Shell Chemical Appalachia LLC
300 Frankfort Rd
Monaca, PA 15061

January 2, 2024

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 Ethane Cracking Furnace #5 (Source ID 035) NOx 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 Ethane Cracking Furnace #5 beginning on November 28, 2023, and through December 4, 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**
  Beginning on November 28 at 02:00 AM and continuing through December 04 at 12:00 AM the Ethane Cracking Unit (ECU) Furnace #5 stack's NOx emissions exceeded the permit limit of 6.20 lb/hr while in Warm/Hot Steam Standby (HSSB) mode for approximately 5.5 days (131 hours).

  Cause of the NOx mass emissions exceedance was determined to be that one of the fuel gas flowmeters (105FI078) in Furnace #5 was not reading. The second fuel gas flowmeter (105FI079) in Furnace #5 continued to read correctly.

- **Time when the malfunction or breakdown was first observed**
  December 04, at 08:00

- **The date and time that the malfunction started and ended**
  Started on November 28, 2023, at 02:00 and ended on December 04, at 12:00

- **An estimate of the emissions associated with the malfunction**
  113.08 lb of excess NOx emissions over the duration of the event

- **The calculations that were used to determine that quantity**
  The calculation is based on the ECU Furnace #5 CEMS analyzer readings for the only fuel gas flow meter available (105FI079) over the period of the malfunction window. Total fuel to each furnace is split approximately 50/50 to opposite sides and measured by two independent flowmeters.

Engineering calculations were performed to estimate the NOx mass emissions to account for the unmeasured fuel gas flow on Furnace #5 by substituting the average volumetric flow rate of the missing fuel meter (105FI078) with the data from the operational available fuel gas meter (105FI079). Total heat input was then calculated according to 40CFR75, Appendix D, Equation D-6. Once the furnace heat input calculation was assessed it was used to evaluate the mass emissions for the missing hours as required by (40CFR75, Appendix F, Equation F-24).

After all missing NOx (mass) data was generated from the Engineering calcs report then the total excess emissions were calculated as follows: (Sum NOx lb/hr emission rates for each hour exceeding 6.20 lb/hr) minus (NOx permit limit of 6.20 lb/hr) times (Total number of hours exceeding 6.20 lb/hr).

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

  Once the incorrect flow reading was discovered, Shell's Process Automation, Control and Optimization team instructed the console operators to lower the Furnace #5 NOx lb/hr control logic set point (SP) to account for the unmeasured fuel gas flow.

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

  Following the event, the reason why the Furnace #5 fuel gas flow meter was reading zero when it was expected to be reading flow with the furnace on Warm/HSSB mode, was investigated by the Instrumentation and Analyzer (I&A) team and found that the low flow cutoff for the vortex flowmeter was incorrectly set high. This was corrected and the flow reading came in as expected. It was not able to be determined why the setting was incorrectly high but it occurred during a period of downtime for all furnaces and measures will be implemented to reduce likelihood of recurrence.

- **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**

  1. Immediate: Instrumentation and Analyzer (I&A) team re-verified that the low flow cutoff settings on all other furnace fuel gas vortex flowmeters were set correctly.

  2. Short term: PACO and ECU Operations to develop a proactive technical monitoring or alarming strategy that identifies fuel gas no flow condition and generates reactive alerts. This will enable console operators to take actions earlier to avoid NOx mass related emissions exceedances.

  3. Long Term: failure of a vortex meter to reliably measure fuel gas to furnaces has been included in the ECU Furnace Improvement Plan strategy to replace fuel gas vortex flowmeters with an alternate flow technology (e.g., Coriolis flow meter). The goal is to be able to reliably measure fuel gas flows at turndown conditions since it goes into Shell's environmental reporting (and NOx control scheme).

- **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**
  Corrective action is final to restore the fuel flowmeter reading as well as the immediate re-verification of all other identical furnace fuel flowmeter readings. Short term improvement measures are expected to be complete in Q1, 2024, and long term improvement measures are in development and to be determined.

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

Sincerely,

Kimberly Kaal
Environmental Manager, Attorney-in-Fact

CC:
Scott Beaudway, Air Quality Specialist
Kristin Goddard, Environmental Compliance Specialist
Beth Speicher, Environmental Group Manager

Attachment A

ECU Furnace #5 Emission Calculations Data

date_time	Fuel 1, lb/h	Fuel 2, lb/h	Total Fuel, lb/h	Total Fuel HHV, BTU/lb	Total Fuel HI rate, MMBTU/h	NOx mass, lb/h (av. 1 hour)
11/28/2023 21:59	3,257	3,257	6,514	23,381	152.3	7.0
11/28/2023 22:59	3,261	3,261	6,522	23,353	152.3	7.1
11/28/2023 23:59	3,250	3,250	6,500	23,359	151.8	7.1
11/29/2023 0:59	3,230	3,230	6,460	23,380	151.0	7.1
11/29/2023 1:59	3,270	3,270	6,540	23,368	152.8	7.1
11/29/2023 2:59	3,252	3,252	6,504	23,372	152.0	7.1
11/29/2023 3:59	3,272	3,272	6,544	23,355	152.8	7.1
11/29/2023 4:59	3,303	3,303	6,606	23,370	154.4	7.1
11/29/2023 5:59	3,288	3,288	6,576	23,355	153.6	7.3
11/29/2023 6:59	3,285	3,285	6,570	23,341	153.4	6.7
11/29/2023 7:59	3,252	3,252	6,504	23,370	152.0	7.1
11/29/2023 8:59	3,259	3,259	6,518	23,369	152.3	7.1
11/29/2023 9:59	3,226	3,226	6,452	23,370	150.8	7.0
11/29/2023 10:59	3,233	3,233	6,466	23,370	151.1	7.1
11/29/2023 11:59	3,239	3,239	6,478	23,380	151.5	7.1
11/29/2023 12:59	3,294	3,294	6,588	23,359	153.9	7.1
11/29/2023 13:59	3,334	3,334	6,668	23,360	155.8	7.1
11/29/2023 14:59	3,308	3,308	6,616	23,354	154.5	7.1
11/29/2023 15:59	3,217	3,217	6,434	23,351	150.2	7.1
11/29/2023 16:59	3,241	3,241	6,482	23,353	151.4	7.0
11/29/2023 17:59	3,239	3,239	6,478	23,339	151.2	7.1
11/29/2023 18:59	3,268	3,268	6,536	23,342	152.6	7.1
11/29/2023 19:59	3,268	3,268	6,536	23,340	152.6	7.1
11/29/2023 20:59	3,279	3,279	6,558	23,341	153.1	7.1
11/29/2023 21:59	3,292	3,292	6,584	23,345	153.7	7.1
11/29/2023 22:59	3,248	3,248	6,496	23,335	151.6	7.1
11/29/2023 23:59	3,277	3,277	6,554	23,327	152.9	7.1
11/30/2023 0:59	3,268	3,268	6,536	23,305	152.3	7.1
11/30/2023 1:59	3,274	3,274	6,548	23,314	152.7	7.1
11/30/2023 2:59	3,312	3,312	6,624	23,335	154.6	7.1
11/30/2023 3:59	3,283	3,283	6,566	23,316	153.1	7.1
11/30/2023 4:59	3,330	3,330	6,660	23,315	155.3	7.1
11/30/2023 5:59	3,314	3,314	6,628	23,342	154.7	7.3
11/30/2023 6:59	3,288	3,288	6,576	23,321	153.4	6.7
11/30/2023 7:59	3,310	3,310	6,620	23,339	154.5	7.1
11/30/2023 8:59	3,263	3,263	6,526	23,306	152.1	7.1
11/30/2023 9:59	3,199	3,199	6,398	23,319	149.2	7.0

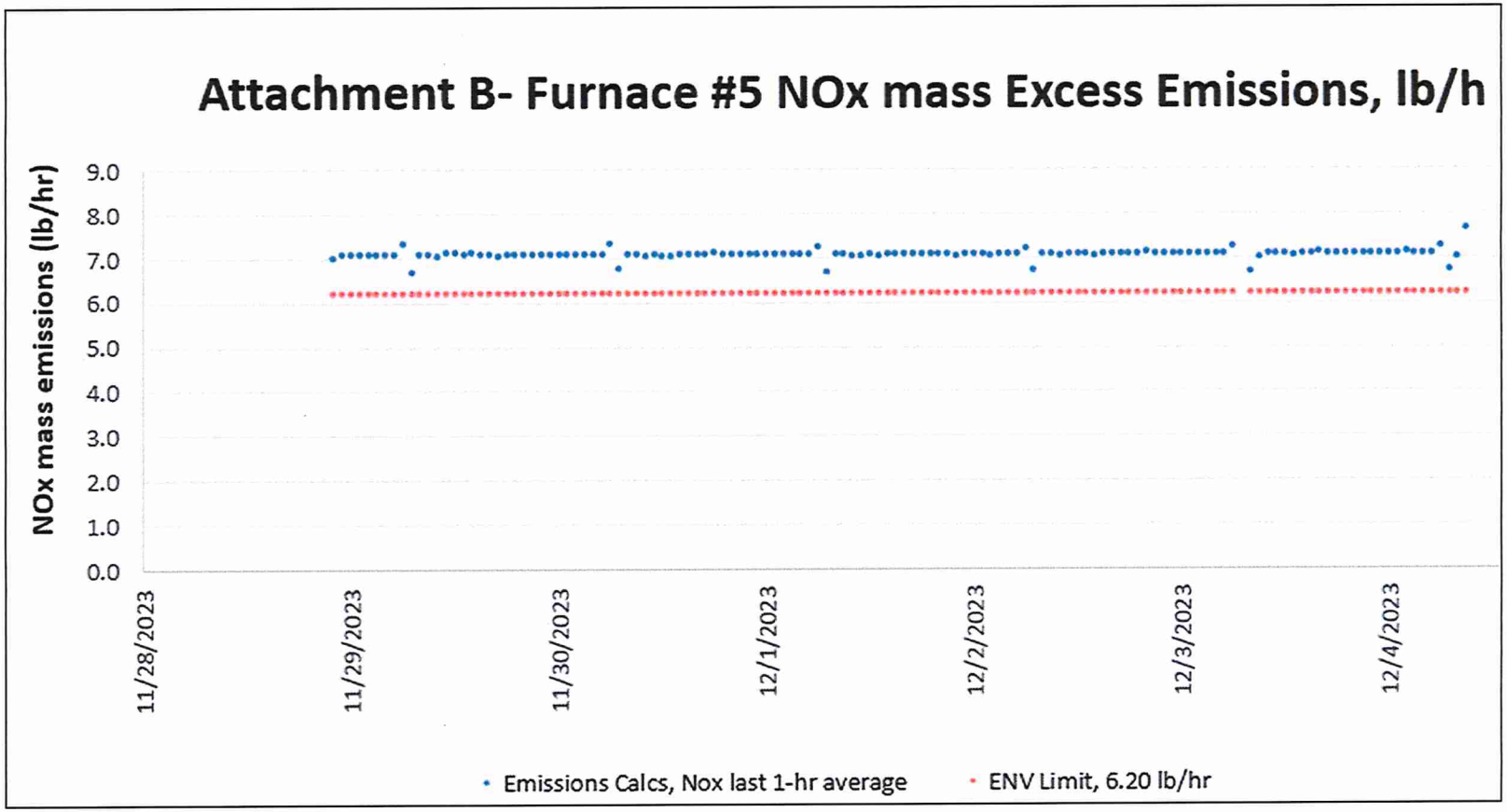
11/30/2023 10:59	3,230	3,230	6,460	23,336	150.8	7.1
11/30/2023 11:59	3,160	3,160	6,320	23,328	147.4	7.0
11/30/2023 12:59	3,153	3,153	6,306	23,329	147.1	7.1
11/30/2023 13:59	3,120	3,120	6,240	23,344	145.7	7.1
11/30/2023 14:59	3,153	3,153	6,306	23,330	147.1	7.1
11/30/2023 15:59	3,147	3,147	6,294	23,329	146.8	7.1
11/30/2023 16:59	3,122	3,122	6,244	23,340	145.7	7.1
11/30/2023 17:59	3,184	3,184	6,368	23,347	148.7	7.1
11/30/2023 18:59	3,155	3,155	6,310	23,348	147.3	7.1
11/30/2023 19:59	3,217	3,217	6,434	23,337	150.2	7.1
11/30/2023 20:59	3,193	3,193	6,386	23,344	149.1	7.1
11/30/2023 21:59	3,195	3,195	6,390	23,337	149.1	7.1
11/30/2023 22:59	3,193	3,193	6,386	23,337	149.0	7.1
11/30/2023 23:59	3,215	3,215	6,430	23,337	150.1	7.1
12/1/2023 0:59	3,233	3,233	6,466	23,306	150.7	7.1
12/1/2023 1:59	3,228	3,228	6,456	23,341	150.7	7.1
12/1/2023 2:59	3,244	3,244	6,488	23,322	151.3	7.1
12/1/2023 3:59	3,204	3,204	6,408	23,321	149.4	7.1
12/1/2023 4:59	3,175	3,175	6,350	23,337	148.2	7.1
12/1/2023 5:59	3,164	3,164	6,328	23,319	147.6	7.2
12/1/2023 6:59	3,195	3,195	6,390	23,350	149.2	6.7
12/1/2023 7:59	3,188	3,188	6,376	23,341	148.8	7.1
12/1/2023 8:59	3,244	3,244	6,488	23,324	151.3	7.1
12/1/2023 9:59	3,173	3,173	6,346	23,329	148.0	7.0
12/1/2023 10:59	3,162	3,162	6,324	23,343	147.6	7.0
12/1/2023 11:59	3,208	3,208	6,416	23,340	149.7	7.1
12/1/2023 12:59	3,166	3,166	6,332	23,347	147.8	7.0
12/1/2023 13:59	3,166	3,166	6,332	23,349	147.8	7.1
12/1/2023 14:59	3,129	3,129	6,258	23,345	146.1	7.1
12/1/2023 15:59	3,120	3,120	6,240	23,355	145.7	7.1
12/1/2023 16:59	3,138	3,138	6,276	23,333	146.4	7.1
12/1/2023 17:59	3,149	3,149	6,298	23,349	147.1	7.1
12/1/2023 18:59	3,144	3,144	6,288	23,335	146.7	7.1
12/1/2023 19:59	3,147	3,147	6,294	23,345	146.9	7.1
12/1/2023 20:59	3,140	3,140	6,280	23,342	146.6	7.1
12/1/2023 21:59	3,138	3,138	6,276	23,322	146.4	7.0
12/1/2023 22:59	3,127	3,127	6,254	23,346	146.0	7.1
12/1/2023 23:59	3,111	3,111	6,222	23,349	145.3	7.1
12/2/2023 0:59	3,136	3,136	6,272	23,350	146.5	7.1
12/2/2023 1:59	3,118	3,118	6,236	23,352	145.6	7.0

12/2/2023 2:59	3,111	3,111	6,222	23,335	145.2	7.1
12/2/2023 3:59	3,098	3,098	6,196	23,324	144.5	7.1
12/2/2023 4:59	3,094	3,094	6,188	23,337	144.4	7.1
12/2/2023 5:59	3,111	3,111	6,222	23,312	145.0	7.2
12/2/2023 6:59	3,111	3,111	6,222	23,349	145.3	6.7
12/2/2023 7:59	3,120	3,120	6,240	23,327	145.6	7.1
12/2/2023 8:59	3,107	3,107	6,214	23,340	145.0	7.1
12/2/2023 9:59	3,100	3,100	6,200	23,307	144.5	7.0
12/2/2023 10:59	3,094	3,094	6,188	23,339	144.4	7.1
12/2/2023 11:59	3,074	3,074	6,148	23,337	143.5	7.1
12/2/2023 12:59	3,076	3,076	6,152	23,303	143.4	7.1
12/2/2023 13:59	3,058	3,058	6,116	23,352	142.8	7.0
12/2/2023 14:59	3,054	3,054	6,108	23,367	142.7	7.1
12/2/2023 15:59	3,065	3,065	6,130	23,387	143.4	7.1
12/2/2023 16:59	3,089	3,089	6,178	23,394	144.5	7.1
12/2/2023 17:59	3,111	3,111	6,222	23,386	145.5	7.1
12/2/2023 18:59	3,087	3,087	6,174	23,345	144.1	7.1
12/2/2023 19:59	3,109	3,109	6,218	23,369	145.3	7.1
12/2/2023 20:59	3,142	3,142	6,284	23,348	146.7	7.1
12/2/2023 21:59	3,136	3,136	6,272	23,382	146.7	7.1
12/2/2023 22:59	3,129	3,129	6,258	23,383	146.3	7.1
12/2/2023 23:59	3,120	3,120	6,240	23,380	145.9	7.1
12/3/2023 0:59	3,116	3,116	6,232	23,364	145.6	7.1
12/3/2023 1:59	3,129	3,129	6,258	23,393	146.4	7.1
12/3/2023 2:59	3,140	3,140	6,280	23,391	146.9	7.1
12/3/2023 3:59	3,147	3,147	6,294	23,389	147.2	7.1
12/3/2023 4:59	3,142	3,142	6,284	23,385	147.0	7.1
12/3/2023 5:59	3,122	3,122	6,244	23,354	145.8	7.2
12/3/2023 7:59	3,133	3,133	6,266	23,366	146.4	6.7
12/3/2023 8:59	3,127	3,127	6,254	23,393	146.3	7.0
12/3/2023 9:59	3,096	3,096	6,192	23,409	144.9	7.1
12/3/2023 10:59	3,078	3,078	6,156	23,402	144.1	7.1
12/3/2023 11:59	3,072	3,072	6,144	23,400	143.8	7.1
12/3/2023 12:59	3,074	3,074	6,148	23,376	143.7	7.0
12/3/2023 13:59	3,069	3,069	6,138	23,396	143.6	7.1
12/3/2023 14:59	3,083	3,083	6,166	23,380	144.2	7.1
12/3/2023 15:59	3,124	3,124	6,248	23,385	146.1	7.1
12/3/2023 16:59	3,124	3,124	6,248	23,385	146.1	7.1
12/3/2023 17:59	3,155	3,155	6,310	23,386	147.6	7.1
12/3/2023 18:59	3,144	3,144	6,288	23,389	147.1	7.1

12/3/2023 19:59	3,127	3,127	6,254	23,413	146.4	7.1
12/3/2023 20:59	3,116	3,116	6,232	23,364	145.6	7.1
12/3/2023 21:59	3,144	3,144	6,288	23,370	147.0	7.1
12/3/2023 22:59	3,180	3,180	6,360	23,395	148.8	7.1
12/3/2023 23:59	3,136	3,136	6,272	23,389	146.7	7.1
12/4/2023 0:59	3,191	3,191	6,382	23,396	149.3	7.1
12/4/2023 1:59	3,180	3,180	6,360	23,367	148.6	7.1
12/4/2023 2:59	3,177	3,177	6,354	23,398	148.7	7.1
12/4/2023 3:59	3,151	3,151	6,302	23,386	147.4	7.1
12/4/2023 4:59	3,160	3,160	6,320	23,393	147.8	7.1
12/4/2023 5:59	3,182	3,182	6,364	23,386	148.8	7.2
12/4/2023 6:59	3,171	3,171	6,342	23,404	148.4	6.7
12/4/2023 7:59	3,083	3,083	6,166	23,384	144.2	7.0
12/4/2023 8:59	3,601	3,601	7,202	23,393	168.5	7.6

Attachment B

Furnace #5 NOx mass Excess Emissions, lb/h


Attachment B- Furnace #5 NOx mass Excess Emissions, lb/h
NOx mass emissions (lb/hr)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
11/28/2023
11/29/2023
11/30/2023
12/1/2023
12/2/2023
12/3/2023
12/4/2023
Emissions Calcs, Nox last 1-hr average
ENV Limit, 6.20 lb/hr