US EPA ARCHIVE DOCUMENT

Enterprise Products

ENTERPRISE PRODUCTS PARTNERS L.P.
ENTERPRISE PRODUCTS HOLDINGS LLC
(General Partner)

ENTERPRISE PRODUCTS OPERATING LLC

June 21, 2013

Return Receipt Requested
7007 0220 0000 4311 6052

Ms. Wren Stenger
Director Multimedia Planning and Permitting Division
Environmental Protection Agency
1445 Ross Avenue, Suite 1200
Dallas TX 75202-2733

RE: Enterprise Products Operating LLC
Response to GHG PSD Permit Application Information Request
Propane Dehydrogenation Unit: Mont Belvieu Complex
Mont Belvieu, Chambers County, Texas

Dear Ms. Stenger:

Please find the attached the response to the EPA Information Request dated June 7, 2013 for the Propane Dehydrogenation unit (PDH) at the Enterprise Products Operating LLC (Enterprise) Mont Belvieu Complex. Please note that the response to question one and most of question two have been consolidated into a revised process flow diagram and description. We feel that the additional detail provided in the response will answer the individual questions, and the consolidated response to these questions provide a more understandable flow to the PDH process. The remainder of the questions lent themselves to individual responses. We would welcome the opportunity to discuss the responses with you at your office should you require further detail.

In addition to the response to your questions, it was indicated by your letter that the EPA received the Biological Assessment and Cultural Resources Report on May 14, 2012. According to our records the EPA received the Biological Assessment and Cultural Resources Report on March 20th, 2013. Please find attached the email confirmation from our records.

The PDH project is important to our business and we want to do everything possible to expedite the issuance of the permit. Should you have any questions, or require additional information regarding this registration, please contact me at (713) 381-5437 or Ed Bergman at (713) 381-5807.

Sincerely,

Christopher Benton
Manager, Environmental Permitting

/bjm
Enclosures

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bcc: Jon Fields
Wayne Rivera

Enterprise Mont Belvieu PDH Plant
GHG Permit Application
Responses to Questions in June 7, 2013 Completeness Letter
June 21, 2013

1. See the attached process description and flow diagrams that have been revised to more clearly describe the process. If additional questions remain, Enterprise is available to meet in your offices at your convenience to address questions.

2. See the attached process description and flow diagrams that have revised to more clearly describe the process. Specific responses to questions 2.C, and 2.I are provided below. If additional questions remain, Enterprise is available to meet in your offices at your convenience to address questions.

2.C There is a typographical error on Table 2F. The cell that reads "Combustion Unit Cap" should read "Reactor Charge Heater". There should be a separate line in the table above this line that says "Combustion Unit Cap". A revised Table 2F with the correct representation is submitted with these responses. The Charge Heater is a separate combustion unit with its own stack exhausting to the atmosphere.

2.I LTRU (Low Temperature Recovery Unit) Offgas is normally sent to the PSA Unit for hydrogen recovery. If the PSA Unit is down, the LTRU Offgas will be used as fuel in the various combustion units as indicated.

3. The cooling tower is not a source of GHG emissions. There are no heat exchangers that are in "GHG service". However, Enterprise would like to point out that the PDH Project is subject to NNSR for VOC and will therefore meet LAER requirements for control of VOC emissions from all sources of VOC, including the cooling tower. To the extent that the VOC streams that have the potential to leak into the cooling water might contain trace amounts of GHGs, the LAER requirements that will be implemented for VOCs will further insure that the cooling tower will be a negligible source of GHG emissions.

4. The turbines exhaust into the WHB which contains a heat recovery steam generator that recovers as much of the waste heat as is practical from the exhausts from the various combustion sources (including the turbines) that feed into the WHB to produce steam required by the PDH process. This practice significantly increases the overall efficiency of the turbines; however, since several combustion units provide waste heat to the WHB, it is difficult to assign an efficiency to individual units such as the turbines. Because all recoverable "waste" heat from the turbines is recovered in the WHB, the overall thermal efficiency will be essentially the same for any turbine selected regardless of any small variation in efficiency of the turbines themselves.

5. The combustion turbines will vent through the WHB under normal conditions. There is a separate bypass stack for each turbine that will be used for startup, which is expected to be about 2% of the time. GHG emissions are generated from combustion of natural gas in the turbines, and the emission rate of these GHGs will be calculated based on the natural gas firing

rate and GHG emission factors for natural gas, which are well-known, consistent, and reliable emission factors. There are no post-combustion controls for GHG emissions; therefore, whether the turbines exhaust through the bypass stacks or the WHB stack has no effect on the GHG emissions that are released to the atmosphere.

6. The cited statement on Page 4-1 of the permit application was a qualitative statement included in the overall description of the process as provided by the firm selected to provide the proposed process technology. Thus, the statement is only intended by that firm to emphasize the features of their technology. The PDH process itself does not produce significant GHG emissions. As Table 5-1 of the permit application shows, almost all (95%) of the total GHG emissions are from fuel combustion, and about 72% of these are accounted for in the sources that vent exhaust through the WHB where all recoverable heat energy from these and other exhaust streams is used to generate steam for the process.

7. Benchmarking data is not available at this time. Enterprise contracted with Lummus, who has added design elements using their own distinctive technology, in which comparative benchmarking is/may not be representative.

8. In addition to the combustion unit cap, the permit application presents the maximum GHG emissions for each facility included in the cap. If these individual emission rates are summed, they significantly exceed the cap. Enterprise is not opposed to these individual facility emission rates also being limits in the permit. However, without the cap, the total allowable GHG emission rate would exceed the amount that the overall process is actually capable of emitting. This is because most facilities have the capability of burning one of several fuels which have different GHG potentials (lb/mmBtu). For example, deethanizer offgas, which is primarily ethane, can be burned in several different facilities, but it will primarily be used as fuel in the Reactor Charge Heater. This fuel has a GHG emission factor of about 132 lb/mmBtu; whereas natural gas has a factor of about 118 lb/mmBtu. Enterprise is requesting the flexibility to burn this fuel in several other units; therefore, when burning the offgas, each unit would have the potential to emit 132 lb of GHG per mmBtu. The total emissions and the cap are based on burning all available deethanizer offgas at the plant. Thus the amount of GHG emissions from this fuel is the same for the plant as whole, regardless of which facility uses it as fuel. The proposed cap allows for this flexibility while at the same time ensuring that the plant is not allowed to emit more total GHG emissions than necessary.

9. The designs for the Charge Heater, Air Heater, and WHB are specified in detail by our technology provider, Lummus. In all three cases, the approved vendor list includes experts in burner, refractory and low emission firing technologies. Another air heater design was considered but it would not provide the ability to burn the feedstock ethane component which would then have to be flared, increasing the overall GHG emissions. Also, as explained in the response to Question No. 4, like the turbines, the Air Heater exhausts through the WHB where any recoverable waste heat is recovered to the maximum extent possible to produce process steam. Therefore, minor differences in efficiency among different turbines and heaters are compensated for by recovering the waste heat in the WHB. This will tend to result in the same overall combined efficiency of the system regardless of the efficiency of the individual units.

10. The process plan calls for inspecting the burner tips and convection tubes on all fired equipment during the unit turnaround. Even so, the fired equipment efficiencies will be monitored using stack temperature and stack CO. If evidence of refractory damage via excessive skin temperatures (determined with an infrared temperature device) that put the equipment at risk, the unit will be shutdown and repaired. Since the fuels being consumed do not include large amounts of olefins or diolefins, it is not expected that there will be burner fouling, particularly with the duct burners in the WHB and Air Heater. But, if the CO level indicates incomplete combustion in the Charge Heater, those burners can be decoked online. Taking a shutdown to clean burners more frequently than planned turnarounds will emit more GHG emissions than the fouled burners due to the flaring necessary to safely bring the plant down.

11. Enterprise will monitor the flow rate and btu value of the combined flare stream as required by the TCEQ air permit. This is necessary to ensure that the minimum heating value (300 btu/scf) required to achieve adequate destruction of VOCs is maintained. Natural gas will be added to the vent stream as needed to maintain the required heating value. Natural gas combustion adds to the GHG emissions emitted by the flare; therefore, monitoring the heat content of the vent streams to determine the optimal amount of natural gas needed minimizes GHG emissions by avoiding unnecessary combustion of natural gas. Flaring of vent gases is minimized by using process gas as fuel to the extent possible. For example, if deethanizer offgas and PSA tail gas are not used as fuel in the various combustion units, these gases would require flaring. Additional information comparing the proposed vent streams to other facilities is not available.

12. The operation of the SCR and oxidation catalysts in the WHB system does not affect the operation of the WHB beyond the reduction of emissions of NO_x (SCR) and CO/VOC (oxidation catalyst). The SCR does not control GHG emissions and does not produce any significant GHG emissions. The oxidation catalysts are designed to control VOC and CO emissions by oxidizing them to CO_2; therefore, the oxidations catalysts result in a small amount of GHG emissions that would not otherwise occur. For example, the first catalyst bed in the WHB will destroy the VOC that exits the reactors. This VOC is converted to 5,580 tpy of CO_2 as shown in Table 5-1 of the permit application. This is an insignificant amount of GHG emissions, about 0.4% of the total CO_2 produced by the plant. This small amount of CO_2 emissions is far more preferable than several hundred tons per year of additional VOC that would be emitted in the absence of the oxidation catalyst.

Enterprise Mont Belvieu PDH Plant
Process Description

Overview

A brief overview of the process is included below, and a simplified process flow diagram of the PDH process is shown in Figures 4-1 and 4-2.

The proposed PDH Unit will convert propane to propylene over a catalyst. The unconverted propane is recycled so that propylene is the only net product. A hydrogen byproduct is also produced.

Operating conditions are selected to optimize the relationships among selectivity, conversion, and energy consumption. Side reactions, occurring simultaneously with the main reaction, cause the formation of some light and heavy hydrocarbons as well as the deposition of coke on the catalyst.

The process takes place in fixed-bed reactors that operate on cyclic basis. The multiple reactor system permits the continuous flow of the major process streams. In one complete cycle, hydrocarbon vapors are dehydrogenated, the reactor is then purged with steam and blown with air to reheat the catalyst and burn off the small amount of coke that is deposited on the catalyst during the reaction cycle. These steps are followed by an evacuation and reduction, and then another cycle is begun.

A key feature of the process is that the heat absorbed during the endothermic dehydrogenation period is obtained by the adjustment of the air and hydrocarbon inlet temperatures and by the oxidation of the coke.

The low temperature recovery area, product purification, and refrigeration systems have been integrated to minimize initial investment and optimize energy efficiency. The design contains:

- Cascade propylene and ethylene refrigeration system.
- A high efficiency cold box design that minimizes equipment count and refrigerant compressor power demand.
- A low pressure Deethanizer that eliminates the need for feed pumps.
- A low pressure Product Splitter integrated with the propylene refrigeration system.

Detailed Description

Fresh propane feed is combined in the Feed Vaporization Drum with recycle material from the Product Splitter and the Deoiler's overhead product. The total feed from the Feed Vaporization Drum overhead is heated through a series of exchangers before being introduced to the Reactor Charge Heater.

The feed is raised to reaction temperature in the Reactor Charge Heater and sent to the reactors. The heater is fired with fuel gas generated in the unit and supplemented, as needed, with natural gas. The heater is equipped with low NOx burners and a selective catalytic reduction (SCR) catalyst system to control NOx emissions.

Propane is converted to propylene while passing through a fixed catalyst bed in the Reactors. The reactor system consists of a single train of ten reactors operating in a cyclic manner. In one complete cycle, the reactor dehydrogenates the hydrocarbon feed, is purged with steam, is blown with air to reheat and de-coke the catalyst, is evacuated, and undergoes reduction in preparation for the next on-stream period. Each reactor goes through the same cycle in a defined automated sequence, resulting in continuous, uninterrupted flow of hydrocarbon and air through the entire unit.

Hot effluent from the reactors is cooled by generating steam in the Steam Generator and by heat exchange with the reactor feed. This allows the unit to operate in a more energy efficient manner by recovering heat available from the reaction area.

The cooled reactor effluent is fed to the Product Compressor system where it is compressed in successive compression stages. The Product Compressor is a steam-driven machine. Exchangers and interstage knockout drums are provided at each compressor discharge to cool the gas and condense any liquids before entering the next compressor stage. Water that condenses after each of the stages of compression is separated in the interstage knockout drums and is sent to the Waste Water Stripper system before routing to a wastewater treatment facility in the unit.

The compressor's last stage discharge is cooled and the resulting vapor-liquid mixture is separated in the Product Gas Dryer KO Drum. The condensed hydrocarbon liquid from the KO Drum is sent to the Deethanizer Feed Dryer to remove water prior to being fed to the Deethanizer. The uncondensed vapor from the KO Drum is sent to the Product Gas Dryer to remove water prior to flowing to the low temperature recovery unit (LTRU). The main piece of equipment in the LTRU is the Cold Box. The Cold Box chills the product gas and recovers energy by reheating a variety of process streams.

The uncondensed vapor from the Product Gas Dryer is progressively cooled and condensed in a series of exchangers both inside and outside of the Cold Box. The resultant two-phase mixture is separated. The liquid portion is reheated and fed to the Deethanizer. The vapor undergoes further chilling and condensation in the Cold Box. The resultant two-phase mixture is again separated, with the resultant liquid fed to the Deethanizer. The vapor part is reheated, with a portion of the gases sent to the Reactor Reduction System and the remainder to the Hydrogen Recovery Unit (PSA).

The Deethanizer is fed from both the Deethanizer Feed Dryer and Cold Box. The Deethanizer's overhead vapor is heated through a series of exchangers in the Cold Box. The gas is then sent to the fuel gas system for unit consumption. The bottoms product from the Deethanizer is sent to the Product Sulfur Removal Bed prior to flowing to the Product Splitter.

The Product Splitter is designed to produce polymer grade propylene product. The desulfurized Deethanizer bottoms liquid is fed to the Splitter. The bottoms product from the Splitter is recycled back to the Feed Vaporization Drum. The Splitter's overhead vapor is fed to the Propylene Compressor System where it is compressed in successive compression stages. The Propylene Compressor is a steam-driven machine.

A portion of the Splitter overhead stream is compressed in the Propylene Compressor System and then subcooled in the Cold Box before returning to the Product Splitter as reflux. A portion of the liquid separated in the Propylene Compressor System is sent to the battery limits as propylene product.

The Ethylene Compressor System is a closed loop system which provides refrigeration to the Cold Box. The compressor is motor-driven.

Liquid from the Feed Vaporization Drum is sent to the Deoiler. Heavy hydrocarbons are removed in the bottoms stream. A portion of the liquid from the Deoiler Reflux Drum is returned to the Deoiler as reflux. The net liquid overhead is returned to the Feed Vaporization Drum.

The condensate from the Product Compressor knockout drums is collected and sent to the Waste Water Stripper. The Waste Water Stripper reduces the hydrocarbon content in the condensate by steam stripping before the condensate is sent to the OSBL Waste Water Treatment facilities. Stripper overhead vapor is routed to the fire box of the Reactor Charge Heater for destruction of stripped hydrocarbons.

The offgas from the Cold Box is sent to the Reactor Reduction System and the remainder to the PSA.

The Reduction System provides for better catalyst operation. Spent gases from the Reduction System are sent to the Waste Heat Boiler to burn unreacted hydrocarbons, as well as to recover heat in the unit.

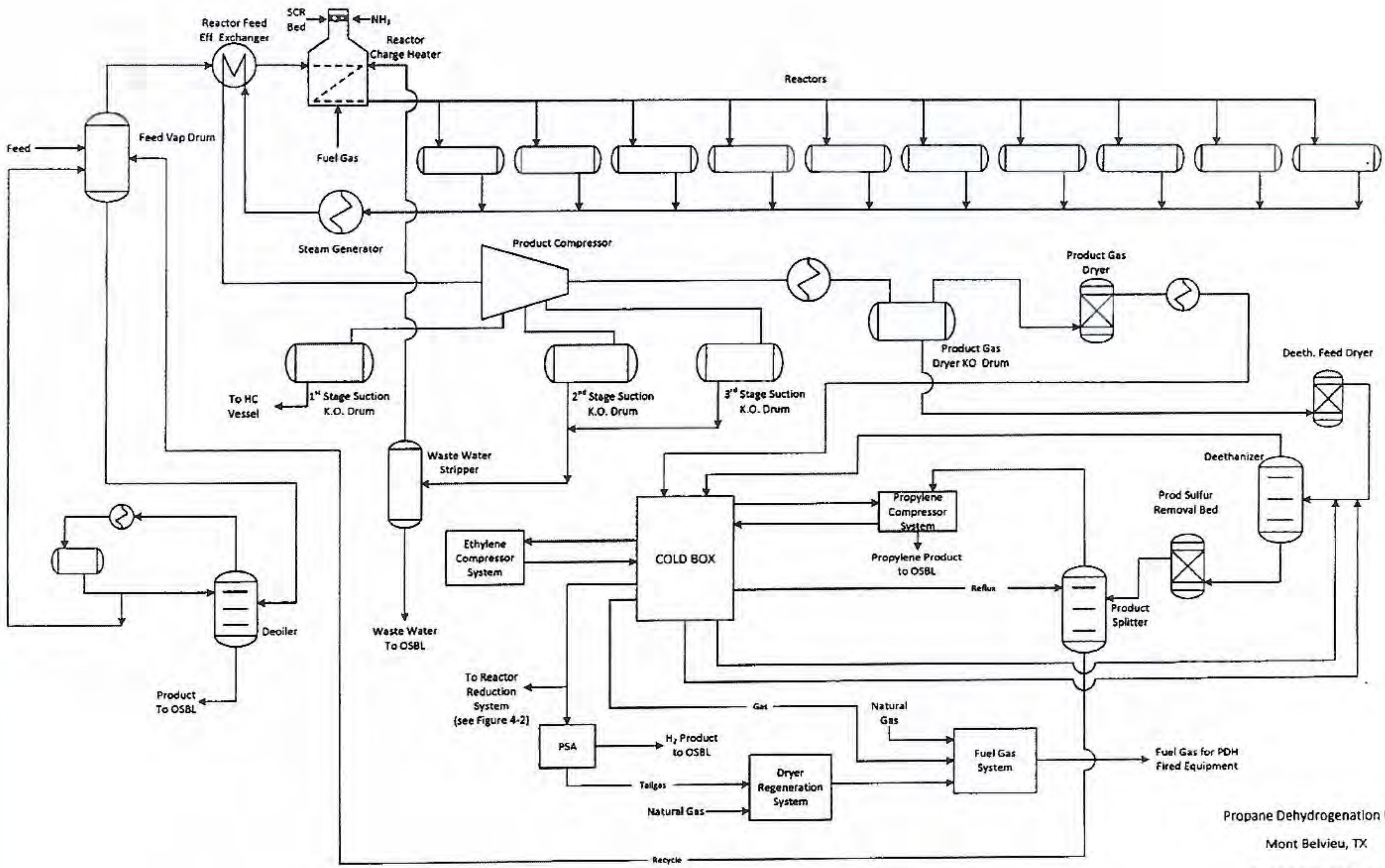
The purpose of the PSA is to recover a high purity hydrogen product. Tail gas from the PSA is sent to the Dryer Regeneration System. Tail gas from the PSA and natural gas are combined and fed to the Dryer Regeneration System. The purpose of the regeneration system is to regenerate the various dryers in the unit. Spent regeneration gas is sent to the Fuel Gas System for use in firing the PDH fired equipment.

The Fuel Gas System is a blend of natural gas, Deethanizer offgas, and spent regeneration gas. It is used to fire the fired equipment in the unit.

The reactors are regenerated and reheated by air. Regeneration air is supplied by the Regeneration Air Compressor and is heated in the Regeneration Air Heater before passing through the reactors. When regeneration is completed, the reactor is re-evacuated for the next on-stream period. The spent regeneration air stream leaving the reactors flows to the Waste Heat Boiler. The Regeneration Air Compressor is driven by a natural gas turbine.

The Waste Heat Boiler collects spent gases from the reactor regeneration and exhaust gas from the Regeneration Air Compressor Gas Turbine. The heat recovered from the Waste Heat Boiler feed streams generate steam and boiler feed waters for use in the unit.

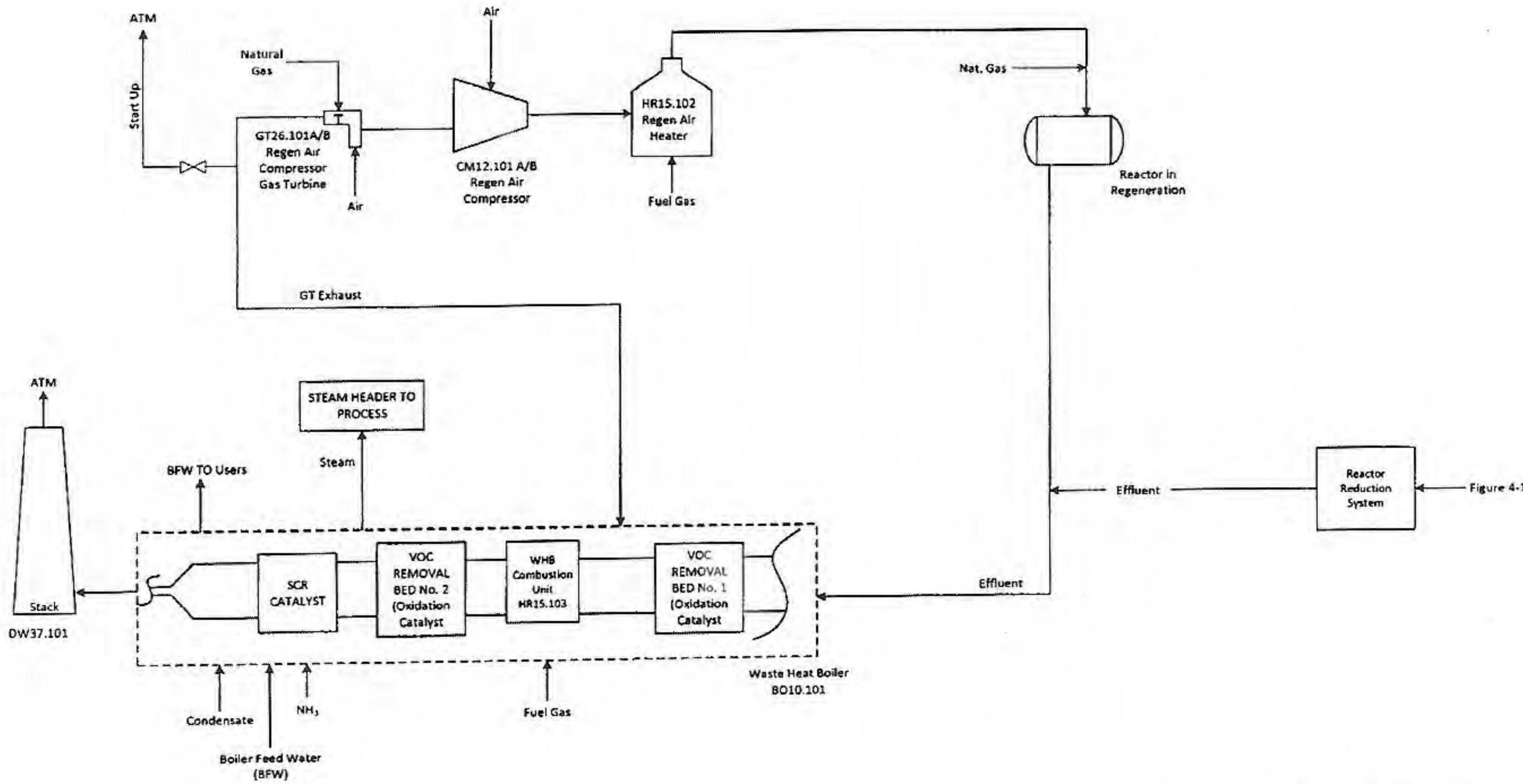
The Waste Heat Boiler is equipped with a volatile organic and selective catalytic reduction (SCR) catalyst system to control volatile organic compounds (VOC), carbon monoxide (CO), and nitrogen oxides (NOx) emissions in its gas stream. The gas stream in the Waste Heat Boiler flows through these catalyst beds prior to exiting the Stack to atmosphere. The Waste Heat Boiler is fired with unit fuel gas and supplemented with natural gas as needed.



Propane Dehydrogenation Unit

Mont Belvieu, TX

Process Flow Diagram
Figure 4-1



Propane Dehydrogenation Unit

Mont Belvieu, TX

Process Flow Diagram
Figure 4-2

TABLE 2F
PROJECT EMISSION INCREASE

Pollutant[1]:	GHG	Permit No.:	TBD
Baseline Period:	NA	Project Name:	PDH Unit

	Affected or Modified Facilities[2]			Permit No.	December	A	B				
	FIN	EPN	Facility Name		Actual Emissions[3] (tons/yr)	Baseline Emissions[4] (tons/yr)	Proposed Emissions[5] (tons/yr)	Projected Actual Emissions (tons/yr)	Difference (B-A)[6] (tons/yr)	Correction[7] (tons/yr)	Project Increase[8] (tons/yr)
	Combustion Unit Cap			TBD	-	-	1,281,586	-	1,281 586	0	1,281,586
1	HR15.101	HR15.101	Reactor Charge Heater	TBD							
2	HR15.103	DW37.101	Waste Heat Boiler Burner	TBD							
3	HR15.102		Regeneration Air Heater	TBD							
4	GT26.101A		Regen Air Comp. Gas Turbine A, including bypass stack	TBD							
5	GT26.101B		Regen Air Comp. Gas Turbine B, including bypass stack	TBD							
6	BO10.103A		Auxiliary Boiler A	TBD							
7	BO10 103B		Auxiliary Boiler B	TBD							
8	SK25.801	SK25.801	Process Flare, Routine	TBD	-	-	2,820 56		2,820.56	0.00	2,820.56
9	SK25.801	SK25.801	Process Flare, MSS	TBD	-	-	4,439 30		4,439.30	0.00	4,439.30
10	FUG-PDH	FUG-PDH	Process Fugitives	TBD	-	-	5.24		5 24	0 00	5.24
11	FUG-NGAS	FUG-NGAS	Nat. Gas Pipeline Fugitives	TBD	-	-	273.75		273 75	0 00	273.75
12	PM18.803	PM18 803	Fire Water Pump Engine	TBD	-	-	16.14		16.14	0.00	16 14
13	PM18.850C	PM18.850C	Raw Water Pump Engine	TBD	-	-	8.40		8.40	0.00	8.40
14											
15											
										Page Subtotal[9]:	1,289,149
										Project Total:	1,289,149