

March 20, 2015

Mr. Richard Procanik  
Core States Group  
58 Mount Bethel Road, Suite 301  
Warren, NJ 07059

**Re: Sound Study of Fuel Cell at Home Depot in Norwalk, Connecticut**

**Ref# 3977**

Dear Richard:

Tech Environmental, Inc. (Tech) is pleased to provide this letter report summarizing the results of an acoustical modeling study of a proposed Bloom Energy ES-5700 fuel cell at an existing Home Depot site located at 600 Connecticut Avenue in Norwalk, Connecticut. The seven module fuel cell is proposed to be located near the facility property line on the north side of the Home Depot site. The goal of this work is to demonstrate that the proposed fuel cell will comply with noise requirements of the Connecticut DEP Noise Regulation (RCSA Section 22a-69). The CT DEP regulations set decibel limits for continuous sound at sensitive receptors which are based on the type of land use. In cases where background levels exceed the limits, a source shall be considered to comply if it does not exceed the background noise level by 5 dBA, provided it does not exceed 80 dBA at any time.

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 March 17, 2015, 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 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 City of Norwalk Noise Control Ordinance.

## **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  $\mu$ Pa), 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 commercial/residential area, such as that surrounding the Home Depot in Norwalk, primarily results from motor vehicle traffic on Interstate 95, Route 1 and local roadways. Typical sound levels associated with various activities and environments are presented in Table 2<sup>1</sup>.

**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

<sup>1</sup> 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 March 17, 2015 from 1:42 AM to 3:03 AM at the Home Depot site, near the location of the proposed fuel cell. 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 lines, which could be impacted by the proposed fuel cell. During the sound level monitoring program, the sources of ambient sounds were predominantly roadway traffic on Interstate 95, Route 1 and local roads. The Home Depot store was closed during the sound level measurements, although some sporadic truck unloading activities were audible at times. There were no trucks idling in the loading dock area while sound level measurements were collected. The weather conditions during the field monitoring were conducive to accurate sound monitoring. The temperature was 38°F, the skies were overcast, and winds were calm.

Both broadband (dBA) and residual octave band sound level measurements were made with a B&K 2250 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<sub>90</sub>, which is typically considered the ambient background sound level. The B&K 2250 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<sub>90</sub> level was 49 dBA. These are typical levels for an urban area adjacent to an interstate.

**TABLE 3**  
**AMBIENT BASELINE NIGHTTIME SOUND LEVEL MEASUREMENTS**  
**NEAR HOME DEPOT NORTH PROPERTY LINE, NORWALK, CONNECTICUT**

**March 17, 2015 from 1:42 AM to 3:03 AM**

Sound Level Measurement	1:42 AM to 2:02 AM	2:02 AM to 2:32 AM	2:22 AM to 2:42 AM	2:43 AM to 3:03 AM
<u>Broadband (dBA)</u>				
Background (L <sub>90</sub> )	49.1	49.3	50.1	51.2
Average (L <sub>eq</sub> )	52.0	51.9	53.1	53.8
Maximum (L <sub>max</sub> )	61.3	64.7	64.5	59.7

**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<sup>2</sup>. 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<sup>3</sup>. The nearest sensitive receptors to the proposed fuel cell are the property lines of 42 Juhasz Road, 99 Keeler Avenue, 97 Keeler Avenue and 95 Keeler Avenue, which are respectively just west, north, northeast and east of the proposed location of the Norwalk Home Depot fuel cell. The locations of the nearest sensitive receptors are illustrated in the attached Figure 1. These parcels are clearly residential, and therefore, are defined as Class A Noise Zones. Table 4 summarizes the Connecticut DEP Noise Regulation Noise Zone standards for a Class B emitter to a Class A receptor. Since the proposed fuel cell is proposed to operate at all hours, day and night, the nighttime limit is governing.

**TABLE 4  
CONNECTICUT DEP NOISE REGULATION  
NOISE ZONE STANDARDS**

Class A or B Emitter to	Daytime Limit	Nighttime Limit
Class A Receptor	55 dBA	45 dBA

In cases where background levels exceed the limits presented in Table 4, a source shall be considered to comply if it does not exceed the background noise level by 5 dBA, provided it does not exceed 80 dBA at any time. Since the lowest measured background level at night was 49 dBA, the prescriptive limit for continuous sound from the proposed Norwalk Home Depot fuel cell at nearest property lines 54 dBA.

The City of Norwalk Noise Control Ordinance sets sound limits applicable to this project that are equivalent to those in the Connecticut DEP Noise Regulation<sup>4</sup>. Therefore, compliance with the Connecticut DEP Noise Regulation infers compliance with the City of Norwalk Noise Control Ordinance.

<sup>2</sup> Connecticut General Statutes Sec. 22a-69-2.3  
<sup>3</sup> Connecticut General Statutes Sec. 22a-69-2.4  
<sup>4</sup> Norwalk Municipal Code, Chapter 68, Section 68-5

## 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 lines of the Home Depot site in Norwalk, Connecticut.

### 4.1 Modeling Assumptions

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

1. The operational sound pressure level ( $L_p$ ) of the proposed fuel cell (i.e. 7 modules) was assumed to be 53.2 dBA at a distance of 50 feet as determined by Cavanaugh Tocci Associates, and documented in a letter report to Core States Group<sup>5</sup>. The study determined that all seven (7) modules of an ES-5700 fuel cell collectively produced a sound pressure level of 53.2 dBA at a distance of 50 feet, which is equivalent to 44.7 dBA from each module at that same distance.
2. The location of the proposed fuel cell was based on a site plan obtained from Core States Group dated January 7<sup>th</sup>, 2015 and revised February 6<sup>th</sup>, 2015<sup>6</sup>. The plan shows the proposed location of the fuel cell is near to the facility property line on the northern most section of the site. The fuel cell is positioned in a north-to-south orientation, with the north edge of the of the fuel cell 3'-0" from the existing curb, and the west edge of the fuel cell 5'-0" from the existing curb. The location of the proposed fuel cell is illustrated in the attached Figure 1.
3. The existing site has an approximately 12-foot tall wooden stockade fence installed along the perimeter of the concrete curb, which would be located between the proposed fuel cell and the property lines of the nearest sensitive receptors. It is our understanding is that this fence is not constructed to be an effective sound barrier (i.e. having a high density of 5 pounds per square foot with no gaps or holes), and thus has not been included in the acoustic modeling as an effective sound barrier.

### 4.2 Future Sound Levels

Cadna-A is a sophisticated 3-D model for sound propagation and attenuation based on International Standard ISO 9613. Atmospheric absorption is the process by which sound energy is absorbed by the air and was calculated using ANSI S1.26-1995. 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 official USGS digital elevation data for the study area.

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<sup>5</sup> Environmental Sound Emission Study, Bloom Energy Fuel Cells and UPM, Macys' – Cheshire, CT, Cavanaugh Tocci Associates, Incorporated, January 27, 2014.

<sup>6</sup> Site Plan, The Home Depot #6204, HOM4300, New Construction of Clean Energy Server, 600 Connecticut Avenue, Norwalk, CT 06854, 1/7/2015, revised 2/6/2015.

Maximum sound levels were predicted for the continuous operation of the proposed fuel cell at the nearest site property lines. The modeling results conclude that the fuel cell would result in a maximum sound level impact of 51.2 dBA ( $L_{eq}$ ) at the nearest property line of 99 Keeler Avenue. Table 5 summarizes the modeling results and confirms the proposed fuel cell complies with the DEP Noise Regulation and the City of Norwalk Noise Control Ordinance noise limits for continuous sound at all of the nearest sensitive locations.

**TABLE 5**  
**PREDICTED CONTINUOUS SOUND LEVELS**  
**OF THE FUEL CELL AT THE NORWALK, CT HOME DEPOT**

Sensitive Receptor Property Line (PL) Location	Maximum Sound Level	CT DEP Sound Limit	Norwalk Sound Limit
PL – 43 Juhasz Avenue	47 dBA	54 dBA	54 dBA
PL – 99 Keeler Avenue	51 dBA	54 dBA	54 dBA
PL – 97 Keeler Avenue	42 dBA	54 dBA	54 dBA
PL – 95 Keeler Avenue	39 dBA	54 dBA	54 dBA

In conclusion, the proposed fuel cell at the Home Depot in Norwalk, 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 City of Norwalk Noise Control Ordinance.

Thank you for the opportunity to serve you.

Sincerely,

TECH ENVIRONMENTAL, INC.



Matthew L. Riegert  
 Environmental Engineer



**Figure 1. Sound Monitoring Location and Sensitive Receptors**

**Home Depot Fuel Cell Sound Study  
600 Connecticut Avenue, Norwalk, CT**

