



Shell Chemical Appalachia LLC
300 Frankfort Rd
Monaca, PA 15061

July 8, 2025

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

RE: PA-04-00740C Ground Flares #1 and #2 (Source IDs C205A and B) Excess Emissions, and Source ID 032 & 033 Visible Emissions, and National Response Center Incident ID #1433560 Malfunction Report

Dear Mr. Gorog,

Shell Chemical Appalachia LLC ("Shell"), located in Beaver County PA, is submitting this malfunction report to the Pennsylvania Department of Environmental Protection (PADEP) for visible emissions from Ethane Cracking Unit ("ECU") Furnaces 2 and 3 (Source IDs: 032 & 033) and flaring emissions (Source IDs C205A/B) on June 9, 2025.

This malfunction did not pose an imminent and substantial danger to 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**

At approximately 10:11 AM on June 9, 2025, Unit 2 of the Heat Recovery Steam Generator (HRSG) at Cogen experienced an unexpected trip. In response, the facility initiated a controlled shutdown of the Ethylene Refrigeration Compressor (ERC) in accordance with the site's steam load shedding protocol.

This shutdown led to a shift in tail gas composition, which in turn caused visible emissions from Furnace 2 and 3. Additionally, the event triggered flaring activity from the Totally Enclosed Ground Flares (Source IDs C205A/B).

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

The malfunction was first observed when the HRSG tripped on June 9th at 10:11 AM.

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

The malfunction started on June 9, 2025 at 10:11 and ended 23:00

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

The flaring emissions are captured in Table 1 below.

Table 1: Flaring Emissions

Pollutant	Emissions (tons)
CO ₂ e	2935.542
CO	5.633
NO _x	1.571
PM (filt)	0.043
PM 10	0.172
PM 2.5	0.172
VOC	5.878
HAP (total)	0.263
1, 3 Butadiene	0.254
Benzene	0.005

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

Flaring Emissions

The flaring emissions associated with this event were calculated using the measured vent gas flow rate and composition, engineering estimates for any non-measured constituents, application of accepted hydrocarbon destruction efficiencies, and applications of emission factors for products of combustion. In addition, a representative flaring baseline rate and composition for the time leading up to the compressor trip was established and subtracted from the totals to calculate the excess emissions. The flaring event gas chromatograph (GC) and flow data are included in Appendix A.

Visible Emissions

Based on a review of camera footage a summary of the visible emissions is provided in Table 2.

Table 2 – Visible Emissions Summary

Malfunction Date	ECF	Start Time	End Time	Total Minutes
6/9/2025	032	10:25	10:27	2
	033	10:25	10:27	2
		10:39	10:46	7

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

In response to the ERC trip, the operations team initiated a control module designed to reduce the furnace feed by 70% within 5 minutes to reduce fuel flow and return excess O₂ to the firebox.

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

At approximately 10:11 AM on June 9, 2025, UGF experienced a trip of the Heat Recovery Steam Generator (HRSG) Unit 2. At the time of the HRSG trip, the facility was operating under a steam deficit due to limited steam production from the ECU and an ongoing HRSG Unit 3 overhaul. As a result, Superheated Header Pressure (SHP) began to decline, prompting the ECU cold side to initiate a shutdown of the Ethylene Refrigeration Compressor (ERC) trip in accordance with the site's steam load shed protocol.

Upon ERC shutdown, furnace feed rates automatically reduced by 70%. This shift caused the tail gas to become ethylene-rich, significantly increasing the BTU content in the furnace fuel gas. Concurrently, the AC reactor tripped on low flow at 10:25 AM, halting tail gas flow to the furnaces and triggering natural gas supplementation to maintain fuel gas supply.

The sudden change in BTU content led to a drop in excess O₂ levels in Furnace 1, 2, and 3 resulting in visible emissions which were observed:

- Furnace 2: 10:25 – 10:27 AM
- Furnace 3: 10:25 – 10:27 AM and 10:39 – 10:46 AM

As a further consequence of the ERC Trip, ECU flared approximately 178 tph of forward feed from the furnaces. Flaring continued throughout the HRSG, ERC, and ECU restart process and ended on June 9th at 23:00.

- **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**

To prevent recurrence of the recent incident, the facility has implemented several enhancements to the automated control logic within the ECU. These modifications are designed to improve system responsiveness, enhance safety interlocks and ensure more stable operations during upset conditions. The key changes are as follows:

- SIS HMI Trip Button Functionality - Verified and corrected the Safety Instrumented System (SIS) Human-Machine Interface (HMI) trip button functionality to ensure effective tripping of the compressor and associated SIS groups directly from graphic interface, rather than relying on matrix panels
- Oxygen Register Pulsing – Configure the system to pulse the O₂ air registers to their current output upon a major compressor trip, mitigating the risk of low oxygen levels in the furnace firebox.
- AC Reactor Pressure Controller Valve Response – Implemented logic to the valve to open to 30% (configurable) during an ERC trip to prevent an AC reactor trip due to low flow conditions.

- Flow Control Valve Logic – Updated control logic for the flow control valve between the C2 splitter and propane subcooler to pulse to 0% output during an ERC Trip (provided the ethane recycle system is not tripped), and to 100% output during an ethane recycle trip. This change will help stabilize ethane recycle temperatures and prevent downstream overpressure.
 - Tail Gas Pressure Control Valve Pulse Removal – Remove the pulse to the valve during an ERC trip to allow a more gradual change in fuel gas density, thereby reducing the impact on furnace and hot-side operations.
 - Automated Zone PC Setpoint Adjustment: Develop and implement “easy button” to automatically pulse zone pressure controller (PC) setpoints to 0.2 barg (configurable) during major unit compressor or AC reactor trip. This facilitates rapid fuel gas reduction in response to density changes.
 - Furnace Turndown Reset Logic – Revised the reset logic furnace turndowns to eliminate the need for manual intervention by control engineers. This enhancement minimizes delays in restoring steam header stability.
- **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**

This is the final report for this malfunction.

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

The implementation of all corrective actions detailed in this report was completed on or before June 30, 2025.

If you have any questions regarding this matter, please don't hesitate to contact Kimberly Kaal at kimberly.kaal@shell.com or myself at Nathan.Levin@shell.com.

Sincerely,



Nathan Levin
Operations Manager

Attachment A

HP Flare GC and Flow Data

HP Flare System GC Hourly Average Mol% Compositions, Wt % Compositions, Flow, and NHV^a
Shell Polymers Monaca

	Elemental Hydrogen % mol	Nitrogen % mol	Carbon Dioxide % mol	Water % mol	Methane % mol	Ethane % mol	Acetylene % mol	Ethylene % mol	C3 % mol	C4 % mol	C4 Olefins % mol	C5 % mol	C6+ % mol	Total % mol	Elemental Hydrogen % wt	Nitrogen % wt	Carbon Dioxide % wt	Water % wt	Methane % wt	Ethane % wt	Acetylene % wt	Ethylene % wt	C3 % wt	C4 % wt	C4 Olefins % wt	C5 % wt	C6+ % wt	Total % wt	Actual Flow Rate m3/hr	Flow Density kg/m3	Mass Rate tonne/hr	NHVcz Btu/scf
09-Jun-25 10:00:00	49.04	6.36	0.03	0.75	22.15	7.05	0.08	14.22	0.06	0.10	0.01	0.14	0.01	100.00	7.74	13.91	0.09	1.05	27.76	16.57	0.17	31.17	0.19	0.47	0.05	0.77	0.06	100.00	92,073	0.61	63.74	1,139.63
09-Jun-25 11:00:00	30.32	0.73	0.01	2.22	7.69	26.49	0.21	30.81	0.45	0.09	0.41	0.41	0.16	100.00	3.06	1.02	0.02	2.00	6.16	39.76	0.27	43.14	0.95	0.26	1.11	1.47	0.78	100.00	142,715	0.97	139.15	1,346.94
09-Jun-25 12:00:00	31.07	0.83	0.01	2.31	7.43	25.80	0.23	29.34	1.60	0.14	0.95	0.25	0.03	100.00	3.14	1.17	0.01	2.08	5.96	38.79	0.31	41.14	3.39	0.39	2.57	0.89	0.16	100.00	155,035	0.98	151.92	1,348.11
09-Jun-25 13:00:00	32.73	0.78	0.00	2.46	7.93	23.02	0.23	31.09	0.80	0.10	0.72	0.11	0.01	100.00	3.45	1.13	0.01	2.31	6.63	36.08	0.32	45.46	1.77	0.31	2.03	0.42	0.06	100.00	159,774	0.93	148.93	1,323.01
09-Jun-25 14:00:00	33.22	0.80	0.00	2.21	8.10	22.10	0.24	31.77	0.73	0.10	0.70	0.00	0.02	100.00	3.54	1.18	0.01	2.10	6.84	35.02	0.34	46.95	1.63	0.30	2.00	0.00	0.08	100.00	158,472	0.93	148.22	1,322.85
09-Jun-25 15:00:00	33.51	0.78	0.00	2.04	8.15	21.64	0.25	32.13	0.70	0.10	0.66	0.00	0.04	100.00	3.58	1.15	0.01	1.95	6.91	34.42	0.35	47.67	1.56	0.31	1.89	0.00	0.18	100.00	156,961	0.94	147.61	1,322.60
09-Jun-25 16:00:00	33.56	0.81	0.00	2.13	8.30	21.15	0.26	32.31	0.68	0.09	0.66	0.00	0.04	100.00	3.60	1.20	0.01	2.04	7.06	33.73	0.35	48.08	1.53	0.29	1.92	0.00	0.20	100.00	158,658	0.94	149.05	1,319.51
09-Jun-25 17:00:00	33.59	0.59	0.00	1.95	7.85	21.92	0.25	32.38	0.68	0.09	0.66	0.00	0.04	100.00	3.58	0.88	0.00	1.86	6.65	34.82	0.35	47.98	1.51	0.28	1.89	0.00	0.21	100.00	168,308	0.95	160.70	1,326.78
09-Jun-25 18:00:00	33.43	0.76	0.00	2.02	7.99	21.99	0.25	32.15	0.66	0.09	0.63	0.00	0.03	100.00	3.57	1.12	0.01	1.92	6.77	34.93	0.34	47.64	1.48	0.27	1.81	0.00	0.15	100.00	176,200	0.95	166.82	1,321.23
09-Jun-25 19:00:00	34.53	0.70	0.00	2.04	8.08	20.96	0.26	32.24	0.61	0.07	0.44	0.06	0.01	100.00	3.76	1.06	0.00	1.98	6.99	33.97	0.36	48.73	1.40	0.21	1.29	0.23	0.03	100.00	172,095	0.93	161.73	1,304.82
09-Jun-25 20:00:00	34.76	0.61	0.00	2.21	8.09	20.56	0.18	32.25	0.76	0.06	0.45	0.06	0.01	100.00	3.80	0.93	0.00	2.15	7.02	33.42	0.25	48.91	1.74	0.19	1.34	0.22	0.03	100.00	175,062	0.93	161.81	1,308.24
09-Jun-25 21:00:00	33.97	0.91	0.00	2.42	8.26	20.62	0.00	32.36	1.06	0.05	0.36	0.00	0.00	100.00	3.68	1.36	0.01	2.33	7.10	33.23	0.00	48.65	2.41	0.15	1.07	0.00	0.02	100.00	176,296	0.93	164.21	1,299.05
09-Jun-25 22:00:00	34.86	0.76	0.00	2.46	8.24	20.69	0.00	32.15	0.73	0.01	0.09	0.00	0.00	100.00	3.85	1.17	0.00	2.42	7.23	34.02	0.00	49.31	1.68	0.04	0.26	0.00	0.02	100.00	173,080	0.91	157.97	1,287.94
09-Jun-25 23:00:00	35.32	0.72	0.00	2.51	8.53	19.84	0.00	32.32	0.65	0.02	0.08	0.00	0.01	100.00	3.94	1.11	0.01	2.50	7.55	32.95	0.00	50.08	1.52	0.07	0.24	0.00	0.03	100.00	171,791	0.90	155.88	1,287.03
10-Jun-25 00:00:00	34.98	0.74	0.00	2.27	8.58	19.97	0.00	32.89	0.45	0.02	0.08	0.00	0.00	100.00	3.89	1.14	0.01	2.25	7.57	33.03	0.00	50.73	1.05	0.06	0.25	0.00	0.02	100.00	163,515	0.91	148.59	1,290.55
10-Jun-25 01:00:00	34.97	0.70	0.00	2.07	8.58	20.01	0.00	33.33	0.29	0.01	0.03	0.00	0.00	100.00	3.89	1.08	0.00	2.06	7.57	33.11	0.00	51.47	0.69	0.02	0.10	0.00	0.02	100.00	182,373	0.91	166.86	1,295.10
10-Jun-25 02:00:00	32.61	0.69	0.00	1.55	8.17	20.16	0.00	36.47	0.28	0.01	0.04	0.00	0.01	100.00	3.49	1.03	0.00	1.48	6.94	32.09	0.00	54.16	0.63	0.02	0.13	0.00	0.03	100.00	183,438	0.96	175.06	1,303.46
10-Jun-25 03:00:00	39.80	0.86	0.00	1.87	9.67	16.26	0.00	30.89	0.42	0.05	0.18	0.00	0.00	100.00	4.79	1.43	0.01	2.01	9.23	29.11	0.00	51.59	1.05	0.19	0.58	0.00	0.02	100.00	150,733	0.85	127.75	1,247.50
10-Jun-25 04:00:00	49.46	1.03	0.00	1.93	11.87	10.39	0.00	23.95	0.69	0.10	0.53	0.03	0.00	100.00	7.11	2.05	0.01	2.48	13.55	22.24	0.00	47.81	2.09	0.42	2.07	0.14	0.02	100.00	120,345	0.68	83.24	1,177.36
10-Jun-25 05:00:00	70.32	1.36	0.01	1.95	14.89	1.95	0.00	8.02	0.55	0.14	0.73	0.08	0.00	100.00	17.43	4.68	0.04	4.31	29.29	7.18	0.00	27.59	2.86	1.00	4.86	0.71	0.04	100.00	92,389	0.40	36.34	1,051.86
10-Jun-25 06:00:00	64.10	2.04	0.02	1.57	25.51	1.82	0.00	3.95	0.25	0.13	0.54	0.05	0.00	100.00	15.37	6.77	0.12	3.36	48.58	6.51	0.00	13.15	1.27	0.89	3.48	0.45	0.05	100.00	57,263	0.40	22.06	1,066.15
10-Jun-25 07:00:00	48.17	7.21	0.01	0.51	17.12	18.52	0.00	3.54	2.24	0.77	1.74	0.14	0.00	100.00	6.55	13.60	0.04	0.62	18.49	37.50	0.00	6.68	6.38	3.03	6.38	0.70	0.02	100.00	16,906	0.71	11.34	1,194.84
10-Jun-25 08:00:00	46.03	8.63	0.01	0.44	16.41	17.38	0.00	4.09	3.85	0.91	2.09	0.15	0.00	100.00	5.87	15.26	0.04	0.50	16.61	32.97	0.00	7.23	10.29	3.35	7.17	0.69	0.02	100.00	12,337	0.74	9.17	1,097.90
10-Jun-25 09:00:00	60.27	8.54	0.01	0.15	20.98	1.33	0.01	4.78	1.70	0.31	1.72	0.19	0.01	100.00	11.35	22.29	0.06	0.25	31.37	3.74	0.01	12.50	6.69	1.67	8.74	1.29	0.05	100.00	10,333	0.50	5.07	1,025.72
10-Jun-25 10:00:00	48.04	15.36	0.02	0.24	22.19	1.18	0.01	3.24	4.75	0.72	3.74	0.49	0.01	100.00	6.48	28.72	0.05	0.29	23.76	2.37	0.01	6.06	13.42	2.80	13.59	2.37	0.07	100.00	9,272	0.71	6.31	1,065.14
10-Jun-25 11:00:00	48.54	17.80	0.02	0.19	24.44	0.81	0.00	2.26	2.57	0.46	2.47	0.42	0.01	100.00	7.09	36.08	0.06	0.25	28.36	1.76	0.00	4.59	7.88	1.94	9.72	2.20	0.06	100.00	31,004	0.65	18.08	912.44

Constants

Property	Hydrogen (H2)	Nitrogen (N2)	Methane (CH4)	Ethane (C2H6)	Acetylene (C2H2)	Ethylene (C2H4)	C3	C4	C4 Olefins	C5	C6+
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