



Shell Chemical Appalachia LLC  
300 Frankfort Rd  
Monaca, PA 15061

September 8, 2023

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 Spent Caustic Vent Incinerator (Source ID C206), Storage Tanks (Recovered Oil, Equalization Wastewater, and Spent Caustic) (Source IDs 401 and 402), and WEMCO Depurator (Source ID 505) Excess Emissions Malfunction Report**

Dear Mr. Gorog,

Shell Chemical Appalachia LLC (“Shell”) is submitting this malfunction report to the Pennsylvania Department of Environmental Protection (PADEP) for excess emissions from the flow equalization and oil removal (FEOR) A and B, recovered oil, spent caustic storage tanks, and temporary WEMCO Depurator between August 8 and August 9, 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 August 9, 2023 at 17:04 the Spent Caustic Thermal Oxidizer<sup>1</sup> (SCTO) tripped offline due to high natural gas supply pressure. Operations initiated troubleshooting and discovered that the trip was valid and due to a sudden increase in natural gas flow related to a composition change of the waste gas and subsequent drop in the oxidizer temperature. The control scheme responded as it should, and resulted in the natural gas supply pressure increasing just slightly above the SCTO trip point.
- **Time when the malfunction or breakdown was first observed**  
August 8, 2023 at 17:04
- **The date and time that the malfunction started and ended**  
Start on August 8, 2023 at 17:04 and ended on August 9, 2023 at 06:00 when the SCTO was back online and target combustion temperature achieved.
- **An estimate of the emissions associated with the malfunction**

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<sup>1</sup> Identified as Spent Caustic Vent Incinerator (Source ID C206) in PA-04-00740C

Pollutant	Emissions (lbs)
Total VOC	3.20
Benzene	0.91
Toluene	1.92
Naphthalene	0.25
HAP (Total)	3.20

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

For reference, the SCTO controls overhead vapors collected in a closed vent system from the FEOR A and B, recovered oil, and spent caustic storage tanks as well as the spent caustic oxidation system<sup>2</sup>. Each storage tank is additionally controlled by internal floating roof and a nitrogen blanket which normally would flow to the SCTO. When the SCTO trips offline, the spent caustic oxidation system is isolated from the spent caustic storage tank and any generated spent caustic accumulates in the storage tank. The spent caustic storage, FEOR, and recovered oil tanks periodically vented to atmosphere through relief valves following the SCTO trip. The emissions associated with this are addressed in a later section of this report.

Excess emissions from the internal floating roof-controlled storage tanks during this outage were modeled using Pro-Max equations of state for flashing, breathing, and working losses. Inputs to the model include the storage tank and internal floating roof physical characteristics, measured liquid throughputs using liquid level indicators, measured tank liquid temperatures, pressure of input liquid streams, and representative tank sample data. Emissions from the WEMCO unit were calculated using existing Pro-II model output data and updating it to represent the WEMCO feed flow and composition data at the time of this malfunction.

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

Emissions were minimized through the isolation and shutdown of the spent caustic oxidation system during the SCTO outage and utilizing the spent caustic storage tank to accumulate spent caustic. Emissions were also minimized through design and operation of the storage tank internal floating roofs and nitrogen blanket. Lastly, emissions were also minimized through prioritization of the troubleshooting required to get the SCTO back in service before the spent caustic storage tank filled to its high level and necessitated use of the spent caustic oxidation system.

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

The cause of the initiating trip was identified quickly and is known to be the result of high natural gas supply pressure due to the control system's response to a sudden change in waste gas composition.

- **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**

No specific action items or control system changes stemmed from the result of this investigation.

- **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

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<sup>2</sup> Identified as the Spent Caustic Vent Header System (Source ID 206) in PA-04-00740C

- **Corrective action is final or timeline for implementation**  
N/A

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 Beaudway, Air Quality Specialist  
Kristin Goddard, Air Quality District Supervisor  
Beth Speicher, Environmental Group Manager

**Attachment A**  
Pro-Max Model Inputs and Outputs

**Attachment B**  
WEMCO Calculation Data

Table 1 SCTO Downtime Internal Floating Roof Tank Emissions Calculations, Emissions Calculations  
Shell Chemical Appalachia LLC, Monaca Cracker Plant

**Timeframe of Analysis**

Timeframe start 8/8/2023 17:04 Tank Throughput Calculator FEOR ROT and SC.xlsx  
 Timeframe end 8/9/2023 6:00 Tank Throughput Calculator FEOR ROT and SC.xlsx  
 Time 11.9 hours  
 776 minutes

**Tank Data/Sample Data**

Tank Name	Tank ID	Contents	Length/ Height (ft)	Diameter (ft)	Temp (C)	Pressure (barg)	Throughput (gal)	Flow Rate (gpm)	Samples Used
Spent Caustic Tank	T-53501	2% Spent Caustic	48	35	45.98	0.01	12,621.21	16.26	Average of 7/25/2023, 8/1/2023, 8/8/2023, Balance Water
FEOR B Tank	T-59707B	Waste Water, sheen of oil	47.9	55.8	28.38	0.01	632.78	0.82	Average of 7/25/2023, 8/1/2023, 8/8/2023, Balance Water
FEOR A Tank	T-59707A	Waste Water, sheen of oil	47.9	55.8	29.42	0.01	98,407.78	126.81	Average of 7/25/2023, 8/1/2023, 8/8/2023, Balance Water
Recovered Oil Tank	T-59708	Slip Oil/water mixture	48	43	28.97	0.01	400.64	0.52	5/24/2023, Balance Water

**Sample Data**

Constituent	7/25/2023 Spent Caustic		8/1/2023 Spent Caustic		8/8/2023 Spent Caustic		Average Spent Caustic Tank		7/25/2023 FEOR B		8/1/2023 FEOR B		8/8/2023 FEOR B		Average FEOR B		7/25/2023 FEOR A		8/1/2023 FEOR A		8/8/2023 FEOR A		Average FEOR A		5/24/2023 Recovered Oil Tank		
	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	
Benzene	1.4	0.00014	1.2	0.00012	4.2	0.00042	0.00022667	6.3	0.00063	8.5	0.00085	4.7	0.00047	0.00065900	0.1	0.00001	0.16	0.000016	0.12	0.000012	0.0001267	24.2	0.00242				
Ethylbenzene	0.063	0.0000063	0	0	0.034	0.000034	0.0000323	0	0	0	0	0.27	0.00027	0.00009900	0.073	0.0000073	0.13	0.000013	0	0	0.0000677	32	0.0032				
Styrene	0	0	0	0	0.18	0.000018	0.00000660	0	0.44	0.000044	0.4	0.00004	0.00002800	0.097	0.0000097	0.18	0.000018	0.039	0.0000039	0.00001053	19.2	0.00192					
Toluene	0.73	0.000073	0.52	0.000052	1.6	0.00016	0.00009500	3.5	0.00035	4.3	0.00043	3.7	0.00037	0.00038333	0.68	0.000068	1.1	0.00011	0.19	0.000019	0.00006567	181	0.0181				
Xylenes	0.2	0.00002	0	0	0	0	0.00000667	0	0	0	0	0	0	0.00000000	0.073	0.0000073	0.11	0.000011	0	0	0.00006610	25.51	0.002551				
1,2,4-Trimethylbenzene	0	0	0	0	0	0	0.00000000	0	0	0	0	0	0	0.00000000	0	0	0	0	0	0.00000000	1.16	0.000116					
n-Propyl Benzene	0	0	0	0	0	0	0.00000000	0	0	0	0	0	0	0.00000000	0	0	0	0	0	0.00000000	16	0.0016					
Butylbenzene	0	0	0	0	0	0	0.00000000	0	0	0	0	0	0	0.00000000	0	0	0	0	0	0.00000000	1.85	0.000185					
2-Methylnaphthalene	0	0	0	0	0	0	0.00000000	0	0	0	0	0	0	0.00000000	0	0	0	0	0	0.00000000	10.7	0.00107					
Acenaphthene	0	0	0	0	0	0	0.00000000	0	0.0058	0.0000058	0.0048	0.0000048	0.00000035	0	0	0.0068	0.0000068	0.0039	0.0000039	0.00000036	0	0					
Acenaphthylene	0	0	0	0	0	0	0.00000000	0	0.0521	0.0000052	0.0035	0.0000035	0.00000029	0	0.0071	0.0000071	0.0029	0.0000029	0.00000034	0	0						
Anthracene	0	0	0	0	0	0	0.00000000	0	0.0006	0.0000006	0	0	0.00000002	0	0.0018	0.0000018	0.0006	0.0000006	0.00000008	0.0866	0.0000866						
Fluoranthene	0	0	0	0	0	0	0.00000000	0	0	0	0	0	0.00000000	0	0.0018	0.0000018	0.0005	0.0000005	0.00000008	0.14	0.000014						
Fluorene	0	0	0	0	0	0	0.00000000	0	0.0061	0.00000061	0.0037	0.0000037	0.00000033	0	0.0075	0.0000075	0.004	0.0000004	0.00000038	0.529	0.000529						
Naphthalene	0	0.006	0.000006	0	0.026	0.0000026	0.0000107	0	0.68	0.000068	0.43	0.000043	0.00003700	0	0.054	0.0000054	0.081	0.0000081	0.00000450	25.4	0.00254						
Phenanthrene	0	0	0	0	0	0.00000000	0	0	0.055	0.0000055	0.051	0.0000051	0.00000030	0	0.013	0.0000013	0.0059	0.00000059	0.00000063	0.77	0.000077						
Phenol	0	0.038	0.0000038	0	0.11	0.0000011	0.00000493	0	0.25	0.000025	0.13	0.000013	0.00001267	0	0.006	0.0000006	0.0072	0.00000072	0.00000044	0	0						
Pyrene	0	0	0	0	0	0	0.00000000	0	0	0	0	0	0.00000000	0	0.0037	0.0000037	0.0011	0.0000011	0.00000016	0.21	0.000021						
Water	Balance	99.9997607	Balance	99.9998236	Balance	99.999385	99.99965643	Balance	99.99902	Balance	99.99857573	Balance	99.99903526	99.99887701	Balance	99.9998977	Balance	99.99982182	Balance	99.99995439	99.99981130	Balance	99.96612444				

Table 2

SCTO Downtime Internal Floating Roof Tank Emissions Calculations, Emissions Calculations  
Shell Chemical Appalachia LLC, Monaca Cracker Plant

	Spent Caustic Tank Emissions (lb/event)				FEOR A Tank Emissions (lb/h)				FEOR B Tank Emissions (lb/h)				Recovered Oil Tank Emissions (lb/h)				Total (4 Tanks) Total Losses (lb/event)
	Rim Seal Losses (lb/event)	Deck Fitting Losses (lb/event)	Withdrawal Losses (lb/event)	Total Losses (lb/event)	Rim Seal Losses (lb/event)	Deck Fitting Losses (lb/event)	Withdrawal Losses (lb/event)	Total Losses (lb/event)	Rim Seal Losses (lb/event)	Deck Fitting Losses (lb/event)	Withdrawal Losses (lb/event)	Total Losses (lb/event)	Rim Seal Losses (lb/event)	Deck Fitting Losses (lb/event)	Withdrawal Losses (lb/event)	Total Losses (lb/event)	
Total VOC	1.815E-03	9.285E-04	1.618E-06	2.745E-03	1.098E-03	3.969E-04	2.883E-06	1.497E-03	9.701E-03	3.509E-03	1.718E-07	1.321E-02	5.762E-02	3.686E-02	4.987E-06	9.448E-02	0.11194
Benzene	1.041E-03	5.329E-04	9.969E-07	1.575E-03	9.306E-05	3.365E-05	2.726E-07	1.270E-04	4.779E-03	1.728E-03	9.042E-08	6.507E-03	8.347E-03	5.341E-03	2.766E-07	1.369E-02	0.02190
Ethylbenzene	2.946E-05	1.508E-05	1.931E-08	4.456E-05	9.880E-05	3.573E-05	1.980E-07	1.347E-04	1.314E-04	4.754E-05	1.702E-09	1.789E-04	3.386E-03	2.166E-03	4.972E-07	5.553E-03	0.00591
Styrene	1.655E-05	8.473E-06	3.518E-08	2.506E-05	4.648E-05	1.681E-05	3.020E-07	6.360E-05	1.237E-04	4.475E-05	5.194E-09	1.685E-04	1.218E-03	7.796E-04	2.927E-07	1.998E-03	0.00226
Toluene	6.812E-04	3.487E-04	4.928E-07	1.030E-03	7.528E-04	2.722E-04	1.667E-06	1.027E-03	4.399E-03	1.591E-03	6.291E-08	5.989E-03	4.143E-02	2.651E-02	2.441E-06	6.794E-02	0.07599
Xylenes	4.095E-05	2.096E-05	3.987E-08	6.195E-05	5.991E-05	2.166E-05	1.784E-07	8.175E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.275E-03	1.455E-03	3.964E-07	3.790E-03	0.00387
1,2,4-Trimethylbenzene	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.576E-05	2.288E-05	2.041E-08	5.866E-05	0.00006
n-Propyl Benzene	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.653E-04	4.903E-04	2.814E-07	1.257E-03	0.00126
Butylbenzene	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.209E-05	2.053E-05	3.634E-08	5.265E-05	0.00005
2-Methylnaphthalene	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.595E-05	1.020E-05	2.227E-07	2.637E-05	0.00003
Acenaphthene	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.851E-06	1.755E-06	1.529E-08	6.622E-06	4.719E-06	1.707E-06	9.612E-11	6.427E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.00001
Acenaphthylene	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.765E-12	6.385E-13	1.425E-08	1.425E-08	1.508E-12	5.453E-13	7.861E-11	8.066E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.00000
Anthracene	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.296E-07	3.361E-07	3.927E-09	1.270E-06	2.325E-07	8.409E-08	6.348E-12	3.166E-07	2.309E-09	1.477E-09	2.259E-09	6.045E-09	0.00000
Fluoranthene	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.404E-06	2.677E-06	4.457E-09	1.009E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.706E-10	3.011E-10	4.144E-09	4.916E-09	0.00001
Fluorene	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.020E-12	3.690E-13	1.740E-08	1.740E-08	8.874E-13	3.209E-13	9.769E-11	9.889E-11	1.102E-10	7.047E-11	1.287E-08	1.305E-08	0.00000
Naphthalene	4.695E-06	2.403E-06	7.721E-09	7.106E-06	3.153E-05	1.140E-05	1.588E-07	4.309E-05	2.594E-04	9.384E-05	8.445E-09	3.533E-04	1.063E-04	6.803E-05	4.765E-07	1.748E-04	0.00058
Phenanthrene	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.172E-07	3.317E-07	3.092E-08	1.280E-06	2.914E-06	1.054E-06	6.348E-10	3.968E-06	8.655E-09	5.538E-09	2.009E-08	3.428E-08	0.00001
Phenol	6.270E-09	3.209E-09	2.613E-08	3.560E-08	8.954E-10	3.239E-10	1.140E-08	1.262E-08	2.581E-08	9.338E-09	2.124E-09	3.728E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.00000
Pyrene	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.379E-07	3.392E-07	8.912E-09	1.286E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.331E-10	8.517E-11	6.215E-09	6.434E-09	0.00000
Total POM (minus Naphthalene)	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.504E-05	5.439E-06	9.515E-08	2.057E-05	7.866E-06	2.845E-06	9.135E-10	1.071E-05	1.596E-05	1.021E-05	2.683E-07	2.644E-05	0.00006
Total HAP	1.814E-03	9.285E-04	1.618E-06	2.744E-03	1.098E-03	3.970E-04	2.883E-06	1.498E-03	9.700E-03	3.508E-03	1.717E-07	1.321E-02	5.677E-02	3.633E-02	4.648E-06	9.311E-02	0.11056











**WEMCO Vent Calculation Data**

	<b>Feed</b>	<b>Vent</b>
<b>Total Mass Rate (kg/hr)</b>	259235	46
<b>Component Weight Percents</b>		
BENZENE	1.20E-05	0.067565
TOLUENE	2.50E-05	0.140738
STYRENE	0.00E+00	0
NAPHTHLN	3.50E-06	0.019176
PHENOL	8.50E-07	0.00465
ACENAP	3.00E-07	0.001121
ACENAPHT	2.40E-07	0.000934
ANTH	0.00E+00	0
FLUANTHE	0.00E+00	0
FLUORENE	3.40E-07	0.000822
PHAN	4.70E-07	0.00012
PYRENE	0.00E+00	0
H2O	1.00E+02	2.020059
N2	0	97.74481
<i>*feed concentration data based on 8/8/23 sample</i>		
<b>Component Mass Rates (kg/hr)</b>		
BENZENE	3.11E-02	3.11E-02
TOLUENE	6.48E-02	6.48E-02
STYRENE	0.00E+00	0.00E+00
NAPHTHLN	9.07E-03	8.83E-03
PHENOL	2.20E-03	2.14E-03
ACENAP	7.78E-04	5.16E-04
ACENAPHT	6.22E-04	4.30E-04
ANTH	0.00E+00	0.00E+00
FLUANTHE	0.00E+00	0.00E+00
FLUORENE	8.81E-04	3.79E-04
PHAN	1.22E-03	5.53E-05
PYRENE	0.00E+00	0.00E+00
H2O	2.59E+05	9.30E-01
N2	0	4.50E+01
<b>Component Mass Rates (lb/hr)</b>		
BENZENE	6.86E-02	0.068577
TOLUENE	0.142879	0.142845
STYRENE	0	0
NAPHTHLN	0.020003	0.019463
PHENOL	0.004858	0.004719
ACENAP	0.001715	0.001138
ACENAPHT	0.001372	0.000948
ANTH	0	0
FLUANTHE	0	0
FLUORENE	0.001943	0.000835
PHAN	0.002686	0.000122
PYRENE	0	0
H2O	571514.2	2.050297
N2	0	99.2079