FIGURE 4 – PHOTOGRAPH OF TURBINE FROM MICROPHONE

FIGURE 5 – PHOTOGRAPH OF TURBINE FROM MET MAST

FIGURE 6 – PHOTOGRAPH OF MICROPHONE ON MEASUREMENT BOARD

5. Instrumentation

Measurements were based on the approach described in the BWEA standard[1] using the instrumentation described in Table 3.

TABLE 3 – INSTRUMENTATION DETAILS

Equipment Item	Make and Model	Serial Number	Calibration Date
Integrating sound level meter	Pulsar P33 Real Time Analyzer	T226566	14/01/10
Microphone	Pulsar MK:224	20042763	13/01/10
Acoustic calibrator	Pulsar Model 105	45109	14/01/10
Anemometer	Vector Instruments A100LK	5461/TJW	08/01/09
Wind Vane	Vector Instruments W200P	13578	N/A
Data Logger	Campbell Scientific CR1000	4033	02/06/09

Wind speed was measured at a height of hub height +2% (flow correction factors applied during analysis). Wind direction was measured at 11m AGL. Both instruments were located 16.5m (3D) from the wind turbine. The met mast was at 250° when referenced from the wind turbine.

6. Acoustic Data

6.1 Set-up and Measurement Sessions

Audible noise measurements were made using a Pulsar P33 sound level meter with a ½ inch microphone. The microphone was positioned at the centre of a 1 metre diameter, 18mm thick ground board made from plywood. The board was accurately placed 15m downwind of the tower for each measurement series, resulting in a slant distance (rotor centre to microphone) of 19.85m. The microphone had a primary wind shield only.

The sound level meter had a calibration check before and after each measurement session.

Noise, wind speed, wind direction, temperature and pressure were all measured at a sampling rate of 1 Hz and over a 1 minute averaging period. The sound level meter was synchronised with the data logger at the start of each measurement series. If the sound level meter did not successfully synchronise or the synchronisation drifted over the duration of the measurement session the records would become void.

In order to always have the anemometer in the upwind sector, noise measurements were only accepted when the wind direction was between 170° and 290°. Sectors 160°-170° and 290°-340° were not used due to incomplete site calibration flow correction factors – these sectors would have made up the 180° sector (250° ±90°) stated in the BWEA standard[2].

Details of each measurement session are shown in Table 4.

TABLE 4 – DETAILS OF MEASUREMENT SESSIONS

Session / Register	Date	Hub Height Wind Speed range (m/s)	Wind Direction (°)	Microphone Location (°)	Average Pressure (kPa)	Average Temperature (°C)	Average Turbulence Intensity (%)
0	26/02/2010 10:13:00	8.86-11.01	282.7-296.9	85	98	7.1	14.2%
1	void	void	void	void	void	void	void
2	26/02/2010 10:36:00	8.5-11.84	279.5-295.5	85	98.1	7.6	12.9%
3	void	void	void	void	void	void	void
4	26/02/2010 11:46:00	7.52-9.2	271.7-279.7	85	98.1	8	14.5%
5	void	void	void	void	void	void	void
6	26/02/2010 12:06:00	7.77-10.06	268.7-277.3	85	98.2	7.7	13.2%
7	26/02/2010 13:45:00	6.4-9.12	257.9-263.4	85	98.2	8.1	13.9%
8	26/02/2010 13:56:00	6.56-9.62	260.4-271.5	85	98.2	8.6	15.9%

9	26/02/2010 14:05:00	5.55-8.96	256.1-270.4	85	98.2	8.2	13.6%
10	26/02/2010 14:23:00	5.48-10.72	247.8-270.5	85	98.2	8.5	12.9%
11	26/02/2010 15:33:00	6.8-10.05	249.3-260.8	85	98.2	8.6	13.2%
12	26/02/2010 16:29:00	5.27-6.80	245.4-254.2	85	98.2	7.8	15.6%
13	26/02/2010 16:45:00	4.84-7.36	239.5-247.9	85	98.1	7.6	13.2%
14	26/02/2010 17:14:00	5.11-7.47	236.6-246.9	85	98.1	7.3	12.8%
15	26/02/2010 17:34:00	4.54-6.46	235.6-240.3	85	98.1	7.3	12.9%
16	27/02/2010 09:54:00	3.57-5.84	220.1-245	40	97.4	7.4	12.1%
17	void	void	void	void	void	void	void
18	27/02/2010 10:19:00	3.33-4.61	246-259.2	40	97.4	7.8	12.0%
19	27/02/2010 10:34:00	4.11	261	40	97.4	8	16.3%
20	27/02/2010 10:59:00	2.36-6.5	223.7-265.7	40	97.4	7.8	14.0%
21	27/02/2010 11:35:00	5.29-6.71	231.5-242.8	40	97.4	8.2	11.0%
22	27/02/2010 11:45:00	4.55-6.26	230.8-246.3	40	97.4	8.2	13.0%
23	27/02/2010 12:03:00	4.13-5.82	224.4-235.1	40	97.4	8.5	12.8%
24	27/02/2010 12:22:00	3.72-5.17	231.5-253.4	40	97.4	8.5	13.2%
25	18/03/2010 08:21:00	7.47-9.26	163.2-176.9	15	99.4	10.3	16.4%
26	void	void	void	void	void	void	void
27	void	void	void	void	void	void	void
28	18/03/2010 11:24:00	9.67-12.08	178.2-184.4	15	99.3	10.4	13.8%
29	void	void	void	void	void	void	void
30	void	void	void	void	void	void	void
31	void	void	void	void	void	void	void
32	18/03/2010 13:38:00	9.21-12.32	183.9-189.7	15	99.1	10.2	14.7%

33	void	void	void	void	void	void	void
34	18/03/2010 14:12:00	10.29-11.06	192-193.8	15	99.1	10.4	14.2%
35	void	void	void	void	void	void	void
36	test	test	test	test	test	test	test
37	test	test	test	test	test	test	test
38	test	test	test	test	test	test	test
39	test	test	test	test	test	test	test
40	void	void	void	void	void	void	void
41	29/04/2010 08:11:00	4.31	207.2	60	99.6	10.6	8.7%
42	29/04/2010 08:14:00	4.14-4.44	217.4-219.6	60	99.6	10.6	6.5%
43	void	void	void	void	void	void	void
44	29/04/2010 08:38:00	1.65-2.98	211.2-221.6	60	99.6	10.7	11.2%
45	29/04/2010 09:58:00	0.67-1.18	157.3-209.8	60	99.5	11.3	11.1%

6.2 Broadband

Noise versus wind speed at hub height was measured for the turbine running and for the turbine stopped (i.e. background noise). 154 data pairs of wind speed and noise for the turbine running and 89 data pairs of wind speed and noise for the turbine parked were obtained. Figure 7 shows the relationship between these two sets of data.

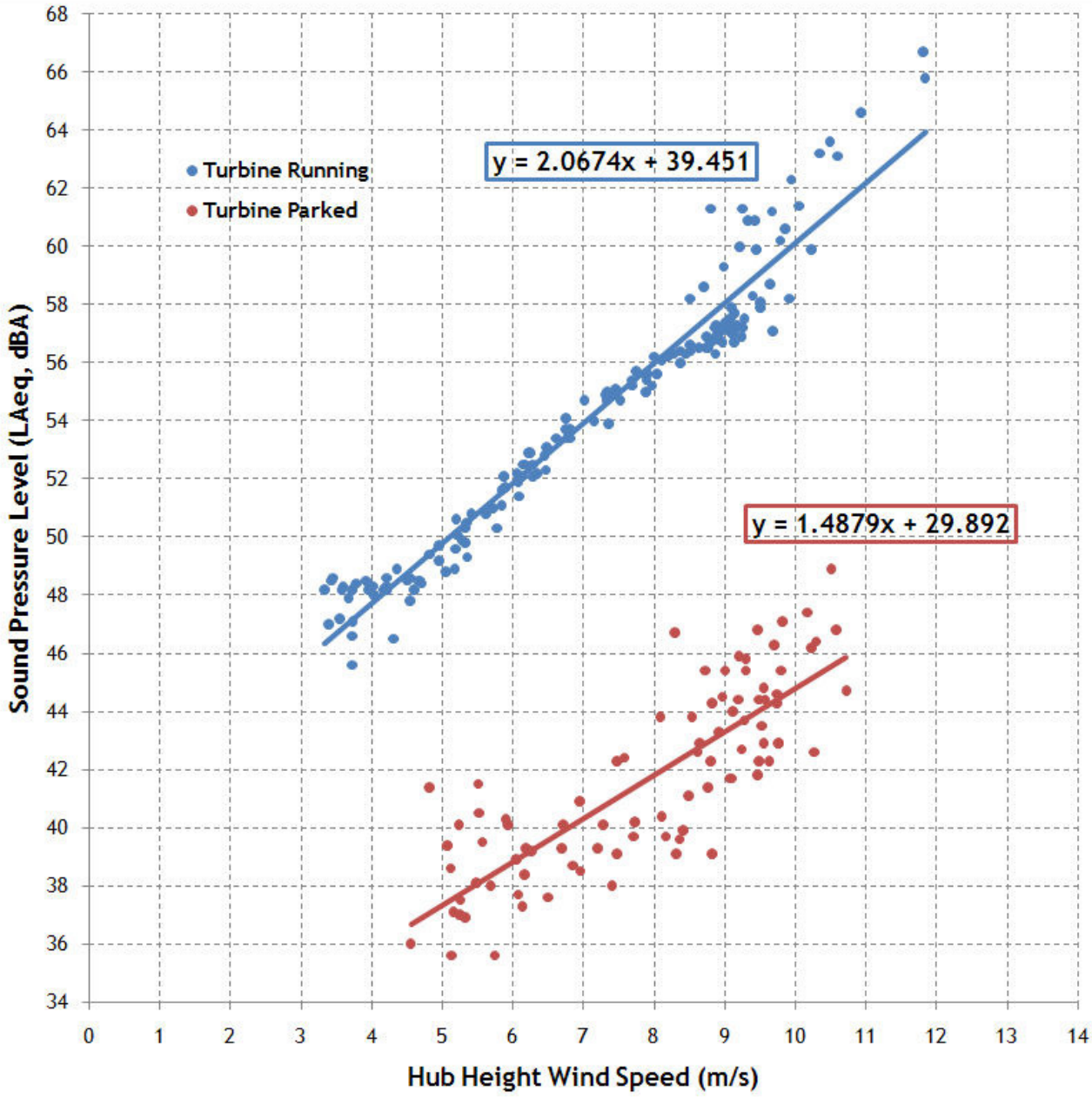

FIGURE 7 - SOUND PRESSURE LEVEL ON THE GROUND BOARD AT A SLANT DISTANCE OF 19.85M (1)

The uncertainty, S_{ey} (U_A) of the linear regression for the turbine running was 1.055dB. This type A uncertainty is used with the type B uncertainties in Section 6 to estimate a combined uncertainty (U_C) of 1.37dB. This procedure was performed in accordance with BS EN 61400-11:2003[1] Annex D.

Figure 8 shows the data from Figure 7 plus the background corrected sound pressure levels (i.e. the wind turbine specific noise after the removal of the contribution from the background noise). These points were calculated from the turbine running and turbine parked linear regression lines.

A combined uncertainty, U_C of 1.37dB was used to determine the uncorrected and corrected levels plus $1.645U_C$, these lines are also shown in Figure 8. It is the background corrected level plus $1.645U_C$ which is used as the basis of calculation of declared power levels. The $1.645U_C$ is used in accordance with the BWEA standard[2] and equates to a 95% confidence level that the noise will be below the value.

From Figure 8 it can be seen that correcting for background has the effect of increasing the slope of the linear regression. It was this slope – 2.095dB/m/s that was used in the calculations of the noise map. The background corrected regression line was then used to calculate the Declared Emission Sound Power Level for a hub height wind speed of 8m/s by applying a -6dB correction for the board reflection and a +36.9dB correction for the slant distance of 19.85m. Table 5 shows a summary of the results.

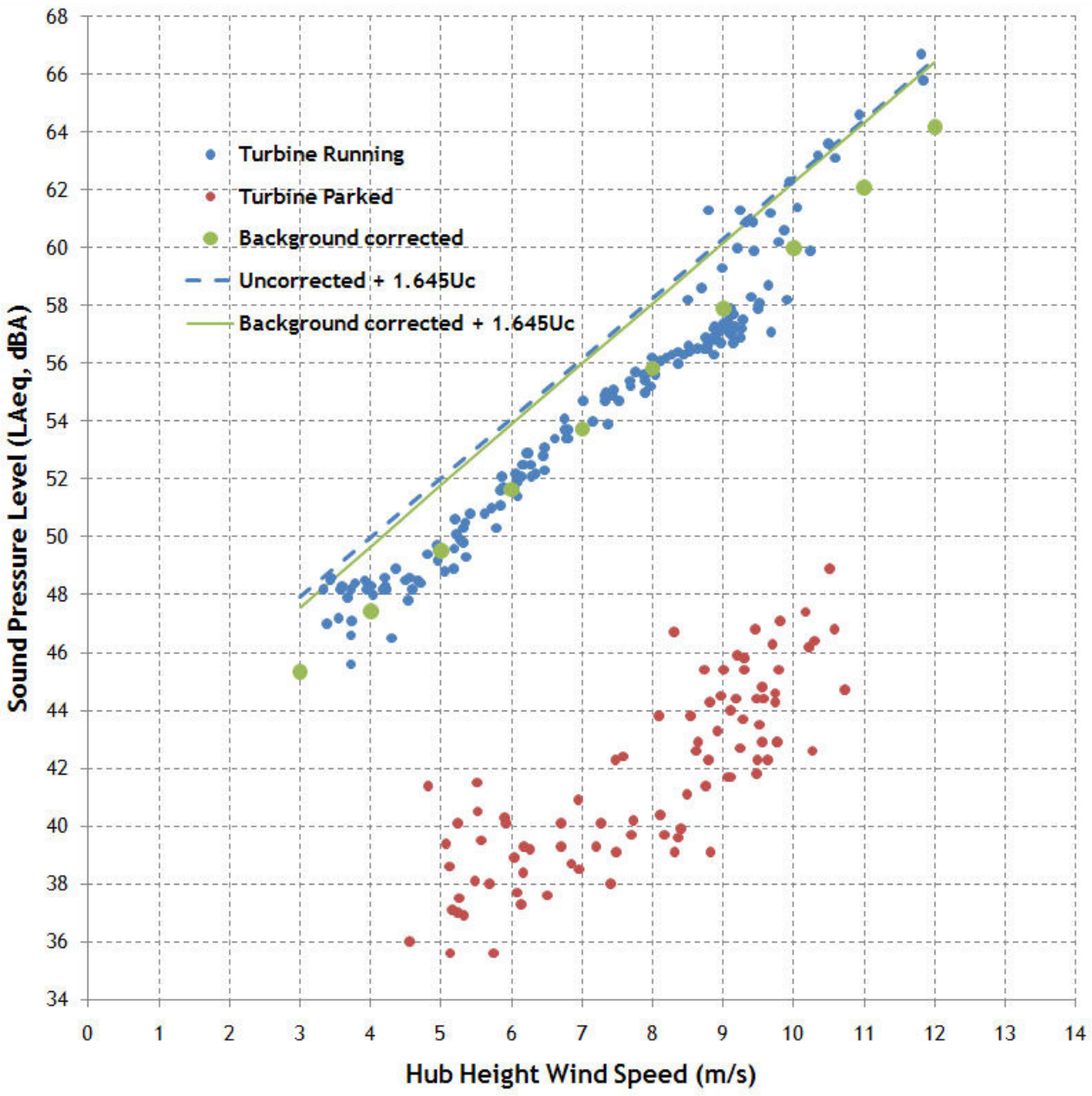

FIGURE 8 - SOUND PRESSURE LEVEL ON THE GROUND BOARD AT A SLANT DISTANCE OF 19.85M (2)

TABLE 5 – NOISE EMISSION SOUND POWER LEVELS

Parameter	Value at a Hub Height Wind Speed of 8m/s
Apparent Emission Sound Power Level, $L_{W,8m/s}$ (dB)	**86.8**
Declared Apparent Emission Sound Power Level, $L_{W,8m/s}$ (dB)	**89.0**
Estimated Combined Uncertainty, U_C (dB)	**1.37**
Wind Speed Dependence, S_{dB} (dB/m/s)	**2.095 (σ of fit on slope 0.01dB)**

6.3. Noise Character

Two aspects of the turbine noise character were investigated:

- The frequency content
- Tonality

1/3rd octave data was obtained for wind speeds around cut-in (3m/s), reference (8m/s) and speed control (12m/s). For each of these wind speeds, data was collected while the turbine was running and while the turbine was parked. The measured frequency bands were first energy averaged and then corrected for background levels. Figure 9 shows the turbine frequency content at 2.82m/s (energy average of 3 1-minute spectra). Figure 10 shows the turbine frequency content at 7.99m/s (energy average of 10 1-minute spectra). Figure 11 shows the turbine frequency content at 11.64m/s (energy average of 3 1-minute spectra).

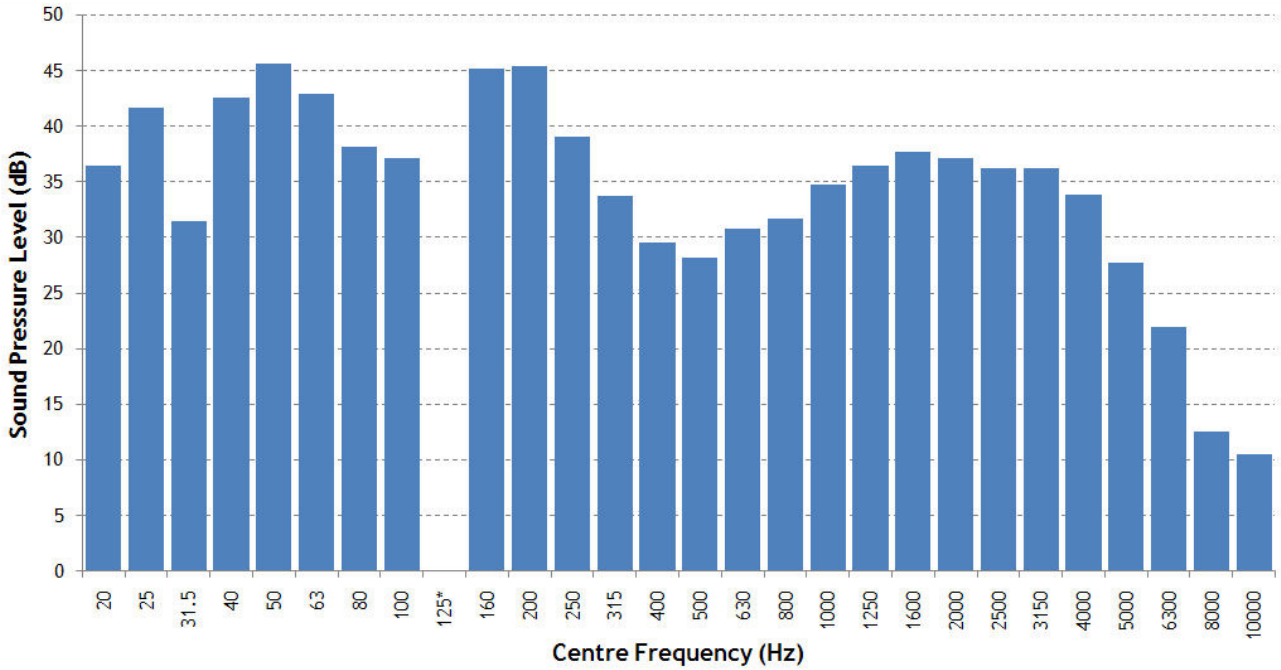

FIGURE 9 - UNWEIGHTED 1/3RD OCTAVE BAND FREQUENCY SPECTRUM FOR 2.82M/S AT A SLANT DISTANCE OF 19.85M

The 125Hz band in Figure 9 was not measureable because the background noise at 125Hz was louder than when the turbine was running. The dB(Lin), dB(A) and dB(C) for the spectrum was 53.4,44.9 and 52.9 respectively.

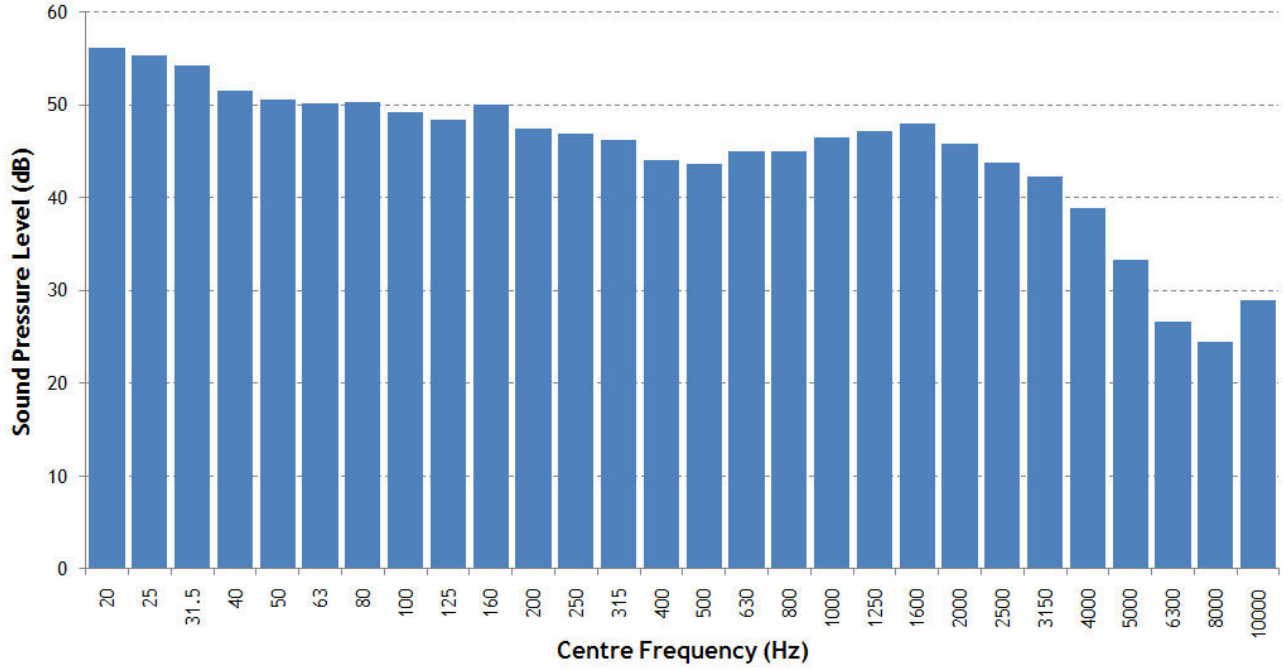

FIGURE 10 - UNWEIGHTED 1/3RD OCTAVE BAND FREQUENCY SPECTRUM FOR 7.99M/S AT A SLANT DISTANCE OF 19.85M

The dB(Lin), dB(A) and dB(C) for the 7.99m/s spectrum was 63.5, 54.2 and 61.6 respectively.

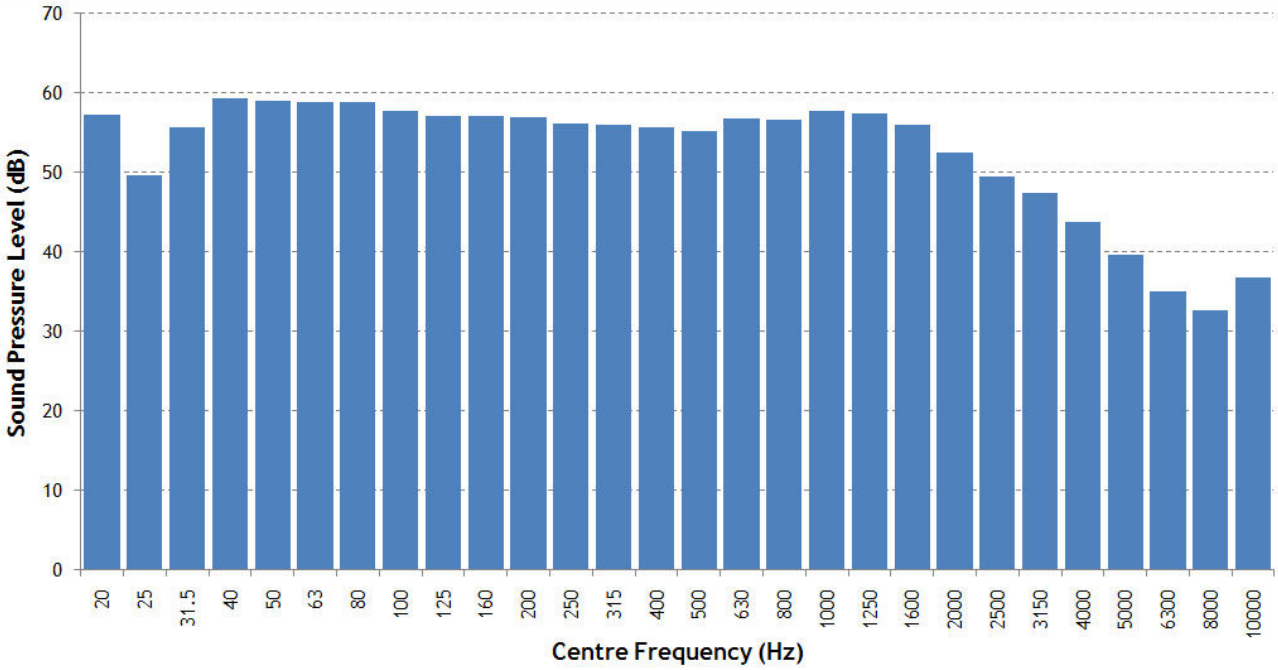

FIGURE 11 – UNWEIGHTED 1/3RD OCTAVE BAND FREQUENCY SPECTRUM FOR 11.64M/S AT A SLANT DISTANCE OF 19.85M

The dB(Lin), dB(A) and dB(C) for the 11.64m/s spectrum was 70.3, 63.4 and 69.5 respectively.

According to the tonal procedure required by the BWEA standard[2] the turbine does not have any tonal content.

6.4. Noise Immission

All measurements were made 15m (horizontal distance) downwind of the turbine on a ground board. Estimates can however be made for free field noise immission at any distance from the turbine using the results in Table 5. The method used was that provided in the BWEA standard2. The standardised noise map for the Evance R9000 is shown in Figure 12. For planning applications that require greater than 100m slant distances an extended noise map can be found in Figure 13.

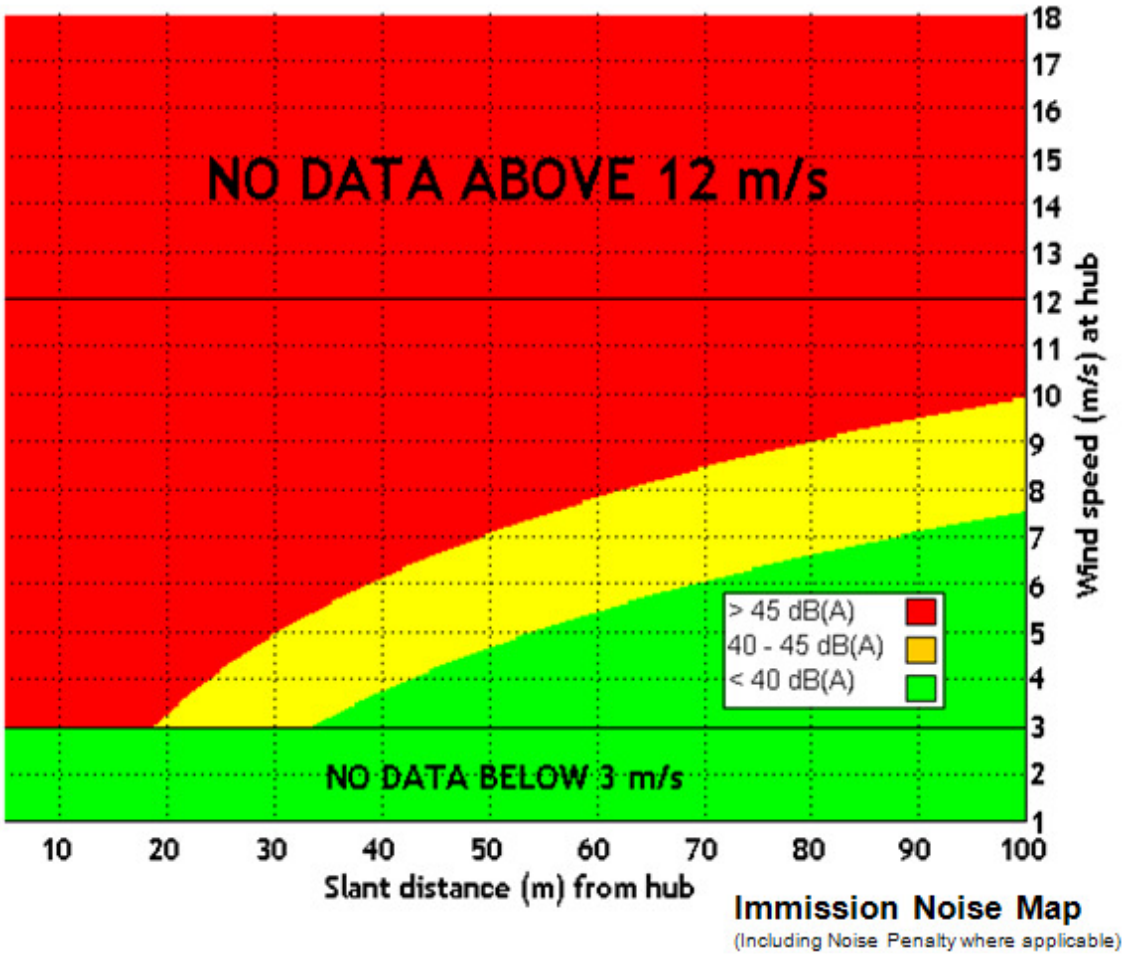

FIGURE 12 - NOISE MAP

In addition to the noise map two indicators were calculated at fixed slant distances (25m and 60m) at the reference hub height wind speed of 8m/s. For the Evance R9000 these are:

- The BWEA reference 25m sound level, $L_{p,25m}$ = **53dB(A)**
- The BWEA reference 60m sound level, $L_{p,60m}$ = **45.5dB(A)**

No measurements of directivity were undertaken but the turbine was subjectively much quieter in the plane of the blades (perpendicular to wind direction) than the measured downwind location.

Guidance on the use of the Immission Noise Map can be found in Appendix 1 of this report and the BWEA standard[2].

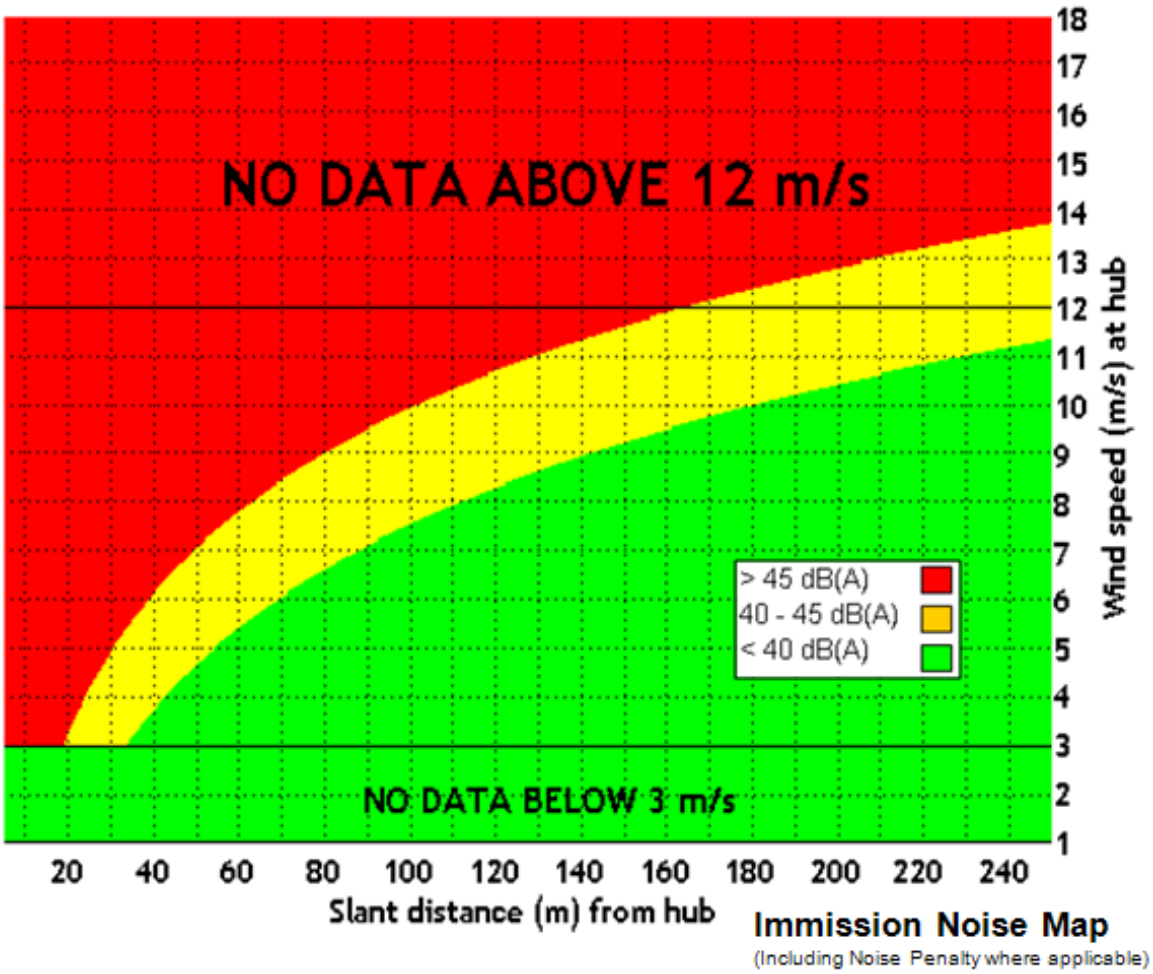

FIGURE 13 - EXTENDED NOISE MAP

7. Uncertainty

Table 6 shows the parameters involved in the calculation of the standard error for the noise map. The uncertainty is made up of a Type A component (obtained from the linear regression of the 'turbine running') and several Type B components (site effects). The procedure used was that described in BS EN 61400-11:2003[1] Annex D.

The combined uncertainty, U_C is calculated using the equation:

$$U_C = \sqrt{U_A^2 + U_{B1}^2 + U_{B2}^2 + U_{B3}^2 + U_{B4}^2 + U_{B5}^2 + U_{B6}^2 + U_{B7}^2 + U_{B8}^2 + U_{B9}^2}$$

TABLE 6 - ESTIMATION OF UNCERTAINTY IN APPARENT SOUND POWER LEVEL

Component	Possible Typical Standard Uncertainty (dB)	Assumed Standard Uncertainty (dB)	Comments
Type A - Measured, U_A			
Noise Versus Wind Speed	--	**1.055**	From linear regression
Type B - Estimated, U_B			
Calibration, U_{B1}	0.2	0.2	Typical value
Instrument, U_{B2}	0.2	0.2	Typical value
Board, U_{B3}	0.3	0.3	Typical value
Distance, U_{B4}	0.1	0.1	Within 2%
Impedance, U_{B5}	0.1	0.1	Typical value
Turbulence, U_{B6}	0.4	0.4	Typical value
Wind Speed, U_{B7}	0.9	0.6	Site calibration completed on test site
Direction, U_{B8}	0.3	0.3	Typical value
Background, U_{B9}	0.1	0.06	0.21/(2*√3) - Average applied correction
Combined Uncertainty, U_C		**1.370**	

8. Deviations from BWEA Small Wind Turbine Performance and Safety Standard

There were no exceptions to the standards.

9. References

1. BS EN 61400-11:2003, Wind Turbine Generator Systems, Part11 – Acoustic Noise Measurement Techniques, 2003

2. Small Wind Turbine Performance and Safety Standard. British Wind Energy Association. 29 Feb 2008

10. Appendix 1 - Guidance on the use of the Immission Noise Map

The following procedure can be used to assist the reader in considering the suitability of a prospective site. This method is the same as in the BWEA standard[2], except that it also includes a look-up chart based on the noise map provided in this report to simplify the process.
The method is based on the NOABL mean wind speed database which provides wind data at 45m, 25m and 10m height in 1 km squares covering Great Britain and Northern Ireland.

The BWEA standard defines the following process:

1. Find the national grid reference for the proposed site. This can be found from a map or from the Postcode if a suitable conversion program is available. Shorten the reference to the NOABL required format; e.g. if the Grid Reference is NS641532, then the NOABL input value is NS 64 53.

2. Use NOABL to get the average annual wind, $V_{avg,10}$ at 10m height for the location.

3. Assume a Rayleigh wind speed distribution and therefore calculate the 90% wind $V_{90,10}$ for 10m height as:

$$V_{90,10} = 1.52 * V_{avg,10}$$

4. Apply a wind correction factor from 10m height using a power law (in accordance with IEC 61400-2) to get an estimate of wind at the installed rotor centre height, H, as:

$$V_{90,H} = V_{90,10} * (H/10)^{0.2}$$

5. Draw a horizontal line on the immission noise map at the $V_{90,H}$ wind speed.

6. Read off the distance for the 45dB(A) and 40dB(A) values.

7. Compare these distances with the slant distances to the nearest noise sensitive location(s) for the planned installation.

The value of 45dB(A) is based on World Health Organisation (WHO) guidance. The second line at 40dB(A) has been included in the standard since at the time of writing firm criteria had not been agreed and adopted by all parties involved in the planning process relating to wind turbines and it therefore this provides a measure of the sensitivity of the process to the assumed noise criteria.

In order to simplify the process, Stages 3 to 6 in the list above have been carried out for a 12m, 15m and 18.3m tower, as shown in Figure 14.

The x-axis is the annual mean wind speed at 10m height and can be found from the NOABL database as described above. The solid lines provide the slant distance (straight line distance between rotor hub and noise sensitive location) that is predicted to meet the 45dB(A) noise criterion for the wind speed that will be exceeded 10% of the time. The dotted lines are for the 40dB(A) criterion.

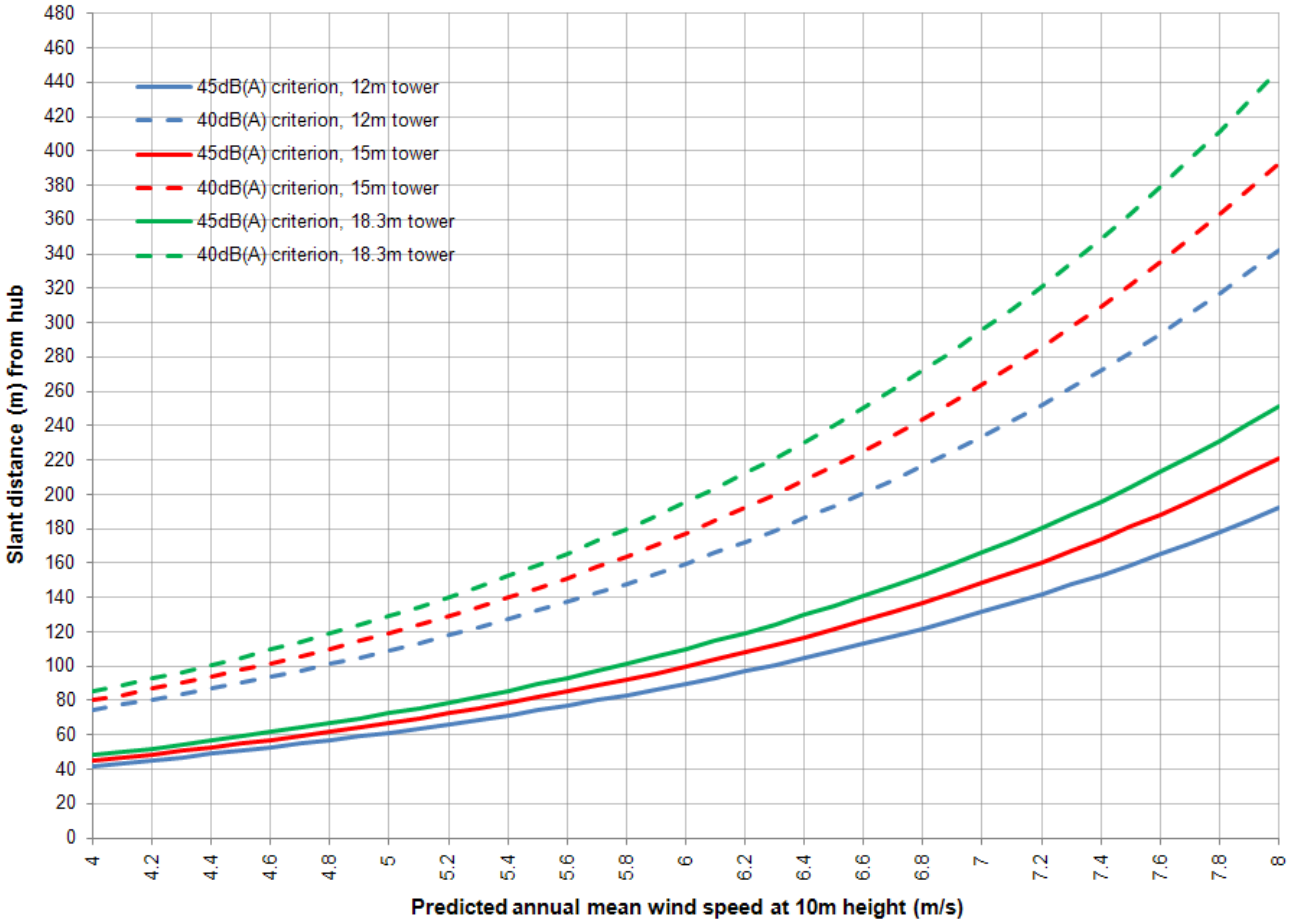

FIGURE 14 - AMWS NOISE IMMISSION SUMMARY

11. Appendix 2 – Broadband Raw Data

11.1. Turbine Running

L_{Aeq} (dBA)	L90 (dBA)	Wind Speed (m/s)	Wind Speed Standard Deviation (m/s)	Corrected Wind Speed (m/s)	Wind Direction (°)	Microphone Location (°)	Pressure (kPa)	Temperature (°C)	Turbulence Intensity	Angle between Microphone and Wind Direction (°)
58.7	55.3	9.6	1.267	9.64	287.2	85	98.0	6.8	13.2%	22.2
60.9	55.2	9.39	1.486	9.43	287.4	85	98.0	6.8	15.8%	22.4
56.3	54.2	8.83	1.159	8.86	288.7	85	98.0	7.1	13.1%	23.7
61.2	55.2	9.63	1.859	9.67	285.7	85	98.0	7.5	19.3%	20.7
56.9	54.4	8.83	1.437	8.86	287.5	85	98.0	7.3	16.3%	22.5
57.3	55.6	8.98	1.274	9.01	288.7	85	98.0	7.3	14.2%	23.7
61.3	54.4	8.76	1.547	8.79	285.6	85	98.1	7.6	17.7%	20.6
66.7	62.1	11.76	0.884	11.80	285.3	85	98.0	7.6	7.5%	20.3
65.8	59.1	11.73	1.366	11.84	279.5	85	98.1	7.5	11.6%	14.5
63.1	56.7	10.55	1.208	10.59	283	85	98.1	7.5	11.5%	18
61.3	55.8	9.21	1.6	9.24	283	85	98.1	7.6	17.4%	18
60.9	55.8	9.29	1.374	9.33	287.6	85	98.1	7.5	14.8%	22.6
59.9	56.8	10.19	1.019	10.23	288.8	85	98.1	7.6	10.0%	23.8
62.3	55.2	9.9	1.953	9.94	289.2	85	98.1	7.1	19.7%	24.2
63.6	56.5	10.45	1.683	10.49	286.8	85	98.1	7.1	16.1%	21.8
60.6	55.3	9.82	1.55	9.86	285	85	98.1	7.3	15.8%	20
57.1	55.4	9.64	0.871	9.68	287	85	98.1	7.6	9.0%	22
58.2	53.6	8.47	1.599	8.50	287.5	85	98.1	7.6	18.9%	22.5
60.2	56.8	9.75	1.026	9.79	287.3	85	98.1	7.7	10.5%	22.3
64.6	57.5	10.89	1.568	10.93	287.8	85	98.1	7.6	14.4%	22.8
56.4	54	8.48	0.936	8.51	285.9	85	98.1	7.7	11.0%	20.9
56.9	54.1	9.2	1.004	9.23	284	85	98.1	7.9	10.9%	19
63.2	56.5	10.3	1.242	10.34	287.7	85	98.1	8.0	12.1%	22.7
55	52	7.814	0.999	7.89	279.7	85	98.2	7.4	12.8%	14.7
55.2	53.5	7.616	1.099	7.69	273.3	85	98.2	7.4	14.4%	8.3
56.1	53.5	8.03	1.131	8.10	276	85	98.2	7.4	14.1%	11
57	55	9.03	1.148	9.11	277.3	85	98.2	7.5	12.7%	12.3
55.4	53.9	7.61	1.092	7.68	273.5	85	98.2	7.8	14.3%	8.5
56.7	54.8	8.88	1.195	8.96	276.6	85	98.1	8.1	13.5%	11.6
54.7	52.6	7.452	1.037	7.52	276.3	85	98.1	8.3	13.9%	11.3
55.2	51.1	7.894	1.404	7.97	279.1	85	98.1	8.5	17.8%	14.1
55.6	52.9	7.964	1.322	8.04	271.7	85	98.1	8.6	16.6%	6.7
57.7	55.7	9.06	1.162	9.14	277.4	85	98.1	8.7	12.8%	12.4
56.4	53.1	8.29	1.405	8.37	277.4	85	98.1	8.5	16.9%	12.4
60	54.4	9.12	1.523	9.20	275.4	85	98.1	8.2	16.7%	10.4
57.5	54.1	8.99	1.086	9.07	275.2	85	98.1	8.0	12.1%	10.2
55.6	53.7	7.83	0.868	7.90	274.8	85	98.2	7.9	11.1%	9.8

53.4	49.2	6.773	1.386	6.80	260.8	85	98.2	8.7	20.5%	-4.2
58.6	54.6	8.67	1.412	8.69	252.7	85	98.2	8.8	16.3%	-12.3
54.7	51.6	6.993	1.489	7.01	256.8	85	98.2	8.8	21.3%	-8.2
58.3	54.9	9.37	1.087	9.40	251.5	85	98.2	8.9	11.6%	-13.5
57.9	53.6	9.07	1.486	9.10	256.8	85	98.2	8.9	16.4%	-8.2
57.5	55.5	9.2	1.271	9.28	249.3	85	98.2	8.8	13.8%	-15.7
57.2	55.6	9.23	0.914	9.26	253.9	85	98.2	8.8	9.9%	-11.1
56.7	55.6	9.11	0.712	9.14	253.5	85	98.2	8.8	7.8%	-11.5
56.8	54.8	8.89	1.096	8.92	253.2	85	98.2	8.7	12.3%	-11.8
56.5	54.8	8.71	1.03	8.73	257.4	85	98.2	8.7	11.8%	-7.6
56.6	53.8	8.48	1.352	8.50	252.4	85	98.2	8.7	15.9%	-12.6
56.2	53.5	7.972	1.493	7.99	256.3	85	98.2	8.8	18.7%	-8.7
57.1	55.2	8.91	1.242	8.94	255.8	85	98.2	8.8	13.9%	-9.2
61.4	55.3	10.02	1.209	10.05	254.7	85	98.2	8.7	12.1%	-10.3
58.2	56.8	9.88	0.896	9.91	254.7	85	98.2	8.6	9.1%	-10.3
58.1	56.4	9.48	0.96	9.51	253.5	85	98.2	8.6	10.1%	-11.5
57.3	55.7	9.14	0.893	9.17	254.1	85	98.2	8.6	9.8%	-10.9
56.9	55.7	8.72	1.04	8.74	252.1	85	98.2	8.6	11.9%	-12.9
56.5	54.7	8.74	1.048	8.76	250.5	85	98.2	8.6	12.0%	-14.5
54.9	53.8	7.41	0.605	7.43	253.4	85	98.2	8.6	8.2%	-11.6
55.4	52.6	7.869	1.384	7.89	253	85	98.2	8.6	17.6%	-12
56.3	54.4	8.25	1.295	8.27	252.8	85	98.2	8.6	15.7%	-12.2
55.1	53.4	7.427	1.009	7.45	258.9	85	98.2	8.6	13.6%	-6.1
54.9	52.8	7.291	0.877	7.31	254.2	85	98.2	8.5	12.0%	-10.8
55	52.8	7.312	1.166	7.33	252.7	85	98.2	8.4	15.9%	-12.3
57.2	55.7	8.83	1.026	8.85	252.2	85	98.2	8.3	11.6%	-12.8
59.9	56	9.41	1.142	9.44	253.3	85	98.2	8.3	12.1%	-11.7
55.7	52.7	7.726	1.369	7.75	251.8	85	98.2	8.4	17.7%	-13.2
56.5	54.6	8.61	1.014	8.63	255.7	85	98.2	8.5	11.8%	-9.3
57.1	55.4	9.05	0.933	9.08	253.6	85	98.2	8.6	10.3%	-11.4
59.3	54.5	8.96	1.546	8.99	257.3	85	98.2	8.5	17.3%	-7.7
57.2	55.3	9.13	1.069	9.16	255.2	85	98.2	8.5	11.7%	-9.8
57.3	54.9	8.85	1.207	8.88	252.7	85	98.2	8.5	13.6%	-12.3
57.9	55.9	9.47	1.156	9.50	255	85	98.2	8.5	12.2%	-10
57.2	55.1	9.14	1.26	9.17	252.6	85	98.2	8.4	13.8%	-12.4
57.2	55.4	9.02	0.978	9.05	251.7	85	98.2	8.5	10.8%	-13.3
57.2	55.8	8.95	1.005	8.98	253.8	85	98.2	8.5	11.2%	-11.2
57.4	54.9	8.98	1.185	9.01	253.6	85	98.2	8.5	13.2%	-11.4
56	53.7	8.34	1.324	8.36	251.8	85	98.2	8.5	15.9%	-13.2
56.3	54.6	8.42	0.854	8.44	253.7	85	98.2	8.4	10.1%	-11.3
56.2	54.4	8.17	0.993	8.19	256	85	98.2	8.4	12.2%	-9
54.7	52.4	7.302	1.293	7.32	253.5	85	98.2	8.4	17.7%	-11.5
55.6	53.3	7.849	1.296	7.87	254.2	85	98.2	8.4	16.5%	-10.8
56.7	55.2	8.77	0.88	8.79	256.3	85	98.2	8.4	10.0%	-8.7
53.7	50.7	6.782	1.152	6.80	252.1	85	98.2	8.0	17.0%	-12.9

53.4	51.4	6.595	0.748	6.61	254.2	85	98.2	7.7	11.3%	-10.8
49.9	47.9	5.229	0.88	5.27	248.3	85	98.2	7.7	16.8%	-16.7
51.6	48.8	5.787	0.717	5.84	247.4	85	98.1	7.6	12.4%	-17.6
53.4	51.5	6.712	0.831	6.77	243.3	85	98.1	7.6	12.4%	-21.7
52.5	50.4	6.091	0.865	6.14	244.1	85	98.1	7.7	14.2%	-20.9
52.1	49.8	6.227	0.815	6.28	243.8	85	98.1	7.8	13.1%	-21.2
52.2	48.5	6.283	0.952	6.34	246.1	85	98.1	7.9	15.2%	-18.9
54.1	52.8	6.69	0.635	6.75	247.9	85	98.1	8.0	9.5%	-17.1
53.9	53	7.295	0.398	7.36	243.3	85	98.1	8.0	5.5%	-21.7
52.5	51.5	6.121	0.553	6.17	245.3	85	98.1	8.0	9.0%	-19.7
50.6	48	5.151	1.052	5.20	244.4	85	98.1	8.0	20.4%	-20.6
50.1	47.5	5.166	0.803	5.21	245.5	85	98.1	7.9	15.5%	-19.5
52.1	50.6	6.081	0.835	6.13	244.7	85	98.1	7.8	13.7%	-20.3
52.2	50.1	6	0.765	6.05	245.5	85	98.1	7.7	12.8%	-19.5
51	48.2	5.667	1.001	5.72	243.3	85	98.1	7.7	17.7%	-21.7
53.7	50.5	6.69	1.056	6.75	243.1	85	98.1	7.6	15.8%	-21.9
52.8	49.5	6.39	1.19	6.44	246.1	85	98.1	7.5	18.6%	-18.9
52.5	49.6	6.221	0.922	6.27	240.2	85	98.1	7.5	14.8%	-24.8
54	52.9	7.086	0.84	7.15	243.3	85	98.1	7.5	11.9%	-21.7
52.1	49.6	5.815	0.847	5.86	240.8	85	98.1	7.4	14.6%	-24.2
52.9	51.4	6.164	0.746	6.22	241.1	85	98.1	7.4	12.1%	-23.9
53.1	52.2	6.391	0.498	6.47	239.5	85	98.1	7.4	7.8%	-25.5
52.9	50.6	6.19	0.808	6.24	242.8	85	98.1	7.4	13.1%	-22.2
51.4	49.4	6.033	0.57	6.08	246.1	85	98.1	7.3	9.4%	-18.9
49.8	48.2	5.273	0.851	5.32	244	85	98.1	7.3	16.1%	-21
50.8	48.6	5.363	0.624	5.41	244.1	85	98.1	7.3	11.6%	-20.9
51.9	49.1	6.02	0.933	6.07	240.3	85	98.1	7.3	15.5%	-24.7
50.8	49	5.569	0.674	5.62	240.2	85	98.1	7.3	12.1%	-24.8
49.6	47.2	5.14	0.691	5.18	240.2	85	98.1	7.3	13.4%	-24.8
50.5	48.8	5.277	0.709	5.34	235.9	85	98.1	7.3	13.4%	-29.1
49.4	48	4.751	0.588	4.81	239.5	85	98.1	7.3	12.4%	-25.5
47.8	46.6	4.48	0.614	4.54	238.3	85	98.1	7.3	13.7%	-26.7
48.4	46.8	4.647	0.618	4.71	235.6	85	98.1	7.2	13.3%	-29.4
51.7	49.5	5.812	0.801	5.89	236.6	85	98.1	7.2	13.8%	-28.4
52.3	50.6	6.382	0.707	6.46	237.5	85	98.1	7.2	11.1%	-27.5
50.3	48.7	5.704	0.493	5.78	236.6	85	98.1	7.3	8.6%	-28.4
50.3	47.3	5.25	0.748	5.32	236.9	85	98.1	7.2	14.2%	-28.1
49.3	48.4	5.261	0.63	5.35	225.7	40	97.4	7.3	12.0%	5.7
48.9	48	4.278	0.54	4.35	226.5	40	97.4	7.3	12.6%	6.5
46.6	45	3.673	0.47	3.72	230.4	40	97.4	7.3	12.8%	10.4
45.6	45.1	3.66	0.331	3.72	222.4	40	97.4	7.4	9.0%	2.4
46.5	45.8	4.226	0.556	4.30	229.1	40	97.4	7.4	13.2%	9.1
48	47.3	3.966	0.39	4.04	229.5	40	97.4	7.4	9.8%	9.5
48.4	47.5	3.886	0.764	3.95	228.6	40	97.4	7.4	19.7%	8.6
49.2	48.2	4.868	0.641	4.95	220.1	40	97.4	7.4	13.2%	0.1

48.8	47.8	4.963	0.463	5.05	227.7	40	97.4	7.4	9.3%	7.7
49.7	48.4	4.861	0.475	4.95	225.7	40	97.4	7.4	9.8%	5.7
48.2	47.8	4.167	0.417	4.22	233	40	97.4	7.4	10.0%	13
48.2	47.8	3.884	0.465	3.95	228.8	40	97.4	7.5	12.0%	8.8
48.2	47.7	3.527	0.527	3.57	233.2	40	97.4	7.5	14.9%	13.2
48.2	47.4	4.539	0.471	4.60	236.8	40	97.4	7.5	10.4%	16.8
48.5	47.6	4.62	0.634	4.68	235.1	40	97.4	7.5	13.7%	15.1
51.1	49.5	5.787	0.697	5.84	245	40	97.4	7.5	12.0%	25
47.2	46	3.532	0.346	3.54	259.2	40	97.4	7.8	9.8%	39.2
48.5	47.8	3.88	0.613	3.91	248.5	40	97.4	7.7	15.8%	28.5
48.2	45.9	3.319	0.4	3.33	254.3	40	97.4	7.7	12.1%	34.3
48.6	47.8	3.412	0.436	3.44	248.4	40	97.4	7.8	12.8%	28.4
48.3	47.7	3.58	0.714	3.59	252.2	40	97.4	7.8	19.9%	32.2
47	45.6	3.374	0.503	3.38	250.7	40	97.4	7.8	14.9%	30.7
47.1	46.1	3.721	0.272	3.73	255	40	97.4	7.9	7.3%	35
48.5	47.7	3.401	0.45	3.43	248	40	97.4	7.9	13.2%	28
48.4	47.8	3.717	0.626	3.78	223.8	40	97.4	8.6	16.8%	3.8
47.9	46.6	3.638	0.89	3.67	247.2	40	97.4	8.7	24.5%	27.2
48.6	48	4.507	0.64	4.55	245.4	40	97.4	8.7	14.2%	25.4
48.5	47.8	4.617	0.479	4.66	244.8	40	97.4	8.6	10.4%	24.8
48.9	48.1	5.129	0.506	5.17	249	40	97.4	8.5	9.9%	29
48.2	47.7	3.689	0.5	3.72	244.9	40	97.4	8.4	13.6%	24.9
48.5	47.8	4.459	0.542	4.50	245.5	40	97.4	8.4	12.2%	25.5
48.3	47.7	3.973	0.515	4.01	243.1	40	97.4	8.4	13.0%	23.1
48.3	47.8	4.172	0.43	4.21	240.5	40	97.4	8.4	10.3%	20.5
48.6	48.2	4.153	0.551	4.21	237.1	40	97.4	8.4	13.3%	17.1
48.2	47.3	4.116	0.3	4.17	231.5	40	97.3	8.2	7.3%	11.5

11.2. Turbine Parked

L_{Aeq} (dBA)	L90 (dBA)	Wind Speed (m/s)	Wind Speed Standard Deviation (m/s)	Corrected Wind Speed (m/s)	Wind Direction (°)	Microphone Location (°)	Pressure (kPa)	Temperature (°C)	Turbulence Intensity	Angle between Microphone and Wind Direction (°)
38.1	35.8	5.456	1.018	5.48	268.5	85	98.2	8.1	18.7%	3.5
39.3	36.5	7.165	1.068	7.20	264.4	85	98.2	8.3	14.9%	-0.6
41.1	36.9	8.45	0.952	8.49	268.1	85	98.2	8.4	11.3%	3.1
39.1	36	8.74	0.987	8.82	270.5	85	98.2	8.5	11.3%	5.5
42.3	38.6	9.44	1.034	9.48	263.8	85	98.2	8.5	11.0%	-1.2
46.7	37.6	8.26	0.645	8.30	261.7	85	98.2	8.5	7.8%	-3.3
42.9	39.4	8.62	0.933	8.64	259.8	85	98.2	8.6	10.8%	-5.2
45.4	41.6	9.27	0.983	9.30	256.5	85	98.2	8.8	10.6%	-8.5
44.6	39.9	9.71	0.847	9.74	256.8	85	98.2	8.8	8.7%	-8.2
42.7	39.6	9.21	1.343	9.24	255.2	85	98.2	8.8	14.6%	-9.8
46.8	42.5	10.55	1.081	10.58	258.2	85	98.2	8.7	10.2%	-6.8
47.4	40.3	10.14	1.479	10.17	258.6	85	98.2	8.6	14.6%	-6.4
44	39.7	9.08	1.193	9.11	256.5	85	98.2	8.5	13.1%	-8.5
40.1	35.6	7.249	1.142	7.27	259.6	85	98.2	8.4	15.8%	-5.4
44.4	38.4	9.16	1.294	9.19	259.6	85	98.2	8.4	14.1%	-5.4
44.3	40.8	9.71	0.841	9.74	258	85	98.2	8.4	8.7%	-7
42.3	38.9	9.6	1.041	9.63	258	85	98.2	8.4	10.8%	-7
40.2	37.1	7.703	1.152	7.72	257	85	98.2	8.4	15.0%	-8
44.3	37.2	8.79	1.398	8.81	257.9	85	98.2	8.4	15.9%	-7.1
41.7	38.3	9.04	0.768	9.07	259.8	85	98.2	8.4	8.5%	-5.2
46.3	42	9.67	1.043	9.70	257	85	98.2	8.4	10.8%	-8
40.9	37.4	6.923	1.056	6.94	259.6	85	98.2	8.6	15.3%	-5.4
42.9	38.1	9.47	1.251	9.55	247.8	85	98.2	8.8	13.2%	-17.2
39.7	36.1	7.676	1.029	7.70	254.5	85	98.2	8.8	13.4%	-10.5
42.3	37.9	8.77	1.044	8.79	253.3	85	98.2	8.9	11.9%	-11.7
44.4	39.5	9.45	1.317	9.48	254.1	85	98.2	8.9	13.9%	-10.9
42.6	39.6	8.59	1.183	8.61	250.4	85	98.2	8.9	13.8%	-14.6
44.4	39.9	9.54	1.252	9.57	251.3	85	98.2	8.9	13.1%	-13.7
45.8	37.7	9.27	1.305	9.30	255.6	85	98.2	8.8	14.1%	-9.4
40.4	37.4	8.08	0.948	8.10	254	85	98.2	8.7	11.7%	-11
43.8	37.4	8.06	1.236	8.08	253.1	85	98.2	8.7	15.3%	-11.9
42.6	39.8	10.18	0.822	10.27	249.9	85	98.2	8.6	8.1%	-15.1
44.5	38.1	8.94	1.106	8.97	251.2	85	98.2	8.6	12.4%	-13.8
42.9	38.9	9.73	0.93	9.76	252.2	85	98.2	8.6	9.6%	-12.8
47.1	39	9.78	1.365	9.81	254.2	85	98.2	8.6	14.0%	-10.8
43.5	38.5	9.49	2.077	9.52	252.1	85	98.2	8.6	21.9%	-12.9
44.8	38.4	9.52	1.58	9.55	254.7	85	98.2	8.6	16.6%	-10.3
39.7	36.9	8.14	1.288	8.16	259.4	85	98.2	8.6	15.8%	-5.6
46.8	37.2	9.43	1.434	9.46	251.3	85	98.2	8.7	15.2%	-13.7
45.4	38.8	8.7	1.348	8.72	253.8	85	98.2	8.7	15.5%	-11.2
46.4	41.8	10.26	0.876	10.29	254.8	85	98.2	8.7	8.5%	-10.2
45.9	38.7	9.17	1.618	9.20	254.3	85	98.2	8.6	17.6%	-10.7
39.9	37.9	8.38	0.882	8.40	251	85	98.2	8.5	10.5%	-14

41.7	38.6	9.07	1.444	9.10	251.8	85	98.2	8.6	15.9%	-13.2
46.2	40.5	10.19	1.011	10.22	252.3	85	98.2	8.5	9.9%	-12.7
41.4	37.9	8.73	1.251	8.75	253.5	85	98.2	8.4	14.3%	-11.5
48.9	42.3	10.48	1.02	10.51	251.4	85	98.2	8.3	9.7%	-13.6
43.3	40	8.89	1.058	8.92	255.8	85	98.2	8.2	11.9%	-9.2
45.4	40.2	9.76	1.476	9.79	259.1	85	98.2	8.3	15.1%	-5.9
44.7	40.7	10.69	0.84	10.72	256.7	85	98.2	8.4	7.9%	-8.3
41.8	39.2	9.44	0.884	9.47	257.4	85	98.2	8.5	9.4%	-7.6
43.7	39.8	9.25	1.307	9.28	257.4	85	98.2	8.6	14.1%	-7.6
43.8	38.3	8.51	1.539	8.53	255.9	85	98.2	8.6	18.1%	-9.1
45.4	38	8.98	1.64	9.01	256.7	85	98.2	8.4	18.3%	-8.3
42.3	36.7	7.447	1.036	7.47	259.5	85	98.2	8.3	13.9%	-5.5
42.9	39.5	9.74	0.936	9.77	257.6	85	98.2	8.3	9.6%	-7.4
38	34.9	7.37	0.879	7.40	260.2	85	98.2	8.4	11.9%	-4.8
39.1	36.5	8.29	0.985	8.31	258.2	85	98.2	8.5	11.9%	-6.8
39.6	37.1	8.32	0.869	8.36	262.3	85	98.2	8.6	10.4%	-2.7
42.4	36.4	7.543	1.084	7.58	261	85	98.2	8.6	14.4%	-4
38.9	35.8	5.99	0.83	6.04	246.2	85	98.1	7.3	13.9%	-18.8
40.5	36.5	5.473	0.551	5.52	244.4	85	98.1	7.2	10.1%	-20.6
39.3	36.1	6.638	1.148	6.69	245.1	85	98.1	7.2	17.3%	-19.9
37.6	35.5	6.443	0.575	6.50	242.2	85	98.1	7.2	8.9%	-22.8
37.3	35.3	6.079	0.845	6.13	246.9	85	98.1	7.2	13.9%	-18.1
38.4	36.5	6.112	0.763	6.16	243.1	85	98.1	7.3	12.5%	-21.9
38.5	36.2	6.896	1.185	6.96	242.7	85	98.1	7.3	17.2%	-22.3
39.1	36.5	7.411	0.592	7.47	242.7	85	98.1	7.3	8.0%	-22.3
38.7	36.7	6.76	0.621	6.85	239.6	85	98.1	7.4	9.2%	-25.4
40.1	37	6.645	0.774	6.70	241.1	85	98.1	7.4	11.6%	-23.9
39.3	36.3	6.122	0.689	6.17	245.8	85	98.1	7.4	11.3%	-19.2
37.7	35.4	6.022	1.309	6.07	241.9	85	98.1	7.4	21.7%	-23.1
38	35.1	5.633	0.691	5.68	241.7	85	98.1	7.4	12.3%	-23.3
38.6	36.4	5.05	0.507	5.11	236.6	85	98.1	7.4	10.0%	-28.4
37.5	36.2	5.21	0.578	5.25	240.8	85	98.1	7.3	11.1%	-24.2
37	35.8	5.195	0.793	5.24	240.1	85	98.1	7.3	15.3%	-24.9
36.9	33	5.258	0.876	5.32	234.9	40	97.4	8.2	16.7%	14.9
39.5	36.5	5.495	0.901	5.56	239.6	40	97.4	8.2	16.4%	19.6
39.4	33	5.005	1.226	5.07	231.2	40	97.4	8.3	24.5%	11.2
40.1	35.1	5.849	0.714	5.92	230.8	40	97.4	8.2	12.2%	10.8
40.3	36	5.849	0.7	5.90	245.8	40	97.4	8.1	12.0%	25.8
39.2	35.6	6.182	0.565	6.26	239.9	40	97.4	8.2	9.1%	19.9
35.6	31.2	5.67	0.432	5.74	238	40	97.4	8.1	7.6%	18
35.6	30.2	5.084	0.528	5.13	242.9	40	97.4	8.1	10.4%	22.9
40.1	33.9	5.191	0.456	5.24	246.3	40	97.4	8.1	8.8%	26.3
41.5	35.9	5.459	0.525	5.51	241.4	40	97.4	8.1	9.6%	21.4
41.4	33.8	4.773	0.68	4.81	244.9	40	97.4	8.1	14.2%	24.9
36	31.5	4.514	0.731	4.55	244.6	40	97.4	8.2	16.2%	24.6
37.1	33	5.094	0.566	5.16	236.1	40	97.4	8.3	11.1%	16.1

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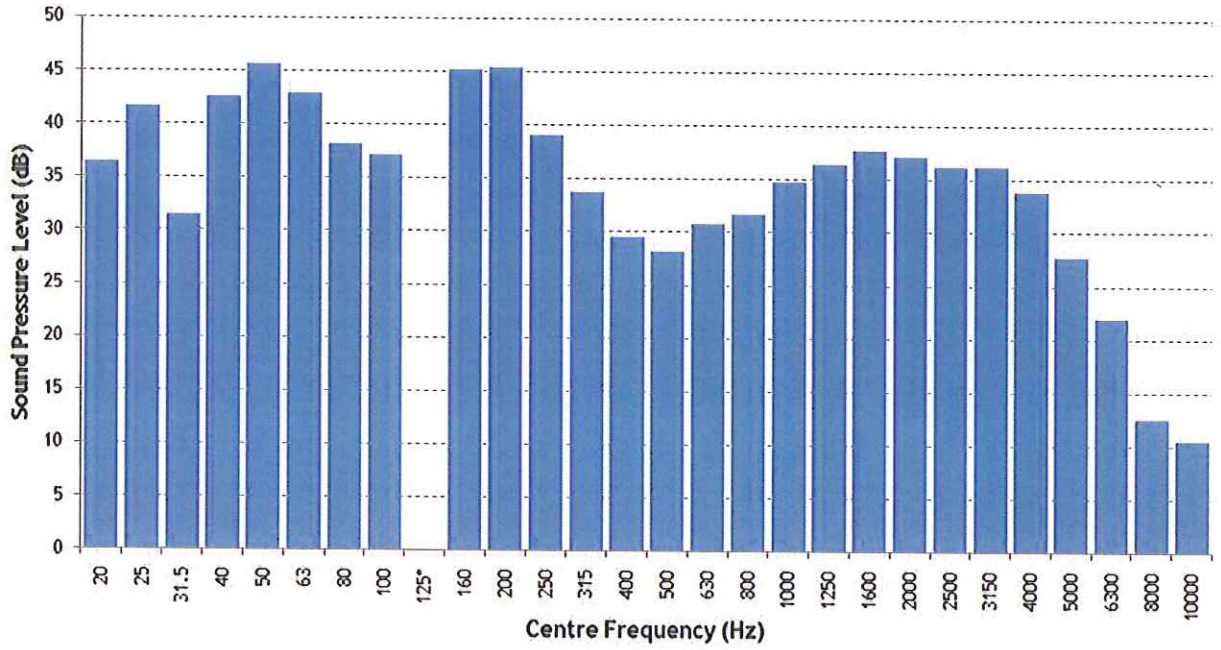


FIGURE 9 - UNWEIGHTED 1/3RD OCTAVE BAND FREQUENCY SPECTRUM FOR 2.82M/S AT A SLANT DISTANCE OF 19.85M

The 125Hz band in Figure 9 was not measureable because the background noise at 125Hz was louder than when the turbine was running. The dB(Lin), dB(A) and dB(C) for the spectrum was 53.4,44.9 and 52.9 respectively.

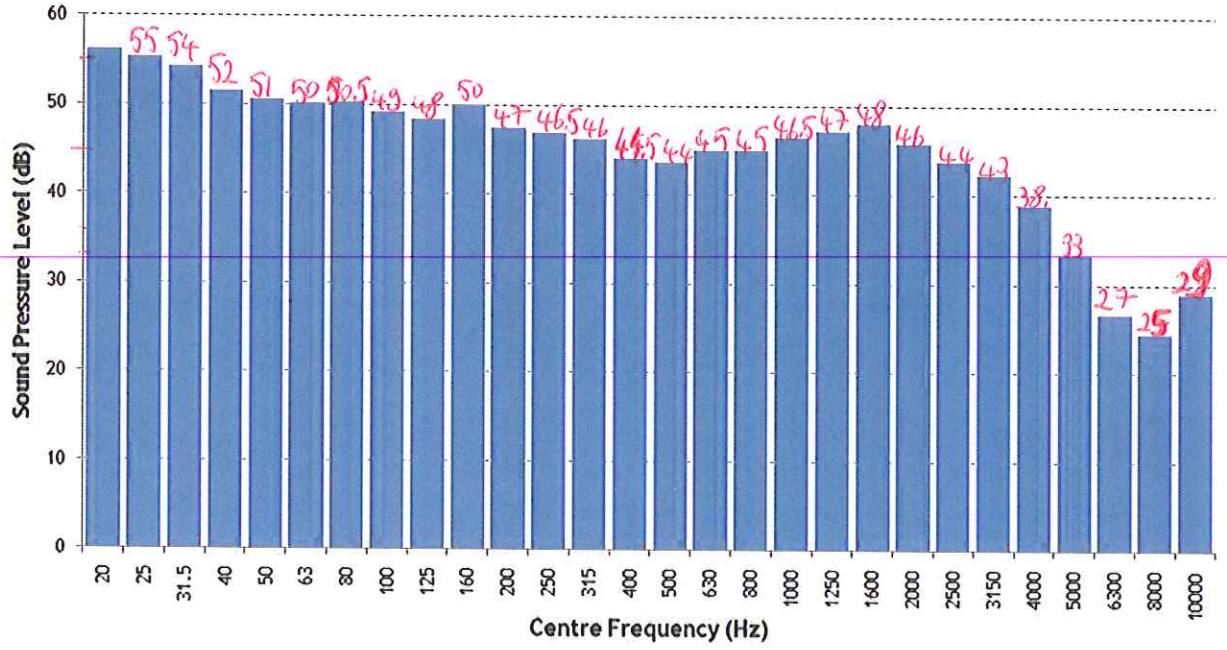


FIGURE 10 - UNWEIGHTED 1/3RD OCTAVE BAND FREQUENCY SPECTRUM FOR 7.99M/S AT A SLANT DISTANCE OF 19.85M

The dB(Lin), dB(A) and dB(C) for the 7.99m/s spectrum was 63.5, 54.2 and 61.6 respectively.

TNEI SUMMARY ANALYSIS OF NOISE DATA FOR : Eoltech-Scirocco-Generic blade-Full mode-15hub

Turbine identification:	
Manufacturer:	Eoltech
Model Name:	Scirocco
Blade Type/Name:	Generic
Operational Mode:	Full
Hub Height:	15

Available Noise Document(s) Considered in the analysis of this turbine:

	Doc. Date	Doc. Name
Manufacturer doc:	15/03/2011	Narec: 1580/04
Test Report1:	10/04/2007	HM:1820/R1
Test Report2:		
Test Report3:		

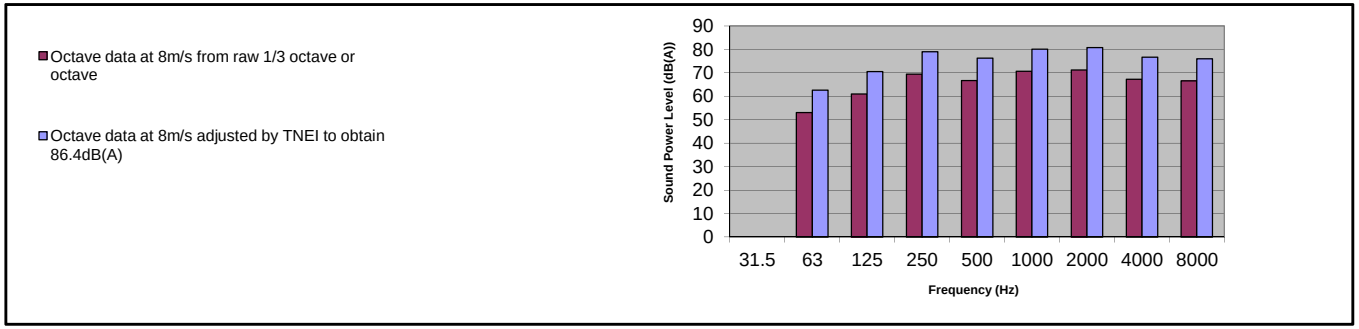
Summary of Sound Power Levels(Lw_{Aeq}) at various wind speeds:

Wind Speed (standardised 10m)	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Manufacturer Lw raw as found in document		75.6	77.7	79.9	82.1	84.2	86.4	88.6	90.7	92.9	95.1
Manufacturer specified Lw +Manufacturer Uc+TNEI Uc (used for modeling by TNEI)		75.6	77.7	79.9	82.1	84.2	86.4	88.6	90.7	92.9	95.1
Comment: No Uc added as reports have accounted enough											

Summary of Octave Data (LwA_{eq}) used for modelling:

Octave data is from Test Report1 at 8m/s										
Frequency (Hz)	31.5	63	125	250	500	1000	2000	4000	8000	Overall
Octave data at 8m/s from raw 1/3 octave or octave	0.0	53.1	61.0	69.4	66.7	70.6	71.2	67.2	66.5	76.9
Octave data at 8m/s adjusted by TNEI to obtain 86.4dB(A)	0.0	62.6	70.5	78.9	76.2	80.1	80.7	76.7	76.0	86.4
Comment: Used 1/3 Octave data from Hayes Mckenzie report HM:1820/R1										

Plot of Octave Data



Additional Comment:

Data analysed in accordance with the guidance from the IOA GPG May 2013.

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8.1 Immission Noise Map

In accordance with section 3.1.4 of the BWEA standard, the immission noise map for the Eoltec Scirocco E5.6-6 is shown in Figure 5 below;

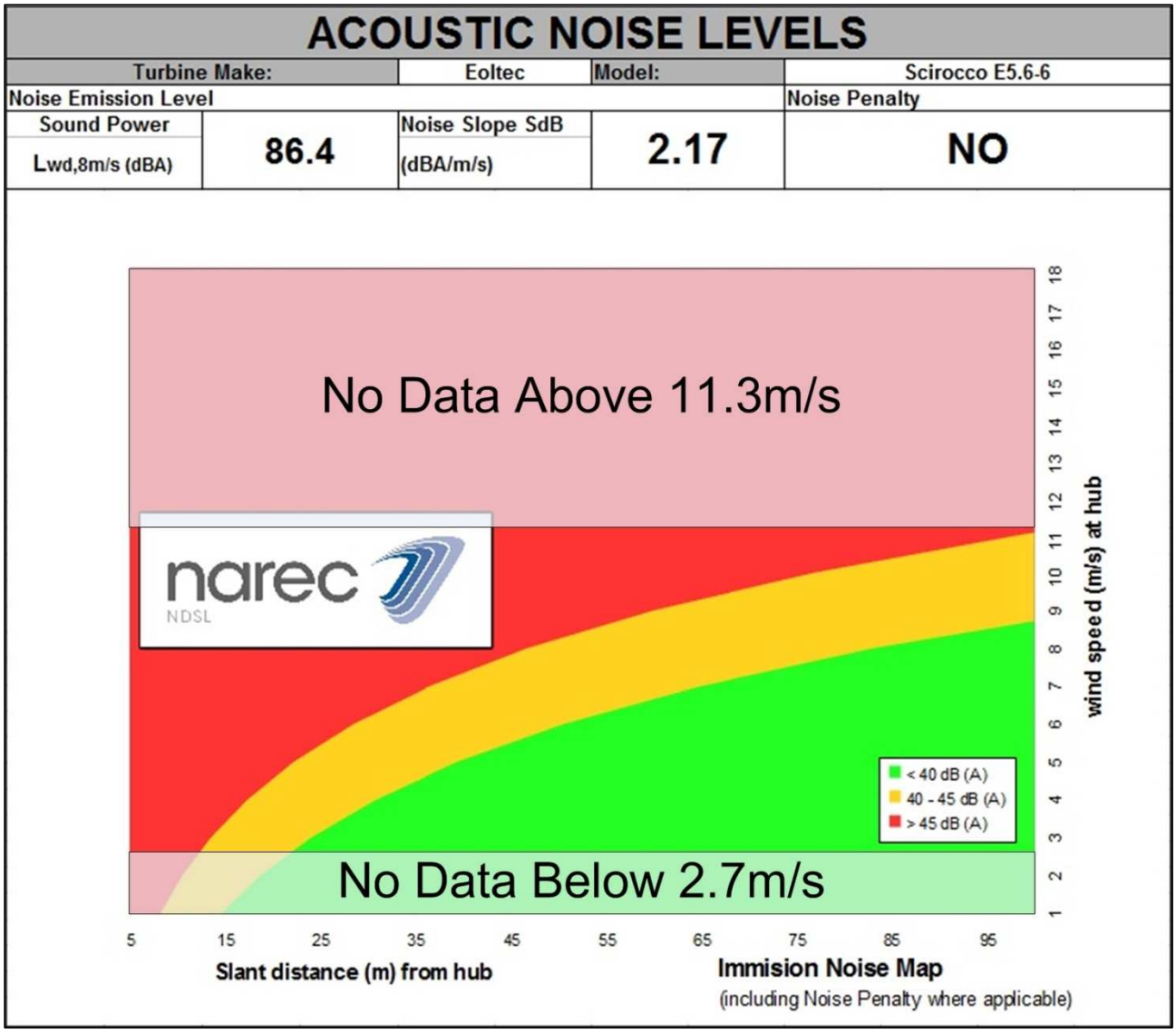


Figure 5 - Immission Noise Map – Eoltec Scirocco E5.6-6

TNEI SUMMARY ANALYSIS OF NOISE DATA FOR : Proven-6KW-Generic blade-Full mode-15hub

Turbine identification:	
Manufacturer:	Proven
Model Name:	6KW
Blade Type/Name:	Generic
Operational Mode:	Full
Hub Height:	15

Available Noise Document(s) Considered in the analysis of this turbine:

	Doc. Date	Doc. Name
Manufacturer doc:		No manufacturer data used. Used measufred level from test report1 + 1.5dB (1.645*0.9)
Test Report1:	01/04/2007	6kW 15m Noise Sgurr 2007 test report.
Test Report2:		
Test Report3:		

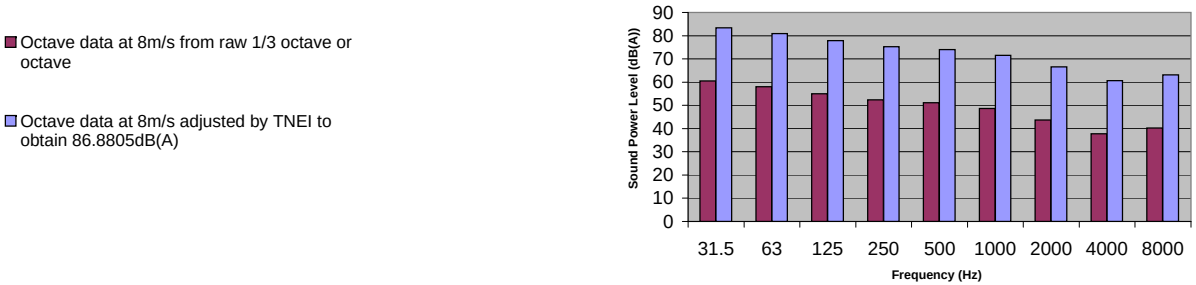
Summary of Sound Power Levels(Lw_{Aeq}) at various wind speeds:

Wind Speed (standardised 10m)	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Manufacturer Lw raw as found in document											
Manufacturer specified Lw +Manufacturer Uc+TNEI Uc (used for modeling by TNEI)			77.9	80.2	82.4	84.7	86.9	89.1	91.4	93.6	95.9
Comment: No manufacturer data used. Used measufred level from test report1 + 1.5dB (1.645*0.9)											

Summary of Octave Data (LwA_{eq}) used for modelling:

Octave data is from Test Report1 at 8m/s										
Frequency (Hz)	31.5	63	125	250	500	1000	2000	4000	8000	Overall
Octave data at 8m/s from raw 1/3 octave or octave	60.5	58.0	55.0	52.4	51.2	48.6	43.7	37.7	40.2	64.0
Octave data at 8m/s adjusted by TNEI to obtain 86.8805dB(A)	83.4	80.9	77.9	75.3	74.1	71.5	66.6	60.6	63.1	86.8
Comment: 1/3 octave data from "6kW 15m Sgurr additional Freq Graphs.pdf"										

Plot of Octave Data



Additional Comment:

Data analysed in accordance with the guidance from the IOA GPG May 2013.

Document No. 6414/001/O/R/07/001
Issue : B3

sgurrENERGY
sustainable energy solutions

Proven Energy

6kW WTGS at Neilston
Noise Survey

April 2007

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Proven Energy

6kW WTGS at Neilston Noise Survey

SUMMARY:

A noise survey has been conducted on an installed Proven 6kW wind turbine generator system (WTGS) for the purposes of characterising its noise emissions. The WTGS had been installed to provide electricity to a consumer and the site was not entirely suitable for a survey where all the parameters of interest could be fully controlled. Notwithstanding this, and although there is not yet a recognised standard by which noise emissions from small WTGS can be measured, a procedure was designed and the noise emissions were characterised in accord with the procedure.

CLIENT: **Proven Energy**

Contact: Jonathan Nowill

DISTRIBUTION :

Client: **SgurrEnergy:** Adam Spearey

	Name	Job Title	Signature
Prepared by	Jim Clive	Principal Noise Consultant	[redacted]
Checked by	Adam Spearey	Renewable Energy Consultant	
Authorised by	Ian Irvine	Technical Director	
Date of Issue	April 2007	**Classification:**	Confidential

9002/000/SF/04/023 B4

AMENDMENT RECORD			
Issue	**Date of Issue**	**Changes from Previous Issue**	**Purpose of Issue**
A1	April 2007		Internal review
B1	April 2007	Minor edits, Figure 1 added	Issue to Client
B2	April 2007	Minor Revisions, Glossary added	Issue to Client
B3	April 2007	Figure 2 added	Issue to Client

Certificate No. FS 85385
ISO 9001:2000

Certificate No. EMS 85386
ISO 14001:2004

Contents

1 INTRODUCTION

Prior to the installation of a wind turbine generating system (WTGS) it is often required to conduct an assessment of its environmental impact. Part of this exercise can involve predictions of the impact of noise attributable to the operation of the WTGS upon the surroundings wherein it is intended to be installed. Such an exercise requires knowledge of the noise emissions from the WTGS and the character of these emissions. A standard exists describing the techniques to be applied in acoustic measurements for large WTGSs, Reference 1. This European standard has the status of a British Standard and thus has wide international recognition. The power of the WTGSs that this standard applies to is currently in the range of hundreds of kilowatts to several megawatts. This existing standard presents measurement and reporting procedures that can be expected to provide accurate results that can be replicated. No standard is yet available for measuring the acoustic character of small WTGSs. Experience of others in deriving such tests, together with reference to other standards, can lead to a standard procedure for characterising acoustic emissions from small WTGSs in a repeatable manner. Such a procedure will require that many of the parameters involved will have to be carefully controlled, so much so that many sites will be inappropriate for the purpose of repeatable measurements of WTGS acoustic characteristics.

Operational noise from WTGSs varies with windspeed, as does the residual noise in the area adjacent to the WTGS. The noise attributable to the WTGS, and that attributable to residual sources, therefore has to be related to windspeed, which itself is normally a time variable.

Sgurr Energy were asked to measure acoustic characteristics on a Proven 6kW WTGS already installed at a site for the purposes of producing electrical power to a consumer. It is not the purpose of this report to specify a procedure by which acoustic characteristics of small WTGSs should be measured. Rather it is to describe the procedure for this particular WTGS in its present location, together with the results obtained.

2 TOPOGRAPHY

The speed of the wind, and the turbulence within it, depends upon features of the topography within which the WTGS is situated. Ideally the ground surface should be flat and of a known roughness and there should be an absence of obstruction to free flow of wind for a considerable area around the WTGS being examined. Such obstructions will include trees, bushes, buildings and transmission lines etc all of which can increase turbulence in wind regimes.

3 WIND SPEED

It is necessary to measure the speed with which the wind encounters the rotor of the WTGS. Wind speed across ground surfaces varies for several reasons one of which is height above ground. It is an industry standard that noise emissions from WTGSs be related to the windspeed at a height of 10m above ground level as measured between 2 and 4 rotor diameters upwind of the rotor.

4 GROUND REFLECTION OF SOUND

4.1 When sound from a source encounters the ground it is partly reflected and partly absorbed. The relationship between these two phenomena depends upon the acoustic nature of ground surface. To make this determinate and repeatable a ground board is normally laid under the position of the measuring microphone and an allowance made for the reflection.

4.2 Wind blowing across a measuring microphone generates noise that can add to that of the measured source. To minimise this contribution the microphone is fitted with a wind shield and fitted low to the ground where wind speed, and hence generated noise is least.

5 RESIDUAL NOISE

Ambient noise normally has a contribution from the source of interest and a residual contribution from other sources. To accurately discriminate between the two requires that the contribution from the source of interest is sufficiently greater than the residual noise.

6 PROCEDURE

The objective of the exercise was to measure the sound power level and the coefficient of regression for a Proven 6kW WTGS. The procedure adopted in measuring the noise characteristics of the Proven 6kW WTGS installed at a site near Neilston was designed to comply, as best as possible, with the above listed, and other considerations. The sound pressure levels measured were averaged over contiguous 10 second intervals as were the mean wind speeds with which the sound levels were compared. The survey was done for periods when the WTGS was in service and for similar periods when it had been removed from service. The periods with the WTGS in operation gave us the ambient noise against wind speed whilst those with the WTGS out of service gave us the residual noise against wind speed. The anemometer mast was located so that it would be upwind of the WTGS when the wind was from a direction of least obstruction. The client required the test results early so that particular aspect of the procedure was not fully complied with.

A one third octave bandwidth spectrum was measured and the results examined for evidence of the presence of a prominent tone that, using an appropriate criterion, would perhaps attract a correction to the apparent sound power level when assessed.

7 RESULTS

7.1 Measurements

The results of the noise survey are shown in the attached Figure 1. The best fit second order polynomials drawn through the data scatter are very close to the first order polynomials through the same scatters.

7.2 Calculations

The symbols and units are the same as in Reference 1.

Ro	= 10m
H	= 15m
R_1	= 18m
SPL of ambient noise at a 10m high wind speed of 8ms^{-1}	= 55.5dB(A)
SPL of residual noise at a 10m high wind speed of 8ms^{-1}	= 42.5dB(A)
SPL attributable to WTGS operation at 10m high wind speed of 8ms^{-1}	= 55.3dB(A)
SWL of WTGS at a 10m high wind speed of 8ms^{-1}	= 85.4dB(A)
Coefficient of Regression	= 2.24dB/ms^{-1}

8 DISCUSSION OF RESULTS

It should be noted that the conditions under which the survey was conducted were unavoidably removed from the ideal case that would have prevailed if the WTGS had been installed at a suitable test site. The sound power level and the coefficient of regression obtained should be treated as provisional until a test under properly controlled conditions is conducted.

The measured one third octave spectra were examined for evidence of prominent tones that would attract a correction to the measured apparent sound power level when assessed in accord with an appropriate criterion. No such prominent tone occurred at the measurement point under the conditions prevailing in the survey.

9 CONCLUSIONS

9.1 The sound power level of a 6kW Proven WTGS has been estimated from a survey conducted on such a WTGS previously installed at an existing site for the purposes of supplying power to an electricity consumer.

9.2 The site at which the WTGS was installed was not ideal with regard to topographical, wind direction and other requirements.

9.3 The sound power level measured for a 10m height wind speed of 8ms^{-1} was 85.4dB(A) with a coefficient of regression of 2.24dB/ms^{-1}. These values should be treated as provisional until a test under suitably controlled conditions can be performed.

9.4 The sound pressure level attributable to the WTGS at a horizontal distance of 10m from the base of the tower was measured as 55.3dB(A) (for a 10m height wind speed of 8ms^{-1}). Figure 2 shows how the SPL attributable to the WTGS varies with distance. These values should be treated as provisional until a test under suitably controlled conditions can be performed.

REFERENCES

1 British Standard BS EN 61400 – 11:2003 Wind turbine generator systems - Part 11: Acoustic noise measurement techniques.

Figure 1 - Noise Survey Results - 6kW Proven WTGS

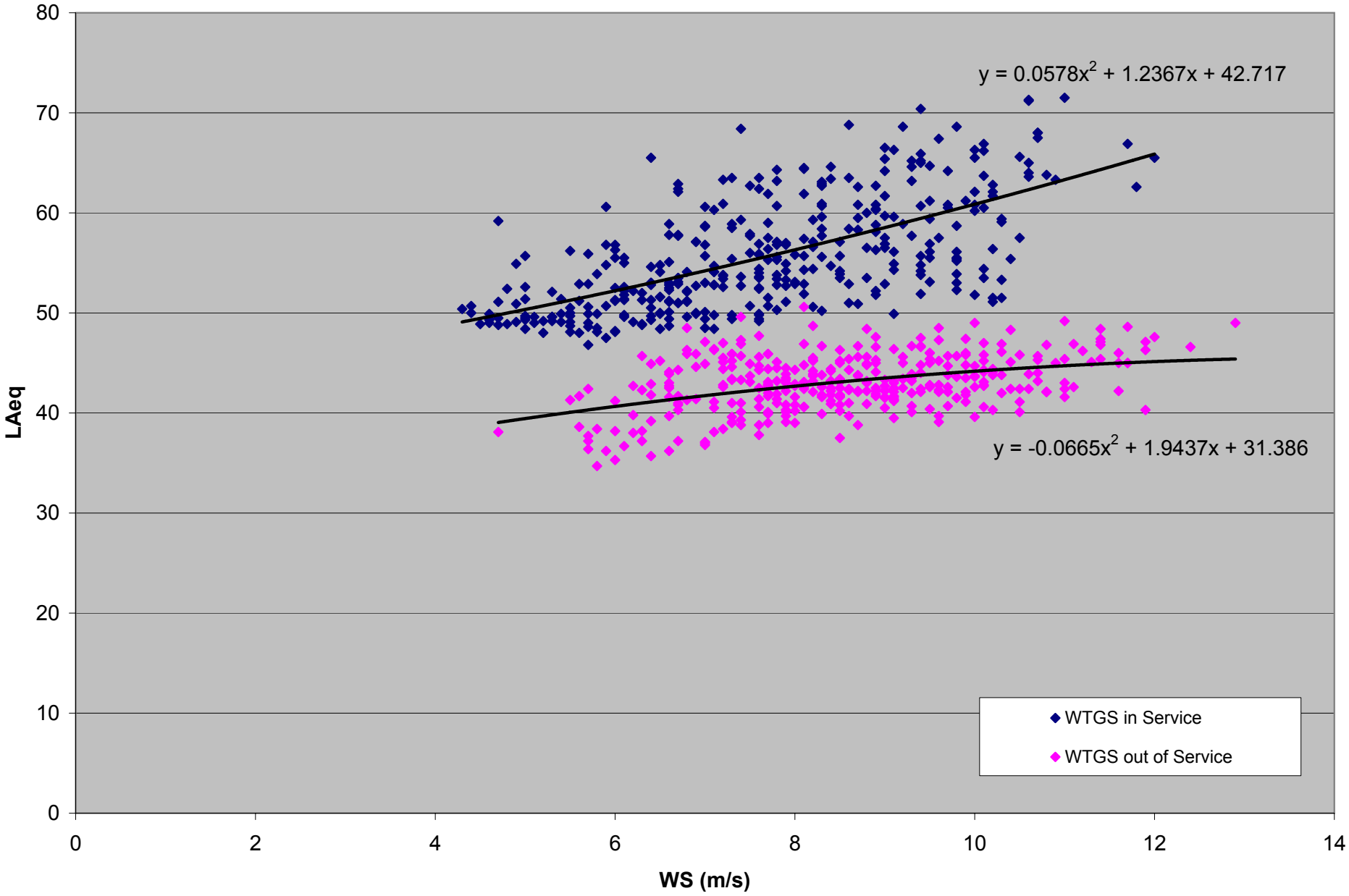
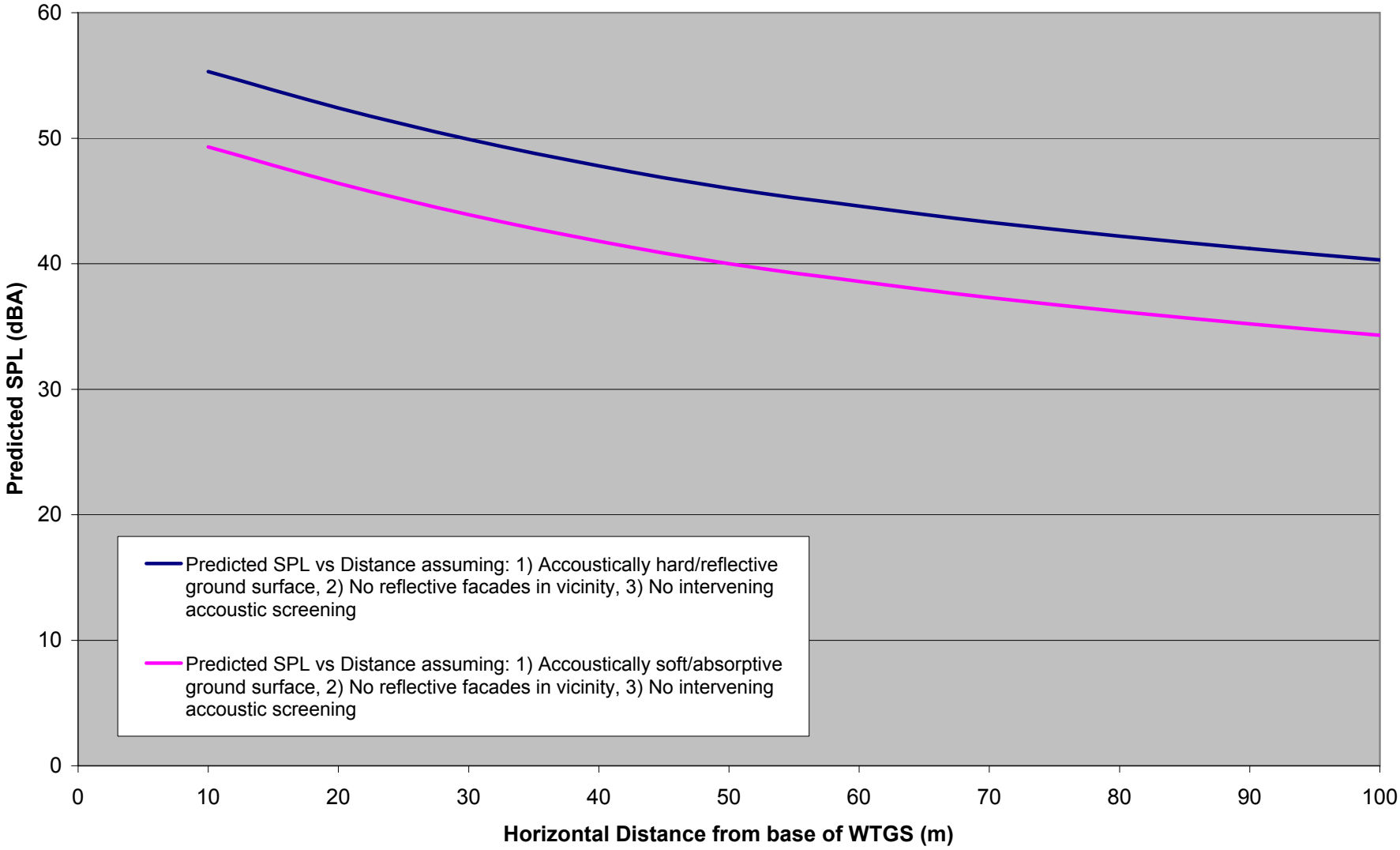


Figure 2 - 6kW Proven WTGS - SPL vs Distance



GLOSSARY OF TERMS

Sound

The word describes everything that the ears can hear; it can be music, spoken words, traffic, wind or just noise. The word noise is often used to describe unwanted sound. The properties of sound can be given objectively in physical terms. As a result of the psychological and physiological differences between individuals, reactions of persons or animals to noise, such as being disturbed or annoyed, are subjective and therefore difficult to predict.

Sound Power

Most sound sources can be conveniently described by giving their rate of production of noise energy. This rate is called sound power and has the symbol W (unit Watt). Sound power is intrinsic to a sound source, it is independent of influences resulting from interaction with the surrounding environmental acoustic features.

Sound Power Level, SWL

Ten times the logarithm to the base 10 of the ratio of the source sound power, W, to a standard reference power, W_{ref}, of standardised value, 1 picowatt. In this form the sound power is expressed as a level in decibels.

Sound Pressure

The increase or decrease in the atmospheric pressure due to the passage of a sound wave. The unit of measure in the SI system of units is the Pascal, (Pa). The human ear can detect sound pressure over a range from 20 micropascals to 20 Pascals. The sound pressure by itself is not characteristic of the sound source. The sound pressure is dependent on the sound power of the source, distance from the source and acoustic features in the environment surrounding both source and receiver.

The decibel

Sound pressure and sound power are expressed on a logarithmic scale simply because of the large difference in linear terms between the weakest and strongest audible sounds perceived by humans. The word level is added to indicate the use of a scale. The decibel is therefore not a unit of measurement.

Sound Pressure Level, L_p or SPL

Ten times the logarithm to the base 10 of the square of the ratio of the effective or root mean square of the sound pressure fluctuations, P, and a standard reference pressure, P_{ref}, of 20 micropascals. In this form the sound pressure is expressed as a level in decibels.

A-weighting

The human ear is not equally sensitive over the audible spectrum. It is most sensitive at frequencies around 4000Hz. It is much less sensitive at low frequencies. This non linearity is level dependent. In order to make the reading of the sound level meter correspond to loudness as perceived by normal human hearing frequency weighting is employed. The internationally standardised 'A' weighting is designed to mimic hearing response at a loudness of 40 Phons. Response to noise has been found to correlate well with levels measured using this weighting.

Typical Approximate Noise Levels	
Source	**Sound Pressure Level dB(A)**
Whisper	30
Library Reading Room	40
Quiet Office	50
Normal Conversation at 1m	60
Noisy Office	70
Domestic Vacuum Cleaner at 1m	80
Factory Machinery at 1m	90

Frequency

The time rate of repetition measured in number of cycles per second, expressed as Hertz (abbreviated to Hz).

Sound Level Meter (SLM)

An instrument used to measure sound in an accurate reproducible manner.

dB(A)

This indicates that the A - weighting has been applied to the measurements.

Specific noise source

The noise source under investigation.

Ambient noise

Totally encompassing sound in a given situation at a given time.

Residual noise

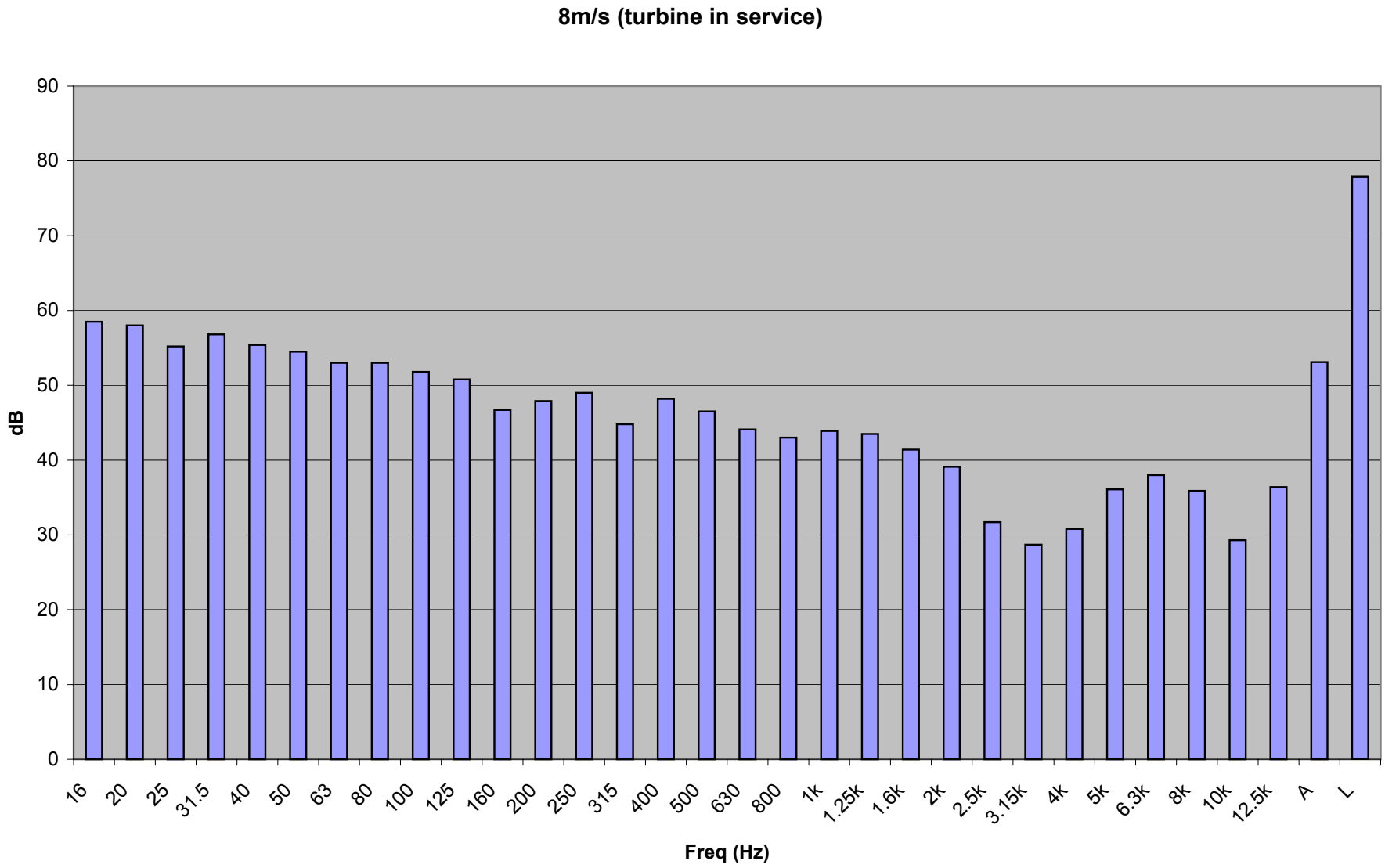
The noise remaining when a specific noise source is suppressed to such a degree that it does not contribute to the ambient noise.

Background noise level, $L_{A90,\,T}$.

The A-weighted percentile sound pressure level of the residual noise exceeded for 90% of a given time interval, T.

Equivalent continuous sound pressure level, $L_{eq,T}$.

The equivalent continuous steady sound pressure level that gives the same noise exposure as a fluctuating noise measured over the same time interval.


8m/s (turbine in service)
dB
90
80
70
60
50
40
30
20
10
0
16
20
25
31.5
40
50
63
80
100
125
160
200
250
315
400
500
630
800
1k
1.25k
1.6k
2k
2.5k
3.15k
4k
5k
6.3k
8k
10k
12.5k
A
L
Freq (Hz)

ANNEX 8 – Topographical Corrections

Table 1 Likely Effects Calculations

Location		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Lower Hollingarth	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	27.3	30.9	34.7	36.1	36.2	36.2	36.2	36.2	36.2
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	-2.6	-0.3	1.9	4.2	6.4	8.7	10.9	13.2	13.2
	Difference	-	-	-	-	31.2	32.8	31.9	29.8	27.5	25.3	23	23
NAL2 - Whirligarth	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	30.5	34.1	37.8	39.2	39.4	39.4	39.4	39.4	39.4
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	0	2.3	4.5	6.8	9	11.2	13.5	15.7	15.7
	Difference	-	-	-	-	31.8	33.3	32.4	30.4	28.2	25.9	23.7	23.7
NAL3 - Easterlee	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	30.3	33.9	37.6	39.1	39.2	39.2	39.2	39.2	39.2
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	18.9	21.2	23.4	25.7	27.9	30.2	32.4	34.7	34.7
	Difference	-	-	-	-	12.7	14.2	13.4	11.3	9	6.8	4.5	4.5
NAL4 - Gentletown	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	27.5	31.1	34.8	36.2	36.4	36.4	36.4	36.4	36.4
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	19.3	21.5	23.8	26	28.3	30.5	32.8	35	35
	Difference	-	-	-	-	9.6	11	10.2	8.1	5.9	3.6	1.4	1.4
NAL5 - Littlester	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	25.8	29.5	33.2	34.6	34.7	34.7	34.7	34.7	34.7
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	25.3	27.5	29.8	32.1	34.3	36.6	38.8	41.1	41.1
	Difference	-	-	-	-	2	3.4	2.5	0.4	-1.9	-4.1	-6.4	-6.4
NAL6 - Hamnavoe	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	24.5	28.1	31.8	33.2	33.4	33.4	33.4	33.4	33.4
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	6.6	8.8	11.1	13.3	15.6	17.8	20.1	22.3	22.3
	Difference	-	-	-	-	19.3	20.7	19.9	17.8	15.6	13.3	11.1	11.1
NAL7 - Helenquhida	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	26.6	30.2	34	35.4	35.5	35.5	35.5	35.5	35.5
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	23.4	25.6	27.8	30	32.3	34.5	36.7	38.9	38.9
	Difference	-	-	-	-	4.6	6.2	5.4	3.2	1	-1.2	-3.4	-3.4
NAL8-Kettlester	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	26.4	30	33.7	35.1	35.3	35.3	35.3	35.3	35.3
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	23.5	25.7	27.9	30.1	32.3	34.5	36.7	38.9	38.9
	Difference	-	-	-	-	4.3	5.8	5	3	0.8	-1.4	-3.6	-3.6
NAL9 - Islesview	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	28.7	32.3	36	37.4	37.6	37.6	37.6	37.6	37.6
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	20.6	22.9	25.1	27.4	29.6	31.9	34.1	36.4	36.4
	Difference	-	-	-	-	9.4	10.9	10	8	5.7	3.5	1.2	1.2
NAL10 - Westerlee	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	27.7	31.3	35	36.4	36.6	36.6	36.6	36.6	36.6
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	22.5	24.8	27	29.3	31.5	33.7	36	38.2	38.2
	Difference	-	-	-	-	6.5	8	7.1	5.1	2.9	0.6	-1.6	-1.6
NAL11 - Kletterlea	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	26.5	30.2	33.9	35.3	35.4	35.4	35.4	35.4	35.4
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	31.4	33.6	35.9	38.1	40.4	42.7	44.9	47.2	47.2
	Difference	-	-	-	-	-3.4	-2	-2.8	-5	-7.3	-9.5	-11.8	-11.8
NAL12 - The School House	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	23.7	27.3	31.1	32.5	32.6	32.6	32.6	32.6	32.6
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	25.5	27.7	30	32.3	34.5	36.8	39	41.3	41.3
	Difference	-	-	-	-	-0.4	1.1	0.2	-1.9	-4.2	-6.4	-8.7	-8.7
NAL13 - Cluness Cottage	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	25.6	29.2	32.9	34.3	34.5	34.5	34.5	34.5	34.5
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	34.1	36.3	38.5	40.6	42.8	45	47.2	49.3	49.3
	Difference	-	-	-	-	-7.1	-5.6	-6.3	-8.3	-10.5	-12.7	-14.8	-14.8

NAL14 - Staneygarth	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	25.2	28.9	32.6	34	34.1	34.1	34.1	34.1	34.1
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	27.4	29.6	31.8	34	36.2	38.4	40.5	42.7	42.7
	Difference	-	-	-	-	-0.7	0.8	0	-2.1	-4.3	-6.4	-8.6	-8.6
NAL15 - Giggleswick	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	25.4	29	32.7	34.2	34.3	34.3	34.3	34.3	34.3
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	29.9	32.2	34.4	36.7	39	41.2	43.5	45.7	45.7
	Difference	-	-	-	-	-3.2	-1.7	-2.5	-4.7	-6.9	-9.2	-11.4	-11.4

Table 2 - Wind Turbines

Wind Farm/ Turbine	Turbine Modelled	Easting	Northing
Beaw Field 1	Senvion-3.4M 104-RE50.8 blade-Full mode	450454	1183369
Beaw Field 2	Senvion-3.4M 104-RE50.8 blade-Full mode	450654	1183105
Beaw Field 3	Senvion-3.4M 104-RE50.8 blade-Full mode	451094	1183089
Beaw Field 4	Senvion-3.4M 104-RE50.8 blade-Full mode	450670	1182757
Beaw Field 5	Senvion-3.4M 104-RE50.8 blade-Full mode	451343	1182860
Beaw Field 6	Senvion-3.4M 104-RE50.8 blade-Full mode	450910	1182525
Beaw Field 7	Senvion-3.4M 104-RE50.8 blade-Full mode	451627	1182659
Beaw Field 8	Senvion-3.4M 104-RE50.8 blade-Full mode	451079	1182243
Beaw Field 9	Senvion-3.4M 104-RE50.8 blade-Full mode	451998	1182488
Beaw Field 10	Senvion-3.4M 104-RE50.8 blade-Full mode	451678	1182109
Beaw Field 11	Senvion-3.4M 104-RE50.8 blade-Full mode	451223	1181970
Beaw Field 12	Senvion-3.4M 104-RE50.8 blade-Full mode	452188	1182283
Beaw Field 13	Senvion-3.4M 104-RE50.8 blade-Full mode	452008	1181933
Beaw Field 14	Senvion-3.4M 104-RE50.8 blade-Full mode	451469	1181732
Beaw Field 15	Senvion-3.4M 104-RE50.8 blade-Full mode	452111	1181525
Beaw Field 16	Senvion-3.4M 104-RE50.8 blade-Full mode	451610	1181433
Beaw Field 17	Senvion-3.4M 104-RE50.8 blade-Full mode	452358	1181254
Other Turbines 18	EVANCE ISKRA R9000 5KW 10m Hub	452229	1180022
Other Turbines 19	Proven-6KW-Generic blade-Full mode	451588	1180224
Other Turbines 20	Eoltech-Scirocco-Generic blade-Full mode	451966	1179967
Other Turbines 21	EVANCE ISKRA R9000 5KW 10m Hub	451250	1180300
Other Turbines 22	EVANCE ISKRA R9000 5KW 10m Hub	451194	1180286
Other Turbines 23	EVANCE ISKRA R9000 5KW 10m Hub	451313	1180253
Other Turbines 24	EVANCE ISKRA R9000 5KW 10m Hub	451297	1180208
Other Turbines 25	EVANCE ISKRA R9000 5KW 10m Hub	451700	1179525

Concave/Barrier Corrections

Wind Farm	Hub	T ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Beaw Field 1	95	1	-2	0	0	0	0	0	-2	0	0	0	-2	-2	0	0	0
Beaw Field 2	95	2	-2	0	0	0	0	-2	-2	0	0	0	-2	-2	0	0	0
Beaw Field 3	95	3	0	3	0	0	0	-2	-2	0	0	0	-2	-2	0	0	0
Beaw Field 4	95	4	-2	0	0	0	0	-2	0	0	0	0	-2	-2	0	0	0
Beaw Field 5	95	5	0	0	0	0	0	0	-2	0	0	0	0	-2	0	0	0
Beaw Field 6	95	6	0	0	0	0	0	0	0	0	0	0	-2	-2	0	0	0
Beaw Field 7	95	7	0	0	0	0	0	0	-2	0	0	0	0	-2	-2	-2	-2
Beaw Field 8	95	8	0	0	0	0	0	0	0	0	0	0	-2	-2	0	0	0
Beaw Field 9	95	9	0	0	0	0	0	0	-2	0	0	0	0	-2	0	-2	0
Beaw Field 10	95	10	0	0	0	0	0	0	-2	0	0	0	0	-2	0	0	0
Beaw Field 11	95	11	0	0	0	0	0	0	0	0	0	0	0	-2	0	0	0
Beaw Field 12	95	12	0	0	0	0	0	0	-2	0	0	0	0	-2	0	0	0
Beaw Field 13	95	13	0	0	0	0	0	0	0	0	0	0	0	-2	0	0	0
Beaw Field 14	95	14	0	0	0	0	0	0	0	0	0	0	0	-2	0	0	0
Beaw Field 15	95	15	0	0	0	0	0	0	0	0	0	0	0	-2	0	0	0
Beaw Field 16	95	16	0	0	0	0	0	0	0	0	0	0	0	-2	0	0	0
Beaw Field 17	95	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ANNEX 9 – Alternative Noise Limits which would apply if Turbine 20 is removed

Annex 9 – Alternative noise limits should the Cluness Turbine (T20) be removed

TNEI understand that the small turbine on land at Cluness Cottage may be removed. As such a revised set of Total and Site Specific noise limits and cumulative noise predictions have been produced for each of the Noise Assessment Locations. The relevant tables from the main report have been reproduced below to detail the revised limits and predictions.

Should T20 be removed the tables below detail the Site Specific Noise Limits which should be adopted for the Proposed Development.

Total ETSU-R-97 Noise Limits (Stage 1)

The Total ETSU-R-97 noise limits have been established for each of the NALs as detailed in Table 6.3 and Table 6.4 below, based on a fixed minimum of 40dB(A) (Quiet daytime) or 43 dB(A) (Night-time) or background plus 5 dB(A).

Due to the proximity of small wind turbine developments to NAL11 and NAL15 it has been assumed that the occupiers are financially involved with the wind turbine developments as such, a higher limit of 45dB or permissible margin above background noise (5dB) has been assumed for those receptors during the quiet daytime and night time periods.

Table 6.3 Total ETSU-R-97 Noise Limits Quiet Daytime

Noise Assessment Location	Wind Speed (ms^{-1}) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NAL1- Lower Hollingarth	40	40	40	40	40	40	40	40.1	41.8	42.6	42.6	42.6
NAL2- Whirliegarth	40	40	40	40	40	40	40	40	40.5	42.9	42.9	42.9
NAL3- Easterlee	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
NAL4 - Gentletown	40	40	40	40	40	40	40	41.8	44.6	46.8	48	48
NAL5 - Littlester	40	40	40	40	40	40	41.3	44.4	47.2	49.6	51.3	51.3
NAL6 - Hamnavoe	40	40	40	40	40	40	40	40.1	41.8	42.6	42.6	42.6
NAL7 - Helnaquhida	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
NAL8 - Kettlester	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
NAL9 - Islesview	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
NAL10 - Westerlee	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
NAL11 - Kletterlea*	45	45	45	45	45	45	45	45	47.2	49.6	51.3	51.3
NAL12 - The School House	40	40	40	40	40	40	41.3	44.4	47.2	49.6	51.3	51.3
NAL13 – Cluness Cottage	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
NAL14 - Staneygarth	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
NAL15 - Giggleswick *	45	45	45	45	45	45	45	45	45	46.8	48	48

* assumes FI with the nearby operational wind turbine

Table 6.4 Total ETSU-R-97 noise limits Night-Time

Noise Assessment Location	Wind Speed (ms^{-1}) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NAL1- Lower Hollingarth	43	43	43	43	43	43	43	43	43	43	43	44.1
NAL2- Whirliegarth	43	43	43	43	43	43	43	43	43	43	43.7	43.7
NAL3- Easterlee	43	43	43	43	43	43	43	43	43	43	45.1	45.1
NAL4 - Gentletown	43	43	43	43	43	43	43	43	43	44	46.1	46.1
NAL5 - Littlester	43	43	43	43	43	43	43	43	44.5	47.3	49.8	51.8
NAL6 - Hamnavoe	43	43	43	43	43	43	43	43	43	43	43	44.1
NAL7 - Helnaquhida	43	43	43	43	43	43	43	43	43	43	45.1	45.1
NAL8 - Kettlester	43	43	43	43	43	43	43	43	43	43	45.1	45.1
NAL9 - Islesview	43	43	43	43	43	43	43	43	43	43	45.1	45.1
NAL10 - Westerlee	43	43	43	43	43	43	43	43	43	43	45.1	45.1
NAL11 - Kletterlea	45	45	45	45	45	45	45	45	45	47.3	49.8	51.8
NAL12 - The School House	43	43	43	43	43	43	43	43	44.5	47.3	49.8	51.8
NAL13 – Cluness Cottage	43	43	43	43	43	43	43	43	43	43	45.1	45.1
NAL14 - Staneygarth	43	43	43	43	43	43	43	43	43	43	45.1	45.1
NAL15 - Giggleswick*	45	45	45	45	45	45	45	45	45	45	46.1	46.1

* assumes FI with the nearby operational wind turbine

Predicting the likely effects and the requirement for a cumulative noise assessment (Stage 2)

Table 6.7 and Table 6.8 and shows that the predicted cumulative wind turbine noise immission levels (without T20) meet the Total ETSU-R-97 noise limits under all conditions and at all locations for both quiet daytime and night-time periods

Table 6.7 Compliance Table - Likely Cumulative Noise - Quiet Daytime

Location		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Lower Hollingarth	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40.1	41.8	42.6	42.6	42.6
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.6	31.2	35	36.4	36.5	36.5	36.5	36.5	36.5
	Exceedance Level L_{A90}	-	-	-	-12.4	-8.8	-5	-3.6	-3.6	-5.3	-6.1	-6.1	-6.1
NAL2 - Whirliegarth	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40	40.5	42.9	42.9	42.9
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.5	34.1	37.8	39.2	39.4	39.4	39.4	39.4	39.4
	Exceedance Level L_{A90}	-	-	-	-9.5	-5.9	-2.2	-0.8	-0.6	-1.1	-3.5	-3.5	-3.5
NAL3 - Easterlee	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.6	34.1	37.8	39.2	39.5	39.7	40	40.5	40.5
	Exceedance Level L_{A90}	-	-	-	-9.4	-5.9	-2.2	-0.8	-0.5	-2.7	-4.6	-6.2	-6.2
NAL4 - Gentletown	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	41.8	44.6	46.8	48	48
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28	31.5	35.1	36.6	36.9	37.3	37.9	38.6	38.6
	Exceedance Level L_{A90}	-	-	-	-12	-8.5	-4.9	-3.4	-4.9	-7.3	-8.9	-9.4	-9.4
NAL5 - Littlester	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	41.3	44.4	47.2	49.6	51.3	51.3
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.6	31.6	34.8	36.5	37.5	38.7	40.2	42	42
	Exceedance Level L_{A90}	-	-	-	-11.4	-8.4	-5.2	-4.8	-6.9	-8.5	-9.4	-9.3	-9.3
NAL6 - Hamnavoe	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40.1	41.8	42.6	42.6	42.6
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	24.6	28.2	31.9	33.3	33.5	33.5	33.6	33.7	33.7
	Exceedance Level L_{A90}	-	-	-	-15.4	-11.8	-8.1	-6.7	-6.6	-8.3	-9	-8.9	-8.9
NAL7 - Helnaquhida	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.9	31.2	34.7	36.2	36.8	37.5	38.4	39.7	39.7
	Exceedance Level L_{A90}	-	-	-	-12.1	-8.8	-5.3	-3.8	-3.2	-4.9	-6.2	-7	-7
NAL8 - Kettlester	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.4	30.8	34.3	35.8	36.3	36.9	37.8	38.9	38.9
	Exceedance Level L_{A90}	-	-	-	-12.6	-9.2	-5.7	-4.2	-3.7	-5.5	-6.8	-7.8	-7.8
NAL9 -Isleview	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.3	32.7	36.3	37.8	38.2	38.5	39.1	39.9	39.9
	Exceedance Level L_{A90}	-	-	-	-10.7	-7.3	-3.7	-2.2	-1.8	-3.9	-5.5	-6.8	-6.8
NAL10 - Westerlee	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.8	32.1	35.6	37.1	37.7	38.3	39.2	40.3	40.3
	Exceedance Level L_{A90}	-	-	-	-11.2	-7.9	-4.4	-2.9	-2.3	-4.1	-5.4	-6.4	-6.4
NAL11 - Kletterlea	Total ETSU-R-97 Noise Limit	45	45	45	45	45	45	45	45	47.2	49.6	51.3	51.3
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	32.6	35.3	38	40	41.6	43.4	45.4	47.5	47.5
	Exceedance Level L_{A90}	-	-	-	-12.4	-9.7	-7	-5	-3.4	-3.8	-4.2	-3.8	-3.8
NAL12 - The School House	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	41.3	44.4	47.2	49.6	51.3	51.3
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.7	30.5	33.6	35.3	36.7	38.1	39.9	41.8	41.8
	Exceedance Level L_{A90}	-	-	-	-12.3	-9.5	-6.4	-6	-7.7	-9.1	-9.7	-9.5	-9.5
Cluness Cottage	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	26.9	30.2	33.6	35.2	35.8	36.5	37.6	38.8	38.8
	Exceedance Level L_{A90}	-	-	-	-13.1	-9.8	-6.4	-4.8	-4.2	-5.9	-7	-7.9	-7.9
NAL14 - Staneygarth	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	26.5	29.9	33.3	34.9	35.5	36.2	37.2	38.5	38.5
	Exceedance Level L_{A90}	-	-	-	-13.5	-10.1	-6.7	-5.1	-4.5	-6.2	-7.4	-8.2	-8.2
NAL15 - Giggleswick	Total ETSU-R-97 Noise Limit	45	45	45	45	45	45	45	45	45	46.8	48	48
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	31.2	33.8	36.6	38.5	40.2	41.9	43.9	45.9	45.9
	Exceedance Level L_{A90}	-	-	-	-13.8	-11.2	-8.4	-6.5	-4.8	-3.1	-2.9	-2.1	-2.1

Table 6.8 Compliance Table - Likely Cumulative Noise - Night time

Location		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Lower Hollingarth	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	43	44.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.6	31.2	35	36.4	36.5	36.5	36.5	36.5	36.5
	Exceedance Level L_{A90}	-	-	-	-15.4	-11.8	-8	-6.6	-6.5	-6.5	-6.5	-6.5	-7.6
NAL2 - Whirlegarth	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	43.7	43.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.5	34.1	37.8	39.2	39.4	39.4	39.4	39.4	39.4
	Exceedance Level L_{A90}	-	-	-	-12.5	-8.9	-5.2	-3.8	-3.6	-3.6	-3.6	-4.3	-4.3
NAL3 - Easterlee	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	45.1	45.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.6	34.1	37.8	39.2	39.5	39.7	40	40.5	40.5
	Exceedance Level L_{A90}	-	-	-	-12.4	-8.9	-5.2	-3.8	-3.5	-3.3	-3	-4.6	-4.6
NAL4 - Gentletown	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	44	46.1	46.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28	31.5	35.1	36.6	36.9	37.3	37.9	38.6	38.6
	Exceedance Level L_{A90}	-	-	-	-15	-11.5	-7.9	-6.4	-6.1	-5.7	-6.1	-7.5	-7.5
NAL5 - Littlester	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	44.5	47.3	49.8	51.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.6	31.6	34.8	36.5	37.5	38.7	40.2	42	42
	Exceedance Level L_{A90}	-	-	-	-14.4	-11.4	-8.2	-6.5	-5.5	-5.8	-7.1	-7.8	-9.8
NAL6 - Hamnavoe	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	43	44.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	24.6	28.2	31.9	33.3	33.5	33.5	33.6	33.7	33.7
	Exceedance Level L_{A90}	-	-	-	-18.4	-14.8	-11.1	-9.7	-9.5	-9.5	-9.4	-9.3	-10.4
NAL7 - Helnaquhida	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	45.1	45.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.9	31.2	34.7	36.2	36.8	37.5	38.4	39.7	39.7
	Exceedance Level L_{A90}	-	-	-	-15.1	-11.8	-8.3	-6.8	-6.2	-5.5	-4.6	-5.4	-5.4
NAL8 - Kettlester	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	45.1	45.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.4	30.8	34.3	35.8	36.3	36.9	37.8	38.9	38.9
	Exceedance Level L_{A90}	-	-	-	-15.6	-12.2	-8.7	-7.2	-6.7	-6.1	-5.2	-6.2	-6.2
NAL9 -Isleview	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	45.1	45.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.3	32.7	36.3	37.8	38.2	38.5	39.1	39.9	39.9
	Exceedance Level L_{A90}	-	-	-	-13.7	-10.3	-6.7	-5.2	-4.8	-4.5	-3.9	-5.2	-5.2
NAL10 - Westerlee	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	45.1	45.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.8	32.1	35.6	37.1	37.7	38.3	39.2	40.3	40.3
	Exceedance Level L_{A90}	-	-	-	-14.2	-10.9	-7.4	-5.9	-5.3	-4.7	-3.8	-4.8	-4.8
NAL11 - Kletterlea	Total ETSU-R-97 Noise Limit	45	45	45	45	45	45	45	45	45	47.3	49.8	51.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	32.6	35.3	38	40	41.6	43.4	45.4	47.5	47.5
	Exceedance Level L_{A90}	-	-	-	-12.4	-9.7	-7	-5	-3.4	-1.6	-1.9	-2.3	-4.3
NAL12 - The School House	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	44.5	47.3	49.8	51.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.7	30.5	33.6	35.3	36.7	38.1	39.9	41.8	41.8
	Exceedance Level L_{A90}	-	-	-	-15.3	-12.5	-9.4	-7.7	-6.3	-6.4	-7.4	-8	-10
Cluness Cottage	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	45.1	45.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	26.9	30.2	33.6	35.2	35.8	36.5	37.6	38.8	38.8
	Exceedance Level L_{A90}	-	-	-	-16.1	-12.8	-9.4	-7.8	-7.2	-6.5	-5.4	-6.3	-6.3
NAL14 - Stanegarth	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	45.1	45.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	26.5	29.9	33.3	34.9	35.5	36.2	37.2	38.5	38.5
	Exceedance Level L_{A90}	-	-	-	-16.5	-13.1	-9.7	-8.1	-7.5	-6.8	-5.8	-6.6	-6.6
NAL15 - Giggleswick	Total ETSU-R-97 Noise Limit	45	45	45	45	45	45	45	45	45	45	46.1	46.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	31.2	33.8	36.6	38.5	40.2	41.9	43.9	45.9	45.9
	Exceedance Level L_{A90}	-	-	-	-13.8	-11.2	-8.4	-6.5	-4.8	-3.1	-1.1	-0.2	-0.2

Derivation of Site Specific Noise Limits (Stage 3)

Tables 6.10 and 6.11 show the site specific noise limits for the proposed development and the predicted wind turbine noise levels based on the Senvion 3.4M 104 which is the louder of the two candidate turbines. A negative exceedence demonstrates compliance with the site specific noise limits.

Table 6.10 Site Specific Limits Compliance Table - Quiet Daytime

Location		Wind Speed (ms-1) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Lower Hollingarth	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	40	40	40	40.1	41.8	42.6	42.6	42.6
	Predicted Wind Turbine Noise L_{A90}	-	-	-	27.3	30.9	34.7	36.1	36.2	36.2	36.2	36.2	36.2
	Exceedance Level L_{A90}	-	-	-	-12.7	-9.1	-5.3	-3.9	-3.9	-5.6	-6.4	-6.4	-6.4
NAL2 - Whirliegarth	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	40	40	40	40	40.5	42.9	42.9	42.9
	Predicted Wind Turbine Noise L_{A90}	-	-	-	30.5	34.1	37.8	39.2	39.4	39.4	39.4	39.4	39.4
	Exceedance Level L_{A90}	-	-	-	-9.5	-5.9	-2.2	-0.8	-0.6	-1.1	-3.5	-3.5	-3.5
NAL3 - Easterlee	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	39.9	39.9	39.8	39.7	42.1	44.3	46.4	46.4
	Predicted Wind Turbine Noise L_{A90}	-	-	-	30.3	33.9	37.6	39.1	39.2	39.2	39.2	39.2	39.2
	Exceedance Level L_{A90}	-	-	-	-9.7	-6	-2.3	-0.7	-0.5	-2.9	-5.1	-7.2	-7.2
NAL4 - Gentletown	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	39.9	39.9	39.8	41.6	44.4	46.6	47.8	47.8
	Predicted Wind Turbine Noise L_{A90}	-	-	-	27.5	31.1	34.8	36.2	36.4	36.4	36.4	36.4	36.4
	Exceedance Level L_{A90}	-	-	-	-12.5	-8.8	-5.1	-3.6	-5.2	-8	-10.2	-11.4	-11.4
NAL5 - Littlester	Site Specific Noise Limit : ETSU-R-97	40	39.9	39.9	39.9	39.7	39.6	40.8	44	46.8	49.2	50.9	50.9
	Predicted Wind Turbine Noise L_{A90}	-	-	-	25.8	29.5	33.2	34.6	34.7	34.7	34.7	34.7	34.7
	Exceedance Level L_{A90}	-	-	-	-14.1	-10.2	-6.4	-6.2	-9.3	-12.1	-14.5	-16.2	-16.2
NAL6 - Hamnavoe	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	40	40	40	40.1	41.8	42.6	42.6	42.6
	Predicted Wind Turbine Noise L_{A90}	-	-	-	24.5	28.1	31.8	33.2	33.4	33.4	33.4	33.4	33.4
	Exceedance Level L_{A90}	-	-	-	-15.5	-11.9	-8.2	-6.8	-6.7	-8.4	-9.2	-9.2	-9.2
NAL7 - Helnaquhida	Site Specific Noise Limit : ETSU-R-97	40	39.9	39.9	39.9	39.9	39.8	39.7	39.5	41.9	44.1	46.2	46.2
	Predicted Wind Turbine Noise L_{A90}	-	-	-	26.6	30.2	34	35.4	35.5	35.5	35.5	35.5	35.5
	Exceedance Level L_{A90}	-	-	-	-13.3	-9.7	-5.8	-4.3	-4	-6.4	-8.6	-10.7	-10.7
NAL8 - Kettlester	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	39.9	39.9	39.8	39.7	42.1	44.3	46.4	46.4
	Predicted Wind Turbine Noise L_{A90}	-	-	-	26.4	30	33.7	35.1	35.3	35.3	35.3	35.3	35.3
	Exceedance Level L_{A90}	-	-	-	-13.6	-9.9	-6.2	-4.7	-4.4	-6.8	-9	-11.1	-11.1
NAL9 -Isleview	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	39.9	39.9	39.8	39.6	42	44.2	46.3	46.3
	Predicted Wind Turbine Noise L_{A90}	-	-	-	28.7	32.3	36	37.4	37.6	37.6	37.6	37.6	37.6
	Exceedance Level L_{A90}	-	-	-	-11.3	-7.6	-3.9	-2.4	-2	-4.4	-6.6	-8.7	-8.7
NAL10 - Westerlee	Site Specific Noise Limit : ETSU-R-97	40	39.9	39.9	39.9	39.9	39.8	39.7	39.4	41.8	44	46.1	46.1
	Predicted Wind Turbine Noise L_{A90}	-	-	-	27.7	31.3	35	36.4	36.6	36.6	36.6	36.6	36.6
	Exceedance Level L_{A90}	-	-	-	-12.2	-8.6	-4.8	-3.3	-2.8	-5.2	-7.4	-9.5	-9.5
NAL11 - Kletterlea	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	40	40	41.3	43.2	45.3	47.8	49.2	49.2
	Predicted Wind Turbine Noise L_{A90}	-	-	-	26.5	30.2	33.9	35.3	35.4	35.4	35.4	35.4	35.4
	Exceedance Level L_{A90}	-	-	-	-13.5	-9.8	-6.1	-6	-7.8	-9.9	-12.4	-13.8	-13.8
NAL12 - The School House	Site Specific Noise Limit : ETSU-R-97	40	39.8	39.8	39.8	39.7	39.6	40.7	43.9	46.8	49.2	50.9	50.9
	Predicted Wind Turbine Noise L_{A90}	-	-	-	23.7	27.3	31.1	32.5	32.6	32.6	32.6	32.6	32.6
	Exceedance Level L_{A90}	-	-	-	-16.1	-12.4	-8.5	-8.2	-11.3	-14.2	-16.6	-18.3	-18.3
NAL13 Clunes Cottage	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	39.9	39.9	39.8	39.6	42	44.2	46.3	46.3
	Predicted Wind Turbine Noise L_{A90}	-	-	-	25.6	29.2	32.9	34.3	34.5	34.5	34.5	34.5	34.5
	Exceedance Level L_{A90}	-	-	-	-14.4	-10.7	-7	-5.5	-5.1	-7.5	-9.7	-11.8	-11.8
NAL14 - Staneygarth	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	39.9	39.9	39.8	39.7	42.1	44.3	46.4	46.4
	Predicted Wind Turbine Noise L_{A90}	-	-	-	25.2	28.9	32.6	34	34.1	34.1	34.1	34.1	34.1
	Exceedance Level L_{A90}	-	-	-	-14.8	-11	-7.3	-5.8	-5.6	-8	-10.2	-12.3	-12.3
NAL15 - Giggleswick	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	40	40	40	41.8	42.7	44.1	44.3	44.3
	Predicted Wind Turbine Noise L_{A90}	-	-	-	25.4	29	32.7	34.2	34.3	34.3	34.3	34.3	34.3
	Exceedance Level L_{A90}	-	-	-	-14.6	-11	-7.3	-5.8	-7.5	-8.4	-9.8	-10	-10

Table 6.11 Site Specific Limits Compliance Table - Night-time

Location		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Lower Hollingarth	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	43	43	43	43	43	43	44.1
	Predicted Wind Turbine Noise L_{A90}	-	-	-	27.3	30.9	34.7	36.1	36.2	36.2	36.2	36.2	36.2
	Exceedance Level L_{A90}	-	-	-	-15.7	-12.1	-8.3	-6.9	-6.8	-6.8	-6.8	-6.8	-7.9
NAL2 - Whirliegarth	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	43	43	43	43	43	43.7	43.7
	Predicted Wind Turbine Noise L_{A90}	-	-	-	30.5	34.1	37.8	39.2	39.4	39.4	39.4	39.4	39.4
	Exceedance Level L_{A90}	-	-	-	-12.5	-8.9	-5.2	-3.8	-3.6	-3.6	-3.6	-4.3	-4.3
NAL3 - Easterflee	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	43	42.9	42.9	42.8	42.6	44.7	44.7
	Predicted Wind Turbine Noise L_{A90}	-	-	-	30.3	33.9	37.6	39.1	39.2	39.2	39.2	39.2	39.2
	Exceedance Level L_{A90}	-	-	-	-12.7	-9.1	-5.4	-3.8	-3.7	-3.6	-3.4	-5.5	-5.5
NAL4 - Gentletown	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	43	42.9	42.9	42.8	43.7	45.8	45.8
	Predicted Wind Turbine Noise L_{A90}	-	-	-	27.5	31.1	34.8	36.2	36.4	36.4	36.4	36.4	36.4
	Exceedance Level L_{A90}	-	-	-	-15.5	-11.9	-8.2	-6.7	-6.5	-6.4	-7.3	-9.4	-9.4
NAL5 - Littlester	Site Specific Noise Limit : ETSU-R-97	43	42.9	42.9	42.9	42.9	42.8	42.6	42.4	43.8	46.7	49.2	51.4
	Predicted Wind Turbine Noise L_{A90}	-	-	-	25.8	29.5	33.2	34.6	34.7	34.7	34.7	34.7	34.7
	Exceedance Level L_{A90}	-	-	-	-17.1	-13.4	-9.6	-8	-7.7	-9.1	-12	-14.5	-16.7
NAL6 - Hamnavoe	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	43	43	43	43	43	43	44.1
	Predicted Wind Turbine Noise L_{A90}	-	-	-	24.5	28.1	31.8	33.2	33.4	33.4	33.4	33.4	33.4
	Exceedance Level L_{A90}	-	-	-	-18.5	-14.9	-11.2	-9.8	-9.6	-9.6	-9.6	-9.6	-10.7
NAL7 - Helnaquhida	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	42.9	42.9	42.8	42.6	42.3	44.4	44.4
	Predicted Wind Turbine Noise L_{A90}	-	-	-	26.6	30.2	34	35.4	35.5	35.5	35.5	35.5	35.5
	Exceedance Level L_{A90}	-	-	-	-16.4	-12.8	-8.9	-7.5	-7.3	-7.1	-6.8	-8.9	-8.9
NAL8 - Kettlester	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	42.9	42.9	42.8	42.7	42.6	44.6	44.6
	Predicted Wind Turbine Noise L_{A90}	-	-	-	26.4	30	33.7	35.1	35.3	35.3	35.3	35.3	35.3
	Exceedance Level L_{A90}	-	-	-	-16.6	-13	-9.2	-7.8	-7.5	-7.4	-7.3	-9.3	-9.3
NAL9 -Isleview	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	42.9	42.9	42.8	42.7	42.5	44.5	44.5
	Predicted Wind Turbine Noise L_{A90}	-	-	-	28.7	32.3	36	37.4	37.6	37.6	37.6	37.6	37.6
	Exceedance Level L_{A90}	-	-	-	-14.3	-10.7	-6.9	-5.5	-5.2	-5.1	-4.9	-6.9	-6.9
NAL10 - Westerflee	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	42.9	42.9	42.8	42.7	42.5	42.1	44.2	44.2
	Predicted Wind Turbine Noise L_{A90}	-	-	-	27.7	31.3	35	36.4	36.6	36.6	36.6	36.6	36.6
	Exceedance Level L_{A90}	-	-	-	-15.3	-11.6	-7.9	-6.4	-6.1	-5.9	-5.5	-7.6	-7.6
NAL11 - Kletterflea	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	43	43	43	44.1	43.6	46.3	50
	Predicted Wind Turbine Noise L_{A90}	-	-	-	26.5	30.2	33.9	35.3	35.4	35.4	35.4	35.4	35.4
	Exceedance Level L_{A90}	-	-	-	-16.5	-12.8	-9.1	-7.7	-7.6	-5.7	-8.2	-10.9	-14.6
NAL12 - The School House	Site Specific Noise Limit : ETSU-R-97	43	42.9	42.9	42.9	42.9	42.8	42.6	42.4	43.7	46.6	49.2	51.4
	Predicted Wind Turbine Noise L_{A90}	-	-	-	23.7	27.3	31.1	32.5	32.6	32.6	32.6	32.6	32.6
	Exceedance Level L_{A90}	-	-	-	-19.2	-15.6	-11.7	-10.1	-9.8	-11.1	-14	-16.6	-18.8
NAL13 Cluness Cottage	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	42.9	42.9	42.8	42.7	42.4	44.5	44.5
	Predicted Wind Turbine Noise L_{A90}	-	-	-	25.6	29.2	32.9	34.3	34.5	34.5	34.5	34.5	34.5
	Exceedance Level L_{A90}	-	-	-	-17.4	-13.8	-10	-8.6	-8.3	-8.2	-7.9	-10	-10
NAL14 - Staneygarth	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	42.9	42.9	42.8	42.7	42.5	44.6	44.6
	Predicted Wind Turbine Noise L_{A90}	-	-	-	25.2	28.9	32.6	34	34.1	34.1	34.1	34.1	34.1
	Exceedance Level L_{A90}	-	-	-	-17.8	-14.1	-10.3	-8.9	-8.7	-8.6	-8.4	-10.5	-10.5
NAL15 - Giggleswick	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	43	43	43	42.7	39.9	36.5	36.5
	Predicted Wind Turbine Noise L_{A90}	-	-	-	25.4	29	32.7	34.2	34.3	34.3	34.3	34.3	34.3
	Exceedance Level L_{A90}	-	-	-	-17.6	-14	-10.3	-8.8	-8.7	-8.4	-5.6	-2.2	-2.2

The results in this Annex show that predicted wind turbine noise from the proposed development meets the site specific noise limits at all locations during both daytime and night time periods (assuming turbine T20 is removed).