Doosan Fuel Cell America, Inc.
101 East River Dr
East Hartford, CT 06108
T - 860 727 2200

March 17, 2020

PETITION NO. 1393- Doosan Fuel Cell America, Inc. petition for a declaratory, pursuant to Connecticut General Statutes §4-176 and §16-50k, for the proposed construction, maintenance and operation of a 440- kilowatt customer-side combined heat and power fuel cell facility and associated equipment to be located at Cherry Street Lofts, 375 Howard Ave, Bridgeport, Connecticut 06605.

RE: ADD SOUND STUDY TO PETITION NO. 1393

Doosan Fuel Cell America, Inc. ("Doosan") hereby submits the acoustical sound study to the petition.

Respectfully Submitted,
Doosan Fuel Cell America, Inc.

Donald Emanuel
Installation Project Manager
Donald.Emanuel@doosan.com
Doosan Fuel Cell America, Inc.

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: **Cherry Street Lofts**
440 KW Fuel Cell
Airborne Noise Assessment
At 437 Howard Avenue

Author: **Carl Cascio**

Date: **March 14, 2020**

Revision: **0**

Table of Contents

Country of Origin is the United States of America

Summary

This document makes a positive acoustic assessment that should help in meeting any acoustic noise concerns during the operation of a Doosan 440 KW fuel cell at the Cherry Street Lofts site at 437 Howard Avenue in Bridgeport, CT. An acoustic assessment plan was developed and executed to acquire airborne acoustic information to explain and mitigate the potential airborne noise issues associated with operation of the Doosan fuel cell. It is important to show that the airborne noise generated by the fuel cell will not significantly impact the facility's neighbors.

The airborne noise levels expected to be generated by the Doosan fuel cell operating at the Bridgeport site were simulated by exciting a set of six co-located speakers at the fuel cell Cooling and Power Module positions. (The Cooling Module is the dominant noise source.) The six speakers produced an overall airborne noise level that was 13 to 14 dB higher than the levels measured for a similar Doosan fuel cell installed at New Britain High School in New Britain, CT. One-third octave band analysis showed the speakers to be slightly above the New Britain fuel cell airborne noise levels at frequencies up to 250 Hertz where the airborne noise levels were low and to exceed the fuel cell signature by 5 to 20 dB at higher frequencies where the fuel cell signature was higher in noise level. Airborne noise with the speakers operating was measured at distances from 5 to 103 meters from the proposed fuel cell location at the Bridgeport site. The speakers produced overall A-weighted sound pressure of approximately 85 dBA at 5 meters and 82 dBA at 10 meters (ref 20 microPascals) from the proposed fuel cell Cooling Module location. Airborne noise from the speakers at nearby properties was measured at levels from 50 - 82 dBA. Industrial Zone measurements on Howard Avenue and Cherry Street were lower because of the longer distance to the speakers. Analysis of the speaker data indicated propagation losses from 31 to 35 dB from the fuel cell location to the nearby industrial property lines. The source level at 10 meters from the operation of a Doosan fuel cell at New Britain High School was then used as a basis for making the Doosan fuel cell airborne noise estimates at all the locations.

Operation of the Doosan fuel cell should produce noise levels below the Industrial Zone noise limit of 70 dBA at all of the nearby properties. All of the nearby Residential Zone properties to the north east are expected to be below residential noise limits with expected airborne noise below 42 dBA with the fuel cell on. Industrial Zone properties outside the Cherry Street Loft court yard should not be affected by the airborne noise from the fuel cell. Residences and the school in the Cherry Street Loft court yard are very close to the new fuel cell. These properties will see airborne noise levels just below the 70 dBA limit in an Industrial Zone. The highest expected airborne noise level of 68 dBA will be at the residence about 10 meters from the fuel cell. Other residences and the school within the court yard should see levels no higher than 65 dBA. Airborne noise from the fuel cell should be mitigated to preclude the combined fuel cell and I95 traffic noise from exceeding the 70 dBA limit. This mitigation should be designed to provide sufficient sound attenuation to show that the airborne noise generated by the fuel cell will not significantly impact the facility's very closest neighbors. A goal of reducing the airborne noise to levels below 51 dBA at the residences in the court yard is recommended.

The Connecticut's Noise Code (Reference 1) also calls for review of acoustic issues associated with impulse noise, prominent discrete tones, infrasonic and ultrasonic noise. Operation of the fuel cell is expected to meet all of these requirements at all of the nearby properties.

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 Cherry Street Lofts at 437 Howard Avenue in Bridgeport, CT. Responding to a request from Donald Emanuel, a site visit was made on March 11, 2020. During the visit, a survey of the airborne noise levels produced by a set of speakers simulating the airborne noise produced by a Doosan Fuel Cell was made in order to identify potential airborne noise issues. Airborne noise measurements were taken to quantify the propagation of the simulated fuel cell airborne noise to the adjacent properties. Background airborne noise levels were also made with the speakers off. This document provides an acoustic assessment to assist in meeting acoustic noise concerns during the permitting process for the Cherry Street Lofts siting of a Doosan fuel cell at 437 Howard Avenue in Bridgeport, CT.

Development of the Acoustic Assessment Plan

The purpose of this effort is to acquire acoustic information useful in explaining the potential airborne noise issues associated with the operation of a Doosan 440 KW fuel cell at the Cherry Street Lofts housing facility. The site at 437 Howard Avenue is located in a Mixed Use Industrial Light Zone near Interstate 95 and is surrounded by Mixed Use Industrial Light Zones to the east and west, a Residential Zone to the north east and Industrial Light Zones to the north and south. (The Bridgeport zoning map is given below.) It is important to determine whether the airborne noise generated by the Doosan fuel cell will impact these neighbors.

The acoustic impact is assessed in the following way. The 440-kW fuel cell is yet to be installed so there is no way to measure fuel cell operating airborne noise levels at the new site. The fuel cell airborne noise has been measured at other sites and both overall and one-third octave band airborne noise data of Doosan 400- and 440-KW fuel cells are available (References 2 and 3). The only difference between the 400-KW and 440-kW fuel cells is the electrical output of the cell stacks. The rest of the machine including fans and fan noise remain the same between the models. Using this data, a set of six speakers have been programmed through a set of octave and one-third octave band filters to generate a noise spectrum similar to that of the new fuel cell. (It is assumed that the Cooling and Power Module noise in the two measured units are similar to the new unit.) This spectrum will then be played through an audio amplifier to create the electrical voltage necessary to drive the six speakers. In order to overcome the potentially high background noise at the site the speaker output will be increased to a level about 13 to 14 dB higher than the overall noise level measured on a fuel cell at a distance of 10 meters. With the six speakers on, this approach then follows the traditional “What is the airborne noise level at the neighbor’s property line?”. The six speakers were run and airborne measurements made near the proposed fuel cell locations and at the nearest neighbor’s property lines. This measured site data can also be used to estimate noise levels at other neighbor’s property lines. The City of Bridgeport has a Noise Ordinance (Ref. 4) with similar noise requirements to the State of Connecticut’s Noise Code and both have been consulted to assess the impact of the measured and estimated acoustic levels. Because of the closeness of the fuel cell site to the nearby buildings 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 440 KW Doosan Fuel Cell are described below: Airborne sound pressure measurements and audio tape recordings were conducted at the Cherry Street Lofts site on and near 437 Howard Avenue on March 11, 2020 during the daylight hours (10 am – 1 pm). This testing established both background airborne noise levels and simulated airborne noise levels with the speakers operating. The overall A-weighted airborne noise measurements were made with an ExTech model 407780A Digital Sound Level Meter (s/n 140401544) that was calibrated prior to and just after the test with a Quest model QC-10 Calibrator (s/n Q19080194). Measurements were 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 audio tape recordings were made with a Sony Digital Audio Tape Recorder (model TCD-D7 s/n 142000) with microphones on channels 1 and 2. The two PCB microphones (model 130F20 s/n 53933 and 130F20 s/n 53994) were powered by two Wilcoxon P702B power supply/amplifiers (s/n 1992 and 1995 respectively). The PCB microphones were also calibrated prior to and after the test with the Quest model QC-10 Calibrator (s/n Q19080194). All but one of the measurements were made with the microphones at a height above ground between five and six feet. A Hewlett Packard model HP3561A Dynamic Signal Analyzer, s/n 2338A00659, was used to perform A-weighted spectral analysis on the tape-recorded data. The tape-recorded data were also used to verify the ExTech sound level meter overall dBA readings.

At the Cherry Street Lofts site "speaker on" and background airborne noise measurements were taken at the following seven nearby property lines in the Mixed Use Industrial Light Zones:

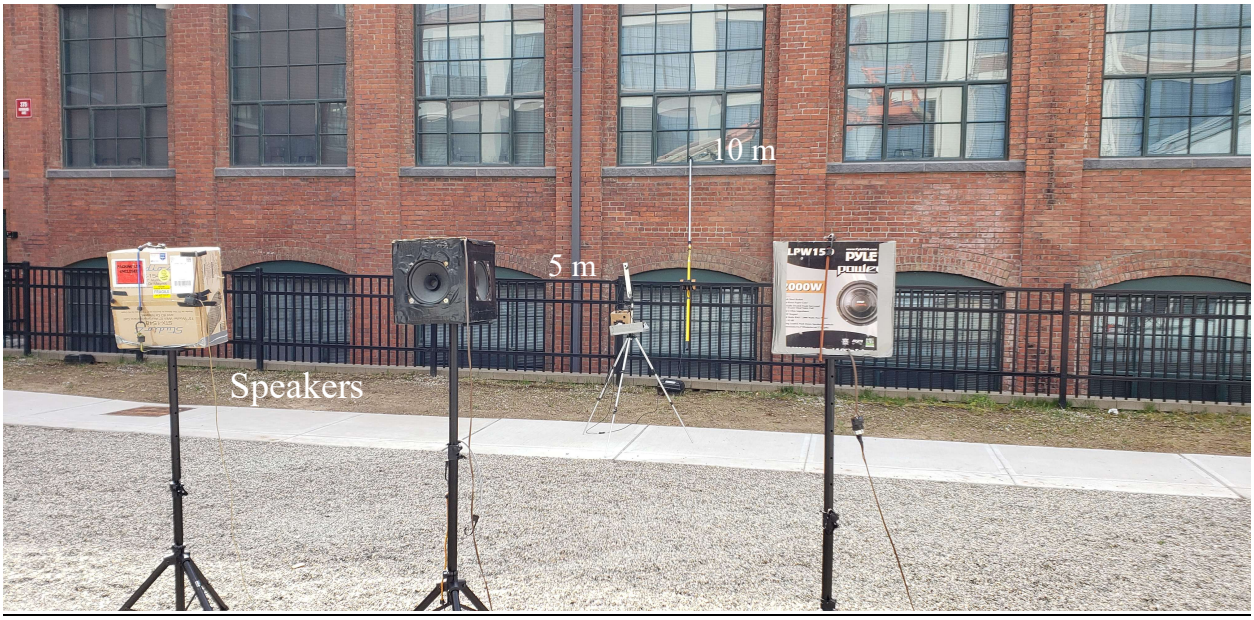
Location	**Business**	**Distance**	**Zone Type**
A - 437 Howard Avenue	Cherry Street Lofts	5 &10 meters	MU Industrial Light
B - 437 Howard Avenue	Cherry Street Lofts	5 &10 meters	MU Industrial Light
P1 – East (Cherry S. L.)	School	15 meters	MU Industrial Light
P2 – North (Cherry S. L.)	Residence	25 meters	MU Industrial Light
P3 – West (Cherry S. L.)	Residence	47 meters	MU Industrial Light
P4 – South (Cherry S. L.)	Residence	10 meters	MU Industrial Light
P5 – North West (Cherry S. L.)	Residence	52 meters	MU Industrial Light
P6 – 410 Howard Avenue	Ryder Truck	53 meters	MU Industrial Light
P7 – 56 Cherry Street	I95 / Frontage Road	103 meters	MU Industrial Light

Locations P1 - P5 are at the inside walls of the courtyard within the Cherry Street Lofts property. Locations P6 and P7 are at the only two street openings. See the Google satellite map in Figure 1 for the approximate measurement locations. Measurements near the proposed operating Cooling and Power Module sites at positions A and B were simultaneously taken with the ExTech sound level meter and two microphones recording on the digital tape recorder. Figures 2 and 3 provide photographs of the site locations for the Cooling and Power Modules as well as the sensors at 5 and 10 meters. At locations A and B, a one-minute record of the acoustic noise was stored for the speakers in the "on" condition at the start of the airborne noise measurements. There is a slight decrease of 1.4 dB in sound output from the speakers as they warmed up. One minute of background airborne noise data were also recorded at the two speaker positions.

Figure 1. Bridgeport Cherry Street Lofts 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 Bridgeport Airport (closest data to the Cherry Street Lofts) for the acoustic measurements on March 11, 2020. Measurements were taken over the period from 10:00 am until 1:00 pm. The table below shows the temperature and wind speeds in hourly intervals. Wind conditions were very good for most of the day with only one period higher than 10 mph (10:53 am). Acoustic measurements were further enhanced by the shielding provided by the nearby buildings and the wind did not affect the operating and background airborne noise measurements. There was no rain during the testing on March 11. The traffic noise from Interstate 95 next to the Cherry Street Lofts site generated most of the background noise for all of the measurement locations. Motor traffic along Howard Avenue and the Frontage Road was light and very few of the measurements had to be delayed until no traffic was present. Background noise levels at all but one of the measurement positions were acceptable with levels from 53 to 56 dBA. The position just outside the facility entrance on the Frontage Road (P7) saw background levels of 58 dBA due to the closeness of the Interstate 95 highway. This location was 103 yards from the speakers and the speakers could not be heard.

Figure 2. Position A Cooling Module Location at the Bridgeport Cherry Street Lofts Site



Note: The 10-meter microphone was raised to a height of about 8 feet so that it would be next to the window of the building shown in the figure.

Table 1. Approximate Bridgeport Weather Data on March 11, 2020
https://www.wunderground.com/history/daily/KHVN/date/2020-3-11

Time (EST)	Temp. (°F)	Humidity (%)	Dew Point (°F)	Barometer (in HG)	Wind Speed (mph)	Wind Direction	Condition
6:53 AM	44 F	63 %	32 F	30.07 in	3 mph	NW	Fair
7:53 AM	42 F	65 %	31 F	30.09 in	6 mph	N	Fair
8:53 AM	45 F	46 %	25 F	30.11 in	9 mph	N	Fair
9:53 AM	48 F	39 %	24 F	30.12 in	10 mph	N	Fair
10:53 AM	51 F	33 %	23 F	30.12 in	14 mph	N	Partly Cloudy
11:53 AM	52 F	30 %	21 F	30.10 in	10 mph	N	Cloudy
12:53 PM	53 F	29 %	21 F	30.09 in	7 mph	N	Cloudy
1:53 PM	54 F	29 %	22 F	30.08 in	6 mph	NW	Cloudy
2:53 PM	50 F	46 %	30 F	30.07 in	5 mph	SW	Fair
3:53 PM	48 F	50 %	30 F	30.05 in	5 mph	SSW	Fair
4:53 PM	51 F	38 %	26 F	30.04 in	6 mph	SW	Fair

Figure 3. Position B Fuel Module Location at the Bridgeport Cherry Street Lofts Site

Data Analysis

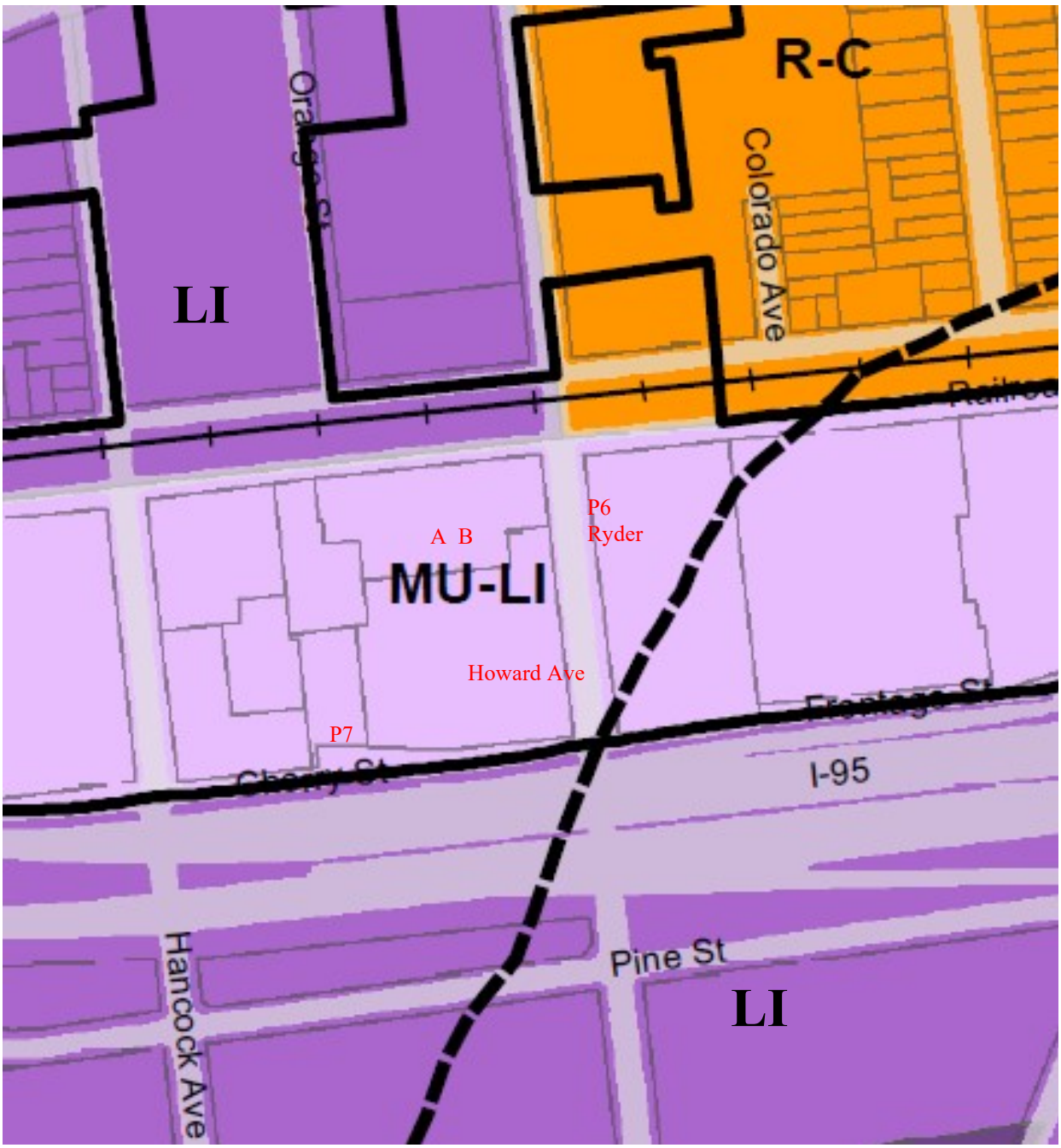
This section analyzes the airborne noise levels measured at the Bridgeport site and then estimates the source level and transmission loss to nearby property lines expected during actual fuel cell operation. These estimated levels will be compared to the noise limits in the Connecticut and Bridgeport noise ordinances. Both background noise levels at the Bridgeport Cherry Street Lofts site and the measured speaker operating noise levels are reported in Table 2. The background data are used to correct the measured operating airborne noise levels providing estimates of only the speaker noise contribution at each location. Table 3 then reports estimated fuel cell equipment operating noise levels. Comparing these Cherry Street Lofts fuel cell estimated levels with the state and city noise limits will identify which nearby locations do or do not meet the airborne noise requirements.

The complete set of overall A-weighted airborne noise levels that were measured at the Cherry Lofts site in Bridgeport are provided in Table 2 for the conditions with the speakers on and off. Figure 4 is a map showing the Bridgeport zoning districts in the Bridgeport Cherry Street area. The range from the speakers to the microphone locations that are shown in Table 2 were calculated with Google Maps. The estimates of the range in meters to each location are given in Table 2 and also in Table 3. Each value is the range to the center of the Cooling Module, the largest source of noise. The closest measurement location is P4, which is about 10 meters south to the edge of the residences abutting the courtyard. The next closest measurement location is P1, which is about 15 meters east to the school building which is on the east side of the courtyard. The next closest measurement location is P2, which is about 25 meters north to the residences on the north side of the courtyard. Neighboring industrial properties along Howard Avenue and Cherry Street are 52 to 103 meters away. The closest residential property is 220 meters to the north east at 11 Clinton Avenue. Airborne noise at the residential locations cannot be heard when the speakers are operating.

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

Location	Range in Meters	Speakers A	Background	Bkgd Corrected	Speakers B	Background	Bkgd Corrected
Speaker 5 m	5	85.0	55.3	85.0	83.6	54.9	83.6
Speaker 10 m	10	82.4	56.5	82.4	78.6	54.9	78.6
P1 – East	15	76.0	56.6	76.0	77.4	54.9	77.4
P2 – North	25	68.9	55.5	68.7	67.4	53.5	67.2
P3 – West	47	64.8	56.4	64.1	63.3	55.6	62.5
P4 – South	10	82.4	56.5	82.4	77.8	56.1	77.8
P5 – North West	52	61.1	58.4	57.8	60.1	54.3	58.8
P6- Ryder	53	58.6	58.0	49.7	59.2	58.2	52.4
P7- I95 / Frontage Rd	103	69.9	70.8	<50	70.0	69.6	<50

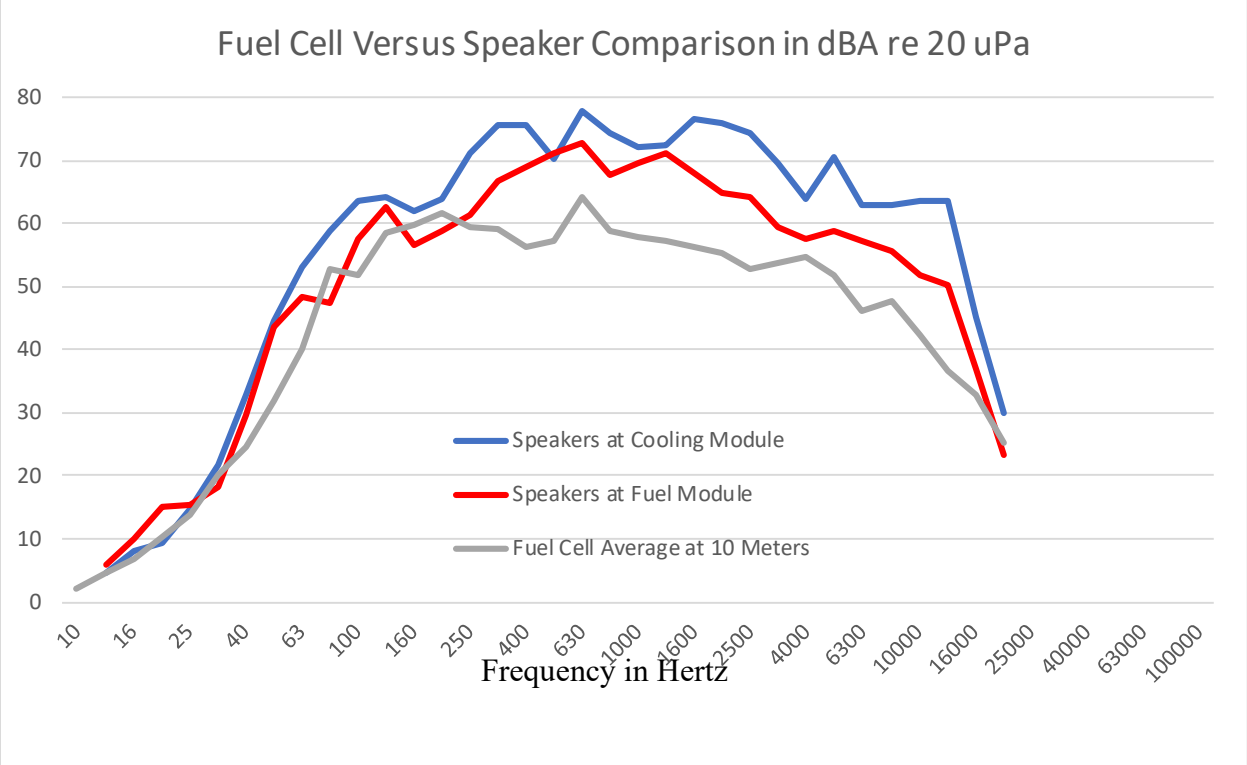
Figure 4. Bridgeport Zoning Map Showing Speaker Location at Positions A & B



A comparison of the airborne noise produced at 10 meters by the Doosan fuel cell at the New Britain High School site with the airborne noise produced by the speakers at the Bridgeport Cherry Street Lofts site is shown in Figure 5. The speakers slightly exceed the fuel cell airborne noise for frequencies below 250 Hertz and greatly exceed the fuel cell airborne noise at the middle frequencies where the fuel cell airborne noise levels are the highest. The overall airborne noise levels are 14.1 and 12.7 dB higher for the speakers at Site A and Site B locations,

respectively, as compared to what is expected from the Doosan 440 KW fuel cell that was measured at New Britain High School in New Britain, CT. The 13 to 14 dB differences in level were subtracted from the Bridgeport measured levels to estimate the expected fuel cell's acoustic signature at each location. These noise calculations are displayed in Table 3 below. The New Britain fuel cell airborne noise levels at 10 meters were used with the Bridgeport speaker data to estimate the expected Cherry Street Lofts fuel cell airborne noise for nearby neighbors at the Bridgeport Cherry Street Lofts court yard and property lines.

Figure 5. At 10 Meters, 6 Speakers Generate Airborne Noise Above That of a Single Fuel Cell



The estimated airborne noise levels to be produced by the Doosan fuel cell are shown in Table 3. For each of the seven locations the Bridgeport measurements are corrected to account for the higher speaker levels. The fuel cell noise correction at the Site A Cooling Module location is estimated to be 14.1 dB because the speaker levels are that much higher than the New Britain fuel cell levels. The speakers at the Site B Power Module were estimated to be 12.7 dB higher. (These estimates are based on the overall dBA readings for the two sets of measurements. If individual one-third octave band values were calculated and then averaged over the frequencies of interest, the result would be numbers about 1 or 2 dB higher. The lower, more conservative overall noise level values were used in this report to scale the speaker data.)

The measurements at the Cherry Street Lofts site were taken at various distances from the speakers and then background corrected. Close to the speakers in the court yard at 437 Howard Avenue the maximum airborne noise values are expected to range from 55 dBA to 68 dBA, which is slightly below the industrial noise limit. The residences to the south and the school to the east are most effected with levels from 65 to 68 dBA. All the industrial properties outside

the court yard are expected to be below 50 dBA, the amount depending on how close the locations are to the fuel cell. The properties in the Residential Zone to the north east are all expected to have airborne noise levels due to the fuel cell that are well below 4 dBA.

Table 3. Expected Cherry Street Lofts Overall Sound Pressure Levels, dBA ref. 20 microPascals

Location	Range in Meters	Speakers at A	Correction	Cooling Estimated SPL in dBA	Speakers at B	Correction	Power Mod. Estimated SPL in dBA
P1 – East	15	76.0	-14.1	61.9	77.4	-12.7	64.7
P2 – North	25	68.7	-14.1	54.6	67.2	-12.7	54.5
P3 – West	47	64.1	-14.1	50	62.5	-12.7	49.8
P4 – South	10	82.4	-14.1	68.3	77.8	-12.7	65.1
P5 – North West	52	57.8	-14.1	43.7	58.8	-12.7	46.1
P6- Ryder	53	49.7	-14.1	35.6	52.4	-12.7	39.7
P7- I95 / Frontage Rd	103	<64.1	-14.1	<50	<62.7	-12.7	<50

Red indicates locations above the industrial noise limit of 70 dBA – there are none

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 Bridgeport Noise Ordinance has the same noise levels as the CT Noise Ordinance but redefines daytime and night time as "Day-time hours means the hours between seven a.m. and six p.m. Monday through Friday, and the hours between nine a.m. through six p.m. on Saturday and Sunday" (Reference 4).

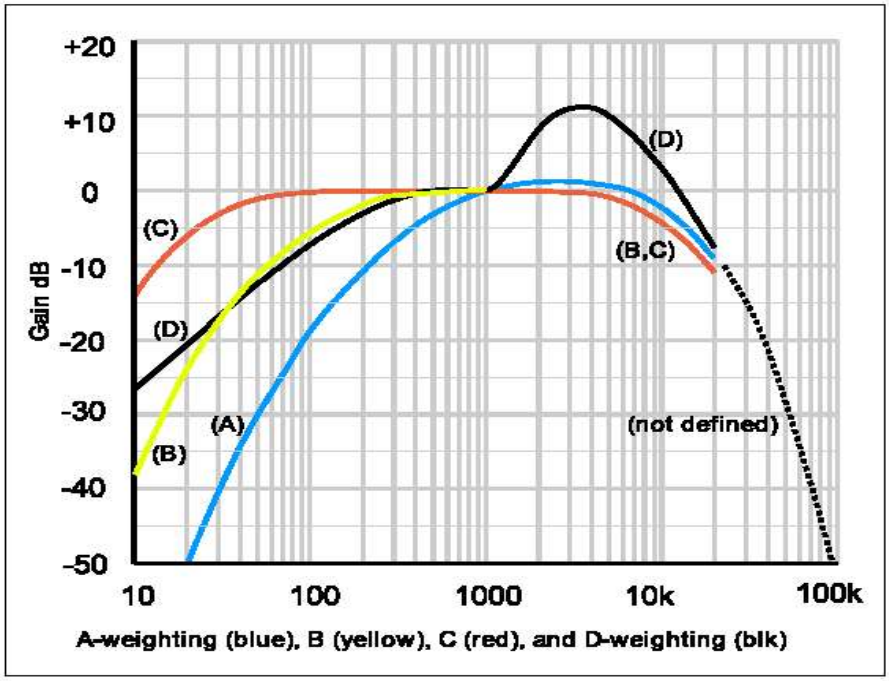
These ordinances will be used to evaluate the noise generated by the Doosan 440 KW fuel cell. Following sections discuss each type of noise using the results obtained from the New Britain and Mount Sinai fuel cell measurements as well as the Bridgeport speaker measurements.

The southern part of the Bridgeport zoning map near Cherry Street is given in Figure 4. As stated above, this site at 437 Howard Avenue is located in a Mixed Use Industrial Light Zone near Interstate 95 and is surrounded by Mixed Use Industrial Light Zones to the east and west, a Residential Zone to the north east and Industrial Light Zones to the north and south. The closest home is 220 meters away at 11 Clinton Avenue in a R-C Residential Multi-Family Zone on the other side of the Amtrak tracks. The nearest part of the Residential Zone is a park 100 meters away and still across the railroad tracks. Sound from the speakers cannot be heard or measured at either of these locations. The acoustic estimates from positions P5 and P6 show that the speaker noise was below 59 dBA at distances of 52 and 53 meters. The fuel cell noise, which is

13 to 14 dB lower, should be below 45 dBA, the lowest possible residential noise limit at 62 meters from the fuel cell. Using the Bridgeport speaker measurements, the airborne noise level expected at the nearest residential property line (at a distance of 100 meters) should be below 42 dBA. Other nearby residential properties at greater distances are also expected to be well below the night time Residential Zone noise limit of 45 dBA for an emitter in a Commercial Zone.

Figure 6. Acoustic Airborne Noise Weighting Curves

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



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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. Bridgeport has the same 80 dB and 100 dB noise limits but defines night time as 6 pm to 7 am.

Impulse noise in excess of 80 dB was not observed on the tape-recorded data during any of the measurements of the Doosan 440 KW fuel cell made at the New Britain High School on 30 July, 2018. This fuel cell design is similar to the unit that will be installed in Bridgeport. Given the steady state nature of the fuel cell's noise signature there should be no acoustic issues with the State of Connecticut'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 6 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.

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. Bridgeport's noise regulations do not mention discrete tones. 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 Cherry Street Lofts fuel cell is a Class C emitter in an Industrial Zone. The noise zone standards in *CT section 22a-69-3.5* state that a Class C emitter cannot exceed the following overall sound pressure levels:

To Class C 70 dBA To Class B 66 dBA To Class A 61 dBA (day) 51 dBA (night)

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

To Class C 65 dBA To Class B 61 dBA To Class A 56 dBA (day) 46 dBA (night)

To address the discrete tone issue, we use measured data from the testing of a similar Doosan fuel cell (Reference 3). This data does not have A-weighting. The photo in Figure 7 plots the airborne noise measured 10 meters from the Mount Sinai Cooling Module (Reference 3) for frequencies from 0 to 1000 Hertz. This curve shows the two largest discrete tones produced by the Doosan Fuel Cell Cooling Module. The first tone is at 86 Hertz at a level of 65 dB reference 20 microPascals. The second tone is at 630 Hertz at a level of 56 dB reference 20 microPascals. (88.6 dB added to the dBV values in the figure.) The A-weighting corrections are -21.5 dB at 86 Hertz and -1.9 dB at 630 Hertz. Incorporating these corrections gives A-weighted levels of 44 dBA at 86 Hertz and 54 dBA at 630 Hertz (for the fuel cell) both at a distance 10 meters from the Cooling Module. The minimum transmission loss to the residences to the south is 0 dB so the maximum possible discrete tone would be about 54 dBA at the residences. This level is below the 65 dBA requirement in an Industrial Zone. The minimum transmission loss to the closest Residential Zone property lines to the north east is at least 24.8 dB so the maximum possible discrete tone would be below 30 dBA at the park across the railroad tracks. This level is well below the 46 dBA requirement in a Residential Zone. Operating the Doosan fuel cell should produce airborne noise levels well below the CT discrete tone requirement at all the property lines. There should be no acoustic issue with the CT discrete tone noise requirements.

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. Bridgeport's noise regulations do not mention infrasonics and ultrasonics.

Narrow bandwidth sound pressure spectrums in dB reference 20 microPascals at the 10-meter Cooling Module location given in Reference 3 can be used to compare with these Infrasonic and Ultrasonic noise requirements. Mount Sinai Hospital airborne noise data were processed in the 0 to 100 Hertz and 0 to 100,000 Hertz frequency ranges. The bandwidth of each data point is 0.375 Hertz for the 100 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 8. The maximum level at 10 meters is 57 dB reference 20 microPascals for one fuel cell. The entire 20 Hertz band can be power summed and equals 66 dB reference 20 microPascals, well below the requirement at 10 meters. The closest residence is at 10 meters so the maximum possible infrasonic noise would be 66 dBA at the southern residences. All the other locations will be below 63 dBA.

The ultrasonic noise for frequencies up to 100 KiloHertz is given in Figure 9. The maximum level at 10 meters is 20 dB reference 20 microPascals for one fuel cell. The entire 80 KiloHertz band from 20 to 100 kiloHertz has been power summed and equals a noise level value of 31 dB ref. 20 microPascals. Both of the infrasonic and ultrasonic noise levels will fall well below the 100 dB limit at a distance 10 meters from the Cooling Module. The ultrasonic airborne noise at the closest residence will be 31dB. All the other court yard locations will be below 28 dBA. The noise levels at the closest Residential Zone will be much lower and there should be no issue with either infrasonic or ultrasonic noise at any of the neighboring properties.

While the spectrum analysis covers frequencies up to 100 kiloHertz, the microphone sensors lose sensitivity above 25 kiloHertz. The gradual roll off reduces the amplitudes measured at higher frequencies. Fortunately, the measured noise levels are low at 20 kiloHertz and decrease with higher frequencies and thus, no ultrasonic acoustic issues are expected above 25 kiloHertz.

Overall Sound Pressure Levels

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

To Class C 70 dBA To Class B 66 dBA To Class A 61 dBA (day) 51 dBA (night)

The Bridgeport Cherry Street Lofts site is in an Industrial Zone that is surrounded by other Industrial Zones and a Residential Zone to the north east. The nearest Residential Zone is shielded by buildings and is too far away (greater than 100 meters) to be affected by noise from the Cherry Street Lofts site. The nearby neighbors are classified as industrial with noise limits of 70 dBA. The city of Bridgeport has this same noise limit as the State of Connecticut.

Figure 7. Discrete Tones Produced by Fuel Cell Cooling Module (0 dBV = 88.6 dB re20µPa)

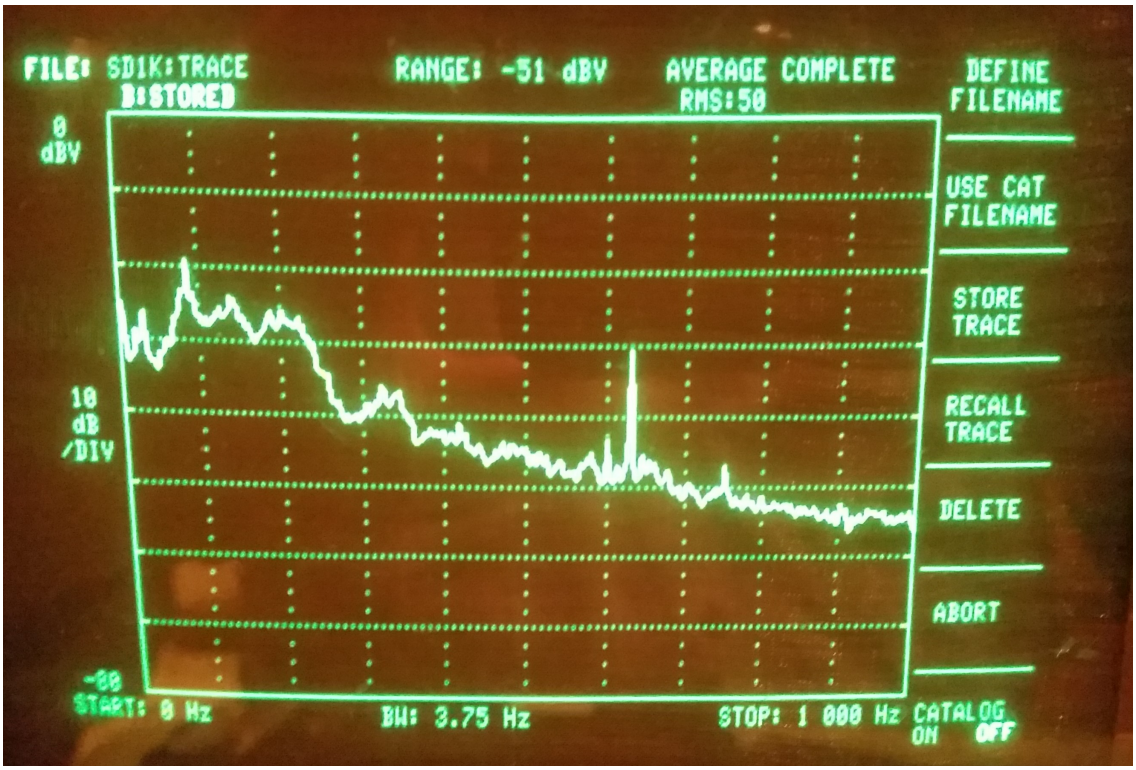


Figure 8. Infrasonic Noise from the Fuel Cell Cooling Module (0 dBV = 88.6 dB re 20µPa)

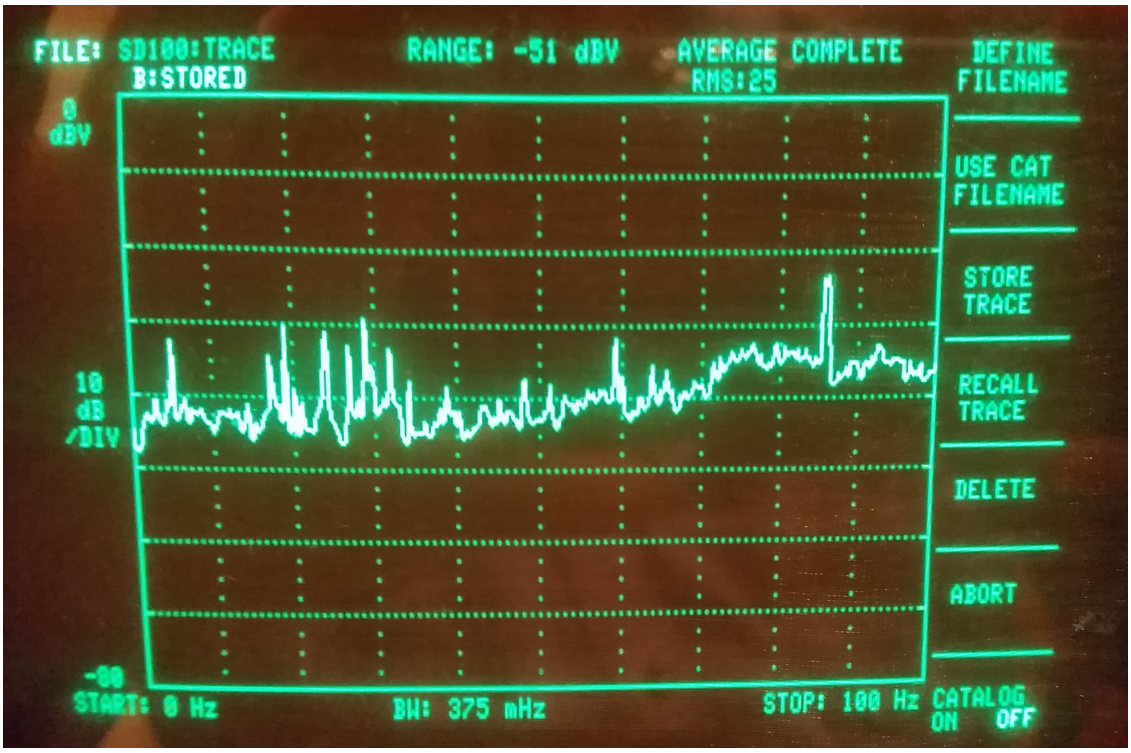
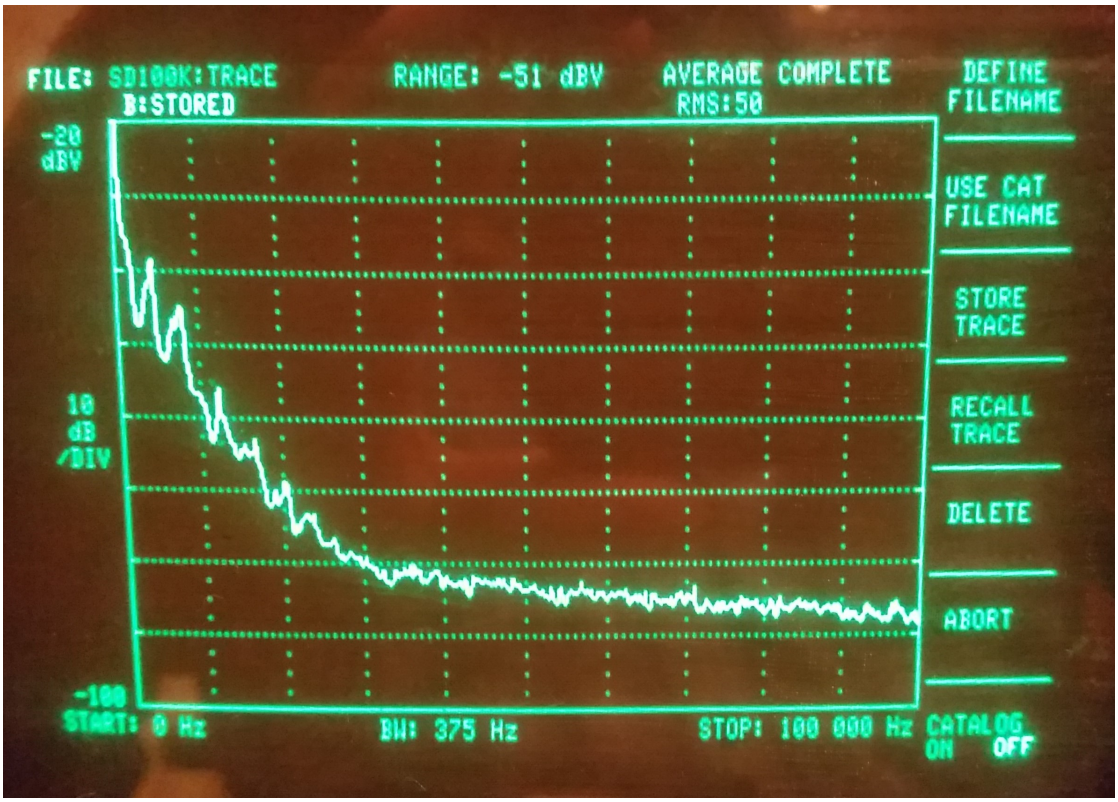


Figure 9. Ultrasonic Noise from the Fuel Cell Cooling Module (0 dBV = 88.6 dB re 20µPa)



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 March 11, 2020. The second column gives the approximate distance from the speakers to the measurement location, with locations identified by a P number in Figure 1. Column 3 gives the noise levels measured with the speakers "on" at site A while column 6 gives the noise levels measured with the speakers "on" at site B. Background levels before the speakers were turned on can be found in Table 2. Background corrections were applied in creating the values in Table 3. The background corrected speaker noise at 5 and 10 meters is also given in Table 2. The airborne noise values in Table 3 with the background noise removed are then corrected to estimate the contribution provided by the new fuel cell at both Cooling and Power Module locations. Column 5 has the site A Cooling Module estimates while column 8 has the site B Power Module estimates. Values shown in red would be above the industrial noise requirements.

Reviewing Table 2 and Table 4 below, it is clear that the expected airborne noise levels are high near the residences and school that are within 25 meters of the fuel cell. The highest background corrected speaker level was measured at 82 dBA at Position 4, the residence right adjacent to the speakers. The P4 residence should see airborne noise levels no higher than 68 dBA with the fuel cell operating by itself. Because of the increasing loss with distance to the other court yard locations the expected fuel cell noise levels will fall below 65 dBA for these locations. The residential properties to the north east should all be lower than 42 dBA. All the expected

maximum values (worse case between speaker locations) are shown in Table 4 below. All of the property line estimates will meet the 70 dBA Industrial Zone noise limits.

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

P1	P2	P3	P4		Industrial
65 dBA	55 dBA	50 dBA	68 dBA	←	Court Yard
P5	P6	P7		←	Nearby
46 dBA	40 dBA	<50 dBA			

Operation of the Doosan fuel cell will have no acoustic impact at all of the Residential Zone properties to the north east of the Cherry Street Lofts site. The industrial properties next to the Cherry Street Lofts site on Cherry Street, Hancock, Railroad and Howard Avenues should see airborne noise levels from the fuel cell no higher than 50 dBA well below the industrial noise limit of 70 dBA. All of the nearby industrial properties should not be affected by the operation of the fuel cell. While below the industrial requirement the residences and school in the court yard facing the fuel cell will see noise levels considerably higher than usually found in Residential and Commercial Zones. Background airborne levels of 55 to 58 dBA from the traffic on Interstate 95 were measured in the court yard during a normal working day. Combining this traffic noise with the expected fuel cell noise will bring the total noise close to the 70 dBA noise limit. These background noise levels will drop during the overnight hours as the traffic levels decrease. As a result, the fuel cell noise will become the dominant noise source in the court yard. Noise mitigation is recommended to bring the fuel cell noise levels down to values more typical of residential areas. A goal of reducing the airborne noise to levels below 51 dBA at the residences in the court yard is recommended.

Conclusions

The purpose of this effort is to evaluate the acoustical environment at the proposed Cherry Street Lofts fuel cell site in Bridgeport, CT. This has been accomplished and the results show that the operation of a Doosan 440 KW fuel cell will meet all of the State of Connecticut and Bridgeport airborne noise requirements at all the nearby properties. Properties outside the Cherry Street Loft court yard should not be affected by the airborne noise from the fuel cell. Residences and the school in the Cherry Street Loft court yard are very close to the new fuel cell. These properties will see airborne noise levels just below the 70 dBA limit in an Industrial Zone. Airborne noise from the fuel cell should be mitigated to preclude the combined fuel cell and I95 traffic noise from exceeding the 70 dBA limit. This mitigation should be designed to provide sufficient sound attenuation to show that the airborne noise generated by the fuel cell will not significantly impact the facility's closest neighbors.

Acoustical Technologies Inc.

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) New Britain High School Fuel Cell Acoustic Assessment, Acoustical Technologies Inc., August 8, 2018

3) Mount Sinai Rehabilitation Hospital Airborne Noise Assessment, Carl A. Cascio, Acoustical Technologies Inc., January 26, 2017

4) Bridgeport Noise Ordinance https://library.municode.com/ct/bridgeport/codes/code_of_ordinances?nodeId=TIT8HESA_CH8.80NOCORE

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: Cherry Street Lofts
440 KW Fuel Cell
Airborne Noise Recommendations
At 375 Howard Avenue

Author: Carl Cascio

Date: March 17, 2020

Revision: 1

Table of Contents

Summary

This document makes noise control recommendations to assist in meeting acoustic noise concerns during the operation of a Doosan 440 KW fuel cell on the Cherry Street Lofts site at 375 Howard Avenue in Bridgeport, CT. An acoustic assessment plan was developed and executed to acquire acoustic information to explain and mitigate the airborne noise issues associated with the future operation of a Doosan 440 KW fuel cell in Bridgeport. The results show that noise propagating to the closest residences in the court yard should be addressed.

The airborne noise levels expected to be generated by the Doosan fuel cell were simulated by exciting a set of six co-located speakers at the Cooling and Power Module positions. (The Cooling Module is the dominant noise source.) Airborne noise was measured at distances from 5 to 103 meters from the fuel cell location with the speakers on at overall A-weighted noise levels of 85 dBA at 5 meters and 82 dBA at 10 meters (ref. 20 microPascals). The speaker airborne noise levels at nearby residences were measured at noise levels from 58 to 82 dBA. Industrial Zone levels on Howard Avenue and Cherry Street were even lower because of the intervening buildings and long distance to the speakers. The speaker data indicated sound losses of 31-35 dB from the fuel cell location to the nearby industrial property lines. Residential Zone locations to the north east were very quiet with levels that could not be heard with the speakers on. The source level at 10 meters from the operation of a Doosan fuel cell at New Britain High School was then used as a basis for making the Doosan fuel cell airborne noise estimates in Bridgeport.
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The overall airborne noise estimates are expected to meet the state and city 70 dBA requirement at all the Cherry Street Lofts residences and school. Operation of the fuel cell is expected to meet the state and city noise requirement for all the neighboring Industrial and Residential Zone properties without any additional noise treatment. While below the industrial requirement, the nearest residences in the court yard facing the fuel cell are expected to see noise levels considerably higher than usually found in Residential Zones. Operation of the fuel cell is expected to meet all requirements associated with impulse noise, prominent discrete tones, infrasonic and ultrasonic noise at all nearby properties without additional noise treatment.

Operation of the fuel cell produces airborne noise predominately from the Cooling Module. Efforts to reduce the fuel cell's airborne noise should be directed at adding a sound barrier treatment to block the Cooling Module's noise from reaching the closest residences in the court yard. The performance of a commercially available noise barrier, from Acoustical Solutions, called ABBC-EXT-R Sound Curtains is able to provide the necessary mitigation.

Installation of 12-foot-high barrier material is recommended on the north, south and west sides of the Cooling Module. (See Figure 13.) This amount of barrier material should reduce the airborne noise by about 10 dB to 58 dBA at the 2nd floor of the closest residence. Noise levels at other residences should be at or below 55 dBA. Given that the day time ambient noise from I95 traffic averages 56 dBA, this reduction of the airborne noise generated by the fuel cell should mitigate the impact on the Cherry Street Lofts neighbors and will be further below all state and city noise requirements at all the neighbor's property lines. The acoustic barrier surrounding the Cooling Module should remove any acoustic concerns about siting and operating the fuel cell.

Introduction

Acoustical Technologies Inc. was tasked with an assessment of potential acoustic issues associated with fuel cell airborne noise reaching the properties adjacent to the Cherry Street Lofts site at 375 Howard Avenue in Bridgeport, CT (Reference 1). Responding to a request from Donald Emanuel, a site visit was made on March 11, 2020. During the visit, measurement of the simulated airborne noise levels expected to be produced by the Doosan 440 KW Fuel Cell was made in order to identify potential noise issues. Estimated airborne noise levels along the closest industrial property lines were lower than the state and city noise requirement at all the locations. While below the 70 dBA industrial requirement, the nearest residences in the court yard facing the fuel cell are expected to see noise levels considerably higher than usually found in Residential Zones. The fuel cell may become the dominant noise source in the court yard. Noise mitigation is recommended to bring the fuel cell noise levels down to values more typical of residential areas. A goal of reducing the airborne noise to levels at or below 51 dBA at the residences in the court yard is recommended. This document provides a design for the installation of a noise control treatment that will reduce the chances of there being any acoustic noise concerns during the operation of the Doosan fuel cell.

The purpose of this effort is to utilize the available acoustic data to mitigate potential airborne noise issues associated with the operation of a Doosan Fuel Cell at 375 Howard Avenue in Bridgeport, CT. The State of Connecticut and the City of Bridgeport Noise Ordinances have been consulted to assess the impact of the estimated acoustic noise levels. Noise mitigation is recommended to reduce the airborne noise propagated by the fuel cell to the closest nearby residences directly to the north and south of the fuel cell location.

Acoustic Measurement Program

Airborne sound pressure measurements and audio tape recordings were conducted at the Bridgeport site on and near 375 Howard Avenue on March 11, 2020 during the daylight hours. The purpose was to measure both background and airborne noise levels with the six speakers simulating the operation of a Doosan 440 KW fuel cell. Speaker and background airborne noise measurements were taken at each neighbor's property at seven locations surrounding the Cherry Street Lofts site. Five measurements were made in the courtyard closest to the fuel cell. Two measurements were made at the street openings to the Cherry Street Lofts (see Table 1). Speaker operating measurements at 5 and 10 meters from the Site A Cooling Module location were simultaneously taken with a sound level meter and two microphones recording on a digital tape recorder. These tape recorder measurements were repeated for the Power Module Site B location. One-third octave and overall airborne noise levels were calculated and reported[1].

See Figures 1 and 2 below for photographs of similar Fuel Cell Power and Cooling Modules that have been installed at the Mount Sinai Hospital site in Hartford, CT. Figure 3 provides a Google Map of the Cherry Street Lofts site with the measurement locations identified as P1 through P7. Figures 4 and 5 provide photographs showing the speakers at the intended Cooling (Site A) and Power Module (Site B) locations where the fuel cell hardware will be placed. The photographs show the speakers at the center of the module locations and the two microphones at 5 and 10 meters from the speakers.

Figure 1. Doosan Fuel Cell Power Module at the Mount Sinai Hospital Site in Hartford CT

Figure 2. Doosan Fuel Cell Cooling Module at the Mount Sinai Hospital Site in Hartford CT

Figure 3. Bridgeport Cherry Street Lofts Site Map from Google Maps

Table 1 provides distances from the Cooling Module speakers and estimates of the expected Doosan fuel cell airborne noise at each of the seven nearby measurement locations. Positions 4 and 1 showed the highest airborne noise levels at distances that were closest to the speakers.

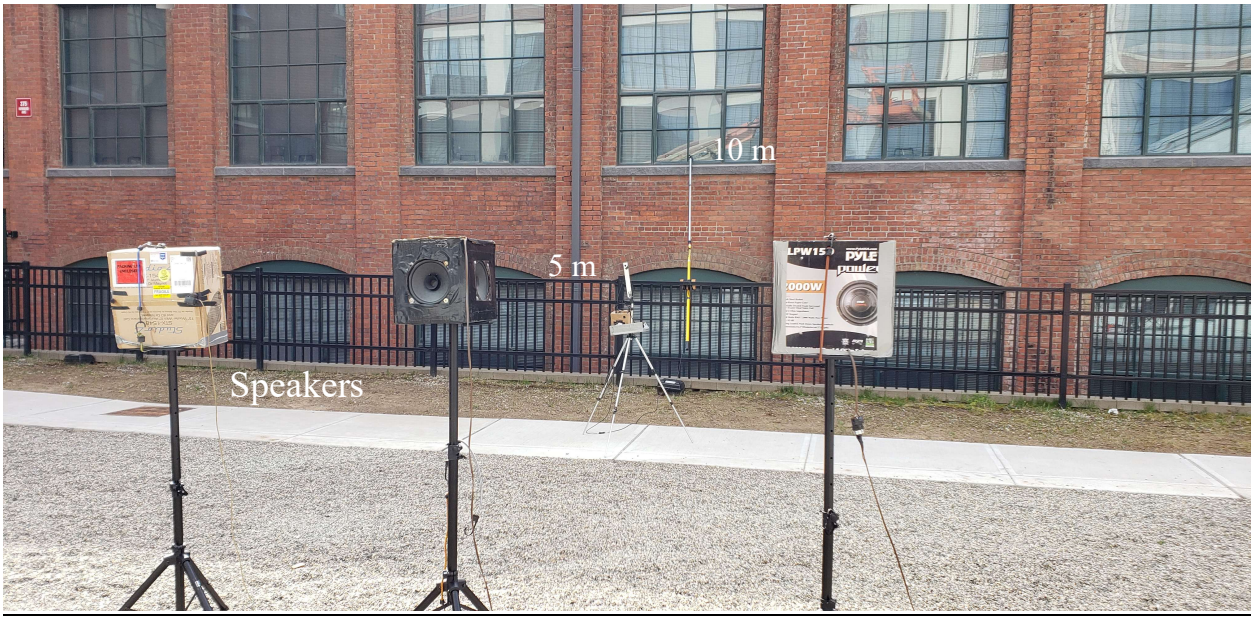
Table 1. Estimated Bridgeport Overall Sound Pressure Levels in dBA ref. 20 microPascals

Location	Range in Meters	Speakers at A	Correction	Cooling Estimated SPL in dBA	Speakers at B	Correction	Power Mod. Estimated SPL in dBA
P1 – East	14	76.0	-14.1	**61.9**	77.4	-12.7	**64.7**
P2 – North	25	68.7	-14.1	**54.6**	67.2	-12.7	**54.5**
P3 – West	47	64.1	-14.1	**50**	62.5	-12.7	**49.8**
P4 – South	10	82.4	-14.1	**68.3**	77.8	-12.7	**65.1**
P5 – North West	52	57.8	-14.1	**43.7**	58.8	-12.7	**46.1**
P6- Ryder	53	49.7	-14.1	**35.6**	52.4	-12.7	**39.7**
P7- I95 / Frontage Rd	103	<64.1	-14.1	**<50**	<62.7	-12.7	**<50**

Allowable Noise Levels

CT section 22a-69-3.1 (Reference 2) 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 City of Bridgeport and the CT noise ordinances have been used to evaluate the noise generated by the Doosan Fuel Cell Power and Cooling Modules. The following subsection discusses the overall noise requirement and discusses the results obtained from the measurements at the Cherry Street Lofts site in order to determine what noise treatment needs to be applied. The Impulse, Prominent Discrete Tones, Infrasonic and Ultrasonic measurements of fuel cell airborne noise showed no acoustic concerns and will not be discussed further as no acoustic treatment is needed to meet these other requirements.

Figure 4. Position A Cooling Module Location at the Bridgeport Cherry Street Lofts Site



Note: The 10-meter microphone was raised to a height of about 8 feet so that it would be next to the window of the building shown in the figure.

Overall Sound Pressure Levels

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

Class C emitter to C 70 dBA B 66 dBA A/day 61 dBA A/night 51 dBA

The nearby neighbors are classified as Industrial with the Industrial noise limit at 70 dBA while further away there is a Residential Zone limit at 61 dBA during the day and 51 dBA at night. All the neighboring Industrial properties are expected to meet the Industrial noise requirements. The Residential Zone locations are expected to meet the nighttime and day time residential limits.

Figure 5. Position B Fuel Module Location at the Bridgeport Cherry Street Lofts Site

All the expected maximum values on the first floor (worse case between the two speaker locations) are shown in Table 2 below. Operation of the Doosan fuel cell will have a major acoustic impact by being close to or exceeding 70 dBA at the properties in the court yard closest to the Cooling Module. Higher floors are expected to have slightly lower sound pressure values because of the slightly greater distance to the upper floors from the fuel cell.

Table 2. Expected Airborne Noise Levels from Operating a Doosan Fuel Cell (ref. 20 µPA)

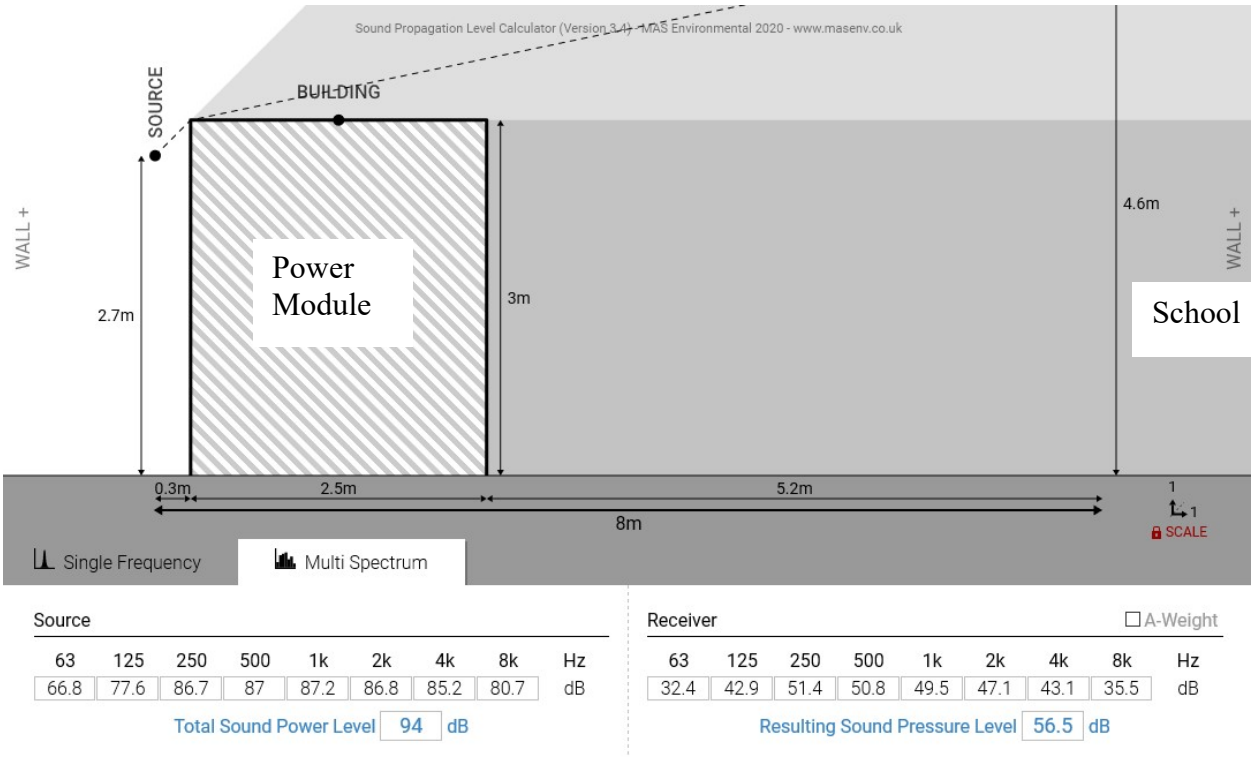
P1	**P2**	**P3**	**P4**	**P5**		**Industrial**
65 dBA	55 dBA	50 dBA	**68 dBA**	46 dBA	←	Court Yard
	P6	P7			←	Nearby
	40 dBA	<50 dBA				

Noise Treatment Recommendations

New Britain High School airborne noise data indicate that the Cooling Module is the dominant noise source (Reference 3). The Power Module noise levels are about 6 dB below the Cooling Module. A reduction of 17 dB of the noise level of the Cooling Module noise will reduce the Cooling Module contribution to the desired 51 dBA at the closest residence. With this Cooling Module reduction, the Fuel Module's noise now needs to be considered. We want to keep the Power Module from adding more noise to the school on the east side and the residences on the south and north sides of the court yard. The Power Module noise is dominated by its exhaust fan. The fan, as shown on the left side of Figure 6, will be located away from the school. The New Britain data shows a drop of about 8 dB between noise levels on the fan side versus noise levels on the opposite side. Without treatment the fan's level at the school would be 56.5 dBA as shown in Figure 7. The Power Module contribution would be 64 dBA on the 1st floor, 63 dBA on the 2nd Floor and 62 dBA on the 3rd floor. These levels are below 66 dBA, the Commercial Zone limit for a school. Adding the Cooling Module contribution brings these levels up to 66 dBA. Putting the fan on the west side should alleviate the concern with regards to the school.

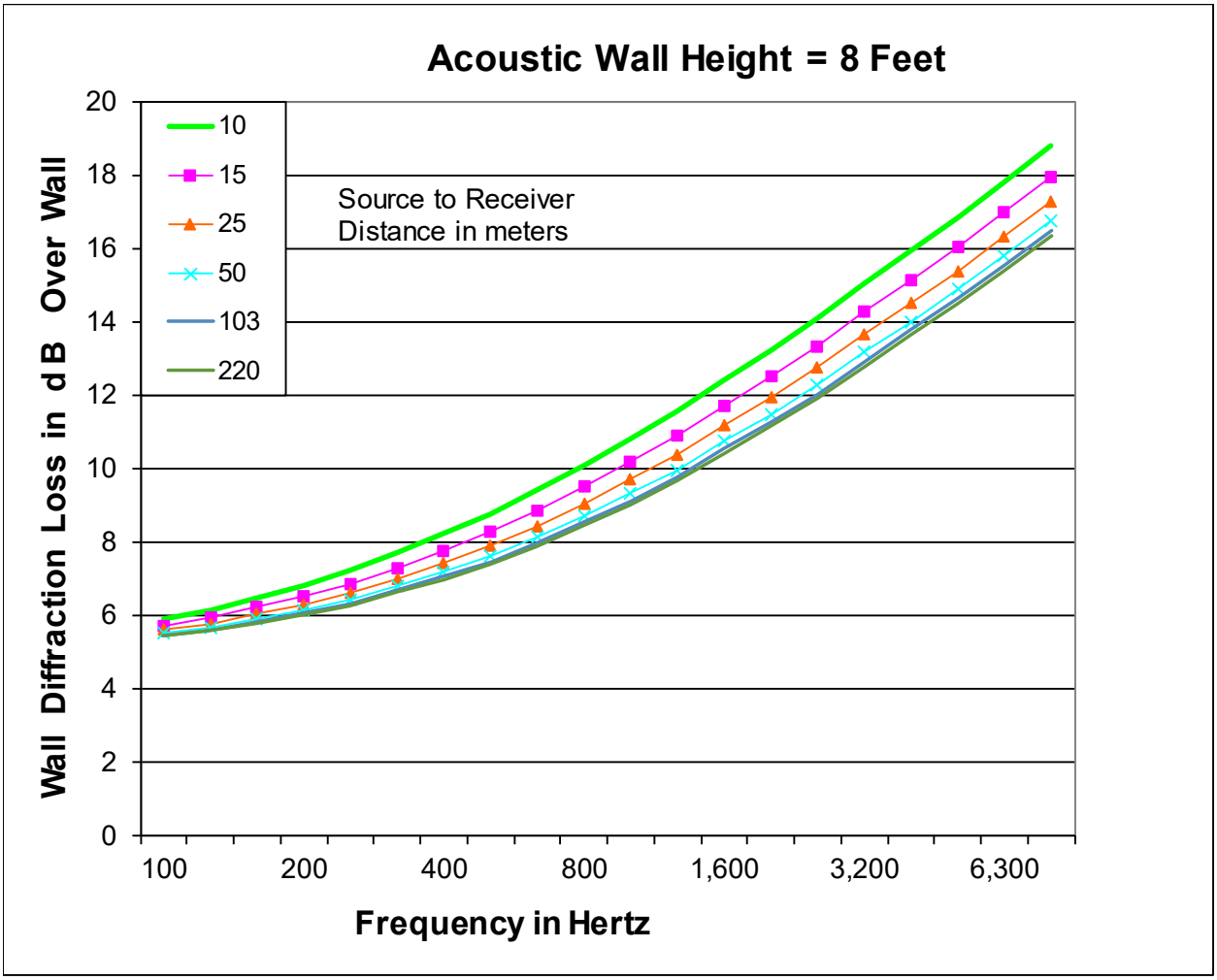
Figure 6. New Britain Power Module Showing the Fan Side of the Unit

Figure 7. Estimated 2nd Floor School Noise Level from the Untreated Power Module Fan



The fuel cell including the Cooling Module will normally be surrounded by an 8-foot-high chain link fence and the first option for noise control would be to attach an acoustic barrier material to the fence. Calculating the acoustic performance of the barrier requires an estimate of the transmission loss through the barrier as well as an estimate of the acoustic leakage over and around the barrier. Typical noise treatments will have in excess of 20 dB of performance for sound traveling through the treatment. The diffraction over the top of the acoustic barrier has been calculated and the results are shown in Figure 8 versus frequency. The figure looks at the sound diffraction over the top of an 8-foot wall showing the performance expected for the nearby properties that have distances from the fuel cell of 10 to 220 meters. The curve labeled 10 is for the closest residence. The curves labeled 15, 25, and 50 are for the other properties in the court yard. The 103- and 220-meter curves are for properties outside the court yard in the Residential Zone. The spread in performance is small (less than 2 dB) for all the properties and indicates that the noise treatment should be equally effective. Closer to the wall is slightly better because it is more in the acoustic shadow of the wall. Note that we achieve 17 dB of performance only at the very highest frequencies with an 8-foot-high wall. The Cooling Module signature peaks below 1 KiloHertz where the 8-foot wall's performance is 10 dB or less. We will need a taller noise treatment than 8 feet to achieve 17 dB of mitigation. This can be achieved by increasing the height of the noise treatment. The following calculations will show estimates for treatments heights from 6 to 12 feet.

Figure 8. Acoustic Diffraction Performance for Different Receiver Locations



Another path of noise transmission to consider is the path directly through the barrier. The transmission loss for a one-inch thick material from Acoustical Solutions called ABBC-EXT-R Sound Curtains[4] is shown in Figure 9 as the Direct Path. The material has great high frequency performance and the lower frequencies still have 10 dB better performance than the diffraction of sound over the barrier. (Increasing the thickness of the noise treatment from one to two inches would help the lower frequencies.)

To evaluate the ability of this material to provide the performance we seek requires the combination of both propagating paths leading to an estimate of the airborne noise level at the property boundaries. This has been done and the results are shown in Figure 10. The overall sound pressure levels (in dBA) just outside each floor of the court yard residences are plotted versus the possible height of the noise treatment. The higher floors see higher levels because the sound path is not as blocked by the treatment. Figure 11 shows the results for the 2nd floor of the south building. The 68.3 dBA estimate for the untreated ground floor is only reduced to a level of 63.6 dBA for the 2nd floor while the ground floor is reduced to 60.7 dBA. More treatment height than 8 feet is needed to improve the performance on both floors.

Figure 9. The Effect of an Acoustic Barrier on Transmission to Nearby Properties

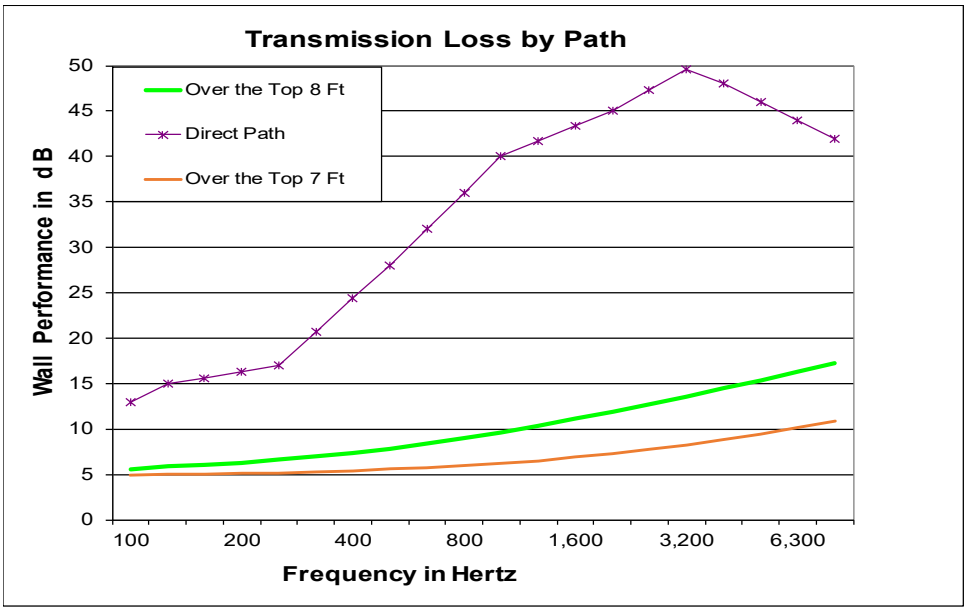


Figure 10. Estimated Airborne Noise Levels versus Wall Height for the Residences

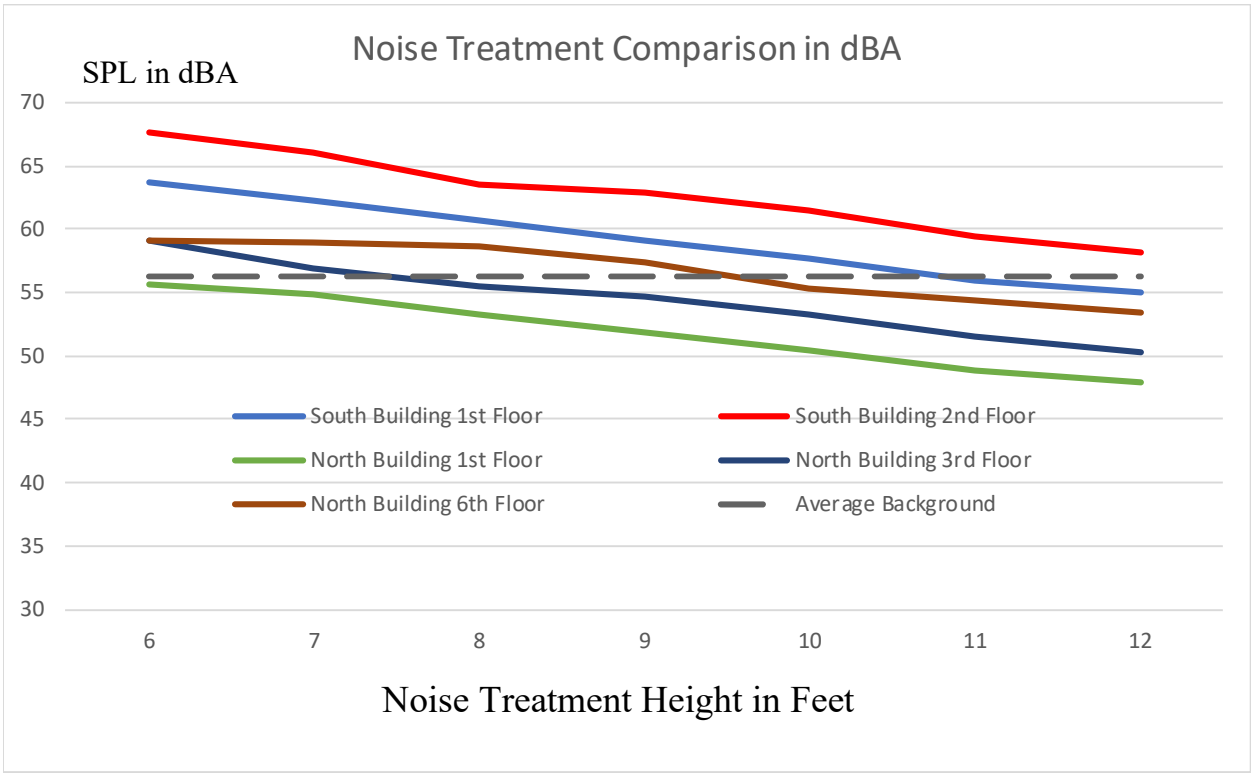
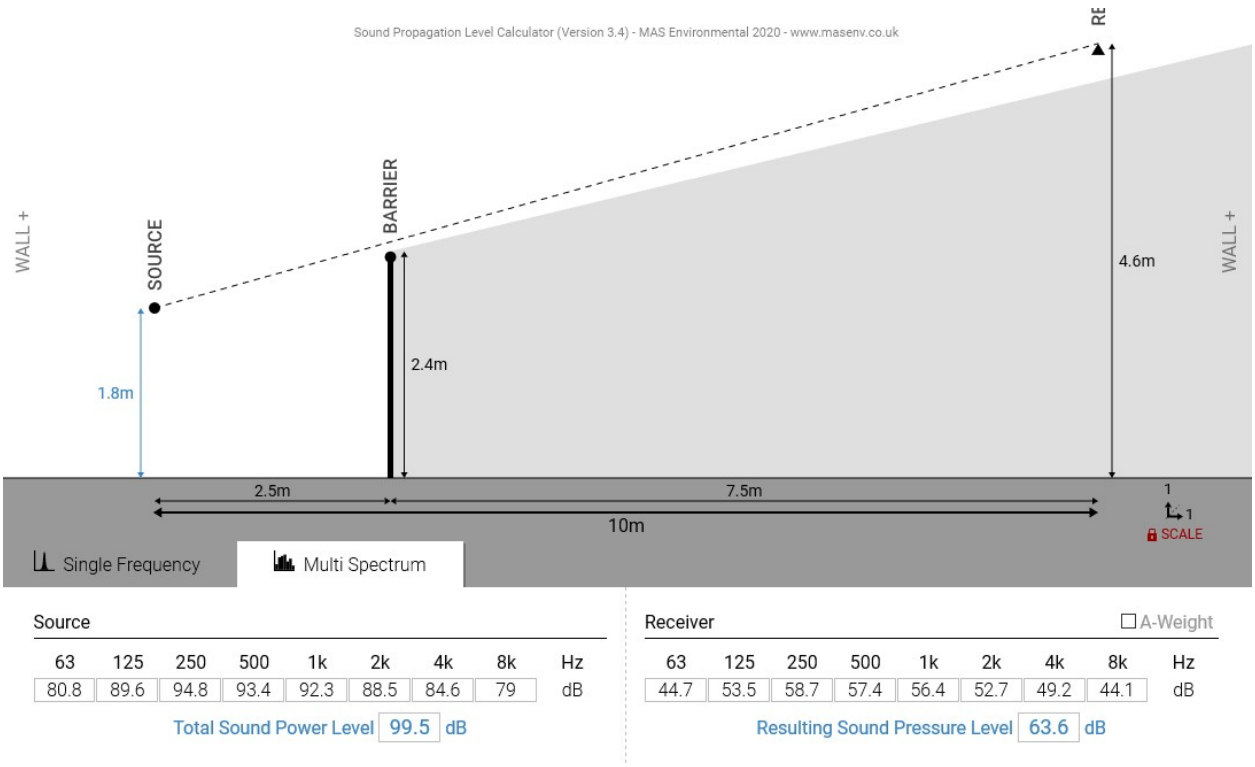


Figure 11. Sample Calculation for an 8-foot Treatment for the 2nd Floor of The South Building

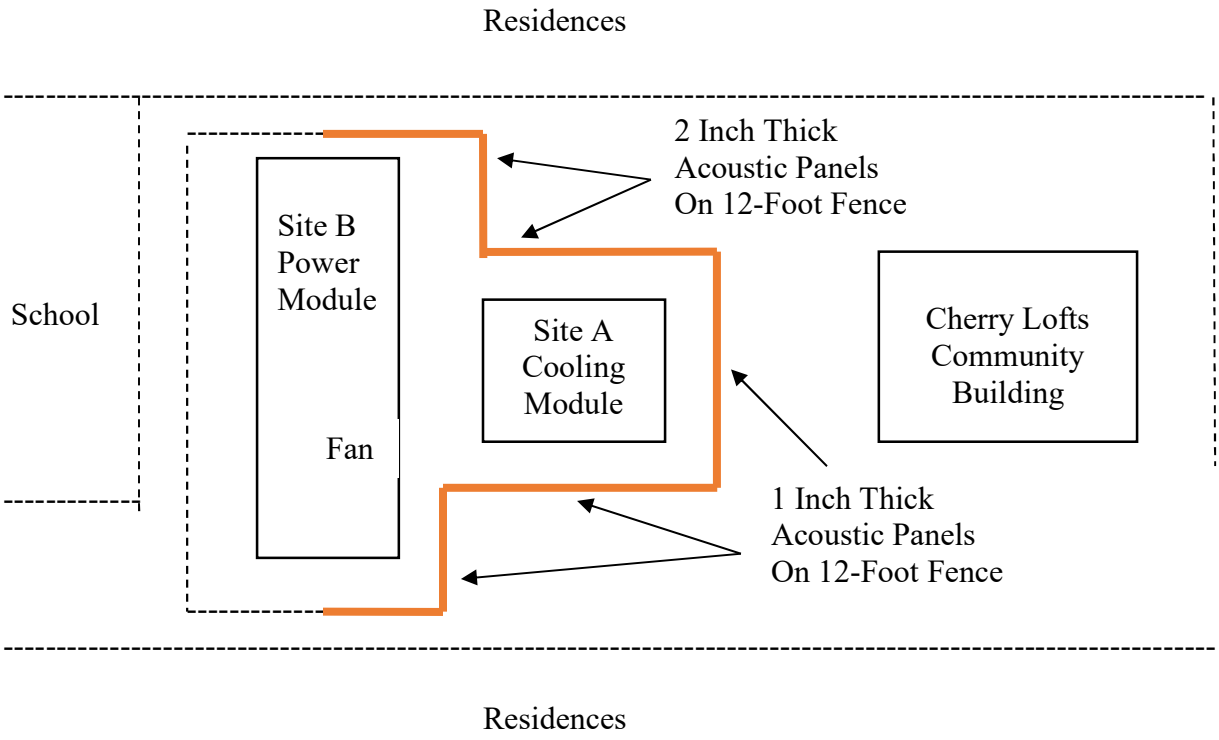


Installation of a twelve-foot-high acoustic barrier is recommended to mitigate the airborne noise reaching the residences in the court yard. Materials such as the ABBC-EXT-R Sound Curtains from Acoustical Solutions (Reference 4) or equivalent should be sufficient to produce the sound reduction needed. The two-inch material should be specified for the south side of the fence and one-inch material for the west and north sides. (The south side residence maximum levels are about 5 dB higher than the north side residences.) An example of a noise treatment installation is shown in Figure 12. The ABBC-EXT-R Sound Curtains were hung from two sides of a security fence around the Cooling Module at the fuel cell installation at Mount Sinai Hospital in Hartford.

Coverage at Cherry Street Lofts should extend around three sides of the Cooling Module as shown in Figure 13. Looking at Figure 10, the south side requires the thicker treatment since it has the shortest distance between the Cooling Module and the residences. This side should be at least 12 feet in height to drop the expected noise levels to the 55 to 58 dBA range. The average day time background airborne noise level in the court yard was 56 dBA so the total noise level should stay below the 61 dBA limit for an industrial source transmitting into a residential zone. Similar numbers could be achieved with an 9-foot-high fence on the north and west sides. However, using a 12-foot fence on all three sides will drop the north side noise levels to the low 50's that was our goal. Keeping the noise levels below the average background level of 56 dBA will require 12-foot in height on all three sides. This is recommended. On the school side the airborne noise levels are expected to be in the 64 to 66 dBA range with the fan on the west side of the Power Module. This airborne noise level should be acceptable without treatment since it is at or below the 66 dBA limit in a Commercial Zone (where schools are typically placed).

Figure 12. Eight Foot Fence Surrounding Doosan Cooling Module with Noise Treatment

Figure 13. Sketch of Recommended Noise Treatment Design



Conclusions

The purpose of this effort has been to evaluate the acoustical environment at the Cherry Street Lofts site at 375 Howard Avenue in Bridgeport, CT. This has been accomplished and the results show that the acoustic impact on the closest residences in the court yard needs to be addressed. Operation of the fuel cell should meet all state and city noise requirements. The closest property in the court yard is expected to be within 2 dB of the Industrial Zone 70 dBA airborne noise limit without treatment. Background noise from I95 during the day will bring the total noise close to or above the industrial limit. A twelve-foot-high acoustic barrier as described in this report should mitigate this Cooling Module noise issue and greatly remove any acoustic noise concerns about siting and operating the Doosan 440 KW fuel cell at the Cherry Street Lofts site.

References

1) Cherry Street Lofts Acoustic Siting Report, Carl A. Cascio, Acoustical Technologies Inc., March 14, 2020

2) 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

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4) https://acousticalsolutions.com/product/abbc-13-ext-audioseal-exterior-sound-blanket/