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DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION

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MEMORANDUM

July 21, 2020

To: James Boylan
Thru: Byeong-Uk Kim
From: Henian Zhang
Subject: **Modeling Analysis for Ethylene Oxide as Described in Permit Application #27375 Innovative Chemical Technologies, Inc., Cartersville, Bartow County, GA**

GENERAL INFORMATION

Air dispersion modeling of ethylene oxide was conducted by the Georgia Environmental Protection Division (GA EPD) to assess the impacts of ethylene oxide emissions from sources at Innovative Chemical Technologies, Inc**.,** in Cartersville, GA (hereafter, ICT), on ambient air surrounding the facility. Although this modeling is not for issuance of an air quality permit, GA EPD followed the procedures described in GA EPD's *Guideline for Ambient Impact Assessment of Toxic Air Pollutant Emissions*[1] (hereafter, "Georgia Air Toxics Guideline").

Computer models are used to predict the concentrations of toxic air pollutants (TAPs) being analyzed using facility information provided by the source and other information developed by GA EPD staff. The modeling results are compared to the 15-min and annual Acceptable Ambient Concentrations (AACs). GA EPD's 15-min AACs are derived from Occupational Safety and Health Administration (OSHA) permissible exposure limits. GA EPD's annual AACs are derived from U.S. EPA's risk values which are found in EPA's Integrated Risk Information System (IRIS) database. Appendix B contains detailed calculations for the 15-min and annual ethylene oxide AACs.

GA EPD uses AACs as a screening tool to ensure that public health is protected. No further evaluation is needed if the modeled concentrations are below the corresponding AACs. If the modeled concentration is above the AAC, GA EPD requires the company to consider a reduction in pollutant emission rates, additional controls, and/or an increase in stack heights, followed by a site-specific risk assessment.

After performing a site-specific risk assessment, if it is infeasible for the applicant to comply with the AAC, the Director at his/her discretion may approve control technology which reflects the maximum degree of reduction in emissions of hazardous air pollutants that the Director determines is achievable by the source, provided that such control technology is no less effective than the level of emission control which is achieved in practice by the best controlled similar source.

This memo discusses modeling results and the input data used to perform the ethylene oxide dispersion modeling. The modeled maximum ground-level concentrations (MGLCs) for the 15-min and annual period were below their corresponding AACs. Therefore, a site-specific risk assessment was not required. The results are summarized in the following sections of this memorandum.

[1] https://epd.georgia.gov/air-protection-branch-technical-guidance-0/toxic-impact-assessment-guideline

INPUT DATA

1. **Meteorological Data** – Hourly meteorological data (2014 to 2018)[2] were generated by GA EPD. Surface measurements were obtained from the Cartersville Airport, Cartersville, GA. Upper air observations were obtained from the Atlanta Regional Airport – Falcon Field, Peachtree City, GA. These measurements were processed using the AERSURFACE (v13016), AERMINUTE (v15272), and AERMET (v18081) with the adjusted surface friction velocity option (ADJ_U*).

2. **Source Data** – Emission release parameters and emission rates were provided by ICT and reviewed by the GA EPD Stationary Source Permitting Program (see Table A1 in Appendix A for details). The facility-wide modeled ethylene oxide emission rate was 0.038 lbs/year.

3. **Receptor Locations** – Discrete receptors with no more than 50-meter intervals were placed along the property line. Receptors extend outwards from the property line at 100-meter intervals on a Cartesian grid to approximately 5 km. This domain (approximately 11 km by 11 km) is sufficient to capture the maximum impact. All receptor locations are represented in the UTM projections, Zone 16, North American Datum 1983.

4. **Terrain Elevation** – Topography was found to be generally flat in the site vicinity. Terrain data from the USGS 1-sec National Elevation Dataset (NED) were extracted to obtain the elevations of all sources, buildings, and receptors by the AERMAP terrain processor (v18081).

5. **Building Downwash** – The potential effect for building downwash was evaluated via the "Good Engineering Practice (GEP)" stack height analysis and was based on the building parameters submitted by ICT using the BPIPPRM program (v04274). The BPIPPRM model was used to derive building dimensions for the downwash assessment and the assessment of cavity-region concentrations.

AIR TOXICS ASSESSMENT

The impacts of facility-wide ethylene oxide emissions were evaluated according to the Georgia Air Toxics Guideline. The 15-min and annual AACs were reviewed based on OSHA Permissible Exposure Limit (PEL), OSHA Total Weight Average (TWA) PEL, and U.S. EPA IRIS Risk Based Air Concentration (RBAC) according to the Georgia Air Toxics Guideline. For this assessment, GA EPD used the annual AAC derived according to the Georgia Air Toxics Guideline (see Appendix B for details). The EPA's 2014 National Air Toxic Assessment (NATA) used a higher annual AAC value (see Appendix C for details). The modeled 1-hour and annual ground-level concentrations were calculated using the AERMOD dispersion model (v19191).

Table 1 summarizes the MGLCs and the AAC levels. The 15-min MGLC is based on the 1-hour MGLC multiplied by a factor of 1.32. The 15-min and annual MGLCs were below their corresponding AACs. Therefore, a site-specific risk assessment was not required.

Table 1. Modeled MGLCs and their Respective AACs.

Averaging period	MGLC ($\mu g/m^3$)	AAC ($\mu g/m^3$)
Annual	0.00024	0.00033
15-min	0.24	900

[2] https://epd.georgia.gov/air-protection-branch-technical-guidance-0/air-quality-modeling/georgia-aermet-meteorological-data

CONCLUSIONS

The dispersion modeling analysis for ethylene oxide shows the modeled 15-min and annual maximum ground-level concentrations did not exceed their respective AACs; therefore, a site-specific risk assessment was not required.

Appendix A

Emissions and Model Input Parameters

Table A1. Source Parameters

Stack Parameters

Model ID	Description	Exhaust Type[1]	UTM Zone 16 NAD 83		Base Elevation	Stack Height		Potential Long Term Emissions[2]		Short Term Emission Rate[2]		Stack Temperature[3]		Adjusted Stack Velocity[4]		Stack Diameter	
		(D/H)	X (m)	Y (m)	(m)	(ft)	(m)	(lb/hr)	(g/s)	(lb/hr)	(g/s)	(F)	(K)	(ft/s)	(m/s)	(in)	(m)
R11	Reactor 11	D	700253.37	3780423.8	228.09	33	10.06	2.10E-06	2.64E-07	3.06E-04	3.86E-05	284	413.15	N/A	0.001	1	0.0254
VPR11	Vacuum Pump for R11	H	700223.67	3780427.3	227.82	32.5	9.91	1.86E-09	2.34E-10	2.71E-07	3.42E-08	-459.67	0	N/A	0.001	2	0.0508

Volume Source Parameters[5]

Model ID	Description	UTM Zone 16 NAD 83		Base Elevation	Releaqse Height[6]		Potential Long Term Emissions[2]		Short Term Emission Rate[2]		Initial Lateral Dimension Syint[7]		Initial Vertical Dimension Szinit[8]	
		X (m)	Y (m)	(m)	(ft)	(m)	(lb/hr)	(g/s)	(lb/hr)	(g/s)	(ft)	(m)	(ft)	(m)
VL1	Building Fugitives	700258.94	3780423.2	228.04	16	4.88	1.12E-06	1.41E-07	2.34E-05	2.94E-06	10.70	3.26	14.88	4.54
VL2	Building Fugitives	700258.9	3780409.2	228.84	16	4.88	1.12E-06	1.41E-07	2.34E-05	2.94E-06	10.70	3.26	14.88	4.54

Notes:
1. D: Downward, H: Horizontal
2. From Table 1.
3. Ambient exhaust is set to 0 Kelvin which causes AERMOD to use the ambient temperature as the exit temperature.
4. Velocity adjusted to 0.001 m/s to represent downward facing stack. As the velocity for the horizontal stack is unkown, it has been conservatively represented as 0.001 m/s (and the POINHOR option has not been used in the model).
5. Production area where the reactor is located. As the area is rectangular (95 ft by 46 ft) the area was divided into two volume sources.
6. Release Height is the center of the volume above ground [US EPA's User's Guide for the AMS/EPA Regulatory Model (AERMOD), EPA-454/B-19-027, August, 2019].
7. Initial lateral dimension of the volume: length of side divided (46 ft) by 4.3 [US EPA's User's Guide for the AMS/EPA Regulatory Model (AERMOD), EPA-454/B-19-027, August, 2019].
8. Initial vertical dimension of the volume: building height (32 ft) divided by 2.15. [US EPA's User's Guide for the AMS/EPA Regulatory Model (AERMOD), EPA-454/B-19-027, August, 2019].

Appendix B

GA EPD Calculation of the 15-min and Annual AACs
for Ethylene Oxide

GA EPD Calculation of the 15-min and Annual AACs for Ethylene Oxide

According to the GA EPD's *Guideline for Ambient Impact Assessment of Toxic Air Pollutant Emissions*, the 15-min and annual AACs for ethylene oxide are calculated as following:

15-min AAC

The OSHA 15-min permissible exposure limit (PEL) for ethylene oxide is 5 ppm. To convert the PEL from ppm to mg/m^3, the following conversion formula from the guidance is used:

$$(5\ ppm \times 44.05\ g/mol) / (24.45\ L/mol) = 9\ mg/m^3$$

where, 44.05 is the molecular weight for ethylene oxide and 24.45 is the molar volume at 25°C and 760 mmHg. After applying a safety factor of 10 for acute sensory irritants, the 15-min AAC is calculated as:

15-min AAC = ($9\ mg/m^3 \times 1{,}000\ \mu g/mg$) / 10 (safety factor)
15-min AAC = 900 µg/m³

Annual AAC

In the EPA Integrated Risk Information System (IRIS)[3], the Inhalation Unit Risk (IUR) for ethylene oxide is 3×10^{-3} per $\mu g/m^3$. Since ethylene oxide is carcinogenic to humans, it belongs to Group A[4] with a cancer risk of 1/1,000,000. Therefore, the annual AAC is calculated as:

Annual AAC = Cancer Risk / IUR = $(1/1{,}000{,}000)/(0.003/\mu g/m^3)$
Annual AAC = 0.00033 µg/m³

[3] https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/1025_summary.pdf
[4] https://www.epa.gov/fera/risk-assessment-carcinogenic-effects

Appendix C

EPA Calculation of the Annual AAC
for Ethylene Oxide

EPA Calculation of the Annual AAC for Ethylene Oxide

According to EPA's IRIS, inhalation unit risk (IUR) for ethylene oxide (EtO) is $3x10^{-3}$ per $\mu g/m^3$ (as discussed in Appendix B). However, because of the elevated risk due to the mutagenic mode of action through early-life exposures, EPA multiplied the IUR by 1.6:

Modified IUR for EtO = $3x10^{-3}$ per $\mu g/m^3$ x 1.6 = $0.005/\mu g/m^3$

EPA's NATA used (100/1,000,000) individual risk for the purpose of determining "acceptable risk" (AR) in their national assessment.

AR Exposure Concentration = Cancer Risk / IUR = $(100/1{,}000{,}000)/(0.005/\mu g/m^3)$ **= 0.02 µg/m^3**