Shell Chemical Appalachia LLC
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September 23, 2025

Mark Gorog
Air Quality Program Regional Manager
Pennsylvania Department of Environmental Protection
Bureau of Air Quality - Southwest Regional Office
400 Waterfront Drive
Pittsburgh, PA 15222-4745

Re: Shell Chemical Appalachia LLC
Shell Polymers Monaca
Potter and Center Townships, Beaver County
Plan Approval Application Flare Gas Recovery Additional Information

Dear Mr. Gorog:

As requested by the Pennsylvania Department of Environmental Protection ("DEP") during a September 8, 2025, teleconference, and in support of the Shell Polymers Monaca ("SPM") plan approval application submitted on September 13, 2024, Shell Chemical Appalachia LLC ("Shell") is providing supplemental technical information related to the feasibility of flare gas recovery for vent streams routed to SPM's four flares: Totally Enclosed Ground Flare (TEGF) A, TEGF B, Multi-point Ground Flare (MPGF), and High Pressure (HP) Elevated Flare.

These flares control vent streams from the ethylene manufacturing plant and three polyethene ("PE") manufacturing units. Vent streams from these process units consist of routine vent streams as well as intermittent streams associated with start-up, shut-down, maintenance, and turnaround operations. The use of flare gas recovery was previously analyzed as part of the revised plan approval application submitted to DEP on February 16, 2015. The February 16, 2015 analysis included an extensive review of the United States Environmental Protection Agency's (EPA's) RACT/BACT/LAER Clearinghouse (RBLC) database, permits, EPA/Department of Justice (DOJ) consent decrees (CDs), and State Implementation Plan (SIP) requirements and regulations. Based on this analysis, DEP concluded that flare gas recovery was not technically feasible and determined that Lowest Achievable Emission Rate (LAER) and Pennsylvania Best Available Technology (PaBAT) for flare vent streams was work practices and equipment design to minimize the quantity (i.e., mass) of gases directed to the flares. SPM was required to develop and implement a flare minimization plan and to maximize the VOC destruction efficiency of the flares which has been reviewed and approved by DEP. Plan Approval Nos. 04-00740A and 04-00740C require a flare minimization plan, flare vent gas heating value requirements, and a minimum volatile organic compound (VOC) destruction efficiency for the SPM flares.

This conclusion was further confirmed based on a recent review of the RBLC database, South Coast Air Quality Management District (SCAQMD) BACT Guidelines, Bay Area Air Quality Management District (BAAQMD) BACT/Best Available Control Technology for Toxics (TBACT) Workbook, and California

and Texas RACT as part of the April 11, 2025 Fifth Response to Plan Approval Application Technical Deficiency Letter (see responses to Request Nos. 3 and 5 for this analysis).

Updated Flare Gas Recovery Evaluation

In addition to the previously performed analyses referenced above, Shell has reviewed recent EPA/DOJ CDs (e.g., Westlake - Civil Action No.2:22-cv-01577-JDC-KK, Chevron Phillips Chemical Company LP - Civil Action No. 4:22-cv-737, and Shell Chemical LP - Civil Action No. 2:18-cv-1404-EEF-JVM) issued since the February 16, 2015 plan approval application submittal. The following sections summarize the results of this review.

Polyethylene Manufacturing Vent Streams

The PE units at SPM have both continuous and intermittent process vents. These vents contain significant amounts of diluents (i.e., air and nitrogen) that make their capture and recovery for use as fuel technically infeasible. If a vent gas containing a significant amount of nitrogen is mixed with another fuel, the heat content of the stream is reduced. This in turn results in a fuel that has significant amount of inert gas that will require additional fuel to supplement the heat content to fuel gas standards.

The continuous vent thermal oxidizer (CVTO) incinerator, receives both continuous and intermittent vents, and unlike the cracking furnaces and cogen units, was designed to combust vent gases with significant amounts of diluents with highly variable combustion characteristics. Only during maintenance operations of the CVTO are these vents streams routed to the MPGF (approximately 2 weeks per year). As required by Shell's internal design and engineering practices, which require a flare gas recovery review to be completed for all proposed new facilities to determine whether vent streams are recoverable, an evaluation studied continuous vent streams from PE1, PE2 and the PE3 units for three different operating cases. The data were analyzed in simulations to evaluate the lower heating value of the low-pressure vent stream obtained by mixing the vent streams from PE units for each of the three cases. The resulting heating value of the mixed vent stream was determined to be below the design and engineering practices which require recovered gas to be > 25 MJ/kg to qualify as recoverable fuel. Furthermore, technical concerns were identified regarding the potential carryover of PE fines during an emergency shutdown of PE units.

Only intermittent vents associated with startups, shutdowns, and malfunctions and regenerations, reactor blowdowns and purges, and the PE3 degasser are routed to the HP Flare System and are very high in nitrogen content (typically above 75% N2). When these vents are routed to the HP Flare System, they must be supplemented with fuel gas to offset the nitrogen content to ensure the heating value remains above the applicable regulatory limits.

Based on these analyses Shell determined that flare gas recovery was not technically feasible for PE unit vent streams. This conclusion is consistent with the findings of a recent review of CDs, the RBLC database, SCAQMD BACT Guidelines, BAAQMD BACT/TBACT Workbook, and California and Texas RACT. Shell identified no instances where flare gas recovery has been utilized on vent gas streams from PE manufacturing plant operations. Furthermore, per the review of the recent CDs involving PE manufacturing plant operations which required FGR as injunctive relief, the PE vents were either not part of the flare gas recovery system or were exempt from recovery by the flare gas recovery system.

Ethylene Manufacturing Vent Streams

To assess the technical feasibility of controlling ethylene plant vent streams, Shell did an updated review of vent streams routed to flares that originate from ethylene manufacturing process units. As documented

in the CDs, not all streams at ethylene manufacturing plants were deemed appropriate for flare gas recovery as certain streams were considered “Non-Recoverable Waste Gas Streams”, meaning streams with high nitrogen content and very low heating values. These streams were thus deemed not useful for fuel. Flare gas recovery was not required for a large percentage of the flares addressed in the CDs, and instead the facilities were required to implement work practice standards in the form of flare minimization plans similar to those already incorporated into SPM’s existing plan approval and as required by the Ethylene maximum achievable control technology (MACT) regulations in 40 Code of Federal Regulations (CFR) 63 Subpart YY.

The CDs previously referenced above include instances in which flare gas recovery has been employed at ethylene manufacturing plants as injunctive relief. It is critical to note that several of the flares at ethylene plants covered in the CDs which incorporated flare gas recovery are part of larger integrated facilities that include petroleum refinery operations, multiple separate ethylene manufacturing units, and/or other separate chemical process units and thus are not directly relevant for comparison to operations at SPM. SPM is a standalone single-train facility with one ethylene manufacturing unit and three polyethylene manufacturing units. Since SPM is not part of larger facility with other manufacturing operations that generate recoverable gases, it was not designed as an integrated facility with a fuel gas distribution system and fuel gas blend drum which are used at those integrated facilities to appropriately mix and otherwise dilute inerts to a useful fuel gas mixture.

As part of the ethylene manufacturing process at SPM, tailgas (the light products from the cracking process – primarily hydrogen and methane) is recovered and used as fuel in the cracking furnaces or as supplemental fuel for compliance with the heating value regulatory requirements at the TEGFs. During normal operation of the cracking unit, no routine vent gases other than analyzer vents, natural gas purges, and supplemental fuel for heating value are directed to the flares. As a result, during normal operations there is little or no VOC gas to recover using a flare gas recovery system. Essentially, any gas that could be recovered would provide no beneficial use as fuel and the recovery would not result in the reduction of VOC emissions as there is no VOC for recovery. Note that most of the natural gas purges in the flare headers were previously nitrogen purges but were changed to natural gas to assist the flares in meeting the heating value regulatory limit.

The ethylene manufacturing plant at SPM has intermittent process vents which are associated with start-up, shutdown, and turnaround maintenance operations. Individual stream venting ranges from 2 hours per year (hr/yr) to 547 hr/yr, with the average across all vent streams less than 164 hr/yr or approximately 7 days per year. Turnaround-related vent streams may occur only once every three to five years depending on the specific turnaround schedule for the equipment being emptied. As required by Shell’s internal design and engineering practices, a review was conducted to assess technical feasibility of flare gas recovery for these intermittent vent streams as part of the initial design. Due to the intermittent nature of the ethylene manufacturing vent streams and the composition of the streams it was determined that flare gas recovery was not technically feasible due to gas quality and quantity.

The start-up and shutdown venting from the ethylene manufacturing process of VOC gases to the flares is infrequent as discussed above and primarily composed of ethylene. Capture and recovery of ethylene for use as a fuel gas at the cogen units and furnaces are not technically feasible because ethylene has significantly different combustion characteristics (e.g., adiabatic flame temperature, flame velocity, and heat release rate) compared to tailgas (primarily hydrogen and methane) and natural gas (primarily methane with lesser amounts of ethane and propane). The cracking furnaces are designed to efficiently and cleanly combust tailgas and natural gas. The cogen units are designed to burn natural gas only. As a result, use of either the furnaces or cogen units to combust ethylene would result in 1) damage to the burners due to ethylene's high heat release and 2) burner fouling due to the formation of polymerization residue. Furthermore, the combustion turbines use dry low nitrogen oxide (NO_X) combustors, which are

designed for a particular fuel type. It is not possible to design a dry low NO_X combustor to burn both natural gas and ethylene due to the dissimilarity in the combustion characteristics.

The capture and recovery of cracking furnace product gas during a unit startup, shutdown, or malfunction for use as a feedstock is not technically feasible because of the low purity of the captured gases. The furnaces require high purity ethane to produce desirable product (i.e., ethylene). Using these start-up/shutdown gases as a cracking furnace feedstock would result in rapid coking of the cracking furnace tubes resulting in decoking more frequently and leading to increased CO emissions.

Conclusion

Based on a detailed review of characteristics (i.e., heating values in British thermal units per standard cubic feet (Btu/scf) and vent stream frequency) of PE units and ethylene manufacturing plant vent streams routed to the SPM flares, the conclusion that flare gas recovery is not technically feasible was reaffirmed. Specifically, Shell performed a detailed review and analysis of the PE unit and ethylene plant vent streams routed to the SPM flares to determine whether any of the vent streams would be recoverable for use as fuel. Based on this review it was determined that vent streams were either non-recoverable vent streams associated with the PE units or ethylene manufacturing vent streams that were intermittent or associated with start-up/shutdown and turnaround maintenance-related operations. Thus, the relatively infrequent generation of these streams and the inability to use these gases as fuel in the cracking furnaces and cogen units makes the recovery of these ethylene manufacturing vent streams technically infeasible.

This detailed vent gas analysis further supports the determinations reached in the February 16, 2015 plan approval application as well as the determinations documented in the April 11, 2025 Fifth Response to Plan Approval Application Technical Deficiency Letter. As such, Shell believes the current LAER, BACT, and PaBAT determination for flare vent streams (i.e., work practices and equipment design to minimize the quantity of the gases directed to the flares and to maximize the VOC destruction efficiency of the flares) is accurate and flare gas recovery is technically infeasible.

If you have any questions regarding this additional information, please contact me at (724) 709-2906 or laura.l.sabolyk@shell.com.

Sincerely,

Laura Sabolyk

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