Shell Chemical Appalachia LLC
300 Frankfort Rd
Monaca, PA 15061

November 20, 2023

BY ELECTRONIC MAIL

Mark Gorog, P.E.
Air Quality Program Manager
Department of Environmental Protection/Southwest Regional Office
400 Waterfront Drive
Pittsburgh, PA 15222-4745

RE: Shell Chemical Appalachia LLC Commissioning Report and Flare Report

Dear Mark:

Shell Chemical Appalachia LLC ("Shell") located in Beaver County, Pennsylvania submits this Commissioning and Flare Report to the Pennsylvania Department of Environmental Protection (PADEP), as required by the May 24, 2023 Consent Order and Agreement (COA) Section 9.a.

On January 30, 2023 Shell submitted to the PADEP an Emission Exceedance Report and Mitigation Plan in response to a Notice of Violation received December, 2022. In this report, Shell detailed the commissioning process for its world scale polyethylene production facility built in southwestern Pennsylvania. Specifically, this report evaluated the commissioning process, identified the causes of excess emissions and sources where the excess emissions occurred, measures that were employed and measures that could have been employed to reduce or prevent excess emissions. Please refer to Shell's Emission Exceedance Report and Mitigation Plan dated January 30, 2023 for detailed information on the commissioning process for the facility. On March 31, 2023, Shell also submitted a response to the Department's correspondence seeking further clarification on some of the items in the January 30, 2023 report.

i. Identify the Causes of the Excess Emissions;

Please refer to Shell's Emission Exceedance Report and Mitigation Plan dated January 30, 2023 for this information. Please also refer to Shell's Malfunction Reports submitted to the Department which detail each malfunction's root cause, and emissions associated with each malfunction event.

ii. Identify Sources Where Excess Emissions Occurred

Please refer to Shell's Emission Exceedance Report and Mitigation Plan dated January 30, 2023 for this information. Please also refer to Shell's Malfunction Reports submitted to the Department which detail each source associated with each malfunction, and emissions associated with each malfunction event.

Shell also submits monthly reports to the Department which provides information on the following:

- Cumulative 12-month emissions data (see COA Exhibit A);
- Emission factors, assumptions, and calculation protocol;

- All Malfunctions; and
- Monthly Fence Line Monitoring data.

The table in Attachment 1 summarizes the sources where excess emissions occurred.

iii. Identify measures that were employed to reduce or prevent excess emissions, and measures that were not, but could have been, employed to have reduce or prevented excess emissions;

Please refer to Shell's Emission Exceedance Report and Mitigation Plan dated January 30, 2023 for this information. Also please refer to malfunction reports previously submitted and referenced in Attachment 1. Each report identifies the steps, if any, that the facility took to limit the duration and/or quantity of [excess] emissions associated with the malfunction.

Attachment 2 contains a memorandum with an updated analysis demonstrating Shell continues to meet the Lowest Achievable Emission Rate (LAER) for NOx and VOCs written by Shell's Plan Approval consultant. The memorandum affirms Shell's 2015 Plan Approval is still representative for demonstrating LAER and indicates no new technologies or more stringent permits have been issued since Shell's Plan Approvals were originally issued.

iv. Examine how frequently different pieces of process equipment and air pollution control equipment experienced upsets or malfunctions

The following table, Attachment 3, summarizes how frequently different pieces of process equipment and air pollution control equipment experienced upsets or malfunctions. Malfunctions have been documented and Malfunction Reports are provided to PADEP which identifies the various equipment relating to malfunctions or upsets. The number of upsets may not correlate to the number of Malfunction Reports because malfunctions may have involved multiple pieces of equipment.

v. Examine the operation of, and emissions from, TEGFs during Commissioning

Please refer to Shell's Emission Exceedance Report and Mitigation Plan dated January 30, 2023 for this information.

vi. Evaluate whether the TEGFs control emissions to the degree predicted in Shell's applications for the plan approvals for the Facility

Please refer to Shell's Emission Exceedance Report and Mitigation Plan dated January 30, 2023 for this information. In this report, Shell provided test results to PADEP on testing that was conducted on the Totally Enclosed Ground Flares. On March 31, 2023, Shell also submitted additional technical information to further clarify some of the items in the January 30, 2023 report.

On May 24, 2023 Shell and PADEP signed a Consent Order and Agreement which disclosed a memo from the flare vendor indicating that the current mechanical condition of these enclosed ground flares are considered to be in good working order.

Shell also conducts daily inspections of the TEGFs and summarizes their status in a monthly TEGF Inspection Report to the Department. In this report, Shell attests the TEGFs are still operating within the manufacturers guaranteed minimum destruction efficiency of 98%.

vii. Determine whether the flares were operated to reduce emissions to the maximum extent possible;

The May 24, 2023 Consent Order and Agreement requires Shell provide the Department technical reports: TEGF Repair Report and Steam Report. These reports were developed to assess causes, mitigations, and final corrective actions to remedy visible emissions associated with the high-pressure (HP) flare system. Shell provided correspondence to the Department on November 18, 2022 which summarized how the HP flare system was operated to reduce emissions.

viii. Identify how flare operations changed throughout Commissioning

- Stages with damaged tips were removed from service.
- Staging curves were corrected to follow the manufacturer intended design.
- Staging order was modified to eliminate visible emissions.
- Operations worked to reduce the amount of gas to be flared.

Shell provided correspondence to the Department on November 18, 2022 which summarized how the HP flare system was operated throughout commissioning up to that point.

ix. Identify causes of "black smoke," improper combustion, or non- optimal combustion observed from TEGFs and Elevated Flare.

Causes of black smoke and improper combustion have been provided to PADEP through Malfunction Reports. These causes are summarized below.

Causes of Black Smoke in TEGFs:

- Smoke was observed from some end row burners.
- Smoke was observed during high wind events.

Improper Combustion or non-optimal combustion:

- During this start up, the team also captured drone footage showing a correlation of the visible emissions (light brown/yellow) with the lack of cross lighting of all burners within some stages.

Smoke at the elevated flare results from insufficient steam for the amount of gas being burned.

The May 24, 2023 Consent Order and Agreement requires Shell provide the Department technical reports: TEGF Repair Report and Steam Report which both address visible emissions from HP flares.

Shell is submitting this Commissioning and Flare Report in compliance with Shell's requirement via Section 9.a. of the May 24, 2023 COA.

Sincerely,

Kimberly Kaal

Digitally signed by Kimberly Kaal
DN: cn=Kimberly Kaal
Date: 2023.11.20 17:06:29 -05'00'

Kimberly Kaal
Environmental Manager, Attorney-in-Fact

CC:

Michael Heilman, Litigation Coordinator
Pierre Espejo, Shell Senior Legal Counsel
Jim Miller, SW Regional Manager

Attachment 1

Unit	Malfunction Description	Date Started	Date Ended	Root Cause	Impacted Control Device and ID Number	Steps took to limit duration and/or quantity of emissions	Corrective Actions stemmed from Root Cause Investigation
PE3	Reactor Recirculation Pump Leak around Pump Shaft	9/3/2022	9/4/2022	Pump seal cartridge and stuffing box installation issue during construction (missing O-ring gasket)	HP Ground Flares (C205A/B)	- Depressured PE3 reactor system to flare to avoid a large pump seal release to atmosphere - Addressed discovered seal installation issue	- No medium-long term corrective actions identified
UGF	HP Ground Flares VE	9/6/2022	9/24/2022	Flaring related to ECU startup	HP Ground Flares (C205A/B)	- Vendor engagement for troubleshooting support	- Longer term HP Ground Flare repair plan
ECU	Demethanizer Low Temperature Feed Drum Flange Leak	9/8/2022	9/8/2022	Thermal stress due lower temperatures experienced during startup	NA- flange leak to atmosphere	- Made an expedited online repair to address the flange leak	- No medium-long term corrective actions identified
ECU	Ethylene Refrigerant Compressor (ERC) Trip Cold Flare Drum Flange Leak	9/8/2022	9/10/2022	Low dewpoint trip Thermal stress due lower temperatures experienced during startup	HP Elevated Flare and HP Ground Flares (C205A/B/C) NA- flange leak to atmosphere	- Reduced ECU rate to minimum to minimize flaring - Made an expedited online repair to address the flange leak	- Updated applicable ECU startup procedures
ECU	Ethylene Refrigerant Compressor Trip cascading to Cracked Gas Compressor Trip	9/10/2022	9/11/2022	High ERC Vibrations	HP Elevated Flare and HP Ground Flares (C205A/B/C)	- Quick troubleshooting of initiating trip, including reviewing startup procedures - Maintained ECU rate at minimum to minimize flaring	- No medium-long term corrective actions identified
ECU	Cracked Gas Compressor Trip	9/15/2022	9/16/2022	Incorrect suction drum level instrument calibration	HP Elevated Flare and HP Ground Flares (C205A/B/C)	- Quick troubleshooting of initiating trip, followed by expeditiously updating the level instrument's calibration setting	- Updating other similar level instruments calibration settings within the plant, which were discovered to be calibrated for the incorrect process fluid
ECU	Propane Refrigerant Compressor Trip	9/18/2022	9/18/2022	Low suction pressure	HP Elevated Flare and HP Ground Flares (C205A/B/C)	- Quick troubleshooting of all instrumentation and control schemes to indentify source of the trip	- Adjusted the suction pressure controller's tuning to improve response and avoid future trips
ECU	Acetylene Reactor Trip	9/21/2022	9/22/2022	High methanol drum level	HP Elevated Flare and HP Ground Flares (C205A/B/C)	- Quick troubleshooting of methanol drum level fluctuations, which was determined to be non-condensable gases in the vapor space	- Operational adjustments were made to the methanol cooling system to avoid another similar trip
PE3	Reactor Recirculation Pump Seal Failure	10/2/2022	10/2/2022	Seal failure during startup transients	HP Ground Flares (C205A/B)	- Expedited seal repair	- No medium-long term corrective actions identified
ECU	C2 Splitter Feed Strainer Restriction	10/5/2022	10/22/2022	Basket strainer plugged with debris from startup activities	HP Ground Flares (C205A/B)	- Several online attempts were made to clear the strainer prior to shutting down the unit - ECU was shut down completely to minimize flaring vs. keeping a continuous flow of feed into the unit - Pulled and cleaned the strainer	- No medium-long term corrective actions identified
ECU	Boil Off Gas Compressor Downtime	10/17/2022	11/25/2022	Compressor coupling failure due to vibrations	LP Multipoint Ground Flare (C204B)	- Minimized ethylene storage tank levels	- Addressed system issues during extended downtime
ECU	Off-Spec Acetylene Reactor Outlet	10/24/2022	10/26/2022	Elevated system CO	HP Elevated Flare and HP Ground Flares (C205A/B/C)	- Quick troubleshooting of initiating cause	- No medium-long term corrective actions identified
ECU	Elevated CO Levels Resulting in C2 Splitter Feed Flaring	11/15/2022	11/16/2022	Elevated pipeline ethane CO	HP Ground Flares (C205A/B)	- Quick elevation of the issue to the pipeline company	- No medium-long term corrective actions identified
ECU	C2 Splitter Upset causing Off-Spec Ethylene	11/20/2022	11/20/2022	Process upset- no specific root cause identified	HP Ground Flares (C205A/B)	- Quick console operator intervention to get the ethylene back on-spec	- No medium-long term corrective actions identified
UGF	Gas Turbine Generator (GTG) Trip causing ECU Upset and Flaring	11/28/2022	11/29/2022	Following a control system upgrade, an erroneous signal was sent to Gas Turbine Generator 1, forcing a slowdown of that unit. Cascading console operator response to this resulted in an inadvertent GTG trip	HP Ground Flares (C205A/B)	- Quick stabilizing of the steam system and then ECU	- Event learnings shared with the site
PE1	Unit Shutdown due to Cycle Gas Compressor Issue Multipoint Ground Flare PE Header VE	12/14/2022	12/14/2022	High cycle gas compressor vibrations Inadequate response of assist air to increased vent gas flow	LP Multipoint Ground Flare (C204B)	- Shutdown of PE1 before the compressor tripped, yielding a more controlled shutdown - Manual console operator moves to ramp the air fan speed to stop the smoking	- No medium-long term corrective actions identified
Sitewide	Equipment and instrumentation impacted by freeze	12/24/2022	1/6/2023	Extremely cold ambient temperatures (well-below freezing)	HP Elevated Flare and HP Ground Flares (C205A/B/C)	- The whole plant was safely shutdown in response to the freezing event to minimize flaring	- Took steps to mitigate the future freezing of similar equipment and instrumentation to avoid future malfunctions. Updates and continuous improvement of sitewide winterization procedures.
UGF	Spent Caustic Thermal Oxidizer Low Fuel Gas Pressure Trip	1/4/2023	1/10/2023	Failed fuel gas pressure regulator	Spent Caustic Vent Incinerator (C206)	- Quick troubleshooting to identify and address the root cause of the trip - Replaced the fialed pressure regulator	- No medium-long term corrective actions identified

ECU	Demethanizer Upset	1/20/2023	1/20/2023	Too rapid of an increase in front-end ECU rate	HP Ground Flares (C205A/B)	- Quick troubleshooting to identify and address the root cause of the trip	- Updated applicable operator field rounds and startup procedures
ECU	Elevated CO Level Causing Off-Spec Acetylene Reactor Product	2/3/2023	2/3/2023	Suspected residual air left in process equipment that was put into service leading up to the event	HP Ground Flares (C205A/B)	- Quick troubleshooting to identify and address the root cause of the trip	- Updated applicable startup procedures to ensure testing for oxygen content is conducted prior to placing key pieces of equipment back in service
ECU	Cracked Gas Compressor Trip	2/13/2023	2/18/2023	Control system logic issue, slowing turbine governor to minimum	HP Elevated Flare and HP Ground Flare B (C205B/C)	- Decision made to remove ECU feed and wait until both HP Ground Flares were available for ECU restart.	- The control logic switch error was corrected and an audit of similar logic controls in other areas was actioned
ECU	Cracked Gas Compressor Trip	3/14/2023	3/17/2023	High compressor knockout drum level due to cascading process upset	HP Ground Flares (C205A/B)	- ECU feed Furnace was immediately reduced, and then backed out completely to stabilize unit operations and cease flaring	- Operator training to avoid a similar upset - Updated applicable alarms to avoid a similar upset
UGF	HP Seal Drum Damage	3/17/2023	4/18/2023	Flame propagation back into seal drum following nitrogen purge line opening, which pushed flare gas to flare tip when there was air present in the flare header from a recent elevated flaring event	HP Elevated Flare (C205C)	- Decision made to shut down facility and to safely de-inventory portions of the various process units to allow repair of the HP flare seal drum.	- The nitrogen purge line valve lineup remains open to prevent air entering the flare line to prevent the flammable atmosphere from forming. This line is now car sealed open and inspected once per shift to verify nitrogen flow locally.
ECU	Caustic Piping Leak	3/25/2023	3/26/2023	Carbon steel piping incompatible with the polymer inhibitor injected into the caustic stream; unit had to be shutdown due to inability to isolate this section of the line	HP Ground Flares (C205A/B)	- ECU was immediately shutdown	- Replaced section of line with a more compatible metallurgy (304 stainless steel) and added an injection quill such that the inhibitor does not come into direct contact with remaining carbon steel piping. Also added an isolation valve to avoid a full unit deinventory in the event of future leaks.
UGF	Wastewater Treatment Plant Odors	4/11/2023	4/20/2023	Carryover of oil from Flow Equalization and Oil Removal tank to biotreater due to inadequate level transmitter span	Wastewater Treatment Plant (502)	- Flow Equalization and Oil Removal (FEOR) Tanks were isolated from the biotreaters to prevent additional hydrocarbons from entering the system - Excess hydrocarbon was vacuumed off the top of the biotreaters	- Updated FEOR tank alarm level settings - Installation of an induced nitrogen flotation system to improve hydrocarbon removal capacity in the WWTP
UGF	HP Ground Flare A VE	5/24/2023	5/24/2023	Low vent gas rates coupled with high ethylene concentrations during ECU startup	HP Ground Flare A (C205A)	- Manual adjustments of staging - Created operator instructions with key steps to be taken to minimize VE	- Longer term HP Ground Flare repair plan
UGF	Spent Caustic Thermal Oxidizer Trip- low fuel gas pressure and then again on low combustion air	6/24/2023	6/28/2023	Failed fuel gas transmitter Water in air regulator used to control air fan damper	Spent Caustic Vent Incinerator (C206)	- Quick troubleshooting to identify the root cause of the initiating trip - Spent caustic oxidation system was shut down to minimize venting from this system - Replaced failed guel gas transmitter	- Updated applicable procedures to blow down air lines prior to commencing an air fan startup
ECU	ECU Acetylene Reactor Trip Multipoint Ground Flare Ethylene Tank Header VE related to ECU Upset	7/10/2023	7/13/2023	Loose wire in Emergency Isolation System/Emergency Depressuring System panel located in the control building Inadequate permit air fan response to prevent smoking	HP Elevated Flare and HP Ground Flares (C205A/B/C) LP Multipoint Ground Flare (C204B)	- ECU and PE units were stabilized as quickly as possible - Quick troubleshooting to identify the root cause of the initiating trip - Manual ramping of MPGF ethylene header assist air fan until VE ceased	- Checked for loose wires in other similar systems within the plant - Car seal opened the inlet and outlet isolation valves around the HP elevated flare steam control valve (to address elevated flare smoking) - Flow has been bypassed around the plugged condensate strainer that ultimately cause the ethylene tank overpressure to the MPGF until a longer term solution can be determined
ECU	Boil Off Gas Compressor Trip- Multipoint Ground Flare Ethylene Tank Header VE	8/3/2023	8/4/2023	Loose wire between the DCS cabinet and the compressor motor's variable frequency drive Inadequate permit air fan response to prevent smoking	LP Multipoint Ground Flare (C204B)	- Quick troubleshooting to identify the root cause of the initiating trip - Manual ramping of MPGF ethylene header assist air fan until VE ceased	- Pending for MPGF VE: Test run to develop a new fan curve (appropriate fan speed for a range of waste gas flows) with vendor support
UGF	Spent Caustic Thermal Oxidizer Trip- High Fuel Gas Pressure	8/8/2023	8/9/2023	Sudden change in waste gas composition, requiring more fuel gas to burner	Spent Caustic Vent Incinerator (C206)	- Quick troubleshooting to identify the root cause of the initiating trip - Spent caustic oxidation system was shut down to minimize venting from this system	- No medium-long term corrective actions identified
PE1/2	PE1/2 Trip- HP Flaring Multipoint Ground Flare Ethylene Tank Header VE	9/2/2023	9/3/2023	Main ethylene feed isolation valve failing closed	HP Ground Flares (C205A/B) LP Multipoint Ground Flare (C204B)	- Quick troubleshooting to identify the root cause of the initiating trip - Manual ramping of MPGF ethylene header assist air fan until VE ceased	- Pending for MPGF VE: Test run to develop a new fan curve (appropriate fan speed for a range of waste gas flows) with vendor support

ECU	ECU Ethylene Refrigerant Compressor (ERC) Trip- HP Flaring MPGF Ethylene Tank Header VE	10/8/2023	10/12/2023	Trip due to failure of the compressor's turbine extraction valve actuator; issues with compressor's restart to due presence of a contaminant in the lube oil	HP Elevated Flare and HP Ground Flares (C205A/B/C) LP Multipoint Ground Flare (C204B)	- Quick troubleshooting to identify the root cause of the initiating trip - Manual ramping of MPGF ethylene header assist air fan until VE ceased	- Filter lube oil system of the ERC - Pending for MPGF VE: Test run to develop a new fan curve (appropriate fan speed for a range of waste gas flows) with vendor support
UGF	Spent Caustic Thermal Oxidizer Trip- Loss of Combustion Air	10/19/2023	10/22/2023	Inadvertent shutdown of combustion air blower	Spent Caustic Vent Incinerator (C206)	- Plant was down so there was minimal material being vented to the SCTO prior to its trip	- TBD pending final malfunction report

RTP ENVIRONMENTAL ASSOCIATES, INC.®

304-A West Millbrook Road
Raleigh North Carolina 27609
(919) 845-1422

Memorandum

To: Kim Kaal & James Sewell, Shell Polymers Monaca

From: Phillip May and Robert Barton

CC: Pierre Espejo, Shell Legal Services

Date: February 27, 2023 (original) September 28, 2023 (revised update)

Re: Shell Polymers Monaca NO_x/VOC LAER Update

The following memo summarizes RTP Environmental Associates' (RTP's) update of the NOx and VOC LAER analyses for the emissions units that comprise the Shell Polymers Monaca (Shell) plant in Beaver County, Pennsylvania. This evaluation was conducted to determine whether the LAER analyses performed in support of the 2015 plan approval application is still representative for each emissions unit given the possibility that other facilities in this class or category may have been permitted more recently, constructed, begun actual operation, and achieved in practice more stringent limits since issuance of Shell's 2015 plan approval.

METHODOLOGY

RTP evaluated the permits for gas-fired combined cycle units, ethane cracking, and polyethylene manufacturing projects that have been issued since 2014 and been in commercial operation for a period of at least six months. The evaluation focused on projects in Texas and Louisiana where the majority of ethylene/polyethylene production is located.

In addition to the Texas and Louisiana permitting databases, RTP used the following data sources as part of the evaluation:

- EPA's RBLC Database
- Recent permits issued by South Coast Air Quality Management District (SCAQMD)
- Recent permits issued by Bay Area Air Quality Management District (BAAQMD)
- SCAQMD LDAR Regulations
- NSPS Subpart CC regulations

SUMMARY OF FINDINGS

Although there have been several similar projects permitted that have begun commercial operation since the Shell project's permit was issued, the original limits still represent NO_x and VOC LAER for nearly all the emissions units with possible exceptions as noted below.

Ethane Cracking Furnaces

NO_x LAER

A summary of the results of the NO_x LAER update analysis for ethylene cracking furnaces is presented in Table 1. As shown, the only facility with a more stringent NO_x limit is the Plaquemine Expansion Project.[1] This project includes four new furnaces, each with a NO_x limit of 0.009 lb/MMBtu. However, compliance with this limit is based on the average of three one-hour stack tests. Because compliance with this limit is not tracked on a continuous basis, it is considered less stringent than Shell's existing permit limit.

As shown, the Dow Texas Operations cracking furnace short-term and annual NO_x limits during normal operation are the same.[2] Texas also issues separate permits covering operations during non-normal operations (i.e., maintenance, startup, and shut down). These permits are referred to as MSS permits. The MSS permit for this project was not found. However, maintenance related operation limits would cover the same types of operation as is covered by Shell's permit limits for decoking, hot steam standby, feed in, or feed out modes and the startup and shut down conditions would also be parallel. Because these type limits would be unit and unit size specific it is concluded that the Dow Texas Operations limits are equivalent.

As shown, the Gulf Coast Ventures Project (GCVP) cracking furnace short-term and annual NO_X limits during normal operation are the same. For this project a technical review document was identified which provides additional insight to what was considered non-normal operation, as follows:

> The furnaces are fired at a reduced rate during decoking operations and while on hot steam standby. The furnace exhaust cannot be controlled by SCR during these times because its temperature is not sufficiently high to support catalyst activity. The permit provides waivers from the NOx and CO concentration limits during defined non-routine operations (start-up, shutdown, hot steam standby, decoking, feed in and feed out)

Based on this finding it is concluded that the GCVP limits are the equivalent to Shell's.

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[1] There are several expansion projects although the most recent is Plant 1. The final permit was issued in 2018.
[2] Texas issues separate permits covering operations during non-normal operations, maintenance, startup, and shut down. These permits are referred to as MSS permits.

GCVP limits do not apply during shakedown where "shakedown" is defined as 180 days or after the stack test is complete (short term limits). For their long-term limits (annual), "shakedown" includes the 12-month period beginning with the initial startup of the unit.

VOC LAER

No VOC limits were identified that are more stringent than the current Shell VOC limits. As shown in Table 2, the Eagle Lotte (LA) limit of 0.002 lb/MMBtu is approximately the same as Shell (*i.e.*, 1.18 lb/hr ~ 0.00192 lb/MMBtu @ 620 MMBtu/hr rated heat input for the Shell furnaces).

Table 1 – Ethylene Cracker LAER Update (NO_x)

Shell's Current Limits and Requirements			
Control(s)	LNB/SCR		
Shell Permit Limit(s)	• 0.010 lb/MMBtu (normal operating mode) (12-month rolling average) • 0.015 lb/MMBtu (normal operating mode) (1-hr average) • 6.20 lb/hr during decoking, hot steam standby, feed in, or feed out modes • 31.1 lb/hr during startup or shutdown		
Compliance Method	CEMS		
2023 LAER Update			
Plant Name	Dow Texas Operations	Gulf Coast Ventures Project	Plaquemine Plant 1 Expansion
Location	Freeport, TX	Gregory, TX	Plaquemines Parish, LA
Description	New ethylene plant (light hydrocarbon 9) including 8 cracking furnaces (~600 MMBtu/hr)	New ethylene plant, monoethylene glycol plant, (2) LDPE plants. 8x pyrolysis furnaces @ 560 MMBtu/hr each	4x 90 MMBtu/hr cracking furnaces
Final Permit Issued	2018	2019	2018
Commercial Operation	2020	2022	2020
Control(s)	LNB/SCR	SCR	LNB/SCR
Permit Limit(s)	0.015 lb/MMBtu (1-hr block) (normal operations) 0.010 lb/MMBtu (annual) (normal operations)	0.015 lb/MMBtu (1-hr block) (normal operating mode) 0.010 lb/MMBtu (annual) (all operating modes) Limits do not apply during unit shakedown	0.009 lb/MMBtu 3x1-hr test runs (average)
Compliance Method	CEMS	CEMS	Stack Test

Table 2 - Ethylene Cracker LAER Update (VOC)

Shell's Current Limits and Requirements	
Control(s)	Good Combustion Design & Operation
Shell Permit Limit(s)	1.18 lb/hr
Compliance Method	Stack test (every 5 years)
2023 LAER Update	
Plant Name	Eagle Lotte Ethylene Cracker
Location	Westlake, Calcasieu Parish, LA
Description	(7) ethane cracking furnaces
Final Permit Issued	2015
Date of Commercial Operation	2019
Control(s)	GCP and periodic tune-ups
Permit Limit(s)	0.002 lb/MMBtu

Combined Cycle Units

NO_X LAER

A summary of recent determinations identified in the RBLC and SCAQMD for combined cycle projects is presented in **Error! Reference source not found.**. As shown, RTP did not identify any steady-state limits for gas-fired units that are more stringent than the Shell NO_X limits. Two recent permits were identified that included the same limit (2 ppmvd @ 15% O_2). RTP notes that the Glenarm Plant limit excludes SUSD and turbine/control equipment commissioning.

VOC LAER

No VOC limits that are more stringent than the current Shell limit were identified.

Table 3 – Combined Cycle Units LAER Update (NO_X)

Shell's Current Limits and Requirements		
Control(s)	LNB/SCR	
Shell Permit Limit(s)	• 2 ppmvd @ 15% O_2 (1-hr roll) (excluding periods of defined startup or shutdown) • 70.4 tons/yr (12-mth roll) from all turbines and duct burners (combined) including startup & shutdown • 113 lb/hr during startup and shutdown (each turbine/duct burner)	
Compliance Method	CEMS	
2023 LAER Update		
Plant Name	MIT Central Utility Plant	Glenarm Power Plant
Location	Cambridge, MA	Pasadena, CA
Description	(2) new combined cycle units	(1) new combined cycle unit
Final Permit Issued	2017	2016
Commercial Operation	2020	2017
Control(s)	LNB/SCR	Water injection/SCR
Permit Limit(s)	2 ppm@15% O_2 (1 hour) (NG) 6.8 ppm@15% O_2 (1-hour) (ULSD) 0.0074 lb/MMBtu 1.65 lb/hr (no duct firing) - NG 32 lb/startup (3-hours) - NG 12.4 lb/shutdown (1-hour) - NG (separate startup limits for ULSD)	2 ppm@15% O_2 (1-hour) (LAER) Limit does not apply during turbine commissioning, SUSD, water injection tuning or ammonia injection grid tuning
Compliance Method	CEMS	CEMS

Table 4 – Combined Cycle Units LAER Update (VOC)

Shell's Current Limits and Requirements	
Control(s)	Oxidation catalyst/GCP
Permit Limit(s)	• 1 ppmvd @ 15% O2 (1-hr average)
Compliance Method	Stack test (every 5 years)
2023 LAER Update	
Plant Name	Glenarm Power Plant
Location	Pasadena, CA
Description	(1) new combined cycle unit
Final Permit Issued	2016
Commercial Operation	2017
Control(s)	Oxidation catalyst
Permit Limit(s)	2 ppm@15% O_2 (1-hour) (LAER) Limit does not apply during turbine commissioning, SUSD, water injection tuning or ammonia injection grid tuning
Compliance Method	Stack test (every 3 years)

Equipment Leaks

VOC LAER

Shell's initial LAER determination was based, in part, on the leak detection requirements in the following state regulations:

- South Coast Air Quality Management District (SCAQMD) Rule 1173
- Bay Area Air Quality Management District (BAAQMD) BACT guidelines
- TCEQ Tex. Admin. Code tit. 30, Chapter 115 Subchapters D and H

The leak detection thresholds in these regulations are significantly lower than all applicable NSPS and NESHAP. A comparison of the leak detection thresholds is provided in Table 5.

RTP reviewed the latest versions of these regulations to determine whether these agencies have proposed any more stringent leak detection requirements since the Shell permit was issued. Based on this review it was concluded that there have been no updates to any of these regulations, which indicates the current LAER determination for equipment leaks remains valid.

Shell implements an enhanced leak detection and repair (LDAR) program that is designed to minimize VOC emissions resulting from equipment leaks. The LDAR program is based on the requirements in 40 CFR Part 60 subparts VV and VVa, 40 CFR Part 61 subparts J and V, and 40 CFR Part 63 subparts UU, YY, and FFFF with the following enhancements:

- Lowering the monitoring exemption threshold from <10% VOC to <5% VOC.
- Lower definition of a "leaking" component threshold concentration, as measured at the potential leak interface. This has the effect of accelerating or broadening the repair obligations for leaking components to include components that would not require repair under the NESHAP/NSPS rules.
- Increase leak monitoring frequencies, which has the effect of accelerating the identification and repair of leaking components.
- Disallowing reduced monitoring frequency for valves (skip periods)

Table 5 – Comparison of Leak Detection Thresholds

Equipment type	Leak Detection Threshold (ppmv)			
	Plan Approval 04-00740A	SCAQMD Rule 1173	BAAQMD Rule 18	TCEQ 28 LAER
Pump seals (light liquid service)	100	500	500	500
Compressor seals (gas/vapor & light liquid service)	100	500	500	500
Flanges (gas/vapor & light liquid service)	100	500	100	500
Valves (gas/vapor & light liquid service)	100	500	100	500
Agitators (light liquid service)	500	N/A	N/A	500
Atmospheric pressure relief devices without a rupture disk	200	200	500	N/A
Pump seals/compressor seals/agitators/flanges/valves/pressure relief devices (heavy liquid service)	500	100	Same as above for each equipment type	500
Other equipment (as defined in plan approval): screwed connections, heat exchanger heads, sight glasses, meters, gauges, sampling connections, bolted manways & hatches)	500	Components not required to be monitored	100	N/A

Polyethylene Process Vents, Storage, Handling

VOC LAER

VOCs from the polyethylene process vents and storage and handling operations are currently controlled by a limit on the pellet VOC content and a VOC control system.

As shown in Table 6, no more stringent pellet VOC content limits than the Shell limit of 50 ppm (monthly average) were identified. Additional evaluation of the VOC control system, which includes the LP Thermal Incinerator, HP Ground Flare, and HP Elevated Flare is provided below.

Table 6 – Process Vents, Storage, Handling LAER Update (VOC)

Shell's Current Limits and Requirements	
Control(s)	VOC containing vents directed to control system (see LP Thermal Incinerator, HP Ground Flare, and HP Elevated Flare requirements below)
Permit Limit(s)[3]	• All VOC containing PE Units 1 & 2 vents located upstream of and including Product Purge Bin will be directed to a VOC control system • All VOC containing PE Unit 3 vents located upstream of the degasser will be directed to a VOC control system The residual VOC content in the resin exiting the Product Purge Bins at PE Units 1 & 2 shall be less than 50 ppmw • Residual VOC content of resin exiting the degasser at PE Units 3 shall be less than 50 ppmw
Compliance Method	Monthly average residual VOC content for each PE line as measured downstream of the product purge bin in the gas phase technology PE manufacturing line and downstream of and including the degasser at the slurry PE manufacturing line.
2023 LAER Update	
Plant Name	Gulf Coast Ventures Project
Location	Gregory, TX
Description	New organic chemicals plant includes ethylene plant, monoethylene glycol plant, (2) LDPE plants. (8) pyrolysis furnaces @ 560 MMBtu/hr each)
Final Permit Issued	2019
Commercial Operation	2022
Control(s)	VOC control system
Permit Limit(s)	50 ppm residual VOC in pellets
Compliance Method	Monthly testing

Storage Tanks and Vessels

VOC LAER

As shown in Table 7, VOC emissions from storage tanks and vessels are controlled by a VOC control system. The flow equalization, recovered oil storage, and spent caustic tanks vent to the Spent Caustic Vent Thermal Incinerator (see requirements below) and the light gasoline, hexane, and pyrolysis fuel oil tanks vent to the LP Thermal Incinerator (see requirements below). The diesel fuel storage tank vents are controlled by carbon canisters designed to reduce VOC emissions by a minimum of 95%.

[3] Applicable vents are listed in Appendix D of the *Air Quality Plan Approval Application – Petrochemicals Complex, Shell Chemical Appalachia LLC, Beaver County, Pennsylvania, February 2015 Update*.

Table 7 – Storage Tanks and Vessels LAER Update (VOC)

Shell's Current Limits and Requirements	
Control(s)	• LP Thermal Incinerator (Destruction Rate Efficiency 99.9%) • Spent Caustic Vent Thermal Incinerator (Destruction Rate Efficiency 99%) • Carbon canisters
Requirements	• Light gasoline and hexene tanks will be equipped with internal floating roofs & vent to LP Thermal Incinerator • Pyrolysis fuel oil tank will be equipped with cone roof and vent to LP Thermal Incinerator • Flow equalization, recovered oil storage, and spent caustic tanks will vent to the Spent Caustic Vent Thermal Incinerator • Diesel locomotive, and small diesel fuel tanks (each <20,000 gallons) will be vented to carbon canisters (minimum removal efficiency of 95%
2023 LAER Update	
See LP Thermal Incinerator and Spent Caustic Vent Thermal Incinerator sections.	

Liquid Loading Operations

VOC LAER

The update to the LAER determination for the LPG loading process is based on a review of the following VOC loading regulations. As shown in Table 8, there have been no updates to any of these regulations since the Shell's plan approval was issued. Thus, the current LAER determination remains valid.

- South Coast Air Quality Management District (SCAQMD) Rule 1173
- Bay Area Air Quality Management District (BAAQMD) BACT guidelines
- TCEQ Tex. Admin. Code tit. 30, Chapter 115 Subchapters D and H
- SCAQMD Rule 1173
- TCEQ Subchapter C, §115.212
- LDEQ LAC 33:III.2107

Vent gases from other liquid loading operations are controlled by the LP Thermal Incinerator as discussed below in the LP Thermal Incinerator and Spent Caustic Vent Thermal Incinerator sections.

Table 8 – Liquid Loading Operations LAER Update (VOC)

Shell's Current Limits and Requirements	
Control(s)	Design and work practices
Requirements	Low Vapor Pressure Organic Liquids: • Vent gases generated by the loading of coke residue/tar into trucks shall be vented back to the process • Vent gases generated by loading recovered oil into trucks/rail cars shall be vented to the Spent Caustic Incinerator Pyrolysis Fuel Oil and Light Gasoline: • Displaced gases resulting from loading pyrolysis fuel oil and light gasoline shall be routed through a closed vent system to the LP Thermal Incinerator C3+ Liquids (based on loading of LPG): • Low leak couplings • Pressurized loading
2023 LAER Update	
Low Vapor Pressure Organic Liquids/ Pyrolysis Fuel Oil and Light Gasoline: See LP Thermal Incinerator and Spent Caustic Thermal Incinerator sections. C3+ Liquids (based on loading of LPG): No changes based on a review of the underlying regulations used to establish current LAER.	

LP Thermal Incinerator

VOC LAER

A summary of the results for the LP Thermal Incinerator is presented in Table 9. As shown, only one plant (Mont Belvieu) was identified that has a thermal oxidizer with a DRE requirement (99.99%) that is more stringent than the DRE currently specified for the Shell LP Thermal Incinerator. At the time of the 2015 issuance of the plan approval for the Shell Polymers, Monaca Project, this precedent, which did not begin operation until 2017, had not been demonstrated in practice and was not considered as part of the Shell design. At this time, additional research is needed to determine if the Mont Belvieu incinerator is of similar design to the LP Thermal Incinerator and whether VOC characteristics are comparable since the DRE is dependent upon the incinerator design characteristic (e.g. residence time and incinerator operating temperature at the units design capacity) as well as the VOC properties of the stream being controlled.

Table 9 – LP Thermal Incinerator LAER Update (VOC)

Shell's Current Limits and Requirements		
Control(s)	Waste gas minimization & operation to achieve good destruction removal efficiency	
Requirements	• Operation in accordance with approved waste gas minimization plan • LP Thermal Incinerator designed and operated to achieve a 99.9% Destruction Rate Efficiency	
2023 LAER Update		
Plant Name	Sweeny/Old Ocean Polyethylene Plant	Mont Belvieu Plastics Plant
Location	Sweeny, TX	Mont Belvieu, TX
Description	(2) new PE production units (expansion of existing plant)	(2) new PE production units (expansion of existing plant)
Final Permit Issued	2013	2013
Commercial Operation	2017	2017
Control(s)	Thermal oxidizer and vapor destruction unit (both with DRE = 99.9% or 10 ppmv@3% O_2)	Thermal oxidizer with DRE = 99.99% used to control the VOC in unreacted gases removed from the gas/resin in the purge system upstream of the granular resin feed hoppers

MP/HP Ground Flares and HP Elevated Flare

VOC LAER

A summary of the current LAER requirements related to Shell's multi-point ground flare, high pressure ground flare (totally enclosed ground flare), and high-pressure elevated flare is presented in Table 10. The evaluation of more recent precedents is based on identifying flares with higher DREs or more restrictive combustion conditions (*i.e.*, net heating value (NHV)) associated with higher destruction efficiency for each flare type. RTP did not identify any precedents with more stringent requirements for the high-pressure ground flare or the high-pressure elevated flare. As shown in Table 10, there are two recent precedents for the multi-point ground flare that appear to have more stringent requirements. The following explains why these precedents are not considered to be applicable.

The Sweeny/Old Ocean Polyethylene Plant includes a pressure-assisted, multi-point ground flare with a DRE design requirement of 99% for volatile organic compounds containing only hydrogen and three or fewer carbons, as well as methanol, ethanol, propanol, ethylene oxide, and propylene oxide and a DRE of 98% for all other volatile organic compounds.[4] No testing requirement to verify that these higher levels of destruction have been achieved in practice is required. During routine operation and most routine maintenance, the low-pressure stages of the Sweeny/Old Ocean flare operate in compliance with 40 CFR §60.18 and 40 CFR §63.11, which suggests that a 98% DRE[5] is achieved in practice. While the Shell flares operate in compliance with 40 CFR §60.18 and 40 CFR §63.11, the

[4] These DREs are consistent with the Texas Commission on Environmental Quality (TCEQ) NSR emissions calculation guidance for flare operating in compliance with 40 CFR 60.18. https://www.tceq.texas.gov/assets/public/permitting/air/Guidance/NewSourceReview/emiss_calc_flares.pdf

[5] In accordance with several of the NSPS and NESHAP regulations (e.g., NSPS Part 60 subpart DDD or NESHAP Part 63 subpart CC), it is assumed that greater than 98% destruction efficiency is achieved when a flare is operated in compliance with the requirements of 40 CFR §60.18 or 40 CFR §63.11.

expected DRE is higher because the Shell flares are required to operate in compliance with a more stringent minimum NHV_{cz} limit of 500 Btu/scf.

The Mont Belvieu permit includes a multi-point ground flare with a DRE requirement of 99.5% and specifications for a waste gas minimum NHV of 800 Btu/scf [6,7] with a testing requirement to verify the DRE[8]. The flare is installed on the high-pressure system and utilizes a pressure-assisted design with no assist-air and near-sonic flare tip velocities. In contrast, the Shell low-pressure, multi-point flare controls three independent gas headers each operating at relatively low supply pressure[9] with air-assist to achieve smokeless operation and much lower flare tip velocities[10]. Based on these significant design differences, the Mont Belvieu determination is not considered to be in the same class or category as the MP Ground Flare.

[6] Flare does not use air or steam assist. NHV and LFL is determined based on gas header measurements. As a result, this NHV requirement is also the NHVcz.
[7] There is also an LFL requirement of 6.5 %vol for the flare. This value is equivalent to the NHV.
[8] The source successfully petitioned TCEQ to eliminate the testing requirement although RTP was unable to determine the reason for eliminating this requirement and whether this testing was ever completed.
[9] Maximum supply pressure is 0.5 bar on Header 3 operating as backup to the LP incinerator.
[10] Maximum burner exit velocity is Mach 0.445 on Header 3 operating a backup to the LP incinerator.

Table 10 – MP/HP Flares LAER Update (VOC)

Shell's Current Limits and Requirements		
MP Ground Flare	• Operation in accordance with approved waste gas minimization plan • Root cause analysis for flaring events that exceed baseload by 500,000 scf in 24-hour period • Corrective actions consistent with good engineering practice • Flare designed to meet limitations on maximum exit velocity, as set forth in the general provisions at 40 CFR §60.18 & §63.11 • Flare operated to meet minimum net heating value requirements for gas streams combusted in the flares, as set forth at 40 CFR § 60.18 & § 63.11 • The net heating value of the combustion gases shall be determined no less frequently than once every 15 minutes when the flare is in use • The net heating value in the combustion zone shall be equal to or greater than 500 Btu/scf	
HP Ground Flares (Totally Enclosed Ground Flare)	• Operation in accordance with approved flare minimization plan • Root cause analysis for flaring events that exceed baseload by 500,000 scf in 24-hour period • Corrective actions consistent with good engineering practice • Flare designed to meet limitations on maximum exit velocity, as set forth in the general provisions at 40 CFR §60.18 & §63.11 • Flare operated to meet minimum net heating value requirements for gas streams combusted in the flares, as set forth at 40 CFR § § 60.18 & 63.11 • Each flare shall be equipped with automated controls for supplemental gas flow rate& steam mass rate (if used for assist) to the flare • The net heating value of the combustion gases shall be determined no less frequently than once every 15 minutes when the flare is in use • The net heating value in the combustion zone shall be equal to or greater than 500 Btu/scf • A net heating value of 1212 BTU/scf shall be used for hydrogen	
HP Elevated Flare	• Operation in accordance with approved flare minimization plan • Root cause analysis for flaring events that exceed baseload by 500,000 scf in 24-hour period • Corrective actions consistent with good engineering practice • Flare designed to meet limitations on maximum exit velocity, as set forth in the general provisions at 40 CFR §60.18 & §63.11 • Flare operated to meet minimum net heating value requirements for gas streams combusted in the flares, as set forth at 40 CFR § 60.18 & § 63.11	
2023 LAER Update		
Plant Name	Sweeny/Old Ocean Polyethylene Plant	Mont Belvieu Plastics Plant
Location	Sweeny, TX	Mont Belvieu, TX
Description	(2) new PE production units (expansion of existing plant)	(2) new PE production units (expansion of existing plant)
Final Permit Issued	2013	2013
Date of Commercial Operation	2017	2017
Control(s)	Multipoint ground flare designed with 99% DRE for <C4 and 98% for C4+ (LAER)	Multipoint ground flare with 99.5% DRE and 40 CFR 60.18 to control reactor and high capacity feed supply depressurizations.

Spent Caustic Vent Thermal Incinerator

VOC LAER

Table 11 summarizes the updated VOC LAER analysis for the spent caustic vent thermal incinerator. The Formosa plant includes an incinerator with a 99.5% efficiency. At the time of the 2015 issuance of the plan approval for the Shell Polymers, Monaca Project, this precedent, which did not begin operation until 2020, had not been demonstrated in practice and was not considered as part of the Shell design. At this time, additional research is needed to determine if this unit is of similar design to the Spent Caustic Vent Thermal Incinerator and whether VOC characteristics are comparable since the DRE is dependent upon the incinerator design characteristic (e.g. residence time and incinerator operating temperature at the units design capacity) as well as the VOC properties of the stream being controlled.

Table 11 – Spent Caustic Thermal Incinerator LAER Update (VOC)

Shell's Current Limits and Requirements		
Requirements	99% destruction rate efficiency	
2023 LAER Update		
Plant Name	Formosa	PTTGC America
Location	Port Comfort, TX	Belmont, OH
Description	New polyethylene production facility at an existing chemical plant	New petrochemical complex composed of ethylene and ethylene-based derivative plants to manufacture high-density polyethylene (HDPE)and linear low-density polyethylene/HDPE
Final Permit Issued	2014	2018
Date of Commercial Operation	2020	Not yet operational
Control(s)	99.5% destruction rate efficiency	99% destruction rate efficiency or 10 ppm @ 3% O_2

Attachment 3

Unit	Equipment Name/Event	Impacted Control Device and ID Number	No. of Upsets
PE3	Reactor Circulation Pump	HP Ground Flares (C205A/B)	2
ECU	Demethanizer Low Temperature Feed Drum	HP Elevated Flare and HP Ground Flares (C205A/B/C)	1
ECU	Cold Flare Drum	NA- flange leak to atmosphere	1
ECU	Ethylene Refrigerant Compressor- various trips	HP Elevated Flare and HP Ground Flares (C205A/B/C)	3
ECU	Cracked Gas Compressor- various trips	HP Elevated Flare and HP Ground Flares (C205A/B/C)	4
ECU	Propane Refrigerant Compressor Trip	HP Elevated Flare and HP Ground Flares (C205A/B/C)	1
ECU	Acetylene Reactor Trip	HP Elevated Flare and HP Ground Flares (C205A/B/C)	1
ECU	C2 Splitter Feed Strainer Plugging	HP Ground Flares (C205A/B)	1
ECU	Boil Off Gas Compressor Trip	LP Multipoint Ground Flare (C204B)	2
ECU	Elevated System CO	HP Elevated Flare and HP Ground Flares (C205A/B/C)	3
ECU	C2 Splitter Upset	HP Ground Flares (C205A/B)	1
UGF	Gas Turbine Generator Trip causing ECU Upset	HP Ground Flares (C205A/B)	1
PE1	Cycle Gas Compressor- high vibrations	LP Multipoint Ground Flare (C204B)	1
UGF	MPGF PE1/2 header assist air response time	LP Multipoint Ground Flare (C204B)	1
Sitewide	Equipment and instrumentation impacted by freeze	HP Elevated Flare and HP Ground Flares (C205A/B/C)	1
UGF	SCTO Fuel Gas Pressure Trip	Spent Caustic Vent Incinerator (C206)	3
ECU	Demethanizer Upset	HP Ground Flares (C205A/B)	1
UGF	HPEF Seal Drum Damage	HP Elevated Flare (C205C)	1
ECU	Caustic piping leak	HP Ground Flares (C205A/B)	1
UGF	FEOR A Tank Level malfunction	Wastewater Treatment Plant (502)	1
ECU	Emergency Isolation System/Emergency Depressuring System loose wire	HP Elevated Flare and HP Ground Flares (C205A/B/C)	1
ECU	Ethylene Subcoolers	LP Multipoint Ground Flare (C204B)	2
UGF	MPGF ethylene header assist air response time	LP Multipoint Ground Flare (C204B)	4
PE1/2	Ethylene Feed Isolation Valve	HP Elevated Flare and HP Ground Flares (C205A/B/C) and LP Multipoint Ground Flare (C204B)	1
UGF	SCTO Loss of Combustion Air Manual Trip	Spent Caustic Vent Incinerator (C206)	1