



Shell Chemical Appalachia LLC  
300 Frankfort Rd  
Monaca, PA 15061

September 28, 2023

Mark Gorog P.E., Regional Manager Air Quality Program  
Pennsylvania Department of Environmental Protection (PADEP)  
Southwest Regional Office  
400 Waterfront Drive  
Pittsburgh, PA 15222

**RE: PA-04-00740C Polyethylene Manufacturing Lines (Source ID 202), Low Pressure (LP) Header System (Source ID 204) Visible and Excess Emissions Malfunction Report**

Dear Mr. Gorog,

Shell Chemical Appalachia LLC (“Shell”), located in Beaver Co. is submitting this malfunction report to the Pennsylvania Department of Environmental Protection (PADEP) for excess emissions and visible emissions from the Low-Pressure Multipoint Ground Flare (MPGF)<sup>1</sup> on September 02, 2023.

This malfunction did not pose an imminent and substantial danger to the public health and safety or the environment.

- **Name and location of the facility**

Shell Polymers Monaca  
300 Frankfort Road, Monaca PA, 15061

- **Nature and cause of the incident**

On September 02, 2023, at approximately 11:27, the Polyethylene Manufacturing Lines (PE Units) (Source ID 202) suddenly tripped due to a main ethylene feed isolation valve failing closed, stopping ethylene feed flow to PE Units. At the time of the PE Units trip, the Ethane Cracking Unit (ECU) was supplying approximately 130 tons per hour of ethylene feed to the PE Units, the majority of which had to be diverted to the ethylene product tank. As its capacity was reached, ethylene was then routed on to the ethylene tank header of the Low-Pressure MPGF for destruction. This resulted in visible emissions (VE) from the MPGF in excess of 5 minutes in a 2-hour period.

An investigation into the initiating event by Shell’s instrumentation and maintenance teams found that the trip was caused by the failure of a shaft internal to the valve’s actuator causing the Emergency Shutdown Valve (ESDV) to go to its fail-safe position (i.e., failing closed) providing isolation of the PE 1 and PE2 Units from ECU process.

- **Time when the malfunction or breakdown was first observed**

Ethylene vapor gas was first released to the Low-Pressure MPGF on September 02, 2023, at 20:08 and then smoking was observed beginning on September 02, 2023, at 20:25.

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<sup>1</sup> Identified as the LP Multipoint Ground Flare (MPGF), Control ID C204B in PA-04-00740C, and part of the LP Header System. The MPGF ethylene storage tank Vent Header was used during this event.

- **The date and time that the malfunction started and ended**

The PE1 and PE2 Units trip event resulted in use of the Low-Pressure MPGF starting on September 02, at 20:08 and the associated flaring ceased on September 03, at 22:05. The PE Units trip also resulted in flaring to the High Pressure Flare System<sup>2</sup> that started on the morning of September 02, at 11:40 and continued until midnight of September 02, at 23:59. Flaring in the High Pressure Flare System was contained entirely within the High Pressure Ground Flares. No visible emissions were observed from the High Pressure Flares.

- **An estimate of the emissions associated with the malfunction**

Estimated emissions from the Low-Pressure MPGF header system:

Pollutant	Emissions (tons)
CO2e	145.039
CO	0.313
NOx	0.069
PM (filt)	0.002
PM 10	0.008
PM 2.5	0.008
VOC	0.466

Estimated emissions from the High-Pressure Header System:

Pollutant	Emissions (tons)
CO2e	1,396.813
CO	2.734
NOx	0.675
PM (filt)	0.018
PM 10	0.074
PM 2.5	0.074
VOC	4.369
HAP (total)	0.182
1,3 Butadiene	0.048
Benzene	0.128

- **The calculations that were used to determine that quantity**

Estimated emissions from the flaring event were based on measured flow rates, estimated vent gas compositions, application of accepted hydrocarbon destruction efficiencies, and the use of emission factors for products of combustion. See attached gas composition and flow data used for these calculations.

Summary of Visible Emissions (VE) elapsed time in the Low-Pressure MPGF as determined by review of camera footage is captured below. Method 22 observations were initiated and performed by field operations and included as Attachment B. However, the VE had ended by time the observer was able to get into place due to the short overall duration of the VE.

<sup>2</sup> Including HP Ground Flares #1 and #2, Control IDs C205A and C205B in PA-04-00740C

- 14 minutes and 12 seconds of VE observed between 20:25:23 and 20:39:35

- **The steps, if any, that the facility took to limit the duration and/or quantity of emissions associated with the malfunction**

The board operator received a high flare flow alarm and observed smoke via the flare camera. The operator immediately took manual control of the Low-Pressure MPGF and ramped up the speed of the perimeter air assist blower to provide additional combustion air until smoking stopped.

The shaft and actuator of the ethylene feed isolation valve was repaired. After the repairs were completed, the ECU was able to re-direct ethylene production to the PE Units rather than to the Ethylene Tank and Low-Pressure MPGF flare header.

- **A detailed analysis that sets forth the Root Cause of the malfunction, to the extent determinable**

Shell's Process Automation, Control and Optimization (PACO) discipline team has provided the valve's damaged shaft element to the original manufacturer to conduct Root Cause Failure Analysis (RCFA) and develop recommendations to minimize the potential of recurrence.

The cause of the VE has been identified as the inability of the MPGF ethylene storage tank vent header blower to automatically ramp up fast enough in CAS (cascade) mode to provide enough air for proper combustion to prevent smoking without the board operator taking manual control during high flow flaring events.

- **An analysis of the measures, if any, that are available to reduce the likelihood of a recurrence of a malfunction resulting from the same Root Cause or contributing causes in the future**

The following corrective action will be implemented to prevent future PE Units tripping due to failure of main isolation valve:

- **Pending**- Upon receiving the RCFA report, Shell's PACO and maintenance teams will assign responsible parties and schedule execution dates for each corrective action to prevent recurrence of an identical incident.

The following corrective action will be implemented to further investigate the MPGF air blower response/control scheme:

- **Pending**- Possible long-term improvements to the perimeter air assist blowers' automatic response and speed control remain under investigation. The vendor is currently evaluating the flow and composition basis of the blower curve to make recommended adjustments.

The current mitigation remains taking manual control of the blower speed in response to events which result in VE from the MPGF.

- **To the extent that investigations of the causes and/or possible corrective action(s) still are underway on the due date of the report, a statement of the anticipated date by which a follow-up report will be submitted**

No follow up report is anticipated.

- **Corrective action is final or timeline for implementation**

Final corrective actions and implementation timelines are pending recommendations from the main ethylene feed isolation valve original manufacturer and MPGF manufacturer.

September 28, 2023

If you have any questions regarding this matter, please contact me at (724) 709-2467 or [kimberly.kaal@shell.com](mailto:kimberly.kaal@shell.com).

Sincerely,



Kimberly Kaal  
Environmental Manager, Attorney-in-Fact

CC:  
Scott Beudway, Air Quality Specialist  
Kristin Goddard, Air Quality District Supervisor  
Beth Speicher, Environmental Group Manager

**Attachment A**  
HP Flare GC and Flow Data

### MPGF Ethylene Header Average Vol% Compositions, Wt % Compositions, Flow, and NHV

Date and Time	Nitrogen % vol	Ethylene % mol	Total % mol	Nitrogen % wt	Ethylene % wt	Total % wt	Mass Rate kg/hr	NHVcz Btu/scf
02-Sep-23 20:00:00	22.80	77.20	100.00	22.65	77.35	100.00	901.70	1140.21
02-Sep-23 21:00:00	11.74	88.26	100.00	11.65	88.35	100.00	1752.60	1303.56
02-Sep-23 22:00:00	10.85	89.15	100.00	10.76	89.24	100.00	1897.81	1316.82
02-Sep-23 23:00:00	10.36	89.64	100.00	10.28	89.72	100.00	1986.91	1323.99
03-Sep-23 00:00:00	10.31	89.69	100.00	10.23	89.77	100.00	1996.03	1324.69
03-Sep-23 01:00:00	9.53	90.47	100.00	9.45	90.55	100.00	2160.60	1336.28
03-Sep-23 02:00:00	9.57	90.43	100.00	9.50	90.50	100.00	2150.99	1335.66
03-Sep-23 03:00:00	8.62	91.38	100.00	8.55	91.45	100.00	2388.08	1349.68
03-Sep-23 04:00:00	8.31	91.69	100.00	8.24	91.76	100.00	2477.87	1354.29
03-Sep-23 05:00:00	7.48	92.52	100.00	7.42	92.58	100.00	2750.89	1366.46
03-Sep-23 06:00:00	7.78	92.22	100.00	7.71	92.29	100.00	2647.83	1362.16
03-Sep-23 07:00:00	7.78	92.22	100.00	7.72	92.28	100.00	2646.37	1362.10
03-Sep-23 08:00:00	7.98	92.02	100.00	7.92	92.08	100.00	2579.03	1359.10
03-Sep-23 09:00:00	7.55	92.45	100.00	7.49	92.51	100.00	2728.20	1365.54
03-Sep-23 10:00:00	7.53	92.47	100.00	7.47	92.53	100.00	2735.05	1365.82
03-Sep-23 11:00:00	7.19	92.81	100.00	7.13	92.87	100.00	2865.39	1370.87
03-Sep-23 12:00:00	11.20	88.80	100.00	11.12	88.88	100.00	1836.90	1311.51
03-Sep-23 13:00:00	14.05	85.95	100.00	13.95	86.05	100.00	1464.08	1269.42
03-Sep-23 14:00:00	14.41	85.59	100.00	14.30	85.70	100.00	1428.33	1264.23
03-Sep-23 15:00:00	13.16	86.84	100.00	13.07	86.93	100.00	1563.24	1282.57
03-Sep-23 16:00:00	14.32	85.68	100.00	14.21	85.79	100.00	1437.20	1265.54
03-Sep-23 17:00:00	13.76	86.24	100.00	13.66	86.34	100.00	1495.11	1273.72
03-Sep-23 18:00:00	16.01	83.99	100.00	15.89	84.11	100.00	1285.37	1240.60
03-Sep-23 19:00:00	24.64	75.36	100.00	24.48	75.52	100.00	834.33	1113.07
03-Sep-23 20:00:00	25.65	74.35	100.00	25.49	74.51	100.00	801.38	1098.14
03-Sep-23 21:00:00	26.65	73.35	100.00	26.48	73.52	100.00	771.26	1083.38
* 03-Sep-23 22:00:00	95.04	4.96	100.00	95.00	5.00	100.00	182.96	73.25

\*only the first 5 minutes of this hour were flaring event emissions

### Constants

Property	Nitrogen (N2)	Ethylene (C2H4)
NHV (Btu/scf)	0	1,595
MW (lb/lb-mol)	28.01	28.05



HP Flare System GC Hourly Average Mol% Compositions, Wt % Compositions, Flow, and NHV

Date and Time	Elemental Hydrogen % mol	Nitrogen % mol	Methane % mol	Ethane % mol	Acetylene % mol	Ethylene % mol	C3 % mol	C4 % mol	C4 Olefins % mol	C5 % mol	CF+ % mol	Total % mol	Elemental Hydrogen % wt	Nitrogen % wt	Methane % wt	Ethane % wt	Acetylene % wt	Ethylene % wt	C3 % wt	C4 % wt	C4 Olefins % wt	C5 % wt	CF+ % wt	Total % wt	Actual Flow Rate m3/hr	Flow Density kg/m3	Mass Rate ton/hr	NHVz Btu/scf
02-Sep-23 11:00:00	1.34	11.37	52.83	4.38	0.00	18.60	5.84	0.39	1.76	1.13	1.36	100.00	0.11	14.35	35.11	5.46	0.00	21.62	10.68	0.94	3.95	4.41	100.00	242.67	1.05	25.41	1,133.76	
02-Sep-23 11:00:00	2.21	10.01	6.33	0.78	0.00	72.88	1.90	0.11	0.58	1.60	0.60	100.00	0.16	9.94	3.60	0.83	0.00	75.42	2.97	0.22	1.12	4.09	1.66	100.00	587.10	1.31	76.73	1,362.52
02-Sep-23 11:00:00	2.37	12.20	2.65	0.59	0.00	79.28	0.26	0.04	0.08	2.09	0.43	100.00	0.17	12.06	1.50	0.63	0.00	78.48	0.41	0.09	0.16	5.31	1.20	100.00	56.883	1.33	74.74	1,362.40
02-Sep-23 11:00:00	1.29	11.02	9.46	0.92	0.00	75.55	0.03	0.03	0.01	1.36	0.34	100.00	0.10	11.28	5.54	1.01	0.00	77.41	0.05	0.05	0.01	3.57	0.97	100.00	45.083	1.22	55.05	1,363.05
02-Sep-23 11:00:00	1.28	14.11	10.30	0.96	0.00	71.35	0.07	0.03	0.02	1.46	0.41	100.00	0.09	14.45	6.04	1.06	0.00	73.13	0.12	0.06	0.03	3.85	1.17	100.00	45.113	1.22	55.05	1,363.04
02-Sep-23 11:00:00	0.89	15.26	10.30	0.94	0.00	69.66	0.51	0.04	0.16	1.01	0.30	100.00	0.05	15.64	6.05	1.03	0.00	71.67	0.29	0.06	0.10	3.13	0.97	100.00	45.480	1.21	55.05	1,363.04
02-Sep-23 11:00:00	0.66	16.62	10.16	0.88	0.00	68.30	0.72	0.05	0.23	0.86	0.28	100.00	0.04	18.57	5.90	0.90	0.00	71.37	0.82	0.09	0.10	2.66	0.86	100.00	46.105	1.24	55.05	1,363.04
02-Sep-23 11:00:00	0.50	18.18	10.08	0.82	0.00	67.09	0.82	0.04	0.18	0.92	0.35	100.00	0.04	22.63	7.35	1.05	0.00	64.08	0.96	0.10	0.45	2.28	0.79	100.00	46.105	1.24	55.05	1,363.04
02-Sep-23 11:00:00	0.48	21.95	12.45	0.95	0.00	62.09	0.59	0.04	0.23	1.64	0.76	100.00	0.07	55.45	23.95	3.52	0.00	64.08	1.38	0.18	0.50	4.78	1.01	100.00	46.105	1.24	55.05	1,363.04
02-Sep-23 11:00:00	0.89	47.19	36.93	2.90	0.00	6.67	0.77	0.07	0.23	1.40	0.69	100.00	0.11	54.64	27.94	4.00	0.00	57.7	0.56	0.12	0.17	4.23	2.57	100.00	14.158	1.15	16.33	609.48
02-Sep-23 11:00:00	1.26	46.48	41.50	3.17	0.00	5.07	0.30	0.05	0.07	1.40	0.69	100.00	0.11	48.92	31.53	3.84	0.00	7.32	0.20	0.09	0.03	3.26	2.64	100.00	30.703	0.87	18.03	776.43
02-Sep-23 11:00:00	24.28	31.64	39.61	2.11	0.00	4.73	0.08	0.03	0.01	0.83	0.47	100.00	2.71	48.92	28.90	3.48	0.00	6.05	0.15	0.08	0.01	3.70	2.83	100.00	30.222	0.83	18.84	766.11
02-Sep-23 23:00:00	25.15	34.07	38.02	2.12	0.00	3.95	0.06	0.02	0.00	0.94	0.66	100.00	2.77	52.05	28.90	3.48	0.00	6.05	0.15	0.08	0.01	3.70	2.83	100.00	30.222	0.83	18.84	766.11

Constants

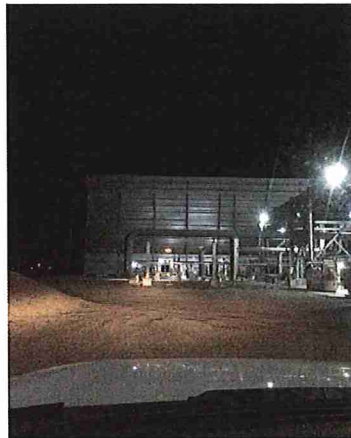
Property	Hydrogen (H2)	Nitrogen (N2)	Methane (CH4)	Ethane (C2H6)	Ethylene (C2H4)	Acetylene (C2H2)	C3	C4	C4 Olefins	C5	CF+
NHV (Btu/scf)	1.212	0	896	1.404	1.477	1.595	2.281	2.968	2.826	3.655	3.655
MW (lb/lb-mol)	2.02	28.01	16.04	30.07	26.04	28.05	44.1	58.12	54.09	72.15	78.11

**Attachment B**  
Method 22 Observation Form



**Shell Polymers Monaca**  
**Method 22 Visible Emissions Observation Form SPM-HSE-FO-0003**

Observer Name: allen  
 Observer Title: Field Operator  
 Date and Time (MM/DD/YY XX:XX): 9/2/23 20:45  
 Sky Conditions: Clear  
 Precipitation: None  
 Wind Direction (direction from): E 70.15  
 Wind Speed (m/s): 0.75  
[Site MET Data \(Wind Direction 500QT-060A and Speed 500QT-050A\)](#)  
 Visible Emissions Source: Multipoint Ground Flare (A-59004)  
 Observation Location: H (MPGF)  
 Observation Picture:



**Observations**

Begin	Clock Time	Observation Period (when you are actually looking at stack)	Emissions Observed (when you actually see smoke)
	9/2/2023 20:45		20:45:00
	21:00		0:00:00
	21:15		0:00:00
	21:30		0:00:00
	21:45		0:00:00
	22:00		0:00:00
	22:15		0:00:00
	22:30		0:00:00
	22:45		0:00:00
End	23:00		0:00:00
Compliant? (Y/N)	Y	10 sec intervals Y	