

Acoustic Test Report For

Evoco 10 Horizontal Axis Wind Turbine

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1 Document Purpose

This report documents the acoustic test of an Evoco 10 wind turbine which was installed at a test site operated by Evoco Energy Ltd at Queensbury in West Yorkshire. The test was conducted in accordance with British Standard BS EN BS EN 61400-11, where applicable to small wind turbines, and incorporating the amendments given in the British Wind Energy Association (BWEA) document 'Small Wind Turbine Performance and Safety Standard'. The test further followed the guidelines given in Narec's own internal document 'Guidelines for the Acoustic Testing of Small Wind Turbines'.

2 Reference Documents

The documents in Table 1 have been referenced in the production of this report;

Table 1 - Table of Reference Documents

Title	Reference	Date	Revision
Wind turbine generator systems - Acoustic noise measurement techniques	BS EN BS EN 61400-11	31 August 2006	A1
British Wind Energy Association Small Wind Turbine Performance and Safety Standard		29 Feb 2008	
Guidelines for the Acoustic Testing of Small Wind Turbines	GU 18135		Draft
Guide to the expression of uncertainty in measurement (GUM)	PD 6461-3	13 June 2003	Amd No 14133

3 Description of Wind Turbine

The wind turbine under test is an Evoco 10 which is shown in Figure 1, and its specifications are listed in Table 2 below.



Figure 1 - The Evoco 10

Table 2 – Manufacturer Turbine Configuration Data

General Information :	
Turbine Make	Evoco
Turbine Model	Evoco 10
Generator Serial Number	PMG12KBH01020809
Nacelle Serial Number	EVO-10WT-00011
Year of Manufacture	2010
Rotation Axis	Clockwise (viewed from the front of the rotor)
Horizontal/Vertical	Horizontal
Orientation	Downwind
Rotor Diameter (m)	9.7
Hub Height (m)	12.72

Performance :	
Rated Power (kW)	10
Rated Wind Speed (m/s)	11
Cut-In Wind Speed (m/s)	3.0
Cut-Out Wind Speed (m/s)	30
Manufacturer Data :	
Manufacturer	Evoco
Address	St Pegs Mill, Thornhill Beck Lane, Brighouse, West Yorkshire, HD6 4AH

4 Description of the Test Site

4.1 Site Location

The test site for the Evoco 10 is located at Upper Fleet Farm, Queensbury in West Yorkshire, which is approx 5.5 miles WSW of Bradford (grid reference SE 093 305, full grid reference 409366, 430533), and is owned/leased by Evoco Ltd. The site is at an elevation of approx 360m above sea level, with the prevailing winds bearing from the SW at 225° relative to true North.

An aerial view of the site, including the locations of key devices, is shown in Figure 2 below.



Figure 2 - Aerial View of Queensbury Test Site in West Yorkshire

4.2 Test Turbine and Meteorological Tower

The wind turbine under test is located within the site as indicated in Figure 2 previous, and the rotor hub height is 12.72m above ground level. The meteorological mast is located 27.0m from the turbine at a bearing of 220° relative to true North. This positions the meteorological mast at a distance of just over 2.5 rotor diameters away from the turbine (2.78 diameters), and almost in the centre of the prevailing wind direction.

4.3 Site Layout

Figure 3 below shows the layout of the Queensbury site, and indicates the locations of the turbine under test, the meteorological mast, the location used for the acoustic test, the prevailing wind direction, and the locations of nearby buildings. The cable route for both the power output of the turbine, and the power/voltage measuring devices runs to the local shed enclosure adjacent the turbine.

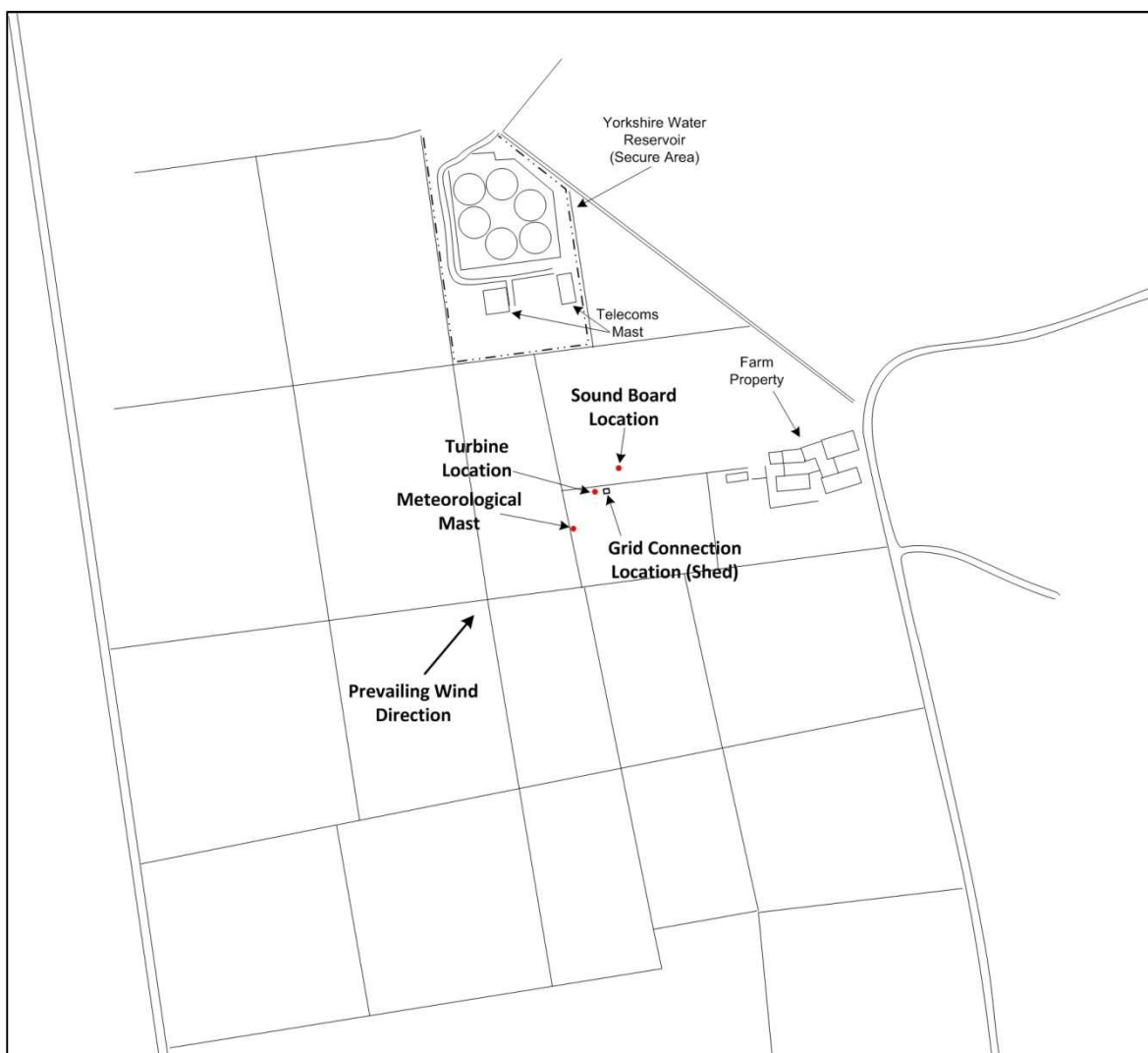


Figure 3 - Site Layout Showing Turbine & Met Mast Locations & Prevailing Wind Direction

5 Acoustic Testing

5.1 Acoustic Testing 11th August 2010

Initial acoustic testing was undertaken on August 11th 2010 over the entire day, during which the wind was predominantly from the West (average direction for the test period was 259°), and therefore the test arrangement was established as per Figure 4 below;

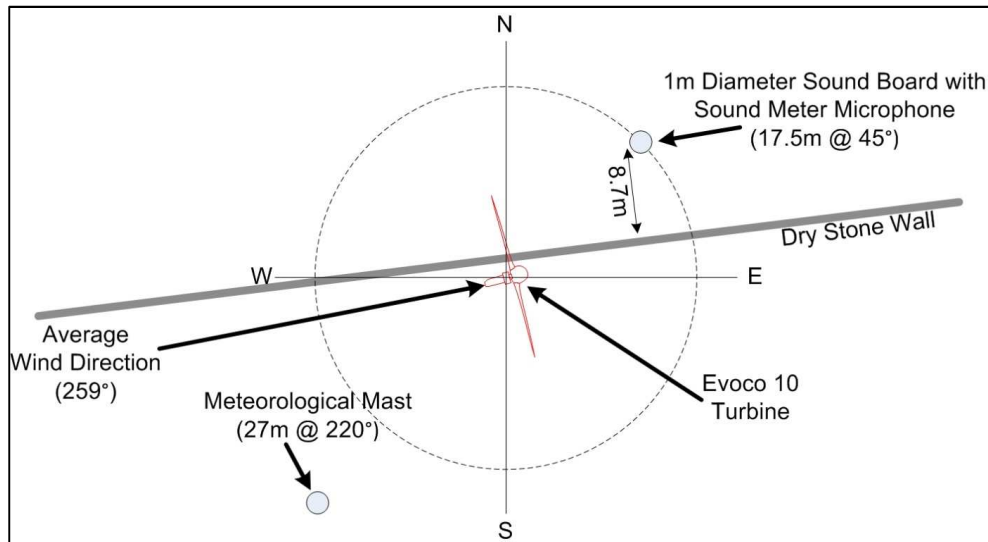


Figure 4 – Acoustic Test Arrangement 11th August 2010

Noise measurements were made using the ½" microphone of a Bruel & Kjaer 2250 sound monitor, which was mounted at the centre of a 1m diameter ¾" thick varnished plywood board, which was positioned flat on the ground at a distance of 17.57m, which results in a slant angle of 35.9° (see Figure 4 above). The microphone was mounted flat to the plane of the sound board within one half of a Bruel & Kjaer 90mm foam ball (part number UA-0237) to provide a primary windshield, and was connected via a 10m extension cable to the sound monitor. Further the microphone was aligned facing the direction of the turbine. The sound board was bedded onto a base of damp sand to even out the ground surface, and damp sand was further used to even out the edges of the sound board to ground level. Photographs showing this preparation can be seen in Figure 5 and Figure 6 below.



Figure 5 – Using Damp Sand to Mount Sound Board



Figure 6 – Measurement from Turbine to Board

Once the sound board set up was complete the sound meter was calibrated using a Bruel & Kjaer 4231 calibrator, the operation and result of which is shown in Figure 7 and Figure 8 below;



Figure 7 – Calibrating Sound Monitor



Figure 8 – Sound Monitor Calibration Result

In order to measure the noise level in complete synchronicity with the wind speed, the Bruel & Kjaer 2250 analogue output was utilised by connecting this signal back to the data logger used for the power performance measurement. In this way not only are there no synchronising issues with the resulting data, but as the data logger performs 1 minute averaging the resulting noise data is processed in the same way, and at the same time, as the wind speed measurement. The signal cable connecting the 2250 to the data logger can be seen in Figure 9 and Figure 10 below;



Figure 9 – The Test in Operation Looking WSW



Figure 10 – The Test in Operation Looking ENE

Similarly the wind speed anemometer is mounted at the same height as the turbine hub, and therefore there is no need to perform any adjustment calculation in respect of height difference.

With the sound board located at 45° relative to the turbine, and in accordance with section 3.4.5 of the BWEA standard, this results in wind from between 165° and 285° being valid for the purposes of noise measurements ($\pm 60^\circ$ around the sound board downwind location). Throughout the course of the test the wind direction was always between 245° and 277°, and therefore all resulting records are valid from the perspective of wind direction.

Weather conditions on the day were mostly cloudy, and persisted at octas 6 – 8 throughout the course of the test.

Attention is drawn in particular to Figure 9, which shows the test arrangement during the noise measurement, with the Bruel & Kjaer 2250 some 8m further downwind of the sound board, so that it doesn't cause any noise interference itself. Note also that whilst a better location may have been at perhaps 80° from the perspective of the wind direction, this was deliberately avoided so that the sound board could be located a reasonable distance from the dry stone wall and thereby avoid any potential reflections from that source. As can be seen in Figure 4 the distance between the sound board and the wall was 8.7m.

5.1.1 Acoustic Testing Periods

During the course of the day testing was alternated between running noise tests and background noise tests, so that similar wind resource could be measured in both states. Accordingly this resulted in the following test periods;

Table 3 - Testing Periods 11th August 2010

Test Type	Start Time	Finish Time	Duration	Number of Points
Running	10:48	12:55	2:07	128
Background	13:00	15:35	2:35	156
Running	15:39	16:15	0:36	37

Throughout the test periods no external noise events were observed, and therefore all records are contiguous. The resulting wind speed data for these periods varied between 5.9m/s and 13.3m/s, and noise records varied between 40dB(A) and 72.8dB(A), although further analysis and scatter plots are discussed later in the document.

5.1.2 Conclusion of The Initial Test

Once the testing was concluded for the day, the sound meter was once again calibrated. The calibration in operation and the result can be seen in Figure 11 and Figure 12 below;



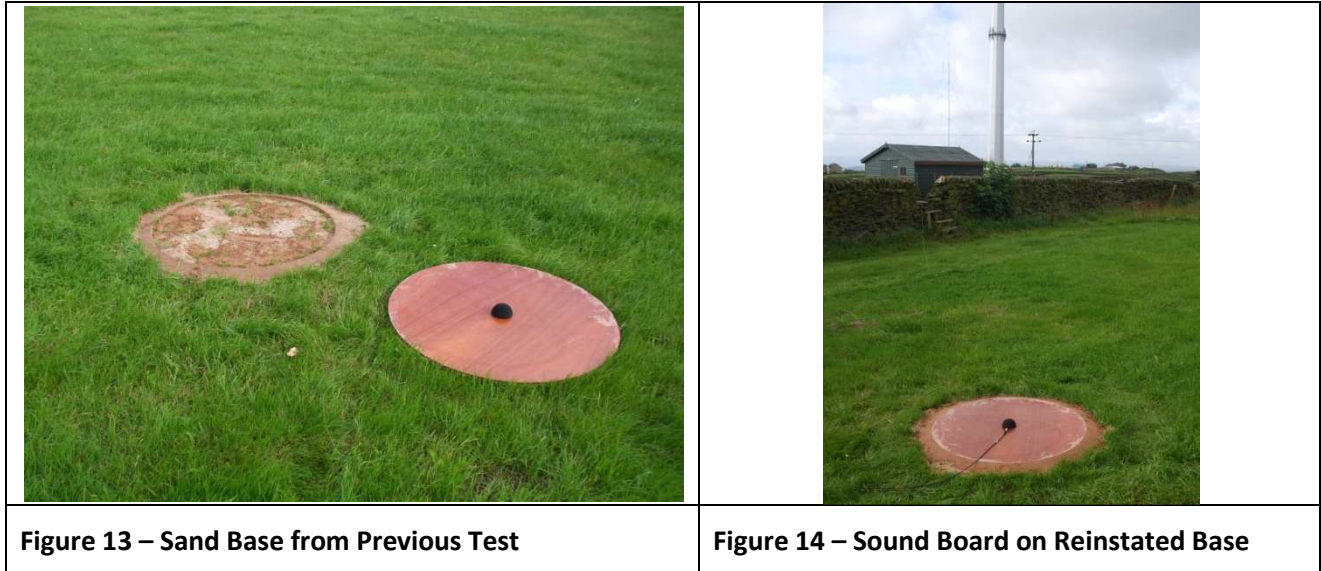
Figure 11 – Calibration on Test Conclusion



Figure 12 – Final Calibration Result

5.2 Acoustic Testing 19th August 2010

A little over one week after the first noise testing period was undertaken, a further opportunity arose with good winds predicted on the 19th of August, and therefore a further noise testing campaign was arranged. On arrival at the test site it was apparent that the wind direction was approximately the same as the week prior, and therefore the same sound board position was used again, with a minor amount of remedial work required to repair the sand base etc. This is shown in Figure 13 and Figure 14 below;



Although clearly the sand was from testing the previous week, the distance to the turbine was once again checked and verified at 17.57m.

The test set up on this occasion was therefore as illustrated in Figure 15 below;

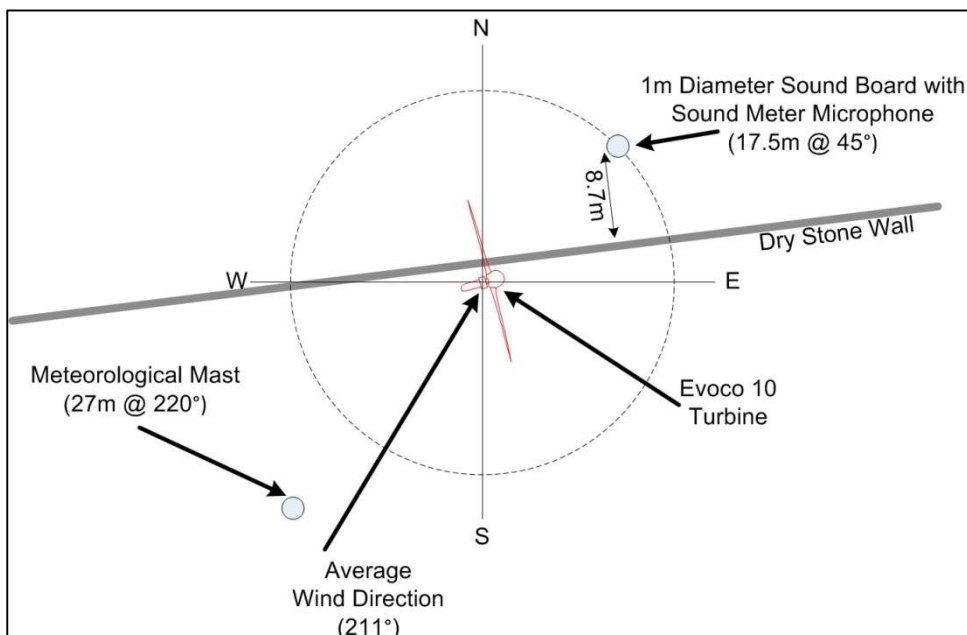


Figure 15 – Acoustic Test Arrangement 19th August 2010

All equipment and components were as used in the previous test i.e. the same Bruel & Kjaer 2250 sound monitor, the same 1m diameter ¾" thick varnished plywood board, and the same microphone extension lead etc. The sound monitor was once again connected to the data logger so that all data was synchronised to the wind speed, and averaged over the same time periods.

Again with the sound board located at 45° relative to the turbine, and in accordance with section 3.4.5 of the BWEA standard, this results in wind from between 165° and 285° being valid for the purposes of noise measurements (±60° around the sound board downwind location). Throughout the course of the test on this day the wind direction was always between 183° and 235°, and therefore all resulting records are valid from the perspective of wind direction.

Weather conditions on the day were partially cloudy, and persisted at octas 6 throughout the course of the test.

Once the sound board set up was complete the sound meter was calibrated using a Bruel & Kjaer 4231 calibrator, the operation and result of which is shown in Figure 16 and Figure 17 below;



Figure 16 – Calibrating Sound Monitor



Figure 17 – Sound Monitor Calibration Result

5.2.1 Acoustic Testing Periods

During the course of the day testing was alternated between running noise tests and background noise tests, so that similar wind resource could be measured in both states. Accordingly this resulted in the following test periods;

Table 4 – Testing Periods 19th August 2010

Test Type	Start Time	Finish Time	Duration	Number of Points
Running	10:15	11:00	0:45	46
Background	11:37	12:15	0:38	39
Running	12:18	12:53	0:35	36
Background	13:18	13:53	0:35	35
Running	14:00	15:02	1:02	59

Throughout the test periods no external noise events were noticed, except during the final running test when an aircraft was heard between 14:35 and 14:38, and therefore these data points were removed from the final dataset.

The resulting wind speed data for these periods varied between 3.4m/s and 9.1m/s, and noise records varied between 34dB(A) and 66dB(A), although further analysis and scatter plots are discussed later in the document.

5.2.2 Conclusion of The Test

Once the testing was concluded for the day, the sound meter was once again calibrated. The calibration in operation and the result can be seen in Figure 18 below;



Figure 18 – Calibration on Test Conclusion

6 Test Results

Over the course of the two days of noise testing undertaken, a total of 535 noise versus wind speed pairs were recorded, which are divided into 305 pairs taken during normal running of the turbine, and 230 pairs taken measuring background noise with the turbine shut down.

Although the recorded data points during running condition didn't quite commence at the turbine cut in point (cut in being between 2.5m/s and 3.0m/s for the Evoco 10), it is felt that the recorded data gathered commenced sufficiently low enough (4.3m/s) to evidence the applicable noise level via linear regression.

6.1 Summary Scatter Plot With Turbine Shutdown

In total 230 noise versus wind speed pairs were recorded for background noise measurement i.e. with the turbine shutdown. A scatter plot showing a summary of this data and applicable linear regression is shown in Figure 19 below;

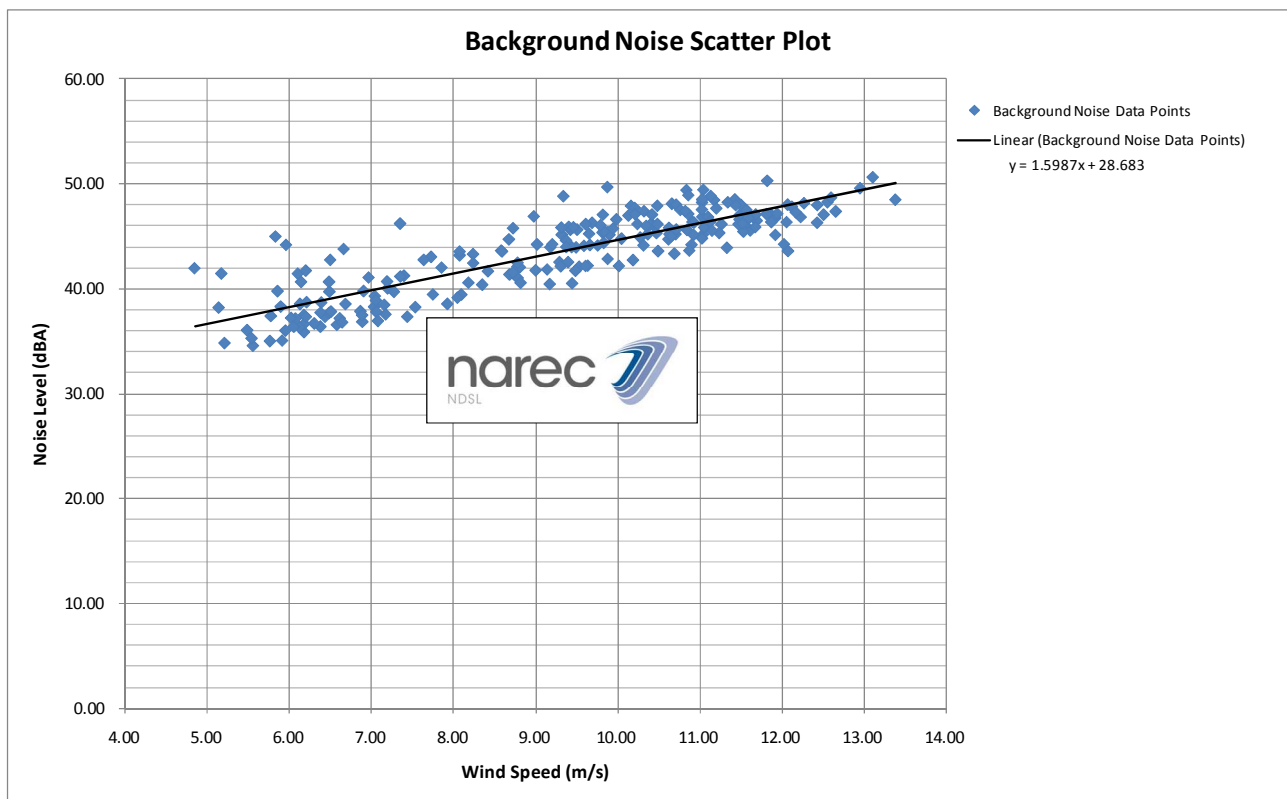


Figure 19 – Scatter Plot All Noise vs Wind Speed Pairs – Turbine Shut Down

6.2 Summary Scatter Plot During Normal Running – All Wind Speeds

Taking all 305 noise versus wind speed pairs, and plotting them onto a single scatter plot, gives the result shown in Figure 20 below;

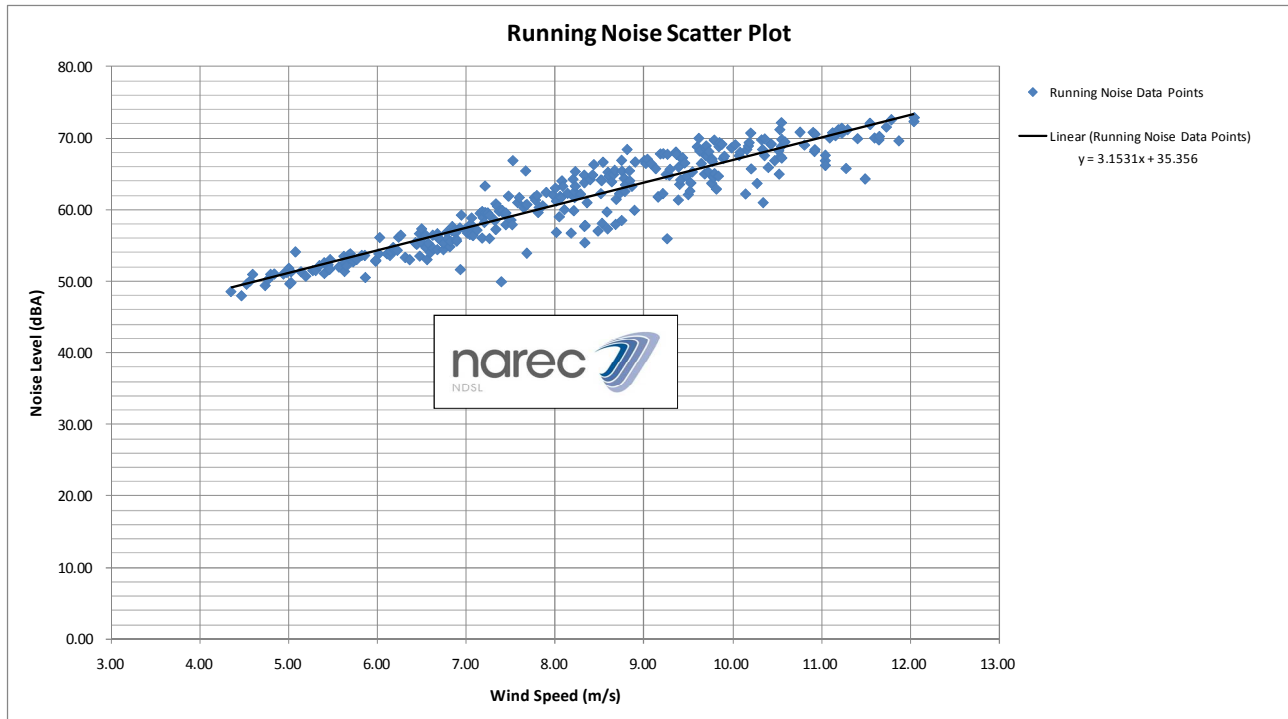


Figure 20 – Scatter Plot All Noise vs Wind Speed Pairs – Turbine Operational

As can be seen in Figure 20, the result is quite linear across all wind speeds, which was slightly unexpected. The reason for this is that the turbine has a pitching mechanism, which subjectively activates between 8m/s and 9m/s, and when the pitch is active the turbine creates much more wind disturbance across the blades. The change in noise from this is quite noticeable in the form of going from a swishing sound, to the rushing sound of a non aerodynamic object moving rapidly through the air, as the air becomes much more turbulent across the blade. Nevertheless, the resulting noise measurement does not seem to be significantly affected by this mechanism, in the form of increased noise emissions, and the noise slope effectively continues very much the same as below the pitch point.

6.3 Scatter Plot of Normal Running Data with Background Noise Correction Applied Plus $1.645U_c$

Figure 21 below shows the same data as shown in Figure 20, but now with the addition of background noise correction, as well as $1.645 * U_c$ for both corrected and uncorrected noise.

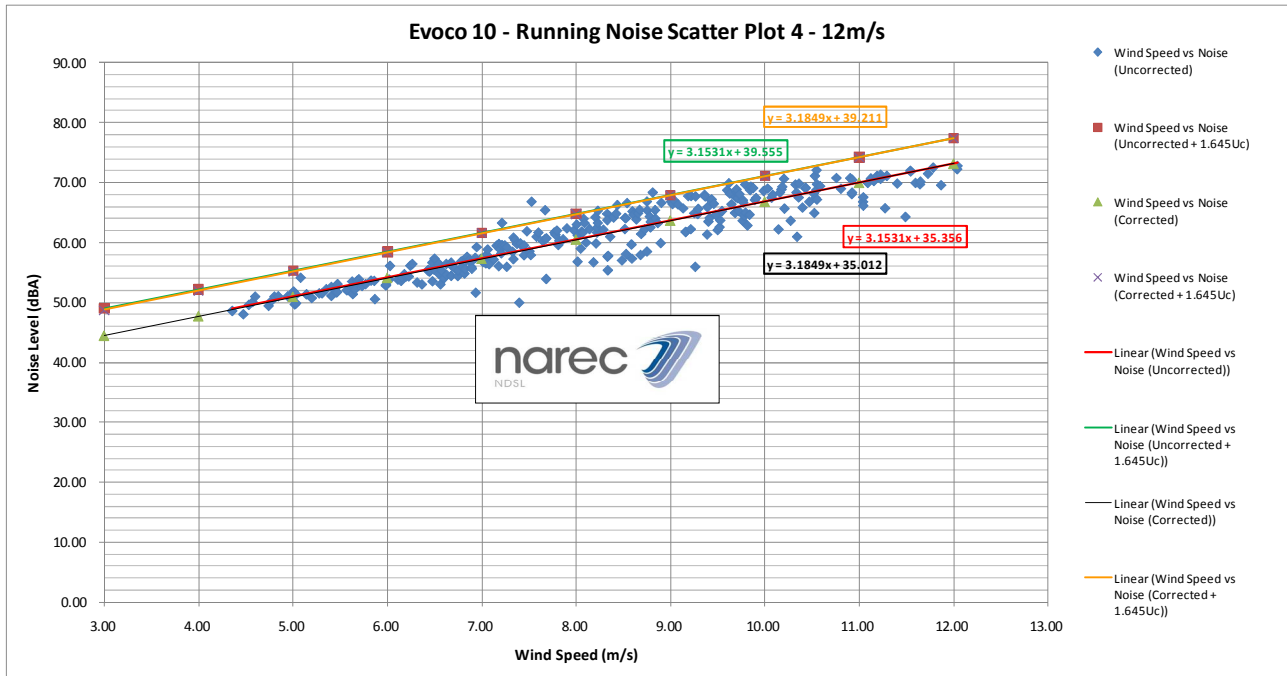


Figure 21 - Regressions for Corrected & Uncorrected Noise and With/Without $1.645U_c$ Applied

The regression for the background corrected sound pressure level was used to calculate the apparent emission sound power level, for a rotor centre wind speed of 8m/s. Also a -6dB correction (for the sound board reflection) was applied, as well as a +37.72dB correction for the slant distance of 21.69m from the rotor centre to the microphone of the sound meter.

6.4 Estimation of Uncertainty in Apparent Sound Power Level

Table 5 below shows each of the respective Type A and Type B uncertainty components, and the factors accounted for in the estimation of apparent sound power level, as recommended in Annex D of BS EN 61400-11.

Table 5 - Estimation of Uncertainty Components

Uncertainty Component	Typical Range (dB)	Standard Uncertainty Used (dB)	Comment
Type A Measured			
Noise vs Wind Speed		2.30	From Linear Regression
Type B Estimated			
Acoustic Calibration U_{B1}	± 0.3	0.12	Calibration
Instrument U_{B2}	± 0.3	0.2	Calibration
Board Mounting U_{B3}	± 0.5	0.3	Board mounted on level sand base
Measured Distance U_{B4}	± 0.1	0.03	15.57m ± 0.05 m
Impedance U_{B5}	± 0.2	0.1	Short distance, board mounted on prepared base
Turbulence U_{B6}	± 0.7	0.4	Few obstructions so typical value
Wind Speed U_{B7}	± 1.5	0.9	Synchronised measurement at hub height
Wind Direction U_{B8}	± 0.5	0.3	Synchronised measurement at hub height
Background U_{B9}		0.1	Average Correction
Combined Uncertainty U_C		2.55	
Number of Data Points		305	

As can be seen from Table 5, the combined uncertainty U_C is 2.55dB, and therefore this value of uncertainty has been used in the determination of the apparent sound power level at 8m/s.

6.5 Noise Emission Power Levels for Normal Running

Based upon the foregoing regression values and uncertainty calculations, a summary of the normal running sound power levels is shown in Table 6 below;

Table 6 - Summary of Noise Emissions for Normal Running

Parameter	Value at 8m/s Wind Speed at Hub Height
Apparent Emission Sound Power Level $L_{W,8m/s}$	92.24dB
Wind Speed Dependence S_{dB}	3.18dB per m/s
Estimated Combined Uncertainty U_C	2.55dB
Noise Penalty	0dB
Declared Apparent Emission Sound Power Level $L_{Wd,8m/s}$	96.4dB

6.6 BWEA Reference Sound Levels

From the preceding test result data, the BWEA Reference Sound Levels are as follows;

- $L_{P,25m} = 60.5\text{dB(A)}$
- $L_{P,60m} = 52.9\text{dB(A)}$

6.7 Noise Map

The resulting declared apparent emission power level at 8m/s, and associated wind speed dependence, has been used to generate the noise map shown in Figure 22 below;

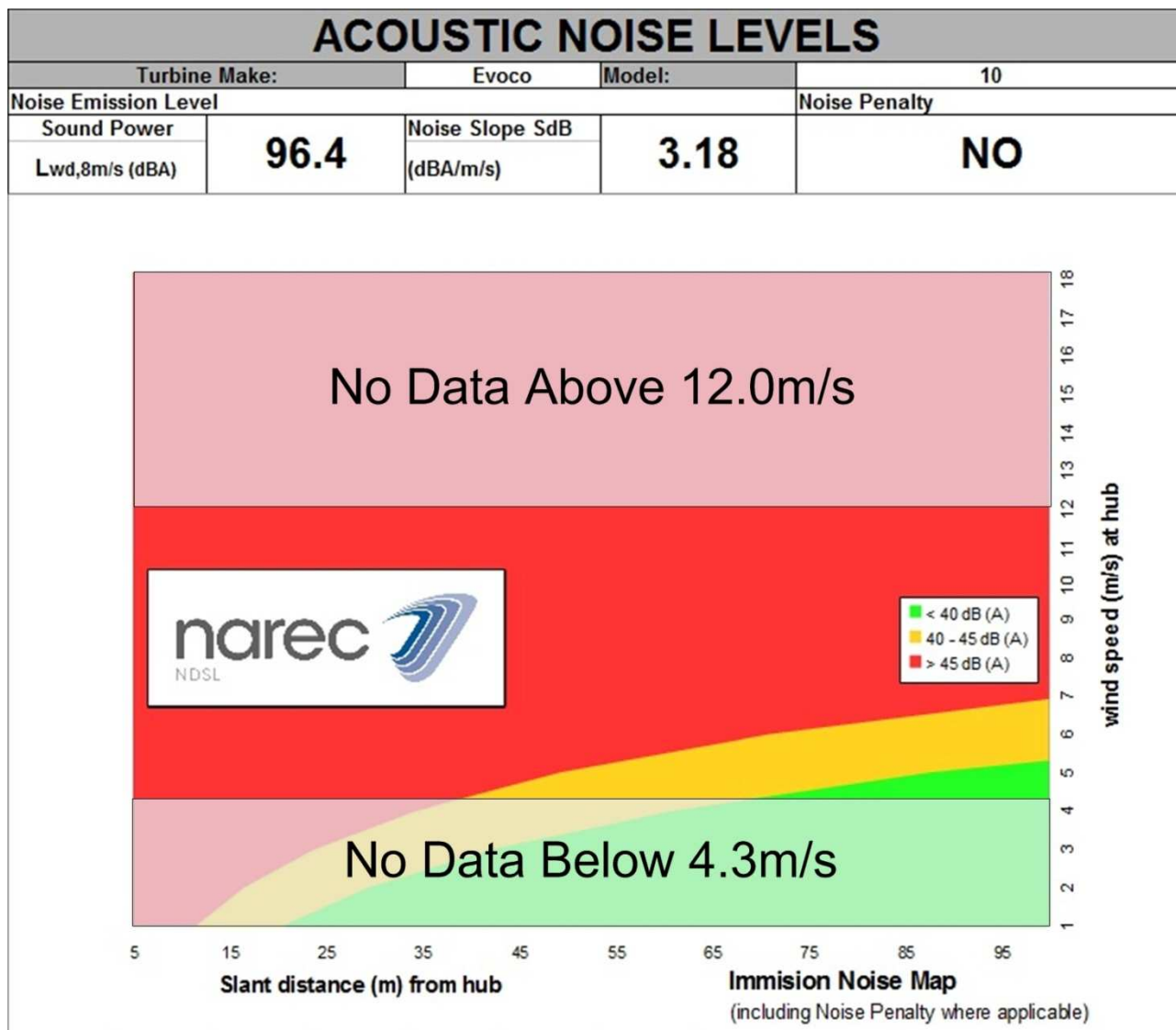


Figure 22 - Noise Map In Accordance With BWEA Standard

Note that in accordance with section 3.4.15 of the BWEA standard regarding tonal assessment, the Evoco 10 does not exhibit any tonal quality. This is further examined throughout section 6.8 below.

6.8 Noise Character

Two different areas of noise character have been looked at, which are frequency content and tonality. These are covered in sections 6.8.1 and 6.8.2 below;

6.8.1 Frequency Content

The frequency content of the turbine noise emissions was assessed from the 1/3 octave data captured and recorded on the Bruel & Kjaer 2250 noise meter. Figure 23, Figure 24, Figure 25, and Figure 26 below show the A weighted 1/3 octave spectra for 4.3m/s, 7m/s, 8m/s, and 12m/s respectively for the normal running condition, versus 4.8m/s, 7m/s, 8m/s, and 12m/s respectively for the stopped condition. It was felt that frequency analysis at both 7m/s and 8m/s would be beneficial as this is the approximate region where the blade pitching mechanism takes effect.

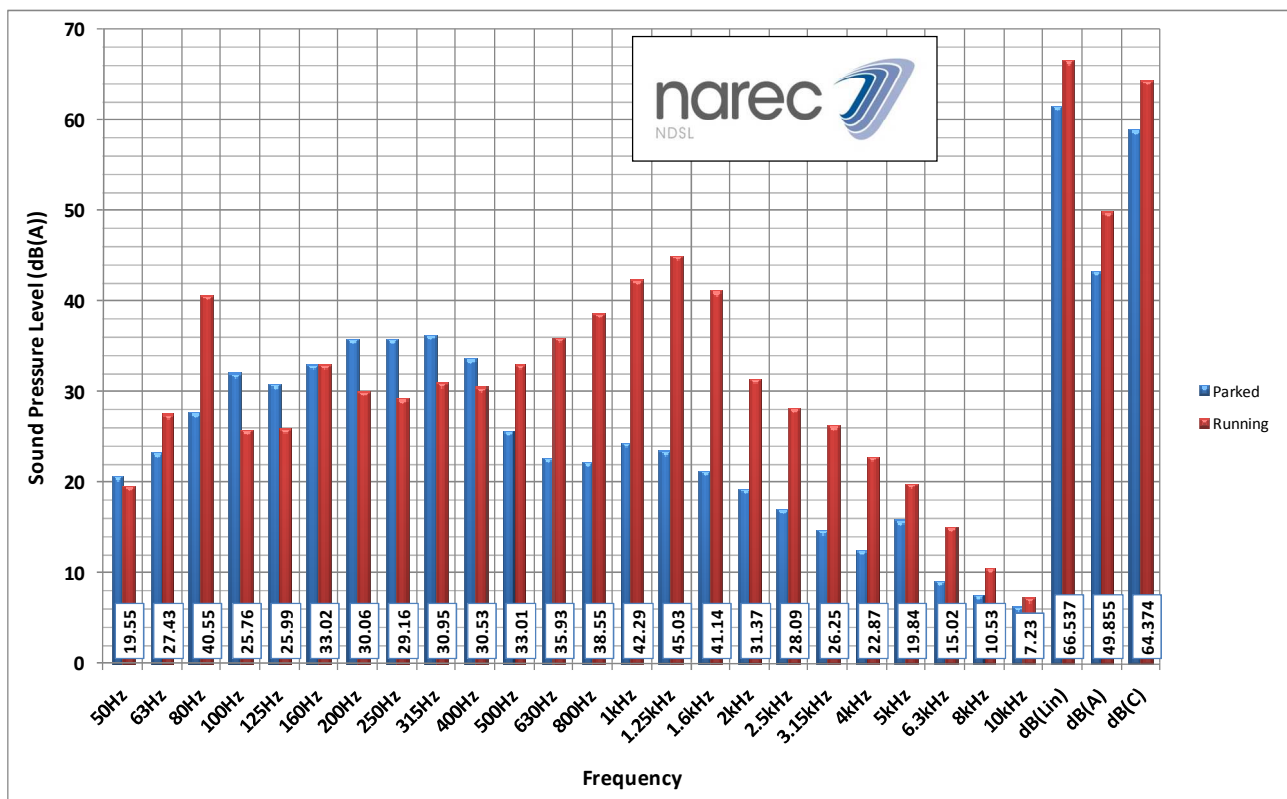


Figure 23 - Normalised 1/3rd Octave Frequency Spectrum at 4.3m/s

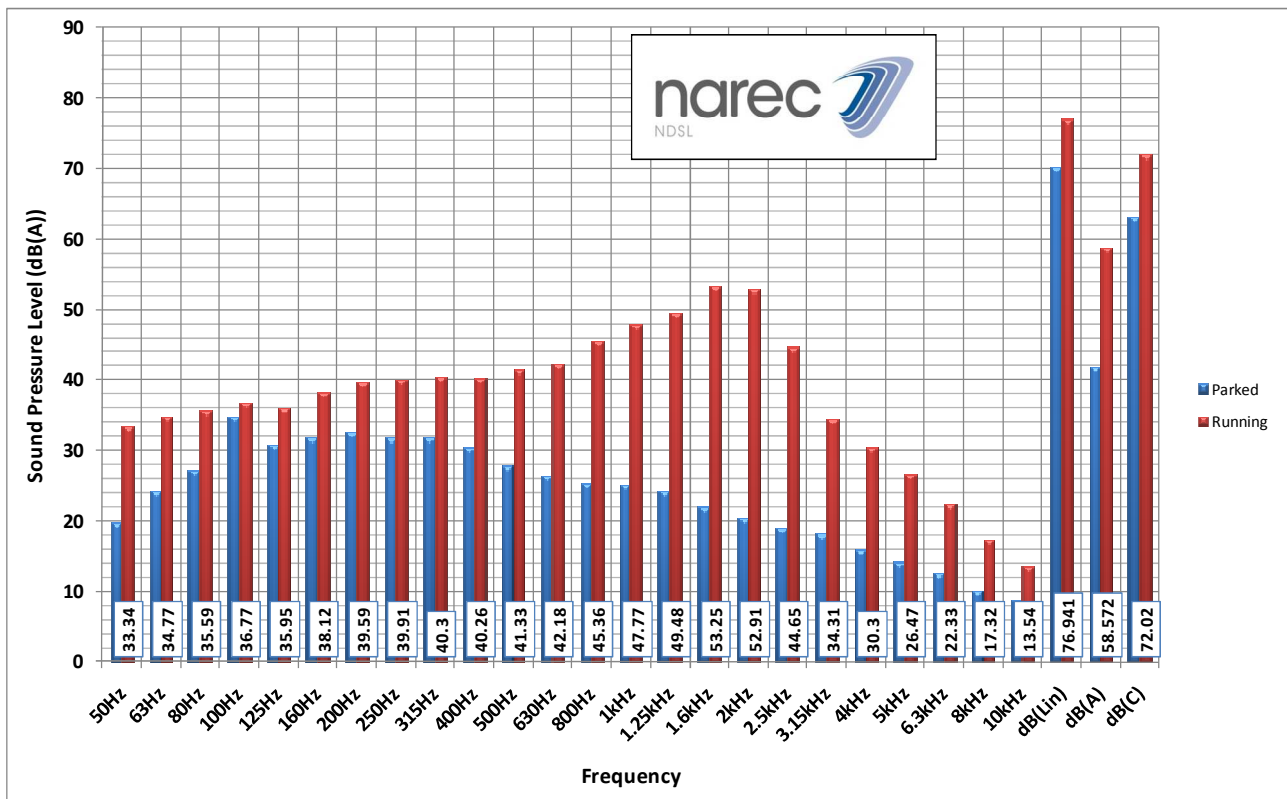


Figure 24 - Normalised 1/3rd Octave Frequency Spectrum at 7m/s

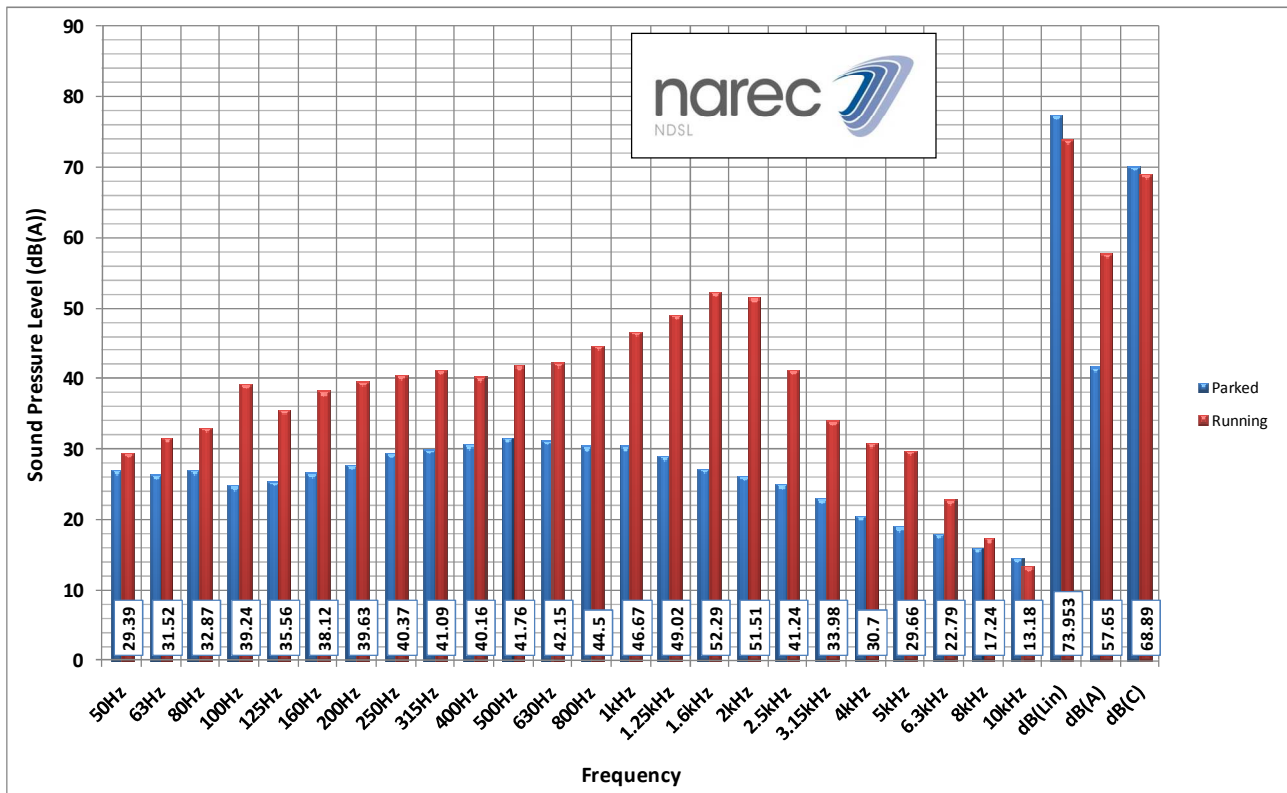


Figure 25 - Normalised 1/3rd Octave Frequency Spectrum at 8m/s

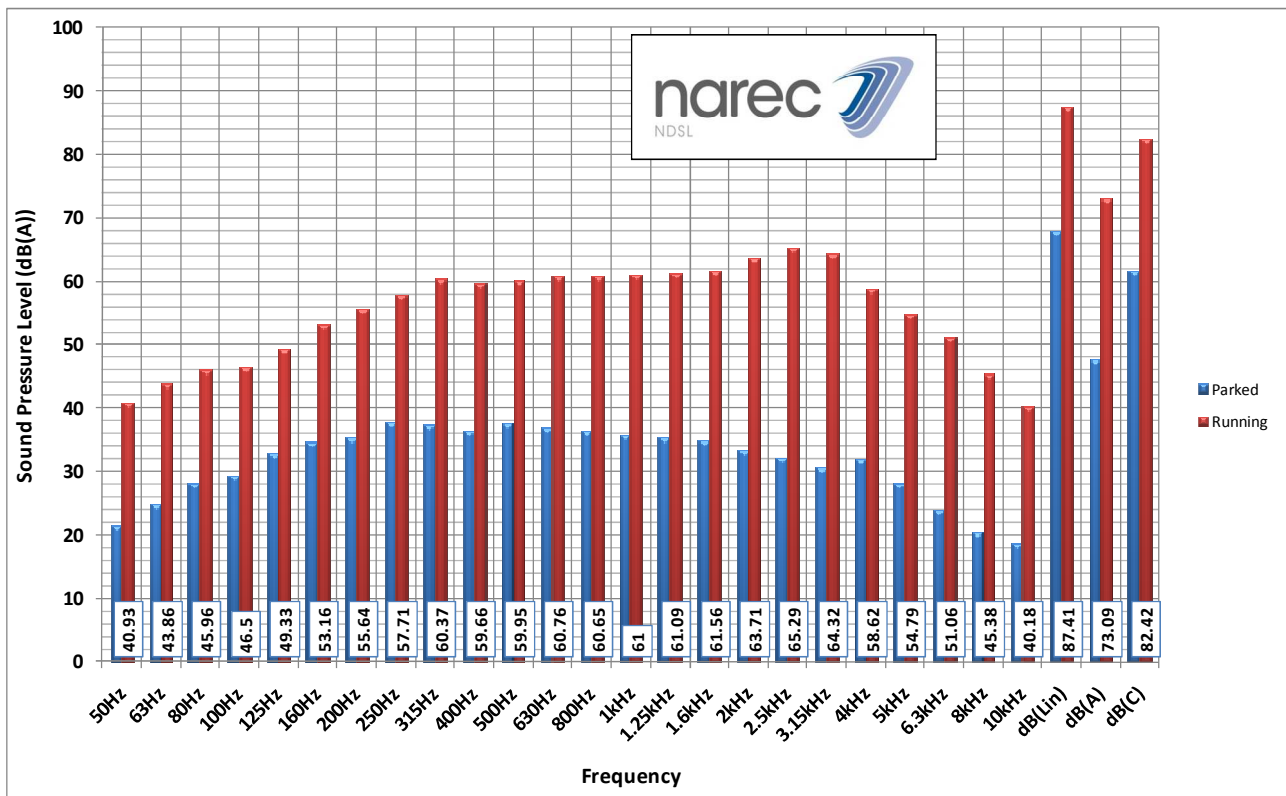


Figure 26 - Normalised 1/3rd Octave Frequency Spectrum at 12m/s

6.8.2 Tonality

A simple assessment of tonality was undertaken in accordance with section 3.4.15 of the BWEA standard, which declares the turbine as tonal if both adjacent 1/3 octave bands is higher than the following limits at any wind speed range;

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

As can be seen in Figure 23, Figure 24, Figure 25, and Figure 26 above, there are occasions where the frequency in one adjacent band is higher than the acceptable limit, but as this doesn't occur on both adjacent bands, the turbine can be declared as not tonal.

7 Conclusions

From the foregoing test results, the following conclusions can be drawn on the Evoco 10;

1. The Declared Apparent Emission Sound Power value $L_{Wd,8m/s}$ is 96.4dB(A)
2. The BWEA Reference Sound Level at 25m $L_{P,25m}$ is 60.5dB(A)
3. The BWEA Reference Sound Level at 60m $L_{P,60m}$ is 52.9dB(A)
4. The turbine is not tonal.
5. The noise level has generated the noise map shown in Figure 22.

The results contained within this report are valid for the model of turbine detailed in Table 2 and no other. Any changes to the design should be reported to the certification body and/or test laboratory so that any potential retesting work can be assessed.

8 Test Equipment

8.1 Instruments Used During Testing

The devices used to perform the measurements during the acoustic testing of the Evoco 10 wind turbine are listed in Table 7 below;

Table 7 - Test Device List

Data Acquisition Unit	
Make/Model :	Second Wind Nomad 2
Serial Number :	08431
Location :	Met mast at approx 1.5m above ground level
Calibration :	Performed by Narec 3/9/10 Due 2/9/11
Anemometers	
Make/Model :	Vector Instruments A100LK
Met Tower Location :	Mast Top (Primary) and 1.5m below mast top (Control)
Serial Numbers :	Primary - Body :8110, Cup : E32A DKD Cal No 10/0168 Control - Body :8109, Cup : E31A DKD Cal No 10/0167
Calibration Due :	11/01/2011 (Both devices)
Wind Vane	
Make/Model :	Vector Instruments W200P
Met Tower Location :	1.5m below mast top
Serial Number :	
Calibration Due :	N/A
Sound Level Meter	
Make/Model-:	Brueel & Kjaer - 2250
Serial Number-:	2626169
Last Calibration-:	5 th November 2009
Calibration Due-:	4 th November 2011

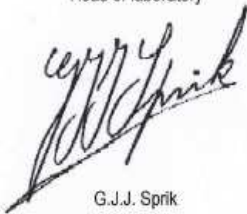
Sound Level Calibrator	
Make/Model:-	Brue! & Kjaer – 4231
Serial Number:-	2623808
Last Calibration:-	5 th November 2009
Calibration Due:-	4 th November 2010

9 Calibration Certificates

The following pages contain scanned copies of the calibration certificates for the equipment used during the course of the acoustic tests.

9.1 Fluke 725 Process Calibrator

The Fluke 725 process calibrator was used to check the calibration of all configured channels of the Nomad 2 data logger. Results of the logger calibration can be found in section 9.2.

CalNet®		Report of Calibration		FLUKE®	
No.: 653043					
We confirm that, the below instrument meets or exceeds the manufacturers published specifications at the points tested. All measurements are traceable to national and/or international standards or have been derived by approved ratio techniques. This certificate may not be reproduced other than in full. Calibration certificates without signature and seal are not valid.					
Model	FLUKE-725EX				
Object	INTRINSICALLY SAFE CALIBRATOR				
Manufacturer	FLUKE				
Serial number	9801081R				
Inventory number	-				
Customer	EXPRESS INSTRUMENT HIRE TARLETON				
Site number	2382079				
Number of pages	5				
Date of calibration	26 May 10				
Date of recalibration	26 May 11				
Tested by	R.J. Kaszubiak				
Seal	Head of laboratory				
					
G.J.J. Sprik					
Fluke Nederland B.V. is certified by Kema for ISO 9001:2000 Fluke Nederland B.V. / Science Park Eindhoven 5108 / 5692 EC Son Tel: +31 (0)40 2675308 Fax: +31 (0)40 2675321					

9.2 Nomad 2 Calibration Certificate

The following certificate documents the results of the calibration check performed by Narec on the Nomad 2 data logger, serial number 08431. Note that the relevant channels in respect of noise versus wind speed testing are C1 for wind speed, and A6 for the noise input.

Calibration Results - Data Logger Serial Number 08431											
		100%		75%		50%		25%		0%	
Channel											
A1	Reading	2.500V	360.0°	1.875V	270°	1.249V	180°	0.625V	90°	0.001V	0°
	Calibrator Signal	2.500V		1.875V		1.250V		0.625V		0.000V	
C1	Reading	976	50.1	732	37.6	488	25.1	244	12.6	1	0.2
	Calibrator Signal	976	50.09	732	37.60	488	25.10	244	12.61	1	0.17
A2	Reading	2.500V	-100.0°C	1.875V	1.7°C	1.249V	25.0°C	0.625V	52.0°C	0.000V	227.7°C
	Calibrator Signal	2.500V		1.875V		1.250V		0.625V		0.000V	
C2	Reading	986	50.1	739.5	37.6	493	25.1	247	12.7	1	0.2
	Calibrator Signal	986	50.07	740	37.62	493	25.12	247	12.67	1	0.22
A3	Reading	1089.76	4.998V	964.75	3.748V	839.75	2.499V	715.12	1.251V	590.12	0.001V
	Calibrator Signal	1090.00	5.00V	965.00	3.75V	840.00	2.50V	715.00	1.25V	590.00	0.00V
C3	Reading	Not Configured									
	Calibrator Signal										
A4	Reading	12.0kW	5.000V	8.7kW	3.748V	5.5kW	2.500V	2.2kW	1.250V	-1.0kW	0.000V
	Calibrator Signal	12.000kW	5.00V	8.750kW	3.75V	5.500kW	2.50V	2.250kW	1.25V	-1.000kW	0.00V
C4	Reading	Not Configured									
	Calibrator Signal										
A5	Reading	299.945V	4.997V	224.912V	3.749V	149.874V	2.499V	74.84V	1.249V	0.027V	0.000V
	Calibrator Signal	300.00V	5.00V	225.00V	3.75V	150.00V	2.50V	75.00V	1.25V	0.00V	0.00V
C5	Reading	Not Configured									
	Calibrator Signal										
A6	Reading	249.84	4.994V	187.30	3.749V	125.05	2.499V	62.53	1.249V	0.07	0.000V
	Calibrator Signal	250.00	5.00V	187.50	3.75V	125.00	2.50V	62.50	1.25V	0.00	0.00V
C6	Reading	Not Configured									
	Calibrator Signal										
A7	Reading	Not Configured									
	Calibrator Signal										
C7	Reading	Not Configured									
	Calibrator Signal										
A8	Reading	Not Configured									
	Calibrator Signal										
C8	Reading	Not Configured									
	Calibrator Signal										

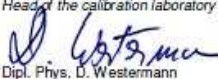
Date of Calibration :-	3rd Sept. 2010
Engineer :-	D. Hinch



All signals applied using Fluke 725Ex process calibrator serial number 9801081R, certificate number 653043 (see separate calibration certificate)

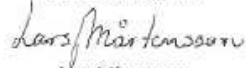
9.3 Primary Anemometer Calibration Certificate

The following sheet is the calibration certificate of the primary anemometer used for all wind speed testing of this turbine. Note that it was also continually monitored for calibration deviance using the method of in situ calibration described in Annex K of BS EN 61400-12-1.

DEUTSCHER KALIBRIERDIENST DKD		
Kalibrierlaboratorium / Calibration laboratory Akkreditiert durch die / accredited by the Akkreditierungsstelle des Deutschen Kalibrierdienstes		
	Deutsche WindGuard Wind Tunnel Services GmbH Varel	 DKD-K- 36801
Kalibrierschein Calibration Certificate		Kalibrierzeichen Calibration label
		10/0168 DKD-K-36801 01/2010
Gegenstand Object	A 100 LK	Dieser Kalibrierschein dokumentiert die Rückführung auf nationale Normale zur Darstellung der Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI). Der DKD ist Unterzeichner der multi-lateralen Übereinkommen der European co-operation for Accreditation (EA) und der International Laboratory Accreditation Cooperation (ILAC) zur gegenseitigen Anerkennung der Kalibrierscheine. Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich. <i>This calibration certificate documents the traceability to national standards, which realize the units of measurement according to the International System of Units (SI). The DKD is signatory to the multilateral agreements of the European co-operation for Accreditation (EA) and of the International Laboratory Accreditation Cooperation (ILAC) for the mutual recognition of calibration certificates.</i> <i>The user is obliged to have the object recalibrated at appropriate intervals.</i>
Hersteller Manufacturer	Windspeed LTD Denbighshire LL18 2AB	
Typ Type	A 100 LK	
Fabrikat/Serien-Nr. Serial number	Body: 8110 Cup: E32A	
Auftraggeber Customer	Western Windpower UK Gloucestershire GL53AP	
Auftragsnummer Order No.	VT10101	
Anzahl der Seiten des Kalibrierscheines Number of pages of the certificate	3	
Datum der Kalibrierung Date of calibration	11.01.2010	
Dieser Kalibrierschein darf nur vollständig und unverändert weiterverbreitet werden. Auszüge oder Änderungen bedürfen der Genehmigung sowohl der Akkreditierungsstelle des DKD als auch des ausstellenden Kalibrierlaboratoriums. Kalibrierscheine ohne Unterschrift und Stempel haben keine Gültigkeit. <i>This calibration certificate may not be reproduced other than in full except with the permission of both the Accreditation Body of the DKD and the issuing laboratory. Calibration certificates without signature and seal are not valid.</i>		
Stempel Seal	Datum Date	Leiter des Kalibrierlaboratoriums Head of the calibration laboratory
	11.01.2010	Bearbeiter Person in charge
		 Dipl. Phys. D. Westermann
		 Dipl. Ing. (FH) Catharina Herold
Deutsche WindGuard Wind Tunnel Services GmbH Oldenburger Str. 65 26316 Varel ; Tel. ++49 (0)4451 9515 0		
		

9.4 Brüel & Kjaer 2250 Calibration Certificate

The following certificate is for the Brüel & Kjaer 2250 sound meter used throughout each of the acoustic tests.

CERTIFICATE OF CALIBRATION		 UKAS CALIBRATION 0174 Page 1 of 11 Pages
Date of Issue:	05 November 2009	
Certificate Number:	C0909326	
Brüel & Kjaer S&V A/S		
Skodsborgvej 307, DK-2850 Nærum, Denmark Tel: +45 45 800 500 Fax: +45 45 801 405 Email: ukservice@bksv.com		 Approved Signatory  Lars Mårtensson
CALIBRATION OF:		
Sound Level Meter	2250	No: 2626169
Microphone:	4189	No: 2621164
Associated Calibrator:	Brüel & Kjaer 4231	No: 2623808
Calibrator Certificate	C0909325	Level: 94.06 dB SPL
Inventory ID:		
Date of receipt:	26 October 2009	
Date of calibration:	05 November 2009	
CUSTOMER:		
	NaREC Eddie Ferguson House Ridley Street NE24 3AG Blyth Northumberland United Kingdom	
Customer Ref.:	094043	
CALIBRATION CONDITIONS:		
Preconditioning:	12 hours at 23 °C	
Environment conditions:	Air temperature: 23.0 °C Air pressure: 99.4 kPa Relative Humidity: 51.0 %RH	
SPECIFICATIONS:		
The Sound Level Meter was calibrated according to the procedure given in BS7580: Part 1: 1997.		
PROCEDURE:		
The measurements have been performed with the assistance of Brüel & Kjaer Sound Level Meter Calibration System B&K 3630 with application software type 7763 and test collection 2250-4189.		
RESULTS:		
Unless otherwise stated herein, the reported uncertainty is based upon a standard uncertainty multiplied by a coverage factor $k = 2$, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements. The uncertainties refer to the measured values only with no account being taken of the ability of the device under test to maintain its calibration.		
This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to recognised national standards, and to units of measurement realised at the National Physical Laboratory or other recognised national standards laboratories. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.		

9.5 Brüel & Kjær 4231 Sound Level Calibrator

The following certificate is for the Brüel & Kjær 4231 sound level calibrator, which was used to calibrate the sound meter both before and after each test.

CERTIFICATE OF CALIBRATION		 0174 Page 1 of 2 pages Approved signatory  Henning Ploug
Date of issue: 05 November 2009	Certificate Number: C0909325	
Brüel & Kjær  The Calibration Laboratory Skodsborgvej 307, DK-2850 Nærum, Denmark E-Mail: ukservice@bksv.com		
Customer: NaREC Eddie Ferguson House Ridley Street NE24 3AG Blyth Northumberland United Kingdom	Manufacturer: Brüel & Kjær Description: Sound Level Calibrator Type: 4231 Serial No: 2623808	
Inventory ID: - Customer Ref: 094043	Date of receipt: 26 October 2009 Calibration Date: 05 November 2009	
The calibration was performed to laboratory procedure TW1-104-DK. Sound pressure level in the coupler of this calibrator was measured with a calibrated, laboratory grade condenser microphone specified in the certificate. In the case of 1/2 inch microphone, the 1/2 inch adaptor supplied with the calibrator was used. Choice of 1 or 1/2 inch microphone is specified in the customers order. Sound pressure level measured was compared with sound pressure level generated in the coupler of a working standard pistonphone calibrated by the National Physical Laboratory using the same microphone and at the same ambient conditions. Appropriate corrections for atmospheric pressure during calibration and for measurement system frequency and level response were taken into account. Sound pressure level results given in the certificate are the mean of 5 measurements. Calibration results apply at ambient conditions during the process of calibration, which are given in the certificate. The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor $k=2$, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.		
This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to recognised national standards, and to units of measurements realised at the National Physical Laboratory or other recognised national standards laboratories. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory. CLBK4231A09		

End Of Report