ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
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MEMORANDUM

DATE: December 17, 2019

TO: File, Construction Permit Application No. 19100015

FROM: Steven King, Modeling Unit, Air Quality Planning Section, Bureau of Air

SUBJECT: Vantage Specialties, Inc. (ID No. 097035AAQ)

Background

Vantage Specialties, Inc. (Vantage) operates a chemical manufacturing plant in Gurnee, Illinois. The facility is located at 3938 Porett Drive. At this facility, Vantage produces surfactants, cleaning products, lubricants, food-grade ingredients, and industrial products.

In December 2016, the United States Environmental Protection Agency (U.S. EPA) issued a summary report[1] which supported the Integrated Risk and Assessment System (IRIS) upgrade of ethylene oxide from "probably carcinogenic to humans" to "carcinogenic to humans" (p. 2). The adult-based inhalation cancer risk estimate for ethylene oxide, called the "unit risk estimate", was changed from 0.0001 per microgram per cubic meter ($\mu g/m^3$) to 0.003 per $\mu g/m^3$, which equates to a 30-fold cancer potency increase. Per the 2016 report (p. 5), "*When using the adult-based unit risk estimates to estimate extra cancer risks for a given exposure scenario, the standard age-dependent adjustment factors (ADAFs) should be applied, in accordance with the EPA's Supplemental Guidance (U.S. EPA, 2005b). Applying the ADAFs to obtain a full lifetime total cancer unit risk estimate yields 5.0 × 10^{-3} per $\mu g/m^3$.*" For the modeling demonstration submitted by Vantage, the 0.005 per $\mu g/m^3$ lifetime unit risk estimate is the appropriate metric to apply to the dispersion modeling results for residential areas. In commercial, industrial, or off-site adult worker areas, a 0.003 per $\mu g/m^3$ unit risk estimate consistent with U.S. EPA's assumption of an 8.5-hour workday, 250 days a year, for 25 years, and an 0.087 exposure factor, is the appropriate method for estimating risk.

In August 2018, U.S. EPA publicly released the 2014 National Air Toxics Assessment (NATA)[2] This report identified, in part, areas of the country that may have an increased cancer risk based on 2014 emissions estimates for toxic compounds and screening level air quality modeling. The NATA estimated nationwide average "background" cancer risk from air toxics exposure as

[1] Evaluation of the Inhalation Carcinogenicity of Ethylene Oxide. December 2016 U.S. Environmental Protection Agency Office of Research and Development. https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/1025_summary.pdf

[2] Technical Support Document; EPA's 2014 National Air Toxics Assessment. Office of Air Quality Planning and Standards. August 2018

approximately 30 in a million[3]. In addition, the NATA report identified census tracts around the country with cancer risk levels that were more than a 1 in 10,000 (100 in a million) increase in cancer risk. The risk "level" is based on the likelihood that a person could develop cancer based on air toxic exposure over 70 years (i.e. "lifetime" risk). The 100 in a million level is considered the upper limit of acceptable lifetime cancer risk for the most exposed person. The NATA is primarily designed to identify areas where cancer risk may be elevated and does not address a specific individual's risk at the local scale. What it does do, is identify areas that warrant further study on what pollutants and sources may be contributing to the elevated risk. According to the 2014 NATA, the Waukegan-Gurnee area was identified as potentially having overall cancer risk estimates greater than 100 in a million, with ethylene oxide identified as the predominant pollutant driving this estimate. In this area, both Medline Industries Inc. in Waukegan and Vantage in Gurnee, which are separated in distance by approximately 5 kilometers, are the known emitters of ethylene oxide. Both sources are taking actions to reduce their emissions and impacts.

Vantage Permit Application

This memorandum relates to a construction permit application that Vantage submitted to the Illinois EPA on October 22, 2019 in order to comply with State of Illinois Public Act 101-23 (Senate Bill 1854). Namely, Vantage requested a permit that would set a site-specific annual cap on the ethylene oxide emissions from its facility. It also submitted documentation and a demonstration via dispersion modeling for the ambient air impacts. Subsequently, it submitted additional revised modeling on October 28, 2019 and October 29, 2019 based on agency comments. The final revision to the modeling is dated October 29, 2019. The remainder of this memorandum summarizes that modeling analysis and reviews the appropriateness of the methodology utilized in the air quality analysis.

Illinois EPA Review

Ramboll Environmental (Ramboll) performed the air quality analysis on behalf of Vantage. The technical description, modeling summary, and electronic modeling input/output data for the ethylene oxide air quality impact analysis, was prepared by Ramboll.

The process equipment at the plant that emits ethylene oxide is located in the Alkoxylation Area. Emissions are controlled by a scrubber followed by a dry bed absorption device. Vantage used the following stack parameters and emissions for the control system for the process equipment in the Alkoxylation Area:

[3] 2014 National Air Toxics Assessment : Fact Sheet https://www.epa.gov/sites/production/files/2018-08/documents/2014_nata_overview_fact_sheet.pdf

• **Ethylene Oxide Emissions:** 0.00072 grams per second (0.005714 pounds per hour)*
• **Stack Height:** 19.5 meters (64.0 feet) and 34.5 meters (113.3 feet) above grade
• **Stack Diameter:** 0.3042 meters (0.998 feet)
• **Stack Temperature:** 294.26 degrees Kelvin (70.0 degrees Fahrenheit)
• **Stack Exit Velocity:** 7.26 meters per second (23.8 feet per second)

* Equivalent to 50 pounds per year

Vantage submitted modeling for two different stack heights, the existing stack at 64 feet above grade, and a taller stack at 113 feet. This taller stack height is based on the equation in U.S. EPA's good engineering practice stack height technical report[4]. This modeling incorporates site specific building and stack data to compute an appropriate height to avoid excessive impacts due to building-induced downwash.

Vantage also modeled fugitive (i.e. non-stack) ethylene oxide emissions. These types of emissions occur for components in piping associated with railcar unloading to the storage tank area (south end of the facility near the rail line) and from system components such as pumps, valves, connectors, and flanges in Alkoxylation Area (northeast corner of property). Since these emissions do not have release characteristics typical of stacks such as exhaust temperatures and plume rise, they were appropriately modeled as area sources. The area sources were also modeled for three distinct locations (55% of the fugitive emissions) in the railcar unloading and storage area (south end) and two locations adjacent to each other in the reactor area (north end). The total ethylene oxide emissions modeled was 60 pounds per year from fugitive sources.

The following summary reflects my evaluation regarding the acceptability of the air quality analysis for:

- Ramboll performed the dispersion modeling analysis using U.S. EPA's AERMOD model (version 19191) to predict impacts from the facility for the proposed project. AERMOD is a state and federally approved regulatory model appropriate for use in an air quality analysis of this nature. The AERMOD version utilized is the update released in July 2019.
- Ramboll addressed building-induced plume downwash for the current and proposed stack using U.S. EPA's Building Profile Input Program with PRIME algorithm (BPIPPRM, version 04274) to determine building parameters to model building wake effects. All structures on the facility's property as well as three nearby buildings identified by Illinois EPA off-property on the northern end, were included in the inputs to the BPIPPRM program. Modeling inputs utilized Illinois EPA and U.S EPA recommended regulatory options, which simulate phenomena such as atmospheric stability, plume rise, and downwash.

[4] Guideline for Determination of Good Engineering Practice Stack Height (Revised); June 1985. U.S. EPA

- Ramboll applied five years of locally representative meteorology to the modeling. Illinois EPA developed this meteorological dataset utilizing AERMET version 19191 and provided the applicant with 2014-2018 surface meteorological data from Waukegan Regional Airport (WBAN No. 14880) and upper air from Davenport Regional Airport (WBAN No. 94982). The 5-year hourly meteorological dataset was developed in accordance with the U.S. EPA Region V and States Meteorological Data Processing Protocol (May 2018). Illinois EPA considers this dataset representative of meteorological conditions within the modeling domain.
- Illinois EPA provided guidance on the density of the receptor grid both to satisfy statutory requirements and adequately identify the location of the maximum impact area. The receptor network submitted consists of a receptor grid with 50-meter spacing from the emissions sources out to 500-meters, and 100-meter spacing from 500-meters out to 1-kilometer away. The grid contains a total of 1139 receptor points. For both scenarios, Illinois EPA requested eight additional receptors be placed near the area of the predicted maximum impact to effectively determine the maximum residential concentration.
- Illinois EPA accepts the applicant's rationale for running AERMOD in rural dispersion mode based on the Auer's land use classifications within a 3-kilometer radius of the facility. This analysis indicated that land use is greater than 50% rural (Illinois EPA in-house analysis concurs), making rural the more appropriate model setting.
- AERMAP (version 18081) was implemented appropriately in conjunction with U.S. Geological Survey 3D elevation data to determine terrain heights for sources, buildings, and receptors.

Ramboll utilized the previously identified software and settings, along with indicated stack and area source parameters and proposed cap on annual ethylene oxide emissions (110 pound per year total, of which no more than 60 pounds per year would be fugitive) to predict the five-year average concentration at each receptor point. This five-year timeframe is considered to reasonably represent long-term (lifetime/70-year) exposures and impacts.

Table 1 presents the maximum predicted five-year average ethylene oxide concentration for the annual emissions cap, different stack heights (64' and 113'), and release point characteristics for the stack and area sources. Illinois EPA has audited the modeling results for the scenarios and verifies that the correct inputs and procedures were used in the modeling exercise. Illinois EPA also confirms that the area of maximum impact for both non-residential and residential areas is sufficiently determined in the modeling demonstration.

Table 1
Maximum Predicted Average Ethylene Oxide Concentration by Scenario

Averaging Period	Scenario	Receptor Location of Domain Maximum		Maximum Predicted 5-Year Average Concentration (µg/m^3)		
		UTM Easting (m)	UTM Northing (m)	Entire Domain	Off-Property	Entire Domain Highest Residential
5-years	64'	421967.1	4622473.0	0.01975*	0.00781	0.00182
5-years	113'	421919.0	4622256.0	0.00123	0.00123	0.00048
5-years	Fugitive Only	425980.4	4692829.0	0.23679	0.13560	0.01238

* Maximum predicted concentration for 64' stack only "scenario" is within Vantage's property.

For Stack Emissions with the 64' stack height (Existing stack), the maximum predicted five-year average ethylene oxide concentration in the domain is **0.01975** micrograms per cubic meter (µg/m^3). This predicted maximum is on Vantage's property. The highest predicted off-property concentration is **0.00781** µg/m^3. This predicted off-property maximum occurs approximately 50 meters east of Vantage's railcar and storage area. To determine an "in a million" risk estimate for these maximum predicted *non-residential impacts*, Illinois EPA adhered to calculation procedures outlined in the OAQPS August 2019 (p. 16) risk report for another ethylene oxide emitting facility in Illinois.[5] These calculations yield a maximum lifetime risk of **5 in a million** for on-site workers. For off-property workers, the lifetime risk is **2 in a million**. The maximum predicted *residential* concentration is approximately **0.00182** µg/m^3, located approximately 430 meters to the east of the current stack at Vantage. This impact represents a maximum *residential lifetime risk* of approximately **9 in a million**.

For Stack Emissions with the 113' stack (Taller stack), the maximum predicted five-year average ethylene oxide concentration in the entire modeling domain is **0.00123** µg/m^3. This predicted domain-wide maximum is off-property and approximately 245 meters northeast of the current stack. This maximum concentration represents a *non-residential* lifetime risk of **0.3 in a million** for off-site workers. The maximum predicted *residential* concentration is approximately **0.00048** µg/m^3, located approximately 430 meters to the northeast of the current stack at Vantage. This impact represents a maximum residential lifetime risk of approximately **3 in a million**.

[5] Risk Assessment Report for the Sterigenics Facility in Willowbrook, Illinois; August 2019. EPA's Office of Air Quality Planning and Standards Office of Air and Radiation

For Fugitive Emissions, the maximum predicted five-year average ethylene oxide concentration in the entire modeling domain is **0.23679** µg/m^3. This predicted maximum is on Vantage's property at a receptor on its northeastern fence-line, approximately 10 meters east of the reactor's area sources. The highest predicted off-property concentration is **0.1356** µg/m^3. This predicted maximum occurs approximately 50 meters east of Vantage's railcar and storage area. For the highest predicted concentration at the fence-line, risk calculations yield a maximum lifetime risk of **62 in a million** for on-site workers. For off-property workers, the maximum lifetime risk is **35 in a million**. The maximum predicted *residential* concentration is approximately **0.01238** µg/m^3, located approximately 430 meters to the east of the current stack at Vantage. This impact represents a maximum *residential lifetime risk* of approximately **62 in a million**.

Table 2 reports the two source groupings of impacts: Stack (64' and 113') and fugitive emissions.

Table 2
Maximum Predicted Average Ethylene Oxide Concentration by Source Groupings

Averaging Period	Source Groupings	Receptor Location of Domain Maximum		Maximum Predicted 5-Year Average Concentration (µg/m^3)		
		UTM Easting (m)	UTM Northing (m)	Entire Domain	Off-Property	Entire Domain Highest Residential
5-years	64' Stack + Fugitive	425980.4	4692829.0	0.23769	0.13760	0.01409
5-years	113' Stack + Fugitive	425980.4	4692829.0	0.23682	0.13628	0.01286

For the 64' stack + fugitive source emissions grouping, the maximum predicted five-year average ethylene oxide concentration in the domain is **0.23769** µg/m^3. This predicted maximum is on Vantage's property at a receptor on its northeastern fence-line, approximately 10 meters east of the reactor's area sources. The highest predicted off-property concentration is **0.1376** µg/m^3. This predicted maximum occurs approximately 50 meters east of Vantage's railcar and storage area. For the highest predicted concentration at the fence-line (entire domain), risk calculations yield a maximum lifetime risk of **62 in a million** for on-site workers. For off-property workers, the maximum lifetime risk is **36 in a million**. The maximum predicted *residential* concentration is approximately **0.01409** µg/m^3, located approximately 430 meters to the east of the current stack at Vantage. This impact represents a maximum *residential lifetime risk* of **70 in a million**.

For the 113' stack + fugitive emissions grouping , the maximum predicted five-year average ethylene oxide concentration in the domain is **0.23682** µg/m^3. This predicted maximum is on Vantage's property at a receptor on its northeastern fence-line, approximately 10 meters east of

the reactor's area sources. The highest predicted off-property concentration is **0.1363** µg/m^3. This predicted maximum occurs approximately 50 meters east of Vantage's railcar and storage area. For the highest predicted concentration at the fence-line (entire domain), risk calculations yield a maximum lifetime risk of **62 in a million** for on-site workers. For off-property workers, the maximum lifetime risk is **36 in a million**. The maximum predicted *residential* concentration is approximately **0.01286** µg/m^3, located approximately 430 meters to the east of the current stack at Vantage. This impact represents a maximum *residential lifetime risk* of approximately **64 in a million**.

Table 3 provides a summary of non-residential and residential lifetime risks for the individual source and the source grouping.

Table 3
Maximum Predicted Lifetime Risk

Stack Height/Scenario	Maximum Predicted Lifetime Risk (in a million)		
	Entire Domain Non-Residential	Off-Property Non-Residential	Entire Domain Highest Residential
64'	5	2	9
113'	< 1	< 1	2
Fugitive Only	62	35	62
64' Stack + Fugitive	62	36	70
113' Stack + Fugitive	62	36	64

Recommendation

The area of maximum predicted impact for both scenarios has been sufficiently determined. All receptor locations within one-square kilometer of the facility for all scenarios, predict overall risk attributable to Vantage below U.S. EPA's upper limit of acceptable lifetime cancer risk for the most exposed person of 100 in a million. The topography beyond one kilometer of the facility is generally flat to gently rolling. Thus, standard dispersion principles intrinsic to the model's gaussian - plume equation will calculate a decreasing gradient of concentrations and risk beyond the one-kilometer extent of the modeling domain. Based upon my review and audit of the applicant's dispersion modeling, including associated emission rate, revised stack configuration, modeling procedures, and modeled impacts, the ethylene oxide air quality analysis submitted by Ramboll on behalf of Vantage is an acceptable demonstration of ambient air impacts.