Shell Polymers Monaca Flare Minimization Plan

SHELL POLYMERS
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High Pressure and Low Pressure Flare Header Systems Minimization Plan

September 2020

Project No.: 0526034

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1. INTRODUCTION

Shell Chemical Appalachia LLC (Shell) operates the Shell Polymers Monaca site (SPM or Site) in Potter and Center Township, Beaver County, Pennsylvania. The facility's purpose is to convert ethane into ethylene and subsequently polyethylene, which is the key building block for many plastic products used daily. In order to ensure safe working conditions for the employees on-site and minimal environmental impact for the surrounding area, VOC emissions resulting from startup, shutdown, maintenance, and unforeseeable events are combusted by flares. The site has two flaring header systems incorporating four (4) flare systems and one (1) thermal oxidizer. The flaring header systems receive process discharges from the inside battery limits (ISBL) process units and outside battery limits (OSBL) ancillary equipment of the ethylene and polyethylene manufacturing lines. The High Pressure (HP) Flare Header system controls vapor streams generated by the ethane cracking unit (ethylene manufacturing line) and polyethylene manufacturing line. The High Pressure Flare system consists of two enclosed Ground Flares (HP Ground Flares) and one Elevated Flare. The Low Pressure Flare system consists of a continuous vent thermal oxidizer (CVTO) and a Multipoint Ground Flare (LP MPGF). The CVTO controls continuous vents from PE 1/2, PE3, railcar rack, and the storage tank vents, while the LP MPGF controls episodic/emergency reliefs from PE 1/2, vents from the refrigerated ethylene storage tank, and the CVTO stream in the event the thermal oxidizer is not available. See **Appendix A** for a full facility-wide plot plan including flare locations. The units and equipment associated with the HP and LP Flare Headers are summarized in **Table 1** below.

Table 1: Units Connected to the HP and LP Flare Header Systems

Flare Header	Process Units Connected (ISBL)	Ancillary Equipment Connected (OSBL)
High Pressure	Vapor from ECU Area Vapor from PE1 and PE 2 Units Vapor from PE3 Unit	Vapor from V-64303 (Storage Vessel) Vapor from Railcar Loading Area Vapor from Ethylene Storage Area Vapor from C3+, Butane Storage Area Vapor from Bullets Storage Area
Low Pressure	Vents from PE1 and PE2 Units Continuous Gases from PE3 Unit Episodic Vents from PE1 and PE2	Blowdown from P-64302A/B Vents from Hexene Disengaging Drum Vent from Hexene, Light Gasoline & Pyrolysis Fuel Oil Area Ethylene Vapors from Refr. Tank T-64210 Vapors from Railcar Loading Area

Appendices attached to this document include the facility-wide plot plan (**Appendix A**), flare diagrams (**Appendix B**), flare operation, maintenance, and minimization procedures (**Appendix C**), flare connection list (**Appendix D**), monitoring equipment specifications (**Appendix E**), and flare minimization plan revision log (**Appendix F**).

1.1 Purpose

Shell has developed and implemented this Flare Minimization Plan (FMP) pursuant to the requirements of Plan Approval No. 04-00740A ("Plan Approval") and the Settlement Agreement[1]. These binding documents require that Shell:

- Establish a baseline flow volume for all operating scenarios;

[1] Following the June 18, 2015 issuance of Plan Approval No. 04-00740A to Shell Chemical Appalachia LLC ("Shell") for SPM, Clean Air Council and Environmental Integrity Project submitted an appeal on August 3, 2015. The appeal was settled without further litigation, and a Settlement Agreement was signed by both parties. The Settlement Agreement, among other stipulations, require that Shell adhere to additional operational conditions regarding their flaring systems.

- Document procedures for operating and maintaining the High Pressure and Low Pressure flaring systems during periods of process unit startup, shutdown, and unforeseeable events;
- Implement a program of corrective action for malfunctioning process equipment;
- Identify procedures to minimize discharges either directly to the atmosphere or to the HP and LP systems during the planned and unplanned startup or shutdown or process unit and air pollution control equipment;
- Conduct a root cause analysis (RCA) and corrective action analysis (CAA) into the cause of flaring that exceeds an applicable flow threshold (500,000 standard cubic feet per day [SCFD] over identified baseline in any 24-hour period);
- Implement (or develop a schedule for implementing) the corrective actions identified through the RCAs; and
- Continuously monitor the volume, composition/net heating value (NHV) of streams vented to flare, pilot flame presence, and visible emissions from the flares.

The development and implementation of this FMP is a mandatory requirement of the Plan Approval. As required by the Plan Approval, the plan is submitted to the Pennsylvania Department of Environmental Protection (PADEP). In addition to meeting mandatory Plan Approval requirements, this FMP provides evergreen documentation of SPM's commitment to reduce emissions from its flares.

Deviations from this FMP – including unavoidable or inadvertent deviations – must be reported to the SPM Environmental Department immediately (or in advance when advance notice is feasible). This FMP may be amended as necessary to reflect new information or future changes in equipment or operations. The SPM Environmental Department should be consulted before changes are made to this FMP or to the procedures and equipment it addresses.

1.2 Minimizations

SPM achieves flare minimization through careful planning and evaluation of flaring events from similar facilities. Although work processes and systems are in place to minimize flaring to a practical extent, some flaring events still do occur. Flaring events or those events that exceed applicable permit or regulatory limits are investigated to determine root cause(s), followed by corrective actions which are taken to prevent recurrence. Flaring events which do not exceed permit limits are reported to management staff and may be reviewed, as appropriate, to understand the failure modes and access recurrent failures. The site will adjust the operation of process units to minimize flaring when consistent with safe operation.

1.2.1 Site-Wide Minimization Measures

At the site, various prevention measures related to procedures, best practices, and other resources used to minimize or eliminate flaring are in place during operation. These prevention measures include:

- Site maintenance and turnaround environmental requirements;
- Environmental incidents reporting; and
- Reliability and maintenance programs.

Site maintenance and turnaround requirements involve a specific plan for each planned turnaround or major maintenance activity. This would include the evaluation of past turnarounds to improve on current procedures as a means to further reduce flaring. Environmental incident reporting describes the procedure for internal reporting of environmental occurrences. The procedure addresses reporting, tracking, and investigation of flaring events caused by planned and unplanned startup or shutdown of process unit and air pollution control equipment. Any unplanned flaring is covered by this procedure and recommends the level of investigation required. Reliability and maintenance programs are part of the several key work processes that keep flare instrumentation and controls operating.

Prevention measures related to process equipment and hardware at the site include monitoring and controlling NHV and specific gravity of tailgas/natural gas blends. This monitoring helps maintain the stability of the cracking furnaces and allow operators to anticipate changes in raw fuel composition that are required for stable operation of the Ethylene Cracking Units (ECU). The ability to pressure control the tailgas system with purchased natural gas reduces flaring which may otherwise result from dynamic variations of fuel gas contributors. Proper fuel gas system supply pressure is important for the reliable operation of the ECU. Having a range of streams available to provide pressure control minimizes the risk of fuel system pressure disturbances which would otherwise lead to process upsets and result in flaring.

1.2.2 Unit-Specific Reductions

Individual process units were designed to utilize the flaring system in certain planned or unplanned conditions, and minimization techniques were incorporated into equipment and process design. Shell developed a approach for the ECU involving an Off-Spec Sphere, designed to re-use the ethane and ethylene mixture generated during initial plant start-up. The sphere serves to both hold clean ethane in case of a process upset, as well as provide additional storage capacity for the purged ethane/ethylene mixture. The Off-Spec sphere is not required to operate the plant, but its use increases flaring mitigation, improves reliability and up-time, and extends the range of acceptable ethylene.

The ECU was designed for a minimum turndown of 40% feed, while typical crackers are designed with a minimum plant throughput of around 60%. During the normal startup (as well as initial startup) of similar units, flaring is expected at various stages as the unit is inventoried, stabilized, and brought on-test. Shell designed and constructed recycle loops from the back-end to the front-end of the process in order to build up higher volume than the direct feed and minimize flaring at these start-up stages.

In order to limit the potential for flaring, specialized equipment (along with various controls) were added to the ECU and the Polyethylene Units (PE). This equipment is liquefies portions of the product to reduce flaring and increase overall reliability of the plant. The liquefied portion is sent to an atmospheric storage tank capable of holding enough ethylene to provide spare capacity or full flow of ethylene in case of PE or ECU trip, respectively.

1.3 Revisions to the Flare Minimization Plan

The SPM FMP is reviewed annually. Revisions are captured and made to the contents of the Flare Minimization Plan when changes or corrections are made to any of the following:

- SPM Flare Minimization practices and procedures;
- Flare equipment or controls, information, and drawings included in this narrative or associated appendices; or
- Baseline flows to either the Low Pressure or High Pressure flaring systems.

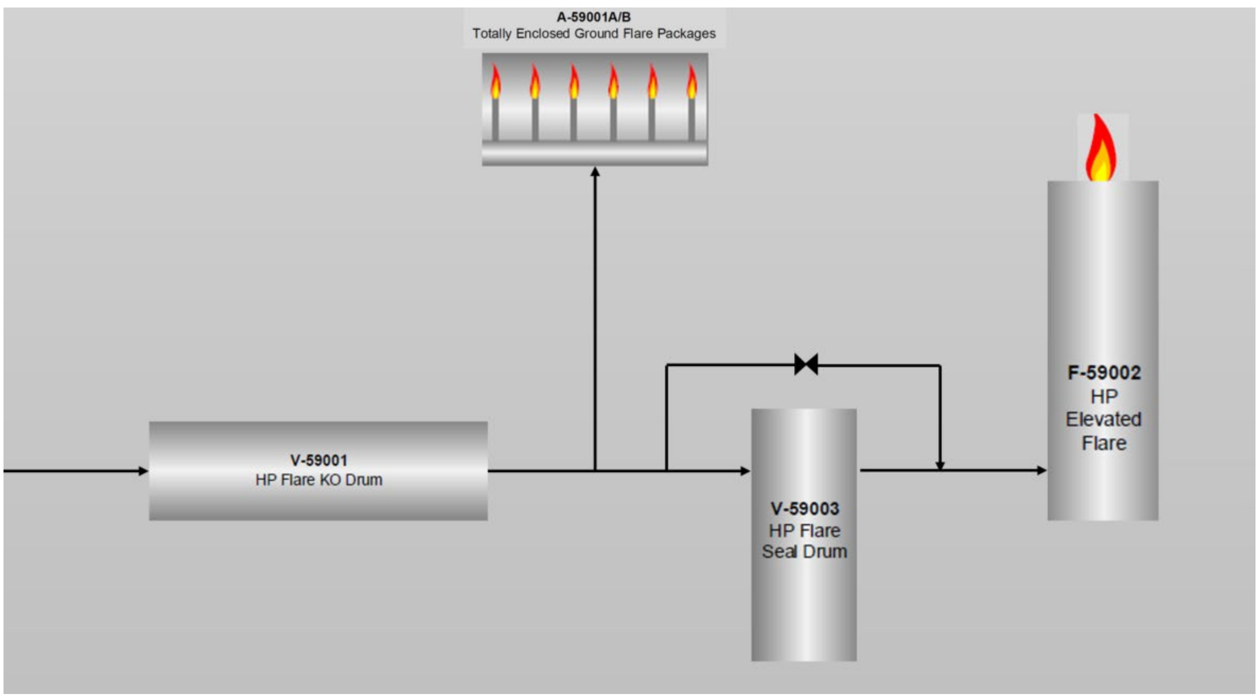
Each version of this FMP is maintained to enable tracking of progress, and is documented and tracked within the revision log incorporated into the document (**Appendix F**).

2. HIGH PRESSURE FLARING SYSTEM

2.1 General Description of the High Pressure Flaring System

The High Pressure Flare Header system receives process discharges from protective safety devices from the ISBL (ECU, PE1, PE2, and PE3) and OSBL units. The header feeds discharges to two totally enclosed Ground Flares (HP Ground Flares), each rated at 150 tonnes per hour [TPH], and one Elevated Flare (HP Elevated Flare) rated at 1,350 TPH. All HP Flare streams, except those from OSBL, are routed through each unit's flare knockout drum(s) before connecting to the main HP Flare Header at the unit battery limits. A main HP Flare Knockout (K.O.) Drum, V-59001, is installed upstream of the HP Ground Flares, A-59001A/B, and the Elevated Flare, A-59002. The HP Elevated Flare is steam assisted while the two HP Ground flares are unassisted. **Figure 1** below shows the configuration of the HP Flare Header system.

Figure 1: High Pressure Flare Header System Overview



The two HP Ground Flares are used on a routine basis and are the primary flares in the HP Header system. Shell operates the HP Elevated Flare as a secondary system to be used when the combined capacities of the two HP Ground Flares are exceeded.

2.2 Flare Specifications

The HP Flare Header physical system components and operating parameters are listed below in Table 2:

Table 2: HP Flare Header Components and Parameters

	HP Ground Flare #1 and HP Ground Flare #2	HP Elevated Flare
A. Flare Tip		
Type	Ground Flare	Elevated Flare
Date Installed	Projected 2021	Projected 2021
Manufacturer	Zeeco	Zeeco
Nominal Tip Diameter	Not Applicable	5'4"
Effective Tip Diameter	Not Applicable	6'
B. Knockout or Surge Drum(s) or Pot(s)		
Vessel Name	V-59001	
Dimensions	5.5 m (ID) x 27.5 m (T/T)	
Design Volume	697 m^3	
Location	Upstream of HP Ground Flares (#1 and #2) and HP Elevated Flare. See **Appendix A**.	
C. Smokeless Capacity		
Smokeless Capacity (based on 15-minute block average and design conditions)	300 TPH (150 TPH each)	180 TPH
D. Assist System		
Assist Type	Unassisted	Steam Assisted
Maximum Flow Total	Not applicable	84,000 kg/hr
E. Ignition System		
Number of Pilots	17	4
Pilot Fuel Type	Natural Gas	Natural Gas or Propane
Pilot Fuel Rate	20.4 SCFM each	68,600 kJ/hr
Flame Presence Detection Method	Thermocouple	Thermocouple
F. Lines Exempt from Monitoring		
Lines	Pilot line	Pilot line
G. **Additional Parameters**		
Description of Water Seal	There is no water seal installed at the HP Ground Flares.	V-59003 Seal Drum. 50% Glycol, 50% Water
Flare Gas Recovery System	A flare gas recovery system is not used.	A flare gas recovery system is not used.

Table 3 below describes specific flows to the HP header and associated flaring systems, their respective rates, and introduction locations (if applicable):

Table 3: HP Flare Header Flows

	HP Ground Flare #1 and HP Ground Flare #2	HP Elevated Flare
A. Supplemental Gas		
Supplemental Gas Type	Natural Gas	
Maximum Supplemental Gas Flow Rate	78 kg/hr	
Supplemental Gas Introduction Locations	Introduced to vent gas header downstream of V-59001 via 590FCV-012.	
B. Sweep Gas		
Sweep Gas Type	Nitrogen and Natural Gas	
Maximum Sweep Gas Flow Rate	740 kg/hr	
Sweep Gas Introduction Locations	Introduced to vent gas header downstream of V-59001.	
C. Purge Gas		
Purge Gas Type	Not Applicable	Nitrogen
Minimum Purge Gas Flow Rate	Not Applicable	No purge during normal operation.
Maximum Purge Gas Flow Rate	Not Applicable	2500 kg/hr
Purge Gas Introduction Locations	Not Applicable	Introduced to vent gas header downstream of V-59003 via 500UZV-112.
D. Vent Gas		
Maximum Vent Gas Flow Rate	300,000 kg/hr	1,350,000 kg/hr

Flare drawings and connections can be found in **Appendices B and C**.

2.3 Monitoring System Description

This section provides a technical description of the flare-specific monitoring equipment at SPM required by the Settlement Agreement and Plan Approval. The HP Flares are monitored by the following equipment:

- Flame detection system monitoring pilot flame presence;
- Video surveillance camera for visible emissions;
- Flare header volumetric flow rate monitor; and
- Flare vent gas composition monitor.

The Settlement Agreement references NESHAPs Subpart CC (Refinery MACT) 40 Code of Federal Regulations (CFR) §63.670 and §63.671, which establish various monitoring requirements for flare systems. Pilot flame detection at the flare tip(s) is conducted using fixed thermocouples on each pilot. Visible emissions are monitored via video surveillance of the HP Flares. The video surveillance camera(s) are placed at a reasonable distance and at an angle suitable for such observations, and real-time output is provided to the control room/continuously manned locations where the images may be viewed at any time.

Flare header volumetric flow rate monitors are required for flare vent gas, steam assist and air assist flows to verify compliance with applicable flare tip velocity and flow rate limits, including the root cause analysis threshold over the determined baseline. Volumetric flow rate monitors are installed for the HP header, including requisite monitors for continuous steam flows. Finally, the HP Flare Header is equipped with a gas chromatograph, which monitors the composition of the flare vent gas to demonstrate compliance with NHV requirements, detailed below. See **Appendix E** for the monitoring system instrumentation data sheets.

The Settlement Agreement requires Shell to operate and maintain the NHV of the flare combustion zone at or above a certain level. The NHV of each flare shall be monitored and calculated as specified in the Plan Approval No. 04-00740A and the Settlement Agreement. For the HP Elevated Flare, the NHV should be maintained at or above 300 British Thermal Units per standard cubic foot (BTU/SCF) determined on a 15 minute period basis when regulated material is routed to the flare for at least 15 minutes. For the HPGFs, the NHV should be maintained at or above 500 BTU/SCF determined on a 15 minute period basis when regulated material is routed to the flare for at least 15 minutes. In the case that the heat content falls below the requisite threshold, supplemental natural gas is injected to restore gross heat content to above the requirement.

2.4 Flaring Activities at the Process Level

The Flare Minimization Plan conditions outlined in the Plan Approval require SPM to:

- Document procedures for operating and maintaining the HP and LP Systems during periods of process unit startup, shutdown, and unforeseeable events; and
- Identify procedures to minimize discharges either directly to the atmosphere or to the HP and LP Systems during the planned and unplanned startup or shutdown of process unit and air pollution control equipment.

Appendix C lists procedures in place at SPM for the operation and maintenance of the HP system, as well as procedures to minimize discharges to the atmosphere or HP system, both during planned and unplanned conditions.

2.5 Flaring Activities at the Process Level – Reductions Previously Realized

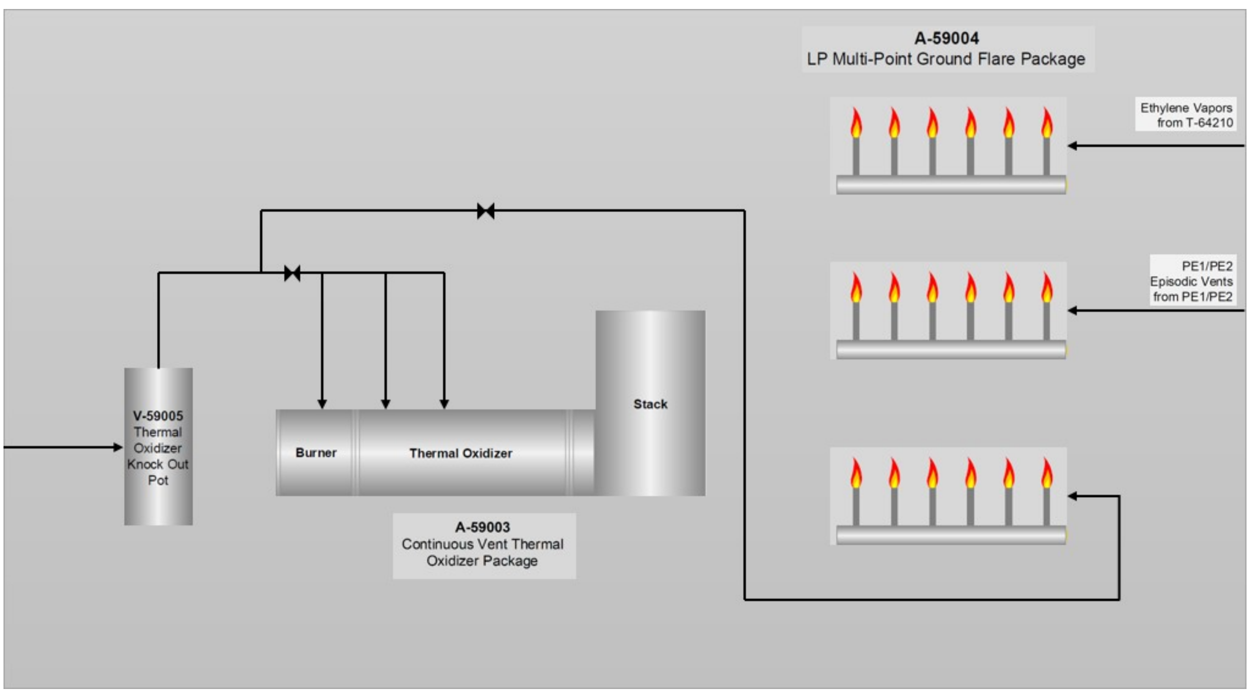
As of the September 2020 revision of this FMP, no additional reductions other than those designed in process or included in previously described procedures have been implemented. This section remains evergreen and will be updated upon each revision to document all reductions realized.

3. LOW PRESSURE FLARING SYSTEM

3.1 General Description of the Low Pressure Flaring System

The Low Pressure Flare Header system comprises of a Continuous Vent Thermal Oxidizer (CVTO), A-59003, and a Multipoint Ground Flare Package (LP MPGF), A-59004. A dedicated Thermal Oxidizer Knockout [K.O.] Pot, V-59005) is located upstream of the CVTO. The CVTO processes continuous vents from PE1/2 and PE3, the railcar rack vents, and the storage tank vents. While the CVTO is a thermal oxidizer and not a flare, it is included in the flare minimization plan as it provides integral support to the LP flaring system at SPM by minimizing flows to the LP MPGF. Additionally, the CVTO is included in Section D, Source ID: 204, Low Pressure (LP) Header System of Plan Approval No. 04-00740A, which requires the development of the flare minimization plan for the LP Header System, of which the CVTO is a part. The LP MPGF processes episodic and emergency reliefs from PE1/2, vents from the refrigerated ethylene storage tank, and the CVTO stream in the event that the thermal oxidizer is not available. The CVTO is sized for 10 TPH design capacity, with a normal flow of less than 7 TPH. The LP MPGF is sized with three independent headers, with relative capacities of 32,219 kilograms/hour [kg/hr], 26,900 kg/hr, and 14,947 kg/hr. The low pressure episodic vents from the PE1/2 units are connected to a dedicated LP Flare Header at the PE1/2 battery limits, and is routed to the LP MPGF directly. The refrigerated ethylene tank storage vent discharges through a dedicated line directly to the LP MPGF. The LP MPGF package is unassisted. Figure 2 below shows the configuration of the LP Flare Header system.

Figure 2: Low Pressure Flare Header System Overview



During normal operation, gases from the railcar loading area, hexene disengaging drum, blowdown from P-64302A/B, vents from hexene, light gasoline & pyrolysis fuel oil area, vents from PE 1/2 units, and from the PE3 unit are directed to the CVTO, rated at 10 TPH. During emergency situations, when these gases exceed the capacity of the CVTO, the excess gas is directed to one dedicated header in the LP MPGF. The CVTO is sized and designed to ensure a residence time and operating temperature that results in a high destruction efficiency (i.e. > 99.9%) when combusting routinely generated vent gases from the PE unit.

3.2 Flare Specifications

The LP Flare Header system components and operating parameters are listed below in Table 4.

Table 4: LP Flare Header Components and Parameters

	MPGF Line 1 (PE-1/PE-2)	MPGF Line 2 (Ethylene)	MPGF Line 3 (Back-Up to TO)	Continuous Vent Thermal Oxidizer
A. General Information				
Type	Ground Flare	Ground Flare	Ground Flare	Thermal Oxidizer
Date Installed	Projected 2021	Projected 2021	Projected 2021	TBD
Manufacturer	Zeeco	Zeeco	Zeeco	John Zink Company, LLC
Number of Burners	14	17	7	1
B. Knockout or Surge Drum(s) or Pot(s)				
Vessel Name	LP Flare Knockout Drum	Not applicable	V-59005	
Dimensions	2.0 m (ID) x 7.1m (T/T)	Not applicable	2.5m (ID) x 6.625m (T/T)	
Design Volume	24.4 m^3	Not applicable	36.6m^3	
Location	PE 1-2	Not applicable	Upstream of CVTO and MPGF Back-up to TO. See **Appendix A**.	
C. Smokeless Capacity				
Smokeless Capacity (based on 15-minute block average and design conditions)	32,219 kg/hr	26,900 kg/hr	14,947 kg/hr	10,000 kg/hr
D. Assist System				
Assist Type	Air	Air	Air	Air
Maximum Flow Total (Nm^3/hr)	69,716	136,629	23,629	132,468
E. Ignition System				
Number of Pilots	14	17	7	1
Pilot Fuel Type	Natural Gas, Propane for some start-ups	Natural Gas, Propane for some start-ups	Natural Gas, Propane for some start-ups	Natural Gas, spark ignition
Pilot Capacity	68,600 kJ/hr	68,600 kJ/hr	68,600 kJ/hr	530,000 kJ/hr
Flame Presence Detection Method	Thermocouple (2 per pilot)	Thermocouple (2 per pilot)	Thermocouple (2 per pilot)	2 UV Flame Scanners
F. Lines Exempt from Monitoring				
Lines	Pilot line	Pilot line	Pilot line	Pilot line
G. Additional Parameters				
Description of water seal	There is no water seal installed at Units in the LP Flare Header system.			
Flare Gas Recovery System	A flare gas recovery system is not used in the LP Flare Header system.			

Table 5 below describes specific flows to the LP Flare Header and associated flaring systems, their respective rates, and introduction locations (if applicable):

Table 5: LP Flare Header Flows

	MPGF Line 1 (PE-1/PE-2)	MPGF Line 2 (Ethylene)	MPGF Line 3 (Back-Up to TO)	Continuous Vent Thermal Oxidizer
A. Supplemental Gas				
Supplemental Gas Type	Natural Gas	Not Applicable	Natural Gas	Natural Gas
Maximum Supplemental Gas Flow Rate	1,550 kg/hr		1,550 kg/hr	224 kg/hr
Supplemental Gas Introduction Locations	Natural gas introduced to stream via regulating flow control valve 590FCV-046		Natural gas introduced to stream via regulating flow control valve 590FCV-045	Natural gas introduced to stream via 590FCV-401
B. Sweep Gas				
Sweep Gas Type	Natural Gas	Not Applicable	Natural Gas	
Maximum Sweep Gas Flow Rate	35.75 kg/hr		60.5 kg/hr	
Sweep Gas Introduction Locations	Natural gas introduced to stream via regulating flow control valve 590FCV-046		Natural gas introduced to stream via regulating flow control valve 590FCV-045	
C. Purge Gas				
Purge Gas Type	Not Applicable			
Minimum Purge Gas Flow Rate	Not Applicable			
Purge Gas Introduction Locations	Not Applicable			
D. Vent Gas				
Maximum Vent Gas Flow Rate	32,219 kg/hr	26,900 kg/hr	14,947 kg/hr	10,000 kg/hr

Flare drawings and connections can be found in **Appendices B and C**.

3.3 Monitoring System Descriptions

This section provides a technical description of the flare-specific monitoring equipment at SPM required by the Settlement Agreement and Plan Approval. The LP flares are monitored by the following equipment:

- Flame detection system monitoring pilot flame presence;
- Video surveillance camera for visible emissions;
- Flare header volumetric flow rate monitor; and
- Flare vent gas composition monitor.

The Settlement Agreement references NESHAPs Subpart CC (Refinery MACT) 40 Code of Federal Regulations (CFR) §63.670 which establishes various monitoring requirements for flare systems. Pilot flame detection at the flare tip(s) is conducted using fixed thermocouples on each pilot. Visible emissions are monitored via video surveillance of the LP Flares. The video surveillance camera(s) are placed at a reasonable distance and at an angle suitable for such observations, and real-time output is provided to the control room/continuously manned locations where the images may be viewed at any time.

Flare header volumetric flow rate monitors are required for flare vent gas, steam assist and air assist flows to verify compliance with applicable flare tip velocity and flow rate limits, including the root cause analysis threshold over the determined baseline. Finally, the LP Flare Header is equipped with a gas chromatograph, which monitors the composition of the flare vent gas to demonstrate compliance with NHV requirements, detailed below. See **Appendix E** for the monitoring system instrumentation data sheets.

The Settlement Agreement requires Shell to operate and maintain the NHV of the flare combustion zone at or above a certain level. The NHV of each flare shall be monitored and calculated as specified in the Plan Approval No. 04-00740A and the Settlement Agreement. For the LP MPGF, the NHV should be maintained at or above 500 BTU/SCF determined on a 15 minute period basis when regulated material is routed to the flare for at least 15 minutes.

3.4 Flaring Activities at the Process Level

The Flare Minimization Plan conditions outlined in the Plan Approval require SPM to:

- Document procedures for operating and maintaining the HP and LP Systems during periods of process unit startup, shutdown, and unforeseeable events; and
- Identify procedures to minimize discharges either directly to the atmosphere or to the HP and LP Systems during the planned and unplanned startup or shutdown of process unit and air pollution control equipment.

Appendix C lists procedures in place at SPM for the operation and maintenance of the HP system, as well as procedures to minimize discharges to the atmosphere or HP system, both during planned and unplanned conditions.

3.5 Flaring Activities at the Process Level – Reductions Previously Realized

As of the September 2020 revision of this Flare Minimization Plan, no additional reductions other than those designed in process or included in previously described procedures have been implemented. This section remains evergreen and will be updated upon each revision to document all reductions realized.

4. BASELINE FLOW DETERMINATION

Plan Approval No. 04-00740A requires that the baseline flow to the HP and LP Systems be determined in accordance with provisions of 40 CFR §60.103a(a)(4) (40 CFR Subpart Ja). This subsection describes that a baseline flow is the level of flare gas observed during normal operation of the flare. Baseline flow is to be determined after implementing the minimization assessment. Baseline flows do not include pilot gas flow or purge gas flow provided these flows remain reasonably constant. Separate baseline flow rates may be established for different operating conditions. In compliance with the Plan Approval, baseline flows have been established for the HP and LP Header systems.

4.1 High Pressure Header

The HP Header System Baseline was determined using anticipated operational and maintenance flows to the flare that are predicted to occur during normal operation. Compliance with this baseline is determined by output from the HP Header flow meter (590-FI-002A) located between the V-59001 Knockout Drum and the HP Ground Flare system.

Baseline flows to the HP flare header include the following:

- Sweep Flow;
- Dry gas compressor seals;
- Pump seals; and
- Analyzers.

The primary baseline flow for the High Pressure Header has been set at: **6,400,000 SCFD**

4.2 Low Pressure Header

Unlike the High Pressure Header system, the Low Pressure Flaring System features three (3) independent headers via the LP MPGF. Each header has an individual flow meter, so three separate baselines for this system have been established:

- LP Header Flows to the Thermal Oxidizer;
- LP MPGF PE-1/2 Burner Header; and
- LP MPGF Ethylene Burner Header.

There is no baseline for the third line in the MPGF package (relief from Thermal Oxidizer) as venting to this line would only occur in emergency/upset situations where the capacity of the CVTO is exceeded. Compliance with each baseline is determined by output from each header's respective flow meter.

The primary baseline flows for each header are as follows:

- LP Header Flows to the Thermal Oxidizer: **4,500,000 SCFD**
- LP MPGF PE-1/2 Burner Header: **0 SCFD**
- LP MPGF Ethylene Burner Header: **0 SCFD**

4.3 Alternate Baseline (Process Scenario Description, Daily Flow, Expected Duration)

As of the September 2020 revision of this Flare Minimization Plan, no alternate baselines have been implemented. This section remains evergreen and will be updated as necessary to capture process scenarios to be considered as alternate baselines.

5. FLARING EVENT MANAGEMENT

Plan Approval No. 04-00740A requires Shell to conduct an RCA following any flaring events caused by startup, shutdown, or unforeseeable circumstances. Flaring events or those events that exceed permit or regulatory limits are investigated to determine root cause(s), followed by corrective actions which can be taken to prevent recurrence. A flaring event is defined as an event that exceeds the baseline by 500,000 SCF within a 24-hour period. An RCA is required to be conducted within 45 days of the exceedance.

The RCA is a written assessment conducted through a process of investigation to determine the primary cause, and any other contributing cause(s), of flaring that exceeded any of the above listed thresholds. The RCA should include a corrective action analysis to identify corrective actions minimize the likelihood of the recurrence of the primary cause and any contributing cause(s) of the reportable flaring event that resulted in the exceedance of the baseline. A detailed description of what must be included in the root cause analysis (per Plan Approval No. 04-00740A) is as follows:

a. The date and time that the flaring event started and ended;

b. The total quantity of gas flared during each event;

c. An estimate of the quantity of VOC that was emitted and the calculations used to determine the quantities;

d. The steps taken to limit the duration of the flaring event of the quantity of emissions associated with the event;

e. A detailed analysis that sets forth the root cause and all significant contributing causes of the flaring event to the extent determinable;

f. An analyses of the measures that are available to reduce the likelihood of a recurrence of a flaring event resulting from the same root cause or significant contributing causes in the future; and

g. A demonstration that the actions taken during the flaring event are consistent with the procedures specified in the flare minimization plan.

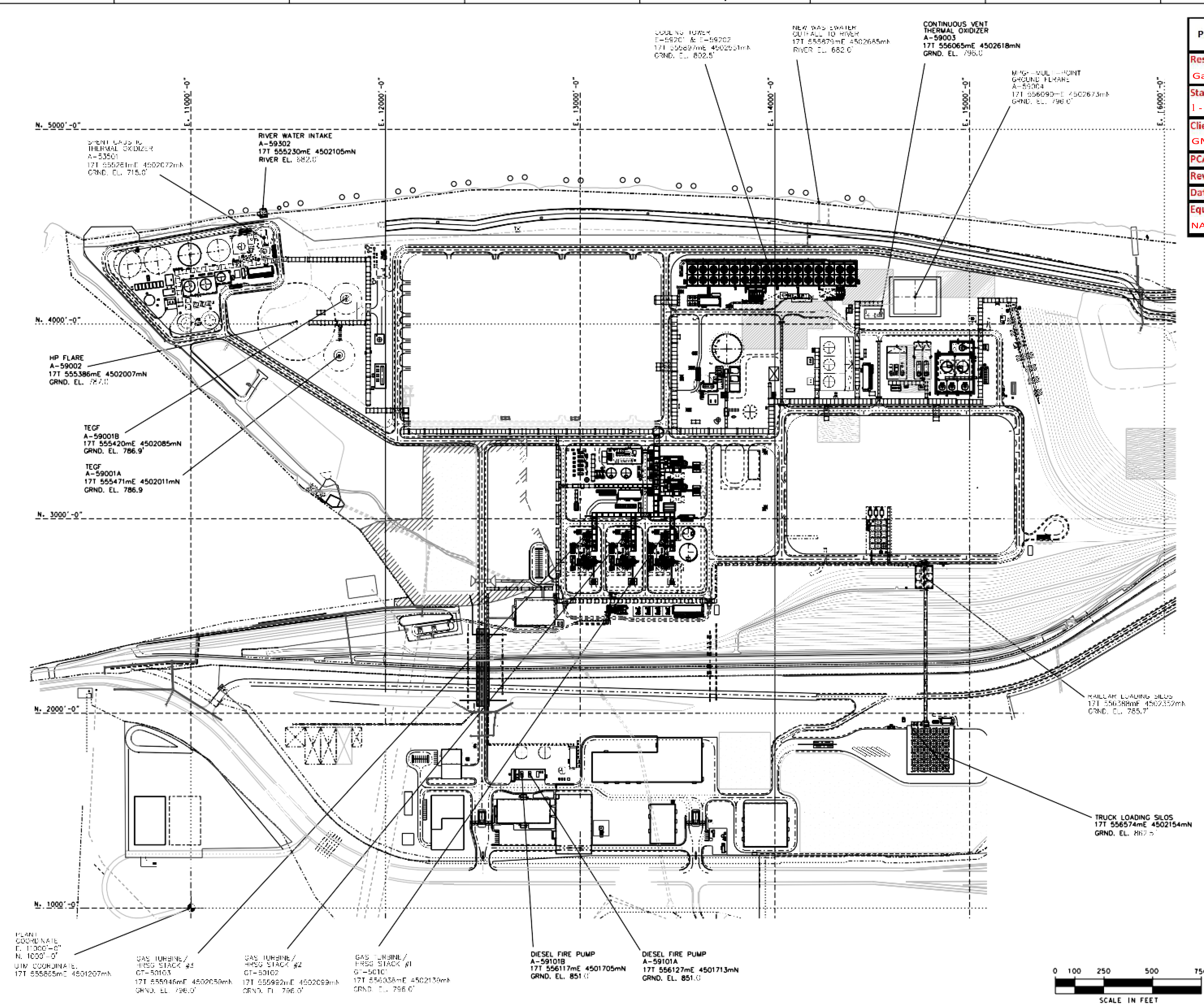
A Root Cause Analysis must be completed within 45 days of the exceedance of the threshold, and identified corrective actions should be implemented as expeditiously as possible. If any items of the analysis are still under investigation after 45 days, the root cause analysis should include a statement of the anticipated date by which a follow-up report fully confirming the RCA requirements will be completed.

The Root Cause Analysis process for reportable flaring events is contained within Shell's Fountain Incident Management (FIM) system and is driven by both the Environmental and Causal Learning departments, with input from the site leadership team. Following an exceedance, the Environmental Department logs the event in FIM and the Causal Learning team classifies the event, establishes terms of reference, defines the problem statement, gathers data, and develops the analysis. The Environmental Department uses the resulting analysis to develop the final RCA report for submittal within the 45 day time period.

Copies of the written RCA reports should be maintained on site for at least five years (the required document retention time detailed in PA No. 04-00740A, Section C, Requirement #014).

APPENDIX A FACILITY-WIDE PLOT PLANS – FLARE LOCATIONS

Project Franklin Shell Consolidator Stamp
Responsible Person: Gayake_Hrishikesh
Status Code: 1 - Work May Proceed
Client Doc No: GM1-700-U50010-CX-4180-00001
PCAP No: NA
Revision: 00B
Date: 29-May-2016
Equipment No: NA



AIR PERMIT - OSBL EMISSION POINTS	
EQUIP. NO.	DESCRIPTION
GT-50101	GAS TURBINE/ HRSG EXHAUST STACK #1
GT-50102	GAS TURBINE/ HRSG EXHAUST STACK #2
GT-50103	GAS TURBINE/ HRSG EXHAUST STACK #3
A-59101A	DIESEL ENGINE DRIVEN FIRE PUMP 'A'
A-59101B	DIESEL ENGINE DRIVEN FIRE PUMP 'B'
A-59001A	TEGF-TOTALLY ENCLOSED GROUND FLARE 'A'
A-59001B	TEGF-TOTALLY ENCLOSED GROUND FLARE 'B'
A-59002	HIGH PRESSURE ELEVATED FLARE
A-53501	SCTO-SPENT CAUSTIC THERMAL OXIDIZER
A-59003	CVTO-CONTINUOUS VENT THERMAL OXIDIZER
A-59004	MPGF-MULTI-POINT GROUND FLARE

OTHER - OSBL COORDINATE POINTS	
EQUIP. NO.	DESCRIPTION
	RAILCAR LOADING SILOS
	TRUCK LOADING SILOS
E-59201 E-59202	32 CELL COOLING TOWER
	WASTE WATER OUTFALL TO RIVER
A-59302	RIVER WATER PUMP HOUSE INTAKE

NOTES:

1. THE EMISSION POINT COORDINATES NOTED ARE IN UNIVERSAL TRANSVERSE MERCATOR (UTM) COORDINATE SYSTEM. THE GROUND ELEVATION NOTED IS IN DECIMAL FEET ABOVE MEAN SEA LEVEL.

REV	DATE	DESCRIPTION	BY	CHK	APP	PEM	CLIENT
00B	11MAR16	ISSUED FOR INFORMATION	VE	FH	WV	NK	-
00A	7-31-14	ISSUED FOR INFORMATION	VE	SJL	SJL	DP	-

BECHTEL OG&C
PROJECT FRANKLIN

25873-001
ECCN - EAR 99

WBS/MODULE NO:
BECHTEL DRAWING NO: 25873-001-P1-000-00003
REV 00B

OSBL AND COGEN
EMISSION POINT COORDINATES
AND OTHER PLANT COORDINATE POINTS

LOCATION:	PLANT AREA:	COMPANY PROJECT NO:	SCALE:	SHEET:
Monaca, PA	OSBL	GM1	1" = 250'-0"	1 of 2

PROJECT FRANKLIN
COMPANY DRAWING NO: GM1-700-U50010-CX-4180-00001
REV 00B

PCAP=N/A

Redacted High Pressure Flare Diagram

Redacted High Pressure Flare Diagram

APPENDIX B FLARE DIAGRAMS (P&IDS) - REDACTED

APPENDIX C FLARE OPERATION, MAINTENANCE AND MINIMIZATION PROCEDURES

Appendix C - Flare Operation, Maintenance, and Minimization Procedures
Shell Petrochemicals Flare Minimization Plan
Shell Chemical Appalachia LLC

Procedure Name	Procedure Number	Unit	Operating Conditions	Flares Utilized	Description
---	UGF-590-0001.1	UGF	---	HP	---
---	UGF-590-0001.2	UGF	---	HP	---
---	UGF-590-0001.3	UGF	---	HP	---
---	UGF-590-0001.4	UGF	---	HP	---
---	UGF-590-0001.5	UGF	---	HP	---
---	UGF-590-0001.6	UGF	---	HP	---
---	UGF-590-0001.7	UGF	---	HP	---
---	UGF-590	UGF	---	LP	---
Cracked Gas Compressor Startup with Cracked Gas	ECU-131-0001-SU	ECU/131	---	HP	---
Cracked Gas Compressor Shutdown (Long)	---	ECU/131	---	HP	---
Cracked Gas Compressor K-13101 Turbine KT-13102 Normal Shutdown Short/Compressor Actions	ECU-131-0001-SD	ECU/131	---	HP	---
Cracked Gas Compressor Restart after a trip	---	ECU/131	---	HP	---
Propane Refrigerant Compressor Inventory C3C with Propane	ECU-146-0005-SU	ECU/146	---	HP	---
Propane Refrigerant Compressor Startup	ECU-146-0006-SU	ECU/146	---	HP	---
Propane Refrigerant Compressor Shutdown (Long)	---	ECU/146	---	HP	---
Propane Compressor Restart after a Trip	ECU-146-0007-SU	ECU/146	---	HP	---
Propane Refrigerant Compressor - Secure Compressor after a Trip	ECU-146-0002-SD	ECU/146	---	HP	---
Ethylene Refrigerant Compressor Startup with Ethane	ECU-144-0001-ISU	ECU/144	---	HP	---
Ethylene Refrigerant Compressor Inventory with Ethylene	---	ECU/144	---	HP	---
Ethylene Refrigerant Compressor Startup with Ethylene	---	ECU/144	---	HP	---
Ethylene Refrigerant Compressor Shutdown (Long)	---	ECU/144	---	HP	---
Ethylene Compressor Restart after a Trip	---	ECU/144	---	HP	---
PSA Normal Startup	ECU-148-0001-SU	ECU/148	---	HP	---
Hydrogen Compressor K-14802A/B Startup	---	ECU/148	---	HP	---
Methanol Normal Startup	ECU-187-0001-SU	ECU/187	---	HP	---
Ethylene Atmospheric Storage Tank T-64210 Startup	ECU-642-0001-SU	ECU/642	---	LP	---
BOG Compressor Normal Startup	---	ECU/642	---	LP	---
Propane Compressor K-64241 Startup	ECU-642-0003-SU	ECU/642	---	LP	---
Methanol V-64230 System Startup	ECU-642-0002-SU	ECU/642	---	LP	---

Procedure Name	Procedure Number	Unit	Operating Conditions	Flares Utilized	Description
Ethylene Off Spec Vessel V-64220 Startup	ECU-642-0001-ISU	ECU/642	---	LP	---
Ethylene Storage Tank Pump P-64211A/B Return from Maintenance	---	ECU/642	---	LP	---
Ethylene Storage tank Pump P-64211A/B Prepare for Maintenance	---	ECU/642	---	LP	---
C2 Splitter C-14301 Startup	ECU-143-0001-SU	ECU/143	---	HP	---
C2 Splitter C-14301 Shutdown	---	ECU/143	---	HP	---
C2 Splitter C-14301 Restart after Loss of Feed	---	ECU/143	---	HP	---
Demethanizer Feed Train and Demethanizer Startup with Cracked Gas	ECU-140-0001-SU	ECU/140	---	HP	---
Demethanizer C-14101 and Feed System Restart after Loss of Feed	ECU-140-0002-SU	ECU/140	---	HP	---
C2 Hydrogenation Reactor R-13901 Off Spec for Acetylene	ECU-139-0001-NOP	ECU/139	---	HP	---
Deethanizer and AC Reactor Startup with Cracked Gas	ECU-138-0001-SU	ECU/138	---	HP	---
C3 Absorber/Deethanizer (C-13801/C-13802) Shutdown	---	ECU/138	---	HP	---
Cold Side Total Loss of Feed	ECU-GEN-0001-SD	ECU/GEN	---	HP	---
C3 Absorber/Deethanizer C-13801/C-13802 Restart after Loss of Feed	ECU-138-0005-SU	ECU/138	---	HP	---
Deethanizer Reboilers E-13811A/B Prepare for Maintenance	ECU-138-0003-NOP	ECU/138	---	HP	---
Deethanizer Reboilers E-13811A/B Return from Maintenance	ECU-138-0007-NOP	ECU/138	---	HP	---
Heavy Hydrocarbon Absorber and Dryers C-13601/D-13641A/B/C Startup	ECU-136-0001-SU	ECU/136	---	HP	---
Heavy Hydrocarbon Absorber and Dryers (C-13601/D-13641A/B/C) Shutdown	---	ECU/136	---	HP	---
Cracked Gas Dryers (D-13641A/B/C) Shutdown for Maintenance	ECU-136-0002-SD	ECU/136	---	HP	---
Cracked Gas Dryers (D-13641A/B/C) Return from Maintenance	---	ECU/136	---	HP	---
Water/HC Heater (E-13614) Bypass/Shutdown for Maintenance	ECU-136-0003-SD	ECU/136	---	HP	---
Water/HC Heater (E-13614) Return from Maintenance/Place on Line	---	ECU/136	---	HP	---
Ethane Feed Preheating Warm Branch Startup	ECU-125-0002-ISU	ECU/125	---	HP	---
Ethane Dryers D-12541A/B Shutdown for Maintenance	ECU-125-0002-SD	ECU/125	---	HP	---
Ethane Dryers D-12541A/B Return from Maintenance	---	ECU/125	---	HP	---
Quench System Startup	ECU-128-0001-SU	ECU/128	---	HP	---
Caustic Scrubber Startup	ECU-134-0001-SU	ECU/134	---	HP	---
Caustic Scrubber Shutdown (Long)	---	ECU/134	---	HP	---

Procedure Name	Procedure Number	Unit	Operating Conditions	Flares Utilized	Description
Spent Caustic Stripper C-13501 Startup	ECU-135-0001-SU	ECU/135	---	HP	---
Spent Caustic Stripper (C-13501) Shutdown (Long)	---	ECU/135	---	HP	---
Gasoline Redistillation System Startup	---	ECU/158	---	HP	---
Gasoline Redistillation System Shutdown (Long)	---	ECU/158	---	HP	---
Gasoline Redistillation Tower Reboiler E-15811A/B Preparation for Maintenance	ECU-158-0005-NOP	ECU/158	---	HP	---
Gasoline Redistillation Tower Reboiler E-15811A/B Return from Maintenance	ECU-158-0004-NOP	ECU/158	---	HP	---
Wash Oil System Startup	ECU-188-0001-SU	ECU/188	---	HP	---
Wash Oil System Shutdown (Long)	---	ECU/188	---	HP	---
Methanol Vaporizer E-19012 Startup	---	ECU/190	---	HP	---
Fuel Gas System Initial Startup	ECU-184-0002-ISU	ECU/184	---	HP	---
Regeneration System Startup Tail Gas	ECU-189-0001-ISU	ECU/189	---	HP	---
Loss of Cooling water	ECU-192-0001-ESD	ECU/192	---	HP/LP	---
Loss of Ethane Feed	---	ECU/125	---	HP	---
Trip of all Furnaces	---	ECU/101-107	---	HP	---
Loss of Boiler Feed Water	---	ECU/183	---	HP	---
Loss of Power	ECU-100-0001-ESD	ECU/100	---	HP	---
Loss of Instrument Air	---	ECU/185	---	HP	---
Quench System Shutdown (Long)	---	ECU/128	---	HP	---
Ethane Cleanup	ECU-GEN-0005-ISU	ECU/125	---	HP	---
Ethane Feed Preheating Cold Branch Startup	ECU-125-0001-ISU	ECU/125	---	HP	---
C2 Hydrogenation Methanol System Startup/Inventory	ECU-139-0001-SU	ECU/139	---	HP	---
Caustic Slop Drum V-19732 and System Startup	ECU-197-0001-ISU	ECU/197	---	HP	---
Propane Refrigerant Compressor Shutdown Short/Process Actions	ECU-146-0003-SD	ECU/146	---	HP	---
Loss of Nitrogen	ECU-186-0001-ESD	ECU/186	---	HP/LP	---
Natural Gas Initial Startup	ECU-184-0001-ISU	ECU/184	---	HP	---
Ethane Feed Preheating Shutdown	---	ECU/125	---	HP	---
Ethane Feed Preheating Restart after Loss of Feed	---	ECU/125	---	HP	---
Ethane Superheater II E-12512 Bypassing/Shutdown	ECU-125-0003-SD	ECU/125	---	HP	---
Ethane Superheater II E-12512 Startup	ECU-125-0003-SU	ECU/125	---	HP	---
Shut down of process steam generator E-13011x	ECU-130-0002-SD	ECU/130	---	HP	---
Cracked Gas Compressor Secure after a Trip	---	ECU/131	---	HP	---

Procedure Name	Procedure Number	Unit	Operating Conditions	Flares Utilized	Description
Deethanizer Bottoms Pumps (P-13872A/B) Startup/Swap	ECU-138-0003-SU	ECU/138	---	HP	---
Deethanizer Reflux Pumps (P-13871A/B) Startup/Swap)	ECU-138-0004-SU	ECU/138	---	HP	---
Demethanizer C-14101 and Feed System Shutdown	---	ECU/140	---	HP	---
LP Tail gas Expander/Booster KT-14103/K-14105 Startup	ECU-141-0001-SU	ECU/141	---	HP	---
HP Tail gas Expander/Booster KT-14102/K-14104 Startup	ECU-141-0002-SU	ECU/141	---	HP	---
LP Tail gas Expander/Booster KT-14103/K-14105 Shutdown	ECU-141-0001-SD	ECU/141	---	HP	---
HP Tail gas Expander/Booster KT-14102/K-14104 Shutdown	ECU-141-0002-SD	ECU/141	---	HP	---
Ethylene Refrigerant Compressor Shutdown Short/Process Actions	ECU-144-0002-SD	ECU/144	---	HP	---
Ethylene Refrigerant Compressor - Secure after a Trip	---	ECU/144	---	HP	---
PSA Normal Shutdown	---	ECU/148	---	HP	---
Hydrogen Compressor (K-14802 A/B) Shutdown Procedure	---	ECU/148	---	HP	---
Fuel Gas System Shutdown	---	ECU/184	---	HP	---
Methanol Normal Shutdown	ECU-187-0001-SD	ECU/187	---	HP	---
DMDS System Startup	ECU-188-0003-SU	ECU/188	---	HP	---
Ammonia Water System Startup	ECU-188-0005-SU	ECU/188	---	HP	---
Regeneration System Line Up for Ethane - Ethane Cleanup	ECU-189-0003-ISU	ECU/189	---	HP	---
Regeneration System Line Up for Tail Gas - Normal Lineup	ECU-189-0001-NOP	ECU/189	---	HP	---
Methanol Vaporizer E-19012 Shutdown	---	ECU/190	---	HP	---
BOG Compressor Normal Shutdown	---	ECU/642	---	LP	---
Propane Compressor K-64241 Shutdown	---	ECU/642	---	LP	---
Propane Compressor - Secure after a Trip	---	ECU/642	---	LP	---
Ethylene storage tank Pump (P-64211A/B) Startup procedure	---	ECU/642	---	LP	---
---	UGF-584-0001	UGF	---	HP/LP	---
---	UGF-590UZ410	UGF	---	LP	---
---	UGF-590-590UZ	UGF	---	LP	---
---	UGF-590-0001	UGF	---	LP	---
---	UGF-590-0002	UGF	---	LP	---

APPENDIX D FLARE CONNECTION LIST - REDACTED

APPENDIX E MONITORING EQUIPMENT SPECIFICATIONS AND DATA SHEETS - REDACTED

APPENDIX F FLARE MINIMIZATION PLAN REVISION LOG

Appendix F Flare Management Plan Revision Log

The flare management plan revision log is shown below. Upon each periodic review, the log will be completed and the plan will be resubmitted, if necessary. The Pennsylvania Petrochemicals Complex Flare Management Plan is to be updated annually. Revisions are captured and made to the contents of the Flare Management Plan when changes or corrections are made to any of the following: practices and procedures; flare equipment or controls, information, and drawings included in the Flare Management Plan or associated appendices; or baseline flows to either the Low Pressure or High Pressure flaring systems.

No.	Reviewed By	Submittal Information		Description of amendments
0		Submittal required	Yes No _	
		Date submitted		
1		Submittal required	Yes No _	
		Date submitted		
2		Submittal required	Yes No _	
		Date submitted		
3		Submittal required	Yes No _	
		Date submitted		
4		Submittal required	Yes No _	
		Date submitted		