Veneklasen Associates
Consultants in Acoustics | Noise | Vibration | AV | IT

July 27, 2021

Bloom Energy
4353 North 1st Street
San Jose, California 95134

Attention: **Brandon Leaverton | Supply Chain Specialist – Construction**

Subject: **Kaiser Permanente, Santa Rosa, California**
Fuel Cell Acoustical Analysis
Veneklasen Project No. 4631-021

Dear Brandon:

Veneklasen Associates, Inc. (Veneklasen) was contracted to evaluate noise impact of the proposed fuel cell for the subject project in Santa Rosa, California. This report includes the predicted noise levels and the adjacent property lines and an evaluation of necessary mitigation, if warranted, to comply with the local noise ordinance in the surrounding community. This report documents our findings.

Noise Criteria

Section 17-16.030 of the Santa Rosa Municipal Code provides the following ambient base noise level criteria for which noise levels can be compared to. These are summarized in Table 1 below.

Table 1. Ambien Base Noise Level Criteria

Zone	Daytime (7am to 10pm)	Nighttime (10pm to 7am)
R1 and R2	50	45
Multi-family	55	50
Office and Commercial	60	55
Intensive Commercial	65	55
Industrial	70	70

Additionally, Section 17-16.120 “Machinery and Equipment” states that:

> *It is unlawful for any person to operate any machinery, equipment, pump, fan, air-conditioning apparatus, or similar mechanical device in any manner so as to create any noise which would cause the noise level at the property line of any property to exceed the ambient base noise level by more than five decibels.*

The fuel cell system is a constant, steady state noise source without substantial tonal noise, impulsive noise, or noise consisting of speech or music. It is assumed that the proposed fuel cell will run 24-hours per day. Therefore, for nearby residential and hospital receptors, Veneklasen will design to the nighttime hourly level noise limit set forth by the city code.

Property Line Noise Analysis

Drawings dated June 29, 2021 indicate that the proposed fuel cells will be installed to the east side of the project site, facing 3424 Mendocino Ave, Santa Rosa, California. The proposed fuel cell locations are shown below in Figure 1 in green. Additionally, the nearest sensitive receptors to the proposed fuel cell location are annotated in blue.

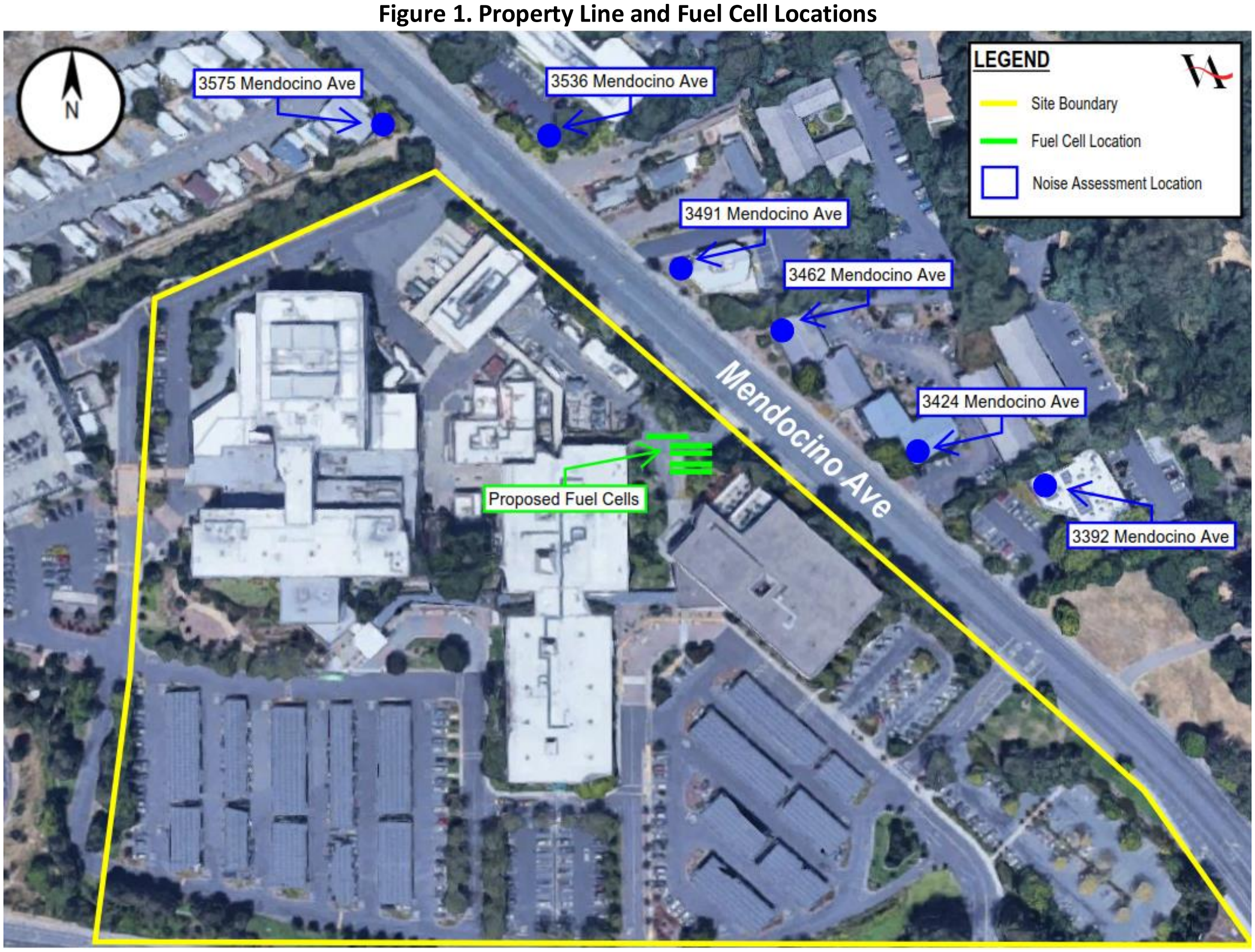
The calculated fuel cell noise levels as compared with the city noise requirements are presented below in Table 2. Note that the reported distances between property lines and the fuel cell are taken from the closest face of the fuel cell to the associated property line.

The current fuel cell installation method includes a foam dampening material that is installed at the doors and exhaust to the fuel cells. Measurement data of these units when compared to units without foam indicate that the foam compound reduces noise levels produced by the cells by approximately 5 decibels. See Appendix A below for fuel cell sound power data and foam compound reduction data used in the following analysis.

Table 2. Fuel Cell Property Line Noise Levels: No Mitigation

Sensitive Receptor	Property Type	Distance from Fuel Cell, ft	Calculated Fuel Cell Noise Level, dBA	Noise Limit (Night), dBA	Code Compliant?
3392 Mendocino Ave	Commercial	393	35	60	Yes
3424 Mendocino Ave	Commercial	155	45	60	Yes
3462 Mendocino Ave	Commercial	180	43	60	Yes
3491 Mendocino Ave	Commercial	295	41	60	Yes
3536 Mendocino Ave	Commercial	393	37	60	Yes
3575 Mendocino Ave	Residential	492	24	50	Yes

Figure 1. Property Line and Fuel Cell Locations



Calculated fuel cell noise levels to adjacent sensitive receptor locations are all compliant with city noise requirements without mitigation.

Summary

Veneklasen has reviewed the subject project proposed fuel cell property line noise levels as they pertain to the applicable Santa Rosa Municipal Code noise requirements. All property line noise levels are in compliance with the noise requirements as designed and require no mitigation.

If you have any questions, please do not hesitate to call.

Sincerely,
Veneklasen Associates, Inc.

Kevin Patterson
Associate

John LoVerde, *FASA*
Principal

Appendix A – Sound Power Levels

Sound power data was taken from the Mei Wu Acoustics (MWA) Report titled “Bloom Energy – ES5 Linear Sound Power Measurement”, dated June 21, 2016. These reported levels were measured without the sound dampening foam described above.

Table 3. Fuel Cell Measured Sound Power Levels

Dampening Product Installed?	Measured Sound Power Level [dB] – 1/1 Octave Bands							
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	LwA
No	77.9	80.9	84.1	82.3	80.5	76.9	69.4	84.9
Yes	77.9	80.9	81.0	77.9	73.7	67.2	64.8	79.3

In a study conducted at an existing installation of the fuel cell systems, measurements were taken of the fuel cell banks with and without the dampening product. The Noise Reduction (NR) of the dampening product was calculated by taking the difference of these measured values at octave band frequencies. Note that no significant reduction was shown at the 63 Hz and 125 Hz bands. The modified sound levels for the fuel cells that were utilized in calculations shown in this report are shown in Table 3.

Table 4. Measured Sound Dampening Foam Mitigation

Condition	Measured Sound Pressure Level [dB] @10ft – 1/1 Octave Band				
	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
No Foam	70.8	66.8	65.5	62.4	53.6
Foam	67.8	62.5	58.7	52.8	49.0
Difference (NR)	3.1	4.4	6.8	9.7	4.6

Appendix B – Calculation Methods

Sound level attenuates over distance by a factor of -6 dB per doubling of distance. For example, if a sound source was measured to be 60 dBA at a distance of 10 feet, the measured sound level at 20 feet would be 54 dBA. Sound level reduction due to distance is calculated according to the following equation:

$$L_p = L_w + 10\log_{10} Q - 20\log_{10} d - 0.7$$

Where:
d = The distance between the center of the fuel cell unit to the property line in feet.
L_p = The sound pressure level at a distance *d* in decibels.
L_w = The sound power level from the fuel cell. Sound power levels are reported above in Appendix A in decibels.
Q = The directivity factor which dictates how sound radiates outward from the source. See Figure 2 below from the 2015 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) Handbook, Chapter 48 describing *Q* factors and their associated sound radiation patterns.

Figure 2. ASHRAE Handbook: Q Factor Sound Radiation Patterns

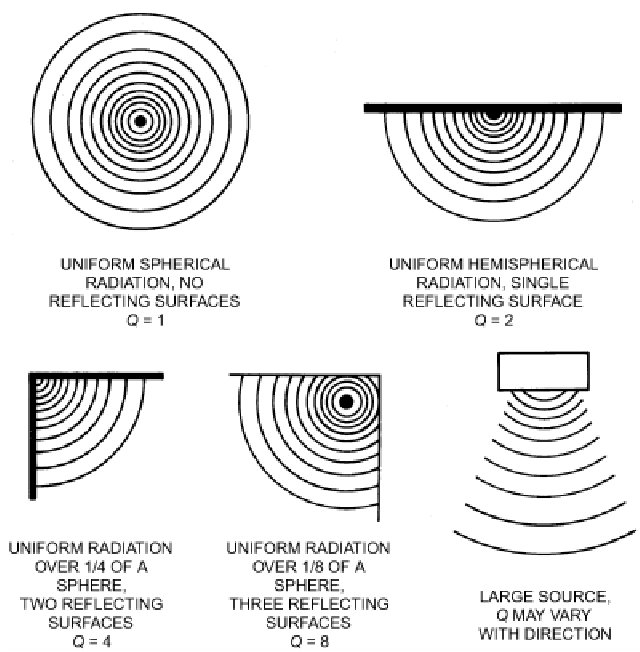


Fig. 30 Directivity Factors for Various Radiation Patterns

In the equation above, the greater the distance away from the sound source (*d*), the lower the sound level. This is intuitive and most people would consider this common knowledge.

In general, the more reflecting surfaces there are adjacent to a noise source, the more sound will bounce off these surfaces and radiate outward. In other words, larger *Q* factors will increase the noise level. For example, a fuel cell sitting on the ground, with nothing else around, would have a *Q* factor of 2 because the ground that the fuel cell is sitting on acts as a single reflecting surface. Another example would be a fuel cell sitting on the ground with a retaining wall on one side of it; this system would have a *Q* factor of 4 because both the ground and the retaining wall act as reflecting surfaces. A doubling of the *Q* factor increases the receiver noise level, L_p, by 3 dB.