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PROPOSED REPLACEMENT WIND TURBINE AT HIGHFIELD FARM, CUMBRIA

NOISE IMPACT ASSESSMENT

Technical Report: R10359-3 Rev 1

Date: 18th September 2024

For: Constantine Wind Energy Ltd
First Floor River Court
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24 Acoustics Document Control Sheet

Project Title: Proposed Replacement Wind Turbine at Highfield Farm, Cumbria
Noise Impact Assessment

Report Ref: R10359-3 Rev 1

Date: 18th September 2024

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For and on behalf of 24 Acoustics Ltd				

Document Status and Approval Schedule

Revision	Description	Prepared By	Checked by	Approved By
0	Approved for Issue	John Edhouse	David Coles	David Coles
1	Approved for Issue	John Edhouse	David Coles	David Coles

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EXECUTIVE SUMMARY

24 Acoustics Ltd has been instructed by Constantine Wind Energy Ltd to undertake an assessment of the noise impact of the operation of a wind turbine at Highfield Farm in Cumbria. It is proposed to decommission and replace the existing wind turbine on the site with a single wind turbine. The replacement turbine type is not confirmed and therefore three candidate turbine options have been considered within this report to assess potential noise impacts. Candidate turbines comprise an Enercon E48 wind turbine (operating in a reduced power mode), Vestas V47 and Vestas V52 operating in '100dB mode'.

The assessment has been undertaken taking the background noise environment at the nearest noise-sensitive receptors to the proposed turbine into account and is based upon acoustic modelling of the noise emission from the turbine to predict operational noise levels at the receptor locations under a range of wind speeds.

The assessment has established that the noise emission from the proposed candidate turbines will fall within the guidance stipulated in ETSU-R-97 at all locations and at all wind speeds.

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1.0 INTRODUCTION

1.1 24 Acoustics Ltd has been instructed by Constantine Wind Energy Ltd to undertake an assessment of the noise impact of the operation of a wind turbine at Highfield Farm in Cumbria. It is proposed to decommission and replace the existing wind turbine on the site with a single wind turbine. The replacement turbine type is not confirmed and therefore three candidate turbines have been considered within this report to assess potential noise impacts.

1.2 The assessment has been undertaken taking the background noise environment at the nearest noise-sensitive receptors to the proposed turbine into account and is based upon acoustic modelling of the noise emission from the turbine to predict operational noise levels at the receptor locations under a range of wind speeds.

1.3 All sound pressure levels quoted in this report are in dB relative to 20 µPa. All sound power levels are quoted in dB relative to 10e-12 Watts. A glossary of the acoustic terminology used in this report is provided in Appendix A.

2.0 SITE DESCRIPTION AND WIND TURBINE

2.1 Highfield Farm is situated close to the west coast of Cumbria, approximately 5.5 km south of Whitehaven.

2.2 The site currently operates a single wind turbine. It is proposed to decommission this and replace with a single wind turbine at OS co-ordinates 298945, 512795 with a hub height of 50m. The replacement turbine type is not confirmed and therefore three candidate turbines have been considered within this report to assess potential noise impacts. Candidate turbines comprise the following:

- Enercon E48 wind turbine;
- Vestas V47 wind turbine;
- Vestas V52 wind turbine.

2.3 The nearest residential properties to the site are detailed as follows, with distances shown to the closest part of the curtilage (in accordance with best practice):

No	Name/ Address	OSGB36 Grid Reference	Approx. Distance from Turbine to Curtilage
1	Highfield Farm	298732,512457	400 m
2	Coronation Terrace	298456,512855	495 m
3	Wireless Station	299206,512374	495 m
4	Quarry Cottages	299409,512737	470 m
5	Low Walton	298543,513100	505 m

Table 1: Receptor Locations

2.4 Figure 1 provides an aerial image of the site, turbine and receptor locations.

3.0 ASSESSMENT CRITERIA AND CONSULTATION

3.1 For assessment of noise from turbines/wind farms in the UK, ETSU-R-97 'The Assessment and Rating of Noise from Wind Farms' [Reference 1] is used. This document defines a framework for the measurement of noise from wind turbines and suggests noise limits for use in assessing the noise impact from wind turbines at the planning application stage of a project.

3.2 ETSU-R-97 requires the assessment of wind turbine noise to be assessed at night (between 23:00 and 07:00 hours) and during the 'quiet daytime hours' (evenings from 18:00- 23:00, Saturday afternoons between 13:00 and 18:00 and Sundays from 07:00 until 18:00). For the day-time period a noise limit of 35-40 dBA or 5 dBA above the prevailing background noise level is set (whichever is the greater). The distinction between the use of the absolute noise limit of 35 or 40 dBA is not explicitly stated, however, it relates to the number of receptor properties, the effect of the noise limit on the amount of electrical power generated and the duration of the level of exposure. At night the noise limit is 43 dBA or 5 dBA above the prevailing background noise level, whichever is greater.

3.3 Where the occupier of a property has some financial involvement with the wind turbine/ wind farm, the day and night-time lower noise limits are increased to 45 dB(A).

3.4 The noise limits apply across the turbine operational wind speeds (usually between 4 and 10 m/s) and it is necessary to quantify both the background noise level and the noise level emitted by the turbine(s) as a function of wind speed. The background noise level is measured simultaneously with wind speed (determined at a height of 10 m) and noise level is set by calculation of a best fit curve through values of background noise plotted against wind speed for both the quiet daytime and night-time operational periods.

3.5 Both the noise emitted from the turbine and the background noise levels are determined in terms of the overall A-weighted $L_{90,10\ min}$ sound pressure level. For wind turbine noise, the $L_{A90,10min}$ is considered to be 2 dB less than the $L_{Aeq,10min}$ over the same period.

3.6 ETSU-R-97 provides a simplified methodology for smaller or more remote schemes when the predicted noise level from the turbine does not exceed 35 dB L_{A90} at all wind speeds of up to 10 m/s. This can avoid the need to undertake background noise surveys when this scenario arises.

3.7 ETSU-R-97 also states that a penalty should be added to the predicted noise levels, where any tonal component is present. The level of this penalty is described and is related to the level by which any tonal components exceed audibility.

3.8 The noise limits in ETSU-R-97 take into account the fact that all wind turbines exhibit specific noise characteristics described as blade swish to a certain extent. Severe cases of blade swish can exhibit themselves as amplitude modulation. Some parties also have concern about infrasound and low frequency noise from wind farms.

3.9 There have been many planning appeals and public inquiries relating to proposed wind farm/ wind turbine sites. There have been a number of technical disputes between acoustic consultants working on behalf of the different parties. To minimise these disputes an agreement between these groups was published by the Institute of Acoustics in April 2009 [Reference 2] (known as the IOA Agreement).

3.10 In summary the IOA Agreement provides clarification of the following issues:

- The acquisition of baseline noise data at receptor locations and analysis of this data to take into account site- specific wind shear. Specifically, this states that to account for the effects of local wind shear, wind speeds should preferably be measured at two heights and then derived to a 10 m height (rather than measured, as stipulated in ETSU-R-97). When background noise surveys are carried out for sites where wind speeds can only be measured at 10 m height, then the noise assessment should take account of the wind shear variations using a method that should be explained. Where noise assessments are based solely on measured 10 m height wind speeds the noise limits in planning conditions should also refer to measured 10 m height wind speeds;

- The prediction of wind turbine noise at receptor locations- stating that the propagation methodology of ISO 9613 [Reference 3] be used with a ground effects condition of G=0.5 used with a 4 m receptor height and the turbine vendor's sound power level data, together with the effect of acoustic barriers, ensuring that no account should be taken of barrier attenuation caused by a landform unless there is no line-of-sight between the receptor and the highest point of the turbine rotor (in which case a barrier correction of 2 dB(A) can be justified);

- Vibration and low frequency noise. It is concluded that there is no robust evidence that low frequency noise (including noise and ground-borne vibration) from wind farms, generally has adverse effects on wind farm neighbours.

IOA Good Practice Guide

3.11 The Institute of Acoustics published a *'Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise'* [Reference 4] in May 2013. This document provides some useful guidance on best practice for the modelling of wind turbine noise, measurement of background noise levels, and analysis of data, such as:

- The use of regression lines for background noise data;
- Removal of samples immediately before and after rainfall;
- Removal of elevated background noise levels due to the dawn chorus;
- Applying a wind shear correction to predicted turbine noise levels where a 10 metre met mast has been used during the background noise survey.

3.12 Where practicable, the guidance contained in the Good Practice Guide has been followed in this assessment.

4.0 BACKGROUND AND WIND SPEED SURVEYS NOISE LEVELS

4.1 Background noise surveys were carried out between 21st March and 16th April 2024 in accordance with the requirements of ETSU-R-97 at the receptor locations representative of residential properties most likely to be affected by noise from the proposed wind turbine, as shown in Figure 1 and described below:

- Location 1: Coronation Terrace (at OS coordinates 298451,512848).

4.2 Photographs showing the survey locations are displayed in Figure 5.

4.3 The noise surveys were undertaken using the following instrumentation:

- 1 x Rion NL-52 precision grade class 1 accuracy sound level meter;
- Brüel and Kjær Type 4231 acoustic calibrator.

4.4 The instrumentation was calibrated before and after the surveys in accordance with the manufacturers' instructions. No drift in calibration was recorded. The calibration certificates of the instrumentation used are provided in Appendix B.

4.5 The sound level meter was installed at a height of approximately 1.5 m above local grade level. A bespoke dual-layer windshield designed to comply with the requirements of the IOA Good Practice Guide (GPG) was fitted to the microphone. Measurements were undertaken in samples of ten minutes in terms of the $L_{A90,\,10\,min}$ sound pressure level.

4.6 A 10 m mast was installed at a location representative of the proposed turbine location at Waunfawr (at OS coordinates 392518,844888) and an NRG #40C calibrated anemometer installed at the apex. The mast and associated instruments were used to log wind speed, wind direction, precipitation and air temperature throughout the survey period.

4.7 The results of the surveys for the quiet daytime and night-time periods (as defined in ETSU-R-97) are detailed below.

Wind Speed m/s (10 m AGL) and Background Noise Level, dB L_{A90}						
4	**5**	**6**	**7**	**8**	**9**	**10**
32.4	33.9	35.8	38.2	40.9	43.9	47.1

Table 2: Quiet Daytime Background Noise Levels, Location 1, Coronation Terrace

Wind Speed m/s (10 m AGL) and Background Noise Level, dB L_{A90}						
4	**5**	**6**	**7**	**8**	**9**	**10**
26.6	29.7	33.0	36.5	40.0	43.2	45.8

Table 3: Night-time Background Noise Levels, Location 1, Coronation Terrace

5.0 CALCULATIONS AND ASSESSMENT

5.1 It is proposed to replace the existing turbine with a single wind turbine. The replacement turbine type is not confirmed and therefore three candidate turbine options have been considered.

5.2 Predictions of the noise emission from the candidate wind turbines have been carried out using IMMI noise mapping software. The propagation methodology of ISO 9613 has been used, which takes into account the effects of geometric divergence, acoustic screening and atmospheric and ground absorption.

5.3 The calculations have assumed an ambient temperature of 10 °C and relative humidity of 70%. Downwind propagation conditions have been assumed throughout. The calculations have determined the noise level from the turbine at a receptor height of 4 m above local grade level and have assumed a ground absorption factor of G=0.5 (which complies with current agreed understanding).

5.4 At this site no account has been taken of any acoustic shielding that may be provided by the natural topography of the land. The calculations therefore represent a worst-case assessment.

5.5 Wind turbine noise information, calculations and assessment results for each candidate turbine type are provided in the following sections.

Enercon E48

5.6 The turbine source sound power level has been taken from Enercon E48 noise reports (reproduced in Appendix C). This turbine would be operated in a reduced power mode, with a maximum power output of 225 kW. The report named "*SIAS-04-SPL E48 red Rev1.1 eng-eng.doc*" provides sound power data for a number of reduced power modes, with the closest being 300 kW. The document states that the sound power level for this mode will be 97.5 dBA at 95% rated power, and that an uncertainty of 1 dB should be used.

5.7 The document "*Extract of test report M64 550/8*" provides spectra measured from the turbine operating in full power mode. In full power mode, the power output from the turbine is closest to 300 kW for a 10 m height wind speed of 6 m/s, and these data are shown in Table 4.

Octave Band Sound Power Level, dBA Octave Band Centre Frequency, Hz							
63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
82.5	88.8	93.9	94.1	90.0	84.1	81.2	76.8

Table 4: Sound Power Level Frequency Spectrum for Standardised 10 m Wind Speed of 6 m/s (power output ~ 300 kW)

5.8 The manufacturer's report states that no tones with a tonal audibility greater than 2 dBA can be expected from this turbine, and therefore no tonal penalty has been applied to the sound power level.

5.9 Calculations have been completed for the E48 candidate turbine. The results of the acoustic model are provided graphically in Figure 2 as a noise contour map (assuming the maximum noise output specified at 95% rated power) and described below in Table 5. The turbine noise levels have been corrected from L_{Aeq} sound pressure levels to L_{A90} sound pressure levels by subtracting 2 dBA in accordance with the ETSU-R-97 methodology.

Receptor		**Predicted Wind Turbine Sound Pressure Level, dB L_{A90}**
No.	**Name/ Address**	
1	Highfield Farm	33.6
2	Coronation Terrace	31.6
3	Wireless Station	31.6
4	Quarry Cottages	32.1
5	Low Walton	31.4

Table 5: Enercon E48 - Noise Calculation Results, 10 m/s wind speed at 10 m height.

5.10 The calculations indicate that the noise level at all properties will be below 35 dB $L_{A90,T}$ under all wind speeds and hence compliant with the ETSU-R-97 simplified methodology.

Vestas V47

5.11 The noise source data for the V47 wind turbine have been taken from Vestas noise reports (reproduced in Appendix D). Paragraph 6c of the report states that there is no significant tonal component to the noise. A correction of +2 dB has been added for uncertainty in accordance with the IOA Good Practice Guide. Noise levels for the V47 are summarised in the following tables for the turbine when operating in full power mode.

	Wind Speed, m/s and L_{Aeq} Sound Power Levels, dB							
	5	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Apparent Sound Power Level, $L_{WA,k}$ (dB)	99.5	99.9	100.4	100.8	101.3	101.7	102.2	102.6
ETSU-R-97 Tonal Correction	0	0	0	0	0	0	0	0
Uncertainty (dB)	2	2	2	2	2	2	2	2
Effective sound power level, L_{WA} (dB)	101.5	101.9	102.4	102.8	103.3	103.7	104.2	104.6

Table 6: V47 L_{Aeq} Sound Power Levels, Normalised to 10 m Hub Height

Octave Band Sound Power Level, dB Octave Band Centre Frequency								
31.5	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
-	76.5	84.1	90.6	95.9	94.7	89.7	83.7	68.7

Table 7: V47 L_{Aeq} Sound Power Level Frequency Spectrum, 8 m/s Wind Speed

5.12 Calculations have been completed for the V47 candidate turbine. The results of the acoustic model are provided graphically in Figure 3 as a noise contour map (assuming the maximum noise output specified at 10m/s wind speed) and described in Table 8. The turbine noise levels have been corrected from L_{Aeq} sound pressure levels to L_{A90} sound pressure levels by subtracting 2 dBA in accordance with the ETSU-R-97 methodology.

Receptor		Predicted Wind Turbine Sound Pressure Level, dB L_{A90}
No.	**Name/ Address**	
1	Highfield Farm	38.4
2	Coronation Terrace	36.3
3	Wireless Station	36.2
4	Quarry Cottages	36.8
5	Low Walton	36.0

Table 8: Vestas V47 - Noise Calculation Results, 10 m/s wind speed at 10 m height.

5.13 The calculations indicate that the noise level at all receptors identified will be marginally greater than 35 dB $L_{A90,T}$ at 10 m/s wind speed (at 10 m AGL). As a result, the noise levels at these properties have been compared to the background noise levels described above in accordance with the ETSU-R-97 methodology for both the quiet daytime and for the night-time periods. Figures 6 and 7 show the measured background noise levels, the derived ETSU-R-97 noise limits, and the noise level predicted from the turbine for both the quiet daytime and night-time periods. The corresponding data are provided in tabular format in Appendix F.

5.14 The analysis indicates that the predicted noise levels from the turbine will be lower than the ETSU-R-97 noise limits for both the quiet daytime and night-time periods at all receptors at all wind speeds.

Vestas V52

5.15 This turbine has a rated power output of 850 kW however would be operated in a reduced noise level '100dB mode'. The turbine source sound power level has been taken from Vestas V52 noise reports (reproduced in Appendix E) and is summarised in Tables 9 and 10.

	Standardised 10 m Wind Speed, m/s						
	4	**5**	**6**	**7**	**8**	**9**	**10**
Apparent Sound Power Level, $L_{WA,k}$ (dB)	90.7	95.8	98.3	99.1	99.8	100.5	101.2
ETSU-R-97 Tonal Correction (dB)	0	0	0	0	0	0	0
IOA GPG Uncertainty (dB)	2	2	2	2	2	2	2
Effective sound power level, L_{WA} (dB)	92.7	97.8	100.3	101.1	101.8	102.5	103.2

Table 9: V52 Sound Power Levels, 100 dB mode, 49m hub height

Octave Band Sound Power Level, dBA Octave Band Centre Frequency, Hz							
63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
82.9	89.3	95.0	97.1	97.0	95.3	89.8	76.2

Table 10: Sound Power Level Frequency Spectrum for Standardised 10 m Wind Speed of 10 m/s, V52 100 dB mode

5.16 The manufacturer's report states that no tones with a tonal audibility greater than 2 dBA can be expected from this turbine, and therefore no tonal penalty has been applied to the sound power level.

5.17 Calculations have been completed for the V52 100dB Mode candidate turbine. The results of the acoustic model are provided graphically in Figure 4 as a noise contour map (assuming the maximum noise output specified at 10m/s wind speed) and described in Table 11. The turbine noise levels have been corrected from L_{Aeq} sound pressure levels to L_{A90} sound pressure levels by subtracting 2 dBA in accordance with the ETSU-R-97 methodology.

Receptor		Predicted Wind Turbine Sound Pressure Level, dB L_{A90}
No.	**Name/ Address**	
1	Highfield Farm	38.0
2	Coronation Terrace	35.9
3	Wireless Station	35.8
4	Quarry Cottages	36.4
5	Highfield Farm	35.6

Table 11: Vestas V52 100dB Mode - Noise Calculation Results, 10 m/s wind speed at 10 m height.

5.18 The calculations indicate that the noise level at all receptors identified will be marginally greater than 35 dB $L_{A90,T}$ at 10 m/s wind speed (at 10 m AGL). As a result, the noise levels at these properties have been compared to the background noise levels described above in accordance with the ETSU-R-97 methodology for both the quiet daytime and for the night-time periods. Figures 8 and 9 show the measured background noise levels, the derived ETSU-R-97 noise limits, and the noise level predicted from the turbine for both the quiet daytime and night-time periods. The corresponding data are provided in tabular format in Appendix F.

5.19 The analysis indicates that the predicted noise levels from the turbine will be lower than the ETSU-R-97 noise limits for both the quiet daytime and night-time periods at all receptors at all wind speeds.

Wind Shear

5.20 A correction has been applied to the predicted turbine noise levels in order to assess the potential impact of wind shear. This has been undertaken in accordance with the IOA Good Practice Guide which states that for hub heights up to 60 metres, a correction of 2 m/s should be applied (when wind speed has been measured directly at 10 metres height). This is shown as horizontal error bars in Figures 6 to 9. This pessimistic correction indicates that wind shear should not affect the outcome of the assessment.

6.0 CONCLUSIONS

6.1 24 Acoustics Ltd has been instructed by Constantine Wind Energy Ltd to undertake an assessment of the noise impact of the operation of a wind turbine at Highfield Farm in Cumbria. It is proposed to decommission and replace the existing wind turbine on the site with a single wind turbine. The replacement turbine type is not confirmed and therefore three candidate turbine options have been considered within this report to assess potential noise impacts. Candidate turbines comprise an Enercon E48 wind turbine (operating in a reduced power mode), Vestas V47 and Vestas V52 operating in '100dB mode'.

6.2 The assessment has been undertaken taking the background noise environment at the nearest noise-sensitive receptors to the proposed turbine into account and is based upon acoustic modelling of the noise emission from the turbine to predict operational noise levels at the receptor locations under a range of wind speeds.

6.3 The assessment has established that the noise emission from the proposed candidate turbines will fall within the guidance stipulated in ETSU-R-97 at all locations and at all wind speeds.

REFERENCES

1. ETSU-R-97, Assessment and Rating of Noise from Wind Farms, Department of Trade and Industry, 1997.

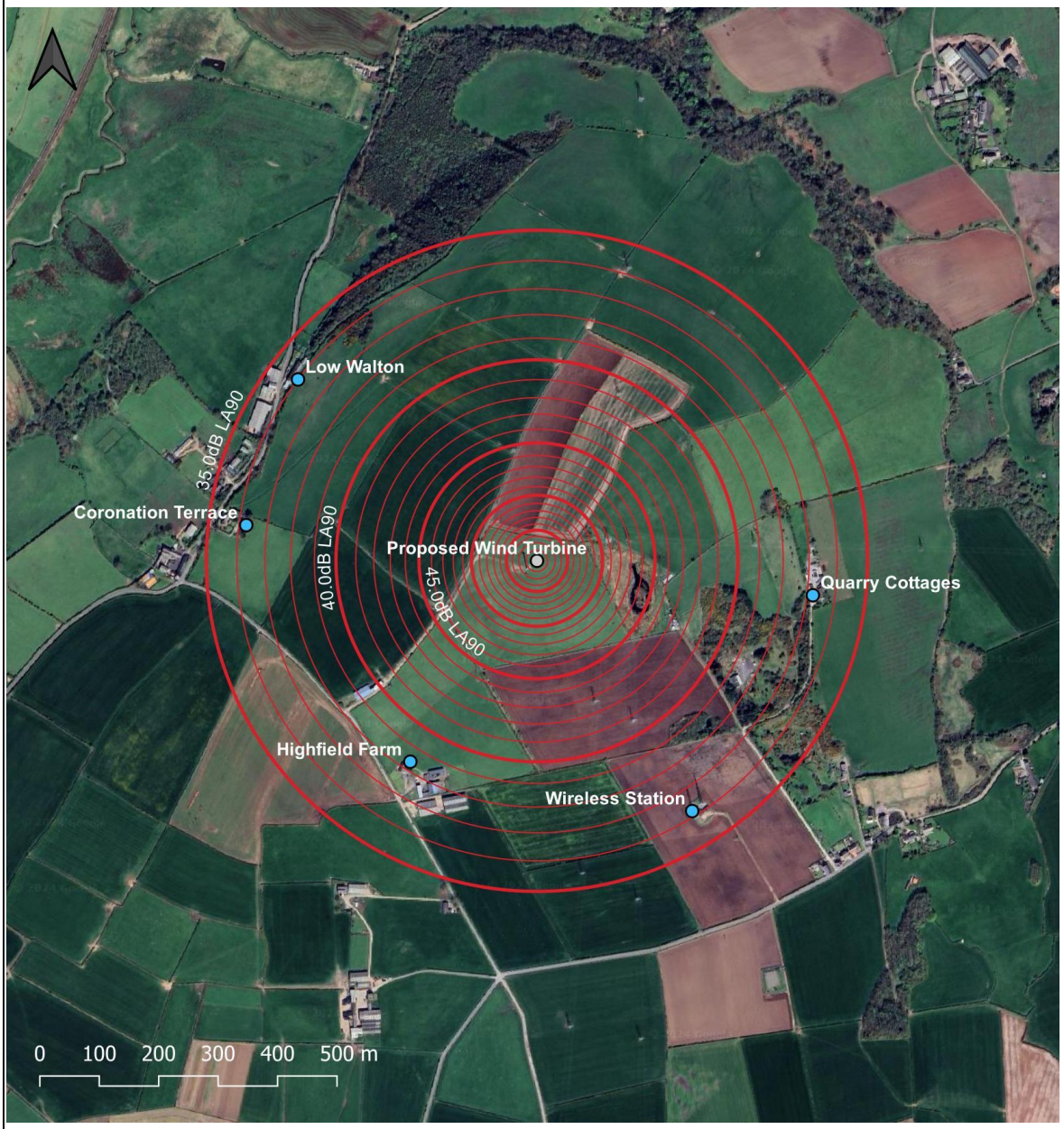
2. Prediction and Assessment of Wind Turbine Noise, Institute of Acoustics, Acoustics Bulletin March, April 2009.

3. ISO 9613, Acoustics- Attenuation of Sound During Propagation Outdoors, International Standards Organisation, 1993.

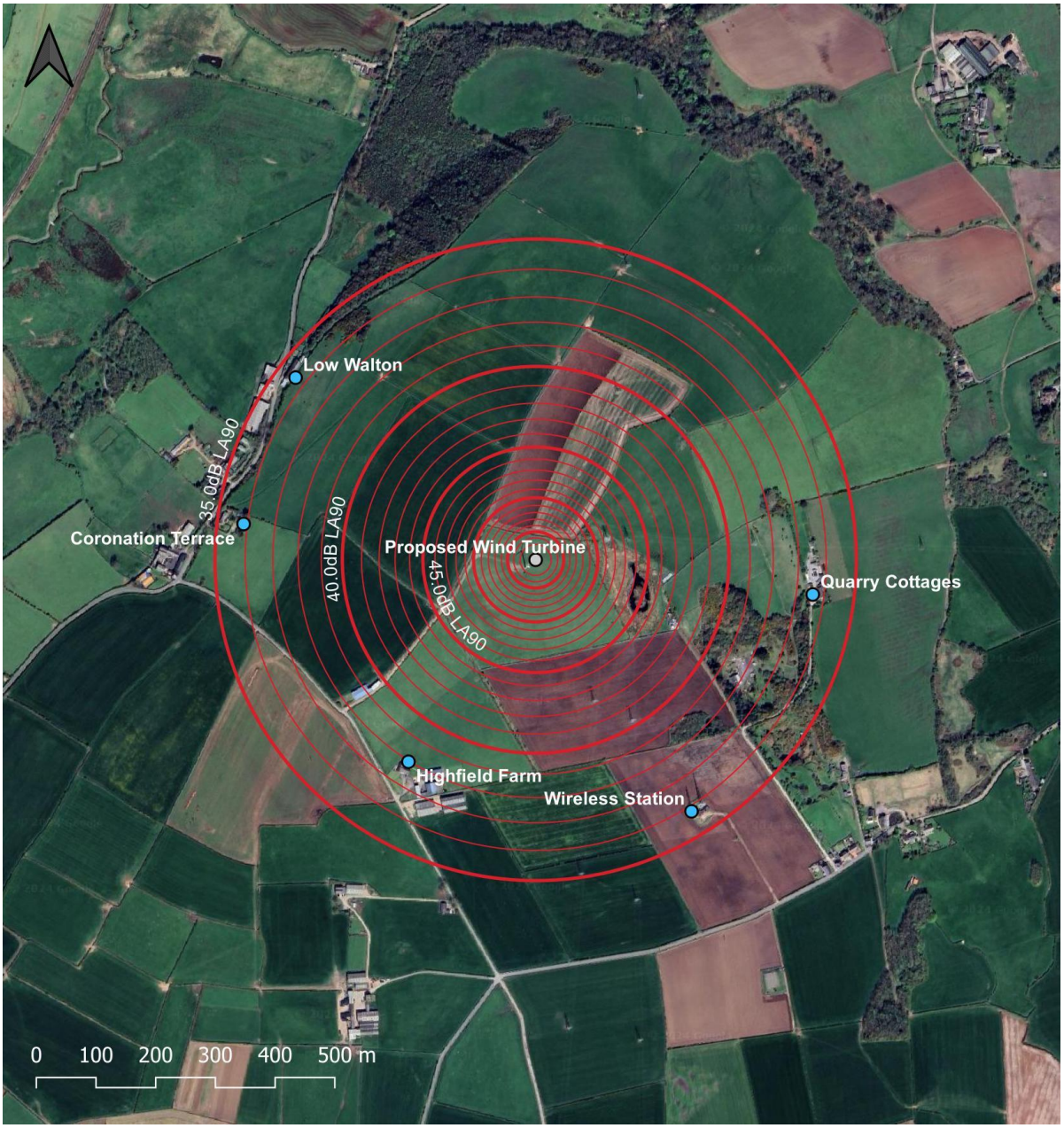
4. 'A Good Practice Guide to the Application of ETSU-R-97 For The Assessment And Rating Of Wind Turbine Noise', Institute of Acoustics, May 2013.

Project: Highfield Farm	**Title:** Turbine, Receptor & Background Noise Survey Locations	
DWG No: Figure 1	**Scale:** N.T.S.	**Rev:** -
Date: September 2024	**Drawn By:** JE	**Job No:** 10359

Project: Highfield Farm	**Title:** Enercon E48, reduced power mode 300 kW Site Noise Contours- 10 m/s @ 10 m AGL	
DWG No: Figure 2	**Scale:** N.T.S.	**Rev:** -
Date: September 2024	**Drawn By:** JE	**Job No:** 10359



Project: Highfield Farm	**Title:** Vestas V47 Site Noise Contours- 10 m/s @ 10 m AGL	
DWG No: Figure 3	**Scale:** N.T.S.	**Rev:** -
Date: September 2024	**Drawn By:** JE	**Job No:** 10359



Project: Highfield Farm	**Title:** Vestas V52 100dB Mode Site Noise Contours- 10 m/s @ 10 m AGL		
DWG No: Figure 4	**Scale:** N.T.S.	**Rev:** -	
Date: September 2024	**Drawn By:** JE	**Job No:** 10359	

Noise Monitor, Location, Near Coronation Cottages

Project: Highfield Farm	**Title:** Photographs of Noise Monitor Location	
DWG No: Figure 5	**Scale:** N.T.S.	**Rev:** -
Date: September 2024	**Drawn By:** JE	**Job No:** 10359

Figure 6: ETSU-R-97 Noise Impact Assessment (Vestas V47), Quiet Daytime

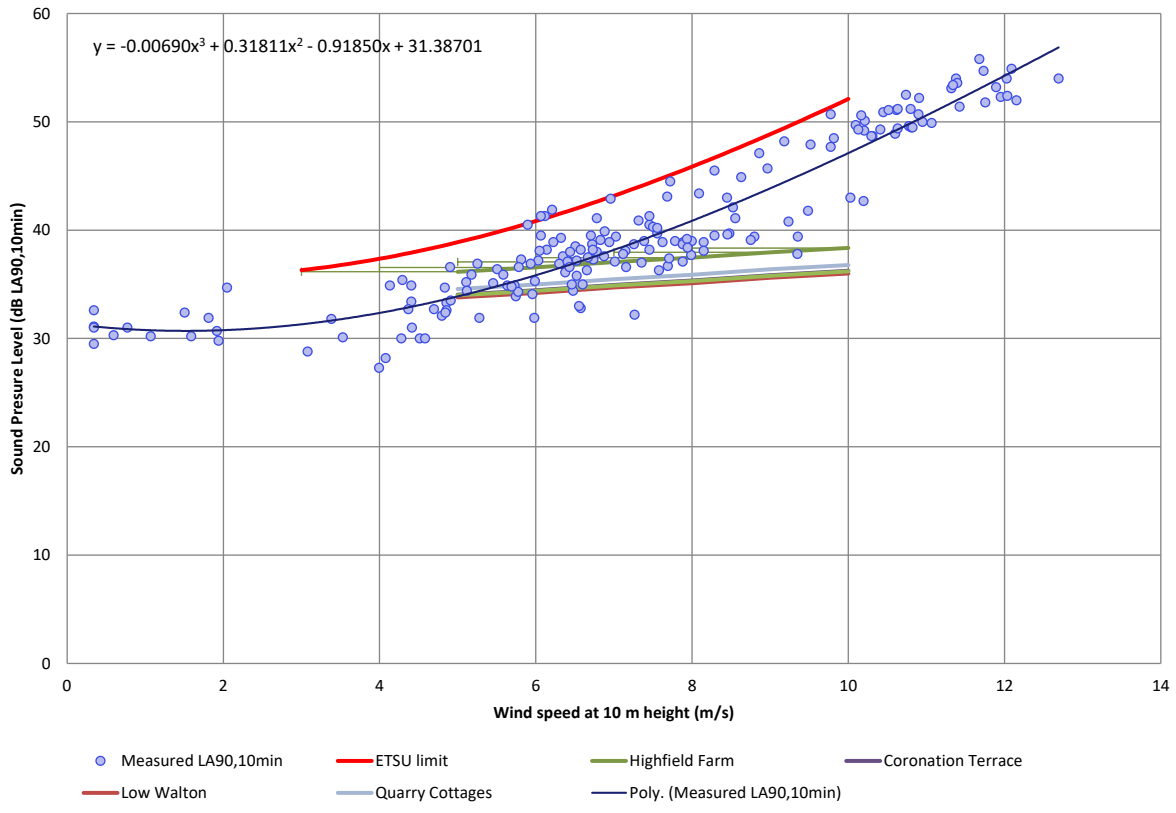


Figure 7: ETSU-R-97 Noise Impact Assessment (Vestas V47) - Night-time

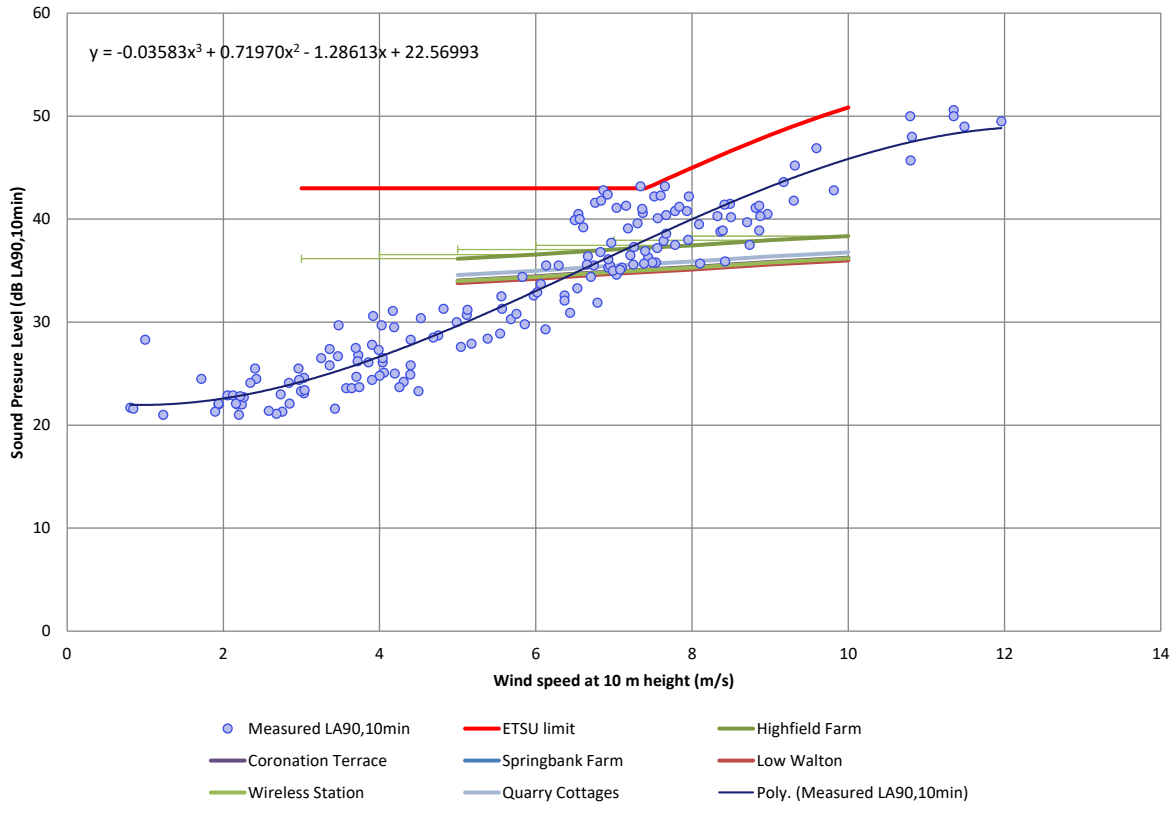


Figure 8: ETSU-R-97 Noise Impact Assessment (Vestas V52), Quiet Daytime

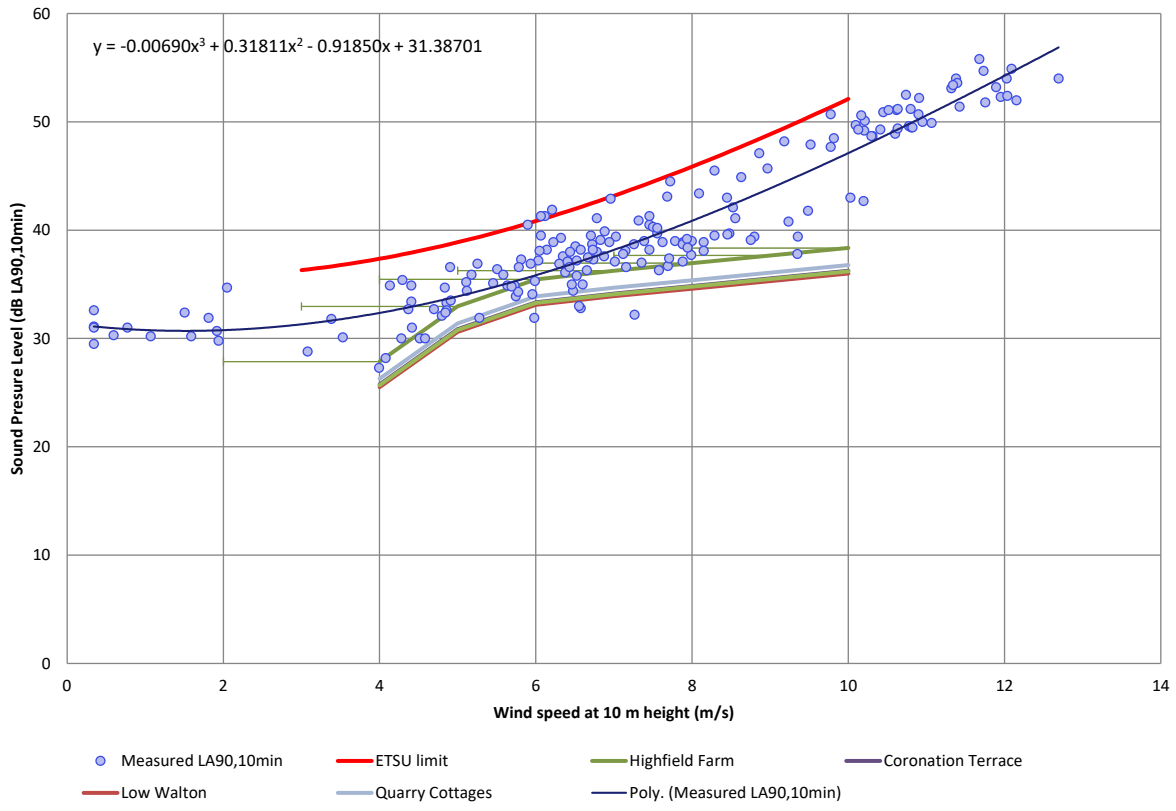
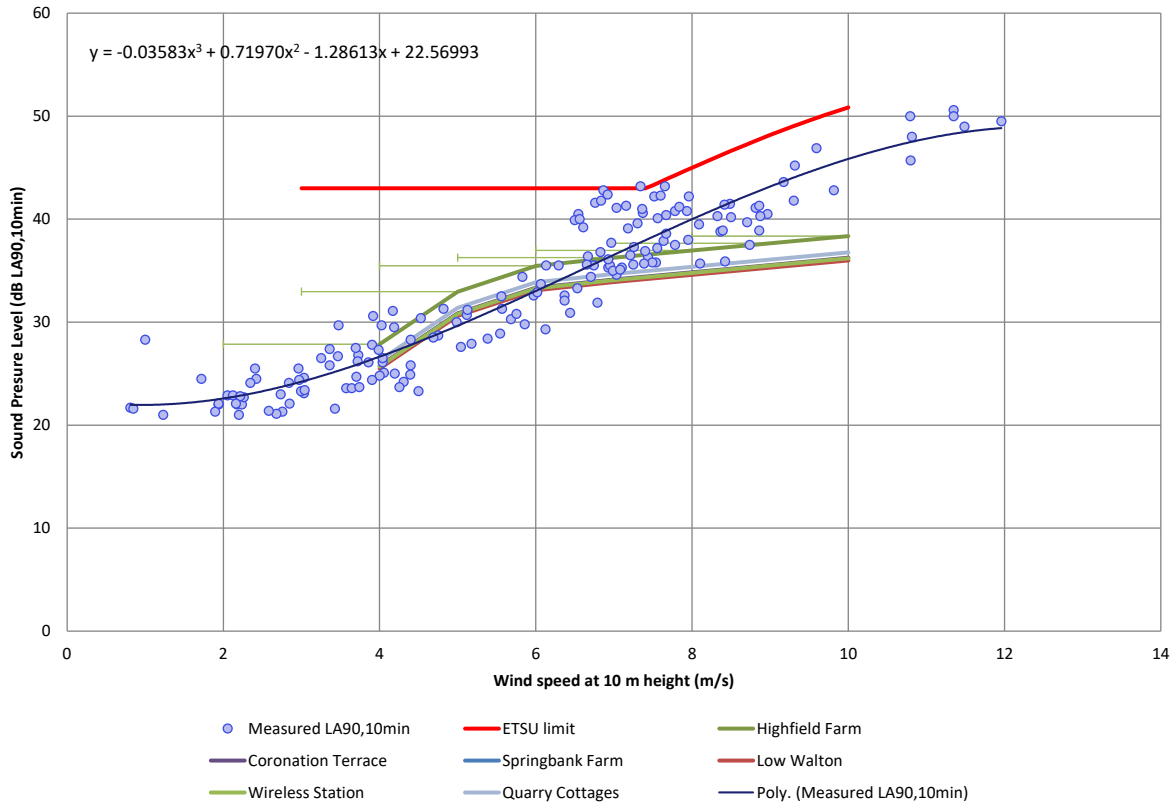


Figure 9: ETSU-R-97 Noise Impact Assessment (Vestas V52) - Night-time



APPENDIX A – ACOUSTIC TERMINOLOGY

Noise is defined as unwanted sound. The range of audible sound is from 0 to 140 dB. The frequency response of the ear is usually taken to be around 18 Hz (number of oscillations per second) to 18000 Hz. The ear does not respond equally to different frequencies at the same level. It is more sensitive in the mid-frequency range than the lower and higher frequencies and because of this, the low and high frequency components of a sound are reduced in importance by applying a weighting (filtering) circuit to the noise measuring instrument. The weighting which is most widely used and which correlates best with subjective response to noise is the dBA weighting. This is an internationally accepted standard for noise measurements.

For variable sources, such as traffic, a difference of 3 dBA is just distinguishable. In addition, a doubling of traffic flow will increase the overall noise by 3 dBA. The 'loudness' of a noise is a purely subjective parameter, but it is generally accepted that an increase/ decrease of 10 dBA corresponds to a doubling/ halving in perceived loudness.

External noise levels are rarely steady, but rise and fall according to activities within an area. In attempt to produce a figure that relates this variable noise level to subjective response, a number of noise indices have been developed. These include:

i) The L_{Amax} noise level

This is the maximum noise level recorded over the measurement period.

ii) The L_{Aeq} noise level

This is "equivalent continuous A-weighted sound pressure level, in decibels" and is defined in British Standard BS 7445 as the "value of the A-weighted sound pressure level of a continuous, steady sound that, within a specified time internal, T, has the same mean square sound pressure as a sound under consideration whose level varies with time".

It is a unit commonly used to describe construction noise and noise from industrial premises and is the most suitable unit for the description of other forms of environmental noise. In more straightforward terms, it is a measure of energy within the varying noise.

iii) The L_{A10} noise level

This is the noise level that is exceeded for 10% of the measurement period and gives an indication of the noisier levels. It is a unit that has been used over many years for the measurement and assessment of road traffic noise.

iv) The L_{A90} noise level

This is the noise level that is exceeded for 90% of the measurement period and gives an indication of the noise level during the quieter periods. It is often referred to as the background noise level and is used in the assessment of disturbance from industrial noise.

APPENDIX B – INSTRUMENTATION CALIBRATION CERTIFICATES

ANV MEASUREMENT SYSTEMS

CERTIFICATE OF CALIBRATION

ilac-MRA UKAS CALIBRATION 0653

Date of Issue: 26 February 2024

Certificate Number: UCRT24/1310

Calibrated at & Certificate issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Page 1 of 2 Pages

Approved Signatory

K. Mistry

Customer: 24 Acoustics Limited, Armstrong House, 3 Bassett Avenue, Southampton, SO16 7DP

Order No. SG

Description: Sound Level Meter / Pre-amp / Microphone / Associated Calibrator

Identification:

Manufacturer	*Instrument*	*Type*	*Serial No. / Version*
Rion	Sound Level Meter	NL-52	00610211
Rion	Firmware		2.0
Rion	Pre Amplifier	NH-25	10205
Rion	Microphone	UC-59	05742
Rion	Calibrator	NC-75	34334830
	Calibrator adaptor type if applicable		NC-75-022

Performance Class 1

Test Procedure: TP 2.SLM 61672-3 TPS-49

Procedures from IEC 61672-3:2006 were used to perform the periodic tests.

Type Approved to IEC 61672-1:2002 YES Approval Number 21.21 / 13.02

If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

Date Received 22 February 2024 ANV Job No. UKAS24/02168

Date Calibrated 26 February 2024

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent testing organisation responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2003, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002, the sound level meter submitted for testing conforms to the class 1 requirements of IEC 61672-1:2002.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	22 May 2023	UCRT23/1690	0653

Calibration Certificate

Calibration undertaken by Noise and Vibration Calibration Services Ltd
The Old Kennels Building, 3 Bassett Avenue, Southampton, SO16 7DP
+44 (0)23 8155 5020 hello@nvcal.co.uk

IEC 60942:2003 Calibration

Periodic tests were performed in accordance with procedures from Annex B of IEC 60942:2003 (using the Insert Voltage Technique) on **3rd May 2023** for the following sound calibrator:

Brüel & Kjær 4231, serial number 2432098

Calibration result

Sound Calibrator: Brüel & Kjær 4231, serial 2432098
Performance Specification: IEC 60942:2003 Class 1
Date: 3rd May 2023
Certificate Number: C00433

PASS

Approved Signatory: .....

Test results

Level		**94.00**	**dB** re 20 µPa	+/- 0.091 dB
		114.05	**dB** re 20 µPa	+/- 0.091 dB
Frequency	@ 94 dB	**999.988**	**Hz**	+/- 0.01 Hz
	@ 114 dB	**999.988**	**Hz**	+/- 0.01 Hz
Distortion	@ 94 dB	**0.55**	**%**	+/- 0.021 %
	@ 114 dB	**0.18**	**%**	+/- 0.012 %

Notes

As public evidence was available, from a testing organisation (PTB) responsible for approving the result of pattern evaluation tests, to demonstrate that the model of sound calibrator fully confirmed to the requirements for pattern evaluation described in Annex A of IEC 60942:2003, the sound calibrator tested is considered to confirm to all the class 1 requirements of IEC 60942:2003.

This certificate provides traceability of measurement to the SI system of units and to units of measurements realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

APPENDIX C – ENERCON E48 NOISE SOURCE REPORT

Sound Power Level of the ENERCON E-48 Reduced Modes (Data Sheet)

Imprint

Publisher: ENERCON GmbH ▪ Dreekamp 5 ▪ 26605 Aurich ▪ Germany
Phone: +49 4941 927-0
Fax: +49 4941 927-109

Revision

Revision: 1.1

Department: ENERCON GmbH / Site Assessment

Glossary

WEC	means an ENERCON wind energy converter.
WECs	means more than one ENERCON wind energy converter.

Document information:		© Copyright ENERCON GmbH. All rights reserved.	
Author/Revisor/ date:	Sr / June 2012	Documentname	SIAS-04-SPL E48 red Rev1.1 eng-eng.doc
Approved / date:	RWo / June 2012	Revision /date:	1.1 / June 2012
Translation / date:			

ENERCON ENERGY FOR THE WORLD	Sound Power Level E-48	Page 2 of 2

Sound Power Levels for the E-48 with reduced rated power

Sound Power Levels for the E-48 with reduced rated power					
	$P_{N,red}$=700 kW $n_{N,red}$=29,0 U/min	$P_{N,red}$=600 kW $n_{N,red}$=28,5 U/min	$P_{N,red}$=500 kW $n_{N,red}$=28,0 U/min	$P_{N,red}$=400 kW $n_{N,red}$=26,5 U/min	$P_{N,red}$=300 kW $n_{N,red}$=25,0 U/min
95% rated power	101.5 dB(A)	100.6 dB(A)	100.0 dB(A)	98.5 dB(A)	97.5 dB(A)

Measured value at 95% nominal power		***99,6 dB(A)*** *WICO 439SEC04/02*	***99,0 dB(A)*** *MBBM 69 130/1*		***95,6 dB(A)*** *MBBM 64 550/6*

1. The respective SPL is given for 95% $P_{N,red}$ and is therefore valid for all hub heights.
2. A tonal audibility of $\Delta L_{a,k}$ < 2 dB can be expected over the whole operational range (valid in the near vicinity of the turbine according to IEC 61 400 -11 ed. 2).
3. The sound power level values given in the table are valid for the respective reduced Modes (defined via the reduced rated power $P_{N,red}$ and the reduced rated rotational speed $n_{N,red}$).
4. The power curves for the respective reduced modes are given in a separate document which can be made available upon request.
5. Due to the typical measurement uncertainties, if the sound power level is measured according to one of the accepted methods the measured values can differ from the values shown in this document in the range of +/- 1 dB.

   Accepted measurement methods are:

   a) IEC 61400-11 ed. 2 („Wind turbine generator systems – Part 11: Acoustic noise measurement techniques; Second edition"), and

   b) the FGW-Guidelines („Technische Richtlinie für Windenergieanlagen – Teil 1: Bestimmung der Schallemissionswerte", published by the association "Fördergesellschaft für Windenergie e.V.", 18th revision).

   If the difference between total noise and background noise during a measurement is less than 6 dB a higher uncertainty must be considered.
6. Sound Power values for further reduced modes can be provided upon request.
7. The sound power level of a wind turbine depends on several factors such as but not limited to regular maintenance and day-to-day operation in compliance with the manufacturer's operating instructions. Therefore, this data sheet can not, and is not intended to, constitute an express or implied warranty towards the customer that the E-48 WEC will meet the exact sound power level values as shown in this document at any project specific site.

Document information:			
Author/Revisor/ date: Approved / date: Translation / date:	Sr / June 2012 RWo / June 2012	Documentname Revision /date:	SIAS-04-SPL E48 red Rev1.1 eng-eng.doc 1.1 / June 2012

Extract of test report **page 1/2**

Master Sheet "Noise", according to "Technische Richtlinien für Windenergieanlagen, Teil 1: Bestimmung der Schallemissionswerte"
Method of calculating apparent sound power level to another hub height according to Annex C of [1] and [2]

Extract of test report M64 550/8
regarding noise emission of wind turbine (WT) Enercon E-48

General		Technical specifications (manufacturer)	
Manufacturer:	Enercon GmbH Dreekamp 5 26605 Aurich	Rated power (generator):	800 kW
		Rotor diameter:	48 m
		Hub height above ground:	60 m
Serial number:	48184	Tower design:	tube tower
WT-location:	RW: 35.10.132 HW: 58.26.563	material:	precast concrete parts
		Power control:	pitch
Complementations of rotor (manufacturer)		**Complementations of gear and generator (manufacturer)**	
blades:	Enercon GmbH	Manufacturer of gear:	---
Type of blades:	E48/1	Type of gear:	---
Pitch angel:	variabel	Manufacturer of generator:	Enercon GmbH
Number of blades:	3	Type of generator:	E-48
Rated speed(s)/speed range:	16 - 30 rpm (mode I)	Rated speed(s)/speed range:	16 - 30 rpm (mode I)
test report of power curve:	Enercon GmbH: Calculated output curve of the E-48 from august 2004		

	Reference		Noise emission parameter	Remarks
	Standardized wind speed at 10 m above ground	Electric power		
Sound Power level $L_{WA,P}$	6 m/s	287,7 kW	98,7 dB(A)	
	7 m/s	460,6 kW	100,2 dB(A)	
	8 m/s	639,6 kW	102,1 dB(A)	
	9 m/s	751,8 kW	102,3 dB(A)	
	10 m/s	798,6 kW	101,3 dB(A)	
	9,2 m/s	*760,0 kW*	*102,2 dB(A)*	[3]
Tonality (close-up range) K_{TN}	6 m/s	287,7 kW	--- dB	
	7 m/s	460,6 kW	--- dB	
	8 m/s	639,6 kW	--- dB	
	9 m/s	751,8 kW	--- dB	
	10 m/s	798,6 kW	--- dB	
	9,2 m/s	*760,0 kW*	*--- dB*	[3]
Impulsivity (close-up range) K_{IN}	6 m/s	287,7 kW	--- dB	
	7 m/s	460,6 kW	--- dB	
	8 m/s	639,6 kW	--- dB	
	9 m/s	751,8 kW	--- dB	
	10 m/s	798,6 kW	--- dB	
	9,2 m/s	*760,0 kW*	*--- dB*	[3]

one third octave sound power level at reference point v_{10} = 6 m/s

frequency	50	63	80	100	125	160	200	250	315	400	500	630
$L_{WA,P,1/3\_octave}$	74,3	77,2	80,0	81,7	83,8	85,7	87,2	89,8	90,0	90,0	90,0	87,7
frequency	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
$L_{WA,P,1/3\_octave}$	86,8	85,2	82,7	80,3	79,3	78,0	77,0	76,9	75,3	73,0	72,0	71,0

octave sound power level at reference point v_{10} = 6 m/s

requency	63	125	250	500	1000	2000	4000	8000
$L_{WA,P,octave}$	82,5	88,8	93,9	94,1	90,0	84,1	81,2	76,8

one third octave sound power level at reference point v_{10} = 7 m/s

requency	50	63	80	100	125	160	200	250	315	400	500	630
$L_{WA,P,1/3\_octave}$	73,4	77,6	80,8	82,6	84,9	87,2	88,9	91,5	91,9	91,4	91,4	89,2
requency	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
$L_{WA,P,1/3\_octave}$	88,5	86,6	84,1	81,6	80,8	79,7	79,1	78,9	76,1	73,0	71,1	69,6

octave sound power level at reference point v_{10} = 7 m/s

requency	63	125	250	500	1000	2000	4000	8000
$L_{WA,P,octave}$	83,0	90,0	95,7	95,5	91,5	85,5	83,0	76,2

one third octave sound power level at reference point v_{10} = 8 m/s

frequency	50	63	80	100	125	160	200	250	315	400	500	630
$L_{WA,P,1/3\_octave}$	75,9	79,2	83,1	85,0	87,2	89,7	91,1	93,3	93,6	93,0	93,1	90,8
frequency	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
$L_{WA,P,1/3\_octave}$	90,0	88,5	86,2	84,2	83,2	82,2	81,5	80,8	78,0	74,8	72,4	69,9

octave sound power level at reference point v_{10} = 8 m/s

frequency	63	125	250	500	1000	2000	4000	8000
$L_{WA,P,octave}$	85,1	92,5	97,6	97,2	93,3	88,0	85,1	77,6

one third octave sound power level at reference point v_{10} = 9 m/s												
requenz	50	63	80	100	125	160	200	250	315	400	500	630
$L_{WA,P,Terz}$	76,1	79,4	83,3	85,2	87,4	89,9	91,3	93,5	93,8	93,2	93,3	91,0
requenz	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
$L_{WA,P,Terz}$	90,2	88,7	86,4	84,4	83,4	82,4	81,7	81,0	78,2	75,0	72,6	70,1

octave sound power level at reference point v_{10} = 9 m/s								
requenz	63	125	250	500	1000	2000	4000	8000
$L_{WA,P,Terz}$	85,3	92,7	97,8	97,4	93,5	88,3	85,3	77,8

one third octave sound power level at reference point v_{10} = 10 m/s												
Frequenz	50	63	80	100	125	160	200	250	315	400	500	630
$L_{WA,P,Terz}$	74,4	78,6	81,8	83,6	85,9	88,2	89,9	92,5	92,9	92,4	92,4	90,2
requenz	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
$L_{WA,P,Terz}$	89,5	87,6	85,1	82,6	81,8	80,7	80,1	79,9	77,1	74,0	72,1	70,6

octave sound power level at reference point v_{10} = 10 m/s								
Frequenz	63	125	250	500	1000	2000	4000	8000
$L_{WA,P,Terz}$	84,0	91,1	96,8	96,6	92,6	86,6	84,0	77,3

This test report extract is only valid with the manufacturer's certificate from 1.12.2006.

The declarations in this extract are only valid in combination with the test report M64 550/8 from 20.2.2007 [4] (especially for calculations of sound propagation).

Remarks:

[1] Technische Richtlinien für Windenergieanlagen, Teil 1: Bestimmung der Schallemissionswerte
Rev. 17 vom 01. Juli 2006 (Herausgeber: Fördergesellschaft Windenergie e.V., Stresemannplatz 4, D-24103 Kiel)

[2] IEC 61400-14 TS ed. 1, Declaration of Sound Power Level und Tonality Values of Wind Turbines, 2005-03

[3] The working point of 95% of the rated power, for which the maximum sound power level was stated, is according to the reference power curve and the hub height of the measured WT under standardized meteorological conditions v10= 9,2 m/s

[4 Müller-BBM testreport M64 550/8 from 20.2.2007

calculated by : Müller-BBM GmbH
brand office Gelsenkirchen
Am Bugapark 1
D-45 899 Gelsenkirchen

MÜLLER-BBM GMBH
NIEDERLASSUNG GELSENKIRCHEN
AM BUGAPARK 1
45899 GELSENKIRCHEN
TELEFON (0209) 9 83 08 - 0

Schallemission FGW 2009 Konformitätssiegel

date: 28.09.2009

Dipl.-Ing. (FH) M. Köhl

Akkreditiertes Prüflaboratorium
nach ISO/IEC 17025

Deutscher Akkreditierungs Rat
DAP-PL-2465.10

APPENDIX D – VESTAS V47 NOISE SOURCE REPORT

11.3 Enclosure 2, noise measurement

11.4 Noise resume of VESTAS V47-660 kW Wind Turbine

1. The measurement has been done by:

   Acoustica as
   Fælledvej 3
   8800 Viborg

   under the accreditation, registration no. 134, from DANAK.

2. This resume has been worked out on September 3, 1996 by Vestas Wind Systems A/S.

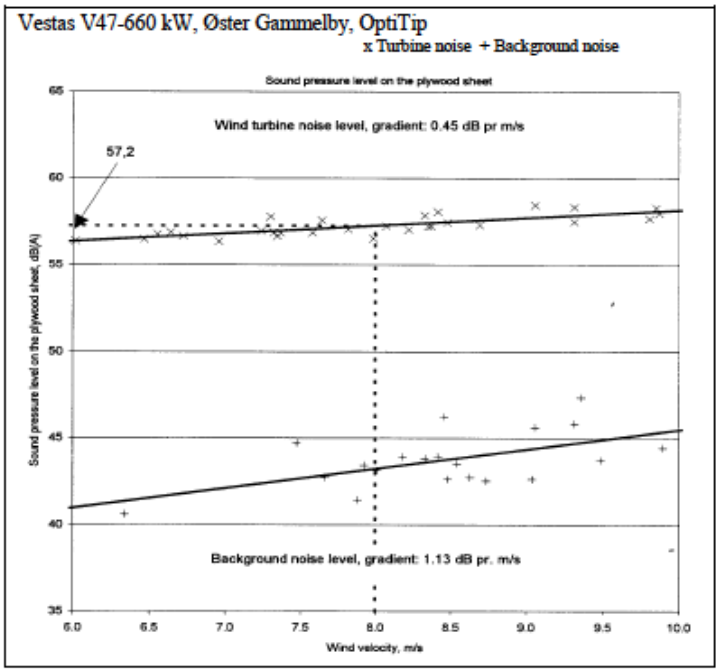
3. The noise measurements have been reported in Acoustica report no. P4.010.97 dated August 6, 1997. The noise measurements has been carried out July 28, 1997.

4. The measurements were carried out to determine the noise emission from a VESTAS V47-660 kW.

5. The noise emission has been determined according to statutorial order no. 304 of may, 14, 1991, and relevant parts of Guideline no. 6/1984, "Noise from Industrial Plants", from the Danish Ministry of the Environment.

6. Results of Measurements:

6a.



The apparent A-

weighted sound power level can be calculated from the equivalent continuous A-weighted sound pressure level, using the following expression:

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

Where, d = distance from the base of the wind turbine to the measurement position (d= 75m).
h = hub height (h = 40,5m + 0,5m).

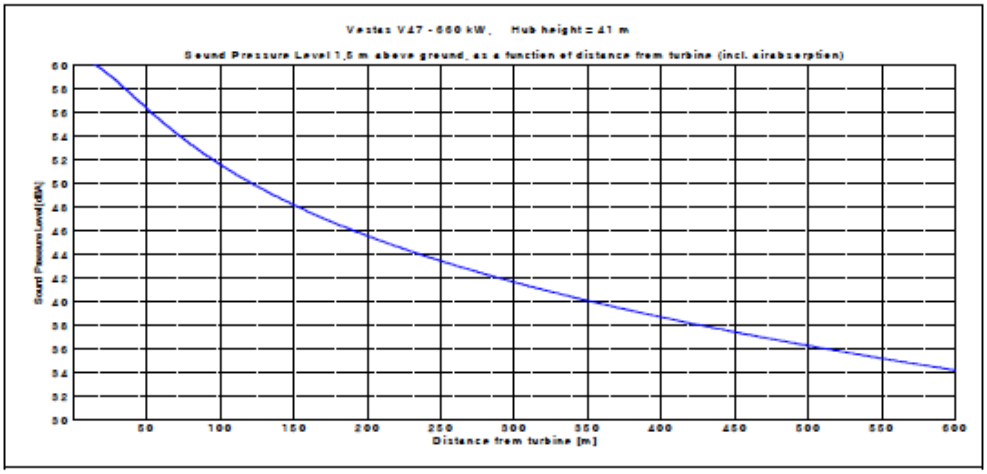
6b. The measurement show the following results at a wind speed of 8 m/s. The measurements is given respectively, as the A-weighted sound pressure level $L_{Aeq,ref}$ and the A-weighted sound power level $L_{WA,ref}$.

Frequency	$L_{Aeq,ref}$ [dB(A)]	$L_{WA,ref}$ [dB(A)]
1/1 octave 63 Hz	34,6	78,2
1/1 octave 125 Hz	42,5	86,1
1/1 octave 250 Hz	46,2	89,8
1/1 octave 500 Hz	51,6	95,2
1/1 octave 1 kHz	53,4	97,0
1/1 octave 2 kHz	49,2	92,9
1/1 octave 4 kHz	44,2	87,9
1/1 octave 8 kHz	25,6	69,2
A-weighted, total	57,2	100,8

According to statoturial order no. 304 of May 14, 1991, from the Danish Ministry of the Environment, the degree of accuracy on the results is ±2 dB.

6c. An analysis of the noise in a distance of 75 meter show, that the noise from the turbine contains no clearly audible tones or impulses. The analysis has been performed according to guideline no. 6/1984, "Noise from Industrial Plants", from the Danish Ministry of the Environment.

6d.



APPENDIX E – VESTAS V52 NOISE SOURCE REPORT

Schallleistungspegel /
Acoustic Noise Level
V52-850 kW
OptiSpeed™-Windenergieanlage

Rev. 5
2007-07-23

1.5. Betriebsmode 100 dB(A)

1.5.1. Verifizierende Richtlinie: IEC 61400-11

1.5. Mode 100 dB(A)

1.5.1. Verification Standard: IEC 61400-11

Schallleistungspegel in Nabehöhe ,V52-850kW, Betriebsmode 100 dB(A) ***Sound Power Level at Hub Height, V52-850kW, Mode 100 dB(A)***										
Umgebungsbedingungen / ***ambient conditions:***	Windscherung wie in der Tabelle unten beschrieben / *Wind shear as described in table below.*									
	Maximale Turbulenz in 10 m Höhe ü.G. / *Max turbulence at 10 meter height:*					0.16				
	Vertikaler Anströmwinkel / Inflow angle (vertical):					0 ± 2°				
	Luftdichte / *Air density*:					1.225 kg/m3				
Allgemeine Bedingungen/ ***General conditions:***	Verifizierende Richtlinie / *verification standard:*					IEC 61400-11 Ed. 2				
	Genauigkeit / *Accuracy:*					± 2dB(A)				
Nabenhöhe / ***Hub height*** **[m]**	**36.5**	**40**	**44**	**49**	**55**	**60**	**65**	**70**	**74**	**86**
Windscherung / *Wind shear*	0.16									
	[dB(A) re 1pW]									
L_{WA} @ 4m/s (10 m. ü. G.) / L_{WA} @ 4m/s (10 m. a. g. l)	89.8	90.0	90.3	90.7	91.1	91.3	91.6	91.8	92.0	92.5
L_{WA} @ 5m/s (10 m. ü. G.) / L_{WA} @ 5m/s (10 m. a. g. l)	94.8	95.1	95.4	95.8	96.2	96.5	96.7	97.0	97.1	97.6
L_{WA} @ 6m/s (10 m. ü. G.) / L_{WA} @ 6m/s (10 m. a. g. l)	98.0	98.1	98.2	98.3	98.4	98.5	98.5	98.6	98.6	98.7
L_{WA} @ 7m/s (10 m. ü. G.) / L_{WA} @ 7m/s (10 m. a. g. l)	98.9	98.9	99.0	99.1	99.2	99.2	99.3	99.3	99.4	99.5
L_{WA} @ 8m/s (10 m. ü. G.) / L_{WA} @ 8m/s (10 m. a. g. l)	99.6	99.6	99.7	99.8	99.9	99.9	100.1	100.1	100.1	100.4
L_{WA} @ 9m/s (10 m. ü. G.) / L_{WA} @ 9m/s (10 m. a. g. l)	100.2	100.3	100.4	100.5	100.6	100.7	100.7	100.8	100.8	101.0
L_{WA} @ 10m/s (10 m. ü. G.) / L_{WA} @ 10m/s (10 m. a. g. l)	100.8	100.9	101.2	101.2	101.2	101.3	101.4	101.5	101.6	101.7

m. ü. G.: Meter über Grund
m. a. g .l: meter above ground level

1.5.2. Verifizierende Richtlinie: FGW

1.5.2. Verification Standard: FGW

Schallleistungspegel in Nabehöhe ,V52-850kW, Betriebsmode 100 dB(A) ***Sound Power Level at Hub Height, V52-850kW, Mode 100 dB(A)***										
Umgebungsbedingungen / *ambient condition:*	Windscherung wie in der Tabelle unten beschrieben / *Wind shear as described in table below.*									
	Maximale Turbulenz in 10 m Höhe ü.G. / *Max turbulence at 10 meter height:* 0.16									
	Vertikaler Antrömwinkel / Inflow angle (vertical): 0 ± 2°									
	Luftdichte / *Air density*: 1.225 kg/m3									
Allgemeine Bedingungen/ *General conditions:*	Verifizierende Richtlinie / *verification standard:* FGW Teil 1, Rev. 17 FGW part 1, Rev. 17									
	Genauigkeit / *Accuracy:* +/- 2dB(A)									
Nabenhöhe / *Hub height* [m]	**36.5**	**40**	**44**	**49**	**55**	**60**	**65**	**70**	**74**	**86**
Windscherung / *Wind shear*	0.16									
	[dB(A) re 1pW]									
L_{WA} @ 6-10m/s (10 m. ü. G.) / L_{WA} @ 6-10m/s (10 m. a. g. l)	100.5	100.5	100.5	100.5	100.5	100.5	100.5	100.5	100.5	100.5

m. ü. G.: Meter über Grund
m. a. g .l: meter above ground level

APPENDIX F – RECEPTOR NOISE LEVEL SUMMARY TABLES

Highfield Farm, Quiet Daytime						
Wind speed (m/s)	5	6	7	8	9	10
Background Noise Level (dB)	33.9	35.8	38.2	40.9	43.9	47.1
ETSU-R-97 Noise Limit (dB)	38.9	40.8	43.2	45.9	48.9	52.1
Turbine Noise Level (dB)	36.2	36.6	37.1	37.5	38.0	38.4
Excess Over Limit (dB)	-2.7	-4.3	-6.1	-8.4	-10.9	-13.8
Highfield Farm, Night-time						
Wind speed (m/s)	5	6	7	8	9	10
Background Noise Level (dB)	29.7	33.0	36.5	40.0	43.2	45.8
ETSU-R-97 Noise Limit (dB)	43.0	43.0	43.0	45.0	48.2	50.8
Turbine Noise Level (dB)	36.2	36.6	37.1	37.5	38.0	38.4
Excess Over Limit (dB)	-6.8	-6.4	-5.9	-7.5	-10.2	-12.5
Coronation Terrace, Quiet Daytime						
Wind speed (m/s)	5	6	7	8	9	10
Background Noise Level (dB)	33.9	35.8	38.2	40.9	43.9	47.1
ETSU-R-97 Noise Limit (dB)	38.9	40.8	43.2	45.9	48.9	52.1
Turbine Noise Level (dB)	34.1	34.5	35.0	35.4	35.9	36.3
Excess Over Limit (dB)	-4.8	-6.4	-8.2	-10.5	-13.0	-15.9
Coronation Terrace, Night-time						
Wind speed (m/s)	5	6	7	8	9	10
Background Noise Level (dB)	29.7	33.0	36.5	40.0	43.2	45.8
ETSU-R-97 Noise Limit (dB)	43.0	43.0	43.0	45.0	48.2	50.8
Turbine Noise Level (dB)	34.1	34.5	35.0	35.4	35.9	36.3
Excess Over Limit (dB)	-9.0	-8.6	-8.1	-9.6	-12.3	-14.6
Low Walton, Quiet Daytime						
Wind speed (m/s)	5	6	7	8	9	10
Background Noise Level (dB)	33.9	35.8	38.2	40.9	43.9	47.1
ETSU-R-97 Noise Limit (dB)	38.9	40.8	43.2	45.9	48.9	52.1
Turbine Noise Level (dB)	33.8	34.2	34.7	35.1	35.6	36.0
Excess Over Limit (dB)	-5.1	-6.6	-8.5	-10.8	-13.3	-16.1
Low Walton, Night-time						
Wind speed (m/s)	5	6	7	8	9	10
Background Noise Level (dB)	29.7	33.0	36.5	40.0	43.2	45.8
ETSU-R-97 Noise Limit (dB)	43.0	43.0	43.0	45.0	48.2	50.8
Turbine Noise Level (dB)	33.8	34.2	34.7	35.1	35.6	36.0
Excess Over Limit (dB)	-9.2	-8.8	-8.3	-9.9	-12.6	-14.8
Wireless Station, Quiet Daytime						
Wind speed (m/s)	5	6	7	8	9	10
Background Noise Level (dB)	33.9	35.8	38.2	40.9	43.9	47.1
ETSU-R-97 Noise Limit (dB)	38.9	40.8	43.2	45.9	48.9	52.1
Turbine Noise Level (dB)	34.0	34.4	34.9	35.3	35.8	36.2
Excess Over Limit (dB)	-4.9	-6.4	-8.3	-10.6	-13.1	-15.9
Wireless Station, Night-time						
Wind speed (m/s)	5	6	7	8	9	10
Background Noise Level (dB)	29.7	33.0	36.5	40.0	43.2	45.8
ETSU-R-97 Noise Limit (dB)	43.0	43.0	43.0	45.0	48.2	50.8
Turbine Noise Level (dB)	34.0	34.4	34.9	35.3	35.8	36.2
Excess Over Limit (dB)	-9.0	-8.6	-8.1	-9.7	-12.4	-14.7
Quarry Cottages, Quiet Daytime						
Wind speed (m/s)	5	6	7	8	9	10
Background Noise Level (dB)	33.9	35.8	38.2	40.9	43.9	47.1
ETSU-R-97 Noise Limit (dB)	38.9	40.8	43.2	45.9	48.9	52.1
Turbine Noise Level (dB)	34.6	35.0	35.5	35.9	36.4	36.8
Excess Over Limit (dB)	-4.3	-5.9	-7.7	-10.0	-12.5	-15.3
Quarry Cottages, Night-time						
Wind speed (m/s)	5	6	7	8	9	10
Background Noise Level (dB)	29.7	33.0	36.5	40.0	43.2	45.8
ETSU-R-97 Noise Limit (dB)	43.0	43.0	43.0	45.0	48.2	50.8
Turbine Noise Level (dB)	34.6	35.0	35.5	35.9	36.4	36.8
Excess Over Limit (dB)	-8.4	-8.0	-7.5	-9.1	-11.8	-14.1

Table F1: Predicted Noise Levels (Vestas V47) vs ETSU-R-97 Derived Noise Limits

Highfield Farm, Quiet Daytime							
Wind speed (m/s)	4	5	6	7	8	9	10
Background Noise Level (dB)	32.4	33.9	35.8	38.2	40.9	43.9	47.1
ETSU-R-97 Noise Limit (dB)	37.4	38.9	40.8	43.2	45.9	48.9	52.1
Turbine Noise Level (dB)	27.9	33.0	35.5	36.3	37.0	37.7	38.4
Excess Over Limit (dB)	-9.5	-5.9	-5.4	-6.9	-8.9	-11.2	-13.8
Highfield Farm, Night-time							
Wind speed (m/s)	4	5	6	7	8	9	10
Background Noise Level (dB)	26.6	29.7	33.0	36.5	40.0	43.2	45.8
ETSU-R-97 Noise Limit (dB)	43.0	43.0	43.0	43.0	45.0	48.2	50.8
Turbine Noise Level (dB)	27.9	33.0	35.5	36.3	37.0	37.7	38.4
Excess Over Limit (dB)	-15.1	-10.0	-7.5	-6.7	-8.0	-10.5	-12.5
Coronation Terrace, Quiet Daytime							
Wind speed (m/s)	4	5	6	7	8	9	10
Background Noise Level (dB)	32.4	33.9	35.8	38.2	40.9	43.9	47.1
ETSU-R-97 Noise Limit (dB)	37.4	38.9	40.8	43.2	45.9	48.9	52.1
Turbine Noise Level (dB)	25.8	30.9	33.4	34.2	34.9	35.6	36.3
Excess Over Limit (dB)	-11.6	-8.0	-7.5	-9.0	-11.0	-13.3	-15.9
Coronation Terrace, Night-time							
Wind speed (m/s)	4	5	6	7	8	9	10
Background Noise Level (dB)	26.6	29.7	33.0	36.5	40.0	43.2	45.8
ETSU-R-97 Noise Limit (dB)	43.0	43.0	43.0	43.0	45.0	48.2	50.8
Turbine Noise Level (dB)	25.8	30.9	33.4	34.2	34.9	35.6	36.3
Excess Over Limit (dB)	-17.3	-12.2	-9.7	-8.9	-10.1	-12.6	-14.6
Low Walton, Quiet Daytime							
Wind speed (m/s)	4	5	6	7	8	9	10
Background Noise Level (dB)	32.4	33.9	35.8	38.2	40.9	43.9	47.1
ETSU-R-97 Noise Limit (dB)	37.4	38.9	40.8	43.2	45.9	48.9	52.1
Turbine Noise Level (dB)	25.5	30.6	33.1	33.9	34.6	35.3	36.0
Excess Over Limit (dB)	-11.9	-8.3	-7.7	-9.3	-11.3	-13.6	-16.1
Low Walton, Night-time							
Wind speed (m/s)	4	5	6	7	8	9	10
Background Noise Level (dB)	26.6	29.7	33.0	36.5	40.0	43.2	45.8
ETSU-R-97 Noise Limit (dB)	43.0	43.0	43.0	43.0	45.0	48.2	50.8
Turbine Noise Level (dB)	25.5	30.6	33.1	33.9	34.6	35.3	36.0
Excess Over Limit (dB)	-17.5	-12.4	-9.9	-9.1	-10.4	-12.9	-14.8
Wireless Station, Quiet Daytime							
Wind speed (m/s)	4	5	6	7	8	9	10
Background Noise Level (dB)	32.4	33.9	35.8	38.2	40.9	43.9	47.1
ETSU-R-97 Noise Limit (dB)	37.4	38.9	40.8	43.2	45.9	48.9	52.1
Turbine Noise Level (dB)	25.7	30.8	33.3	34.1	34.8	35.5	36.2
Excess Over Limit (dB)	-11.7	-8.1	-7.5	-9.1	-11.1	-13.4	-15.9
Wireless Station, Night-time							
Wind speed (m/s)	4	5	6	7	8	9	10
Background Noise Level (dB)	26.6	29.7	33.0	36.5	40.0	43.2	45.8
ETSU-R-97 Noise Limit (dB)	43.0	43.0	43.0	43.0	45.0	48.2	50.8
Turbine Noise Level (dB)	25.7	30.8	33.3	34.1	34.8	35.5	36.2
Excess Over Limit (dB)	-17.3	-12.2	-9.7	-8.9	-10.2	-12.7	-14.7
Quarry Cottages, Quiet Daytime							
Wind speed (m/s)	4	5	6	7	8	9	10
Background Noise Level (dB)	32.4	33.9	35.8	38.2	40.9	43.9	47.1
ETSU-R-97 Noise Limit (dB)	37.4	38.9	40.8	43.2	45.9	48.9	52.1
Turbine Noise Level (dB)	26.3	31.4	33.9	34.7	35.4	36.1	36.8
Excess Over Limit (dB)	-11.1	-7.5	-7.0	-8.5	-10.5	-12.8	-15.3
Quarry Cottages, Night-time							
Wind speed (m/s)	4	5	6	7	8	9	10
Background Noise Level (dB)	26.6	29.7	33.0	36.5	40.0	43.2	45.8
ETSU-R-97 Noise Limit (dB)	43.0	43.0	43.0	43.0	45.0	48.2	50.8
Turbine Noise Level (dB)	26.3	31.4	33.9	34.7	35.4	36.1	36.8
Excess Over Limit (dB)	-16.7	-11.6	-9.1	-8.3	-9.6	-12.1	-14.1

Table F1: Predicted Noise Levels (Vestas V52 100dB Mode) vs ETSU-R-97 Derived Noise Limits