Technical Report

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Project

Barnsley BSF
Wind Turbine Noise Assessment
Darton School

Prepared for

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By

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Summary

Surveys have been done to help assess the impact of noise from the proposed wind turbine installation at Darton 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 one wind turbine at Darton School.

2. Proposed Wind Turbine Installation

As part of the redevelopment of Darton School it is proposed to erect one wind turbine on the school playing fields. It would be located on the western site boundary as indicated on the plan in Appendix 1. To the east, dwellings along Holme View Road, Highfields Road and the end of Birthwaite Road, would have a clear view of the turbine at distances of 230 to 320 metres. Also, dwellings to the south-east of the site, off Upper Field Lane, would also have a view of the turbine, the closest home at a distance of 235 metres. At present the houses in Upper Field Lane are shielded from the turbine site by the school buildings which are to be demolished.

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 1500 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

$L_{Aeq} = 1.94u + 46.64$ $\quad 3 \leq u \leq 9$ 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

iv) During the middle of the day under no or low wind conditions.

The measurements were located close to residential properties that were thought most likely to be affected by wind turbine noise. These were houses in Holme View Road and at the top end of Birthwaite Road, as shown in the plan in Appendix 1. Houses in Upper Field Lane will be similarly affected, but are very sheltered by the existing school buildings that will eventually be demolished. Here, measurements would be particularly unrepresentative of the future situation and so were not taken. However, in the future, their situation relative to wind turbine noise would be similar to that of the houses in Holme View Road. The location of the wind monitor 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 levels (L_{A90}) measurements.

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 and 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 Figures 1 and 2. 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 or low wind conditions the wind was considered not to be affecting the background noise levels. The typical background noise levels during the daytime, at the time of day when wind noise was monitored were 42 to 43 dBL_{A90} at Holme View Road (Location 1). Further north along Highfields Road and the end of Birthwaite Road (Location 2) construction noise affected the measurements, so during daytime noise surveys concentrated on location 1. At higher wind speeds the background levels measured were around 50dBL_{A90} and are representative of wind generated noise. A check also showed that under windy conditions the background noise at location 2 was the same as at location 1.

The plot of background noise versus wind speed shows an excellent correlation (R>0.95). There is minimal difference between the linear and geometric regression curves over the range of measurement. 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 sources 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	– 42 dBL_{A90}
Night-time	– 36 dBL_{A90}

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Daytime:

- Lowest background is 42 dBL_{A90}
- Criterion for turbine noise is the higher of 35 dBL_{A90} and (background +5 dB)
- The lowest background +5 dB is 47 dBL_{A90}
- Therefore, the lowest daytime criterion for turbine noise is 47 dBL_{A90}, which is marginally higher than the turbine noise would reach even at a wind speed of 12m/s at the reference height of 10m above ground level level.
- At all wind speeds the measured background noise is greater than the predicted turbine noise by at least 5dB. Therefore, the turbine noise would also be well below the background +5 dB.

Night-time:

- Lowest background is 36 dBL_{A90}
- Criterion for turbine noise is the higher of 43 dBL_{A90} and (background +5 dB)
- The lowest background +5 dB is 41 dBL_{A90}
- Therefore, the lowest night-time criterion for turbine noise is 43 dBL_{A90}, which it would reach at a wind speed of around 8.5m/s at the reference height of 10m above ground level.
- At this wind speed of 8.5m/s (10m), the predicted background noise (+5 dB) would be 55 $dBL_{A90,}$ higher than the turbine noise. At higher wind speeds, the measured background noise is greater than the predicted turbine noise by at least 5dB. Therefore, the turbine noise would be well below the background +5 dB.

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

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7. Conclusions

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 one turbine 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

Darton School, Kexbrough, Barnsley. For measurement positions see Appendix 1

A2. Dates & Type of Surveys

8/9 October 2009 – Evening/Night-time, no/low wind.
18 October 2009 – Daytime low wind – short survey
8 november 2009 – Daytime no/low wind
19 November 2009 – Daytime moderate to high wind

A3. Personnel Present During Surveys

Mark Graham (8, 18 October & 8 November 2009)
Nick Swainston (19 November 2009)
Mark Hinds (20 November 2009)

A4. Instrumentation

Bruel & Kjaer
Type 4231 Sound Level Calibrator, S/N 2528393, S/N 2482655, S/N 2545771
Type 2250 Sound Level Meter, S/N 2506736, S/N 2559287, S/N 2548190
Type 4189 Microphone, S/N 2529958, S/N 2556367, S/N 2543365
Type 4231 Sound Level Calibrator, S/N 2506736
Type 2260 Sound Level Meter, S/N 2370478
Type 4189 Microphone, S/N 2616485

Davis

Type Vantage Pro 2 – 6152UK Weather Station, S/N A90708N037

A5. Calibration Procedure

Before and after the survey the measurement apparatus was check calibrated to an accuracy of ±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.

Appendix 3

Survey Results at Darton School

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

Evening/Night – No wind

Date Position	Time	L_{A90}	L_{Aeq}	Comments
08.10.09				
2	21:02	48	50	Plant noise
1	21:18	50	52	Football on playing field
2	21:32	49	51	Plant noise
1	21:46	48	51	Football
2	22:02	45	48	
1	22:17	46	50	Cars leaving football
09.10.09				
2	02:00	41	43	
1	02:16	42	45	
2	12:30	37	40	
1	02:45	42	45	
2	03:00	36	39	
1	03:13	41	44	

Daytime no wind

Date Position	Time	L_{A90}	L_{Aeq}	Comments
08.10.09				
2	10:00	48	51	Construction noise
1	10:14	43	45	
2	10:28	49	51	Construction noise
1	10:45	45	47	Noise from adjacent premises-untypical
2	11:01	50	52	Construction noise
1	11:15	42	44	Light rain
-	11:30			Survey ended by rain

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Daytime – Moderate to strong wind

Date Position	Time	L_{A90}	L_{Aeq}	Wind speed m/s @ 10m	Comments
19.11.09					
1	12:23	51	57	9.8	
	12:44	52	55	8.9	
	12:55	51	54	8.9	
	13:25	51	54	8.5	
	13:43	51	55	8.0	
	13:55	51	55	8.9	
2	13:11	51	54	8.9	
20.11.09					
1	10:40	48	50	7.2	
	10:50	49	50	7.2	
	11:00	49	52	7.6	
	11:10	-	-	-	Heavy rain shower
	11:20	48	51	6.3	
	11:30	49	51	5.8	
	11:40	49	53	7.2	
	11:50 -12:30	-	-	-	Construction noise affecting readings followed by school lunch break
18.10.09					
1	10:10	42	45	3.2	
8.11.09					
1	11:15	42	45	2.1	

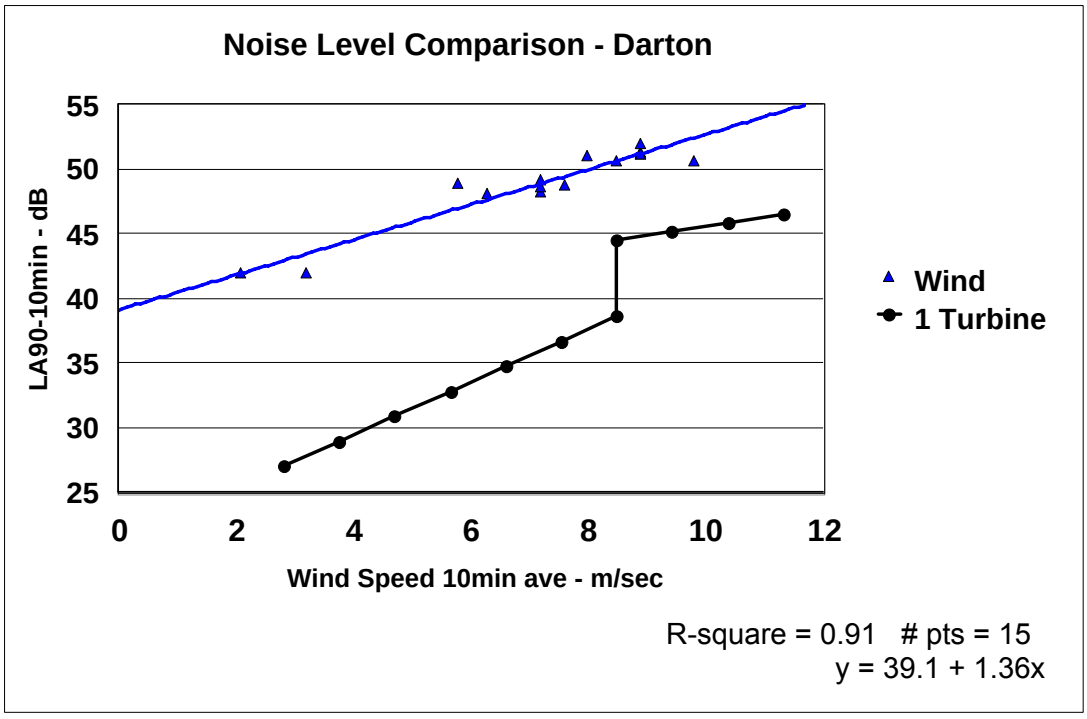
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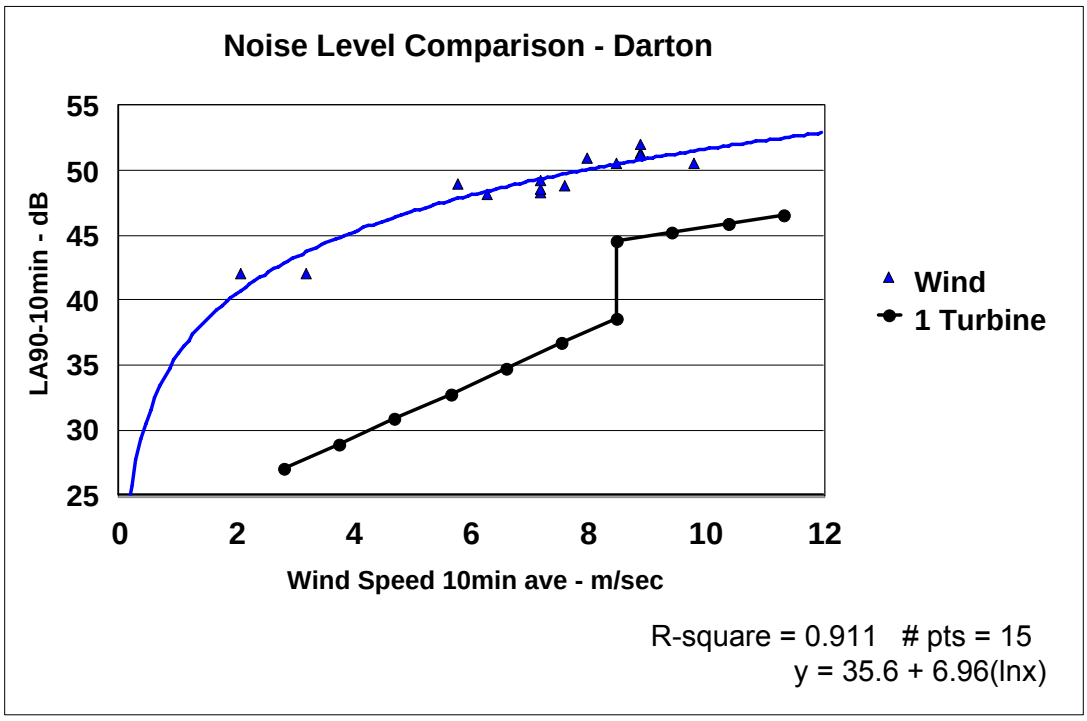
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Appendix 4

Assessment Results

Figures 1 and 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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