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Proven P35-2 Wind Turbine Noise Performance Test

Report HM: 2264/R1

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PROVEN P35-2 WIND TURBINE NOISE PERFORMANCE TEST

Report	HM: 2284/R1
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Site:	Little Laight, Cairnryan, Stranraer, Dumfries and Galloway, UK
Dates of Measurements:	29th July 2010 (Sylvia Broneske Dipl.-Ing. MIOA and Seth J Roberts BSc AMIOA) 29th August 2010 (Sylvia Broneske Dipl.-Ing. MIOA)
Prepared by:	Sylvia Broneske Dipl.-Ing. MIOA
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1. Introduction

1.1 A turbine noise performance test has been carried out on a Proven Energy P35-2 wind turbine at Little Laight which is located to the north of Cairnryan and approximately 6 miles north east of Stranraer, Dumfries and Galloway, United Kingdom.

1.2 The turbine has a hub height of 15 m and a downwind rotor with a diameter of 8.5 m. It is passive stall regulated and free yawing with self-regulating speed control. It has a rated power of 11.5 kW, which is achieved at a wind speed of 11m/s at hub height.

1.3 The objective of this test was to measure the noise performance characteristics of the wind turbine. The test consisted of measurements of the sound power level and tonal characteristics.

1.4 This noise test was conducted in accordance with the BWEA Small Wind Turbine Performance and Safety Standard (February 2008) which is based on BS EN 61400-11 (2003) with exceptions to allow for the specific operational characteristics of small wind turbines.

1.5 The test took place on two days: 29th July 2010 with wind speeds ranging from 4.8 to 9.3 m/s at rotor centre height and 29th August 2010 with wind speeds ranging from 8 to 17.7 m/s at rotor centre height.

2. Turbine Specification

2.1 The wind turbine is a three-bladed, passive stall downwind turbine. A summary of the turbine's specification, as supplied by the manufacturer, is shown in Table 1 below.

Table 1: Turbine Specifications

Parameter	**Value/Feature**
Manufacturer	Proven Energy Ltd.
Model Number	P35-2
Type (upwind/downwind)	Downwind
Hub Height	15 m
Rotor Diameter	8.5 m
Rated Power	11.5 kW (peak power 15 kW)
Tower Type	self-supporting monopole
Turbine Control (stall/pitch)	Passive stall

Parameter	**Value/Feature**
Rotational Speed	variable (rated speed 150 rpm at 11m/s)
Number of Blades	3
Cut-in Wind Speed	3.5 m/s
Cut-out Wind Speed	-
Max wind speed (survival)	54 m/s

3. Measurement

Site Layout and Measurement Position

3.1 The site layout is shown in Appendix A and consists of open farmland bordered by hedgerows and fences, with remains of brick and concrete from buildings. To the south of the turbine location are maintenance buildings which house the controls of the turbine and a holiday cottage, Little Laight, in a walled courtyard. The Proven P35-2 is the only wind turbine on the site. At the time of the first measurement in July 2010, cows were grazing on the field and sheep were kept on the adjacent field. The cows kept well away from the microphone so that no interference from the animals with the measurement equipment was caused. At the time of the first measurement in July 2010, cows were grazing on the adjacent fields.

3.2 The BWEA Small Wind Turbine Performance and Safety Standard dated February 2008 [1] states that acoustic noise emissions shall be measured in general accordance with BS EN 61400-11 (2003) [2] with exceptions to allow for the specific operational characteristics of small wind turbines. BS EN 61400-11:2003 including amendment A1:2006 (2006) is the latest version of [2]. The amendments have been applied if applicable.

3.3 [1] and [2] specify that the microphone used for the noise tests is to be mounted on a 1 m diameter ground-mounted board, facing in the direction of the wind turbine under test, at a distance corresponding to the tip height of the turbine (+/- 20%) directly downwind of the turbine. According to [1], measured noise data is valid as long as the board is substantially within the downwind sector (i.e. +/- 60° of the directly downwind direction) to allow for frequent yawing of small wind turbines. Photos of the noise monitoring equipment set up are shown in Appendix B.

3.4 The microphone was fitted inside a primary open cell foam wind shield of 90 mm in diameter which had been cut in half to allow it to lie flat on the board. The primary wind shield was surrounded by a secondary wind shield, consisting of a 465 mm diameter hemisphere of 43 mm thickness foam.

3.5 [1] requires an anemometer to measure wind speed, to be placed at a distance of 2 to 4 D, directly upwind of the turbine rotor, where D is the rotor diameter of the wind turbine (here D = 8.5 m). Wind speed values are valid as long as the anemometer position is within the upwind sector (i.e. +/- 90° of the directly upwind direction).

3.6 Synchronised wind speed and wind direction measurements were made using a mobile 10 m high mast.

3.7 The microphone and the met mast position were in its acceptable range throughout the whole measurement period.

3.8 Table 2 details the measurement positions. $R_{0,i}$ is the reference distance on each measurement day and R_1 is the slant distance from the measurement position to the centre of the hub where it meets the nacelle. The distances were measured using a measuring tape.

Table 2: Distances and Reference Values

Parameter		**Value**
Hub Height	H	15 m
Rotor Diameter	D	8.5 m
Reference Distance	$R_{0,calc}$	19.25 m
Reference Distance day 1	$R_{0,1}$	19.1 m
Reference Distance day 2	$R_{0,2}$	17.65 m
Slant Distance day 1	R_1	22.7 m
Slant Distance day 2	R_2	21.6 m
Reference Roughness Length	z_{0ref}	0.05 m
Anemometer Height	z	10 m
Reference Height	h_{ref}	15 m

3.9 During the noise tests the wind turbine was shut down for certain periods to allow for background noise measurements to be included as part of the test procedure in order to establish the level of contribution from other noise sources.

4. Instrumentation

4.1 Noise measurements were carried out using the following equipment:

General
Bruel & Kjær Type 4231 calibrator (Serial No. 2218188)

Reference Position
01dB-Metravib Blue Solo Data logging integrating sound Level meter (Serial No. 61375)
GRAS 1/2" Microphone model MCE 212 (S/N 92466)
01dB-Metravib Pre-Amplifier PRE 21 S (S/N 14578)

4.2 The microphone was connected via 5 m of microphone cable to the sound level meter, which was programmed to continuously record the equivalent continuous sound pressure levels (L_{Aeq}) and WAV audio recording of the overall and background noise. The time clock of the sound level meter was set to BST (local time) at the start of the measurements.

4.3 The equipment was calibrated prior to measurements being performed and checked at the end. The maximum calibration drift recorded for measurements was 0.1 dB on the 2nd measurement day.

4.4 Wind speed and wind direction were measured in 1 minute periods at 10 m height with a Second Wind C3 anemometer and a NRG #200P wind vane connected to a Nomad 2 GSM data logger which was set to GMT at the start of the measurements.

5. Calculation of Wind Speed

5.1 According to [1] the wind speed shall be measured and not derived from a turbine power curve. Minimum measurement height is 5 m.

5.2 Wind speed was measured at 10 m height. The reference height for small wind turbines is the rotor centre height. The reference height wind speed was calculated by using following equation:

$$v_{ref} = v_{10m} \cdot \frac{\ln \frac{h_{ref}}{z_0}}{\ln \frac{10\,\mathrm{m}}{z_0}}$$

where:

v_{ref}	is the wind speed at reference height (here at 15 m)
v_{10m}	is the wind speed at 10 m height
h_{ref}	is the reference height = hub height
z_0	roughness length (0.05 m for farmland with some vegetation)

6. Results

Measured Noise Levels

6.1 1-minute average measured L_{Aeq} noise data was plotted against the reference height wind speed for operational noise periods and separately for background noise periods. All noise data has been filtered such that any 1-minute period that was affected by specific extraneous noises such as aircraft, vehicles, and any other anomalies has been removed from the assessment.

6.2 Appendix C shows the measured total noise and measured background noise at the microphone position, plotted against the wind speed at rotor centre height for both days. After the removal of data as described above, the data base of the first survey consists of 252 and for the second survey of 315 wind speed – noise data pairs for total measured noise.

6.3 It was found that a 2nd and 3rd order regression curve provided a better fit than a linear regression line which is specified in [1]. The curves were plotted through the measured L_{Aeq} of the total noise for each day and through the measured background data at the reference position, as shown in Appendix C.

6.4 A further plot has been produced which shows a 2nd order regression curve through the sound power level of both days combined and, in line with [1], two separate linear regressions of which one spans the range from 5 to 10 m/s and the other the range from 11 to 17 m/s at reference height. The first one is used for the calculation of the Apparent Emission Sound Power Level as required in [1].

6.5 The equation obtained for the regression curve of the data of both measurement days was used to determine the turbine and background noise levels at each integer wind speed. The margin between measured total noise and background noise was sufficiently large (minimum of 16.4 dB) so that no background noise correction needed to be applied.

Calculation of Sound Power Level

6.6 The methodology prescribed by [2] was used to calculate the apparent sound power level of the turbine under test with the exception of using a 2nd and 3rd order regression instead of 4th order which provided the same fit. Summary tables detailing the steps are shown below in Table 3-5.

Table 3: Calculation of Sound Power Level for 29th July 2010 (R_1= 22.7 m)

Reference height wind speed (m/s)	4	5	6	7	8	9	10
Total Noise Level (dB L_{Aeq} re 20 µPa)		54.7	55.6	56.8	58.1	59.7	
Background Noise Level (dB L_{Aeq} re 20 µPa)		34.4	36.6	38.8	41.1	43.3	
Difference Between Total and Background Noise (dB)		20.3	19.0	18.0	17.1	16.4	
Apparent Sound Power Level, $L_{WA,k}$ (dB L_{WA} re 1 pW)		**86.7**	**87.7**	**88.8**	**90.2**	**91.7**	

Table 4: Calculation of Sound Power Level for 29th August 2010 (R_2= 21.6 m)

Reference height wind speed (m/s)	8	9	10	11	12	13	14	15	16	17
Total Noise Level (dB L_{Aeq} re 20 µPa)	62.7	65.2	67.2	68.9	70.2	71.2	72.0	72.7	73.3	73.8
Background Noise Level (dB L_{Aeq} re 20 µPa)	38.2	39.8	41.4	43.0	44.5	46.1	47.7	49.3	50.9	52.4
Difference Between Total and Background Noise (dB)	24.4	25.4	25.9	25.9	25.7	25.1	24.3	23.4	22.4	21.4
Apparent Sound Power Level, $L_{WA,k}$ (dB L_{WA} re 1 pW)	**94.3**	**96.9**	**98.9**	**100.6**	**101.9**	**102.9**	**103.7**	**104.4**	**104.9**	**105.4**

6.7 Each 1-minute average sound power level was calculated from the measured total noise with the respective slant distance for each measurement day taken into account, and plotted against the wind speed at rotor centre height. A 2nd order regression curve was used to derive the apparent sound power level for each wind speed bin as shown in Table 5.

Table 5: Apparent Sound Power Level for both measurement days from 2nd order regression

Reference height wind speed (m/s)	5	6	7	8	9	10	
Apparent Sound Power Level, $L_{WA,k}$ (dB L_{WA} re 1 pW)	82.7	86.3	89.6	92.6	95.2	97.6	
Reference height wind speed (m/s)	**11**	**12**	**13**	**14**	**15**	**16**	**17**
Apparent Sound Power Level, $L_{WA,k}$ (dB L_{WA} re 1 pW)	99.7	101.4	102.9	104.0	104.9	105.4	105.6

6.8 In line with [1] two separate linear regressions were also fitted to the data ranging from 5 to 10 m/s and 11 to 17 m/s at rotor centre height. The results are shown in Table 6 below. The declared Apparent Emission Sound Power Level for the reference height wind speed of 8 m/s $L_{Wd,8m/s}$ is calculated from this linear regression line.

Table 6: Apparent Sound Power Level for both measurement days according to BWEA standard

Reference height wind speed (m/s)	**5**	**6**	**7**	**8**	**9**	**10**	
Apparent Sound Power Level, $L_{WA,k}$ (dB L_{WA} re 1 pW)	84.0	86.7	89.4	92.0	94.7	97.4	
Reference height wind speed (m/s)	**11**	**12**	**13**	**14**	**15**	**16**	**17**
Apparent Sound Power Level, $L_{WA,k}$ (dB L_{WA} re 1 pW)	101.0	101.9	102.7	103.6	104.5	105.3	106.2

1/3 Octave Band Data

6.9 The four 1-minute average periods closest to the reference height wind speed of 8 m/s for the measurement on 27/07/2010 have been used to calculate the energy average 1/3 octave band spectra between 20 and 8 kHz as measured at the Reference Position for the first measurement day. The linear, A-weighted and C-weighted results are shown in Appendix D. As mentioned above, it was not necessary to correct the data for the influence of background noise.

6.10 As there were only 2 values close to the reference height wind speed of 8 m/s measured on the second measurement day, the energy average 1/3 octave band spectra between 20 and 8 kHz has been calculated for a reference height wind speed of 9 m/s. The linear, A-weighted and C-weighted results are also shown in Appendix D. No background correction was carried out.

Tonality

6.11 The tonality assessment was carried out according to the method specified in ISO 1996-2: 2007 Annex D [3], as suggested in [1].

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

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

6.13 For the assessment four 1/3 octave band spectra from the first measurement day and four 1/3 octave band spectra from the second measurement day, closest to the wind speed of 8 and 9 m/s respectively at rotor centre height, were used.

6.14 The tonal analysis was carried out for the linear, A-weighted and C-weighted 1/3 octave band spectra of the total noise measured at the microphone reference point as shown in Appendix E.

6.15 Based on the 4 spectra being closest to the reference height wind speeds of 8 and 9 m/s at rotor centre height from the measurement on 29/07/2010 and 29/08/2010 respectively, the Proven P35-2 wind turbine was not found to be tonal.

6.16 In addition, the same analysis has been carried out for the 4 spectra being closest to the reference wind speed for 5 m/s from the measurement on 29/07/2010. The turbine is also not found to be tonal for this wind speed.

6.17 This assessment is valid for the reference point, where the noise measurement took place and describes the noise character for the proximity of the wind turbine only.

7. Uncertainty

7.1 An assessment of measurement uncertainty has been carried out for the reference height wind speed range of 5 to 10 m/s , based on the procedure outlined in Annex D of [2], as follows: Type A uncertainties are evaluated from the extent to which the measured values vary around the derived mean based on the regression analysis; Type B uncertainties are a measure of the assumed accuracy of various factors in the measurements procedure and have been taken from the Annex D. The total uncertainty U_C is evaluated from the square root of the sum of the squares of each individual component.

7.2 The standard uncertainty of the apparent sound power is calculated in Table 7 using Equation D.1 in Annex D of [2]. The total uncertainty of the measured L_{WA} calculated from all uncertainties, as given in Table 8, is ± 2.4 dB for the Reference Position.

Table 7: Calculation of L_{WA} Uncertainty U_A

Number of Elements	308
sum((y-y(est))^2)	1014.5
Standard Error U_A	1.82

Table 8: Calculation of Uncertainty U_C

Type A Uncertainty	
Standard Error of L_{WA} Estimate from Regression Analysis	1.82
Type B Uncertainty	
Calibration	0.2
Instrument	0.2
Board & Mounting	0.5
Distance	0.1
Impedance	0.1
Turbulence	0.6
Wind Speed Derived	1.2
Direction	0.3
Total	**2.4**

8. Tables of Results

8.1 According to [1] the declared apparent emission sound power level $L_{Wd,\ 8m/s}$ is calculated using the approach of [4] for a 95% confidence level:

$$L_{Wd,8m/s} = L_{W,8m/s} + 1.645 \cdot \sigma$$

where

$L_{Wd,\ 8m/s}$ is the declared apparent sound power level at the reference wind speed 8 m/s

$L_{W,\ 8m/s}$ is the apparent sound power level at the reference wind speed 8 m/s

σ is here equivalent to the measurement uncertainty U_C.

Table 9: Noise Levels of a Proven P35-2 Wind Turbine for a reference wind speed of 8 m/s

Parameter	**Value**
Apparent Sound Power Level $L_{W,\ 8m/s}$	92.0 dB(A)
Measurement Uncertainty U_C	2.4 dB
Declared Apparent Emission Sound Power Level $L_{Wd,\ 8m/s}$	95.9 dB(A)
Noise Slope S_{dB}	2.68
Noise Penalty P	-

Table 10: Immission Sound Pressure Levels at given Distance for a reference wind speed of 8 m/s

Parameter	**Value**
Immission Sound Pressure Level at 60 m $L_{p,60m}$	52.3 dB(A)
Immission Sound Pressure Level at 25 m $L_{p,25m}$	59.9 dB(A)
Slant Distance required for 45 dB(A)	140 m
Slant Distance required for 40 dB(A)	248 m

8.2 The Noise Label according to [1] is attached in Appendix F.

9. Conclusions

9.1 A noise test has been carried out, according to BWEA Small Wind Turbine Performance and Safety Standard on a Proven P35-2 wind turbine installed at Little Laight, Cairnryan to measure the sound power level and tonal characteristics.

9.2 According to the BWEA standard for small wind turbines [1], the turbine was calculated to have an apparent sound power level of 92.0 dB(A) ± 2.4 dB at a wind speed of 8 m/s at rotor centre height, as measured at the Reference Position directly downwind of the turbine. The declared apparent emission sound power level for 8 m/s at rotor centre height was calculated to be 95.9 dB(A).

9.3 Using a 2nd order regression through all measured data, the apparent sound power level equals to 92.6 dB(A) ± 2.17 dB at a wind speed of 8 m/s at rotor centre height. The declared apparent emission sound power level for 8 m/s at rotor centre height in this case was calculated to be 96.2 dB(A).

9.4 The tonal output from the Proven P35-2 wind turbine has been assessed using the methodology prescribed in [1]. Based on the methodology described in [3], Annex D, no tonal characteristics were found.

Reference List

[1] Small Wind Turbine Performance and Safety Standard
British Wind Energy Association, February 2008

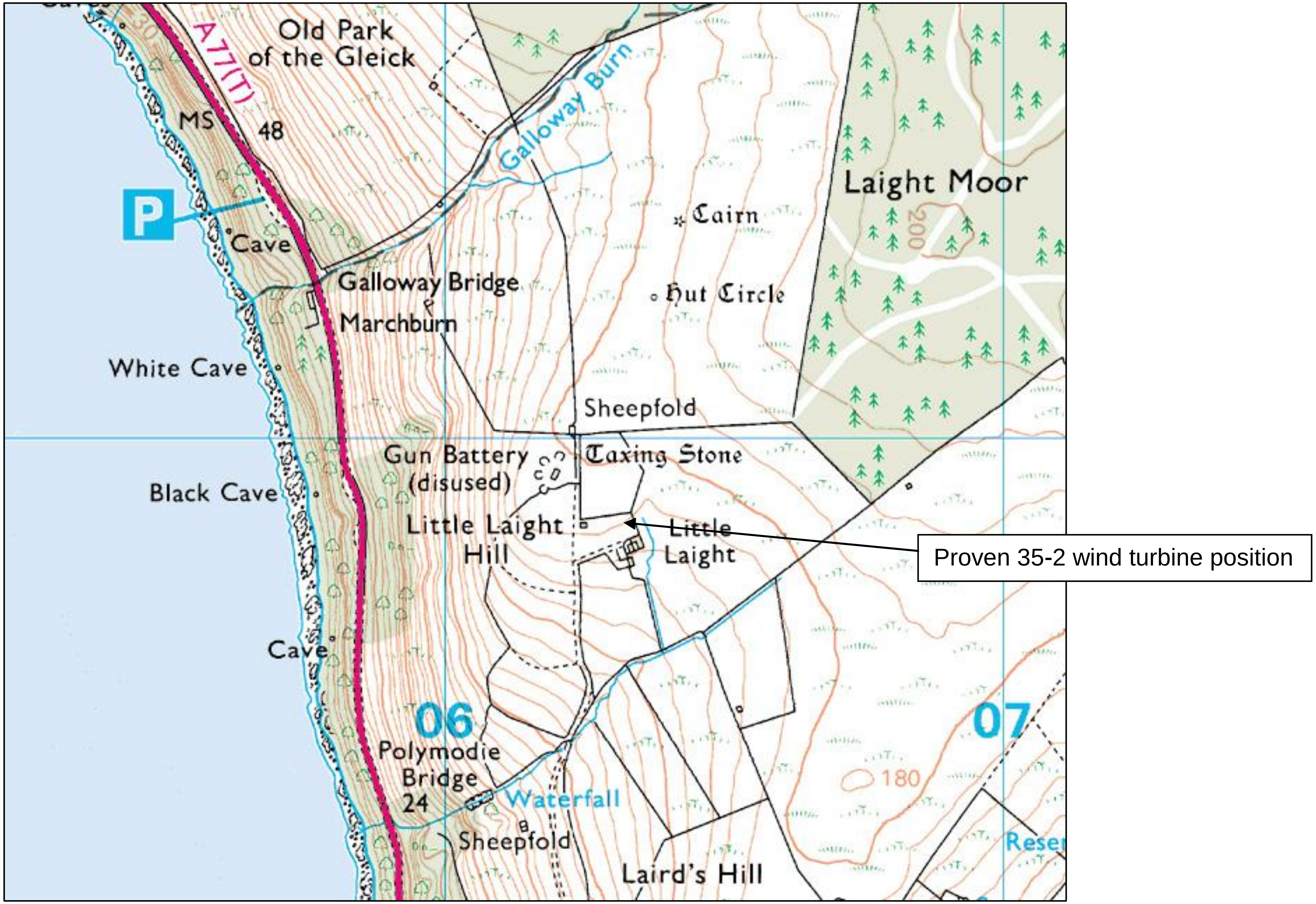
[2] BS EN 61400-11 Wind turbine generator systems – Part 11: Acoustic noise measurement techniques (identical with IEC 61400-11:2002)
Standards Policy and Strategy Committee, August 2003

BS EN 61400-11:2003 including Amendment A1:2006 Wind turbine generator systems – Part 11: Acoustic noise measurement techniques Incorporating Amendment no. 1 (identical with IEC 61400-11:2002 including amendment 1:2006)
Standards Policy and Strategy Committee, August 2006

[3] ISO 1996-2 Acoustics – Description, measurement and assessment of environmental noise, Part 2: Determination of environmental noise levels
International Organization for Standardization, 2007

[4] IEC TS 61400-14 Wind turbines – Part 14: Declaration of apparent sound power level and tonality values
International Electrotechnical Commission, 2005

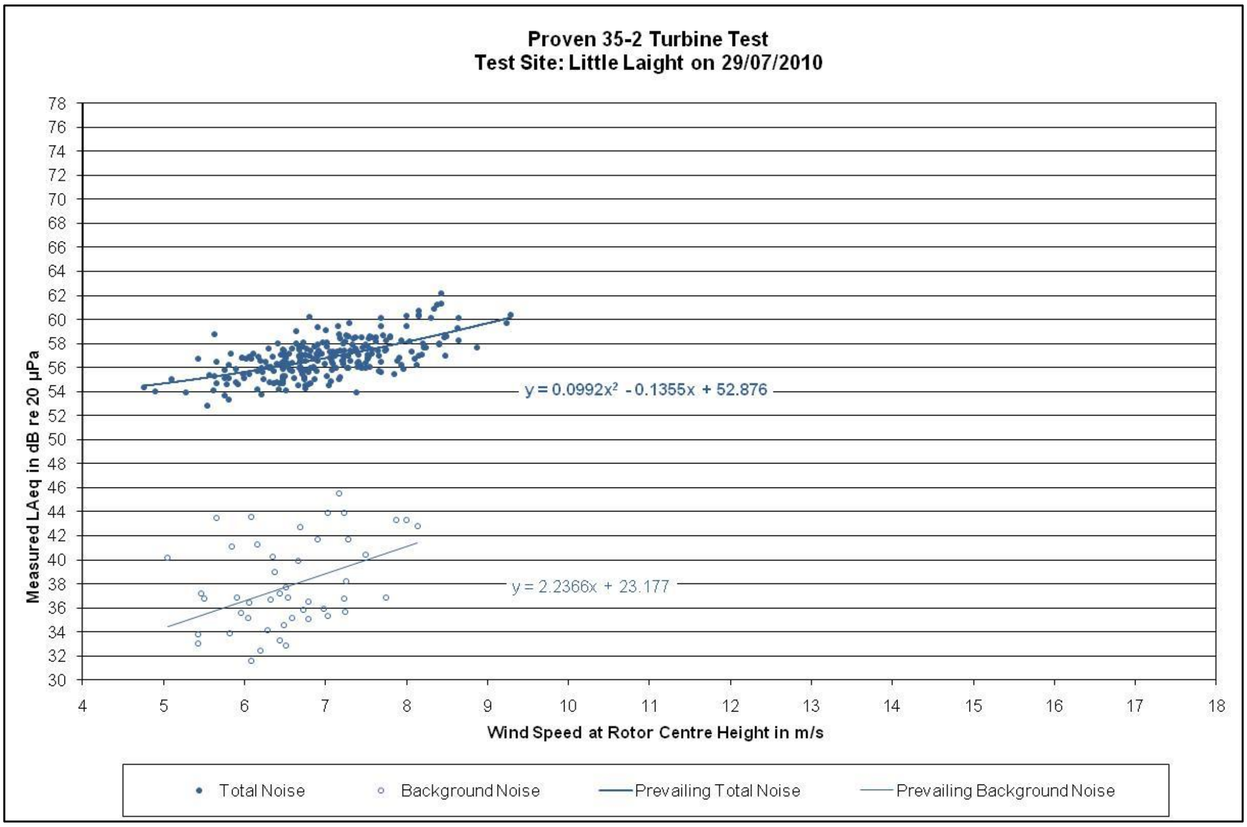
Appendix A
Site Layout

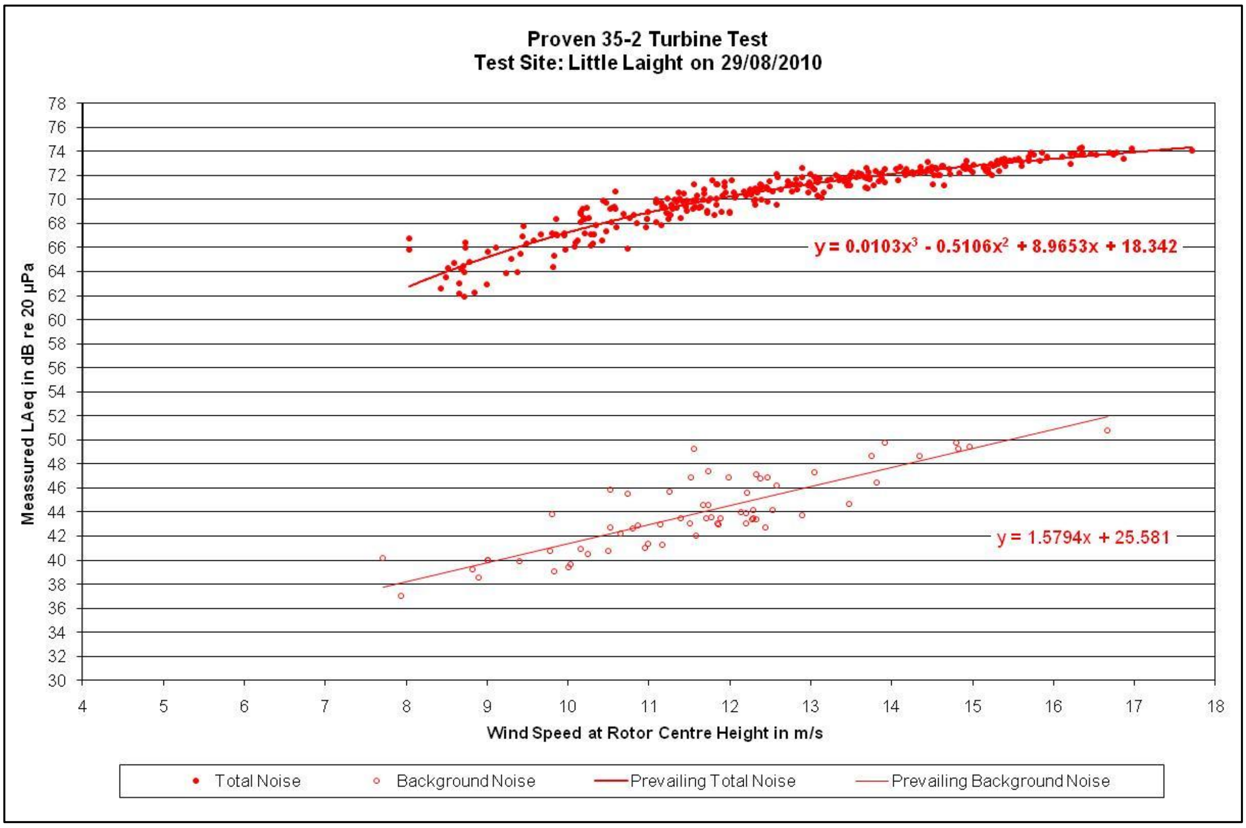

Old Park of the Gleick
A77(T)
MS
48
Galloway Burn
P
Cave
Galloway Bridge
Marchburn
Cairn
Hut Circle
Laight Moor
200
White Cave
Sheepfold
Taxing Stone
Gun Battery (disused)
Black Cave
Little Laight Hill
Little Laight
Proven 35-2 wind turbine position
Cave
06
07
Polymodie Bridge
24
Waterfall
180
Sheepfold
Laird's Hill

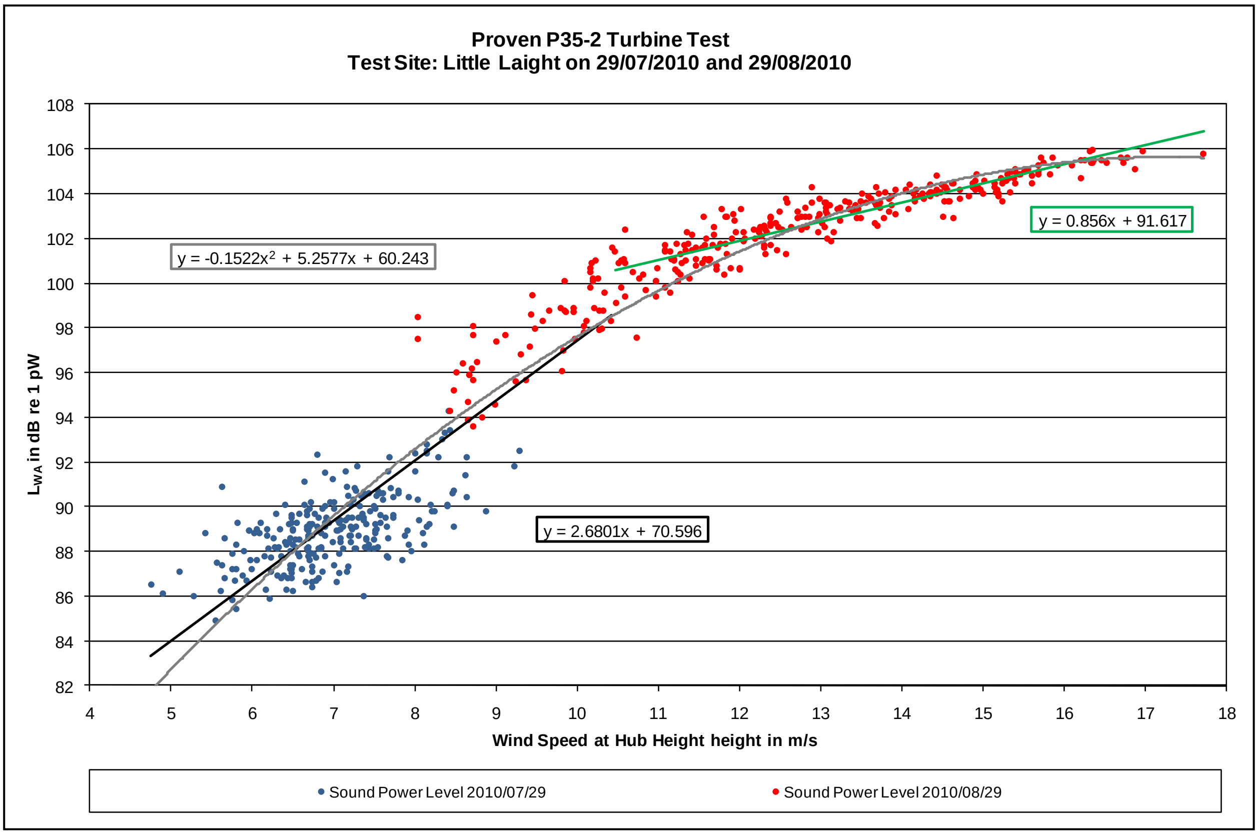
Appendix B
Photos of Noise Measurement Equipment

Photographs of Noise Measurement Equipment
(Proven 35-2 Wind Turbine on 29th July and 29th August 2010)

Appendix C
Noise Data for Calculation of Sound Power Level


Proven 35-2 Turbine Test
Test Site: Little Laight on 29/07/2010
Measured LAeq in dB re 20 µPa
Wind Speed at Rotor Centre Height in m/s
y = 0.0992x² - 0.1355x + 52.876
y = 2.2366x + 23.177
Total Noise
Background Noise
Prevailing Total Noise
Prevailing Background Noise


Proven 35-2 Turbine Test
Test Site: Little Laight on 29/08/2010
Measured LAeq in dB re 20 µPa
Wind Speed at Rotor Centre Height in m/s
y = 0.0103x³ - 0.5106x² + 8.9653x + 18.342
y = 1.5794x + 25.581
Total Noise
Background Noise
Prevailing Total Noise
Prevailing Background Noise

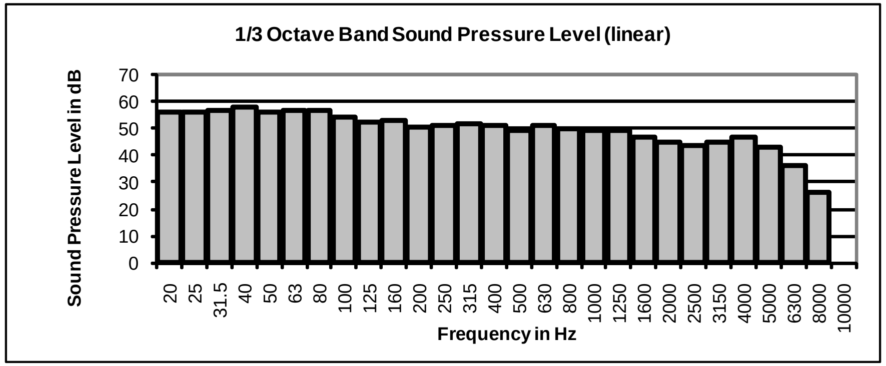

Proven P35-2 Turbine Test
Test Site: Little Laight on 29/07/2010 and 29/08/2010
L_{WA} in dB re 1 pW
Wind Speed at Hub Height height in m/s
y = -0.1522x² + 5.2577x + 60.243
y = 2.6801x + 70.596
y = 0.856x + 91.617
Sound Power Level 2010/07/29
Sound Power Level 2010/08/29
108
106
104
102
100
98
96
94
92
90
88
86
84
82
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

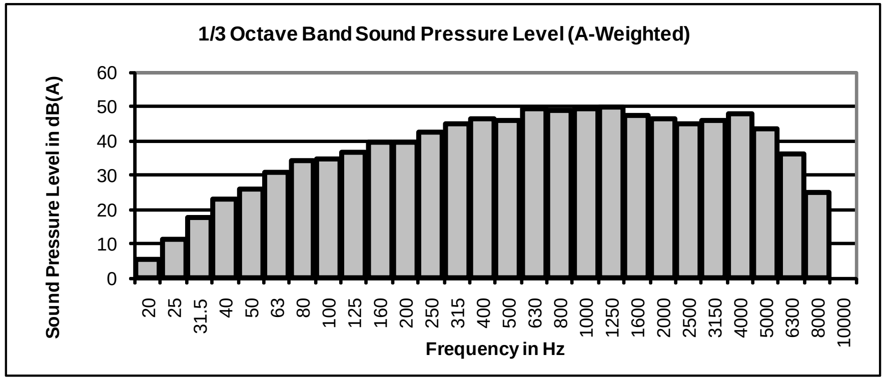
Appendix D
1/3 Octave Band Data

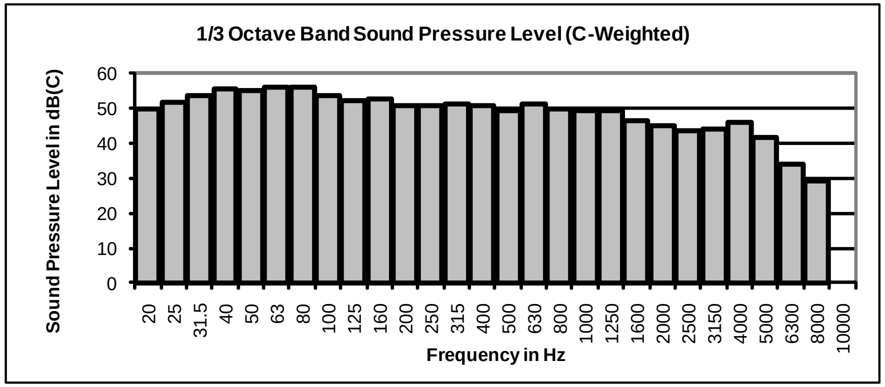
For Reference Wind Speed of 8 and 9 m/s
at Rotor Centre Height

1/3 Octave Band Levels - Sound Pressure Level for a wind speed of 8 m/s at rotor centre height (Measurement Date 29/07/2010)

f (Hz)	$L_{W,1/3\ Octave}$ (dB(lin))	$L_{W,1/3\ Octave}$ (dB(A))	$L_{W,1/3\ Octave}$ (dB(C))
20	54.2	6.8	3.7
25	54.4	12.1	9.7
31.5	55.1	18.7	15.7
40	55.8	24.7	21.2
50	54.7	26.9	24.5
63	55.4	31.1	29.2
80	54.9	35.3	32.4
100	52.3	35.9	33.2
125	51.1	36.8	35.0
160	51.4	40.3	38.0
200	49.0	40.6	38.1
250	49.2	43.4	40.6
315	49.5	46.5	42.9
400	48.9	48.0	44.1
500	47.2	48.1	44.0
630	48.9	51.1	47.0
800	47.5	50.8	46.7
1000	47.2	50.9	47.2
1250	47.4	51.2	48.0
1600	44.7	48.9	45.7
2000	43.2	47.8	44.4
2500	41.7	46.5	43.0
3150	43.0	47.0	44.2
4000	45.1	48.6	46.1
5000	41.3	45.1	41.8
6300	34.3	37.4	34.2
8000	24.9	25.3	23.8
10000			

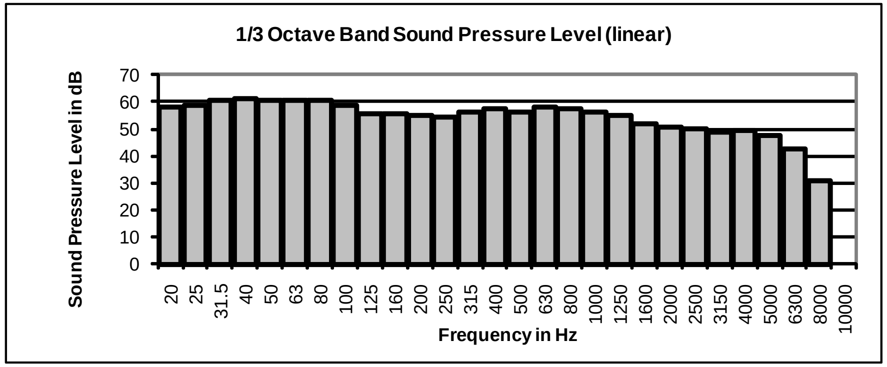


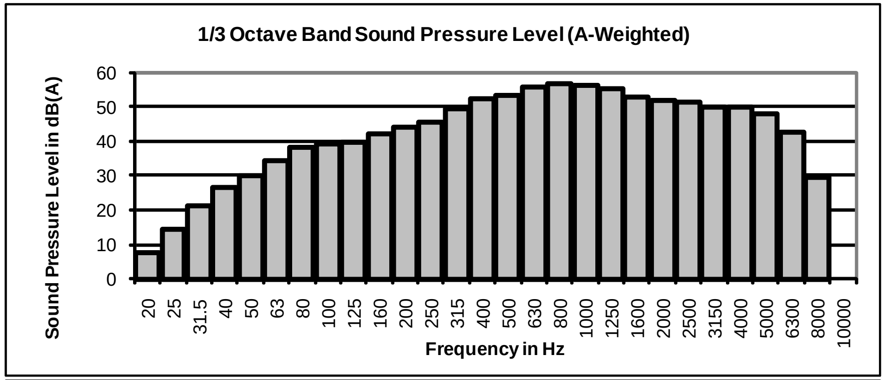


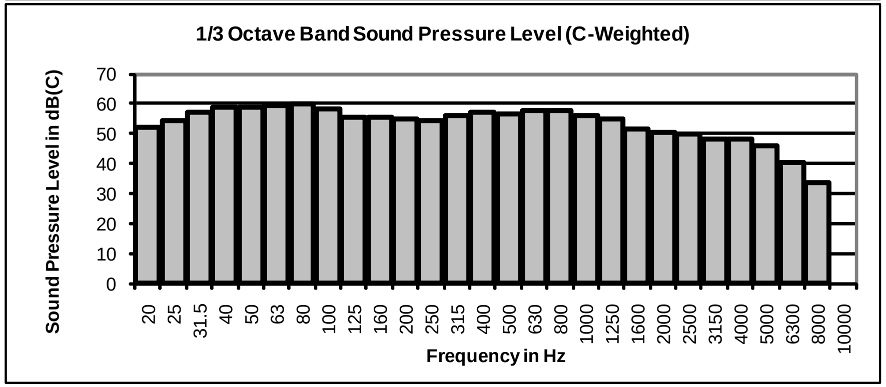


1/3 Octave Band Levels - Sound Pressure Level for a wind speed of 9 m/s at rotor centre height (Measurement Date 29/08/2010)

f (Hz)	$L_{W,1/3\ Octave}$ (dB(lin))	$L_{W,1/3\ Octave}$ (dB(A))	$L_{W,1/3\ Octave}$ (dB(C))
20	58.2	7.7	52.0
25	59.0	14.3	54.6
31.5	60.4	21.0	57.4
40	61.1	26.5	59.1
50	60.3	30.1	59.0
63	60.3	34.1	59.5
80	60.7	38.2	60.2
100	58.5	39.4	58.2
125	55.8	39.7	55.6
160	55.6	42.2	55.5
200	55.0	44.1	55.0
250	54.3	45.7	54.3
315	56.0	49.4	56.0
400	57.3	52.5	57.3
500	56.5	53.3	56.5
630	57.8	55.9	57.8
800	57.6	56.8	57.6
1000	56.3	56.3	56.3
1250	54.9	55.5	54.9
1600	51.8	52.8	51.7
2000	50.9	52.1	50.7
2500	50.0	51.3	49.7
3150	48.9	50.1	48.4
4000	49.1	50.1	48.3
5000	47.4	47.9	46.1
6300	42.5	42.4	40.5
8000	30.5	29.4	33.5
10000			







Appendix E
Spectra for Tonality Assessment

For Reference Wind Speed of 8 and 9 m/s
at Rotor Centre Height

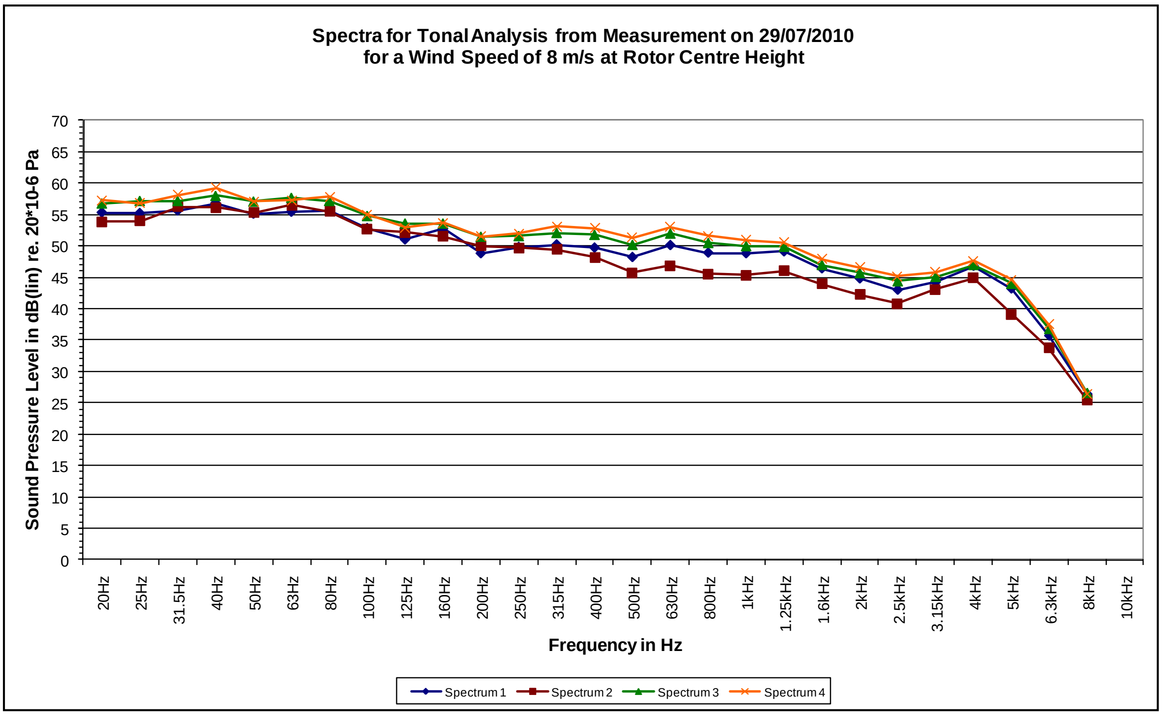


Figure 1: Linear 1/3 Octave Band Spectra for Total Measured Noise at Reference Point on 29/07/2010

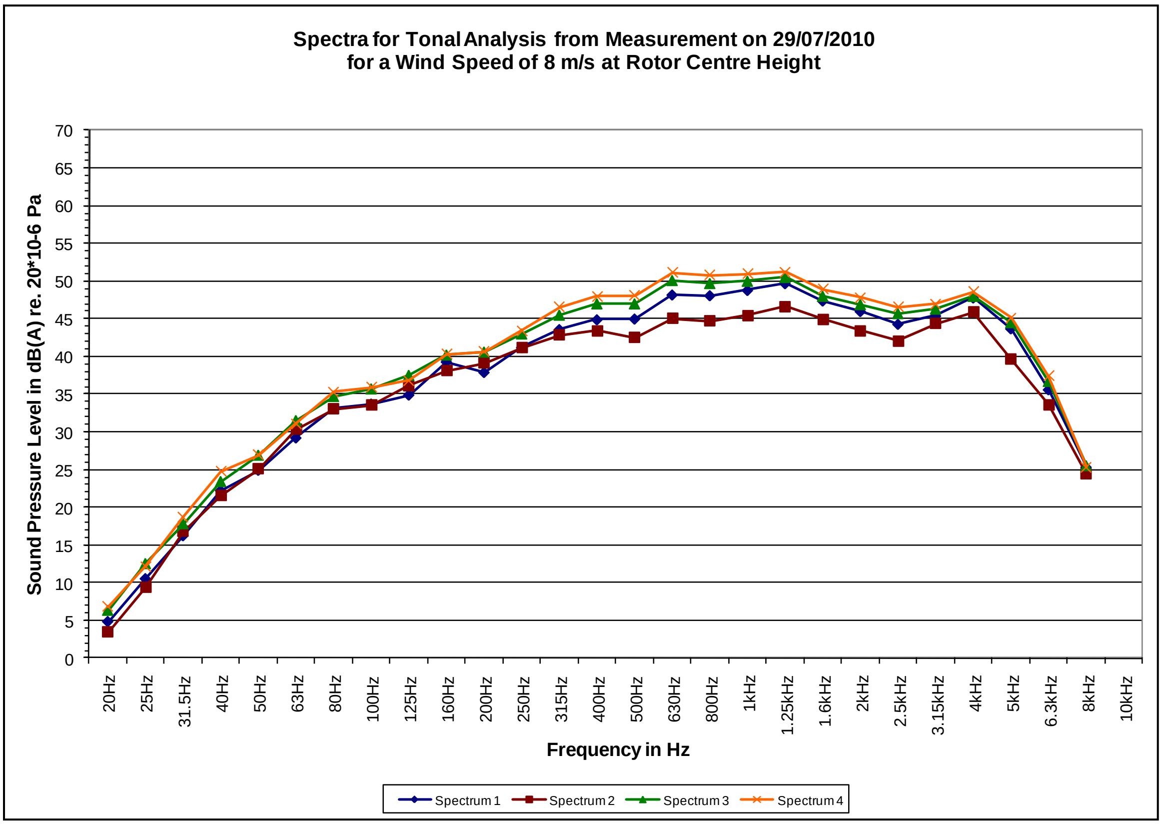


Figure 2: A-Weighted 1/3 Octave Band Spectra for Total Measured Noise at Reference Point on 29/07/2010

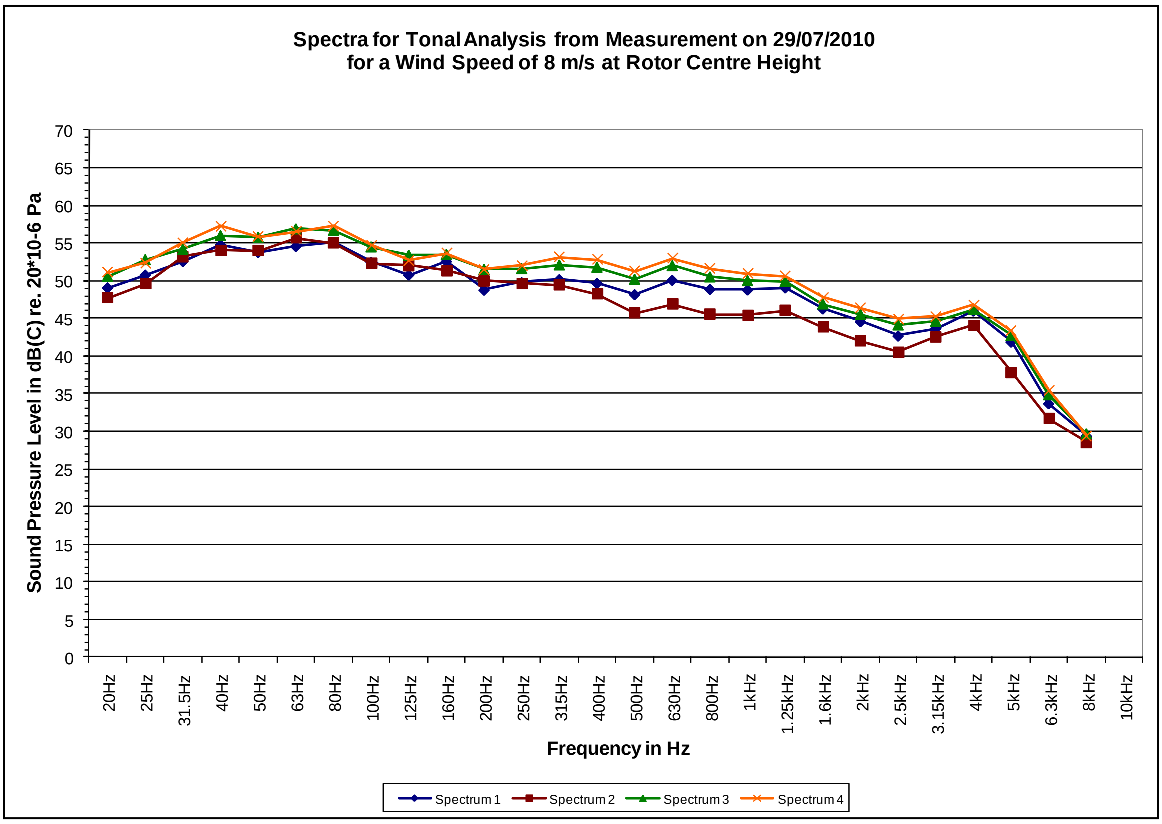


Figure 3: C-Weighted 1/3 Octave Band Spectra for Total Measured Noise at Reference Point on 29/07/2010

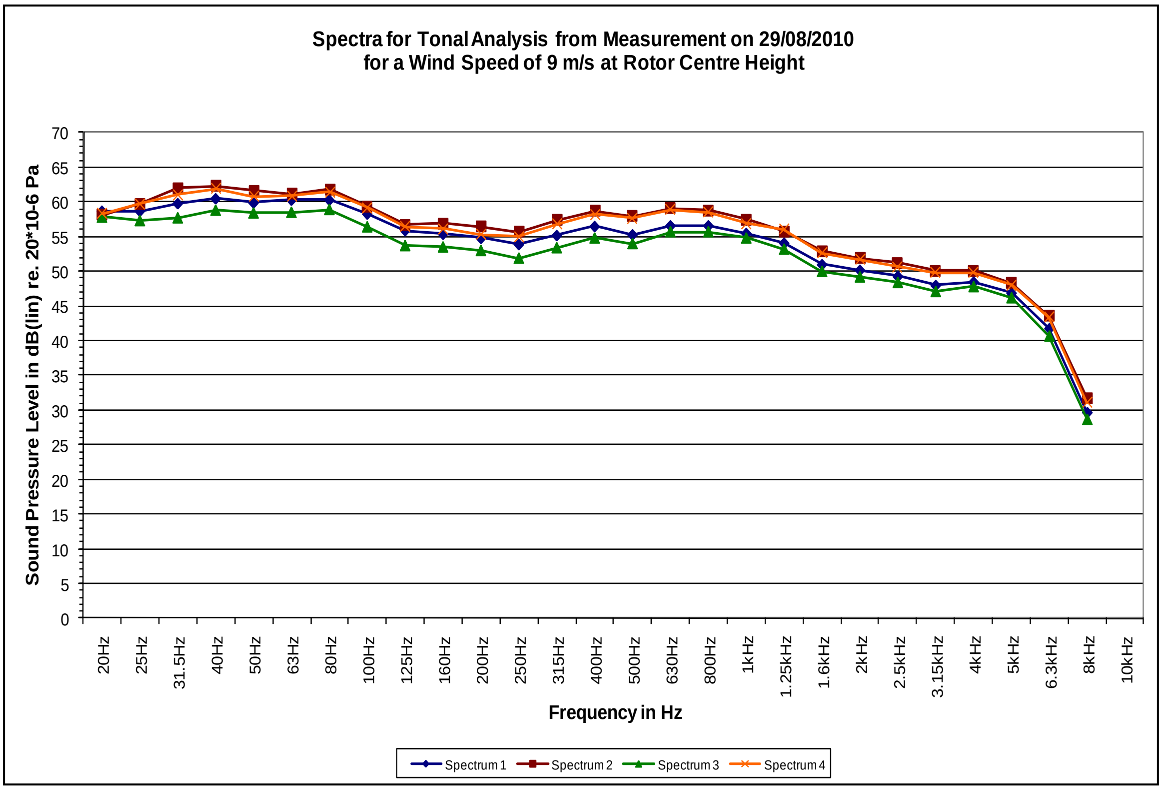


Figure 4: Linear 1/3 Octave Band Spectra for Total Measured Noise at Reference Point on 29/08/2010

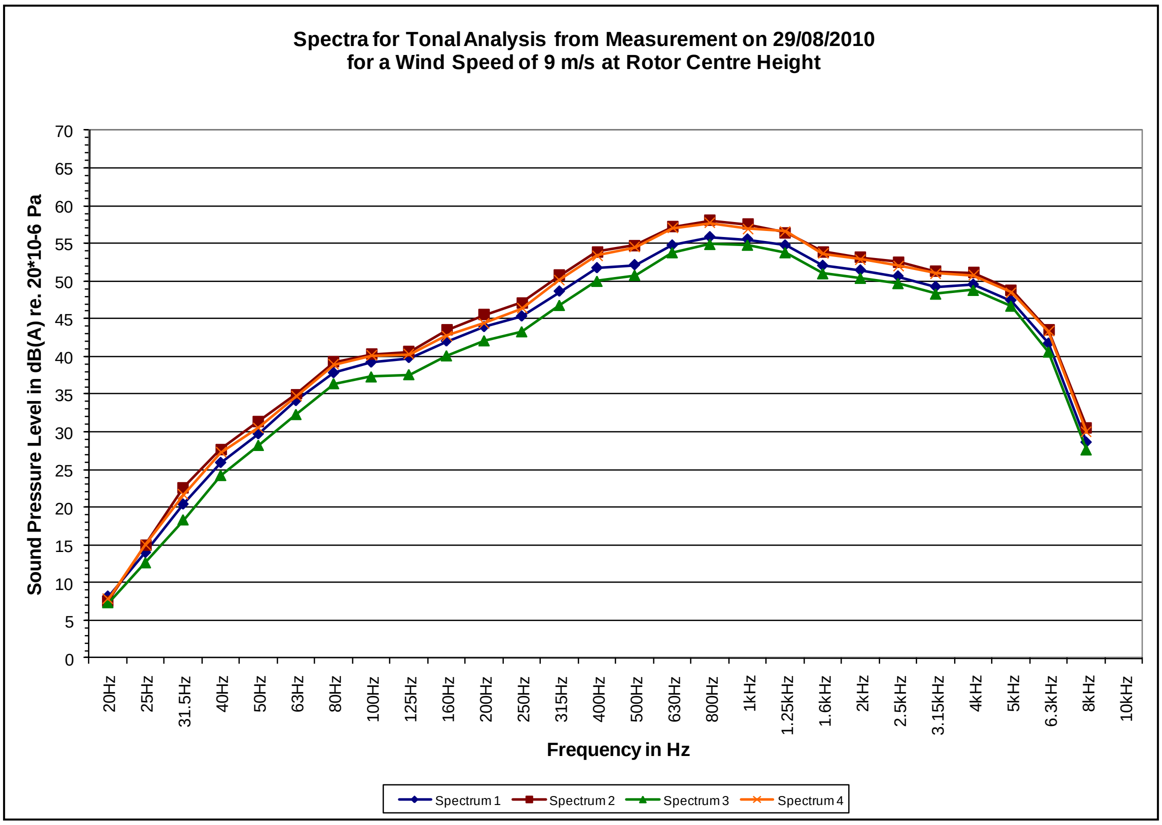


Figure 5: A-Weighted 1/3 Octave Band Spectra for Total Measured Noise at Reference Point on 29/08/2010

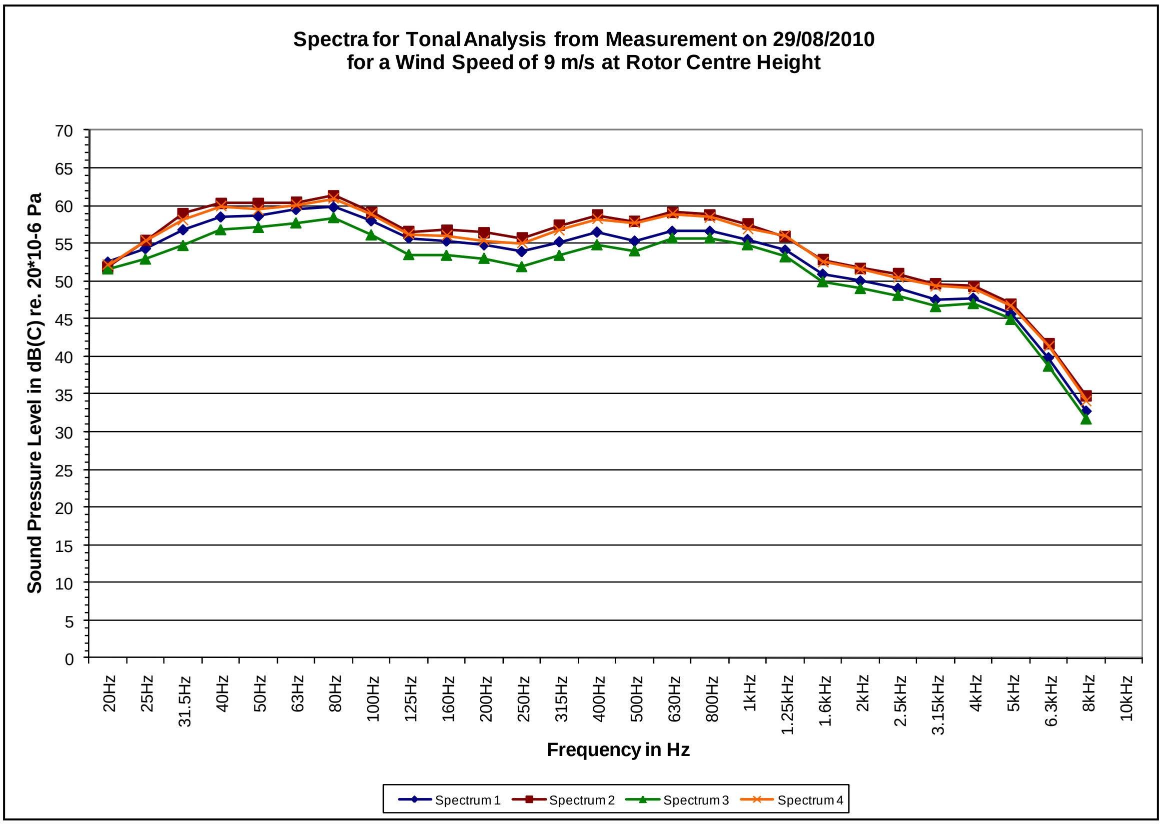
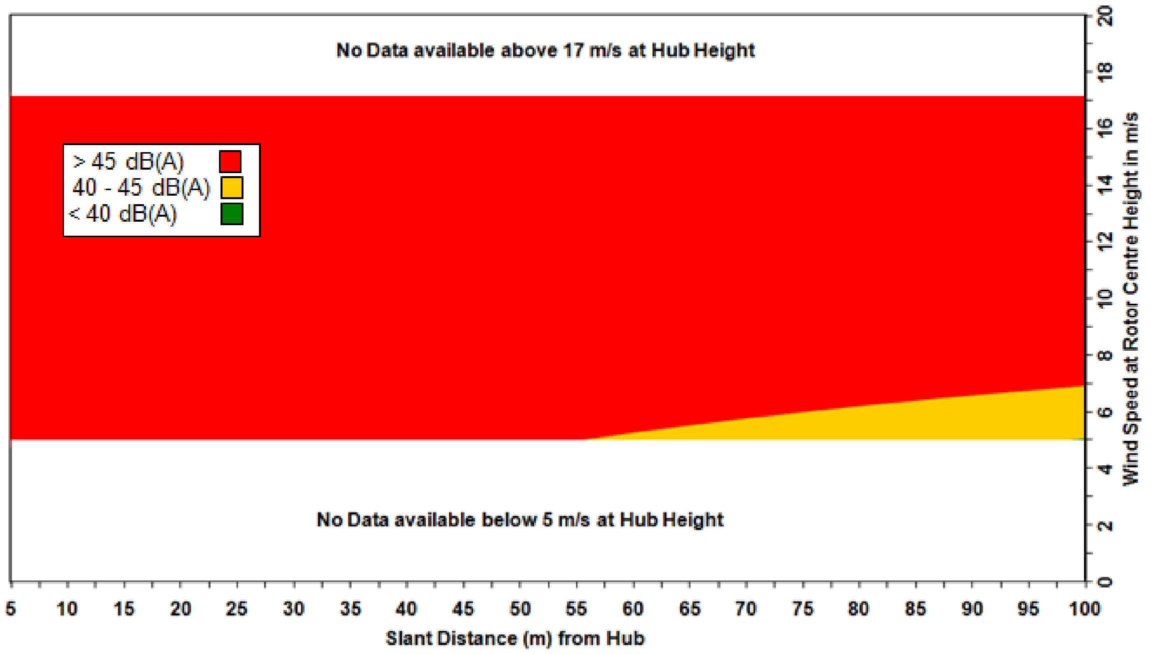


Figure 6: C-Weighted 1/3 Octave Band Spectra for Total Measured Noise at Reference Point on 29/08/2010

Appendix F
Noise Label

For Reference Wind Speed of 8 m/s
at Rotor Centre Height

Acoustic Noise Levels					
Turbine Make:	Proven Energy Ltd	**Model:**	P35-2		
NOISE EMISSION LEVEL					**NOISE PENALTY**
Sound Power $L_{Wd,8m/s}$	**95.9 dB(A)**	**Noise Slope, SdB (dB/m/s)**	**2.68**		**NO**



HM: 2284/R1
Turbine Test at Little Laight/Cairnryan

Tested and Issued by:
Hayes McKenzie Partnership Ltd.
September 2010