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DATE: January 6, 2025

TO: Mohamed Otry, Environmental Protection Engineer, State/FESOPs Unit, Permits/BOA

FROM: David Coy, Modeling Unit, Permits/BOA

SUBJECT: T5 @ Chicago III – Northlake, Hoffman Estates, Cook County, Illinois – 031471AEU, Permit Application # 24020017

T5@Chicago III, LP (T5) is applying for a Construction Permit for a new data center located at 11650 West Grand Ave, Northlake, Illinois, 60164. The complex is classified as a synthetic minor source under federal air quality regulations. T5 has also applied for Federally Enforceable State Operating Permit (FESOP).

The data center would typically draw electricity from the local power grid, but it would be equipped with 18 diesel-fired emergency generators (Gen1-Gen18) and their associated fuel storage tanks. Each proposed new generator is manufactured by Caterpillar and would have a power output of 3,250 Kilowatt-electrical (kWe). These generators would operate only during emergencies when the data center is unable to draw electricity from the local power grid or for routine monthly maintenance and testing of the generators.

Since T5 is presently located in an Environmental Justice (EJ) community and would have a permitted increase in emissions, Illinois EPA asked the facility to submit an air quality analysis as part of its construction permit application. This is to ensure that the project would not violate or threaten existing National Ambient Air Quality Standards (NAAQS). In response, T5 contracted Environmental Resources Management, Inc. (ERM) to conduct a detailed air quality dispersion modeling analysis to assess the potential impact of the data center on air quality from emissions of carbon monoxide (CO), particulate matter (PM_{10} and $PM_{2.5}$), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and volatile organic material (VOM).

Modeling Unit Analysis

The air quality analysis was conducted by ERM, with the initial modeling report submitted on September 10, 2024. Following an initial review, the Illinois EPA Modeling Unit requested a revised analysis for the maximum 1-hour NO_2 impact, as the initial results were very close to the NAAQS limit. The original air quality report was based on a limit of 52 hours per year at full load per generator. ERM revised the model by lowering the limit to 42 hours per year at full load per generator.

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ERM submitted a revised modeling report on November 22, 2024. This final analysis depended on the implementation of several control measures as outlined below in the main dot entries:

- The maximum number of emergency engines that would run simultaneous for non-emergency operations is six.
- The emergency generators would only be able to operate 7am to 7pm (average 43,800hr/year) and the facility proposed to limit operations to only four hours per day.
- The 18 diesel-fired emergency generators (Gen1-Gen18) would be limited to an equivalent of 42 hours per year at full load per generator.
- Limiting a total of 262,351 gallons of diesel fuel per year for all 18 generators.

ERM utilized the modeling methodology detailed in the main bullets points below:

- ERM used AERMOD (version 23132),[1] which is a federally approved regulatory model for air quality analysis. The Modeling Unit also used this version for their audit runs.

- Modeling inputs utilized IEPA – and USEPA – recommended default regulatory options to simulate phenomena such as atmospheric stability, plume rise, and downwash. The model used five years of locally representative meteorology. The Modeling Unit obtained National Weather Service (NWS) meteorological data files from years 2019 through 2023 from the National Centers for Environmental Information (NCEI). This data came from the National Weather Service: surface data from O'Hare International Airport in Chicago and upper air data from the National Weather Service in Davenport, IA. The applicant processed the weather data using AERMET (version 23132).[1]

- AERMOD's terrain tool, AERMAP (version 18081)[1], was used to find the elevation of receptors, sources, and buildings. It read detailed elevation maps from the National Elevation Database (NED) provided by the United States Geological Survey (USGS). The site elevation at the T5 is about 204.8 meters above sea level.

ERM utilized a cartesian grid to distribute a total of 3771 receptors, with receptor placed every 50 meters along the facility fence line. The following receptor grid densities in **Table 1** were applied:

[1] A new version of AERMOD, AERMAP, and AERMET (v. 24142) has been released, but it is not expected to impact the results of this modeling analysis. Therefore, the use of AERMOD (v. 23132), AERMET (v. 23132), and AERMAP (v. 18081) was approved for this analysis since the modeling was submitted before the release of the new versions. Tillerson, Clint (2024, November 20) *Release of the regulatory AERMOD Modeling System (AERMOD, AERMET, and AERMAP), AERSURFACE, and AERPLOT (Version 24142), and MMIF (Version 4.1.1).* USEPA https://gaftp.epa.gov/air/aqmg/scram/models/preferred/aermod/AERMOD_24142_transmittal_memo.pdf

Table 1
Receptor Grid

Discrete Cartesian Grid Format	
Spacing	**Range**
50 m	Fenceline out to 500 m.
100 m	500 m to 2 km.
250 m	2 km to 5 km.
500 m	5 km to 10 km

- Building downwash effects on plumes from the stacks at the facility were considered in the model using USEPA's Building profile Input Program (BPIPRM version 04274). The dimension and locations of buildings and structures, including heights and coordinates, were provided by the facility.

- ERM selected the urban modeling option in their analysis. The Modeling Unit developed its Auer's Analysis using 2021 National Land Cover Data (NLCD) within a 3-km radius of the facility following Appendix W, Section 7.2.1.1 (b)(i).[2] Results of the analysis showed that the surrounding area is 68% urban.

- The USEPA's Appendix W, Section 4.2.3.4[2] outlines the three tiers for modeling the conversion of NOx to NO_2:

    - Tier 1: Assumes that all the NOx emitted from the source's emissions units is converted to NO_2.

    - Tier 2: Uses a representative atmospheric equilibrium default value, developed from conversion ratios based on monitored NOx and NO_2 concentrations.

    - Tier 3: Allows for a detailed analysis using either the Ozone Limiting Method (OLM) or the Plume Volume Ratio Method (PVMRM) as regulatory screening options in AERMOD. These methods account for Ozone titration chemistry and the resulting NO_2 concentrations.

  ERM applied a Tier 2 approach to model NO_2. ERM used the regulatory default Ambient Ratio Method (ARM2) option in AERMOD, which utilized ambient NO_2 /NOx ratios ranging from 0.5 (lower limit) to 0.9 (upper limit).

- The modeling analysis was based on the maximum number of engines that would be run simultaneously for non-emergency operations, which is six. Therefore, the modeling was performed using the top six worst-case engines for the short-term averaging periods.

  The methodology implemented to identify the top six worst-case engines is as follows:

[2] Appendix W to Part 51, *Guideline on Air Quality Models,* 40 CFR 51 (2024).

1. Simulate all 18 engines running with a unit emission rate of 1 gram/second, for each load case and averaging period.

2. Identify the maximum impact point for each load case and averaging period.

3. For each maximum impact point identified, conduct a secondary simulation for that location and associated meteorological period to define source-by-source culpability at the maximum impact location.

4. Rank all 18 generators by decreasing impact at the maximum impact point.

5. The worst-case engine group is defined by the highest 6 ranked culpable sources.

- The modeling analysis included six emergency generators operating simultaneously, representing the worst-case scenario out of the total 18 generators. For testing and maintenance, the facility would typically not operate all 18 generators at once. The modeled emission rates varied depending on the pollutant and the averaging period.

    - For annual averaging periods, the 100% load condition was modeled. Emissions for each generator were annualized based on 52 hours per year of non-emergency operation.[3] Since the generators are limited to operating between 7:00 AM and 7:00 PM for non-emergency use, emissions were averaged across 4,380 hours per year to obtain the modeled emission rate for the annual averaging periods.

    - The modeling for the1-hour SO_2 standard used the same annualized emission rate based on 52 hours per year of non-emergency operation.[3] This approach reflects the intermittent nature of emission and is consistent with the probabilistic form the 1-hour standard. For $SO_{2,}$ this corresponds to the 99th percentile of the annual daily maximum 1-hour average.

    - The modeling for 1-hour NO_2 standard used the same annualized emission rate based on 42 hours per year of non-emergency operation. This approach reflects the intermittent nature of emissions and is consistent with the probabilistic form of the 1-hour standard. For NO_2, this corresponds to the 98th percentile, of the annual daily maximum 1-hour average. This methodology aligns with the UEPA's memorandum "Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard."[4] The NO_2 modeling used the USEPA-approved default model options for Tier II NO_2 analysis (ARM2).

    - For the 24-hour averaging periods for PM_{10} and $PM_{2.5}$, the maximum lb/hr

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[3] Since the analysis results were below the NAAQS, re-modeling of pollutants at the new 42-hour-per-year limit was not required.

[4] USEPA (2011). *Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard* https://www.epa.gov/sites/default/files/2020-10/documents/clarificationmemo_appendixw_hourly-no2-naaqs_final_06-28-2010.pdf

emission rates were adjusted by a factor of 4/12 to account for the four hours of daily operation within the 12-hour period (7:00 AM to 7:00 PM).

- For CO, the short-term averaging period emission rates were based on the maximum hourly emission rate for each generator.

- The short-term modeling accounted for four different load scenarios (25%, 50%, 75%, and 100% load), with stack release parameters and emission rates varying depending on the load scenario.

Significant Impact Analysis

ERM performed a significant impact analysis to determine whether more detailed modeling would be required for any of the criteria pollutants (NO_2, SO_2, CO, $PM_{2.5}$, and PM_{10}) associated with this project. T5 modeled the allowable emission rates for each pollutant and averaging period. Modeled concentrations were compared against significant impact levels (SIL) for each pollutant and averaging period. The results of this analysis are displayed in **Table 2** below.

Table 2
Significant Impact Modeling Results

Pollutant	Averaging Period	Load	Modeled Concentration (µg/m³)	Standard (µg/m³)	>SIL
CO	1-hour	100%	794.1	2000	No
		75%	924.9		No
		50%	2089.8		Yes
		25%	922.8		No
	8-hour	100%	636.8	500	Yes
		75%	736.8		Yes
		50%	1650.7		Yes
		25%	663.8		Yes
NO_2	1-hour	100%	106.6	7.5	Yes
		75%	63.4		Yes
		50%	48.2		Yes
		25%	36.3		Yes
	Annual	100%	7.9	1.0	Yes
PM_{10}	24-hours	100%	4.4	5	No
		75%	2.8		No
		50%	8.3		Yes
		25%	5.7		Yes
$PM_{2.5}$	1-hour	100%	3.8	1.2	Yes
		75%	2.3		Yes

		50%	7.0		Yes
		25%	5.3		Yes
	Annual	100%	0.034	1.3	No
SO_2	1-hour	100%	0.09	7.9	No
		75%	0.08		No
		50%	0.06		No
		25%	0.04		No
	3-hour	100%	7.8	25	No
		75%	5.6		No
		50%	4.7		No
		25%	3.7		No
	24-hour	100%	3.1	7.9	No
		75%	1.7		No
		50%	1.5		No
		25%	1.2		No
	Annual	100%	0.007	1	No

The $PM_{2.5}$ results displayed in Table 2 include both primary and secondary impacts. Details of the secondary $PM_{2.5}$ and Ozone (O_3) analysis are described in the following section.

Ozone and Secondary $PM_{2.5}$ formation.

Precursor emission of NOx, SO_2, and VOM chemically react with the atmosphere to form secondary $PM_{2.5}$ and O_3. The AERMOD dispersion model cannot estimate secondary formation of pollutants due to the complex chemistry and meteorological conditions involved. Secondary formation of pollutants requires complex photochemical modeling techniques. To analyze the formation of secondary formed $PM_{2.5}$ and O_3 on their respective NAAQS, ERM performed Tier 1 demonstration following guidance[5,6,7] from USEPA on modeled emission rates for precursors (MERPs).

ERM utilized the most conservative MERP values for locations in the Upper Midwest. It should be noted that a recent clarification memorandum from USEPA on April 30, 2024,[5] noted that MERP values presented as an emission rate should no longer be utilized as they are based upon an annual $PM_{2.5}$ SIL value that is no longer appropriate. As such, the Illinois EPA verified ERMs

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5 USEPA (2024). *Clarification on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program*. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

6 USEPA (2019). *Guidance on the Use of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program*. Publication No. EPA 454/R–19–003. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

7 USEPA (2022). *Guidance for Ozone and Fine Particulate Matter Permit Modeling*. Publication No. EPA 454/R–22–005. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

MERPs analysis using the approach outlined by USEPA in the recent guidance memorandum. The Modeling Unit approach utilized values that can be found in the USEPA's MERPs View Qlik tool.[8]

The Modeling Unit utilized a hypothetical source located in Porter, Indiana. The hypothetical source with a stack height of 10 m, and source emissions of 500 tpy was utilized in the modeling analysis. The results were based upon facility emissions of 45 tpy of NOx, 0.04 tpy of SO_2, and 0.64 tpy of VOM.

Ozone Impacts

Table 3 summarizes the Ozone impacts for T5.

Table 3
MERPs Analysis for Ozone

	Concentration (ppb)	SIL (ppb)
8-hour Ozone	0.106	1

T5 have estimated O_3 impacted below the 1 ppb SIL, which are further reflective that the emissions of NO_x and VOM would not impact the O_3 NAAQS.

Secondary $PM_{2.5}$

The secondary $PM_{2.5}$ results displayed in **Table 4** summarized the MERPs calculations from the Modeling Unit.

Table 4
MERPs Analysis for Secondary $PM_{2.5}$

	Concentration ($\mu g/m^3$)	SIL ($\mu g/m^3$)
24-hour $PM_{2.5}$	0.02101	1.2
Annual $PM_{2.5}$	0.00107	0.13

The total second $PM_{2.5}$ concentration were added to the primary $PM_{2.5}$ impacts modeled with AERMOD for each respective averaging period for comparison to the $PM_{2.5}$ SIL. The combined primary and secondary results were 0.034$\mu g/m^3$ for annual $PM_{2.5}$ (less than the SIL of 0.13 $\mu g/m^3$) and 3.8 $\mu g/m^3$ for 24-hour $PM_{2.5}$ at 100% load (greater than the SIL of 1.2 $\mu g/m^3$).

[8] USEPA (2019). MERPs View Qlik. *Support Center for Regulatory Atmospheric Modeling (SCRAM).* Retrieved from: https://www.epa.gov/scram/merps-view-qlik

Therefore, further analysis against the NAAQS was required for 24-hour $PM_{2.5}$.

Since pollutant concentrations exceeded the SIL for 1-hour (50% load) and 8-hour (All loads) CO, 1-hour (All loads) and Annual (100% load), NO_2, 24-hour (50% and 25% load) PM_{10} and 24-hour (All loads) $PM_{2.5}$, further analysis was needed to demonstrate that the emissions from this facility would not exceed any of the NAAQS for these pollutants.

Cumulative Impact Analysis

The results of the significant impact analysis show further analysis is required to evaluate the project's impact against the 1-hour and 8-hour CO, 1-hour and Annual, NO_2, 24-hour PM_{10} and 24-hour $PM_{2.5}$ NAAQS. ERM developed a cumulative modeling analysis that incorporated background concentration from monitored concentrations and nearby emission inventory sources that were not accounted for in the monitoring data.

The background monitors were selected based on their proximity and representativeness of the area surrounding the facility. The background concentrations are displayed in **Table 5** below.

Table 5
Monitored Background Concentrations

AQS ID	Location	Pollutant	Averaging Period	Modeled Statistic	Design Values				Units
					2021	2022	2023	2021-2023	
17-031-4201	Northbrook, IL	CO	1-hour	Highest 2nd High recent 3-year period.	0.964	1.286	1.147	1.286	ppm
			8-hour	Highest 2nd High recent 3-year period.	0.8	0.7	1	1	ppm
		PM_{10}	24-hour	Highest 2nd High recent 3-year period.	59	40	36	59	µg/m³
17-031-3103	Schiller Park, IL	NO_2	1-hour	98th percentile of daily max 1-hour concentration	54.3	51.6	54.1	53.3	ppb
			Annual	98th percentile of daily max 1-hour concentration	17.14	17.21	17.01	17.2	ppb

		$PM_{2.5}$	24-hour	3-year average annual arithmetic mean	22.8	26	14	20.9	µg/m³

ERM was provided an inventory of sources from the Modeling Unit that included sources located within 10 km radius from the facility. For the 1-hour NO_2 analysis, intermittent sources were excluded from the nearby source inventory based on guidance issued by the USEPA.[9]

Table 6 shows the ERM results for the cumulative NAAQS analysis of CO, NO_2, $PM_{2.5}$ and PM_{10}.

Table 6
NAAQS Modeling Results

Pollutant	Averaging Period	Modeled Statistic	Load	Modeled Concentration (incl. background)	Secondary $PM_{2.5}$	Total Concentration	Standard
				(µg/m³)	(µg/m³)	(µg/m³)	(µg/m³)
PM_{10}	24-hour	Highest 6th High Over 5 Years	50%	69.14	-	69.14	150
			25%	67.02	-	67.02	150
$PM_{2.5}$	24-hour	5-Year Mean of the Annual 8th High	100%	28.28	0.021	28.30	35
			75%	28.25	0.021	28.27	35
			50%	30.48	0.021	30.50	35
			25%	29.45	0.021	29.47	35
NO_2	1-hour	5-Year Mean of the Annual 8th High	100%	164.35	-	164.35	188
	Annual	Maximum	100%	43.46	-		100
CO	1-hour	Highest 2nd High	50%	3581.07	-	3581.07	40000
	8-hour	Highest 2nd High	100%	1744.96	-	1744.96	10000
			75%	1853.26	-	1853.26	10000
			50%	2726.78	-	2726.78	10000
			25%	814.31	-	814.31	10000

[9] USEPA (2011). *Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO2 National Ambient Air Quality Standard.*

The Modeling Unit audit confirmed the results presented in ERM analysis, and all modeled concentrations for the criteria pollutant and averaging periods mentioned above were below their respected NAAQS.

For the pollutants analyzed by ERM, including 1-hour and 8-hour CO, annual NO_2, and 24-hour PM_{10} and $PM_{2.5}$, the modeling was based on 52 hours of operation per year. However, for 1-hour NO_2, the analysis was conducted using 42 hours per year, as the results for 1-hour NO_2 were very close to the NAAQS when calculated with 52 hours. The facility reduced the modeled concentration by limiting the operational hours to 42 hours per year for 1-hour NO_2.

Summary

This analysis was based on the implementation of several control measures as outlined below in the main dot entries:

- The maximum number of emergency engines that would run simultaneous for non-emergency operations is six.
- The emergency generators would only be able to operate 7am to 7pm (average 43,800hr/year) and the facility proposed to limit operations to only four hours per day.
- The 18 diesel-fired emergency generators (Gen1-Gen18) would be limited to an equivalent of 42 hours per year at full load per generator.
- Limiting a total of 262,351 gallons of diesel fuel per year for all 18 generators.

Based on the applicant's submittal and the Modeling Unit's review of ERM's air quality modeling report, the analysis confirmed that the proposed operations with the information presented above do not exceed the NAAQS for $PM_{2.5}$, PM_{10}, NO_2, SO_2, or CO.

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