THE EFFECT OF WIND GENERATED NOISE ON SOUND MEASUREMENTS AND HOW WINDSHIELDS HELP

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1 ABSTRACT

Legislation and guidance publications recommend meteorological conditions that are favourable for making environmental noise measurements. However, it is not always possible or appropriate to make measurements under these conditions. The effect of meteorological conditions upon acoustic signal propagation has been investigated, but the effect of the noise generated by the flow of air past the microphone is often overlooked. Experiments have been performed to investigate how this wind-generated noise varies with wind speed. Simultaneously recorded acoustic and meteorological data have been measured over flat grassland with wind speeds between 2 and 13m/s. The effect of removing the microphone windshield has also investigated.

2 INTRODUCTION

Ideally noise measurements should be made under favourable weather conditions to minimise the influences of meteorology on the sound measurements. Suitable weather conditions for particular measurements are usually defined within the relevant publications such as PPG 24 (1994) [1] and BS4142 (1990) [2]. However, it is not always possible to make measurements under these conditions, for example if the event to be measured only occurs during high winds.

In addition to influencing the acoustic signal propagation, the wind generates noise at the microphone. Wind-induced noise is often the most significant source of background noise outdoors and therefore should be considered, particularly when trying to measure low-level signals. The aim of this study was to investigate the characteristics of the noise induced by the flow of air past a ½ microphone, the impact that this wind-induced noise has upon outdoor noise measurements and the benefits of using a foam windshield.

3 WIND-INDUCED NOISE AT THE MICROPHONE

Turbulence is produced by the presence of the microphone in a moving air stream. This generates unwanted signal that is superimposed on the acoustic signal received by the microphone. Microphone manufacturers recommend that microphones are fitted with a polyurethane foam windshield to reduce the effects of wind-induced noise. Windshields are effective at reducing wind-induced noise, but do not completely eliminate it.

The use of a windshield will slightly effect the free-field response characteristics of the microphone, particularly at high frequencies, but correction curves are available and can be used to correct this. Experiments have been performed to investigate the characteristics of wind-induced noise at a microphone and how this varies with wind speed. The effect of removing the foam windshield was also investigated.

4 EXPERIMENTAL METHOD

Four experiments took place over an 18-month period in order to obtain a set of wind-induced noise measurements over a range of wind speeds from 2m/s to 13 m/s. Experiments took place over flat grassland in remote areas with few other sources of background noise. Acoustic data were recorded to a 16-channel DAT recorder. Four ½ free-field microphones were positioned at the corners of a square of side 20m. The microphones were positioned 1.2m from the ground and were orientated at 180° to the ground so that the airflow due to the wind was incident at 90° to the diaphragm. The microphones were fitted with 90mm polyurethane foam windshields. Meteorological data was recorded by an automatic weather station on a 10m mast.

The wind speed data was studied in order to determine periods of time when the variation in wind speed was low and the mean wind speed corresponded to 2, 4, 6, 8, 10 and 12 m/s. For each of these mean wind speeds the corresponding acoustic data were used to obtain a minimum of five $L_{Aeq,\ 5min}$ measurements. The overall wind noise levels and 1/3 octave band levels were determined for each wind speed by calculating the arithmetic average of the $L_{Aeq,\ 5min}$ measurements.

5 RESULTS

Figure 1 shows that wind-induced noise levels for a ½ microphone fitted with a windshield increase with wind speed, but this is not a linear relationship. For wind speeds below 5m/s and above 10m/s, this increase is approximately 1dB per 1m/s increase in wind speed. For wind speeds between 5 and 10m/s, the wind-induced noise level increases at 2.5dB per 1m/s increase in wind speed. Wind-induced noise levels were found to be related to wind speed only. Changes in wind direction had negligible effect upon the average wind-induced noise levels at the microphone.

Figure 2 shows that the frequency spectrum of the wind-induced for a ½ microphone fitted with a foam windshield falls at a rate of between 5 and 8dB per octave from 1Hz to around 1.5kHz. Increases in the wind speed cause similar increases in all 1/3 octave bands, therefore the relative frequency content of the wind noise signal is unchanged.

The results at Table 1 show that fitting the windshield reduced the wind-induced noise level by 16.7dB (28.7dB(A)). Figure 3 shows the effect of the windshield on the frequency spectrum of the wind-induced noise. The windshield provides 20 to 30dB of attenuation in the 1/3-octave bands up to 2.5kHz. The attenuation falls of gradually above 2.5kHz. The highest attenuation occurs between 100 and 500Hz.

6 DISCUSSION

The results of these experiments have shown that wind-induced noise can have a significant effect on the signal to noise ratio at the microphone when making outdoor noise measurements. This effect is related only to wind speed and not wind direction, therefore, although the vector wind speed in the direction of propagation maybe low, the overall wind speed must be considered when assessing the likely level of wind-induced noise at the microphone.

For wind speeds between 5 and 10m/s the wind-induced noise increases at a rate of 2.5dB per 1m/s increase in wind speed. Wind speeds commonly fluctuate between these values throughout a day, so it is important to consider that the background noise level due to the wind alone could vary by up to 15dB during this period.

Fitting a foam windshield to the microphone has been shown to attenuate wind-induced noise by 16.7dB. When A-weighting is used, the windshield reduces the wind-induced noise by 28.7dB.

7 CONCLUSIONS

A foam windshield should be fitted to the microphone when making acoustic measurements outdoors. Windshields are very effective at reducing wind-induced noise, particularly when using A-weighting, but corrections to the free-field response of the microphone will be necessary.

Wind–induced noise is mainly low frequency (below 1kHz). The frequency spectrum falls at a rate of 5 to 8dB per octave between 1Hz and 1.5kHz and the relative frequency content does not vary with wind speed.

The level of wind-induced noise at the microphone is related to the wind speed and not direction, therefore the orientation of the receiver with respect to the source will have negligible effect on the wind noise level. Wind-induced noise levels increase with wind speed. The measured increase in wind noise level between wind speeds of 2m/s and 12m/s was 17dB. The rate of increase in wind-induced noise level with wind speed is greatest for wind speeds between 5 and 10m/s. Ideally, outdoor measurements should be made when the wind speed is less than 5m/s to minimise the overall wind-induced noise level at the microphone and the variation in this level over the measurement period.

8 REFERENCES

1. PPG 24 (1994) Planning policy guidance: Planning and noise. Department of the Environment.
2. BS4142 (1990) Method for rating industrial noise affecting mixed residential and industrial areas.

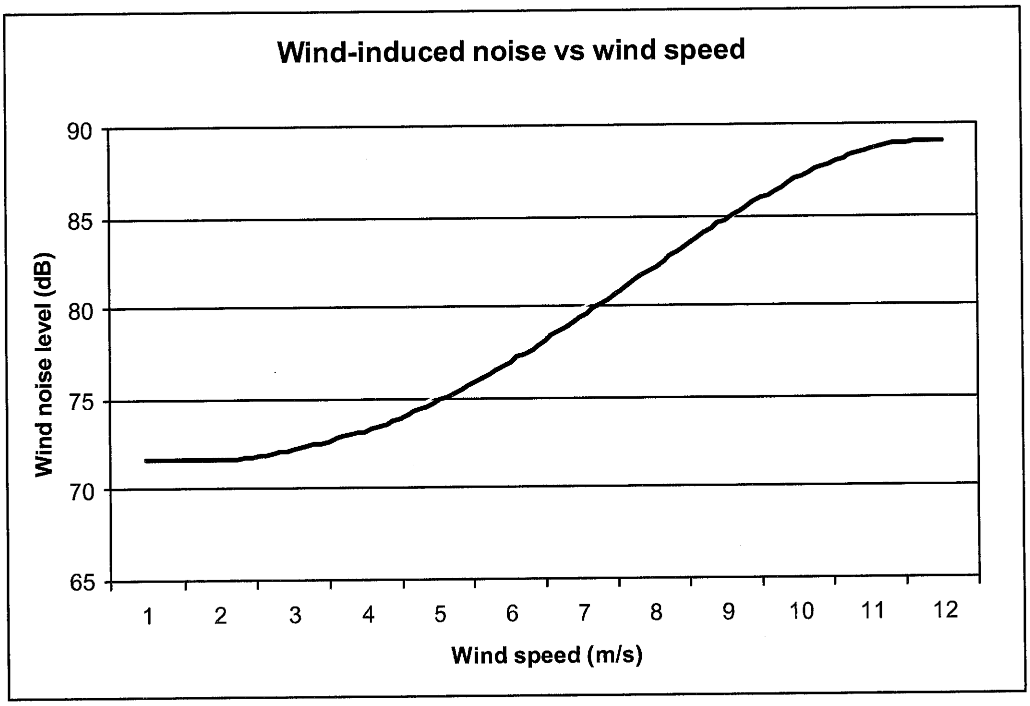

Figure 1: Variation of wind-induced noise at a ½ microphone fitted with a 90mm foam windshield with wind speed. (Data has been smoothed for clarity).

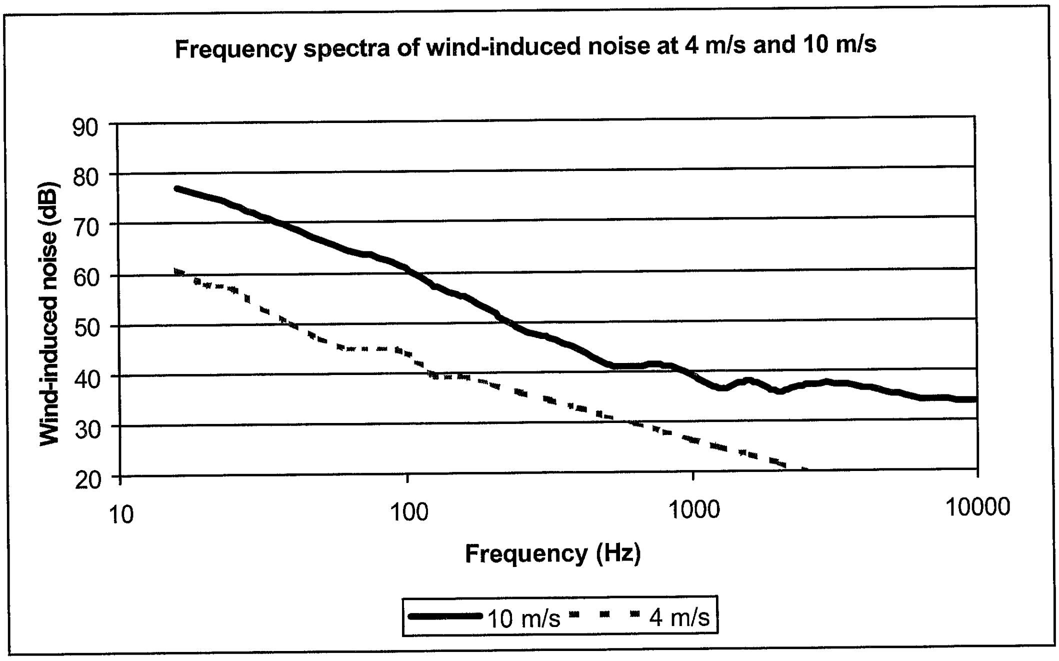

Figure 2: Frequency spectra of wind-induced noise at a ½ microphone fitted with a 90mm foam windshield at wind speeds of 4 m/s and 10 m/s.

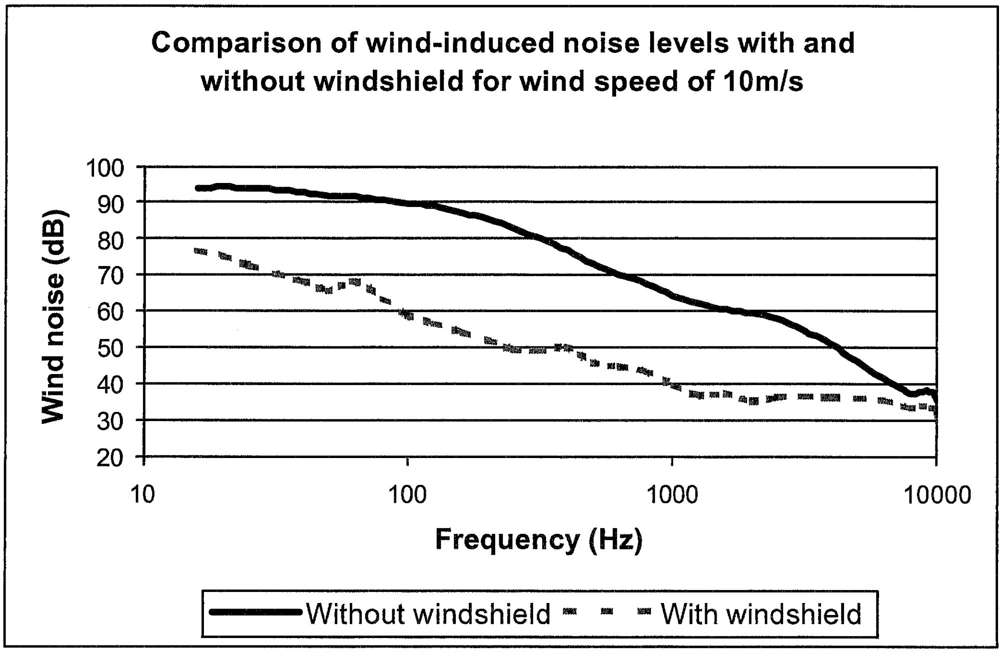

Figure 3: Comparison of wind-induced noise levels with and without windshield for wind speed of 10m/s

	$L_{Aeq,\ 5min}$ (dB)	$L_{eq,\ 5min}$ (dB)
Windshield fitted	45.7	79.5
Windshield removed	74.3	96.2

Table 1: Wind-induced noise levels with and without windshield for wind speed of 10m/s