Technical Note

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EFFECT OF A 35 dB(A) MINIMUM CRITERION ON A WIND FARM DEVELOPMENT

Adam Cook[1], Tom Evans[2] and Rhys Brown[3]
[1]AECOM, Level 28, 91 King William Street, Adelaide, SA 5000
[2] Resonate Acoustics, 97 Carrington Street, Adelaide, SA 5000
[3]AECOM, Level 8, 540 Wickham Street, Fortitude Valley, QLD 4006

INTRODUCTION

Environmental noise criteria for wind farms in Australia are normally determined individually for nearby receiver locations. The criteria take the form of a minimum criterion or the background $L_{A90,10min}$ noise level plus 5 dB(A), whichever is the greater, for each integer wind speed between turbine cut-in and rated power.

At low wind speeds, the minimum criterion typically applies due to the lower background noise levels than during periods of higher wind speeds. A minimum criterion of 40 dB(A) is specified in the following standards and guidelines that are typically applied in Australia:

- New Zealand Standard 6808:1998 *Acoustics – The assessment and measurement of sound from wind turbine generators* (NZS 6808:1998) [1]
- New Zealand Standard 6808:2010 *Acoustics – Wind farm noise* (NZS 6808:2010) [2]
- South Australian *Wind Farms Environmental Noise Guidelines* 2009 (2009 SA Guidelines) [3].

In Western Australia and New South Wales, the 2003 version of the South Australian *Wind Farms Environmental Noise Guidelines* (2003 SA Guidelines) [4] has been adopted for the majority of recent wind farm projects, and this version applies a 35 dB(A) minimum criterion.

It is important to note that both NZS 6808:2010 and the SA Guidelines also consider a 35 dB(A) minimum criterion, although the application of this is limited to particular situations. NZS 6808:2010 states that a 35 dB(A) minimum criterion may be applied in "high amenity areas" which is to be considered only where a district plan promotes a higher degree of acoustic amenity protection to an area, and where the wind speed and measured background noise levels are low enough to justify the application. The SA Guidelines apply a minimum criterion of 35 dB(A) to receivers located in areas primarily intended for rural living, as defined by the relevant Development Plan. However, this is not commonly applied in our experience, as most wind farms are located in zones intended for primary production.

This technical note investigates the effect of applying a minimum criterion of 35 dB(A) based on AECOM's database of background noise measurements at 60 separate receiver locations adjacent to 10 different wind farm developments. Noise criteria are determined for both a 35 and 40 dB(A) minimum criterion, and the difference in criteria between the two cases investigated for three different wind turbine models.

This is also relevant to the recently released *Draft NSW Planning Guidelines: Wind Farms* (Draft NSW Guidelines) [5]. These guidelines propose a minimum criterion of 35 dB(A) and suggest that, because of the 5 dB(A) reduction in the minimum criterion, turbines will be sited approximately twice as far away as would be required in other Australian states.

BACKGROUND NOISE LEVELS

Background $L_{A90,10min}$ noise level measurements undertaken by AECOM at over 60 sites have been collated to determine a mean background noise level at hub height wind speeds for the measurement set. All of the noise level measurements are correlated against hub height wind speeds at the meteorological mast at the proposed wind farm site (a height of approximately 80 metres), and periods of rain and extraneous noise have been removed from the data set. After removal of these data points, the majority of the measurement sites include over 2000 data points, with 12 sites including between 1400 and 2000 data points.

The average background noise level at each integer wind speed for each site was determined by a best fit regression analysis. A mean background noise level for the entire dataset was then determined by averaging the background noise levels at each integer wind speed across the sites. Finally, a best fit regression analysis was conducted on the average background noise levels to determine a background noise level at each integer wind speed for the 60 sites.

The above analysis has been conducted in accordance with the method prescribed in the 2009 SA Guidelines, with the exception that all wind speeds have been considered and not just those between turbine cut-in and rated power. This has been done intentionally to provide an indication of the lower wind speeds at which the 35 dB(A) criterion may affect the end compliance result. This method is similar to the 2003 SA Guidelines except that it considers wind speeds at hub height rather than at 10 metre height. The use of hub height wind speeds is preferable as it minimises the potential effects of air stability which can result in variations in the relationship between wind speeds measured at hub height and those at 10 metres.

Figure 1 presents the mean background noise levels (with bars shown corresponding to one standard deviation), the best

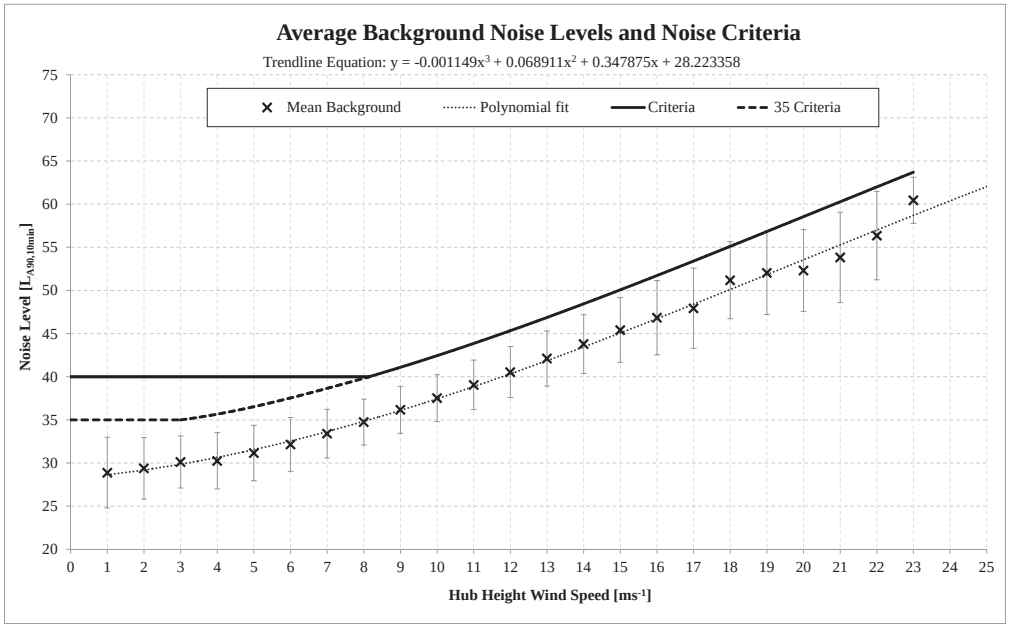

Figure 1. Average background noise levels and noise criteria

fit regression curve and the corresponding noise criteria for a both a 35 dB(A) and 40 dB(A) minimum criterion.

The results indicate that a 35 dB(A) minimum criterion would typically control the noise criteria at hub height wind speeds of approximately 3 to 4 m/s before the background noise level starts to increase with higher wind speed. The criteria determined under both situations would typically be identical at wind speeds of approximately 8 m/s or greater.

WIND FARM NOISE LEVELS

Wind farm noise levels will also increase with increasing wind speed, as the turbine sound power levels increase between cut-in and rated power. Evans and Cooper [6] found that the increase in turbine noise level against hub height wind speed at a receiver location closely matched the increase in the sound power level of the turbines at the wind farm.

Therefore, to approximate the wind farm noise level at a receiver location for comparison with the noise criteria

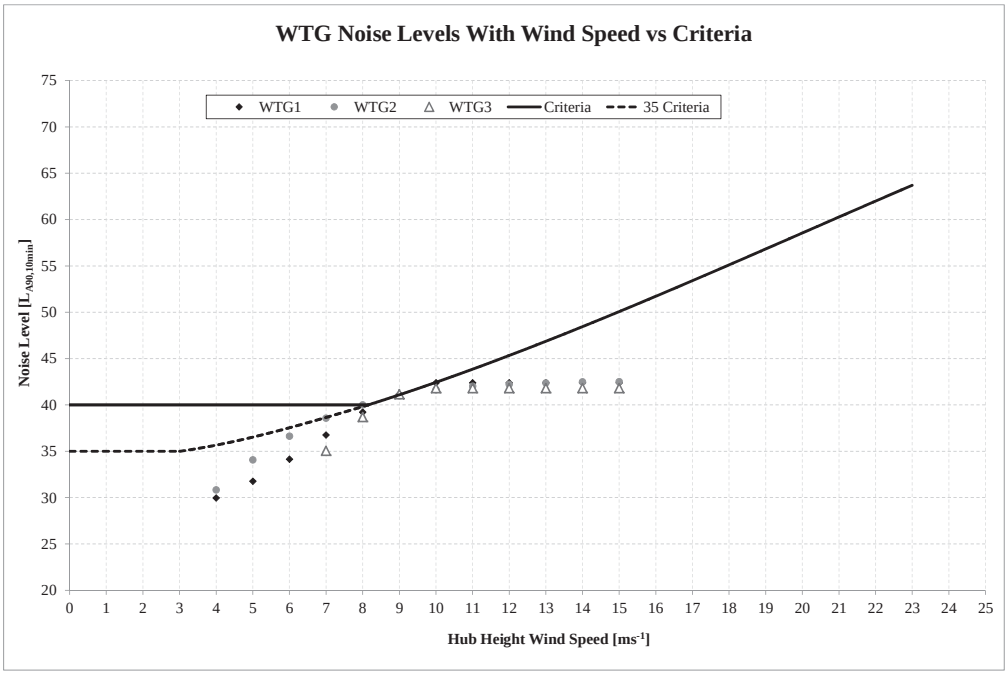

Figure 2. WTG noise levels with wind speed vs criteria

presented in Figure 1, the sound power levels of three modern wind turbines against hub height wind speed were sourced from manufacturer data available online. The three turbines, each from a different manufacturer, are:

- WTG 1: Vestas V112-3.0MW [7]
- WTG 2: Nordex N90 2.5MW [8]
- WTG 3: GE 2.5MW-103 [9].

The sound power versus wind speed profiles for the three turbines were scaled so that compliance with a 40 dB(A) minimum criterion would just be met, emulating noise levels at a location where the wind farm had been designed to comply with a 40 dB(A) minimum criterion. The turbine noise levels are plotted against the previously determined noise criteria in Figure 2.

The results in Figure 2 indicate that the application of a 35 dB(A) minimum criterion has minimal effect on the compliance of a proposed wind turbine layout with the noise criteria, for the turbine models considered. This is as the peak noise levels occur at hub height wind speeds above 8 m/s.

Table 1 summarises exceedances of the criteria that would occur when incorporating a 35 dB(A) minimum criterion at each of the 60 measurement sites based on a turbine noise level just compliant with the 40 dB(A) criteria. It can be seen that the majority of the receivers remain compliant with the more stringent criteria. For 90% of the receiver locations, there would be no noticeable reduction in noise levels (i.e. 2 dB(A) or less) due to the application of the 35 dB(A) minimum criterion, whichever of the three turbine models were selected.

Table 1. Percentage of receiver sites at which exceedance of criteria with 35 dB(A) minimum criterion would occur

Exceedance	WTG 1	WTG 2	WTG 3
0 dB(A)	80%	60%	78%
1 dB(A)	12%	22%	12%
2 dB(A)	3%	7%	5%
3 dB(A)	2%	8%	2%
4 dB(A)	3%	3%	3%
5 dB(A)	0	0	0

DISCUSSION

Based on an analysis of background noise measurements at 60 sites adjacent to 10 different wind farm developments, and manufacturer's data for three different wind turbine models, it appears that a turbine layout designed to comply with a 40 dB(A) minimum criterion would still comply with a 35 dB(A) criterion in the majority of cases. At 90% of the considered receiver locations, there would be no noticeable reduction in noise levels required to achieve compliance with the more stringent criteria (i.e. 2 dB or less). This appears to contradict the assumption that a 35 dB(A) minimum criterion would result in turbines being sited significantly further away from residences.

A further suggestion from this analysis is that Regulatory authorities that currently apply the 2003 SA Guidelines could consider the adoption of the updated 2009 SA Guidelines, with minimal changes to noise levels at residential locations. The 2009 SA Guidelines provide other advantages such as updated noise level measurement, prediction and assessment techniques. The use of hub height, rather than 10 metre height, wind speeds is one example.

REFERENCES

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