Shell Chemical Appalachia LLC
300 Frankfort Rd
Monaca, PA 15061

July 24, 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-04-0740C Source ID 033, 034, 036, & 037 Visible Emissions and National Response Center Incident ID # 1435255 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 3, 4, 6, and 7 (Source IDs: 032, 033, 036, 037) and flaring emissions (Source IDs C205A/B) on June 26, 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**

  A sudden increase in pressure due to a control panel input error resulted in a slowdown of the Cracked Gas Compressor (CGC) which led to a trip of the Acetylene (AC) Reactor. This led to a shift in tail gas composition, which in turn caused visible emissions from Furnaces 2, 3, 6, and 7. These visible emissions were assumed to be greater than 30% opacity during this event. Additionally, the event resulted in flaring from the Totally Enclosed Ground Flares (Source IDs C205A/B).

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

  The AC reactor tripped at approximately 14:35 which resulted in a shift of tail gas causing visible emissions at approximately 14:40.

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

  The AC reactor tripped at 14:35, and visible emissions were observed from 14:40 to 14:42.

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

  Flaring Emissions

  The flaring emissions from the event are provided in Table 1 below.

Table 1: Flaring Emissions

Pollutant	Emissions (tons)
CO2e	3,088
CO	5.017
NOx	1.743
PM (filt)	0.048
PM 10	0.191
PM 2.5	0.191
VOC	6.188
HAP (total)	0.157
1, 3 Butadiene	0.154
Benzene	0.000

- **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

  A summary of the visible emissions is provided in Table 2 which were verified by camera footage.

Table 2 – Visible Emissions Summary

Malfunction Date	ECF	Start Time	End Time	Total Minutes
6/26/2025	033	14:40	14:41	1
	034	14:40	14:42	2
	036	14:40	14:41	1
	037	14:40	14:42	1

- **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 AC reactor trip, the distributed control system (DCS) 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**

  On June 26, 2025, the console operator was gradually reducing the quench tower overhead pressure in preparation for an upcoming furnace changeover for Furnace 2 from Hot Steam Standby (HSSB) from the quench tower to the firebox. While operating the quench tower at a lower pressure is not a formal requirement for changeover, it typically facilitates a smoother transition.

  At the time, the quench tower pressure was elevated due to a previous operating mode. Over the course of approximately one hour, the operator methodically reduced the overhead pressure from in small increments of 0.01–0.02 barg.

  During an attempt to further reduce the setpoint, the operator inadvertently pressed the "up" arrow on the controller faceplate, causing the setpoint to jump back up. This sudden change prompted the CGC to slow down in response, leading to a significant drop in AC reactor flow ultimately tripping the reactor on low flow.

  The loss of tail gas resulted in rapid change in BTU content in the furnaces and resulted in a low-O2 scenario in the fireboxes, smothering the furnaces resulting in visible emissions summarized in Table 1. Additionally, the ECU flared process gas as recovery efforts continued and resulted in 6.2 tons of VOC emitted which contained 0.154 tons of 1,3 Butadiene over 31 hours. This flaring resulted in the release of 1,3-Butadiene above than the reportable quantity (RQ 10 lbs) prompting a notification to the National Response Center.

- **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**

  On June 6, 2025, the facility experienced a malfunction that led to low oxygen levels within the furnaces, resulting in visible emissions. A malfunction report outlining the incident and proposed corrective actions was submitted on July 7, 2025. However, these corrective actions had not yet been implemented prior to a subsequent event on June 26, 2025.

  The corrective measures – developed specifically to prevent recurrence of the June 6 incident – were fully implemented by June 30, 2025. These actions targeted enhancement to the automated control logic within the ECU, aimed at improving system responsiveness, strengthening safety interlocks, and ensuring more stable operations during upset conditions.

  The facility believes that had these corrective actions been fully implemented prior to June 26, the visible emissions associated with that event would likely have been avoided.

  In addition to the previously identified measures, the facility has developed a new corrective action to further reduce the risk of operator error leading to unit upsets. The facility is currently evaluating the feasibility of implementing SP/OP (Setpoint / Output) custom logic or limiters on this critical controller and potentially on other critical controllers across the ECU consoles to prevent incorrect control moves that could destabilize operations.

- **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 corrective actions that were listed above and included in both this malfunction report as well as the report that was submitted on July 7, 2025 were completed on or before June 30, 2025. The new corrective action which includes evaluation of implementing SP/OP custom logic will be completed by November 30, 2025.

If you have any questions regarding this matter, please contact Kimberly Kaal at kimberly.kaal@shell.com or Aaron Signarovitz at aaron.signarovitz@shell.com.

Sincerely,

Martin Padilla
HSSE 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

	Hydrogen	Nitrogen	Carbon Di	Water	Methane	Ethane	Acetylene	Ethylene																								
Date and Time	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			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
26-Jun-25 15:00:00	30.66	1.03	0.00	3.17	6.35	21.74	0.25	34.87	1.18	0.08	0.65	0.02	0.01	100.00	3.13	1.46	0.00	2.89	5.14	33.02	0.33	49.40	2.52	0.24	1.78	0.07	0.02	100.00	198,077	0.94	185.59	1,315.88
26-Jun-25 16:00:00	32.44	1.01	0.00	3.06	7.00	24.10	0.19	30.09	1.11	0.11	0.73	0.13	0.01	100.00	3.38	1.46	0.00	2.85	5.79	37.38	0.25	43.54	2.43	0.33	2.07	0.48	0.02	100.00	190,405	0.94	178.74	1,317.36
26-Jun-25 17:00:00	33.97	1.00	0.00	2.66	7.39	21.55	0.23	31.63	0.73	0.08	0.60	0.15	0.01	100.00	3.64	1.48	0.00	2.54	6.29	34.39	0.31	47.09	1.64	0.25	1.74	0.58	0.03	100.00	179,671	0.93	166.89	1,312.26
26-Jun-25 18:00:00	33.92	1.07	0.00	2.75	7.54	21.11	0.00	32.64	0.54	0.04	0.33	0.05	0.01	100.00	3.67	1.61	0.00	2.65	6.48	33.99	0.00	49.03	1.22	0.14	0.99	0.21	0.03	100.00	170,726	0.91	156.86	1,287.77
26-Jun-25 19:00:00	36.34	1.33	0.00	2.44	8.30	18.69	0.00	32.32	0.43	0.01	0.13	0.00	0.00	100.00	4.12	2.09	0.00	2.46	7.46	31.51	0.00	50.84	1.03	0.05	0.41	0.00	0.02	100.00	171,118	0.88	150.09	1,279.32
26-Jun-25 20:00:00	37.61	1.22	0.00	2.34	7.99	16.83	0.00	33.70	0.29	0.00	0.02	0.00	0.00	100.00	4.35	1.96	0.00	2.41	7.34	28.99	0.00	54.15	0.69	0.01	0.08	0.00	0.02	100.00	155,789	0.86	134.30	1,257.64
26-Jun-25 21:00:00	48.20	1.58	0.00	2.31	9.83	12.38	0.00	25.61	0.08	0.00	0.01	0.00	0.00	100.00	6.78	3.09	0.01	2.90	10.98	25.92	0.00	50.02	0.24	0.00	0.04	0.00	0.03	100.00	119,326	0.69	84.57	1,159.45
26-Jun-25 22:00:00	70.62	2.60	0.01	2.44	13.68	1.63	0.00	9.00	0.01	0.00	0.01	0.00	0.00	100.00	18.24	9.31	0.04	5.61	28.06	6.26	0.00	32.27	0.07	0.00	0.08	0.00	0.05	100.00	86,481	0.37	32.40	1,024.09
26-Jun-25 23:00:00	72.37	2.35	0.01	2.35	15.56	3.61	0.00	3.70	0.04	0.00	0.01	0.01	0.00	100.00	20.32	9.14	0.04	5.89	34.68	15.09	0.00	14.41	0.23	0.00	0.05	0.10	0.05	100.00	85,189	0.34	29.37	1,038.14
27-Jun-25 00:00:00	74.53	2.50	0.01	0.77	16.31	2.00	0.00	3.84	0.03	0.00	0.00	0.01	0.00	100.00	22.59	10.50	0.05	2.07	39.24	9.03	0.00	16.15	0.17	0.00	0.03	0.11	0.06	100.00	79,723	0.32	25.37	1,029.72
27-Jun-25 01:00:00	76.27	3.45	0.01	0.00	16.53	0.41	0.00	3.30	0.01	0.00	0.01	0.00	0.01	100.00	24.73	15.52	0.06	0.00	42.55	2.00	0.00	14.86	0.10	0.00	0.07	0.00	0.12	100.00	61,171	0.29	17.65	1,019.57
27-Jun-25 02:00:00	73.97	4.99	0.01	0.32	16.90	0.39	0.00	3.35	0.02	0.00	0.00	0.05	0.00	100.00	22.08	20.67	0.06	0.85	40.06	1.75	0.00	13.88	0.11	0.00	0.01	0.49	0.05	100.00	40,800	0.31	12.60	1,003.65

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