Statement of Basis

Draft Greenhouse Gas Prevention of Significant Deterioration Preconstruction Permit for the Equistar Chemicals LP, Channelview North Plant

Permit Number: PSD-TX-1272-GHG

May 2013

This document serves as the statement of basis for the above-referenced draft permit, as required by 40 CFR § 124.7. This document sets forth the legal and factual basis for the draft permit conditions and provides references to the statutory or regulatory provisions, including provisions in 40 CFR § 52.21, that would apply if the permit is finalized. This document is intended for use by all parties interested in the permit.

I. Executive Summary

On September 29, 2011, Equistar Chemicals, LP (Equistar) submitted to EPA Region 6 a Prevention of Significant Deterioration (PSD) permit application for greenhouse gas (GHG) emissions. A revised application was submitted on May 15, 2012 (hereinafter, referred to as "the application"). In connection with the same proposed project, Equistar submitted PSD and Nonattainment New Source Review (NNSR) permit applications for non-GHG pollutants to the Texas Commission on Environmental Quality (TCEQ) on September 29, 2011. Equistar proposes to construct a new cracking furnace at the Olefins Production Unit 1 (OP-1) and a new cracking furnace at the Olefins Production Unit 2 (OP-2) at the existing Channelview North Plant. After reviewing the application, EPA Region 6 has prepared the following Statement of Basis (SOB) and draft air permit to authorize construction of new equipment at Equistar's Channelview North Plant.

This SOB provides the information and analysis used to support EPA's decisions in drafting the air permit. It includes a description of the facility and proposed modification, the air permit requirements based on BACT analyses conducted on the proposed new units, and the compliance terms of the permit.

EPA Region 6 concludes that Equistar's application is complete and provides the necessary information to demonstrate that the proposed project meets the applicable air permit regulations. EPA's conclusions rely upon information provided in the permit application, supplemental information provided by Equistar at EPA's request, and EPA's own technical analysis. EPA is making this information available as part of the public record.

II. Applicant

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III. Permitting Authority

On May 3, 2011, EPA published a federal implementation plan (FIP) that made EPA Region 6 the PSD permitting authority for the pollutant GHGs. See 75 FR 25178 (promulgating 40 CFR § 52.2305).

The GHG PSD Permitting Authority for the State of Texas is:

EPA, Region 6
1445 Ross Avenue
Dallas, TX 75202

The EPA Region 6 Permit Writer is:
Aimee Wilson
Air Permitting Section (6PD-R)
(214) 665-7596

IV. Facility Location

The Equistar Channelview North Plant is located in Harris County, Texas, and this area is currently designated “nonattainment” for ozone. The nearest Class 1 area is the Breton National Wildlife Refuge, which is located over 100 miles from the site. The geographic coordinates for this facility are as follows:

Latitude: 29º 50’ 0.7” North
Longitude: - 95º 07’12.66” West

Below, Figure 1 illustrates the facility location for this draft permit.

Figure 1. Equistar Chemicals, Channelview Plant Location

V. Applicability of Prevention of Significant Deterioration (PSD) Regulations

EPA concludes that Equistar's application is subject to PSD review for GHGs because the project would result in an emissions increase of 75,000 tpy CO_2e or more as described at 40 CFR § 52.21(b)(49)(v)*(b)* and an emissions increase greater than zero tpy on a mass basis as described at 40 CFR § 52.21(b)(23)(ii) (Equistar calculates an increase of 602,000 tpy CO_2e). EPA Region 6 implements a GHG PSD FIP for Texas under the provisions of 40 CFR § 52.21 (except paragraph (a)(1)). See 40 CFR § 52.2305.

As the permitting authority for regulated NSR pollutants other than GHGs, TCEQ has determined that the modification is subject to PSD review for CO, PM_{10}, and $PM_{2.5}$, and NO_x and subject to NNSR for VOC. TCEQ has issued the required PSD and NNSR permits for this proposed modification.[1]

EPA Region 6 applies the policies and practices reflected in the EPA document entitled "PSD and Title V Permitting Guidance for Greenhouse Gases" (March 2011). Consistent with this guidance, we have not required the applicant to model or conduct ambient monitoring for GHGs, and we have not required any assessment of impacts of GHGs in the context of the additional impacts analysis or Class I area provisions of 40 CFR § 52.21(o) and (p), respectively. Instead, EPA has determined that compliance with the selected Best Available Control Technology (BACT) is the best technique that can be employed at present to satisfy the additional impacts analysis and Class I area requirements of the rules with respect to emissions of GHGs. We note again, however, that the project has triggered review for regulated NSR pollutants that are non-GHG pollutants under the PSD and NNSR permit amendments sought from TCEQ, so air quality modeling or ambient monitoring may have been required in order for TCEQ to issue the permits for the non-GHG pollutants.

VI. Project Description

The Olefins Production units (OP-1 and OP-2) receive hydrocarbon feedstock where it is fed into pyrolysis furnaces. The pyrolysis furnaces, which are fired on natural gas and/or process gas, heat the feedstock to a high temperature where it cracks and reforms as alkenes or olefins. The proposed GHG PSD permit, if finalized, will allow Equistar to expand their Olefins Production units (OP-1 and OP-2) by constructing two new cracking furnaces at the existing facility at the Channelview North Complex located in Channelview, Harris County, Texas. The project will increase the plant's nominal production capacity by 750,000 tpy. The plant also produces other products at varying capacities, but ethylene is the predominant product.

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[1] *See* EPA, Question and Answer Document: Issuing Permits for Sources with Dual PSD Permitting Authorities, April 19, 2011, http://www.epa.gov/nsr/ghgdocs/ghgissuedualpermitting.pdf

The process effluent from the furnaces is quenched and scrubbed with water. Pyrolysis gasoline is removed as a product during water scrubbing. The quenched gases are compressed, dried, and cooled prior to a series of purification/distillation steps. A hydrogen-rich stream from the final chilling step is further purified in a pressure swing absorber to produce hydrogen.

The purification section consists of a series of distillation columns that separate the process gas stream into acetylene, ethylene, propylene, mixed C4s, and pyrolysis gasoline (pygas) products. Ethane and propane recovered during distillation and separation are recycled as process gas feedstock into the pyrolysis (cracking) furnaces.

Periodically, coke (primarily carbon) deposited in the furnace tubes must be removed. The decoking operation consists of two steps, of which only the second produces GHG emissions:

- An initial steam purge which moves hydrocarbons and coke particles further into the process, and
- A burn step which produces CO and CO_2, and routes the vent stream including coke particles to a cyclone separator.

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VII. General Format of the BACT Analysis

The BACT analyses for this draft permit were conducted in accordance with EPA's *PSD and Title V Permitting Guidance for Greenhouse Gases* (March 2011), which outlines the steps for conducting a "top-down" BACT analysis. Those steps are listed below.

(1) Identify all potentially available control options;
(2) Eliminate technically infeasible control options;
(3) Rank remaining control options;
(4) Evaluate the most effective controls and document the results; and
(5) Select BACT.

VIII. Applicable Emission Units for BACT

The majority of the GHGs associated with the proposed project are from combustion units (i.e., cracking furnaces). The site has some fugitive emissions from piping components, which contribute a relatively small amount of GHGs. These stationary combustion units primarily emit carbon dioxide (CO_2) and small amounts of nitrous oxide (N_2O) and methane (CH_4). The following new emission units are subject to this GHG PSD permit:

- Cracking Furnaces (EPNs: EF3419 and EF4419)
- Decoke Pot (EPNs: EOP1DECOKE2 and EOP2DECOKE2)
- Fugitive Emissions (EPNs: EOP1FUGEXP and EOP2FUGEXP)

IX. BACT Analysis for Cracking Furnaces (EPNs: EF3419 and EF4419)

The Olefins Production Unit (OP-1 and OP-2) expansion consists of two cracking furnaces (EF3419 and EF4419), one at each production unit. The furnaces are equipped with low NO_x burners and selective catalytic reduction (SCR) systems to control NO_x emissions. The furnaces combust natural gas as a primary fuel, but may combust process gas containing ethane/propane and/or hydrogen as a secondary fuel when practicable and available.

As part of the PSD review, Equistar provides in the GHG permit application a 5-step top-down BACT analysis for the two cracking furnaces. EPA has reviewed Equistar's BACT analysis for the furnaces, which has been incorporated into this Statement of Basis, and also provides its own analysis in setting forth BACT for this proposed permit, as summarized below.

Step 1 – Identification of Potential Control Technologies for GHGs

- *Use Hydrogen as the Primary Fuel* –When burned, hydrogen does not generate CO_2 emissions.
- *Carbon Capture and Storage* – CCS is an available add-on control technology that is applicable for all of the site's affected combustion units.
- *Fuels Selection* –When burned, fuels containing lower concentrations of carbon generate less CO_2 than other higher-carbon fuels. Typically, gaseous fuels such as natural gas or a hydrogen-rich gas stream contain less carbon, and thus lower CO_2 potential, than liquid or solid fuels such as diesel or coal. Equistar proposes to use a hydrogen-rich gas stream as the secondary fuel for the furnaces.
- *Energy Efficient Design* – Equistar selected a furnace design that will maximize efficiency by incorporating the latest improvements in heat transfer and fluid flow to maximize energy efficiency and energy recovery.
- *Best Operation Practices* – Best operation practices include periodic tune-ups and oxygen trim controls. The tune-ups will include instrument calibrations and cleaning of dirty or fouled mechanical parts. Oxygen trim control allows excess oxygen to be controlled at optimum levels, allowing the furnace to operate at continuous high levels of efficiency.
- *N_2O Catalysts* – N_2O catalysts have been used in nitric/adipic acid plants to minimize N_2O emissions.
- *Low NO_x Burners* – Low NO_x burners limit the formation of NO_x (including N_2O) emissions.
- *Post-Combustion Catalytic Oxidation* – Post-combustion catalytic oxidation provides rapid conversion of hydrocarbons into CO_2 and water vapor in the presence of available oxygen.

Carbon Capture and Storage (CCS)

CCS is a GHG control process that can be used by "facilities emitting CO_2 in large concentrations, 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)."[2] CCS systems involve the use of adsorption or absorption processes to remove CO_2 from flue gas, with subsequent desorption to produce a concentrated CO_2 stream. The three main capture technologies for CCS are pre-combustion capture, post-combustion capture, and oxyfuel combustion (IPCC, 2005). Of these approaches, pre-combustion capture is applicable primarily to gasification plants, where solid fuel such as coal is converted into gaseous components by applying heat under pressure in the presence of steam and oxygen (U.S. Department of Energy, 2011). Accordingly, pre-combustion capture and oxyfuel combustion are not considered applicable control options for this proposed modification. The third approach, post-combustion capture, is available and applicable to the cracking furnaces.

Once CO_2 is captured from the flue gas, the captured CO_2 is compressed to 100 atmospheres (atm) or higher for ease of transport (usually by pipeline). The CO_2 would then be transported to an appropriate location for underground injection into a suitable geological storage reservoir, such as a deep saline aquifer or depleted coal seam, or used in crude oil production for enhanced oil recovery (EOR). There is a large body of ongoing research and field studies focused on developing better understanding of the science and technologies for CO_2 storage.[3]

Step 2 – Elimination of Technically Infeasible Alternatives

All options identified in Step 1 are considered technically feasible except for N_2O catalysts and post-combustion catalytic oxidation.[4]

N_2O catalysts have not been used to control N_2O emissions from cracking furnaces. In addition, the low N_2O concentrations present in the exhaust stream would make installation of N_2O catalysts technically infeasible. The N_2O concentration of the furnace exhaust is less than 1 ppm. In comparison, the application of a catalyst in the nitric acid industry sector has been effective

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[2]U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, *PSD and Title V Permitting Guidance for Greenhouse Gases*, March 2011, <http:/www.epa.gov/nsr/ghgdocs/ghgpermittingguidance.pdf> (March 2011)

[3] U.S. Department of Energy, Office of Fossil Energy, National Energy Technology Laboratory *Carbon Sequestration Program: Technology Program Plan*, <http://www.netl.doe.gov/technologies/carbon_seq/refshelf/2011_Sequestration_Program_Plan.pdf>, February 2011

[4] Based on the information provided by Equistar and reviewed by EPA for this BACT analysis, while there are some portions of CCS that may be technically infeasible for this project, EPA has determined that overall Carbon Capture and Storage (CCS) technology is technologically feasible at this source.

due to the high (1,000 – 2,000 ppm) N_2O concentration in those streams. N_2O catalysts are therefore eliminated as a technically feasible option for the proposed project.

The cracking furnace flue gas design temperature is in the range of 370 ^oF to 408 ^oF. It is expected to contain about 1 ppmv CH_4. The temperature is below the lowest operating temperature for catalytic oxidation of 482 ^oF or greater. In addition, the flue gas CH_4 concentration is about two orders of magnitude below the lower end of VOC concentration streams that would typically be fitted with catalytic oxidation for control. Therefore, the addition of post-combustion catalytic oxidation to the reformer furnace for control of CH_4 is not an applicable control option for the proposed project and can be eliminated as technically infeasible.

Step 3 – Ranking of Remaining Technologies Based on Effectiveness

- Use of Hydrogen as the Primary Fuel
- Carbon capture and storage
- Fuel Selection
- Energy Efficient Design
- Best Operation Practices
- Low NO_x Burners

Hydrogen has no capacity to produce CO_2 when combusted. Combusting hydrogen as a primary fuel would provide 100% effectiveness in control of CO_2 emissions from the cracking furnace and is thus considered to be the most effective control. CCS is capable of achieving up to 90% reduction of produced CO_2 emissions. Combusting low carbon fuels can reduce emissions of CO_2 by varying amounts depending on the fuel. If methane was used as the primary fuel, as opposed to another fossil fuel, it could have a minimum of 12% control effectiveness. Natural gas is the lowest carbon fuel that could be relied upon for continuous fueling of the proposed operation. The olefins plants (OP-1 and OP-2) each include a demethanizer, which is a distillation column that separates methane from the process stream of heavier components. This is a primary source of plant-produced process gas that could be used for a fuel in the cracking furnaces instead of being combusted in the flare. Energy efficient design, use of low-carbon fuel, and best operation practices are all considered effective and have a range of efficiency improvements that cannot be directly quantified; therefore, the above ranking is approximate only. The estimated efficiencies were obtained from Energy Efficiency Improvement and Cost Saving Opportunities for the Petrochemical Industry: An ENERGY STAR Guide for Energy and Plant Managers (Environmental Energy Technologies Division, University of California, sponsored by USEPA, June 2008). This report addressed improvements to existing energy systems as well as new equipment. Low NOx burners limit the formation of NOx including N_2O.

Step 4 – Evaluation of Control Technologies in Order of Most Effective to Least Effective, with Consideration of Economic, Energy, and Environmental Impacts

Use of Hydrogen as the Primary Fuel

Hydrogen could be used as the only fuel for the cracking furnaces, providing 100% elimination of CO_2 from the flue gas, if hydrogen was readily available and the necessary firebox heat release and temperatures could be produced. However, the National Renewable Energy Laboratory (NREL) has determined that the net effect of using hydrogen as a fuel when produced by the most common means, steam methane reforming, results in an overall increase in GHG emissions.[5] Accordingly, the sole use of hydrogen as the primary fuel is eliminated as BACT based on the negative environmental impact of collateral increases in CO_2.

Carbon Capture and Storage

Equistar developed an analysis for CCS that provided the basis for eliminating the technology in step 4 of the BACT process as a viable control option based on economic costs and environmental impact. The recovery and purification of CO_2 from the stack gases would necessitate significant additional processing of the stack gases to achieve the necessary CO_2 concentration for effective sequestration, while resulting in environmental and air quality penalties.

The majority of the cost for CCS was attributed to the necessary capture and compression facilities. The capital cost for CO_2 capture alone is estimated to be more than $108,000,000. The capital cost of transportation is estimated at $21,000,000. The pipeline needed for transport would be 30 miles away from the facility, thereby necessitating the construction of a new pipeline to connect. The estimated annual operation and maintenance costs for the pipeline are $260,000. The estimated CCS capital needed only for capture and a new pipeline for the current project results in an increase of 60% - 70% in the capital costs for Equistar's project. EPA Region 6 reviewed Equistar's CCS cost estimate and believes it adequately approximates the cost of CCS control for this project and demonstrates that those costs are prohibitive in relation to the overall cost of the proposed project. As a result, CCS has been eliminated as BACT for this project as cost prohibitive.[6]

Equistar also asserts that CCS can result in a collateral increase of National Ambient Air Quality Standards (NAAQS) pollutants. Implementation of CCS would increase emissions of GHGs, NO_x, CO, VOC, PM_{10}, SO_2, and ammonia by as much as 30%. The proposed plant is located in an area of ozone non-attainment and the generation of additional NO_x and VOC could have an

[5] NETL publication, *Life Cycle Assessment of Hydrogen Production via Natural Gas Steam Reforming*, page 23, Conclusions. http://www.nrel.gov/docs/fy01osti/27637.pdf

[6] Equistar also examined utilization of the salt dome caverns they currently own and operate for CCS, and estimated that it would cost $1.8 billion for development and injection well installation, which is also economically infeasible.

adverse environmental impact. Equistar also indicated that carbon capture would result in an energy penalty of approximately 30%. The proposed plant is located in the Houston, Galveston, and Brazoria (HGB) area of ozone non-attainment and the generation of additional NOx and VOC could exacerbate ozone formation in the area. Since the project is located in an ozone non-attainment area, energy efficient technologies are preferred over add-on controls such as CCS that would cause an increase in emissions of NOx and VOCs to the HGB non-attainment area airshed. Accordingly, CCS could possibly be eliminated as BACT for this project based on its adverse environmental and energy impacts.

Fuel Selection

The use of low-carbon fuel is economically and environmentally practicable for the proposed project. Natural gas is the lowest emitting carbon fuel that could be relied upon for the proposed operation. Olefins plants produce gas streams (process gas containing low carbon levels) that are suitable for introduction to a fuel gas system. These gases are primarily methane and hydrogen, along with occasional quantities of materials such as acetylene. The Olefins plants, OP-1 and OP-2 both include a demethanizer, which is a distillation column that separates methane from the heavier components of the process stream. This is one of the primary sources of plant-produced process gas. If flared as opposed to being used as a fuel, essentially all carbon content of the process gas would be converted to CO_2 with no beneficial use of the heating value of the flared gases. The furnaces may combust hydrogen rich process gas as a secondary fuel when practicable and when available. The process produces hydrogen that may enter the commercial hydrogen market. If a portion of the produced hydrogen is not exported from the unit as a product, it may be used as a fuel to capture its heating value, thus offsetting some of the heat input that would otherwise come from natural gas or process gas. The availability of hydrogen for combustion in the furnaces is not assured. Further, combustion of natural gas and process gas in lieu of higher carbon-based fuels such as diesel and coal reduces emissions of other combustion products such as NO_x, CO, VOC, PM_{10}, and SO_2, thereby providing additional environmental benefits.

Energy Efficient Design

The use of an energy efficient furnace and unit design is economically and environmentally practicable for the proposed project. By optimizing energy efficiency, the project requires less fuel than comparable less-efficient operations, resulting in cost savings. Further, reduction in fuel consumption corresponding to energy efficient design reduces emissions of other combustion products such as NO_x, CO, VOC, PM_{10}, and SO_2, providing additional environmental benefits. Equistar will design the cracking furnaces to be energy efficient by implementing the latest improvements and technologies in heat transfer and fluid flow to maximize the energy efficiency and energy recovery. The radiant tubes in the firebox will be located in the center of the box in a configuration to minimize the shadowing effect of adjacent radiant tubes, which allows for increased radiant heat transfer to the radiant tubes and high radiant transfer efficiency. The burner layout will be engineered to allow radiant heat to be transferred uniformly. This will help maintain high energy efficiency of radiant heat transfer. A combination of high temperature brick and ceramic fiber insulation will be utilized on the walls of the firebox to reduce heat loss and to maximize reflection of radiant heat back to the radiant tubes. The burners will be designed to operate with minimum excess air to maintain high combustion efficiency. The convection section of the cracking heater will be designed to maximize heat recovery. The cracking furnaces shall be designed with an induced draft fan in combination with a stack damper to allow for oxygen to be controlled at the desired low level for efficiency. Integral quench exchangers/steam drum will be provided with the cracking heaters to increase overall heater efficiency.

Best Operation Practices

Best operation practices effectively support the energy efficient design. Thus, the economic and environmental benefits of energy efficient design techniques also apply to the use of best operation practices.

Low NO_x Burners

The use of low NO_x burners will limit the formation of NOx, including N_2O emissions. In light of the low cost of low NOx burners, and the lack of energy or environmental impacts associated with this technology, they are not eliminated.

Step 5 – Selection of BACT

To date, other facilities with a furnace and a GHG BACT limit are summarized in the table below:

Company / Location	Process Description	Control Device	BACT Emission Limit / Requirements	Year Issued	Reference
BASF FINA Petrochemicals LP, NAFTA Region Olefins Complex Port Arthur, TX	Ethylene Production	Energy Efficiency/ Good Design & Combustion Practices	Limit flue gas exhaust temperature $\leq$ 309 ^{o}F. 365-day average, rolling daily	2012	PSD-TX-903-GHG

Company / Location	Process Description	Control Device	BACT Emission Limit / Requirements	Year Issued	Reference
Williams Olefins LLC, Geismar Ethylene Plant Geismar, LA	Ethylene Production	Energy Efficiency/Low-emitting Feedstocks/Lower-Carbon Fuels	Cracking heaters to meet a thermal efficiency of 92.5% Ethane/Propane to be used as feedstock Fuel gas containing 25% volume hydrogen on an annual basis	2012	PSD-LA-759
Ineos Olefins & Polymers U.S.A. Alvin, TX	Ethylene Production	Energy Efficiency Low Carbon Fuels	Cracking heater to meet thermal efficiency of 92.6% and flue gas exhaust temperature ≤ 340 °F 0.85 lbs GHG/lbs of ethylene 35% hydrogen in fuel to maintain a 0.71 carbon percentage in fuel	2012	PSD-TX-97769-GHG
Chevron Phillips, Olefins Unit Cedar Bayou, TX	Ethylene Production	Energy Efficiency/ Good Design & Combustion Practices	Limit flue gas exhaust temperature ≤ 350 °F. 365-day average, rolling daily	2013	PSD-TX-748-GHG
Equistar Chemicals, Channelview Plant Channelview, TX	Methanol Production	Energy Efficiency/ Good Design & Combustion Practices	Reformer furnace to meet a thermal efficiency of 90% and flue gas exhaust temperature ≤ 320 °F	2013	PSD-TX-1280-GHG
Equistar Chemicals, La Porte Complex La Porte, TX	Ethylene Production	Energy Efficiency/ Good Design & Combustion Practices	Cracking furnaces to meet a thermal efficiency of 91% and flue gas exhaust temperature ≤ 302 °F	2013	PSD-TX-752-GHG

BASF and Williams have differing processes for producing ethylene. BASF is a steam-driven operation using multiple feedstocks, whereas Williams uses electrical-driven compressors and only ethane/propane as a feedstock, which requires less energy consumption. The Chevron Phillips facility will be constructed similar to the BASF facility in that it too will be steam-driven and will utilize ethane as the primary feedstock. The Chevron Phillips facility also uses a configuration that combines the steam production of eight cracking furnaces with a very high pressure boiler. The previously permitted Equistar facilities that had cracking furnaces both had a thermal efficiency of 90% to 91% and exhaust temperatures that were similar to other facilities in the above table. The Equistar Olefins cracking furnaces for this project are designed for a liquid feed instead of a gas (ethane) feed like those listed in the table above. The proposed thermal efficiency is lower and the stack temperature is higher than the cracking furnaces listed in the table above due to higher temperature streams feeding the upper levels of the furnace convection section. Also, the cracking furnaces are being added to an existing unit which has established energy balances that dictate certain constraints in the design of the new cracking furnaces. The higher temperature feed results from capture of heat energy in the feed streams prior to entry to the furnace. The cracking process is highly endothermic, and high amounts of heat must be input to the process fluids to break down the hydrocarbon feed to lighter gases. Typical liquid hydrocarbon feed temperatures of a new unit installed as part of a Greenfield new plant construction would be in the range of 100^{o}F to 150^{o}F. Equistar is proposing the addition of new cracking furnaces as a de-bottleneck to the existing feed system that is equipped with 30 liquid feed cracking furnaces. Equistar’s existing feed system design (with feed preheaters) provides feed to the cracking furnaces at 250^{o}F to 260^{o}F. This allows the cracking furnaces to fire less with lower overall emissions. Equistar provided data to show that the targeted efficiency of the cracking furnaces would be 89.5% with a maximum annual average stack temperature of 408^{o}F. Equistar will monitor the thermal efficiency and exhaust temperature as BACT.

The following specific BACT practices are proposed for the cracking furnaces:

- *Energy Efficient Design* -A thermal efficiency of no less than 89.5% will be maintained. Equistar will design the cracking furnaces to be energy efficient by implementing the latest improvements and technologies in heat transfer and fluid flow to maximize the energy efficiency and energy recovery. The radiant tubes in the firebox will be located in the center of the box in a configuration to minimize the shadowing effect of adjacent radiant tubes, which allows for increased radiant heat transfer to the radiant tubes and high radiant transfer efficiency. The burner layout will be engineered to allow radiant heat to be transferred uniformly. This will help maintain high energy efficiency of radiant heat transfer. A combination of high temperature brick and ceramic fiber insulation will be utilized on the walls of the firebox to reduce heat loss and to maximize reflection of radiant heat back to the radiant tubes. The burners will be designed to operate with minimum excess air to maintain high combustion efficiency. The convection section of the cracking furnace will be designed to maximize heat recovery. The cracking furnaces shall be designed with an induced draft fan in combination with a stack damper to allow for oxygen to be controlled at the desired low level for efficiency. Integral quench exchangers/steam drum will be provided with the cracking heaters to increase overall heater efficiency.

- *Low Carbon Fuels* – Using natural gas as the primary fuel, and process gas containing hydrocarbons (methane) and/or hydrogen as a supplemental fuel provides a reduction in combustion CO_2 when compared to diesel or coal.
- *Best Operation Practices* – The use of best operation practices includes periodic combustion tune-ups and maintaining the recommended combustion air and fuel ranges of the equipment as specified by its design, with the assistance of oxygen trim control.
- *Low NO_x Burners* – The use of low NO_x burners will limit the formation of NO_x including N_2O emissions.

BACT Compliance:

Equistar elects to demonstrate compliance with energy efficient operations by continuously monitoring the exhaust stack temperature of each cracking furnace. The maximum stack exit temperature of 408°F on a 12-month rolling average basis will be calculated daily for each cracking furnace. Thermal efficiency will be calculated monthly from these parameters using equation G-1 from American Petroleum Institute (API) methods 560 (4th ed.) Annex G. Equistar determined that they could maintain a thermal efficiency of no less than 89.5%. Efficient cracking furnace design, use of low carbon fuels, and good combustion practices of the furnaces corresponds to a permit limit of 300,706 tpy CO_2e for each cracking furnace. The annual emission limit includes emissions from the furnaces during all operations and includes MSS activities.

Equistar will design the cracking furnaces to be energy efficient by implementing the latest improvements and technologies in heat transfer and fluid flow to maximize the energy efficiency and energy recovery. Equistar will implement the following to ensure efficient operation of the cracking furnaces:

- Radiant section thermal efficiency - Vertical process tubes combined with floor mounted burners. Highly luminous radiant section, maximizing radiant heat transfer. Process tube placement to assure uniform heating, and to minimize shadowing.
- Sealed system - Minimize air infiltration with proper sealing of firebox penetrations.
- Reduce heat loss - Brick and ceramic fiber insulation to reduce heat loss.
- Energy recovery - Preheating of process fluids in the convection section. Use of integral quench exchangers and steam drum.
- Physical characteristics - Triangular pitch in convection section with corbels to control hot combustion gas flow and maximize transfer of heat into the process fluids. Properly sized and designed induced draft fan. Properly sized and placed stack.
- Burner design - Long, thin flames parallel to tubes with highly luminous flame envelopes. Minimum excess air design to enhance efficiency. Low-NO_x burners.
- Careful control of feedstock/steam ratios, temperatures, pressures, and residence times to maximize production rate at normal firing rates.

Equistar will demonstrate compliance with the CO_2 emission limit for each furnace using the emission factors for natural gas from 40 CFR Part 98 Subpart C, Table C-2, and the site specific fuel analysis for process fuel gas. The equation for estimating CO_2 emissions as specified in 40 CFR § 98.33(a)(3)(iii) is as follows:

$$CO_2 = \frac{44}{12} * Fuel * CC * \frac{MW}{MVC} * 0.001 * 1.102311$$

Where:

CO_2 = Annual CO_2 mass emissions from combustion of natural gas (short tons)
Fuel = Annual volume of the gaseous fuel combusted (scf). The volume of fuel combusted must be measured directly, using fuel flow meters calibrated according to § 98.3(i).
CC = Annual average carbon content of the gaseous fuel (kg C per kg of fuel). The annual average carbon content shall be determined using the same procedures as specified for HHV at § 98.33(a)(2)(ii).
MW = Annual average molecular weight of the gaseous fuel (kg/kg-mole). The annual average molecular weight shall be determined using the same procedure as specified for HHV at § 98.33(a)(2)(ii).
MVC = Molar volume conversion factor at standard conditions, as defined in § 98.6.
44/12 = Ratio of molecular weights, CO_2 to carbon.
0.001 = Conversion of kg to metric tons.
1.102311 = Conversion of metric tons to short tons.

The proposed permit also includes an alternative compliance demonstration method in which Equistar may install, calibrate, and operate a CO_2 Continuous Emissions Monitoring System (CEMS) and volumetric stack gas flow monitoring system with an automated data acquisition and handling system for measuring and recording CO_2 emissions.

The emission limits associated with CH_4 and N_2O are calculated based on emission factors provided in 40 CFR Part 98, Table C-2, site-specific analysis of process fuel gas, and the actual heat input (HHV). Comparatively, the emissions from CO_2 contribute the most (greater than 99%) to the overall GHG emissions from the furnaces and, therefore, additional analysis is not required for CH_4 and N_2O. To calculate the CO_2e emissions, the draft permit requires calculation of the emissions based on the procedures and Global Warming Potentials (GWP) contained in the Greenhouse Gas Regulations, 40 CFR Part 98, Subpart A, Table A-1. Records of the calculations would be required to be kept to demonstrate compliance with the emission limits on a 365-day average, rolling daily.

An initial stack test demonstration will be required for CO_2 emissions from the emission units. An initial stack test demonstration for CH_4 and N_2O emissions are not required because the CH_4

and N_2O emission are less than 0.01% of the total CO_2e emissions from the furnaces and are considered a *de minimis* level in comparison to the CO_2 emissions.

X. BACT Analysis for Decoke Pots (EPNs: EOP1DECOKE2 and EOP2DECOKE2)

Cracking furnaces require periodic decoking to remove coke deposits from the furnace tubes. Coke buildup is unavoidable in cracking furnaces, and removal of coke at optimal periods maintains the furnace at efficient conversion rates without increasing energy (fuel) demand. Decoking too frequently is unnecessary and results in excess shutdown/start-up cycles. Decoking too infrequently results in fouled furnace tubes that reduce conversion rates and increases heat demand. The GHG emissions consist of CO_2 that is produced from combustion of the coke buildup on the coils.

Step 1 – Identification of Potential Control Technologies

There are no available technologies that have been applied to furnace decoking activities to control CO_2 emissions once generated. Proper design and operation of the furnaces in accordance with manufacturer's recommendations is important in managing the formation of coke in furnace tubes.

Step 2 – Elimination of Technically Infeasible Alternatives

Proper cracking furnace design and operation to minimize coke formation is considered technically feasible for the cracking furnaces.

Step 3 – Ranking of Remaining Technologies Based on Effectiveness

The only options, proper design and operation of the cracking furnace, have been identified for controlling GHG emissions from decoking operations. Therefore, ranking by effectiveness is not applicable.

Step 4 – Evaluation of Control Technologies in Order of Most Effective to Least Effective, with Consideration of Economic, Energy, and Environmental Impacts

The options for control of CO_2 from decoking operations is to follow the design and operational parameters integrated into the cracking furnaces to limit the need for decoking, thereby reducing the corresponding CO_2 emissions generated. As such, it is inherent in the design and operation of cracking furnaces to minimize coke formation as an economic necessity.

Step 5 – Selection of BACT

Equistar proposes to incorporate a combination of design and recommended operation to limit coke formation in the tubes to the extent practicable. No more than 26 decokes will occur per year per cracking furnace. Managing coke buildup through such methods will result in limited CO_2 formation from the biweekly decoking operations.

XI. Bact Analysis for Fugitive Emissions (EPNs: EOP1FUGEXP and EOP2FUGEXP)

GHG emissions from leaking pipe components (fugitive emissions) in the proposed project contain CO_2 and CH_4. The majority of the fugitive emissions are CH_4.

Step 1 – Identification of Potential Control Technologies

- *Installation of leakless technology components to eliminate fugitive emission sources.*
- *Instrumented Leak Detection and Repair (LDAR) program (Method 21).*
- *Leak Detections and Repair with remote sensing technology*
- *Auditory, Visual, and Olfactory (AVO) monitoring program.*
- *Design and construct facilities with high quality components, with materials of construction compatible with the process.*

Step 2 – Elimination of Technically Infeasible Alternatives

All of the options identified in Step 1 are technically feasible.

Leakless/Sealless Technology – Leakless technology valves may be incorporated in situations where highly toxic or otherwise hazardous materials are present. Likewise, some technologies, such as bellows valves, cannot be repaired without a unit shutdown.

Instrument LDAR Programs – LDAR programs have traditionally been developed for control of VOC emissions. Instrumented monitoring is considered technically feasible for components in CH_4 service.

Remote Sensing – Remote sensing technologies have been proven effective in leak detection and repair. The use of sensitive infrared camera technology has become widely accepted as a cost effective means for identifying leaks of hydrocarbon.

AVO Monitoring – Leaking components can be identified through AVO methods. AVO programs are common and in use in the olefins industry and are considered technically feasible.

High quality components - A key element in control of fugitive emissions is the use of high quality equipment that is designed for the specific service in which it is employed. The olefins unit at Equistar's La Porte plant utilizes such components and materials of construction, including gasketing, that are compatible with the service in which they are employed.

Step 3 – Ranking of Remaining Technologies Based on Effectiveness

- Leakless Technologies (~100%)
- Instrumented LDAR 28LAER (97%)
- LDAR with Remote Sensing (>75%)
- AVO Monitoring Program (30%)
- Design and Construct Using High Quality Components (Not Measurable)

Leakless technologies are nearly 100% effective in eliminating fugitive emissions from the specific interface where installed. However, leak interfaces remain even with leakless technology components in place. In addition, the sealing mechanism, such as a bellows, is not repairable online and may leak in the event of a failure until the next unit shutdown. This is the most effective control.

Instrumented monitoring can identify leaking CH_4, making identification of components requiring repair possible. This is the second most effective control.

Remote sensing using an infrared imaging has proven effective for identification of leaks. Instrument LDAR programs and the alternative work practice of remote sensing using an infrared camera have been determined by EPA to be equivalent methods of piping fugitive controls.[7]

As-observed AVO methods are generally somewhat less effective than instrument LDAR and remote sensing because they are not conducted at specific intervals. This method cannot generally identify leaks at as low a leak rate as instrumented reading can identify. This method, due to frequency of observation, is effective for identification of larger leaks.

Use of high quality components is effective in preventing emissions of GHGs relative to use of lower quality components.

[7] 73 FR 78199-78219 (December 22, 2008).

Step 4 – Evaluation of Control Technologies in Order of Most Effective to Least Effective, with Consideration of Economic, Energy, and Environmental Impacts

Use of leakless technology can have adverse environmental impacts. Following a failure of one of these parts, the component is most often not repairable online and may leak until the next unit shutdown, resulting in the emissions from the leak itself as well as the emissions of GHGs and other criteria pollutants that result from the need to shutdown and restart the facility. Based on these adverse environmental impacts, leakless technologies are eliminated as BACT.

LDAR programs for which instrumented detection of leaks is an essential activity have traditionally been developed for control of VOC emissions. The adverse impact of non-VOC fugitive emissions of CH_4 due to global warming potential has not been quantified, and no reasonable cost effectiveness has been assigned. Equistar proposes to use TCEQ method 28LAER for LDAR.

Remote sensing of fugitive components in CH_4 service can provide an effective means to identify leaks. However, this option is rejected as BACT because the higher ranked 28LAER program will be adopted for control of fugitive CH_4 emissions. However, as an alternative, Equistar may conduct remote sensing for detection of leaks for pipes with fugitive emissions components that are in methane service.

The adverse environmental impacts of as-observed AVO methods have not been noted, and no reasonable cost-effectiveness has been assigned. Equistar proposes to use AVO methods as additional monitoring for leaks.

Design to incorporate high quality components is effective in proving longer term emissions control.

Step 5 – Selection of BACT

Equistar proposes to use TCEQ method 28LAER for LDAR for fugitive emissions of methane for components that are in methane service. EPA concurs with Equistar's assessment that using the TCEQ 28LAER LDAR program is an appropriate control of GHG emissions. . As noted above, LDAR programs would not normally be considered for control of GHG emissions alone due to the small amount of GHG emissions from fugitives, and while the existing LDAR program is being imposed in this instance, the imposition of a numerical limit for control of those negligible emissions is not feasible.

XII. Endangered Species Act

Pursuant to Section 7(a)(2) of the Endangered Species Act (ESA) (16 U.S.C. 1536) and its implementing regulations at 50 CFR Part 402, EPA is required to insure that any action authorized, funded, or carried out by EPA is not likely to jeopardize the continued existence of any federally-listed endangered or threatened species or result in the destruction or adverse modification of such species' designated critical habitat.

To meet the requirements of Section 7, EPA is relying on a Biological Assessment (BA) prepared by the applicant and adopted by EPA. Further, EPA designated Equistar and its consultant, URS Corporation ("URS"), as non-federal representatives for purposes of preparation of the BA.

A draft BA has identified twelve (12) species listed as federally endangered or threatened in Harris County, Texas:

Federally Listed Species for Harris County by the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), and the Texas Parks and Wildlife Department (TPWD)	**Scientific Name**
Plant	
Texas Prairie Dawn Flower	*Hymenoxys texana*
Birds	
Red-cockaded Woodpecker Whooping Crane	*Picoides borealis* *Grus americana*
Fish	
Smalltooth Sawfish	*Pristis pectinata*
Mammals	
Louisiana Black Bear Red Wolf	*Ursus americanus luteolus* *Canis rufus*
Amphibians	
Houston Toad	*Bufo houstonensis*
Reptiles	
Green Sea Turtle Kemp's Ridley Sea Turtle Leatherback Sea Turtle Loggerhead Sea Turtle Hawksbill Sea Turtle	*Chelonia mydas* *Lepidochelys kempii* *Dermochelys coriacea* *Caretta caretta* *Eretmochelys imbricate*

EPA has determined that issuance of the proposed permit will have no effect on any of the twelve (12) listed species, as there are no records of occurrence nor designated critical habitat for any of these species within the action area.

Because of EPA's "no effect" determination, no further consultation with the USFWS and NMFS is needed.

Any interested party is welcome to bring particular concerns or information to our attention regarding this project's potential effect on listed species. The final draft biological assessment can be found at EPA's Region 6 Air Permits website at http://yosemite.epa.gov/r6/Apermit.nsf/AirP.

XIII. Magnuson-Stevens Act

The 1996 Essential Fish Habitat (EFH) amendments to the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) set forth a mandate for NOAA's National Marine Fisheries Service (NMFS), regional fishery management councils (FMC), and other federal agencies to identify and protect important marine and anadromous fish habitat.

To meet the requirements of the Magnuson-Stevens Act, EPA is relying on an EFH Assessment prepared by the applicant and reviewed and adopted by EPA.

The facility is adjacent to tidally influenced portions of the San Jacinto River, which empties into Galveston Bay system. These tidally influenced portions have been identified as potential habitats of postlarval, juvenile, subadult or adult red drum (*Sciaenops ocellatus*), white shrimp (*Penaeus setiferus*), brown shrimp (*Penaeus aztecus*), dog snapper (*Lutjanus jocu*), dwarf sandperch (*Diplectrum bivittatum*), lane snapper (*Lutjanus synagris*), and red snapper (*Lutjanus campechanus*). The EFH information was obtained from the NMFS's website (http://www.habitat.noaa.gov/protection/efh/efhmapper/index.html).

Based on the information provided in the EFH Assessment, EPA concludes that the proposed PSD permit allowing Equistar to expand Olefins OP-1 and OP-2 units within the existing facility property will have no adverse impacts on listed marine and fish habitats, because impacts from the construction and operation of the project on the San Jacinto River are negligible. Air modeling indicates that pollutant levels will be below *de minimus* levels over the water, and all wastewater and stormwater discharges that will be generated as a result of the project will be pretreated onsite resulting in negligible impacts on the water quality of the San Jacinto Tidal.

Any interested party is welcome to bring particular concerns or information to our attention regarding this project's potential effect on listed species. The final essential fish habitat report can be found at EPA's Region 6 Air Permits website at http://yosemite.epa.gov/r6/Apermit.nsf/AirP.

XIV. National Historic Preservation Act (NHPA)

Section 106 of the NHPA requires EPA to consider the effects of this permit action on properties eligible for inclusion in the National Register of Historic Places. To make this determination, EPA relied on and adopted a cultural resource report prepared by URS submitted on December 21, 2013.

For purposes of the NHPA review, the Area of Potential Effect (APE) was determined to be the construction footprint associated with the existing OP-1 and OP-2 furnaces located within Equistar's facility. URS conducted desktop review on the archaeological background and historical records within a 0.5-mile radius area of potential effect (APE) which included a review of the Texas Historical Commission's online Texas Archaeological Site Atlas (TASA) and the National Park Service's National Register of Historic Places (NRHP). Based on the results of the cultural review, no archaeological resources or historic structures were found within the APE.

EPA Region 6 determines that because no historic properties are located within the APE and that a potential for the location of archaeological resources within the construction footprint itself is low, issuance of the permit to Equistar will not affect properties potentially eligible for listing on the National Register.

On April 4, 2013, EPA sent letters to Indian tribes identified by the Texas Historical Commission as having historical interests in Texas to inquire if any of the tribes have historical interest in the particular location of the project and to inquire whether any of the tribes wished to consult with EPA in the Section 106 process. EPA received no requests from any tribe to consult on this proposed permit. EPA will provide a copy of the report to the State Historic Preservation Officer for consultation and concurrence with its determination. Any interested party is welcome to bring particular concerns or information to our attention regarding this project's potential effect on historic properties. A copy of the report may be found at http://yosemite.epa.gov/r6/Apermit.nsf/AirP.

XV. Environmental Justice (EJ)

Executive Order (EO) 12898 (59 FR 7629 (Feb. 16, 1994)) establishes federal executive branch policy on environmental justice. Based on this EO, the EPA's Environmental Appeals Board (EAB) has held that environmental justice issues must be considered in connection with the issuance of federal PSD permits issued by EPA Regional Offices [See, e.g., *In re Prairie State Generating Company*, 13 E.A.D. 1, 123 (EAB 2006); *In re Knauf Fiber Glass*, Gmbh, 8 E.A.D.

121, 174-75 (EAB 1999)]. This permitting action, if finalized, authorizes emissions of GHG controlled by what we have determined is BACT for those emissions. It does not select environmental controls for any other pollutants. Unlike the criteria pollutants for which EPA has historically issued PSD permits, there is no NAAQS for GHGs. The global climate-change inducing effects of GHG emissions, according to the "Endangerment and Cause or Contribute Finding", are far-reaching and multi-dimensional (75 FR 66497). Climate change modeling and evaluations of risks and impacts are typically conducted for changes in emissions that are orders of magnitude larger than the emissions from individual projects that might be analyzed in PSD permit reviews. Quantifying the exact impacts attributable to a specific GHG source obtaining a permit in specific places and points would not be possible [PSD and Title V Permitting Guidance for GHGS at 48]. Thus, we conclude it would not be meaningful to evaluate impacts of GHG emissions on a local community in the context of a single permit. Accordingly, we have determined an environmental justice analysis is not necessary for the permitting record.

XVI. Conclusion and Proposed Action

Based on the information supplied by Equistar, our review of the analyses contained in the TCEQ PSD Permit Application and the GHG PSD Permit Application, and our independent evaluation of the information contained in our Administrative Record, it is our determination that the proposed conditions in the draft permit represent BACT for GHGs. Therefore, EPA is proposing to issue Equistar a PSD permit for GHGs for the facility, subject to the PSD permit conditions specified therein. This permit is subject to review and comments. A final decision on issuance of the permit will be made by EPA after considering comments received during the public comment period.

APPENDIX

Annual Facility Emission Limits

Annual emissions, in tons per year (TPY) on a 12-month, rolling average, shall not exceed the following:

Table 1. Facility Emission Limits

FIN	EPN	Description	GHG Mass Basis		TPY CO_2e[1,2]	BACT Requirements
				TPY[1]		
EF3419	EF3419	Cracking Furnace (OP-1)	CO_2	300,400	300,706	Furnace Gas Exhaust Temperature ≤ 408 °F. Maintain a Minimum Thermal Efficiency of 89.5%. See permit condition III.A.1.m. through o.
			CH_4	5.7		
			N_2O	0.6		
EF4419	EF4419	Cracking Furnace (OP-2)	CO_2	300,400	300,706	Furnace Gas Exhaust Temperature ≤ 408 °F. Maintain a Minimum Thermal Efficiency of 89.5%. See permit condition III.A.1.m. through o.
			CH_4	5.7		
			N_2O	0.6		
EOP1DECOKE2	EOP1DECOKE2	Decoke Pot (OP-1)	CO_2	281	281	Good Combustion Practices. See permit condition III.A.1.
EOP2DECOKE2	EOP2DECOKE2	Decoke Pot (OP-2)	CO_2	281	281	Good Combustion Practices. See permit condition III.A.1.
EOP1FUGEXP	EOP1FUGEXP	Fugitive Process Emissions (OP-1)	CH_4	No Emission Limit Established[3]	No Emission Limit Established[3]	Implementation of LDAR program. See permit condition III.A.2.
EOP2FUGEXP	EOP2FUGEXP	Fugitive Process Emissions (OP-2)	CH_4	No Emission Limit Established[3]	No Emission Limit Established[3]	Implementation of LDAR program. See permit condition III.A.2.
Totals[4]			**CO_2**	**601,362**	**CO_2e 602,000**	
			CH_4	**12.6**		
			N_2O	**1.2**		

1. The TPY emission limits specified in this table are not to be exceeded for this facility and include emissions from the facility during all operations and include MSS activities.
2. Global Warming Potentials (GWP): CH_4 = 21, N_2O = 310
3. Fugitive process emissions from EPN EOP1FUGEXP and EOP2FUGEXP are estimated for each process unit (OP-1 and OP-2) to be 0.6 TPY of CH_4, and 13 TPY CO_2e. In lieu of an emission limit, the emissions will be limited by implementing a design/work practice standard as specified in the permit.
4. Total emissions include the PTE for fugitive emissions. Totals are given for informational purposes only and do not constitute emission limits.