Doosan Fuel Cell America, Inc.
101 East River Drive
East Hartford, CT 06108

Date

Melanie Bachman, Executive Director
Connecticut Siting Council
Ten Franklin Square
New Britain, CT 06051

RE: Doosan Fuel Cell America, Inc. Notice of Exempt Modification Pursuant to RCSA 16-50j-57(a) to Existing Energy Facility Site at 471 Main St., East Hartford, CT ("Notice of Exempt Modification")

Dear Ms. Bachman,

Doosan Fuel Cell America, Inc. ("DFCA") hereby gives notice to the Connecticut Siting Council of its intent to undertake an exempt modification in accordance with Section 16-50j-57(a) of the Regulations of Connecticut State Agencies ("RCSA") for the modification to DFCA's fuel cell installation at Coca Cola 471 Main St., East Hartford. Location coordinates are 41*45'14.44"N 72*38'31.44"W.

**Proposed Modification**

The proposed modification would take place within the existing fenced area measuring 57' x 55' at the Coca Cola Bottling plant at 471 Main St., East Hartford, CT. The existing facility consists of a combined heat and power installation utilizing two ground mounted Doosan Fuel cells capable of producing 440kw each.

DFCA proposes the following modification to the facility:

- Removal of both existing fuel cells and associated cooling modules.
- Installation of two (2) current generation Doosan Model 400 fuel Cells (direct replacement)
- Installation of new cooling modules.
- Replacement of new feeder cable to comply with current electrical code.
- Replacement of obsolete distributed generation meter.

The existing facility layout with proposed modification is shown on Attachment 1 Drawing GA1.

The proposed modification would not have a substantial adverse environmental effect or cause a significant adverse change or alteration in the physical or environmental characteristics of the facility because:

- The modification would be made within the facilities existing fenced area and would not impair the structural integrity of the facility.
- The new equipment would be a direct replacement for the existing equipment and is dimensionally the same as the existing equipment and would not cause any significant adverse change in the physical or environmental characteristics of the facility.
- The modifications would not affect waterways or wetlands and the facility is not in a flood zone.
- There are no endangered, threatened or special concern species in the vicinity of the facility as listed in the NDDB.
- Sound pressure levels will not increase as a result of the modifications.
- There would be no television or radio interference as a result of the modifications.
- Electric and magnetic field levels will not be affected by the modification due to low or no export of power from the site and the low voltage produced by the fuel cells.

DFCA proposes to commence work on the modification in February 2022 and scheduled to be complete by March 2022.

Pursuant to CSC covid response DFCA is submitting this filing electronically and will provide one hard copy and the $625.00 filing fee by us mail.

A notice of the exempt modification filing has been provided to the Mayor of East Hartford and to the property owner.

Please direct all communications regarding this filing to Donald Emanuel at 203.525.4566 or via email Donald.emanuel@doosan.com

Signed ___________________________

Donald Emanuel

Installation Project Manager

Doosan Fuel Cell America, Inc

STATE OF CONNECTICUT
*CONNECTICUT SITING COUNCIL*
Ten Franklin Square, New Britain, CT 06051
Phone: (860) 827-2935 Fax: (860) 827-2950
E-Mail: siting.council@po.state.ct.us
Web Site: www.ct.gov/csc

## Modification of Existing Energy Facilities

**April 2013**

### I. Existing Energy Facilities

The Regulations of Connecticut State Agencies — RCSA § 16-50j-57(b)— describe conditions under which modifications to an existing energy facility do not constitute a substantial adverse environmental effect and, therefore, do not need a Certificate of Environmental Compatibility and Public Need to be issued by the Siting Council. In such cases, a company must notify the Council of its intent to make exempt modifications in accordance with RCSA § 16-50j-58. A company must also send a copy of its notice to the chief elected official of the municipality in which the facility is located and the property owner of record, if the property owner of record is different from the owner or operator of the energy facility and associated equipment.

A notice of intent to make exempt modifications should consist of the following components:

- A narrative that: 1) describes the existing facility including location (with latitude and longitude coordinates), boundaries of the site, height of facility components, and size of the existing equipment compound; 2) describes the nature and extent of the proposed modifications including energy components to be installed, type of mounting, and ground equipment to be installed; and 3) describes how the proposed modifications comply with the conditions identified in RCSA § 16-50j-57(b).
- ICDS Engineering drawings that depict the existing facility and show the modifications to be made. Drawings should include plan and elevation views.
- ICDS An engineering analysis describing the existing facility's structural capability to accommodate the proposed modifications. This analysis should identify any structural changes and/or reinforcements that may be needed to accommodate the proposed modifications. The analysis must be stamped by a Professional Engineer.
- ICDS A calculation of the electric and magnetic field levels, based on the Council's Best Management Practices for Electric and Magnetic Fields, at the site boundary.
- Casciro A calculation of the noise levels at the site boundary.
- All documents, including but not limited to maps, shall be dated (ie: effective dates, revision dates, or dates of adoption). If the document date is unavailable, the date the document was obtained shall be provided. Maps must include a key table(s) and a matching source list/table, appropriately organized.

The applicant must submit an original and 2 copies of its notice of exempt modification with a $625 filing fee (Conn. Gen. Stat. §4-189j; Regs., Conn. State Agencies § 16-50v-1a).

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East Hartford, CT 06108

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**Prepared For:** **Doosan Fuel Cell America, Inc.**

**Point of Contact:** **Donald Emanuel**

**Prepared by:** **Acoustical Technologies Inc.**

**50 Myrock Avenue**

**Waterford, CT 06385-3008**

**Subject:** **Coca Cola**

**471 Main Street**

**East Hartford, CT 06118**

**Airborne Noise Test**

**Author:** **Carl Cascio**

**Date:** **Feb 9th 2022**

**Revision:** **0**

# Table of Contents

## Summary

This document makes a positive acoustic assessment that should assist in meeting any acoustic noise concerns during the operation of two Doosan 460 KW fuel cells at the East Hartford Coca Cola site at 471 Main Street in East Hartford, CT. An acoustic assessment plan was developed and executed to acquire airborne acoustic information useful in explaining and mitigating the potential airborne noise issues associated with operation of the two Doosan Pure Cell 460 KW fuel cells. It is important to show that the airborne noise generated by the fuel cells will not significantly impact any of the facility's neighbors.

The airborne noise levels generated by the two existing fuel cells operating at the East Hartford site were measured on November 11 and 13, 2021. The fuel cells produced an overall average airborne noise level that varied depending on direction from 61 to 74 dBA (reference 20 microPascals) at a distance of 10 meters around the Cooling and Power Modules. (The Cooling Module is the dominant noise source by about 7 dB.) The airborne noise levels in the direction of the nearest neighbors varied from 65 to 67 dBA. The airborne noise from the two existing 400 KW fuel cells is about 5 dB higher than the airborne noise from a similar 460 KW fuel cell measured in Montville last year. The estimated airborne noise from the two Coca Cola 460 KW fuel cells was increased by 3 dB over a single unit to account for operation of two units.

Airborne noise levels with the East Hartford fuel cells operating were measured at distances 51 to 112 meters from the fuel cell location at the nearby properties at levels from 52.4 to 60.4 dBA. The highest background corrected level of 60.4 dBA was measured at the House of Flowers at 456 Main Street. The transmission loss from the two fuel cells to the House of Flowers was 8 dB. All the other nearby commercial measurement locations to the east have airborne noise at or below 60 dBA with the fuel cells on. Analysis of the fuel cell data indicated propagation losses from 8 to 16 dB from the fuel cell location to the nearby Commercial (Business) property lines.

Operation of the two Doosan fuel cell is expected to produce noise levels below the Commercial Zone noise limit of 62 dBA at all of the nearby Commercial property lines. The highest expected airborne noise level of 58.2 dBA was across the street from the fuel cells. The other Commercial properties have levels no higher than 58 dBA. All nearby residential property lines are expected to be below both the day time and night time residential noise limits with the two fuel cells on. **No acoustic issues** are expected during operation of the two new Doosan 460 KW fuel cells.

The State of Connecticut's Noise Code[1] calls for review of the acoustic issues associated with impulse noise. Operation of the two fuel cells is expected to meet all of the impulse noise requirements at all of the nearby properties. The CT Noise Code calls for review of acoustic issues associated with prominent discrete tones, infrasonic and ultrasonic noise. Operation of the two fuel cells is expected to meet all of the discrete, infrasonic and ultrasonic noise requirements at all of the nearby properties. **No acoustic issues** are expected during operation of the fuel cells.

It should be stated that these estimates assume the current fuel cell physical configuration is repeated with the new fuel cells. Because the cooling modules are about 7 dB noisier than the power modules the cooling modules cannot be moved closer to Main Street without adding a noise mitigating barrier that the existing power modules currently provide.

## Introduction

Acoustical Technologies Inc. was tasked as part of a Doosan site permitting process with an assessment of potential acoustic issues associated with fuel cell airborne noise reaching the properties adjacent to the Coca Cola site at 471 Main Street in East Hartford, CT. Responding to a request from Donald Emanual, site visits were made on November 11 and 13, 2021. During the visits, surveys of the airborne noise levels produced by the two existing fuel cells were made in order to identify any potential airborne noise issues. Airborne noise measurements were taken to quantify the propagation of the PureCell fuel cells' airborne noise to the adjacent properties. This document provides an acoustic assessment to assist in meeting acoustic noise concerns during the permitting process for the siting of two 460 KW Doosan fuel cells at 471 Main Street in East Hartford, CT. The existing Power and Cooling Modules are identified in Figures 1 and 2.

## Development of the Acoustic Assessment Plan

The purpose of this effort is to acquire acoustic information useful in understanding the potential airborne noise issues associated with the operation of two new Doosan 460 KW fuel cells at the Coca Cola facility. The two new units will replace the existing units. The East Hartford site at 471 Main Street is located in a Business Zone near CT Route 2 and is surrounded by Commercial (Business) Zones to the east, north, west and south, a Residential Zone to the east and the water of the Connecticut River to the west. (The East Hartford zoning map is given in Figure 7 below.) It is important to determine whether the airborne noise generated by the two new Doosan fuel cells will negatively impact the neighbors on Main Street as well as the surrounding areas.

The acoustic impact is assessed in the following way. The fuel cell operating airborne noise levels of two existing similar fuel cells was measured at the site on November 11 and 13, 2021. Using this data, adjustments are made to account for the performance of the new fuel cells and the resulting noise level estimates are compared to the allowable noise levels in the State of Connecticut Noise Ordinance[1]. (East Hartford currently does not regulate this type of noise.) With the two new full cells operating at full power, this approach then follows the traditional "What is the airborne noise level at the neighbor's property line?". Is the airborne noise below the allowable airborne noise levels? This measured site data can also be used to estimate noise levels at other neighbor's property lines. The effect of background noise will also be considered by operating the two existing fuel cells at reduced power and measuring the airborne noise at the nearby property lines. The State of Connecticut's Noise Ordinance will be used to assess the impact of the measured and estimated acoustic levels. Because of the closeness of the Coca Cola fuel cell site to the nearest property lines noise mitigation may be recommended if the airborne noise estimated for the new fuel cells comes near or exceeds the airborne noise requirements at the neighbors' property lines. (The noise radiated from a similar new fuel cell has been recently measured at another Doosan site[2] and will be used to adjust the results of the Coca Cola property line measurements that were taken in East Hartford on the older currently operating fuel cells.)

Figure 1. PureCell Fuel Cell Power Module Name Plate Information

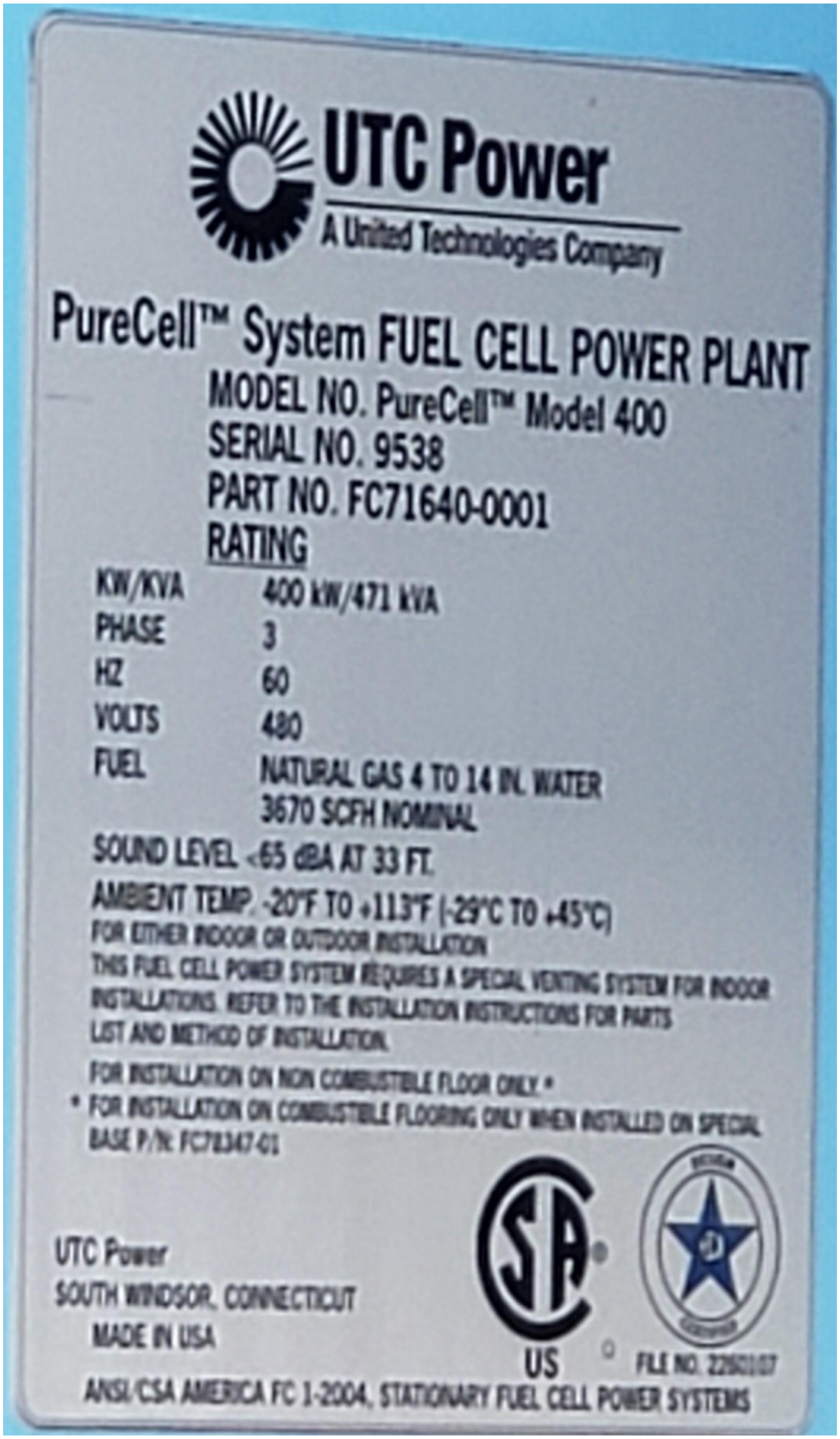


Figure 2. Colmac Radiator Cooling Module Name Plate Information

## Acoustic Measurement Program

The acoustic data necessary to assess the impact of the two new 460 KW Doosan Fuel Cells are described below: Airborne sound pressure measurements and spectral analysis were conducted at the Coca Cola site on November 11 and 13, 2021 during the daylight hours. This testing established combined background airborne noise levels and fuel cell operating noise levels. (The fuel cells were turned to a reduced power level on November 13 to make independent background measurements.) The overall A-weighted airborne noise measurements were made with an ExTech model 407780A Digital Sound Level Meter (s/n 140401544) that had been calibrated prior to and just after the test with a Quest model QC-10 Calibrator (s/n Q19080194). Measurements were all taken with A-weighting (frequency filtering that corresponds to human hearing) and with the sound level meter in a Slow response mode. For reference, a noise level increase of 1 dB is equal to an airborne sound pressure increase of 12.2 per cent. The spectral analysis was made with a Hewlett Packard Dynamic Signal Analyzer (model 3561A s/n 2502A01592). The PCB microphone (model 130F20 s/n 53933) was powered by the Hewlett Packard analyzer. The PCB microphone was also calibrated prior to and after the test with the Quest model QC-10 Calibrator (s/n Q19080194). All measurements were made with the microphones at a height above ground between five and six feet. The Hewlett Packard model HP3561A Dynamic Signal Analyzer was also used to perform overall A-weighted spectral analysis that confirmed the ExTech readings at two measurement locations.

At the East Hartford site fuel cell operating and background airborne noise measurements were taken at the following nine nearby property lines in the Commercial (Business) Zone:

| **Location** | **Business** | **Distance** | **Zone Type** |
|---|---|---|---|
| Fuel Cells – 471 Main Street | Coca Cola | 5 &10 meters | Business B2 |
| P1 – 468 Main Street | Krauser's | 63 meters | Business B2 |
| P2 – 456 Main Street | House of Flowers | 55 meters | Business B2 |
| P3 – 456 Main Street | Villa Milano | 51 meters | Business B2 |
| P4 – 454 Main Street | Kam's Wine & Spirits | 54 meters | Business B2 |
| P5 – 452 Main Street | Willow Apartments | 112 meters | Business B2 |
| P6 – 450 Main Street | Genuine Auto | 70 meters | Business B2 |
| P7 – 442 Main Street | C-Town Market | 112 meters | Business B2 |
| P8 - 16 Sisson Street | Residence | 103 meters | Business B2 |
| P9 – 21 Sisson Street | Residence | 107 meters | Business B2 |

The Coca Cola facility has fans and other operating equipment that contribute to the airborne noise measured near the fuel cells. These background noise sources could not be turned off. As a result, the estimated fuel cell contribution may actually be a little lower than reported. See the Google satellite map in Figure 3 below for all the approximate measurement locations. Measurements near the operating Cooling and Power Module sites were taken with the ExTech sound level meter and one microphone recording on the Hewlett Packard analyzer. Figures 4, 5 and 6 provide photographs of the site locations for the Cooling and Power Modules with sensors at 5 and 10 meters. At each location, a one-minute record of the acoustic noise was analyzed. At a few locations recording was limited to 30 seconds to avoid the traffic noise on Main Street.

Figure 3. East Hartford Site Map from Google Maps


Airborne noise measurements taken outside are corrupted by rain and wind so a day was selected when the winds were expected to be 10 miles per hour or less. Table 1 provides the weather data at Hartford-Brainard Airport (the closest data to East Hartford) for the acoustic measurements on November 11 and 13, 2021. Measurements were taken over the time period from 10:15 am until 2:30 pm on November 11 and from 8:15 am until 10:15 am on November 13. The table below shows the temperature and wind speeds in hourly intervals. Wind conditions were very good for both days with no wind gusts and no wind speeds above 10 mph. Acoustic measurements were suspended during truck, car and plane passing and these short periods did not significantly affect the operating airborne noise measurements. There was no rain during the testing on either day. Motor traffic along the nearby roads was heavy of November 11 and property line measurements were deferred until November 13 when traffic on Saturday was much lighter. A few of the property line measurements had to be delayed until no traffic was present. Because the fuel cell could not be completely shut down the background measurements were taken on November 13 at a reduced power level. The reduced power operation dropped the 5 and 10 meter airborne noise levels by about 5 dB in the direction (east) of the nearby properties. Airborne noise levels at the other directions next to the cooling modules (north and west) dropped by 8 to 11 dB.

Figure 4. Two Fuel Cell Power Modules Operating at the East Hartford Site

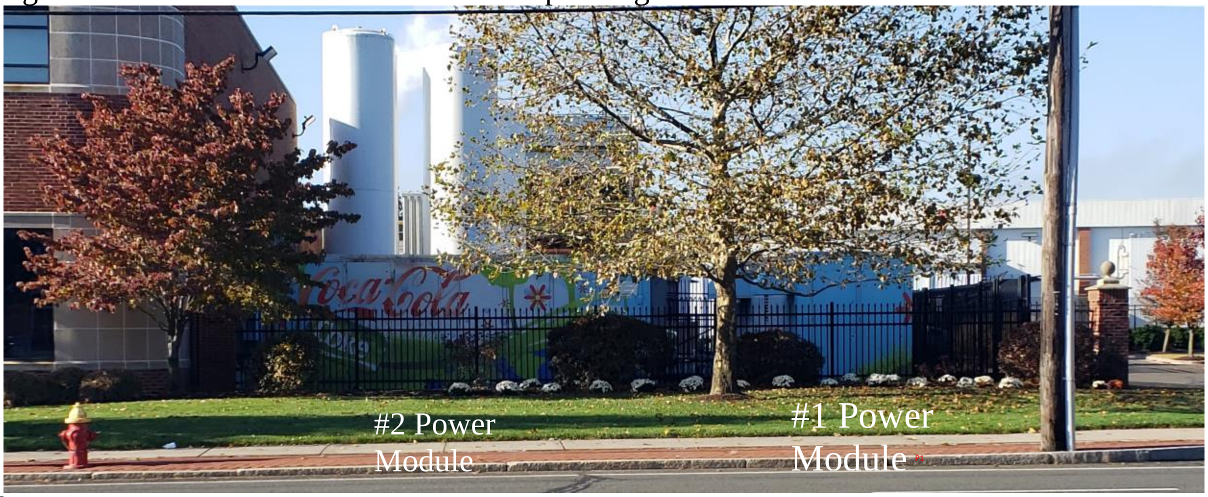



Figure 5. The Two Fuel Cell Cooling Modules at the East Hartford Site

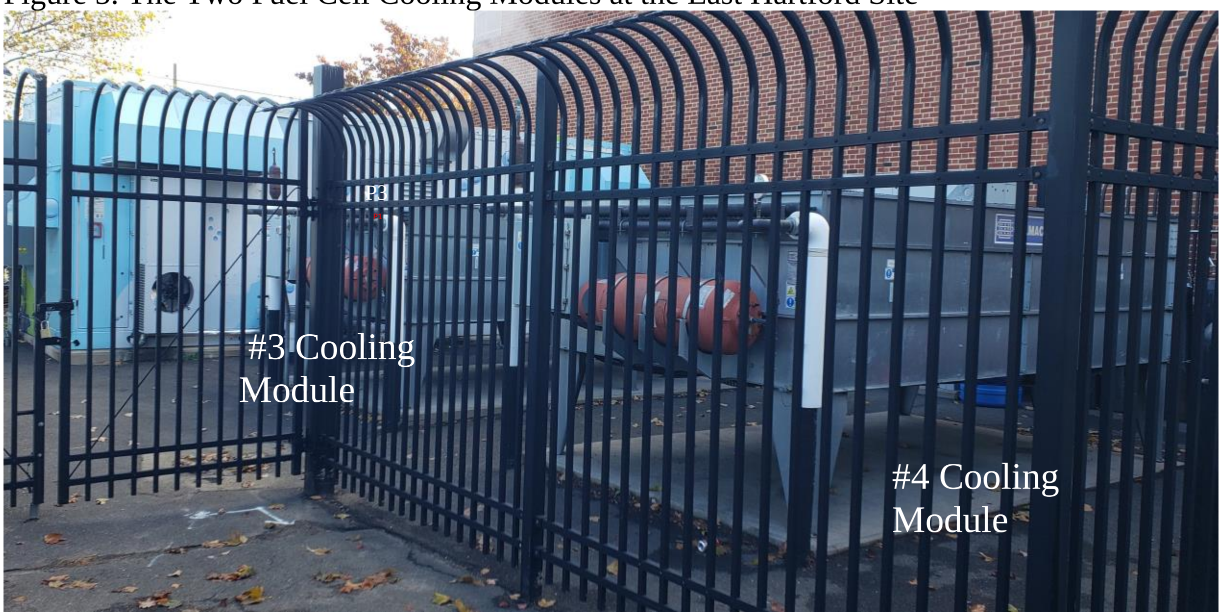



Figure 6. The Nearby Residences and Businesses at the East Hartford Site

Table 1. Weather Data near East Hartford on November 11 and 13, 2021
https://www.wunderground.com/history/daily/us/ct/hartford/KHFD/date/2021-11-11

| Time (EST) | Temp. (°F) | Dew Point (°F) | Humidity (%) | Wind Direction | Wind Speed (mph) | Barometer (in HG) | Condition |
|---|---|---|---|---|---|---|---|
| | 11-11-21 | Below | | | | | |
| 7:53 AM | 35 °F | 32 °F | 89 % | CALM | 0 mph | 30.34 in | Fair |
| 8:53 AM | 42 °F | 32 °F | 67 % | CALM | 0 mph | 30.34 in | Fair |
| 9:53 AM | 46 °F | 32 °F | 58 % | NNW | 3 mph | 30.34 in | Fair |
| 10:53 AM | 50 °F | 29 °F | 44 % | CALM | 0 mph | 30.34 in | Fair |
| 11:53 AM | 54 °F | 30 °F | 40 % | CALM | 0 mph | 30.30 in | Fair |
| 12:53 PM | 57 °F | 31 °F | 37 % | CALM | 0 mph | 30.28 in | Fair |
| 1:53 PM | 59 °F | 33 °F | 38 % | S | 10 mph | 30.27 in | Partly Cloudy |
| 2:53 PM | 58 °F | 34 °F | 41 % | S | 6 mph | 30.27 in | Mostly Cloudy |
| 3:53 PM | 56 °F | 35 °F | 45 % | S | 7 mph | 30.27 in | Mostly Cloudy |
| 4:53 PM | 53 °F | 36 °F | 52 % | SSE | 5 mph | 30.28 in | Mostly Cloudy |
| 5:53 PM | 53 °F | 37 °F | 55 % | SSE | 5 mph | 30.29 in | Mostly Cloudy |
| 6:53 PM | 53 °F | 38 °F | 57 % | ESE | 3 mph | 30.29 in | Mostly Cloudy |
| | 11-13-21 | Below | | | | | |
| 6:58 AM | 37 °F | 36 °F | 96 % | CALM | 0 mph | 29.87 in | Fog |
| 7:29 AM | 37 °F | 36 °F | 96 % | CALM | 0 mph | 29.87 in | Fog |
| 7:53 AM | 39 °F | 37 °F | 93 % | CALM | 0 mph | 29.87 in | Fog |
| 8:07 AM | 39 °F | 38 °F | 96 % | CALM | 0 mph | 29.86 in | Fog |
| 8:26 AM | 40 °F | 38 °F | 93 % | E | 3 mph | 29.86 in | Cloudy |
| 8:33 AM | 40 °F | 39 °F | 97 % | CALM | 0 mph | 29.85 in | Fog |
| 8:53 AM | 40 °F | 38 °F | 93 % | CALM | 0 mph | 29.84 in | Fog |
| 9:03 AM | 41 °F | 39 °F | 93 % | NNE | 3 mph | 29.83 in | Fog |
| 9:13 AM | 42 °F | 40 °F | 92 % | CALM | 0 mph | 29.83 in | Fog |
| 9:35 AM | 45 °F | 42 °F | 90 % | CALM | 0 mph | 29.81 in | Partly Cloudy |
| 9:53 AM | 47 °F | 42 °F | 83 % | NNW | 5 mph | 29.80 in | Fair |
| 10:53 AM | 50 °F | 43 °F | 77 % | CALM | 0 mph | 29.76 in | Fair |
| 11:53 AM | 57 °F | 47 °F | 69 % | ESE | 3 mph | 29.71 in | Partly Cloudy |
| 12:53 PM | 62 °F | 36 °F | 38 % | S | 12 mph | 29.66 in | Partly Cloudy |
| 1:53 PM | 61 °F | 44 °F | 54 % | SSE | 13 mph | 29.57 in | Fair |
| 2:53 PM | 59 °F | 46 °F | 62 % | S | 18 mph | 29.55 in | Fair |

## Data Analysis

This section analyzes the airborne noise levels measured at the East Hartford site and then estimates the source level and transmission loss to nearby property lines during fuel cell operation. These levels will be compared to the noise limits in the Connecticut noise ordinance. The measured fuel cell operating noise levels are reported in Tables 2 and 3. These values include both background and fuel cell operating noise. The L90 and Leq levels will later be used to correct the measured operating airborne noise levels providing estimates of only the fuel cell noise contribution. Table 4 reports the background corrected fuel cell operating noise levels. (All of the nearby locations are below the allowable noise level even with the background contribution.) Table 5 compares the East Hartford fuel cell source levels at 5 and 10 meters with similar measurements made on a 460 KW Fuel cell at Montville, CT. The newer Montville Doosan 460 KW fuel cell is quieter and the existing East Hartford 400 KW fuel cell levels will be lowered by 2.2 dB. Comparing these East Hartford 460 KW fuel cell estimated levels with the CT state noise limit will identify which nearby locations do or do not meet the airborne noise requirements.

As stated above, the complete set of overall A-weighted airborne noise levels that were measured in East Hartford are provided in Tables 2 and 3. Figure 7 is a map showing the East Hartford zoning districts in the Coca Cola area. The GPS range from the fuel cell to the microphone locations that are shown in Table 2 were calculated with Google Maps. The GPS accuracy is approximately 3 meters. The estimates of the range from the center of the fuel cell in meters to each location are given in Table 2 and also in Table 3. The closest measurement location is P3, which is about 51 meters east to the Villa Milano business across the street from the Coca Cola property at 471 Main Street. The next closest measurement location is P4, which is about 54 meters east across the street from Coca Cola. Other neighboring commercial properties along Main Street are 55 to 112 meters away. P8, the closest residential home is 103 meters away due east at 16 Sisson Street. At this residential location airborne noise from the operating fuel cells could not be heard. The residential noise level was about 55 dBA due to an a/c unit at Krauser's. Across the street at 21 Sisson Street the fuel cells could not be heard in background ambient with a noise level of approximately 53 dBA.

The ExTech model 407780A Digital Sound Level Meter provided the following acoustic calculations which have been recorded in Tables 2 and 3 for each sensor location. In the "Slow" measurement mode one second sound pressure samples are taken for a period of one minute and analyzed as follows:

Leq: Equivalent continuous sound level over one-minute measurement period.
SPL MAX: Maximum sound level over one-minute measurement period.
SPL MIN: Minimum sound level over one-minute measurement period.
L10: - 10% percentile sound level
L90: - 90% percentile sound level – **this is the level to be identified as estimated fuel cell noise**

The Connecticut State Noise Ordinance identifies the L90 calculation as useful in estimating background noise levels. We use it here to eliminate some of the background airborne noise that is combined with the fuel cell noise. L90 is the level that is exceeded 90% of the time.

L90 eliminates the highest 10% of the measurements which is this case are predominantly due to vehicle traffic that cannot be seen because buildings block the line of sight. Because the fuel cell noise is essentially constant the L90 value also excludes some of the transient noise made by birds and other non-fuel cell sources. The L90 value averages 1 dB lower than the Leq value.

Table 2. Existing Full Power Overall Sound Pressure Levels in dBA reference 20 microPascals

| Location | Range in Meters | Direction | Leq | Max | Min | L10 | L90 |
|---|---|---|---|---|---|---|---|
| Cooling #4 | 5 | West | 76.7/77.3 | 77.4/77.9 | 76.3/76.8 | 77/77.6 | 76.6/76.9 |
| Cooling #4 | 10 | West | 73.8 | 74.4 | 73.5 | 74.1 | 73.7 |
| Cooling #4 | 5 | North | 78.3/78.4 | 79.2/79.2 | 78/77.9 | 78.7/78.7 | 78.1/78.2 |
| Cooling #4 | 10 | North | 73.5 | 74.4 | 72.9 | 73.9 | 73.2 |
| Power #1 | 5 | North | 64.4/66.7 | 73.8/69.9 | 64/65.7 | 64.9/67.3 | 64.2/65.8 |
| Power #1 | 10 | North | 64 | 67.2 | 63.6 | 64.5 | 63.7 |
| Power #1 | 5 | East | 69.7/66.9 | 86.6/72 | 68.4/66.1 | 70.6/67.3 | 68.9/66.3 |
| Power #1 | 10 | East | 65.9 | 69.7 | 63.8 | 66.4 | 65.2 |
| Power #2 | 5 | East | 71.9/72.5 | 74.7/74.2 | 70.7/71.4 | 72.4/73 | 71.4/71.8 |
| Power #2 | 10 | East | 67.4 | 72.3 | 66.4 | 68.1 | 66.7 |
| P1 468 Main | 63 | Krauser's | 60.5 | 60.9 | 60.3 | 60.7 | 60.3 |
| P2 456 Main | 55 | Flowers | 60.8 | 79.9 | 59.9 | 61.4 | 60.6 |
| P3 456 Main | 51 | V Milano | 57.9 | 58.5 | 57.1 | 58.3 | 57.4 |
| P4 454 Main | 54 | Kam's | 60.7 | 76.1 | 58.6 | 60.7 | 59.8 |
| P5 452 Main | 112 | Willow A | 55.1 | 59 | 54.3 | 55.8 | 54.5 |
| P6 450 Main | 70 | Genuine A | 58.4 | 78.4 | 56.7 | 59 | 56.8 |
| P7 442 Main | 112 | C-Town | 56.7 | 81.5 | 55.9 | 57.7 | 56.1 |
| P8 16 Sisson | 103 | Residence | 57.1 | 58.6 | 56.7 | 57.5 | 56.8 |
| P9 21 Sisson | 107 | Residence | 54.8 | 56.7 | 53 | 55.6 | 53.3 |
| | | | | | | | |
| Cooling & | Power | Data | 1st # on | Nov 11 | 2nd # on | Nov 13 | Full On |

The reduced power data shown in Table 3 were an attempt to measure the background noise with the two existing fuel cells in a quiet condition. Table 3 shows noise levels that dropped from 3 to 4 dB in the reduced power condition. Positions P5, P6 and P7 did not drop in level when the fuel cell power was reduced because the background noise was higher than the fuel cell contribution. The positions closest to the fuel cells did show a drop in level during reduced power and are shown in bold in Table 4. Approximate estimates of the fuel cell contribution from two existing fuel cells are shown in the last two columns of Table 4 for positions P1, P2, P3, and P4. Positions P8 and P9 dropped by less than 1 dB and probably indicate only a small change in background level since the fuel cells could not be heard at these locations. All the values are below 61 dBA and thus below the business airborne noise limit of 62 dBA.

Table 3. Reduced Power Overall Sound Pressure Levels in dBA reference 20 microPascals

| Location | Time | Direction | Leq | Max | Min | L10 | L90 |
|---|---|---|---|---|---|---|---|
| Cooling #4 | 10:03 am | West | 74.1 | 76.2 | 72.9 | 74.7 | 73.4 |
| Cooling #4 | 5 Meters | West | 3.2 dB | Lower | | Lower | 3.5 dB |
| Cooling #4 | 10:01 am | North | 74.6 | 76.1 | 73.6 | 75.1 | 74.3 |
| Cooling #4 | 5 Meters | North | 3.8 dB | Lower | | Lower | 3.9 dB |
| Power #1 | 10 am | North | 63.1 | 63.8 | 62.1 | 63 | 62.6 |
| Power #1 | 5 Meters | North | 3.7 dB | Lower | | Lower | 3.2 dB |
| Power #1 | 9:58 am | East | 64.1 | 64.8 | 63.5 | 64.2 | 63.7 |
| Power #1 | 5 Meters | East | 2.8 dB | Lower | | Lower | 2.6 dB |
| Power #2 | 9:57 am | East | 69.2 | 70.9 | 67.7 | 69.8 | 68.5 |
| Power #2 | 5 Meters | East | 3.3 dB | Lower | | Lower | 3.3 dB |
| P1 468 Main | 9:45 am | Krauser's | 59.1 | 82.5 | 57.8 | 59.5 | 58.3 |
| P2 456 Main | 9:28 am | Flowers | 57.2 | 85.8 | 55.9 | 57.8 | 56.4 |
| P3 456 Main | 9:33 am | V Milano | 57.6 | 80.9 | 55.9 | 58.1 | 56.2 |
| P4 454 Main | 9:35 am | Kam's | 58.1 | 61.6 | 56 | 59.8 | 56.7 |
| P5 452 Main | 9:50 am | Willow A | 55.3 | 56.8 | 54.5 | 55.8 | 54.9 |
| P6 450 Main | 9:48 am | Genuine A | 57.9 | 60.8 | 56.3 | 59.3 | 57 |
| P7 442 Main | 9:54 am | C-Town | 58.5 | 61.1 | 57.7 | 58.9 | 57.8 |
| P8 16 Sisson | 9:41 am | Residence | 56.1 | 60 | 55 | 56.9 | 55.2 |
| P9 21 Sisson | 9:69 am | Residence | 52.9 | 68.5 | 50 | 54.8 | 51 |
| | | | | | | | |

Table 4. Corrected Existing Overall Sound Pressure Level in dBA reference 20 microPascals

| Location | Direction | Leq | L90 | Leq | L90 | Leq | L90 |
|---|---|---|---|---|---|---|---|
| | | Full | Power | Reduced | Power | Bkgd | Corrected |
| P1 468 Main | Krauser's | 60.5 | 60.3 | 59.1 | 58.3 | **60.3** | **60.1** |
| P2 456 Main | Flowers | 60.8 | 60.6 | 57.2 | 56.4 | **60.7** | **60.4** |
| P3 456 Main | V Milano | 57.9 | 57.4 | 57.6 | 56.2 | **57.6** | **57.1** |
| P4 454 Main | Kam's | 60.7 | 59.8 | 58.1 | 56.7 | **60.6** | **59.6** |
| P5 452 Main | Willow A | 55.1 | 54.5 | 55.3 | 54.9 | 54.5 | 53.8 |
| P6 450 Main | Genuine A | 58.4 | 56.8 | 57.9 | 57 | 58.1 | 56.4 |
| P7 442 Main | C-Town | 56.7 | 56.1 | 58.5 | 57.8 | 56.3 | 55.7 |
| P8 16 Sisson | Residence | 57.1 | 56.8 | 56.1 | 55.2 | 56.7 | 56.4 |
| P9 21 Sisson | Residence | 54.8 | 53.3 | 52.9 | 51 | 54.2 | 52.4 |
| Last 2 | Columns | are | Fuel | Cell | only | Levels | |

Table 5. Comparison of Overall Sound Pressure Levels in dBA reference 20 microPascals

| Location | Range in Meters | Direction | Leq | Max | Min | L10 | L90 |
|---|---|---|---|---|---|---|---|
| Cooling 1 unit[2] | 5 | South | 68.9 | 69.4 | 68.4 | 69.2 | 68.7 |
| Cooling 1 unit | 5 | West | 69.7 | 70.5 | 69.1 | 70.1 | 69.4 |
| Cooling #4 | 5 | West | 76.7/77.3 | 77.4/77.9 | 76.3/76.8 | 77/77.6 | 76.6/76.9 |
| Cooling #4 | 5 | North | 78.3/78.4 | 79.2/79.2 | 78/77.9 | 78.7/78.7 | 78.1/78.2 |
| | Average | Difference | **-8.4** | | | | **-8.4** |
| Cooling 1 unit[2] | 10 | South | 65.2 | 66.2 | 64.5 | 65.9 | 64.7 |
| Cooling | 10 | West | 64.2 | 64.7 | 63.7 | 64.4 | 64.0 |
| Cooling | 10 | North | 64.4 | 65.1 | 60.7 | 64.7 | 61.4 |
| Cooling #4 | 10 | West | 73.8 | 74.4 | 73.5 | 74.1 | 73.7 |
| Cooling #4 | 10 | North | 73.5 | 74.4 | 72.9 | 73.9 | 73.2 |
| | Average | Difference | **-9.7** | | | | **-10.7** |
| Power 1 unit[2] | 5 | South | 61.8 | 62.5 | 61.4 | 62.1 | 61.7 |
| Power #1 | 5 | East | 69.7/66.9 | 86.6/72 | 68.4/66.1 | 70.6/67.3 | 68.9/66.3 |
| Power #2 | 5 | East | 71.9/72.5 | 74.7/74.2 | 70.7/71.4 | 72.4/73 | 71.4/71.8 |
| | Average | Difference | **-8.5** | | | | **-7.9** |
| Power 1 unit[2] | 10 | South | **61.2** | 62.3 | 60.5 | 61.9 | **60.8** |
| Power #1 | 10 | East | 65.9 | 69.7 | 63.8 | 66.4 | 65.2 |
| Power #2 | 10 | East | 67.4 | 72.3 | 66.4 | 68.1 | 66.7 |
| | Average | Difference | **-5.5** | | | | **-5.2** |

Table 6. Estimated Property Line Overall Sound Pressure Levels in dBA ref. 20 microPascals

| Location | Range in Meters | Allowed | Source Adj | Leq | **L90** | Status | Acoustic Concern |
|---|---|---|---|---|---|---|---|
| P1 468 Main | 63 | 62 | -2.2 dB | **58.1** | **57.9** | OK | None |
| P2 456 Main | 55 | 62 | -2.2 dB | **58.5** | **58.2** | OK | None |
| P3 456 Main | 51 | 62 | -2.2 dB | **55.4** | **54.9** | OK | None |
| P4 454 Main | 54 | 62 | -2.2 dB | **58.4** | **57.4** | OK | None |
| P5 452 Main | 112 | 62 | -2.2 dB | <54.5 | <53.8 | OK | None |
| P6 450 Main | 70 | 62 | -2.2 dB | <58.1 | <56.4 | OK | None |
| P7 442 Main | 112 | 62 | -2.2 dB | <56.3 | <55.7 | OK | None |
| P8 16 Sisson | 103 | 62 | -2.2 dB | 54.5 | 54.2 | OK | None |
| P9 21 Sisson | 107 | 62 | -2.2 dB | 52.0 | 50.0 | OK | None |

Figure 7. East Hartford Zoning Map Showing the Fuel Cells and Nearby Areas


Table 5 provides a comparison of the airborne noise levels of the two Coca Cola 400 KW fuel cells with that of a single 460 KW fuel cell that was measured in Montville CT[2] on July 13, 2020. In the direction of the nearby property lines the L90 airborne noise of the newer 460 KW fuel cell was 5.2 dB lower. Because there will be two fuel cells at Coca Cola and thus 3 dB more noise than a single fuel cell, an adjustment of -2.2 dB has been added to the existing property line values. This makes all the estimates of all property line values with the two new fuel cells to be below 58 dBA, at least 4 dB below the Business Zone noise requirement.

The estimated airborne noise levels produced by the Doosan fuel cell are shown in Table 5. For each of the nine locations the East Hartford L90 measurements were used to eliminate some of the background noise. The measurements at the Coca Cola site were taken at various distances from the fuel cell. Close to the fuel cell at 454 to 468 Main Street the airborne noise values are expected to be in the 55 to 58 dBA range, at least 4 dB below the business noise limit. The two closest residences on Sisson Street are expected to have background limited airborne noise levels of 50 and 54 dBA well below the business noise limit. The other four nearby businesses were also background limited with levels that should be below 56.5 dBA. Airborne noise at these four locations could not be heard. Other properties being more than 70 meters from the fuel cells are also not expected to hear the new fuel cells airborne noise. All the nearby commercial and residential properties are expected to be well below the 62 dBA noise limit, the amount depending on how close the locations are to the fuel cells.

It should be stated that these estimates assume the current fuel cell physical configuration is repeated with the new fuel cells. Because the cooling modules are about 7 dB noisier than the power modules the cooling modules cannot be moved closer to Main Street without adding a noise mitigating barrier that the existing power modules currently provide.

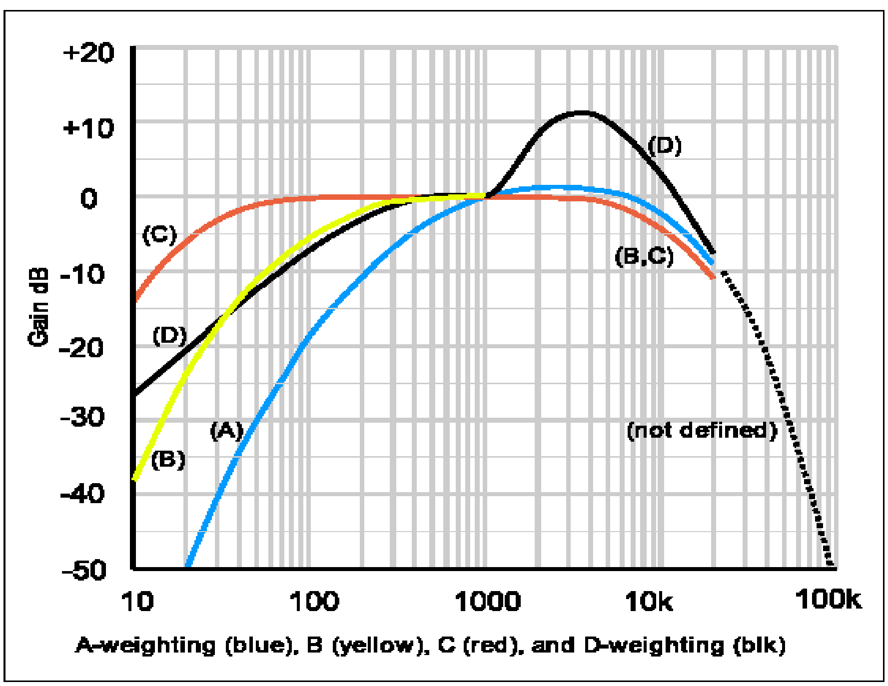
## Allowable Noise Levels

The Connecticut regulation for the control of noise provides in *CT section 22a-69*-3 (Ref. 1) the requirements for noise emission in Connecticut. *CT section 22a-69*-3.1 states that no person shall cause or allow the emission of excessive noise beyond the boundaries of his/her Noise Zone so as to violate any provisions of these Regulations. (East Hartford currently does not regulate this type of noise.) The CT ordinance will be used to evaluate the noise generated by the two Doosan 460 KW Fuel Cells. Following sections discuss each type of noise using the results obtained from the November 11 and 13, 2021 fuel cell measurements at the Coca Cola site in East Hartford and the Doosan 460 KW July 13, 2020 test in Montville.

The western part of the East Hartford zoning map is given in Figure 7. As stated above, the East Hartford site at 471 Main Street is located in a Business Zone near CT Route 2 and is surrounded by Commercial (Business) Zones to the east, north, west and south, a Residential Zone to the east and the water of the Connecticut River to the west. The closest residential area is 180 meters away at 39 Lilac Street in a R-4 Residential Zone. Based on the source levels at 5 and 10 meters the airborne noise from the fuel cells should be below 40 dBA at about 180 meters from the fuel cells. Other nearby residential properties at greater distances are also expected to be well below the day time and night time Residential Zone noise limits for an emitter in a commercial zone. The airborne noise estimated at all the properties along Main Street in the business zone is well below the allowable noise level of 62 dBA in a commercial zone.

Figure 8. Acoustic Airborne Noise Weighting Curves

http://upload.wikimedia.org/wikipedia/commons/3/39/Acoustic_weighting_curves_(1).svg




1 of 1

1/25/2013 9:35 PM

## Impulse Noise

The Connecticut noise code states in *CT section 22a-69*-3.2 (part a) *Impulse Noise* that no person shall cause or allow the emission of impulse noise in excess of 80 dB peak sound pressure level during the night time to any class A Noise Zone. Night time is defined as 10 pm to 7 am. *CT section 22a-69-3.2 (part b) Impulse Noise* states that no person shall cause or allow the emission of impulse noise in excess of 100 dB peak sound pressure level at any time to any Noise Zone.

Impulse noise in excess of 100 dBA was not observed during any of the nine property line measurements of the two fuel cells made at the East Hartford site on November 13, 2021. A maximum level of 87 dB was measured five meters from the cooling module. Across the street at the House of Flowers the maximum measured level was 76 dB. These unweighted impulse noise levels were determined using the Hewlett Packard spectrum analyzer. The Main Street property lines showed a maximum noise level of 81.5 dBA due to the vehicles driving by on Main Street. Given the steady state nature of the fuel cell's noise signature there should be no acoustic issues with Connecticut's impulse noise requirements at any neighboring property.

A few words are in order to discuss the difference between A-weighted and un-weighted impulse noise. A-weighting emphasizes the middle and higher frequencies while reducing the influence of the low frequencies. Figure 8 plots the A-weighting curve versus frequency in blue. Below a frequency of 1 kiloHertz the acoustic level is attenuated by increasing amounts. The reduction is about 10 dB at 200 Hertz, 20 dB at 90 Hertz and 30 dB at 50 Hertz. It also reduces the level at very high frequency being down in level by 10 dB at 20 kiloHertz. The fuel cell measurements show the unweighted overall levels to be about 9 dB higher than the A-weighted noise levels.

## Prominent Discrete Tones

The Connecticut regulation for the control of noise states in *CT section 22a-69-3.3 Prominent discrete tones:* Continuous noise measured beyond the boundary of the Noise Zone of the noise emitter in any other Noise Zone which possesses one or more audible discrete tones shall be considered excessive noise when a level of 5 dBA below the levels specified in section 3 of these Regulations is exceeded. The CT Regulations establish different noise limits for different land use zones. Residential (homes and condominiums) and hotel uses are in Class A. Schools, business, parks, recreational activities and government services are in Class B. Forestry and related services are in Class C. By my reading of the regulations the Coca Cola site is a Class B emitter in a Business Zone. The noise zone standards in *CT section 22a-69-3.5* state that a Class B emitter cannot exceed the following overall sound pressure levels:

To Class C 62 dBA To Class B 62 dBA To Class A 55 dBA (day) 45 dBA (night)

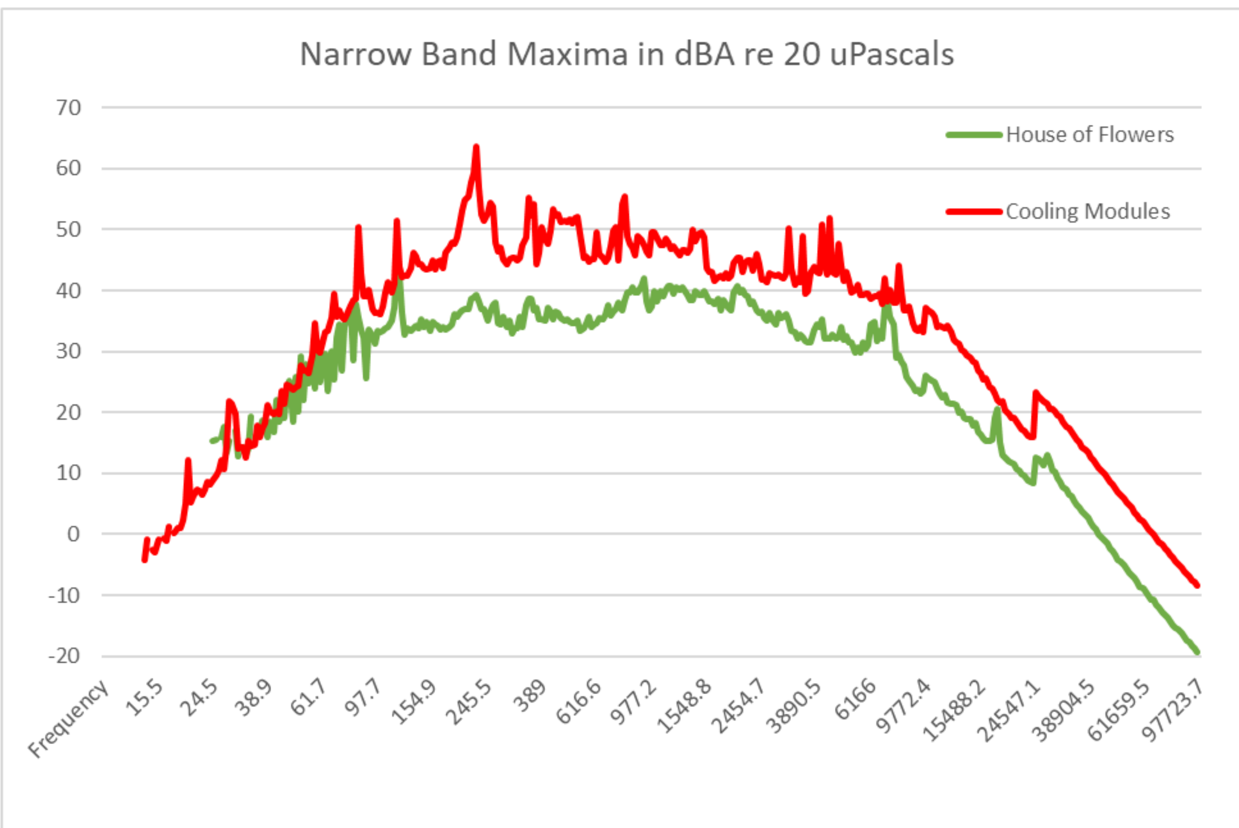
The discrete tones limits are 5 dBA lower so that no tone may be higher than the following:

To Class C 57 dBA To Class B 57 dBA To Class A 50 dBA (day) 40 dBA (night)

The East Hartford noise requirements do not discuss discrete tones so the CT Noise Ordinance will be used. To address the discrete tone issue, we use measured spectral data from the

November 11, 2021 testing. Figure 9 plots the airborne noise measured 5 meters from the Cooling Module #4 and at the House of Flowers across the street from the Coca Cola site. The data is the maximum level received in 1/30 octave bands for frequencies from 15 Hz to 100,000 Hz. This figure shows the large discrete tones in the middle frequencies produced by the Doosan Fuel Cell Cooling Module at 5 meters. For the cooling module the highest peak is at 63.7 dBA reference 20 microPascals at 229.1 Hz. Another high cooling module peak is at 51.5 dBA at 117.5 Hertz. At the House of Flowers, the highest peak is 44.7 dBA reference 20 microPascals at 117.5 Hz. This is about 7 dB lower than the corresponding peak at the cooling module. The second highest tone is at 933 Hz at a level of 42 dBA reference 20 microPascals. All the other House of Flowers site tones are at or below a level of 40 dBA reference 20 microPascals. All these frequencies are well below the 57 dBA discrete tone requirement. Operating the two new Doosan fuel cell should produce airborne noise levels about 2 dB lower than the existing fuel cells and well below the CT discrete tone requirement at all the other business property lines. These locations are at similar or further distances from the fuel cells. The residential zone is even further away and the discrete tones should be below the 40 dBA night time limit at all the residences. There should be no acoustic issue with the CT discrete tone noise requirements.

Figure 9. Discrete Tones from Fuel Cell Cooling & Power Modules in 1-30th octave bands



## Infrasonic and Ultrasonic Noise

The Connecticut regulation for the control of noise states in *CT section 22a-69-3.4 Infrasonic and Ultrasonic* that no person shall emit beyond his/her property infrasonic or ultrasonic sound in excess of 100 dB at any time. 100 dB with respect to the reference of 20 microPascals is a sound pressure of 2 Pascals or 0.00029 psi. Infrasonic sounds are sound pressure fluctuations below a frequency of 20 Hertz. Ultrasonic sounds are sound pressure fluctuations at frequencies above 20,000 Hertz. There is no East Hartford Noise Ordinance to limit infrasonic or ultrasonic noise so the State of CT Noise Ordinance will be discussed.

Narrow bandwidth sound pressure spectrums in dB reference 20 microPascals made at the western 5-meter Cooling Module location can be used to compare with the infrasonic and ultrasonic noise requirements. The East Hartford airborne noise data were processed in the 0 to 200 Hertz and 0 to 100,000 Hertz frequency ranges. The bandwidth of each data point is 0.75 Hertz for the 200 Hertz range and 375 Hertz for the 100,000 Hertz frequency range. The infrasonic noise for frequencies up to 20 Hertz is shown in Figure 10 for both the 400 KW units at Coca Cola and the 460 KW unit at Montville[2]. The maximum level at 5 meters is 58.4 dB reference 20 microPascals at Coca Cola. The maximum level at 10 meters is 48 dB reference 20 microPascals at Montville. The entire 20 Hertz band can be power summed and never exceeds about 70 dB reference 20 microPascals at 5 meters at Coca Cola. The entire 20 Hertz band can be power summed and never exceeds 70 dB reference 20 microPascals at 10 meters in Montville. Both levels are well below the requirement of 100 dB for a commercial property. The minimum transmission loss to the nearest property line is at least 8 dB so the maximum possible infrasonic noise at the eastern property line would be less than 60 dB. There should be no issue with the infrasonic noise requirement at any of the neighboring properties.

The ultrasonic noise for frequencies up to 100 KiloHertz is given in Figure 11. The maximum level at 10 meters is 36 dB reference 20 microPascal at 5 meters at Coca Cola. The microphone at Coca Cola begins to roll off above 25 KHz. The Montville data uses a microphone with flat high frequency performance and provides a better estimate since it measures the newer 460 KW fuel cell. The entire 80 KiloHertz band from 20 to 100 kiloHertz has been power summed and never exceeds a noise level of 62 dB reference 20 microPascals 5 meters from the fuel cell at Montville. Adding 3 dB to account for two fuel cells at Coca Cola plus the minimum transmission loss to the nearest residential property line of at least 8 dB leads to a maximum possible ultrasonic noise at the eastern property line of 57 dB. The noise levels at the other nearby neighbors will be lower and there should be no issue with ultrasonic noise at any of the neighboring properties.

It should be noted that the spectrum analysis covers frequencies up to 100 kiloHertz and the PCB microphone model 378C01 s/n 121246 in the Montville test has a sensor that can measure up to 100 KHz. This sensor was not used on the Coca Cola measurements resulting in the high frequency roll off shown in Figure 11. The more sensitive PCB model 130F20 s/n 53933 microphone has a sensor with a much lower noise floor better capable of handling frequencies below 25 KiloHertz. The model 130F20 sensor was used for all the spectral measurement locations at Coca Cola. Data below 25 KHz has 94 Hz bandwidth while data above 25 KHz has 375 Hz bandwidth causing the step up in level at 25 KHz seen in Figure 11.

Figure 10. Infrasonic Noise from Fuel Cell Cooling Modules in 1-30th octave bands

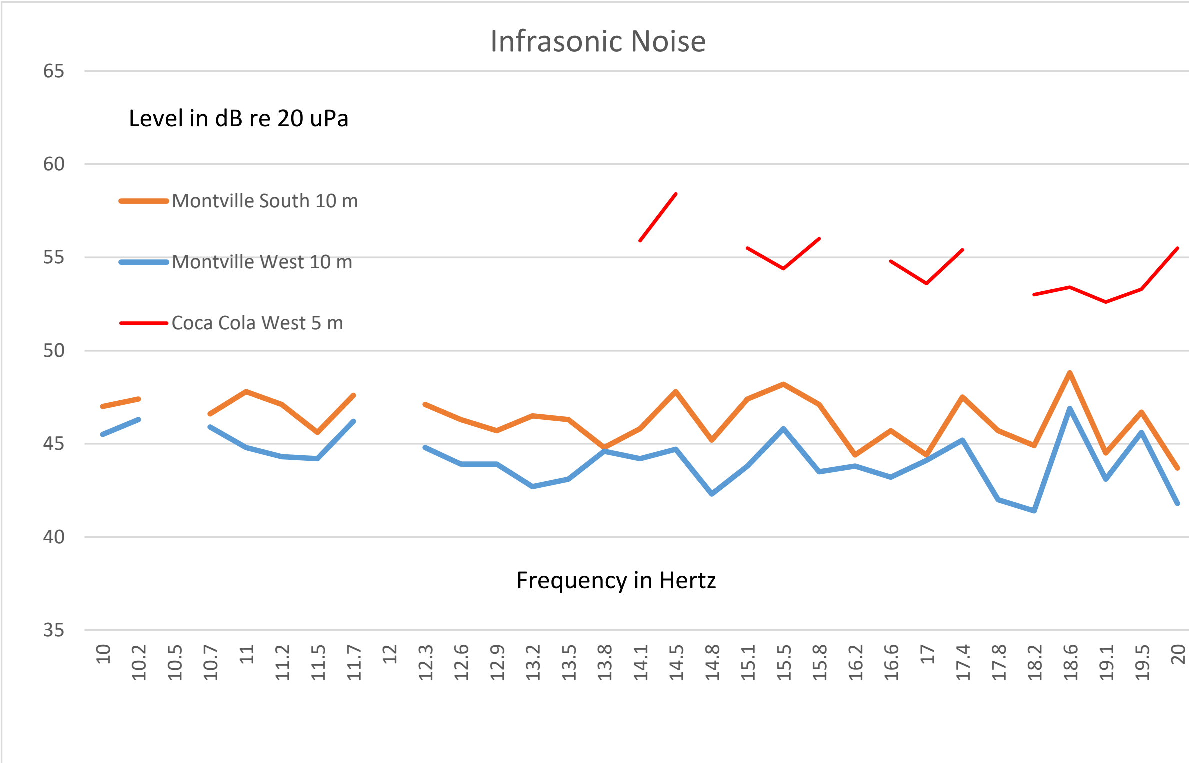
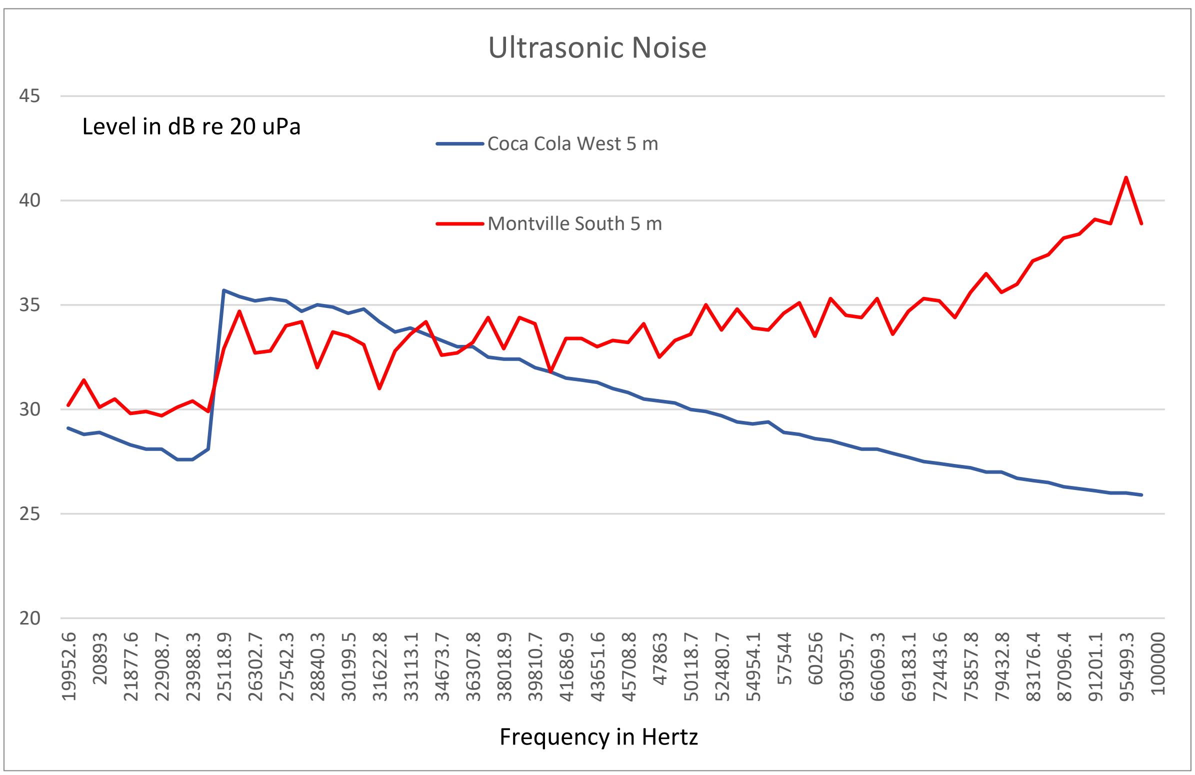



Figure 11. Ultrasonic Noise from Fuel Cell Cooling Modules in 1-30th octave bands



## Overall Sound Pressure Levels

The Connecticut regulations for the control of noise state that
*(a) No person in a Class B Noise Zone shall emit noise exceeding the levels below:*

To Class C 62 dBA To Class B 62 dBA To Class A 55 dBA (day) 45 dBA (night)

The Coca Cola site is in a Business Zone that has a Residential Zone to the east and Commercial Zones in all the other directions. The nearby neighbors are classified as either residential or commercial with residential noise limits of 55 dBA during the day and 45 dBA at night. The airborne noise limit at the commercial locations is 62 dBA.

The estimated overall A-weighted sound pressure level measurements in dBA reference 20 microPascals are given in Tables 6 above for the background corrected measurements made on November 13, 2021. The second column gives the approximate distance from the fuel cell to the measurement location, with locations identified by a P number in Figure 1. Column 3 gives the allowable noise levels. The airborne noise values given in columns 5 and 6 are the average measured level (Leq) and the estimated fuel cell level (L90), respectively. The L90 level in Table 6 has some of the background noise removed in order to estimate the contribution provided by the new fuel cells' Cooling and Power Modules. This is an upper limit to the fuel cell noise. (The fuel cell could not be turned off to make a true background measurement.) Column 7 tells whether the measured levels are above or below the requirements. The values are all below the business zone noise limit. The values at three of the closest locations are expected to be about 4 dB below the noise requirement (58 dBA). The other locations are at least 7 dB below the noise requirement. Because of the increasing loss with distance to the residential properties to the east should all be lower than 45 dBA. All the property line estimates should meet the 62 dBA Commercial, 55 dBA day time residential and 45 dBA night time noise limits.

Operation of the two Doosan fuel cells will have no acoustic impact at all of the nearby properties adjacent to the Coca Cola site at 471 Main Street. The commercial properties close to Coca Cola should see airborne noise levels from the fuel cells at least 2 dB below the airborne noise produced by the two existing fuel cells. Commercial properties further away from the fuel cell along Main Street that do not currently hear the fuel cells are expected to continue in this condition. The Main Street properties should not be affected by the operation of the fuel cells.

## Conclusions

The purpose of this effort is to evaluate the acoustical environment at the East Hartford Coca Cola site during operation of the two new Doosan 460 KW fuel cells. This effort has been accomplished and the results show that the operation of the Doosan 460 KW fuel cells will meet all of the State of Connecticut airborne noise requirements at all the nearby properties. Residences to the east are also expected to meet all the noise requirements because they are at least 180 meters away from the new fuel cells. Locations at distances greater than 60 meters do not hear the currently operating 400 KW fuel cells that are estimated to be about 2 dB noisier than the new 460 KW fuel cells.

## References

1) CT DE&EP *Noise Control Regulation RCSA Section 22a-69*-1 to 22a-69-7.4 http://www.ct.gov/dep/lib/dep/regulations/22a/22a-69-1through7.pdf

2) Town of Montville Water Pollution Control Authority Airborne Noise Test At 83 Pink Row, Acoustical Technologies Inc., July 13, 2020

# Connecticut Siting Council

**Electric and Magnetic Fields Best Management Practices**
**For the Construction of Electric Transmission Lines in Connecticut**

**Revised on February 20, 2014**

## I. Introduction

To address a range of concerns regarding potential health risks from exposure to transmission line electric and magnetic fields (EMF), whether from electric transmission facilities or other sources, the Connecticut Siting Council (Council) (in accordance with Public Act 04-246) issues this policy document "*Electric and Magnetic Fields Best Management Practices for the Construction of Electric Transmission Lines in Connecticut*." It references the latest information regarding scientific knowledge and consensus on EMF health concerns; it also discusses advances in transmission-facility siting and design that can affect public exposure to EMF.

Electric and magnetic fields (EMF) are two forms of energy that surround an electrical device. The strength of an electric field (EF) is proportional to the amount of electric voltage at the source, and decreases rapidly with distance from the source, diminishing even faster when interrupted by conductive materials, such as buildings and vegetation. The level of a magnetic field (MF) is proportional to the amount of electric current (not voltage) at the source, and it, too, decreases rapidly with distance from the source; but magnetic fields are not easily interrupted, as they pass through most materials. EF is often measured in units of kilovolts per meter (kV/m). MF is often measured in units of milligauss (mG).

Transmission lines are common sources of EMF, as are other substantial components of electric power infrastructure, ranging from transformers at substations to the wiring in a home. However, any piece of machinery run by electricity can be a source of EMF: household objects as familiar as electric tools, hair dryers, televisions, computers, refrigerators, and electric ovens.

In the U.S., EMF associated with electric power have a frequency of 60 cycles per second (or 60 Hz). Estimated average background levels of 60-Hz MF in most homes, away from appliances and electrical panels, range from 0.5 to 5.0 mG (NIEHS, 2002). MF near operating appliances such as an oven, fan, hair dryer, television, etc. can range from 10's to 100's of mG. Many passenger trains, trolleys, and subways run on electricity, producing MF: for instance, MF in a Metro-North Railroad car averages about 40-60 mG, increasing to 90-145 mG with acceleration (Bennett Jr., W. 1994). As a point of comparison to these common examples, the Earth itself has an MF of about 570 mG (USGS 2007). Unlike the MF associated with power lines, appliances, or computers, the Earth's MF is steady; in every other respect, however, the Earth's MF has the same characteristics as MF emanating from man-made sources.

Concerns regarding the health effects of EMF arise in the context of electric transmission lines and distribution lines, which produce time-varying EMF, sometimes called extremely-low frequency electric and magnetic fields, or ELF-EMF. As the weight of scientific evidence indicates that exposure to electric fields, beyond levels traditionally established for safety, does not cause adverse health effects, and as safety concerns for electric fields are sufficiently addressed by adherence to the National Electrical Safety Code, as amended, health concerns regarding EMF focus on MF rather than EF.

MF levels in the vicinity of transmission lines are dependent on the flow of electric current through them and fluctuate throughout the day as electrical demand increases and decreases. They can range from about 5 to 150 mG, depending on current load, height of the conductors, separation of the conductors, and distance from the lines. The level of the MF produced by a transmission line decreases with increasing distance from the conductors, becoming indistinguishable from levels found inside or outside homes (exclusive of MF emanating from sources within the home) at a distance of 100 to 300 feet, depending on the design and current loading of the line (NIEHS, 2002).

In Connecticut, existing and proposed transmission lines are designed to carry electric power at voltages of 69, 115, or 345 kilovolts (kV). Distribution lines, i.e. those lines directly servicing the consumer's building, typically operate at voltages below 69 kV and may produce levels of MF similar to those of transmission lines. The purpose of this document is to address engineering practices for proposed electric transmission lines with a design capacity of 69 kV or more and MF health concerns related to these projects, but not other sources of MF.

## II. Health Concerns from Power-Line MF

While more than 40 years of scientific research has addressed many questions about EMF, the continuing question of greatest interest to public health agencies is the possibility of an association between time weighted MF exposure and demonstrated health effects. The World Health Organization (WHO) published its latest findings on this question in an Electromagnetic Fields and Public Health fact sheet, June 2007) http://www.who.int/peh-emf/publications/facts/fs322/en/index.html The fact sheet is based on a review by a WHO Task Group of scientific experts who assessed risks associated with ELF-EMF. As part of this review, the group examined studies related to MF exposure and various health effects, including childhood cancers, cancers in adults, developmental disorders, and neurobehavioral effects, among others. Particular attention was paid to leukemia in children. The Task Group concluded "that scientific evidence supporting an association between ELF magnetic field exposure and all of these health effects is much weaker than for childhood leukemia". (WHO, 2007) For childhood leukemia, WHO concluded recent studies do not alter the existing position taken by the International Agency for Research on Cancer (IARC) in 2002, that ELF-MF is "possibly carcinogenic to humans."

Some epidemiology studies have reported an association between MF and childhood leukemia, while others have not. Two broad statistical analyses of these studies reported an association with estimated average exposures greater than 3 to 4 mG, but at this level of generalization it is difficult to determine whether the association is significant. In 2005, the National Cancer Institute (NCI) stated, "Among more recent studies, findings have been mixed. Some have found an association; others have not . . . . Currently, researchers conclude that there is limited evidence that magnetic fields from power lines cause childhood leukemia, and that there is inadequate evidence that these magnetic fields cause other cancers in children." The NCI stated further: "Animal studies have not found that magnetic field exposure is associated with increased risk of cancer. The absence of animal data supporting carcinogenicity makes it biologically less likely that magnetic field exposures in humans, at home or at work, are linked to increased cancer risk."

The National Institute of Environmental Health Sciences (NIEHS) concluded in 1999 that EMF exposure could not be recognized as "*entirely safe*" due to some statistical evidence of a link with childhood leukemia. Thus, although no public health agency has found that scientific research suggests a causal relationship between EMF and cancer, the NIEHS encourages "inexpensive and safe reductions in exposure" and "suggests that the power industry continue its current practice of siting power lines to reduce exposures" rather than adopting strict regulatory guidelines (NIEHS, 1999, pp. 37-38). In 2002 NIEHS restated that while this evidence was "weak" it was "still sufficient to warrant limited concern" and recommended "continued education on ways of reducing exposures" (NIEHS, 2002, p. 14).

Reviews by other study groups, including IARC (2002), the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) (2003), the British National Radiation Protection Board (NRPB) (2004a), and the Health Council of the Netherlands ELF Electromagnetic Fields Committee (2005), are similar to NIEHS and NCI in their uncertainty about reported associations of MF with childhood leukemia. In 2004, the view of the NRPB was:

> "[T]he epidemiological evidence that time-weighted average exposure to power frequency magnetic fields above 0.4 microtesla [4 mG] is associated with a small absolute raised risk of leukemia in children is, at present, an observation for which there is no sound scientific explanation. There is no clear evidence of a carcinogenic effect of ELF EMFS in adults and no plausible biological explanation of the association can be obtained from experiments with animals or from cellular and molecular studies. Alternative explanations for this epidemiological association are possible…Thus: any judgments developed on the assumption that the association is causal would be subject to a very high level of uncertainty." (NRPB, 2004a, p. 15)

Although IARC classified MF as "possibly carcinogenic to humans" based upon pooling of the results from several epidemiologic studies, IARC further stated that the evidence suggesting an association between childhood leukemia and residential MF levels is "limited," with "inadequate" support for a relation to any other cancers. The WHO Task Group concluded "the evidence related to childhood leukemia is not strong enough to be considered causal" (WHO, 2007).

The Connecticut Department of Public Health (DPH) has produced an EMF Health Concerns Fact Sheet (May 2007) that incorporates the conclusions of national and international health panels. The fact sheet states that while "the current scientific evidence provides no definitive answers as to whether EMF exposure can increase health risks, there is enough uncertainty that some people may want to reduce their exposure to EMF."
http://www.ct.gov/dph/lib/dph/environmental_health/eoha/pdf/emf_fact_sheet_-_2008.pdf

In the U.S., there are no state or federal exposure standards for 60-Hz MF based on demonstrated health effects. Nor are there any such standards world-wide. Among those international agencies that provide guidelines for acceptable MF exposure to the general public, the International Commission on Non-Ionizing Radiation Protection (ICNIRP) established a level of 833 mG, based on an extrapolation from experiments involving transient neural stimulation by MF at much higher exposures. Using a similar approach, the International Committee on Electromagnetic Safety (ICES) calculated a guideline of 9,040 mG for exposure to workers and the general public (ICNIRP, 1998; ICES/IEEE, 2002). This situation reflects the lack of credible scientific evidence for a causal relationship between MF exposure and adverse health effects.

In November 2010, ICNIRP updated its guidelines. The new guideline establishes 2,000 mG as an acceptable exposure level for the general public replacing the previous 1998 exposure guideline of 833 mG. (See "ICNIRP Statement – Guidelines for Limiting Exposure to Time-Varying Electric and Magnetic Fields (1 Hz to 100 kHz). Health Physics 99(6):818-836; 2010" http://www.icnirp.org/documents/LFgdl.pdf and "Fact Sheet on the Guidelines for Limiting Exposure to Time-Varying Electric and Magnetic Fields (1 Hz to 100 kHz) Published in Health Physics 99(6):818-836;2010" http://www.icnirp.org/documents/FactSheetLF.pdf at www.icnirp.org.)

## III. Policy of the Connecticut Siting Council

The Council recognizes that a causal link between power-line MF exposure and demonstrated health effects has not been established, even after much scientific investigation in the U.S. and abroad. Furthermore, the Council recognizes that timely additional research is unlikely to prove the safety of power-line MF to the satisfaction of all. Therefore, the Council will continue its cautious approach to transmission line siting that has guided its Best Management Practices since

1993. This continuing policy is based on the Council's recognition of and agreement with conclusions shared by a wide range of public health consensus groups, and also, in part, on a 2006 review which the Council commissioned as to the weight of scientific evidence regarding possible links between power-line MF and adverse health effects[1]. Under this policy, the Council will continue to advocate the use of effective no-cost and low-cost technologies and management techniques on a project-specific basis to reduce MF exposure to the public while allowing for the development of efficient and cost-effective electrical transmission projects. This approach does not imply that MF exposure will be lowered to any specific threshold or exposure limit, nor does it imply MF mitigation will be achieved with no regard to cost.

The Council has developed its precautionary guidelines in conjunction with Section 16-50p(i) of the Connecticut General Statutes, enacted by the General Assembly to call special attention to their concern for children. Subject to technological feasibility, the Act restricts the siting of overhead 345-kV transmission lines in areas where children congregate. These restrictions cover transmission lines adjacent to "residential areas, public or private schools, licensed child day-care facilities, licensed youth camps, or public playgrounds."

**Developing Policy Guidelines**

One important way the Council seeks to update its Best Management Practices is to integrate policy with specific project development guidelines. In this effort, the Council has reviewed the actions of other states. Most states either have no specific guidelines or have established arbitrary MF levels at the edge of a right-of-way that are not based on any demonstrated health effects. California, however, established a no-cost/low-cost precautionary-based EMF policy in 1993 that was re-affirmed by the California Public Utilities Commission in 2006. California's policy aims to provide significant MF reductions at no cost or low cost, a precautionary approach consistent with the one Connecticut has itself taken since 1993, consistent with the conclusions of the major scientific reviews, and consistent with the policy recommendations of the Connecticut Department of Public Health and the WHO. Moreover, California specifies certain benchmarks integral to its policy. The benchmark for "low-cost/no-cost" is an increase in aggregate project costs of zero to four percent. The benchmark for "significant MF reduction" is an MF reduction of at least 15 percent. With a policy similar to Connecticut's, and concrete benchmarks as well, California offers the Council a useful model in developing policy guidelines.

**No-Cost/Low-Cost MF Mitigation**

The Council seeks to continue its precautionary policy, in place since 1993, while establishing a standard method to allocate funds for MF mitigation methods. The Council recognizes California's cost allotment strategy as an effective method to achieve MF reduction goals; thus, the Council will follow a similar strategy for no-cost/low-cost MF mitigation.

The Council directs the Applicant to initially develop a baseline Field Management Design Plan that depicts the proposed transmission line project designed according to standard good utility practice and incorporating "no-cost" MF mitigation design features. The Applicant shall then modify ~~the~~ this base design by adding low-cost MF mitigation design features specifically where portions of the project are adjacent to residential areas, public or private schools, licensed child day-care facilities, licensed youth camps, or public playgrounds. The overall cost of low-cost design features are to be calculated at four percent of the initial Field Management Design Plan, including related substations. The best estimates of total project costs that are worked out during the Council proceedings should be employed, with the amounts proposed to be incurred for MF mitigation excluded. It is important to note that the four percent guideline is not an absolute cap, because the

[1] Current Status of Scientific Research, Consensus, and Regulation Regarding Potential Health Effects of Power-Line Electric and Magnetic Fields (EMF) http://www.ct.gov/csc/lib/csc/emf_bmp/emf_report.pdf

Council does not want to eliminate prematurely a potential measure that might be available and effective but would cost more than the four percent, or exclude arbitrarily an area adjacent to the ROW that might be suitable for MF mitigation. Nor is the four percent an absolute threshold, since the Council wants to encourage the utilities to seek effective field reduction measures costing less than four percent. In general, the Council recognizes that projects can vary widely in the extent of their impacts on statutory facilities, necessitating some variance above and below the four percent figure.

The four percent guideline for low-cost mitigation should aim at a magnetic field reduction of 15 percent or more at the edge of the utility's ROW. This 15 percent reduction should relate specifically to those portions of the project where the expenditures would be made. While experience with transmission projects in Connecticut since 1993 has shown that no-cost/low-cost designs can and do achieve reductions in MF on the order of 15 percent, the 15 percent guideline is no more absolute than the four percent one, nor must the two guidelines be correlated by rote. The nature of guidelines is to be constructive, rather than absolute.

The Council will consider minor increases above the four percent guideline if justified by unique circumstances, but not as a matter of routine. Any cost increases above the four percent guideline should result in mitigation comparably above 15 percent, and the total costs should still remain relatively low.

Undergrounding transmission lines puts MF issues out of sight, but it should not necessarily put them out of mind. After all, soils and other fill materials do not shield MF; rather, MF is reduced by the underground cable design (refer to page 9 for further information). However, special circumstances may warrant some additional cost in order to achieve further MF mitigation for underground lines. The utilities are encouraged, prior to submitting their application to the Council, to determine whether a project involves such special circumstances. Note that the extra costs of undergrounding done for purposes other than MF mitigation should be counted in the base project cost and not as part of the four percent mitigation spending.

Additionally, the Council notes two general policies it follows in updating its EMF Best Management Practices and conducting other matters within its jurisdiction. One is a policy to support and monitor ongoing study. Accordingly, the Council, during the public hearing process for new transmission line projects, will consider and review evidence of any new developments in scientific research addressing MF and public health effects or changes in scientific consensus group positions regarding MF. The second Council policy is to encourage public participation and education. The Council will continue to conduct public hearings open to all, update its website to contain the latest information regarding MF health effect research, and revise these Best Management Practices to take account of new developments in MF health effect research or in methods for achieving no-cost/low-cost MF mitigation.

During its review of two recent transmission-line projects–Docket No. 424, approved December 27, 2012 and Docket No. 435, approved September 5, 2013–the Council pursued its policy of monitoring research on EMF.

In Council Docket No. 424 the document titled, "*Current Status of Research on Extremely Low Frequency Electric and Magnetic Fields and Health: Interstate Reliability Project, June 10, 2011*" was centered around the WHO 2007 report examining reports or scientific statements regarding the potential health effects of ELF-EMF over the ~~past~~ previous five years. In Council Docket No. 435 the document titled, "*Update of Research on Extremely Low Frequency Electric and Magnetic Fields and Health May 1, 2011 – July 31, 2012 Stamford Reliability Cable Project August 30, 2012*" provides a bibliography of peer-reviewed national and international research and reviews. In general, the conclusions of these two documents are consistent with the scientific consensus articulated by the WHO and other scientific organizations and have not found any *consistent* associations with regard to ELF EMF exposure and any type of cancer or disease, except childhood leukemia, nor have they concluded that there is a cause-and-effect link with any health effect, including childhood leukemia.

Applying its policy of encouraging public participation and education the Council will continue to require that notices of proposed overhead transmission lines provided in utility bill enclosures pursuant to Conn. Gen. Stats. §16-50/(b) state the proposed line will meet the Council's Electric and Magnetic Fields Best Management Practices, specifying the design elements planned to reduce magnetic fields. The bill enclosure notice will inform residents how to obtain siting and MF information specific to the proposed line at the Council's website; this information will also be available at each respective town hall. Phone numbers for follow-up information will be made available, including those of DPH and utility representatives. The project's final post-construction structure and conductor specifications, including calculated MF levels, shall also be available at the Council's website and each respective town hall.

Finally, we note that Congress has directed the Department of Energy (DOE) periodically to assess congestion along critical transmission paths or corridors and apply special designation to the most significant ones. Additionally, Congress has given the Federal Regulatory Commission supplemental siting authority in DOE-designated areas. This means the Council must complete all matters in an expeditious and timely manner. Accordingly, the cooperation of all parties will be of particular importance in fulfilling the policies set forth above.

## IV. MF Best Management Practices: Further Management Considerations

The Council's EMF Best Management Practices will apply to the construction of new electric transmission lines in the State, and to modifications of existing lines that require a certificate of environmental compatibility and public need. These practices are intended for use by public service utilities and the Council when considering the installation of such new or modified electric transmission lines. The practices are based on the established Council policy of reducing MF levels at the edge of a right-of-way (ROW), and in areas of particular interest, with no-cost/low-cost designs that do not compromise system reliability or worker safety, or environmental and aesthetic project goals.

Several practical engineering approaches are currently available for reducing MF, and more may be developed as technology advances. In proposing any particular methods of MF mitigation for a given project, the Applicant shall provide a detailed rationale to the Council that supports the proposed MF mitigation measures. The Council has the option to retain a consultant to confirm that the Field Management Design Plan and the proposed MF reduction strategies are consistent with these EMF Best Management Practices.

### A. MF Calculations

When preparing a transmission line project, an applicant shall provide design alternatives and calculations of MF for pre-project and post-project conditions, under 1) peak load conditions at the time of the application filing, and 2) projected seasonal maximum 24-hour average current load on the line anticipated within five years after the line is placed into operation. This will allow for an evaluation of how MF levels differ between alternative power line configurations. The intent of requiring various design options is to achieve reduced MF levels when possible through practical design changes. The selection of a specific design will also be affected by other practical factors, such as the cost, system reliability, aesthetics, and environmental quality.

MF values shall be calculated from the ROW centerline out to a distance of 300 feet on each side of the centerline, at intervals of 25 feet, including at the edge of the ROW. In accordance with industry practice, the calculation shall be done at the location of maximum line sag (typically mid-span), and shall provide MF values at 1 meter above ground level, with the assumption of flat terrain and balanced currents. The calculations shall assume “all lines in” and projected load growth five years beyond the time the lines are expected to be put into operation, and shall include changes to the electric system approved by the Council and the Independent System Operator – New England.

As part of this determination, the applicant shall provide the locations of, and anticipated MF levels encompassing, residential areas, private or public schools, licensed child day care facilities, licensed youth camps, or public playgrounds within 300 feet of the proposed transmission line. The Council, at its discretion, may order the field measurement of post-construction MF values in select areas, as appropriate, and compare and contrast projected values with actual measured values.

### B. Buffer Zones and Limits on MF

As enacted by the General Assembly in Section 4 of Public Act No. 04-246, a buffer zone in the context of transmission line siting is deemed, at minimum, to be the distance between the proposed transmission line and the edge of the utility ROW. Buffer zone distances may also be guided by the standards presented in the National Electrical Safety Code (NESC), published by the Institute of Electrical and Electronic Engineers (IEEE). These standards provide for the safe installation, operation, and maintenance of electrical utility lines, including clearance requirements from vegetation, buildings, and other natural and man-made objects that may arise in the ROW. The safety of power-line workers and the general public are considered in the NESC standards. None of these standards include MF limits.

In assessing whether a right-of-way provides a sufficient “buffer zone,” the Council will emphasize compliance with its own Best Management Practices, but may also take into account approaches of other states, such as those of Massachusetts, New York, and Florida.

Since 1985, the Massachusetts Energy Facilities Siting Board (EFSB) has used an edge-of-ROW level of 85 mG as a benchmark for comparing different design alternatives. This benchmark, however, has not served as a generally applicable standard or guide. Rather, in particular cases since 1985 where a proposed transmission line has caused public concern, such as in densely populated areas and near schools, EFSB has “encouraged the use of practical and cost-effective design to minimize magnetic fields along transmission ROW. The EFSB requires EMF mitigation which in its judgment is consistent with minimizing cost." (Massachusetts Energy and Environmental Affairs Case No. EFSB 08-2/08-105/08-106:page 84) This approach is similar to Connecticut's.

Massachusetts has not adopted any generally applicable standards or guidelines concerning transmission facility magnetic fields. However, since 1985, the EFSB has considered projected magnetic field exposures in its proceedings for approval of electric transmission lines and substations. Where a transmission line is proposed in densely populated areas and near schools, the EFSB will “require EMF mitigation which in its judgment is consistent with minimizing cost.”

New York and Florida have general MF guidelines that are designed to maintain the “status quo”, i.e., that fields from new transmission lines not exceed those of existing transmission lines. In 1991, the New York Public Service Commission established an interim policy based on limits to MF. It required new high-voltage transmission lines to be designed so that the maximum magnetic fields at the edge of the ROW, one meter above ground, would not exceed 200 mG if the line were to operate at its highest continuous current rating. This 200 mG level represents the maximum calculated magnetic field level for 345 kV lines that were then in operation in New York State. The Council confirms no change to the New York policy.

The Florida Environmental Regulation Commission established a maximum magnetic field limit for new transmission lines and substations in 1989. The MF limits established for the edge of 230-kV to 500-kV transmission line ROWs and the property boundaries for substations ranged from 150 mG to 250 mG, depending on the voltage of the new transmission line and whether an existing 500-kV line was already present. In 2008, the Florida policy was revised to add a provision making the 250 mG magnetic field limit at the edge of the ROW and at substation property boundaries applicable to transmission lines and substations with a nominal voltage greater than 500-kV. Florida limits apply to one meter above ground level under an assumption that the transmission line is operating at its maximum continuous current rating.

Although scientific evidence to date does not warrant the establishment of MF exposure limits at the edge of a ROW, the Council will continue to monitor the ways in which states and other jurisdictions determine MF limits on new transmission lines.

### C. Engineering Controls that Modify MF Level

When considering an overhead electric transmission-line application, the Council will expect the applicant to examine the following engineering controls to limit MF in publicly accessible areas: distance, height, conductor separation, conductor configuration, optimum phasing, increased voltage, and underground installation. Any design change may also affect the line's impedance, corona discharge, mechanical behavior, system performance, cost, noise levels and visual impact. The Council will consider all of these factors in relation to the MF levels achieved by any particular engineering control. Thus, utilities are encouraged to evaluate other possible engineering controls that might be applied to the entire line, or just specific segments, depending upon land use, to best minimize MF at a low or no cost.

Consistent with these Best Management Practices and absent any line performance and visual impacts, the Council expects that applicants will propose no-cost/low-cost measures to reduce magnetic fields by one or more engineering controls, including:

*Distance*

MF levels from transmission lines (or any electrical source) decrease with distance; thus, increased distance results in lower MF. Horizontal distances can be increased by purchasing wider ROWs, where available. Other distances can be increased in a variety of ways, as described below.

*Height of Support Structures*

Increasing the vertical distance between the conductors and the edge of the ROW will decrease MF: this can be done by increasing the height of the support structures. The main drawbacks of this approach are an increase in the cost of supporting structures, possible environmental effects from larger foundations, potential detrimental visual effects, and the modest MF reductions achieved, unless the ROW width is unusually narrow.

*Conductor Separation*

Decreasing the distances between individual phase conductors can reduce MF. Because at any instant in time the sum of the currents in the individual phase conductors is zero, or close to zero, moving the conductors closer together improves their partial cancellation of each other's MF. In other words, the net MF produced by the closer conductors reduces the MF level associated with the line. Placing the conductors closer together has practical limits, however. The distance between the conductors must be sufficient to maintain adequate electric code clearance at all times, and to assure utility employees' safety when working on energized lines. One drawback of a close conductor installation is the need for more support structures per mile (to reduce conductor sway in the wind and sag at mid-span); in turn, costs increase, and so do visual impacts.

*Conductor Configuration*

The arrangement of conductors influences MF. Conductors arranged in a flat, horizontal pattern at standard clearances generally have greater MF levels than conductors arranged vertically. This is due to the wider spacing between conductors found typically on H-frame structure designs, and to the closer distance between all three conductors and the ground. For single-circuit lines, a compact triangular configuration, called a "delta configuration", generally offers the lowest MF levels. A simple vertical configuration – one conductor above another – may cost more and may have increased visual impact. Where the design goal is to minimize MF levels at a specific location within or beyond the ROW, conductor configurations other than vertical or delta may produce equivalent or lower fields.

*Optimum Phasing*

Optimum phasing applies in situations where more than one circuit exists in an overhead ROW or in a duct bank installed underground. Electric transmission circuits utilize a three-phase system with each phase carried by one conductor, or a bundle of conductors. Optimum phasing reduces MF through partial cancellation. For a ROW with more than two circuits, the phasing arrangement of the conductors of each circuit can generally be optimized to reduce MF levels under typical conditions. The amount of MF cancellation will also vary depending upon the relative loading of each circuit. For transmission lines on the same ROW, optimizing the phasing of the new line with respect to that of existing lines is usually a low-cost method of reducing MF.
MF levels can be reduced for a single circuit line by constructing it as a "split-phase" line with twice as many conductors, and arranging the conductors for optimum cancellation. Disadvantages of the split-phase design include higher cost and increased visual impact.

*Increased Voltage*

MF are proportional to current, so, for example, replacing a 69-kV line with a 138-kV line, which delivers the same power at half the current, will result in lower MF. This could be an expensive mitigation to address MF alone because it would require the replacement of transformers and substation equipment.

*Underground Installation*

Burying transmission lines in the earth does not, by itself, provide a shield against MF, since magnetic fields, unlike electric fields, can pass through soil. Instead, certain inherent features of an underground design can reduce MF. The closer proximity of the currents in the wires provides some cancellation of MF, but does not eliminate it entirely. Underground transmission lines are typically three to five feet below ground, a near distance to anyone passing above them, and MF can be quite high directly over the line. MF on either side of an underground line, however, decreases more rapidly with increased distance than the MF from an overhead line.

The greatest reduction in MF can be achieved by "pipe-type" cable installation. This type of cable has all of the wires installed inside a steel pipe, with a pressurized dielectric fluid inside for electrical insulation and cooling. Low MF is achieved through close proximity of the wires, as described above, and through partial shielding provided by the surrounding steel pipe. While this method to reduce MF is effective, system reliability and the environment can be put at risk if the cable is breached and fluid is released.

Lengthy high-voltage underground transmission lines can be problematic due to the operational limits posed by the inherent design. They also can have significantly greater environmental impacts, although visual impacts associated with overhead lines are eliminated. The Council recognizes the operational and reliability concerns associated with current underground technologies and further understands that engineering research regarding the efficiency of operating underground transmission lines is ongoing. Thus, in any new application, the Council may require updates on the feasibility and reliability of the latest technological developments in underground transmission line design.

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NOTE:
THE DEVELOPER SHALL NOTIFY THE TOWN OF EAST HARTFORD ENGINEERING DIVISION 24 HOURS PRIOR TO BEGINNING ANY STORM DRAINAGE, ROADWAY PREPARATION, PAVING, SIDEWALK, CURBING, STREET LINE MONUMENTATION, PROPERTY CORNER PINS, ETC. TO SCHEDULE INSPECTIONS. THE DIVISION CAN BE REACHED BETWEEN 8:30 A.M. - 4:30 P.M. AT (860) 291-7380.

TOWN OF EAST HARTFORD
PLANNING AND ZONING COMMISSION
SITE PLAN CERTIFICATE
OF APPROVAL

APPROVAL DATE: ______________________

EXPIRATION DATE: ______________________

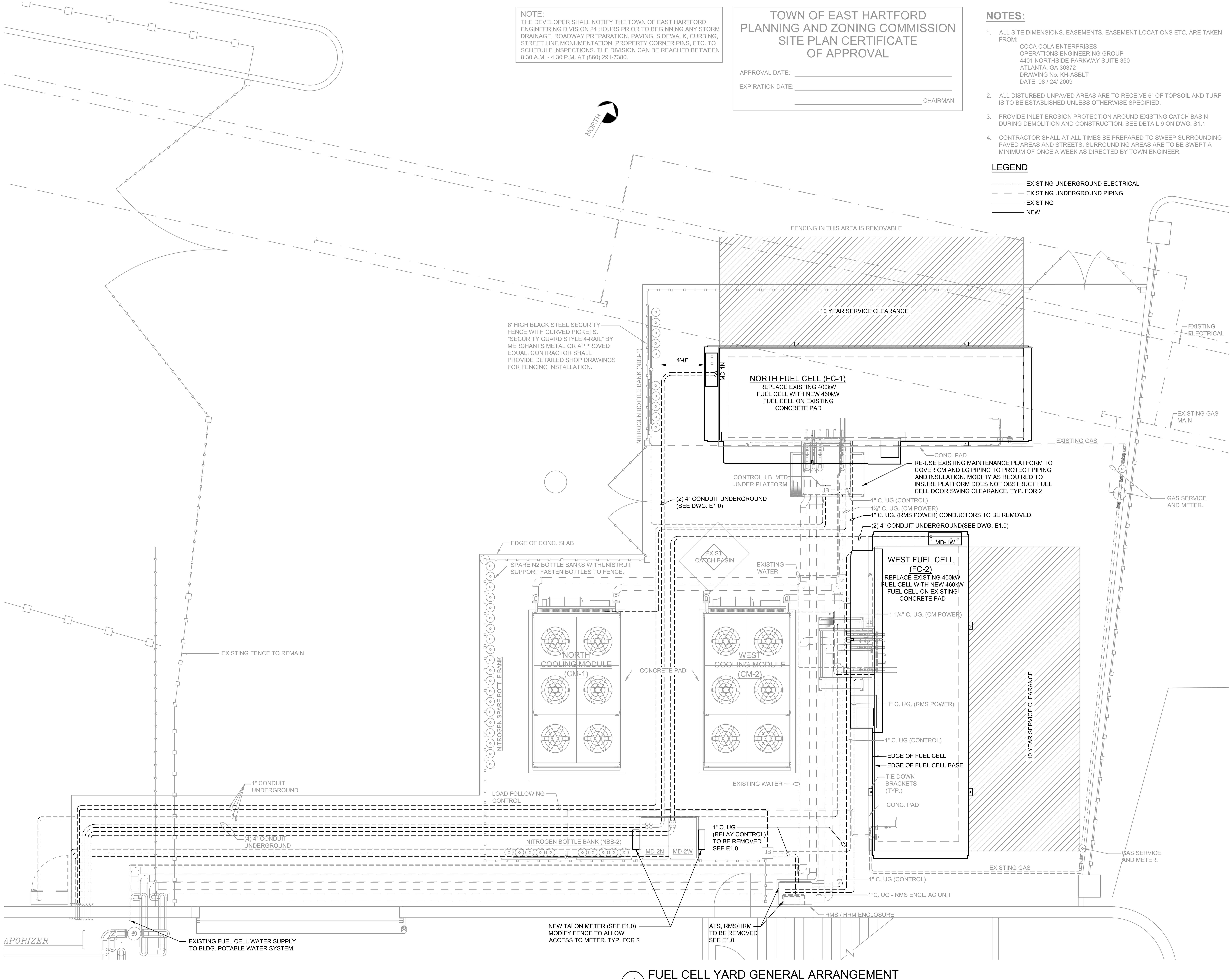
______________________ CHAIRMAN

## NOTES:

1. ALL SITE DIMENSIONS, EASEMENTS, EASEMENT LOCATIONS ETC. ARE TAKEN FROM:
   COCA COLA ENTERPRISES
   OPERATIONS ENGINEERING GROUP
   4401 NORTHSIDE PARKWAY SUITE 350
   ATLANTA, GA 30372
   DRAWING No. KH-ASBLT
   DATE 08 / 24/ 2009
2. ALL DISTURBED UNPAVED AREAS ARE TO RECEIVE 6" OF TOPSOIL AND TURF IS TO BE ESTABLISHED UNLESS OTHERWISE SPECIFIED.
3. PROVIDE INLET EROSION PROTECTION AROUND EXISTING CATCH BASIN DURING DEMOLITION AND CONSTRUCTION. SEE DETAIL 9 ON DWG. S1.1
4. CONTRACTOR SHALL AT ALL TIMES BE PREPARED TO SWEEP SURROUNDING PAVED AREAS AND STREETS. SURROUNDING AREAS ARE TO BE SWEPT A MINIMUM OF ONCE A WEEK AS DIRECTED BY TOWN ENGINEER.

## LEGEND

- EXISTING UNDERGROUND ELECTRICAL
- EXISTING UNDERGROUND PIPING
- EXISTING
- NEW




1 FUEL CELL YARD GENERAL ARRANGEMENT
SCALE: 1/4" = 1'-0"

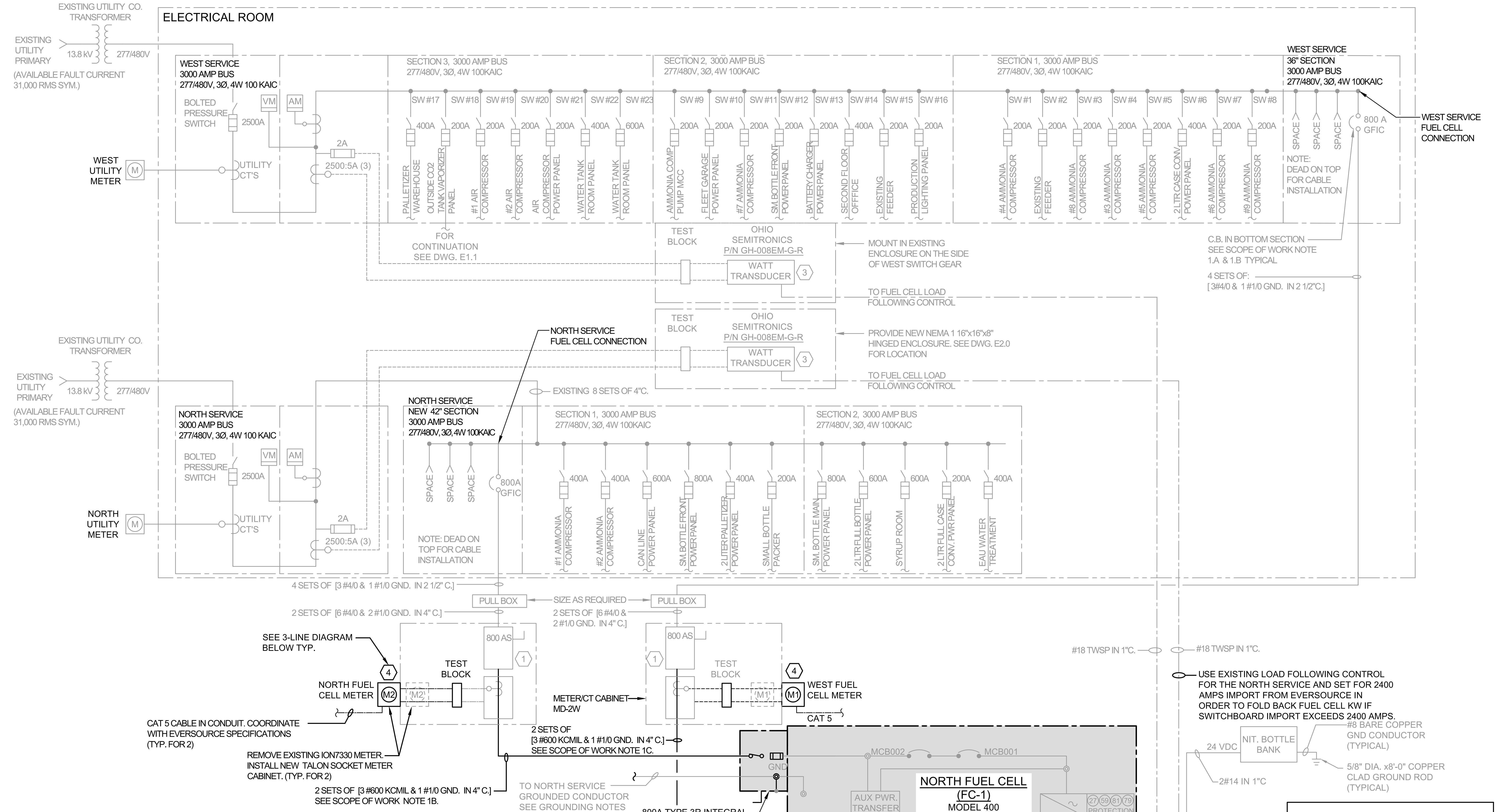
| Rev. | Date | Description |
|---|---|---|
| A | 12/23/21 | INTERCONNECT APPLICATION |

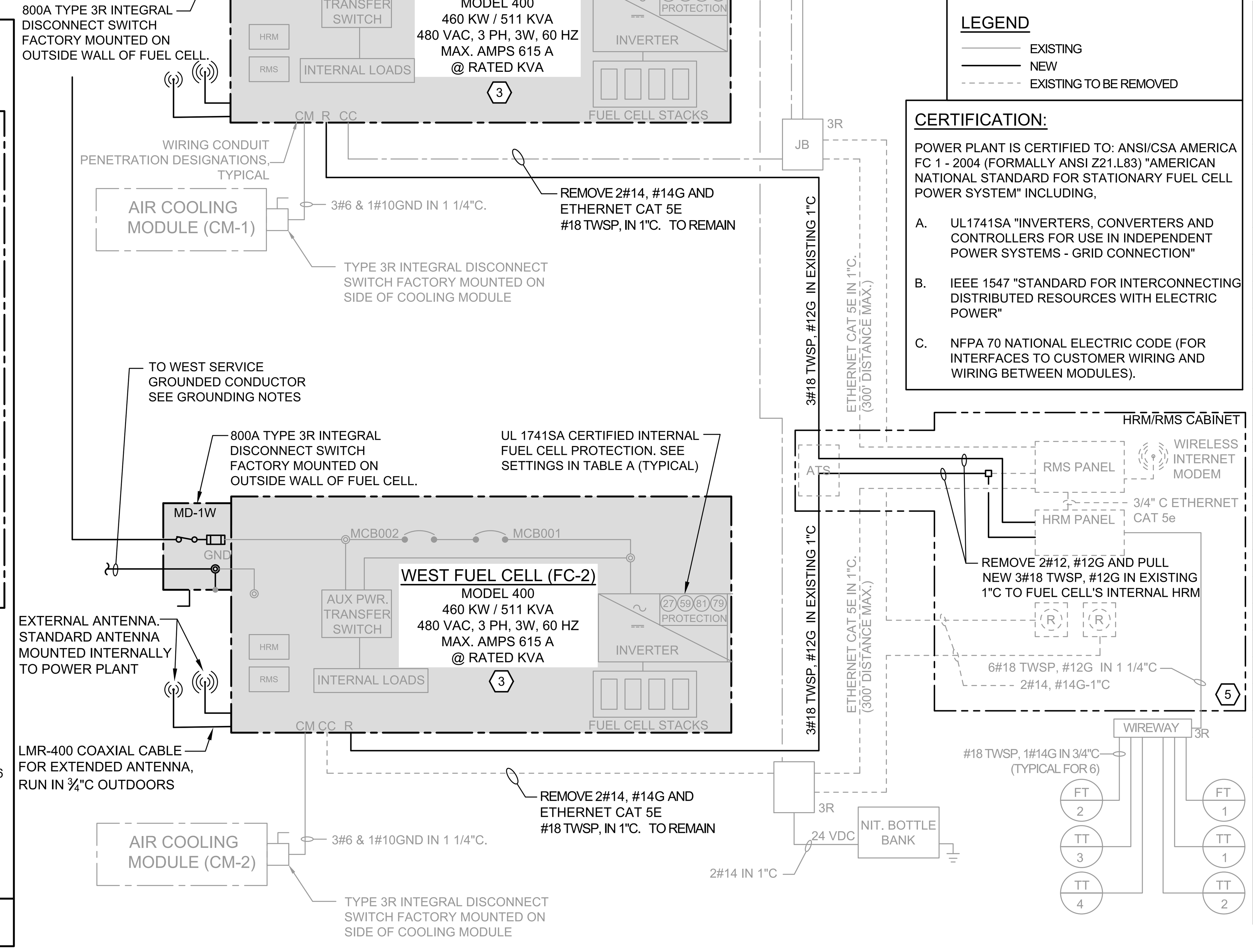
10 White Wood Lane
N. Branford, CT 06471
Phone:(203) 453-8596
Email: info@icdsllc.com
ICDS
Innovative Construction & Design Solutions, LLC

Coca-Cola Beverages
NORTHEAST
451 MAIN STREET
EAST HARTFORD, CT
FUEL CELL YARD GENERAL ARRANGEMENT

| | |
|---|---|
| Project No.: | Drawn By: KFH |
| Date: 12/23/21 | Design By: DSF |
| Scale: AS NOTED | Check By: SDF |

Drawing No.:
GA1.0




## LEGEND

- EXISTING
- NEW
- EXISTING TO BE REMOVED

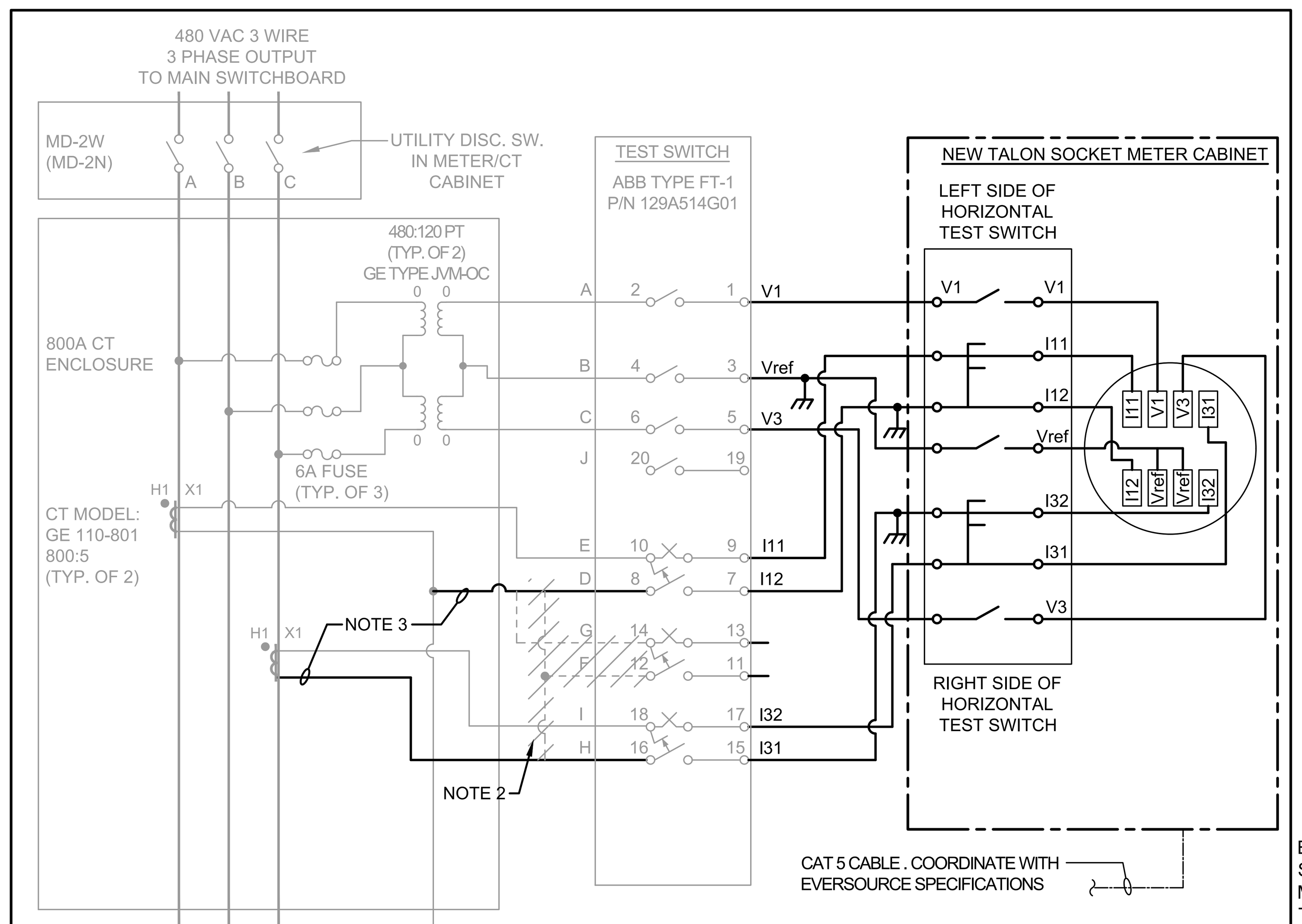
## CERTIFICATION:

POWER PLANT IS CERTIFIED TO: ANSI/CSA AMERICA FC 1 - 2004 (FORMALLY ANSI Z21.L83) "AMERICAN NATIONAL STANDARD FOR STATIONARY FUEL CELL POWER SYSTEM" INCLUDING,

A. UL1741SA "INVERTERS, CONVERTERS AND CONTROLLERS FOR USE IN INDEPENDENT POWER SYSTEMS - GRID CONNECTION"

B. IEEE 1547 "STANDARD FOR INTERCONNECTING DISTRIBUTED RESOURCES WITH ELECTRIC POWER"

C. NFPA 70 NATIONAL ELECTRIC CODE (FOR INTERFACES TO CUSTOMER WIRING AND WIRING BETWEEN MODULES).




### METER REPLACEMENT NOTES

1. DISCONNECT ION7330 WIRES TO ABB TEST SWITCH.
2. REMOVE THE JUMPER WIRES BETWEEN TEST SWITCH TERMINALS 8-12-16.
3. MOVE THE WIRE FROM CT GROUND TO TERMINAL 16 AND ALSO MOVE THE WIRE FROM TEST SWITCH TERMINAL 14 TO TERMINAL 8.
4. REMOVE ION7330 METER
5. INSTALL NEW METER SOCKET BOX TO REPLACE ION7330 METER.
6. ADD WIRES FROM ABB TEST SWITCH TO THE NEW METER SOCKET AT ITS TEST SWITCH AS SHOWN.

## MODEL 400 M1/M2 UTILITY METERING 3-LINE DIAGRAM

## SCOPE OF WORK

1. PROVIDE AND INSTALL ALL NEW ELECTRICAL WORK INDICATED ON DRAWINGS UNLESS OTHERWISE NOTED. INCLUDING BUT NOT LIMITED TO THE FOLLOWING:

   A. REMOVE EXISTING ION 7330 METERS IN METER CABINETS MD-2W AND AND MD-2N. INSTALL NEW TALON SOCKET METER CABINET AT EACH CABINET. EXISTING TEST SWITCHES TO REMAIN.WIRE AS SHOWN IN 3-LINE DIAGRAM BELOW.
   B. CONTRACTOR SHALL REPLACE EXISTING 2 SETS OF [3 #500 KCMIL & 1/0G] FROM NORTH FC-1 TO ED-2N WITH 2 SETS OF [3 #600 KCMIL & 1/0G] IN EXISTING CONDUITS.
   C. CONTRACTOR SHALL REPLACE EXISTING 2 SETS OF [3 #500 KCMIL & 1/0G] FROM WEST FC-2 TO ED-2W WITH 2 SETS OF [3 #600 KCMIL & 1/0G] IN EXISTING CONDUITS.
   D. REMOVE EXISTING RMS / HRM. ENCLOSURE SHALL REMAIN TO BE REUSED AS PULL BOX.
   E. REMOVE ATS AND 120V, 12AWG POWER WIRING FROM ATS BACK TO EACH FC. REUSE EXISTING 1"C. TO PULL 3 #18 TWSP, #12G FOR HEAT RECOVERY INSTRUMENTATION BACK TO FUEL CELL. TYPICAL FOR EACH FUEL CELL.

## KEYED NOTES

1. PROVIDE PLAQUE AT NORTH & WEST SERVICE IN ELECTRIC ROOM INDICATING BUILDING HAS MULTIPLE POWER SOURCES. PROVIDE SIGNAGE PER NEC AT NORTH SERVICE, WEST SERVICE & FUEL CELL MAIN DISCONNECT. PLAQUE AT NORTH & WEST SERVICE SHALL DENOTE THE LOCATION OF THE METER CABINET DISCONNECTS (MD-2N & MD-2W). FURNISH A PERMANENT PLAQUE ON MD-2N & MD-1W INDICATING " PARALLEL GENERATOR DISCONNECT".

2. CONSULT DOOSAN MODEL 400 INSTALLATION DESIGN GUIDE (FUEL CELL POWER PLANT) AND STANDARD INSTALLATION DRAWINGS FOR TECHNICAL REFERENCE.

3. WATT TRANSDUCER
   OHIO SEMITRONICS, MODEL: GH-008EM-G-R
   CT - INSTRUMENT TRANSFORMERS, INC., MODEL: 780-252, 2500:5, C200 RELAY CLASS

4. UTILITY DG METER (M1 & M2)
   METER FURNISHED BY EVERSOURCE, INSTALLED BY CONTRACTOR. METER SOCKET FURNISHED AND INSTALLED BY CONTRACTOR
   MANUFACTURER / MODEL : SIEMENS TALON METER CABINET
   COORDINATE DISCONNECT LINE AND LOAD LUG CONFIGURATIONS BASED UPON CONDUCTOR SIZES AND QUANTITIES ON THIS DWG.
   CT: GE MODEL 110-801, 800:5 (EXISTING)
   PT: GE TYPE JVM-OC (EXISTING)

5. REMOVE RMS, HRM INTERNAL COMPONENTS, ATS AND RELAYS FROM HOFFMAN NEMA 3R ENCLOSURE. HRM PANEL TO REMAIN AS PULL BOX.

## GROUNDING NOTES

1. THE FUEL CELL GROUND LUG INSIDE DISCONNECT SWITCH MD-1W AND MD-1N SHALL BE CONNECTED TO AN EXTERNAL #1/0 COPPER EQUIPMENT GROUNDING CONDUCTOR FROM MAIN SWITCHBOARD'S GROUNDED CONDUCTOR PER NEC ART 692.44, IN ORDER TO PROVIDE THE REQUIRED SINGLE POINT GROUND PER NEC ART 250.24.A & D.

2. NOTE THAT THE FUEL CELL GROUND LUG INSIDE MD-1W AND MD-1N IS BONDED TO ALL METALLIC NON-CURRENT CARRYING METAL PARTS BOTH INSIDE THE FUEL CELL AND ALSO AT EXTERNAL FUEL CELL ASSEMBLIES SUCH AS THE COOLING MODULE, SO ALL FUEL CELL PARTS ARE CONNECTED TO THE EQUIPMENT GROUNDING CONDUCTOR AS REQUIRED BY ART. 250.110.

3. NOTE ALSO THAT THERE IS TO BE NO OTHER GROUNDING ELECTRODE AT THE FUEL CELL OR ANY OF ITS EXTERNAL SUBASSEMBLIES SUCH AS THE COOLING MODULE. ALL OF THE SUBASSEMBLIES ARE TO BE CONNECTED TO THE EQUIPMENT GROUNDING CONDUCTOR INCLUDED WITH THE CIRCUIT CONDUCTORS FROM THE FUEL CELL PER ART. 250.134.B, WHERE THE FUEL CELL GROUND LUG IN MD-1N / MD-1W CARRIES THESE GROUND WIRES BACK TO THE GROUNDED SERVICE CONDUCTOR AT THE MAIN SWITCHBOARD.

4. ANY SUBASSEMBLY ELECTRICAL PANELS CONNECTED TO THE FUEL CELL SHALL BE GROUNDED TO THE EQUIPMENT GROUNDING CONDUCTOR FROM THE FUEL CELL PER ART 250.148 AND SHALL NOT HAVE THEIR OWN GROUND ELECTRODE.

5. THE EXTERNAL NITROGEN RACK IS NOT EXPOSED TO ENERGIZED CIRCUITS GREATER THAN 24 VOLTS DC AND THUS CAN HAVE ITS OWN GROUNDING ELECTRODE.

## TABLE A - SEL547 RELAY
## IEEE1547 / UL1741SA GRID PROTECTION PARAMETER SETTINGS

THE REQUIRED GRID PROTECTION FUNCTIONS AND SETTINGS RESIDE IN THE INTERNAL SEL547 RELAY WITH SETTING NAMES AS SHOWN BELOW. THE SEL547 RELAY USES GROUP 1 (SEE NOTE 2) SETTINGS FOR UL174SA, AND ONLY THOSE GROUP 1 SETTINGS ARE LISTED IN THIS TABLE. THE SETTINGS IN THIS TABLE ARE COMPLIANT WITH EVERSOURCE / UI UL1741SA SETTINGS PER APRIL 5, 2019 EXHIBIT B TECHNICAL REQUIREMENTS APPENDIX C.

| SETTING NAME | DESCRIPTION | GROUP 1 "SUPPORT" 60 Hz SETTING 480VAC Tx RATIO 2.31 : 1 | VOLTAGE P.U. | ANSI/IEEEF FUNCTION NUMBERS |
|---|---|---|---|---|
| 27P1P | SLOW UNDER VOLTAGE LEVEL (V) | 106 | 0.88 | 27 |
| 27P2P | MID UNDER VOLTAGE | 106 | 0.88 | |
| 27P3P | FAST UNDER VOLTAGE LEVEL (V) | 60 | 0.50 | 27 |
| 59P1P | SLOW OVER VOLTAGE LEVEL (V) | 132 | 1.1 | 59 |
| 59P2P | FAST OVER VOLTAGE LEVEL (V) | 144 | 1.21 | 59 |
| 81D1P | FAST UNDER FREQUENCY LEVEL (Hz) | 56.5 | | 81U |
| 81D2P | SLOW UNDER FREQUENCY LEVEL (Hz) | 58.5 | | 81U |
| 81D3P | SLOW OVER FREQUENCY LEVEL | 61.2 | | 81O |
| 81D4P | FAST OVER FREQUENCY LEVEL | 62 | | 81O |
| SV1PU | RECONNECTION TIME DELAY (CYCLES) | 18000 | | |
| SV2PU | FAST OVER FREQUENCY CLEARING TIME (CYCLES) | *5 | | |
| SV3PU | SLOW OVER FREQUENCY CLEARING TIME (CYCLES) | 18000 | | |
| SV4PU | SLOW UNDER FREQUENCY CLEARING TIME (CYCLES) | 18000 | | |
| SV5PU | FASTUNDER FREQUENCY CLEARING TIME (CYCLES) | *5 | | |
| SV6PU | FAST OVER VOLTAGE 120% CLEARING TIME (CYCLES) | *5 | | |
| SV7PU | SLOW OVER VOLTAGE 110% CLEARING TIME (CYCLES) | 120 | | |
| SV8PU | SLOW UNDER VOLTAGE 88% CLEARING TIME(CYCLES) | 120 | | |
| SV9PU | MID UNDER VOLTAGE 88% CLEARING TIME (CYCLES) | 120 | | |
| SV10PU | FAST UNDER VOLTAGE 50% CLEARING TIME (CYCLES) | 66 | | |
| SV12PU | DELAY BETWEEN GRID OK STATUS AND BREAKER OPENING (CYCLES) | 0 | | |

* NOTE 1: THE ACTUAL (TOATAL) PROTECTION CLEARING TIME EQUALS THE SUM OF THE PARAMETER CLEARING TIME SETTING IN THE TABLE PLUS 5 CYCLE BREAKER'S TRIPPING TIME--FOR EXAMPLE ACTUAL (TOTAL) FAST OVER VOLTAGE CLEARING TIME EQUALS PARAMETER SV6PU 5 CYCLES SETTING PLUS THE 5 CYCLE CYCLE BREAKER CLEARING TIME FOR A TOTAL TIME OF 10 CYCLES (0.16 SEC).

NOTE 2: GROUP 1 SETTINGS ARE FOR UL1741SA "GRID SUPPORT" AND GROUP 2 SETTINGS (NOT SHOWN IN THIS TABLE) ARE FOR IEEE1547-2003 NON-SA SETTINGS - USE GROUP 1 FOR UL1741SA SITES

NOTE 3: FOR DOOSAN ON-SITE PERSON - GROUP1 OR GROUP 2 IS SET BY THE GROUP 9 PARAMETER "INVERTERMODE" GROUP 1 = GRID SUPPORT (INVERTER MODE=0=FALSE) =UL1741SA

| Rev. | Date | Description |
|---|---|---|
| A | 12/23/21 | INTERCONNECT APPLICATION |

ICDS
Innovative Construction & Design Solutions, LLC
10 White Wood Lane
N. Branford, CT 06471
Phone:(203) 453-8596
Email: info@icdsllc.com

Coca-Cola Beverages NORTHEAST
451 MAIN STREET
EAST HARTFORD, CT
ELECTRICAL SINGLE LINE DIAGRAM

| | |
|---|---|
| Project No.: | Drawn By: KFH |
| Date: 12/23/21 | Design By: DSF |
| Scale: N.T.S. | Check By: SDF |
| Drawing No.: E1.0 | |

Doosan Fuel Cell America, Inc.
101 East River Drive
East Hartford, CT 06108

Date

Melanie Bachman, Executive Director
Connecticut Siting Council
Ten Franklin Square
New Britain, CT 06051

RE: Doosan Fuel Cell America, Inc. Notice of Exempt Modification Pursuant to RCSA 16-50j-57(a) to Existing Energy Facility Site at 471 Main St., East Hartford, CT ("Notice of Exempt Modification")

Dear Ms. Bachman,

Doosan Fuel Cell America, Inc. ("DFCA") hereby gives notice to the Connecticut Siting Council of its intent to undertake an exempt modification in accordance with Section 16-50j-57(a) of the Regulations of Connecticut State Agencies ("RCSA") for the modification to DFCA's fuel cell installation at Coca Cola 471 Main St., East Hartford. Location coordinates are 41*45'14.44"N 72*38'31.44"W.

**Proposed Modification**

The proposed modification would take place within the existing fenced area measuring 57' x 55' at the Coca Cola Bottling plant at 471 Main St., East Hartford, CT. The existing facility consists of a combined heat and power installation utilizing two ground mounted Doosan Fuel cells capable of producing 440kw each.

DFCA proposes the following modification to the facility:

- Removal of both existing fuel cells and associated cooling modules.
- Installation of two (2) current generation Doosan Model 400 fuel Cells (direct replacement)
- Installation of new cooling modules.
- Replacement of new feeder cable to comply with current electrical code.
- Replacement of obsolete distributed generation meter.

The existing facility layout with proposed modification is shown on Attachment 1 Drawing GA1.

The proposed modification would not have a substantial adverse environmental effect or cause a significant adverse change or alteration in the physical or environmental characteristics of the facility because:

- The modification would be made within the facilities existing fenced area and would not impair the structural integrity of the facility.
- The new equipment would be a direct replacement for the existing equipment and is dimensionally the same as the existing equipment and would not cause any significant adverse change in the physical or environmental characteristics of the facility.
- The modifications would not affect waterways or wetlands and the facility is not in a flood zone.
- There are no endangered, threatened or special concern species in the vicinity of the facility as listed in the NDDB.
- Sound pressure levels will not increase as a result of the modifications.
- There would be no television or radio interference as a result of the modifications.
- Electric and magnetic field levels will not be affected by the modification due to low or no export of power from the site and the low voltage produced by the fuel cells.

DFCA proposes to commence work on the modification in February 2022 and scheduled to be complete by March 2022.

Pursuant to CSC covid response DFCA is submitting this filing electronically and will provide one hard copy and the $625.00 filing fee by us mail.

A notice of the exempt modification filing has been provided to the Mayor of East Hartford and to the property owner.

Please direct all communications regarding this filing to Donald Emanuel at 203.525.4566 or via email Donald.emanuel@doosan.com

Signed ____________________

Donald Emanuel

DOOSAN

Doosan Fuel Cell America, Inc.
101 East River Drive
East Hartford, CT 06108

Date 12-23-2021

David W. Dumont
1 Executive Park Drive
Bedford, NH 03110

RE: Doosan Fuel Cell America, Inc. Notice of Exempt Modification Pursuant to RCSA 16-50j-57(a) to Existing Energy Facility Site at 471 Main St., East Hartford, CT ("Notice of Exempt Modification")

Dear Mr. Dumont,

Doosan Fuel Cell America, Inc. ("DFCA") hereby gives notice to the Connecticut Siting Council of its intent to undertake an exempt modification in accordance with Section 16-50j-57(a) of the Regulations of Connecticut State Agencies ("RCSA") for the modification to DFCA's fuel cell installation at Coca Cola 471 Main St., East Hartford.

**Proposed Modification**

The proposed modification would take place within the existing fenced area at the Coca Cola Bottling plant at 471 Main St., East Hartford, CT. The existing facility consists of a combined heat and power installation utilizing two Doosan Fuel cells.

DFCA proposes the following modification to the facility:

- Removal of both existing fuel cells and associated cooling modules.
- Installation of two (2) current generation Doosan Model 400 fuel Cells (direct replacement)
- Installation of new cooling modules.
- Replacement of feeder cable to comply with current electrical code.
- Replacement of obsolete distributed generation meter.

The proposed modification would not have a substantial adverse environmental effect or cause a significant adverse change or alteration in the physical or environmental characteristics of the facility because:

- The modification would be made within the facilities existing fenced area and would not impair the structural integrity of the facility.
- The new equipment would be a direct replacement for the existing equipment and is dimensionally the same as the existing equipment and would not cause any significant adverse change in the physical or environmental characteristics of the facility.
- The modifications would not affect waterways or wetlands and the facility is not in a flood zone.
- There are no endangered, threatened or special concern species in the vicinity of the facility as listed in the NDDB.

- Sound pressure levels will not increase as a result of the modifications.
- There would be no television or radio interference as a result of the modifications.
- Electric and magnetic field levels will not be affected by the modification.

DFCA proposes to commence work on the modification in February 2022 and scheduled to be complete by March 2022.

Please direct all communications regarding this filing to Donald Emanuel at 203.525.4566 or via email Donald.emanuel@doosan.com

Signed ____________________

Donald Emanuel

Installation Project Manager

Doosan Fuel Cell America, Inc

Doosan Fuel Cell America, Inc.
101 East River Drive
East Hartford, CT 06108

Date 12-23-2021

Mayor Michael P. Walsh
740 Main St.
East Hartford, CT 06108

RE: Doosan Fuel Cell America, Inc. Notice of Exempt Modification Pursuant to RCSA 16-50j-57(a) to Existing Energy Facility Site at 471 Main St., East Hartford, CT ("Notice of Exempt Modification")

Dear Mayor Walsh,

Doosan Fuel Cell America, Inc. ("DFCA") hereby gives notice to the Connecticut Siting Council of its intent to undertake an exempt modification in accordance with Section 16-50j-57(a) of the Regulations of Connecticut State Agencies ("RCSA") for the modification to DFCA's fuel cell installation at Coca Cola 471 Main St., East Hartford.

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- The new equipment would be a direct replacement for the existing equipment and is dimensionally the same as the existing equipment and would not cause any significant adverse change in the physical or environmental characteristics of the facility.
- The modifications would not affect waterways or wetlands and the facility is not in a flood zone.
- There are no endangered, threatened or special concern species in the vicinity of the facility as listed in the NDDB.

DOOSAN

- Sound pressure levels will not increase as a result of the modifications.
- There would be no television or radio interference as a result of the modifications.
- Electric and magnetic field levels will not be affected by the modification.

DFCA proposes to commence work on the modification in February 2022 and scheduled to be complete by March 2022.

Please direct all communications regarding this filing to Donald Emanuel at 203.525.4566 or via email Donald.emanuel@doosan.com

Signed ____________

Donald Emanuel

Installation Project Manager

Doosan Fuel Cell America, Inc