From: Steve Pearson <spearson@vfsmi.com>
Sent: Monday, August 3, 2020 12:56 PM
To: CSC-DL Siting Council <Siting.Council@ct.gov>
Cc: Bachman, Melanie <Melanie.Bachman@ct.gov>
Subject: FW: Petition No. 1394 Decision and Staff Report - Montville WPCA final acoustic test

RE: **PETITION NO. 1394** – VFS, LLC petition for a declaratory ruling, pursuant to Connecticut General Statutes §4-176 and §16-50k, for the proposed construction, maintenance and operation of a 460-kilowatt customer-side fuel cell facility and associated equipment to be located at the Town of Montville Water Pollution Control Facility, 83 Pink Row, Montville (Uncasville), Connecticut.

Hi Melanie, I hope that you are well. Due to CV-19 issues, the Montville WPCA 460 kW project encountered delays. We did achieve PTO with Eversource on June 24, 2020; please see attachment. Since then we have conducted the final acoustic test with Acoustical Technology Inc. The 7/13/2020 Montville fuel cell test report is attached.

This addresses the 2. Requirement: Submit a copy of the post-construction facility operational noise study, and a noise mitigation plan, if necessary;

Please contact me if additional information is needed. Thanks for your great help in this difficult period, Steve

Steve Pearson
Green Energy Financing Executive
VFS LLC
Mobile: 248-417-0674
spearson@VFSMI.com

INT-38549

EVERSOURCE ENERGY

Distributed Energy Resources
P.O. Box 1409
Hartford, CT 06143-1409

June 24, 2020

Attention: Derek Albertson
Town of Montville
310 Norwich New London Turnpike
Uncasville, CT 06382

Regarding: Approval to energize the **460 kW** installation with one (1) 460 kW Doosan PureCell Model 400 Fuel Cell at 480 volts on a three-phase 13.2 kV service, and no energy storing devices at **Town of Montville Sewage Plant, 83 Pink Row, Uncasville, CT 06382**

Approval to Energize Date: June 24, 2020

Dear Mr. Albertson,

This letter is an approval to energize of the above stated project to the Eversource system in accordance with the Interconnection Agreement. As stated in the Interconnection Agreement (enclosed) and the "Generator Interconnection Guidelines", the following items must be provided to the Eversource Distributed Resources Group on a regular basis:

1. Annually: Provide a certificate of insurance as described in the enclosed interconnection agreement prior to the insurance expiration date. Please send it to InsuranceCTDG@Eversource.com or to the following address by that date:

   Eversource Distributed Resources
   P.O. Box 1409
   Hartford, CT 06143-1409

2. You are responsible for the periodic maintenance of the relays, interrupting devices, control schemes, and batteries that involve the protection of the EDC's system. Eversource may audit these reports, logs, and other material regarding the interconnection of the Generating Facility at its discretion.

Sincerely,

James A Cerkanowicz, PE

James A Cerkanowicz
Project Manager – Distributed Energy Resources
Eversource Energy
Tel: 860-665-5108
E-mail: james.cerkanowicz@eversource.com

cc: Doosan & VFS LLC

Prepared For: **Venture Financial Services, LLC**

Point of Contact: **Steve Pearson**

Prepared by: **Acoustical Technologies Inc.**
50 Myrock Avenue
Waterford, CT 06385-3008

Subject: **Town of Montville**
Water Pollution Control Authority
Airborne Noise Test
At 83 Pink Row

Author: **Carl Cascio**

Date: **July 13, 2020**

Revision: **0**

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Summary

This document makes a positive acoustic assessment that should assist in meeting any acoustic noise concerns during the operation of a Doosan 460 KW fuel cell at the Montville Water Pollution Control Authority site at 83 Pink Row South in Montville, 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 Doosan Pure Cell 460 KW fuel cell. It is important to show that the airborne noise generated by the fuel cell will not significantly impact any of the facility's neighbors.

The airborne noise levels generated by the Doosan fuel cell operating at the Montville site were measured on July 7, 2020. The fuel cell produced an overall average airborne noise level that varied from 61 to 65 dBA (reference 20 microPascals) at a distance of 10 meters around the Cooling and Power Modules. (The Cooling Module is the dominant noise source.) Airborne noise levels with the fuel cell operating were measured at distances from 5 to 200 meters from the fuel cell location at the Water Authority. The airborne noise levels from the fuel cell at nearby property lines were measured at levels from 41 to 56 dBA. Residential measurement locations to the west were very quiet with levels below 43 dBA with the fuel cell on. Commercial measurement locations to the north and west were higher because of the shorter distance to the fuel cell along Pink Row South. These commercial measurement locations to the north and west have airborne noise levels below 57 dBA with the fuel cell on. Analysis of the fuel cell data indicated propagation losses from 8 to 12 dB from the fuel cell location to the nearby Commercial property lines. Analysis of the fuel cell data indicated propagation losses from 6 to 13 dB from the fuel cell location to the nearby Residential property lines.

Operation of the Doosan fuel cell produces noise levels below the Commercial Zone noise limit of 62 dBA at all of the nearby Commercial property lines. The highest airborne noise level of 56.4 dBA was just outside the west property line about 64 meters from the fuel cell. The other Commercial properties have levels no higher than 51 dBA. All of the nearby residential property lines to the east, west and south west are below both the day time and night time residential noise limits with airborne noise below 43 dBA with the fuel cell on. The southern residential **property line** closest to the fuel cell has airborne noise levels in the 47.4 to 54.6 dBA range. These numbers are below the day time residential noise limit but above the night time noise limit of 45 dBA. This property is adjacent to Gay Cemetery Pond but does not have any residences. Night time use of the pond may expose people to airborne noise levels near the night time noise limit if close to the fuel cell. **No acoustic issues** are expected during operation of the fuel cell.

The State of Connecticut's Noise Code (Ref. 1) and Montville's Noise Ordinance (Ref. 2) calls for review of acoustic issues associated with impulse noise. Operation of the fuel cell meets all of these 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 fuel cell meets all of these infrasonic and ultrasonic noise requirements at all of the nearby properties. Operation of the fuel cell meets all of these discrete noise requirements at all of the nearby properties except for the southern property line. Discrete tones at 142.5, 213.8 and 298.8 Hertz exceed the night time residential noise limit by up to 6 dB at the southern boundary. **No acoustic issues** are expected during operation of the fuel cell.

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 Montville Water Authority site at 83 Pink Row in Montville, CT. Responding to a request from Steve Pearson (Venture Financial Services, LLC) a site visit was made on July 7, 2020. During the visit, a survey of the airborne noise levels produced by the Doosan 460 KVA Fuel Cell was made in order to identify any potential airborne noise issues. Airborne noise measurements were taken to quantify the propagation of the fuel cell 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 the fuel cell at 83 Pink Row in Montville, CT. The fuel cell Power and Cooling Modules are identified below.

Figure 1. Doosan PureCell Fuel Cell Power Module Name Plate Information

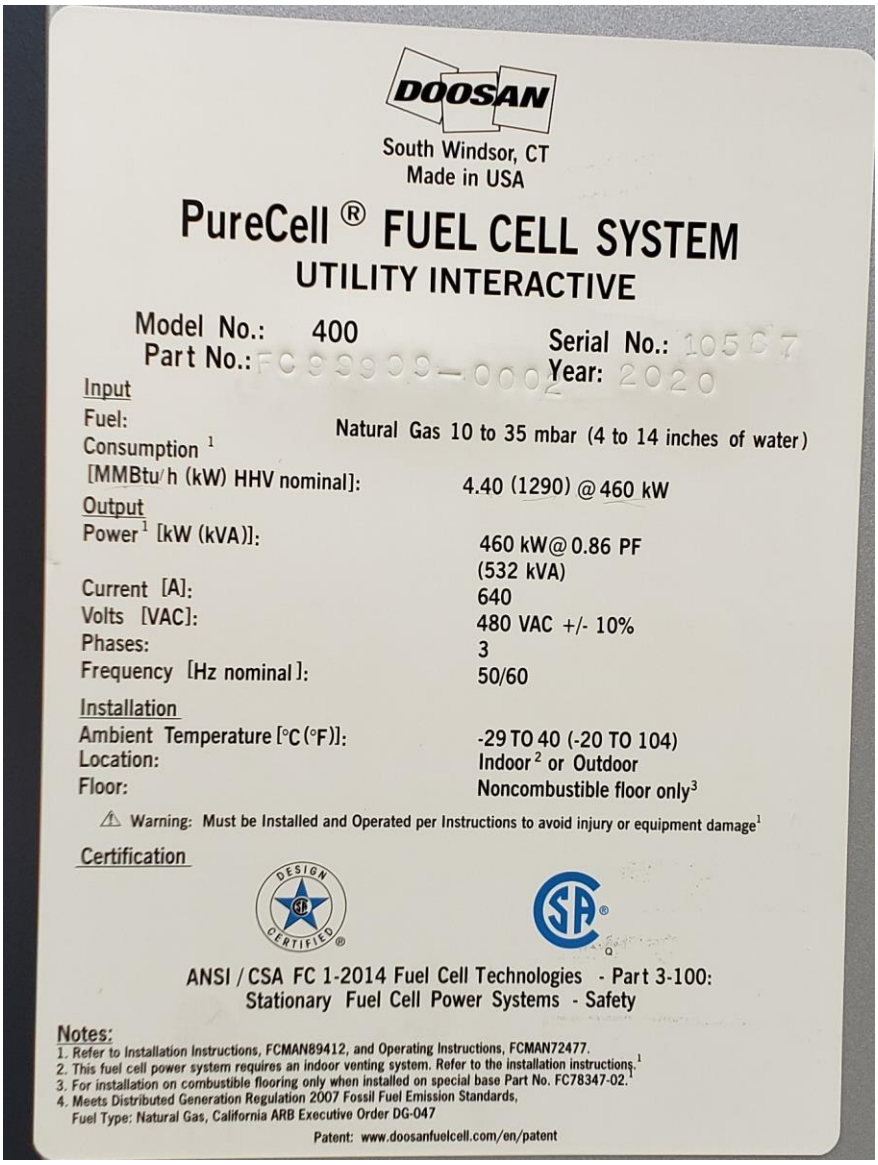
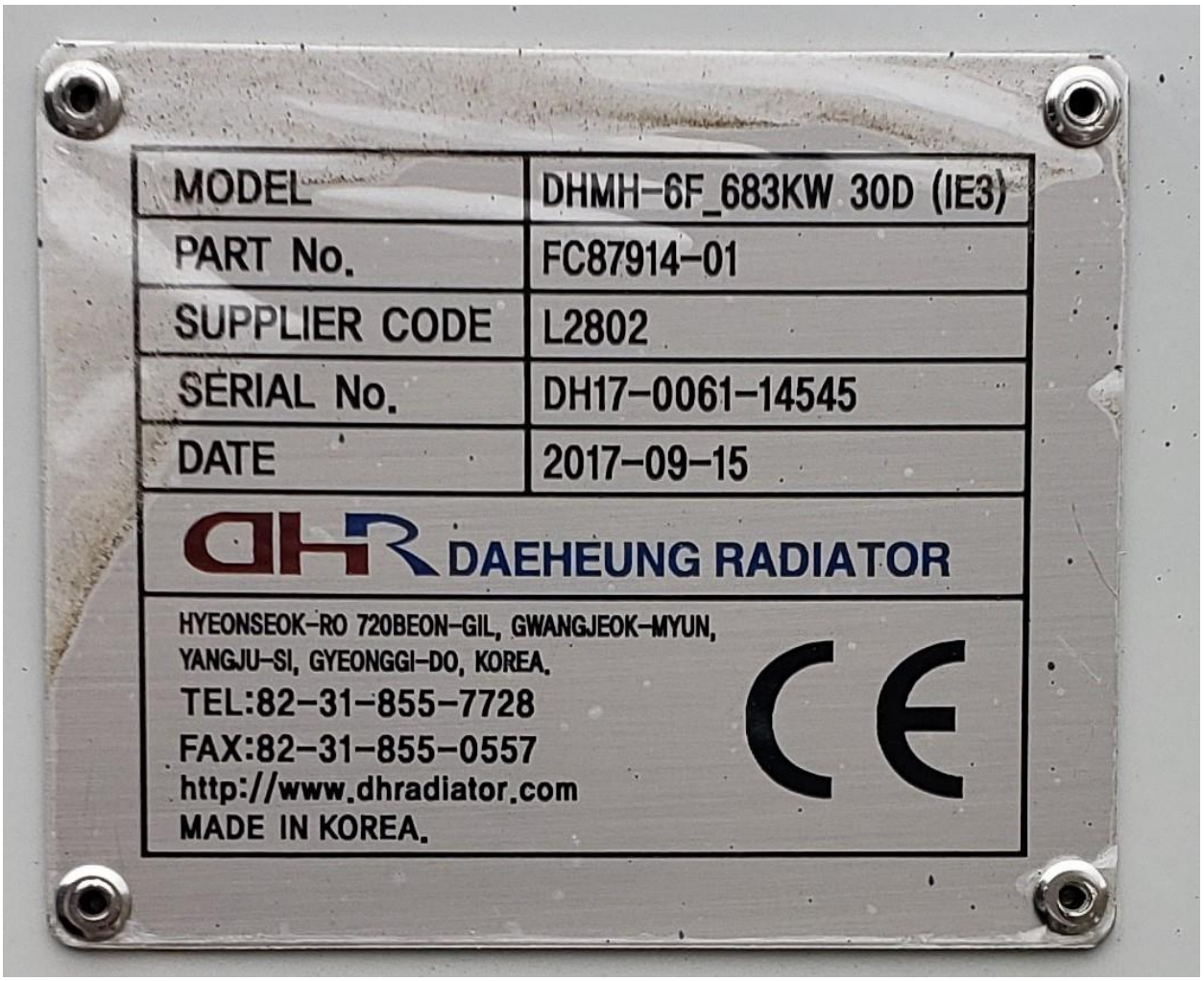


Figure 2. Doosan Daeheung Radiator Cooling Module Name Plate Information



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 a Doosan 460 KW fuel cell at the Montville Water Pollution Control Authority facility. The Montville site at 83 Pink Row South is located in a Government Zone near CT Route 32 and is surrounded by a Commercial Zone to the north and west, a Residential Zone to the south and south west and the water of Horton Cove to the east. (The Montville zoning map is given below.) It is important to determine whether the airborne noise generated by the Doosan fuel cell will negatively impact these neighbors.

The acoustic impact is assessed in the following way. The fuel cell operating airborne noise levels were measured at the new site on July 7, 2020. Using this data, the noise levels are compared to the allowable noise levels in the State of Connecticut and Town of Montville Noise Ordinances. With the full cell 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 can also be considered. The Town of Montville and the State of Connecticut's Noise Code will be consulted to assess the impact of the measured and estimated acoustic levels. Because of the closeness of the Montville Water Authority fuel cell site to the nearest property lines noise mitigation may be recommended if the airborne noise estimated for the fuel cell comes near or exceeds the airborne noise requirements at the neighbors' property lines.

Acoustic Measurement Program

The acoustic data necessary to assess the impact of the 460 KW Doosan Fuel Cell are described below: Airborne sound pressure measurements and spectral analysis were conducted at the Montville site on and near 83 Pink Row on July 7, 2020 during the daylight hours. This testing established combined background airborne noise levels and fuel cell operating noise levels. (The fuel cell could not be turned off 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 two PCB microphones (model 130F20 s/n 53933 and 378C01 s/n 121246) were powered by the Hewlett Packard analyzer. The PCB microphones were 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 to confirm the ExTech readings.

At the Montville site fuel cell operating airborne noise measurements were taken at the following ten nearby property lines in the Commercial and Residential Zones:

Location	**Business**	**Distance**	**Zone Type**
Fuel C - 83 Pink Row South	Water Authority	5 &10 meters	Government
P1 – 78 Pink Row	Residence	200 meters	Residential R20
P2 – 75-105 Pink Row	Business	159 meters	Commercial C2
P3 – Pink Row North	Silvia Engineering	124 meters	Commercial C2
P4 – Pink Row West	Business	64 meters	Commercial C2
P5 – Pink Row North	Business	92 meters	Commercial C2
P6 – Pink Row South	Gay Cemetery Pond	62 meters	Residential R20
P7 – Pink Row South South East	Gay Cemetery Pond	39 meters	Residential R20
P8 – Pink Row South East	Gay Cemetery Pond	59 meters	Residential R20
P9 – Pink Row North East	Business	116 meters	Commercial C2
P10 – Pond South of Fuel Cell	Gay Cemetery Pond	72 meters	Residential R20
P11- Pump at Entrance Building	Water Authority	41 meters	Government
P12 – Exhaust Fan North	Water Authority	32 meters	Government
P13 – Exhaust Fan South East	Water Authority	55 meters	Government

Positions 11, 12 and 13 were located at 1 meter from three significant background noise sources on the Water Authority property. These background noise sources could not be turned off. 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 two microphones 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.

Figure 3. Montville 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 Westerly Airport (closest data to Montville) for the acoustic measurements on July 7, 2020. Measurements were taken over the period from 8:30 am until 2:45 pm. The table below shows the temperature and wind speeds in hourly intervals. Wind conditions were very good for most of the day with no wind gusts and speeds above 10 mph only at the very end of the test (3 pm). Acoustic measurements were suspended during truck, car and plane passing and these short periods did not affect the operating airborne noise measurements. There was no rain during the testing on July 7. The pumping system in the building next to the facility entrance generated most of the background noise near position P4 and contributed to the noise at locations P6 and

P10. The other locations were reasonably quiet. Motor traffic along the nearby roads was light and very few of the measurements had to be delayed until no traffic was present. Because the fuel cell could not be shut down no background measurements were taken during July 7 testing. The sound of birds chirping was the predominant background noise at most locations.

Figure 4. Doosan Fuel Cell Operating at the Montville Site

Figure 5. Sensor at 10-Meters (South) from the Cooling Module at the Montville Site

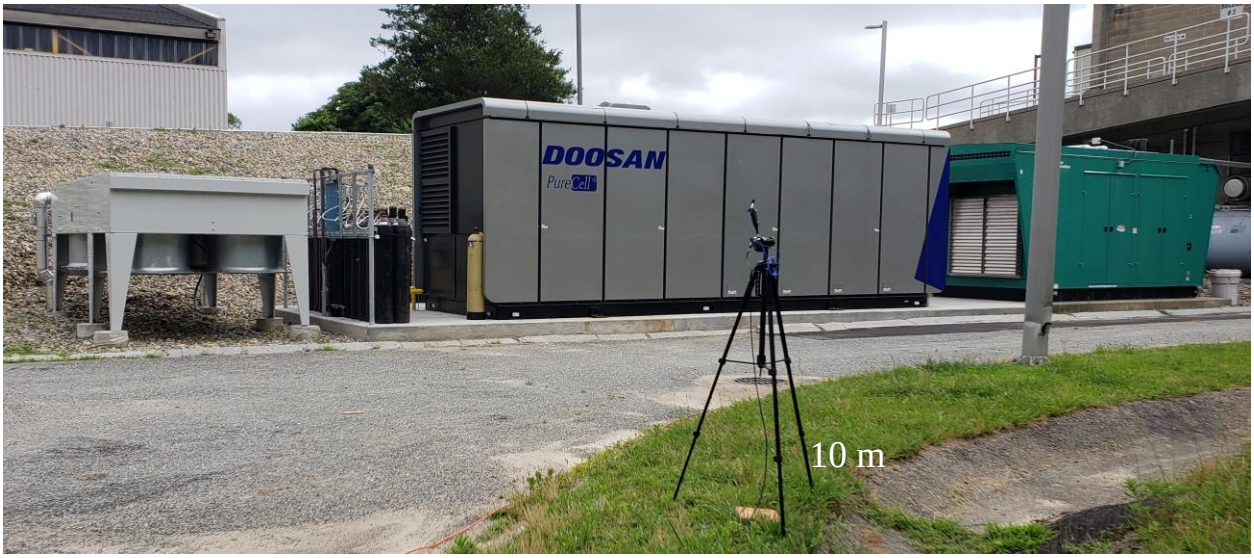


Figure 6. Sensor at 5-Meters (South) from the Power Module at the Montville Site

Table 1. Weather Data near Montville on July 7, 2020
https://www.wunderground.com/history/daily/us/ri/westerly/KWST/date/2020-2-12

Time (EST)	Temp. (°F)	Dew Point (°F)	Humidity (%)	Wind Direction	Wind Speed (mph)	Barometer (in HG)	Condition
8:35 AM	68 F	58 F	70 %	ESE	6 mph	30.10 in	Cloudy
8:53 AM	68 F	58 F	70 %	VAR	6 mph	30.10 in	Cloudy
9:53 AM	69 F	59 F	70 %	E	7 mph	30.10 in	Cloudy
10:53 AM	70 F	60 F	71 %	ESE	6 mph	30.10 in	Cloudy
11:53 AM	72 F	60 F	66 %	SE	10 mph	30.09 in	Cloudy
12:30 PM	71 F	60 F	68 %	SE	9 mph	30.09 in	Cloudy
12:53 PM	72 F	61 F	68 %	ESE	9 mph	30.09 in	Cloudy
1:53 PM	73 F	61 F	66 %	SE	10 mph	30.09 in	Mostly Cloudy
2:32 PM	71 F	60 F	68 %	SE	10 mph	30.08 in	Cloudy
2:53 PM	71 F	60 F	68 %	SE	12 mph	30.08 in	Cloudy
3:19 PM	72 F	60 F	66 %	ESE	10 mph	30.08 in	Cloudy
3:32 PM	71 F	60 F	68 %	SSE	10 mph	30.08 in	Cloudy
3:53 PM	71 F	61 F	70 %	SE	7 mph	30.07 in	Cloudy
4:01 PM	72 F	61 F	68 %	SE	7 mph	30.07 in	Cloudy
4:26 PM	70 F	61 F	73 %	SE	9 mph	30.07 in	Cloudy
4:53 PM	70 F	61 F	73 %	SE	7 mph	30.06 in	Cloudy

Data Analysis

This section analyzes the airborne noise levels measured at the Montville 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 and Montville noise ordinances. The measured fuel cell operating noise levels are reported in Table 2. These values include both background and fuel cell operating noise. The L90 and spectral data will later be used to correct the measured operating airborne noise levels (Leq) providing estimates of only the fuel cell noise contribution at locations that are near the allowable noise levels. (Many of the locations are well below the allowable noise levels even with the background contribution.) Table 3 then reports these background corrected fuel cell operating noise levels. Comparing the Montville fuel cell estimated levels with the state and town noise limits 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 Montville are provided in Table 2. Figure 7 is a map showing the Montville zoning districts in the Montville Water Authority area. The position locations were initially calculated using the Pocket Ranger GPS App from the CT State Parks & Forests. The indicated GPS accuracy varied from 3 to 10 meters. The GPS range from the fuel cell to the microphone locations that are shown in Table 2 were calculated with Google Maps. 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 P7, which is about 39 meters south to the fenced edge of the Residential Zone abutting the Montville Water Authority property at 83 Pink Row. The next closest measurement location is P8, which is about 59 meters south along this same fenced property line. Neighboring commercial properties along Pink Row are 64 to 159 meters away. P1, the closest residential home is 200 meters away due west at 78 Pink Row. At this residential location airborne noise from the operating fuel cell could not be heard. The residential noise level was below 45 dBA. To the south Gay Cemetery Pond is more than 70 meters away from the fuel cell and the closest distance to St Patrick Cemetery is about 290 meters.

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.
L:10□10% percentile sound level
L:90□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. Because the fuel cell noise is essentially constant the L90 value 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.

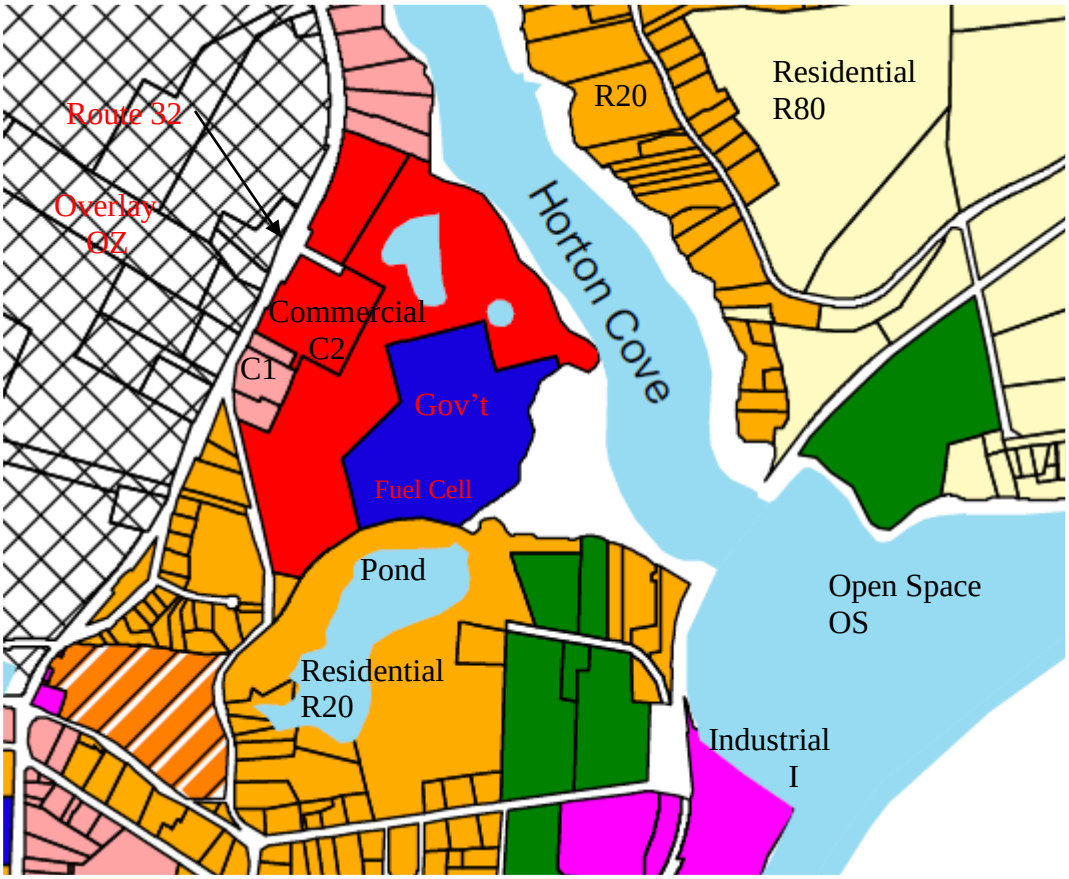
Table 2. Measured Overall Sound Pressure Levels in dBA reference 20 microPascals

Location	Range in Meters	Direction	Leq	Max	Min	L10	L90
Cooling	1	South	76.0	76.8	74.8	76.6	75.3
Cooling	5	South	68.9	69.4	68.4	69.2	68.7
Cooling	10	South	**65.2**	66.2	64.5	65.9	**64.7**
Cooling	1	West	76.8	77.2	76.3	77	76.6
Cooling	5	West	69.7	70.5	69.1	70.1	69.4
Cooling	10	West	**64.2**	64.7	63.7	64.4	**64.0**
Power	1	South	63.4	64.3	62.8	63.7	63.1
Power	5	South	61.8	62.5	61.4	62.1	61.7
Power	10	South	**61.2**	62.3	60.5	61.9	**60.8**
Cooling	10	North	**64.4**	65.1	60.7	64.7	**61.4**
P1 – 78 PR	200	West	44.9	72.7	41.6	46.1	42.5
P2 – 75-105	159	West	43.0	79.7	40.6	44.5	41.2
P3 – Silvia	124	West	49.7	53.6	45.9	51.3	49.5
P4 – PR West	64	Door Open	58.7	59.7	57.9	59.3	58.2
P4 – PR West	64	Closed	57.4	76.9	55.9	59.5	56.4
P5 – PRNorth	92	North	47.8	51.4	46.9	49.7	47.1
P6- PR South	62	South	50.4	52.8	49.2	51.3	49.7
P7- PR SSE	39	SSE	55.4	56.6	54.5	56.1	54.6
P8- PR S East	59	SE	54.1	55.2	53.6	54.4	53.8
P9 – PR NE	116	NE	51.3	54.0	50.8	51.6	51.0
P10 - Pond S	72	Door Open	49.6	56.0	48.4	50.8	48.7
P10 - Pond S	72	Closed	48.5	67.9	47.0	49.3	47.4
P11 - Pump	41	NW	79.8	81.0	76.4	80.6	76.9
P12 – Fan N	52	North	70.0				
P13 – Fan SE	35	SE	69.0				

Note:
The 1-meter airborne noise level from the Water Authority pump at P11 (79.8 dBA) is 3 dB higher than the highest 1-meter fuel cell airborne noise level. The pump noise dominates the measurement at location P4 which is only 21 meters away. The ventilation exhaust fans at positions 12 and 13 contribute to the airborne noise measured at locations P5, P8 and P9.

The “Door Open” and “Closed” events were an attempt to reduce the pump noise leaving the building at the entrance to the Water Authority. Closing this large overhead door did reduce the measured levels by 1 to 2 dB at locations P4 and P10. Unfortunately, a good deal more airborne noise radiated from the large pipe outside the building still influenced the two measured levels.

Figure 7. Montville Zoning Map Showing the Fuel Cell and Nearby Areas



The estimated airborne noise levels produced by the Doosan fuel cell are shown in Table 3. For each of the ten locations the Montville L90 measurements are used to eliminate some of the background noise. The measurements at the Montville Water Authority were taken at various distances from the fuel cell. Close to the fuel cell at 83 Pink Row the maximum airborne noise values to the south are expected to be under 55 dBA, just slightly below the residential day time noise limit. These locations close to the fuel cell and near the pond can be as much as 9.6 dB above the residential night time noise limit. While the small strip of property between the Water Authority and the Gay Cemetery Pond exceeds the night time residential noise limit it is not expected to be a potential airborne noise issue since there are no residences and no one is expected to be there at night. A large part of this "Residential" area is reserved for overhead power lines from an adjacent NRG Montville power plant.

All the commercial properties are expected to be well below the 62 dBA noise limit, the amount depending on how close the locations are to the fuel cell. The residential properties to the south and south west and to the east across Horton Cove are all expected to have airborne noise levels due to the fuel cell that are well below the 45 dBA night time residential limit.

Table 3. Montville Property Line Overall Sound Pressure Levels in dBA ref. 20 microPascals

Location	Range in Meters	Allowed	Leq	**L90**	Status	Night Deficit	Acoustic Concern
P1 – 78 PR	200	45	44.9	**42.5**	OK		None
P2 – 75-105	159	62	43.0	**41.2**	OK		None
P3 – Silvia	124	62	49.7	**49.5**	OK		None
P4 – PR West	64	62	57.4	**56.4**	OK		None
P5 – PRNorth	92	62	47.8	**47.1**	OK		None
P6- PR South	62	45	50.4	**49.7**	Above	4.7	None
P7- PR SSE	39	45	55.4	**54.6**	Above	9.6	None
P8- PR SE	59	45	54.1	**53.8**	Above	6.0	None
P9 – PR NE	116	62	51.3	**51.0**	OK	In dB	None
P10 - Pond S	72	45	48.5	**47.4**	Above	2.4	None

Red indicates locations above the residential night time noise limit of 45 dBA – there are four

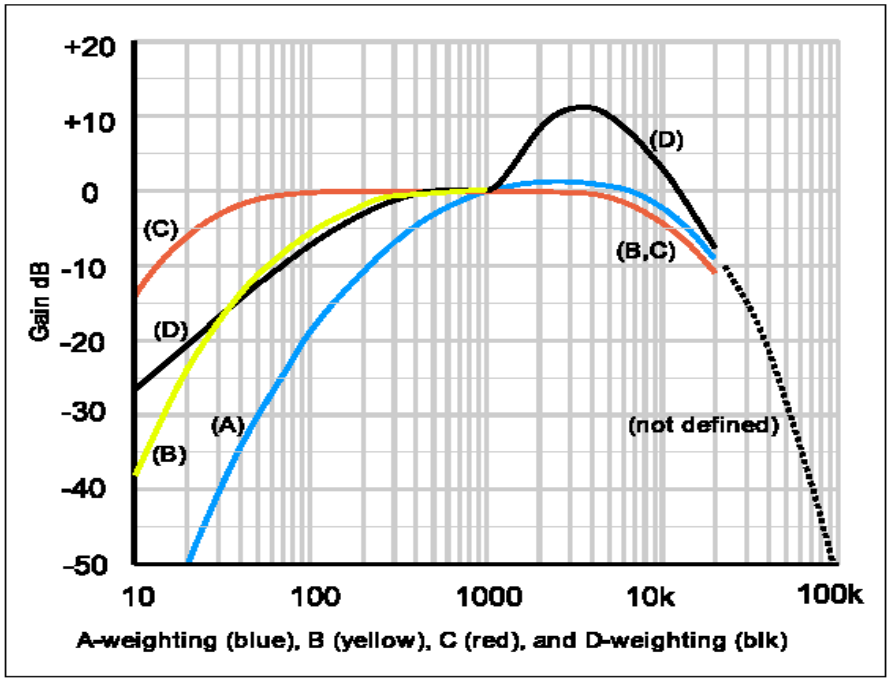
Allowable Noise Levels

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. The Montville Noise Ordinance (Ref. 2) has the same allowable noise levels as the CT ordinance with a 2-hour change in the day-night hours on Sunday. The two ordinances will be used to evaluate the noise generated by the Doosan Fuel Cell. Following sections discuss each type of noise using the results obtained from the July 7, 2020 fuel cell measurements at the Water Pollution Control Authority in Montville.

The southern part of the Montville zoning map is given in Figure 7. As stated above, the Montville site at 83 Pink Row is located in a Government Zone. This site is adjacent to a Residential Zone to the south and south west and a Commercial Zone to the north and west, respectively. The closest home is 200 meters away at 78 Pink Row in a R-20 Residential Zone. The acoustic data from positions P2 and P3 show that the fuel cell noise is expected to drop below 45 dBA between distances of 124 and 159 meters. The fuel cell noise should be below the 45 dBA night time residential noise limit at about 140 meters from the fuel cell. The airborne noise level measured at P1, the 78 Pink Row property line (at a distance of 200 meters), is below the night time allowable level of 45 dBA. Other nearby residential properties at greater distances are also expected to be well below the night time Residential Zone noise limit for an emitter in a commercial zone. The airborne noise measured at all the commercial properties is well below the allowable level of 62 dBA in a commercial zone. The residential zone to the south directly adjacent to the fuel cell shows airborne noise levels from 47.4 to 54.6 dBA. These levels are below the day time noise limit of 55 dBA but are not below the night time noise limit of 45 dBA. This small area is not expected to be an issue because it is not usually occupied at night.

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. The Montville Noise Ordinance prohibits the generation of impulse noise in excess of 100 dB.

Impulse noise in excess of 80 dBA was not observed during any of the ten property line measurements of the Doosan 460 KW fuel cell made at the Montville site on 7 July, 2020. The maximum level measured was 79.7 dBA at location P2 using the ExTech sound level meter. This and the other levels above 70 dBA were caused by vehicle traffic and not by the fuel cell. Unweighted impulse noise levels were determined using the Hewlett Packard spectrum analyzer. (The maximum level ten meters from the fuel cell was 77 dBA.) The closest property line showed 6 dB of transmission loss so the highest expected level at a property line would be below 72 dB. Given the steady state nature of the fuel cell's noise signature there should be no acoustic issues with the State of Connecticut's or the Town of Montville's impulse noise requirements.

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 10 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, 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 Water Pollution Control Authority is a Class B emitter in a Government 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:

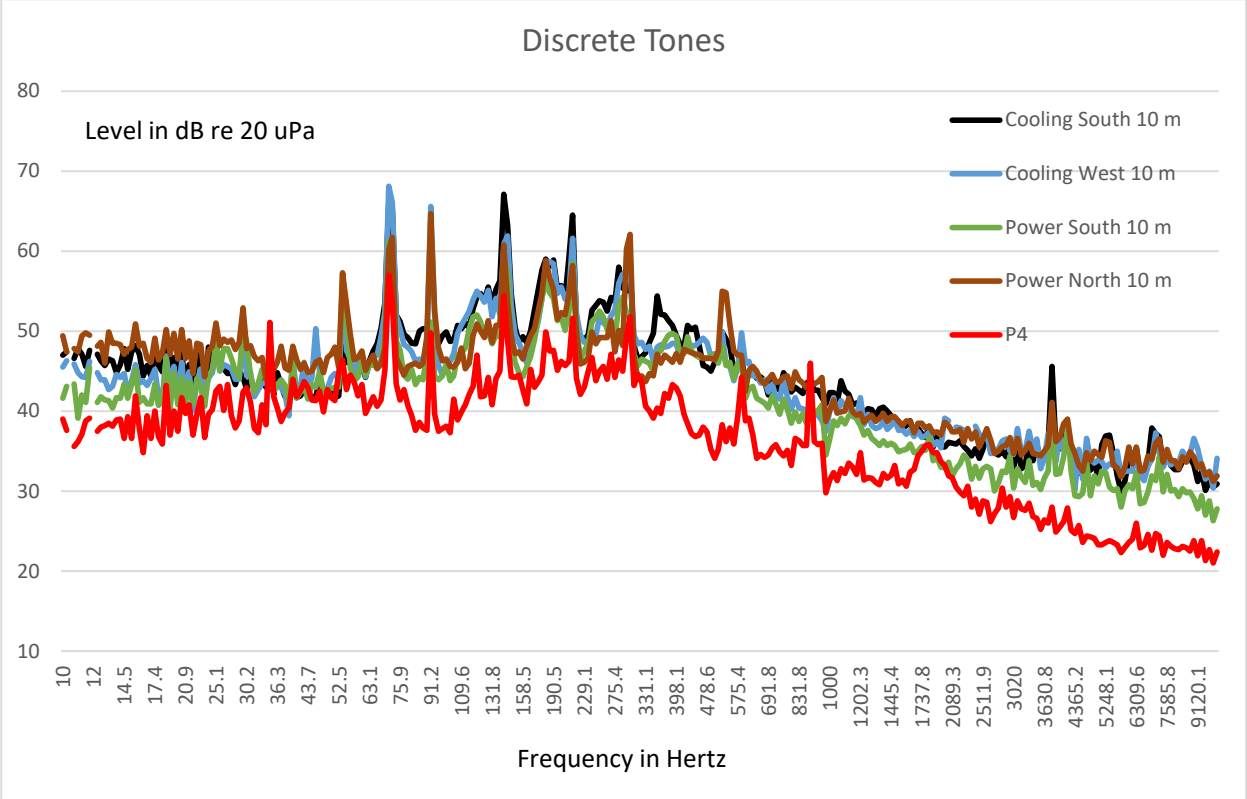
To Class C 57 dBA To Class B 57 dBA To Class A 50 dBA (day) 40 dBA (night)

The Montville Noise Ordinance does 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 July 7, 2020 testing. The measured data in Table 4 does not have A-weighting. Figure 9 plots the airborne noise measured 10 meters from the Cooling Module for frequencies from 0.32 Hz to 100,000 Hz in 1-30th octave bands. This figure shows the discrete tones in the middle frequencies produced by the Doosan Fuel Cell Cooling Module. The eight largest tones are given in Table 4. The highest is 58 dB reference 20 microPascals at 142.5 Hz. The second highest tone is at 213.8 Hz at a level of 56 dB reference 20 microPascals. The third highest tone is at 298.8 Hz at a level of 51 dB reference 20 microPascals. The A-weighting corrections are -16.5 dB at 142.5 Hz, -10 dB at 213.8 Hz and -9 dB at 298.8 Hz. Incorporating these corrections gives un-weighted allowable levels of 56.5 dB at 142.5 Hz, 50 dB at 213.8 Hz and 49 dB at 298.8 Hz. Transmission loss to the residential property lines to the south are included in the values listed in the table. The three frequencies have levels that are above the 40 dBA night time requirement in a Residential Zone by up to 6 dB. The other five frequencies in Table 4 meet all the discrete tone requirements. All the tones meet the day time requirements. While the small strip of property between the Water Authority and the Gay Pond exceeds the discrete residential night time noise limit it is not expected to be a potential airborne noise issue since no one is expected to be there at night. The transmission loss to the Commercial property lines to the west and north is at least 8 dB so the maximum possible discrete tone would be at least 15 dB below the commercial discrete tone requirement. Operating the Doosan fuel cell should produce airborne noise levels well below the CT discrete tone requirement at all the other residential property lines to the south west, west and east. There should be no acoustic issue with the CT discrete tone noise requirements.

Table 4. Montville Peak Discrete Sound Pressure Levels in dB ref. 20 microPascals

Location	Range Meters	54.1 Hz	71.1 Hz	91.9 Hz	142.5 Hz	213.8 Hz	298.8 Hz	3813 Hz	4188 Hz
Allowed - R	**Day**	**79**	**76**	**70**	**66.5**	**60**	**59**	**49**	**50**
Allowed - R	**Night**	**69**	**66**	**60**	**56.5**	**50**	**49**	**39**	**40**
P1 – 78 PR	200	33.7	50.2	29.0	51.1	49.1	43.6	29.1	18.3
P6- PR S	62	38.6	55.1	33.9	56.0	54.0	48.5	34.0	23.2
P7- PR SSE	39	38.8	55.3	34.1	56.2	54.2	48.7	34.2	23.4
P8- PR SE	59	39.0	55.5	34.3	56.4	54.4	48.9	34.4	23.6
P10 - Pond S	72	40.8	57.3	36.1	58.2	56.2	50.7	36.2	25.4
Allowed - C		**86**	**83**	**77**	**73.5**	**67**	**66**	**56**	**57**
P2 – 75-105	159	32.8	48.6	42.8	47.5	43.3	46.6	18.1	19.2
P3 – Silvia	124	33.9	49.7	43.9	48.6	44.4	47.7	19.2	20.3
P4 – PR W	64	36.8	52.6	46.8	51.5	47.3	50.6	22.1	23.2
P5 – PR N	92	35.2	51.0	45.2	49.9	45.7	49.0	20.5	21.6
P9 – PR NE	116	34.2	50.0	44.2	48.9	44.7	48.0	19.5	20.6

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. The Montville Noise Ordinance does not discuss infrasonic or ultrasonic noise so the State of CT Noise Ordinance will be discussed.

Narrow bandwidth sound pressure spectrums in dB reference 20 microPascals at the P4 and 10-meter Cooling Module locations can be used to compare with these infrasonic and ultrasonic noise requirements. The Montville airborne noise data were processed in the 0 to 125 Hertz and 0 to 100,000 Hertz frequency ranges. The bandwidth of each data point is 0.469 Hertz for the 125 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. The maximum level at 10 meters is 51 dB reference 20 microPascals and 42 dB at location P4. The entire 20 Hertz band can be power summed and never exceeds 74 dB reference 20 microPascals at 10 meters. The 20 Hertz band level is less than 61 dB at location P4. Both levels are well below the requirement of 100 dB for a residential property. The minimum transmission loss to the nearest residential property line is at least 6 dB so the maximum possible infrasonic noise at the southern property line would be less than 68 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 53 dB reference 20 microPascal. The entire 80 KiloHertz band from 20 to 100 kiloHertz has been power summed and never exceeds a noise level of 63 dB reference 20 microPascals 10 meters from the fuel cell. The minimum transmission loss to the nearest residential property line is at least 6 dB so the maximum possible ultrasonic noise at the southern property line would be less than 57 dB. The noise levels at the other residential neighbors will be much 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 has a sensor that can measure up to 100 KHz. This sensor was used on the first four 10-m cooling module measurements to demonstrate that there are no issues at frequencies above 20 KHz. 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. This sensor was used for all the spectral measurement locations.

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

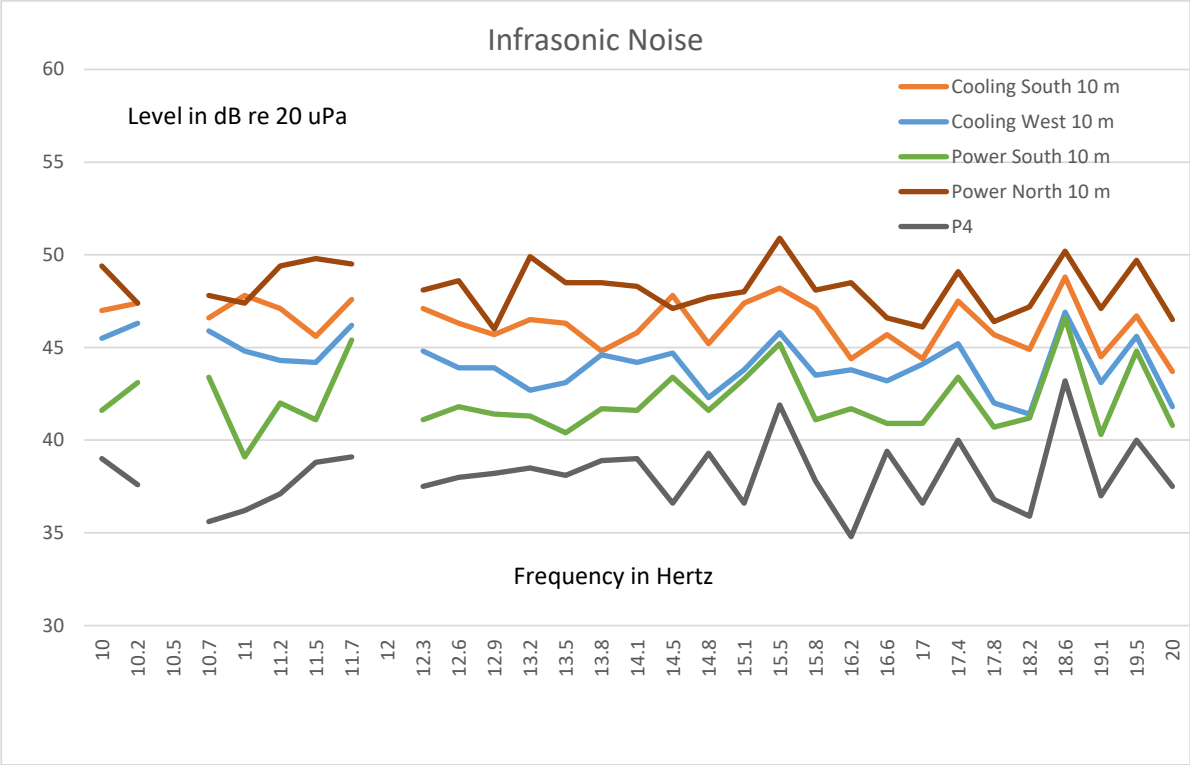
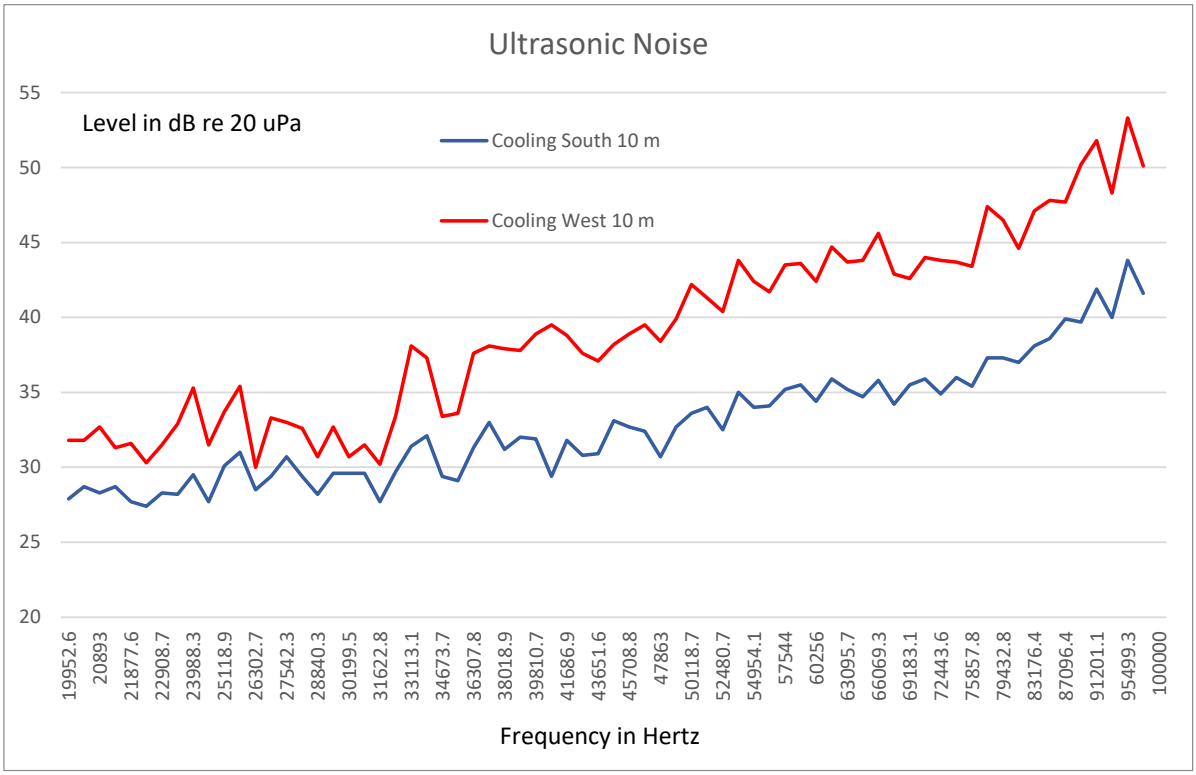


Figure 11. Ultrasonic Noise from Fuel Cell Cooling and Power Modules in 1-30th octave bands



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 Montville Water Authority is in a Government Zone that is surrounded by Residential Zones to the south and south west and Commercial Zones to the north and west. Other Residential Zones to the east are too far away (greater than 550 meters) to be affected by noise from the Montville Water Authority site. 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 Montville Noise Ordinance (Reference 2) has the same allowable noise levels as the State of CT ordinance (Reference 1).

The estimated overall A-weighted sound pressure level measurements in dBA reference 20 microPascals are given in Table 3 above for the background corrected measurements made on July 7, 2020. 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 column 4 and 5 are the average measured level (Leq) and the estimated fuel cell level (L90), respectively. The L90 level in Table 3 has some of the background noise removed in order to estimate the contribution provided by the new fuel cell's 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 6 tells whether the measured levels are above or below the requirements. The values shown in red in Column 7 indicate how much the measured noise along the southern property line is above the residential night time noise requirements. The values at four of the locations are up to 9.6 dB above the night time requirement. (This small area is a location where there are no residences and no one is expected to be there at night.)

Reviewing Table 3 and Table 4 below, it is clear that the airborne noise levels drop significantly in propagating to the nearby properties as the range increases. The highest property line background corrected fuel cell level was measured at 56.4 dBA at Position 4, the property line right adjacent to the Water Authority entrance. The P7 residential property line should see airborne noise levels no higher than 54.6 dBA with the fuel cell operating. Because of the increasing loss with distance to the commercial property lines the expected fuel cell noise levels will fall below 52 dBA for the other commercial properties. The residential properties to the west should all be lower than 45 dBA. All the expected maximum values are shown in Table 4 below. All the property line estimates will meet the 62 dBA Commercial and 55 dBA day time residential noise limits. The property line south of the Water Authority exceeds the night time residential limit by up to 9.6 dB in an area not frequented by people at night.

Operation of the Doosan fuel cell will have no acoustic impact at all of the residential properties adjacent to the Montville Water Authority site on Pink Row. The commercial property next to Montville Water Authority on Pink Row should see airborne noise levels from the fuel cell at least 6 dB below the commercial noise limit. Background airborne levels of 80 dBA from the

Water Authority pumps were measured during a normal working day just inside the entrance to the site at Position 11. Commercial properties further away from the fuel cell along Pink Row are expected to be below 50 dBA and all the commercial properties should not be affected by the operation of the fuel cell.

The southern residential property line close to the fuel cell has airborne noise levels in the 47.4 to 54.6 dBA range. These numbers are below the day time residential noise limit but above the night time noise limit of 45 dBA. This property directly to the south of the Montville Water Authority site borders Gay Cemetery Pond. The closest edge of the pond is 75 meters from the fuel cell so the highest airborne noise levels actually on the pond should be about 50 dBA. Night time use of the pond may expose people to airborne noise levels slightly above the night time noise limit. (There are no residences in this area.) St Patrick Cemetery is at least 290 meters away and airborne noise levels at the cemetery should be much less than 45 dBA. No acoustic issues are expected during operation of the Doosan fuel cell.

Table 4. Overall Airborne Noise Levels from Operating a Doosan Fuel Cell (ref. 20 µPA)

P2	P3	P4	P5	P9		Limit
41.2 dBA	49.5 dBA	56.4 dBA	47.1 dBA	51.0	Commercial	62 dBA
P1	P6	P7	P8	P10	Residential	55 dBA Day
42.5 dBA	49.7 dBA	54.6 dBA	53.8 dBA	47.4		45 dBA Night

Conclusions

The purpose of this effort is to evaluate the acoustical environment at the Montville Water Pollution Control Authority during operation of the Doosan fuel cell. This effort has been accomplished and the results show that the operation of a Doosan 460 KW fuel cell will meet all of the State of Connecticut airborne noise requirements at all the commercial properties to the west and north. Residences to the west, south and south west are also expected to meet all the noise requirements because they are at least 200 meters away from the new fuel cell. Residential properties to the east are further away (550 m) and will not be affected by the Doosan fuel cell's airborne noise. The adjacent Residential Zone property to the south can be as close as 39 meters to the new fuel cell. Airborne noise from the fuel cell will meet the day time noise requirement but exceed the night time noise requirement at this property line. The property contains Gay Cemetery Pond and the airborne noise levels expected at 75 meters and further distances that are actually on the pond should be slightly above the 45 dBA night time airborne noise requirement. Night time use of the pond is not expected and there should not be an acoustic issue.

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) www.townofmontville.org › form-repository › DownloadFile
Montville Noise Control Ordinance