BRUCE L. MCDERMOTT
203.772.7787 DIRECT TELEPHONE
860.240.5723 DIRECT FACSIMILE
bmcdermott@murthalaw.com

August 27, 2021

Melanie A. Bachman, Esq.
Executive Director
Connecticut Siting Council
10 Franklin Square
New Britain, CT 06051

Re: Petition 1406A – Trinity Consultants Fogging/Icing Dispersion Modeling Analysis

Dear Ms. Bachman:

NuPower Bridgeport FC, LLC ("NuPower") hereby submits to the Connecticut Siting Council ("Council") an original and fifteen (15) copies of the August 26, 2021 report prepared by Trinity Consultants that describes the fogging and icing analysis performed by Trinity for NuPower.

As discussed in NuPower's response to interrogatory CSC-32, subsequent to the completion of the initial Trinity report that was included in NuPower's petition (Attachment B) it was determined that it is possible to duct the project's exhaust to the cooling module intakes. Undertaking that modest modification of mixing the original exhaust with the dry air of the cooling modules results in exhausts with significantly lower water vapor concentration and increased exit velocity. This modification will not alter the position of the exhaust vents relative to the highway, as illustrated in Attachment CSC-26-1.

Trinity has conducted modeling to represent the change in exhaust location and has determined the new modeling analysis "predicts the NuPower fuel cell facility *will have no modeled contributions to plume-induced fogging/icing induced impact on the nearby Interstate 95.* Fogging/icing conditions are modeled to be driven by the existing, natural meteorological conditions in the region."

Should you have any questions regarding this filing, please do not hesitate to contact me.

Very truly yours,

Bruce L. McDermott

Enclosure

Trinity Consultants
153 Cordaville Rd, Ste 120, Southborough, MA 01772 / P 508.273.8600 / **trinityconsultants.com**

August 26, 2021

Mr. James Kenney
Doosan Fuel Cell America, Inc.
101 East Riverside Drive
East Hartford, CT 06108
James.kenney@doosan.com

RE: Doosan Fuel Cell America, Inc – Bridgeport, Connecticut
Fogging/Icing Dispersion Modeling Analysis – Proposed Project Revised

Dear Mr. Kenney:

This report was prepared by Trinity Consultants (Trinity) at the request of Doosan Fuel Cell American, Inc. (Doosan) with the purpose of describing the fogging and icing analysis performed for NuPower LLC's (NuPower) proposed project in Bridgeport, Connecticut. NuPower is proposing to construct, maintain, and operate a grid-side 9.66-Megawatt fuel cell facility and associated equipment in Bridgeport, Connecticut and have expressed the desire to evaluate the potential for source-induced fog from the proposed exhaust streams on a nearby roadway.

Since the last submittal in March 2021, the proposed project has been modified to route the initial exhaust to cooling module fans. As such, this modeling has been updated to represent the change in exhaust location, stack parameters (height and diameter), and exhaust flow rate.

The analysis described in this document focuses on the modeling aspects of source-induced fogging events and summarizes the probability of such events based upon represented facility operations.

BACKGROUND INFORMATION

NuPower is seeking approval from the Connecticut Siting Council for a fuel cell project located on a 0.5-acre private industrial site located adjacent to Interstate-95 (I-95). Trinity has simulated the stack plume impacts on the elevated I-95 to determine if there is an increased potential for fogging and icing conditions. Trinity conducted the fogging/icing modeling analysis utilizing the FOG module of the CALPUFF dispersion model[1].

In summary, the conclusion in this report is that the fogging/icing modeling analysis predicts that the NuPower facility has no modeled contributions to plume-induced fogging/icing conditions at the nearby roadway based on the meteorological and source-related inputs to the model. Fogging/icing conditions are driven by the existing, natural meteorological conditions in the region.

Facility Description

The proposed facility is located in Bridgeport, Fairfield County, Connecticut. This 0.5-acre parcel of land is 0.61 meters in elevation, and is bordered by a railroad, Iranistan Avenue, and I-95. The latitude and longitude are approximately 41.1686°N and 73.2006°W. The below Figure 1 is an aerial view of the facility.

[1] http://www.src.com/

The facility is located at the following address:
600 Iranistan Avenue
Bridgeport, Connecticut 06605

Figure 1 – Bridgeport Facility - Aerial View

MODEL SELECTION AND STAGES

Trinity utilized the California Puff (CALPUFF) model FOG codes (version 7.2.1) to determine the potential fogging and icing impacts from 21 exhaust chimneys that are proposed to be routed to cooling module exhaust fans. CALPUFF is a Lagrangian puff model that is typically used as a dispersion model for long-distance transport applications, complex terrain and coastal settings. It is also the only refined dispersion model with the encoded ability to perform visible water plume impacts. The "fogging mode" in CALPUFF allows the user to determine the frequency of visible plume impacts at discrete receptor points (receptor mode), as well as to predict the length and height of visible plumes (plume mode). This report will provide receptor mode impacts.

This modeling system contains pre- and post-processors to compute the visible plume length and fogging/icing statistics. To accommodate these pre- and post-processors, the fogging/icing modeling analysis includes three stages (each with an executable run). These stages are named after their executable and described in further detail below:

- **Stage 1 - FGEMISS.** The first stage involves the pre-processor entitled "Flue Gas Emissions Processor" (FGEMISS). A control file (input file) is generated containing building information, stack release parameters, and water vapor emission rates. After running the FGEMISS executable, it generates a PTEMARB.DAT point source emission file which reformats the control file information. This file (.pt2 file extension) is used in the second stage of the modeling sequence.
- **Stage 2 - CALPUFFLite.** The second stage requires generation of the CALPUFF Lite input file and running the so-called "CALPUFF Lite" dispersion model. Several model options are specified including meteorological and computational grids. A list of receptor data points, including their elevations, is included at the end of the input file. The PTEMARB.DAT file from stage 1, the input file, and meteorological data are utilized in the CALPUFF Lite run. The output file CALFOG.OUT is processed in the third stage of the modeling system.
- **Stage 3 - POSTRM2 (Receptor Mode**). The third stage employs a post-processor. The CALPUFF FOG codes contain two post-processors: plume mode or receptor mode. Trinity selected the receptor mode post-processor which extracts the occurrences (e.g., number of hours) of background fogging/icing conditions and plume-induced fogging/icing conditions from the CALFOG.OUT file for specified data points (receptors).

In order to step through these three stages, Trinity collected the necessary meteorological and elevation datasets. Details about these datasets are briefly described below.

Meteorological Data

In general, CALPUFF is known for utilizing more complex meteorological information; however, the CALPUFF FOG codes use an Industrial Source Complex (ISC)-like meteorological dataset similar to what is used in the regulatory preferred American Meteorological Society Environmental Protection Agency Regulatory Model (AERMOD). This meteorological data set used a meteorological pre-processer utility called CPRAMMET, which is a modification to PCRAMMET that augments its treatment of relative humidity when preparing a data file that is acceptable in CALPUFF.

This meteorological data set utilized National Weather Service (NWS) data from Igor I. Sikorsky Memorial Airport surface data (KBDR) and Brookhaven, NY upper air data (KOKX) for 2016 through 2020. KBDR is located approximately 6 kilometers due east of the proposed project and is the closest meteorological station with complete, high quality surface data.

Elevation Data

Trinity was provided information indicating the I-95 roadway elevations nearby the proposed project. Building and source elevations were interpolated from 1/3 arc-second National Elevation Dataset (NED) data obtained from the U.S. Geological Survey (USGS) from datum year 1983 using the latest version of AERMAP (v18081). Buildings and sources at the facility were assumed to have the same base grade elevation.

MODEL SETUP AND ASSUMPTIONS

This section contains information about the model setup and assumptions.

AERMOD Modeling Files

Trinity prepared an AERMOD basefile to include all of the facility's proposed sources, buildings, and receptors. This AERMOD file was used to obtain the BPIP building downwash block data, coordinate information, and discrete receptor placement.

Coordinate System

Trinity determined the locations of emission sources, structures, and receptors using the Universal Transverse Mercator (UTM) coordinate system, North American Datum 1983 (NAD83). This information was utilized in the CALPUFF input file setup.

Building Downwash

The emission units at the proposed facility were evaluated in terms of their proximity to nearby structures. The purpose of this evaluation is to determine if stack discharges might become caught in the turbulent wakes of these structures leading to downwash of the plumes. Wind blowing around a building creates zones of turbulence that are greater than if the building were absent. For such modeling situations, the direction-specific building dimensions are used as model input. The projected building dimensions in this study were calculated using the U.S. EPA sanctioned Building Profile Input Program, PRIME version (BPIP PRIME), version 04274.

Building downwash characteristics are a required input variable for the FGEMISS control file. The Building Profile Input Program (BPIP) with Plume Rise Model Enhancements (PRIME) was utilized to determine the building downwash characteristics for each stack in 10 degree directional intervals. BPIP PRIME is the most recent, regulatory approved version of BPIP used for air dispersion modeling analyses for AERMOD.

The CALPUFF FOG module only implements BPIP (not BPIP PRIME) variables (which include building height and width information only). Therefore, Trinity ran BPIP PRIME but only incorporated the building height and width (not length) output in the FGEMISS control file. Table 1 lists the buildings included in the BPIP PRIME analysis.

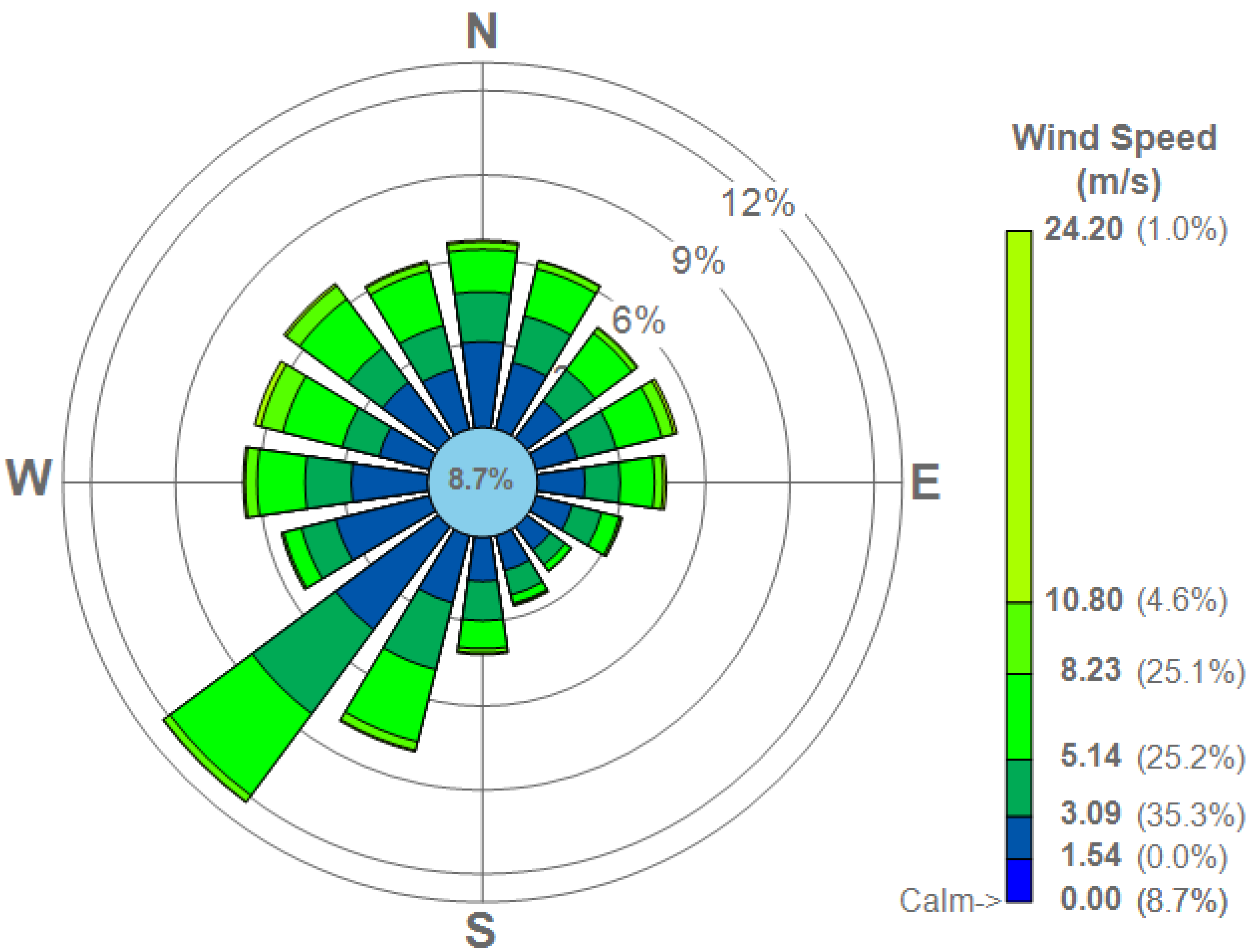
Table 1. Building Parameters

Structure Name	X Dimension (feet)	Y Dimension (feet)	Building Height (feet)
Building 1	148.67	48.88	74.87

Meteorological Data

As previously noted, the meteorological data were processed from 2016 through 2020 and were considered in the fogging/icing modeling analysis. For reference, a wind rose outlining the wind conditions at the Igor I. Sikorsky Memorial Airport is included in Figure 2. The wind rose petals indicate the direction from which the wind is blowing.

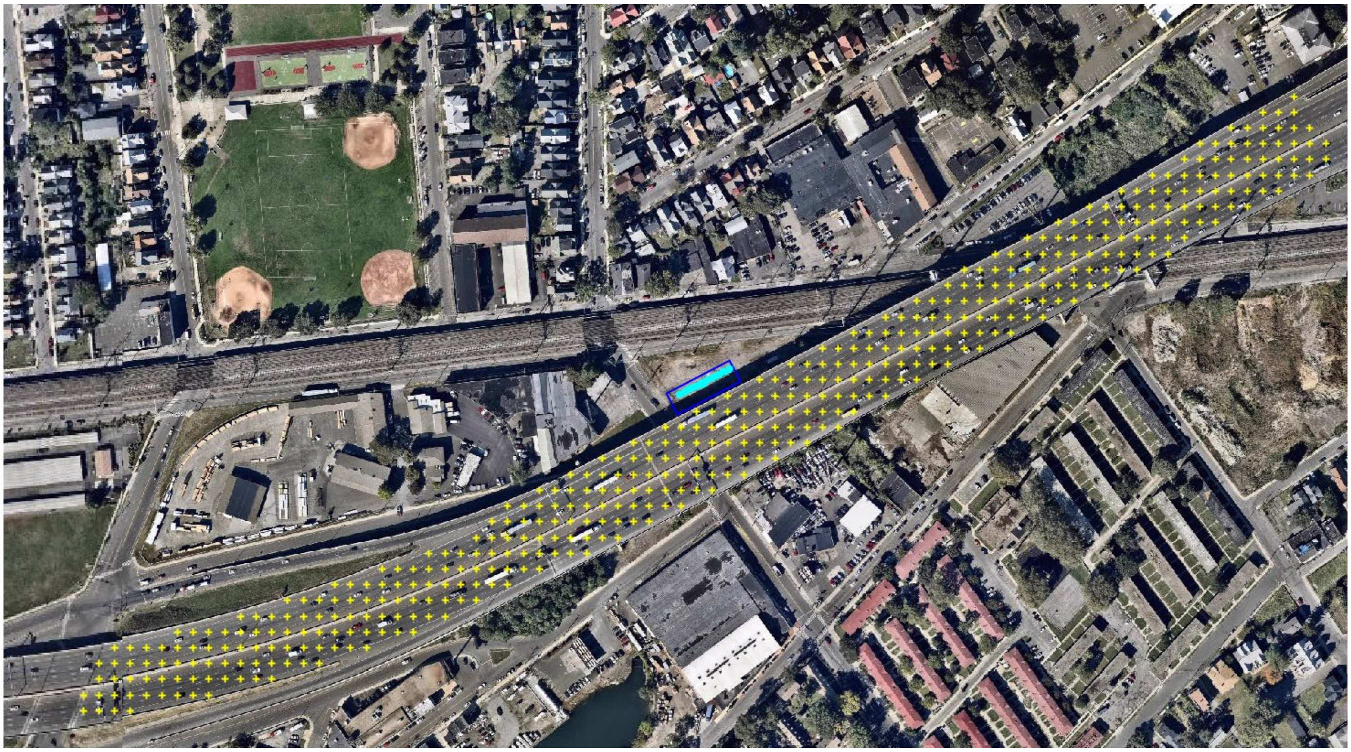
Figure 2. Igor I. Sikorsky Memorial Airport Wind Rose – Years 2016 through 2020



Elevation Data and Roadway Receptors

NuPower provided the above ground elevation for the nearby I-95 elevated roadway. Trinity spaced receptors at 10-meter intervals and used an average elevation above ground level of 63 feet to represent the discrete receptors. Figure 3 shows a schematic of the model setup from AERMOD. The yellow "+" represent discrete receptors, the blue rectangle represents the building, and the teal dots represent the exhaust points.

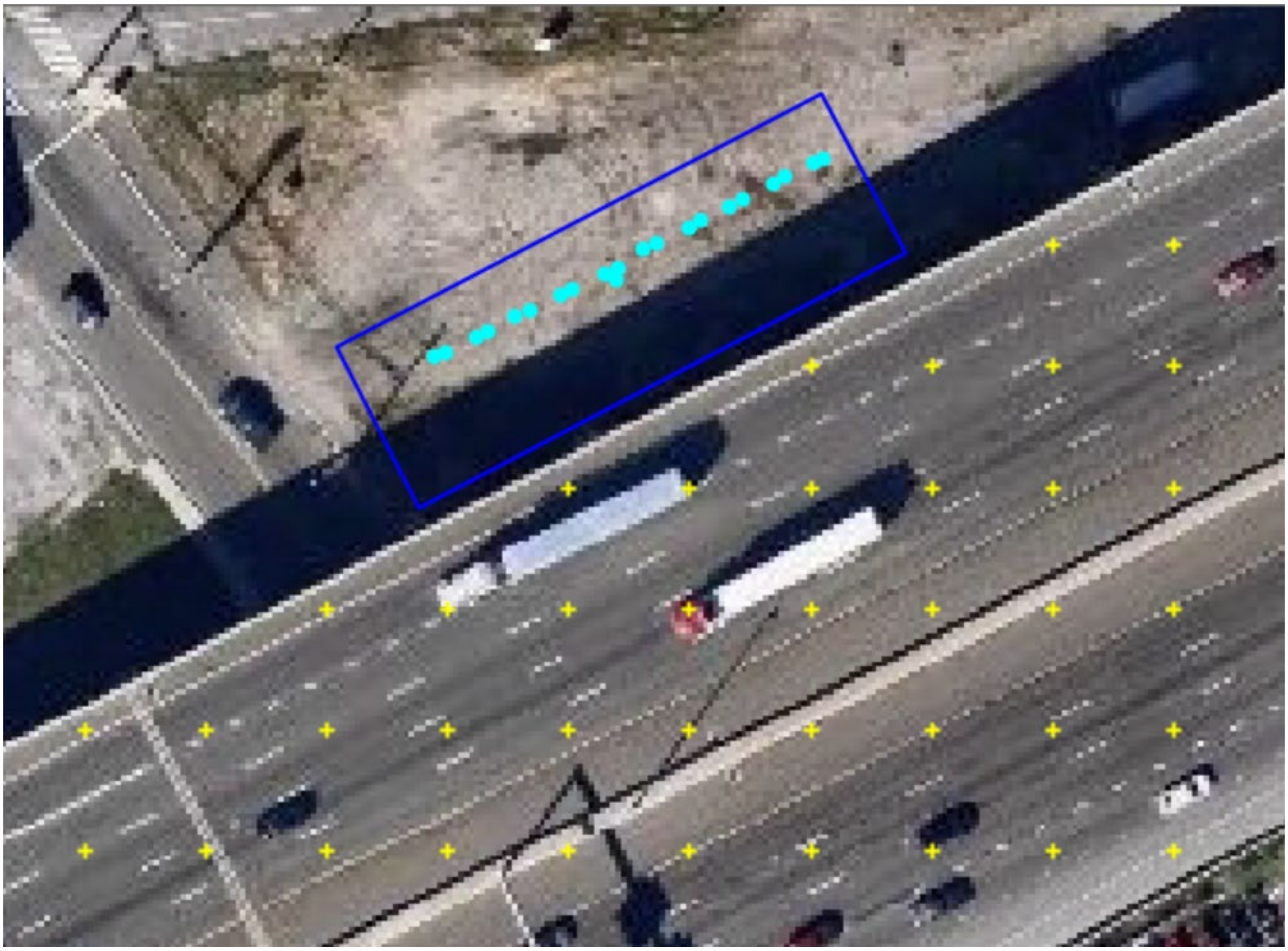
Figure 3 – Discrete Receptor and Model Setup



Source Description

Trinity conducted a fogging/icing modeling review specifically for the exhaust stacks which have exhaust air flows with high moisture content. The 21 exhaust stacks are represented in the model as vertical-oriented point sources. The ductwork from each exhaust point is routed to one of six fans associated with a single cooling module on the roof of the proposed building. There are ten cooling modules on the north side of the building, where two exhaust points will route to a fan from each cooling module, except where one cooling module will have three exhaust points routed to accommodate all 21 exhaust stacks. Figure 4 shows a closer aerial view at the model's stack locations, where the exhaust stacks are noted in as teal dots.

Figure 4 – Stack Location Aerial View



These emission units were parameterized with the following modeling variables:

- Water vapor mass emission rate
- Gas exit temperature
- Gas exit velocity
- Stack height
- Stack Diameter
- Projected downwash dimensions

Table 2 summarizes the source parameters used in the CALPUFF modeling analysis.

Table 2. Model Source Parameters

Description	X Coord. (m)	Y Coord. (m)	Elevation (m)	H_2O Emission Rate (lb/hr)	Stack Height (ft)	Stack Temp. (F)	Stack Velocity (acfm)	Stack Diameter (ft)
Stack 1	650957.6	4559022.10	0.61	461.0	71.00	180	8900	2.50
Stack 2	650958.6	4559022.50	0.61	461.0	71.00	180	8900	2.50
Stack 3	650961.2	4559023.70	0.61	461.0	71.00	180	8900	2.50
Stack 4	650962.1	4559024.30	0.61	461.0	71.00	180	8900	2.50
Stack 5	650964.4	4559025.50	0.61	461.0	71.00	180	8900	2.50
Stack 6	650965.6	4559026.00	0.61	461.0	71.00	180	8900	2.50
Stack 7	650971.7	4559029.00	0.61	461.0	71.00	180	8900	2.50
Stack 8	650969.1	4559027.70	0.61	461.0	71.00	180	8900	2.50
Stack 9	650968.1	4559027.20	0.61	461.0	71.00	180	8900	2.50
Stack 10	650972.7	4559028.50	0.61	461.0	71.00	180	8900	2.50
Stack 11	650972.8	4559029.50	0.61	461.0	71.00	180	8900	2.50
Stack 12	650975	4559031.00	0.61	461.0	71.00	180	8900	2.50
Stack 13	650979.7	4559033.40	0.61	461.0	71.00	180	8900	2.50
Stack 14	650978.7	4559032.80	0.61	461.0	71.00	180	8900	2.50
Stack 15	650976	4559031.50	0.61	461.0	71.00	180	8900	2.50
Stack 16	650982.1	4559034.60	0.61	461.0	71.00	180	8900	2.50
Stack 17	650983.1	4559035.20	0.61	461.0	71.00	180	8900	2.50
Stack 18	650985.7	4559036.50	0.61	461.0	71.00	180	8900	2.50
Stack 19	650986.6	4559037.00	0.61	461.0	71.00	180	8900	2.50
Stack 20	650989	4559038.10	0.61	461.0	71.00	180	8900	2.50
Stack 21	650989.8	4559038.50	0.61	461.0	71.00	180	8900	2.50

MODEL RESULTS AND CONCLUSIONS

Following the steps and setup outlined in the previous sections, Trinity conducted the fogging/icing modeling analysis for the NuPower facility. The output of the "receptor mode" post processor provides the following explanation (note "RH" and "Conc" indicate relative humidity and concentration, respectively).

- "Background fog" hours are those where the background RH = 100%, Temp > 32°F
- "Background ice" hours are those where the background RH = 100%, Temp ≤ 32°F
- "Plume-induced fog" hours are those where the background RH < 100%, Total Conc. > Saturation, Temp > 32°F
- "Plume-induced ice" hours are those where background RH < 100%, Total Conc. > Saturation, Temp ≤ 32°F

The "background" values are based on the existing meteorological conditions as derived from the meteorological data processing. The plume-induced fogging/icing conditions occur when the natural relative humidity is less than 100% and the total concentration of the water in the air when considering the additional plume moisture is greater than saturation. Considering meteorological years 2016-2020, the modeling results are provided in Table 3.

Table 3. CALPUFF FOG Model Fogging/Icing Results

Event	2016	2017	2018	2019	2020
Background Fog	1	1	59	28	27
Background Ice	1	0	0	0	0
Total Background Fog + Ice	2	1	59	28	27
Plume-Induced Fog	0	0	0	0	0
Plume-Induced Ice	0	0	0	0	0
Total Plume-Induced Fog + Ice	0	0	0	0	0

The results presented in Table 3 demonstrate that the NuPower facility, as modeled, would result in no modeled plume induced fog or ice events at the nearby roadway.

In conclusion, this modeling analysis report predicts the NuPower fuel cell facility will have no modeled contributions to plume-induced fogging/icing induced impact on the nearby Interstate 95. Fogging/icing conditions are modeled to be driven by the existing, natural meteorological conditions in the region.

~~~

If you have any questions or comments about the information presented in this letter, please do not hesitate to call me at 847-334-2603.

Sincerely,

TRINITY CONSULTANTS

Simone Wallace
Senior Consultant

Attachments

cc: Mr. Tony Schroeder, Trinity Consultants
~~~