Enterprise Products

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

ENTERPRISE PRODUCTS OPERATING LLC

July 15, 2013

Extra Copy of Enterprise Response to July 2 meeting

Ms. Erica La Doux
Environmental Engineer
Multimedia Planning and Permitting Division
Environmental Protection Agency
1445 Ross Avenue, Suite 1200
Dallas TX 75202-2733

RE: Enterprise Products Operating LLC
July 2, 2013 Meeting Follow-Up to GHG PSD Permit Application Meeting
Propane Dehydrogenation Unit: Mont Belvieu Complex
Mont Belvieu, Chambers County, Texas

Dear Ms. La Doux:

Thank you for meeting with us on July 2, 2013 to discuss your questions and our responses to EPA's completeness letter for our GHG permit application. Please find attached follow-up to information requested in the referenced discussion concerning the Propane Dehydrogenation Unit (PDH) at the Enterprise Products Operating LLC (Enterprise) Mont Belvieu Complex. The enclosures with this letter include a revised flow diagram and responses to questions raised during the July 2rd discussion.

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 response, please do not hesitate to contact me at (713) 381-5437 or Ed Bergmann of my staff at (713) 381-5807.

Thank you for your time and consideration concerning this application.

Sincerely,

Edwin J. Bergmann for

Christopher Benton
Manager, Environmental Permitting

Enclosures

cc: Ms. Wren Stenger, Environmental Protection Agency, Director Multimedia Planning and Permitting Division, Dallas, Texas

Enterprise Mont Belvieu PDH Plant
GHG Permit Application
Followup Submittal to July 2, 2013 EPA Meeting
July 15, 2013

1. The process flow diagrams and process description that were included with Enterprise's June 21, 2013 response to the June 7, 2013 completeness letter have been revised. All EPNs the emit GHGs have been added and identified on the flow diagrams. The process description has been revised to provide more detail on the combustion turbines and their bypass, and the fact that the unit operation requires the waste heat boiler (WHB) to be online.
2. During the meeting, Enterprise indicated that the flare was for emergency purposes only, and at that purge/pilot gas was the only routine flaring. We would like to clarify that as represented in the permit application, a small amount of routine venting to the flare from the process is also allowed for. The permit accounts for intermittent venting from any one of our pressure controlled drums connected to the flare. This would include the Fuel Gas Drum(s), Propylene Compressor Suction Drum(s), or Ethylene Compressor Suction Drum(s).
3. As discussed in the meeting, the efficiency of the combustion turbines themselves has no significant bearing on the overall energy efficiency of the process and also does not reflect all energy recovered from the fuel combusted in the turbines. This is because the turbines exhaust into the WHB where all recoverable waste heat is recovered to produce steam for use in the process. Generally available literature indicates that the manufacturer's rated efficiency of the turbines at full load and ISO conditions is 38.6% with standard fuel; however, actual efficiency will vary with load and other conditions, and this figure does not consider the heat recovered in the WHB. Because the exhaust is comingled with the exhaust from other combustion units that provide heat to the WHB, it is not possible to assign an overall efficiency to the turbines alone.

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 NO_x burners and a selective catalytic reduction (SCR) catalyst system to control NO_x 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.

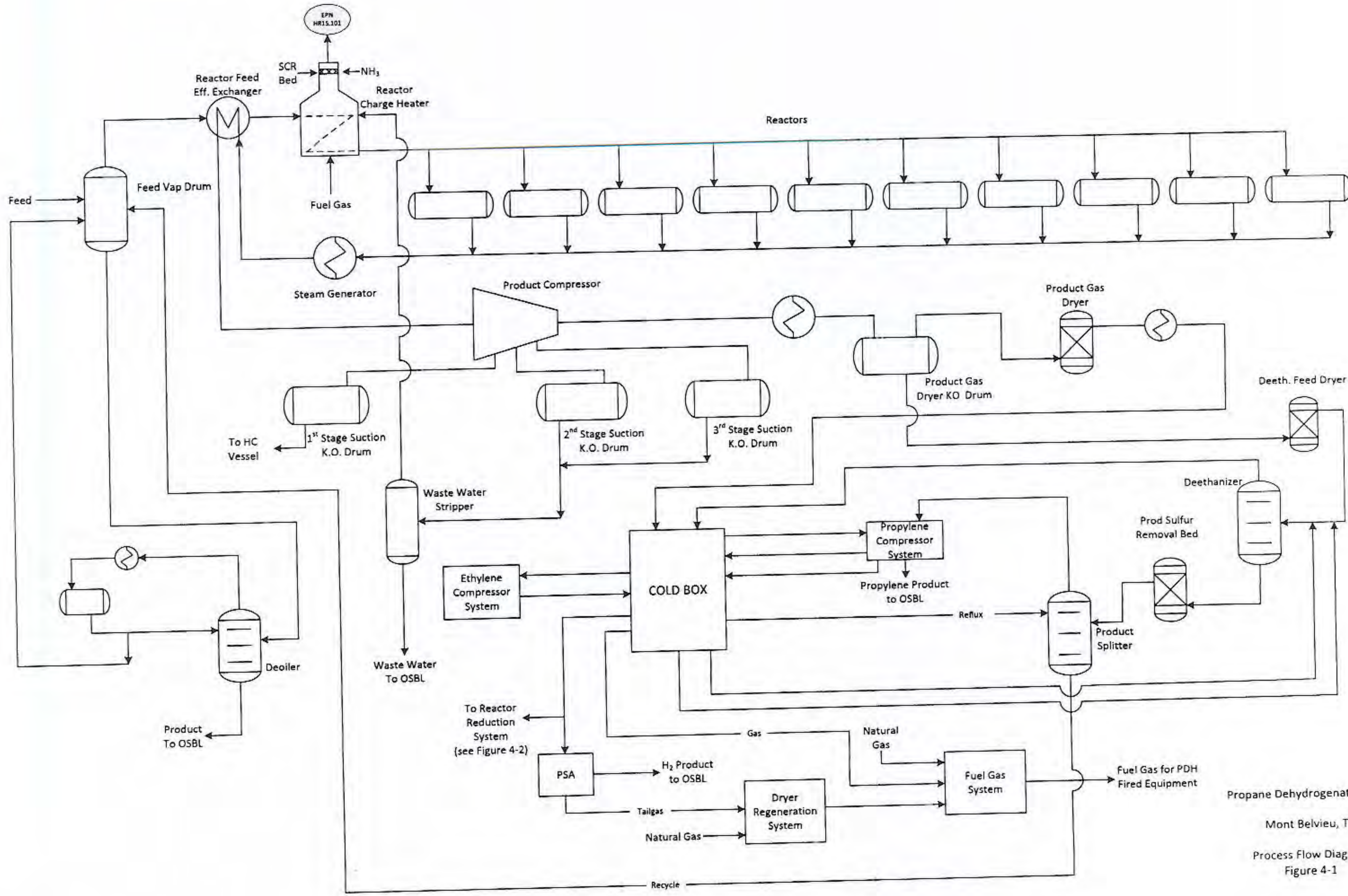
The purpose of the PSA is to recover a high purity hydrogen product. Tail gas from the PSA is sent to the Dryer Regeneration System. Tail gas from the PSA and natural gas are combined and fed to the Dryer Regeneration System. The purpose of the regeneration system is to regenerate the various dryers 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.

During normal operation, the Waste Heat Boiler (WHB) 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 Regeneration Air Compressor Gas Turbine exhaust also contains a bypass valve and line to atmosphere. It is used at startup. It is not intended for use during normal operation after the Waste Heat Boiler is operating.

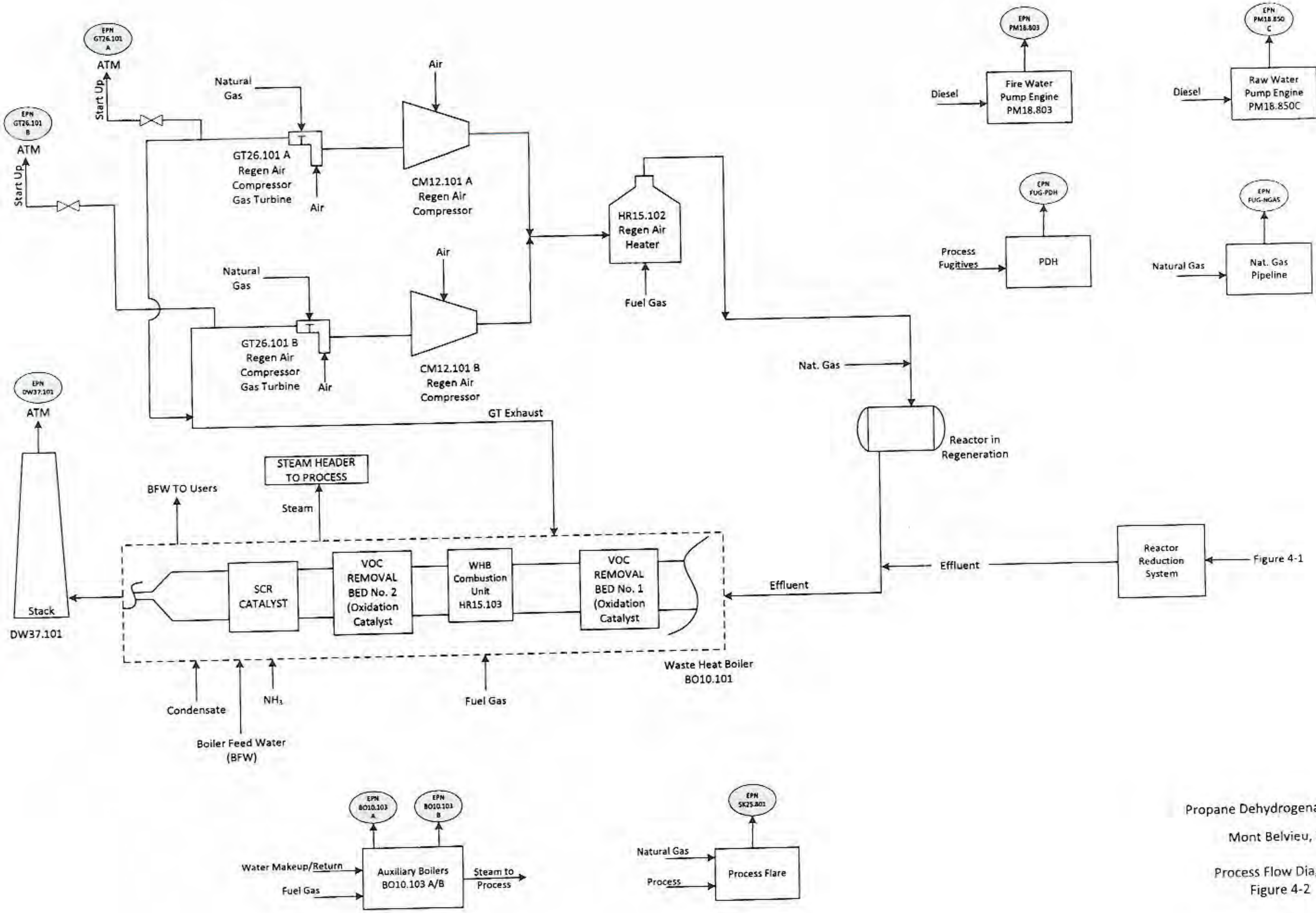
The Waste Heat Boiler is equipped with two catalytic oxidation systems and a selective catalytic reduction (SCR) catalyst system to control volatile organic compounds (VOC), carbon monoxide (CO), and nitrogen oxides (NO_x) emissions in its gas stream. The gas stream in the Waste Heat Boiler flows through 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. The WHB provides the majority of the steam required in the unit; thus, without the WHB, the unit cannot remain operational.



Propane Dehydrogenation Unit

Mont Belvieu, TX

Process Flow Diagram
Figure 4-1



Propane Dehydrogenation Unit

Mont Belvieu, TX

Process Flow Diagram
Figure 4-2