Outside to Inside Attenuation at the Brouha Bedroom

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Introduction

In issuing a Certificate of Public Good for the Sheffield Wind Project, Docket No. 7156, the Vermont Public Service Board determined that Vermont Wind "shall construct and operate the Project so that … indoor sound levels at any existing King George School structures used for residential or instruction purposes and any existing surrounding residences do not exceed 30 dBA(Leq)(1)."

Vermont Wind has monitored noise levels at 4 locations to determine if this standard was violated. The Brouha residence was not one of the four test monitoring locations selected. The home, located at 92 Queen Elizabeth Farm Lane in Sutton VT, experiences significant turbine noise which is clearly audible within the home and exceeds the 30 dBA(Leq)(1) standard set by the Public Service Board.

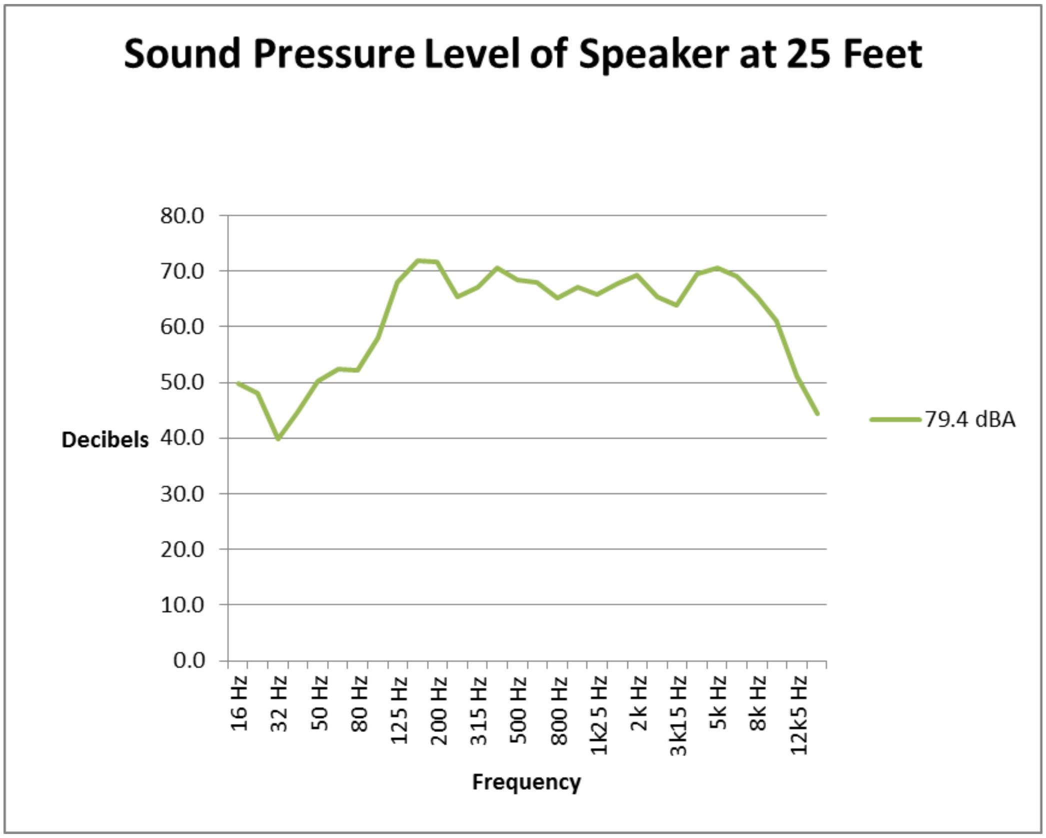
In accordance with the Noise Monitoring Plan submitted to the Board by Vermont Wind on March 29, 2010, and revised May 26, 2010, indoor noise levels are to be calculated by subtracting the attenuation due to the façade of a residence from the exterior noise levels. The attenuation value is determined in accordance with an ASTM Standard, *ASTM E966-04 Standard Guide for Field Measurement of Airborne Sound Insulation of building Facades and Facade Elements (2004)*. According to the Noise Monitoring Plan, "[t]he outside-to-inside sound test will be performed under both windows open and windows closed conditions, weather permitting." To date, only windows closed attenuation measurements have been published by Vermont Wind, and only at two locations.

This report describes the outside to inside level reduction (OILR) of the Brouha residence in the second floor bedroom with the windows open. The bedroom faces the turbine array which is approximately 6,300 feet west of the home. The ASTM test procedure reveals that this bedroom experiences very little attenuation due to the façade when the windows are open.

Test Procedure

Outdoor to indoor noise attenuation of the western second story façade of the Brouha residence was measured on Wednesday May 2, 2012, using the procedure described in ASTM E966-04. A loud speaker was used to broadcast broadband noise at the façade from the direction of the turbines. A 15-20 second sample of the broadband noise was used to measure noise levels. Figure 1 shows the sound pressure levels vs. frequency of the sound source.

Figure 1: Sound Pressure Level of Speaker at 25 Feet.



The outside noise level was determined by measuring the sound pressure level (both A-weighted and 1/3 octave band levels) at 25 feet, the same distance the speaker was set up from the façade, but without any obstructions or reflecting surfaces nearby. The speaker and microphone were each between 9 and 10 feet high. The speaker was 79.4 dBA Leq at 25 feet.

The temperature was in the 50s Fahrenheit; the sky was overcast; and wind was 0-3 mph, with very occasional gusts that were less than 11 mph.

A CEL 590 Type 1 sound level meter was used for all measurements. It was calibrated before and after the measurements. Measurements were not made during gusts.

The free-field radiated sound pressure at 33 degrees off the center access of the speaker at 2000 hz was 6 dB less than the on-axis sound pressure. This speaker did not meet the 45 degree criterion discussed in 8.2.1 of the ASTM standard. The impact of this is negligible, however, given the narrow façade. The Façade is only 20 feet wide and the windows are approximately 7 feet wide. At 25 feet from the façade, the angle to the edge of the façade was less than 22 degrees and the angle to the edge of the windows was 8 degrees. The open windows were the primary avenue of sound transmission and therefore the edge of the windows is the angle of primary concern. Moreover, the angle of incidence was nearly perpendicular and in line with the turbines so a wider angle was unnecessary.

The speaker was mounted atop a ladder, 14 feet 6 inches high, which was lifted another 2 feet 10 inches by a farm tractor. The combined height was 17 feet, 4 inches and the speaker was in line with the turbines on the mountain as seen from the second floor bedroom. The bottom of the window was approximately 12 feet from the ground.

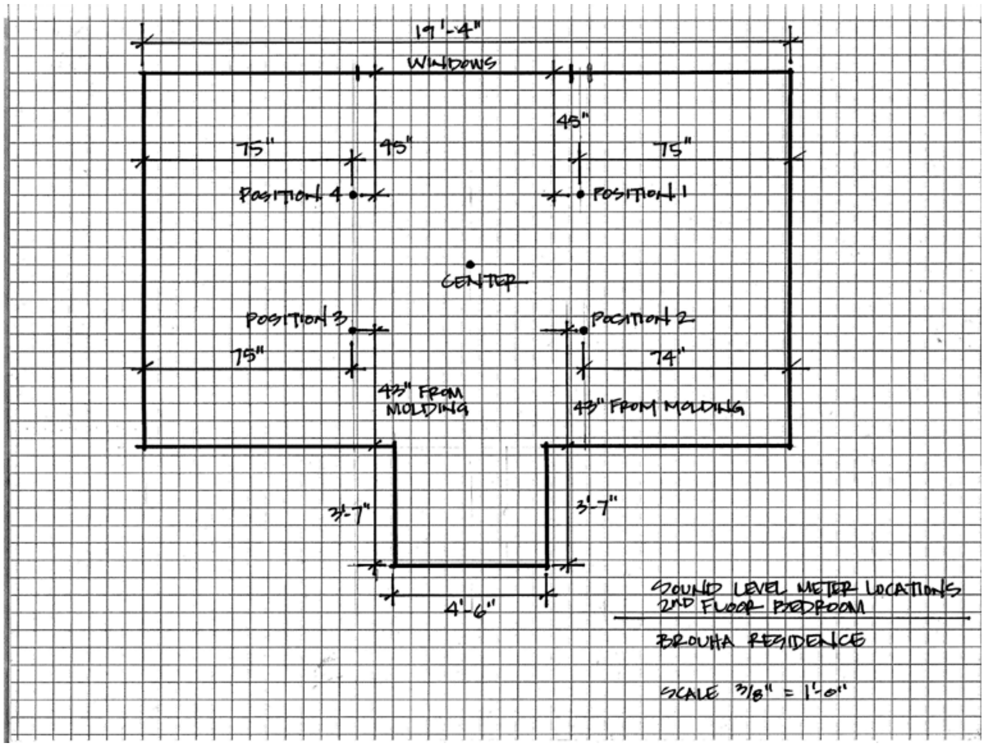
Background levels were taken and are presented in Table 1 below. They were well below the source noise levels used and the background contribution to noise measurements was negligible.

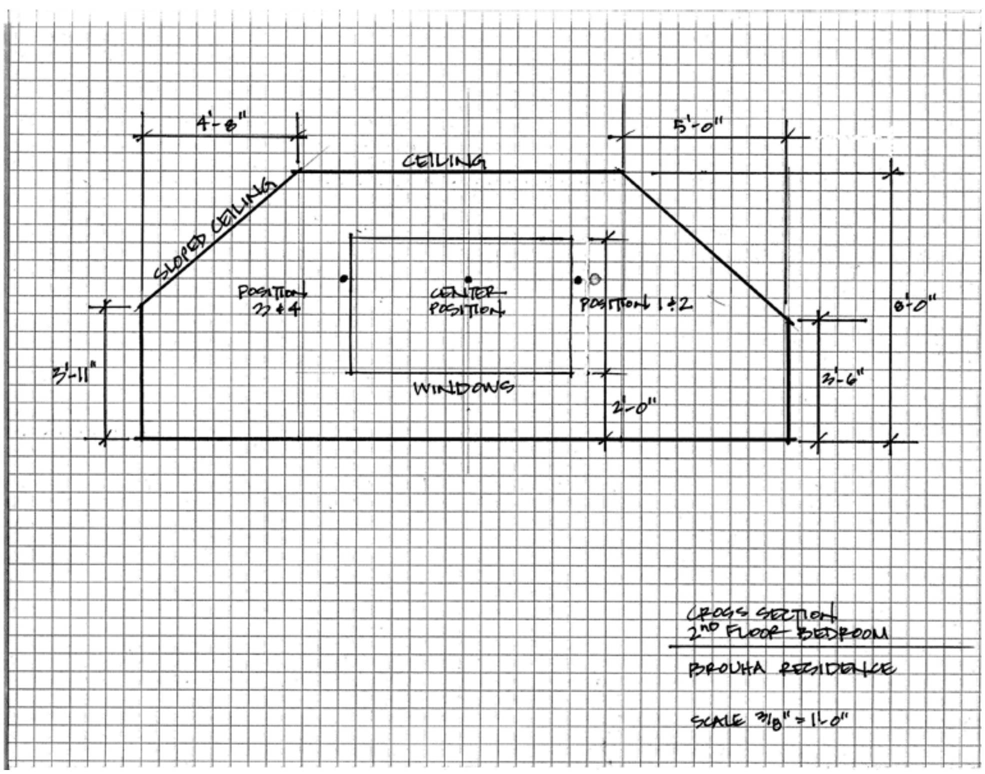
Table 1: Background Noise Levels

Background Levels	**Sound Pressure Level (dBA)**
Outdoor Background Levels	23-30 dBA
Indoor Background Levels with Windows Closed	23.4 dBA
Indoor Background Levels with Windows Opened	29.4 dBA

The test façade is the second story western wall of the home, with four 19x51 inch windows. The wall directly faces the turbines. Indoor measurements were made in the second story bedroom. The room was an enclosed space 19 feet 4 inches by 11 feet 5 inches. Five noise measurement locations were used, including a center position and 4 positions approximately 75 inches from the side walls and 45 inches from the front and back walls. The microphone height of the sound level meter was 5 feet, and was at least 3 feet 4 inches (1 meter) from all surfaces. Figure 2 below shows the room configuration.

Figure 2: Microphone Placement within Room (see full-sized drawings in Appendix)



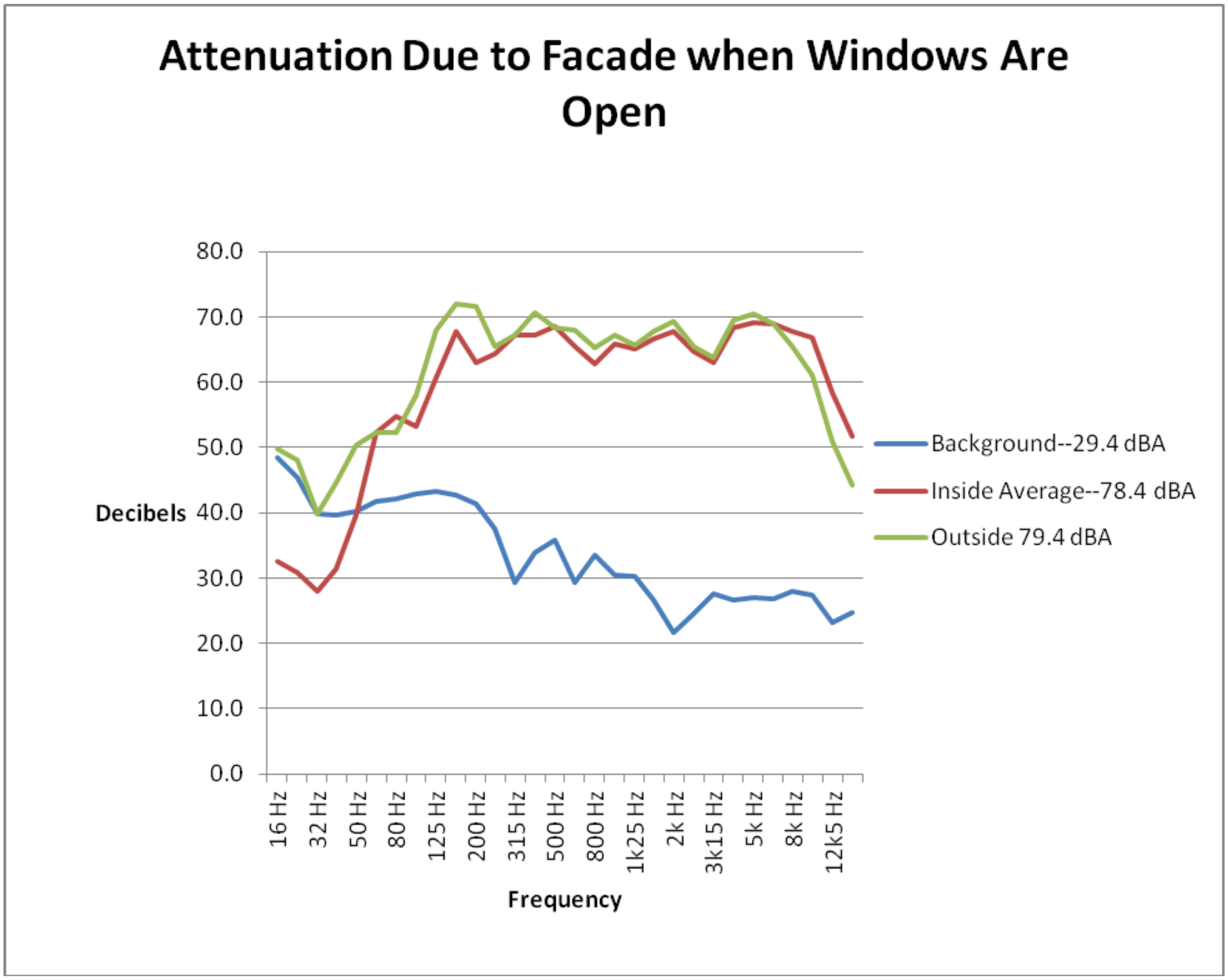


The room volume is 1558 cubic feet. Two beds were removed because they were located where four of the microphone locations were located and to reduce room absorption. The area rug was removed from the room as recommended in the ASTM procedure (at 7.4.1). The following hard objects were left in the room to increase diffusion: 3 plastic storage containers, 3 night stands, 1 desk, 1 small table, 1 luggage frame, 1 small mirrored dresser.

ASTM Test Results

Figure 3 below show the 1/3 Octave Band Frequency Spectra Outside and Inside the Brouha residence.

Figure 3: Attenuation Due to Façade with Windows Open



The reduction in noise levels in the important bands between 80 and 5000 hz, is quite small. Overall, there was a 1 dBA reduction in noise levels between outside and inside when windows are open.

Conclusions

The second floor bedroom of the Brouha residence experiences very little attenuation due to the façade when the windows are opened. The attenuation was 1 dBA using the *ASTM E966-04 Standard. This is* significantly less than the 30 dBA, 33 dBA, and 38 dBA used by Vermont Wind in its Quarterly Noise

Reports. What this means is that exterior noise levels exceeding 31 dBA Leq will exceed the Public Service Board's 30 dBA Leq (1)noise standard. For example, with exterior noise levels at the Brouha residence of 37dBA, and with a 1 dBA reduction in noise due to the façade when windows are open, interior noise levels at the Brouha residence would be 36dBA, or 6 dBA over the standard set by the Public Service Board.