January 29, 2016

Mr. Michael Sousa
Core States Group
58 Mount Bethel Road, Suite 301
Warren, NJ 07059

Re: Sound Study of Fuel Cell Systems at Legrand in West Hartford, Connecticut Ref# 4087

Dear Michael:

Tech Environmental, Inc. (Tech) is pleased to provide this letter report summarizing the results of an acoustical modeling study of two (2) proposed Bloom Energy ES-5 Energy Servers (i.e. fuel cell systems) at Legrand located at 60 Woodlawn Street in West Hartford, Connecticut. The two (2) identical fuel cell systems are to be located between the facility's Building 3 and Building 4, and will be approximately 150 feet from the facility's eastern property line. The goal of this work is to demonstrate that the proposed fuel cell systems will comply with the noise requirements of the Connecticut DEP Noise Regulation (RCSA Section 22a-69). The Town of West Hartford Municipal Code contains decibel limits that mimic the CT DEP Noise Regulation; therefore, compliance with the CT DEP regulation ensures compliance with the local noise ordinance.

This letter report summarizes the modeling analyses performed for this study. Section 1.0 provides an introduction to the common measures of environmental sound. Section 2.0 presents ambient sound monitoring results collected on January 28, 2016, Section 3.0 presents the applicable noise regulations, and Section 4.0 presents the acoustic modeling approach and results. The study concludes that the proposed fuel cell systems will not create a noise nuisance condition and will fully comply with the most stringent sound level limits in the Connecticut DEP Noise Regulation and the Town of West Hartford Municipal Code.

1.0 Common Measures of Environmental Sound

Noise is defined as "unwanted sound", which implies sound pressure levels that are annoying or disrupt activities that people are engaged in. The human sense of hearing is subjective and highly variable between individuals. Noise regulations and guidelines set quantitative limits to the sound pressure level (measured with sound analyzers and predicted with computer models) in order to protect people from sound exposures that most would judge to be annoying or disruptive.

The loudness of a sound is dependent on the radiated energy of the sound source and the propagation and attenuation characteristics of the air. The standard unit of sound pressure level (L_p) is the decibel (dB), a logarithmic scale formed by taking 20 times the $\log_{10}$ of a ratio of two pressures: the measured sound pressure divided by a reference sound pressure. The decibel level scale conveniently compresses the range of audible sound pressures, which span 12 orders of magnitude, into an easy-to-use scale spanning 0 to 120 dB. Airborne sound is referenced to 20 micro-Pascals (20 µPa), which corresponds to 0 dB and the threshold of hearing. A property of the decibel scale is that the sound pressure levels of

two separate sounds are not directly additive. For example, if a sound of 70 dB is added to another sound of 70 dB, the total is only a 3-decibel increase not a doubling to 140 dB. For broadband sounds, a 3 dB change is the minimum change perceptible to the human ear. Table 1 presents the perceived change in loudness of different changes in sound pressure levels.

TABLE 1

SUBJECTIVE EFFECT OF CHANGES IN SOUND PRESSURE LEVELS

Change in Sound Pressure Level	Perceived Change in Loudness
3 dB	Just perceptible
5 dB	Noticeable
10 dB	Twice (or half) as loud

The acoustic environment in an urban industrial/residential area, such as that surrounding Legrand in West Hartford, primarily results from motor vehicle traffic on Interstate 84 and local roadways, and the existing manufacturing facility. Typical sound levels associated with various activities and environments are presented in Table 2[1].

TABLE 2

COMMON SOUND LEVELS

Sound Level (dBA)	Common Indoor Sounds	Common Outdoor Sounds
110	Rock Band	Jet Takeoff at 1000’
100	Inside NYC Subway Train	Chain Saw at 3’
90	Food Blender at 3’	Impact Hammer (Hoe Ram) at 50’
80	Garbage Disposal at 3’	Diesel Truck at 100’
70	Vacuum Cleaner at 10’	Lawn Mower at 100’
60	Normal Speech at 3’	Auto (40 mph) at 100’
50	Dishwasher in Next Room	Busy Suburban Area at night
40	Empty Conference Room	Quiet Suburban Area at night
25	Empty Concert Hall	Rural Area at night

[1] U.S. DOT, FHWA, Noise Fundamentals Training Document, Highway Noise Fundamentals, September, 1980.

2.0 Existing Sound Levels

Nighttime sound level measurements were collected on January 28, 2016 from 12:33 AM to 1:54 AM at the eastern property line of the Legrand facility, near the location of the property line with 118 Woodlawn Street. The location of the sound level measurements is illustrated in the attached Figure 1. Measured sound levels at this location are representative of existing sound levels at the nearest residential property line, which could be impacted by the proposed fuel cell systems. During the sound level monitoring program, the sources of ambient sounds were predominantly roadway traffic on Interstate 84 and local roads, and the existing manufacturing facility. The weather conditions during the field monitoring were conducive to accurate sound monitoring. The temperature was 23°F, the skies were clear, and winds were calm.

Both broadband (dBA) and residual octave band sound level measurements were made with a Larson Davis 831 environmental sound level analyzer. The full octave band frequency analysis was performed on the 11 octave bands spanning 16 to 16,000 Hertz. A time-integrated statistical analysis of the data used to quantify the sound variation was also performed, including the calculation of the L_{90}, which is typically considered the ambient background sound level. The Larson Davis 831 is equipped with a model 1/2" precision condenser microphone and has an operating range of 5 dB to 140 dB and an overall frequency range of 3.5 Hz to 20 kHz. This meter meets or exceeds all requirements set forth in the ANSI S1.4-1983 Standards for Type 1 quality. Prior to any measurements, the sound analyzer was calibrated with an ANSI Type 1 calibrator that has an accuracy traceable to the National Institute of Standards and Technology (NIST). During all measurements, the analyzer was tripod mounted at approximately five feet above the ground in open areas away from vertical reflecting surfaces. All data were downloaded to a computer following the measurement session for the purposes of storage and analysis.

The results of the baseline measurements are presented in Table 3. The lowest measured broadband background L_{90} level was 43 dBA. These are typical levels for an urban area near an interstate and an existing manufacturing facility.

TABLE 3

AMBIENT BASELINE NIGHTTIME SOUND LEVEL MEASUREMENTS
NEAR LEGRAND'S EAST PROPERTY LINE, WEST HARTFORD, CONNECTICUT

Sound Level Measurement	January 28, 2016 12:32 AM to 1:54 AM
Broadband (dBA)	
Background (L_{90})	42.5
Average (L_{eq})	47.2
Maximum (L_{max})	61.6

3.0 Noise Regulations

The authority vested in the Connecticut Department of Environmental Protection (DEP) for regulating noise comes from Connecticut General Statutes Section 22a-67 et seq. and Regulations of Connecticut State Agencies ("R.C.S.A.") Sections 22a-69-1 to 22a-69-7.4. R.C.S.A. Section 22a-69-3.1 states: "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." Noise Zone classifications are based on the actual use of the receptor on any parcel as detailed by the Standard Land Use Classification Manual of Connecticut (SLUCONN) and outlined in R.C.S.A. Section 22a-69-2.

Class A Noise Zones include residential uses where human beings sleep or areas where serenity and tranquility are essential to the intended use of the land.[2] 118 Woodlawn Street is clearly residential, and therefore, is defined as a Class A Noise Zone. Class B Noise Zones include uses commercial in nature, areas where human beings converse and such conversation is essential to the intended use of the land.[3] Class C Noise Zones are lands generally for industrial use, and includes manufacturing, warehousing, and agriculture.[4] The Legrand facility is a Class C Noise Zone per the CT DEP Noise Regulation. The nearest sensitive receptor to the proposed fuel cell systems is the property line of 118 Woodawn Street, which is just east of the proposed location of the fuel cell systems. The location of the proposed fuel cell systems and the nearest sensitive receptor is illustrated in the attached Figure 1. Table 4 summarizes the Connecticut DEP Noise Regulation Noise Zone standards for a Class C emitter to a Class A receptor. Since the proposed fuel cell systems are proposed to operate at all hours, day and night, the nighttime limit is governing.

TABLE 4

CONNECTICUT DEP NOISE REGULATION
NOISE ZONE STANDARDS

Class C Emitter to	Daytime Limit	Nighttime Limit
Class A Receptor	61 dBA	51 dBA

The Town of West Hartford Municipal Code sets sound limits applicable to this project that are equivalent to those in the Connecticut DEP Noise Regulation.[5] Therefore, compliance with the Connecticut DEP Noise Regulation infers compliance with the Town of West Hartford Municipal Code.

[2] Connecticut General Statutes Sec. 22a-69-2.3
[3] Connecticut General Statutes Sec. 22a-69-2.4
[4] Connecticut General Statutes Sec. 22a-69-2.5
[5] Town of West Hartford Municipal Code, Chapter 123, Section 123-13

4.0 Modeling Assumptions and Results

This section describes the modeling approach and assumptions included in our noise modeling analysis, and predicted sound levels at the nearest property line of the Legrand site in West Hartford, Connecticut.

4.1 Modeling Assumptions

Future sound levels of the proposed fuel cell systesm were calculated with the Cadna-A acoustic model assuming continuous operation of the proposed fuel cell systems. The assumptions in our noise modeling analysis are as follows:

1. The location of the proposed fuel cell systems was based on a site plan obtained from Core States Group dated December 3rd, 2015 and revised December 23rd, 2015.[6] The plan shows the proposed location of the fuel cell systems is between the facility's Building 3 and Building 4, and approximately 150 feet from the facility's eastern property line. The fuel cell systems are positioned in a side-by-side orientation, with the "front" of one system facing northeast, and the "front" of the other facing southwest. The location of the proposed fuel cell systems are illustrated in the attached Figure 1.

2. The operational sound power level (L_w) of each of the two (2) proposed Bloom Energy ES-5 Energy Servers was assumed to be a total of 86.5 dBA as determined by Mei Wu Acoustics from measurements of a previously installed unit, and documented in a letter report to Bloom Energy.[7] That study measured and calculated the sound power emitted from each surface of a Bloom Energy ES-5 Energy Server in Newark, Delaware (i.e. front, back, sides and top), with the most substantial being the front of the fuel cell system (i.e. 83.2 dBA). This acoustic modeling study, assumes that each of the two (2) Bloom Energy ES-5 fuel cell systems proposed at Legrand in West Hartford emits the same sound powers as documented in the Mei Wu Acoustics letter report, which totals 86.5 dBA for each system.

4.2 Future Sound Levels

Cadna-A is a sophisticated 3-D model for sound propagation and attenuation based on International Standard ISO 9613.[8] Atmospheric absorption is the process by which sound energy is absorbed by the air and was calculated using ANSI S1.26-1995.[9] Absorption of sound assumed standard conditions and is significant at large distances and at high frequencies. ISO 9613 was used to calculate propagation and attenuation of sound energy by hemispherical divergence with distance, surface reflection, ground, and shielding effects by barriers, buildings, and ground topography. Offsite topography was determined using LiDAR 10-foot digital elevation data for the study area from the University of Connecticut.[10] The

[6] Site Plan, New Construction of 500 kw Clean Energy Server Installation, 60 Woodlawn Street, West Hartford, CT 06110, 12/3/2015, revised 12/23/2015.
[7] Delaware Bloom Energy ES5 V1 Sound Power and Tone Study, Mei Wu Acoustics, February 4, 2015.
[8] International Standard, ISO 9613-2, Acoustics – Attenuation of Sound During Propagation Outdoors, -- Part 2 General Method of Calculation.
[9] American National Standards Institute, ANSI S1.26-1995, American National Standard Method for the Calculation of the Absorption of Sound by the Atmosphere, 1995.
[10] http://clear.uconn.edu/data/ct_dem/ct_dem_download.asp

predicted sound levels are conservative because the acoustic model assumes a ground-based temperature inversion, such as may occur on a calm, clear night when sound propagation is favorable.

Sound levels were predicted for the continuous operation of the proposed fuel cell systems at a height of five feet above ground level at the nearest site property line. The modeling results conclude that the fuel cell systems would result in a predicted sound level impact of 44.6 dBA (L_{eq}) at the property line of 118 Woodlawn Street. This projected sound level of the fuel cell systems is less than the existing nighttime average sound level of 47.2 dBA (Leq). The sound level impacts of the fuel cell systems at locations further away would be even less. Table 5 summarizes the modeling results and confirms the proposed fuel cell systems comply with the CT DEP Noise Regulation and the Town of West Hartford Municipal Code for continuous sound at all of the nearest sensitive locations.

TABLE 5

PREDICTED SOUND LEVEL OF THE FUEL CELL SYSTEMS AT LEGRAND IN WEST HARTFORD, CT

Sensitive Receptor Property Line (PL) Location	Predicted Sound Level	CT DEP Sound Limit	West Hartford Sound Limit
PL - 118 Woodlawn Street	45 dBA	51 dBA	51 dBA

In conclusion, the proposed fuel cell systems at Legrand in West Hartford, Connecticut will not create a noise nuisance condition and will fully comply with the most stringent sound level limits in the Connecticut DEP Noise Regulation and the Town of West Hartford Municipal Code.

Thank you for the opportunity to serve you.

Sincerely,

TECH ENVIRONMENTAL, INC.

Matthew L. Riegert
Environmental Engineer

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Figure 1. Sound Monitoring Location and Sensitive Receptor

Legrand Fuel Cell Systems Sound Study
60 Woodlawn Street, West Hartford, CT

TECH environmental