CHARACTERISTICS OF WIND TURBINE NOISE

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1. INTRODUCTION

Wind power is one of the most promising renewable energy sources available, due to technical advances in the field and its relatively low cost. Wind turbines can produce a large amount of electricity, but the public surrounding these farms are responding negatively to the installation of these turbines in a rural setting. One of the negative aspects expressed vocally by anti-wind farm groups is the special character of the wind turbine noise. Strong complaints have been lodged concerning the health impacts of the low-frequency components of wind turbine noise as well as the amplitude modulation of the rotating noise. A series of measurements were conducted to address the above issues. Two different types of wind turbines were monitored under different scenarios. A low frequency microphone in the operating range of 1 Hz to 10000 Hz was used for the measurement programme. The measurement results of the case study are presented in this paper.

2. BACKGROUND

One of the main noise concerns raised against wind turbine facilities is the presence of inaudible infrasound and their impact on receptors such as dizziness, heart conditions and other such negative health effects. The first generation of wind turbines from the early 80s had strong low frequency components with an old type gear-box located on the ground. The low frequency components are usually expressed in terms of a dBG scale as contained in ISO Standard 7196[1]. The modern wind turbines have very little low frequency components as reported by van den Berg[2], Howe[3], and Levanthal[4]. Levanthal[4] even concluded that most of the loud and belligerent response from anti-wind farm group literature is deceptive.

3. THE EXPERIMENT

The main aim of the experiment was to evaluate the presence of low-frequency components below 20 Hz as well as the amount of amplitude modulation of the wind turbine noise. Very preliminary results were presented in Inter-Noise 2009 conference held in Ottawa, Ontario[5].

The following instrumentation was used for the experiments. A Soundbook analyzer, made by SINUS Messtechik of Germany, was used with GRAS 40AN low-frequency microphone. The whole system is capable of measuring from 0.5 Hz to 10,000 Hz frequency range.

Two areas were chosen for the measurements. The first location, Area A, was serviced by a single wind turbine. The wind turbine characteristics were: 600 kW 3-bladed turbine with 52 m diameter blades. The hub height is 65 m and the nominal rotational speed is 24.5 rpm. The operating wind speed range is 2.5 m/sec to 25 m/sec. Two locations were chosen, a) right under the wind turbine and b) about 30 m from the wind turbine and in direct line of sight of the turbine. The measurements were conducted between 1 am and 2 am so that the influence of road traffic noise from adjacent roadways would be minimal. The wind gusts at 2. 5 m height were minimal.

The second group, Area B, was serviced by more than 50 wind turbines. The wind turbine characteristics were: 1.5 mW 3-bladed turbine with 40 m diameter blades. The hub height is 80 m. Five locations were chosen: i) about 10 m from one wind turbine with minimal influence from other wind turbines; ii) impact from at least 5 wind turbines and the rest of the wind turbines were more than 250 m away; iii) impact from one wind turbine and secondary impact from at least 5 wind turbines and the rest of the wind turbines were more than 250 m away; iv) near a residence with the turbines at least 100 m away; and v) near another residence with one turbine within 50 m and others further away. The measurements were conducted between 4 pm and 5 pm and the wind gusts at 2. 5m height were severe at times. The readings were taken with minimal road traffic as much as possible

4. RESULTS AND DISCUSSION

The measurements were recorded for 15 seconds for Area A and 25 seconds for Area B. The results of the measurements are presented in this section.

The results from one 15 second reading at Location (a) and one 15 second reading at Location (b) are presented below.

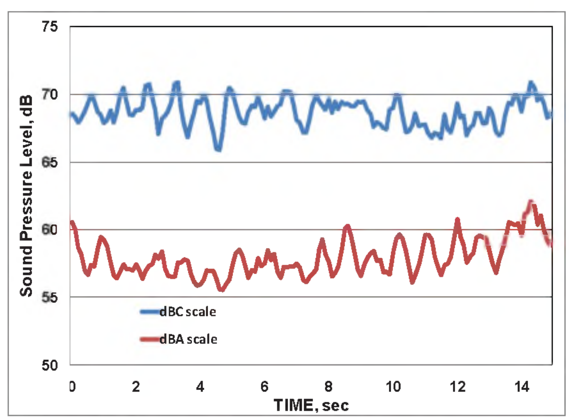

Figure 1. Time History for Location (a), Area A

The results of Figure 1 clearly show that the amplitude modulation can be as high 5 dB right below the 600 kW turbine.

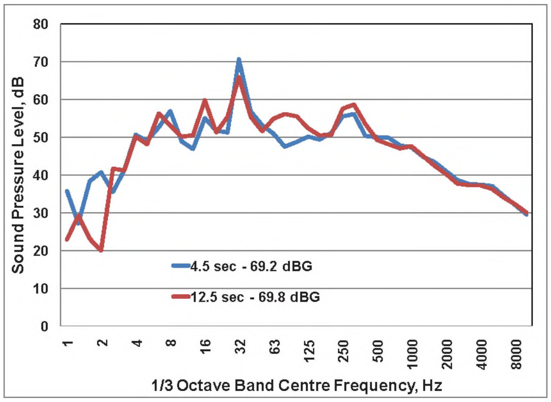

Figure 2. Spectrum for Location (a), Area A

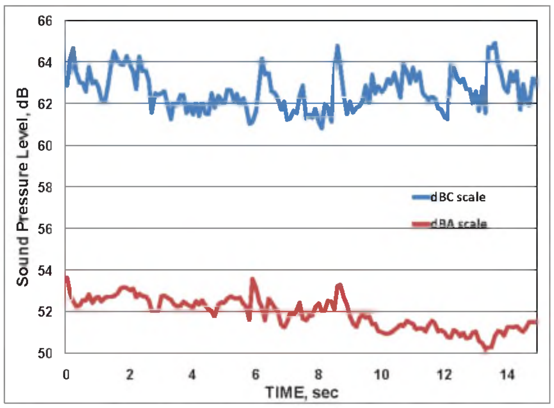

Figure 3. Time History for Location (b), Area A

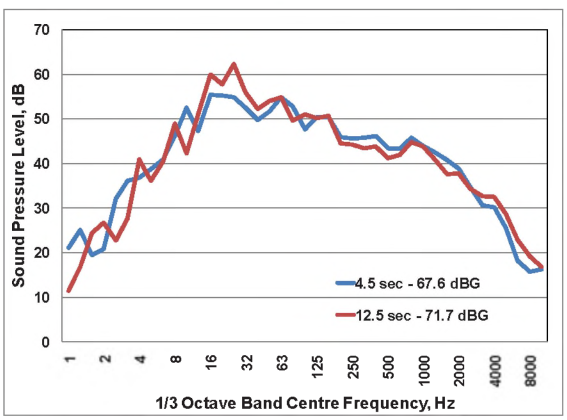

Figure 4. Spectrum for Location (b), Area A

Somewhat similar results are seen for Location b of Area A. The amplitude modulation gets submerged in the background sound and one can discern a 2 dB or less amplitude modulation. The one-third octave band spectra for Location A are presented in Figures 2 and 4. The overall dBG is less than 75 dBG and no frequency components of any major dominance are seen below 5 Hz. The blade-passage frequency is around 1.5 Hz.

Results for Area B are shown in Figures 5 and 6. Similar results to that of Area A are seen even though the turbine produces more power. The ambient wind seems to dominate over the turbine noise. Amplitude modulation of about 5 dB can be discerned from the dBA plot. The spectral results show that there are no dominant frequency components below 5 Hz and the overall dBG is less than 70 dBG and less than the 75 dBG threshold.

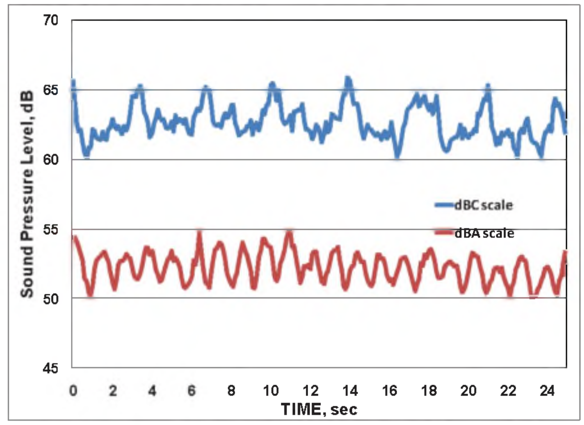

Figure 5. Time History for Location (i), Area B

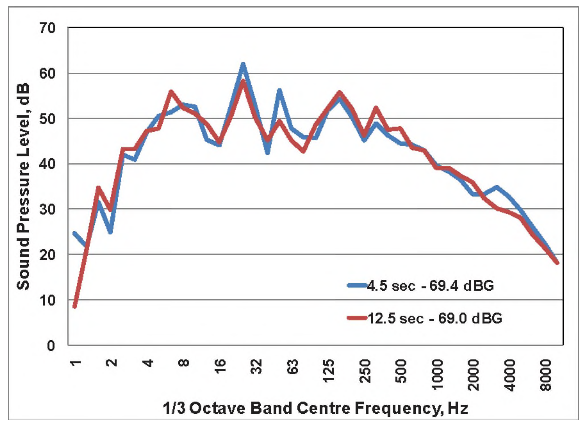

Figure 6. Spectrum for Location (i), Area B

5. CONCLUSIONS

Preliminary results from two different wind turbines show that there is amplitude modulation up to 5 dB, but the infra-sound is non-existent.

REFERENCES

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