Product Certification

Evance R9000 Acoustic Noise Assessment

Issue 05

Certificate Number MCS WT0039
Small Wind Turbine

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1. Introduction

This document presents the results of a repeat acoustic sound test conducted on an Evance R9000, in accordance with BS EN 61400-11[1] and with the additional guidance stated in BWEA Performance and Safety standard[2]. The tests were undertaken in February 2012 and replace TR087 v4. This new report was undertaken for compatibility with the new power performance report TR084 v4.

A summary of the report is shown below in Figure 1. The key results are the Declared Apparent Emission Sound Power Level, $L_{Wd,8m/s}$, at 8m/s hub height wind speed and noise immission predictions for a range of slant distances and hub height wind speeds.

2. Test Summary

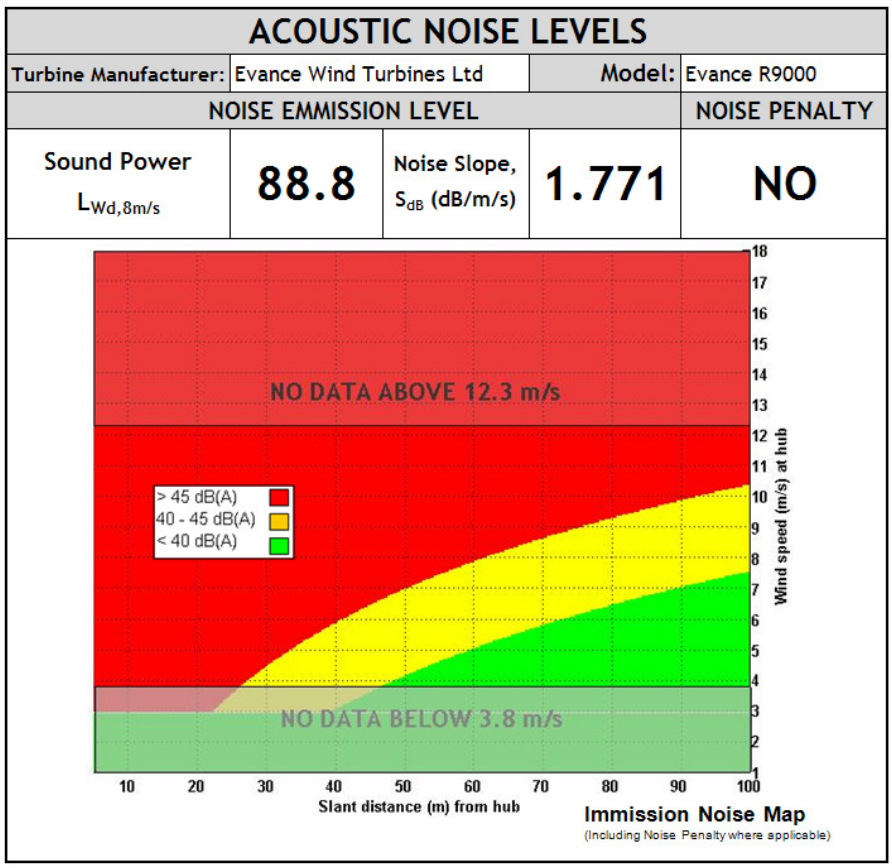


FIGURE 1 – NOISE LABEL

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.

The assessment established the turbine should not be declared as 'tonal' and therefore no penalty should be applied.

The BWEA Reference Sound Levels at 25m and 60m at an 8m/s hub height wind speed are:

$$L_{p,25m} = 52.8dB(A)$$
$$L_{p,60m} = 45.3dB(A)$$

3. Characterisation of Wind Turbine

TABLE 1 – EVANCE R9000 TEST TURBINE SPECIFICATION

WIND TURBINE DETAILS	
MANUFACTURER	Evance Wind Turbines Ltd
MODEL	Evance R9000
SERIAL NUMBER	700
OPERATING DETAILS	
ROTOR ORIENTATION	Upwind
HAWT OR VAWT	Horizontal Axis Wind Turbine
HUB HEIGHT	12.24m
HORIZONTAL DISTANCE FROM ROTOR CENTRE TO TOWER AXIS	0.63m
ROTOR DIAMETER	5.5m
TOWER TYPE	Freestanding (tube)
CONTROL SYSTEM	Patented Reactive Pitch™ Control
ROTATIONAL SPEED	200 rpm nominal, 230 rpm maximum
BWEA REFERENCE POWER (POWER AT 11M/S)	4711W
CUT-IN WIND SPEED	3m/s
SURVIVAL WIND SPEED	42.5m/s 10 minute mean
YAW CONTROL	Passive - Tail Vane and rotor
ROTOR DETAILS	
BLADE TYPE	Glass Fibre Reinforced Composite, low reflection, UV and anti-erosion coatings
NUMBER OF BLADES	3
BLADE SERIAL NUMBERS	296T,300T,307T
GEARBOX	
GEARBOX	None
GENERATOR DETAILS	
GENERATOR	Patented brushless direct drive air-cored high efficiency Permanent Magnet Alternator
BRAKE	
BRAKE	Patented Automatic ElectroBrake™ (with manual control for servicing).

4. Physical Environment

Table 2 presents the key details of the certification test site and turbine.

TABLE 2 - DETAILS OF TEST SITE

Post Code:	TR19 7TS
Wind Turbine Coordinates:	Lat: 50.1542° Long: -5.64296°
Met Mast Coordinates:	Lat: 50.1541° Long: -5.64317° (16.5m, 250° from wind turbine)
Turbine:	Evance R9000
Hub Height:	12.24m

The certification test site for the Evance R9000 wind turbine is located just outside of Pendeen, 4 miles Northeast of Penzance, Cornwall. The site is at an elevation of 143m with Southwesterly prevailing winds. Figure 2 shows an aerial photograph of the test site. The white line on the photograph is 110m long (20D). Figure 3 shows an OS map of the test site and surrounding area. The nearby area is very open but slopes down to the North and up to the South. The surface is mostly short grass with stone walls separating individual fields. The general layout is shown in Figure 4, Figure 5 and Figure 6.

FIGURE 2 - AERIAL PHOTOGRAPH OF TEST SITE

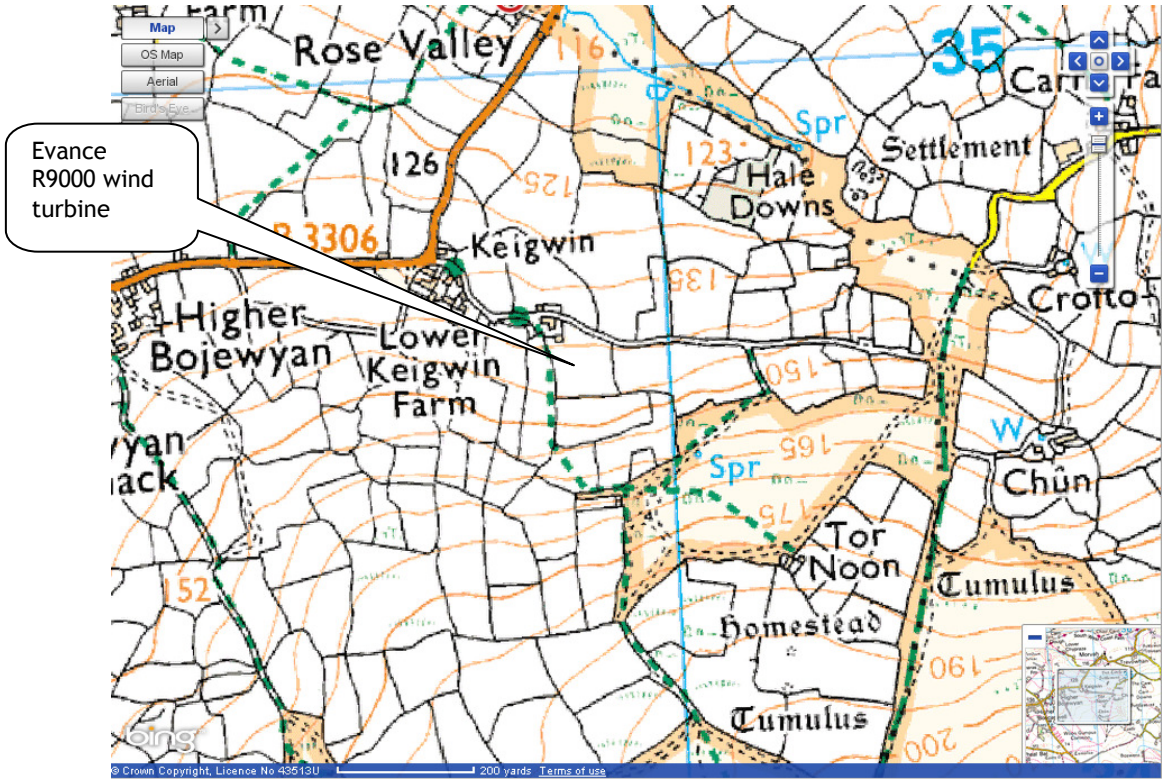


FIGURE 3 - MAP OF THE TEST SITE SHOWING CONTOUR LINES

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	27/01/12
Microphone	Pulsar MK:224	20042763	26/01/12
Acoustic calibrator	Pulsar Model 105	45109	07/12/11
Anemometer	Vector Instruments A100LK	11342/EBP8	02/08/11
Wind Vane	Vector Instruments W200P	13578	N/A
Data Logger	Campbell Scientific CR1000	9455	12/09/11

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, 12mm 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.

Wind speed, wind direction, temperature and pressure were all measured at a sampling rate of 1 Hz and over a 10 second averaging period. Three 10 second averages were combined to make one 30 second record. Noise was analysed over 10 second periods and similarly combined to make one 30 second record using the following expression:

$$Lp_{30\,\mathrm{sec}} = 10Log_{10}\left(\frac{10^{\left(Lp_{1,10\,\mathrm{sec}}/10\right)}+10^{\left(Lp_{2,10\,\mathrm{sec}}/10\right)}+10^{\left(Lp_{3,10\,\mathrm{sec}}/10\right)}}{3}\right)$$

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	2012-02-21 15:45:10	6.52-9.21	206-225	40	101.1	9.2	7.48
1	2012-02-21 16:00:10	6.25-8.78	207-223	40	101.1	9.1	7.76
2	Void	void	void	void	void	void	void
3	2012-02-21 16:14:10	5.21-8.64	212-223	40	101.1	9.1	8.02
4	2012-02-21 16:23:10	6.83-9.65	211-218	40	101.1	9.1	8.63
5	2012-02-21 16:31:10	5.75-9.34	210-226	40	101.1	9	8.14

6	2012-02-22 11:13:10	8.05-12.28	210-224	40	100.7	8.8	9.85
7	2012-02-22 11:24:10	9.38-13.22	212-222	40	100.7	8.9	9.79
8	2012-02-22 11:30:10	9.51-13.13	214-223	40	100.7	8.9	8.15
9	2012-02-22 11:36:10	9.71-9.71	222-222	40	100.7	8.9	6.95
10	2012-02-22 11:37:10	10.15-12.98	217-225	40	100.7	8.9	8.25
11	Void	void	void	void	void	void	void
12	2012-02-23 09:37:10	7.30-9.35	253-266	75	101	9.4	7.99
13	2012-02-23 10:31:10	5.92-7.57	255-261	75	101	9.6	9.63
14	2012-02-23 10:34:10	4.96-8.10	243-261	75	101	9.6	7.31
15	2012-02-23 11:09:10	6.73-8.21	257-268	75	101.1	9.4	6.48
16	2012-02-23 11:20:10	5.90-7.72	255-267	75	101.1	9.4	6.58
17	2012-02-23 11:27:10	6.04-8.27	259-267	75	101.1	9.4	7.14
18	2012-02-24 07:59:10	4.43-7	274-285	90	101.2	8.4	7.42
19	2012-02-24 08:11:10	3.98-5.55	267-280	90	101.2	8.5	6.73
20	2012-02-24 08:18:10	4.32-5.83	261-277	90	101.2	8.6	7.82
21	Void	void	void	void	void	void	void
22	2012-02-24 08:30:10	3.75-5.72	260-273	90	101.2	8.8	7.64
23	2012-02-24 10:27:10	4.04-6.15	263-279	90	101.3	9.4	7.17
24	2012-02-24 10:43:10	3.92-5.92	258-272	90	101.3	9.6	6.91
25	2012-02-24 10:59:10	4.27-5.74	260-271	90	101.3	9.7	6.75
26	2012-02-24 11:08:10	4.2-6.07	257-272	90	101.3	9.7	5.86

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). 280 data pairs of wind speed and noise for the turbine running and 79 data pairs of wind speed and noise for the turbine parked were obtained. Figure 7 shows the relationship between these two sets of data.

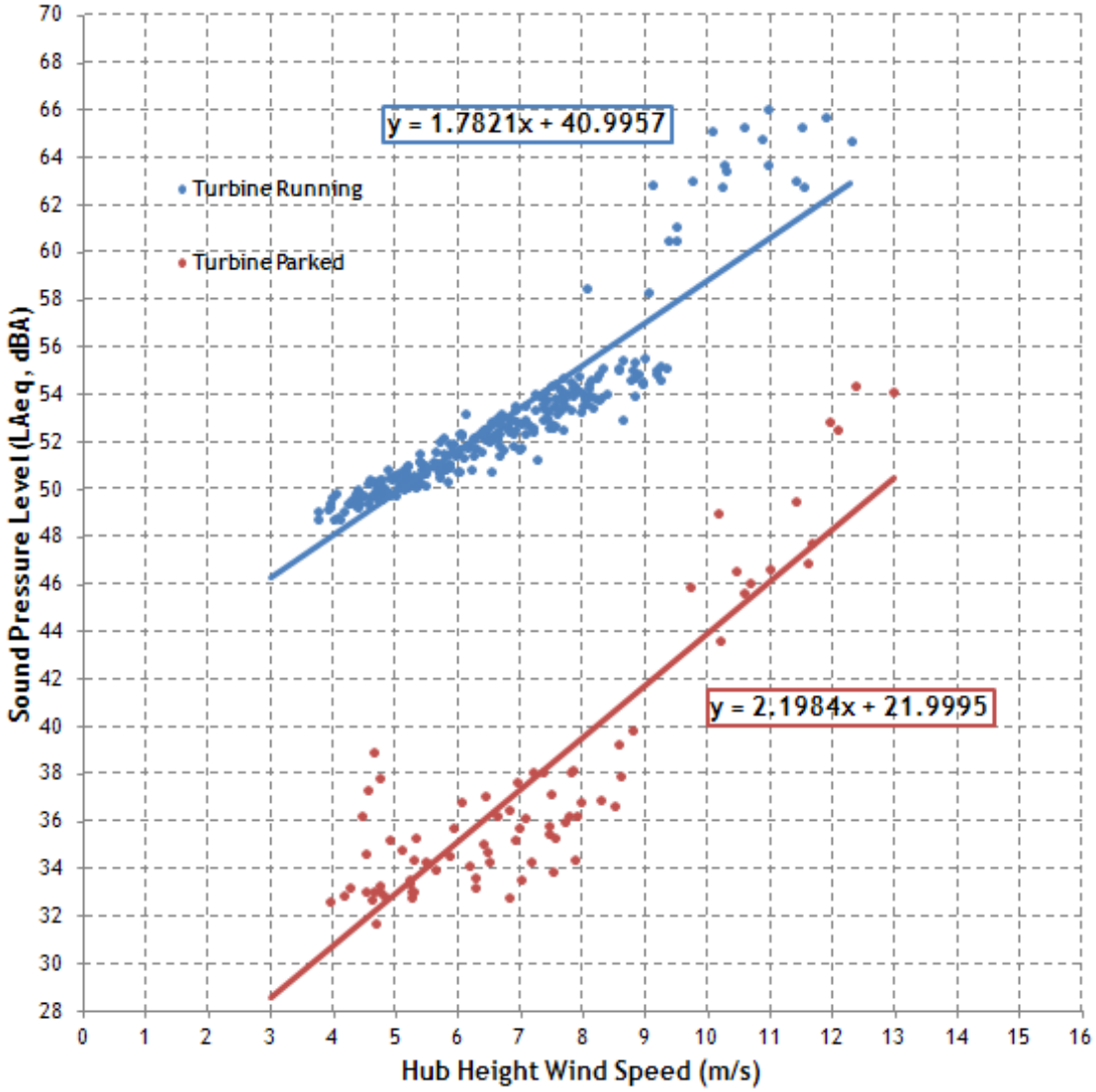


FIGURE 7 - SOUND PRESSURE LEVEL ON THE GROUND BOARD AT A SLANT DISTANCE OF 19.85M (1)

The uncertainty, S_{ey} (U_A) of the linear regression for the turbine running was 1.419dB. This type A uncertainty is used with the type B uncertainties in Section 6 to estimate a combined uncertainty (U_C) of 1.665dB. 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 1.665dB 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.

Correcting for background has the effect of decreasing the slope of the linear regression. It was this slope – 1.771dB/m/s that was used in the calculations of the noise map. The background corrected regression line was then used to calculate the Apparent Emission Sound Power Level for a hub height wind speed of 8m/s using the following expression:

$$L_{W,8m/s} = L_{Aeq,8m/s} - 6 + 10Log(4\pi R_1^2 / S_0)$$

Where the 6dB is a correction for the board reflection, R_1 is the 19.85m slant distance and S_0 is a reference area $1m^2$. Table 5 shows a summary of the results.

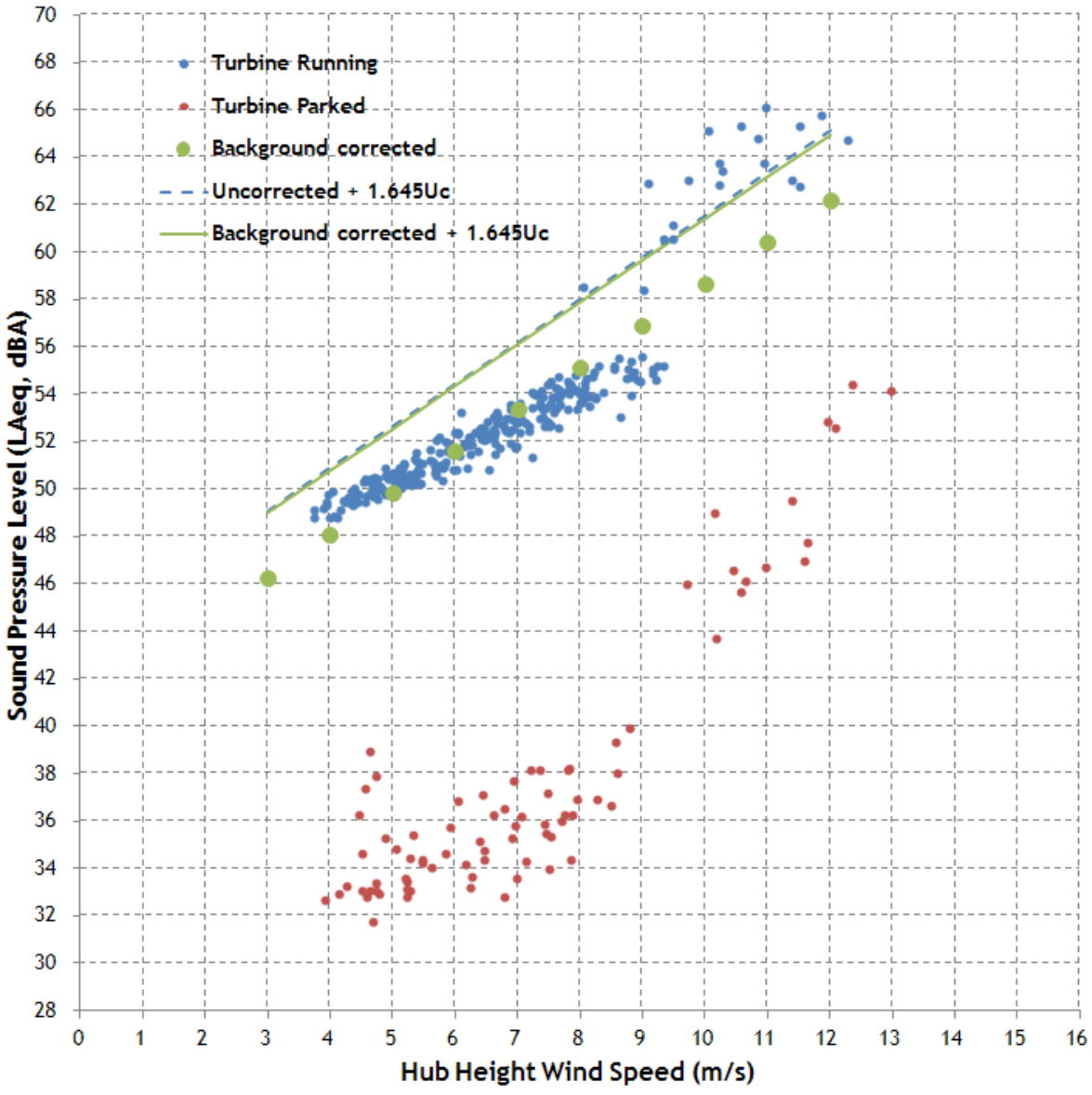


FIGURE 8 - SOUND PRESSURE LEVEL ON THE GROUND BOARD AT A SLANT DISTANCE OF 19.85M (2)

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)	**86.1**
Declared Apparent Emission Sound Power Level, $L_{W,8m/s}$ (dB)	**88.8**
Estimated Combined Uncertainty, U_C (dB)	**1.665**
Wind Speed Dependence, S_{dB} (dB/m/s)	**1.771 (σ of fit on slope 0.005dB)**

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 A weighted. Figure 9 shows the turbine frequency content at 4.05m/s (energy average of four 30-second spectra). Figure 10 shows the turbine frequency content at 7.94m/s (energy average of twenty three 30-second spectra). Figure 11 shows the turbine frequency content at 11.96m/s (energy average of three 30-second spectra).

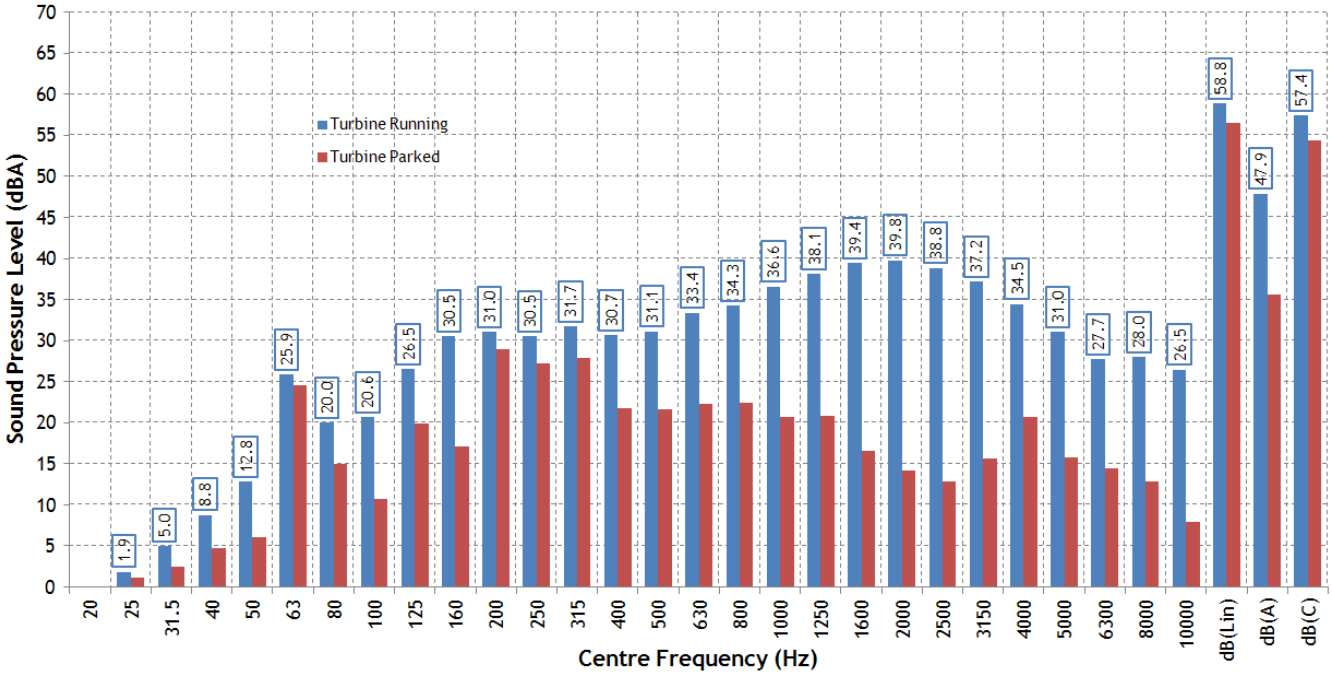


FIGURE 9 - A WEIGHTED 1/3RD OCTAVE BAND FREQUENCY SPECTRUM FOR 4.05M/S AT A SLANT DISTANCE OF 19.85M

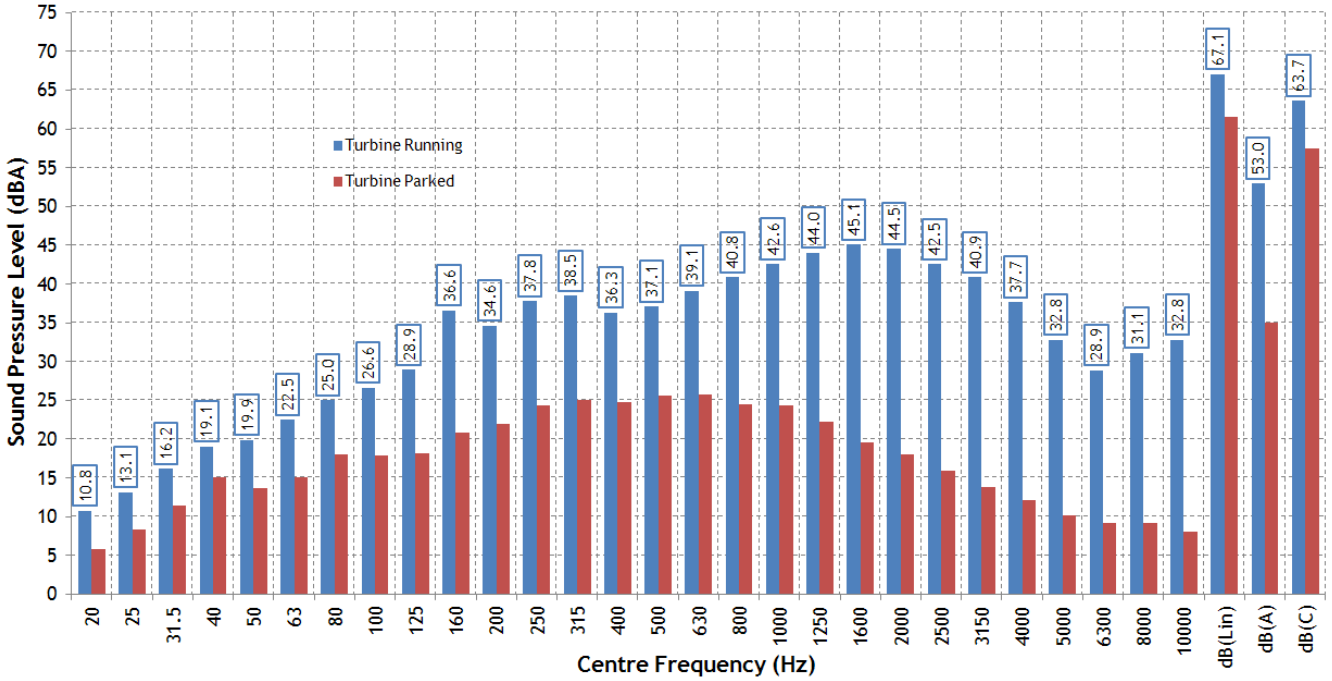


FIGURE 10 - A WEIGHTED 1/3RD OCTAVE BAND FREQUENCY SPECTRUM FOR 7.94M/S AT A SLANT DISTANCE OF 19.85M

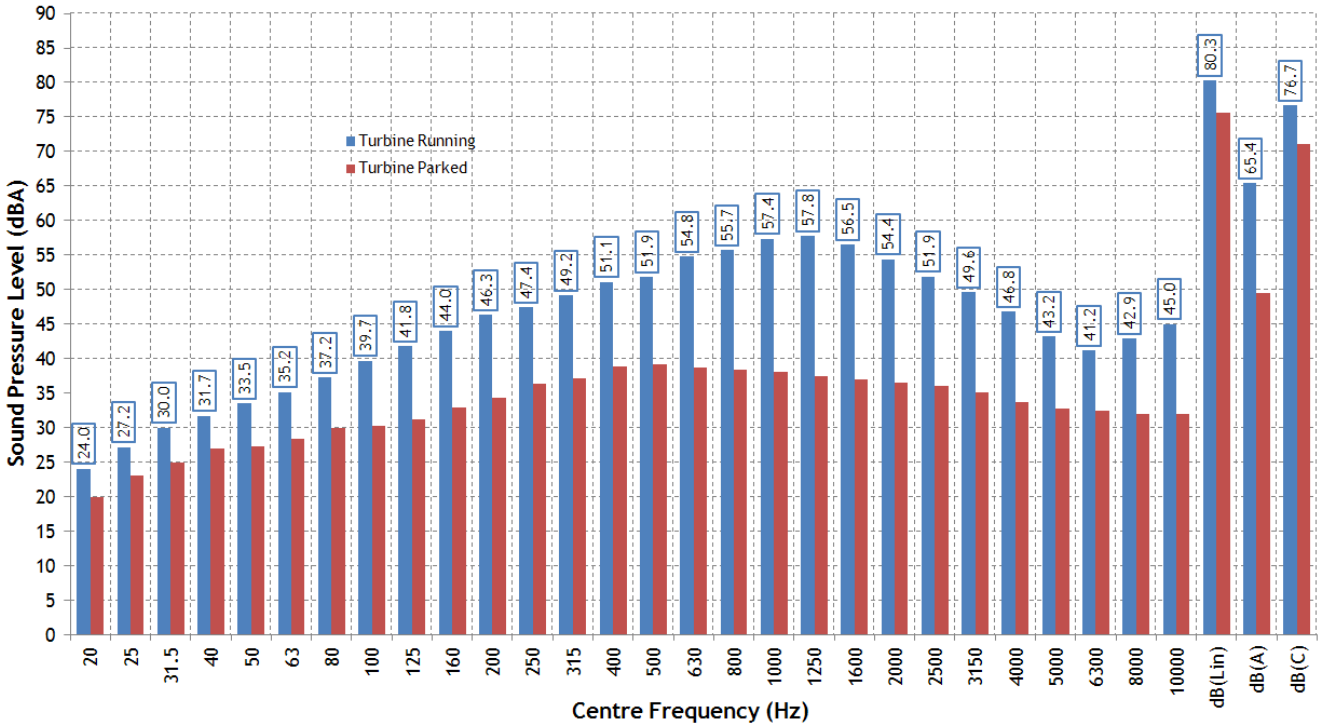


FIGURE 11 – A WEIGHTED 1/3RD OCTAVE BAND FREQUENCY SPECTRUM FOR 11.96M/S AT A SLANT DISTANCE OF 19.85M

The turbine is declared tonal if any 1/3rd octave band is higher than its adjacent bands by:

15dB in the low frequency bands (50 to 125 Hz)
8dB in the mid-frequency bands (160 to 400Hz)
5dB in the high frequency bands (500 to 10000Hz)

According to this tonal procedure 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 standard[2]. 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.

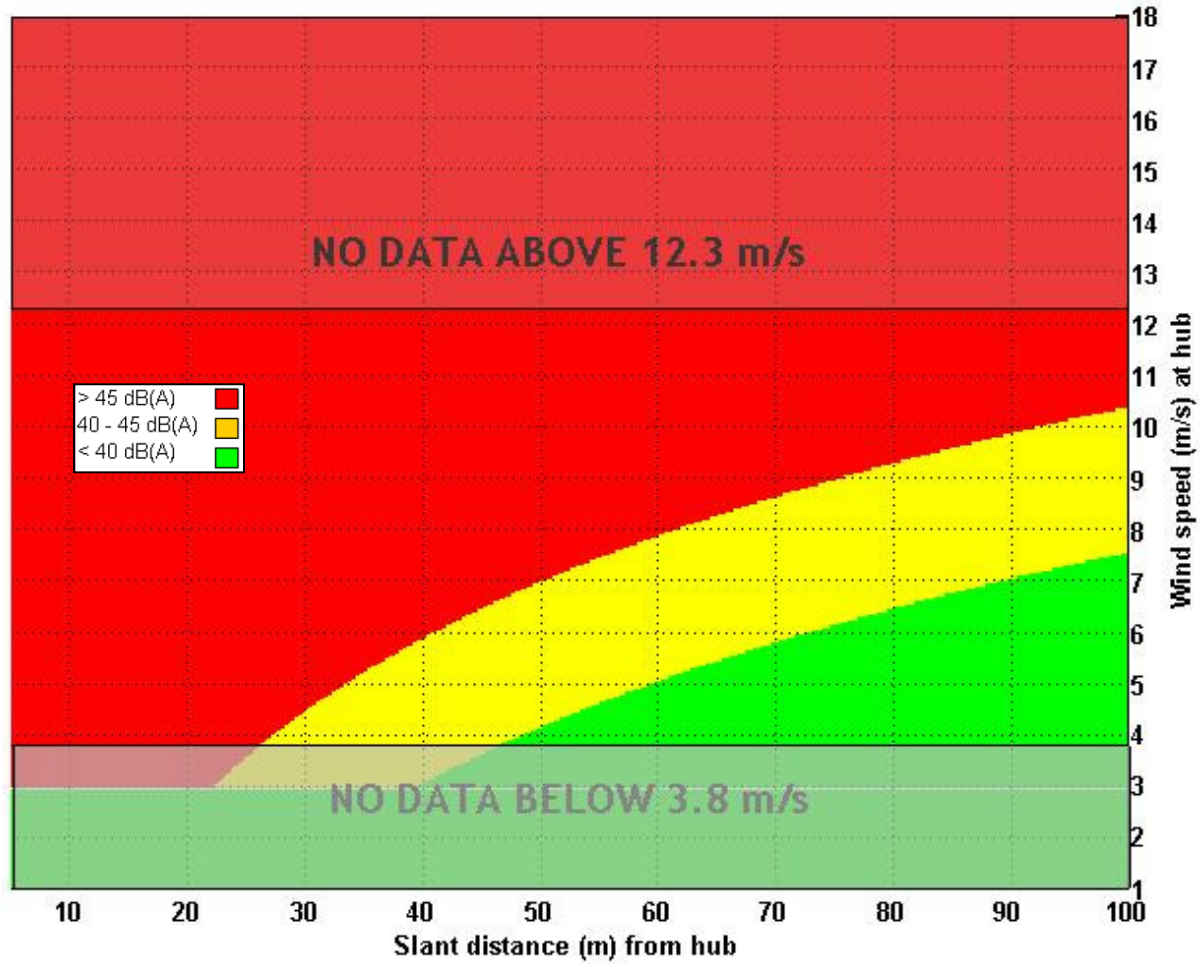


FIGURE 12 - NOISE MAP

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, $L_{p,25m}$ = **52.8dB(A)**
- The BWEA reference 60m sound level, $L_{p,60m}$ = **45.3dB(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].

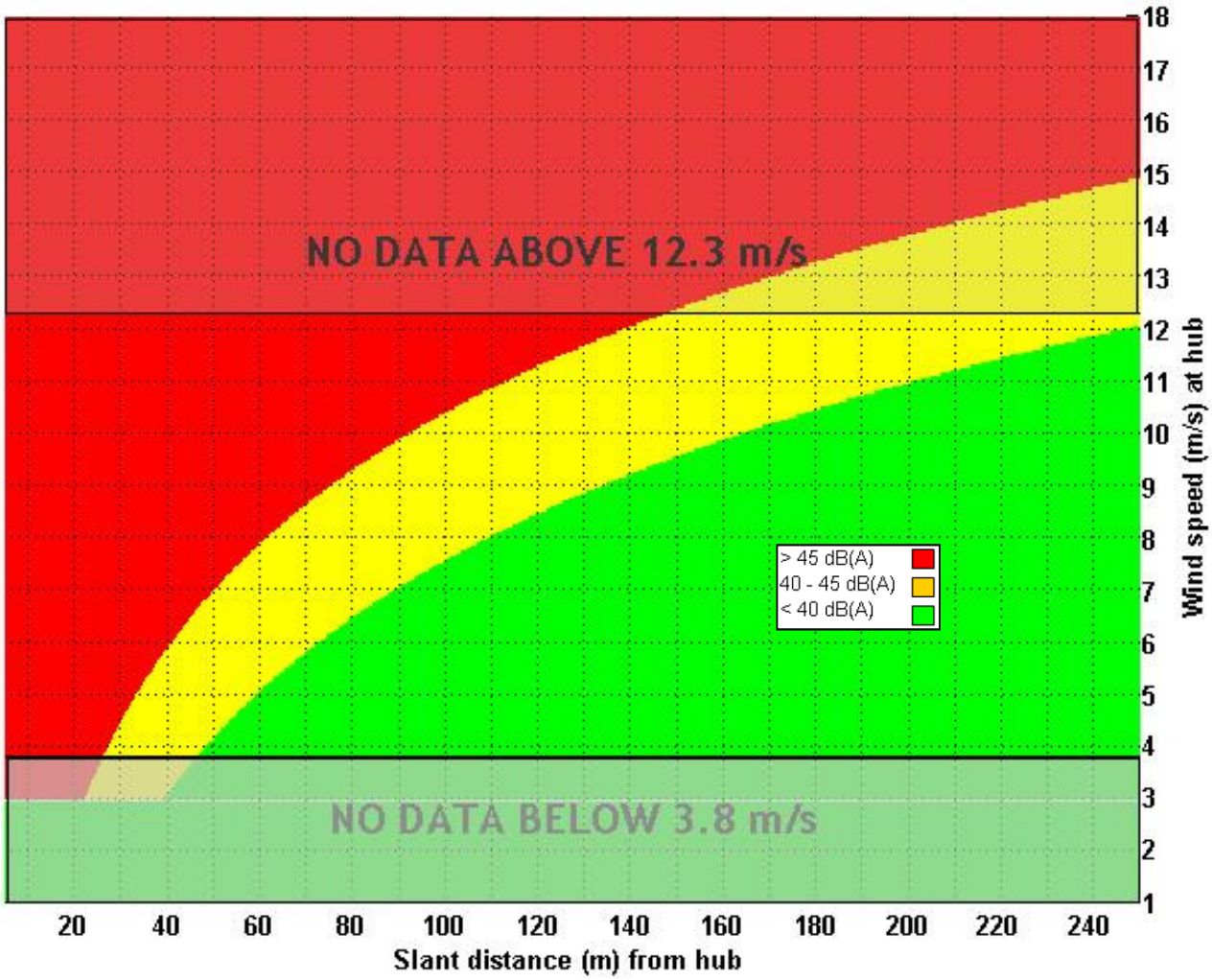


FIGURE 13 - EXTENDED NOISE MAP

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	--	**1.419**	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	0.03	0.12/(2*√3) - Average applied correction
Combined Uncertainty, U_C		**1.665**	

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:

$$V_{90,10} = 1.72 * V_{avg,10}$$

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.

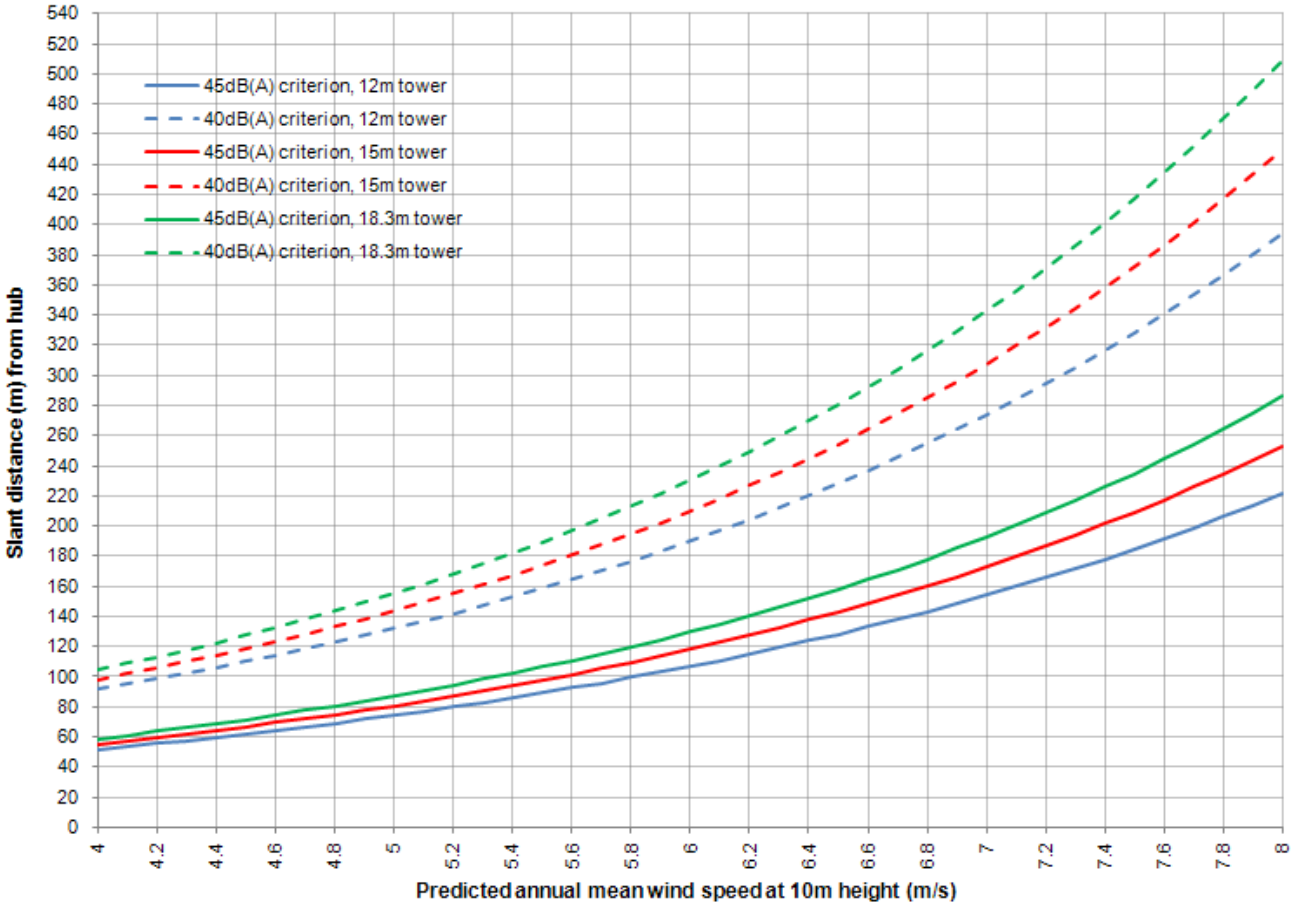


FIGURE 14 - AMWS NOISE IMMISSION SUMMARY

11. Appendix 2 – Broadband Raw Data

11.1. Turbine Running

L_{Aeq} (dB(A))	L90 (dB(A))	Corrected Wind Speed (m/s)	Wind Direction (°)	Microphone Location (°)	Pressure (kPa)	Temperature (°C)	Turbulence Intensity	Angle between Microphone and Wind Direction (°)
54.9	53.7	8.88	225.1	40	101.1	9.2	6.1%	5.1
55.0	53.9	9.15	222.0	40	101.1	9.2	7.4%	2.0
54.2	53.2	7.90	220.1	40	101.1	9.2	5.7%	0.1
53.1	51.2	6.62	211.3	40	101.1	9.2	10.7%	-8.7
52.6	51.6	7.44	219.6	40	101.1	9.2	9.9%	-0.4
54.0	52.7	8.82	214.2	40	101.1	9.2	8.3%	-5.8
54.1	53.2	7.95	223.2	40	101.1	9.2	8.9%	3.2
54.7	53.0	8.82	222.6	40	101.1	9.2	5.1%	2.6
54.7	53.6	8.76	221.0	40	101.1	9.2	6.0%	1.0
54.6	53.5	9.21	217.2	40	101.1	9.2	6.0%	-2.8
54.8	54.1	7.92	217.6	40	101.1	9.2	7.0%	-2.4
53.8	52.9	8.24	219.8	40	101.1	9.2	5.4%	-0.2
52.8	51.6	7.14	215.1	40	101.1	9.2	6.9%	-4.9
51.5	48.1	6.65	210.6	40	101.1	9.2	9.2%	-9.4
53.8	52.5	8.02	213.5	40	101.1	9.2	9.1%	-6.5
52.8	51.6	7.48	217.1	40	101.1	9.2	5.7%	-2.9
53.9	53.2	8.16	214.7	40	101.1	9.2	8.5%	-5.3
54.6	53.8	8.93	215.8	40	101.1	9.2	4.8%	-4.2
53.9	53.0	7.69	220.6	40	101.1	9.1	9.4%	0.6
50.8	49.9	6.53	218.5	40	101.1	9.1	7.1%	-1.5
52.2	51.2	6.52	206.0	40	101.1	9.2	11.5%	-14.0
52.6	51.6	7.51	211.7	40	101.1	9.2	5.9%	-8.3
55.2	54.4	9.34	219.4	40	101.1	9.1	4.9%	-0.6
54.1	53.2	8.36	217.1	40	101.1	9.1	7.6%	-2.9
53.0	50.6	8.64	217.9	40	101.1	9.1	7.0%	-2.1
52.9	50.0	7.07	221.5	40	101.1	9.1	14.0%	1.5
54.3	52.2	8.07	216.0	40	101.1	9.1	9.2%	-4.0
54.9	53.4	9.16	209.6	40	101.1	9.1	6.7%	-10.4
54.0	53.0	8.01	212.1	40	101.1	9.1	8.0%	-7.9
54.4	52.3	8.07	215.9	40	101.1	9.1	7.4%	-4.1
53.7	52.6	8.05	217.0	40	101.1	9.1	4.2%	-3.0
52.4	49.8	6.65	218.0	40	101.1	9.1	9.9%	-2.0
54.1	53.5	7.22	224.5	40	101.1	9.1	9.5%	4.5
53.9	52.8	8.26	219.2	40	101.1	9.1	8.9%	-0.8
52.7	51.6	7.53	220.9	40	101.1	9.1	5.2%	0.9
52.9	51.2	7.35	223.6	40	101.1	9.1	7.5%	3.6
51.4	50.4	6.06	214.3	40	101.1	9.1	6.8%	-5.7

52.4	51.1	6.00	215.3	40	101.1	9.1	11.9%	-4.7
53.0	51.1	6.82	216.3	40	101.1	9.1	11.1%	-3.7
54.5	53.7	8.96	217.2	40	101.1	9.0	5.2%	-2.8
52.6	49.5	7.66	216.9	40	101.1	9.0	7.9%	-3.1
53.9	53.2	7.63	217.0	40	101.1	9.0	8.9%	-3.0
54.0	53.1	7.27	226.2	40	101.1	9.0	5.7%	6.2
54.0	52.9	8.12	226.5	40	101.1	9.0	7.0%	6.5
51.8	50.9	6.22	213.8	40	101.1	9.0	7.9%	-6.2
53.2	52.2	6.10	216.1	40	101.1	9.0	8.3%	-3.9
53.5	52.4	6.89	215.9	40	101.1	9.0	13.2%	-4.1
53.4	51.6	7.62	220.2	40	101.1	9.0	6.2%	0.2
54.1	53.1	7.84	225.6	40	101.1	8.9	8.4%	5.6
51.7	50.5	6.71	221.6	40	101.1	8.9	5.9%	1.6
52.0	51.1	5.86	224.3	40	101.1	8.9	10.0%	4.3
50.9	49.8	5.75	218.4	40	101.1	9.0	11.5%	-1.6
53.5	52.2	7.35	222.5	40	101.1	9.0	8.8%	2.5
53.2	52.4	7.57	224.9	40	101.1	8.9	8.1%	4.9
50.4	49.4	5.81	216.0	40	101.1	8.9	11.3%	-4.0
52.4	50.4	7.19	215.6	40	101.1	8.9	8.9%	-4.4
51.8	50.7	6.99	216.2	40	101.1	8.9	5.7%	-3.8
51.7	51.0	6.95	215.8	40	101.1	9.0	8.5%	-4.2
50.9	49.8	6.19	221.3	40	101.1	9.0	5.7%	1.3
52.4	51.0	7.04	222.1	40	101.1	9.0	10.5%	2.1
50.8	50.1	5.98	218.5	40	101.1	8.9	9.9%	-1.5
54.1	53.2	7.65	216.5	40	101.1	8.9	8.5%	-3.5
53.9	52.3	7.55	215.0	40	101.1	8.9	8.8%	-5.0
52.6	50.9	6.78	216.6	40	101.1	8.9	9.9%	-3.4
53.3	51.7	7.94	214.6	40	101.1	8.9	9.9%	-5.4
55.4	54.0	8.82	212.7	40	101.1	8.9	6.5%	-7.3
55.2	53.8	9.24	218.8	40	101.1	8.9	6.4%	-1.2
55.6	54.8	8.98	216.0	40	101.1	8.9	6.0%	-4.0
53.6	51.8	8.00	219.4	40	101.1	8.9	6.8%	-0.6
53.5	52.5	8.15	222.0	40	101.1	8.9	6.0%	2.0
52.6	51.9	6.42	217.6	40	101.1	8.9	8.1%	-2.4
51.9	50.4	6.88	217.5	40	101.1	8.9	6.9%	-2.5
53.0	51.7	7.41	218.5	40	101.1	8.9	6.6%	-1.5
51.2	50.3	5.84	216.6	40	101.1	8.9	7.7%	-3.4
51.3	49.4	7.24	217.9	40	101.1	8.9	9.8%	-2.1
63.0	59.8	11.40	224.1	40	100.7	8.8	9.0%	4.1
55.1	53.3	8.77	217.4	40	100.7	8.8	6.8%	-2.6
63.4	61.4	10.28	216.6	40	100.7	8.8	8.2%	-3.4
63.1	60.9	9.72	213.9	40	100.7	8.8	10.3%	-6.1
60.6	51.7	9.48	211.9	40	100.7	8.8	12.1%	-8.1
58.4	52.5	9.02	210.3	40	100.7	8.8	11.8%	-9.7
64.8	60.4	10.84	216.1	40	100.7	8.9	7.5%	-3.9

66.1	64.1	10.96	222.7	40	100.7	8.9	7.2%	2.7
63.7	57.9	10.95	216.2	40	100.7	8.8	11.6%	-3.8
65.3	59.0	10.57	222.5	40	100.7	8.8	10.7%	2.5
64.7	59.6	12.28	222.9	40	100.7	8.8	10.2%	2.9
65.8	62.8	11.87	218.0	40	100.7	8.8	7.0%	-2.0
65.3	60.3	11.51	220.3	40	100.7	8.8	9.2%	0.3
62.8	59.6	11.53	219.3	40	100.7	8.8	12.5%	-0.7
58.5	53.4	8.05	216.5	40	100.7	8.8	9.3%	-3.5
61.2	54.7	9.49	217.6	40	100.7	8.9	10.6%	-2.4
65.1	59.5	10.05	211.1	40	100.7	8.9	10.5%	-8.9
63.7	59.9	10.24	216.5	40	100.7	8.9	9.9%	-3.5
62.9	56.5	9.09	216.9	40	100.7	8.9	11.5%	-3.1
62.8	54.1	10.23	219.8	40	100.7	8.9	11.0%	-0.2
54.3	53.5	7.60	260.1	75	101.0	9.3	5.0%	5.1
54.1	53.3	7.39	253.3	75	101.0	9.3	8.3%	-1.7
60.5	56.0	9.35	253.6	75	101.0	9.3	7.3%	-1.4
54.5	52.7	7.54	265.7	75	101.0	9.3	12.6%	10.7
54.4	52.7	7.48	265.4	75	101.0	9.3	12.4%	10.4
54.1	53.0	7.72	257.1	75	101.0	9.4	6.0%	2.1
54.7	53.4	7.66	260.2	75	101.0	9.4	12.1%	5.2
55.0	53.8	8.55	256.8	75	101.0	9.4	5.6%	1.8
55.5	54.5	8.61	260.1	75	101.0	9.4	8.1%	5.1
54.0	53.3	7.32	259.0	75	101.0	9.3	9.5%	4.0
54.7	54.1	8.21	264.0	75	101.0	9.4	9.6%	9.0
54.0	52.6	7.30	259.0	75	101.0	9.4	10.9%	4.0
55.2	54.3	8.30	254.7	75	101.0	9.4	5.3%	-0.3
54.6	53.7	7.81	258.4	75	101.0	9.4	8.8%	3.4
55.2	54.5	8.55	264.5	75	101.0	9.4	4.2%	9.5
54.0	52.9	7.68	261.2	75	101.0	9.4	7.1%	6.2
54.4	53.5	7.84	260.7	75	101.0	9.4	8.5%	5.7
54.9	54.1	8.23	264.0	75	101.0	9.4	4.9%	9.0
53.8	53.1	7.64	263.4	75	101.0	9.4	6.9%	8.4
54.1	53.1	7.98	259.7	75	101.0	9.4	6.8%	4.7
52.7	51.9	6.67	257.7	75	101.0	9.6	8.7%	2.7
52.4	51.8	6.33	258.5	75	101.0	9.6	5.1%	3.5
52.5	51.5	6.61	258.0	75	101.0	9.6	12.4%	3.0
53.6	52.8	7.05	252.9	75	101.0	9.6	5.3%	-2.1
53.0	52.3	7.05	254.6	75	101.0	9.6	6.0%	-0.4
52.5	51.7	6.41	260.0	75	101.0	9.6	7.7%	5.0
52.9	52.0	6.51	253.0	75	101.0	9.6	6.1%	-2.0
51.1	50.3	5.40	261.0	75	101.0	9.6	9.3%	6.0
52.5	51.6	6.90	256.4	75	101.0	9.7	6.0%	1.4
51.6	50.9	5.86	254.1	75	101.0	9.7	11.1%	-0.9
53.6	52.6	7.53	252.7	75	101.0	9.7	3.9%	-2.3
52.2	51.5	6.46	253.0	75	101.0	9.6	7.5%	-2.0

51.9	51.2	5.90	252.8	75	101.0	9.6	8.0%	-2.2
53.4	52.2	7.24	252.1	75	101.0	9.6	5.8%	-2.9
53.5	52.5	7.54	248.5	75	101.0	9.6	5.5%	-6.5
53.9	53.1	7.40	249.9	75	101.0	9.6	5.3%	-5.1
52.7	51.9	6.76	250.3	75	101.0	9.5	9.2%	-4.7
51.5	50.8	5.76	250.7	75	101.0	9.5	9.7%	-4.3
52.3	51.5	6.05	252.9	75	101.0	9.6	6.7%	-2.1
52.3	50.9	6.39	252.2	75	101.0	9.6	9.7%	-2.8
51.9	51.0	6.64	243.1	75	101.0	9.6	8.9%	-11.9
53.4	52.7	6.89	245.8	75	101.0	9.6	8.2%	-9.2
54.4	53.6	7.84	246.2	75	101.0	9.5	8.5%	-8.8
53.2	52.3	6.67	248.7	75	101.0	9.5	8.5%	-6.3
53.6	52.8	7.36	248.5	75	101.0	9.5	7.5%	-6.5
54.0	53.1	7.83	246.3	75	101.0	9.5	6.9%	-8.7
54.7	54.0	8.10	251.2	75	101.0	9.5	7.5%	-3.8
53.3	52.2	7.41	256.0	75	101.0	9.5	7.5%	1.0
52.3	51.5	6.59	251.8	75	101.0	9.4	6.5%	-3.2
52.6	51.4	6.46	250.3	75	101.0	9.5	8.0%	-4.7
52.9	51.9	6.94	249.3	75	101.0	9.5	9.2%	-5.7
53.9	53.1	8.04	248.1	75	101.0	9.5	4.4%	-6.9
53.4	52.9	7.79	251.8	75	101.0	9.5	3.2%	-3.2
52.1	51.2	6.42	250.2	75	101.0	9.4	6.8%	-4.8
52.2	51.1	5.75	248.3	75	101.1	9.5	6.9%	-6.7
53.0	52.3	6.69	248.8	75	101.0	9.5	9.1%	-6.2
53.6	53.1	7.69	252.7	75	101.0	9.5	5.5%	-2.3
52.1	51.4	6.53	253.4	75	101.1	9.5	6.9%	-1.6
51.6	50.8	5.61	247.1	75	101.1	9.5	6.5%	-7.9
51.5	50.8	5.37	256.0	75	101.1	9.6	11.3%	1.0
52.2	51.2	6.63	257.4	75	101.1	9.6	7.6%	2.4
50.6	50.1	4.96	253.6	75	101.1	9.6	5.6%	-1.4
50.8	50.0	5.14	253.5	75	101.1	9.6	10.1%	-1.5
52.1	51.0	5.70	255.3	75	101.1	9.6	8.3%	0.3
54.2	53.3	7.65	254.1	75	101.1	9.7	6.6%	-0.9
52.6	51.6	7.18	251.5	75	101.1	9.6	4.8%	-3.5
52.9	52.0	6.86	248.4	75	101.1	9.5	5.9%	-6.6
52.2	51.5	6.22	251.9	75	101.1	9.5	7.4%	-3.1
52.4	51.6	6.85	259.3	75	101.1	9.5	6.0%	4.3
51.8	51.2	6.14	257.4	75	101.1	9.5	5.8%	2.4
50.9	50.1	5.83	256.4	75	101.1	9.5	7.5%	1.4
51.7	51.0	6.00	256.6	75	101.1	9.6	5.1%	1.6
51.8	51.2	6.27	255.2	75	101.1	9.6	12.2%	0.2
51.5	50.8	6.24	254.9	75	101.1	9.6	6.0%	-0.1
51.3	50.6	5.36	259.8	75	101.1	9.6	8.0%	4.8
50.7	50.0	5.39	258.8	75	101.1	9.6	10.8%	3.8
52.8	52.0	7.09	257.9	75	101.1	9.7	5.5%	2.9

52.2	51.4	6.62	253.2	75	101.1	9.7	5.2%	-1.8
53.4	52.8	7.45	253.3	75	101.1	9.6	5.0%	-1.7
52.2	51.4	6.25	258.0	75	101.1	9.6	7.6%	3.0
51.0	50.4	5.17	253.4	75	101.1	9.6	8.2%	-1.6
50.8	50.4	6.02	282.4	90	101.2	8.4	6.2%	12.4
50.1	49.4	5.31	285.4	90	101.2	8.4	7.5%	15.4
50.9	50.2	5.79	280.5	90	101.2	8.4	7.0%	10.5
51.6	51.0	6.36	277.6	90	101.2	8.4	9.5%	7.6
52.8	52.1	7.00	276.1	90	101.2	8.4	5.3%	6.1
52.4	51.7	6.81	276.6	90	101.2	8.4	6.7%	6.6
52.3	51.5	6.51	278.4	90	101.2	8.4	7.1%	8.4
52.3	51.5	6.05	276.4	90	101.2	8.4	9.7%	6.4
51.2	50.1	5.37	277.3	90	101.2	8.4	10.7%	7.3
49.8	49.2	4.88	275.8	90	101.2	8.4	7.5%	5.8
51.2	50.4	5.60	278.7	90	101.2	8.4	7.0%	8.7
51.9	51.0	6.16	283.8	90	101.2	8.4	8.2%	13.8
52.0	51.3	6.47	279.8	90	101.2	8.4	4.6%	9.8
51.1	50.5	5.47	279.9	90	101.2	8.4	6.9%	9.9
50.6	50.2	4.89	276.1	90	101.2	8.4	7.8%	6.1
50.2	49.4	4.67	282.9	90	101.2	8.4	9.3%	12.9
50.8	50.1	5.16	280.6	90	101.2	8.4	9.6%	10.6
51.4	50.9	5.94	279.2	90	101.2	8.4	4.2%	9.2
51.0	50.2	5.78	280.9	90	101.2	8.4	6.4%	10.9
50.4	49.7	4.76	282.0	90	101.2	8.4	11.2%	12.0
50.3	49.6	4.53	274.1	90	101.2	8.4	6.6%	4.1
49.8	49.3	4.43	281.5	90	101.2	8.4	5.9%	11.5
49.7	48.8	4.68	282.2	90	101.2	8.4	5.7%	12.2
50.0	49.2	4.39	264.6	90	101.2	8.8	11.2%	-5.4
50.8	50.1	5.12	262.4	90	101.2	8.8	8.2%	-7.6
49.9	49.4	4.72	264.4	90	101.2	8.8	7.5%	-5.6
50.8	50.4	5.40	263.4	90	101.2	8.8	7.0%	-6.6
50.0	49.4	4.67	262.9	90	101.2	8.8	10.5%	-7.1
50.4	49.8	5.02	265.8	90	101.2	8.8	6.2%	-4.2
49.9	49.5	4.70	260.2	90	101.2	8.8	5.6%	-9.8
50.9	50.3	5.67	261.5	90	101.2	8.8	4.1%	-8.5
50.6	50.0	5.17	264.6	90	101.2	8.8	7.3%	-5.4
49.9	49.3	4.65	263.0	90	101.2	8.8	9.4%	-7.0
49.8	49.0	4.42	262.4	90	101.2	8.8	11.8%	-7.6
50.6	49.8	5.29	262.3	90	101.2	8.8	9.7%	-7.7
49.7	49.3	4.69	268.3	90	101.2	8.8	7.6%	-1.7
49.7	49.2	4.36	267.9	90	101.2	8.8	6.9%	-2.1
49.4	48.8	4.56	266.0	90	101.2	8.8	10.1%	-4.0
50.7	50.3	5.69	263.0	90	101.2	8.8	5.2%	-7.0
50.2	49.7	5.21	264.5	90	101.2	8.8	5.0%	-5.5
49.8	49.3	4.39	269.5	90	101.2	8.8	8.5%	-0.5

48.9	48.5	4.06	266.2	90	101.2	8.8	9.1%	-3.8
50.2	49.2	5.35	271.2	90	101.2	8.8	11.2%	1.2
50.1	49.6	4.81	269.8	90	101.2	8.8	7.6%	-0.2
49.9	49.2	4.88	268.1	90	101.2	8.8	5.0%	-1.9
49.4	48.7	3.93	272.1	90	101.2	8.8	6.6%	2.1
49.4	48.7	4.25	268.8	90	101.2	8.8	11.9%	-1.2
50.5	50.0	4.72	272.2	90	101.2	8.9	10.4%	2.2
48.8	48.3	3.99	273.3	90	101.2	8.8	6.1%	3.3
49.9	49.3	4.34	268.7	90	101.2	8.8	7.1%	-1.3
49.7	49.3	4.58	269.6	90	101.2	8.9	8.6%	-0.4
49.2	48.6	3.89	273.1	90	101.2	8.9	7.8%	3.1
48.8	48.1	3.75	261.4	90	101.2	8.9	7.8%	-8.6
49.5	48.9	4.21	270.3	90	101.2	8.9	9.0%	0.3
49.3	49.0	3.95	267.8	90	101.2	8.9	8.5%	-2.2
49.8	49.3	4.73	263.0	90	101.2	8.9	5.1%	-7.0
49.7	49.3	3.97	267.5	90	101.2	8.9	8.9%	-2.5
49.6	49.1	4.76	267.9	90	101.2	8.9	8.1%	-2.1
50.8	50.3	5.72	265.8	90	101.2	8.8	3.4%	-4.2
50.4	49.7	4.57	269.7	90	101.2	8.8	5.0%	-0.3
50.3	49.4	5.08	263.9	90	101.2	8.8	6.6%	-6.1
51.0	50.1	5.18	269.0	90	101.2	8.8	8.4%	-1.0
50.3	49.5	4.73	265.8	90	101.2	8.8	10.2%	-4.2
51.2	49.9	5.65	269.0	90	101.2	8.8	4.1%	-1.0
50.3	49.7	5.28	270.1	90	101.2	8.8	6.8%	0.1
49.8	49.2	5.00	267.0	90	101.2	8.8	4.0%	-3.0
49.4	48.8	4.34	266.3	90	101.2	8.8	5.3%	-3.7
50.0	49.2	4.69	267.0	90	101.2	8.8	6.9%	-3.0
49.1	48.4	3.75	266.5	90	101.2	8.8	10.7%	-3.5
50.5	49.8	5.13	262.5	90	101.2	8.8	9.9%	-7.5
50.0	49.2	4.85	267.8	90	101.2	8.8	7.8%	-2.2
49.8	49.1	4.68	267.9	90	101.2	8.8	6.4%	-2.1
50.1	49.3	5.07	269.2	90	101.2	8.8	9.0%	-0.8
50.3	49.2	5.05	262.8	90	101.2	8.8	4.6%	-7.2
49.4	48.9	4.43	275.6	90	101.3	9.3	6.4%	5.6
49.3	48.5	4.37	272.5	90	101.3	9.3	7.7%	2.5
49.6	49.1	4.30	273.1	90	101.3	9.4	7.0%	3.1
49.1	48.7	4.17	277.0	90	101.3	9.4	8.9%	7.0
48.8	48.0	4.11	279.4	90	101.3	9.4	9.0%	9.4
50.4	49.8	5.38	277.7	90	101.3	9.4	7.3%	7.7
49.8	49.3	4.64	278.3	90	101.3	9.4	7.1%	8.3
50.6	49.9	5.69	273.8	90	101.3	9.4	4.8%	3.8
50.7	49.9	5.46	269.6	90	101.3	9.4	5.2%	-0.4
50.2	49.6	5.11	275.2	90	101.3	9.4	6.0%	5.2
50.2	49.6	5.27	271.5	90	101.3	9.4	5.8%	1.5
49.8	49.1	4.47	265.8	90	101.3	9.4	5.9%	-4.2

49.9	49.2	4.04	268.4	90	101.3	9.4	8.8%	-1.6
50.4	49.3	4.93	269.2	90	101.3	9.4	12.3%	-0.8
50.1	49.2	5.03	270.2	90	101.3	9.4	6.1%	0.2
50.3	49.8	5.29	272.8	90	101.3	9.4	8.8%	2.8
51.8	51.2	6.15	272.2	90	101.3	9.4	4.5%	2.2
50.5	49.6	5.05	266.9	90	101.3	9.4	5.8%	-3.1
50.9	50.1	4.87	273.5	90	101.3	9.4	5.4%	3.5
50.4	49.8	4.65	266.8	90	101.3	9.4	8.3%	-3.2
50.7	49.6	5.43	268.6	90	101.3	9.4	7.8%	-1.4
50.4	49.5	5.09	267.5	90	101.3	9.4	8.4%	-2.5
50.3	49.6	5.26	272.4	90	101.3	9.4	5.3%	2.4
50.7	49.8	5.03	269.8	90	101.3	9.5	7.8%	-0.2
51.6	50.9	5.98	262.7	90	101.3	9.5	7.4%	-7.3
50.3	49.7	5.13	264.5	90	101.3	9.5	7.0%	-5.5
50.0	49.1	5.12	268.7	90	101.3	9.5	8.2%	-1.3
50.2	49.5	5.45	276.7	90	101.3	9.5	8.1%	6.7
50.1	49.3	5.18	273.4	90	101.3	9.5	8.5%	3.4
50.4	49.6	5.32	270.7	90	101.3	9.5	5.2%	0.7

11.2. Turbine Parked

L_{Aeq} (dB(A))	L90 (dB(A))	Corrected Wind Speed (m/s)	Wind Direction (°)	Microphone Location (°)	Pressure (kPa)	Temperature (°C)	Turbulence Intensity	Angle between Microphone and Wind Direction (°)
36.9	35.2	7.96	213.4	40	101.1	9.1	5.3%	-6.6
36.7	34.6	8.51	210.1	40	101.1	9.1	6.8%	-9.9
38.0	35.9	8.60	214.8	40	101.1	9.1	7.0%	-5.2
39.3	37.2	8.57	206.7	40	101.1	9.1	4.3%	-13.3
39.9	37.6	8.78	208.3	40	101.1	9.1	5.2%	-11.7
36.0	34.6	7.70	215.5	40	101.1	9.1	9.0%	-4.5
34.4	33.3	7.85	218.7	40	101.1	9.1	6.0%	-1.3
32.8	31.8	6.80	212.7	40	101.1	9.1	10.1%	-7.3
33.6	32.3	6.98	212.5	40	101.1	9.1	4.9%	-7.5
34.7	33.6	6.47	215.1	40	101.1	9.2	10.3%	-4.9
35.3	34.0	6.90	216.4	40	101.1	9.1	8.4%	-3.6
34.4	32.9	6.48	212.8	40	101.1	9.1	8.5%	-7.2
35.9	34.9	7.44	220.1	40	101.1	9.1	8.4%	0.1
35.3	34.4	7.54	222.6	40	101.1	9.1	9.8%	2.6
36.2	34.2	7.07	213.8	40	101.1	9.1	8.1%	-6.2
34.3	32.9	7.15	210.8	40	101.1	9.1	8.7%	-9.2
33.9	32.5	7.50	215.8	40	101.1	9.1	8.3%	-4.2
33.6	32.2	6.28	216.4	40	101.1	9.1	7.6%	-3.6
35.1	33.4	6.40	213.1	40	101.1	9.1	7.7%	-6.9
36.5	34.7	6.80	215.7	40	101.1	9.1	9.6%	-4.3
33.2	31.7	6.25	217.8	40	101.1	9.1	7.1%	-2.2
35.5	34.0	7.45	210.6	40	101.1	9.2	9.6%	-9.4
46.0	43.6	9.71	222.4	40	100.7	8.9	7.0%	2.4
43.7	42.4	10.18	220.6	40	100.7	8.9	7.1%	0.6
46.1	42.4	10.65	216.5	40	100.7	8.9	6.7%	-3.5
46.6	42.9	10.45	221.0	40	100.7	8.9	9.2%	1.0
45.6	43.5	10.56	225.1	40	100.7	8.9	10.5%	5.1
47.8	45.1	11.64	224.3	40	100.7	8.9	7.2%	4.3
49.0	43.4	10.15	222.0	40	100.7	8.9	7.4%	2.0
49.5	46.0	11.39	219.4	40	100.7	8.9	10.6%	-0.6
46.7	44.4	10.97	219.6	40	100.7	8.9	9.2%	-0.4
47.0	45.2	11.58	221.7	40	100.7	8.9	7.4%	1.7
52.6	48.8	12.08	218.0	40	100.7	8.9	12.1%	-2.0
54.4	49.0	12.36	216.8	40	100.7	8.9	5.9%	-3.2
54.1	50.6	12.98	217.7	40	100.7	8.9	7.2%	-2.3
52.9	49.8	11.95	219.7	40	100.7	8.9	6.7%	-0.3
36.2	35.0	7.88	264.0	75	101.1	9.5	4.7%	9.0
36.9	35.5	8.27	264.0	75	101.1	9.4	5.3%	9.0
36.3	34.7	7.75	261.3	75	101.1	9.4	9.1%	6.3

38.2	36.6	7.82	266.6	75	101.1	9.4	4.7%	11.6
37.1	35.2	6.44	261.4	75	101.1	9.4	7.2%	6.4
37.2	35.1	7.48	260.3	75	101.1	9.4	6.9%	5.3
37.7	36.1	6.93	260.4	75	101.1	9.4	7.3%	5.4
38.1	36.7	7.79	263.3	75	101.1	9.4	4.9%	8.3
38.1	36.4	7.36	259.6	75	101.1	9.4	8.7%	4.6
38.1	36.5	7.20	259.8	75	101.1	9.4	6.3%	4.8
36.8	35.0	6.04	261.4	75	101.1	9.4	12.0%	6.4
36.3	34.8	6.62	264.5	75	101.1	9.4	8.2%	9.5
35.8	34.5	6.95	259.0	75	101.1	9.4	4.5%	4.0
34.2	32.7	6.17	263.2	75	101.1	9.4	10.1%	8.2
33.4	31.1	4.74	270.5	90	101.3	9.5	6.7%	0.5
33.3	31.7	4.26	265.4	90	101.3	9.6	10.4%	-4.6
34.4	33.2	5.47	265.4	90	101.3	9.6	4.5%	-4.6
33.1	31.7	4.73	261.6	90	101.3	9.6	6.6%	-8.4
34.8	32.6	5.07	264.2	90	101.3	9.5	4.8%	-5.8
34.6	31.7	4.51	262.5	90	101.3	9.5	6.0%	-7.5
34.4	33.0	5.28	267.7	90	101.3	9.6	6.9%	-2.3
37.4	31.1	4.55	269.1	90	101.3	9.6	7.1%	-0.9
36.3	30.9	4.45	257.9	90	101.3	9.5	8.3%	-12.1
33.4	30.4	5.22	257.8	90	101.3	9.6	9.7%	-12.2
34.6	32.2	5.85	259.4	90	101.3	9.6	4.6%	-10.6
35.4	32.4	5.32	264.5	90	101.3	9.6	4.1%	-5.5
32.8	31.0	5.24	267.6	90	101.3	9.6	7.1%	-2.4
33.1	31.2	5.24	260.6	90	101.3	9.6	8.8%	-9.4
33.1	31.0	5.27	261.3	90	101.3	9.6	7.0%	-8.7
32.9	31.7	4.78	260.0	90	101.3	9.6	6.7%	-10.0
35.8	32.6	5.92	260.0	90	101.3	9.6	4.6%	-10.0
33.1	31.6	4.51	262.2	90	101.3	9.6	7.4%	-7.8
34.2	31.4	5.48	262.7	90	101.3	9.6	6.0%	-7.3
34.0	32.8	5.61	259.0	90	101.3	9.6	6.5%	-11.0
33.1	31.7	4.63	264.7	90	101.3	9.6	6.3%	-5.3
32.9	31.8	4.14	268.1	90	101.3	9.6	12.3%	-1.9
31.7	30.4	4.68	269.5	90	101.3	9.6	7.3%	-0.5
32.6	30.2	3.92	267.0	90	101.3	9.6	7.2%	-3.0
32.8	30.7	4.59	265.6	90	101.3	9.6	6.8%	-4.4
33.6	32.0	5.21	266.0	90	101.3	9.7	8.4%	-4.0
35.3	31.7	4.88	269.0	90	101.3	9.7	5.5%	-1.0
38.9	35.1	4.63	271.8	90	101.3	9.7	6.8%	1.8
37.9	34.4	4.72	270.5	90	101.3	9.7	6.1%	0.5

12. Appendix 3 – Calibration Certificates

Certificate of Calibration

pulsar Instruments Plc

Equipment Details

Instrument Manufacturer	Pulsar Instruments plc
Instrument Type	Sound Level Meter
Model Number	Model 33
Serial Number	T226566

Calibration Procedure

The instrument detailed above has been calibrated to the published test and calibration data as detailed in the instrument handbook, using the techniques recommended in the latest revisions of the International Standards IEC 61672-1:2002, IEC 60651:1979, IEC 60804:2001, IEC 61260:1995, IEC 60942:1997, IEC 61252:1993, ANSI S1.4-1983, ANSI S1.11-1986 and ANSI S1.43-1997 where applicable.

Sound Level Meters: All Calibration procedures were carried out by substituting the microphone capsule with a suitable electrical signal, apart from the final acoustic calibration.

Calibration Traceability

The equipment detailed above was calibrated against the calibration laboratory standards held by Cirrus Research plc. Which are traceable to the appropriate International Standards.

The Cirrus Research plc calibration laboratory standards are:

Microphone Type	B&K4180	Serial Number	1893453	Calibration Ref. S 6009
Pistonphone Type	B&K4220	Serial Number	613843	Calibration Ref. S 5964

Calibrated by T. A. Goodall

Calibration Date 27 January 2012

Calibration Certificate Number 193825

This Calibration Certificate is valid for 12 months from the date above.

Pulsar Instruments plc, The Evron Centre, John Street, Filey, North Yorkshire, YO14 9DQ
Telephone: +44 (0) 1723 518011 Fax: +44 (0) 1723 518043
Email: sales@pulsarinstruments.com

Cirrus Research plc

Calibration Chart for Electret Microphone

Type: MK:224 **Serial No.:** 20042763

Open Circuit Sensitivity at 1kHz:

-24.8 dB rel.1V/Pa

57.7 mV/Pa

Conditions of Tests:

Barometric Pressure	995 kPa
Relative Humidity	40 %
Temperature	20 °C

Signature: **Date:** 26/01/2012

Cirrus Research plc
Acoustic House, Hunmanby YO14 0PH UK
www.cirrusresearch.co.uk

Specifications:

Outside Diameter:

13.2mm with protecting grid

12.7mm without protecting grid

Mounting Thread:

11.7mm 60 UNS 2

Ambient Pressure Coefficient:

-0.02 to +0.02 dB/kPa for

±10% pressure change at 250Hz

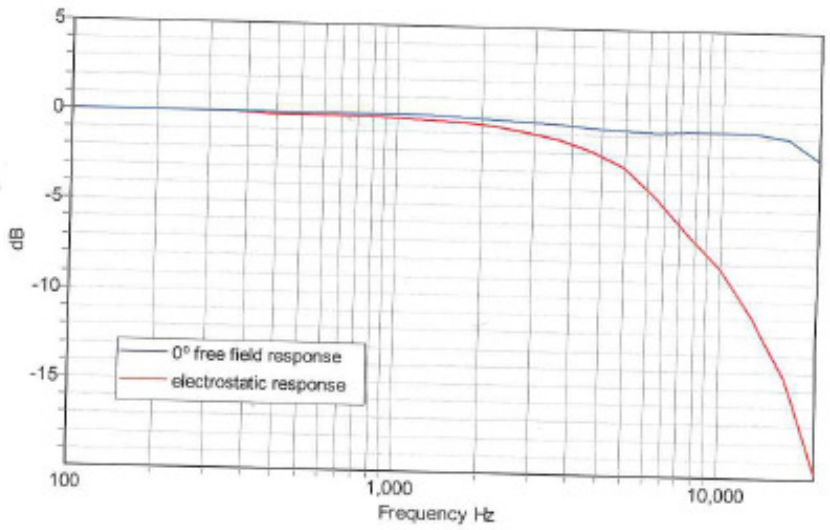
Temperature Coefficient:

-10°C to +50°C

Approx. -0.015dB/k at 250Hz

Dynamic Range:

SPL below which total harmonic distortion is <1%: 130dB



Certificate of Calibration

pulsar Instruments Plc

Equipment Details

Instrument Manufacturer	Pulsar Instruments plc
Instrument Type	Acoustic Calibrator
Model Number	Model 105
Serial Number	45109

Calibration Procedure

The acoustic calibrator detailed above has been calibrated to the published data as described in the operating manual. The procedures and techniques used to follow the recommendations of the IEC standard Electroacoustics – Sound Calibrators IEC 60942:2003, IEC 60942:1997, BS EN 60942:1998 and BS EN 60942:2003 where applicable.. The calibrator's main output is 94.00 dB (1 Pa) and this was set within the 0.01 dB resolution of the test system, i.e. one hundredth of a decibel. Numbers in {parenthesis} refer to the paragraph in IEC 60942.

Calibration Traceability

The calibrator above was calibrated against the calibration laboratory standards held by Cirrus Research plc. These are traceable to International Standards {A.0.6}. The standards are:

Microphone Type	B&K4180	Serial Number	1893453	Calibration Ref.	S 6009
Pistonphone Type	B&K4220	Serial Number	613843	Calibration Ref.	S 5964

Calibration Climate Conditions

The climatic test conditions were all maintained within the permitted limits of IEC 60942:1997.

Temperature	{B.3.2}	Permitted band 15°C to 25°C
Humidity	{B.3.2}	Permitted band 30% to 90% RH
Static Pressure	{B.3.2}	Permitted band 85 kPa to 105 kPa
Ambient Noise Level	{B.3.3.6}	Max permitted level 64 dB(Z)

Measurement Results

The figures below are the Calibration Laboratory test limits for this model calibrator and have a smaller tolerance than those permitted in IEC 60942.

94 dB Output	93.99	dB	Permitted band 93.95 to 94.05dB
Frequency	1000	Hz	Permitted band 990 to 1010Hz

Uncertainty

With an uncertainty coefficient of k=2, i.e. a 95% confidence level, the uncertainty of each measure is

94 dB Output	± 0.13 dB	104 dB Output	± 0.14 dB
Frequency	± 0.1 Hz	Level Stability	± 0.04 dB

Calibrated by T. A. Goodhill

Calibration Date 07 December 2011

Calibration Certificate Number 192501

This Calibration Certificate is valid for 12 months from the date above.

Pulsar Instruments plc, The Evron Centre, John Street, Filey, North Yorkshire, YO14 9DQ
Telephone: +44 (0) 1723 518011 Fax: +44 (0) 1723 518043
Email: sales@pulsarinstruments.com

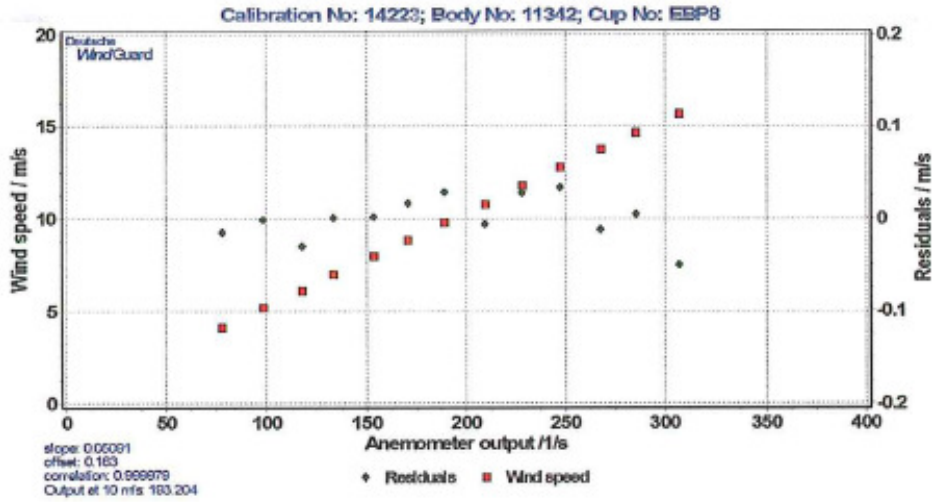
1 Detailed MEASNET[1] Calibration Results

DKD calibration no.	14223
Body no.	11342
Cup no.	EBP8
Date	02.08.2011
Air temperature	26.0 °C
Air pressure	1018.1 hPa
Humidity	49.5 %

Linear regression analysis

Slope	0.05091 (m/s)/(1/s) ±0.00010 (m/s)/(1/s)
Offset	0.163 m/s ±0.020 m/s
St.err(Y)	0.027 m/s
Correlation coefficient	0.999979

Remarks no



[1]) According to MEASNET Cup Anemometer Calibration Procedure 2009-10.
Deutsche WindGuard Wind Tunnel Services is accredited by MEASNET and by the Deutsche Akkreditierungsdienst – DAkkS (German Accreditation Service). Registration: D-K-15140-01-00

Deutsche WindGuard
Wind Tunnel Services GmbH, Varel

CAMPBELL SCIENTIFIC LIMITED
Campbell Park
80 Hathern Road
Shepshed
Loughborough
LE12 9GX

Telephone: +44 (0) 1509 601141
Fax: +44 (0) 1509 601091
Email: support@campbellsci.co.uk

Certificate of Calibration

Customer:

Company Name: Evance
Address: Unit 6 Weldon Road
Derby Road Industrial Est
Loughborough

RMA #: 1016

Log Option: 1

Model: CR1000-RMA Serial Number: 9455

Test Panel Loc. 30
CSI Calibration Number: 110912278
Calibration Procedures: WI/T/0069, 70, 71

Instrument Calibration Condition

Received Disposition:	In Tolerance	Out of Tolerance	Operational Failure *
Returned Disposition:	In Tolerance *		

Recommended Calibration Schedule

If the customer has not requested a calibration interval, a non mandatory recommended interval is provided. Based on past experience and assumed normal usage, it is recommended that this instrument be calibrated by the due date stated below to ensure sustained accuracy and reliable performance.

Calibration Date: 12-Sep-11 Calibration Due Date: 12-Sep-13

Report of Calibration Standards Used

Make/ Model	Test Equipment Number	Calibration Service Certificate Number
Krohn Hite 523	TE2164	AG50112
CSI Oscillator	TE2165	CSI

Campbell Scientific Limited certifies that the above instrument meets or exceeds published specifications and has been calibrated using standards and instruments whose accuracies are traceable to UK National Standards. All standards have been calibrated by a U.K.A.S. accredited calibration service. The uncertainties, including those attributable to the standards used, together with those contributed by personnel, procedures and environment are estimated not to exceed a 4:1 accuracy ratio for any given measurement.

Quality Control Officer responsible for content of certificate: Steve Sharratt

Remarks: Communication problem in before

Based on the selected report options, some fields are intentionally left blank.

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