Pennsylvania
Department of
Environmental Protection

MEMO

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DATE December 22, 2025

RE Inhalation Risk Assessment
Shell Chemical Appalachia LLC
Application for Plan Approval 04-00740D
EMACT Project, WWTP Permanent Controls Project, and Plan Approval Reconciliations
Shell Polymers Monaca Site
Center Township and Potter Township, Beaver County

MESSAGE:
The Pennsylvania Department of Environmental Protection's (DEP) Air Quality Modeling and Risk Assessment Section has completed its technical review of the inhalation risk assessment included in Shell Chemical Appalachia LLC's (Shell) application for Plan Approval 04-000740D for several changes at Shell Polymers Monaca Site in Center Township and Potter Township, Beaver County.

The changes included in Shell's plan approval application are the Ethylene Maximum Achievable Control Technology (EMACT) Project to comply with the revised 40 CFR 63 Subpart YY, the Wastewater Treatment Plant (WWTP) Permanent Controls Project to install permanent equipment to improve oil, grease, and volatile organic compounds removal from the wastewater, and the reconciliations of plan approval source descriptions and conditions as well as potential to emit calculations, referred to as "Plan Approval Reconciliations", based on Shell's latest review of its "as-built" equipment and operations.

During its technical review, the DEP made several revisions to Shell's inhalation risk assessment. The DEP's technical review concludes that Shell's inhalation risk assessment, in conjunction with the revisions made by the DEP, demonstrates that the excess lifetime cancer risk, chronic noncancer risk, and acute noncancer risk due to inhalation of the chemicals of potential concern (COPC) would not exceed the DEP's benchmarks. The DEP's summary of Shell's inhalation risk assessment, along with the DEP's revisions, is attached.

If you have any questions regarding Shell's inhalation risk assessment, you may contact me (ssteirer@pa.gov, 717.772.5620) or Andrew Fleck (afleck@pa.gov, 717.783.9243).

Attachment

cc: Mark Gorog, SWRO/Air Quality
Sherri Guerrieri, SWRO/Air Quality/New Source Review
Nicholas Lazor, BAQ/Director
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DEP Summary of Inhalation Risk Assessment
Shell Chemical Appalachia LLC
Application for Plan Approval 04-00740D
EMACT Project, WWTP Permanent Controls Project, and Plan Approval Reconciliations
Shell Polymers Monaca Site, Center Township and Potter Township, Beaver County
December 22, 2025

I. Background

The Pennsylvania Department of Environmental Protection (DEP) received a plan approval application on September 13, 2024, from Shell Chemical Appalachia LLC (Shell) for several changes at Shell Polymers Monaca Site in Center Township and Potter Township, Beaver County.[1] The changes included are the Ethylene Maximum Achievable Control Technology (EMACT) Project to comply with the revised 40 CFR 63 Subpart YY, the Wastewater Treatment Plant (WWTP) Permanent Controls Project to install permanent equipment to improve oil, grease, and volatile organic compounds removal from the wastewater, and the reconciliations of plan approval source descriptions and conditions as well as potential to emit calculations, referred to as "Plan Approval Reconciliations", based on Shell's latest review of its "as-built" equipment and operations. The plan approval application contained an inhalation risk assessment for facility-wide emissions of chemicals of potential concern (COPC). In response to the DEP's December 20, 2024,[2] technical review comments, the DEP received a revision to the inhalation risk assessment from Shell on May 29, 2025.[3,4] In response to the DEP's July 7, 2025,[5] and July 14, 2025,[6] technical review comments, the DEP received a revision to the inhalation risk assessment from Shell on September 5, 2025.[7,8] The DEP received an additional revision to the inhalation risk assessment from Shell on October 14, 2025.[9]

The plan approval application and the included inhalation risk assessment were prepared by Landau Associates, on behalf of Shell.

II. Regulatory Applicability

Shell's inhalation risk assessment was conducted in support of the application for Plan Approval 04-00740D at the request of the DEP in accordance with 25 Pa. Code § 127.12(a)(2).

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[1] Letter with enclosure (Plan Approval Application for Shell Polymers Monaca) from James Howell, Shell to Mark Gorog, DEP/SWRO/Air Quality. September 13, 2024.
[2] Letter with enclosure from Henry F. Bonifacio and Stephen J. Steirer, DEP/BAQ/Permits/Air Quality Modeling and Risk Assessment to Kimberly Kaal, Shell. December 20, 2024.
[3] Letter with enclosures from Kimberly Kaal, Shell to Alexander Sandy, DEP/SWRO/Air Quality/New Source Review. May 29, 2025.
[4] Email with link to files associated with the inhalation risk assessment from Michael Carbon, Landau Associates. May 29, 2025.
[5] Email with attachment from Henry Bonifacio, DEP/BAQ/Permits/Air Quality Modeling and Risk Assessment to Michael Carbon, Landau Associates. July 7, 2025.
[6] Email with attachment from Stephen Steirer, DEP/BAQ/Permits/Air Quality Modeling and Risk Assessment to Michael Carbon, Landau Associates. July 14, 2025.
[7] Letter with enclosures from Kimberly Kaal, Shell to Mark Gorog, DEP/SWRO/Air Quality. September 5, 2025.
[8] Email with link to files associated with the inhalation risk assessment from Michael Carbon, Landau Associates. September 5, 2025.
[9] Email with link to files associated with the inhalation risk assessment from Todd Higginbotham, Landau Associates to Mark Gorog, DEP/SWRO/Air Quality. October 14, 2025.

III. Inhalation Risk Assessment

Shells's inhalation risk assessment serves as an important tool for protecting human health by identifying and evaluating the risks associated with inhalation exposure. Shell used the U.S. Environmental Protection Agency's (EPA) four-step risk assessment process to evaluate the potential health effects from inhalation exposure to the COPCs emitted from Shell Polymers Monaca Site as described below.[10] Shell provided a detailed description of the inhalation risk assessment in Appendix D-3A (Emission Estimates for the Inhalation Risk Assessment for Shell Polymers Monaca), Appendix D-3B (Dispersion Modeling Analysis for the Inhalation Risk Assessment for Shell Polymers Monaca), and Appendix D-3C (Inhalation Risk Assessment for Shell Polymers Monaca) of the plan approval application.

A. Inhalation Risk Assessment Process

The EPA's risk assessment process includes four steps: hazard identification, dose-response assessment, exposure assessment, and risk characterization. Hazard identification and dose-response are referred together as the toxicity assessment. The toxicity assessment identifies the COPCs and the relationship between the amount of exposure to the COPCs and the probability of adverse health effects. The exposure assessment is the mathematical modeling of transport and dispersion of the COPCs over a defined area beyond the facility fenceline. Risk characterization integrates the toxicity assessment and exposure assessment to measure the potential risks. For cancer, the risk is expressed as the excess lifetime cancer risk (ELCR). For noncancer effects, the risks are expressed as the chronic noncancer hazard quotient (HQ)/hazard index (HI) and acute noncancer HQ.

1. Toxicity Assessment (Hazard Identification and Dose-Response Assessment)

Shell's inhalation risk assessment evaluated emissions of COPCs from the following sources:

- seven (7) ethane cracking furnaces,
- three (3) combustion turbines with duct burners,
- two (2) totally enclosed ground flares,
- one (1) elevated, steam-assisted flare,
- one (1) multi-point ground flare that consists of 38 flare heads,
- one (1) continuous vent thermal oxidizer,
- one (1) spent caustic thermal oxidizer,
- two (2) diesel-fired fire water pumps engines,
- two (2) diesel-fired emergency generator engines,
- two (2) natural gas-fired emergency generator engines,
- one (1) process cooling tower with 26 cells,
- three (3) polyethylene manufacturing lines,[11]
- one (1) liquid loadout for C3+, butene, isopentane, isobutane, and C3 ref,

[10] EPA website: https://www.epa.gov/risk/conducting-human-health-risk-assessment.
[11] Two (2) manufacturing lines' emission points are two (2) shared catalyst filter vents. The last manufacturing line's emission points are two (2) catalyst activator filter vents.

- one (1) liquid loadout for recovered oil,
- twelve (12) ethylene manufacturing equipment components,
- one (1) polyethylene manufacturing line fugitive,
- fourteen (14) OSBL equipment components,[12] and
- two (2) WWTP bioaeration tanks.

The emission factors for the COPCs that are emitted from the sources were obtained from EPA's AP-42 Compilation of Air Pollutant Emission Factors, Ventura County Air Pollution Control District Emission Factors, EPA test methods, process data, engineering calculations, stack test data, vendor data, and emissions modeling. Each source's throughput was applied to the relevant emission factors to calculate the maximum annual and maximum hourly emission rates. The calculated emission rates were used in the risk characterization calculations.

In an inhalation risk assessment, reference values are used as key metrics to evaluate potential health risks associated with inhalation exposures. These reference values include the inhalation unit risk (IUR) and two reference concentrations (RfC). The IUR is used to calculate potential increased cancer risk from a lifetime of continuous exposure (24 hours/day for 70 years) to a COPC and is expressed as the risk per unit concentration in micrograms per cubic meter $(\mu g/m^3)^{-1}$. The chronic RfC is used to assess the potential noncancer effects from long-term exposure to a COPC and is expressed in milligrams per cubic meter (mg/m^3). The acute RfC is used to assess the potential noncancer effects from short-term exposure to a COPC and is expressed in mg/m^3.

COPCs that are determined to be a carcinogen by a mutagenic mode of action by the EPA were identified. Children are more susceptible to cancer and tumor development if exposed to carcinogens with a mutagenic mode of action. To account for this increased susceptibility, Shell applied an age-dependent adjustment factor (ADAF) of 1.63 to the IUR. Application of Shell's ADAF, however, slightly underestimates the ELCR. The DEP more appropriately summed and applied the ADAFs in Table 1 to the IUR.

Table 1: Age-Dependent Adjustment Factors for Mutagenic Mode of Action[13]

Age (years)	Age-Dependent Adjustment Factor
0 - 2	10 x (2 / 70)
2 - 16	3 x (14 / 70)
16 - 70	1 x (54 / 70)

COPCs with associated chronic and acute reference values are listed in Table 2a and Table 2b, respectively.

[12] OSBL stands for "outside the boundary limits." OSBL equipment components include valves, connectors/flanges, relief valves, pumps, and compressor seals at various sources.
[13] U.S. EPA, 2005. Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens. EPA/630/R-03/003F. March 2005. Pages 36-38.

Table 2a: Chemicals of Potential Concern and Chronic Reference Values

COPC[a]	IUR[b] $(\mu g/m^3)^{-1}$	Source[c]	Chronic RfC[b] (mg/m^3)	Source[c]
Acenaphthene	-----	-----	-----	-----
Acenaphthylene	-----	-----	-----	-----
Acetaldehyde	2.20E-06	EPA/IRIS	9.00E-03	EPA/IRIS
Acrolein	-----	-----	2.00E-05	EPA/IRIS
Ammonia[d]	-----	-----	2.00E-01	CalEPA
Anthracene	-----	-----	-----	-----
Arsenic[e]	4.30E-03	EPA/IRIS	1.50E-05	CalEPA
Barium	-----	-----	5.00E-04	EPA/HEAST
Benzene[d]	7.80E-06	EPA/IRIS	3.00E-03	CalEPA
Benz(a)anthracene[f]	9.94E-05	EPA/RPF	-----	-----
Benzo(a)pyrene[g]	1.00E-03	EPA/IRIS	2.00E-06	EPA/IRIS
Benzo(b)fluoranthene[f]	9.94E-05	EPA/RPF	-----	-----
Benzo(e)pyrene	-----	-----	2.00E-06	EPA/PPRTV
Benzo(g,h,i)perylene	-----	-----	-----	-----
Benzo(k)fluoranthene[f]	9.94E-06	EPA/RPF	-----	-----
Beryllium[d]	2.40E-03	EPA/IRIS	7.00E-07	CalEPA
Biphenyl[e]	-----	-----	4.00E-04	EPA/RPF
1,3-Butadiene	3.00E-05	EPA/IRIS	2.00E-03	EPA/IRIS
n-Butane	-----	-----	-----	-----
iso-/n-Butyraldehyde	-----	-----	-----	-----
Cadmium	1.80E-03	EPA/IRIS	1.00E-05	ATSDR
Carbon tetrachloride	6.00E-06	EPA/IRIS	1.00E-01	EPA/IRIS
Chlorobenzene	-----	-----	5.00E-02	EPA/PPRTV
Chloroethane	-----	-----	-----	-----
Chloroform	2.30E-05	EPA/IRIS	3.00E-01	CalEPA
Chromium III	-----	-----	6.00E-05	CalEPA
Chromium VI[g]	1.80E-02	EPA/IRIS	3.00E-05	EPA/IRIS
Chrysene[f]	9.94E-07	EPA/RPF	None	
Cobalt	9.00E-03	EPA/PPRTV	6.00E-06	EPA/PPRTV
Copper	-----	-----	-----	-----
Cyclopentane	-----	-----	-----	-----
Dibenzo(a,h)anthracene[f]	9.94E-04	EPA/RPF	-----	-----
Dibutyl phthalate	-----	-----	-----	-----
Dichlorobenzene	1.10E-05	CalEPA	8.00E-01	EPA/IRIS
1,1-Dichloroethane	1.60E-06	CalEPA	-----	-----
1,2-Dichloroethane	2.60E-05	EPA/IRIS	7.00E-03	EPA/PPRTV
1,2-Dichloropropane	3.70E-06	EPA/PPRTV	4.00E-03	EPA/IRIS
1,3-Dichloropropene	4.00E-06	EPA/IRIS	2.00E-02	EPA/IRIS
7,12-Dimethylbenz(a)anthracene[f]	1.18E-01	CalEPA	-----	-----

COPC[a]	IUR[b] $(\mu g/m^3)^{-1}$	Source[c]	Chronic RfC[b] (mg/m^3)	Source[c]
Ethane	-----	-----	-----	-----
Ethylbenzene	2.50E-06	CalEPA	1.00E+00	EPA/IRIS
Ethylene dibromide	6.00E-04	EPA/IRIS	9.00E-03	EPA/IRIS
Fluoranthene	-----	-----	-----	-----
Fluorene	-----	-----	-----	-----
Formaldehyde[h]	1.10E-05	EPA/IRIS	7.00E-03	EPA/IRIS
n-Heptane	-----	-----	4.00E-01	EPA/PPRTV
n-Hexane	-----	-----	7.00E-01	EPA/IRIS
Indeno(1,2,3-cd)pyrene[f]	9.94E-05	EPA/RPF	-----	-----
Lead	1.20E-05	CalEPA	-----	-----
Manganese	-----	-----	5.00E-05	EPA/IRIS
Mercury[d]	-----	-----	3.00E-05	CalEPA
Methanol[d]	-----	-----	4.00E+00	CalEPA
3-Methylcholanthrene[f]	1.04E-02	CalEPA	-----	-----
Methylcyclohexane	-----	-----	9.50E-02	EPA/PPRTV
Methylene chloride[g]	1.70E-08	EPA/IRIS	6.00E-01	EPA/IRIS
2-Methylnaphthalene	-----	-----	-----	-----
Molybdenum	-----	-----	2.00E-03	ATSDR
Naphthalene	3.40E-05	CalEPA	3.00E-03	EPA/IRIS
Nickel[i]	2.60E-04	CalEPA	1.40E-05	CalEPA
n-Nonane	-----	-----	2.00E-02	EPA/PPRTV
n-Octane	-----	-----	-----	-----
n-Pentane	-----	-----	1.00E+00	EPA/PPRTV
Perchloroethylene[e]	2.60E-07	EPA/IRIS	4.00E-02	EPA/IRIS
Phenanthrene	-----	-----	-----	-----
Phenol	-----	-----	2.00E-01	CalEPA
Polycyclic aromatic hydrocarbon (PAH)[j]	7.10E-02	CalEPA	-----	-----
Propane	-----	-----	-----	-----
Propylene	-----	-----	3.00E+00	CalEPA
Propylene oxide	3.70E-06	EPA/IRIS	3.00E-02	EPA/IRIS
Pyrene	-----	-----	-----	-----
Selenium	-----	-----	2.00E-02	CalEPA
Styrene[d]	-----	-----	9.00E-01	CalEPA
1,1,2,2-Tetrachloroethane	5.80E-05	CalEPA	-----	-----
Toluene[d]	-----	-----	4.20E-01	CalEPA
1,1,2-Trichloroethane	1.60E-05	EPA/IRIS	-----	-----
1,2,3-Trimethylbenzene	-----	-----	6.00E-02	EPA/IRIS
1,2,4-Trimethylbenzene	-----	-----	6.00E-02	EPA/IRIS
1,3,5-Trimethylbenzene	-----	-----	6.00E-02	EPA/IRIS

COPC[a]	IUR[b] $(\mu g/m^3)^{-1}$	Source[c]	Chronic RfC[b] (mg/m^3)	Source[c]
2,2,4-Trimethylpentane	-----	-----	-----	-----
Vanadium	-----	-----	1.00E-04	ATSDR
Vinyl chloride[g]	8.80E-06	EPA/IRIS	-----	-----
Xylenes	-----	-----	1.00E-01	EPA/IRIS
Zinc	-----	-----	-----	-----

[a] Mutagenic COPCs indicated by bold print.
[b] Some COPCs do not have an IUR or chronic RfC.
[c] Source:
ATSDR (U.S. Department of Health and Human Services/Agency for Toxic Substances and Disease Registry)
CalEPA (California Environmental Protection Agency/Office of Environmental Health Hazard Assessment)
EPA/HEAST (EPA/Health Effects Assessment Summary Tables)
EPA/IRIS (EPA/Integrated Risk Information System)
EPA/PPRTV (EPA/Provisional Peer Reviewed Toxicity Values)
EPA/RPF (EPA/Regional Screening Levels Table Relative Potency Factor)
[d] Shell used a chronic RfC from CalEPA that is more protective of human health than the chronic RfC from EPA/IRIS.
[e] Chronic RfC source corrected by the DEP.
[f] IUR corrected by the DEP based on ADAFs in Table 1 above.
[g] IUR corrected by the DEP based on IUR from EPA/IRIS that includes ADAFs.
[h] IUR from EPA/IRIS includes ADAFs.
[i] Shell used an IUR from CalEPA that is more protective of human health than the IUR from EPA/IRIS.
[j] For non-speciated PAH, Shell used an IUR for 7,12-dimethylbenz(a)anthracene from CalEPA that is more protective of human health than the IUR for benzo(a)pyrene from EPA/IRIS.

Table 2b: Chemicals of Potential Concern and Acute Reference Values

COPC	Acute RfC[a] (mg/m^3)	Source[b]
Acenaphthene	-----	-----
Acenaphthylene	-----	-----
Acetaldehyde	4.70E-01	CalEPA
Acrolein	2.50E-03	CalEPA
Ammonia[c]	1.18E+00	ATSDR
Anthracene[d]	3.00E-02	ACGIH
Arsenic	2.00E-04	CalEPA
Barium[d]	7.50E-02	OSHA
Benzene	2.70E-02	CalEPA
Benz(a)anthracene[d]	3.00E-02	NIOSH
Benzo(a)pyrene[d]	3.00E-02	OSHA
Benzo(b)fluoranthene	-----	-----
Benzo(e)pyrene	-----	-----
Benzo(g,h,i)perylene	-----	-----
Benzo(k)fluoranthene	-----	-----
Beryllium	7.50E-06	ACGIH
Biphenyl	1.50E-01	NIOSH

COPC	Acute RfC[a] (mg/m^3)	Source[b]
1,3-Butadiene	6.60E-01	CalEPA
n-Butane	3.57E+02	ACGIH
iso-/n-Butyraldehyde	-----	-----
Cadmium[e]	3.00E-05	ATSDR
Carbon tetrachloride	1.90E+00	CalEPA
Chlorobenzene	6.91E+00	ACGIH
Chloroethane	-----	-----
Chloroform	1.50E-01	CalEPA
Chromium III[f]	4.50E-04	ACGIH
Chromium VI	1.25E-05	ACGIH
Chrysene[d]	3.00E-02	ACGIH
Cobalt[d]	3.00E-03	ACGIH
Copper	1.00E-01	CalEPA
Cyclopentane	4.30E+02	ACGIH
Dibenzo(a,h)anthracene	-----	-----
Dibutyl phthalate	7.50E-01	ACGIH
Dichlorobenzene[g]	7.50E+00	CalEPA
1,1-Dichloroethane	6.07E+01	ACGIH
1,2-Dichloroethane	-----	-----
1,2-Dichloropropane	-----	-----
1,3-Dichloropropene	6.81E-01	ACGIH
7,12-Dimethylbenz(a)anthracene[f]	1.50E-02	NIOSH
Ethane	-----	-----
Ethylbenzene	1.30E+01	ACGIH
Ethylene dibromide	-----	-----
Fluoranthene	-----	-----
Fluorene	-----	-----
Formaldehyde[c]	4.90E-02	ATSDR
n-Heptane	5.12E+01	ACGIH
n-Hexane	2.64E+01	ACGIH
Indeno(1,2,3-cd)pyrene	-----	-----
Lead[d]	7.50E-03	ACGIH
Manganese	3.00E-03	ACGIH
Mercury	6.00E-04	CalEPA
Methanol	2.80E+01	CalEPA
3-Methylcholanthrene	-----	-----
Methylcyclohexane	6.02E+01	ACGIH
Methylene chloride	1.40E+01	CalEPA
2-Methylnaphthalene	4.37E-01	ACGIH
Molybdenum	4.50E-01	CalEPA
Naphthalene[f]	1.88E+00	NIOSH

COPC	Acute RfC[a] (mg/m^3)	Source[b]
Nickel	2.00E-04	CalEPA
n-Nonane	1.57E+02	ACGIH
n-Octane	2.10E+02	ACGIH
n-Pentane	2.66E+02	CalEPA
Perchloroethylene	1.70E+01	ACGIH
Phenanthrene	3.00E-02	ACGIH
Phenol	5.80E+00	CalEPA
Polycyclic aromatic hydrocarbon (PAH)[h]	-----	-----
Propane[d]	2.71E+02	NIOSH
Propylene	1.29E+02	ACGIH
Propylene oxide	3.10E+00	CalEPA
Pyrene[d]	3.00E-02	ACGIH
Selenium[d]	3.00E-02	ACGIH
Styrene	2.10E+01	CalEPA
1,1,2,2-Tetrachloroethane	1.03E+00	ACGIH
Toluene	5.00E+00	CalEPA
1,1,2-Trichloroethane	8.18E+00	ACGIH
1,2,3-Trimethylbenzene	-----	-----
1,2,4-Trimethylbenzene	-----	-----
1,3,5-Trimethylbenzene	-----	-----
2,2,4-Trimethylpentane	-----	-----
Vanadium[c]	8.00E-04	ATSDR
Vinyl chloride	1.80E+02	CalEPA
Xylenes[c]	8.68E+00	ATSDR
Zinc	-----	-----

[a] Some COPCs do not have an acute RfC.

[b] Source:
ACGIH (American Conference of Government Industrial Hygienists)
ATSDR (U.S. Department of Health and Human Services/Agency for Toxic Substances and Disease Registry)
CalEPA (California Environmental Protection Agency/Office of Environmental Health Hazard Assessment)
NIOSH (National Institute for Occupational Safety and Health)
OSHA (Occupational Safety and Health Administration)

[c] Shell used an acute RfC from ATSDR that is more protective of human health than the acute RfC from CalEPA.

[d] Acute RfC source corrected by the DEP.

[e] Shell used an acute RfC from ATSDR that is more protective of human health than the acute RfC from ACGIH.

[f] Acute RfC and source corrected by the DEP.

[g] Incorrect acute RfC, but this value is more protective of human health.

[h] Corrected by the DEP. There is no acute RfC for PAH.

2. Exposure Assessment

Shell utilized air dispersion modeling to calculate the maximum 1-hour and maximum 5-year unitized concentrations at defined receptors along and beyond the facility's fenceline. Shell's air dispersion modeling methodology is described in Appendix D-3B (Dispersion Modeling

Analysis for the Inhalation Risk Assessment for Shell Polymers Monaca) of the plan approval application and summarized in the DEP's memorandum dated December 22, 2025.[14]

For characterizing chronic risks, the 5-year average concentration at a given receptor for a COPC emitted from a specific source was calculated by multiplying the modeled, source-specific 5-year average unitized concentration at that receptor from the exposure assessment by the source's annual average emission rate for the COPC from the toxicity assessment. Subsequently, for each COPC, the 5-year average concentrations from all sources were summed at each receptor. Likewise, for characterizing acute risks, the maximum 1-hour concentration at a given receptor for a COPC emitted from a specific source was calculated by multiplying the modeled, source-specific maximum 1-hour unitized concentration at that receptor by the source's maximum 1-hour average emission rate for the COPC. Subsequently, for each COPC, the maximum 1-hour concentrations from all sources were summed at each receptor.

The location of the maximum exposed individual (MEI) was determined from the defined receptors. Additionally, Shell identified locations of sensitive populations that are near the facility. Sensitive populations include persons that are at increased risk of adverse health effects such as infants and children, the elderly, and individuals with respiratory, cardiovascular, and certain other health conditions.

3. Risk Characterization

Chronic reference values were applied to the 5-year concentrations to calculate both cancer and chronic noncancer risks. Acute reference values were applied to the maximum 1-hour concentrations to calculate acute noncancer risks.

Benchmarks are threshold values indicating when there is a potential concern to public health. Assessing these values involves identifying and analyzing the risks and then evaluating the level of potential health effects. Risk management decisions may be required if the risk exceeds a benchmark.

a. Excess Lifetime Cancer Risk

The ELCR represents the increased possibility that a person may develop cancer due to long-term inhalation exposure to a carcinogenic COPC. The ELCR for each COPC was calculated by multiplying the modeled 5-year concentration by the IUR. The cumulative ELCR was calculated by summing the ELCR across each COPC. The top five (5) COPCs contributing to the highest cumulative ELCR are 1,3-butadiene, benzene, naphthalene, polycyclic aromatic hydrocarbon, and chromium VI. The cumulative ELCR for the MEI would not exceed the DEP's benchmark of 10 in 1 million[15] and is listed in Table 3.

[14] Air Dispersion Modeling for Inhalation Risk Assessment. Shell Chemical Appalachia LLC. Application for Plan Approval 04-00740D. Memorandum from Henry F. Bonifacio, DEP/BAQ/Permits/Air Quality Modeling and Risk Assessment to Alexander Sandy, DEP/SWRO/Air Quality/New Source Review and Stephen J. Steirer, DEP/BAQ/Permits/Air Quality Modeling and Risk Assessment. December 22, 2025.

[15] U.S. EPA, 1998. Region 6 Risk Management Addendum – Draft Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities. EPA-R6-98-002. July 1998. Page ADD-3.

Table 3: Cumulative ELCR for MEI from Shell's COPC Emissions

Cumulative ELCR	DEP Benchmark
8.71	10 in 1 million

b. Chronic Noncancer Risk

The chronic noncancer risk is the evaluation of potential noncancer health effects due to long-term exposure to a COPC and is expressed as an HQ. The chronic noncancer HQ for each COPC was calculated by dividing the modeled 5-year concentration by the chronic RfC. The cumulative chronic noncancer risk, expressed as an HI, was calculated by summing the HQ across each COPC. The top five (5) COPCs contributing to the highest HI are benzene, 1,3-butadiene, naphthalene, acrolein, and toluene. The HI for the MEI would not exceed the DEP's benchmark of 0.25 for a single facility without accounting for background concentrations in the inhalation risk assessment.[16] A benchmark of 1.0 may be used when accounting for background concentrations. The chronic noncancer risk for the MEI is listed in Table 4.

Table 4: Chronic Noncancer Risk for MEI from Shell's COPC Emissions

HI	DEP Benchmark
0.20	0.25

c. Acute Noncancer Risk

The acute noncancer risk is the evaluation of potential noncancer health effects due to short-term exposure to a COPC and is expressed as an HQ. The acute noncancer risk for each COPC was calculated by dividing the modeled maximum 1-hour concentration by the acute RfC. The acute HQ for the MEI for each COPC would not exceed the DEP's benchmark of 1.0.[17] The acute noncancer risk for the MEI are listed by COPC from the highest to lowest HQ in Table 5.

Table 5: Acute Noncancer Risk for MEI from Shell's COPC Emissions

COPC	HQ[a],[b]
Chromium VI	7.94E-01
Cadmium	4.39E-01
Benzene	4.37E-01
Acrolein	3.54E-01
Formaldehyde	1.70E-01
Nickel	1.26E-01
Chromium III	4.70E-02
Vanadium	3.44E-02
Ammonia	3.28E-02
Beryllium	1.92E-02
1,3-Butadiene	1.90E-02
n-Pentane	1.87E-02

[16] Ibid, Page ADD-3.
[17] Ibid. Page ADD-7.

COPC	HQ[a],[b]
Arsenic	1.20E-02
Mercury	5.19E-03
Acetaldehyde	2.94E-03
n-Butane	2.48E-03
Toluene	1.93E-03
Manganese	1.52E-03
Phenanthrene	8.25E-04
Lead	8.14E-04
Naphthalene	7.52E-04
Barium	7.02E-04
Styrene	3.40E-04
Cobalt	3.35E-04
Methanol	3.18E-04
Propane	1.54E-04
Anthracene	1.52E-04
Xylenes	1.45E-04
Pyrene	1.34E-04
Biphenyl	1.22E-04
Copper	1.02E-04
Chloroform	7.05E-05
n-Hexane	6.15E-05
Benz(a)anthracene	4.65E-05
Propylene	4.36E-05
Ethylbenzene	4.01E-05
n-Heptane	3.24E-05
Molybdenum	2.95E-05
Propylene oxide	2.01E-05
7,12-Dimethylbenz(a)anthracene	1.28E-05
Chrysene	1.04E-05
Selenium	9.58E-06
1,1,2,2-Tetrachloroethane	7.31E-06
2-Methylnaphthalene	6.71E-06
1,3-Dichloropropene	6.27E-06
Benzo(a)pyrene	5.31E-06
Carbon tetrachloride	3.13E-06
Dichlorobenzene	1.92E-06
Methylcyclohexane	1.76E-06
Dibutyl phthalate	1.66E-06
Methylene chloride	7.52E-07
Chlorobenzene	6.67E-07
1,1,2-Trichloroethane	6.28E-07
Phenol	5.15E-07

COPC	HQ[a],[b]
n-Octane	1.44E-07
1,1-Dichloroethane	6.27E-08
n-Nonane	6.04E-08
Cyclopentane	4.55E-08
Vinyl chloride	1.34E-08
Perchloroethylene	1.26E-08
Acenaphthene	-----[c]
Acenaphthylene	-----[c]
Benzo(b)fluoranthene	-----[c]
Benzo(e)pyrene	-----[c]
Benzo(g,h,i)perylene	-----[c]
Benzo(k)fluoranthene	-----[c]
iso-/n-Butyraldehyde	-----[c]
Chloroethane	-----[c]
Dibenzo(a,h)anthracene	-----[c]
1,2-Dichloroethane	-----[c]
1,2-Dichloropropane	-----[c]
Ethane	-----[c]
Ethylene dibromide	-----[c]
Fluoranthene	-----[c]
Fluorene	-----[c]
Indeno(1,2,3-cd)pyrene	-----[c]
3-Methylcholanthrene	-----[c]
Polycyclic aromatic hydrocarbon	-----[c]
1,2,3-Trimethylbenzene	-----[c]
1,2,4-Trimethylbenzene	-----[c]
1,3,5-Trimethylbenzene	-----[c]
2,2,4-Trimethylpentane	-----[c]
Zinc	-----[c]

[a] The DEP benchmark is 1.0.
[b] Maximum HQ for each COPC. Shell calculated a maximum HI and reported the HQ contribution of each COPC to the maximum HI.
[c] No HQ calculated since this COPC has no acute RfC.

B. Conclusions

The DEP's technical review concludes that Shell's inhalation risk assessment, in conjunction with the revisions made by the DEP, demonstrates that the ELCR, chronic noncancer risk, and acute noncancer risk due to inhalation of the COPCs would not exceed the DEP's benchmarks.

Files associated with Shell's risk calculations and the DEP's technical review thereof are available upon request.