PREVENTION OF SIGNIFICANT DETERIORATION PERMIT
FOR GREENHOUSE GAS EMISSIONS
ISSUED PURSUANT TO THE REQUIREMENTS AT 40 CFR § 52.21

U.S. ENVIRONMENTAL PROTECTION AGENCY, REGION 6

PSD PERMIT NUMBER:	PSD-TX-1334-GHG
PERMITTEE:	OCI Beaumont LLC
FACILITY NAME:	OCI Beaumont LLC
FACILITY LOCATION:	5470 N. Twin City Hwy Nederland, Jefferson County, Texas 75861

Pursuant to the provisions of the Clean Air Act (CAA), Subchapter I, Part C (42 U.S.C. Section 7470, *et seq.*), and the Code of Federal Regulations (CFR) Title 40, Section 52.21, and the Federal Implementation Plan at 40 CFR § 52.2305 (effective May 1, 2011 and published at 76 FR 25178), the U.S. Environmental Protection Agency (EPA), Region 6 is issuing a Prevention of Significant Deterioration (PSD) permit to OCI Beaumont LLC (OCI) for Greenhouse Gas (GHG) emissions. The Permit applies to the construction of a new pre-reformer heater, pre-reformer, flare and saturator column, in addition to miscellaneous process optimization changes which will increase the capacity of the existing methanol and ammonia plants located in Nederland, Jefferson County, Texas.

OCI is authorized to construct the pre-reformer heater, pre-reformer, flare and saturator column and modify the operations of the methanol and ammonia plants as described herein, in accordance with the permit application (and plans submitted with the permit application), the federal PSD regulations at 40 CFR § 52.21, and other terms and conditions set forth in this PSD permit in conjunction with the corresponding Texas Commission on Environmental Quality (TCEQ) permit PSD-TX-1334. Failure to comply with any condition or term set forth in this PSD permit may result in enforcement action pursuant to Section 113 of the Clean Air Act (CAA). This PSD permit does not relieve OCI of the responsibility to comply with any other applicable provisions of the CAA (including applicable implementing regulations in 40 CFR Parts 51, 52, 60, 61, 72 through 75, and 98) or other federal and state requirements (including the state PSD program that remains under approval at 40 CFR § 52.2303).

In accordance with 40 CFR §124.15(b)(3), this PSD Permit becomes effective immediately upon issuance of this final decision.

Wren Stenger, Director

8/1/14
Date

PROJECT DESCRIPTION

OCI currently operates a methanol and ammonia plant in Nederland, Texas. OCI is requesting an amendment to an existing TCEQ permit and a GHG PSD permit from EPA to increase production from the existing methanol plant by constructing a pre-reformer heater, pre-reformer, a saturator column, reformer flare, and to modify the existing two reformer furnaces with larger-diameter tubes in the methanol plant. There will also be process and energy optimization modifications to the methanol and ammonia plants. Modifications include equipping the heaters with selective catalytic reduction (SCR) technology to reduce NO_x emissions and operational optimizations between the two plants since hydrogen from the methanol plant is used as feed for the ammonia plant, as well as using CO_2 to supplement the feed to the reformers for methanol production.

The ammonia plant will have an increase in GHG emissions from the ammonia plant flare resulting from the purge gas of the ammonia reactor. With the proposed construction, modifications and optimizations, the methanol capacity of the plant will be increased to 1,098,000 metric tons per year and the ammonia plant will have a 12% increase in production to 332,727 metric tons per year.

PROCESS OPERATIONS

The primary feedstock for the methanol plant is natural gas which is combusted with recycle streams (process fuel gas) from various units to produce Syngas. The Syngas is converted to methanol in the reactors, and then refined in four distillation columns to produce the final methanol product, hydrogen gas and a gaseous recycle stream. Methanol is shipped via the docks or pipeline to various customers. The hydrogen gas is sent to the ammonia plant where it is purified to remove the organic components (which are recycled to the fuel gas system of the reformers), and then combined with nitrogen in a converter reactor to form ammonia. The ammonia is condensed, purified, depressurized for additional cooling and then shipped as liquid ammonia from the ammonia refrigeration system.

EQUIPMENT LIST

The emission units (identified by Facility Information Numbers (FIN) and Emission Point Number (EPN) authorized by and subject to the requirements of this GHG PSD permit. No other GHG emitting sources are authorized by this permit.

Emission Units

EPN	FIN	Description
STK41	RFM41	Reformer Furnaces modified to have larger tube diameters
	PRFMHTR	New Pre-Reformer and Pre-Reformer heater unit
	SCRDCTBRN	New SCR Unit Duct Burner for NOx control for all Reformers and new Pre-Reformer heater
FL42	FL42	New Reformer MSS Flare (startup and shutdown) and vent from stripper tailgas tank
MET-FUG247	MET-FUG247	Methanol plant process fugitive equipment (New and Existing)

I. GENERAL PERMIT CONDITIONS

A. Permit Expiration

1. As provided in 40 CFR §52.21(r), this PSD Permit shall become invalid if construction:

   a. is not commenced (as defined in 40 CFR §52.21(b)(9)) within 18 months after the approval takes effect; or
   b. is discontinued for a period of 18 months or more; or
   c. is not completed within a reasonable time.

2. Pursuant to 40 CFR §52.21(r), EPA may extend the 18-month period upon a written satisfactory showing that an extension is justified.

B. Permit Notification Requirements

1. Permittee shall notify EPA Region 6 in writing and by electronic mail of the:

   a. date construction is commenced, postmarked within 30 days of such date;
   b. actual date of initial startup, as defined in 40 CFR §60.2, postmarked within 15 days of such date;
   c. date upon which initial performance tests will commence, in accordance with the provisions of Special Condition VI not less than 30 days prior to such date.

C. Facility Operations

At all times, including periods of startup, shutdown, and maintenance, Permittee shall, to the extent practicable, maintain and operate the facility including associated air pollution control equipment in a manner consistent with good air pollution control practice for minimizing emissions. Determination of whether acceptable operating and maintenance procedures are being used will be based on information available to the EPA, which may include, but is not limited to, monitoring results, review of operating maintenance procedures and inspection of the facility.

D. Malfunction Reporting

1. Permittee shall notify EPA Region 6 by mail within 48 hours following the discovery of any failure of air pollution control equipment, process equipment, or of a process to

operate in a normal manner, which results in an increase in GHG emissions above the allowable emission limits stated in Section II of this permit.

2. Within 10 days of the restoration of normal operations after any failure described in General Condition I.D.1 of this permit, Permittee shall provide a written supplement to the initial notification that includes a description of the malfunctioning equipment or abnormal operation, the date of the initial malfunction, the period of time over which emissions were increased due to the failure, the cause of the failure, the estimated resultant emissions in excess of those allowed in Section II, the methods utilized to mitigate emissions and the date normal operations were restored.
3. Compliance with this malfunction notification provision shall not excuse or otherwise constitute a defense to any violation of this permit or any law or regulation such malfunction may cause.

E. Right of Entry

1. EPA authorized representatives, or representatives of any air pollution control program with jurisdiction, upon the presentation of credentials, shall be permitted:

   a. to enter the premises where the facility is located or where any records are required to be kept under the terms and conditions of this PSD Permit;
   b. during normal business hours, to have access to and to copy any records required to be kept under the terms and conditions of this PSD Permit;
   c. to inspect any equipment, operation, or method subject to requirements in this PSD Permit; and,
   d. to sample materials and emissions from the source(s).

F. Transfer of Ownership

In the event of any changes in control or ownership of the facilities to be constructed, this PSD Permit shall be binding on all subsequent owners and operators. Permittee shall notify the succeeding owner and operator of the existence of the PSD permit and its conditions by letter; a copy of the letter shall be forwarded to EPA Region 6 within thirty days of the letter signature.

G. Severability

The provisions of this PSD Permit are severable, and, if any provision of the PSD Permit is held invalid, the remainder of this PSD Permit shall not be affected.

H. Adherence to Application and Compliance with Other Environmental Laws

Permittee shall construct and operate this project in compliance with this PSD Permit, the application on which this permit is based, TCEQ PSD Permit PSD-TX-1334 and all other applicable federal, state, and local air quality regulations. This PSD permit does not release the Permittee from any liability for compliance with other applicable federal, state and local environmental laws and regulations, including the Clean Air Act.

II. Acronyms And Abbreviations

AVO	Auditory, Visual, and Olfactory
BACT	Best Available Control Technology
CH_4	Methane
CAA	Clean Air Act
CC	Carbon Content
CCS	Carbon Capture and Sequestration
CEMS	Continuous Emissions Monitoring System
CFR	Code of Federal Regulations
CGA	Cylinder Gas Audit
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
DRE	Destruction and Removal Efficiency
EF	Emission Factor
EPN	Emission Point Number
FIN	Facility Identification Number
FR	Federal Register
GCV	Gross Calorific Value
GHG	Greenhouse Gas
GWP	Global Warming Potential
HHV	High Heating Value
HRVOC	Highly Reactive Volatile Organic Compounds
MT	Metric Tons
lb	Pound
LDAR	Leak Detection and Repair
LEL	Lower Explosive Limit
LHV	Lower Heating Value
MMBtu	Million British Thermal Units
MSS	Maintenance, Start-up and Shutdown
N_2O	Nitrous Oxides
NOx	Nitrogen Oxides
NSPS	New Source Performance Standards
O_2	Oxygen

III. ANNUAL EMISSIONS LIMITATIONS

Emission Limits

EPN	Description	GHG Mass Basis		TPY[1,2,3] CO_2e	BACT Limits & Conditions
			TPY[1]		
STK 41	Reformer furnaces, Preheater and SCR duct burner	CO_2	1,173,573	1,178,593	1. Stack temperature to be monitored and not to exceed 422^0 F on an hourly basis, using SCR. Condition IV.2.k 2. Reformer net thermal efficiency 88% based on initial tests. Condition IV.2.l 3. Methanol output BACT limit of 33MMBtu (LHV)/MT on a 12 month rolling average (excluding fuel to the SCR burner)
		CH_4	59.34		
		N_2O	11.87		
FL42	Reformer MSS flare	CO_2	16,721	23,417	1. Use only for startup, shutdown and maintenance activities, and for the stripper tails tank vent. Condition IV.3 2. Meet 40 CFR 60.18 requirements and efficiency of 99%.
		CH_4	265.82		
		N_2O	0.17		
MET-FUG247	Methanol plant fugitives	CO_2	15	80	Work practice standards as noted in Special Condition IV.4
		CH_4	2.6		
	Totals[4]	CO_2	1,190,309	1,202,090	
		CH_4	327.76		
		N_2O	12.29		

1. Compliance with the annual emission limits (tons per year) is based on a 12-month rolling total.
2. 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. This total is rounded off for estimation purposes to two significant figures.
3. Global Warming Potentials (GWP): CO_2 =1, CH_4 = 25, N_2O = 298
4. Totals are given for informational purposes only and do not constitute emission limits.

IV. SPECIAL PERMIT CONDITIONS

A. Emission Unit Work Practice Standards, Operational Requirements, and Monitoring

1. Fuel for Reformers and Pre- reformer Heater and Flare

   a. Fuel to all combustion units identified in the permit shall use only pipeline natural gas and/or plant process fuel gas.
   b. A gas composition monitor/chromatograph should be installed after the point where the process fuel gas mixes with the natural gas or on the process gas line to determine the composition and carbon content of the gas.

c. The fuel gas monitor shall meet the requirements per 40 CFR §98.34(b)(3)(ii)(E) and/or 40 CFR §98.244(b)(4), for the gas chromatograph.
d. If the fuel gas monitor/chromatograph is installed prior to mixing with natural gas, the natural gas quality and carbon content will be obtained by semiannual testing, pursuant to 40 CFR §98.34(b)(3)(A).
e. The fuel analysis shall at a minimum allow for the determination of the fuel volumetric heat content, carbon content, and molecular composition.
f. The heat input as HHV (MMBtu/hr, upper heating value basis) shall be calculated with results from the gas chromatograph and the results recorded.
g. The annual value for determining GHG emissions from the total fuel used will be recorded using equation 40 CFR § 98.3(a)(1)(i), Equation C-2b daily. Upon request, Permittee shall provide a sample and/or analysis of the fuel that is fired in the units covered by this permit at the time of the request, or shall allow a sample to be taken by EPA for analysis.
h. The fuel flow rate to the combustion units will be monitored using an operational non-resettable elapsed flow meter, or by recording the flow rate data in an electronic format with individual flow measurements being taken no less frequently than once every 15 minutes. A computer that collects, sums and stores electronic data from continuous fuel flow meters is an acceptable totalizer. Electronic data may be reduced to hourly averages for recordkeeping.
i. The fuel meter measurement will meet the requirements of 40 CFR § 98.3(i) and quality assurance requirements of 40 CFR §98.3(i)(2) & (3).
j. Permittee shall calibrate and perform preventative maintenance checks of the fuel gas flow meters and document at the minimum frequency established per the manufacturer's recommendation, or at the interval specified per 40 CFR §98.34(b)(1)(ii).

2. Reformers, Pre-Reformer Heater and SCR Duct Burner (EPN STK41)

a. The feed to the reformer shall be pipeline natural gas and/or plant process fuel gas.
b. Permittee shall install, operate, and maintain an oxygen analyzer on the furnace flue gas at locations downstream of the radiant sections of the furnaces and duct burner.
c. The oxygen analyzer shall continuously monitor and record the excess oxygen concentration in the combustion gases. The monitoring data shall be reduced to hourly average concentrations at least once every day using a minimum of four equally spaced data points over each one-hour period.
d. Permittee shall perform preventative maintenance check of the oxygen analyzer and document quarterly.
e. The oxygen analyzer shall be quality-assured at least once per quarter using cylinder gas audits (CGAs) in accordance with 40 CFR Part 60, Appendix F, Procedure 1, § 5.1.2, with the following exception: a relative accuracy test audit is not required once every four quarters (i.e., two successive semiannual CGAs may be conducted).
f. Permittee will validate the oxygen analyzer with zero and span gas at least weekly to maintain 1% accuracy.
g. Excess oxygen shall be controlled to less than 3%.
h. All analyzers identified in section IV.A.1. & 2 shall achieve 95% on-stream time or greater.
i. Permittee shall utilize insulation materials where feasible to reduce heat loss.

j. The reformer furnaces shall not exceed the one-hour maximum firing rate of 2200 MMBtu/hr and shall be determined daily.
k. Permittee shall continuously monitor and record the stack (EPN STK41) gas exhaust temperature hourly and limit the temperature to less than or equal to 422 °F on a 365-day rolling average. This stack temperature is for normal operations and does not include commissioning, startup, and shutdown.
l. Permittee shall perform an initial performance test and show a thermal efficiency of 88%. The thermal efficiency will be calculated from these parameters using equation G-1 from American Petroleum Institute (API) methods 560 (4th ed.) Annex G, or an equivalent method approved by EPA. See Appendix A for the thermal efficiency methodology for the reformers.
m. The reformers shall be continuously monitored for exhaust temperature, input fuel temperature, and stack oxygen to ensure the optimum thermal efficiency.
n. OCI will demonstrate compliance with the CO_2 limit for the reformers based on metered fuel consumption, using the emission factors for natural gas from 40 CFR Part 98, Subpart C, Table C-1, and equation C-5, converted to short tons.
o. OCI will also calculate the CH_4 and N_2O emissions based on the default emission factors contained in 40 CFR Part 98, Subpart C, Table C-2 and equation C-8b, converted to short tons.
p. The CO_2e emissions will be based on procedures and Global Warming Potentials (GWP) contained in the Greenhouse Gas Regulations, 40 CFR Part 98, Subpart A, effective January 1, 2014 (78 FR 71904, Table 1-A). The relevant GWP values include: CO_2 =1; CH_4 = 25; N_2O = 298.
q. The CO_2e mass emissions shall be calculated on a monthly basis and divided by the metric tons of methanol produced during the month. The resulting quotient is added to the 12-month rolling average and compared to the BACT requirement to determine compliance with the BACT limit.
r. Records of the calculations will be required to be kept on-site and made readily available for inspection to demonstrate compliance with the BACT emission limits on a 12-month rolling average for the CO_2e limit.
s. As an alternative, OCI may install, calibrate, and operate a CO_2 CEMS and volumetric stack gas flow monitoring system with an automated data acquisition and handling system for measuring and recording CO_2 emissions. If this alternative is selected, the calculations shall be in accordance with the methodologies provided in 40 CFR § 98.33(a)(4).

3. Reformer MSS Flare (EPN FL42)

a. The flare shall be designed to achieve a minimum destruction and removal efficiency (DRE) of 99% based on flow rate and gas composition measurements.
b. The flare shall only combust pipeline natural gas in the pilots as a continuous stream.
c. The flare shall be designed and operated in accordance with 40 CFR 60.18 including specifications of minimum heating value of the waste gas, maximum tip velocity, and pilot flame monitoring. An infrared monitor is considered equivalent to a thermocouple for pilot flame monitoring purposes.
d. The only process gases flowing continuously to the flare are from the stripper tails tank vent gas. Sweep gas (natural gas) for maintaining maximum destruction efficiency will be used as necessary.

e. A flare header flow meter will measure flow at least once each 15 minutes. The flow meter shall be calibrated at least biannually.
f. The flare shall be equipped with a gas composition analyzer. The analyzer shall measure the gas composition at least once per hour and be calibrated monthly.
g. Permittee must record the time, date, HHV in MMBtu/hr and duration of each MSS event. The records must include hourly CH_4 emission levels as measured by the in-line gas analyzer (Gas chromatograph or equivalent with volumetric stack gas flow rate) and the calculations based on the actual heat input for the CO_2, N_2O, and CH_4 emissions during each MSS event. These records must be kept for five years following the date of each event.
h. CO_2 emissions are calculated using equation Y-1 found in 40 CFR §98.253(b)(1)(ii)(A). CH_4 and N_2O emissions are calculated using equations Y-4 and Y-5 as found in 40 CFR Part 98, Subpart Y.
i. Compliance with the annual emission limit shall be determined on a 12-month rolling total basis.

4. Process Fugitives (MET- FUG247)

a. Permittee shall implement the TCEQ 28VHP leak detection and repair (LDAR) program for fugitive emissions of methane.
b. Permittee shall implement an as-observed AVO program to monitor for fugitive emissions between instrumented monitoring as required in IV.A.4.a above.
c. Permittee shall use high quality components and materials of construction that are compatible with the service in which they are employed.

V. RECORDKEEPING AND REPORTING

In order to demonstrate compliance with the GHG emission limits the Permittee will monitor the following parameters and summarize the data on a calendar month basis.

a. Operating hours for all GHG air emission sources;
b. The fuel usage for all combustion sources, using continuous fuel flow monitors for each combustion unit (including the SCR duct burner); and
c. Semi-annual fuel sampling for natural gas, daily fuel sampling of plant fuel gas, or other frequencies as allowed by 40 CFR §98.34(b)(3) as specified in the previous sections.
d. Permittee shall maintain a file of all records, data, measurements, reports, and documents related to the operation of the facility, including, but not limited to, the following: all records or reports pertaining to significant maintenance performed on any system or device at the facility; duration of startup, shutdown; the initial startup period for the emission units; pollution control units; malfunctions; all records relating to performance tests, calibrations, checks, and monitoring of combustion equipment; duration of an inoperative monitoring device and emission units with the required corresponding emission data; and all other information required by this permit recorded in a permanent form suitable for inspection. The file must be retained for not less than five years following the date of such measurements, maintenance, reports, and/or records.

e. Permittee shall maintain records and submit a written report of all excess emissions to EPA semi-annually, except when: more frequent reporting is specifically required by an applicable subpart; or the Administrator or authorized representative, on a case-by-case basis, determines that more frequent reporting is necessary to accurately assess the compliance status of the source. The report is due on the 30th day following the end of each semi-annual period and shall include the following:

   i. Time intervals, data and magnitude of the excess emissions, the nature and cause (if known), corrective actions taken and preventive measures adopted;
   ii. Applicable time and date of each period during which the monitoring equipment was inoperative (monitoring down-time);
   iii. A statement in the report of a negative declaration; that is; a statement when no excess emissions occurred or when the monitoring equipment has not been inoperative, repaired or adjusted;
   iv. Any failure to conduct any required source testing, monitoring, or other compliance activities; and
   v. Any violation of limitations on operation.

f. Excess emissions shall be defined as any period in which the facility emissions exceed a maximum emission limit set forth in this permit, or a malfunction occurs causing an emissions exceedance.
g. Excess emissions indicated by GHG emission source certification testing or compliance monitoring shall be considered violations of the applicable emission limit for the purpose of this permit.
h. Instruments and monitoring systems required by this PSD permit shall have a 95% on-stream time on an annual basis.
i. All records required by this PSD permit shall be retained for not less than 5 years following the date of such measurements, maintenance, and reporting.
j. Continuously means individual measurement no less frequent than once every 15 minutes. Electronic data may be reduced to hourly averages for recordkeeping purposes.

VI. INITIAL PERFORMANCE TESTING REQUIREMENTS

The Permittee shall perform stack sampling and other testing to establish the actual pattern and quantities of air contaminants being emitted into the atmosphere from the EPN STK 41 to determine the initial compliance with the CO_2 emission limits.

a. Sampling shall be conducted in accordance with 40 CFR § 60.8 and EPA Method 3a or 3b for the concentration of CO_2.
b. Multiply the CO_2 hourly average emission rate determined under maximum operating test conditions by 8,760 hours.
c. If the above calculated CO_2 emission total does not exceed the tons per year (TPY) specified on Table 1, no compliance strategy needs to be developed.
d. If the above calculated CO_2 emission total exceeds the tons per year (TPY) specified in Table 1, the facility shall:

i. Document the potential to exceed in the test report; and
ii. Explain within the report how the facility will assure compliance with the CO_2 emission limit listed in Table 2.

1. An initial performance test to determine the 88% thermal efficiency of the reformer units will be done at 75% and 95% firing rate of the reformers and with the SCR duct burner.

2. The tests should also determine compliance with the BACT methanol output limit of 33 MMBtu (LHV)/MT. The calculations to determine the thermal efficiency methodology of the reformers is in the attached Appendix A.

3. Permittee shall submit a performance test protocol to EPA no later than 30 days prior to the test to allow review of the test plan and to arrange for an observer to be present at the test. The performance test shall be conducted in accordance with the submitted protocol, and any changes required by EPA.

4. The owner or operator must provide the EPA at least 30 days prior notice of any performance test, except as specified under other subparts, to afford the EPA the opportunity to have an observer present and/or to attend a pre-test meeting. If there is a delay in the original test date, the facility must provide at least 7 days prior notice of the rescheduled date of the performance test.

5. No later than 180 days after initial start-up, or restart after modification of the facility, performance test(s) must be conducted and a written report of the performance testing results furnished to the EPA with 60 days after the testing is completed. During subsequent operations, stack sampling shall be performed within 120 days if current production rates exceed the production rate during stack testing by 10 percent or greater, additional sampling may be required by TCEQ or EPA.

6. Performance tests must be conducted under such conditions to ensure representative performance of the affected facility. The owner or operator must make available to the EPA such records as may be necessary to determine the conditions of the performance tests.

7. The owner or operator shall provide, or cause to be provided, performance testing facilities as follows:

   a. Sampling ports adequate for test methods applicable to this facility,
   b. Safe sampling platform(s),
   c. Safe access to sampling platform(s), and
   d. Utilities for sampling and testing equipment.

8. Unless otherwise specified, each performance test shall consist of three separate runs using the applicable test method. Each run shall be conducted for the time and under the conditions specified in the applicable standard. For purposes of determining compliance with an applicable standard, the arithmetic mean of the results of the three runs shall apply.

9. Emissions testing, as outlined above, shall be performed every five years, plus or minus 6 months, of when the previous performance test was performed, or within 180 days after the issuance of a permit renewal, whichever comes later to verify continued performance at permitted emission limits.

VII. AGENCY NOTIFICATIONS

Permittee shall submit GHG permit applications, permit amendments, and other applicable permit information to:

Multi Media Planning and Permitting Division
EPA Region 6
1445 Ross Avenue (6 PD-R)
Dallas, TX 75202

Email: Group R6AirPermits@EPA.gov

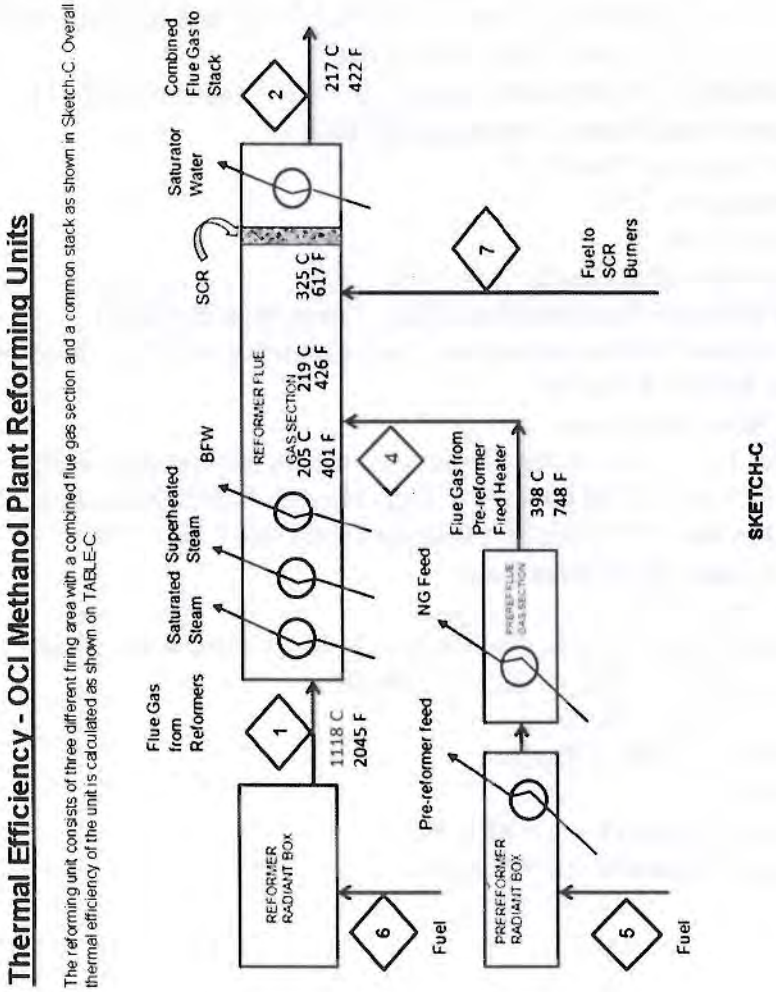
Permittee shall submit a copy of all compliance and enforcement correspondence as required by this Approval to Construct to:

Compliance and Enforcement Division

EPA Region 6
1445 Ross Avenue (6EN)
Dallas, TX 75202

Appendix A

Thermal Efficiency Sketch for the OCI Reformer Units



Net Efficiency based on ANSI/API Standard 560/ISO 13705, Equation G.1
OCI Beaumont, LLC - GHG Permit Application
Site-specific Calculations for OCI Beaumont Reforming System
hL, fuel LHV heat 21,189.9 Btu/lb Total from API Combustion Work Sheet
Air Sensible Mass Heat Correction (SMHC)
cpa, specific heat 0.24 Btu/lb-°F
Ta, air temperature 279.0 °F
Td, datum temp. 60 °F
ma1, required air 16.895 lb/lb fuel From API Excess Air and Relative Humidity Worksheet
ma2, excess air 5.400 lb/lb fuel From API Excess Air and Relative Humidity Worksheet
ma, mass of air 22.295 lb/lb fuel = ma1 + ma2
ΔhA, air SMHC 1,171.8 Btu/lb = cpa · (Ta − Td) * (ma/mf) [mf =1]
Fuel Sensible Mass Heat Correction (SMHC)
cpa, specific heat 0.67 Btu/lb-°F
Tf, fuel temperature 120 °F
Td, datum temp. 60 °F
ΔhF, fuel SMHC 40.0 Btu/lb = cpf * (Tf − Td)
Atomizing Medium Sensible Mass Heat Correction (SMHC)
The OCI reformer will not include any fuel atomizing medium; therefore, this value is zero.
ΔhM, med. SMHC 0 Btu/lb
Radiation Mass Heat Loss
Radiant Heat Loss 2.00 percent Conservative estimate based on design
hL, fuel LHV heat 21,189.9 Btu/lb = Total Heat In * 106 / Mass Fuel Flow
hR, radiation loss 423.8 Btu/lb = Radiant Heat Loss * hL / 100%
Calculated Stack Mass Heat Loss
Te, stack temp. 422 °F
hS, stack heat 2260.7 Btu/lb Total from API Stack Loss Work Sheet
(hL + ΔhA + ΔhF + ΔhM) = 22,401.7 Btu/lb
(hR + hS) = 2,684.5 Btu/lb
22,401.7 Btu/lb - 2,684.5 Btu/lb
22,401.7 Btu/lb
Net Thermal Efficiency = e = 88.0 %
Net Thermal Efficiency = e = * 100%