

Prepared For: HiAxiom, Inc.

Point of Contact: Walter Bonola

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**Subject: Eleven Fuel Cells
Airborne Noise Assessment
At 540 Longbrook Avenue
Stratford, CT 06614**

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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 eleven HiAxiom 460 KW fuel cells at the site at 540 Longbrook Avenue in Stratford, CT. An acoustic assessment plan was developed and executed to acquire airborne acoustic information useful in explaining and mitigating any potential airborne noise issues during operation of the eleven 460 KW fuel cells. It is important to show that the airborne noise generated by the fuel cells will not significantly impact the facility's neighbors.

The airborne noise levels expected to be generated by the HiAxiom fuel cells operating at the Stratford site were simulated by exciting a Soundboks speaker at two of the fuel cell Cooling Module positions. (The Cooling Module is the dominant noise source.) The Soundboks speaker produced an overall airborne noise level that was 25 dB higher than the levels measured for a single HiAxiom fuel cell installed at Montville, CT. One-third octave band analysis showed the speakers' level to be near the Montville fuel cell airborne noise levels at low frequencies where the airborne noise levels were low and to exceed the fuel cell signature by 25 dB at higher frequencies where the Montville fuel cell signature was higher in noise level.

Airborne noise levels with the speakers operating were measured at distances from 5 to 137 meters from the proposed fuel cell location on Longbrook Avenue. The speaker produced overall A-weighted sound pressure levels of approximately 98 dBA at 5 meters and roughly 91 to 92 dBA at 10 meters (reference 20 microPascals) at the proposed fuel cell locations. The airborne noise levels from the speakers as received at nearby properties on site were measured at noise levels of 50 to 76 dBA. Residential measurement locations to the west were just above background but still able to record the airborne noise with the speaker on. Analysis of the speaker data indicated propagation losses of at least 14 to 45 dB from the fuel cells' location to the nearby properties. The source level at 10 meters from the operation of a HiAxiom fuel cell at Montville, CT was then used as a basis for making the Stratford fuel cell airborne noise estimates with eleven units operating.

Operation of the eleven HiAxiom fuel cells will have no significant acoustic impact at all of the nearby properties adjacent to the HiAxiom fuel cell site on Longbrook Avenue. All the residences should be more than 8 dB below the night time noise requirement¹ while all the commercial properties should be more than 4 dB below the commercial requirement².

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 cells is expected to meet all of these requirements at all of the nearby property lines.

Introduction

Acoustical Technologies Inc. was tasked as part of a HiAxiom site permitting process with an assessment of potential acoustic issues associated with fuel cell airborne noise reaching the properties adjacent to the proposed site at 540 Longbrook Avenue in Stratford, CT. Responding to a request from Walter Bonola, a site visit was made on May 28, 2024. During the visit, a survey of the airborne noise levels produced by a Soundboks speaker simulating the airborne noise produced by a HiAxiom 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 speaker off. This document provides an acoustic assessment to assist in meeting acoustic noise concerns during the permitting process for the siting of eleven HiAxiom fuel cells at the 540 Longbrook Avenue site.

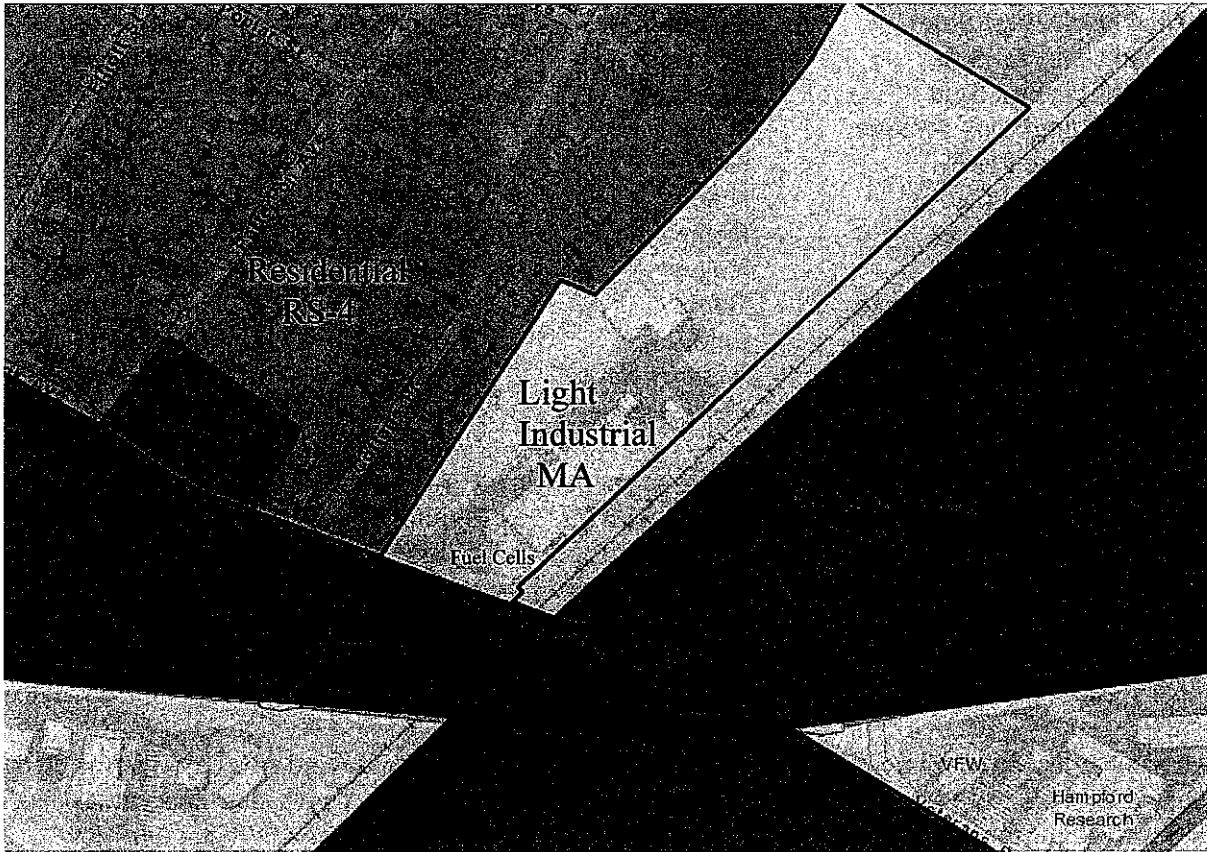
Development of the Acoustic Assessment Plan

The purpose of this effort is to acquire acoustic information useful in explaining the potential airborne noise issues associated with the operation of eleven HiAxiom 460 KW fuel cells at the site on Longbrook Avenue. The proposed site at 540 Longbrook Avenue is located in a Light Industrial (MA) Zone. This Industrial Zone is surrounded by a Residential RS-4 zone to the west and Commercial (CA) Zones to the north, east and south. Figure 1 shows a section of the Stratford zoning map where the site is located. It is important to determine whether the airborne noise generated by the eleven HiAxiom fuel cells will impact these neighbors.

The acoustic impact is assessed in the following way. The fuel cells are 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 a typical HiAxiom 460 KW fuel cell are available (Reference 3). Using this data, a Soundboks speaker has been programmed through a set of filters to generate a noise spectrum similar to that of the 460 KW fuel cell. (It is assumed that the Cooling and Power Module noise in the existing measured 460 KW fuel cell are similar to the new units.) This spectrum will then be played through an audio amplifier to create the electrical voltage necessary to drive the Soundboks speaker. In order to overcome the potentially high background noise at the Stratford site the speaker output will be increased to a level more than 25 dB higher than the overall dBA noise level measured on a 460 KW fuel cell at a distance of 10 meters. With the speaker on, this approach then follows the traditional "What is the airborne noise level at the neighbor's property line?". The speaker will be run and airborne measurements made near the proposed fuel cell locations and at several of the nearest neighbor's properties. This measured site data can also be used to estimate noise levels at other neighbor's property lines. The State of Connecticut's Noise Ordinance¹ and the Town of Stratford Noise Ordinance² will then be consulted to assess the impact of the measured and estimated acoustic levels. Because of the closeness of the proposed fuel cell site to the nearest properties noise mitigation may be recommended if the airborne noise estimated for eleven fuel cells comes near or exceeds the noise requirements at the neighbors' property lines.

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Figure 1. Part of the Stratford Zoning Map Showing the Area near the Eleven Fuel Cells



Acoustic Measurement Program

The acoustic data necessary to assess the impact of eleven 460 KW HiAxiom Fuel Cells are described below: Airborne sound pressure measurements were conducted at the 540 Longbrook Avenue site on May 28, 2024 during the midday hours. This testing established both background airborne noise levels and simulated airborne noise levels with the speaker operating. 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 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. All measurements were made with the microphone at a height above ground between five and six feet. The sound pressure data reported herein are all given in dB reference 20 microPascals.

In Stratford “speaker on” and background airborne noise measurements were taken at 5 and 10 meters from the proposed 460 KW fuel cell site and at the following nine nearby properties.

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Location	Business	Distance	Zone	Type
1 – Fuel Cell West Side	HiAxiom	5 meters	MA	Light Industrial
2 – Fuel Cell West Side	HiAxiom	10 meters	MA	Light Industrial
3 – Fuel Cell East Side	HiAxiom	5 meters	MA	Light Industrial
4 – Fuel Cell East Side	HiAxiom	10 meters	MA	Light Industrial
P1 – 586 Longbrook Avenue	Home	78 meters	RS-4	Residential
P2– 26 Cottage Place	Home	89 meters	RS-4	Residential
P3 – 36 Cottage Place	Home	83 meters	RS-4	Residential
P4 – 44 Cottage Place	Home	81 meters	RS-4	Residential
P5 – 66 Cottage Place	Home	81 meters	RS-4	Residential
P6 – 585 Longbrook Avenue	Home	94 meters	CA	Commercial
P7 – A Longbrook Avenue	Empty Lot	70 meters	CA	Commercial
P8 – 450 Barnum Avenue	Webster Bank	63 meters	CA	Commercial
P9 – 350 Barnum Avenue	Home Depot	137 meters	CA	Commercial

See the Google satellite map in Figure 2 for the approximate measurement locations. Measurements were made near the proposed west and east Cooling Module units. Sound pressure data were taken with the ExTech sound level meter. Figures 3 and 4 provide photographs of the speaker locations for the West and East positions, respectively. At these locations, a one-minute record of the acoustic noise was analyzed for the speakers in the “on” condition. One minute of background noise data was also analyzed at 5 and 10 meters with the same speaker positions and at the nine nearby property lines.

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 in Stratford for the measurements on May 28, 2024. Data was taken from 10:00 am until 1:00 pm. Table 1 shows the temperature and wind speeds in hourly intervals. Wind conditions were very good until noon when the wind speed picked up. The data was not affected because the received levels were high because of the closeness to the speakers to the remaining locations. Also, there was no rain during the testing. Vehicle traffic along Longbrook and Barnum Avenues was heavy and the measurements had to be delayed until all visible traffic was absent.

Because of the distant traffic noise, background noise levels at all of the property line measurement positions were high with levels from 47 to 58 dBA. At all of the measurement locations it was possible to audibly hear the airborne noise from the speaker over the background noise. Airborne noise loss versus range was determined at all nine of these locations. The highest airborne noise levels were obtained across the railroad tracks at Webster Bank from the East speaker location. These east and west transfer functions were then applied to the 460 KW data from Montville³ in order to estimate the received levels for the new 460 KW fuel cells in Stratford. Eleven fuel cells could make as much as 10.4 dB more noise than one fuel cell if they were all in one place. Since they are spread out the highest level across the tracks would be across from the middle of the eleven units. Reasonable estimates for this and the other locations were calculated by looking at the relative distances to the property line for each of the eleven fuel cells. At 80 to 90 meters away the correction is 9.4 dB for eleven modules. At 63 meters the correction is 9.2 dB for eleven modules. At 70 meters the correction is 9.3 dB for eleven modules. At 137 meters the correction is 9.7 dB for eleven modules.

Figure 2. Google Map Showing Measurement Positions P1 through P9



Figure 3. HiAxiom West Cooling Module Location Looking Southeast at Longbrook Avenue



For properties to the west the eleven cooling modules are side by side so the distance to the property is slightly different for each fuel cell. Each cooling module will be modeled at a 10-meter source level of 65 dBA while each power module will be modeled at a 10-meter source level of 61 dBA.³ The fuel cell module layout is shown in Figure 5 below. The adjustments mean the eleven module source levels increase to about 74.5 dB for the cooling modules and about 70.5 dB for the power modules at a distance of 10 meters. The modules combine for an overall source level of 76 dBA at 10 m.

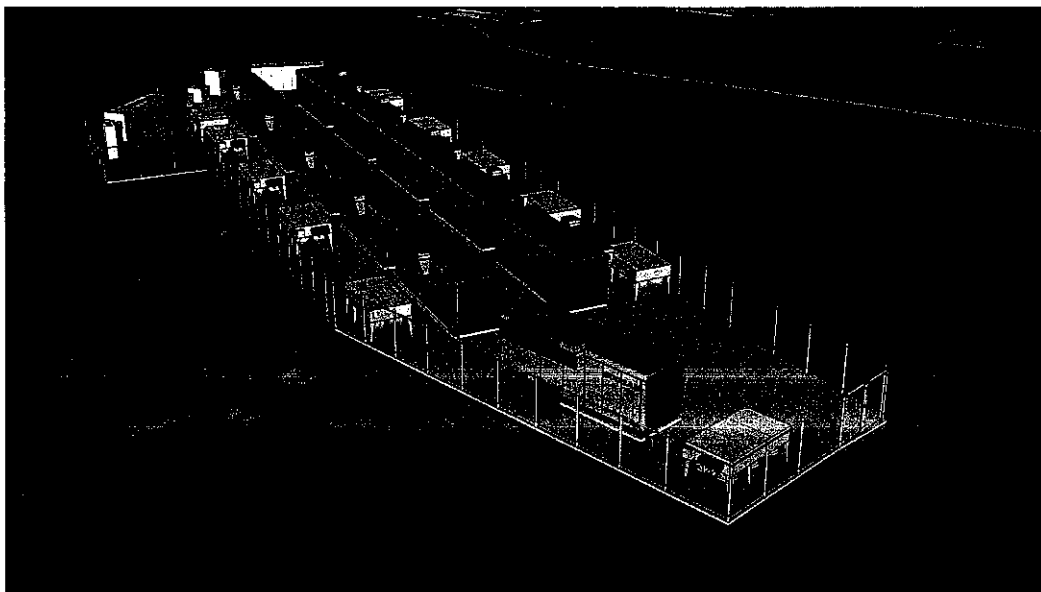
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The west direction requires a combination of cooling module and power module noise. This direction will produce the highest **residential** property line noise levels since the property lines are closest (about 80 meters). The commercial east and south property lines are closer (63 - 137 meters away) and should have slightly higher noise levels. The airborne noise at the property lines is calculated by combining eleven power modules and eleven cooling modules. The Stratford cooling module and power module noise is approximated by adding 9.5 dB to the single fuel cell data from Montville. Calculations are made for all nine locations.

Figure 4. HiAxiom East Location Looking Southeast at Longbrook Avenue



Figure 5. Proposed Fuel Cell Layout



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Table 1. Weather Data near Stratford on May 28, 2024

<https://www.wunderground.com/history/daily/us/ct/stratford/KBDR/date/2024-5-28>

Time	Temp	Dew Point	Humidity	Wind	Wind Speed	Pressure	Condit
8:16 AM	67 °F	66 °F	97 %	SW	9 mph	29.71 in	Mist
8:52 AM	67 °F	66 °F	97 %	SW	12 mph	29.70 in	Mist
9:16 AM	69 °F	65 °F	87 %	SW	9 mph	29.69 in	Mist
9:52 AM	72 °F	65 °F	78 %	SW	10 mph	29.69 in	Haze
10:09 AM	75 °F	63 °F	66 %	W	8 mph	29.68 in	Partly Cloudy
10:52 AM	75 °F	60 °F	60 %	WNW	10 mph	29.69 in	Mostly Cloudy
11:52 AM	75 °F	63 °F	66 %	SSW	17 mph	29.71 in	Mostly Cloudy
12:52 PM	76 °F	60 °F	58 %	SW	16 mph	29.70 in	Fair
1:52 PM	75 °F	59 °F	57 %	SW	14 mph	29.71 in	Fair

Data Analysis

This section analyzes the airborne noise levels measured at the Stratford site and then estimates the received level and transmission loss to nearby properties expected during actual fuel cell operation. These estimated levels will be compared to the noise limits in the Connecticut and Stratford noise ordinances. Speaker operating noise levels at the Stratford site are reported in Table 2 for the west speaker location and Table 3 for the east speaker location. Background noise levels at the Stratford site are reported in Table 4. The background data are used to correct the received speaker levels providing estimates in Table 5 of only the speaker noise contribution at each location. Table 5 also reports the transfer functions and the operating noise levels estimated for the proposed eleven new 460 KW fuel cells at 540 Longbrook Avenue.

Table 2. Overall Sound Pressure Levels in dBA ref. 20 microPascals with West Speaker On

Location	Range in Meters	Location	Leq	Max	Min	L90
Speaker On	5	West	98.4	99.1	96.1	98.3
Speaker On	10	West	92.4	93.3	92.1	92.3
West Speaker						
586 Longbrook	78	Southwest	59.9	71.6	59.2	59.4
26 Cottage PL	89	West	57	66.7	51.2	51.7
36 Cottage PL	83	West	52.1	56	49.7	50
44 Cottage PL	81	West	56.2	68.6	50.9	51.2
66 Cottage PL	81	West	52.7	66.6	51.4	52
585 Longbrook	94	Southwest	61.8	80.1	51.1	61.3
A Longbrook	70	South	69.9	74.6	65.5	67.1

Leq: Equivalent continuous sound level over the measurement period. – **this is normally the level to be identified as the value to be compared with the steady state overall noise requirement. Because of the heavy traffic noise, the L90 value is used instead.**

SPL MAX: Maximum one-second sound level observed during the measurement period.

SPL MIN: Minimum one-second sound level observed during the measurement period.

L90: - 90% percentile sound level –L90 is the level that is exceeded 90% of the time.

The CT State Noise Ordinance¹ identifies the L90 acoustic calculation as useful in determining background airborne noise. **This value will also be used as the background noise level.**

Table 3. Overall Sound Pressure Levels in dBA ref. 20 microPascals with East Speaker On

Location	Range in Meters	Location	Leq	Max	Min	L90
Speaker On	5	East	98.1	98.9	95.6	98
Speaker On	10	East	92.5	93.5	91	90.7
East Speaker						
450 Barnum	63	Southeast	78	80.4	75.8	76.4
350 Barnum	137	East	67.7	72	63.2	64.5

The overall airborne noise levels are about 25 dB higher for the speakers as compared to what was measured from the HiAxiom 460 KW cooling module at Montville, CT. These 25 dB differences in level were subtracted from the Stratford measured levels to estimate the expected fuel cell acoustic signature for one fuel cell. Column 4 of Table 5 provides the background corrected data for the property line measurements. The transfer function to each property line is shown in column 5 and the estimated level for eleven fuel cells in shown in column 6. The 10-meter Montville airborne noise levels were used with the Stratford transmission loss data to estimate the expected eleven fuel cell airborne noise at the nine nearby neighbors. Only the location closest to the fuel cells at 450 Barnum Street is near the 66 dBA noise limit. All the locations measured meet both the residential day time and night time noise requirements as well as the commercial noise limit.

Note: The Cottage Place measurements were made in the front yard at the driveway so the houses were not blocking the sound from the speakers. The lots on Cottage Place appear to be about 100 feet deep so measurements in the back yard could be as much as 33 meters closer than the front yard. Typical spreading loss calculations indicate this would result in as much as 4 dB higher levels in the backyard. The 4 dB increase would mean the Cottage Place residences would still be at least 12 dB below the night time noise limit.

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Table 4. Overall Sound Pressure Levels in dBA ref. 20 microPascals with **Speakers Off**

Location	Range in Meters	Direction	Leq	Max	Min	L90
586 Longbrook	78	Southwest	52.5	54.7	51.3	51.5
26 Cottage PL	89	West	52.8	57	50.3	51.3
36 Cottage PL	83	West	51.3	53.8	49.4	50.1
44 Cottage PL	81	West	49.3	54.1	46.6	47.6
66 Cottage PL	81	West	54.0	68.7	46.7	47.2
585 Longbrook	94	Southwest	54.2	79.4	53.2	53.4
A Longbrook	70	South	57.0	62.3	54.8	55.0
450 Barnum	63	Southeast	56.4	59.4	54.4	55.0
350 Barnum	137	East	58.4	60.5	56.5	57.5

Table 5. Background Corrected L90 Sound Pressure Levels in dBA ref. 20 microPascals

Location	Range in Meters	Direction	L90 Estimate	Transfer Function	Property Line	Night Spec	Over Spec
West Speaker			In dBA	In dB	dBA	dBA	dBA
586 Longbrook	78	Southwest	58.7	-33.6	42.4	51	-8.6
26 Cottage PL	89	West	48.9	-43.4	32.6*	51	-18.4
36 Cottage PL	83	West	47	-45.3	30.7*	51	-20.3
44 Cottage PL	81	West	49.6	-42.7	33.3*	51	-17.7
66 Cottage PL	81	West	50.8	-41.5	34.5*	51	-16.5
585 Longbrook	94	Southwest	60.6	-31.7	44.3	66	-21.7
A Longbrook	70	South	66.8	-25.5	50.5	66	-15.5
East Speaker							
450 Barnum	63	Southeast	76.4	-14.3	61.7	66	-4.3
350 Barnum	137	East	63.7	-27	49	66	-17

Note: * Backyard noise levels could be as much as 4 dB higher than front yard levels

Allowable Noise Levels

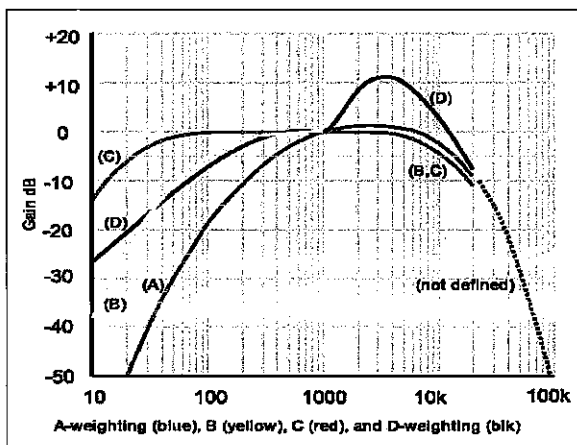
Connecticut's regulation for the control of noise provides in *CT section 22a-69-3*¹ the requirements for noise emission in Connecticut. *Section 22a-69-3.1* states that no person shall cause or allow the emission of excessive noise beyond the boundaries of his/her Noise Zone so as to violate any provisions of these Regulations. The CT ordinance will be used to evaluate the noise generated by the HiAxiom 460 KW Fuel Cells. (The Stratford noise ordinance has the same noise limits.) Following sections discuss each type of noise using the results obtained from the May 28, 2024 speaker measurements in Stratford and the HiAxiom 460 KW fuel cell test in Montville, CT reported on July 13, 2020.

The Stratford site is located in an Industrial Zone on Longbrook Avenue and is surrounded by Residential and Commercial Zones. The closest residential zone on Cottage Place is about 40 meters away. Based on the analysis resulting in Table 5 the airborne noise from the eleven new fuel cells should be well below the 51 dBA noise limit at distances greater than 40 meters. All residential properties at greater distances are expected to be well below the day time and night time Residential Zone noise limits for an emitter in an Industrial zone. The closest commercial zone on Barnum Road is about 45 meters away. Based on the analysis resulting in Table 5, the airborne noise from the eleven new fuel cells should be well below the 66 dBA noise limit at distances greater than 45 meters. All other commercial properties at greater distances are expected to be well below the Commercial Zone noise limits for an emitter in an Industrial zone.

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 Stratford noise ordinance sets the same limits for Impulse Noise.

Figure 6. Acoustic Airborne Noise Weighting Curves



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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, 2020³. 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 a Hewlett Packard HP3561A spectrum analyzer. (The maximum level ten meters from the fuel cell was 77 dBA.) The closest Stratford property showed 14 dB of transmission loss so the highest expected level would be below 64 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 Stratford'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 above plots the A-weighting curve versus frequency in blue. Below a frequency of 1 kiloHertz the acoustic level is attenuated by increasing amounts. The reduction is about 10 dB at 200 Hertz, 20 dB at 90 Hertz and 30 dB at 50 Hertz. It also reduces the level at very high frequency being down in level by 10 dB at 20 kiloHertz. The fuel cell measurements show the unweighted overall levels to be about 9 dB higher than the A-weighted noise levels. Adding 9 dB to the Montville measured levels brings the peak impulse up to about 73 dB reference 20 microPascals. The impulse noise levels on Barnum Road should be no higher than 73 dB reference 20 microPascals, well below both the 80- and 100-dB limits.

Prominent Discrete Tones

The Connecticut regulation for the control of noise states in *CT section 22a-69-3.3 Prominent discrete tones*: Continuous noise measured beyond the boundary of the Noise Zone of the noise emitter in any other Noise Zone which possesses one or more audible discrete tones shall be considered excessive noise when a level of 5 dBA below the levels specified in section 3 of these Regulations is exceeded. The CT Regulations establish different noise limits for different land use zones. Residential (homes and condominiums) and hotel uses are in Class A. Schools, business, parks, recreational activities and government services are in Class B. Forestry and related services are in Class C. By my reading of the regulations the Stratford fuel cells are 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)

The Stratford 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 Reference 3 Montville testing. The data is the maximum level received in 1/30 octave bands for frequencies from 0.32 to 100,000 Hz. Figure 7 plots the airborne noise measured 10 meters from the Cooling and Power Modules in 1-30th octave bands. This figure shows some discrete tones in the middle

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frequencies produced by the HiAxiom Fuel Cell Cooling and Power Modules. The eight largest tones are given in Table 6. The highest is 55.1 dB reference 20 microPascals at 302 Hz. The second highest tone is at 213.8 Hz at a level of 54.3 dB reference 20 microPascals. All the remaining tones are below 53 dBA. The A-weighted discrete tone corrections are given in the 4th row of Table 6. Incorporating the transmission loss to the properties gives the A-weighted levels in the last five rows of Table 6 after the 9.5 dB correction for eleven units is added. All the frequencies at the nearest residences on Cottage Place have levels that are at least 15 dB below the 46 dBA requirement in a Residential Zone. All the nearby residential properties should meet all the discrete tone requirements. The closest commercial property is given in the last row of Table 6. The expected level is at least 10 dB below the limit of 61 dBA. There should be no acoustic issue with the CT discrete tone noise requirements at any of the nearby properties.

Figure 7. Montville Tones 460 KW Fuel Cell Cooling & Power Modules in 1-30th octave bands

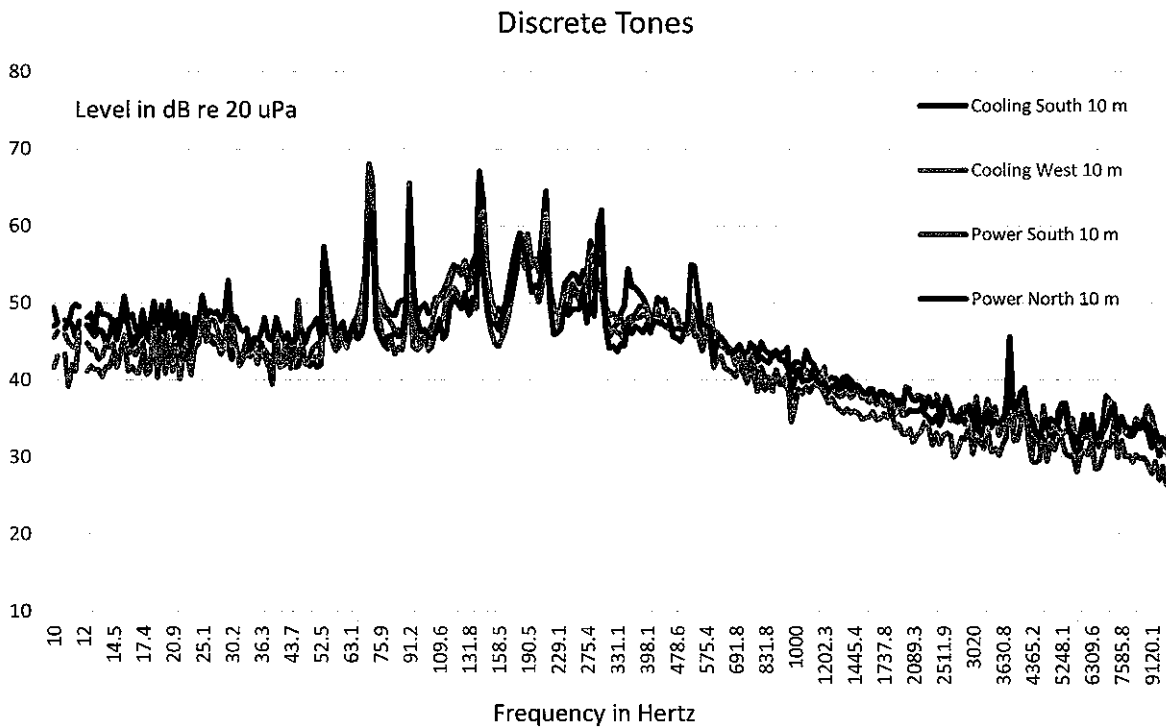


Table 6. Peak Discrete Sound Pressure Level Estimates in dB ref. 20 microPascals

Location	Range Meters	53.7 Hz	70.8 Hz	91.2 Hz	141.3 Hz	213.8 Hz	302 Hz	3801 Hz	4169 Hz
Allowed Level		40	40	40	40	40	40	40	40
Montville	10	57.3	68.1	65.6	67.1	64.5	62.1	45.6	39
A Weighting		-29.0	-24.3	-20.5	-14.7	-10.2	-7.0	1.0	0.9
Stratford 1 unit	10	28.3	43.8	45.1	52.4	54.3	55.1	46.6	39.9
11 Fuel Cells	10	37.8	53.3	54.6	61.9	63.8	64.6	56.1	49.4
586 Longbrook	78	4.2	19.7	21	28.3	30.2	31	22.5	15.8
26 Cottage PL	89	-5.6	9.9	11.2	18.5	20.4	21.2	12.7	6
36 Cottage PL	83	-7.5	8	9.3	16.6	18.5	19.3	10.8	4.1
44 Cottage PL	81	-3.7	11.8	13.1	20.4	22.3	23.1	14.6	7.9
450 Barnum	63	23.5	39	40.3	47.6	49.5	50.3	41.8	35.1

Infrasonic and Ultrasonic Noise

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

Narrow bandwidth sound pressure spectrums in dB reference 20 microPascals made at the Montville western 10-meter Cooling Module location can be used to compare with the infrasonic and ultrasonic noise requirements. The Montville airborne noise data were processed in the 0 to 200 Hertz and 0 to 100,000 Hertz frequency ranges. The bandwidth of each data point is 0.75 Hertz for the 200 Hertz range and 375 Hertz for the 100,000 Hertz frequency range. The infrasonic noise for frequencies up to 20 Hertz is shown in Figure 8 for the 460 KW unit at Montville³. The maximum level at 10 meters is 48 dB reference 20 microPascals. The entire 20 Hertz band can be power summed and never exceeds 70 dB reference 20 microPascals at 10 meters in Montville. After subtracting 14.3 dB for the maximum transfer function correction at Point P8, the closest site, and adding the gain of 9.5 dB for eleven units, the 65.2 dB level is well below the Infrasonic requirement of 100 dB for the Stratford site. The noise levels at all the other nearby residential and commercial neighbors will be lower. There should be no issue with the infrasonic noise requirement at any of the neighboring residential properties.

The ultrasonic noise for frequencies up to 100 KiloHertz is given in Figure 9. The Montville data uses a microphone with flat high frequency performance and provides a good estimate for

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the 460 KW fuel cell. The entire 80 KiloHertz band from 20 to 100 kiloHertz has been power summed and never exceeds a noise level of 62 dB reference 20 microPascals 10 meters from the fuel cell at Montville. After subtracting 14.3 dB for the maximum transfer function correction at Point P8, the closest site, and adding the gain of 9.5 dB for eleven units, the ultrasonic level of about 57.2 dB is well below the requirement of 100 dB for the Stratford site. The noise levels at all the other nearby residential and commercial neighbors will be lower and there should be no issue with ultrasonic noise at any of the neighboring properties.

Figure 8. Infrasonic Noise from Montville Fuel Cell Cooling Modules in 1-30th octave bands

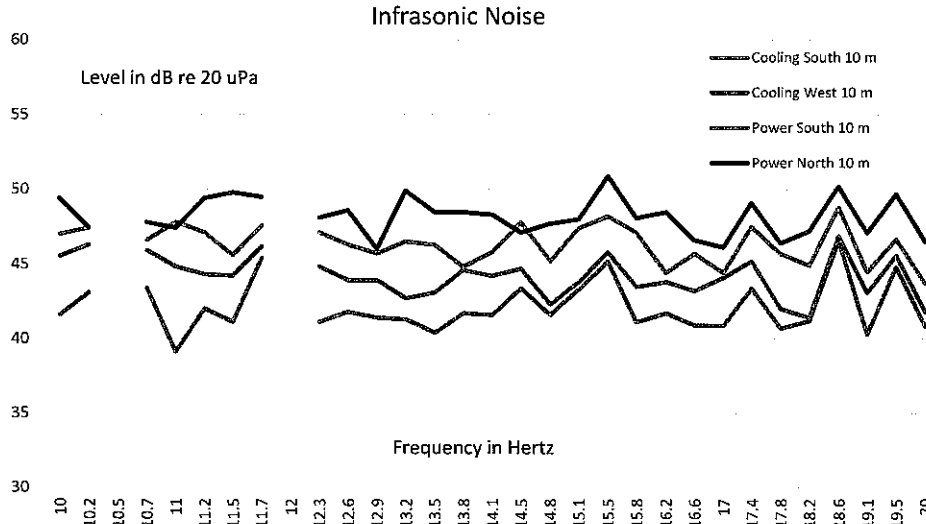
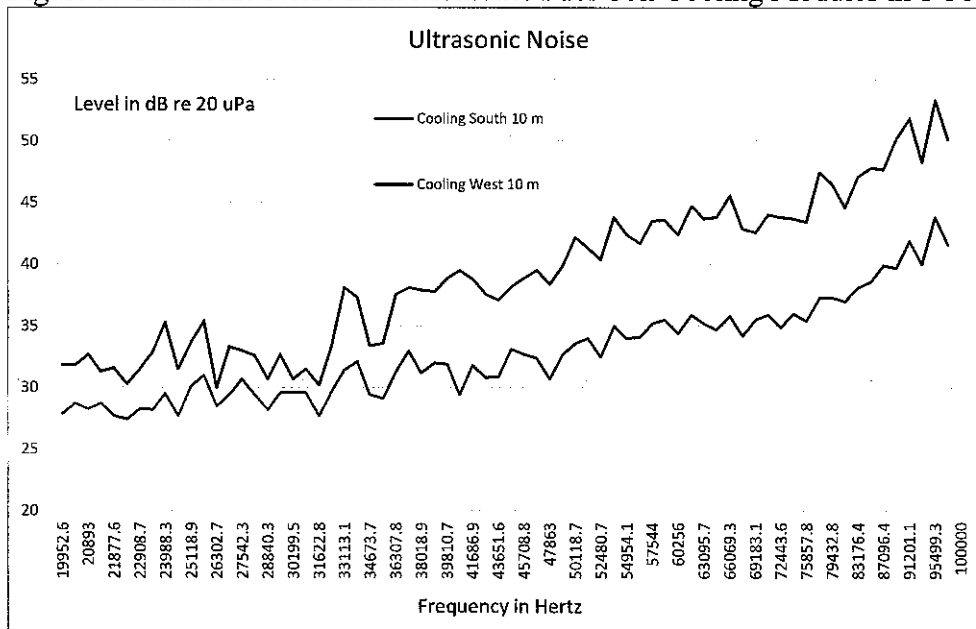


Figure 9. Ultrasonic Noise from Montville Fuel Cell Cooling Modules in 1-30th octave bands



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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 Stratford site is in an Industrial Zone that has surrounding Residential and Commercial Zones. The nearby neighbors in RS-4 residential zones have airborne noise limits of 61 dBA during the day and 51 dBA at night. The Commercial Zone limit is 66dBA.

The estimated overall A-weighted sound pressure levels for eleven fuel cells in dBA reference 20 microPascals are given in column 6 of Table 5 above using the background corrected measurements made on May 28, 2024. The second column gives the approximate distance from the fuel cells to the measurement location, with locations identified by a P number in Figure 2. Column 3 gives the direction from the fuel cell to the property. The airborne noise values given in columns 4 are the estimated received level for one speaker. Transfer functions in column 5 provide the loss in sound level from the fuel cells to the property lines. The values in column 6 provide the estimated airborne noise levels at the property lines with eleven fuel cells operating. The values are all below both the residential and commercial noise limits. Operation of the eleven HiAxiom fuel cells will have no significant acoustic impact on the nearby properties adjacent to the HiAxiom fuel cell site on Longbrook Avenue.

All of the nearby residential and industrial properties should not be affected by the operation of the eleven fuel cells.

Conclusions

The purpose of this effort is to evaluate the acoustical environment at the Stratford site during operation of the eleven HiAxiom 460 KW fuel cells. This effort has been accomplished and the results show that the operation of the eleven HiAxiom 460 KW fuel cells will meet all of the State of Connecticut and Town of Stratford airborne noise requirements at all the nearby properties. All the residences should be more than 8 dB below the night time noise requirement while all commercial properties should be more than 4 dB below the commercial requirement.

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) Stratford Noise Ordinance, stratfordnoiseordinancepdf.pdf
- 3) Town of Montville Water Pollution Control Authority Airborne Noise Test
At 83 Pink Row, Acoustical Technologies Inc., July 13, 2020