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V150-4.2 MW 50 Hz, PO1, 228051

Results of acoustic noise measurements according to IEC 61400-11 Edition 3.0

Vestas Wind Systems A/S

Report No.: 10163788-A-1-A
Date: 2019-08-26

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Table of contents

1 EXECUTIVE SUMMARY

This report describes methods and results of a noise emission measurement according to IEC 61400-11 Edition 3.0 on a wind turbine generator system Vestas V150-4.2 MW 50 Hz near Østerild in Denmark.

2 INTRODUCTION

The order from Vestas Wind Systems A/S dated 2019-06-10 required GL Garrad Hassan Deutschland GmbH (GH-D) to carry out acoustic noise measurements on the wind turbine generator system (WTGS or 'turbine') Vestas V150-4.2 MW 50 Hz of hub height 137 m near Østerild in Denmark. From this turbine the sound power level and frequency spectra, emitted at different wind speeds, have been determined.

The results given in this report relate only to the specific turbine, weather conditions and site. The mentioned results in this report cannot be transferred to other turbines.

3 METHODS

3.1 Measurement procedure

The measurements of the acoustical emissions are performed in accordance with the legacy GH-D management system procedure /2/. This test procedure is an integral part of the management system of DNV GL.

All measurements and analysis described in this report were done in accordance with /2/ in combination with IEC 61400-11 Ed. 3.0 Wind Turbines, Part 11: Acoustic Noise Measurement Techniques, 2012-11-07 /1/.

According to /1/ the sound power level has to be analysed for wind speeds from 0.8 to 1.3 times the wind speed at 85 % of maximum power rounded to the bin centres.

Note: A measured power curve for the turbine was provided by the customer for purposes of converting the measured turbine power output into the standardised wind speed. This power curve is given in the annex.

3.2 Measurement object

Table 3-1 shows the characteristics of the measured WTGS. The remaining characteristics can be found in the manufacturer's certificate in the annex.

Table 3-1 Characteristics of the measured WTGS

Parameter	Value
Manufacturer	Vestas
Type	Vestas V150-4.2 MW 50 Hz
Mode	PO1
Rated Power	4200 kW
Site	Østerild
Turbine serial no.	228051
Hub-height above ground	137 m
Rotor diameter	150 m
Distance middle of tower to middle of blade flange	4.5 m
Gearbox type	ZF, EH1052A
Generator type	Vestas, 3 Phase IG, VND DASG 560/6M
Rotor blades	Vestas Wind Systems A/S, Vestas 73.65m
Blade additional components	Serrated trailing edges
Power control (pitch/stall)	Pitch

3.3 Course of measurements

The total measurement period lasted from 2019-06-26 08:30 h until 2019-06-26 22:00 h.
During turbine operation the measured wind speed at hub height ranged from 5.8 to 17.7 m/s.
The real electrical power output of the turbine ranged between 959 and 4213 kW.

The turbine was running continuously during the operating noise measurements. The sound pressure level was measured with a microphone on an acoustically hard board and fed into a sound level meter. The calculated A-weighted equivalent 1-second average data and the non-acoustic data were acquired by the measurement system with a sampling rate of 1 Hz. Time periods with intermittent background noise of a significant nature, e.g. passing cars, planes flying over, rain etc., were marked accordingly during the measurements and are omitted in the later evaluation. If there were random and reoccurring disturbances which could not be marked during the measurement, a later state correction by means of a comparison with the audio-recording is done.

The wind turbine generator system is sited in farmland. The surface is covered by grass/plants, therefore a typical length of 0.05 m is assumed in the following. The microphone position was chosen to minimise the effect of buildings, trees or bushes in the surrounding area of the wind turbine generator system, which might have had an influence on the measurement results. The conditions comply with free field behaviour over a reflecting plane.

During the noise measurements the meteorological conditions given in Table 3-2 were prevailing.

Table 3-2 Prevailing meteorological conditions during the measurements

Parameter	Value
Barometric pressure at 2 m height above ground [hPa]	1016 - 1018
Air temperature at 2 m height above ground [°C]	14.2 - 18.8
Prevailing wind direction	NW
Range of wind direction [°]	252 - 354
Weather conditions	Dry and bright

3.4 Measuring equipment

The used measuring equipment is listed in the annex. The equipment is tested regularly according to the management system support function /3/ which includes the requirements of the /1/ to ensure a high degree of measurement accuracy as well as data security. The complete acoustic measurement system was checked before and after the measurements using an acoustic calibrator.

3.5 Position of microphone

The microphone was placed according to /1/. The distance from the turbine to the reference measuring point, R_0 = 212.0 m, was chosen taking local circumstances into account. The height of the microphone with respect to the bottom of the turbine foundation was h_A = 0.0 m.

3.6 Position of met mast

To gain results of free wind at the turbine position the met mast was located at the marked area in Figure 1. The aim is to measure the wind speed and wind direction in free-wind conditions by means of an anemometer and wind vane mounted on a 10 m met mast. The wind speed measured at the met mast is used for background noise measurements.

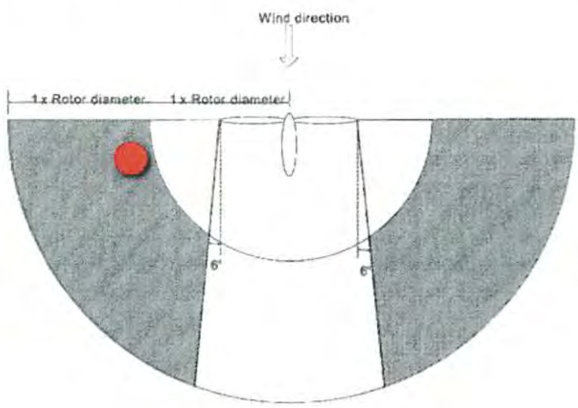

Figure 1: Position of the met mast

4 MEASUREMENT RESULTS

4.1 Determination of noise directivity

As no significant noise directivity was ascertained the reference noise measurement position was chosen to be directly downwind of the turbine. This position ensured that the worst-case sound propagation conditions were taken into account.

4.2 Sound pressure level

The microphone converts the sound pressure into a continuous analogue signal which is then fed to a sound level meter. The resulting dB value (L_{Aeq}) together with the status, the wind speed (WS) at a height of 10 m ($V_{z,m}$) and the measured power output (P_m) of the turbine, all recorded by the measurement system, is plotted against time in a graph given in the annex 9.10.

Here it can be seen at which points in time the turbine is in operation and shut down and provides an overview of the background noise in relation to the operating noise over the whole period of the measurement.

Non-normal background noises occurring in the measurement period, e.g. from aircraft or traffic, were marked during data acquisition to enable their easy omission in the evaluation to follow.

The state signal is used to differentiate between periods when the turbine is in operation and when it is stopped.

Following states have been used for evaluation in this report:

State 0: marks the data to be omitted in the evaluation,

State 0.5: depicts a stopped turbine,

State 1: depicts a turbine in operation.

In order to determine the wind speed at hub height during noise measurement of the turbine the allowed range of the power curve is taken into account based of the following equation:

$$(P_{k+1} - P_{tol}) - (P_k + P_{tol}) > 0 \qquad (1)$$

where

k is the wind speed bin number of the power curve;

P_k is the power curve value at wind speed bin k;

P_{k+1} is the power curve value above wind speed bin k;

P_{tol} is the tolerance on the power reading, in this case it is 1 % of maximum power.

All data points which exceed or are below these limitations are determined with nacelle anemometer and the wind speed from the power curve using the following relation:

$$V_{\text{nac,n}} = \kappa_{nac} \cdot V_{\text{nac,m}} \qquad (2)$$

where

$V_{nac,n}$ is the normalised wind speed from the nacelle anemometer, corrected to hub height;

$V_{nac,m}$ is the wind speed measured with the nacelle anemometer.

Outside the allowed range of the power curve the normalised WS at hub height is $V_{H,n} = V_{nac,n}$.

For this measurement κ_{nac} is determined to be κ_{nac} = 1.01.

For background noise measurements the wind speed is measured at hub height, corrected to a height of 10 m and furthermore multiplied by another K_Z factor to calculate the normalised wind speed.

$$V_{\mathrm{B,n}} = \kappa_Z \cdot V_{\mathrm{Z,m}} \tag{3}$$

where

$V_{Z,m}$ is the wind speed measured with an anemometer at height Z of at least 10 m;

$V_{B,n}$ is the normalised wind speed at hub height.

During background noise measurements: $V_{H,n} = V_{B,n}$.

For this measurement κ_Z is determined to be κ_Z = 1.14.

Besides the equivalent noise level, a 1/3-octave spectrum with centre frequencies between 20 Hz and 10 kHz is calculated from the recorded WAV files and later on is used for the evaluation of the equivalent noise level $L_{Aeq,o,j}$.

$$L_{\mathrm{Aeq,o,j}} = 10 \cdot \log \sum_{i=1}^{28} 10^{\left(\frac{L_{\mathrm{Aeq,i,j}}}{10}\right)} \tag{4}$$

$$\Delta_j = L_{\mathrm{Aeq,j}} - L_{\mathrm{Aeq,o,j}} \tag{5}$$

The difference Δ_j between the noise level and the sum of the 1/3-octave band spectrum is added to each individual band $L_{\mathrm{Aeq,n,i,j}}$ in the 1/3-octave band spectrum for each measurement period j.

$$L_{\mathrm{Aeq,n,i,j}} = L_{\mathrm{Aeq,i,j}} + \Delta_j \tag{6}$$

4.3 Sound power level

In accordance to /1/ the corrected sound pressure level for the 1/3-octave band i is the energetic difference between the total noise level and the background noise level expressed as:

$$L_{\mathrm{V,c,i,k}} = 10 \cdot \log\left(10^{0.1 \cdot L_{\mathrm{V,T,i,k}}} - 10^{0.1 \cdot L_{\mathrm{V,B,i,k}}}\right) \tag{7}$$

The corresponding sound power level $L_{WA,i,k}$ is calculated from the background corrected sound pressure level for the same 1/3-octave band as follows:

$$L_{\mathrm{WA,i,k}} = L_{\mathrm{V,c,i,k}} - 6 + 10 \cdot \lg\left(\frac{4 \cdot \pi \cdot R_1^2}{S_0}\right) \tag{8}$$

where 6 dB is the correction due to the doubled sound pressure sensed by the microphone caused by the coherent interference at the acoustically hard board.

$10 \cdot \lg\left(\frac{4 \cdot \pi \cdot R_1^2}{S_0}\right)$ corresponds to the ratio in dB of the surface area of a sphere having the radius R_1 to the reference surface area of S_0

where
$S_0 = 1\ m^2$

$$R_1 = \sqrt{(R_0 + d)^2 + (H - h_A)^2} \tag{9}$$

The total sound power level $L_{WA,k}$ of the turbine in dB in wind speed bin k is derived by energy summing all the 1/3-octave band sound power levels:

$$L_{WA,k} = 10 \cdot \log \sum_{i=1}^{28} 10^{\left(\frac{L_{WA,i,k}}{10}\right)} \quad (10)$$

The difference between the sum of the 1/3-octave bands of the total noise and the sum of the 1/3-octave band of the background noise has to be at least 3 dB. Otherwise the result shall not be reported. If the difference is larger than 3 dB and smaller than 6 dB the result shall be marked with an asterisk.

The following results are given in the annex:

- A plot of $L_{T,c,l,k}$ and $L_{v,B,l,k}$ against wind speed;
- A plot of L_{Aeq} against power;
- A plot of rotor speed against power;
- A plot of met mast wind speed against wind speed from power curve;
- A plot of nacelle wind speed against wind speed from power curve;
- A time plot of the measurement.

For the Vestas V150-4.2 MW 50 Hz in the present configuration the apparent sound power levels are given in Table 6-1.

4.4 Tonal and frequency analysis

In accordance with the international standard /1/ a tonal analysis is carried out. The frequency spectrum of the noise measured on the acoustically hard board is determined on the basis of a narrow band analysis. This analysis is performed after the measurements using the recorded audio signal.

The results of the tonal analysis of the Vestas V150-4.2 MW 50 Hz according to /1/ are given in Table 6-1.

4.5 One-third octave analysis

The A-weighted sound spectra at all the wind speed bins are given in the annex.

4.6 Uncertainties

4.6.1 Type B uncertainties

For these measurements all the type B measurement uncertainty components as specified in the international standard /1/ are given in Table 4-1. For all of the type B uncertainties mentioned here, a rectangular distribution of possible values is assumed for simplicity with a range described as "±a". The standard deviation for such a distribution is

$$U = \frac{a}{\sqrt{3}} \quad (11)$$

Table 4-1 Type B measurement uncertainty components

Parameter	Value
Calibration, U_{B1}	0.2 dB
Instruments, U_{B2}	Taken from calibration certificates
Board, U_{B3}	0.3 dB
Wind screen insertion loss, U_{B4}	Depending on the frequency
Distance and direction of microphone, U_{B5}	0.1 dB
Air absorption, U_{B6}	Usually no uncertainty assumption
Weather, U_{B7}	0.5 dB
Wind speed (measured), U_{B8} 1)	0.7 m/s
Wind speed (derived), U_{B8} 2)	0.2 m/s
Wind speed from power curve, U_{B9}	0.2 m/s

1) through nacelle anemometer or met mast
2) through power curve

4.6.2 Uncertainty on the wind speed

Before calculating the sound power level uncertainty, the uncertainty on the average wind speed per bin needs to be considered. Specifications are given in the international standard /1/.

The values per bin shall be averaged arithmetically as:

$$\overline{V}_k = \frac{1}{N} \cdot \sum_{j=1}^{N} V_{j,k} \tag{12}$$

where

N is the number of measurements in wind speed bin k;

$V_{j,k}$ is the average value of the wind speed at measurement period j in wind speed bin k.

The type A uncertainty on the average wind speed in the k-th bin is calculated as:

$$s_{V,\mathrm{k}} = \sqrt{\frac{\sum_{j=1}^{N}\left(V_{\mathrm{j,k}} - \overline{V}_k\right)^2}{N \cdot (N-1)}} \tag{13}$$

where

$V_{j,k}$ is the average value of the wind speed at measurement period j;

$\overline{V}_k$ is the average wind speed in the wind-speed bin k.

The type B uncertainty on the wind speed u_{V_j} for each measurement period j is calculated as:

$$u_{V_\mathrm{j}} = \sqrt{\sum_{q=8}^{9} u_{V_{j,q}}^2} \tag{14}$$

Where $u_{V_{j,q}}$ is the type B uncertainty due to the source q on the average wind speed for each measurement period j. Information about the sources are given in Table 4-1.

The type B uncertainty $u_{V,\mathrm{k}}$ on the average wind speed bin k is calculated as:

$$u_{V,k} = \sqrt{\frac{1}{N} \cdot \sum_{j=1}^{N} u_{V_j}^2} \tag{15}$$

The combined uncertainty $u_{com,V,k}$ can be expressed as:

$$u_{com,V,k} = \sqrt{s_{V,k}^2 + u_{V,k}^2} \tag{16}$$

4.6.3 Uncertainty on the average sound spectra

For each 1/3-octave band i the average sound pressure level is energetically averaged as:

$$\overline{L_{i,k}} = 10 \cdot \log\left[\frac{1}{N} \cdot \sum_{j=1}^{N} 10^{\left(\frac{L_{i,j,k}}{10}\right)}\right] \tag{17}$$

where

N is the number of measurements in the wind speed bin k;

$L_{i,j,k}$ is the und pressure level of the 1/3-octave band i in the measurement period j and in wind speed bin k.

The type A uncertainty on the uncertainty on the sound pressure level measured in the wind-speed bin k is calculated as:

$$s_{L_{i,k}} = \sqrt{\frac{\sum_{j=1}^{N}\left(L_{i,j,k} - \overline{L}_{i,k}\right)^2}{N \cdot (N-1)}} \tag{18}$$

where

$\overline{L}_{i,k}$ is the average sound pressure spectrum in the wind speed bin k

The type B uncertainty on the energy averaged sound pressure level of the i-th 1/3-octave band for each measurement period j is calculated as:

$$u_{L_{i,j}} = \sqrt{\sum_{q=1}^{7} u_{L_{i,j,q}}^2} \tag{19}$$

where

$u_{L_{i,j,q}}$ is the type B uncertainty from source q on the average sound pressure level of the 1/3-octave band for each measurement period j.

The type B uncertainty on the average sound pressure level of the 1/3-octave band i in wind speed bin k is calculated as:

$$u_{L_{i,k}} = \sqrt{\frac{1}{N} \cdot \sum_{j=1}^{N} u_{L_{i,j,k}}^2} = u_{L_{i,j,k}} \tag{20}$$

The combined uncertainty can be expressed as:

$$u_{com,L_{i,k}} = \sqrt{s_{L_{i,k}}^2 + u_{L_{i,k}}^2} \quad (21)$$

4.6.4 Uncertainty on the noise levels at bin centres

The sound pressure level for both total noise and background noise at bin centre is calculated at each 1/3- octave band i and at every bin centre of the wind speed k. Using linear interpolation the estimated sound pressure level at wind speed v is given as:

$$L_V(t) = (1-t)\cdot \overline{L}_k + t\cdot \overline{L}_{k+1} \quad (22)$$

Where $\overline{V}_k \le V < \overline{V}_{k+1}$

The t value at a certain wind speed v is given as:

$$t = \frac{(V-\overline{V}_k)}{(\overline{V}_{k+1}-\overline{V}_k)} \quad (23)$$

To fulfil an entire statistical evaluation according to the /1/ a corresponding covariance is calculated as:

$$\mathrm{cov}_{L_{V,i,k}} = \frac{1}{N-1}\cdot\sum_{j=1}^{N}(V_{j,k}-\overline{V}_k)\cdot(L_{i,j,k}-\overline{L}_{i,k}) \quad (24)$$

The corresponding covariance is used to calculate the uncertainty on the sound pressure level at the wind-speed bin centre v by using:

$$u_{L_V}(t) = \sqrt{u_L^2(t) - \frac{\mathrm{cov}_{LV}^2(t)}{u_V^2(t)}} \quad (25)$$

where

$$u_L^2(t) = (1-t)^2\cdot u_{com,L,k}^2 + t^2\cdot u_{com,L,k+1}^2$$

$$u_v^2(t) = (1-t)^2\cdot u_{com,V,k}^2 + t^2\cdot u_{com,V,k+1}^2$$

$$\mathrm{cov}_{LV}(t) = (1-t)^2\cdot\frac{\mathrm{cov}_{LV,k}}{N_k} + t^2\cdot\frac{\mathrm{cov}_{LV,k+1}}{N_{k+1}}$$

N_k is the number of measurements in the wind speed bin k

4.6.5 Uncertainty on the total noise level

If the difference between the total noise level and the background level is higher than 3 dB in the same 1/3- octave band i, the standard deviation of the background-corrected sound-pressure-levels is calculated as follows:

$$u_{c,i,k} = \frac{\sqrt{(u_{L_V,T,i}\cdot 10^{0.1\cdot L_{V,T,i}})^2 + (u_{L_V,B,i}\cdot 10^{0.1\cdot L_{V,B,i}})^2}}{10^{0.1\cdot L_{V,T,i}} - 10^{0.1\cdot L_{V,B,i}}} \quad (26)$$

If the difference between the total noise level and the background level is less than 3 dB in the same 1/3- octave band i, a 3 dB correction is applied and the result is marked with brackets [ ]. The corresponding uncertainty is then calculated, as if the background noise level is 3 dB smaller than the total noise level $L_{v,B,i} = L_{v,T,i} - 3$ dB:

$$u_{c,i,k} = \frac{\sqrt{(u_{L_V,T,i} \cdot 10^{0.1 \cdot L_{V,T,i}})^2 + (u_{L_V,B,i} \cdot 10^{0.1 \cdot L_{V,T,i}-3})^2}}{10^{0.1 \cdot L_{V,T,i}} - 10^{0.1 \cdot (L_{V,T,i}-3)}} \tag{27}$$

4.6.6 Sound power level

The result of the sound power level measurement is subject to uncertainties which are due to the environment, meteorological conditions and the measurement system as calculated is the previous chapters.

There is the assumption all 1/3-octave bands are correlated. Therefore the uncertainty of the sound power level can be expressed as:

$$u_{L_{WA,k}} = \frac{\sum_{i=1}^{28} \left(u_{c,i,k} \cdot 10^{(0.1 \cdot L_{WA,i,k})} \right)}{\sum_{i=1}^{28} 10^{(0.1 \cdot L_{WA,i,k})}} \tag{28}$$

The result of $u_{L_{WA,k}}$ will be shown in the annex.

4.6.7 Uncertainty on the tonality analysis

The uncertainty in the tonality is given in the annex for all the given tones.

5 DEVIATIONS

There are no deviations from the standard.

6 CONCLUSIONS

As ordered by Vestas Wind Systems A/S GL Garrad Hassan Deutschland GmbH took measurements of the acoustic noise emissions on the WTGS Vestas V150-4.2 MW 50 Hz with a hub height of 137 m.

All measurements and analysis of the sound power level and tonality described in this report based on the international standard /1/. The analysis of the sound power level was carried out using the standardised wind speed which was derived from the certified, measured power curve provided by the customer (see annex).

The result of this measurement is given in Table 6-1. For detailed results please refer to the annex.

For the measured turbine in PO1 the relevant wind range according to /1/ is between 7.3 m/s and 11.9 m/s.

Table 6-1 Summary of results at hub height

WS at hub height [m/s]	SPL $L_{WA,k}$ [dB]	Combined uncertainty in the SPL $U_{C,L,WA,k}$ [dB]	Audible tone? 1)	Tonal audibility $\Delta L_{a,k}$ [dB]	Frequency of the most prevalent tone [Hz]
7.5	102.0	1.2	Yes	0.52	126
8.0	103.3	1.1	No	-2.09	134
8.5	104.3	0.8	No	-2.43	140
9.0	104.7	0.7	No	-2.97	142
9.5	104.7	0.6	-	-	-
10.0	104.8	0.7	-	-	-
10.5	104.7	0.7	No	-2.16	143
11.0	104.6	0.7	No	-1.66	144
11.5	104.5	0.7	No	-1.11	143
12.0	104.3	0.7	No	-1.62	144
12.5	104.5	0.8	No	-0.98	143
13.0	104.6	0.8	No	-1.93	144
13.5	104.5	0.7	No	-1.74	143
14.0	104.8	0.8	No	-1.70	143

1) Per /1/ section 9.5.8 a tone is audible if tone is *relevant* and $\Delta L_{a,k} \geq 0$ dB.

Table 6-2 Summary of results at 10 m height

WS at 10 m height [m/s]	SPL $L_{WA,10m,k}$ [dB]	Combined uncertainty in the SPL $U_{C,L,WA,10m,k}$ [dB]
5	101.9	1.1
6	104.7	0.6
7	104.7	0.7
8	104.3	0.7
9	104.5	0.7

It is assured that this report has been drawn up impartially and with best knowledge and conscience.

7 REFERENCES

/1/ IEC 61400-11 Ed. 3.0 Wind Turbines,
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2012-11-07

/2/ ISI-RA-MEA-4601
Noise emission measurements on wind turbines – one third octave level method
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8 LIST OF ABBREVIATIONS

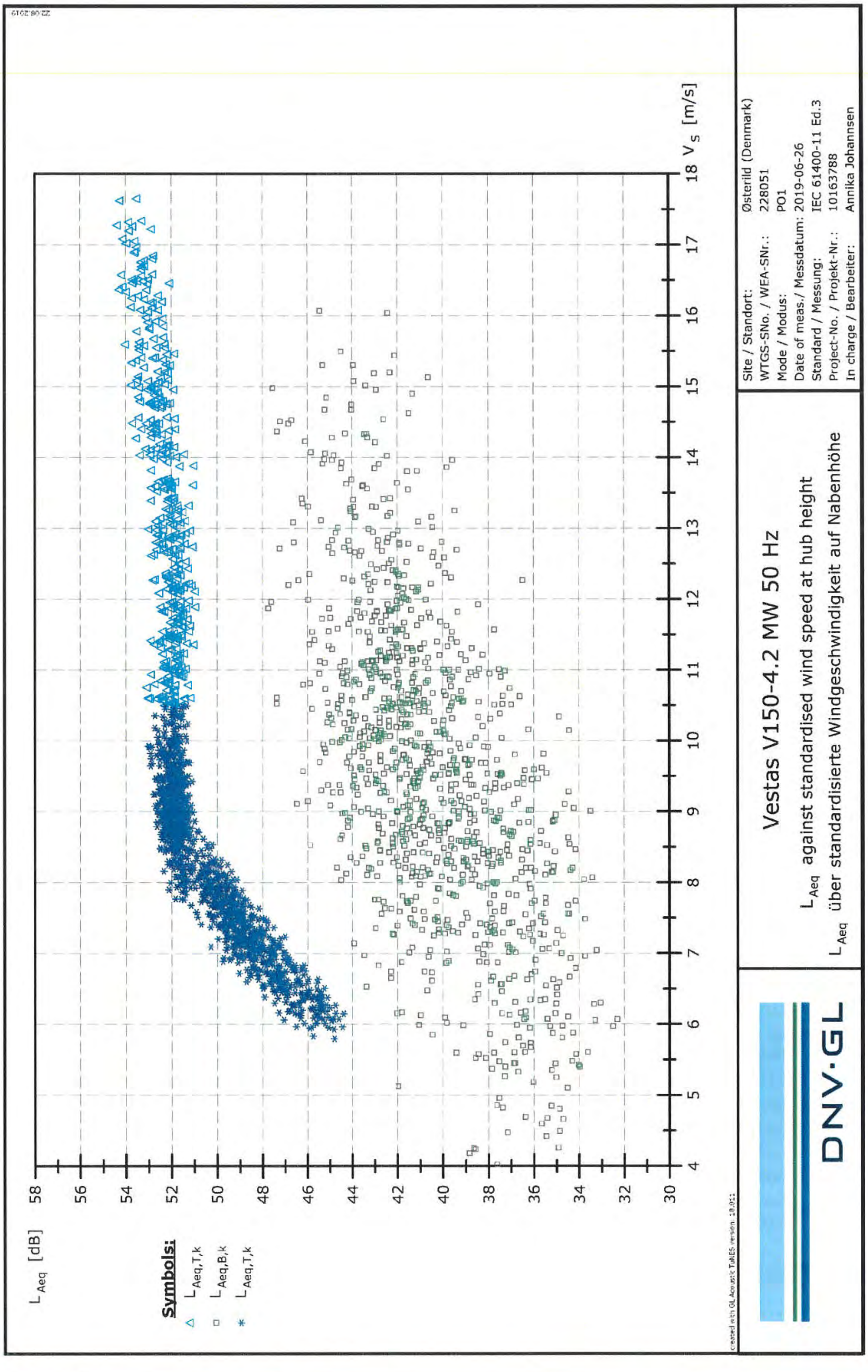
Abbreviation	Description	Unit
d	distance from rotor centre to tower axis	[m]
D	rotor diameter	[m]
H	height of rotor centre above local ground near the wind turbine	[m]
L_A or L_C	A or C-weighted sound pressure level	[dB]
L_{Aeq}	equivalent continuous A-weighted sound pressure level	[dB]
$L_{pn,j,k}$	sound pressure level of masking noise within a critical band in the 'j th' spectrum at the 'k th' wind speed bin	[dB]
$L_{pn,avg,j,k}$	average of analysis bandwidth sound pressure levels of masking noise in the 'j th' spectra at the 'k th' wind speed bin	[dB]
$L_{pt,j,k}$	sound pressure level of the tone or tones in the 'j th' spectra at the 'k th' wind speed bin	[dB]
$L_{WA,k}$	apparent sound power level, where *k* is a wind speed centre value	[dB]
log	logarithm to base 10	
P_m	measured electric power	[kW]
P_n	normalised electric power	[kW]
P_k	power curve value at wind bin *k*	[kW]
P_{tol}	tolerance of the power reading	[kW]
R_0	reference distance	[m]
R_1	slant distance from rotor centre to actual measurement position	[m]
S_0	reference area, $S_0 = 1\ m^2$	[m]
SPL	sound power level	[dB]
T_C	air temperature	[°C]
T_K	absolute air temperature	[K]
u_A	Uncertainty components of Type A	[dB]
u_B	Uncertainty components of Type B	[dB]
$V_{H,n}$	normalised wind speed at hub height *H*	[m/s]
$V_{P,n}$	normalised wind speed derived from power curve	[m/s]
V_z	wind speed at height *z*	[m/s]
$V_{nac,m}$	measured wind speed from nacelle anemometer	[m/s]
$V_{nac,n}$	normalised wind speed from nacelle anemometer	[m/s]
f	frequency of the tone	[Hz]
f_c	centre frequency of critical band	[Hz]
p	atmospheric pressure	[kPa]
z_0	roughness length	[m]
z_{0ref}	reference roughness length, 0.05 m	[m]
z	anemometer height	[m]
κ	Ratio between normalised wind speed and measured wind speed	[-]
$\Delta L_{tn,j,k}$	tonality of the 'j th' spectrum at 'k th' wind speed	[dB]
Φ	inclination angle	[°]
$V_{Z,m}$	is the measured wind speed with an anemometer at height Z of at least 10 m	[m/s]
$V_{B,n}$	is the normalised wind speed at hub height	[m/s]

Description of the subscripts and indexes of the formulas

i	1/3 octave band number (e.g. i = 1 for 20 Hz centre frequency, i = 2 for 25 Hz centre frequency, ... , i = 28 for 10 kHz centre frequency)
j	10 s measurement period number (each bin should have the minimum of 10 points per bin therefore j = 1 to 10 or greater)
k	wind speed bin (i.e. k = 6 m/s bin, k = 6,5 m/s bin, k = 7 m/s bin, etc.)
V	bin centre value; of measured 1/3 octave spectrum
n	normalized spectrum
N	number of measurements in wind speed k
T	total noise
B	background noise
C	background corrected total noise

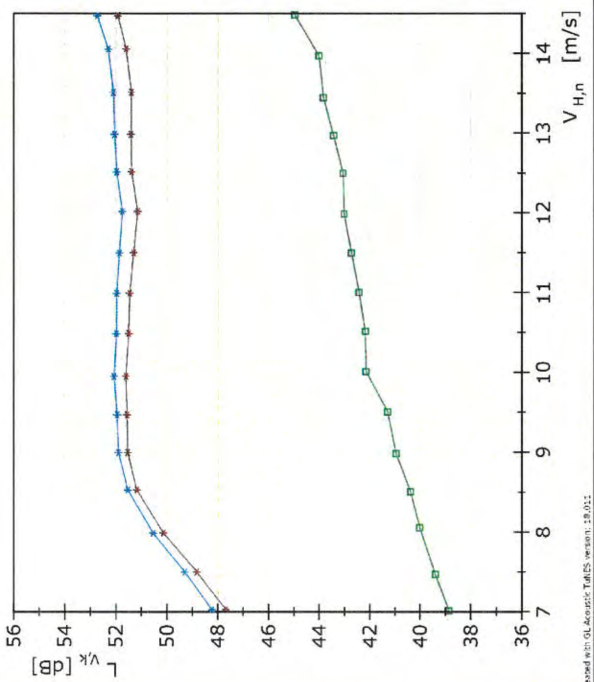
9 APPENDIX

9.1 L_{Aeq} vs. wind speed at hub height



9.2 Summary of the results according to hub height

H	=	137 m	d	=	4.5 m	h_A	=	0.0 m
D	=	150 m	z_0	=	0.05 m	R_0	=	212 m
k_{nac}	=	1.01	$state_{total\ noise}$				=	1.0
k_z	=	1.14	$state_{background\ noise}$				=	0.5
$P_{85\%}$	=	3.57 MW	$V_{P(85\%)}$ * 0.8				=	7.3 m/s
$V_{P(85\%)}$	=	9.2 m/s	$V_{P(85\%)}$ * 1.3				=	11.9 m/s



BIN [m/s]	$L_{V,T,k}$ [dB]	$L_{V,B,k}$ [dB]	$L_{V,C,k}$ [dB]	total n [no.]	backg.n [no.]	$V_{Z,k}$ [m/s]	P_k [MW]	rpm_k [U/min]	$L_{WA,k}$ [dB]	$u_{c,k}$ [dB]
7.5	49.3	39.4	48.8	172	71	5.02	2.11	9.2	102.0	1.2
8.0	50.5	40.0	50.1	149	69	5.35	2.54	9.8	103.3	1.1
8.5	51.5	40.4	51.2	132	100	5.69	3.04	10.2	104.3	0.8
9.0	51.9	40.9	51.5	222	89	6.02	3.44	10.3	104.7	0.7
9.5	51.9	41.3	51.6	144	106	6.36	3.77	10.4	104.7	0.6
10.0	52.1	42.1	51.6	81	88	6.69	4.01	10.4	104.8	0.7
10.5	52.0	42.2	51.5	53	96	7.03	4.16	10.4	104.7	0.7
11.0	52.0	42.4	51.5	39	81	7.36	4.20	10.4	104.6	0.7
11.5	51.9	42.7	51.3	41	51	7.70	4.20	10.3	104.5	0.7
12.0	51.8	43.0	51.1	39	44	8.03	4.20	10.3	104.3	0.7
12.5	52.0	43.0	51.4	30	36	8.37	4.20	10.4	104.5	0.8
13.0	52.0	43.4	51.4	35	27	8.70	4.20	10.3	104.6	0.8
13.5	52.1	43.8	51.4	30	18	9.04	4.20	10.3	104.5	0.7
14.0	52.3	44.0	51.6	24	17	9.37	4.20	10.3	104.8	0.8

22.08.2019

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DNV·GL

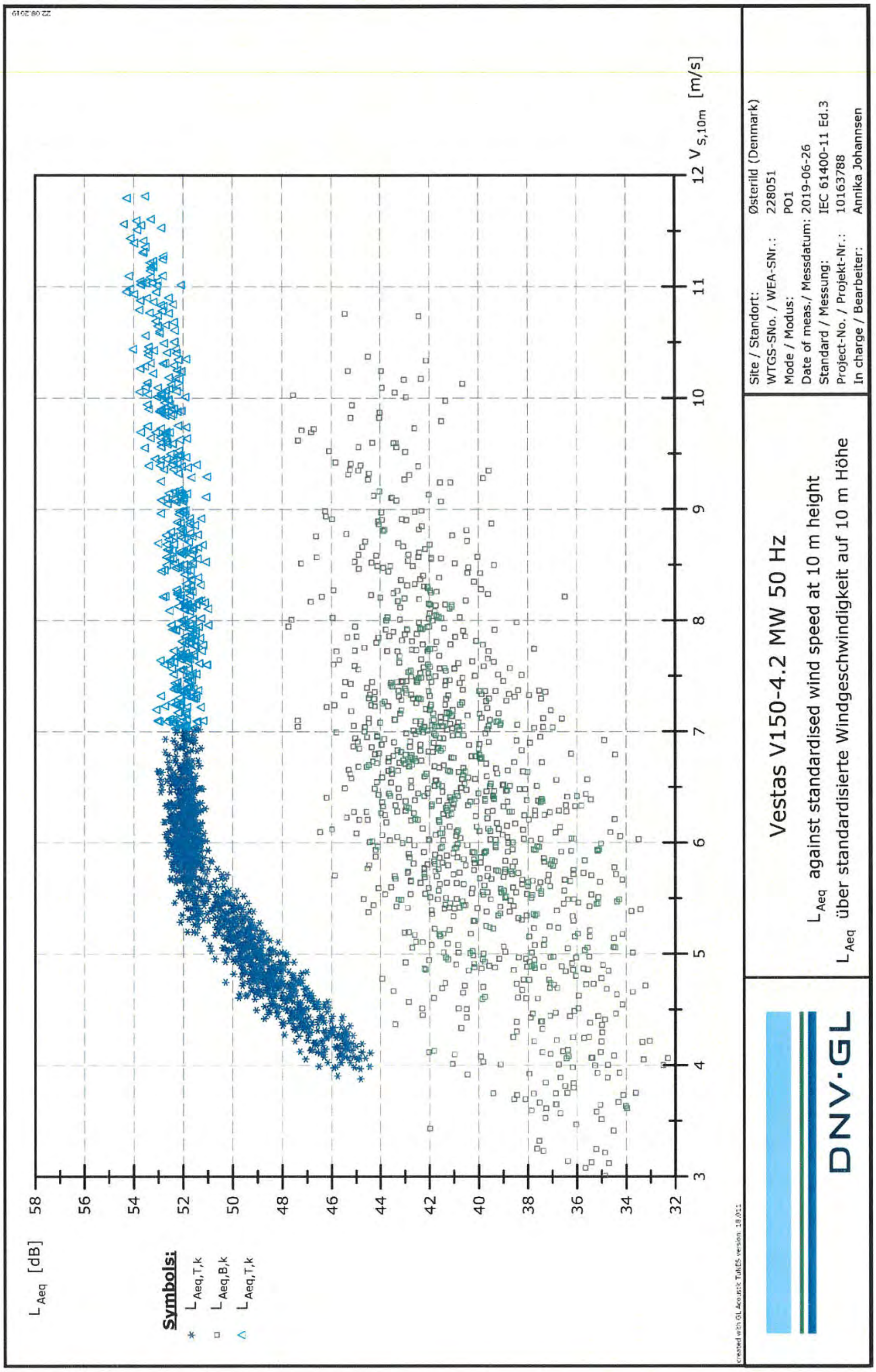
Vestas V150-4.2 MW 50 Hz

Results relating to hub height

Ergebnisse bezogen auf Nabenhöhe

Site / Standort:	Østerild (Denmark)
WTGS-SNo. / WEA-SNr.:	228051
Mode / Modus:	PO1
Date of meas./ Messdatum:	2019-06-26
Standard / Messung:	IEC 61400-11 Ed.3
Project-No. / Projekt-Nr.:	10163788
In charge / Bearbeiter:	Annika Johannsen

9.3 L_{Aeq} vs. wind speed at 10 m height



9.4 Summary of the results according to 10 m height

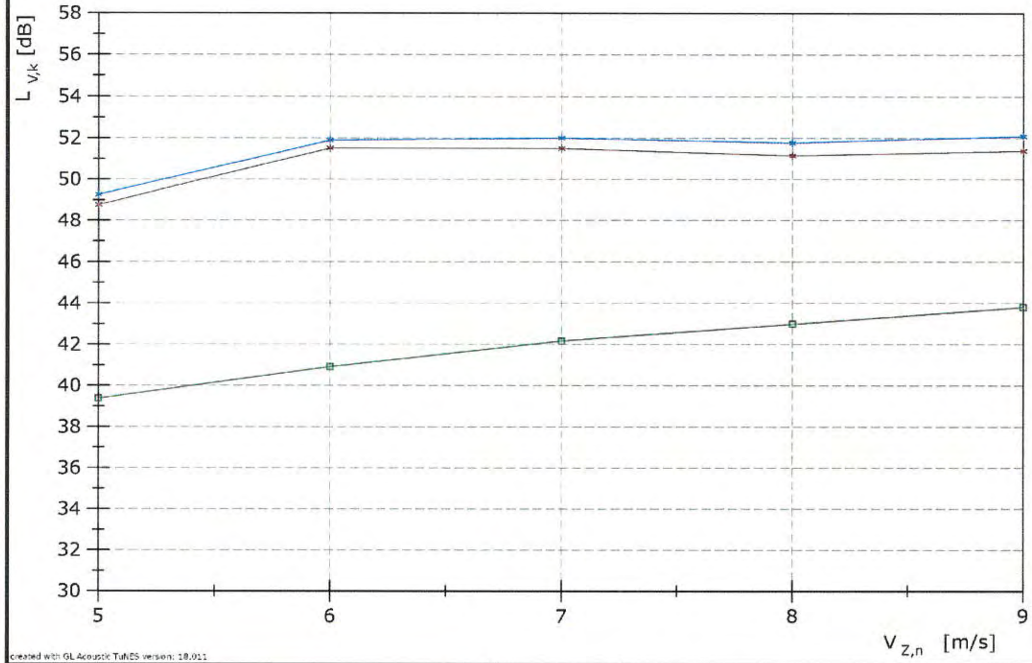
H = 137 m; d = 4.5 m; h_A = 0.0 m

D = 150 m; z_0 = 0.05 m; R_0 = 212 m

k_{nac} = 1.01; k_z = 1.14

$P_{85\%}$ = 3.57 MW; $V_{P(85\%)} * 0.8$ = 7.3 m/s; $state_{total\ noise}$ = 1

$V_{P(85\%)}$ = 9.2 m/s; $V_{P(85\%)} * 1.3$ = 11.9 m/s; $state_{background\ noise}$ = 0.5



BIN [m/s]	$L_{V,T,k}$ [dB]	$L_{V,B,k}$ [dB]	$L_{V,C,k}$ [dB]	$V_{H,k}$ [m/s]	$L_{WA,k}$ [dB]	$u_{c,k}$ [dB]
5.0	49.2	39.4	48.8	7.47	101.9	1.1
6.0	51.9	40.9	51.5	8.96	104.7	0.6
7.0	52.0	42.2	51.5	10.46	104.7	0.7
8.0	51.8	43.0	51.2	11.95	104.3	0.7
9.0	52.1	43.8	51.4	13.45	104.5	0.7

22.08.2019

DNV·GL

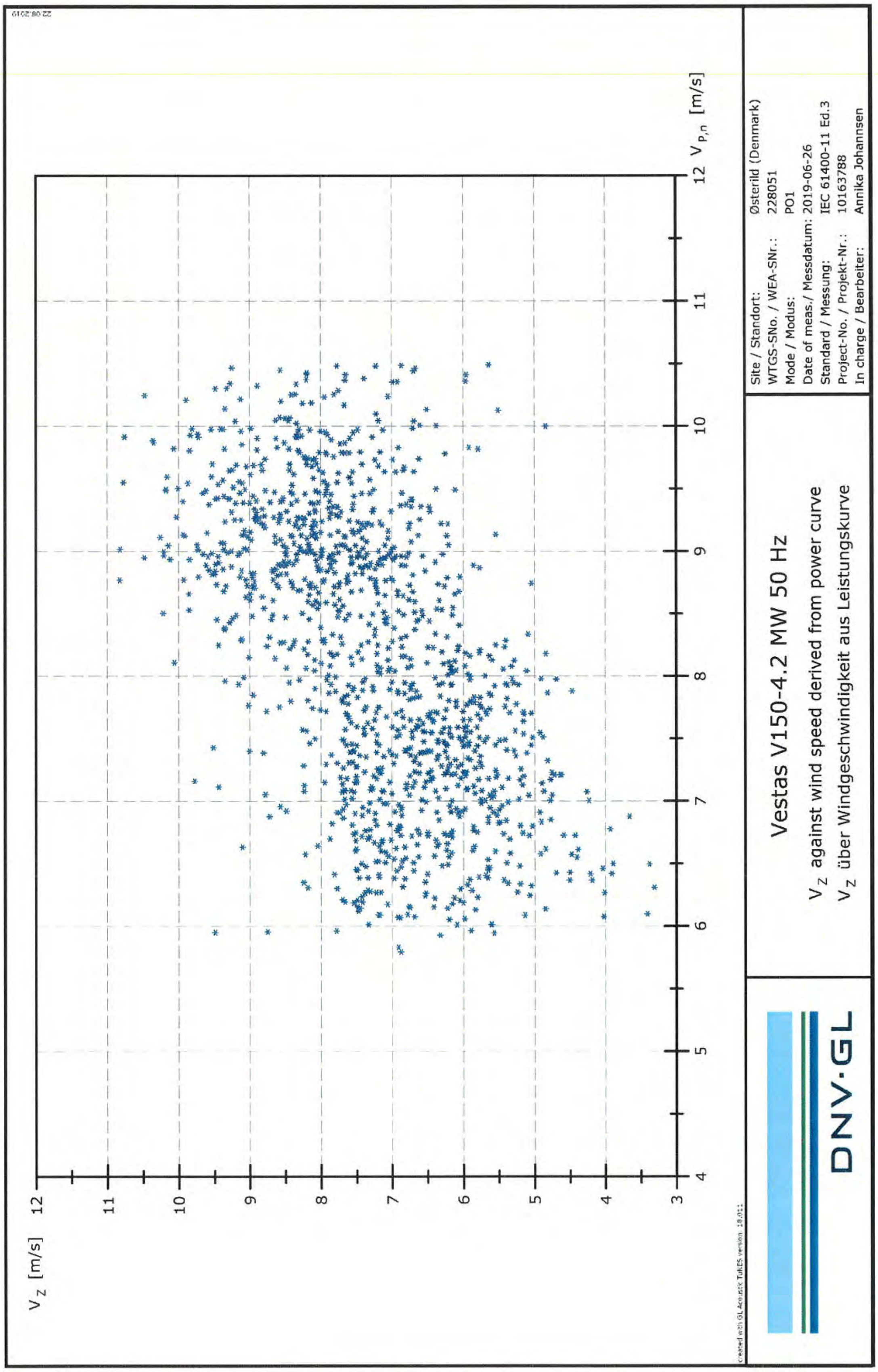
Vestas V150-4.2 MW 50 Hz

Result vs. BIN (10m)

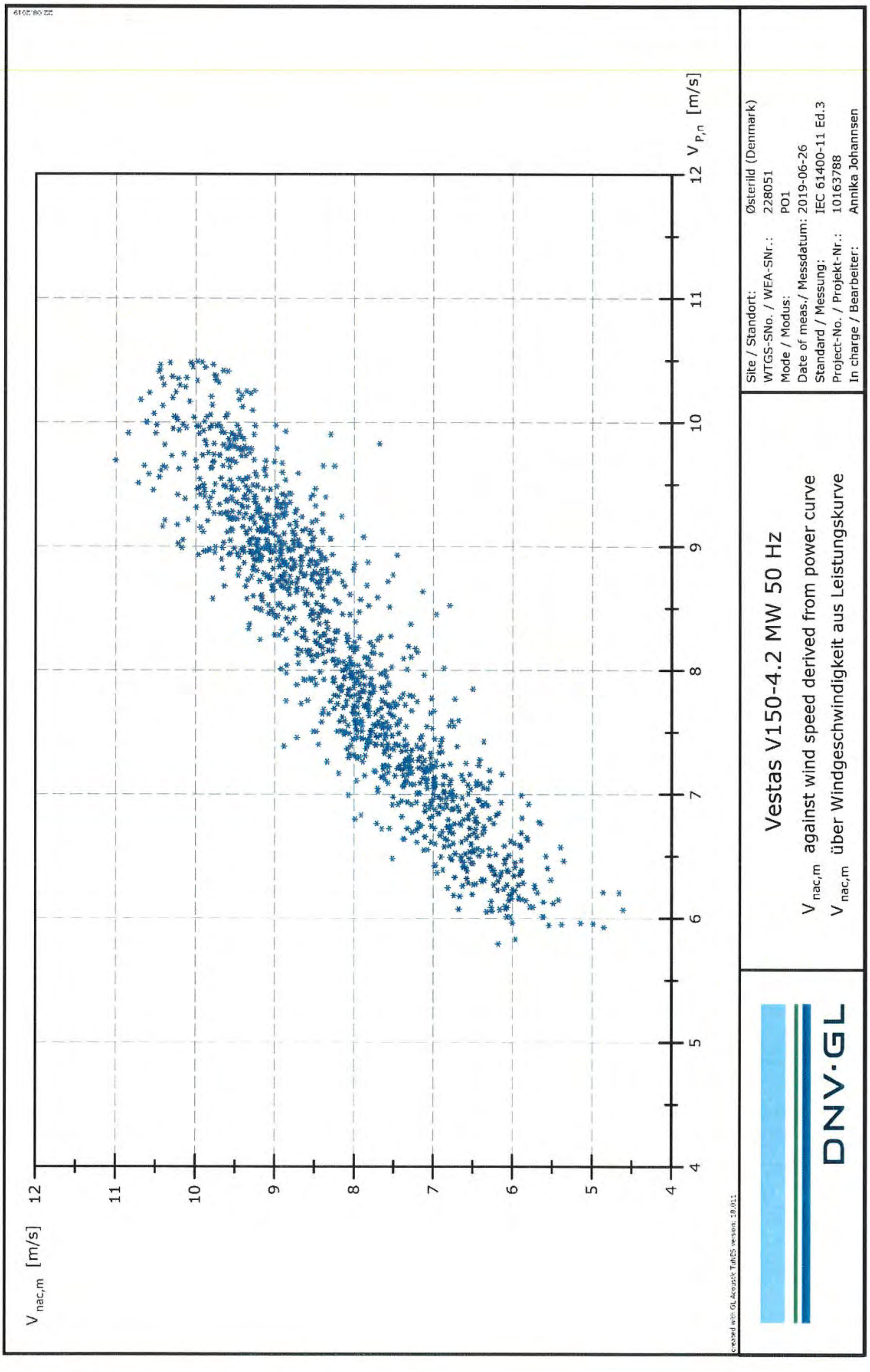
Ergebnisse pro BIN (10m)

Site / Standort:	Østerild (Denmark)
WTGS-SNo. / WEA-SNr.:	228051
Mode / Modus:	PO1
Date of meas./ Messdatum:	2019-06-26
Standard / Messung:	IEC 61400-11 Ed.3
Project-No. / Projekt-Nr.:	10163788
In charge / Bearbeiter:	Annika Johannsen

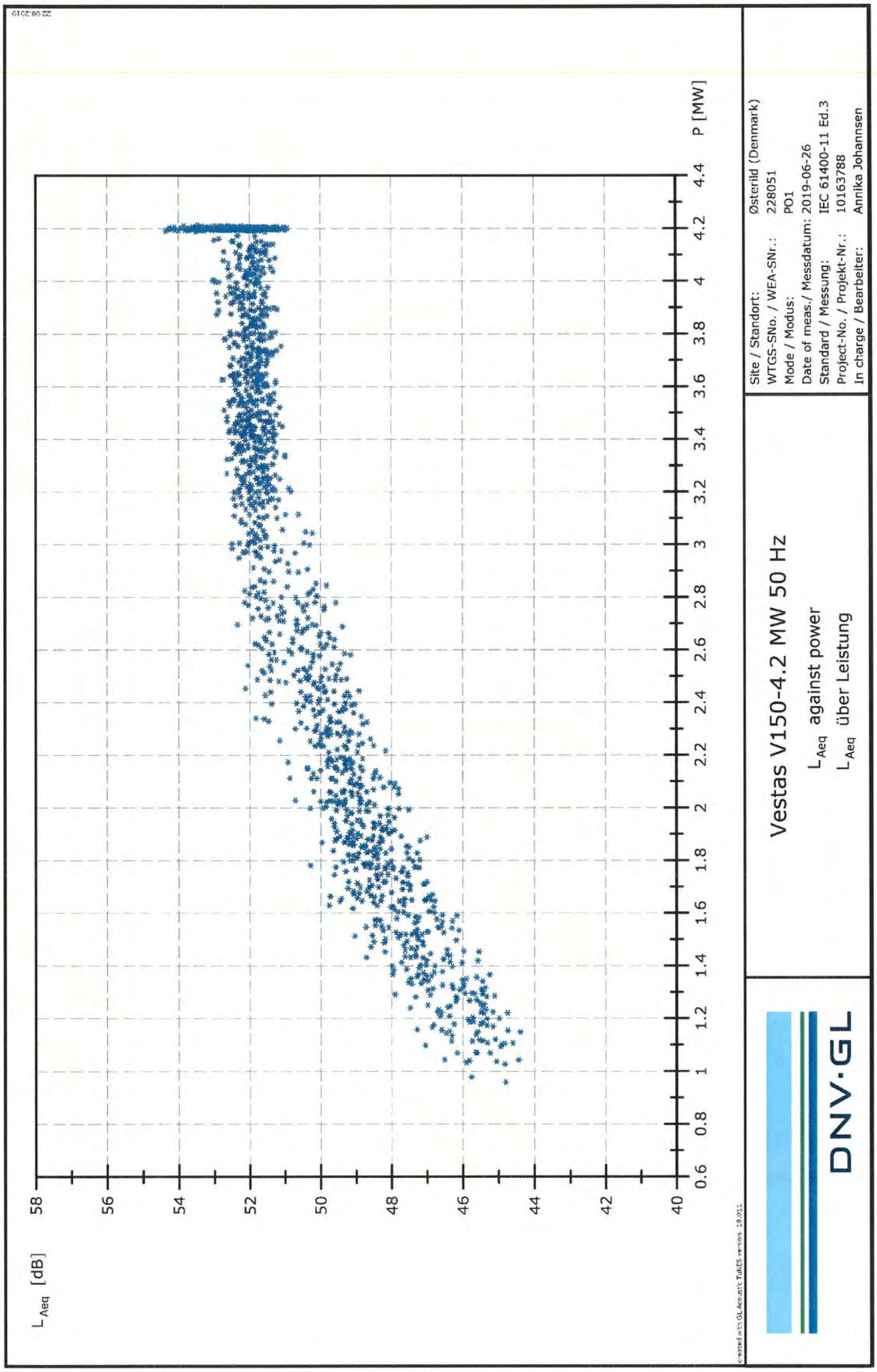
9.5 Measured wind speed at 10 m height vs. wind speed from power curve



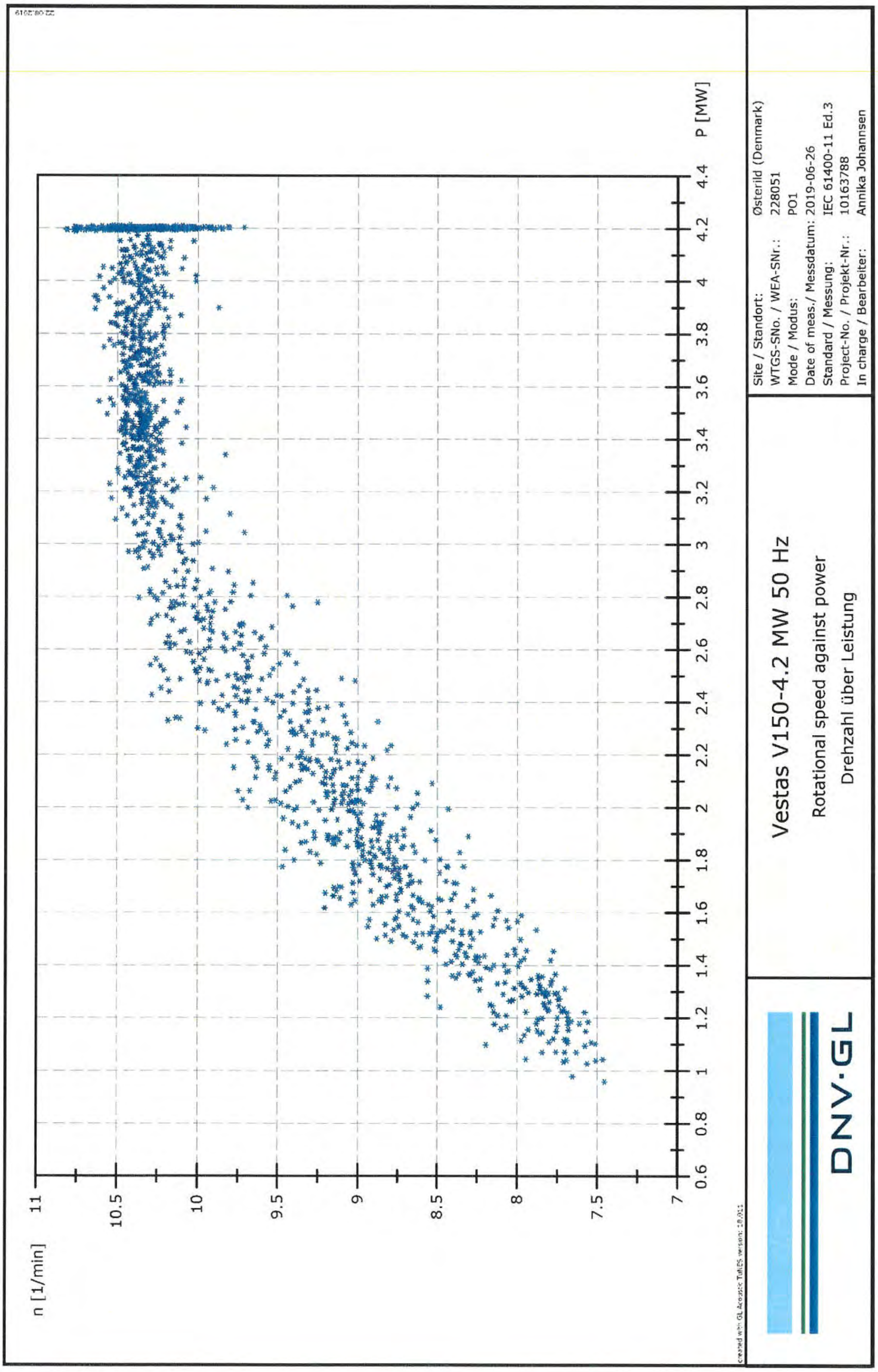
9.6 Measured wind speed at hub height vs. wind speed from power curve



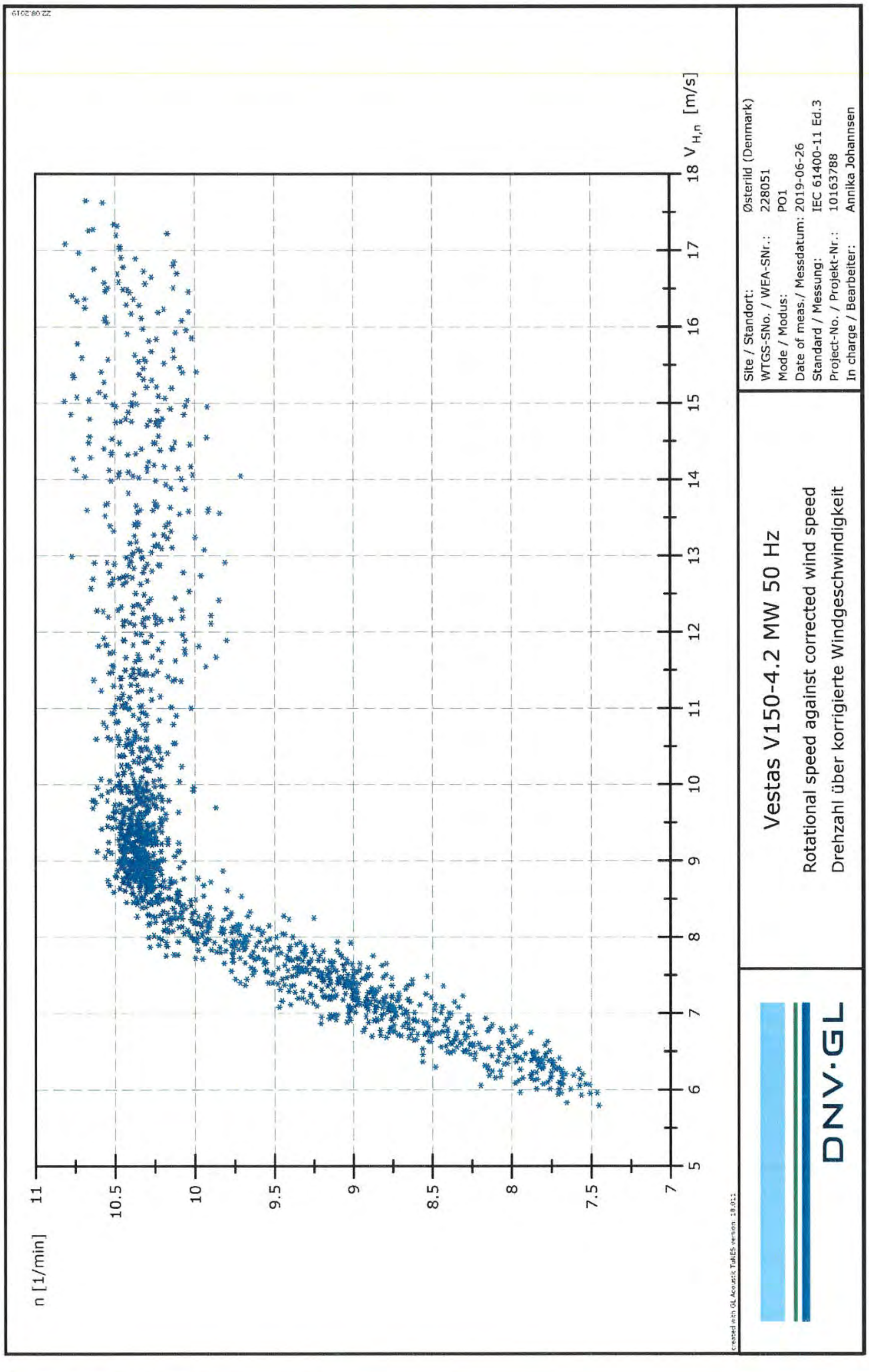
9.7 L_{Aeq} vs. active power



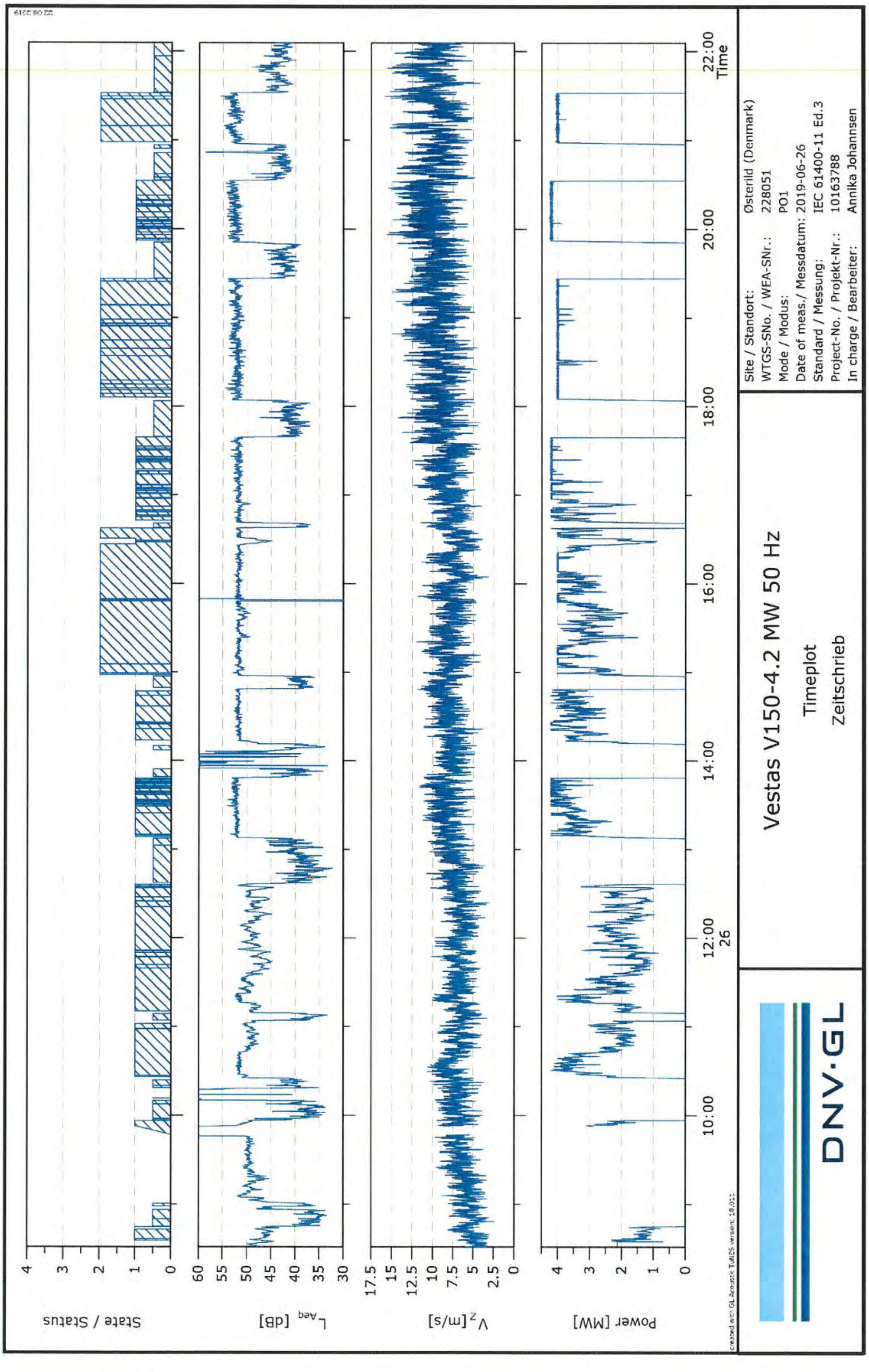
9.8 Rotor speed vs. active power



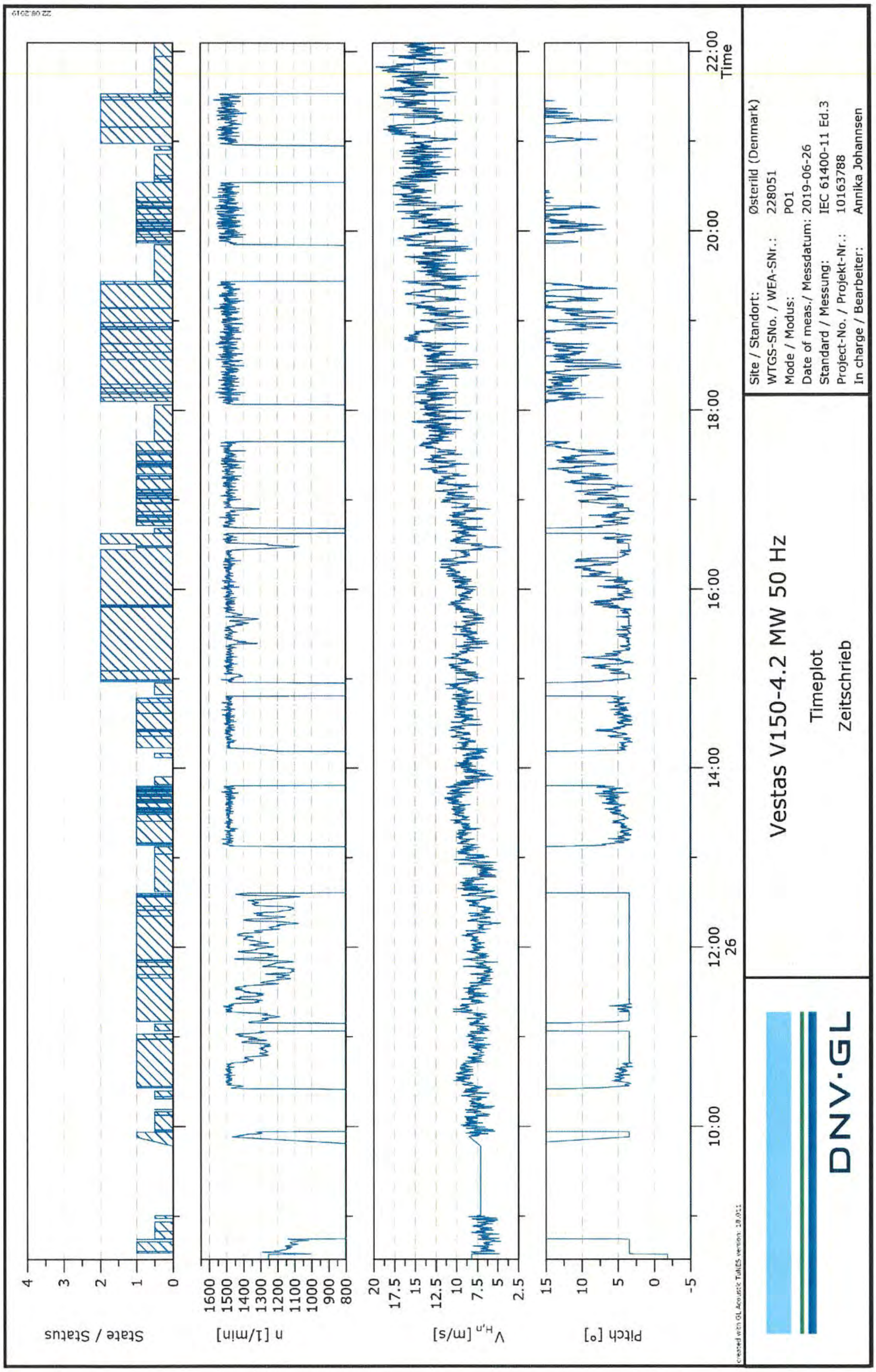
9.9 Rotor speed vs. wind speed at hub height



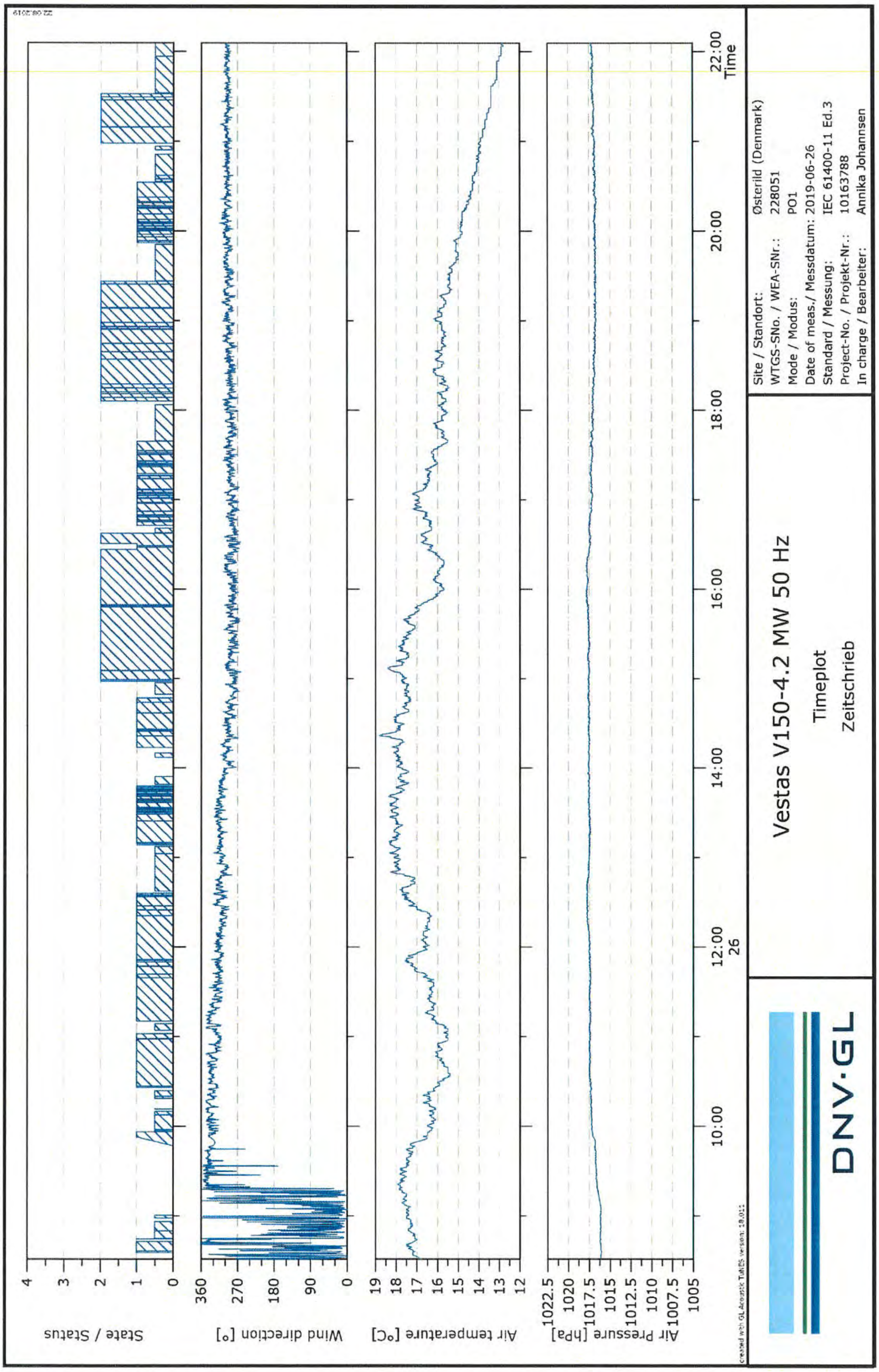
9.10 Time plot of measurement (page 1)



9.11 Time plot of measurement (page 2)



9.12 Time plot of measurement (page 3)



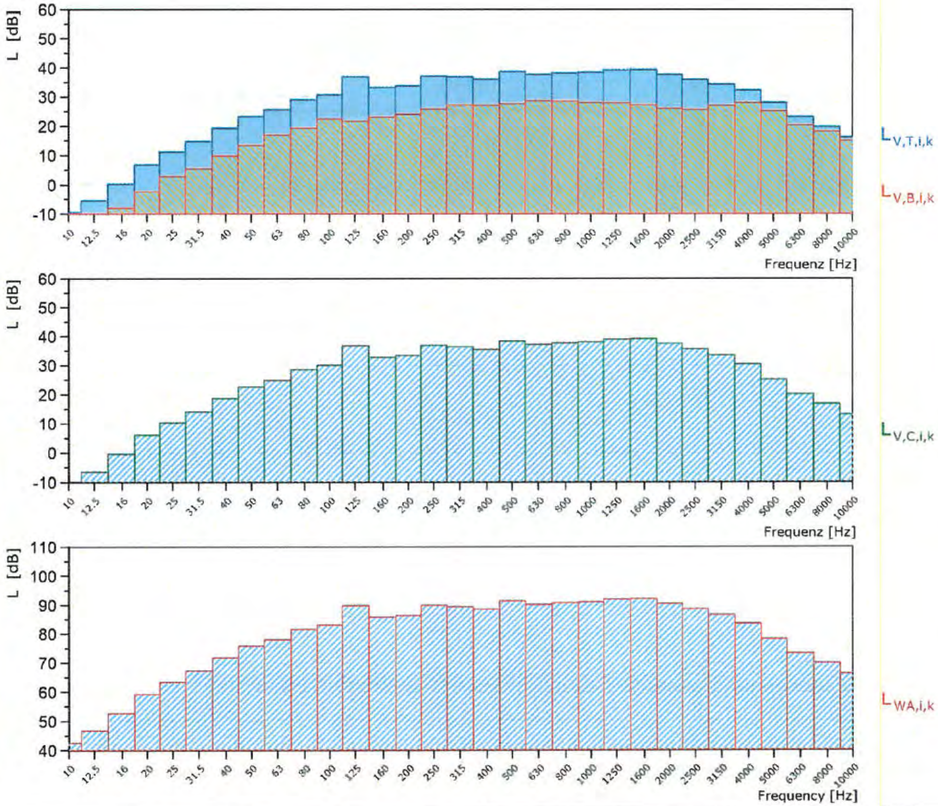
9.13 Third-octave sound power spectra at a WS of 7.5 m/s at hub height

No. of data per BIN / Anzahl der Messdaten pro BIN:
Total noise / Gesamtgeräusch = 172
Background noise / Fremdgeräusch = 71

Reference wind speed / Referenzwindgeschwindigkeit:
$WS_{BIN\ (hub\ height)}$ = 7.5 m/s
$WS_{BIN\ (10\ m)}$ = 5.0 m/s

Sound power level / Schallleistung:
$L_{WA,k}$ = 102.0 dB

f [Hz]	$L_{V,T,i,k}$ [dB]	$u_{Lv,T,i,k}$ [dB]	$L_{V,B,i,k}$ [dB]	$u_{Lv,B,i,k}$ [dB]	$L_{V,C,i,k}$ [dB]	$L_{WA,i,k}$ [dB]	$u_{c,i,k}$ [dB]
10	-9.5	1.7	-15.9	4.3	-10.6	**42.6**	2.6
12.5	-5.5	1.6	-13.0	3.5	-6.4	**46.8**	2.1
16	0.3	1.6	-8.0	2.6	-0.4	**52.7**	1.9
20	6.7	1.6	-2.4	2.4	6.1	**59.3**	1.8
25	11.0	1.4	2.8	2.7	10.3	**63.5**	1.7
31.5	14.7	1.4	5.5	2.5	14.1	**67.2**	1.7
40	19.2	1.4	9.8	2.2	18.7	**71.8**	1.6
50	23.1	1.7	13.3	2.6	22.7	**75.8**	2.0
63	25.5	1.2	16.9	2.7	24.9	**78.1**	1.4
80	29.0	0.8	19.3	3.4	28.5	**81.6**	1.0
100	30.6	0.8	22.3	3.1	30.0	**83.1**	1.1
125	36.8	2.5	21.7	4.0	36.7	**89.9**	2.6
160	33.2	0.7	23.1	3.7	32.8	**85.9**	0.9
200	33.7	0.7	24.0	2.9	33.3	**86.4**	0.8
250	37.1	0.6	25.9	2.6	36.8	**89.9**	0.7
315	36.9	0.8	27.3	2.0	36.4	**89.5**	0.9
400	36.0	0.9	27.1	2.2	35.4	**88.6**	1.1
500	38.7	0.7	27.7	2.2	38.3	**91.5**	0.8
630	37.7	1.2	28.7	2.3	37.1	**90.3**	1.5
800	38.2	1.0	28.5	2.9	37.7	**90.8**	1.1
1000	38.4	1.0	28.1	3.0	38.0	**91.2**	1.1
1250	39.2	0.9	28.0	3.3	38.9	**92.0**	1.0
1600	39.3	0.8	27.3	3.5	39.1	**92.2**	0.9
2000	37.7	0.8	26.0	3.2	37.4	**90.6**	0.9
2500	35.9	0.8	25.7	3.0	35.5	**88.7**	1.0
3150	34.3	0.9	27.0	3.7	33.4	**86.6**	1.4
4000	32.4	1.5	28.1	5.2	30.4	**83.5**	3.8
5000	28.1	1.8	25.2	4.7	[25.1]	**[78.2]**	5.9
6300	23.1	1.6	20.3	2.9	[20.1]	**[73.3]**	4.3
8000	19.8	2.0	18.3	2.8	[16.8]	**[69.9]**	4.9
10000	16.2	2.2	15.1	2.7	[13.2]	**[66.3]**	5.2



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22.08.2019

DNV·GL

Bin 7.5 Vestas V150-4.2 MW 50 Hz

One third octave analysis at hub height

Terzanalyse bezogen auf Nabenhöhe

Site / Standort:	Østerild (Denmark)
WTGS-SNo. / WEA-SNr.:	228051
Mode / Modus:	PO1
Date of meas./ Messdatum:	2019-06-26
Standard / Messung:	IEC 61400-11 Ed.3
Project-No. / Projekt-Nr.:	10163788
In charge / Bearbeiter:	Annika Johannsen

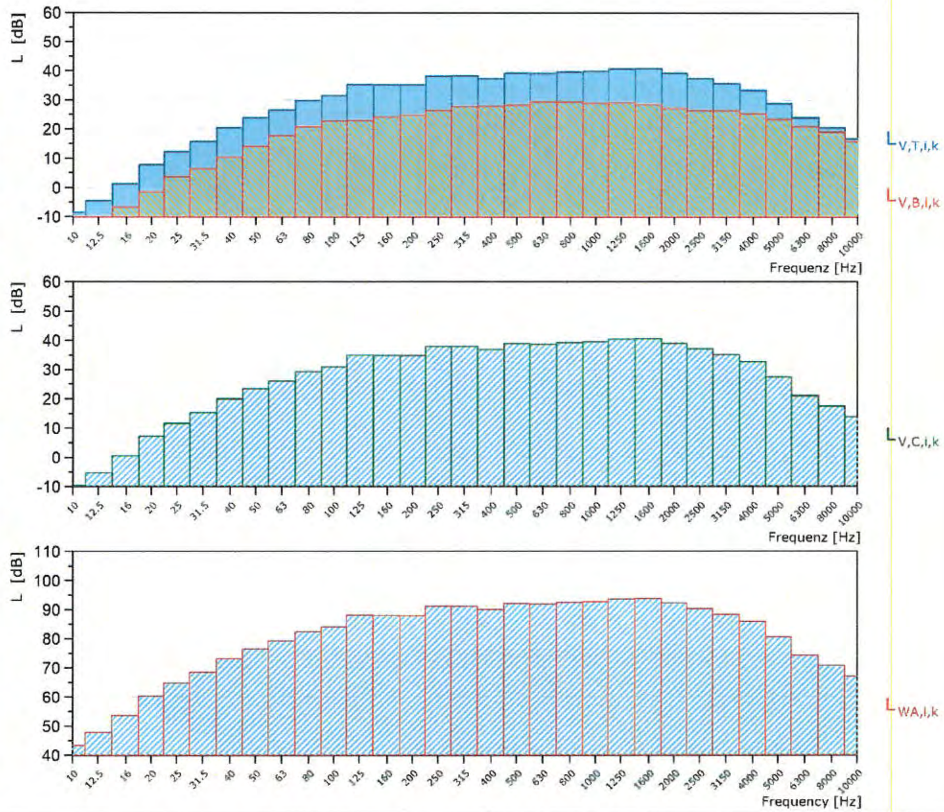
9.14 Third-octave sound power spectra at a WS of 8.0 m/s at hub height

No. of data per BIN / Anzahl der Messdaten pro BIN:
Total noise / Gesamtgeräusch = 149
Background noise / Fremdgeräusch = 69

Reference wind speed / Referenzwindgeschwindigkeit:
$WS_{BIN\ (hub\ height)}$ = 8.0 m/s
$WS_{BIN\ (10\ m)}$ = 5.4 m/s

Sound power level / Schallleistung:
$L_{WA,k}$ = 103.3 dB

f [Hz]	$L_{V,T,i,k}$ [dB]	$u_{Lv,T,i,k}$ [dB]	$L_{V,B,i,k}$ [dB]	$u_{Lv,B,i,k}$ [dB]	$L_{V,C,i,k}$ [dB]	$L_{WA,i,k}$ [dB]	$u_{c,i,k}$ [dB]
10	-8.4	2.5	-14.2	4.8	-9.8	**43.4**	3.7
12.5	-4.4	2.4	-11.6	3.7	-5.3	**47.8**	3.1
16	1.3	2.3	-6.5	3.2	0.6	**53.7**	2.8
20	7.7	2.3	-1.2	2.8	7.1	**60.3**	2.6
25	12.2	2.1	3.8	3.1	11.6	**64.7**	2.6
31.5	15.9	2.2	6.4	2.7	15.3	**68.5**	2.6
40	20.4	2.0	10.5	2.3	19.9	**73.1**	2.3
50	23.8	1.9	14.2	2.8	23.4	**76.5**	2.1
63	26.6	1.7	17.9	3.1	26.0	**79.1**	2.0
80	29.8	1.3	20.9	4.0	29.2	**82.4**	1.6
100	31.5	1.0	22.9	2.8	30.9	**84.1**	1.3
125	35.3	1.4	23.0	4.4	35.0	**88.2**	1.5
160	35.2	1.6	24.2	4.1	34.8	**88.0**	1.8
200	35.2	1.0	24.9	3.3	34.8	**87.9**	1.2
250	38.3	0.6	26.5	2.8	38.0	**91.1**	0.7
315	38.3	0.8	27.8	2.3	37.9	**91.1**	1.0
400	37.4	1.0	28.0	2.5	36.9	**90.0**	1.1
500	39.3	0.7	28.4	2.4	38.9	**92.1**	0.8
630	39.2	1.2	29.5	2.5	38.7	**91.9**	1.4
800	39.6	1.0	29.4	3.1	39.2	**92.4**	1.1
1000	39.9	1.0	29.1	3.2	39.5	**92.7**	1.2
1250	40.7	0.9	29.2	3.5	40.4	**93.6**	1.0
1600	40.8	0.8	28.6	3.7	40.6	**93.7**	0.9
2000	39.3	0.8	27.4	3.7	39.0	**92.2**	0.9
2500	37.5	0.8	26.6	3.4	37.1	**90.3**	1.0
3150	35.7	0.8	26.5	3.1	35.2	**88.3**	1.1
4000	33.5	1.1	25.4	2.9	32.8	**85.9**	1.4
5000	28.9	1.4	23.5	3.2	27.4	**80.6**	2.3
6300	24.0	1.7	21.0	3.3	21.0	**74.2**	4.7
8000	20.6	2.4	19.3	3.3	[17.6]	**[70.7]**	5.9
10000	16.9	2.7	16.1	3.3	[13.9]	**[67.1]**	6.3



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DNV·GL

Bin 8 Vestas V150-4.2 MW 50 Hz

One third octave analysis at hub height

Terzanalyse bezogen auf Nabenhöhe

Site / Standort:	Østerild (Denmark)
WTGS-SNo. / WEA-SNr.:	228051
Mode / Modus:	PO1
Date of meas./ Messdatum:	2019-06-26
Standard / Messung:	IEC 61400-11 Ed.3
Project-No. / Projekt-Nr.:	10163788
In charge / Bearbeiter:	Annika Johannsen

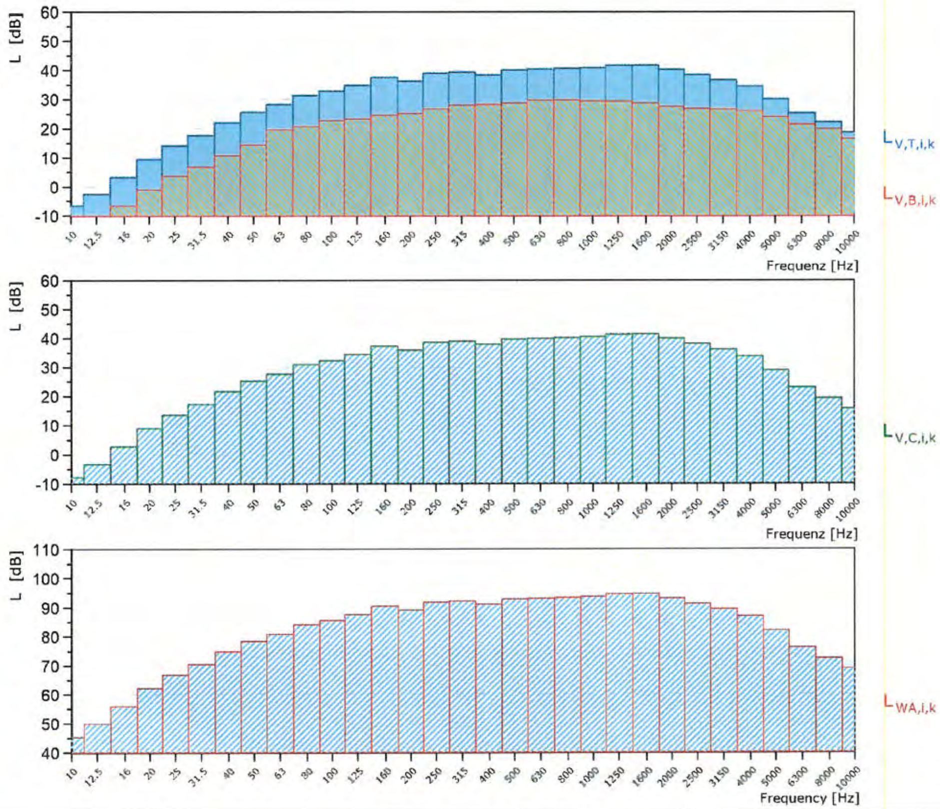
9.15 Third-octave sound power spectra at a WS of 8.5 m/s at hub height

No. of data per BIN / Anzahl der Messdaten pro BIN:
Total noise / Gesamtgeräusch = 132
Background noise / Fremdgeräusch = 100

Reference wind speed / Referenzwindgeschwindigkeit:
$WS_{BIN\ (hub\ height)}$ = 8.5 m/s
$WS_{BIN\ (10\ m)}$ = 5.7 m/s

Sound power level / Schallleistung:
$L_{WA,k}$ = 104.3 dB

f [Hz]	$L_{V,T,i,k}$ [dB]	$u_{LV,T,i,k}$ [dB]	$L_{V,B,i,k}$ [dB]	$u_{LV,B,i,k}$ [dB]	$L_{V,C,i,k}$ [dB]	$L_{WA,i,k}$ [dB]	$u_{c,i,k}$ [dB]
10	-6.6	2.1	-12.8	5.9	-7.8	**45.4**	3.4
12.5	-2.5	2.1	-10.5	4.6	-3.3	**49.9**	2.7
16	3.2	2.1	-6.5	3.6	2.7	**55.9**	2.4
20	9.4	2.0	-0.8	3.1	9.0	**62.1**	2.2
25	14.1	1.9	3.8	3.2	13.6	**66.8**	2.1
31.5	17.7	2.0	6.8	3.0	17.3	**70.5**	2.2
40	22.0	1.8	10.9	2.6	21.7	**74.8**	1.9
50	25.6	1.8	14.5	2.9	25.2	**78.4**	1.9
63	28.2	1.5	19.7	4.4	27.6	**80.7**	1.9
80	31.3	1.3	20.8	4.0	30.9	**84.1**	1.5
100	32.8	1.0	22.9	3.2	32.3	**85.5**	1.2
125	34.8	0.8	23.4	4.7	34.5	**87.7**	1.0
160	37.6	1.9	24.7	4.4	37.4	**90.5**	2.0
200	36.3	0.7	25.3	3.6	35.9	**89.1**	0.8
250	39.0	0.4	26.8	3.2	38.7	**91.9**	0.5
315	39.4	0.6	28.1	2.5	39.0	**92.2**	0.7
400	38.4	0.8	28.3	2.7	37.9	**91.1**	0.9
500	40.0	0.5	28.8	2.7	39.7	**92.9**	0.6
630	40.4	1.0	29.8	2.7	40.0	**93.1**	1.1
800	40.6	0.7	29.9	2.9	40.3	**93.4**	0.8
1000	40.9	0.7	29.5	3.0	40.5	**93.7**	0.8
1250	41.7	0.6	29.4	3.1	41.4	**94.6**	0.7
1600	41.7	0.6	28.8	3.3	41.5	**94.6**	0.6
2000	40.2	0.6	27.7	3.4	40.0	**93.2**	0.6
2500	38.5	0.6	27.0	3.2	38.2	**91.3**	0.7
3150	36.7	0.6	26.7	2.8	36.2	**89.4**	0.8
4000	34.5	0.8	26.1	3.1	33.9	**87.0**	1.1
5000	30.2	1.1	24.2	3.1	28.9	**82.1**	1.9
6300	25.4	1.7	21.6	2.8	23.1	**76.2**	3.5
8000	22.3	2.4	20.0	2.8	[19.3]	**[72.5]**	5.6
10000	18.8	2.7	16.7	2.8	[15.8]	**[69.0]**	6.1



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DNV·GL

Bin 8.5 Vestas V150-4.2 MW 50 Hz

One third octave analysis at hub height

Terzanalyse bezogen auf Nabenhöhe

Site / Standort:	Østerild (Denmark)
WTGS-SNo. / WEA-SNr.:	228051
Mode / Modus:	PO1
Date of meas./ Messdatum:	2019-06-26
Standard / Messung:	IEC 61400-11 Ed.3
Project-No. / Projekt-Nr.:	10163788
In charge / Bearbeiter:	Annika Johannsen

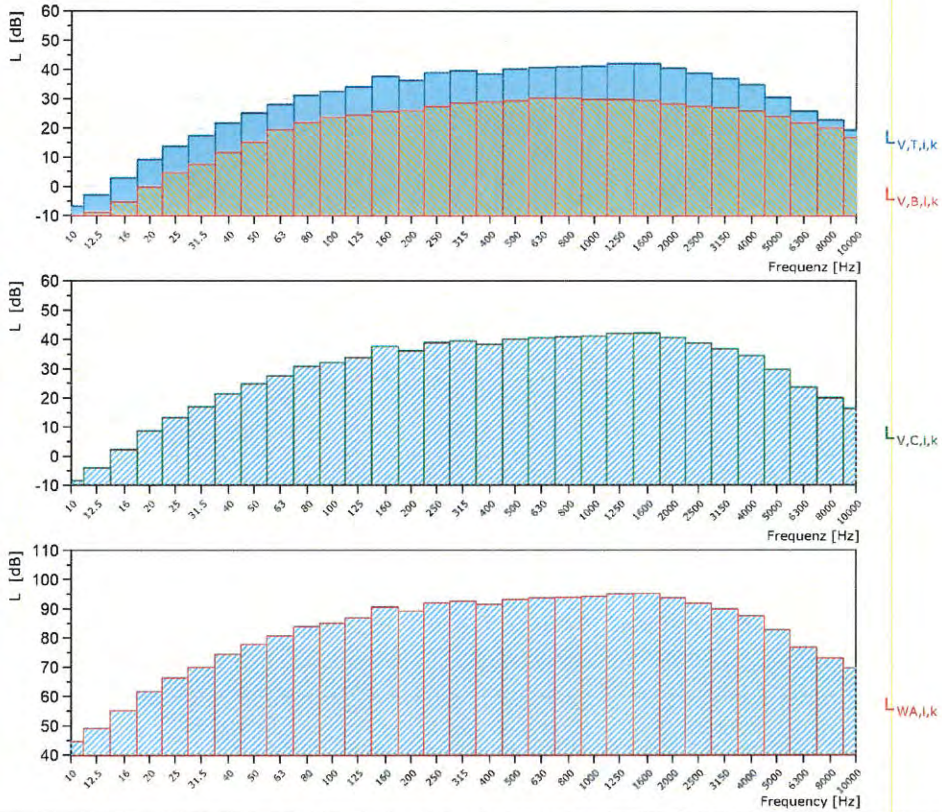
9.16 Third-octave sound power spectra at a WS of 9.0 m/s at hub height

No. of data per BIN / Anzahl der Messdaten pro BIN:
Total noise / Gesamtgeräusch = 222
Background noise / Fremdgeräusch = 89

Reference wind speed / Referenzwindgeschwindigkeit:
$WS_{BIN\ (hub\ height)}$ = 9.0 m/s
$WS_{BIN\ (10\ m)}$ = 6.0 m/s

Sound power level / Schallleistung:
$L_{WA,k}$ = 104.7 dB

f [Hz]	$L_{V,T,i,k}$ [dB]	$u_{Lv,T,i,k}$ [dB]	$L_{V,B,i,k}$ [dB]	$u_{Lv,B,i,k}$ [dB]	$L_{V,C,i,k}$ [dB]	$L_{WA,i,k}$ [dB]	$u_{c,i,k}$ [dB]
10	-6.7	2.3	-11.7	5.7	-8.4	**44.7**	4.3
12.5	-2.8	2.2	-8.8	5.1	-4.0	**49.1**	3.3
16	2.9	2.2	-5.3	4.1	2.1	**55.3**	2.8
20	9.1	2.0	-0.1	3.5	8.6	**61.8**	2.3
25	13.8	1.9	4.7	3.4	13.2	**66.4**	2.2
31.5	17.4	2.0	7.6	3.1	16.9	**70.1**	2.3
40	21.7	1.9	11.7	2.8	21.3	**74.4**	2.1
50	25.2	1.7	15.3	3.1	24.7	**77.9**	1.9
63	28.1	1.4	19.5	3.7	27.4	**80.6**	1.8
80	31.3	1.1	22.0	4.0	30.8	**83.9**	1.3
100	32.7	0.9	23.7	3.4	32.1	**85.3**	1.1
125	34.2	0.7	24.5	4.8	33.8	**86.9**	1.0
160	37.8	1.3	25.7	4.5	37.5	**90.6**	1.5
200	36.4	0.5	26.1	3.6	36.0	**89.2**	0.7
250	39.1	0.4	27.5	3.2	38.8	**92.0**	0.5
315	39.7	0.4	28.7	2.7	39.3	**92.5**	0.5
400	38.7	0.6	29.1	3.0	38.2	**91.4**	0.7
500	40.4	0.3	29.5	2.9	40.0	**93.2**	0.4
630	40.9	0.7	30.4	2.9	40.4	**93.6**	0.8
800	41.1	0.5	30.4	3.0	40.7	**93.9**	0.6
1000	41.3	0.6	29.9	3.0	41.0	**94.2**	0.7
1250	42.2	0.6	30.0	3.1	41.9	**95.1**	0.6
1600	42.2	0.5	29.6	3.2	42.0	**95.1**	0.5
2000	40.7	0.4	28.4	3.3	40.5	**93.6**	0.5
2500	39.0	0.4	27.7	3.2	38.6	**91.8**	0.5
3150	37.2	0.5	27.0	2.9	36.7	**89.9**	0.6
4000	35.0	0.7	25.9	3.0	34.5	**87.6**	0.9
5000	30.7	1.2	24.1	3.1	29.7	**82.8**	1.7
6300	25.9	1.9	22.0	3.3	23.6	**76.8**	3.9
8000	22.9	2.7	20.3	3.3	[19.9]	**[73.1]**	6.3
10000	19.4	3.0	17.1	3.3	[16.4]	**[69.6]**	6.8



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DNV·GL

Bin 9 Vestas V150-4.2 MW 50 Hz

One third octave analysis at hub height

Terzanalyse bezogen auf Nabenhöhe

Site / Standort:	Østerild (Denmark)
WTGS-SNo. / WEA-SNr.:	228051
Mode / Modus:	PO1
Date of meas./ Messdatum:	2019-06-26
Standard / Messung:	IEC 61400-11 Ed.3
Project-No. / Projekt-Nr.:	10163788
In charge / Bearbeiter:	Annika Johannsen

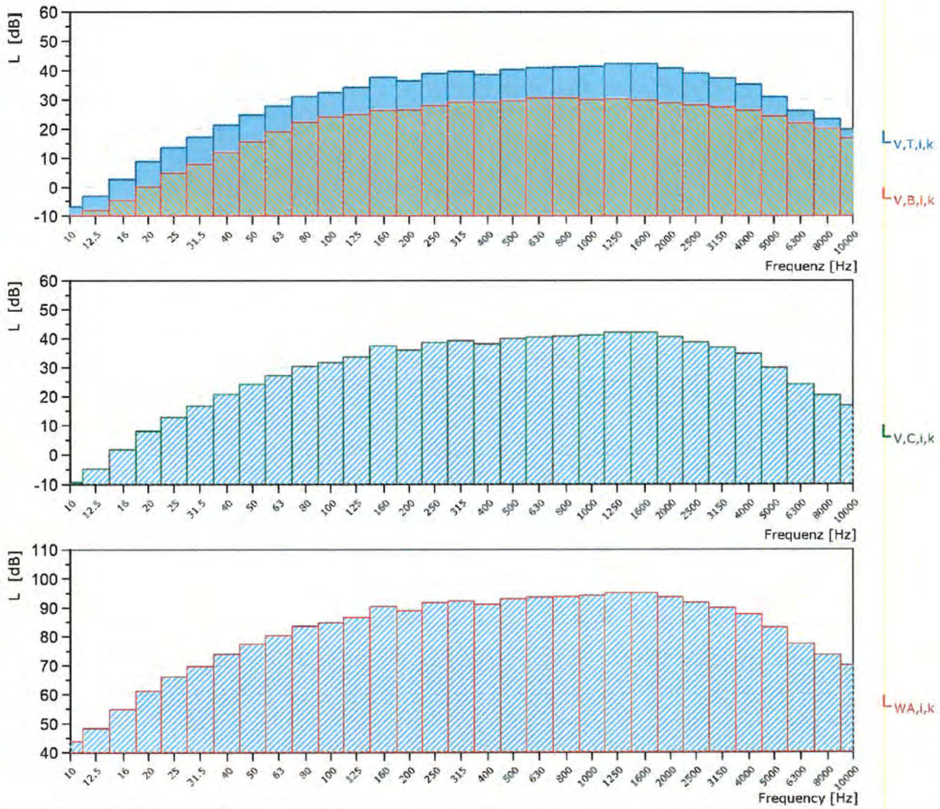
9.17 Third-octave sound power spectra at a WS of 9.5 m/s at hub height

No. of data per BIN / Anzahl der Messdaten pro BIN:
Total noise / Gesamtgeräusch = 144
Background noise / Fremdgeräusch = 106

Reference wind speed / Referenzwindgeschwindigkeit:
$WS_{BIN\ (hub\ height)}$ = 9.5 m/s
$WS_{BIN\ (10\ m)}$ = 6.4 m/s

Sound power level / Schallleistung:
$L_{WA,k}$ = 104.7 dB

f [Hz]	$L_{V,T,i,k}$ [dB]	$u_{Lv,T,i,k}$ [dB]	$L_{V,B,i,k}$ [dB]	$u_{Lv,B,i,k}$ [dB]	$L_{V,C,i,k}$ [dB]	$L_{WA,i,k}$ [dB]	$u_{c,i,k}$ [dB]
10	-7.0	2.0	-10.6	6.1	-9.4	**43.8**	5.8
12.5	-3.1	1.9	-8.1	5.3	-4.8	**48.4**	3.8
16	2.6	2.2	-4.7	4.1	1.7	**54.9**	2.8
20	8.7	1.9	0.1	3.3	8.0	**61.2**	2.2
25	13.5	1.8	4.9	3.2	12.9	**66.0**	2.2
31.5	17.1	1.8	7.8	3.2	16.6	**69.7**	2.1
40	21.3	1.7	11.9	3.0	20.8	**73.9**	2.0
50	24.8	1.6	15.6	3.2	24.3	**77.4**	1.9
63	27.8	1.4	19.1	3.3	27.2	**80.3**	1.7
80	31.0	1.0	22.2	3.8	30.4	**83.6**	1.3
100	32.4	0.8	24.2	3.4	31.7	**84.9**	1.1
125	34.2	0.7	25.0	4.8	33.6	**86.7**	1.0
160	37.7	1.2	26.3	4.4	37.4	**90.6**	1.3
200	36.4	0.5	26.6	3.6	35.9	**89.1**	0.7
250	39.0	0.4	28.0	3.2	38.6	**91.8**	0.5
315	39.6	0.3	29.2	2.7	39.2	**92.4**	0.4
400	38.6	0.5	29.2	2.6	38.1	**91.3**	0.6
500	40.3	0.3	29.8	2.7	39.9	**93.1**	0.4
630	40.9	0.6	30.7	2.6	40.5	**93.7**	0.8
800	41.1	0.4	30.6	2.7	40.7	**93.9**	0.5
1000	41.5	0.6	30.1	2.7	41.2	**94.3**	0.7
1250	42.3	0.5	30.2	2.8	42.0	**95.2**	0.6
1600	42.3	0.4	29.9	3.0	42.0	**95.2**	0.5
2000	40.8	0.4	28.9	3.2	40.5	**93.7**	0.5
2500	39.1	0.4	28.2	3.2	38.8	**91.9**	0.5
3150	37.4	0.6	27.6	3.0	36.9	**90.0**	0.7
4000	35.3	0.8	26.4	3.2	34.7	**87.9**	1.0
5000	31.0	1.1	24.4	2.9	29.9	**83.0**	1.6
6300	26.2	1.8	22.0	2.6	24.2	**77.3**	3.3
8000	23.3	2.6	20.2	2.9	20.4	**73.6**	5.7
10000	19.9	2.8	17.0	2.9	[16.9]	**[70.0]**	6.3



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DNV·GL

Bin 9.5 Vestas V150-4.2 MW 50 Hz

One third octave analysis at hub height
Terzanalyse bezogen auf Nabenhöhe

Site / Standort:	Østerild (Denmark)
WTGS-SNo. / WEA-SNr.:	228051
Mode / Modus:	PO1
Date of meas./ Messdatum:	2019-06-26
Standard / Messung:	IEC 61400-11 Ed.3
Project-No. / Projekt-Nr.:	10163788
In charge / Bearbeiter:	Annika Johannsen

9.18 Third-octave sound power spectra at a WS of 10.0 m/s at hub height

No. of data per BIN / Anzahl der Messdaten pro BIN:
Total noise / Gesamtgeräusch = 81
Background noise / Fremdgeräusch = 88

Reference wind speed / Referenzwindgeschwindigkeit:
$WS_{BIN\ (hub\ height)}$ = 10.0 m/s
$WS_{BIN\ (10\ m)}$ = 6.7 m/s

Sound power level / Schallleistung:
$L_{WA,k}$ = 104.8 dB

f [Hz]	$L_{V,T,i,k}$ [dB]	$u_{Lv,T,i,k}$ [dB]	$L_{V,B,i,k}$ [dB]	$u_{Lv,B,i,k}$ [dB]	$L_{V,C,i,k}$ [dB]	$L_{WA,i,k}$ [dB]	$u_{c,i,k}$ [dB]
10	-6.5	1.9	-9.8	5.3	-9.2	**44.0**	5.7
12.5	-2.7	1.8	-7.3	4.7	-4.5	**48.7**	3.7
16	2.8	1.7	-3.7	3.8	1.7	**54.9**	2.5
20	9.3	1.6	1.2	3.1	8.6	**61.7**	1.9
25	13.8	1.5	5.8	2.9	13.0	**66.2**	1.8
31.5	17.4	1.5	8.6	2.7	16.8	**70.0**	1.8
40	21.7	1.5	12.6	2.7	21.1	**74.3**	1.8
50	25.2	1.4	16.3	2.9	24.6	**77.8**	1.6
63	28.2	1.2	20.0	3.0	27.5	**80.7**	1.5
80	31.4	0.9	23.2	3.4	30.7	**83.8**	1.3
100	32.6	0.8	25.2	3.2	31.7	**84.9**	1.2
125	34.3	0.7	26.3	4.2	33.6	**86.7**	1.2
160	38.1	1.0	27.5	3.9	37.7	**90.9**	1.2
200	36.5	0.5	27.6	3.4	35.9	**89.0**	0.8
250	39.0	0.5	29.1	3.0	38.5	**91.7**	0.6
315	39.7	0.3	30.3	2.6	39.1	**92.3**	0.5
400	38.6	0.4	30.6	2.7	37.8	**91.0**	0.7
500	40.3	0.3	31.0	2.5	39.8	**92.9**	0.5
630	41.0	0.5	31.5	2.3	40.5	**93.7**	0.7
800	41.3	0.5	31.4	2.4	40.8	**93.9**	0.6
1000	41.6	0.6	30.7	2.3	41.3	**94.4**	0.7
1250	42.5	0.6	30.9	2.2	42.2	**95.3**	0.7
1600	42.4	0.5	30.7	2.3	42.1	**95.3**	0.6
2000	41.0	0.5	29.5	2.3	40.7	**93.8**	0.5
2500	39.3	0.5	28.7	2.5	38.9	**92.1**	0.6
3150	37.5	0.6	27.9	2.6	37.0	**90.1**	0.7
4000	35.3	0.6	26.8	3.2	34.6	**87.8**	0.9
5000	30.9	1.0	24.9	3.2	29.7	**82.9**	1.7
6300	26.4	2.0	22.4	3.0	24.2	**77.4**	3.8
8000	23.6	2.7	20.7	3.3	[20.6]	**[73.8]**	6.4
10000	20.2	3.0	17.5	3.3	[17.2]	**[70.3]**	6.8

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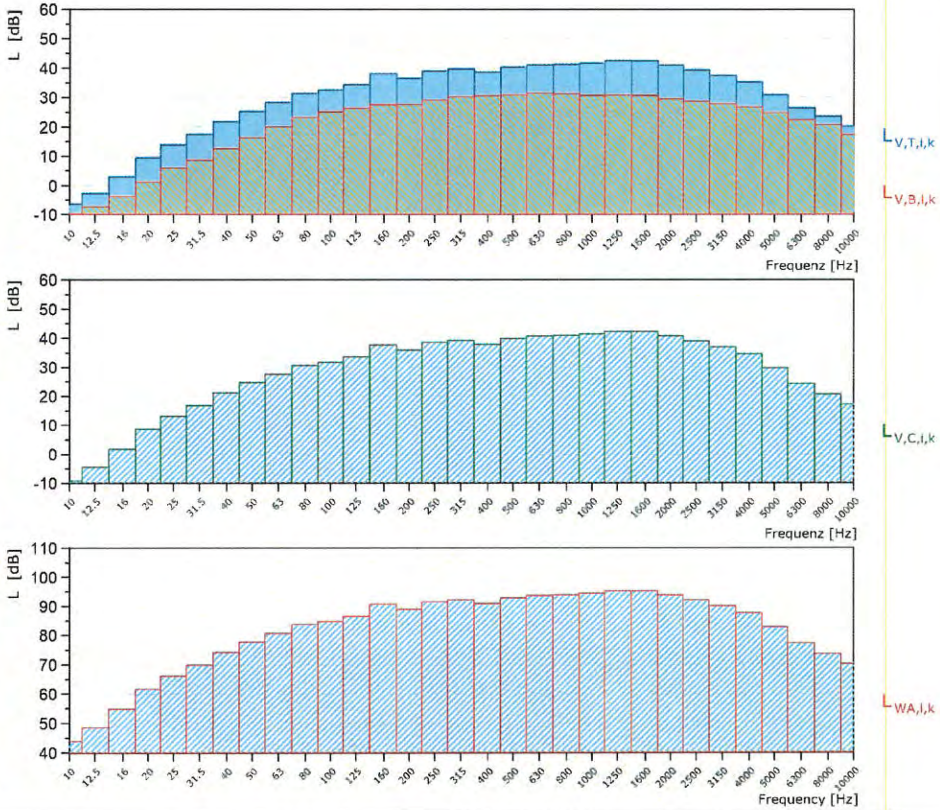

DNV·GL

Bin 10 Vestas V150-4.2 MW 50 Hz

One third octave analysis at hub height

Terzanalyse bezogen auf Nabenhöhe

Site / Standort:	Østerild (Denmark)
WTGS-SNo. / WEA-SNr.:	228051
Mode / Modus:	PO1
Date of meas./ Messdatum:	2019-06-26
Standard / Messung:	IEC 61400-11 Ed.3
Project-No. / Projekt-Nr.:	10163788
In charge / Bearbeiter:	Annika Johannsen

9.19 Third-octave sound power spectra at a WS of 10.5 m/s at hub height

No. of data per BIN / Anzahl der Messdaten pro BIN:
Total noise / Gesamtgeräusch = 53
Background noise / Fremdgeräusch = 96

Reference wind speed / Referenzwindgeschwindigkeit:
$WS_{BIN\ (hub\ height)}$ = 10.5 m/s
$WS_{BIN\ (10\ m)}$ = 7.0 m/s

Sound power level / Schallleistung:
$L_{WA,k}$ = 104.7 dB

f [Hz]	$L_{V,T,i,k}$ [dB]	$u_{LV,T,i,k}$ [dB]	$L_{V,B,i,k}$ [dB]	$u_{LV,B,i,k}$ [dB]	$L_{V,C,i,k}$ [dB]	$L_{WA,i,k}$ [dB]	$u_{c,i,k}$ [dB]
10	-6.4	1.9	-10.3	4.5	-8.7	**44.5**	4.5
12.5	-2.8	1.4	-8.1	4.0	-4.3	**48.9**	2.6
16	3.1	1.9	-4.3	3.2	2.2	**55.4**	2.5
20	9.4	1.8	1.0	2.8	8.7	**61.9**	2.1
25	14.2	1.7	5.7	2.9	13.5	**66.7**	2.1
31.5	17.5	1.7	8.5	3.0	17.0	**70.1**	2.0
40	21.8	1.6	12.4	2.9	21.2	**74.4**	1.8
50	25.3	1.7	16.2	3.1	24.7	**77.8**	2.0
63	28.3	1.6	19.9	3.2	27.7	**80.8**	1.9
80	31.6	1.2	23.3	3.6	30.9	**84.0**	1.6
100	32.6	1.1	25.1	3.1	31.7	**84.9**	1.5
125	34.2	1.0	26.4	4.3	33.4	**86.6**	1.5
160	38.2	1.1	27.5	3.8	37.9	**91.0**	1.3
200	36.4	0.6	27.7	3.3	35.8	**88.9**	0.9
250	38.7	0.6	29.1	2.9	38.2	**91.3**	0.8
315	39.5	0.4	30.1	2.4	38.9	**92.1**	0.6
400	38.6	0.4	30.3	2.4	37.9	**91.1**	0.7
500	40.2	0.4	30.8	2.5	39.6	**92.8**	0.5
630	41.1	0.5	31.5	2.3	40.6	**93.7**	0.6
800	41.1	0.4	31.4	2.4	40.6	**93.8**	0.6
1000	41.5	0.6	30.8	2.4	41.1	**94.3**	0.7
1250	42.4	0.6	31.0	2.4	42.0	**95.2**	0.7
1600	42.4	0.5	30.9	2.6	42.1	**95.2**	0.6
2000	40.9	0.5	29.8	2.6	40.6	**93.8**	0.6
2500	39.3	0.5	29.1	2.7	38.8	**92.0**	0.6
3150	37.3	0.6	28.2	2.7	36.8	**89.9**	0.7
4000	35.1	0.7	26.8	3.0	34.5	**87.6**	0.9
5000	30.7	1.0	24.9	3.1	29.4	**82.5**	1.8
6300	25.6	1.9	22.6	3.0	22.6	**75.8**	4.7
8000	22.7	2.8	20.9	3.1	[19.7]	**[72.8]**	6.4
10000	19.2	3.1	17.7	3.1	[16.2]	**[69.4]**	6.9

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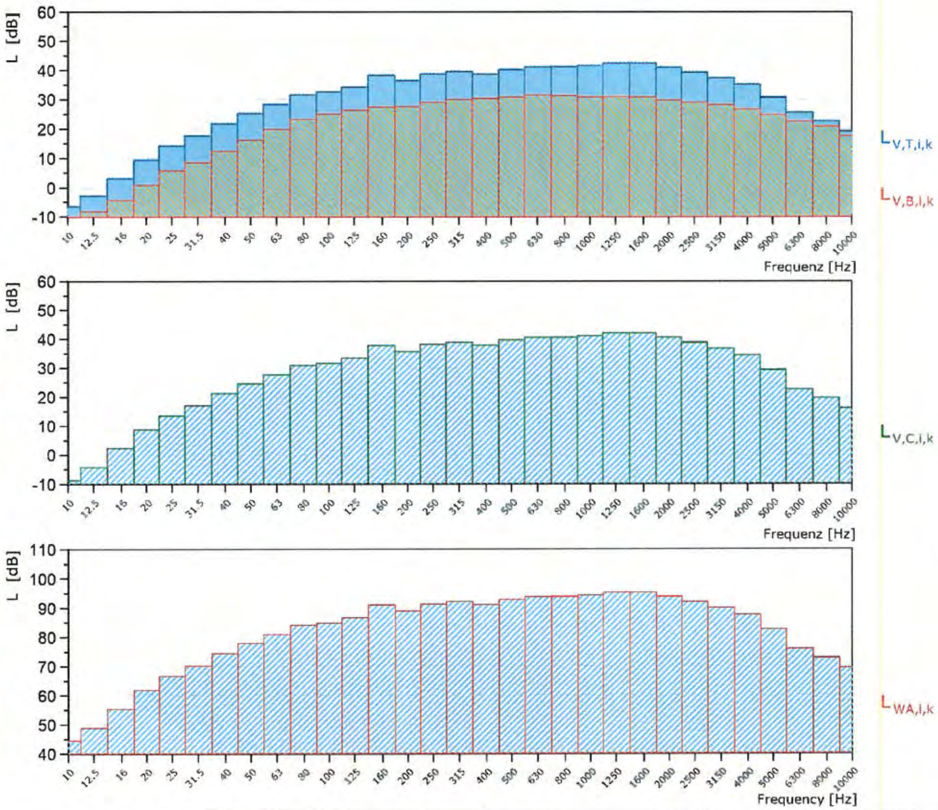


22.08.2019

DNV·GL

Bin 10.5 Vestas V150-4.2 MW 50 Hz

One third octave analysis at hub height

Terzanalyse bezogen auf Nabenhöhe

Site / Standort:	Østerild (Denmark)
WTGS-SNo. / WEA-SNr.:	228051
Mode / Modus:	PO1
Date of meas./ Messdatum:	2019-06-26
Standard / Messung:	IEC 61400-11 Ed.3
Project-No. / Projekt-Nr.:	10163788
In charge / Bearbeiter:	Annika Johannsen

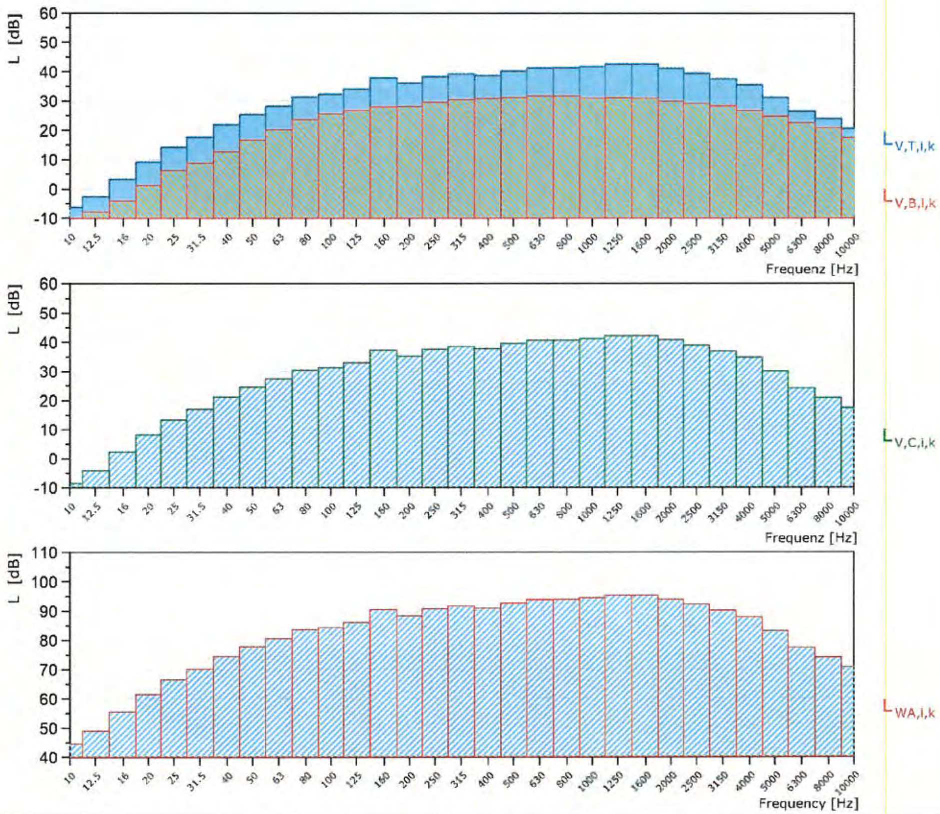
9.20 Third-octave sound power spectra at a WS of 11.0 m/s at hub height

No. of data per BIN / Anzahl der Messdaten pro BIN:
Total noise / Gesamtgeräusch = 39
Background noise / Fremdgeräusch = 81

Reference wind speed / Referenzwindgeschwindigkeit:
$WS_{BIN\ (hub\ height)}$ = 11.0 m/s
$WS_{BIN\ (10\ m)}$ = 7.4 m/s

Sound power level / Schallleistung:
$L_{WA,k}$ = 104.6 dB

f [Hz]	$L_{V,T,i,k}$ [dB]	$u_{Lv,T,i,k}$ [dB]	$L_{V,B,i,k}$ [dB]	$u_{Lv,B,i,k}$ [dB]	$L_{V,C,i,k}$ [dB]	$L_{WA,i,k}$ [dB]	$u_{c,i,k}$ [dB]
10	-6.2	2.0	-10.0	4.5	-8.6	**44.6**	4.7
12.5	-2.6	1.8	-7.8	3.9	-4.1	**49.1**	3.0
16	3.2	1.7	-4.1	3.4	2.3	**55.5**	2.2
20	9.0	1.6	1.3	2.9	8.2	**61.4**	2.0
25	14.1	1.6	6.2	2.9	13.3	**66.5**	2.0
31.5	17.6	1.6	8.8	2.8	17.0	**70.1**	1.9
40	21.8	1.5	12.7	2.9	21.2	**74.4**	1.8
50	25.2	1.5	16.8	3.3	24.6	**77.7**	1.9
63	28.1	1.4	20.1	3.1	27.3	**80.5**	1.8
80	31.3	1.3	23.6	3.3	30.5	**83.6**	1.7
100	32.3	1.0	25.5	3.1	31.3	**84.4**	1.6
125	33.9	1.0	26.7	3.8	33.0	**86.2**	1.5
160	37.8	1.1	27.9	3.2	37.3	**90.5**	1.3
200	36.0	0.5	28.1	2.9	35.2	**88.4**	0.8
250	38.2	0.6	29.5	2.6	37.6	**90.8**	0.8
315	39.2	0.5	30.4	2.2	38.5	**91.7**	0.7
400	38.6	0.5	30.9	2.3	37.8	**90.9**	0.8
500	40.1	0.4	31.1	2.2	39.5	**92.7**	0.6
630	41.1	0.4	31.7	2.3	40.6	**93.8**	0.6
800	41.2	0.5	31.7	2.4	40.7	**93.8**	0.6
1000	41.6	0.6	31.0	2.3	41.2	**94.4**	0.6
1250	42.4	0.5	31.1	2.3	42.1	**95.3**	0.6
1600	42.4	0.5	31.0	2.1	42.1	**95.3**	0.5
2000	41.0	0.4	29.9	2.1	40.7	**93.9**	0.5
2500	39.4	0.5	29.2	2.2	38.9	**92.1**	0.6
3150	37.5	0.6	28.3	2.4	36.9	**90.1**	0.7
4000	35.4	0.8	26.6	2.8	34.7	**87.9**	1.0
5000	31.2	1.2	24.8	3.0	30.0	**83.2**	1.8
6300	26.4	2.4	22.5	3.0	24.2	**77.4**	4.5
8000	23.8	3.3	20.8	3.3	20.9	**74.1**	7.4
10000	20.5	3.6	17.6	3.3	[17.5]	**[70.7]**	7.9



created with GL Acoustic TuNES version: 18.011

DNV·GL

Bin 11 Vestas V150-4.2 MW 50 Hz

One third octave analysis at hub height
Terzanalyse bezogen auf Nabenhöhe

Site / Standort:	Østerild (Denmark)
WTGS-SNo. / WEA-SNr.:	228051
Mode / Modus:	PO1
Date of meas./ Messdatum:	2019-06-26
Standard / Messung:	IEC 61400-11 Ed.3
Project-No. / Projekt-Nr.:	10163788
In charge / Bearbeiter:	Annika Johannsen

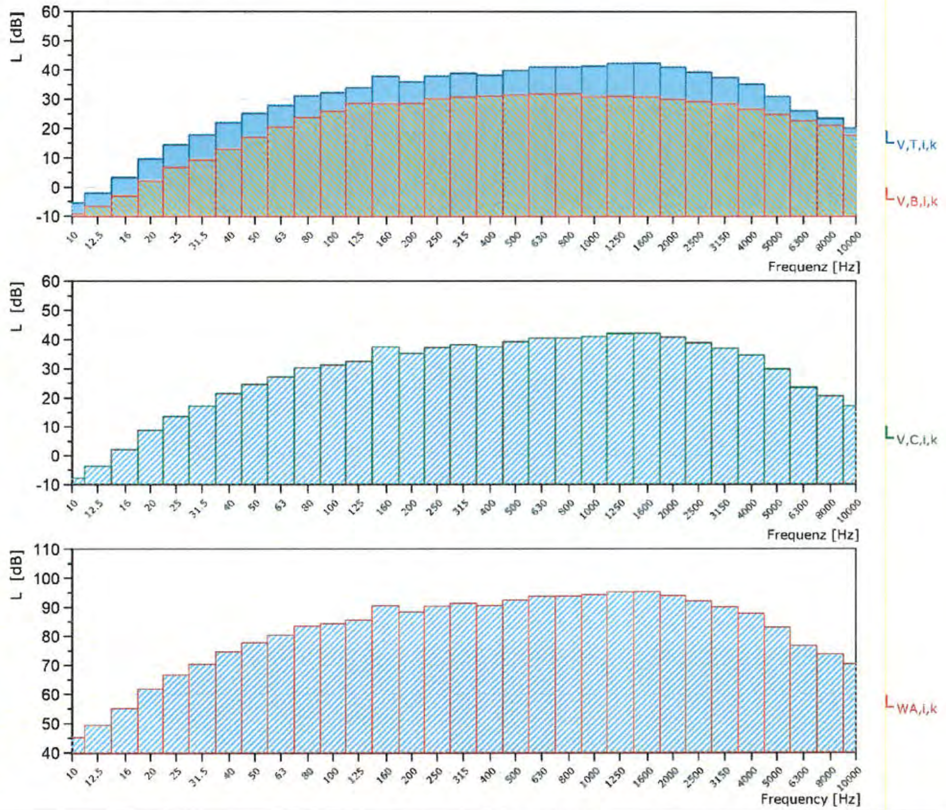
9.21 Third-octave sound power spectra at a WS of 11.5 m/s at hub height

No. of data per BIN / Anzahl der Messdaten pro BIN:
Total noise / Gesamtgeräusch = 41
Background noise / Fremdgeräusch = 51

Reference wind speed / Referenzwindgeschwindigkeit:
$WS_{BIN\ (hub\ height)}$ = 11.5 m/s
$WS_{BIN\ (10\ m)}$ = 7.7 m/s

Sound power level / Schallleistung:
$L_{WA,k}$ = 104.5 dB

f [Hz]	$L_{V,T,i,k}$ [dB]	$u_{Lv,T,i,k}$ [dB]	$L_{V,B,i,k}$ [dB]	$u_{Lv,B,i,k}$ [dB]	$L_{V,C,i,k}$ [dB]	$L_{WA,i,k}$ [dB]	$u_{c,i,k}$ [dB]
10	-5.4	2.0	-9.1	4.5	-7.9	**45.3**	5.0
12.5	-1.9	1.9	-6.5	4.1	-3.8	**49.4**	3.6
16	3.3	1.7	-2.8	3.4	2.1	**55.2**	2.6
20	9.6	1.7	2.3	3.1	8.7	**61.9**	2.2
25	14.4	1.6	6.8	2.3	13.5	**66.7**	2.0
31.5	17.8	1.7	9.4	2.3	17.2	**70.3**	2.0
40	22.0	1.9	13.1	2.3	21.4	**74.6**	2.2
50	25.3	1.8	17.0	2.5	24.5	**77.7**	2.1
63	28.0	1.5	20.6	2.6	27.1	**80.3**	2.0
80	31.2	1.3	23.9	2.6	30.3	**83.5**	1.8
100	32.3	1.2	26.0	2.5	31.2	**84.3**	1.7
125	34.0	0.9	28.7	3.9	32.4	**85.6**	2.1
160	37.9	1.5	28.5	2.6	37.4	**90.5**	1.7
200	36.1	0.5	28.7	2.3	35.2	**88.4**	0.8
250	38.0	0.7	30.2	2.4	37.2	**90.3**	0.9
315	38.9	0.5	30.8	2.1	38.2	**91.3**	0.7
400	38.3	0.4	31.2	2.3	37.4	**90.6**	0.7
500	39.9	0.5	31.5	2.2	39.2	**92.4**	0.6
630	41.1	0.3	31.9	2.1	40.5	**93.7**	0.5
800	41.1	0.5	31.8	2.1	40.5	**93.7**	0.6
1000	41.4	0.5	31.0	2.1	41.0	**94.2**	0.6
1250	42.3	0.5	31.1	2.1	42.0	**95.2**	0.6
1600	42.4	0.5	30.9	2.0	42.1	**95.2**	0.6
2000	41.0	0.5	30.0	2.1	40.7	**93.9**	0.6
2500	39.3	0.5	29.4	2.4	38.9	**92.0**	0.6
3150	37.4	0.4	28.5	2.6	36.9	**90.0**	0.6
4000	35.2	0.5	26.7	2.8	34.6	**87.7**	0.8
5000	31.0	0.8	25.0	2.9	29.8	**82.9**	1.5
6300	26.1	2.0	22.8	2.9	23.4	**76.6**	4.5
8000	23.6	2.9	21.1	3.0	[20.6]	**[73.7]**	6.5
10000	20.2	3.1	17.9	3.0	[17.2]	**[70.4]**	7.0



created with GL Acoustic TuNES version: 18.011

DNV·GL

Bin 11.5 Vestas V150-4.2 MW 50 Hz

One third octave analysis at hub height

Terzanalyse bezogen auf Nabenhöhe

Site / Standort:	Østerild (Denmark)
WTGS-SNo. / WEA-SNr.:	228051
Mode / Modus:	PO1
Date of meas./ Messdatum:	2019-06-26
Standard / Messung:	IEC 61400-11 Ed.3
Project-No. / Projekt-Nr.:	10163788
In charge / Bearbeiter:	Annika Johannsen

9.22 Third-octave sound power spectra at a WS of 12.0 m/s at hub height

No. of data per BIN / Anzahl der Messdaten pro BIN:
Total noise / Gesamtgeräusch = 39
Background noise / Fremdgeräusch = 44

Reference wind speed / Referenzwindgeschwindigkeit:
$WS_{BIN\ (hub\ height)}$ = 12.0 m/s
$WS_{BIN\ (10\ m)}$ = 8.0 m/s

Sound power level / Schallleistung:
$L_{WA,k}$ = 104.3 dB

f [Hz]	$L_{V,T,i,k}$ [dB]	$u_{Lv,T,i,k}$ [dB]	$L_{V,B,i,k}$ [dB]	$u_{Lv,B,i,k}$ [dB]	$L_{V,C,i,k}$ [dB]	$L_{WA,i,k}$ [dB]	$u_{c,i,k}$ [dB]
10	-5.9	1.7	-8.6	4.2	[-8.9]	**[44.2]**	5.5
12.5	-2.4	1.7	-6.1	4.2	-4.8	**48.4**	4.2
16	3.2	1.6	-2.2	3.7	1.7	**54.9**	2.7
20	9.6	1.6	2.5	3.0	8.6	**61.8**	2.1
25	14.3	1.3	6.9	2.5	13.4	**66.6**	1.7
31.5	17.8	1.5	9.4	2.2	17.1	**70.2**	1.8
40	22.0	1.5	13.3	2.2	21.4	**74.6**	1.8
50	25.3	1.4	17.1	2.4	24.6	**77.7**	1.7
63	28.2	1.3	20.7	2.3	27.4	**80.5**	1.7
80	31.4	1.1	24.1	2.4	30.6	**83.7**	1.5
100	32.4	1.0	26.0	2.3	31.3	**84.5**	1.5
125	33.9	1.2	27.4	2.8	32.9	**86.0**	1.7
160	37.4	1.3	28.4	2.4	36.8	**90.0**	1.5
200	35.9	0.4	28.7	2.1	34.9	**88.1**	0.7
250	37.8	0.4	30.0	2.0	37.0	**90.1**	0.6
315	38.6	0.4	30.9	1.9	37.8	**91.0**	0.6
400	38.4	0.5	31.1	1.9	37.4	**90.6**	0.7
500	39.7	0.4	31.6	1.9	39.0	**92.2**	0.6
630	41.0	0.4	32.3	2.0	40.3	**93.5**	0.6
800	40.9	0.5	32.1	2.0	40.3	**93.5**	0.6
1000	41.3	0.6	31.5	2.1	40.8	**94.0**	0.7
1250	42.2	0.5	31.6	2.1	41.8	**95.0**	0.6
1600	42.3	0.5	31.7	2.2	41.9	**95.1**	0.6
2000	41.0	0.5	30.7	2.2	40.6	**93.7**	0.6
2500	39.3	0.5	30.1	2.4	38.7	**91.9**	0.7
3150	37.4	0.6	29.4	2.7	36.7	**89.9**	0.8
4000	35.4	0.8	27.6	2.9	34.6	**87.8**	1.1
5000	31.1	1.0	25.6	2.9	29.6	**82.8**	1.8
6300	25.9	1.5	23.3	2.9	[22.9]	**[76.0]**	4.2
8000	23.3	2.1	21.6	3.0	[20.3]	**[73.4]**	5.2
10000	19.9	2.2	18.3	3.0	[16.9]	**[70.1]**	5.4

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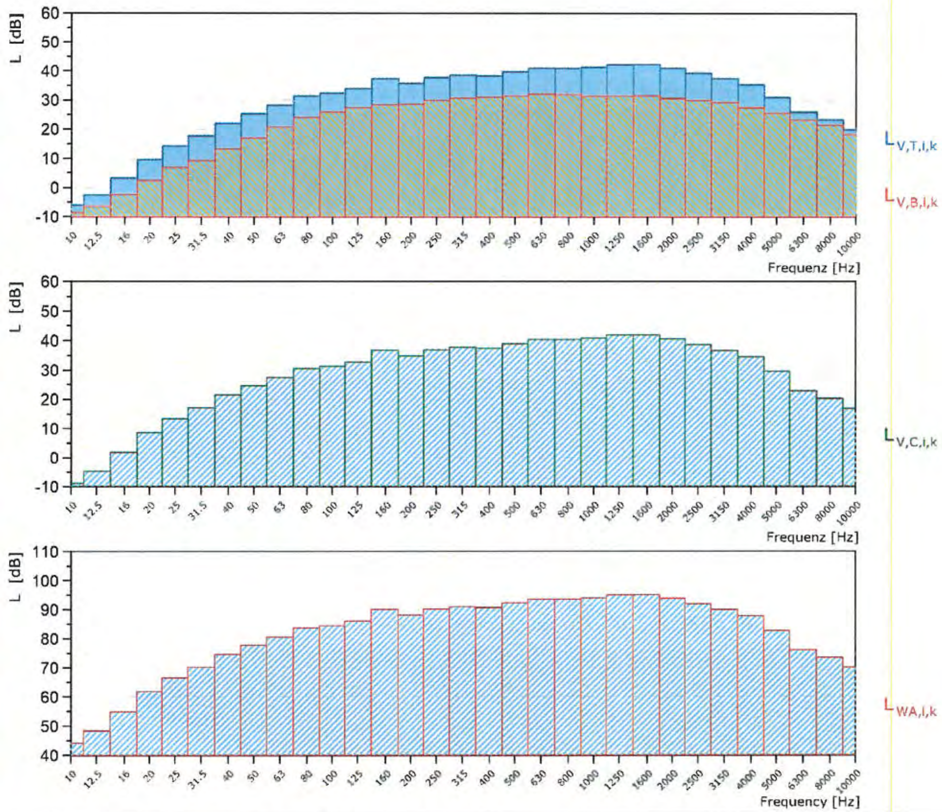

DNV·GL

Bin 12 Vestas V150-4.2 MW 50 Hz

One third octave analysis at hub height

Terzanalyse bezogen auf Nabenhöhe

Site / Standort:	Østerild (Denmark)
WTGS-SNo. / WEA-SNr.:	228051
Mode / Modus:	PO1
Date of meas./ Messdatum:	2019-06-26
Standard / Messung:	IEC 61400-11 Ed.3
Project-No. / Projekt-Nr.:	10163788
In charge / Bearbeiter:	Annika Johannsen

9.23 Third-octave sound power spectra at a WS of 12.5 m/s at hub height

No. of data per BIN / Anzahl der Messdaten pro BIN:
Total noise / Gesamtgeräusch = 30
Background noise / Fremdgeräusch = 36

Reference wind speed / Referenzwindgeschwindigkeit:
$WS_{BIN\ (hub\ height)}$ = 12.5 m/s
$WS_{BIN\ (10\ m)}$ = 8.4 m/s

Sound power level / Schallleistung:
$L_{WA,k}$ = 104.5 dB

f [Hz]	$L_{V,T,i,k}$ [dB]	$u_{Lv,T,i,k}$ [dB]	$L_{V,B,i,k}$ [dB]	$u_{Lv,B,i,k}$ [dB]	$L_{V,C,i,k}$ [dB]	$L_{WA,i,k}$ [dB]	$u_{c,i,k}$ [dB]
10	-5.8	1.9	-9.0	4.3	-8.6	**44.5**	5.3
12.5	-2.2	1.9	-6.5	3.9	-4.2	**49.0**	3.8
16	3.4	2.2	-3.1	3.0	2.3	**55.5**	2.9
20	9.3	1.8	2.4	2.9	8.4	**61.5**	2.4
25	14.3	1.6	6.6	2.1	13.5	**66.6**	2.0
31.5	17.6	1.7	9.4	2.1	16.9	**70.0**	2.0
40	21.8	2.0	13.2	2.4	21.2	**74.3**	2.3
50	25.2	1.8	17.2	2.5	24.4	**77.6**	2.2
63	28.1	1.7	20.6	2.2	27.2	**80.4**	2.2
80	31.2	1.4	23.9	2.4	30.3	**83.5**	1.8
100	32.2	1.3	25.9	2.3	31.0	**84.2**	1.9
125	33.6	1.0	27.3	2.6	32.4	**85.5**	1.6
160	37.9	1.5	28.6	2.4	37.4	**90.5**	1.8
200	35.8	0.5	28.8	2.2	34.8	**88.0**	0.9
250	37.7	0.6	30.1	2.1	36.9	**90.1**	0.8
315	38.8	0.5	30.9	2.1	38.0	**91.2**	0.7
400	38.5	0.6	31.3	2.4	37.6	**90.8**	0.9
500	39.9	0.4	31.7	2.4	39.2	**92.3**	0.7
630	41.1	0.4	32.5	2.5	40.5	**93.6**	0.6
800	41.2	0.4	32.3	2.6	40.6	**93.8**	0.6
1000	41.5	0.5	31.6	2.5	41.1	**94.2**	0.6
1250	42.5	0.5	31.7	2.4	42.1	**95.2**	0.6
1600	42.6	0.6	31.5	2.2	42.2	**95.4**	0.7
2000	41.3	0.6	30.6	2.2	40.9	**94.1**	0.7
2500	39.6	0.5	30.0	2.4	39.1	**92.3**	0.7
3150	37.7	0.5	29.2	2.6	37.1	**90.3**	0.7
4000	35.5	0.5	27.4	2.9	34.8	**88.0**	0.8
5000	31.4	1.0	25.7	3.1	30.0	**83.2**	1.8
6300	26.7	2.2	23.6	3.3	23.8	**76.9**	5.3
8000	24.3	3.0	21.9	3.5	[21.3]	**[74.4]**	6.9
10000	21.0	3.2	18.7	3.5	[18.0]	**[71.1]**	7.3

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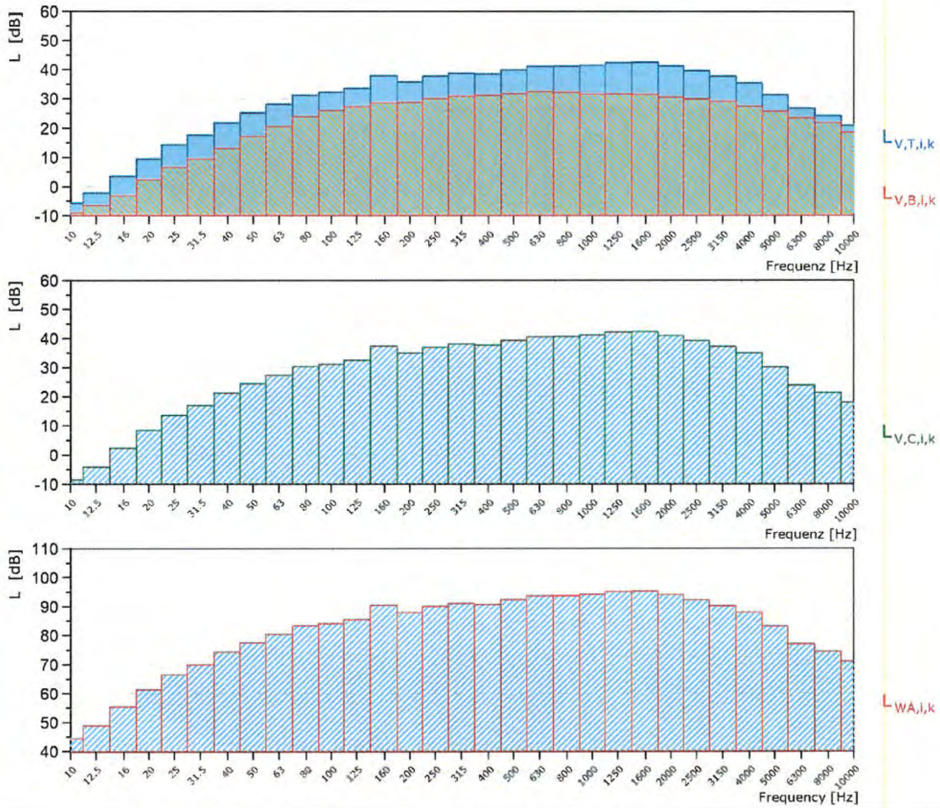


DNV·GL

Bin 12.5 Vestas V150-4.2 MW 50 Hz

One third octave analysis at hub height

Terzanalyse bezogen auf Nabenhöhe

Site / Standort:	Østerild (Denmark)
WTGS-SNo. / WEA-SNr.:	228051
Mode / Modus:	PO1
Date of meas./ Messdatum:	2019-06-26
Standard / Messung:	IEC 61400-11 Ed.3
Project-No. / Projekt-Nr.:	10163788
In charge / Bearbeiter:	Annika Johannsen

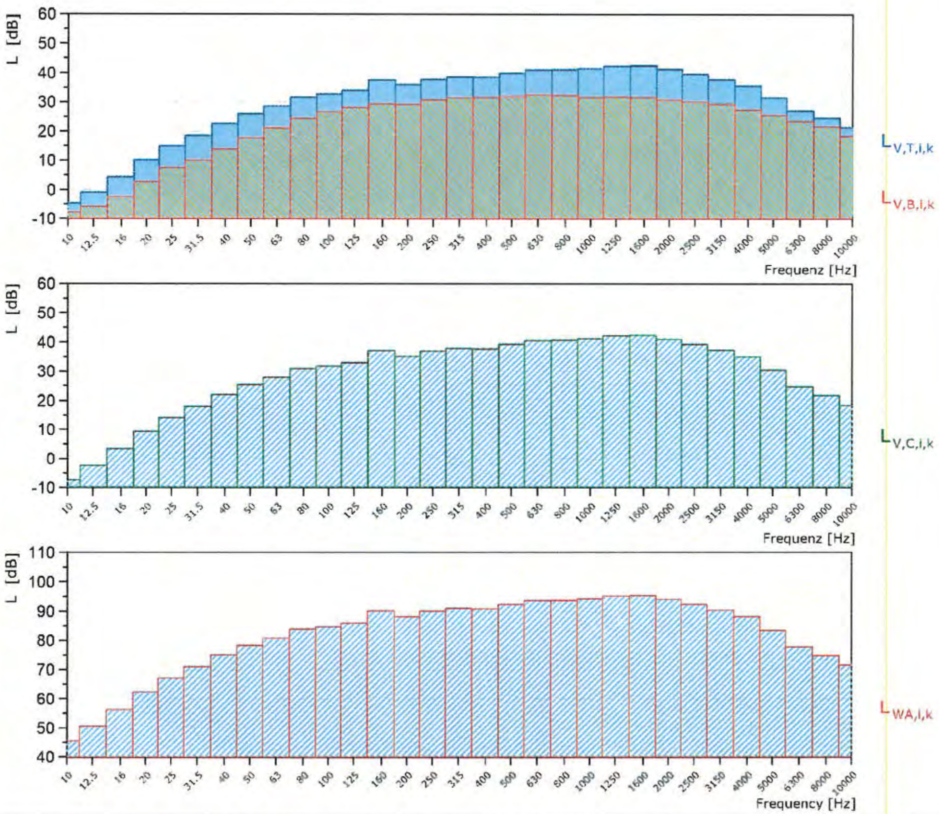
9.24 Third-octave sound power spectra at a WS of 13.0 m/s at hub height

No. of data per BIN / Anzahl der Messdaten pro BIN:
Total noise / Gesamtgeräusch = 35
Background noise / Fremdgeräusch = 27

Reference wind speed / Referenzwindgeschwindigkeit:
$WS_{BIN\ (hub\ height)}$ = 13.0 m/s
$WS_{BIN\ (10\ m)}$ = 8.7 m/s

Sound power level / Schallleistung:
$L_{WA,k}$ = 104.6 dB

f [Hz]	$L_{V,T,i,k}$ [dB]	$u_{Lv,T,i,k}$ [dB]	$L_{V,B,i,k}$ [dB]	$u_{Lv,B,i,k}$ [dB]	$L_{V,C,i,k}$ [dB]	$L_{WA,i,k}$ [dB]	$u_{c,i,k}$ [dB]
10	-4.6	2.0	-7.8	3.9	-7.5	**45.7**	5.3
12.5	-0.8	1.9	-5.8	3.2	-2.5	**50.7**	3.2
16	4.3	2.0	-2.3	2.3	3.3	**56.4**	2.7
20	10.1	2.0	2.8	2.2	9.3	**62.4**	2.5
25	14.9	2.2	7.5	1.6	14.0	**67.2**	2.7
31.5	18.6	2.1	10.1	1.6	18.0	**71.1**	2.4
40	22.6	2.2	14.0	1.5	21.9	**75.1**	2.5
50	26.0	2.1	17.9	1.5	25.2	**78.4**	2.5
63	28.6	1.9	21.3	1.6	27.7	**80.9**	2.3
80	31.7	1.6	24.6	1.5	30.8	**84.0**	2.1
100	32.9	1.6	26.7	1.5	31.7	**84.8**	2.2
125	34.2	1.4	28.3	1.8	32.9	**86.1**	2.0
160	37.7	1.4	29.5	1.6	37.0	**90.2**	1.6
200	36.1	0.5	29.3	1.3	35.1	**88.2**	0.8
250	37.9	0.6	30.8	1.4	37.0	**90.1**	0.8
315	38.8	0.4	31.6	1.5	37.8	**91.0**	0.7
400	38.6	0.5	31.7	1.6	37.7	**90.8**	0.7
500	40.0	0.5	32.1	1.6	39.2	**92.4**	0.6
630	41.1	0.4	32.7	1.7	40.5	**93.6**	0.5
800	41.2	0.4	32.5	1.7	40.6	**93.8**	0.6
1000	41.6	0.4	31.8	1.8	41.1	**94.2**	0.5
1250	42.4	0.5	31.9	2.0	42.0	**95.2**	0.6
1600	42.6	0.5	31.8	2.1	42.2	**95.4**	0.6
2000	41.4	0.6	30.9	2.2	40.9	**94.1**	0.6
2500	39.7	0.6	30.3	2.5	39.2	**92.4**	0.7
3150	37.9	0.6	29.4	2.8	37.3	**90.4**	0.8
4000	35.7	0.6	27.5	2.9	35.0	**88.2**	0.9
5000	31.6	1.0	25.7	3.0	30.3	**83.5**	1.7
6300	27.1	1.8	23.5	3.1	24.7	**77.8**	4.0
8000	24.7	2.4	21.7	3.2	21.7	**74.9**	5.7
10000	21.4	2.5	18.5	3.2	[18.4]	**[71.6]**	6.0



created with GL Acoustic TuNES version: 18.011

DNV·GL

Bin 13 Vestas V150-4.2 MW 50 Hz

One third octave analysis at hub height

Terzanalyse bezogen auf Nabenhöhe

Site / Standort:	Østerild (Denmark)
WTGS-SNo. / WEA-SNr.:	228051
Mode / Modus:	PO1
Date of meas./ Messdatum:	2019-06-26
Standard / Messung:	IEC 61400-11 Ed.3
Project-No. / Projekt-Nr.:	10163788
In charge / Bearbeiter:	Annika Johannsen

9.25 Third-octave sound power spectra at a WS of 13.5 m/s at hub height

No. of data per BIN / Anzahl der Messdaten pro BIN:
Total noise / Gesamtgeräusch = 30
Background noise / Fremdgeräusch = 18

Reference wind speed / Referenzwindgeschwindigkeit:
$WS_{BIN\ (hub\ height)}$ = 13.5 m/s
$WS_{BIN\ (10\ m)}$ = 9.0 m/s

Sound power level / Schallleistung:
$L_{WA,k}$ = 104.5 dB

f [Hz]	$L_{V,T,i,k}$ [dB]	$u_{Lv,T,i,k}$ [dB]	$L_{V,B,i,k}$ [dB]	$u_{Lv,B,i,k}$ [dB]	$L_{V,C,i,k}$ [dB]	$L_{WA,i,k}$ [dB]	$u_{c,i,k}$ [dB]
10	-4.1	2.2	-9.3	3.0	-5.7	**47.4**	3.4
12.5	-0.7	1.9	-6.7	3.2	-2.0	**51.2**	2.8
16	4.2	1.8	-2.2	2.7	3.0	**56.2**	2.5
20	10.3	1.8	2.8	1.8	9.4	**62.6**	2.2
25	14.8	1.5	7.9	1.3	13.8	**67.0**	1.9
31.5	18.3	1.6	10.8	1.4	17.4	**70.6**	2.0
40	22.2	1.6	14.6	1.3	21.3	**74.5**	1.9
50	25.7	1.6	18.6	1.4	24.7	**77.9**	2.0
63	28.4	1.4	22.3	1.3	27.1	**80.3**	1.9
80	31.4	1.2	25.3	1.2	30.2	**83.4**	1.6
100	32.6	1.0	27.3	1.3	31.2	**84.3**	1.5
125	34.2	1.2	29.0	2.0	32.7	**85.8**	1.9
160	37.6	1.5	29.8	1.6	36.8	**90.0**	1.8
200	36.0	0.5	29.6	1.4	34.9	**88.1**	0.8
250	37.9	0.4	31.1	1.5	36.8	**90.0**	0.7
315	38.8	0.4	32.0	1.5	37.8	**90.9**	0.7
400	38.6	0.6	31.8	1.7	37.6	**90.8**	0.9
500	40.0	0.5	32.3	1.8	39.2	**92.4**	0.7
630	41.2	0.4	32.8	1.8	40.5	**93.7**	0.5
800	41.3	0.4	32.7	1.8	40.6	**93.8**	0.6
1000	41.6	0.5	31.9	1.7	41.1	**94.3**	0.6
1250	42.6	0.4	32.2	1.6	42.1	**95.3**	0.5
1600	42.7	0.5	32.4	1.7	42.3	**95.4**	0.5
2000	41.5	0.4	31.7	1.9	41.0	**94.1**	0.5
2500	39.8	0.4	31.2	2.2	39.1	**92.3**	0.6
3150	38.0	0.5	30.4	2.6	37.2	**90.3**	0.8
4000	35.8	0.6	28.1	2.6	35.1	**88.2**	0.9
5000	31.6	1.2	26.0	2.6	30.2	**83.4**	2.0
6300	27.0	2.4	23.3	2.6	24.6	**77.8**	4.6
8000	24.6	3.2	21.2	2.8	21.9	**75.1**	6.4
10000	21.2	3.4	17.9	2.8	18.6	**71.7**	6.8

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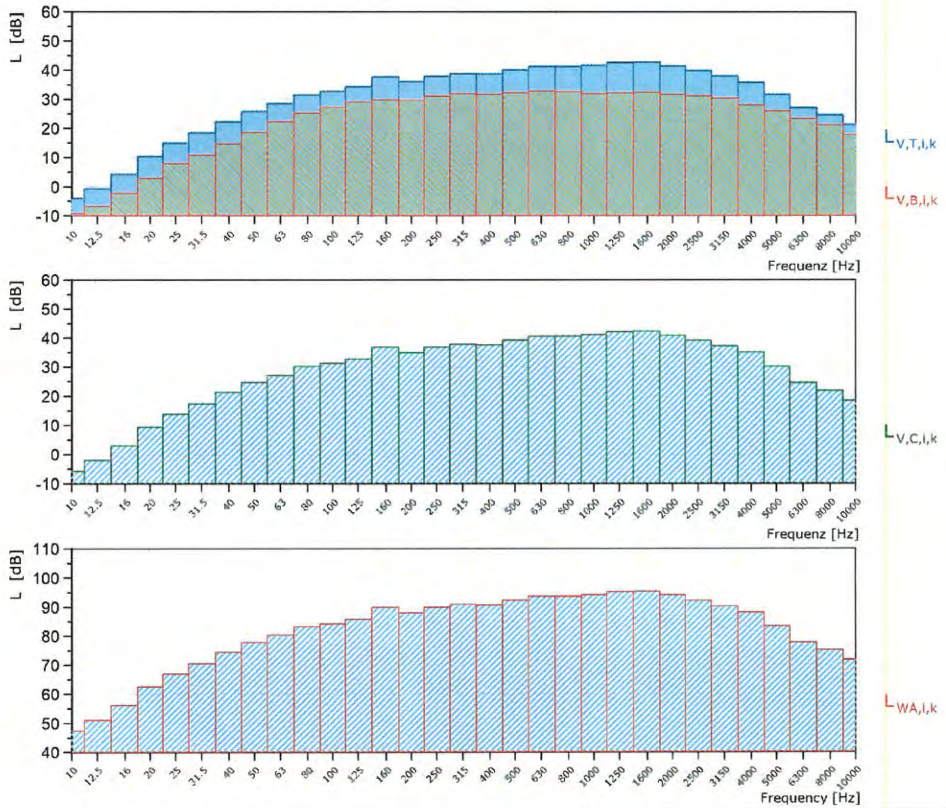


DNV·GL

Bin 13.5 Vestas V150-4.2 MW 50 Hz

One third octave analysis at hub height

Terzanalyse bezogen auf Nabenhöhe

Site / Standort:	Østerild (Denmark)
WTGS-SNo. / WEA-SNr.:	228051
Mode / Modus:	PO1
Date of meas./ Messdatum:	2019-06-26
Standard / Messung:	IEC 61400-11 Ed.3
Project-No. / Projekt-Nr.:	10163788
In charge / Bearbeiter:	Annika Johannsen

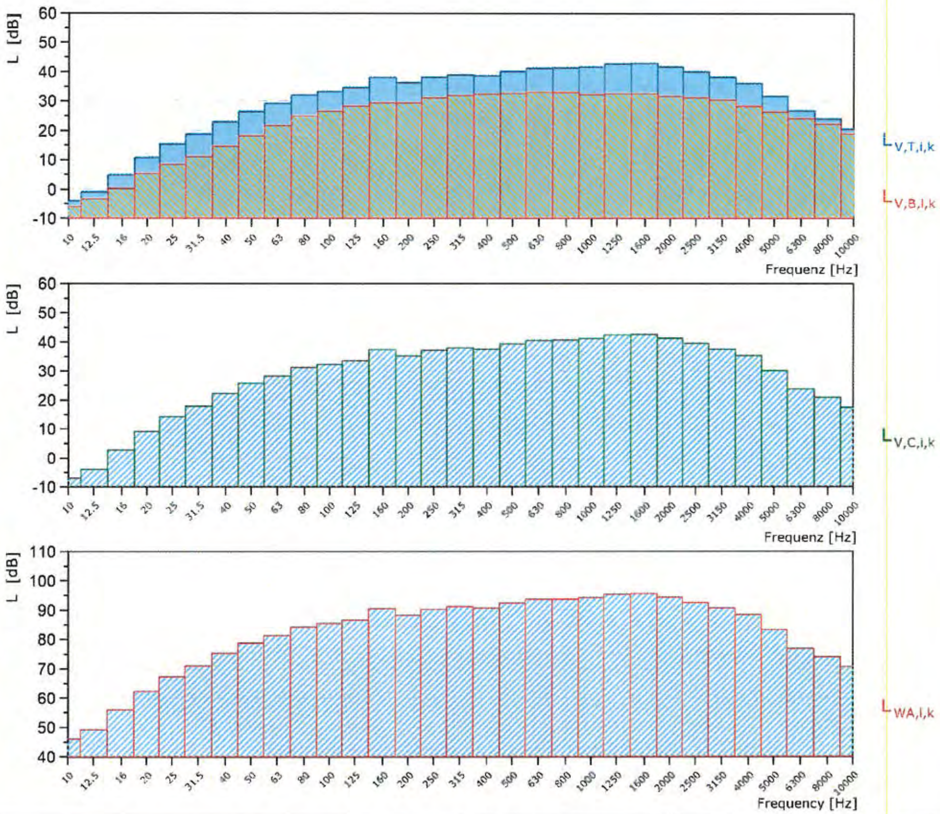
9.26 Third-octave sound power spectra at a WS of 14.0 m/s at hub height

No. of data per BIN / Anzahl der Messdaten pro BIN:
Total noise / Gesamtgeräusch = 24
Background noise / Fremdgeräusch = 17

Reference wind speed / Referenzwindgeschwindigkeit:
$WS_{BIN\ (hub\ height)}$ = 14.0 m/s
$WS_{BIN\ (10\ m)}$ = 9.4 m/s

Sound power level / Schallleistung:
$L_{WA,k}$ = 104.8 dB

f [Hz]	$L_{V,T,i,k}$ [dB]	$u_{Lv,T,i,k}$ [dB]	$L_{V,B,i,k}$ [dB]	$u_{Lv,B,i,k}$ [dB]	$L_{V,C,i,k}$ [dB]	$L_{WA,i,k}$ [dB]	$u_{c,i,k}$ [dB]
10	-4.1	2.0	-6.0	4.8	[-7.1]	**[46.1]**	6.3
12.5	-0.9	1.3	-3.3	5.1	[-3.9]	**[49.3]**	5.7
16	4.8	1.6	0.3	4.4	2.8	**56.0**	3.5
20	10.6	1.6	5.2	3.9	9.1	**62.3**	2.7
25	15.2	1.4	8.4	2.0	14.2	**67.4**	1.8
31.5	18.7	1.6	11.1	2.3	17.9	**71.1**	2.0
40	22.9	1.5	14.6	2.1	22.2	**75.3**	1.8
50	26.3	1.7	18.3	2.2	25.6	**78.8**	2.0
63	29.0	1.4	21.7	2.0	28.2	**81.3**	1.8
80	32.1	1.3	24.9	2.0	31.2	**84.3**	1.6
100	33.3	1.1	26.6	2.1	32.3	**85.4**	1.6
125	34.6	1.1	28.2	2.5	33.5	**86.6**	1.6
160	38.0	1.6	29.4	2.2	37.4	**90.6**	1.9
200	36.2	0.5	29.4	2.0	35.2	**88.4**	0.8
250	38.1	0.5	31.1	1.9	37.2	**90.3**	0.7
315	39.0	0.4	32.0	2.0	38.0	**91.2**	0.7
400	38.7	0.5	32.4	2.3	37.5	**90.7**	1.0
500	40.1	0.4	32.7	2.2	39.3	**92.4**	0.7
630	41.3	0.4	33.2	2.1	40.5	**93.7**	0.7
800	41.4	0.5	33.1	2.0	40.6	**93.8**	0.7
1000	41.7	0.5	32.4	1.9	41.1	**94.3**	0.7
1250	42.7	0.6	32.6	2.0	42.3	**95.5**	0.7
1600	42.9	0.6	32.6	1.9	42.5	**95.6**	0.7
2000	41.7	0.6	31.8	2.0	41.2	**94.4**	0.7
2500	40.1	0.6	31.2	2.2	39.5	**92.7**	0.8
3150	38.3	0.7	30.4	2.5	37.6	**90.7**	0.9
4000	36.1	0.7	28.3	2.5	35.3	**88.5**	1.0
5000	31.7	0.7	26.4	2.7	30.2	**83.3**	1.5
6300	26.7	1.4	24.2	2.9	[23.7]	**[76.9]**	4.1
8000	24.0	2.3	22.3	3.0	[21.0]	**[74.1]**	5.5
10000	20.5	2.5	19.0	3.0	[17.5]	**[70.7]**	5.9



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DNV·GL

Bin 14 Vestas V150-4.2 MW 50 Hz

One third octave analysis at hub height
Terzanalyse bezogen auf Nabenhöhe

Site / Standort:	Østerild (Denmark)
WTGS-SNo. / WEA-SNr.:	228051
Mode / Modus:	PO1
Date of meas./ Messdatum:	2019-06-26
Standard / Messung:	IEC 61400-11 Ed.3
Project-No. / Projekt-Nr.:	10163788
In charge / Bearbeiter:	Annika Johannsen

9.27 Third-octave sound power spectra at a WS of 5 m/s at 10 m height

Reference wind speed / Referenzwindgeschwindigkeit:
$WS_{BIN\ (hub\ height)}$ = 7.5 m/s
$WS_{BIN\ (10\ m)}$ = 5 m/s

Sound power level / Schallleistung:
$L_{WA,k}$ = 101.9 dB

f [Hz]	$L_{V,T,i,k}$ [dB]	$u_{Lv,T,i,k}$ [dB]	$L_{V,B,i,k}$ [dB]	$u_{Lv,B,i,k}$ [dB]	$L_{V,C,i,k}$ [dB]	$L_{WA,i,k}$ [dB]	$u_{c,i,k}$ [dB]
10	-9.6	1.6	-16.1	4.6	-10.7	**42.5**	2.5
12.5	-5.6	1.5	-13.1	3.7	-6.4	**46.7**	2.0
16	0.2	1.5	-8.1	2.7	-0.5	**52.7**	1.8
20	6.7	1.5	-2.5	2.6	6.1	**59.2**	1.7
25	11.0	1.3	2.8	2.9	10.3	**63.4**	1.6
31.5	14.6	1.4	5.5	2.6	14.0	**67.2**	1.6
40	19.2	1.3	9.7	2.3	18.6	**71.8**	1.5
50	23.0	1.6	13.3	2.7	22.6	**75.7**	1.9
63	25.5	1.1	16.8	2.9	24.8	**78.0**	1.4
80	28.9	0.7	19.2	3.6	28.4	**81.6**	0.9
100	30.6	0.8	22.3	3.3	29.9	**83.1**	1.1
125	36.9	2.4	21.6	4.2	36.7	**89.9**	2.5
160	33.1	0.7	23.0	3.9	32.7	**85.8**	0.8
200	33.7	0.6	24.0	3.1	33.2	**86.4**	0.8
250	37.0	0.6	25.8	2.7	36.7	**89.9**	0.7
315	36.8	0.7	27.2	2.2	36.3	**89.5**	0.8
400	36.0	0.9	27.0	2.3	35.4	**88.5**	1.1
500	38.6	0.6	27.6	2.3	38.3	**91.4**	0.7
630	37.6	1.2	28.6	2.4	37.0	**90.2**	1.4
800	38.1	0.9	28.5	3.0	37.6	**90.8**	1.1
1000	38.4	0.9	28.0	3.1	37.9	**91.1**	1.1
1250	39.2	0.9	28.0	3.5	38.8	**92.0**	1.0
1600	39.3	0.8	27.2	3.6	39.0	**92.2**	0.9
2000	37.6	0.8	26.0	3.4	37.3	**90.5**	0.9
2500	35.9	0.8	25.7	3.1	35.4	**88.6**	0.9
3150	34.3	0.9	27.1	3.8	33.3	**86.5**	1.4
4000	32.3	1.4	28.2	5.5	30.2	**83.3**	4.2
5000	28.0	1.7	25.3	4.9	[25.0]	**[78.2]**	6.0
6300	23.1	1.5	20.3	3.0	[20.1]	**[73.2]**	4.2
8000	19.8	1.9	18.2	2.9	[16.8]	**[69.9]**	4.8
10000	16.2	2.1	15.0	2.8	[13.2]	**[66.3]**	5.1

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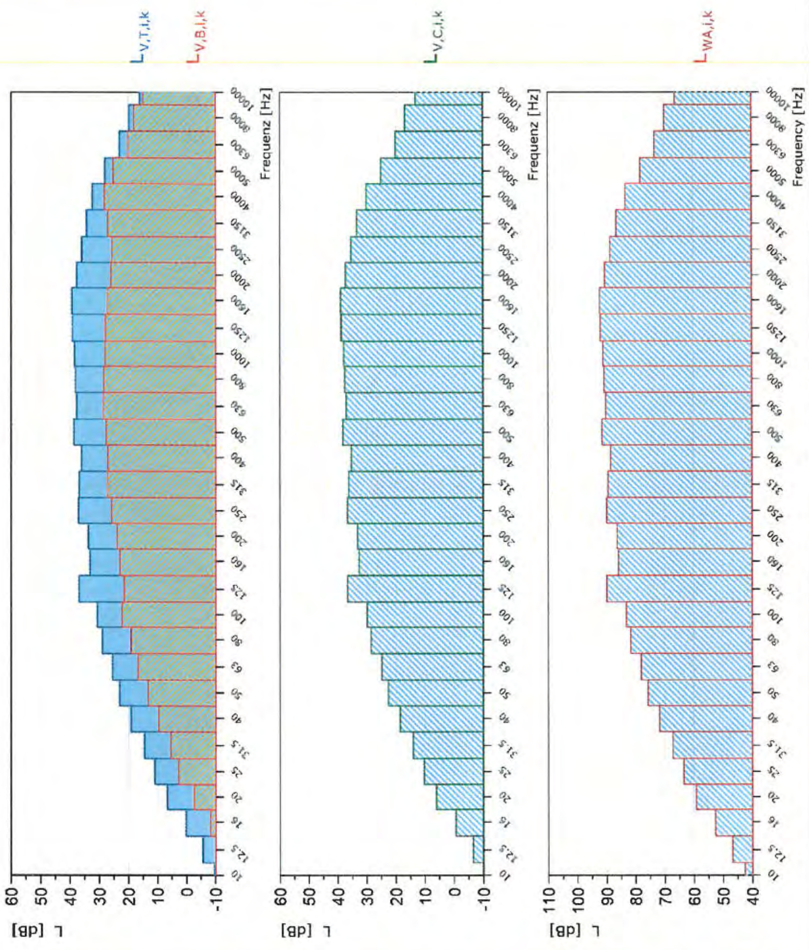


DNV·GL

Bin 5 Vestas V150-4.2 MW 50 Hz

One third octave analysis at 10 m height

Terzanalyse bezogen auf 10 m Höhe

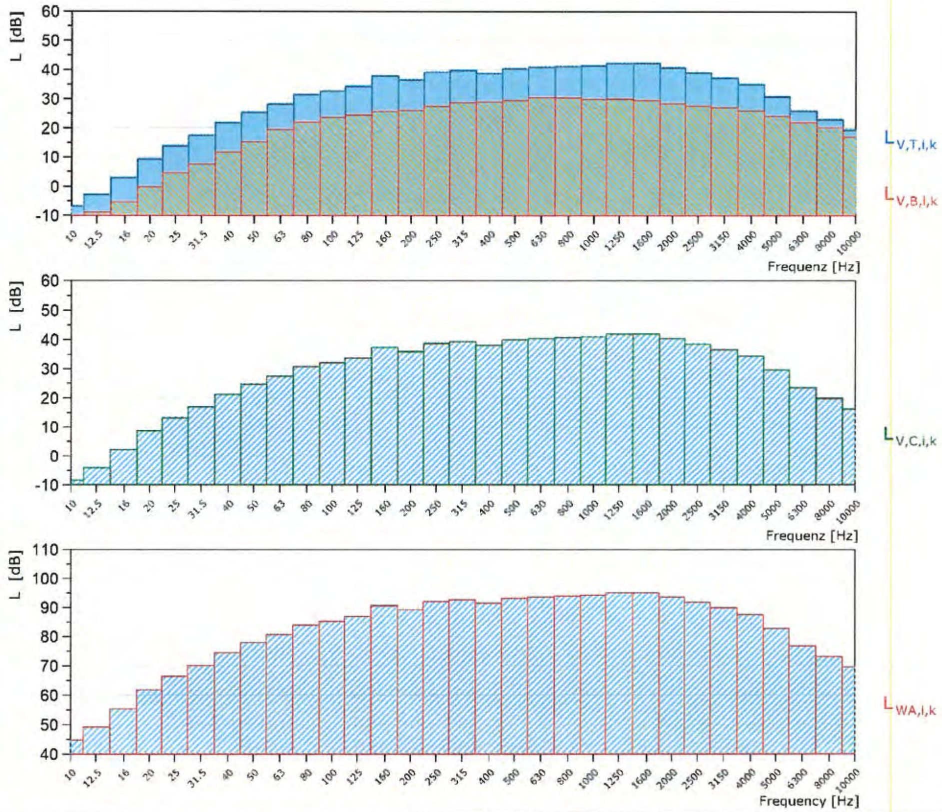
Site / Standort:	Østerild (Denmark)
WTGS-SNo. / WEA-SNr.:	228051
Mode / Modus:	PO1
Date of meas./ Messdatum:	2019-06-26
Standard / Messung:	IEC 61400-11 Ed.3
Project-No. / Projekt-Nr.:	10163788
In charge / Bearbeiter:	Annika Johannsen

9.28 Third-octave sound power spectra at a WS of 6 m/s at 10 m height

Reference wind speed / Referenzwindgeschwindigkeit:
$WS_{BIN\ (hub\ height)}$ = 9.0 m/s
$WS_{BIN\ (10\ m)}$ = 6 m/s

Sound power level / Schallleistung:
$L_{WA,k}$ = 104.7 dB

f [Hz]	$L_{V,T,i,k}$ [dB]	$u_{Lv,T,i,k}$ [dB]	$L_{V,B,i,k}$ [dB]	$u_{Lv,B,i,k}$ [dB]	$L_{V,C,i,k}$ [dB]	$L_{WA,i,k}$ [dB]	$u_{c,i,k}$ [dB]
10	-6.7	2.2	-11.7	5.6	-8.4	**44.8**	4.1
12.5	-2.8	2.0	-8.9	5.1	-4.0	**49.2**	3.1
16	2.9	2.1	-5.3	4.0	2.2	**55.3**	2.6
20	9.2	1.9	-0.1	3.4	8.6	**61.8**	2.2
25	13.8	1.8	4.6	3.3	13.3	**66.4**	2.1
31.5	17.4	1.9	7.5	3.1	17.0	**70.1**	2.2
40	21.7	1.8	11.7	2.8	21.3	**74.5**	2.0
50	25.2	1.6	15.3	3.1	24.7	**77.9**	1.8
63	28.1	1.4	19.6	3.7	27.5	**80.6**	1.7
80	31.3	1.0	22.0	4.0	30.8	**83.9**	1.3
100	32.7	0.9	23.7	3.3	32.1	**85.3**	1.1
125	34.3	0.7	24.4	4.8	33.8	**87.0**	1.0
160	37.8	1.3	25.7	4.5	37.5	**90.6**	1.4
200	36.4	0.5	26.1	3.6	36.0	**89.2**	0.7
250	39.1	0.4	27.5	3.2	38.8	**92.0**	0.5
315	39.7	0.4	28.7	2.7	39.3	**92.5**	0.5
400	38.7	0.5	29.0	3.0	38.2	**91.3**	0.7
500	40.3	0.3	29.5	2.9	40.0	**93.1**	0.4
630	40.8	0.7	30.4	2.8	40.4	**93.6**	0.8
800	41.1	0.4	30.4	3.0	40.7	**93.8**	0.6
1000	41.3	0.6	29.9	3.0	41.0	**94.1**	0.6
1250	42.1	0.5	29.9	3.1	41.9	**95.0**	0.6
1600	42.2	0.4	29.5	3.2	41.9	**95.1**	0.5
2000	40.7	0.4	28.4	3.3	40.4	**93.6**	0.5
2500	39.0	0.4	27.6	3.2	38.6	**91.8**	0.5
3150	37.2	0.5	27.0	2.9	36.7	**89.9**	0.6
4000	35.0	0.7	25.9	3.0	34.4	**87.6**	0.9
5000	30.7	1.1	24.1	3.1	29.6	**82.8**	1.7
6300	25.9	1.8	22.0	3.2	23.6	**76.7**	3.8
8000	22.9	2.5	20.3	3.3	[19.9]	**[73.1]**	6.1
10000	19.4	2.8	17.1	3.3	[16.4]	**[69.5]**	6.5



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22.08.2019

DNV·GL

Bin 6 Vestas V150-4.2 MW 50 Hz

One third octave analysis at 10 m height
Terzanalyse bezogen auf 10 m Höhe

Site / Standort:	Østerild (Denmark)
WTGS-SNo. / WEA-SNr.:	228051
Mode / Modus:	PO1
Date of meas./ Messdatum:	2019-06-26
Standard / Messung:	IEC 61400-11 Ed.3
Project-No. / Projekt-Nr.:	10163788
In charge / Bearbeiter:	Annika Johannsen

9.29 Third-octave sound power spectra at a WS of 7 m/s at 10 m height

Reference wind speed / Referenzwindgeschwindigkeit:
$WS_{BIN\ (hub\ height)}$ = 10.5 m/s
$WS_{BIN\ (10\ m)}$ = 7 m/s

Sound power level / Schallleistung:
$L_{WA,k}$ = 104.7 dB

f [Hz]	$L_{V,T,i,k}$ [dB]	$u_{LV,T,i,k}$ [dB]	$L_{V,B,i,k}$ [dB]	$u_{LV,B,i,k}$ [dB]	$L_{V,C,i,k}$ [dB]	$L_{WA,i,k}$ [dB]	$u_{c,i,k}$ [dB]
10	-6.4	1.9	-10.3	4.2	-8.7	**44.4**	4.3
12.5	-2.8	1.4	-8.0	3.7	-4.3	**48.9**	2.5
16	3.1	1.9	-4.2	3.0	2.2	**55.3**	2.4
20	9.4	1.7	1.0	2.6	8.7	**61.9**	2.1
25	14.2	1.7	5.7	2.7	13.5	**66.7**	2.0
31.5	17.5	1.7	8.6	2.8	17.0	**70.1**	2.0
40	21.8	1.6	12.4	2.6	21.2	**74.4**	1.8
50	25.3	1.6	16.2	2.8	24.7	**77.8**	1.9
63	28.3	1.5	19.9	2.9	27.7	**80.8**	1.8
80	31.5	1.2	23.3	3.3	30.9	**84.0**	1.5
100	32.6	1.1	25.1	2.8	31.7	**84.9**	1.5
125	34.2	1.0	26.4	3.9	33.4	**86.6**	1.4
160	38.2	1.1	27.5	3.5	37.9	**91.0**	1.3
200	36.4	0.6	27.7	3.0	35.8	**88.9**	0.8
250	38.7	0.6	29.1	2.7	38.2	**91.4**	0.7
315	39.5	0.4	30.1	2.2	39.0	**92.1**	0.5
400	38.6	0.4	30.3	2.3	37.9	**91.1**	0.6
500	40.2	0.4	30.8	2.3	39.7	**92.8**	0.5
630	41.1	0.5	31.5	2.2	40.6	**93.7**	0.6
800	41.1	0.4	31.4	2.2	40.6	**93.8**	0.5
1000	41.5	0.6	30.8	2.2	41.1	**94.3**	0.6
1250	42.4	0.6	31.0	2.2	42.0	**95.2**	0.6
1600	42.4	0.5	30.9	2.4	42.1	**95.2**	0.6
2000	40.9	0.5	29.8	2.4	40.6	**93.8**	0.5
2500	39.3	0.5	29.0	2.5	38.8	**92.0**	0.6
3150	37.3	0.5	28.2	2.5	36.8	**89.9**	0.7
4000	35.1	0.7	26.8	2.8	34.5	**87.6**	0.9
5000	30.7	1.0	24.9	2.8	29.4	**82.5**	1.7
6300	25.6	1.8	22.6	2.8	22.7	**75.9**	4.5
8000	22.7	2.7	20.8	2.9	[19.7]	**[72.8]**	6.1
10000	19.2	3.0	17.6	2.9	[16.2]	**[69.4]**	6.6

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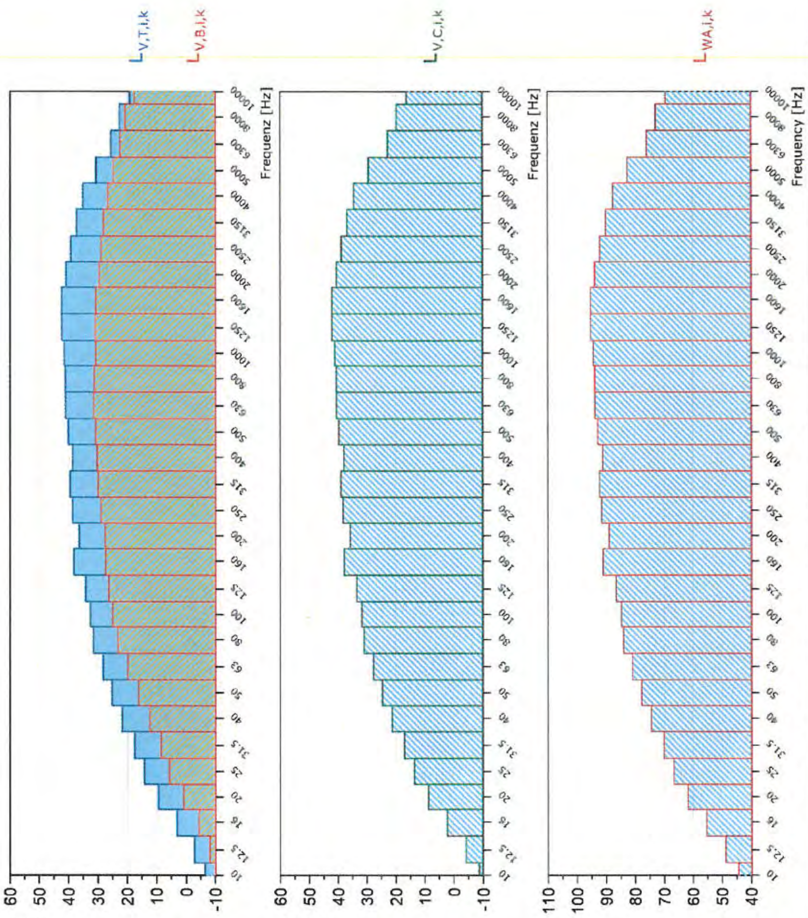


Site / Standort: Østerild (Denmark)
WTGS-SNo. / WEA-SNr.: 228051
Mode / Modus: PO1
Date of meas./ Messdatum: 2019-06-26
Standard / Messung: IEC 61400-11 Ed.3
Project-No. / Projekt-Nr.: 10163788
In charge / Bearbeiter: Annika Johannsen

DNV·GL

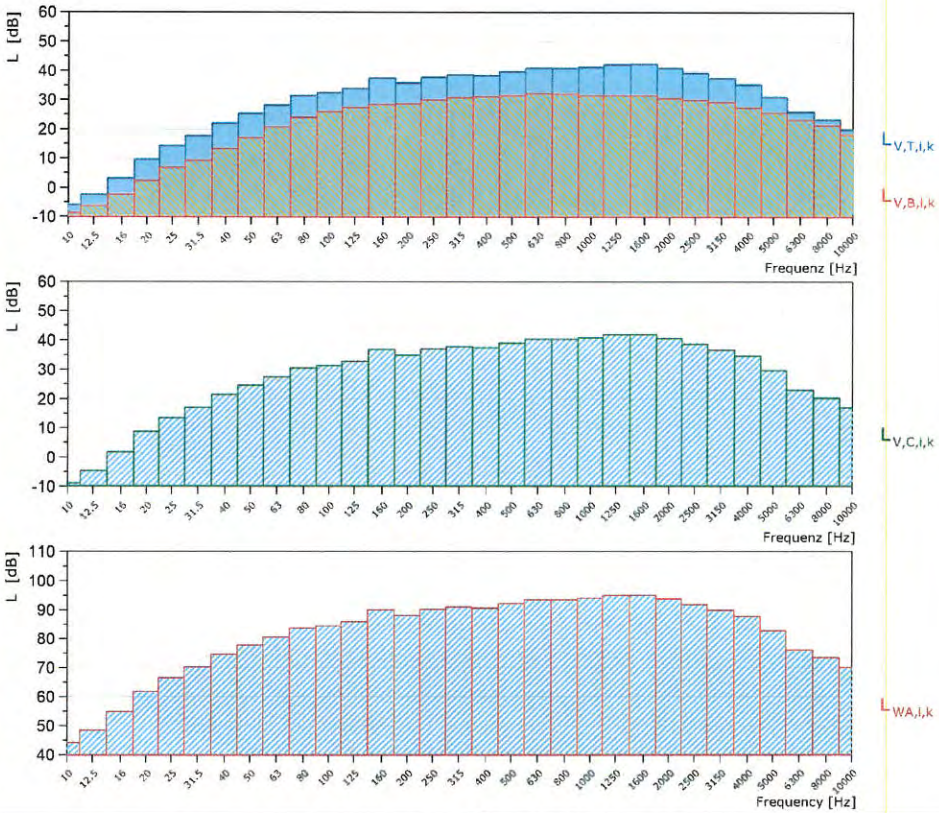
Bin 7 Vestas V150-4.2 MW 50 Hz
One third octave analysis at 10 m height
Terzanalyse bezogen auf 10 m Höhe

9.30 Third-octave sound power spectra at a WS of 8 m/s at 10 m height

Reference wind speed / Referenzwindgeschwindigkeit:
$WS_{BIN\ (hub\ height)}$ = 12.0 m/s
$WS_{BIN\ (10\ m)}$ = 8 m/s

Sound power level / Schallleistung:
$L_{WA,k}$ = 104.3 dB

f [Hz]	$L_{V,T,i,k}$ [dB]	$u_{Lv,T,i,k}$ [dB]	$L_{V,B,i,k}$ [dB]	$u_{Lv,B,i,k}$ [dB]	$L_{V,C,i,k}$ [dB]	$L_{WA,i,k}$ [dB]	$u_{c,i,k}$ [dB]
10	-5.9	1.6	-8.6	4.0	[-8.9]	**[44.3]**	5.2
12.5	-2.3	1.5	-6.2	4.0	-4.7	**48.5**	3.8
16	3.2	1.5	-2.2	3.5	1.7	**54.9**	2.5
20	9.6	1.5	2.5	2.8	8.6	**61.8**	1.9
25	14.3	1.2	6.9	2.4	13.4	**66.6**	1.6
31.5	17.8	1.4	9.4	2.1	17.1	**70.3**	1.7
40	22.0	1.4	13.3	2.1	21.4	**74.6**	1.6
50	25.3	1.3	17.1	2.3	24.6	**77.7**	1.6
63	28.2	1.2	20.7	2.2	27.3	**80.5**	1.6
80	31.4	1.1	24.1	2.3	30.5	**83.7**	1.4
100	32.4	1.0	26.0	2.2	31.3	**84.5**	1.4
125	33.9	1.1	27.5	2.7	32.8	**86.0**	1.6
160	37.5	1.2	28.4	2.3	36.9	**90.1**	1.4
200	35.9	0.4	28.7	2.0	34.9	**88.1**	0.7
250	37.8	0.3	30.1	1.9	37.0	**90.2**	0.6
315	38.6	0.4	30.9	1.8	37.8	**91.0**	0.6
400	38.4	0.4	31.1	1.8	37.4	**90.6**	0.7
500	39.7	0.4	31.6	1.9	39.0	**92.2**	0.5
630	41.0	0.4	32.3	1.9	40.3	**93.5**	0.5
800	40.9	0.4	32.1	2.0	40.3	**93.5**	0.6
1000	41.3	0.5	31.5	2.0	40.8	**94.0**	0.6
1250	42.2	0.5	31.6	2.0	41.8	**95.0**	0.5
1600	42.3	0.5	31.6	2.1	41.9	**95.1**	0.6
2000	41.0	0.5	30.6	2.1	40.6	**93.8**	0.6
2500	39.3	0.5	30.1	2.3	38.7	**91.9**	0.6
3150	37.4	0.5	29.3	2.6	36.7	**89.9**	0.8
4000	35.4	0.7	27.5	2.8	34.6	**87.8**	1.0
5000	31.1	0.9	25.5	2.7	29.6	**82.8**	1.6
6300	25.9	1.4	23.3	2.8	[22.9]	**[76.1]**	3.9
8000	23.3	1.9	21.5	2.9	[20.3]	**[73.5]**	4.8
10000	20.0	2.1	18.3	2.8	[17.0]	**[70.1]**	5.0



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Bin 8 Vestas V150-4.2 MW 50 Hz

One third octave analysis at 10 m height

Terzanalyse bezogen auf 10 m Höhe

DNV·GL

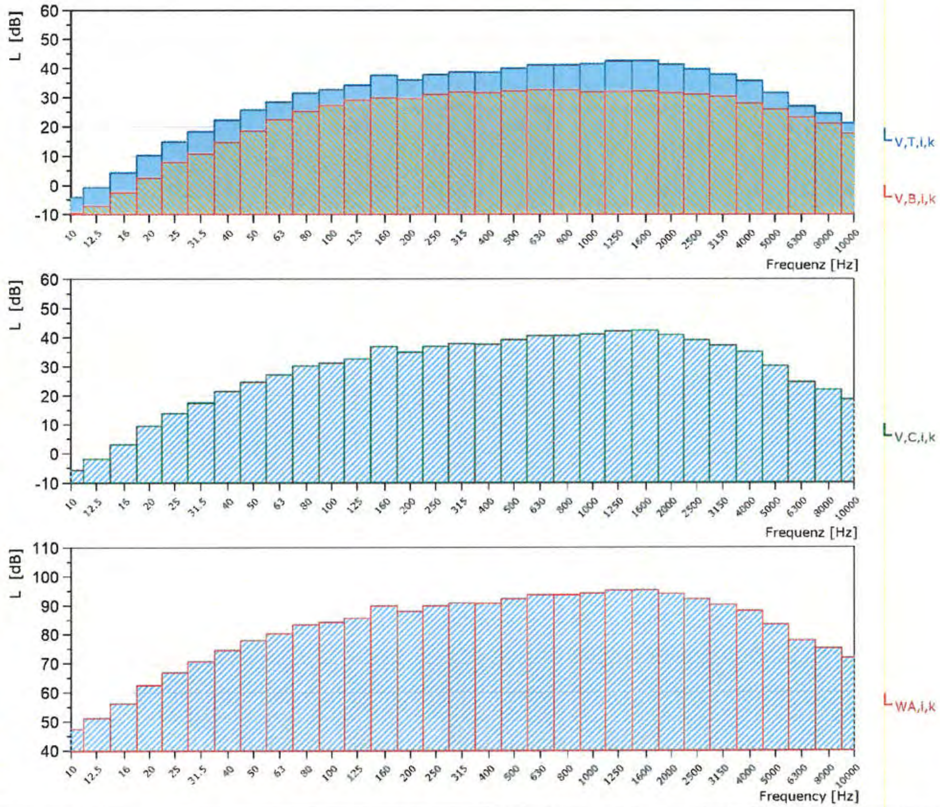
Site / Standort:	Østerild (Denmark)
WTGS-SNo. / WEA-SNr.:	228051
Mode / Modus:	PO1
Date of meas./ Messdatum:	2019-06-26
Standard / Messung:	IEC 61400-11 Ed.3
Project-No. / Projekt-Nr.:	10163788
In charge / Bearbeiter:	Annika Johannsen

9.31 Third-octave sound power spectra at a WS of 9 m/s at 10 m height

Reference wind speed / Referenzwindgeschwindigkeit:
$WS_{BIN\ (hub\ height)}$ = 13.4 m/s
$WS_{BIN\ (10\ m)}$ = 9 m/s

Sound power level / Schallleistung:
$L_{WA,k}$ = 104.5 dB

f [Hz]	$L_{V,T,i,k}$ [dB]	$u_{Lv,T,i,k}$ [dB]	$L_{V,B,i,k}$ [dB]	$u_{Lv,B,i,k}$ [dB]	$L_{V,C,i,k}$ [dB]	$L_{WA,i,k}$ [dB]	$u_{c,i,k}$ [dB]
10	-4.2	2.0	-9.6	3.3	-5.7	**47.5**	3.1
12.5	-0.7	1.8	-7.1	3.4	-1.9	**51.3**	2.5
16	4.2	1.6	-2.5	3.0	3.1	**56.3**	2.3
20	10.2	1.6	2.5	1.9	9.4	**62.6**	2.0
25	14.8	1.4	7.8	1.4	13.8	**67.0**	1.7
31.5	18.3	1.5	10.8	1.5	17.5	**70.7**	1.8
40	22.2	1.4	14.6	1.4	21.4	**74.6**	1.8
50	25.7	1.5	18.6	1.5	24.7	**77.9**	1.9
63	28.4	1.2	22.4	1.4	27.2	**80.3**	1.7
80	31.5	1.1	25.3	1.4	30.2	**83.4**	1.5
100	32.7	0.9	27.3	1.4	31.2	**84.3**	1.4
125	34.2	1.1	29.1	2.2	32.6	**85.8**	1.8
160	37.6	1.3	29.9	1.7	36.8	**90.0**	1.6
200	36.1	0.5	29.7	1.6	34.9	**88.1**	0.8
250	37.9	0.4	31.1	1.7	36.8	**90.0**	0.7
315	38.8	0.4	32.0	1.7	37.8	**90.9**	0.6
400	38.6	0.6	31.7	1.8	37.7	**90.8**	0.8
500	40.0	0.4	32.3	2.0	39.2	**92.4**	0.7
630	41.2	0.4	32.8	2.0	40.5	**93.7**	0.5
800	41.3	0.4	32.6	2.0	40.6	**93.8**	0.6
1000	41.6	0.4	31.9	1.9	41.1	**94.3**	0.5
1250	42.5	0.4	32.2	1.8	42.1	**95.3**	0.5
1600	42.7	0.4	32.4	1.9	42.3	**95.4**	0.5
2000	41.4	0.4	31.7	2.0	40.9	**94.1**	0.5
2500	39.8	0.4	31.3	2.4	39.1	**92.3**	0.6
3150	38.0	0.5	30.4	2.8	37.2	**90.3**	0.8
4000	35.8	0.5	28.1	2.9	35.0	**88.2**	0.9
5000	31.6	1.1	25.9	2.8	30.2	**83.4**	1.9
6300	27.0	2.2	23.3	2.9	24.7	**77.8**	4.3
8000	24.6	2.9	21.1	3.1	22.0	**75.2**	5.8
10000	21.3	3.1	17.7	3.1	18.7	**71.9**	6.1



created with GL Acoustic TuNES version 18.011

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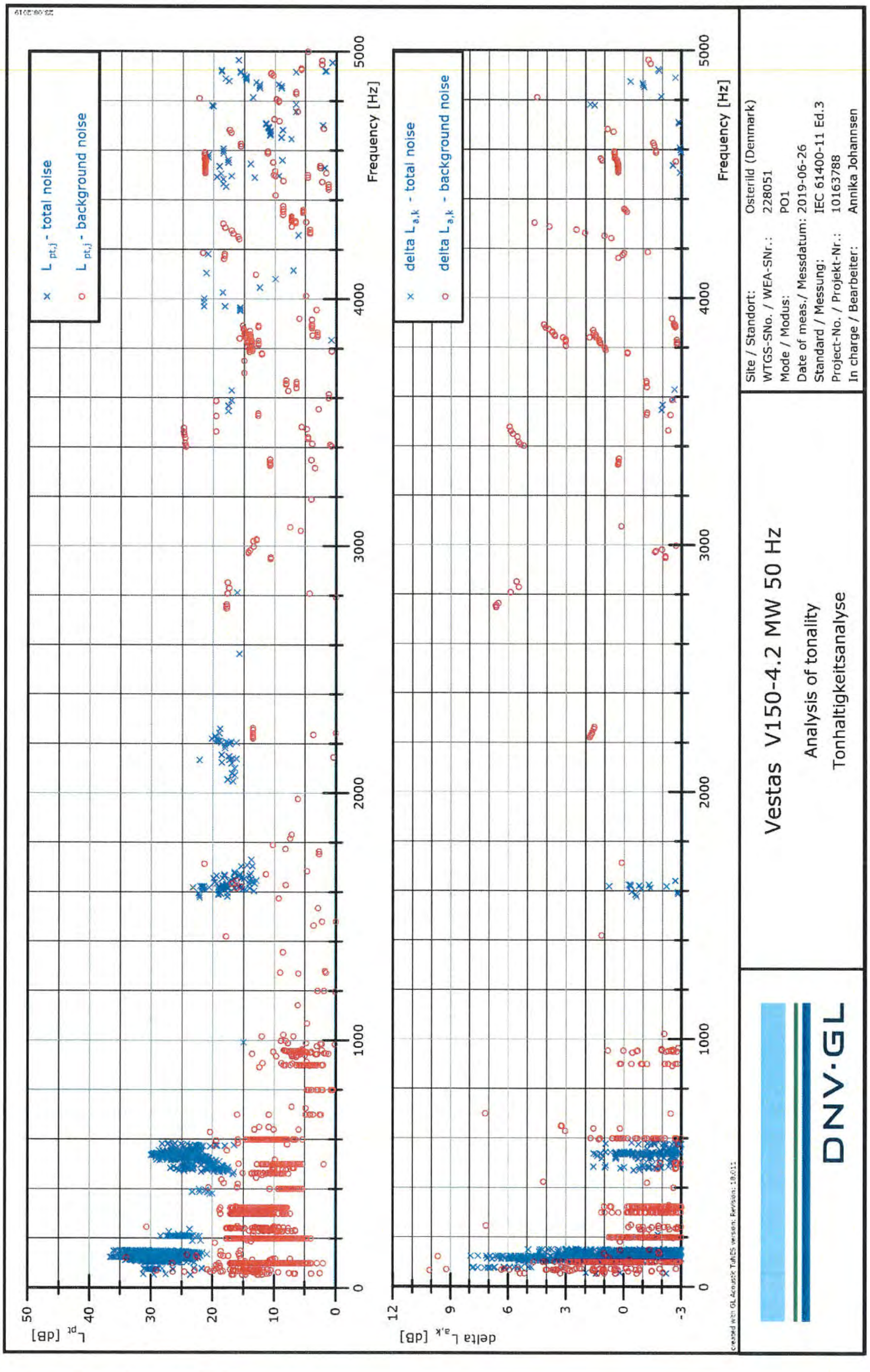
Bin 9 Vestas V150-4.2 MW 50 Hz

One third octave analysis at 10 m height

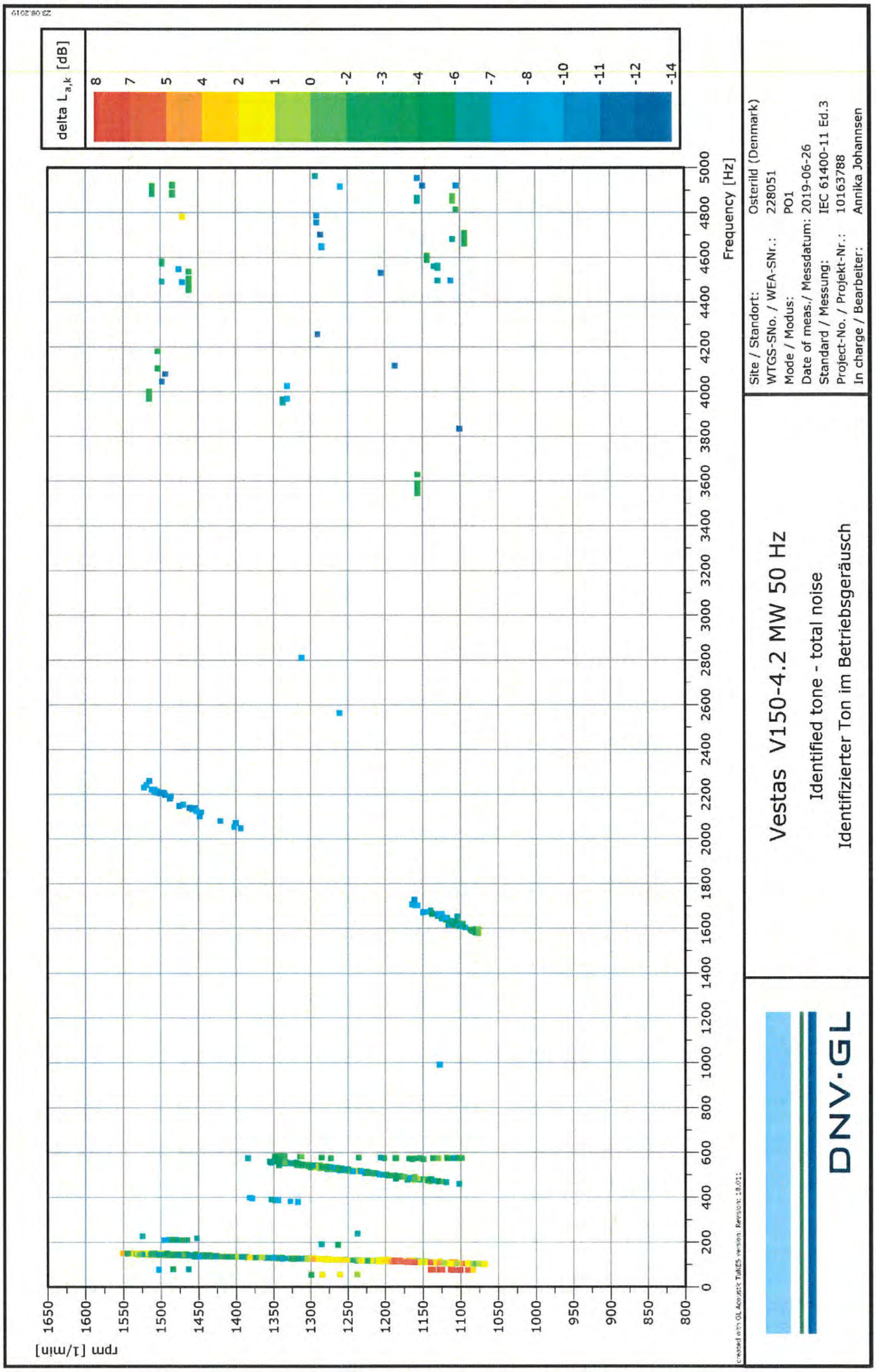
Terzanalyse bezogen auf 10 m Höhe

Site / Standort:	Østerild (Denmark)
WTGS-SNo. / WEA-SNr.:	228051
Mode / Modus:	PO1
Date of meas./ Messdatum:	2019-06-26
Standard / Messung:	IEC 61400-11 Ed.3
Project-No. / Projekt-Nr.:	10163788
In charge / Bearbeiter:	Annika Johannsen

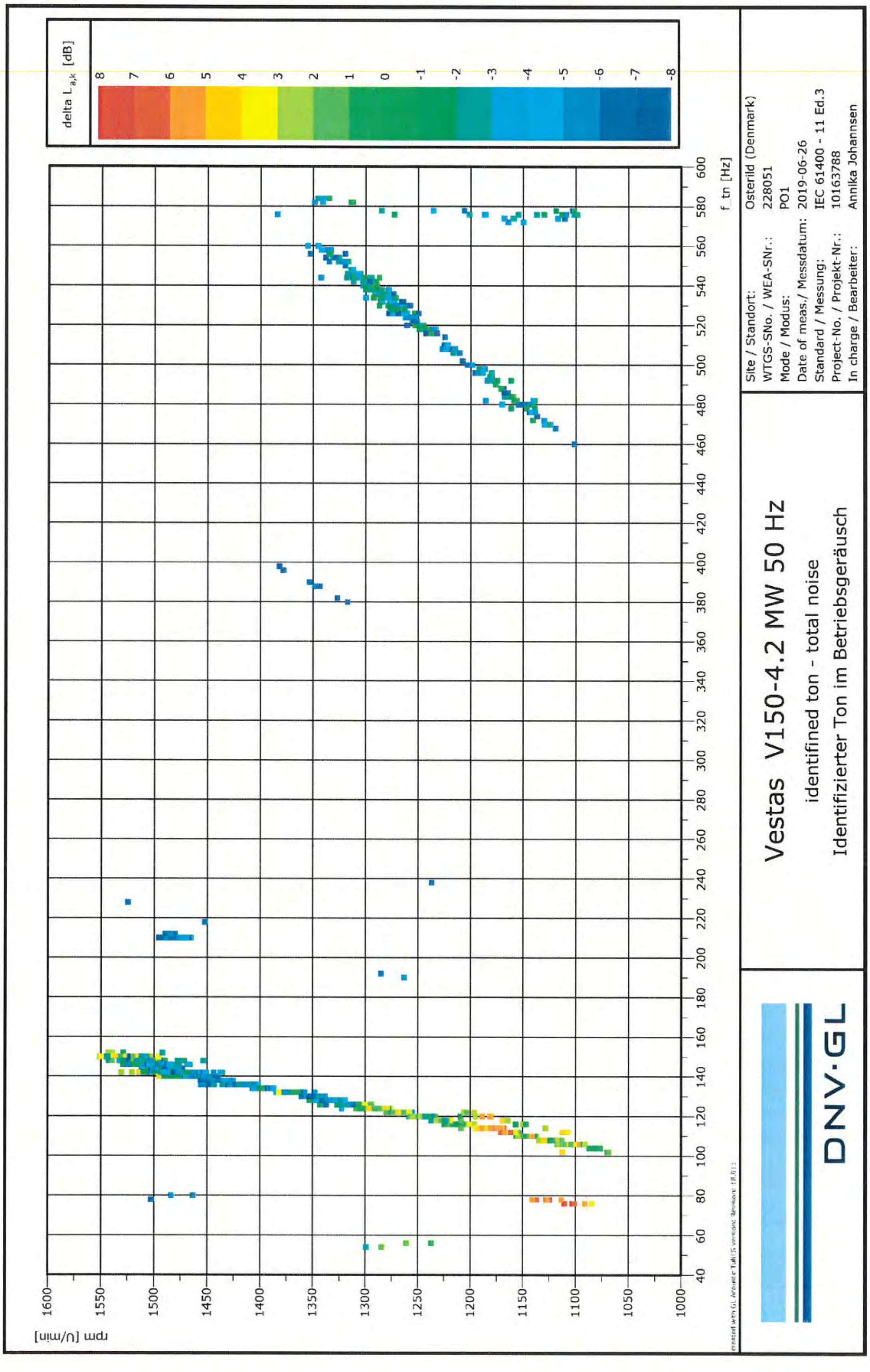
9.32 Tonality analysis - $\Delta L_{pn,j}$ and $\Delta L_{a,k}$ vs. frequency



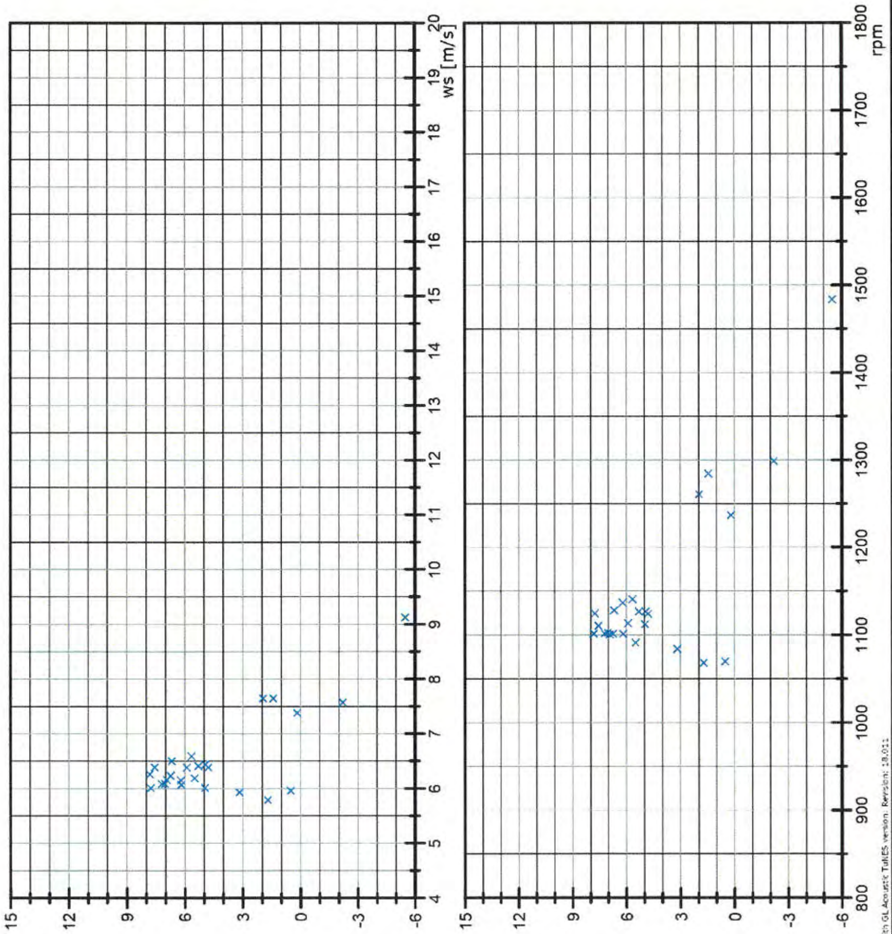
9.33 Tonality analysis - rpm vs. frequency for the identified tones in the total noise (0-5000 Hz)



9.34 Tonality analysis - rpm vs. frequency for the identified tones in the total noise (40-600 Hz)



9.35 Tonality analysis - wind bin overview (page 1)



WS [m/s]	tone f_T [Hz]	n all	n ident	delta $L_{a,k}$ [dB]	WS-BIN complete	delta $L_{a,k}$ > -3 dB
7.5	55	172	4	*0.62*	Yes	No
8.0		149	0		Yes	No
8.5	80	132	1	*-6.70*	Yes	No
9.0	79	222	2	*-6.25*	Yes	No
9.5		144	0		Yes	No
10.0		81	0		Yes	No
10.5		53	0		Yes	No
11.0		39	0		Yes	No
11.5		41	0		Yes	No
12.0		39	0		Yes	No
12.5		30	0		Yes	No
13.0		35	0		Yes	No
13.5		30	0		Yes	No
14.0		24	0		Yes	No

frequency - area = 51.9 Hz to 102.1 Hz

Site / Standort: Osterild (Denmark)
WTGS-SNo. / WEA-SNr.: 228051
Mode / Modus: PO1
Date of meas./ Messdatum: 2019-06-26
Standard / Messung: IEC 61400-11 Ed.3
Project-No. / Projekt-Nr.: 10163788
In charge / Bearbeiter: Annika Johannsen

Vestas V150-4.2 MW 50 Hz

Analysis of tonality

Tonhaltigkeitsanalyse

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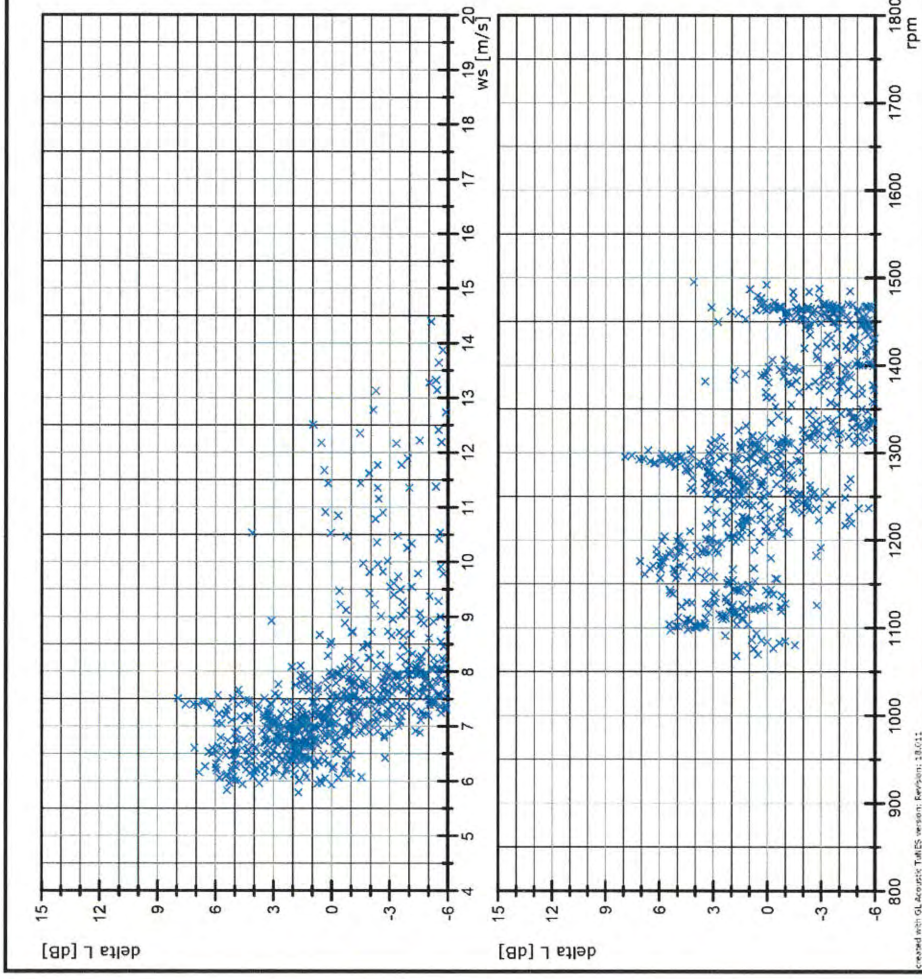
23.08.2019

9.36 Tonality analysis - wind bin overview (page 2)

23.08.2019



WS [m/s]	tone f_T [Hz]	n all	n ident	delta $L_{a,k}$ [dB]	WS-BIN complete	delta $L_{a,k}$ > -3 dB
7.5	126	172	153	0.52	Yes	Yes
8.0	134	149	95	-2.19	Yes	Yes
8.5	138	132	38	-3.27	Yes	No
9.0	140	222	18	-2.71	Yes	No
9.5	140	144	15	-3.88	Yes	No
10.0	139	81	9	-3.45	Yes	No
10.5	140	53	9	-1.20	Yes	No
11.0	139	39	5	-1.27	Yes	No
11.5	140	41	7	-1.66	Yes	No
12.0	139	39	8	-3.16	Yes	No
12.5	138	30	5	-2.64	Yes	No
13.0	139	35	5	-4.09	Yes	No
13.5	138	30	5	-5.65	Yes	No
14.0	136	24	3	-6.33	Yes	No

frequency - area = 89.8 Hz to 140.2 Hz

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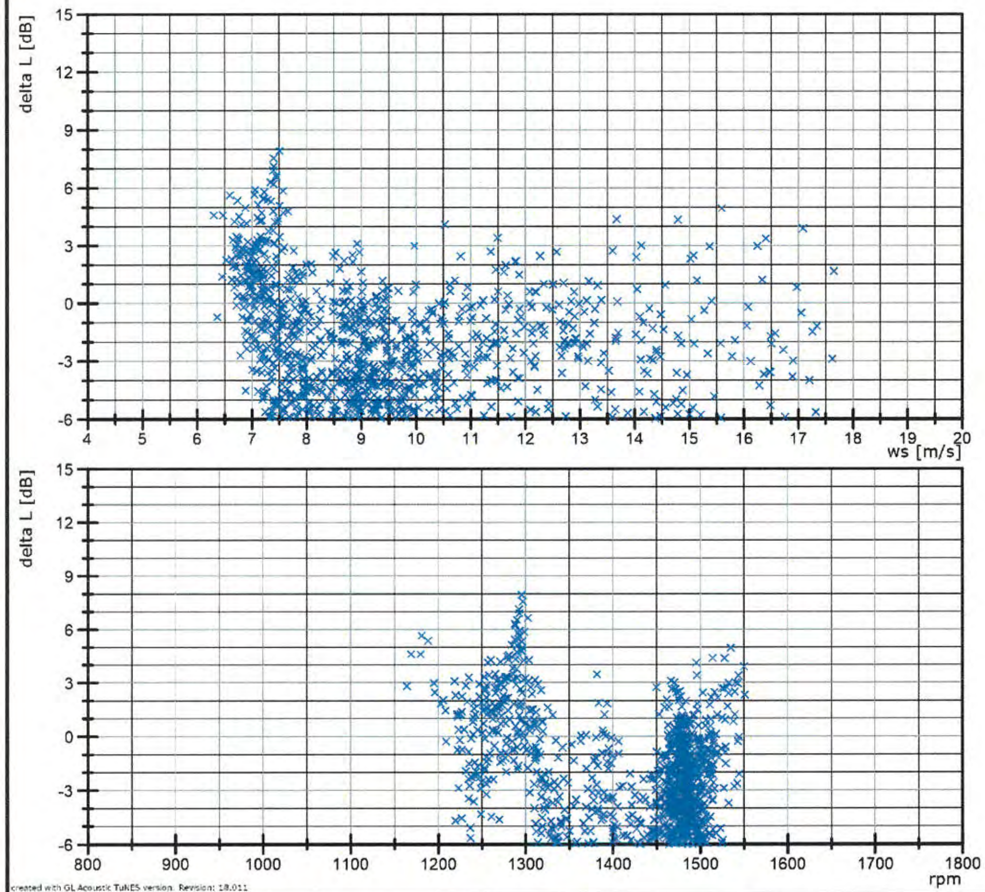
Vestas V150-4.2 MW 50 Hz

Analysis of tonality

Tonhaltigkeitsanalyse

Site / Standort:	Osterild (Denmark)
WTGS-SNo. / WEA-SNr.:	228051
Mode / Modus:	PO1
Date of meas./ Messdatum:	2019-06-26
Standard / Messung:	IEC 61400-11 Ed.3
Project-No. / Projekt-Nr.:	10163788
In charge / Bearbeiter:	Annika Johannsen

9.37 Tonality analysis - wind bin overview (page 3)



WS [m/s]	tone f_T [Hz]	n all	n ident	delta $L_{a,k}$ [dB]	WS-BIN complete	delta $L_{a,k}$ > -3 dB
7.5	126	172	152	*0.52*	Yes	Yes
8.0	134	149	100	*-2.09*	Yes	Yes
8.5	141	132	96	*-2.43*	Yes	Yes
9.0	142	222	154	*-2.97*	Yes	Yes
9.5	142	144	113	*-3.20*	Yes	No
10.0	143	81	70	*-3.00*	Yes	No
10.5	143	53	49	*-2.16*	Yes	Yes
11.0	144	39	32	*-1.66*	Yes	Yes
11.5	143	41	33	*-1.11*	Yes	Yes
12.0	144	39	33	*-1.62*	Yes	Yes
12.5	143	30	25	*-0.98*	Yes	Yes
13.0	144	35	30	*-1.93*	Yes	Yes
13.5	143	30	24	*-1.74*	Yes	Yes
14.0	143	24	16	*-1.70*	Yes	Yes

frequency - area = 117.6 Hz to 168.4 Hz

DNV·GL

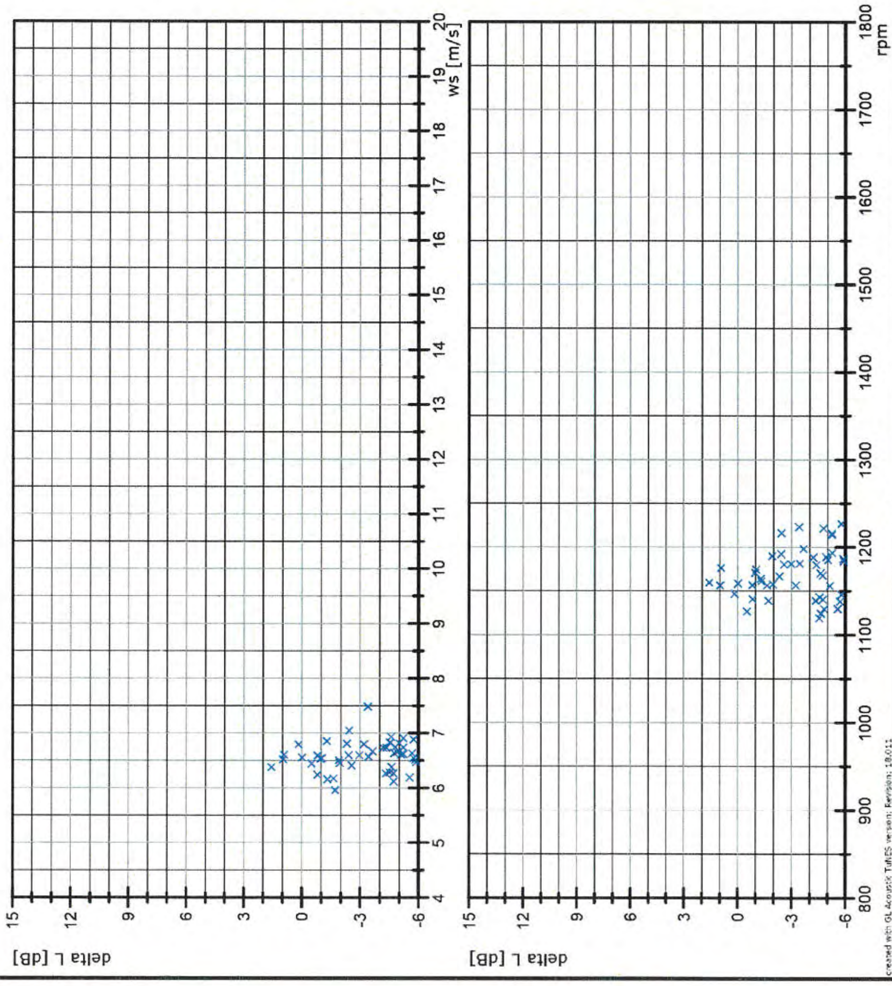
Vestas V150-4.2 MW 50 Hz

Analysis of tonality

Tonhaltigkeitsanalyse

Site / Standort:	Osterild (Denmark)
WTGS-SNo. / WEA-SNr.:	228051
Mode / Modus:	PO1
Date of meas./ Messdatum:	2019-06-26
Standard / Messung:	IEC 61400-11 Ed.3
Project-No. / Projekt-Nr.:	10163788
In charge / Bearbeiter:	Annika Johannsen

9.38 Tonality analysis - wind bin overview (page 4)



WS [m/s]	tone f_T [Hz]	n all	n ident	delta $L_{a,k}$ [dB]	WS-BIN complete	delta $L_{a,k}$ > -3 dB
7.5	508	172	1	*-3.40*	Yes	No
8.0		149	0		Yes	No
8.5		132	0		Yes	No
9.0		222	0		Yes	No
9.5		144	0		Yes	No
10.0		81	0		Yes	No
10.5		53	0		Yes	No
11.0		39	0		Yes	No
11.5		41	0		Yes	No
12.0		39	0		Yes	No
12.5		30	0		Yes	No
13.0		35	0		Yes	No
13.5		30	0		Yes	No
14.0		24	0		Yes	No

frequency - area = 453.0 Hz to 511.0 Hz

23.08.2019

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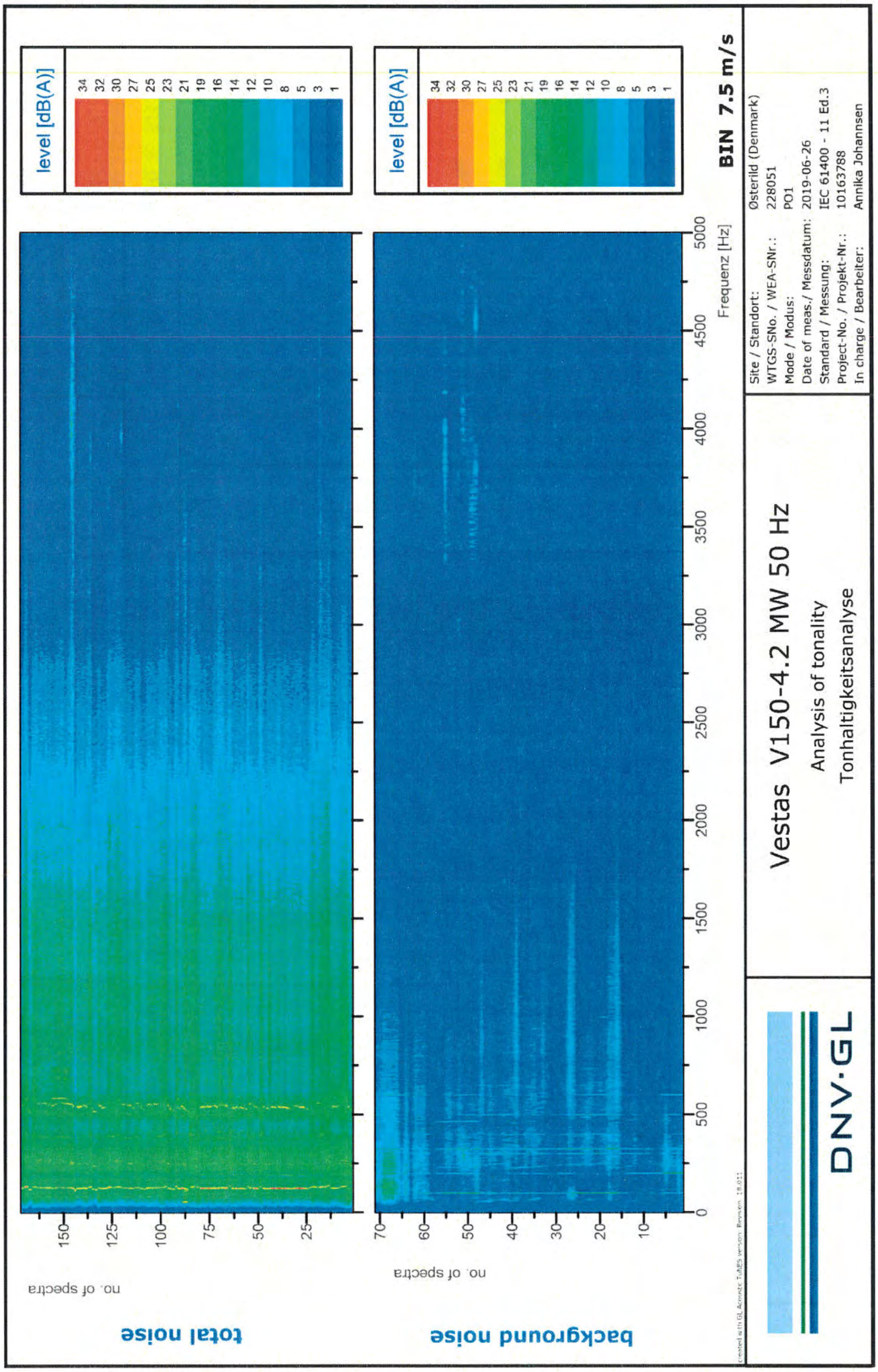
Vestas V150-4.2 MW 50 Hz

Analysis of tonality

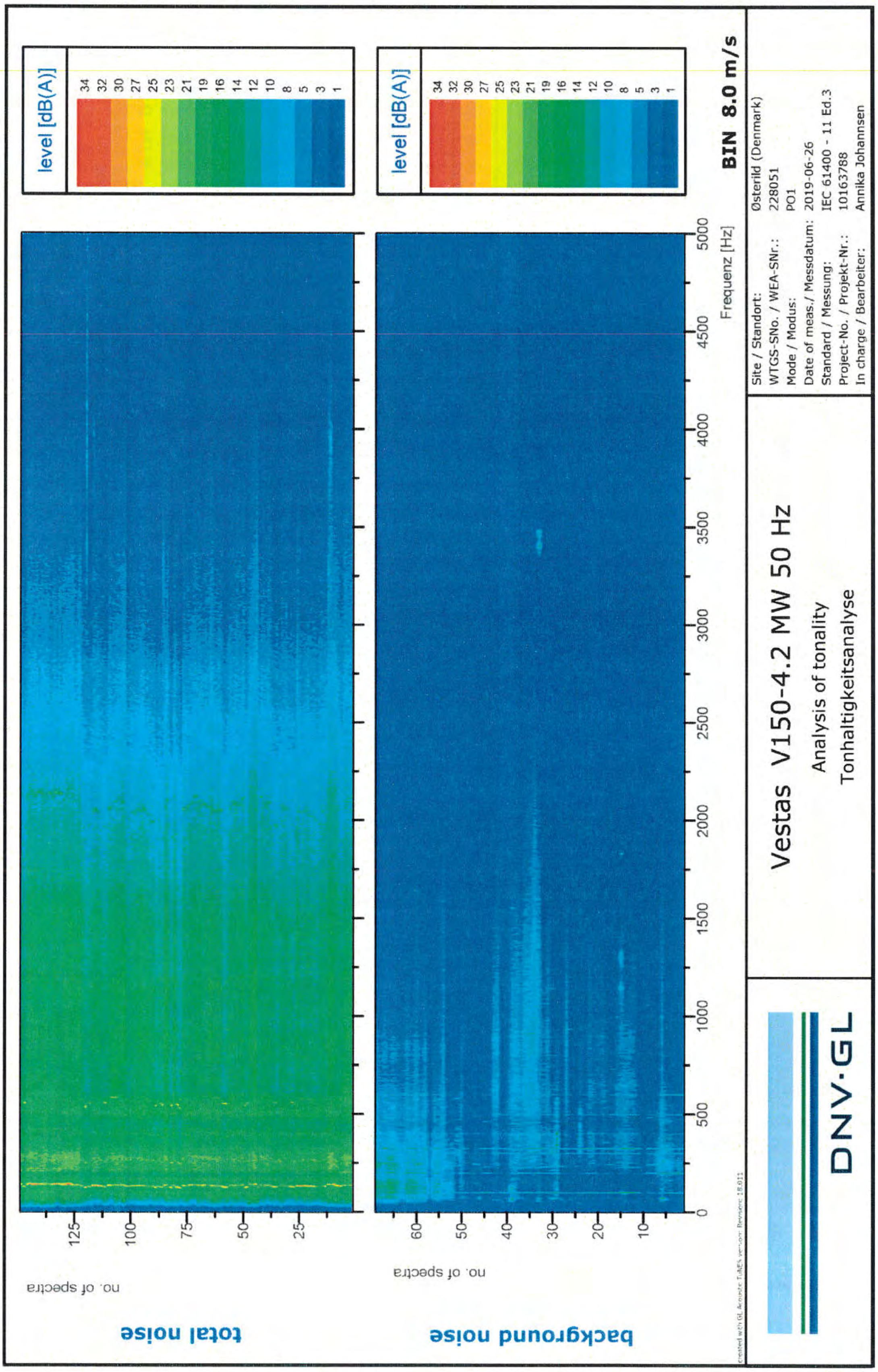
Tonhaltigkeitsanalyse

Site / Standort:	Osterild (Denmark)
WTGS-SNo. / WEA-SNr.:	228051
Mode / Modus:	PO1
Date of meas./ Messdatum:	2019-06-26
Standard / Messung:	IEC 61400-11 Ed.3
Project-No. / Projekt-Nr.:	10163788
In charge / Bearbeiter:	Annika Johannsen

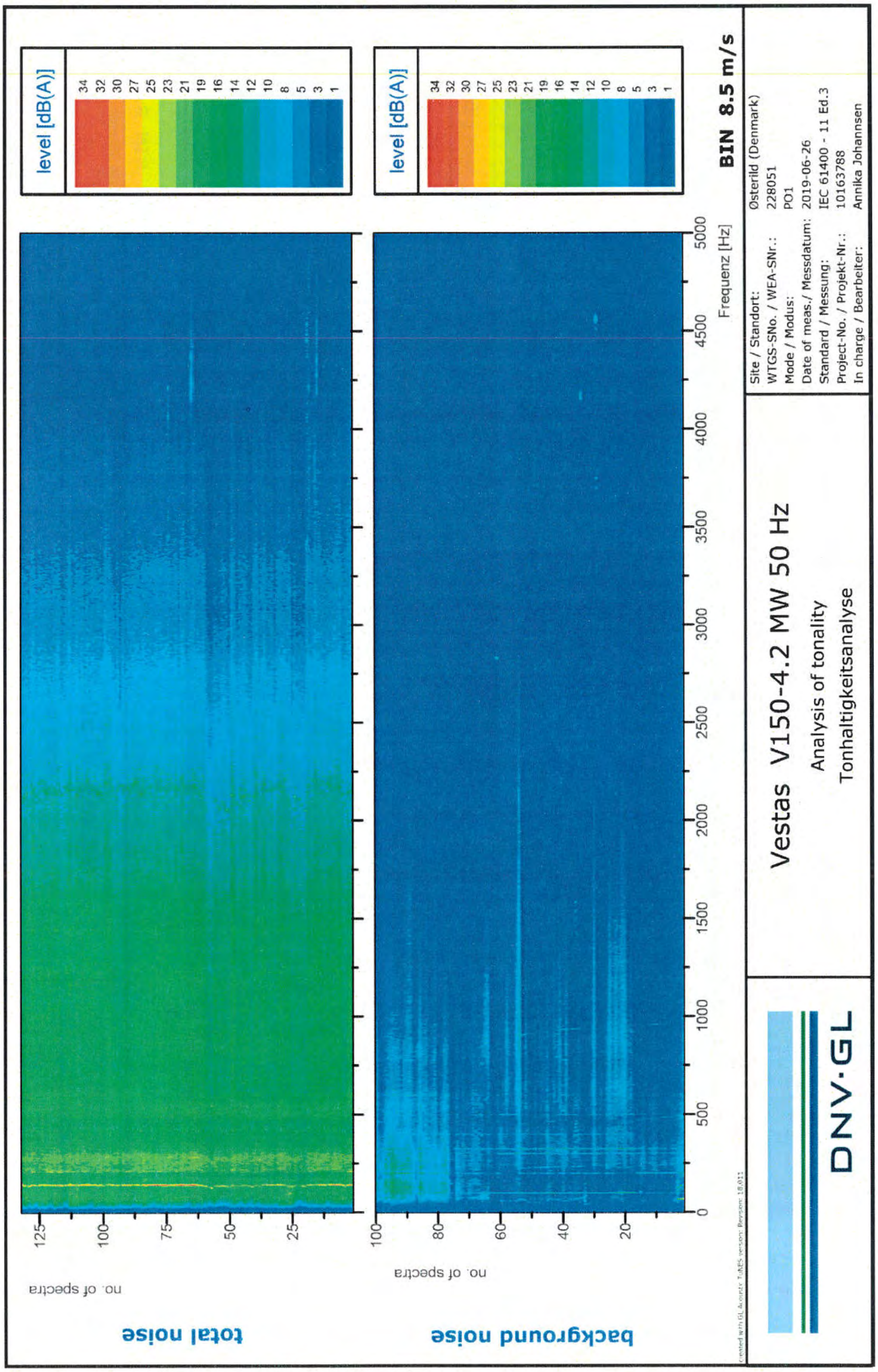
9.39 Frequency spectra of total and background noise at a WS of 7.5 m/s at hub height



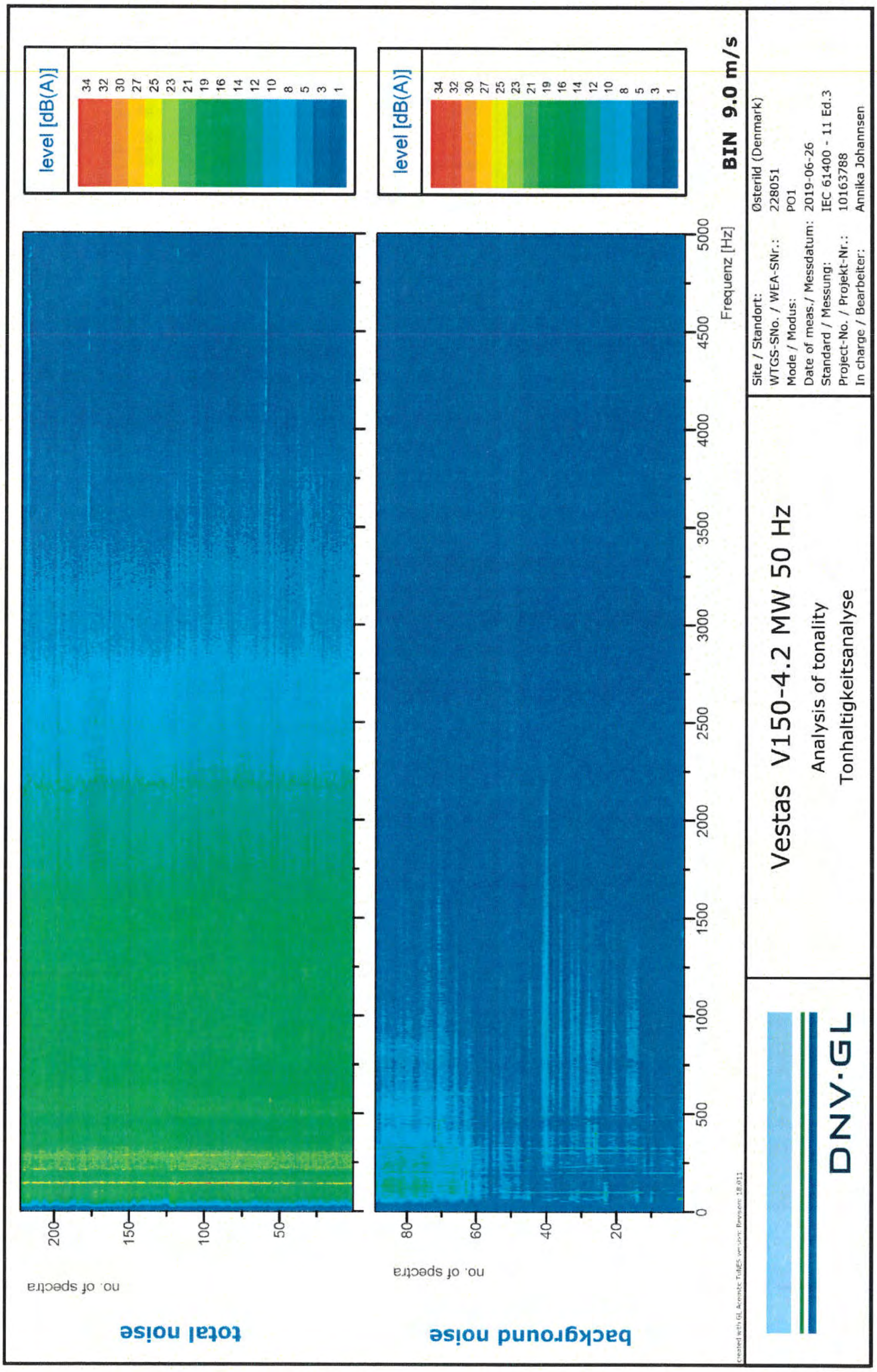
9.40 Frequency spectra of total and background noise at a WS of 8.0 m/s at hub height



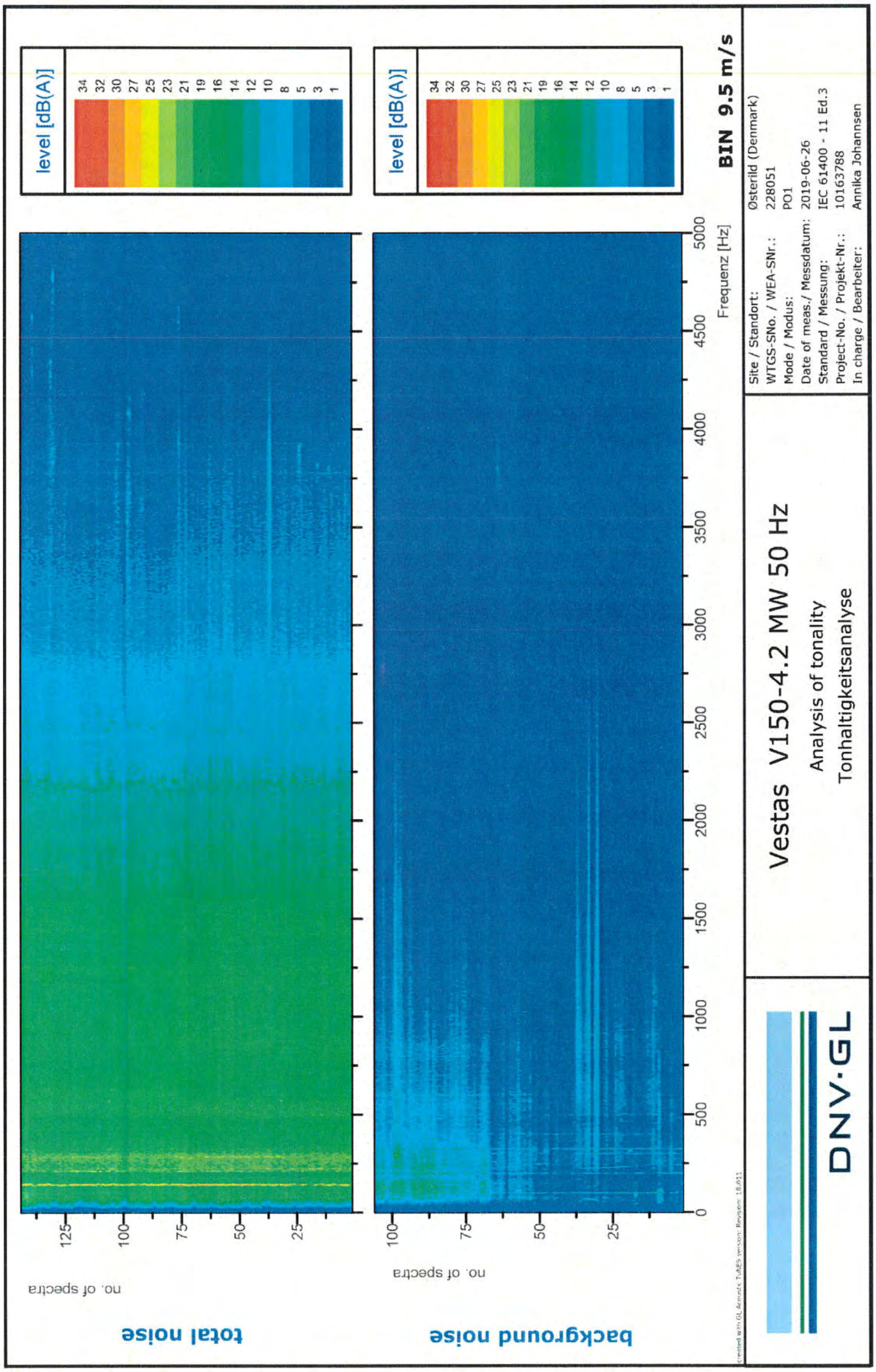
9.41 Frequency spectra of total and background noise at a WS of 8.5 m/s at hub height



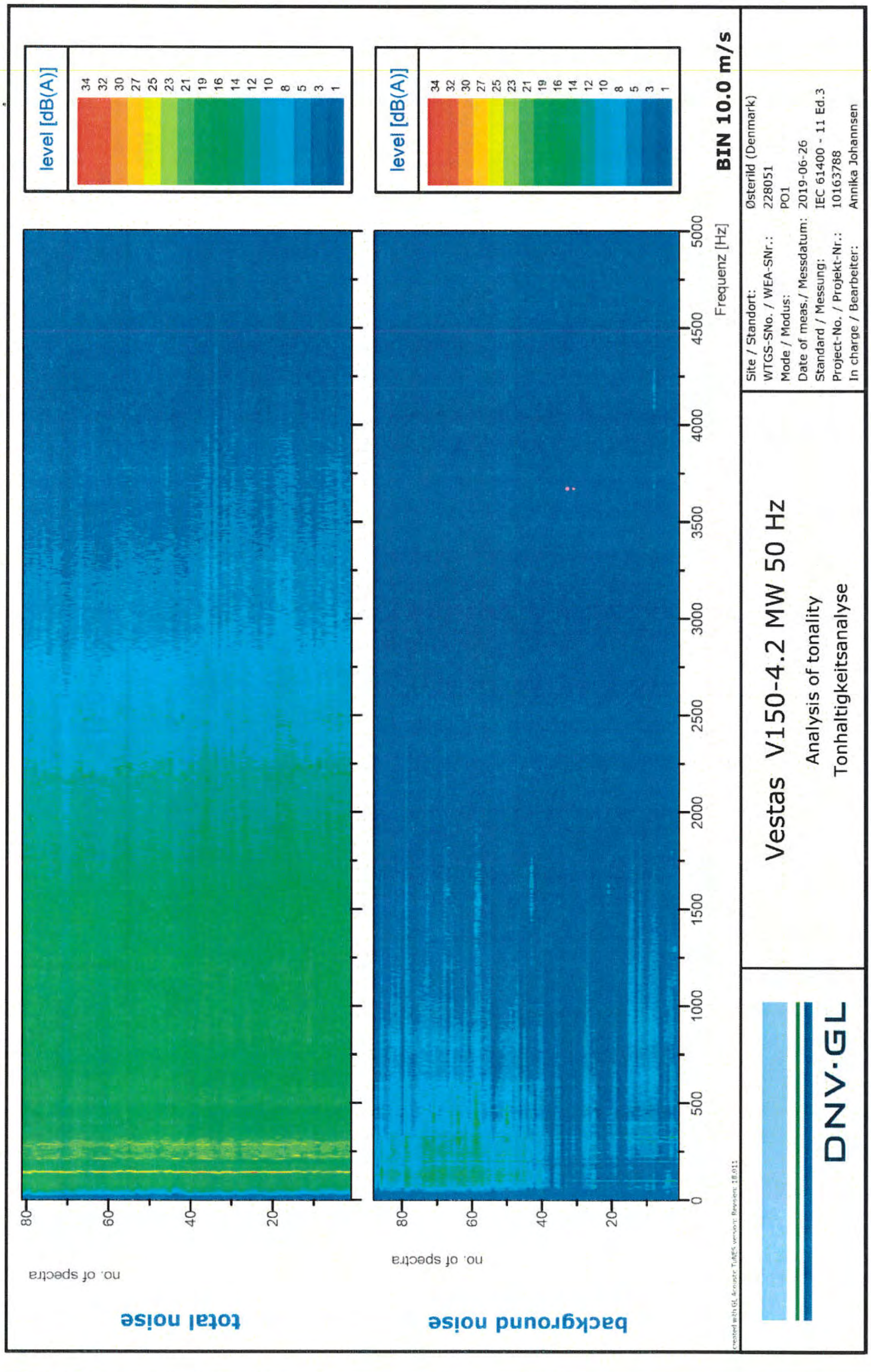
9.42 Frequency spectra of total and background noise at a WS of 9.0 m/s at hub height



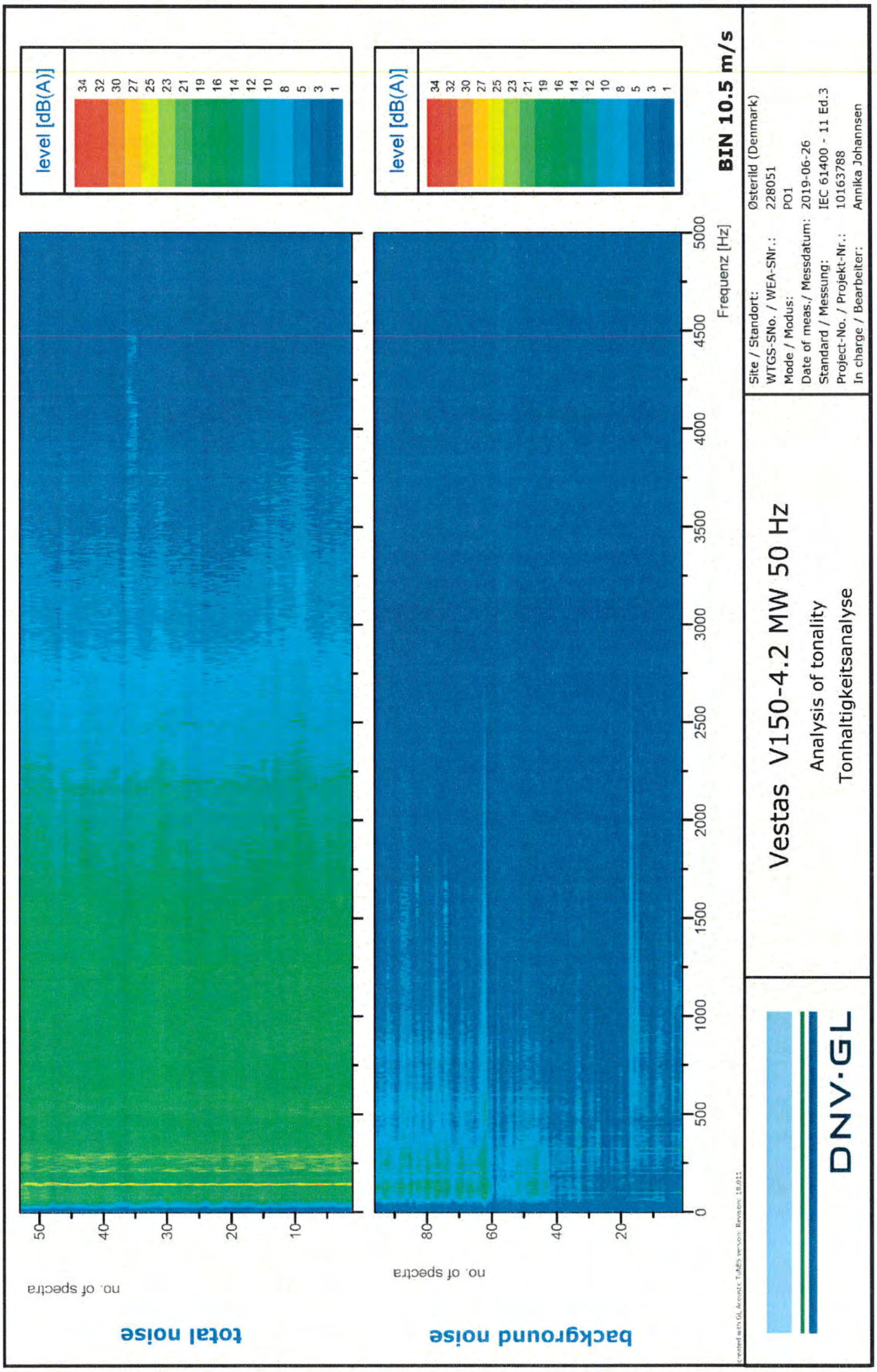
9.43 Frequency spectra of total and background noise at a WS of 9.5 m/s at hub height



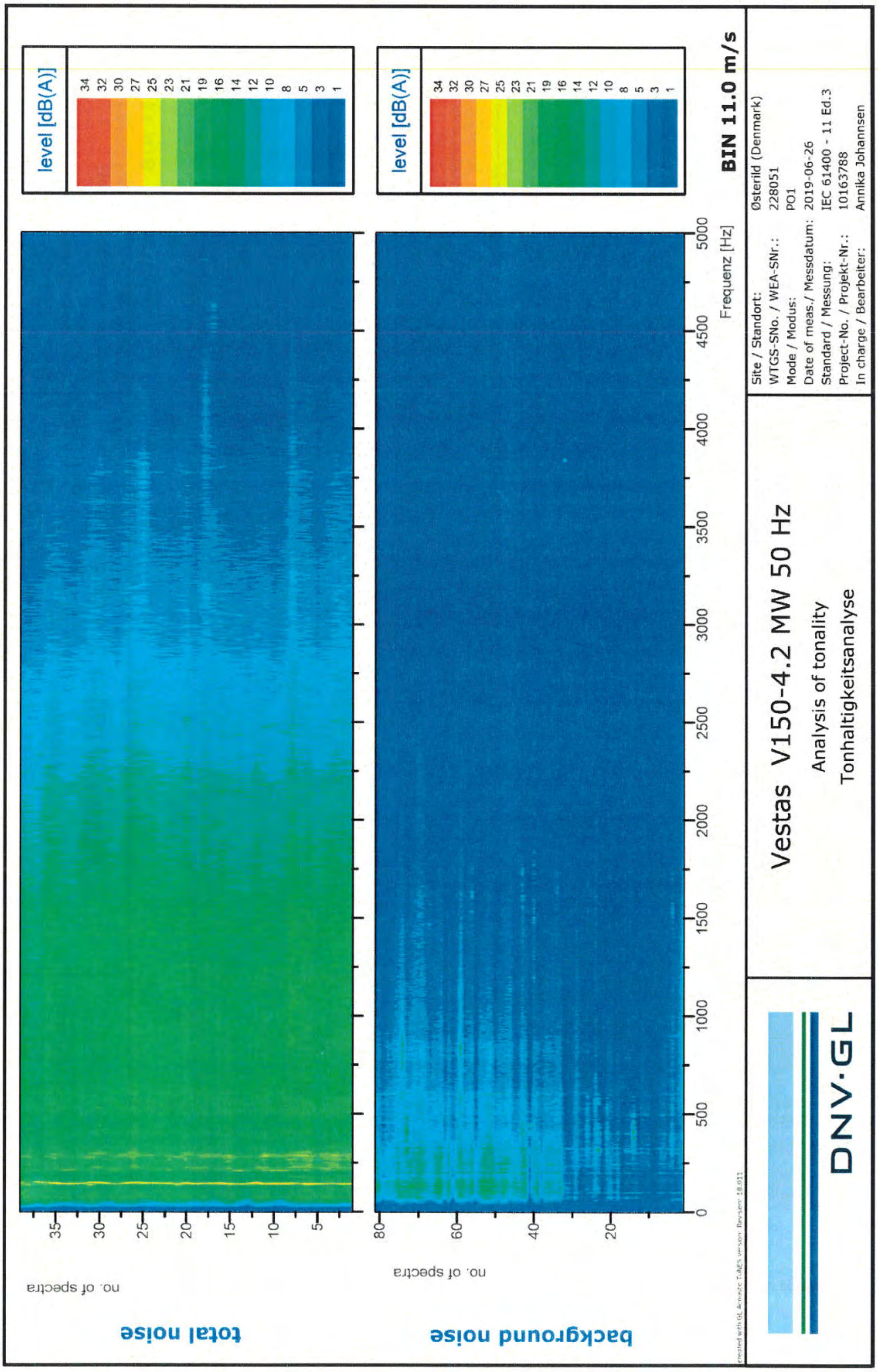
9.44 Frequency spectra of total and background noise at a WS of 10.0 m/s at hub height



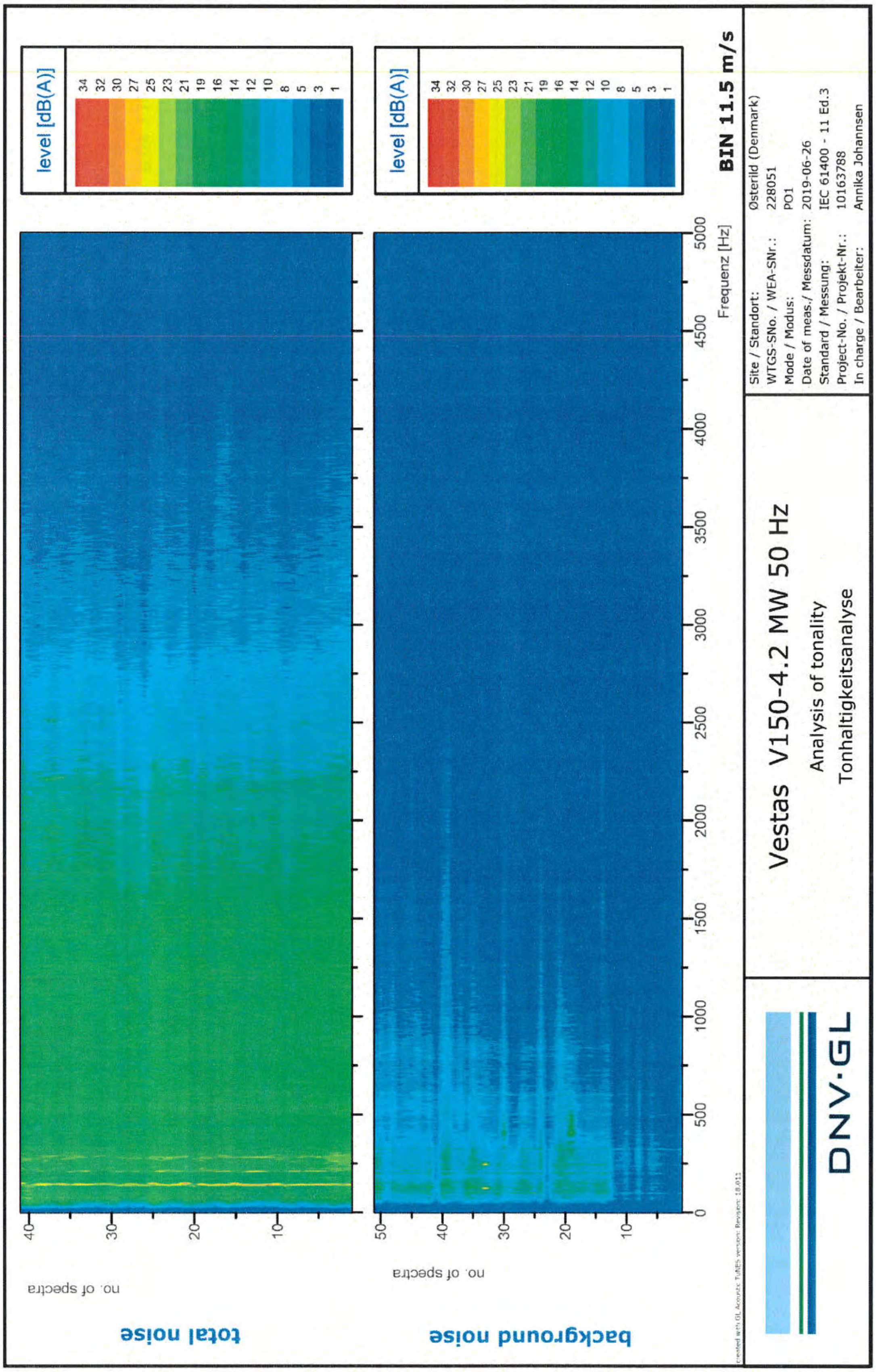
9.45 Frequency spectra of total and background noise at a WS of 10.5 m/s at hub height



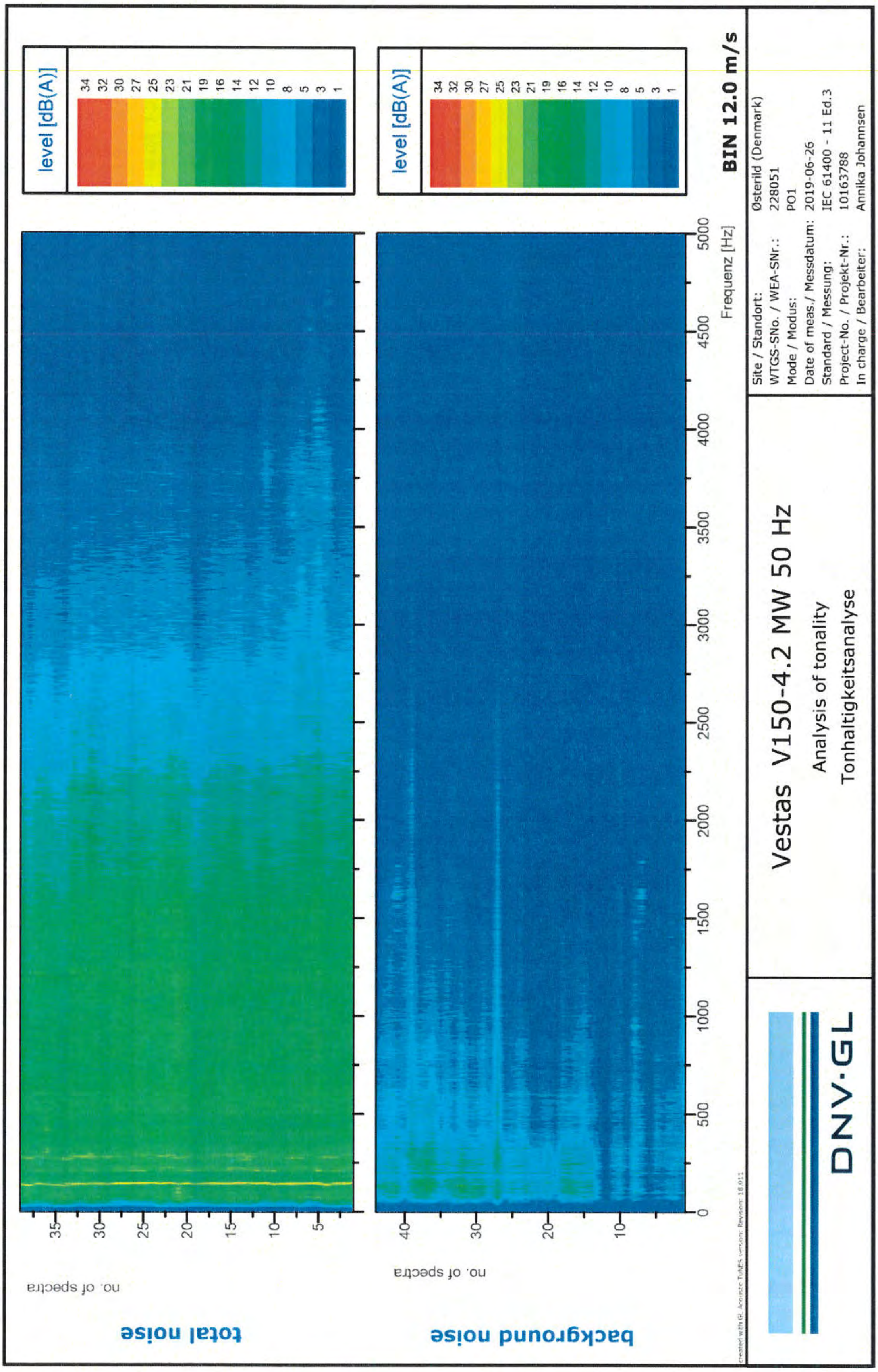
9.46 Frequency spectra of total and background noise at a WS of 11.0 m/s at hub height



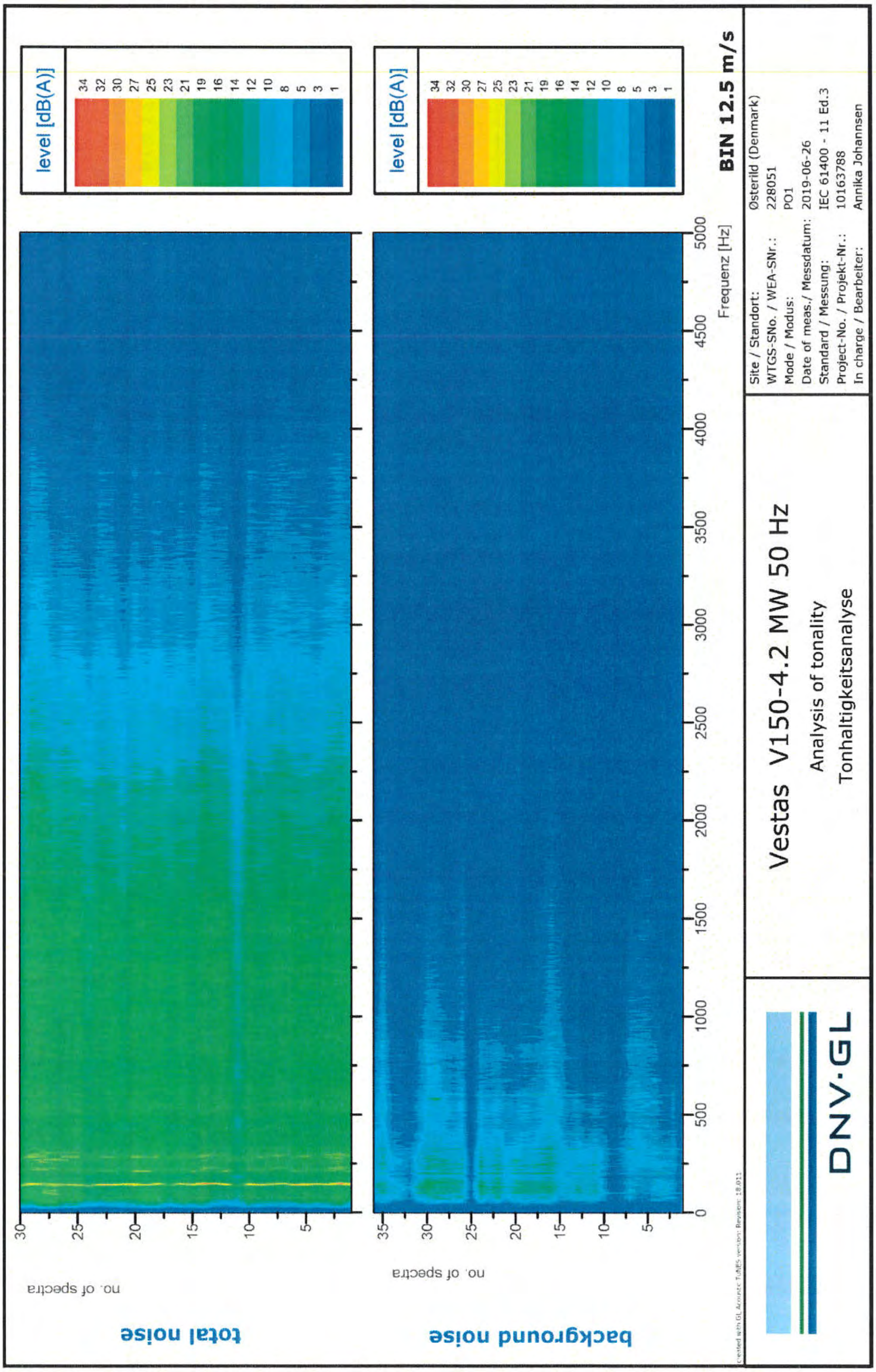
9.47 Frequency spectra of total and background noise at a WS of 11.5 m/s at hub height



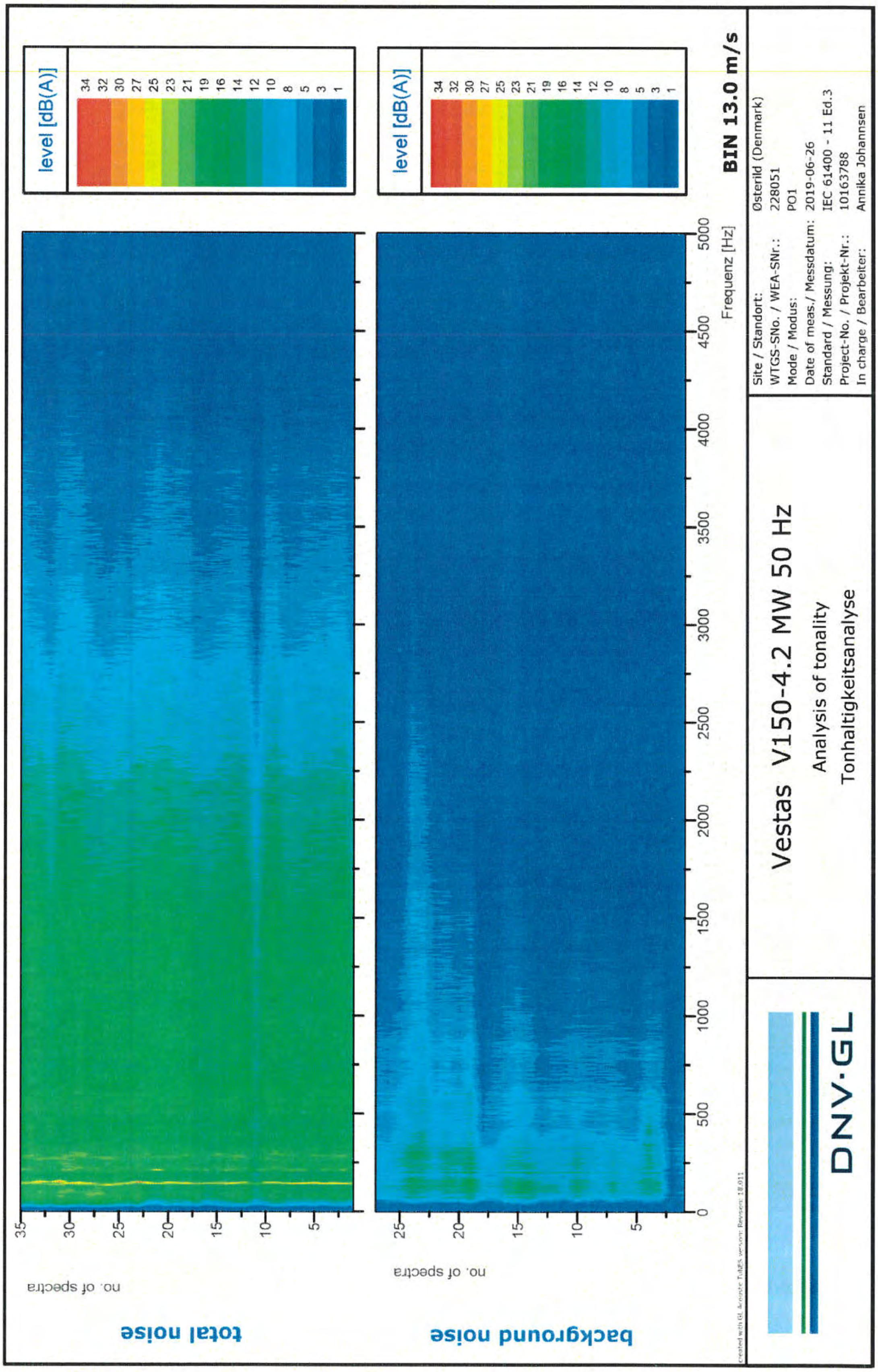
9.48 Frequency spectra of total and background noise at a WS of 12.0 m/s at hub height



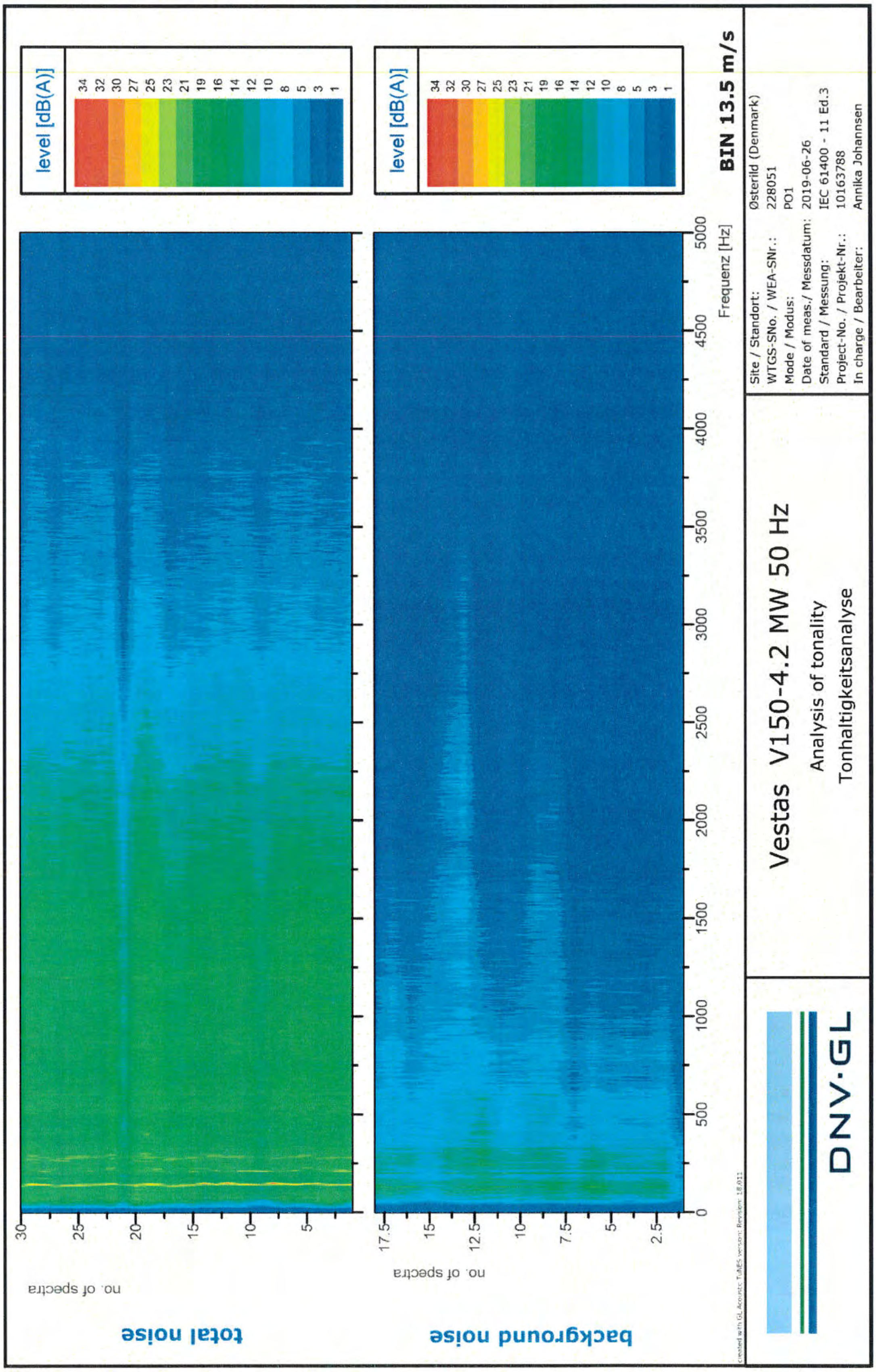
9.49 Frequency spectra of total and background noise at a WS of 12.5 m/s at hub height



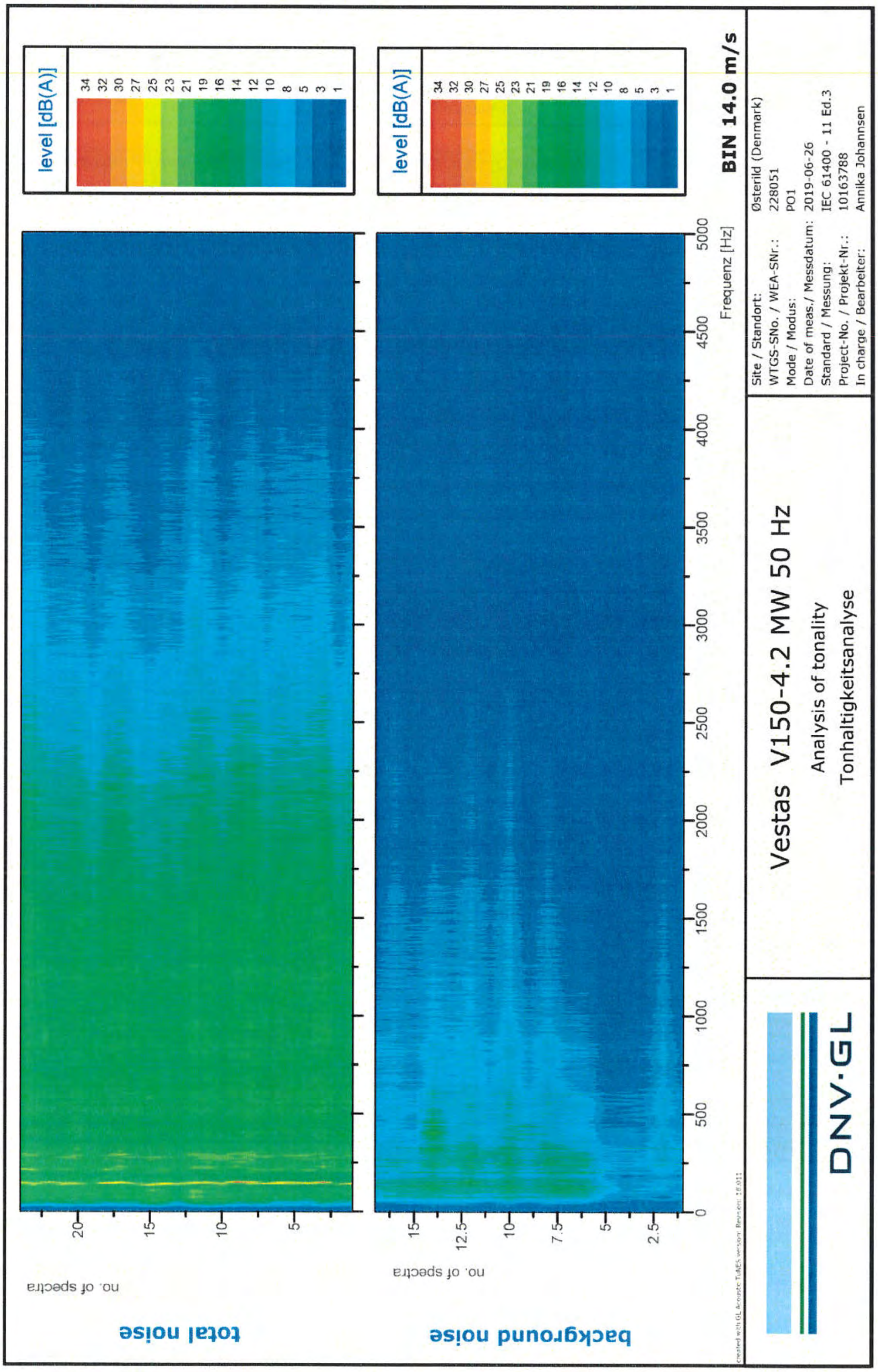
9.50 Frequency spectra of total and background noise at a WS of 13.0 m/s at hub height



9.51 Frequency spectra of total and background noise at a WS of 13.5 m/s at hub height



9.52 Frequency spectra of total and background noise at a WS of 14.0 m/s at hub height



9.53 Power curve used for the analysis

7 Power Curves, Ct Values and Sound Curves, Power Optimized Mode PO1/PO1-0S

7.1 Power Curves, Power Optimized Mode PO1/PO1-0S

	Air density [kg/m³]													
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3.0	**81**	51	54	57	60	62	65	68	70	73	76	79	84	87
3.5	**172**	123	127	132	136	141	145	150	154	159	163	168	177	181
4.0	**285**	210	217	224	231	238	244	251	258	265	272	278	292	299
4.5	**424**	318	328	337	347	357	366	376	386	395	405	415	434	444
5.0	**597**	452	465	478	492	505	518	531	544	557	571	584	610	623
5.5	**809**	616	633	651	669	686	704	721	739	757	774	792	827	844
6.0	**1062**	813	835	858	881	904	926	949	972	995	1017	1040	1085	1108
6.5	**1361**	1045	1074	1103	1131	1160	1189	1218	1247	1275	1304	1332	1389	1418
7.0	**1709**	1317	1353	1389	1425	1461	1496	1532	1568	1603	1639	1674	1744	1779
7.5	**2101**	1628	1671	1715	1758	1802	1845	1888	1931	1974	2016	2058	2143	2185
8.0	**2545**	1982	2034	2086	2137	2189	2240	2292	2343	2394	2444	2494	2594	2644
8.5	**3014**	2375	2435	2496	2556	2616	2674	2732	2790	2848	2904	2959	3067	3120
9.0	**3458**	2791	2856	2921	2986	3052	3112	3172	3232	3292	3348	3403	3510	3562
9.5	**3807**	3180	3246	3312	3377	3443	3499	3556	3613	3669	3715	3761	3845	3884
10.0	**4038**	3543	3602	3662	3722	3781	3824	3866	3909	3951	3980	4009	4059	4079
10.5	**4143**	3842	3884	3926	3969	4012	4035	4059	4083	4107	4119	4131	4150	4158
11.0	**4191**	4055	4078	4100	4122	4145	4154	4162	4171	4180	4184	4187	4193	4195
11.5	**4199**	4152	4160	4168	4176	4185	4188	4190	4193	4196	4197	4198	4199	4200
12.0	**4200**	4185	4188	4191	4194	4198	4198	4199	4199	4200	4200	4200	4200	4200
12.5	**4200**	4197	4197	4198	4199	4200	4200	4200	4200	4200	4200	4200	4200	4200
13.0	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
13.5	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
14.0	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
14.5	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
15.0	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
15.5	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
16.0	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
16.5	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
17.0	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
17.5	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
18.0	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
18.5	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
19.0	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
19.5	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
20.0	**4200**	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200	4200
20.5	**4186**	4186	4186	4186	4186	4186	4186	4186	4186	4186	4186	4186	4186	4186
21.0	**3870**	3870	3870	3870	3870	3870	3870	3870	3870	3870	3870	3870	3870	3870
21.5	**3373**	3373	3373	3373	3373	3373	3373	3373	3373	3373	3373	3373	3373	3373
22.0	**2745**	2745	2745	2745	2745	2745	2745	2745	2745	2745	2745	2745	2745	2744
22.5	**2154**	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154
23.0	**1805**	1805	1805	1805	1805	1805	1805	1805	1805	1805	1805	1805	1805	1805
23.5	**1526**	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526	1526
24.0	**1283**	1283	1283	1283	1283	1283	1283	1283	1283	1283	1283	1283	1283	1283
24.5	**1116**	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116	1116

Table 7-1: Power curve, Power Optimized Mode PO1/PO1-0S

VESTAS PROPRIETARY NOTICE

9.54 Manufacturer's certificate (page 1)

CONFIDENTIAL

Herstellerbescheinigung zu spezifischen Daten einer WEA vom Typ:	Vestas
Manufacturer's certificate on specific data of a WT of the type of installation:	
V150-4.2 MW, PO1 in Østerild, Denmark	

DMS: 0079-5470-V01

1	**Allgemeines**			**General**	
	1	Hersteller	Vestas Wind Systems A/S		manufacturer
	2	Anlagenbezeichnung	V150-4.2 MW 50 Hz		type name
	3	Art (horizontale/vertikale Achse)	HAWT		generic type (horizontal axis /vertical axis)
	4	Nennleistung	4200	kW	rated power
	5	Nennspannung	720 (LV side)	V	rated voltage
	6	Nabenhöhe über Grund	137	m	hub height above ground
	7	Nabenhöhe über Fundamentflansch	-	m	hub height above top of foundation flange
	8	Nennwindgeschwindigkeit	10,1	m/s	rated wind speed (steady wind speed)
	9	Ein- und Abschaltwindgeschwindigkeit	3/24.5	m/s	cut-in and cut-out wind speed
	10	Beitrag zum Stoßkurzschlussstrom	4,5	kA	contribution to short circuit current
2	**Rotor**			**Rotor**	
	1	Durchmesser	150	m	diameter
	2	Bestrichene Fläche	17671	m^2	swept area
	3	Anzahl der Blätter	3		number of blades
	4	Nabenart (pendelnd/starr)	rigid		generic type of hub (teetered/rigid)
	5	Anordnung zum Turm (luv/lee)	luv		relative position to tower (luv/lee)
	6	Nenndrehzahl / -bereich	10,37	1/min / rpm	rated speed / speed range
	7	Auslegungsschnelllaufzahl	9,35		design tip speed ratio
	8	Rotorblatteinstellwinkel	-10 to 95	°	rotor blade pitch setting
	9	Konuswinkel	5,5	°	cone angle
	10	Achsneigung	6	°	tilt angle
	11	Abstand Rotorflanschmittelpunkt und Turmmittellinie	4,5	m	distance between rotor flange centre and tower centre line
3	**Rotorblatt**			**Rotor blade**	
	1	Hersteller	Vestas Wind Systems A/S		manufacturer
	2	Typenbezeichnung	Vestas 73.65m		type name
	3	Profile innen/außen	Infused structural airfoil shell		blade section inner/outer
	4	Material	Fibreglass reinforced epoxy, carbon fibres and Solid Metal Tip (SMT)		material
	5	Länge	73,65	m	length
	6	Profiltiefe max./min.	4.2 / -	m	chord length (max./min.)
	7	Zusatzkomponenten (z.B. stall strips, Vortex-Generatoren, Turbulatoren)	Serrated Trailing Edges		additional components (e.g. stall strips, vortex generators, trip strips)
	8	Extenderlänge	n/a	m	extender length
4	**Getriebe**			**Gear**	
	1	Hersteller	ZF		manufacturer
	2	Typenbezeichnung	EH1052A		type
	3	Ausführung	2 planetary + 1 helical stage		design
	4	Übersetzungsverhältnis	i = 143.37		gear ratio
5	**Generator**			**Generator**	
	1	Hersteller	Vestas		manufacturer
	2	Typenbezeichnung	3 Phase IG, VND DASG 560/6M		type
	3	Anzahl	1		numbers
	4	Art (horizontale/vertikale Achse)	horizontal		design
	5	Nennleistung (en)	4450	kW	rated power (s)
	6	Nennscheinleistung	5057	kVA	rated apparent power
	7	Nenndrehzahlen oder Drehzahlbereich	1485	1/min / rpm	rated speed (s) / speed range
	8	Spannung	800 (at rated speed)	V	voltage
	9	Frequenz	74	Hz	frequency
	10	Nennschlupf	0,54	%	rated slip

Classification: Restricted

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9.55 Manufacturer's certificate (page 2)

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Herstellerbescheinigung zu spezifischen Daten einer WEA vom Typ:	Vestas
Manufacturer's certificate on specific data of a WT of the type of installation:	
V150-4.2 MW, PO1 in Østerild, Denmark	DMS: 0079-5470-V01

6	**Turm**				**Tower**
	1	Hersteller	Vestas Wind Systems A/S		manufacturer
	2	Typenbezeichnung	Tubular		type
	3	Ausführung (Gitter/Rohr, zyl./kon.)	Cylindrical/conical tubular		design (lattice/tubular, cylindical/conical)
	4	Material	Steel		material
	5	Länge	132,1	m	length
7	**Windrichtungsnachführung**				**Yaw control**
	1	Ausführung (aktiv/passiv)	Active		design (active/passive)
	2	Antriebsart (el./mech./hydr.)	Electrical		drive (electr./mech./hydr.)
	3	Dämpfungssystem während des Betriebs	Built-in friction		damping system during operation
8	**Betriebsführung /Regelung**				**Control system/control**
	1	Software version Nr.	2019.06.26		software version No.
	2	- Umrichter	-		- converter
	3	- Steuerung	-		- control system
	4	- Netzschutz	-		- grid protection
	5	- Andere relevante	-		- others
	6	Art der Leistungsregelung	Pitch & Variable speed		generic type of power control
	7	Antrieb der Leistungsregelung	-		actuation of power control
	8	Hersteller der Betriebsführung/Regelung	Vestas Wind Systems A/S		manufacturer of control system
	9	- Typenbezeichnung	System 8000 - VMPGlobal		- type
	10	- Verwendete Steuerungskurve	-		- applied control characteristic
9	**Sonstige elektrische Komponenten**				**Other electric installations**
	1	N_{10}, Einschalten bei Einschaltwind	10		N_{10}, start up at cut in wind speed
	2	N_{120}, Einschalten bei Einschaltwind	120		N_{120}, start up at cut in wind speed
	3	N_{10}, Einschalten bei Nennwind	1		N_{10}, start up at rated wind speed
	4	N_{120}, Einschalten bei Nennwind	12		N_{120}, start up at rated wind speed
	5	N_{10}, Ausschalten bei Nennwind	1		N_{10}, cut off at rated wind speed
	6	N_{120}, Ausschalten bei Nennwind	12		N_{120}, cut off at rated wind speed
	7	N_{10}, Umschalten zwischen den Generatoren	n/a		N_{10}, switching between generators
	8	N_{120}, Umschalten zwischen den Generatoren	n/a		N_{120}, switching between generators
	9	Anzahl der Kompensationsstufen	n/a		number of compensation stages
	10	Blindleistung Stufe 1	n/a	kvar	reactive power stage 1
	11	Blindleistung Stufe 2	n/a	kvar	reactive power stage 2
	12	Blindleistung Stufe _	n/a	kvar	reactive power stage _
	13	Blindleistung Stufe _	n/a	kvar	reactive power stage _
	14	Art der Netzkopplung	Full Scale Converter		generic type of interconnection
	15	- Hersteller	Vestas Wind Systems A/S		- manufacturer
	16	- Typenbezeichnung	-		- type
	17	Netzschutzhersteller	Vestas Wind Systems A/S		grid protection manufacturer
	18	- Typenbezeichnung	VMP Global Tm		- type
	19	- Einstellbereiche	-		- adjustment ranges
	20	Spannungssteigerungsschutz	792	V	overvoltage protection
	21	Spannungsrückgangschutz	648	V	undervoltage protection
	22	Frequenzsteigerungsschutz	53	Hz	overfrequency protection
	23	Frequenzrückgangschutz	46,5	Hz	underfrequency protection
	24	Typenbezeichnung der Abschalteinheit	Schneider - MTz2-32 H10		circuit breaker type
	25	Oberschwingungsfilter (ja/nein) (OS-Filter müssen auf den Netzverknüpfungspunkt ausgelegt sein)	yes		harmonic filter (yes / no) (harmonic filter have to be designed for the point of common coupling)

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9.56 Manufacturer's certificate (page 3)

Herstellerbescheinigung zu spezifischen Daten einer WEA vom Typ:	Vestas
Manufacturer's certificate on specific data of a WT of the type of installation:	
V150-4.2 MW, PO1 in Østerild, Denmark	

DMS: 0079-5470-V01

10	**Umrichter**			**Converter**	
1	Hersteller	Vestas Wind Systems A/S		converter manufacturer	
2	Typenbezeichnung	Full quadrant IGBT		converter type	
3	Spannungsebene	720 (Grid) / 800 (Generator)	V	voltage level	
4	Nennscheinleistung	5100	kVA	converter apparent rated power	
11	**Transformator**			**Transformer**	
1	Hersteller	Siemens (s/n: K832736)		transformer manufacturer	
2	Typenbezeichnung	4GY6781-1EY		transformer type	
3	Schaltgruppe	Dyn5		transformer connection	
4	Nennscheinleistung	5150	kVA	transformer apparent rated power	
5	Spannungsebenen	36.0/1.1	kV	voltage level	
6	Kurzschlussspannung	9,6	%	short circuit voltage	
12	**Bremssystem**			**Brake system**	
1	Bremssystem (primär/sekundär)	aerodynamic (feathering) / mechanical		brake system (primary/secondary)	
2	- Aktivierung	hydraulic / mechnical		- activation	
3	- Anordnung zum Turm (luv/lee)	luv		- location	
4	- Bremsenart	aerodynamic / disc brake		- type	
5	- Bestätigung	Pause & Stop / Emergency Stop		- actuation	
13	**Typenprüfung**			**Type test**	
1	Prüfbehörde	DNV-GL		testing authority	
2	Aktenzeichen	IEC 61400		reference	
14	**Informativer Teil**			**Informative**	
1	Standort der vermessenen WEA	Osterild (Denmark)		location of measured WT	
2	Koordinaten des Standortes	57.066970, 8.884000		geographical coordinates of the location	
3	Seriennummer			serial number of	
4	- WEA	228051		- WT	
5	- Blätter	29101054WHD213007 29101054WHD213012 29101054WHD213010		- blades	
6	- Getriebe	EH1052A-001.P3/LM0001		- gearbox	
7	- Generator	635747		- generator	
8	Netzkurzschlussleistung	805,81	MVA	short-circuit apparent power	
7	Netzimpedanzwinkel	87,96	°	network impedance phase angle	

Anschrift des Herstellers Address of manufacturer	Vestas Wind System A/S Hedeager 42 8200 Aarhus	Stempel, Unterschrift stamp, signature	Vestas Vestas Wind Systems A/S Hedeager 42 8200 Aarhus Phone 9730 0000

Der Hersteller der Windenergieanlage bestätigt, dass die WEA, deren elektrischen Eigenschaften in den Prüfberichten abgebildet sind, hinsichtlich ihrer technischen Daten mit den o.g. Positionen identisch ist.

The manufacturer of the wind turbine (WT) confirms that the WT whose power quality is measured and depicted in the test reports, is identical with the above entries with regard to it-s technical data

9.57 Measuring equipment

Beschreibung *description*	Fabrikat *supplier*	Typ *type*	WT Nr./Ser.Nr. *WT stock number/ serial number*	letzte Kalibrierung *last calibration*	nächste Kalibrierung *next calibration*	letzte Eichung *last verification*	nächste Eichung *next verification*
Schallpegelmesser *sound level meter*	Svantek	979	GLGH 428616-337000021 (45290)	Sep- 17	Sep- 19	Jun- 19	Dez- 21
Mikrofon *microphone*	G.R.A.S.	40AE	zu GLGH 428616-337000021 (240597)	**gemeinsame Kalibration** *common calibration*	**gemeinsame Kalibration** *common calibration*	**gemeinsame Eichung** *common verification*	**gemeinsame Eichung** *common verification*
Vorverstärker *preamp.*	Svantek	SV17	zu GLGH 428616-337000021 (52127)				
Mikrofonkabel *microphone cable*	Svantek	SC93/10	zu GLGH 428616-337000021				
Akustischer Kalibrator *acoustic calibrator*	Brüel & Kjær	4231	GLGH 428604-333000006 (2438819)	Sep- 18	Sep- 19		
Primärwindschirm *primary wind shield*	Brüel & Kjær	UA 0237	-				
Sekundärwindschirm *secondary wind shield*	DNVGL	EWS	15- Okt				
Anemometer *anemometer*	Thies Clima	4.9201.00.000	GLGH 428616-113000298 (06160031)	Sep- 18	Sep- 20		
Windrichtungsgeber *wind direction sensor*	Thies Clima	4.9201.00.000	zu GLGH 428616-113000298 (06160031)				
Temperaturgeber *temperature sensors*	Thies Clima	4.9201.00.000	zu GLGH 428616-113000298 (06160031)				
Luftdruckgeber *pressure sensors*	Thies Clima	4.9201.00.000	zu GLGH 428616-113000298 (06160031)				
Feuchtesensor *humidity sensor*	Thies Clima	4.9201.00.000	zu GLGH 428616-113000298 (06160031)				
WEA Box	Expert	EX9017/F	GLGH 428616-323000008 (66007)	Jul- 18	Jul- 20		
Laser-Entfernungsmesser *laser distance meter*	Bushnell Corporation	Yardage PRO 1000	WT300087704 (027103)	Aug- 17	Aug- 19		
Erfassungsrechner *data acquisition computer*	HP	Elitebook 2570P	GLGH 425515-41100383 (CNU343BB0N)				
Erfassungs- und Auswertesoftware *data acquisition and analytical software*	GfS Aachen Microsoft DATALOG GmbH	DIAdem 2012/2018 Office 2016 Dasy-Lab 10.0					

9.58 Calibration certificate of noise level meter (page 1)

SPEKTRA Schwingungstechnik und Akustik GmbH Dresden

Kalibriersysteme · Spezialausrüstungen · DAkkS Laboratorium · Umweltsimulation

SPEKTRA

akkreditiert durch die / *accredited by the*

Deutsche Akkreditierungsstelle GmbH

als Kalibrierlaboratorium im / *as calibration laboratory in the*

Deutschen Kalibrierdienst **DKD**

ilac-MRA DAkkS Deutsche Akkreditierungsstelle D-K-15183-01-00

Kalibrierschein
Calibration Certificate

Kalibrierzeichen *Calibration mark*

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Gegenstand *Object*	**Schallpegelmesser**
Hersteller *Manufacturer*	**SVANTEK**
Typ *Type*	**SVAN 979**
Fabrikat/Serien-Nr. *Serial number*	**45290**
Auftraggeber *Customer*	**GL Garrad Hassan Deutschland GmbH DE-25709 Kaiser-Wilhelm-Koog**
Auftragsnummer *Order No.*	**171688**
Anzahl der Seiten des Kalibrierscheines *Number of pages of the certificate*	**7**
Datum der Kalibrierung *Date of calibration*	**27.09.2017**

Dieser Kalibrierschein dokumentiert die Rückführung auf nationale Normale zur Darstellung der Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI).
Die DAkkS ist Unterzeichner der multi-lateralen Übereinkommen der European co-operation for Accreditation (EA) und der International Laboratory Accreditation Cooperation (ILAC) zur gegenseitigen Anerkennung der Kalibrierscheine.
Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich.

This calibration certificate documents the traceability to national standards, which realize the units of measurement according to the International System of Units (SI).
The DAkkS is signatory to the multilateral agreements of the European co-operation for Accreditation (EA) and of the International Laboratory Accreditation Cooperation (ILAC) for the mutual recognition of calibration certificates.
The user is obliged to have the object recalibrated at appropriate intervals.

Dieser Kalibrierschein darf nur vollständig und unverändert weiterverbreitet werden. Auszüge oder Änderungen bedürfen der Genehmigung sowohl der Deutschen Akkreditierungsstelle GmbH als auch des ausstellenden Kalibrierlaboratoriums. Kalibrierscheine ohne Unterschrift haben keine Gültigkeit.
This calibration certificate may not be reproduced other than in full except with the permission of both the Deutsche Akkreditierungsstelle GmbH and the issuing laboratory. Calibration certificates without signature are not valid.

Datum *Date*	Stellv. Leiter des Kalibrierlaboratoriums *Deputy head of the calibration laboratory*	Bearbeiter *Person in charge*
27.09.2017	Mario Gutbier	Stefan Jurgeit

"DK17-5102/7"

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9.59 Calibration certificate of noise level meter (page 2)

Seite 2 zum Kalibrierschein vom 27.09.2017
Page *of calibration certificate dated*

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1. Kalibriergegenstand

Gegenstand:	Hersteller:	Typ:	Serien-Nr:	Klassifizierung *)
Schallpegelmesser	**SVANTEK**	**SVAN 979**	**45290**	1
mit:				
Mikrofonkapsel	**G.R.A.S.**	**40AE**	**240597**	
Mikrofonvorverstärker	**SVANTEK**	**SV 17**	**52127**	

*) nach DIN EN 61672-1

Software	**Svantek**	**Version 1.26.2**

2. Kalibrierverfahren

Die akustische Kalibrierung erfolgte in Anlehnung an die Norm DIN EN 61672 im Freifeld nach dem Substitutionsverfahren im Schallfeld ebener, fortschreitender Wellen mit Sinustönen bekannten Schalldrucks, welche über eine Normalmesseinrichtung gemessen wurden. Die Richtung des Schalleinfalls war die Mikrofonlängsachse. Vor der Messung im Freifeld wurde der Schallpegelmesser am Bezugspegel 94 dB mit einem unmittelbar auf das nationale Normal rückgeführten akustischen Kalibrator auf den Referenzpegel justiert.

3. Umgebungsbedingungen

Umgebungstemperatur des Prüflings:	**(22,4 ± 1) °C**
Relative Luftfeuchte:	**(55 ± 5) %**
Statischer Luftdruck:	**(994,9 ± 1) hPa**

4. Messbedingungen

Einstellungen am Kalibriergegenstand:

Zeitbewertung	Fast
Messbereiche	Tief (120 dB)
Frequenzbewertung	LIN, A, C
Mikrofon Kom.-Filter	Freifeld
Windschirm	aus
Mikrofonanschluss	abgesetzt über Kabelverlängerung

Einstellungen an der Normalmesseinrichtung:

Frequenzbereich:	125 Hz bis 20 kHz
Kalibrierpegel:	84 dB
Abstand zur Schallquelle:	84,0 cm
Filtertyp:	Sinusapproximation
Polarisationsspannung:	200 V

Bezugsschalldruck: 20 µPa

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9.60 Calibration certificate of noise level meter (page 3)

5. Messunsicherheit

Die relativen Messunsicherheiten für die ausgewiesenen Werte betragen:

- bei Ermittlung des Schalldruckpegels bei 1 kHz und 94 dB		**0,15 dB**
- bei Ermittlung der Anzeigeabweichung im Freifeld		
125 Hz bis	<250 Hz	**0,35 dB**
250 Hz bis	8000 Hz	**0,30 dB**
>8000 Hz bis	10000 Hz	**0,40 dB**
>10000 Hz bis	20000 Hz	**0,45 dB**

Angegeben ist die erweiterte Messunsicherheit, die sich aus der Standardmessunsicherheit durch Multiplikation mit dem Erweiterungsfaktor k = 2 ergibt. Sie wurde gemäß DAkkS-DKD-3 ermittelt. Der Wert der Messgröße liegt mit einer Wahrscheinlichkeit von 95 % im zugeordneten Werteintervall.

6. Bestandteile der Normalmesseinrichtung

	Hersteller	Typ	Serien-Nr.
Schallpegelkalibrator	Brüel & Kjaer	4231	2694377
Messmikrofonkapsel	Brüel & Kjaer	4191 FF	2929550
Mikrofonvorverstärker	Microtech Gefell	MV203	2329
Kalibriersystem	SPEKTRA	CS18 AK 2	200717
Reflexionsarme Messkammer	SPEKTRA	-	-

7. Ergebnisse

7.1 Einpunktkalibrierung mit Kalibrator

Anzeige vor der Justage

Messbereich in dB	Frequenz-, Zeit-bewertung	Frequenz in Hz	Schalldruck-pegel in dB Sollwert	Schalldruck-pegel in dB Anzeige	Abweichung vom Sollwert in dB
120	LIN, F	1000	94,0	94,3	**0,3**

(Empfindlichkeit = 46,72 mV/Pa; C = 0,59 dB)

Anzeige nach der Justage

Messbereich in dB	Frequenz-, Zeit-bewertung	Frequenz in Hz	Schalldruck-pegel in dB Sollwert	Schalldruck-pegel in dB Anzeige	Abweichung vom Sollwert in dB
120	LIN, F	1000	94,0	94,1	**0,1**

(Empfindlichkeit = 47,53 mV/Pa; C = 0,44 dB)

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9.61 Calibration certificate of noise level meter (page 4)

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7.2 Anzeigeabweichung bei Pegel und Frequenz, Frequenzbewertung LIN

Frequenz in Hz	Bereitgestellter Schalldruckpegel L_{LIN} in dB	*Frequenzgang LIN-Bewertung in dB*	Sollwert der Anzeige $L_{LIN,F}$ in dB	Anzeige am Schallpegelmesser $L_{LIN,F}$ in dB	Abweichung zur LIN - Bewertung in dB
125	84,0	*0,0*	84,0	84,1	**0,1**
160	84,0	*0,0*	84,0	84,1	**0,1**
200	84,0	*0,0*	84,0	84,1	**0,1**
250	84,0	*0,0*	84,0	84,1	**0,1**
315	84,0	*0,0*	84,0	84,0	**0,0**
400	84,0	*0,0*	84,0	84,1	**0,1**
500	84,0	*0,0*	84,0	84,1	**0,1**
630	84,0	*0,0*	84,0	84,2	**0,2**
800	84,1	*0,0*	84,1	84,3	**0,2**
1000	84,0	*0,0*	84,0	84,2	**0,2**
1250	84,0	*0,0*	84,0	84,1	**0,1**
1600	84,0	*0,0*	84,0	84,0	**0,0**
2000	84,0	*0,0*	84,0	84,3	**0,3**
2500	84,0	*0,0*	84,0	83,6	**-0,4**
3150	84,0	*0,0*	84,0	84,0	**0,0**
4000	84,0	*0,0*	84,0	84,0	**0,0**
5000	84,0	*0,0*	84,0	84,1	**0,1**
6300	84,1	*0,0*	84,1	83,8	**-0,3**
8000	84,1	*0,0*	84,1	84,2	**0,1**
10000	84,1	*0,0*	84,1	84,6	**0,5**
12500	84,1	*0,0*	84,1	84,8	**0,7**
16000	84,1	*0,0*	84,1	85,9	**1,8**
20000	84,1	*0,0*	84,1	85,4	**1,3**

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9.62 Calibration certificate of noise level meter (page 5)

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7.3 Anzeigeabweichung bei Pegel und Frequenz, Frequenzbewertung A

Frequenz in Hz	Bereitgestellter Schalldruckpegel L_{LIN} in dB	*Frequenzgang A-Bewertung in dB*	Sollwert der Anzeige $L_{A,F}$ in dB	Anzeige am Schallpegelmesser $L_{A,F}$ in dB	Abweichung zur A - Bewertung in dB
125	84,0	*-16,2*	67,8	67,9	**0,1**
160	84,0	*-13,2*	70,8	70,9	**0,1**
200	84,0	*-10,8*	73,2	73,2	**0,0**
250	84,0	*-8,7*	75,3	75,4	**0,1**
315	84,0	*-6,6*	77,4	77,4	**0,0**
400	84,0	*-4,8*	79,3	79,3	**0,0**
500	84,0	*-3,2*	80,7	80,8	**0,1**
630	84,0	*-1,9*	82,1	82,3	**0,2**
800	84,1	*-0,8*	83,3	83,5	**0,2**
1000	84,0	*0,0*	84,0	84,2	**0,2**
1250	84,0	*0,6*	84,6	84,7	**0,1**
1600	84,0	*1,0*	85,0	85,0	**0,0**
2000	84,0	*1,2*	85,2	85,5	**0,3**
2500	84,0	*1,3*	85,3	84,9	**-0,4**
3150	84,0	*1,2*	85,2	85,2	**0,0**
4000	84,0	*1,0*	85,0	85,0	**0,0**
5000	84,0	*0,6*	84,6	84,8	**0,2**
6300	84,1	*-0,1*	84,0	83,8	**-0,2**
8000	84,1	*-1,1*	82,9	83,2	**0,3**
10000	84,1	*-2,5*	81,6	82,2	**0,6**
12500	84,1	*-4,3*	79,8	80,5	**0,7**
16000	84,1	*-6,7*	77,4	79,0	**1,6**
20000	84,1	*-9,3*	74,7	76,1	**1,4**

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9.63 Calibration certificate of noise level meter (page 6)

Seite 6 zum Kalibrierschein vom 27.09.2017
Page *of calibration certificate dated*

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7.4 Anzeigeabweichung bei Pegel und Frequenz, Frequenzbewertung C

Frequenz in Hz	Bereitgestellter Schalldruckpegel L_{LIN} in dB	*Frequenzgang C-Bewertung* *in dB*	Sollwert der Anzeige $L_{C,F}$ in dB	Anzeige am Schallpegelmesser $L_{C,F}$ in dB	Abweichung zur C - Bewertung in dB
125	84,0	*-0,2*	83,8	83,9	**0,1**
160	84,0	*-0,1*	83,9	84,1	**0,2**
200	84,0	*0,0*	84,0	84,1	**0,1**
250	84,0	*0,0*	84,0	84,1	**0,1**
315	84,0	*0,0*	84,0	84,1	**0,1**
400	84,0	*0,0*	84,1	84,1	**0,0**
500	84,0	*0,0*	84,0	84,0	**0,0**
630	84,0	*0,0*	84,1	84,3	**0,2**
800	84,1	*0,0*	84,1	84,3	**0,2**
1000	84,0	*0,0*	84,0	84,2	**0,2**
1250	84,0	*0,0*	84,0	84,1	**0,1**
1600	84,0	*-0,1*	83,9	83,9	**0,0**
2000	84,0	*-0,2*	83,9	84,1	**0,2**
2500	84,0	*-0,3*	83,7	83,3	**-0,4**
3150	84,0	*-0,5*	83,5	83,5	**0,0**
4000	84,0	*-0,8*	83,2	83,2	**0,0**
5000	84,0	*-1,3*	82,8	82,9	**0,1**
6300	84,1	*-2,0*	82,1	81,9	**-0,2**
8000	84,1	*-3,0*	81,0	81,3	**0,3**
10000	84,1	*-4,4*	79,7	80,3	**0,6**
12500	84,1	*-6,2*	77,9	78,6	**0,7**
16000	84,1	*-8,6*	75,5	77,1	**1,6**
20000	84,1	*-11,3*	72,8	74,2	**1,4**

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9.64 Calibration certificate of noise level meter (page 7)

Seite 7 zum Kalibrierschein vom 27.09.2017
Page *of calibration certificate dated*

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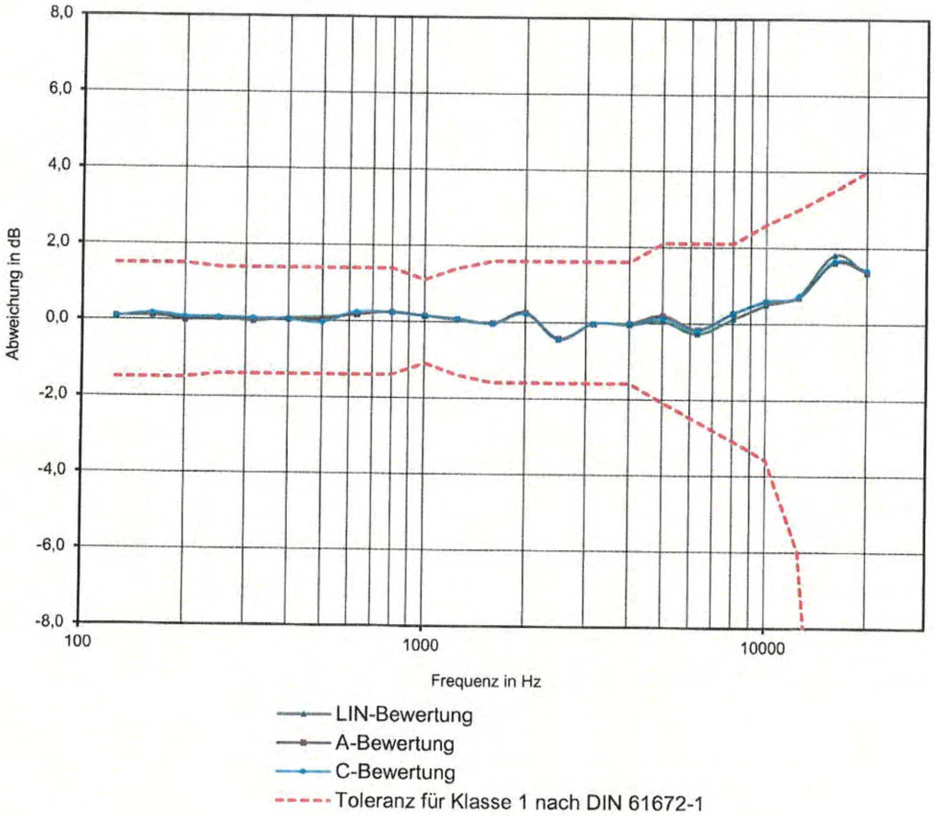
7.5 Anzeigeabweichung im Frequenzbereich 125 Hz bis 20 kHz



7.6 Konformität

Die ermittelten Kennwerte liegen innerhalb der für Klasse 1 nach 61672-1 festgelegten Grenzwerte. Die **Konformität mit DIN EN 61672-1 ist** für die im Kalibrierschein ermittelten Kennwerte **gegeben**.

"DK17-5102/7"

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9.65 Calibration certificate of anemometer (page 1)

DEUTSCHE WINDGUARD

Deutsche WindGuard Wind Tunnel Services GmbH

IECRE and MEASNET approved test laboratory

accredited by the / *akkreditiert durch die*

Deutsche Akkreditierungsstelle GmbH

as calibration laboratory in the / *als Kalibrierlaboratorium im*

Deutschen Kalibrierdienst DKD

DAkkS Deutsche Akkreditierungsstelle D-K-15140-01-00

Calibration certificate
Kalibrierschein

Calibration mark
Kalibrierzeichen

1823138
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09/2018

Object *Gegenstand*	2D Sonic Anemometer
Manufacturer *Hersteller*	Thies Clima D-37083 Göttingen
Type *Typ*	4.9201.00.000
Serial number *Fabrikat/Serien-Nr.*	06160031
Customer *Auftraggeber*	GL Garrad Hassan D-25709 Kaiser-Wilhelm-Koog
Order No. *Auftragsnummer*	PO19194/CC102372/Mdf/AZm
Project No. *Projektnummer*	VT180883
Number of pages *Anzahl der Seiten*	5
Date of Calibration *Datum der Kalibrierung*	26.09.2018

This calibration certificate documents the traceability to national standards, which realize the units of measurement according to the International System of Units (SI).
The DAkkS is signatory to the multilateral agreements of the European co-operation for Accreditation (EA) and of the International Laboratory Accreditation Cooperation (ILAC) for the mutual recognition of calibration certificates.
The user is obliged to have the object recalibrated at appropriate intervals.
Dieser Kalibrierschein dokumentiert die Rückführung auf nationale Normale zur Darstellung der Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI).
Die DAkkS ist Unterzeichner der multilateralen Übereinkommen der European co-operation for Accreditation (EA) und der International Laboratory Accreditation Cooperation (ILAC) zur gegenseitigen Anerkennung der Kalibrierscheine.
Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich.

Date *Datum*	Head of the calibration laboratory *Leiter des Kalibrierlaboratoriums*	Person in charge *Bearbeiter*
26.09.2018	Dipl. Phys. Dieter Westermann	Kai Schuster, B. Eng.

9.66 Calibration certificate of anemometer (page 2)

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Calibration object *Kalibriergegenstand*	2D Sonic Anemometer	
Calibration procedure *Kalibrierverfahren*	IEC 61400-12-1:2017	
Place of calibration *Ort der Kalibrierung*	Wind tunnel of Deutsche WindGuard WindTunnel Services GmbH, Varel	
Test conditions *Messbedingungen*	wind tunnel area	10000 cm²
	anemometer frontal area	340 cm²
	diameter of mounting pipe	48.0 mm EN 10217
	blockage ratio [1)]	0.034 [-]
	software version	P_7.8.05

[1)] Due to the special construction of the test section no blockage correction is necessary.

Ambient conditions *Umgebungsbedingungen*	air temperature	23.1 °C ± 0.1 °C
	air pressure	1028.8 hPa ± 0.3 hPa
	relative air humidity	42.9 % ± 2.0 %

Measurement uncertainty
Messunsicherheit

The expanded uncertainty assigned to the measurement results is obtained by multiplying the standard uncertainty by the coverage factor k=2. It has been determined in accordance with DAkkS-DKD-3. The value of the measurand lies within the assigned range of values with a probability of 95%.
The reference flow speed measurement is traceable to the German NMI (Physikalisch-Technische Bundesanstalt) standard for flow speed. It is realized by using a PTB owned and calibrated Laser Doppler Anemometer (Standard Uncertainty 0.2 %, k=2)

Additional remarks
Zusätzliche Anmerkungen

Orientation: 0°

9.67 Calibration certificate of anemometer (page 3)

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Calibration result
Kalibrierergebnis

Reference Air velocity m/s	Reference Unc m/s	Test item Speed m/s	Test item Direction deg
3.943	0.05	3.959	359.794
6.001	0.05	6.014	360.000
7.958	0.05	7.960	360.000
9.879	0.05	9.903	360.000
11.949	0.05	12.001	360.000
13.916	0.05	13.956	360.000
15.937	0.05	15.982	360.000
14.912	0.05	14.954	360.000
12.912	0.05	12.954	360.000
10.904	0.05	10.941	360.000
8.914	0.05	8.936	360.000
7.016	0.05	7.017	360.000
5.026	0.05	5.019	359.975

Statistical analysis		
	Slope	0.99580 (m/s)/(m/s) ±0.00079 (m/s)/(m/s)
	Offset	0.0168 m/s ±0.008 m/s
	Standard error (Y)	0.011 m/s
	Correlation coefficient	0.999997

Remarks

The calibrated sensor complies with the demanded linearity of MEASNET

Deutsche WindGuard Wind Tunnel Services GmbH measnet

Deutsche WindGuard
Wind Tunnel Services GmbH, Varel

DEUTSCHE WINDGUARD

9.68 Calibration certificate of anemometer (page 4)

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Graphical representation of the result
Grafische Darstellung des Ergebnisses

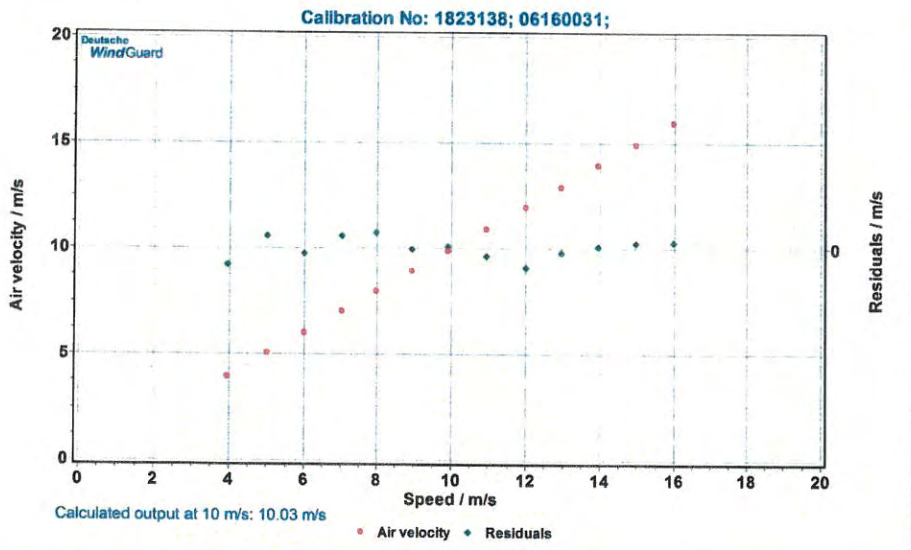
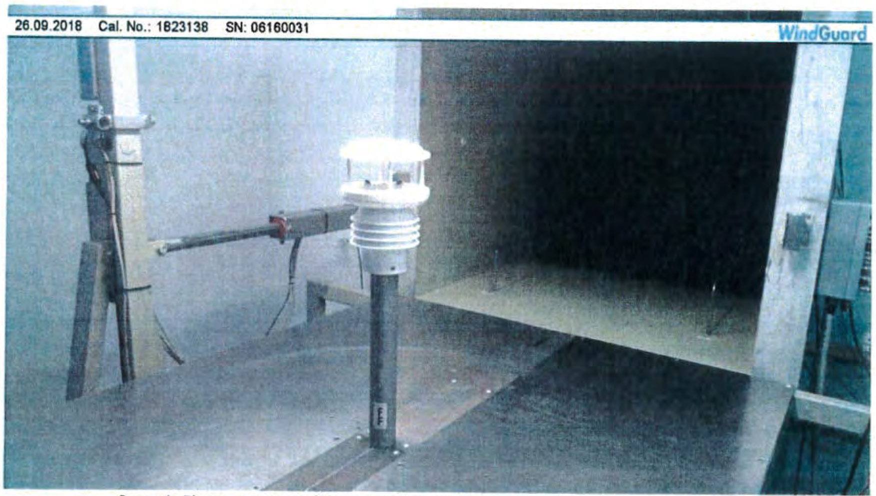


Photo of the measurement setup
Foto des Messaufbaus



Remark: The proportions of the set-up may not be true to scale due to imaging geometry.

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9.69 Calibration certificate of anemometer (page 5)

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Sensor config during calibration
Sensorkonfiguration während der Kalibrierung

00AB80106	00OS00000
00AH00100	00PE00016
00AL00120	00PH00260
00AM00001	00PN00002
00AO00001	00PT00010
00AP00100	00PW00060
00AQ00100	00RD00005
00AR00060	00RT00000
00AT14060	00SH00000
00AV00010	00SM00000
00BO00000	00SN06160031
00BP00008	00ST00001
00BR00096	00SV00401
00BT00000	00TA920100000
00CI00000	00TT00002
00DM00001	00TZ00000
00DO00001	
00DT00000	
00EI00000	
00ET00030	
00HC00010	
00HH00000	
00HP00010	
00HS00001	
00HT00000	
00ID00000	
00II00000	
00KY00000	
00MC00000	
00NC00000	
00OL12789	
00OP00000	
00OR01000	

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DEUTSCHE WINDGUARD

9.70 Extract of the calibration certificate of secondary wind screen

DNV·GL

Extract of the test report GLGH 4286 11 07555 000-C-0075-A

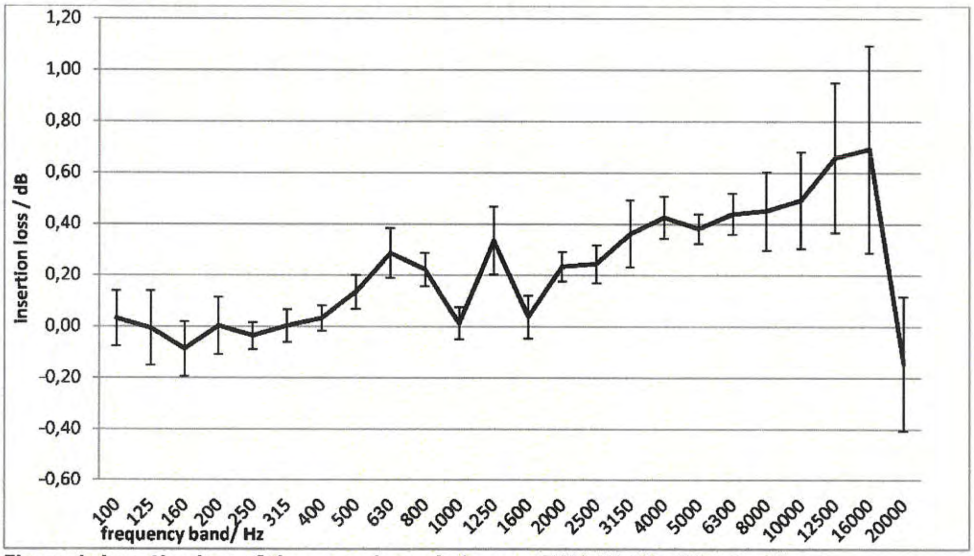


Figure 1: insertion loss of the secondary windscreen EWS-15-10 without optional weatherproof cover (mean and standard deviation of 12 individual measurements)

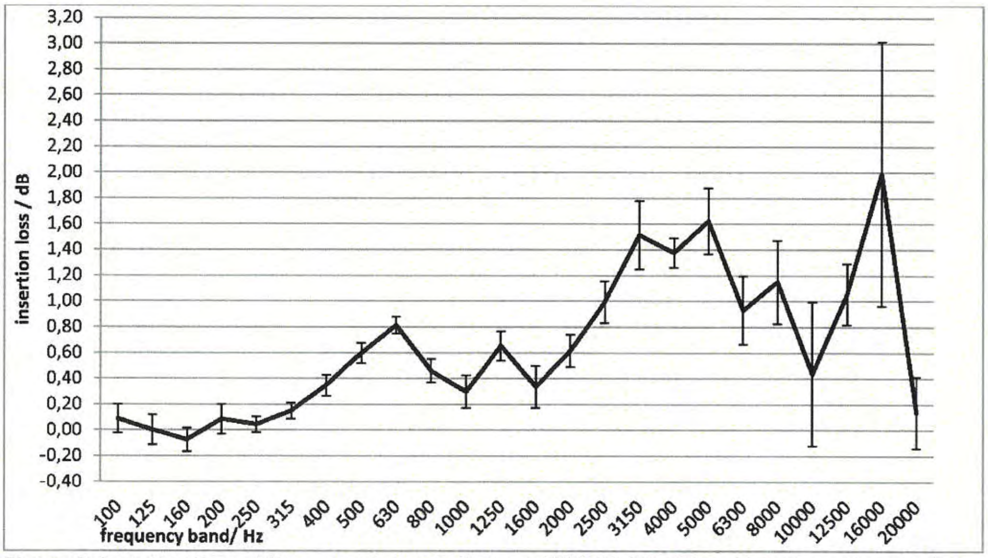
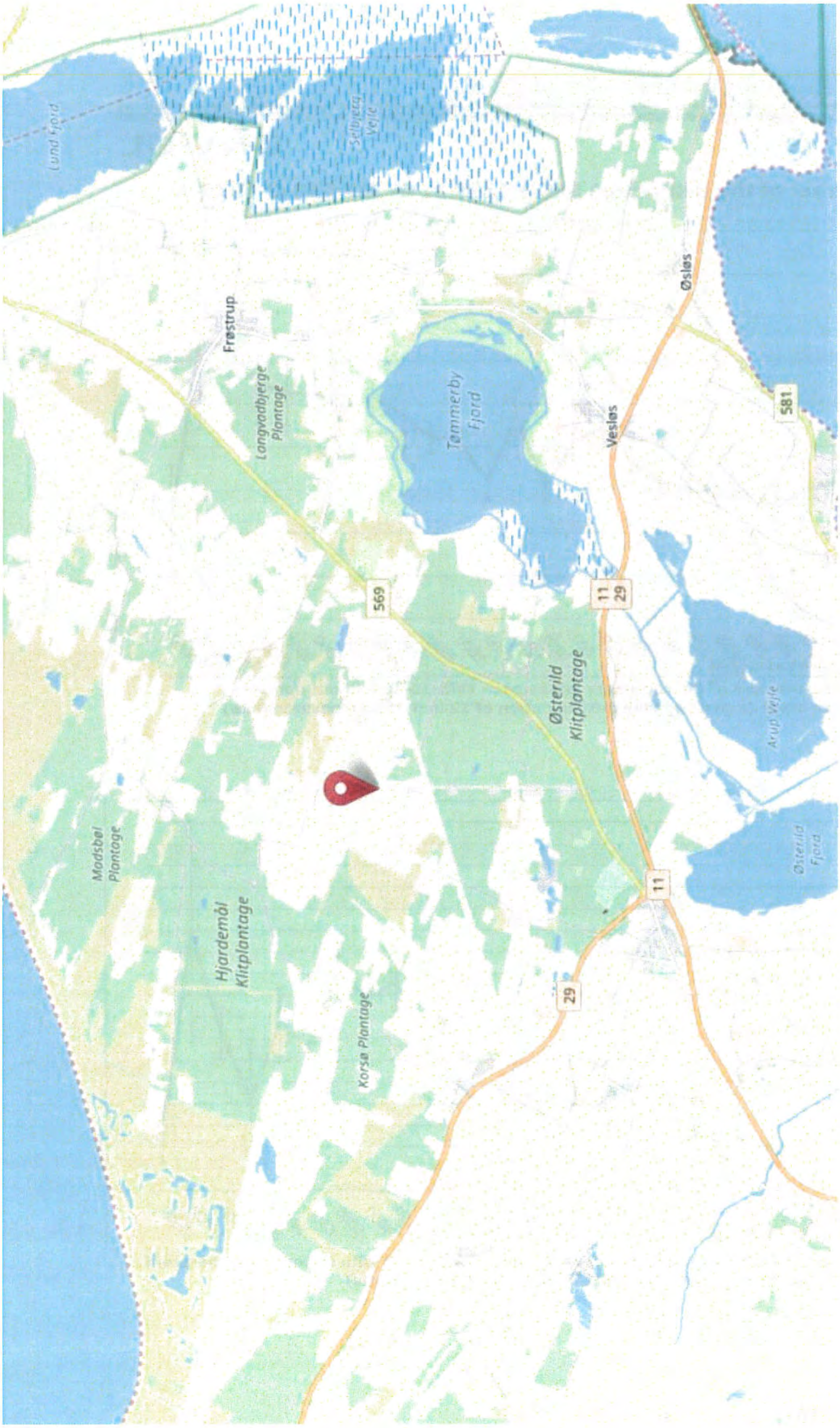


Figure 2: insertion loss of the secondary windscreen EWS-15-10 with optional weatherproof cover (mean and standard deviation of 12 individual measurements)

9.71 Position of the test site

Source: www.openstreetmap.org



9.72 Photos

Photo 1: Measured turbine of the type Vestas V150-4.2 MW 50 Hz

Photo 2: Photo from the wind met mast toward the turbine

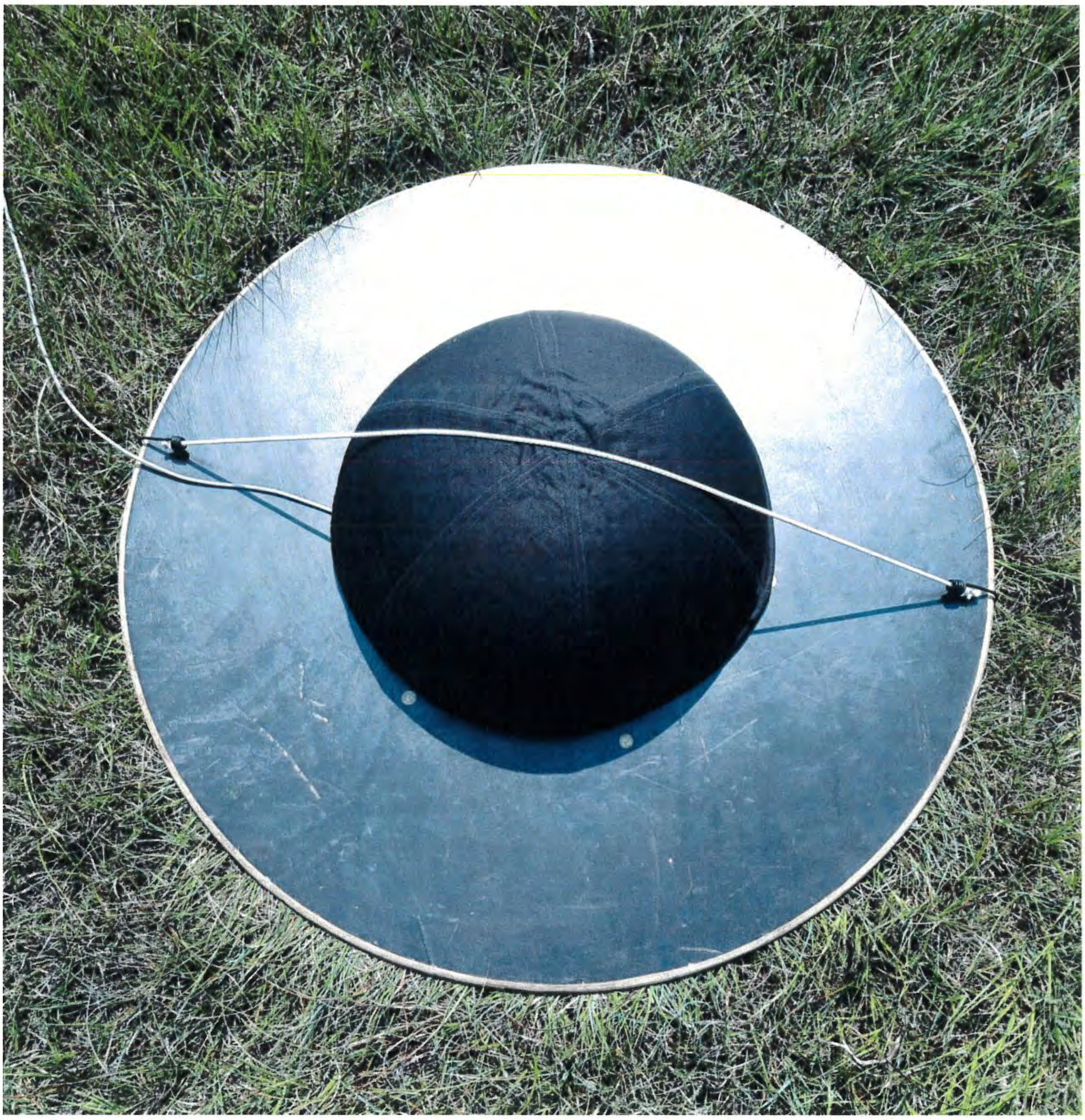


Photo 3: Photo from microphone and board

About DNV GL

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our professionals are dedicated to helping our customers make the world safer, smarter and greener