Technical Report

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Project

Barnsley BSF
Wind Turbine Noise Assessment
Carlton School

Prepared for

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Summary

Surveys have been done to help assess the impact of noise from the proposed wind turbine installation at Carlton School on neighbouring dwellings. Surveys are reported of the measurement of background noise levels at different times of day and of the measurement of the variation of background noise with wind speed. The measurements have been assessed following the method recommended by the Working Group on Noise from Wind Turbines – Final Report (ETSU-R-97).

We conclude that at the dwellings closest to the proposed wind turbine, the ETSU criteria will be met at all wind speeds.





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1. Introduction

As part of the first phase of the BSF development for Barnsley, it is proposed to erect one or more wind turbines at each of the schools in the scheme. In seeking planning approval for this, it is necessary to have assessed the acceptability of noise from the wind turbines affecting the nearby residents. This report considers the noise impact from the operation of two wind turbines at Carlton School.

2. Proposed Wind Turbine Installation

As part of the construction of Carlton School it is proposed to erect two wind turbines on the school site. They would be located, as indicated on the plan in Appendix 1. To the southwest, dwellings in Far Lawns and Cronkhill Lane would have a clear view of the turbine. The closest dwellings are at a distance of 160 metres.

The type of wind turbine proposed is the Proven Energy WT 15000, with the turbine hub installed at 15 metres above ground level. The specifications for this turbine shows that it cuts in at a hub wind speed of 3m/s and starts overspeed control at 13m/s.

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3. Assessment Methodology

The method of assessing noise impact on-site follows that recommended by the Working Group on Noise from Wind Turbines – Final Report (ETSU-R-97).

The wind turbine noise level, expressed as L_{A90}, is predicted at the most affected dwelling(s). If appropriate a tonal correction is made. These predictions are based on measurements done by an independent test organisation of noise output as a function of wind speed. In this case the measurements were done by TUV NEL to an industry protocol, the Small Wind Turbine Performance and Safety Standard (29 February 2008) published by BWEA (British Wind Energy Association).

The background noise level, also expressed as $L_{A90\text{-}10min}$, is measured at the dwelling(s). This must be done at different times and at wind speeds over the range at which the wind turbine is expected to operate, because the background noise level will vary with wind speed. The wind speed as a 10 minute average is measured simultaneously, at the recommended reference height of 10 metres above ground level, at a location representative of the proposed wind turbine siting. The corresponding wind speed at hub height of the proposed turbine is calculated by adjusting the measured speeds according to the equation given in the ETSU report.

The predicted wind turbine noise level is then compared with both

- fixed noise level criteria
- the background noise level as a function of wind speed

The corrected wind turbine noise is considered acceptable outside dwellings if it is no greater than:

- 35dB $L_{A90\text{-}10min}$ during the daytime
- 43dB $L_{A90\text{-}10min}$ during the night-time

  or

- the background $L_{A90\text{-}10min}$ +5dB at any time

  whichever is the higher.

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4. Wind Turbine Noise Levels

The measured and declared sound power levels at 8m/s for the Proven Energy WT 15000 are 94.3 and 97 dBA (L_{wA}) with no tonal correction needed.

This is based on the measured noise levels which show a scatter of results at any given wind speed. Linear regression is done to derive the trend (equation of noise level versus wind speed) and standard deviation to measure the degree of scatter. The declared level is the calculated level at 8m/s plus 1.645 x the standard deviation.

The trend line is significantly different above and below an average speed of 9m/s, due to the way the turbine operates and interacts with the wind. The trend line is given by

$L_{Aeq} = 1.94u + 46.64$ $\quad 3 \le u \le 9$ m/s

$L_{Aeq} = 0.66u + 64.11$ $\quad 9 < u < 15$ m/s

where u is the wind speed at hub height.

The Working Party guidelines use the L_{A90} of the turbine noise as the index for assessment, using the relationship $L_{A90} = L_{Aeq}$-2dB. They recommend assessment is done up to an average wind speed of 12m/s (at 10m height). They also recommend that the wind speed at the hub height (u_h) is calculated from the averaged wind speed at the reference height (u_{10}) of 10 metres using the relationship:

$u_h/u_{10} = \ln(\frac{h}{z_o})/\ln(\frac{10}{z_o})$ where z_o is the roughness factor of the local ground cover. Examples of roughness factor that they give indicate a suitable value for this area to be of the order of $z_o = 0.01$.

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5. Background Noise Measurement

Ambient noise levels (L_{A90} and L_{Aeq}) were measured at different times of day and under different conditions as follows:

i) During the middle of the night-time with no or low wind (below the speed at which the turbines would operate)

ii) During the late evening, as being representative of the quietest part of daytime, with no or low wind

iii) On at least two different days under different wind conditions. Measurements were done on different days in order to monitor a spread of wind speed within the range 3 to 12m/s

The majority of measurements were located close to residential properties that were thought most likely to be affected by wind turbine noise. These were houses on Cronkhill Lane as shown at location 1 in the plan in Appendix 1. Also shown is the location of the wind monitor, which was on a mast at 10 metres above ground level. During the surveys during windy conditions ((iii) above), average wind speed measurements were made every 10 minutes to correspond with the 10 minute background noise level (L_{A90}) measurements.

By the date higher wind speeds were encountered, the construction noise was too continuous at location 1 for measuring even L_{A90} levels. Therefore, the monitoring location was moved about 300 metres to the south-east, off Shaw Lane, to where we consider the wind generated background noise will be very similar. This is shown in Appendix 1 as location 2.

The equipment used to make the measurements and other survey details are given in Appendix 2. The large spherical B&K windshield was used to prevent noise generated at the windshield invalidating the results. It is less affected than other commercially available windshields.

The results are tabulated in Appendix 3. Measurements of L_{Aeq} are included for information although not used in this assessment.

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6. Assessment

The measured relationship between background noise and average wind speed (measured at 10m height) is plotted on figures 1 to 2 in Appendix 4. Linear and geometric regression (trend) lines have been calculated and superimposed on figures 1 and 2 respectively, together with the 'goodness' of fit (R). At low wind speeds the trend line goes below the measured 'no wind' background. In these circumstances the wind generated noise is not affecting the overall background level and is not included in the regression analysis.

The predicted turbine noise at the nearest residences is also superimposed on the plots. This calculation is based on the trend line equations, given in section 4, and the wind speed adjusted to a height of 15m.

Under no and low wind conditions the wind was considered not to affect the background noise levels. Background levels measured during the wind noise survey were sometimes significantly affected by construction noise and these readings were disregarded as not representative. At moderate wind speeds the L_{A90} level was between 42 and 45 dB. At higher wind speed the background was measured up to 50 dBL_{A90}.

The plot of background noise versus wind speed shows a very good correlation (R>0.9). There is no difference between the linear and geometric regression curves over the range measured. As the wind speed drops, one would theoretically expect the wind generated noise to decrease to nothing (-∞dB) at zero wind speed, so a geometric fit might be better. However, other curves will determine the background noise level well before this point is reached.

With no or very low wind the lowest background (L_{A90}) levels measured were as follows:

Daytime (evening) – 32 dBL_{A90}
Night-time – 24 dBL_{A90}

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Daytime:

- Lowest background is 32 dBL_{A90}
- Criterion for turbine noise is the higher of 35 dBL_{A90} and (background +5 dB)
- The lowest background +5 dB is 37 dBL_{A90}
- Therefore, the lowest daytime criterion for turbine noise is 37 dBL_{A90}, which they would reach at a wind speed of 5m/s at the reference height of 10m above ground level.
- At this wind speed of 5m/s (10m), the background noise (+5 dB) would be 47 dBL_{A90} , well above the turbine noise level.
- At higher wind speeds, up to 8m/s, the background noise level is greater than the predicted turbine noise level by at least 5dB. Therefore, the turbine noise would be well below the background + 5 dB.
- Above a wind speed of 8m/s, the predicted background noise level is slightly lower than the turbine noise level. The turbine noise level would, however, be less than the background + 5dB.

Night-time:

- Lowest background is 24 dBL_{A90}
- Criterion for turbine noise is the higher of 43 dBL_{A90} and (background +5 dB)
- The lowest background +5 dB is 29 dBL_{A90}
- Therefore, the lowest daytime criterion for turbine noise is 43 dBL_{A90}, which they would reach at a wind speed of 5m/s at the reference height of 10m above ground level.
- At this wind speed of 5m/s (10m), the predicted background noise (+5 dB) would be 50 $dBL_{A90,}$ well above the turbine noise level. At higher wind speeds, up to 8m/s, the background noise level is greater than the predicted turbine noise level by at least 5 dB. Therefore, the turbine noise would be well below the background + 5 dB.
- Above a wind speed of 8m/s, the predicted background noise level is slightly lower than the turbine noise level. The turbine noise level would, however, be less than the background + 5dB

Therefore, the data show that at all appropriate wind speeds the ETSU criteria would be met for the turbines as proposed.

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7. Concusions

The measured data indicate that the ETSU criteria for the acceptability of wind turbine noise would be met at all wind speeds for both daytime and night-time with two turbines located as proposed.

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Appendix 1

Plan showing Measurement Locations



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Appendix 2

Survey Details

A1. Location of Surveys

Carlton, Barnsley. For measurement positions see Appendix 1.

A2. Dates & Type of Surveys

13 & 14 October 2009 – Evening/Night-time, no/low wind
24 October 2009 – Daytime, moderate wind
19 November 2009 – Daytime, high wind

A3. Personnel Present During Surveys

Mark Graham (13 & 14 October 2009)
Mark Hinds (24 October & 19 November 2009)

A4. Instrumentation

Bruel & Kjaer
Type 4231 Sound Level Calibrator, S/N 2528393
Type 2270 Sound Level Meter, S/N 2623080
Type 4189 Microphone, S/N 2638475
Type 4231 Sound Level Calibrator, S/N 2482655
Type 2250 Sound Level Meter, S/N 2559287
Type 4189 Microphone, S/N 2556367

Davis
Type Vantage Pro2 – 6152uk Weather Station, S/N 90708N037

A5. Calibration Procedure

Before and after the survey the measurement apparatus was check calibrated to an accuracy of $\pm$ 0.3 dB using the type 4231 Sound Level Calibrator

A.6 Survey Procedure

Ambient noise levels and average wind speed were monitored at various positions around the site as shown in Appendix 1. The measurements are tabulated in Appendix 3, and explanations of the parameters used are listed in Appendix 5.

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Appendix 3

Survey Results at Carlton School

Measured Ambient Noise Levels (dB re $2x10^{-5}$ Pa)

Evening/Night – No wind

Date Postition	Time	L_{A90}	L_{Aeq}	Comments
13.10.09				
1	21:03	38	47	
	21:13	37	42	
	21:23	36	42	
	21:33	35	43	
	21:43	36	42	
	21:53	34	43	
	22:03	36	43	
	22:13	35	47	
	22:23	32	41	
	22:33	32	40	
	22:43	33	44	
	22:53	32	44	
14.10.09				
1	02:01	26	53	
	02:11	26	40	
	02.21	25	42	
	02:31	24	33	
	02:41	24	36	
	02:51	25	32	
	03:01	24	28	
	03:11	26	40	

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Daytime; weather – moderate wind – rain curtailed survey at 12:30

Date Position	Time	L_{A90}	L_{Aeq}	Wind speed m/s@10m	Comments
24.10.09					
1	10:10	42	47	5.4	
	10:20	42	48	5.4	
	10:30	43	47	5.8	
	10:40 - 11:40	-	-	-	Football on playing field & significant construction noise
	11:40	-	-	-	Rain
	11:50	44	49	5.8	Football on playing field & some construction noise
	12:00	45	48	5.4	Football on playing field & some construction noise
	12:10	45	48	5.4	Football
	12:20	45	50	5.4	Football

Daytime; weather – high wind

Date Position	Time	L_{A90}	L_{Aeq}	Wind speed m/s@10m	Comments
19.11.09					
2	12:50	48	56	8.0	
	13:00	50	57	8.5	
	13:10	49	56	8.0	
	13:20	47	52	7.2	
	13:30	48	52	7.2	
	13:40	48	54	7.6	
	13:50	48	52	7.2	

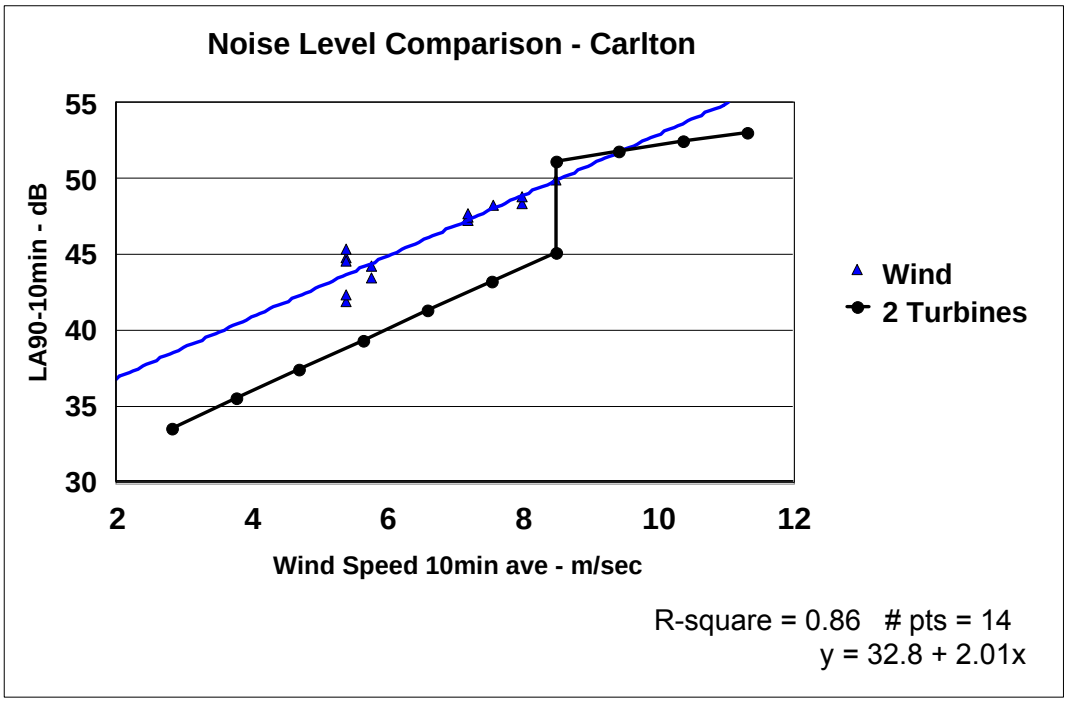
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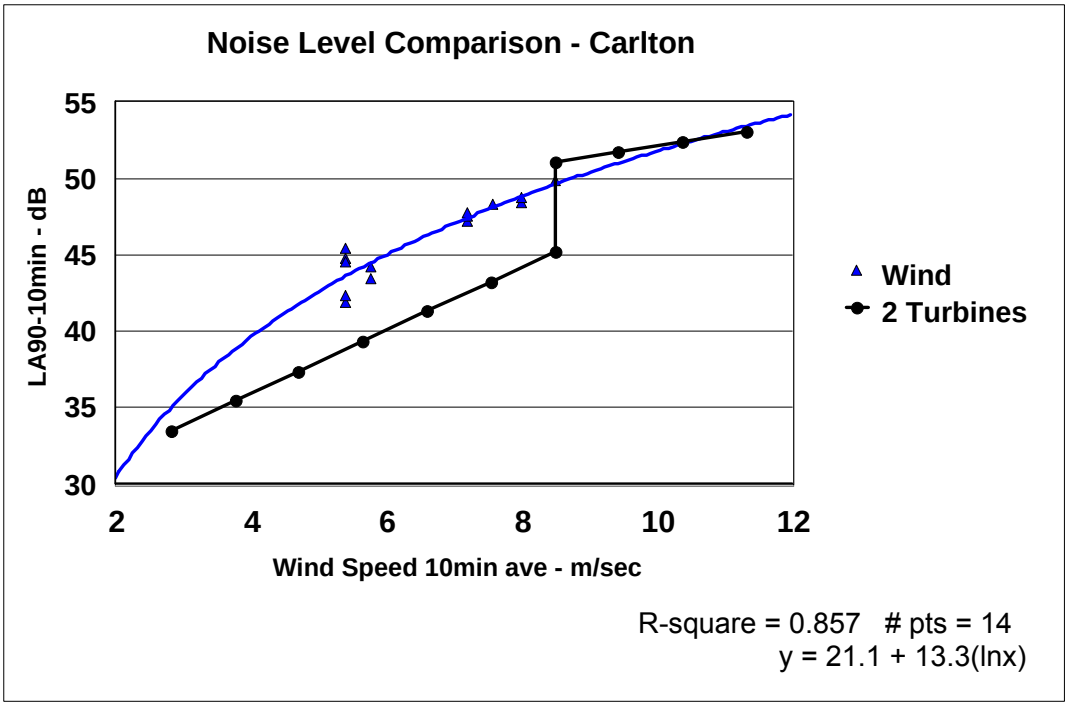
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Appendix 4

Assessment Results

Figures 1 & 2





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Appendix 5

Noise Measurement Parameter Definitions

L_{A90} - The "A" weighted sound pressure level that is exceeded for 90% of the measurement period. It is commonly used as the "Background Noise Level".

L_{Aeq} - The "A" weighted equivalent continuous sound pressure level. A representation of a continuous sound level containing the same amount of sound energy as the measured varying noise, over the measurement period. It can be considered as the "average" noise level.

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