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CAIRNMORE WIND FARM AND EXTENSION

Impact on Cairndard and Other Properties

29th March 2011

The Haven, Low Causeway, Culross, Fife. KY12 8HN

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Impact on Cairndard and Other Properties

1 SUMMARY

1.1 Three existing Vestas V52 wind turbines have been operating on the site since mid-2010 and the current application is for a further 5 turbines of the same type.

1.2 It should be noted that the ES is wrong to say that Ms Robinson, the occupant at Cairndard, is financially involved in the project. Ms Robinson is currently disturbed by the existing turbines and is concerned that the additional turbines will make the position worse.

1.3 The noise section for the original application in 2008 was completely inadequate and under-estimated the noise level at Cairndard and other properties by more than 5dB. As a result it is highly probable that Condition 28 of the consent for the three turbines is currently breached.

1.4 The noise section of the current application is very confused and inaccurate. No information has been provided about the turbine noise levels nor about the parameters used in the calculations of noise levels at surrounding properties.

1.5 It seems that the applicant intends to rely on the ETSU simplified noise assessment restricting turbine noise levels to 35dB at all wind speeds up to 10m/s.

1.6 A proper calculation of the best estimate of wind turbine noise from the eight proposed turbine at Cairndard is 43dB, 8dB over the noise limit set by the applicant and 6dB above the estimated level in the ES.

2 INTRODUCTION AND GENERAL

2.1 This report is prepared for Joan M Robinson of Cairndard, Rhynie, AB54 4NA. Three existing Vestas V52 wind turbines have been operating since mid-2010 and the current application is for a further 5 turbines of the same type. It should be noted that the ES is wrong to say that Ms Robinson is financially involved in the project.

2.2 Cairndard is the nearest property to the existing turbines and will be the nearest to the proposed new turbines with the exception of the landowner property Stonedyke. Ms Robinson is currently disturbed by the existing turbines and is concerned that the additional turbines will make the position worse. I have made an assessment of the existing and proposed noise levels at Cairndard and other surrounding properties.

2.3 I have set out my qualifications and experience in Appendix 2 of this report.

3 EXISTING TURBINES - PREVIOUS APPLICATION APP/2008/1486

3.1 The original application in 2008 was for four turbines and this was later amended to three turbines. There was a revised environmental statement produced for these on 31st August 2008. The noise section of this was less than one page and was completely inadequate. It appears to have been the intention to limit noise levels at all properties to 35dB at wind speeds up to 10m/s. The noise level at Cairndard was calculated in the ES to be 32.6dB.

3.2 When these three turbines were granted consent condition 28 was imposed which said that the noise level shall not exceed 35dBA (LA90) at all wind speeds up to 10m/s. I have calculated most probable noise level of the three existing turbines at Cairndard using the same methodology as I shall describe in section 5 below. At 10m/s wind speed this is 40dB. Even if the turbines are operating in a different mode from the one I assume, the levels will only be slightly lower. This is very significantly in excess of the predicted levels and the levels set out in planning condition 28. I understand that an Environmental Health Officer has been to Cairndard to take measurements and found that they are on the limit. However, I also understand that the wind speed was not high that day so noise levels at higher wind speeds will breach the limits. I suggest that a full investigation of the noise level at Cairndard, using the procedure set out in ETSU-R-97 at pp102 and following, should be carried out at once.

3.3 Table 1 in my Appendix 1 shows the calculated turbine noise levels for the existing turbines at other surrounding properties. As can be seen from the table it seems likely that some other properties on the list are exceeding the existing noise condition at some wind speed.

4 ASSESSMENT METHODOLOGY IN THE ENVIRONMENTAL STATEMENT

4.1 Turning now to the current application, the ES is very confused about noise assessment methodology. The only part of the noise section that appears to deal with this (apart from the summary) is the second full paragraph of page 153 starting "A level of 35-40dB . . . ." It states that "below 35dB(A) it is assumed that even very low background noise from wind or other sources would mask any turbine noise". I am unclear whether this is an interpretation of ETSU-R-97 or whether it is a statement by the author. In either case it is wrong. It is common in rural areas for background noise to be below 30dB when turbines are running.

4.2 What ETSU-R-97 does do is it sets noise limits related to background noise levels and so background noise surveys are required. These background noise levels are used to establish "ETSU" noise limits of 5dB above background noise together with a lower limit that is between 35 and 40dB during the day and 43dB at night. The one exception to this is set out on page 66 of ETSU-R-97 where it says *We are of the opinion that if the noise is limited to an LA_{90},10 min of 35dB(A) up to wind speeds of 10m/s at 10m height then this condition alone would offer sufficient protection of amenity, and background noise surveys would be unnecessary.* So the principle of restricting turbine noise to 35dB to avoid carrying out background noise measurements has support from ETSU-R-97 and I shall assume that this was the applicant's intention.

4.3 As to calculation methodology, on page 152 of the ES it says that the turbine noise was calculated from the manufacturer's data for the V52 850kW turbine but there are no sound power levels provided for the turbines in the ES nor are there any octave band noise levels with which to carry out calculations so we do not know what was used as a base.

4.4 On page 152 it also says that the "ISO-9613 spreading model, as specified in the ETSU-R-97 and other guidance". The references show that this guidance is ETSU-R-97, as stated, and Scottish online guidance for Onshore Wind Turbines. This is wrong. ISO 9613 is not specified or even mentioned in either ETSU-R-97 or in the online guidance. It then goes on to say that the calculations were done using the Danish Statutory Order 304 and says this is "up to the standard of the ISO 9613 spreading model". The Danish method is NOT up to the standard of ISO 9613 – it is quite different and more simplistic. Also in the last paragraph on page 152 it says the calculations were carried out in "A-weighted 1/1 octave band data". The Danish method does not use octave band data.

4.5 So it is quite unclear what methodology has been used. In addition none of the parameters of the calculation and none of the base noise levels has been provided.

5 REALISTIC TURBINE NOISE LEVELS

5.1 The calculation of noise levels of the turbine at surrounding properties has two stages. In the first place the *sound power level* of the turbine needs to be

established. In the second the *attenuation* of noise along the propagation path from the turbine to the houses has to be established or put another way, how much the noise falls away between the turbine and the house?

5.2 I have attached a copy of certified noise measurements of the Vestas V52 adjusted to OptiTip as Appendix 3 to this report. The sound power level is 104.1dB at 8m/s wind speed and the slope is 1.1dB per m/s. This means that the sound power levels are as shown in the table below.

Turbine Noise	Wind Speed m/s						
	4	5	6	7	8	9	10
A-weighted SWL	99.7	100.8	101.9	103.0	104.1	105.2	106.3

5.3 The measurement report also shows the octave band A-weighted sound power levels in section 4. These are shown in the table below.

	Frequency Band (Hz)							
	63	125	250	500	1k	2k	4k	8k
A-weighted SWL	80.4	88.3	94.1	99.7	99.4	95.5	89.1	78.9

5.4 The recommended methodology is indeed ISO 9613 but it has to be correctly used. There is a series of parameters that have to be properly quantified to get the correct result – ground conditions, air absorption conditions and height of the microphone in particular. It is not a question of "conforming" to ISO 9613 it is a question of selecting the parameters to give the most reliable answer. Strictly speaking turbine noise calculations are outside the scope of ISO 9613 (it is not valid in higher wind speeds nor where propagation heights are above a certain figure) and there are estimates of error to be considered as set out in the standard.

5.5 To overcome these problems a methodology was agreed between a group of consultants and published in the Acoustics Bulletin of March/April 2009. Although this methodology has no official status it is now used in nearly all wind farm application and has been accepted at most recent planning inquiries. The method is contained in the Prediction and Assessment of Wind Turbine Noise which I will call PAWTN. There were two methods one of which is to use measured sound power levels and propagation over hard ground. I have done these calculations using a temperature of 10 degrees Celsius and relative humidity of 70%. The noise level at Cairndard from all the turbines will be 43dB – very significantly higher than that that predicted by the applicant and completely unacceptable.

5.6 The noise levels at the other surrounding properties are shown in Table 2 of my Appendix 1.

APPENDIX 1 - TABLES

Table 1 – Calculated noise levels from existing turbines

Turbine Noise LA90	Wind Speed m/s						
	4	5	6	7	8	9	10
Stonedyke	36	37	38	39	40	41	42
Cairndard	34	35	36	37	38	39	40
Meadowbank	32	33	34	35	36	37	38
Cushnie 1	30	32	33	34	35	36	37
Cushnie 2	30	31	32	33	34	35	36
Bankhead	31	32	33	34	35	36	37
Cushnie 3	29	30	31	32	33	34	35
The Broom	27	28	29	30	31	33	34
Hillside	27	28	29	31	32	33	34
Barflat	28	29	30	32	33	34	35
Sandholes	28	30	31	32	33	34	35
Birch Cottage	26	27	29	30	31	32	33
Glenbogie	26	27	28	29	30	31	32

Table 2 – Calculated noise levels from all eight turbines

Turbine Noise LA90	Wind Speed m/s						
	4	5	6	7	8	9	10
Stonedyke	40	41	42	43	44	45	47
Cairndard	37	38	39	40	41	42	43
Meadowbank	35	37	38	39	40	41	42
Cushnie 1	35	36	37	38	39	40	41
Cushnie 2	34	35	36	37	39	40	41
Bankhead	34	35	36	37	38	39	41
Cushnie 3	33	34	35	36	37	38	40
The Broom	32	33	34	35	36	38	39
Hillside	32	33	34	35	36	38	39
Barflat	32	33	34	35	36	38	39
Sandholes	32	33	34	35	37	38	39
Birch Cottage	31	32	33	35	36	37	38
Glenbogie	31	32	33	34	35	36	37

APPENDIX 2 - QUALIFICATIONS

I have been a noise consultant for forty years. I was one of the original members of the Institute of Acoustics, our professional body, when it was founded in 1974 and I have been a Fellow since 1977. I am also a Chartered Engineer, a Chartered Physicist, a Fellow of the Chartered Institution of Building Services Engineers and a Member of the Chartered Institute of Arbitrators. Since 1978 I have given evidence at planning inquiries, civil actions for noise nuisance, civil actions for damages in respect of noise induced deafness and appeals against notices served under the Control of Pollution Act 1974 and the Environmental Protection Act 1990. I have given evidence at twenty wind farm public inquiries.

I have been a supporter of renewable energy for 45 years but I also believe that people have the right to be protected from unreasonable levels of noise. I have been involved in windfarm assessment since I carried out an impact assessment for Scottish Power in 1993. Since then I have examined and reported on about 60 wind farm Environmental Statements on behalf of Local Authorities or objectors. I am currently retained by several local authorities in the UK to provide an independent assessment of the noise issues in their windfarm applications.

There have been six Institute of Acoustics wind farm meetings since September 2005. I organised and chaired the first two and have chaired or attended three others. I have also attended all three International Conferences on Wind Turbine Noise in 2005, 2007 and 2009 and I am on the organising committee of the next conference WTN2011. I have given papers at some of these meetings on planning conditions, background noise, amplitude modulation and wind shear.

APPENDIX 3 – VESTAS V52 NOISE TESTS

TEST REPORT

DANAK
Reg. no. 134

DETERMINATION OF SOUND POWER LEVEL, WIND TURBINE
Vestas V52, Foverup

Pages total: 9

Report no.: 2 (P4.021.00)
Viborg, August 16. 2000
Journal no.: 35.4318.01 OIB/NJH/OIB

Client:

Vestas Wind Systems A/S
Smed Hansens Vej 27
6940 Lem

Claimant

Niels Chr. Møller Nielsen

Tlf. 96 75 26 49

Performed by:

Ole Bust

Signatory:

Niels Jørgen Hviid

Summary:

The noise emission from a Vestas V52-850 kW wind turbine measured on the 11. of August 2000 has been determined according to statutory order no. 304 of May 14. 1991, relevant parts of Guideline no. 6/1984, "Noise From Industrial Plants" from the Danish Ministry of Environment and letter of August 29. 1995 "Measurement Of Noise From Wind Turbines, Correction For The Influence of Background Noise" from The Danish National Laboratory for Noise Measurements.

The purpose was to determine the sound power level of the wind turbine and to test the content of tones, when the pitch-regulation was adjusted to **OptiTip**. Only values where the wind velocity has been between 5 and 9 m/s are used.

The wind turbine is erected near Foverup in Jutland, Denmark. (Appendix 1)

Results:

The sound power level of the wind turbine was determined to $L_{WA,ref}$ = 104,1 dB re. 1 pW, at a wind velocity of 8 m/s at a height of 10 m. The gradient (sound power level/wind velocity) was determined to 1.1 dB pr. m/s.

The noise from the wind turbine contains no clearly audible tones.

The degree of accuracy of $L_{WA,ref}$ based on the definitions given in statutory order no. 304 is 2 dB(A).

(8D)

The Test Report may only be reproduced in full.
However, publication of e.g. test results or conclusions may be used in full accordance with the written permission of the laboratory.

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1 INTRODUCTION

The purpose of the measurements carried out was to determine the sound power level of a Vestas V52-850 kW wind turbine and to test the content of audible tones in the noise from the turbine.

The wind turbine is erected near Foverup in Jutland, Denmark. (Appendix 1)

2 OBJECT UNDER MEASUREMENT

The wind turbine is manufactured by Vestas and the identification is V52-850 kW(11816). The pitch-regulation was adjusted to **OptiTip**. During the measurement the winddirection was north-westerly, and the running conditions of the wind turbine were standard.

3 METHODS OF MEASUREMENT AND ANALYSIS

The sound power level has been determined according to statutory order no. 304 of May 14. 1991, relevant parts of Guideline no. 6/1984, "Noise From Industrial Plants" from the Danish Ministry of Environment and letter of August 29. 1995 "Measurement Of Noise From Wind Turbines, Correction For The Influence of Background Noise" from The Danish National Laboratory for Noise Measurements.

Measurement of sound pressure levels were performed at a distance of 75 meters leeward to the turbine and wind velocity in a distance of 80 meters windward to the turbine.

The measurements were carried out with the microphone placed on a 1,5 x 2.01 meters solid sheet of plywood placed directly on the ground. Wind velocity was measured at a height of 10 meters.

Measurements were performed both with the turbine operating (determination of "total noise") and with the turbine stopped for determination of background noise.

The area around the solid sheet of plywood and between the wind turbine and the plywoodsheet was open agricultural land

For frequency analysis the noise was recorded using a tape recorder.

Apparatus used:

Description	Producer	Type	ACA nr.	Date of calibration	
				latest	next
Microphone	Brüel & Kjær	4189	679	29.03.2000	29.03.2001
Sound lev. mt.	Brüel & Kjær	2260	627	09.02.1999	09.02.2001
Calibration unit	Brüel & Kjær	4231	629	03.03.2000	03.09.2000
Wind meter sta.	Autohelm	Z080	691	25.11.1999	25.11.2001
Tape recorder	Sony	TCD-D8	614	09.04.1999	09.04.2001
Analyser	Brüel & Kjær	2033	36	01.09.1999	01.09.2001

Corresponding values of the equivalent A-weighted sound pressure level (L_{Aeq}) and the mean wind velocity were measured for a number of one-minute periods.

The connection between these corresponding values of the wind velocity and the sound pressure level of the background noise was determined using linear regression analysis.

For each measurement of the total noise the expected value of the background noise at the same wind velocity was determined using the linear regression analysis. The measured values of the total noise are corrected for the influence of the background noise giving the corrected values L_{Aeq} of the noise from the wind turbine. Values not exceeding the background noise by more than 6 dB must be left out in the following calculations.

The connection between corresponding values of the sound pressure level L_{Aeq} and the wind velocity was determined using linear regression analysis. At a wind velocity of 8 m/s the A-weighted sound pressure level ($L_{Aeq,ref}$) is determined using the linear regression analysis. Only values where the wind velocity has been between 5 and 9 m/s are used.

The reference sound power level ($L_{WA,ref}$) of the turbine is calculated by using the formula:

$$L_{WA,ref} = L_{Aeq,ref} + 10 \log (4 \pi (d^2 + h^2)) - 6$$

where

d = distance from the centre of the tower to the measurement position.
h = the level difference from the top of the hub to the measurement position.

4 RESULTS

With d = 75,0 meters, h = 44,0 meters and $L_{Aeq,ref}$ = 60,3 dB(A) (appendix 2) the sound power level of the wind turbine will be:

$L_{WA,ref}$ = 104,1 dB(A)

Below is an octave analysis corresponding to a wind velocity of 8 m/s.

Frequency	Sound pressure level, $L_{Aeq,ref.}$	Sound power level, $L_{WA,ref.}$
1/1 octave 63 Hz	36,6	80,4
1/1 octave 125 Hz	44,5	88,3
1/1 octave 250 Hz	50,3	94,1
1/1 octave 500 Hz	55,9	99,7
1/1 octave 1 kHz	55,6	99,4
1/1 octave 2 kHz	51,7	95,5
1/1 octave 4 kHz	45,3	89,1
1/1 octave 8 kHz	35,1	78,9
Sum	60,3	104,1

The unit of the sound pressure level $L_{Aeq,ref}$ is dB re 20 µPa.
The unit of sound power level $L_{WA,ref}$ is dB re 1 pW.
All values are A-weighted.

The frequency analysis (appendix 3) shows that the noise from the wind turbine contains no clearly audible tones.

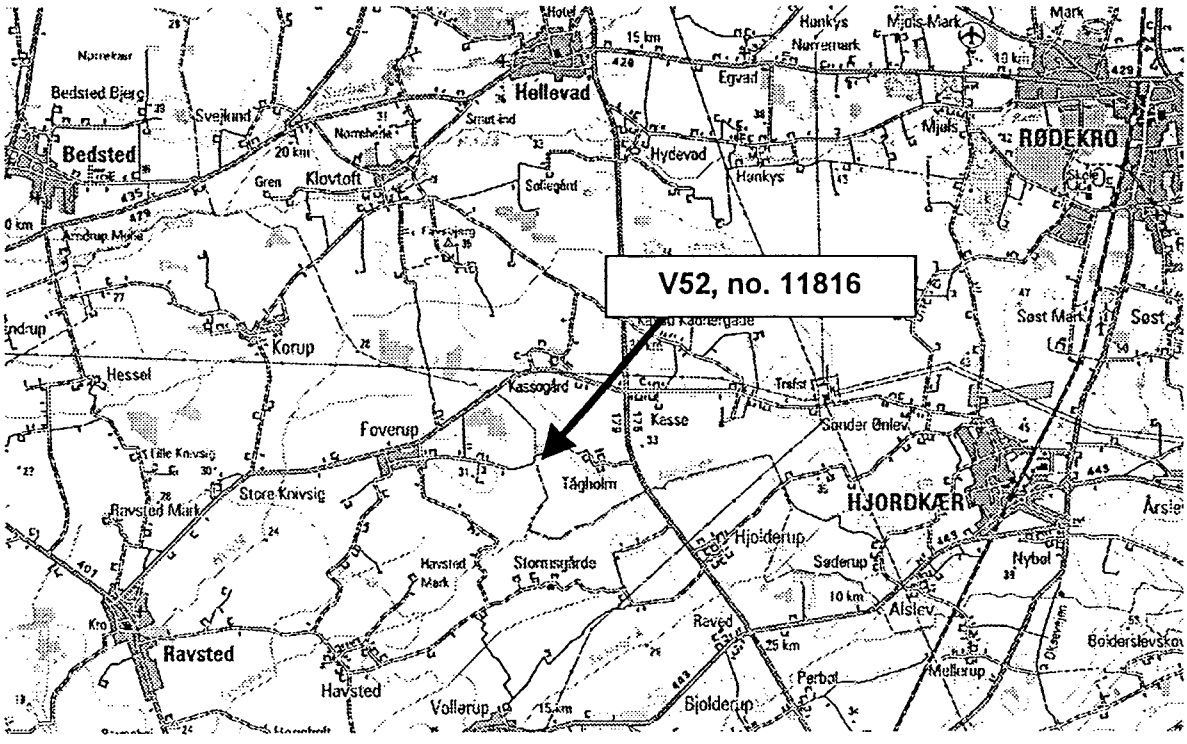
5 CONCLUSION

The sound power level $L_{WA,ref}$ of the Vestas V52-850 kW wind turbine with the adjustment **OptiTip** is determined to 104,1 dB(A) at a wind velocity of 8 m/s in the height of 10 meters.

The noise from the wind turbine contains no clearly audible tones.

The degree of accuracy of $L_{WA,ref}$ based on the definitions given in statutory order no. 304 is 2 dB(A).

Appendix 1
Site plan



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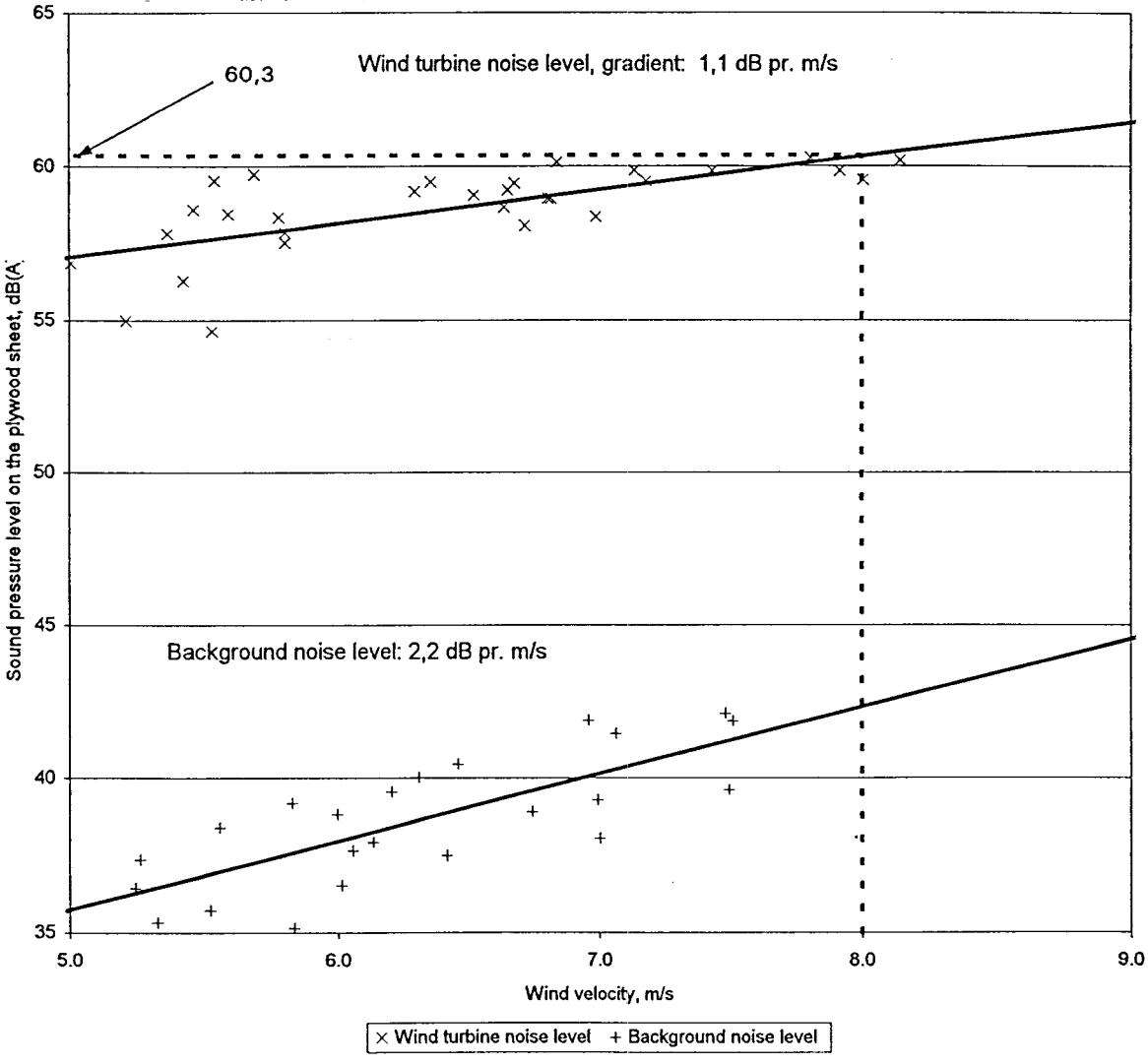
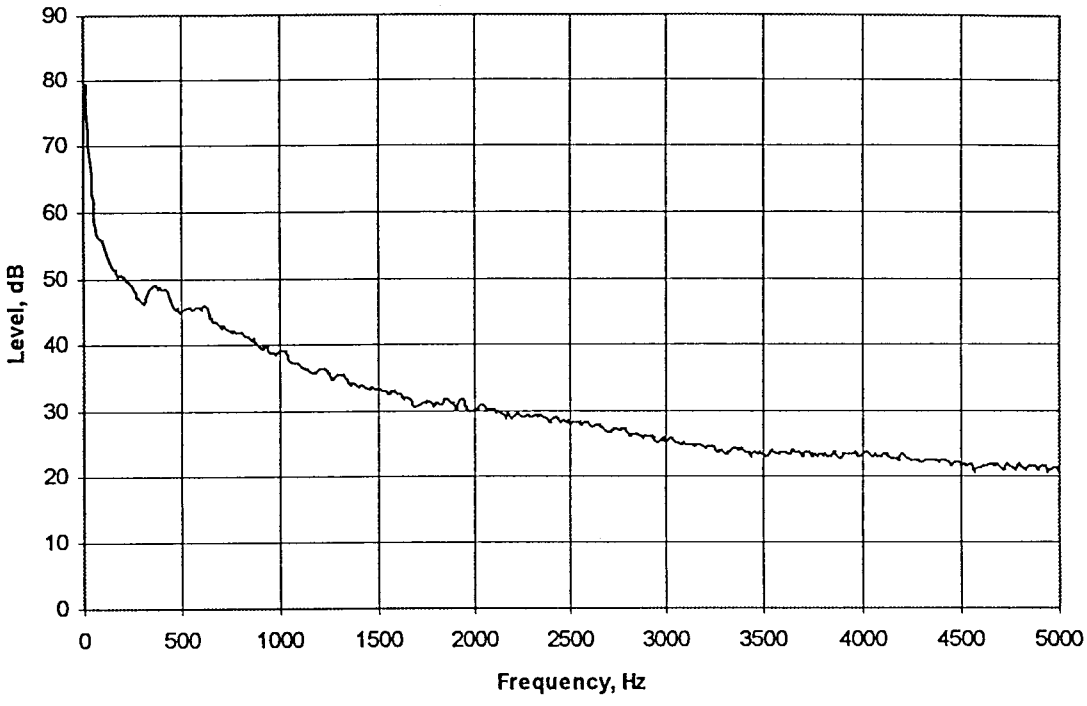
Appendix 2
Correspondence of wind velocity and noise



Appendix 3
Frequency analysis (narrow band) of the noise on the plywood sheet



Analysis parameters:

No. of spectra:	256
Time weighting:	Hanning
Averaging:	Lin
Effective band width:	18,75 Hz

Appendix 4
Data of the wind turbine

Producer	Vestas
Type	V52-850kW
Series no.	11816
Name of the wind turbine	11816
Location	Foverup, Jutland, Denmark
Type of tower	Conical tubular steel
Height of tower	42,1 m
Height of the hub	44 m from the surface
Producer of gear	Lohmann & Stolterfoht
Type of gear	GPV305S-3331
Series no. of gear	3094
Gear-configuration	1xplanet, 2xparallel
Gear-system	Helical
Gear, nominal effect	850 kW
Producer of generator	Leroy Somer
Type of generator	
Series no. of generator	
Effect of generator	850 kW
Diameter of rotor	52 m
Configuration of rotor	Pitch regulated
Producer of blades	Vestas
Type of blades	25 m
Rotor speed	14.9 - 26.2 rpm (OptiSpeed)
Pitchangle of the blade	OptiTip
Pitch control	Program ver. 1.07
Comments	None