} * CC_{gas} / 2000 lb/ton Equation Y-1a
3. N_2O Emission Rate Calculations		
N_2O Emission Factor F_{N2O}	1.0E-04 kg/MMBtu	40 CFR 98 Subpart Y
N_2O Annual Emission Rate =	**1 TPY**	= CO_2 TPY * F_{N2O} / F_{CO2} Equation Y-5
4. CH_4 Emission Rate Calculations		
CH_4 Emission Factor F_{CH4}	1.0E-03 kg/MMBtu	40 CFR 98 Subpart Y
Wt. fraction of carbon in fuel gas from CH_4 f_{CH4}	0.93	Calculated from representative stream speciation
CH_4 Annual Emission Rate =	**2 TPY**	= (CO_2 TPY * F_{CH4} / F_{CO2}) + (CO_2 TPY * CF * MW_{CH4}/MW_{CO2} * f_{CH4}) Equation Y-4
5. CO_2e Emission Rate Calculations		
CO_2 CO_2e Factor Fe_{CO2}	1 ton_{CO2}/ton_{CO2e}	40 CFR 98, Table A-1
N_2O CO_2e Factor Fe_{N2O}	310 ton_{N2O}/ton_{CO2e}	40 CFR 98, Table A-1
CH_4 CO_2e Factor Fe_{CH4}	21 ton_{CH4}/ton_{CO2e}	40 CFR 98, Table A-1
CO_2e Annual Emission Rate =	**521 TPY**	= Σ (TPY * Fe_i)

Note(s): The operational parameters are estimated variables that result in the worst-case maximum allowable emission rates.

ExxonMobil Chemical Company
Mt. Belvieu Plastics Plant
Total Multi-Point Ground Flare
Greenhouse Gas Emissions Calculations

Parameter Name & Variable		Value & Units	Basis/Calculation/Notes
1. CO_2 Emission Rate Calculations			
CO_2 Flaring Annual Emission Rate	=	5,650 TPY	
CO_2 Pilot Gas Annual Emission Rate	=	1,574 TPY	
CO_2 Annual Emission Rate	=	7,224 TPY	Sum of annual CO_2 emissions from all streams
2. N_2O Emission Rate Calculations			
N_2O Flaring Annual Emission Rate	=	**1 TPY**	
N_2O Pilot Gas Annual Emission Rate	=	**1 TPY**	
N_2O Annual Emission Rate	=	2 TPY	Sum of annual N_2O emissions from all streams
3. CH_4 Emission Rate Calculations			
CH_4 Flaring Annual Emission Rate	=	1 TPY	
CH_4 Pilot Gas Annual Emission Rate	=	**3 TPY**	
CH_4 Annual Emission Rate	=	**4 TPY**	Sum of annual CH_4 emissions from all streams
4. CO_2e Emission Rate Calculations			
CO_2 CO_2e Factor	Fe_{CO2}	1 ton_{CO2}/ton_{CO2e}	40 CFR 98, Table A-1
N_2O CO_2e Factor	Fe_{N2O}	310 ton_{N2O}/ton_{CO2e}	40 CFR 98, Table A-1
CH_4 CO_2e Factor	Fe_{CH4}	21 ton_{CH4}/ton_{CO2e}	40 CFR 98, Table A-1
CO_2e Annual Emission Rate	=	**7,928 TPY**	$= \Sigma$ (TPY * Fe_x)

Note(s): The operational parameters are estimated variables that result in the worst-case maximum allowable emission rates.

ExxonMobil Chemical Company
Mt. Belvieu Plastics Plant
Vent Gas to the Multi-Point Ground Flare
Greenhouse Gas Emissions Calculations

Parameter Name & Variable		Value & Units	Basis/Calculation/Notes
1. General Values and Calculations			
Standard Molar Volume	V_{MS}	385 scf/lb-mol	Based on ideal gas law
Total Flare Vent Gas Volume Flow	Q_V	38 MMscf/yr	Based on expected flaring rate
Avg. Molecular Weight of Vent Gas	M_V	42.7 lb/lb-mol	Calculated from representative stream speciation
Avg. Carbon Content of Vent Gas	CC_{gas}	0.73 lb_C/lb_{gas}	Calculated from representative stream speciation
CO_2 Emission Factor	F_{CO2}	60 kg/MMBtu	40 CFR 98 Subpart Y
Flare Efficiency	Eff	99.5%	Based on process knowledge
Flare Efficiency Correction Factor	C_F	0.005	Calculated based on 40 CFR 98 Subpart Y
2. CO_2 Emission Rate Calculations			
CO_2 Annual Emission Rate	**=**	**5,650 TPY**	$= Eff * MW_{CO2} / MW_C * Q_V * 10^6 * M_V / V_{MS} * CC_{gas} / 2000$ lb/ton Equation Y-1a
3. N_2O Emission Rate Calculations			
N_2O Emission Factor	F_{N2O}	6.0E-04 kg/MMBtu	40 CFR 98 Subpart Y
N_2O Annual Emission Rate	**=**	**1 TPY**	$= CO_2\ TPY * F_{N2O} / F_{CO2}$ Equation Y-5
4. CH_4 Emission Rate Calculations			
CH_4 Emission Factor	F_{CH4}	3.0E-03 kg/MMBtu	40 CFR 98 Subpart Y
Wt. fraction of carbon in fuel gas from CH_4	f_{CH4}	0	Calculated from representative stream speciation
CH_4 Annual Emission Rate	**=**	**1 TPY**	$= (CO_2\ TPY * F_{CH4} / F_{CO2}) + (CO_2\ TPY * C_F * MW_{CH4}/MW_{CO2} * f_{CH4})$ Equation Y-4
5. CO_2e Emission Rate Calculations			
CO_2 CO_2e Factor	Fe_{CO2}	1 ton_{CO2}/ton_{CO2e}	40 CFR 98, Table A-1
N_2O CO_2e Factor	Fe_{N2O}	310 ton_{N2O}/ton_{CO2e}	40 CFR 98, Table A-1
CH_4 CO_2e Factor	Fe_{CH4}	21 ton_{CH4}/ton_{CO2e}	40 CFR 98, Table A-1
CO_2e Annual Emission Rate	**=**	**5,981 TPY**	$= \Sigma\ (TPY * Fe_i)$

Note(s): The operational parameters are estimated variables that result in the worst-case maximum allowable emission rates.

ExxonMobil Chemical Company
Mt. Belvieu Plastics Plant
Pilot Gas to the Multi-Point Ground Flare
Greenhouse Gas Emissions Calculations

Parameter Name & Variable		Value & Units	Basis/Calculation/Notes
1. General Values and Calculations			
Standard Molar Volume	V_{MS}	385 scf/lb-mol	Based on ideal gas law
Total Flare Natural Gas Volume Flow	Q_V	3,060 scf/hr	Design rate
Avg. Molecular Weight of Pilot Gas	M_V	17.0 lb/lb-mol	Calculated from representative stream speciation
Avg. Carbon Content of Pilot Gas	CC_{gas}	0.73 lb_C/lb_{gas}	Calculated from representative stream speciation
CO_2 Emission Factor	F_{CO2}	60 kg/MMBtu	40 CFR 98 Subpart Y
Flare Efficiency	Eff	99.5%	Based on process knowledge
Flare Efficiency Correction Factor	C_F	0.005	Calculated based on 40 CFR 98 Subpart Y
Annual Period of Pilot Gas Flaring	t	8,760 hr/yr	Based on expected normal firing hours
2. CO_2 Emission Rate Calculations			
CO_2 Annual Emission Rate	=	**1,574 TPY**	$= Eff * MW_{CO2} / MW_C * Q_V * t * M_V / V_{MS} * CC_{gas} / 2000$ lb/ton Equation Y-1a
3. N_2O Emission Rate Calculations			
N_2O Emission Factor	F_{N2O}	1.0E-04 kg/MMBtu	40 CFR 98 Subpart Y
N_2O Annual Emission Rate	=	**1 TPY**	$= CO_2\ TPY * F_{N2O} / F_{CO2}$ Equation Y-5
4. CH_4 Emission Rate Calculations			
CH_4 Emission Factor	F_{CH4}	1.0E-03 kg/MMBtu	40 CFR 98 Subpart Y
Wt. fraction of carbon in fuel gas from CH_4	f_{CH4}	0.93	Calculated from representative stream speciation
CH_4 Annual Emission Rate	=	**3 TPY**	$= (CO_2\ TPY * F_{CH4} / F_{CO2}) + (CO_2\ TPY * CF * MW_{CH4}/MW_{CO2} * f_{CH4})$ Equation Y-4
5. CO_2e Emission Rate Calculations			
CO_2 CO_2e Factor	Fe_{CO2}	1 ton_{CO2}/ton_{CO2e}	40 CFR 98, Table A-1
N_2O CO_2e Factor	Fe_{N2O}	310 ton_{N2O}/ton_{CO2e}	40 CFR 98, Table A-1
CH_4 CO_2e Factor	Fe_{CH4}	21 ton_{CH4}/ton_{CO2e}	40 CFR 98, Table A-1
CO_2e Annual Emission Rate	=	**1,947 TPY**	$= \Sigma\ (TPY * Fe_i)$

Note(s): The operational parameters are estimated variables that result in the worst-case maximum allowable emission rates.

ExxonMobil Chemical Company
Mt. Belvieu Plastics Plant
Regenerative Thermal Oxidizer
Greenhouse Gas Emissions Calculations

Parameter Name & Variable	Value & Units	Basis/Calculation/Notes
1. General Values and Calculations		
Standard Molar Volume V_{MS}	385 scf/lb-mol	Based on ideal gas law
Avg. Heat Value of Vent Gas HV_{AVG}	5.7 Btu/scf	Calculated from representative stream speciation
Total Vent Gas Heat Input to Regenerative Thermal Oxidizer H	37,070.8 MMBtu/yr	$= Q_V * HV_{AVG}$
Total Regenerative Thermal Oxidizer Vent Gas Volume Flow Q_V	6,516 MMscf/yr	Based on expected firing rate
Avg. Molecular Weight of Vent Gas M_V	28.8 lb/lb-mol	Calculated from representative stream speciation
Carbon Content of Vent Gas F_{cc}	0.002 lb_C/lb_{Gas}	Calculated from representative stream speciation
2. CO_2 Emission Rate Calculations		
CO_2 Annual Emission Rate =	**2,221 TPY**	$= MW_{CO2}/MW_{Carbon} * Q_V * 10^6 * F_{CC} * M_V / V_{MS}$ / 2000 lb/ton Equation C-5
3. N_2O Emission Rate Calculations		
N_2O Emission Factor F_{N2O}	6.0E-04 kg/MMBtu	40 CFR 98, Table C-2
N_2O Annual Emission Rate =	**1 TPY**	$= H * F_{N2O} * 2.205$ lb/kg / 2000 lb/ton Equation C-8b
4. CH_4 Emission Rate Calculations		
CH_4 Emission Factor F_{CH4}	3.0E-03 kg/MMBtu	40 CFR 98, Table C-2
CH_4 Annual Emission Rate =	**1 TPY**	$= H * F_{CH4} * 2.205$ lb/kg / 2000 lb/ton Equation C-8b
5. CO_2e Emission Rate Calculations		
CO_2 CO_2e Factor Fe_{CO2}	1 ton_{CO2}/ton_{CO2e}	40 CFR 98, Table A-1
N_2O CO_2e Factor Fe_{N2O}	310 ton_{N2O}/ton_{CO2e}	40 CFR 98, Table A-1
CH_4 CO_2e Factor Fe_{CH4}	21 ton_{CH4}/ton_{CO2e}	40 CFR 98, Table A-1
CO_2e Annual Emission Rate =	**2,552 TPY**	$= \Sigma (TPY * Fe_x)$

Note(s): The operational parameters are estimated variables that result in the worst-case maximum allowable emission rates.

Analyzers

Greenhouse Gas Emissions Calculations

Parameter Name & Variable		Value & Units	Basis/Calculation/Notes
1. General Values and Calculations			
Vent Flow Rate	F_V	0.012 ft^3/min	Based on process knowledge
No. of Analyzers	A	35	
Vapor Density	d_V	0.08 lb/ft^3	Based on ideal gas law
Total Analyzer Gas Volume Flow	Q_V	2.024 lb/hr	$= F_V * A * d_V * 60$ min/hr
Molecular Weight of Gas	M_V	31 lb/lbmol	Based on process knowledge
Destruction Efficiency of Analyzers	DRE	98%	Based on process knowledge
Annual Period of Operation	t	8,760 hr/yr	Based on expected operating hours
2. CO_2 Emission Rate Calculations			
CO_2 Annual Emission Rate	=	**13 TPY**	$= Q_V * MW_{Carbon} / M_V * DRE * t / 2000$ lb/ton; conservatively assumes [VOC] = 100%
3. CO_2e Emission Rate Calculations			
CO_2 CO_2e Factor	Fe_{CO2}	1 ton_{CO2}/ton_{CO2e}	40 CFR 98, Table A-1
CO_2e Annual Emission Rate	=	**13 TPY**	$= \Sigma (TPY * Fe_x)$

Note(s): The operational parameters are estimated variables that result in the worst-case maximum allowable emission rates.

ExxonMobil Chemical Company
Mt. Belvieu Plastics Plant
Boiler Firing
Greenhouse Gas Emissions Calculations

Parameter Name & Variable		Value & Units	Basis/Calculation/Notes
1. General Values and Calculations			
Standard Molar Volume	V_{MS}	385 scf/lb-mol	Based on ideal gas law
Avg. Heat Value of Fuel Gas	HV_{AVG}	1,006 Btu/scf	Calculated from representative stream speciation
Total Fuel Gas Heat Input to Boilers	H	515,088 MMBtu/yr	Based on expected firing rate
Total Boilers Fuel Gas Volume Flow	Q_V	512 MMscf/yr	Based on expected firing rate
Avg. Molecular Weight of Fuel Gas	M_V	17.0 lb/lb-mol	Calculated from representative stream speciation
Carbon Content of Fuel Gas	F_{cc}	0.727 lb_C/lb_{Gas}	Calculated from representative stream speciation
2. CO_2 Emission Rate Calculations			
CO_2 Annual Emission Rate	=	**30,204 TPY**	= $MW_{CO2}/MW_{Carbon} * Q_V * F_{CC} * M_V / V_{MS}$ / 2000 lb/ton Equation C-5
3. N_2O Emission Rate Calculations			
N_2O Emission Factor	F_{N2O}	6.0E-04 kg/MMBtu	40 CFR 98, Table C-2
N_2O Annual Emission Rate	=	**1 TPY**	= $H * F_{N2O}$ * 2.205 lb/kg / 2000 lb/ton Equation C-8b
4. CH_4 Emission Rate Calculations			
CH_4 Emission Factor	F_{CH4}	3.0E-03 kg/MMBtu	40 CFR 98, Table C-2
CH_4 Annual Emission Rate	=	**2 TPY**	= $H * F_{CH4}$ * 2.205 lb/kg / 2000 lb/ton Equation C-8b
5. CO_2e Emission Rate Calculations			
CO_2 CO_2e Factor	Fe_{CO2}	1 ton_{CO2}/ton_{CO2e}	40 CFR 98, Table A-1
N_2O CO_2e Factor	Fe_{N2O}	310 ton_{N2O}/ton_{CO2e}	40 CFR 98, Table A-1
CH_4 CO_2e Factor	Fe_{CH4}	21 ton_{CH4}/ton_{CO2e}	40 CFR 98, Table A-1
CO_2e Annual Emission Rate	=	**30,556 TPY**	= Σ (TPY * Fe_x)

Note(s): The operational parameters are estimated variables that result in the worst-case maximum allowable emission rates.

Estimated Fugitive Sources

Greenhouse Gas Emissions Calculations

Parameter Name & Variable		Value & Units	Basis/Calculation/Notes
1. General Values and Calculations			
Annual Period of Usage	t	8,760 hr/yr	Based on expected operating hours
2. CO_2 Emission Rate Calculations			
CO_2 Annual Emission Rate	=	2 TPY	= lb/hr rate * t / 2,000 lb/ton
3. CH_4 Emission Rate Calculations			
CH_4 Annual Emission Rate	**=**	**17 TPY**	= lb/hr rate * t / 2,000 lb/ton
4. CO_2e Emission Rate Calculations			
CO_2 CO_2e Factor	Fe_{CO2}	1 ton_{CO2}/ton_{CO2e}	40 CFR 98, Table A-1
CH_4 CO_2e Factor	Fe_{CH4}	21 ton_{CH4}/ton_{CO2e}	40 CFR 98, Table A-1
CO_2e Annual Emission Rate	=	359 TPY	= Σ (TPY * Fe_i)

Component Name	Stream Type		CH_4 Component Count	CO_2 Component Count	Emission Factors (lb/hr-count)	CH_4 Control Efficiency (%)	CO_2 Control Efficiency (%)	CH_4 Emissions (tpy)	CO_2 Emissions (tpy)
Valve	Gas/Vapor	with Ethylene	0	0	0.0258	97	0	0.00	0.00
		w/o Ethylene	443	0	0.0089	97	0	0.52	0.00
		Average	0	0	0.0132	97	0	0.00	0.00
	LL	with Ethylene	0	0	0.0459	97	0	0.00	0.00
		w/o Ethylene	0	0	0.0035	97	0	0.00	0.00
		Average	0	0	0.0089	97	0	0.00	0.00
	HL	w/o Ethylene	-	-	0.0007	0	0	-	-
Non-Insulated Flanges	Gas/Vapor	with Ethylene	0	0	0.0053	30	0	0.00	0.00
		w/o Ethylene	1798	80	0.0029	30	0	15.99	1.02
		Average	0	0	0.0039	30	0	0.00	0.00
	LL	with Ethylene	0	0	0.0052	30	0	0.00	0.00
		w/o Ethylene	0	0	0.0005	30	0	0.00	0.00
		Average	0	0	0.0005	30	0	0.00	0.00
	HL	w/o Ethylene	-	-	0.00007	30	0	-	-
Pump Seals	LL	with Ethylene	0	0	0.1440	100	0	0.00	0.00
		w/o Ethylene	0	0	0.0386	100	0	0.00	0.00
		Average	0	0	0.0439	100	0	0.00	0.00
	HL	with Ethylene	-	-	0.0046	100	0	-	-
		w/o Ethylene	-	-	0.0161	100	0	-	-
		Average	-	-	0.0190	100	0	-	-
Agitator	LL	w/o Ethylene	0	0	0.0386	100	0	0.00	0.00
Compressor Seals	All	All	0	0	0.5027	100	0	0.00	0.00
Relief Valve	All	All	5	0	0.2293	100	0	0.09	0.09
Open-ended Lines	All	with Ethylene	-	-	0.0075	97	0	-	-
		w/o Ethylene	-	-	0.0040	97	0	-	-
		Average	-	-	0.0038	97	0	-	-
Sampling Connections	All	All	0	0	0.0330	97	0	0.00	0.00
Totals			2246	80				16.60	1.11

Note(s): The operational parameters are estimated variables that result in the worst-case maximum allowable emission rates.

ExxonMobil Chemical Company
Mt. Belvieu Plastics Plant
Flameless Thermal Oxidizer MSS
Greenhouse Gas Emissions Calculations

Parameter Name & Variable	Value & Units	Basis/Calculation/Notes
1. General Values and Calculations		
Standard Molar Volume V_{MS}	385 scf/lb-mol	Based on ideal gas law
Avg. Heat Value of Natural Gas HV_{AVG}	1,006 Btu/scf	Calculated from representative stream speciation
Total Pilot Gas Heat Input to Flameless Thermal Oxidizer H	324 MMBtu/yr	Based on expected burner firing
Total Flameless Thermal Oxidizer Pilot Gas Volume Flow Q_V	0.322 MMscf/yr	$= H / HV_{AVG}$
Avg. Molecular Weight of Pilot Gas M_V	17.0 lb/lb-mol	Calculated from representative stream speciation
Carbon Content of Pilot Gas F_{cc}	0.73 lb_C/lb_{Gas}	Calculated from representative stream speciation
2. CO_2 Emission Rate Calculations		
CO_2 Annual Emission Rate =	**19 TPY**	$= MW_{CO2}/MW_{Carbon} * Q_V * 10^6 * F_{CC} * M_V / V_{MS}$ / 2000 lb/ton Equation C-5
3. N_2O Emission Rate Calculations		
N_2O Emission Factor F_{N2O}	6.0E-04 kg/MMBtu	40 CFR 98, Table C-2
N_2O Annual Emission Rate =	**1 TPY**	$= H * F_{N2O}$ * 2.205 lb/kg / 2000 lb/ton Equation C-8b
4. CH_4 Emission Rate Calculations		
CH_4 Emission Factor F_{CH4}	3.0E-03 kg/MMBtu	40 CFR 98, Table C-2
CH_4 Annual Emission Rate =	**1 TPY**	$= H * F_{CH4}$ * 2.205 lb/kg / 2000 lb/ton Equation C-8b
5. CO_2e Emission Rate Calculations		
CO_2 CO_2e Factor Fe_{CO2}	1 ton_{CO2}/ton_{CO2e}	40 CFR 98, Table A-1
N_2O CO_2e Factor Fe_{N2O}	310 ton_{N2O}/ton_{CO2e}	40 CFR 98, Table A-1
CH_4 CO_2e Factor Fe_{CH4}	21 ton_{CH4}/ton_{CO2e}	40 CFR 98, Table A-1
CO_2e Annual Emission Rate =	**350 TPY**	$= \Sigma (TPY * Fe_x)$

Note(s): The operational parameters are estimated variables that result in the worst-case maximum allowable emission rates.

ExxonMobil Chemical Company
Mont Belvieu Plastics Plant
Cooling Tower
Greenhouse Gas Emissions Calculations

Parameter Name & Variable		Value & Units	Calculation Notes
1. General Values and Calculations			
Density of Water	d_{H2O}	8.34 lb/gal	
Total Throughput	Q_V	105,122 gal/min	Based on expected flow rate
Annual Period of Usage	t	8,760 hr/yr	Based on expected operating hours
2. CO_2 Emission Rate Calculations			
CO_2 Concentration	$CONC_{CO2}$	0 ppmw	Calculated based on site-specific speciation
CO_2 Annual Emission Rate	=	**0 TPY**	$= Q_V * 60$ min/hr $* d_{H2O} * CONC_{CO2} / 10^6 * t /$ 2000 lb/ton
3. N_2O Emission Rate Calculations			
N_2O Concentration	$CONC_{N2O}$	0 ppmw	Calculated based on site-specific speciation
N_2O Annual Emission Rate	=	**0 TPY**	$= Q_V * 60$ min/hr $* d_{H2O} * CONC_{N2O} / 10^6 * t /$ 2000 lb/ton
3. CH_4 Emission Rate Calculations			
CH_4 Concentration	$CONC_{CH4}$	0 ppmw	Calculated based on site-specific speciation
CH_4 Annual Emission Rate	=	**0 TPY**	$= Q_V * 60$ min/hr $* d_{H2O} * CONC_{CH4} / 10^6 * t /$ 2000 lb/ton
4. CO_2e Emission Rate Calculations			
CO_2 CO_2e Factor	Fe_{CO2}	1 ton_{CO2}/ton_{CO2e}	40 CFR 98, Table A-1
N_2O CO_2e Factor	Fe_{N2O}	310 ton_{N2O}/ton_{CO2e}	40 CFR 98, Table A-1
CH_4 CO_2e Factor	Fe_{CH4}	21 ton_{CH4}/ton_{CO2e}	40 CFR 98, Table A-1
CO_2e Annual Emission Rate	=	**0 TPY**	$= \Sigma$ (TPY * Fe_x)

Note(s): The values represented in this table are estimates only and are not values upon which compliance shall be based.

ExxonMobil Chemical Company
Mont Belvieu Plastics Plant
Oil Water Separator
Greenhouse Gas Emissions Calculations

Parameter Name & Variable		Value & Units	Calculation Notes
1. General Values and Calculations			
Density of Water	d_{H2O}	8.34 lb/gal	
Total Throughput	Q_V	5 gal/min	Based on expected flow rate
Annual Period of Usage	t	8,760 hr/yr	Based on expected operating hours
2. CO_2 Emission Rate Calculations			
CO_2 Concentration	$CONC_{CO2}$	0 ppmw	Calculated based on site-specific speciation
CO_2 Annual Emission Rate	=	**0 TPY**	$= Q_V * 60$ min/hr $* d_{H2O} * CONC_{CO2} / 10^6 * t /$ 2000 lb/ton
3. N_2O Emission Rate Calculations			
N_2O Concentration	$CONC_{N2O}$	0 ppmw	Calculated based on site-specific speciation
N_2O Annual Emission Rate	=	**0 TPY**	$= Q_V * 60$ min/hr $* d_{H2O} * CONC_{N2O} / 10^6 * t /$ 2000 lb/ton
3. CH_4 Emission Rate Calculations			
CH_4 Concentration	$CONC_{CH4}$	0 ppmw	Calculated based on site-specific speciation
CH_4 Annual Emission Rate	=	**0 TPY**	$= Q_V * 60$ min/hr $* d_{H2O} * CONC_{CH4} / 10^6 * t /$ 2000 lb/ton
4. CO_2e Emission Rate Calculations			
CO_2 CO_2e Factor	Fe_{CO2}	1 ton_{CO2}/ton_{CO2e}	40 CFR 98, Table A-1
N_2O CO_2e Factor	Fe_{N2O}	310 ton_{N2O}/ton_{CO2e}	40 CFR 98, Table A-1
CH_4 CO_2e Factor	Fe_{CH4}	21 ton_{CH4}/ton_{CO2e}	40 CFR 98, Table A-1
CO_2e Annual Emission Rate	=	**0 TPY**	$= \Sigma$ (TPY * Fe_x)

Note(s): The values represented in this table are estimates only and are not values upon which compliance shall be based

ExxonMobil Chemical Company
Mont Belvieu Plastics Plant
Additive Tanks
Greenhouse Gas Emissions Calculations

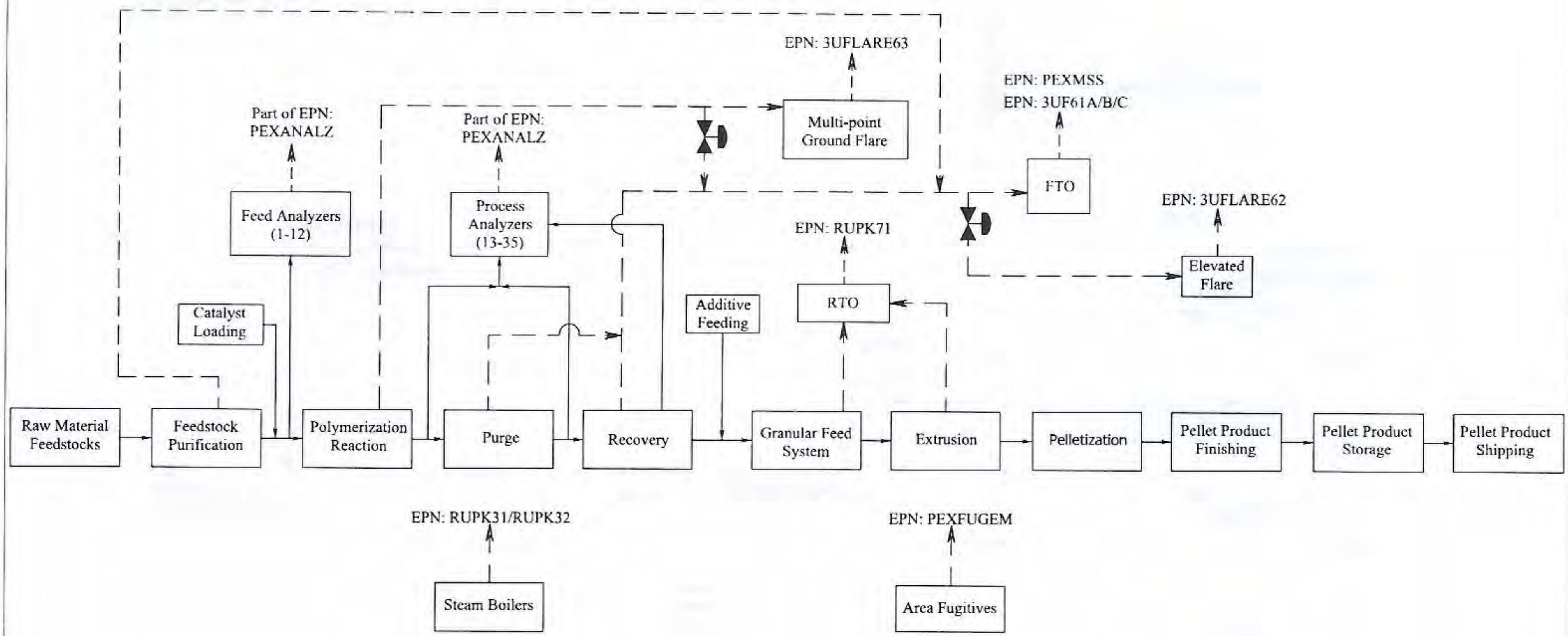
Parameter Name & Variable		Value & Units	Calculation Notes
1. General Values and Calculations			
RLD01 Annual Usage Rate	A_{RLD01}	2,192,190 lb/yr	Estimate based on process knowledge
RLD02 Annual Usage Rate	A_{RLD02}	4,640,610 lb/yr	Estimate based on process knowledge
Total Annual Usage Rate	A_{Em}	6,832,800 lb/yr	$= A_{RLD01} + A_{RLD02}$
2. CO_2 Emission Rate Calculations			
CO_2 Vapor Space Concentration	$CONC_{CO2}$	0 ppmw	Calculated based on site-specific speciation
CO_2 Annual Emission Rate	=	**0 TPY**	$= A_{Em} * CONC_{CO2} / 10^6 / 2000$ lb/ton
3. N_2O Emission Rate Calculations			
N_2O Vapor Space Concentration	$CONC_{N2O}$	0 ppmw	Calculated based on site-specific speciation
N_2O Annual Emission Rate	=	**0 TPY**	$= A_{Em} * 10^6 * CONC_{N2O} / 10^6 / 2000$ lb/ton
3. CH_4 Emission Rate Calculations			
CH_4 Vapor Space Concentration	$CONC_{CH4}$	0 ppmw	Calculated based on site-specific speciation
CH_4 Annual Emission Rate	=	**0 TPY**	$= A_{Em} * 10^6 * CONC_{CH4} / 10^6 / 2000$ lb/ton
4. CO_2e Emission Rate Calculations			
CO_2 CO_2e Factor	Fe_{CO2}	1 ton_{CO2}/ton_{CO2e}	40 CFR 98, Table A-1
N_2O CO_2e Factor	Fe_{N2O}	310 ton_{N2O}/ton_{CO2e}	40 CFR 98, Table A-1
CH_4 CO_2e Factor	Fe_{CH4}	21 ton_{CH4}/ton_{CO2e}	40 CFR 98, Table A-1
CO_2e Annual Emission Rate	=	**0 TPY**	$= \Sigma$ (TPY * Fe_x)

Note(s): The values represented in this table are estimates only and are not values upon which compliance shall be based.

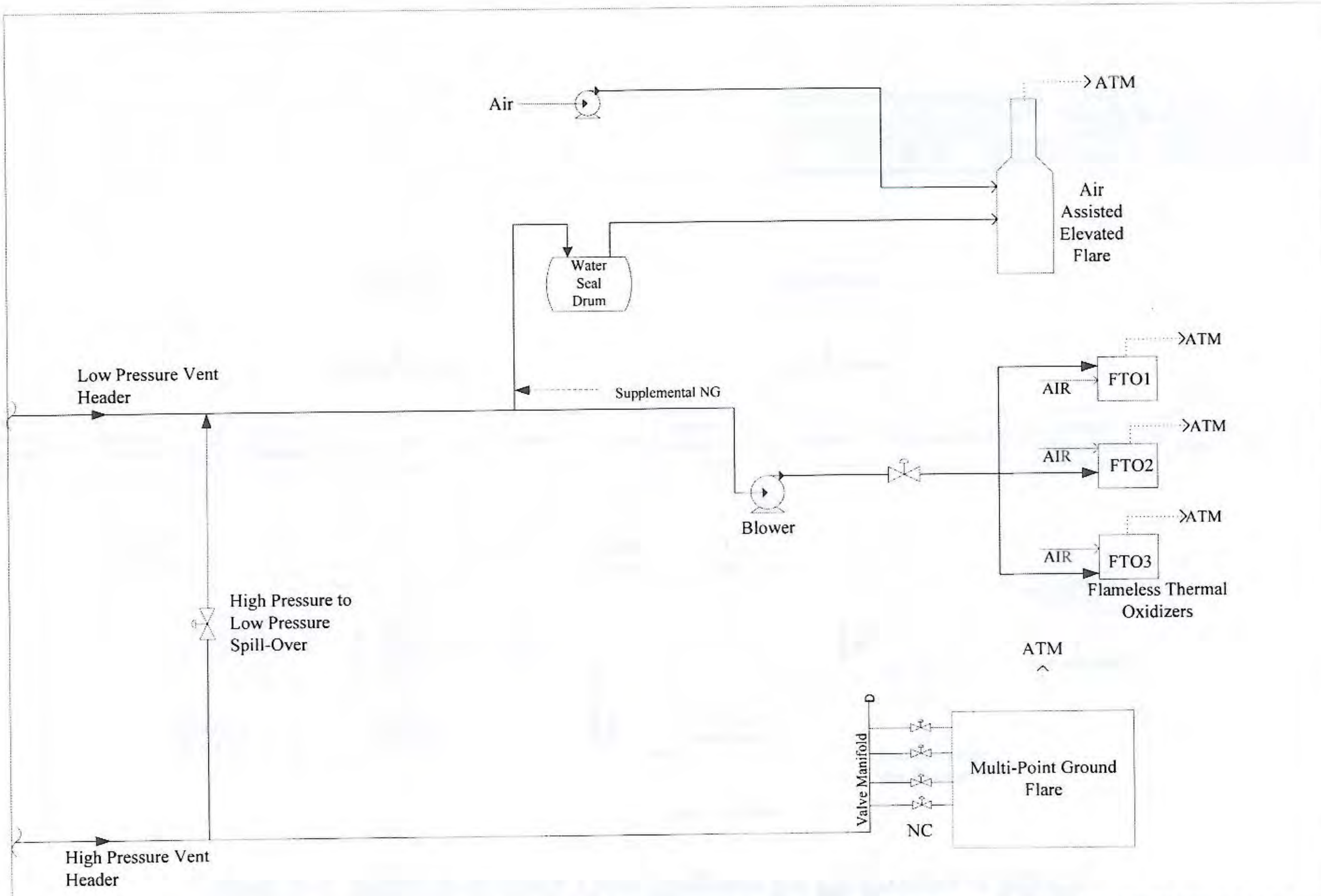
ATTTACHMENT 2

- **Updated Process Flow Diagram**
- **Vent Collection System Simplified Schematic**

Figure 2-1. Simplified Block Flow Diagram for PE Process at MBPP



SAGE ENVIRONMENTAL CONSULTING "Friendly Service. No Surprises!"®	Drawing: BFD.dwg	FIGURE 2-1
	Revision #: 1	BFD for PE Process at MBPP
	Date: Revised November 2012	ExxonMobil Chemical Company
	Project #: 55-6-12	Mont Belvieu PE Plant



NC: Normally Closed

SAGE ENVIRONMENTAL CONSULTING

Vent Collection System Flare Headers Simplified Schematic

ExxonMobil Mont Belvieu Plastics Plant

Date: November 2012	Drawn: BC

RECORD OF COMMUNICATION	_ Phone Call __ Discussion __ Field Trip __ Conference X Other (Specify)	
To:	From: Allen Chang/Erica Le Doux, 6PD-R, 5-7541/5-7265	Date: Nov 13, 2012 Time:

Subject: **Confidential Business Information**

Summary of Communication:

Exxon Mobil Mont Belvieu Plastics Plant (MBPP)
GHG Application Response to Completeness Letter
Data included in response pertains to John Zink burners

Conclusions, Actions Taken, or Required:

Material has been removed from GHG Application Response. This info will be stored separately in Records Center for CBI

ATTTACHMENT 4

Table 3-2

Proposed Work Practice Standards and Operating Limits

ExxonMobil Chemical Company
Table 3-2
Work Practice Standards and Operational Limitations Table

Date:	November 2012	Site Name:	Mont Belvieu Plastics Plant
Company Name:	ExxonMobil Chemical Company	Project:	Polyethylene Unit

Air Contaminant Data		
Emission Point		
EPN	Name	Emission Unit Work Practice Standard, Operational Requirement, or Monitoring
3UF61A/B/C	Flameless Thermal Oxidizers	Consume pipeline quality natural gas, or a fuel with a lower carbon content, as supplemental fuel
		Monitor and record the vent gas flow with a flow Monitoring system
		Monitor and record the supplemental fuel gas flow with a flow Monitoring system
		Monitor the heat content of the vent gas contained in the LP Vent Header
		Monitor the excess oxygen at the exhaust stack and maintain the excess oxygen above the demonstrated and/or vendor specified temperature
		Monitor the temperature and maintain the temperature above the demonstrated and/or vendor specified temperature
		Visually inspect burners during routine preventative maintenance outages and prior to start-up to ensure proper performance
RUPK71	Regenerative Thermal Oxidizer	Consume pipeline quality natural gas, or a fuel with a lower carbon content, as supplemental fuel
		Monitor and record the vent gas flow with a flow Monitoring system
		Monitor and record the supplemental fuel gas flow with a flow Monitoring system
		Monitor the temperature and maintain the temperature above the demonstrated and/or vendor specified temperature
		Visually inspect burners during routine preventative maintenance outages and prior to start-up to ensure proper performance
PEXANALZ	Analyzers	Monitor the temperature and maintain the operating temperature above the minimum temperature indicative of a functioning cartridge heater and catalyst cartridge
		Perform preventative maintenance to replace the catalyst cartridge at least annually
3UFLARE62	Elevated Flare	Monitor and record the vent gas flow through a flow Monitoring system
		Monitor and record the composition and heating value of the vent gas contained in the LP Vent Header through an online analyzer
		Maintain a minimum heating value and maximum exit velocity that meets 40 CFR § 60.18 requirements for the routine streams routed to the elevated flare
		Monitor the pilots for presence of flame
3UFLARE63	Multi-Point Ground Flare	Monitor and record the pressure of the HP Vent Header
		Monitor and record the composition of the vent gas contained in the HP Vent Header through an online analyzer and record the heating value of the HP Vent Header
		Monitor and maintain a minimum heating value of 800 Btu/scf of the waste gas (adjusted for hydrogen) when the multi-point ground flare system is operating; however, if a lower heating value limit can be demonstrated to achieve the same level of combustion efficiency, then this lower limit will be implemented
		Monitor the pressure to the multi-point ground flare to demonstrate that flow routed to the multi-point ground flare system exceeds 4 psig when it is operating; however, if a lower pressure can be demonstrated to achieve the same level of combustion efficiency, then this lower limit will be implemented
		Monitor the pilots for presence of flame
RUPL31/32	Boiler 31/32	Consume pipeline quality natural gas, or a fuel with a lower carbon content, as fuel
		Sample the fuel monthly per the requirements set forth in 40 CFR 98 Subpart C
		Maintain a minimum thermal efficiency ≥ 75% HHV on a 12-month rolling average
PEXFUGEM	Fugitives	Conduct daily as-observed AVO inspection for piping components in non-VOC natural gas service
		Maintain 28 VHP with CNTQ LDAR program for piping components in VOC service