Attachment C

Turbine Specifications

WINDTEST

Kaiser-Wilhelm-Koog GmbH

Report of acoustical emissions of a Siemens wind turbine generator system of the type 2.3 MW Mk II near Høvsøre in Denmark

Date(s) of measurements: 2005-08-11 to 13

September 2005

Report WT 4498/05

Laboratory accredited by DAP Deutsches Akkreditierungssystem Prüfwesen according to DIN EN ISO/IEC 17025. This accreditation is valid for the test and measurement procedures given in the certificate.

Deutscher Akkreditierungs Rat

DAP-PL-1556.00

WINDTEST
Kaiser-Wilhelm-Koog GmbH

Report of acoustical emissions of a Siemens wind turbine generator system of the type 2.3 MW Mk II near Høvsøre in Denmark

Report WT 4498/05

Site or measuring place:	Høvsøre, Denmark in the region of Ringkøbing

Customer:	Siemens Wind Power A/S Borupvej 16 7330 Brande, Denmark

Contractor:	WINDTEST Kaiser-Wilhelm-Koog GmbH Sommerdeich 14 b 25709 Kaiser-Wilhelm-Koog, Germany

Date of order:	2005-08-23	Order No.:	4025 05 03069 64

Engineer:	Checked:
Dipl.-Ing. A. Jensen	Dipl.-Ing. J. Neubert Acoustics Group Leader

Kaiser-Wilhelm-Koog, 2005-09-08

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1 Scope

The order from Siemens Wind Power A/S dated 2005-08-23 required WINDTEST Kaiser-Wilhelm-Koog GmbH (WINDTEST) to carry out acoustic noise measurements on the Siemens wind turbine generator system (WTGS or 'turbine') 2.3 MW Mk II of hub height 80 m near Høvsøre, in the region of Ringkøbing in Denmark. From this, the sound power level, relevant for noise propagation calculations, of the noise emitted from the turbine at different wind speeds, and frequency spectra of the same, was also to be determined.

The results given in this report relate only to this WTGS.

2 Method

2.1 Measurement procedures

All measurements and analysis described in this report were done in accordance with the IEC 61400-11: Wind turbine generator systems – Part 11: Acoustic noise measurement techniques, Ed. 2 [IEC 61400-11] using Method 1 as outlined in 7.3.1.1 "Method 1: determination of the wind speed from the electric output and the power curve". In this report the sound power level and the tonality are given in the range of wind speeds from 6 to 10 $^m/_s$ at a height of 10 m.

Note: A calculated 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.

2.2 Measurement object

Table 1 shows the characteristics of the measured WTGS. The remaining characteristics can be found in the manufacturer's certificate included in the Annex.

Table 1: Characteristics of the measured WTGS

parameter	Value
manufacturer	Siemens Wind Power A/S
type	2.3 MW Mk II
WTGS No.	2300439
site	Høvsøre, Denmark
hub-height above ground	80 m
rotor diameter	92,4 m
distance middle of tower to middle of blade flange	3,5 m
power control (pitch/stall)	pitch

2.3 Course of the measurements

The total measurement period lasted from 2005-08-12 15:00 h until 2005-08-13 20:00 h. During this time the measured wind speed ranged from 5,5 to 12 m/s at a height of 10 m. The real electrical power output of the turbine ranged between 300 and 2300 kW. The turbine was running continuously during the operating noise measurements.

The sound pressure level was recorded with a microphone on an acoustically hard board. The real electrical power output and the wind speed at a height of 10 m, taken upwind of the turbine in clear air, were also recorded. Time periods, where there were intermittent background noise of a significant nature, e.g. passing cars, planes flying over, rain etc., were marked accordingly during the measurements, and were 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 DAT-recording was done.

The wind turbine generator system is sited in farmland. The surface roughness length for this measurement is assumed to be 0.05 m. 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 2 were prevailing.

Table 2: Prevailing meteorological conditions during the measurements

barometric pressure at 2 m height above ground [hPa]	*1001 - 1006*
air temperature at 2 m height above ground [°C]	*14 - 18*
prevailing wind direction	*WNW*
range of wind direction	*280 - 330*
weather conditions	*cloudy and dry*
Turbulence intensity at 10 m height above ground [%]	*14,0*

2.4 Measuring equipment

The measuring equipment used is listed in the Annex. This equipment is tested regularly according to [IEC 61400-11] to ensure a high degree of measurement accuracy as well as security of data. The complete acoustic measurement system was checked before and after the measurements using an acoustic calibrator (B&K 4231).

2.5 Position of microphone

The microphone was placed according to [IEC 61400-11]. The distance from the turbine to the reference measuring point, R_0 = 112 m, was chosen taking local circumstances into account. The height of the microphone with respect to the bottom of the turbine foundation was 0 m.

3 Measurement results

3.1 Determination of directivity

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

3.2 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 at a height of 10 m, WS, and the real power output of the turbine, P_w, all recorded by the measurement system, is plotted against time in a graph given in the Annex. Here it can be seen at which points in time the turbine is switched on and off and provides an overview of the background noise in relation to the operating noise recorded by the measurement system over the whole period of the measurement. As can be seen, data was captured continuously throughout the whole measurement period. 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 running and when it is stopped. *State = 3* depicts a running turbine, *state = 0.5* depicts a stopped turbine, and *state = 0* marks the data to be omitted in the evaluation.

The noise produced by the turbine alone $L_{Aeq,c}$ at wind speeds of 6, 7, 8, 9 and 10 m/s is then determined by converting the dB levels of background and in-service noise to intensities, performing a subtraction and converting back again to dB. In order to determine this, regression curves of the measured sound pressure level with the turbine both running and stopped, plotted with respect to the standardised wind speed at a height of 10 m are required. The wind speed measured during the background noise measurement is multiplied by the factor κ, which is defined as the following:

$$\kappa = \frac{V_s}{V_z}$$

where,

V_s is the standardised wind speed

V_z is the measured wind speed.

For this measurement, κ = 0,93.

The results of this regression analysis are given in the Annex. All relevant sound pressure level values are given in the annex.

Remark: The data have been analysed using a fourth order regression because this is the best fitting approximation through all the relevant data points. In accordance with [IEC 61400-11] the data have also been analysed using a second order regression which is given in the annex only for information purposes. The sound levels resulting from the higher order regression have been applied in the third octave analysis.

3.3 Sound power level of the turbine

In accordance with [IEC 61400-11] the sound power level $L_{WA,k}$ of the turbine in dB is derived from the corrected sound pressure level $L_{Aeq,c,k}$, at wind speeds between 6 and 10 m/s at a height of 10 m, using the following formula:

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

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

$10 \cdot \lg\left(\frac{4 \cdot \pi \cdot R_1^2}{S_0}\right)$ = 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 m²

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

R_0 = distance between tower centre and microphone position

d = distance between tower centre and rotor flange middle point

H = hub-height above ground level

h_A = height of microphone

The following results are given in the Annex:

- A graph showing regressions through all the measured wind turbine sound data L_{Aeq} and background noise data L_n.
- A plot of the background corrected normalised values of L_{WA} against the standardised wind speed.
- A plot of L_{Aeq} and L_n against measured wind speed.
- A plot of L_{Aeq} against power.
- A plot of rotor speed against power.
- A time plot of the measurement.

For the Siemens 2.3 MW Mk II in the present configuration the real power output and the apparent sound power levels are given in table 4.

3.4 Tonal and frequency analyses

In accordance with the technical guideline [IEC 61400-11] a tonal analysis has to be carried out. The frequency spectrum of the noise, which is measured on the acoustically hard board, is determined on the basis of a narrow band analysis by means of the FFT-analyser B&K 2144. This analysis was performed after the measurements using the audio signal recorded on a DAT-recorder.

The results of the tonal analysis of the Siemens 2.3 MW Mk II according to [IEC 61400-11] are given in table 4.

3.5 3rd octave analysis

The A-weighted sound spectra at all the integer wind speeds are given in the Annex.

3.6 Uncertainties

3.6.1 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. For these measurements all the type B measurement uncertainty components as specified in the technical guideline [IEC 61400-11] are given in Table 3. 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:

$$U = \frac{a}{\sqrt{3}}$$

Table 3: Type B measurement uncertainty components

Component	**Range [dB]**	**Uncertainty [dB]**
Calibration, U_{B1}	±0,2	0,12
Chain of acoustic measurement instruments, U_{B2}	±0,4	0,23
Acoustically hard board, U_{B3}	±0,5	0,29
Distance measurement, U_{B4}	±0,1	0,06
Acoustic impedance of air, U_{B5}	±0,2	0,12
Meteorological variation (including turbulence), U_{B6}	±0,7	0,40
Wind speed derived from the power curve, U_{B7}	±0,3	0,17
Wind direction, U_{B8}	±0,5	0,29
$\sum_{i=1}^{8} U_{Bi}^2$		0,44

The error in the background correction U_{B9} in dB has been calculated for each integer wind speed as follows:

$$U_{B9} = L_{Aeq,c,k} - \left[10 \cdot \log\left(10^{0,1 \cdot L_{Aeq,k}} - 10^{0,1(L_n + U_{HG})}\right)\right]$$

where U_{HG} is the error in the background noise in dB defined as follows:

$$U_{HG} = \sqrt{\frac{(y_n - y_{n,est})^2}{N_n - 2}}$$

where:

y_n = measured sound pressure level of background noise in dB

$y_{n,est}$ = estimated sound pressure level of background noise from the regression analysis in dB

N_n = number of background noise measurement values in the wind speed bin corresponding to the integer wind speed.

The combined measurement uncertainty U_C relating to the sound power level $L_{WA,k}$ is calculated as follows:

$$U_C = \sqrt{U_A^2 + U_{B9}^2 + \sum_{i=1}^{8} U_{Bi}^2}$$

where:

$$U_A = \sqrt{\frac{\sum(y - y_{est})^2}{N - 2}}$$

where:

y = measured sound pressure level of total noise (operating plus background) in dB

y_{est} = estimated sound pressure level of total noise from the regression analysis in dB

N = number of total noise measurement values in the wind speed bin corresponding to the integer wind speed.

All values for U_A, U_{B9} and U_C are given in the annex.

3.6.2 One-third octave band spectra

The uncertainty in the one-third octave band spectra is given in the Annex for all the third octave bands.

3.6.3 Tonality

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

4 Summary

As ordered by Siemens Wind Power A/S, 7330 Brande, Denmark, WINDTEST Kaiser-Wilhelm-Koog GmbH took measurements of the acoustic noise emissions on the Siemens WTGS 2.3 MW Mk II with a hub height of 80 m.

All measurements and analyses of the sound power level and tonality described in this report were made on the basis of the technical guideline [IEC 61400-11]. The analysis of the sound power level was carried out using the standardised wind speed which was calculated from the power curve provided by the customer (see Annex).

The data on the Siemens WTGS 2.3 MW Mk II have been evaluated by using a fourth order regression because this is the best fitting approximation over all relevant points.

The results of this measurement are given in table 4.

Table 4: Summary of results

wind speed in 10 m height [m/s]	***6***	***7***	***8***	***9***	***10***
electrical power output calculated from the power curve [kW]	*1049*	*1651*	*2106*	*2260*	*2295*
measured pitch angle [degrees]	*-0,8*	*-0,8*	*-0,8*	*0*	*>1*
measured rotor speed [min^{-1}]	*15,1*	*15,3*	*15,4*	*15,8*	*16,0*
sound power level [dB]	*103,4*	*104,9*	*105,1*	*105,0*	*105,0*
combined uncertainty in the sound power level, U_C [dB]	*1,2*	*1,1*	*1,2*	*1,3*	*1,3*
tonality, ΔL_k [dB]	*-5,58*	*-4,68*	*-6,36*	*-5,43*	*-5,91*
tonal audibility, $\Delta L_{a,k}$ [dB]	*-2,58*	*-1,69*	*-3,36*	*-2,43*	*-3,58*
frequency of the most prevalent tone [Hz]	*1200*	*1200*	*1200*	*1200*	*530*

It is assured that this report has been drawn up impartially in accordance with state-of-the-art science and technology and with best knowledge and conscience.

5 List of employed symbols and abbreviations

d	-	distance from rotor centre to tower axis	m
D	-	rotor diameter	m
$\Delta L_{tn,j,k}$	-	tonality of the 'j th' spectrum at 'k th' wind speed, where j = 1 to 12 and k = 6, 7, 8, 9, 10	dB
ΔL_k	-	energetic average of the 12 $\Delta L_{tn,j,k}$	dB
$\Delta L_{a,k}$	-	tonal audibility	dB
f	-	frequency of the tone	Hz
f_c	-	centre frequency of critical band	Hz
H	-	height of rotor centre (horizontal axis turbine) or height of rotor equatorial plane (vertical axis turbine) above local ground near the wind turbine	m
h_A	-	location point height (in measurement equal to microphone height)	m
κ	-	the ratio between standardised wind speed and measured wind speed	-
L_A or L_C	-	A or C-weighted sound pressure level	dB
$L_{Aeq,k}$	-	equivalent continuous A-weighted sound pressure level, where k = 6, 7, 8, 9, 10	dB
$L_{Aeq,c,k}$	-	equivalent continuous A-weighted sound pressure level corrected for background noise at each integer wind speed and corrected to reference conditions, where k = 6, 7, 8, 9, 10	dB
L_n	-	equivalent continuous sound pressure level level of the background noise	dB
L_p	-	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, where j = 1 to 12 and k = 6, 7, 8, 9, 10	dB
$L_{pn,avg,j,k}$	-	average of analysis bandwidth sound pressure levels of masking noise in the 'j th' spectrum at the 'k th' wind speed, where j = 1 to 12 and k = 6, 7, 8, 9, 10	dB
$L_{pt,j,k}$	-	sound pressure level of the tone or tones in the 'j th' spectrum at the 'k th' wind speed, where j = 1 to 12 and k = 6, 7, 8, 9, 10	dB
L_s	-	equivalent continuous sound pressure level of only wind turbine noise	dB
L_{s+n}	-	equivalent continuous sound pressure level of combined wind turbine and background noise	dB
$L_{WA,k}$	-	apparent sound power level, where k = 6, 7, 8, 9, 10	dB
N	-	Number of measured values	-
P_W	-	effective electrical power	kW
R_0	-	reference distance	m
R_i	-	slant distance from rotor centre to actual measurement position	m
S_0	-	reference area, $S_0 = 1\ m^2$	m
U_A, U_B	-	Uncertainty components	dB
U_C	-	Total uncertainty	dB
U_{HG}		Error in the background noise	dB
V_m	-	derived wind speed from power curve	m/s
V_S	-	standardised wind speed	m/s
WTGS	-	wind turbine generator system	-
y	-	measured sound pressure level of operating plus background noise	dB
y_{est}	-	estimated sound pressure level of operating plus background noise from the regression analysis	dB

6 References

[IEC 61400-11] IEC 61400-11, Wind turbine generator systems - Part 11: Acoustic noise measurement techniques, Ed. 2.

7 Annex

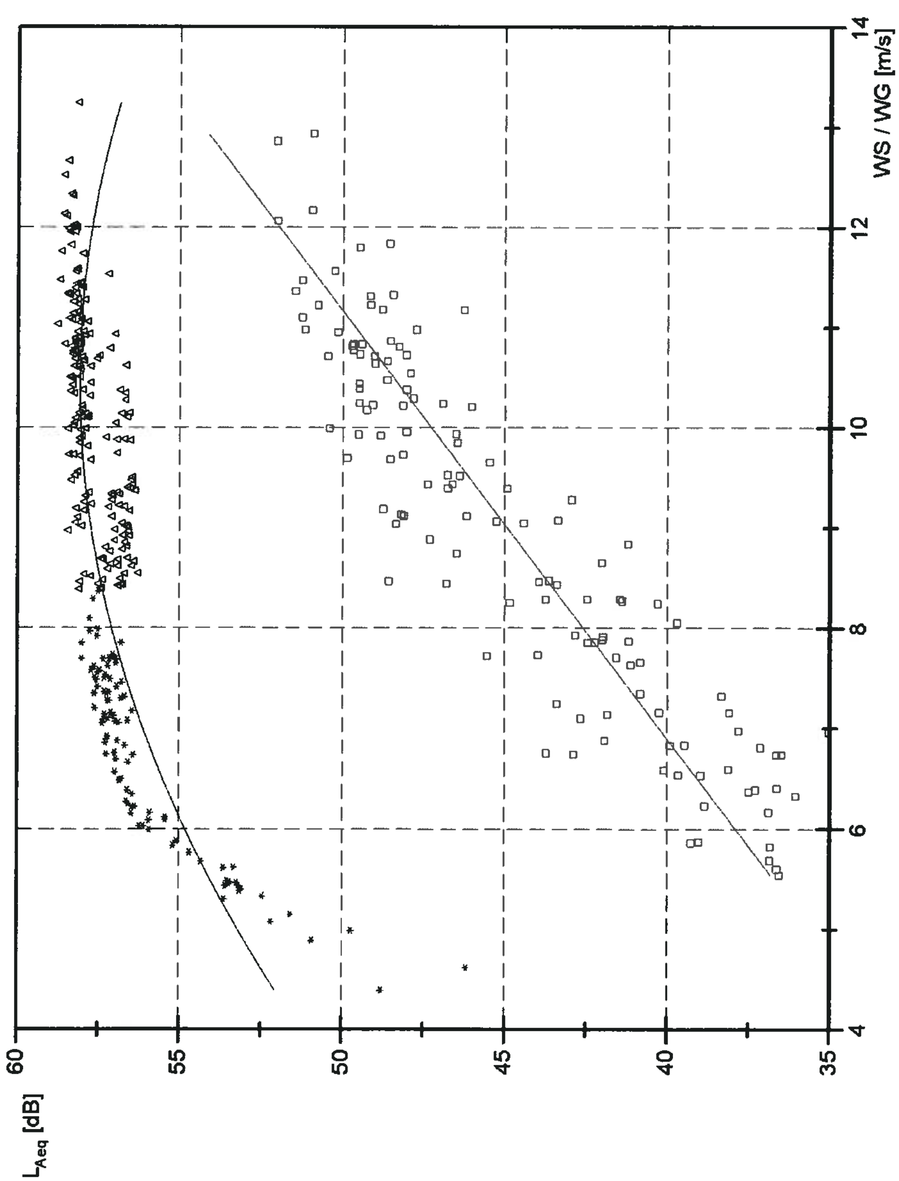
Annex 1: Measuring equipment used

Beschreibung *description*	**Fabrikat** ***supplier***	**Typ/*type***	**WT Nr./Ser.Nr.** ***WT stock number/serial number***	**Kal. am** *cal. on*	**Eichung am** ***standardisation***	**Einsatz** *used*
Akustischer Kalibrator *acoustic calibrator*	Brüel & Kjær	4231	WT 300083004 (2438819)	-	31.12.2006	x
Mikrofon *microphone*	Brüel & Kjær	4188	zu WT 30002904 (2427565)	-	31.12.2006	x
Vorverstärker *preamp.*	Brüel & Kjær	ZC 0030	zu WT 30002904	-	31.12.2006	x
Mikrofonkabel *microphone cable*	Brüel & Kjær	AO 0560	zu WT 30002904	-	31.12.2006	x
Handschallpegelmesser *decibel meter*	Brüel & Kjær	2238	WT 30002904 (2437622)	-	31.12.2006	x
Primärwindschirm *primary wind shield*	Brüel & Kjær	UA 0237	-	-	-	x
Sekundärwindschirm *secondary wind shield*	Delta Acoustics	SIM	-	-	-	
DAT-Rekorder *DAT-recorder*	Sony	TCD-D100	WT 300083304 (541959)	-	-	x
Anemometer *anemometer*	Thies Clima	4.3519.00.000	WT 010041504 (PN 457 0604)	Jun. 04	-	x
Windrichtungsgeber *wind direction sensor*	Thies Clima	4.3129.00.012	WT 020013504 (0504426	-	-	x
Temperaturgeber *temperature sensors*	Heraeus (Logger)	PT100	WT 300084704	Jul. 05	-	x
Temperaturgeber *temperature sensors*	Heraeus (W+W)	PT100	WT 300084604	Jul. 05	-	x
Luftdruckgeber *pressure sensors*	Wilmers Messtechnik (Logger)	0619	WT 090021803	Jul. 05	-	x
Luftdruckgeber *pressure sensors*	Wilmers Messtechnik (W+W)	0619	WT 090022804	Jul. 05	-	x
Leistungsumformer *power transducer*	Metrawatt (DME 1)	SINEAX DME 442	WT 300070903	Jun. 04	-	
Leistungsumformer *power transducer*	Metrawatt (DME 2)	SINEAX DME 442	WT 300055202	Aug. 03	-	
Leistungsumformer *power transducer*	Metrawatt (DME 3)	SINEAX DME 442	WT 300018898	Feb. 05	-	
Leistungsumformer *power transducer*	Metrawatt (DME 4)	SINEAX DME 442	WT 300079804	Feb. 05	-	
Zangenstromwandler *current clamps*	Chauvin Arnoux (DME 1)	D32N	WT 300071603 bis 300071803	Jul. 05	-	
Zangenstromwandler *current clamps*	Chauvin Arnoux (DME 2)	D32N	WT 300053501 bis 300053701	Jul. 05	-	
Zangenstromwandler *current clamps*	Chauvin Arnoux (DME 3)	AmpFLEX A100	WT 300091804 bis 300092004	Jul. 05	-	
Zangenstromwandler *current clamps*	Chauvin Arnoux (DME 4)	AmpFLEX A100	WT 300085804 bis 300086004	Jul. 05	-	
Datenlogger *datalog*	Th. Friedrichs	1020	WT 030013504 (091630)	Jul. 04	-	x
Zweikanal-Echtzeit-Frequenzanalysator *2-channel real time frequency analyser*	Brüel & Kjær	2144	WT 9904897 (1732981)	Sep. 03	-	x
Erfassungs- und Auswertesoftware *data acquisition and analytical software*	GfS Aachen Microsoft DATALOG GmbH	DIAdem 8.1 Excel 2000 Dasy-Lab 7.0	-	-	-	x
Erfassungsrechner *data acquisition Computer*	HP	Compaq nx 9005	WT 400023903 (CNF 3371X4F)	-	-	
Erfassungsrechner *data acquisition Computer*	HP	OmniBook XE3	WT 400021502 (TW 21806701)	-	-	
Erfassungsrechner *data acquisition Computer*	HP	OmniBook XE3	WT 400020802 (TW 21121810)	-	-	
Erfassungsrechner *data acquisition Computer*	HP	Compaq nx 5000	WT 400026604 (CNU43700RT)	-	-	
Erfassungsrechner *data acquisition Computer*	HP	Compaq nx 9005	WT 400024003 (CNF 3371X70)	-	-	
Erfassungsrechner *data acquisition Computer*	HP	Compaq nx 9005	WT 400024103 (CNF 3371X4X)	-	-	x
10 m – Teleskopmast *10 m – telescopic mast*	Clark (SMS 3)	QT 12M/HP	WT 050019003	-	-	x
Unterbrechungsfreie Spannungsversorgung *uninterruptable power supply*	APS	Smart UPS 1000	WT 30009002104	-	-	x

Annex 2.1a: 2nd order regression of L_{Aeq} and L_n against standardised wind speed

exp. factor	ar.factor oper.	ar.factor backgr.
0	4.0228616E+01	2.3825399E+01
1	3.4089624E+00	2.3449583E+00
2	-1.6261043E-01	

WEC oper. / WEA Betrieb: A+B*X+C*X^2
Background / Hintergrund: A+B*X
table 4: regression parameters / Tab. 4: Regressionsparameter



Symbols:

* * $L_{Aeq\ (operating)}$ (WS <= $WS_{95\%\ (10m)}$)

□ □ $L_{n\ (background)}$

△ △ $L_{Aeq\ (operating)}$ (WS > $WS_{95\%\ (10m)}$)

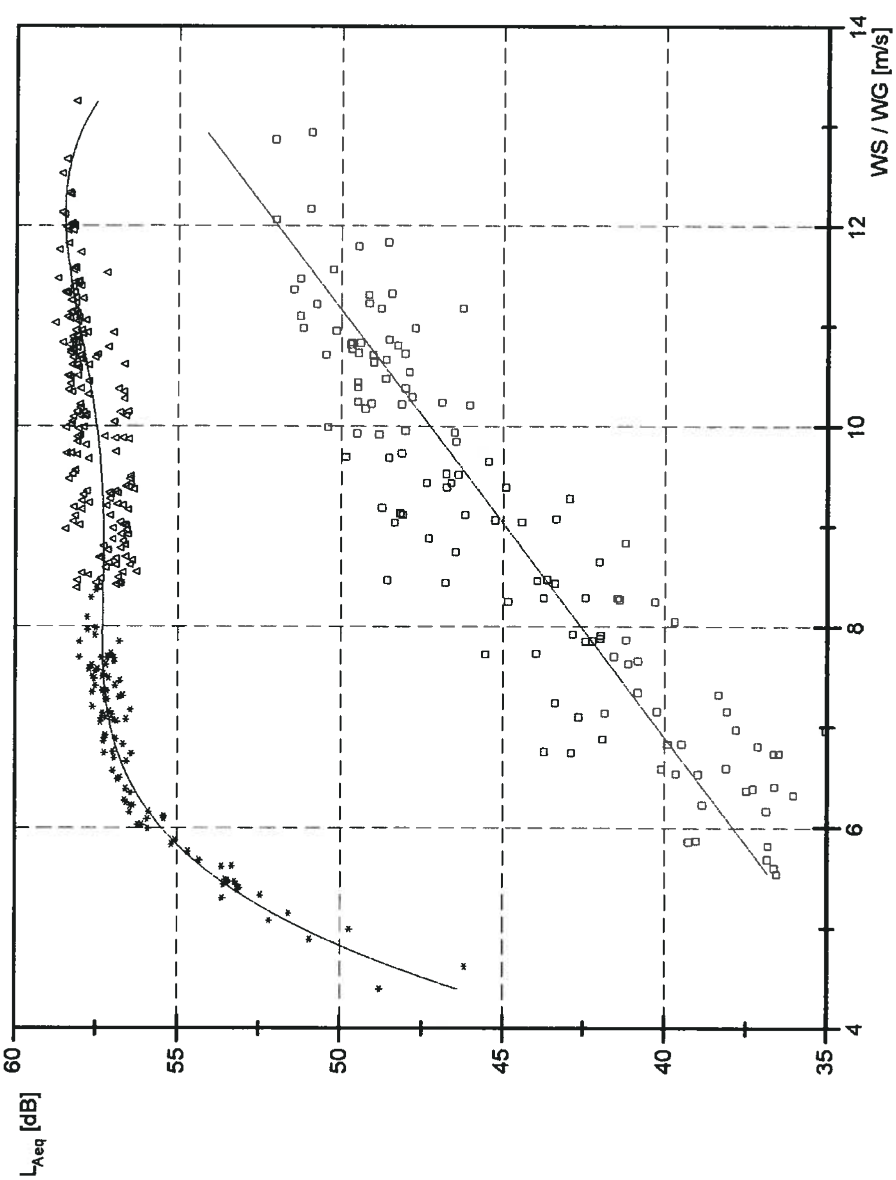
WINDTEST
Kaiser-Wilhelm-Koog GmbH

Siemens 2.3 MW Mk II

L_{Aeq} against wind speed / L_{Aeq} über Windgeschwindigkeit

Site / Standort:	Høvsøre, Denmark
WTGS-SNr./WEA-SNr.:	2300439
Mode / Modus:	Standard Mode 2300
Date of meas. / Messdatum:	2005-08-12/13
Standard / Messung:	IEC 61400-11 Ed. 2
Data base / Datenbasis:	1 Hz sampling
In charge / Bearbeiter:	Dipl.-Ing. Joerg Neubert

Annex 2.1b: Higher order regression of L_{Aeq} and L_n against standardised wind speed



exp. factor	ar.factor oper.	ar.factor backgr.
0	-9.6637770E+01	2.3825399E+01
1	6.6848109E+01	2.3449583E+00
2	-1.0751798E+01	
3	7.5743877E-01	
4	-1.9659184E-02	

WEC oper. / WEA Betrieb: A+B*X+C*X^2+D*X^3+E*X^4
Background / Hintergrund: A+B*X
table 4: regression parameters / Tab. 4: Regressionsparameter

Symbols:

* * $L_{Aeq\ (operating)}$ (WS <= $WS_{95\%\ (10m)}$)
□ □ $L_{n\ (backgound)}$
△ △ $L_{Aeq\ (operating)}$ (WS > $WS_{95\%\ (10m)}$)

Graphic file: D:\temp\Alte\0120_SM2300_IEC60s_Leq_WG_Reg 07.09.2005
Source file: Ite\0120_SM2300_IEC60s_60r_10m_BG_HG_95

WINDTEST
Kaiser-Wilhelm-Koog GmbH

Siemens 2.3 MW Mk II

L_{Aeq} against wind speed / L_{Aeq} über Windgeschwindigkeit

Site / Standort:	Høvsøre, Denmark
WTGS-SNr./WEA-SNr.:	2300439
Mode / Modus:	Standard Mode 2300
Date of meas. / Messdatum:	2005-08-12/13
Standard / Messung:	IEC 61400-11 Ed. 2
Data base / Datenbasis:	1 Hz sampling
In charge / Bearbeiter:	Dipl.-Ing. Joerg Neubert

Annex 2.2: Summary of analysis input parameters and results

Parameters of evaluation / Auswerteparameter :

H = 80.0 m		d = 3.50 m		h_A = 0.0 m		P_{rated} / P_{Nenn} = 2.30 MW	
D = 93.0 m		z_0 = 0.050 m		R_0 = 112.0 m		$WS_{95\%}$ / $WG_{95\%}$ = 11.67 m/s	

Results / Ergebnisse :

$WS_{95\%(10m)}$ / $WG_{95\%(10m)}$ = 8.38 m/s

$Power_{95\%}$ / $Leistung_{95\%}$ = 2.185 MW

Range of the wind direction / Windrichtungsbereich = 284.40° - 325.68°

κ = 0.93

average turbulence intensity / mittlere Turbulenzintensität = 14.0 %

WS_{10m} WG_{10m}	U_A [dB]	U_{B9} [dB]	U_C [dB]
6	0.44	0.04	1.2
7	0.31	0.05	1.1
8	0.41	0.08	1.2
9	0.64	0.14	1.3
10	0.68	0.25	1.3

table 1: uncertainty / Tabelle 1: Messunsicherheiten

WS_{10m} WG_{10m}	$L_{Aeq,k}$ [dB]	L_{backgr} [dB]	$L_{Aeq,c,k}$ [dB]	$L_{WA,k}$ [dB]
6	55.5	37.9	55.4	103.4
7	57.1	40.2	57.0	104.9
8	57.3	42.6	57.2	105.1
9	57.3	44.9	57.0	105.0
10	57.5	47.3	57.1	105.0

table 2: results L = f(WS) / Tabelle 2: Ergebnisse L = f(WG)

$WS_{95\%}$ $WG_{95\%}$	$L_{Aeq,k}$ [dB]	L_{backgr} [dB]	$L_{Aeq,c,k}$ [dB]	$L_{WA,k}$ [dB]
8.38	57.3	43.5	57.1	105.1

table 3: results L = f($WS_{95\%}$) / Tabelle 3: Ergebnisse L = f($WG_{95\%}$)

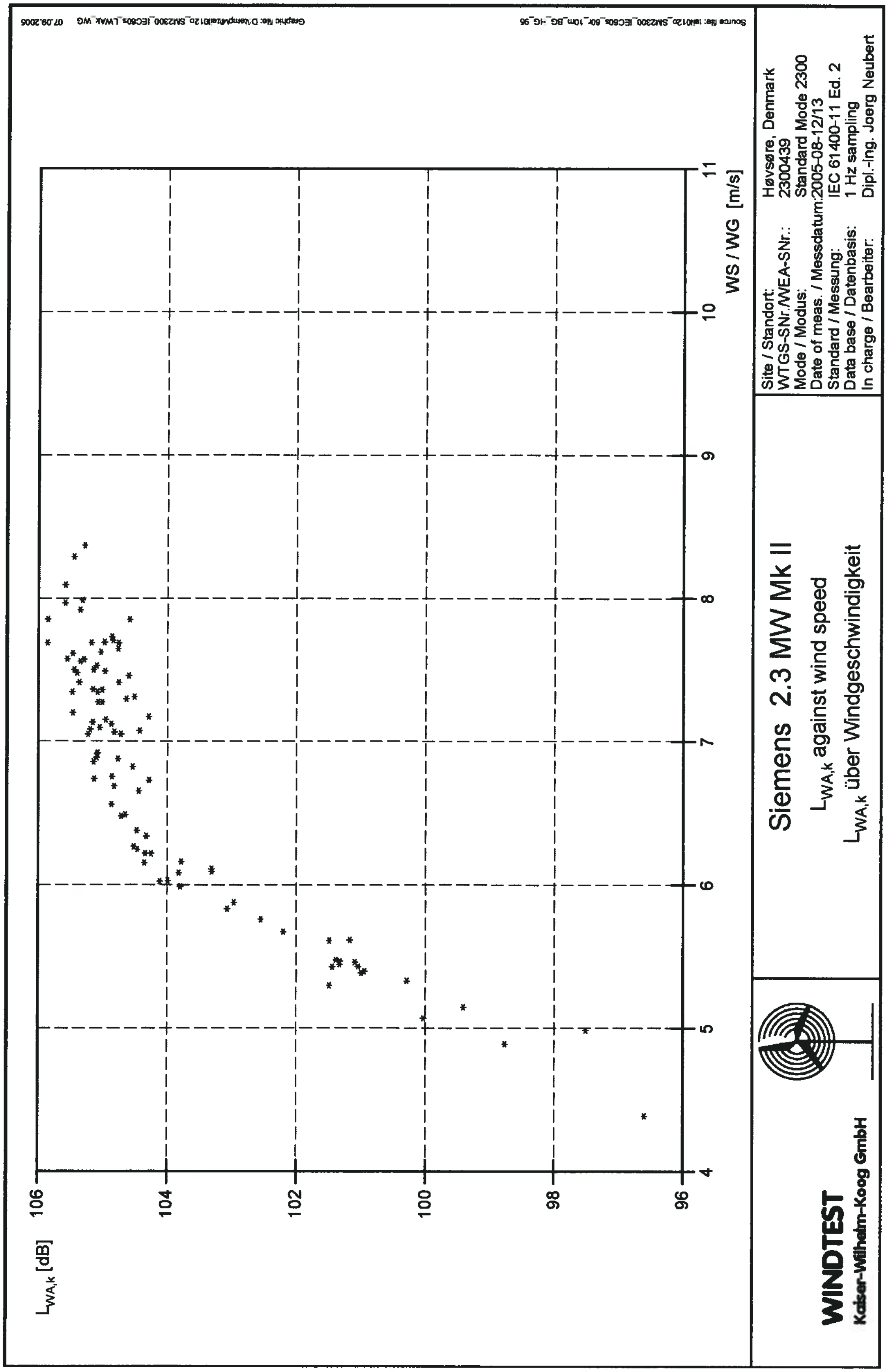
WINDTEST
Kaiser-Wilhelm-Koog GmbH

Siemens 2.3 MW Mk II

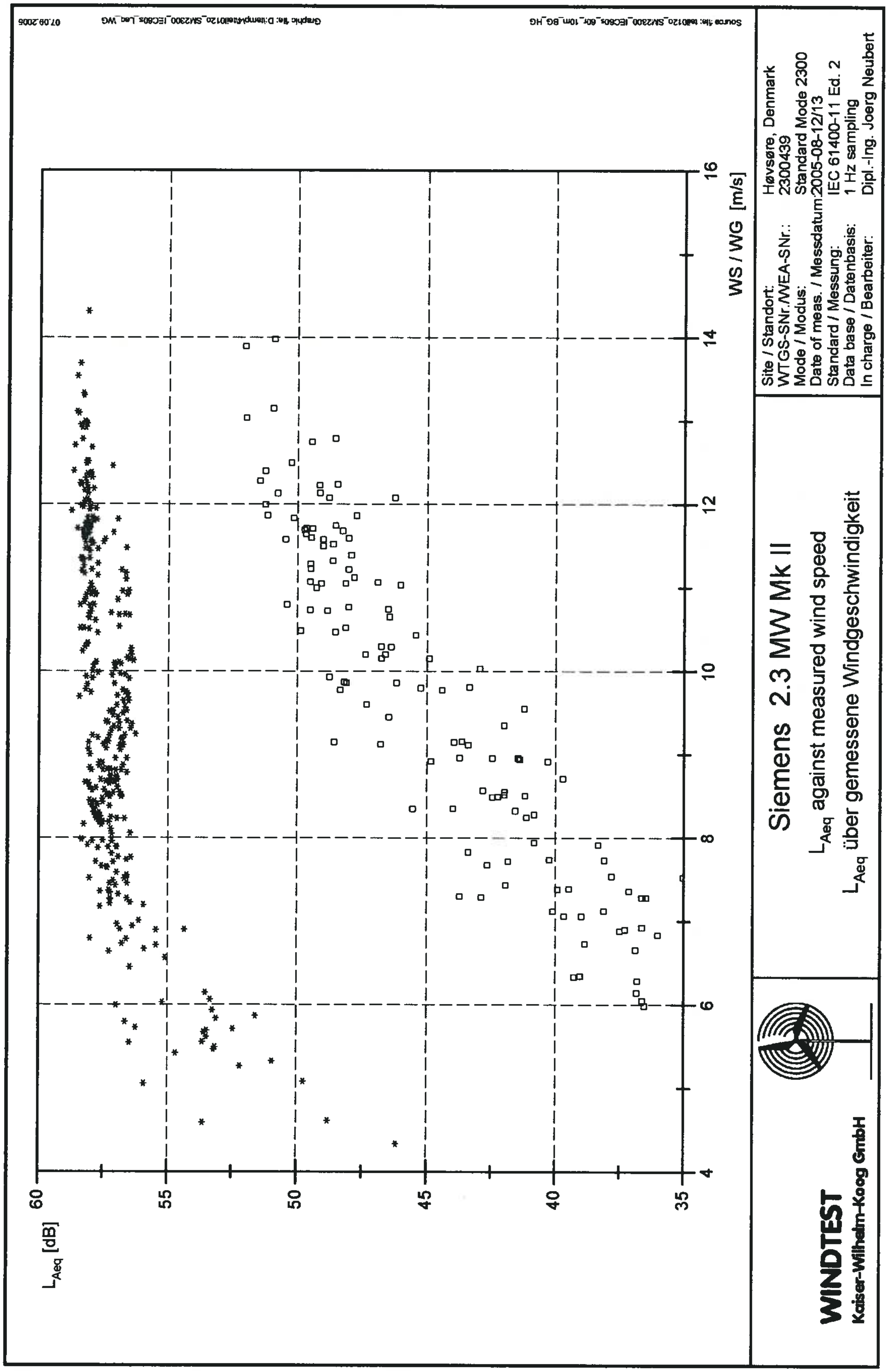
Results / Ergebnisse

Site / Standort:	Høvsøre, Denmark
WTGS-SNr./WEA-SNr.:	2300439
Mode / Modus:	Standard Mode 2300
Date of meas. / Messdatum:	2005-08-12/13
Standard / Messung:	IEC 61400-11 Ed. 2
Data base / Datenbasis:	1 Hz sampling
In charge / Bearbeiter:	Dipl.-Ing. Joerg Neubert

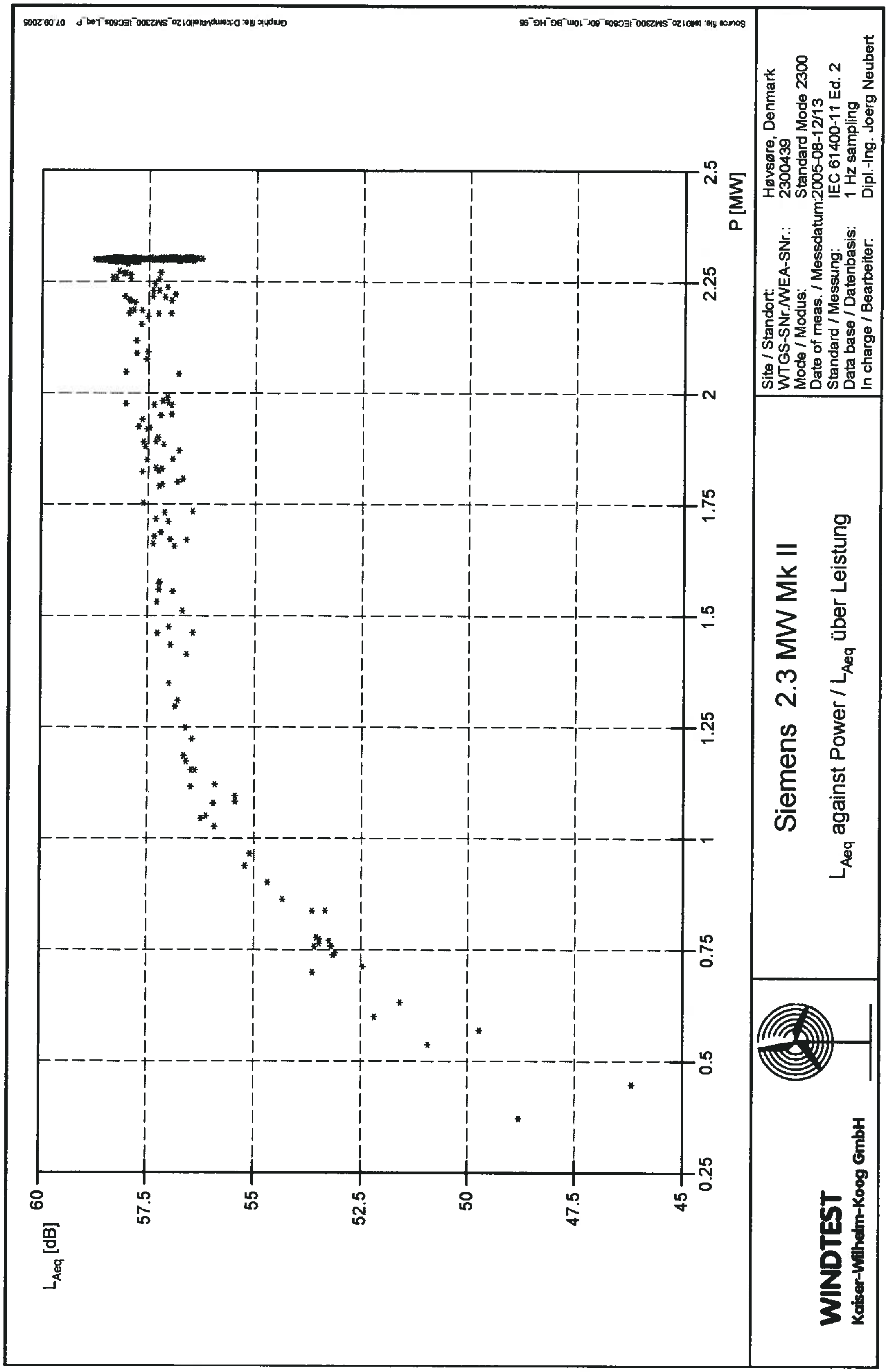
Annex 2.3: Plot of L_{WA} against standardised wind speed



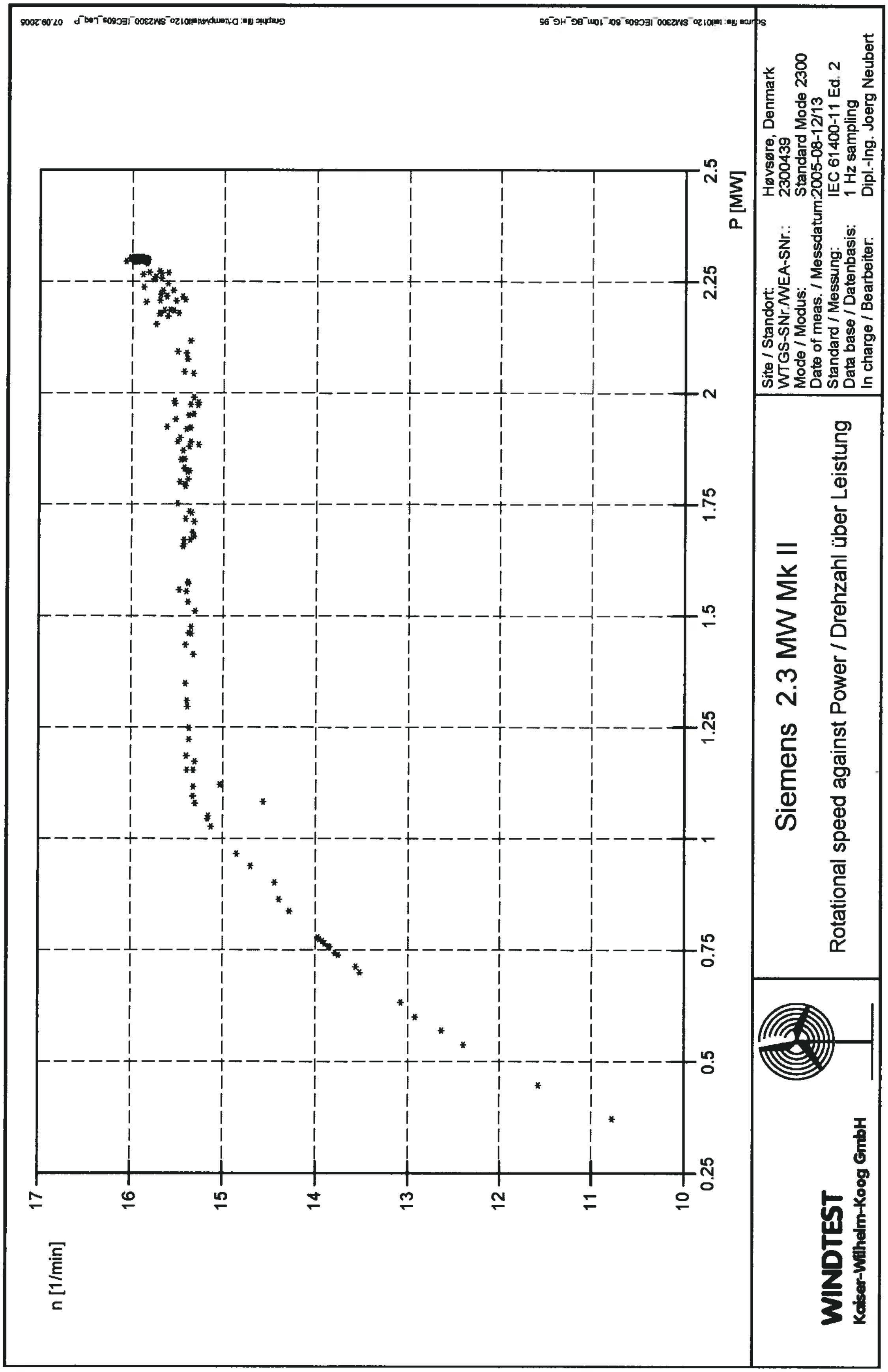
Annex 2.4: Plot of L_{Aeq} and L_n against measured wind speed



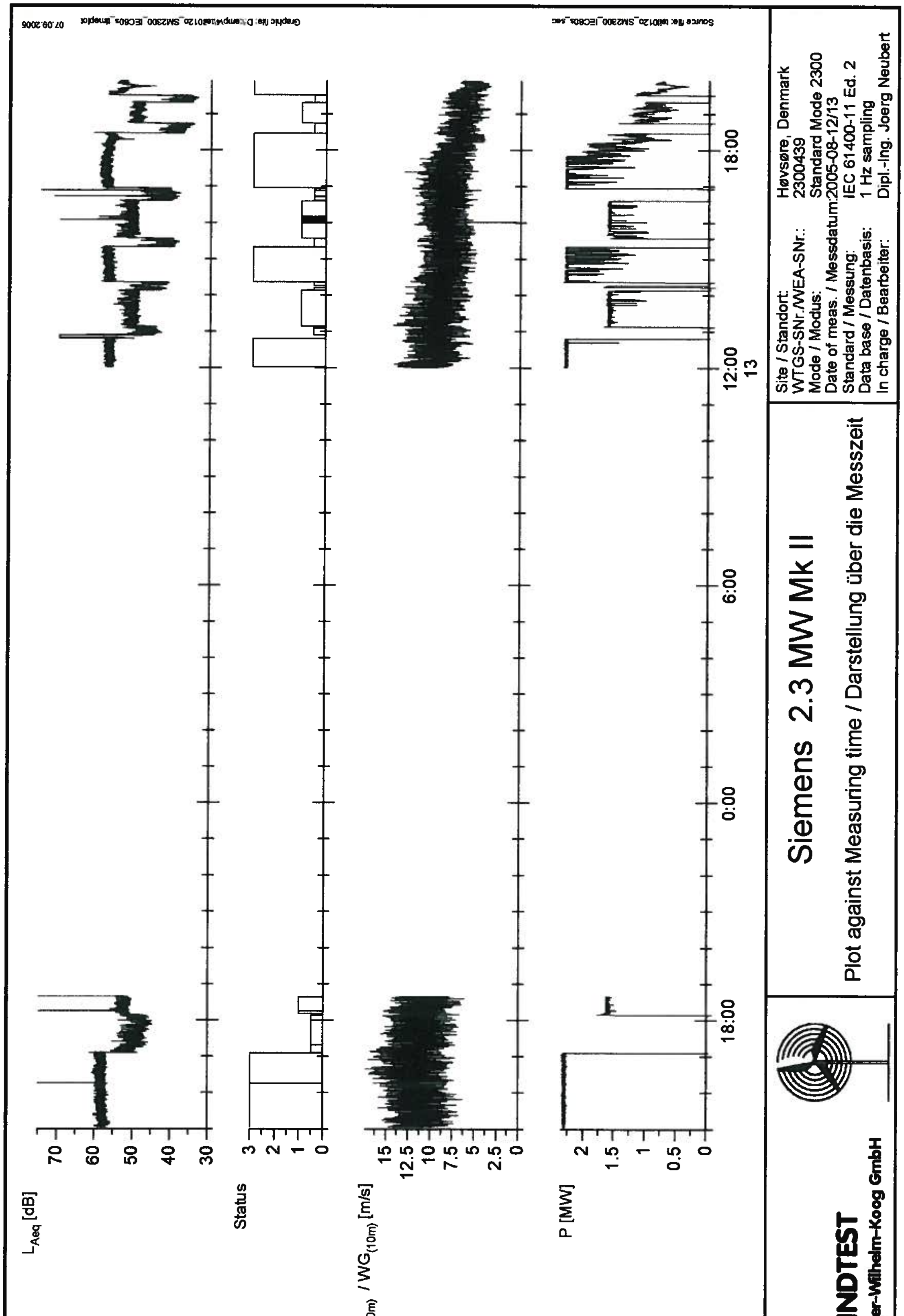
Annex 2.5: Plot of L_{Aeq} against power



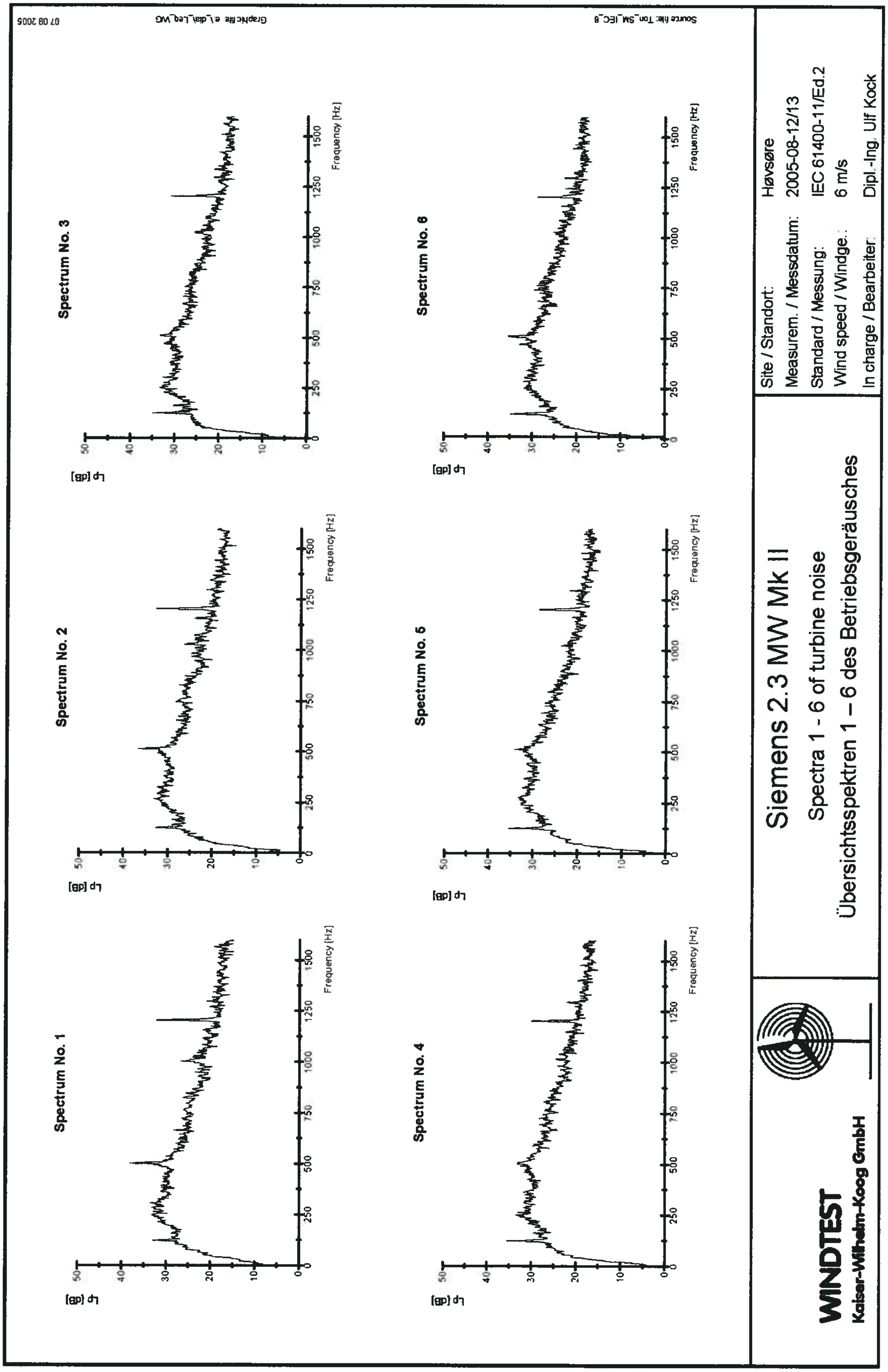
Annex 2.6: Plot of rotor speed against power



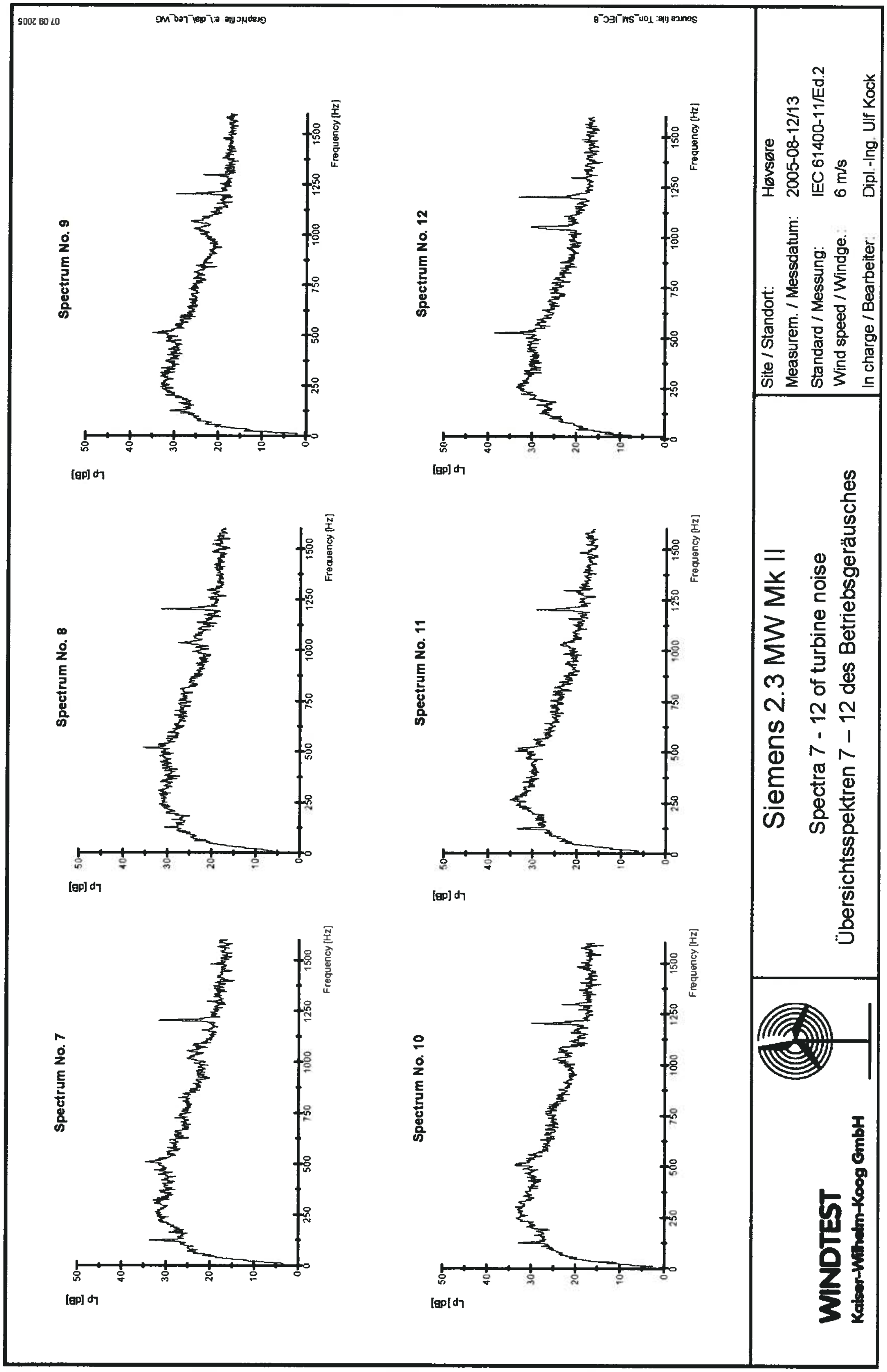
Annex 2.7: Time plot of measurement



Annex 3.1a: Overview spectra 1-6 of turbine noise at a wind speed of 6 m/s



Annex 3.1b: Overview spectra 7-12 of turbine noise at a wind speed of 6 m/s



Annex 3.1c: Analysis of tonality of turbine noise at a wind speed of 6 m/s

07.09.2005 Graphic file: a:\deta_Lea_WG Source file: Ton_SM_IEC_8

m No.	tone fT [Hz]	delta f [Hz]	Lpn,avg,j,k [dB]	Lpt,j,k [dB]	Lpn,j,k [dB]	delta Ltn,j,k [dB]	La [dB]	delta La,k [dB]
1	1204	2.00	19.36	33.06	37.29	-4.23	-3.00	-1.24
2	1204	2.00	20.40	33.91	38.33	-4.42	-3.00	-1.43
3	1204	2.00	20.14	31.73	38.07	-6.34	-3.00	-3.35
4	1204	2.00	20.19	30.86	38.12	-7.26	-3.00	-4.26
5	1204	2.00	19.57	29.77	37.49	-7.73	-3.00	-4.73
6	1204	2.00	20.97	30.07	38.90	-8.83	-3.00	-5.83
7	1204	2.00	19.65	32.98	37.57	-4.59	-3.00	-1.60
8	1202	2.00	20.35	32.08	38.27	-6.19	-2.99	-3.20
9	1202	2.00	19.20	31.01	37.12	-6.11	-2.99	-3.12
10	1204	2.00	18.92	31.62	36.85	-5.22	-3.00	-2.23
11	1202	2.00	19.38	30.27	37.31	-7.04	-2.99	-4.04
12	1202	2.00	18.82	34.02	36.74	-2.73	-2.99	0.27

Energetic average of delta Lt (delta Lk) = -5.58 [dB]

Frequency dependant audibility criterion (La) [dB] = -3.00 [dB]

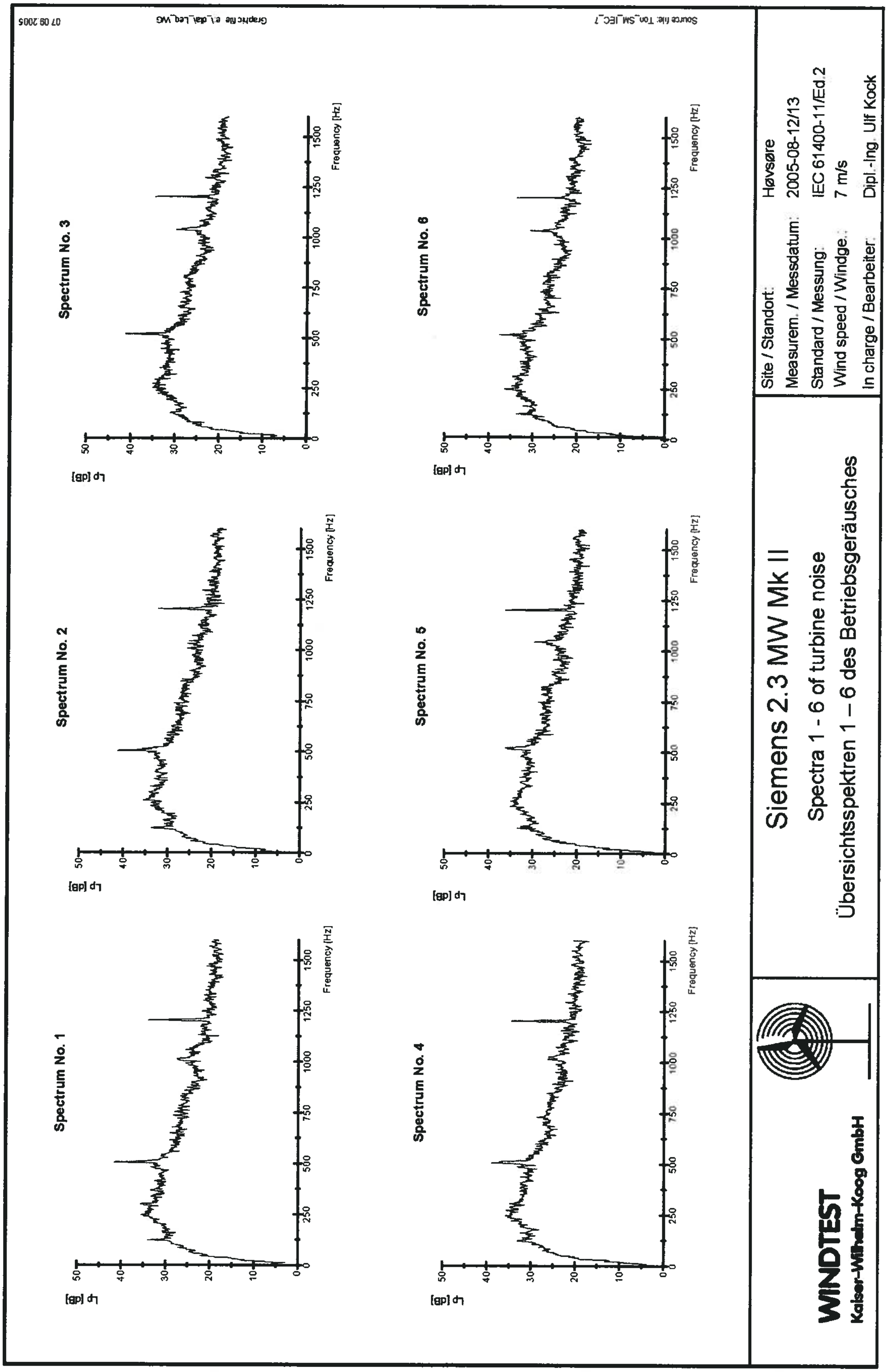
Audibility, delta Lk - La (delta La,k) = -2.58 [dB]

Uncertainty of delta La,k (Ua) = 2.41 [dB]

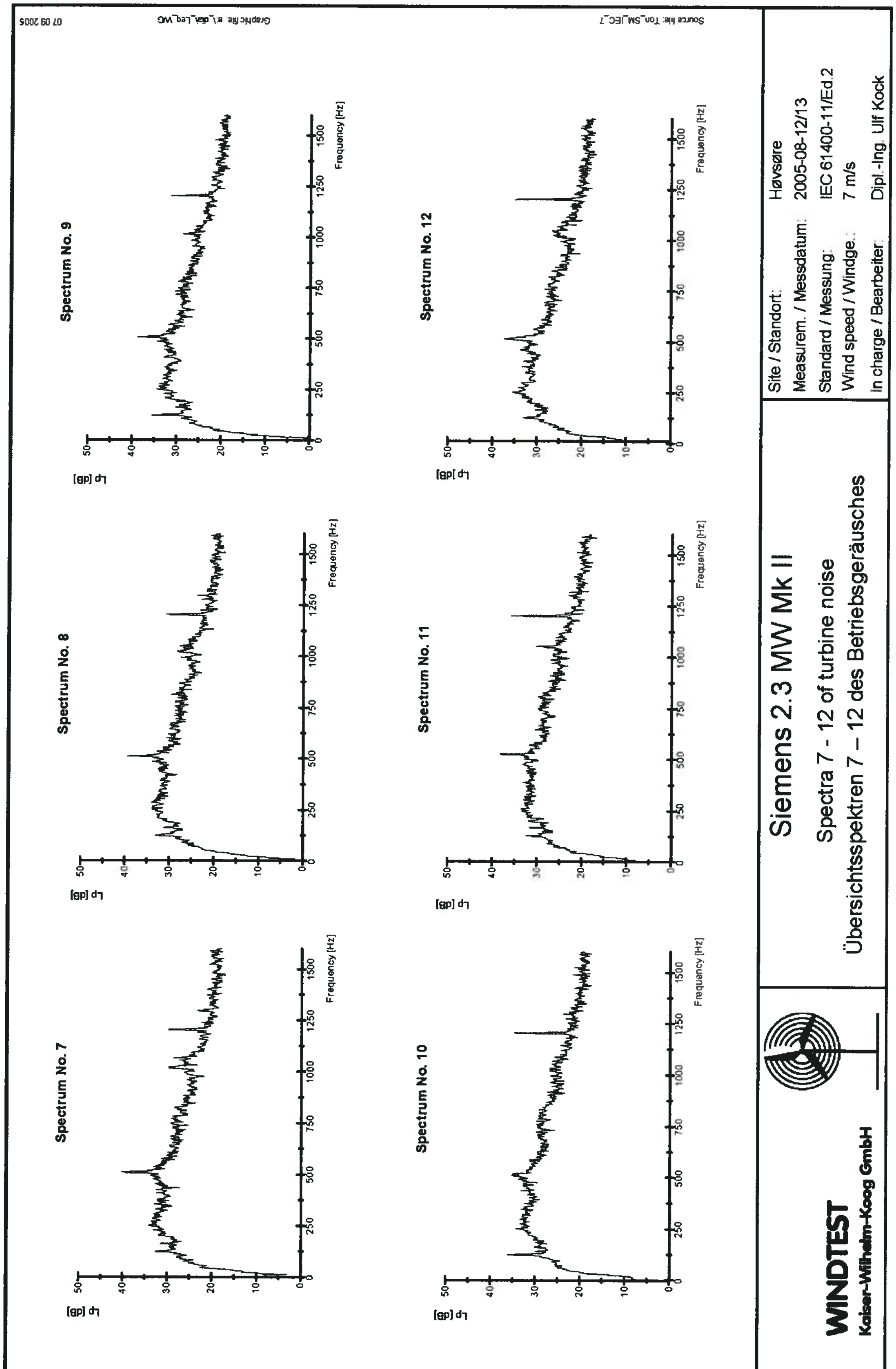
Audibility greater than or equal to -3.0 dB ?: Yes

WINDTEST Kaiser-Wilhelm-Koog GmbH	Siemens 2.3 MW Mk II Analysis of tonality of turbine noise Tonhaltigkeitsbewertung des Betriebsgeräusches	Site / Standort: Measurem. / Messdatum: Standard / Messung: Wind speed / Windge.: In charge / Bearbeiter:	Høvsøre 2005-08-12/13 IEC 61400-11/Ed.2 6 m/s Dipl.-Ing. Ulf Kock

Annex 3.2a: Overview spectra 1-6 of turbine noise at a wind speed of 7 m/s



Annex 3.2b: Overview spectra 7-12 of turbine noise at a wind speed of 7 m/s



Annex 3.2c: Analysis of tonality of turbine noise at a wind speed of 7 m/s

07.09.2005

Graphic file: e_tal_Leq_WG

m No.	tone fT [Hz]	delta f [Hz]	Lpn,avg,j,k [dB]	Lpt,j,k [dB]	Lpn,j,k [dB]	delta Ltn,j,k [dB]	La [dB]	delta La,k [dB]
1	1204	2.00	20.72	34.72	38.65	-3.93	-3.00	-0.94
2	1204	2.00	21.03	33.39	38.95	-5.57	-3.00	-2.57
3	1202	2.00	21.44	35.77	39.36	-3.59	-2.99	-0.60
4	1204	2.00	21.13	35.80	39.06	-3.26	-3.00	-0.26
5	1202	2.00	21.86	36.97	39.78	-2.82	-2.99	0.18
6	1202	2.00	21.88	34.03	39.80	-5.78	-2.99	-2.78
7	1204	2.00	21.62	30.69	39.55	-8.87	-3.00	-5.87
8	1204	2.00	22.07	31.40	40.00	-8.60	-3.00	-5.60
9	1204	2.00	22.34	31.52	40.27	-8.75	-3.00	-5.75
10	1204	2.00	22.48	35.58	40.41	-4.83	-3.00	-1.83
11	1202	2.00	22.37	36.62	40.29	-3.68	-2.99	-0.68
12	1202	2.00	20.90	36.18	38.82	-2.64	-2.99	0.36

Energetic average of delta Lt (delta Lk) = -4.68 [dB]

Frequency dependant audibility criterion (La) [dB] = -3.00 [dB]

Audibility, delta Lk - La (delta La,k) = -1.69 [dB]

Uncertainty of delta La,k (Ua) = 2.43 [dB]

Audibility greater than or equal to -3.0 dB ?: Yes

Source file: Ton_SM_IEC_7

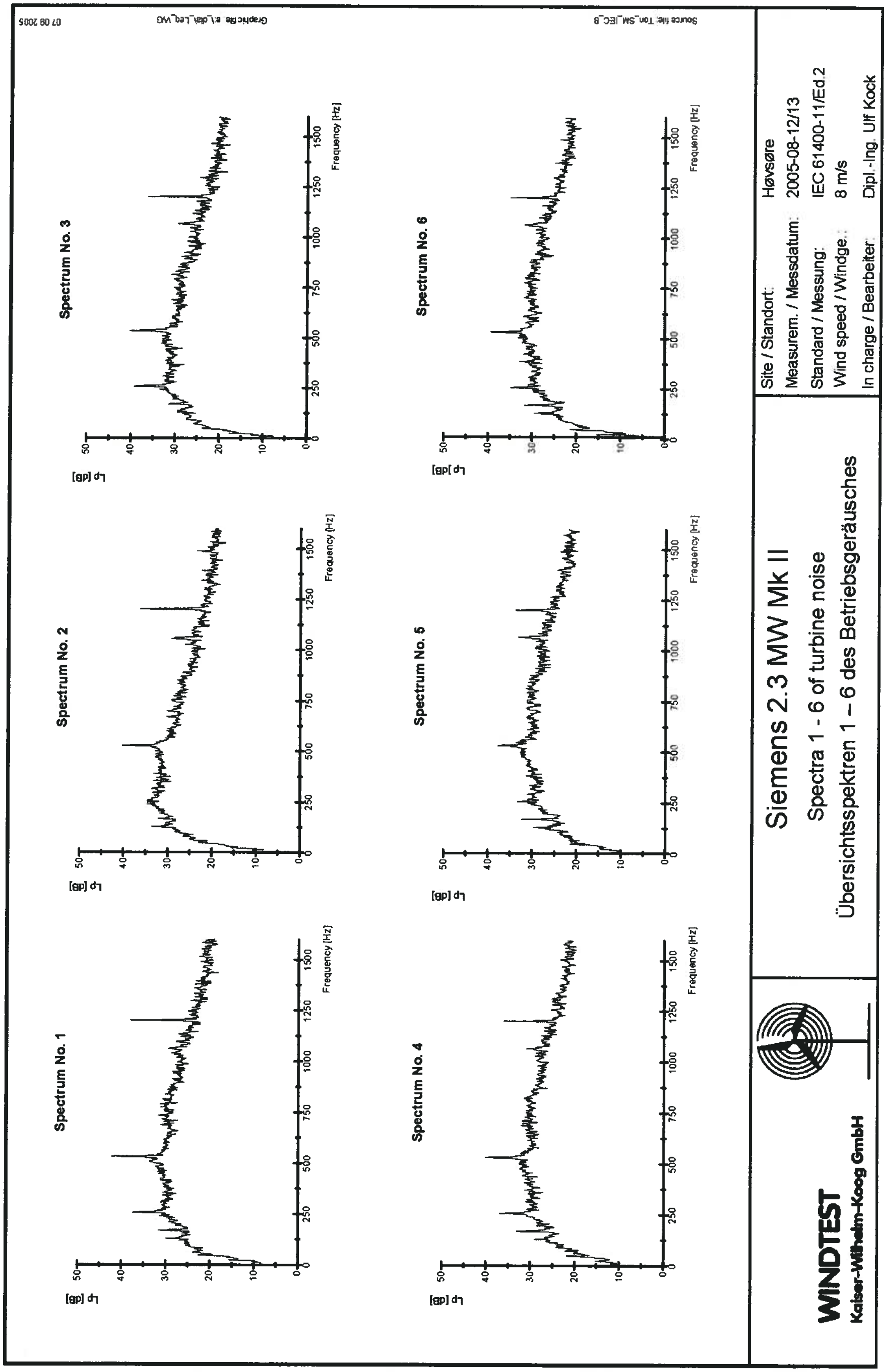
WINDTEST
Kaiser-Wilhelm-Koog GmbH

Siemens 2.3 MW Mk II

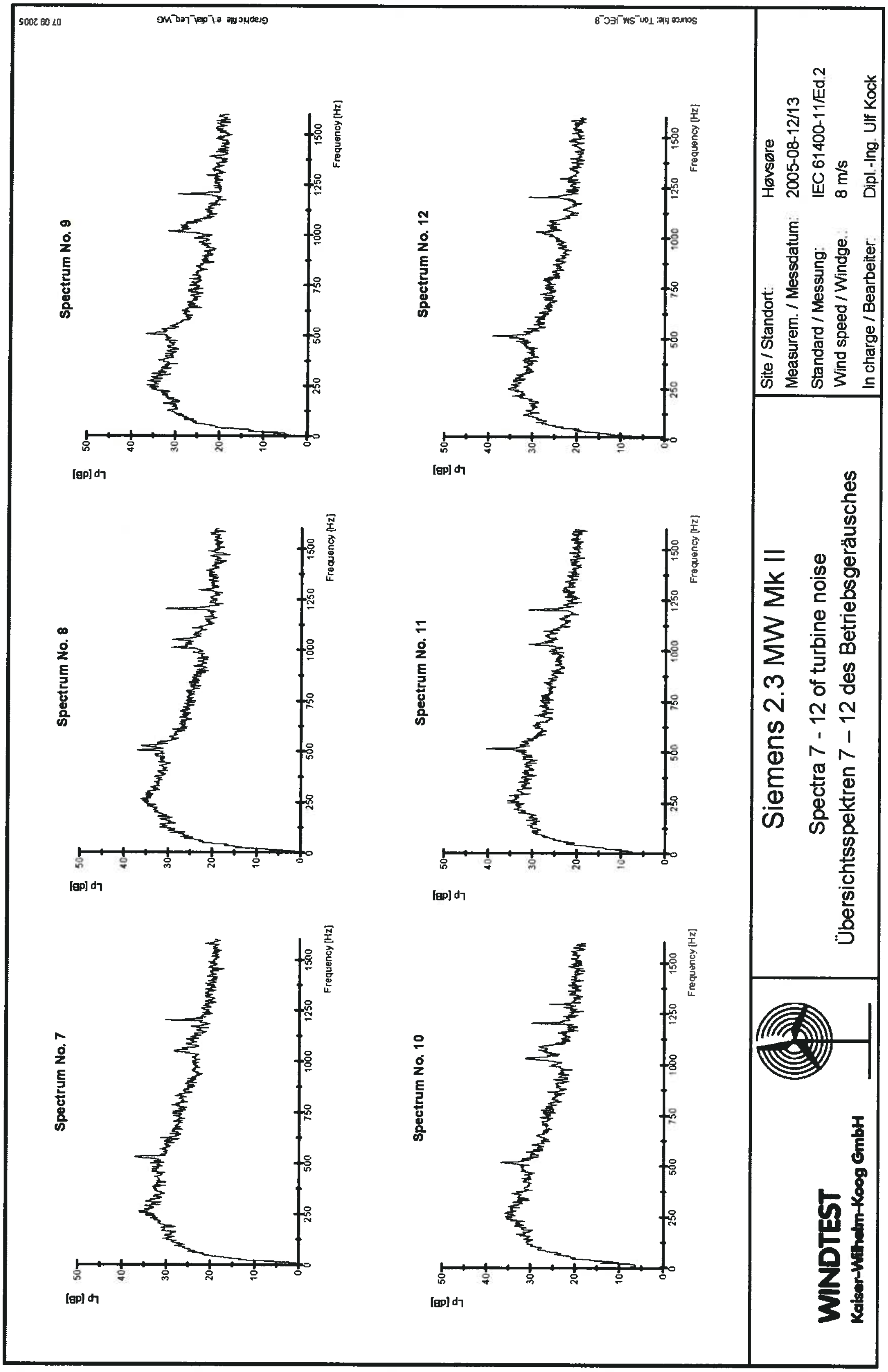
Analysis of tonality of turbine noise
Tonhaltigkeitsbewertung des Betriebsgeräusches

Site / Standort:	Høvsøre
Measurem. / Messdatum:	2005-08-12/13
Standard / Messung:	IEC 61400-11/Ed.2
Wind speed / Windge.:	7 m/s
In charge / Bearbeiter:	Dipl.-Ing. Ulf Kock

Annex 3.3a: Overview spectra 1-6 of turbine noise at a wind speed of 8 m/s



Annex 3.3b: Overview spectra 7-12 of turbine noise at a wind speed of 8 m/s



Annex 3.3c: Analysis of tonality of turbine noise at a wind speed of 8 m/s

07 09 2005

Graphic file: e:_ap__Tel__WG

m No.	tone fT [Hz]	delta f [Hz]	Lpn,avg,j,k [dB]	Lpt,j,k [dB]	Lpn,j,k [dB]	delta Ltn,j,k [dB]	La [dB]	delta La,k [dB]
1	1202	2.00	24.17	38.84	42.09	-3.24	-2.99	-0.25
2	1202	2.00	21.96	36.91	39.88	-2.97	-2.99	0.03
3	1202	2.00	23.10	36.78	41.02	-4.24	-2.99	-1.25
4	1202	2.00	25.03	36.71	42.95	-6.25	-2.99	-3.25
5	1202	2.00	25.78	34.91	43.70	-8.78	-2.99	-5.79
6	1202	2.00	25.29	35.47	43.21	-7.74	-2.99	-4.75
7	1202	2.00	22.13	28.51	40.05	-11.54	-2.99	-8.55
8	1202	2.00	20.56	32.53	38.48	-5.95	-2.99	-2.96
9	1204	2.00	21.44	30.29	39.37	-9.08	-3.00	-6.08
10	1202	2.00	21.77	31.03	39.70	-8.67	-2.99	-5.67
11	1202	2.00	22.44	31.96	40.36	-8.41	-2.99	-5.41
12	1204	2.00	21.66	31.46	39.59	-8.13	-3.00	-5.13

Energetic average of delta Lt (delta Lk) = -6.36 [dB]

Frequency dependant audibility criterion (La) [dB] = -2.99 [dB]

Audibility, delta Lk - La (delta La,k) = -3.36 [dB]

Uncertainty of delta La,k (Ua) = 2.56 [dB]

Audibility greater than or equal to -3.0 dB ?: No

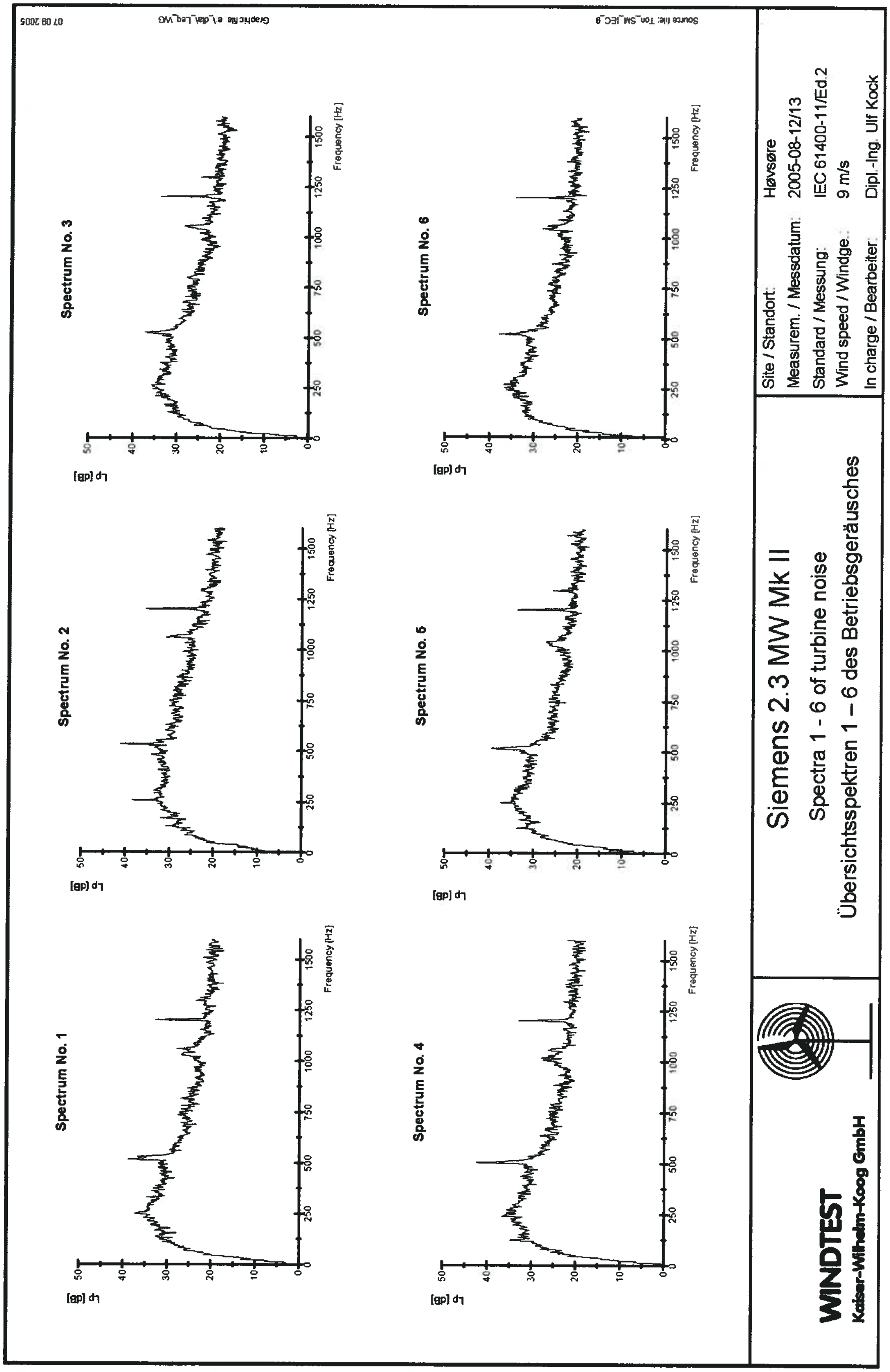
Source file: Ton_SM_IEC_8

WINDTEST
Kaiser-Wilhelm-Koog GmbH

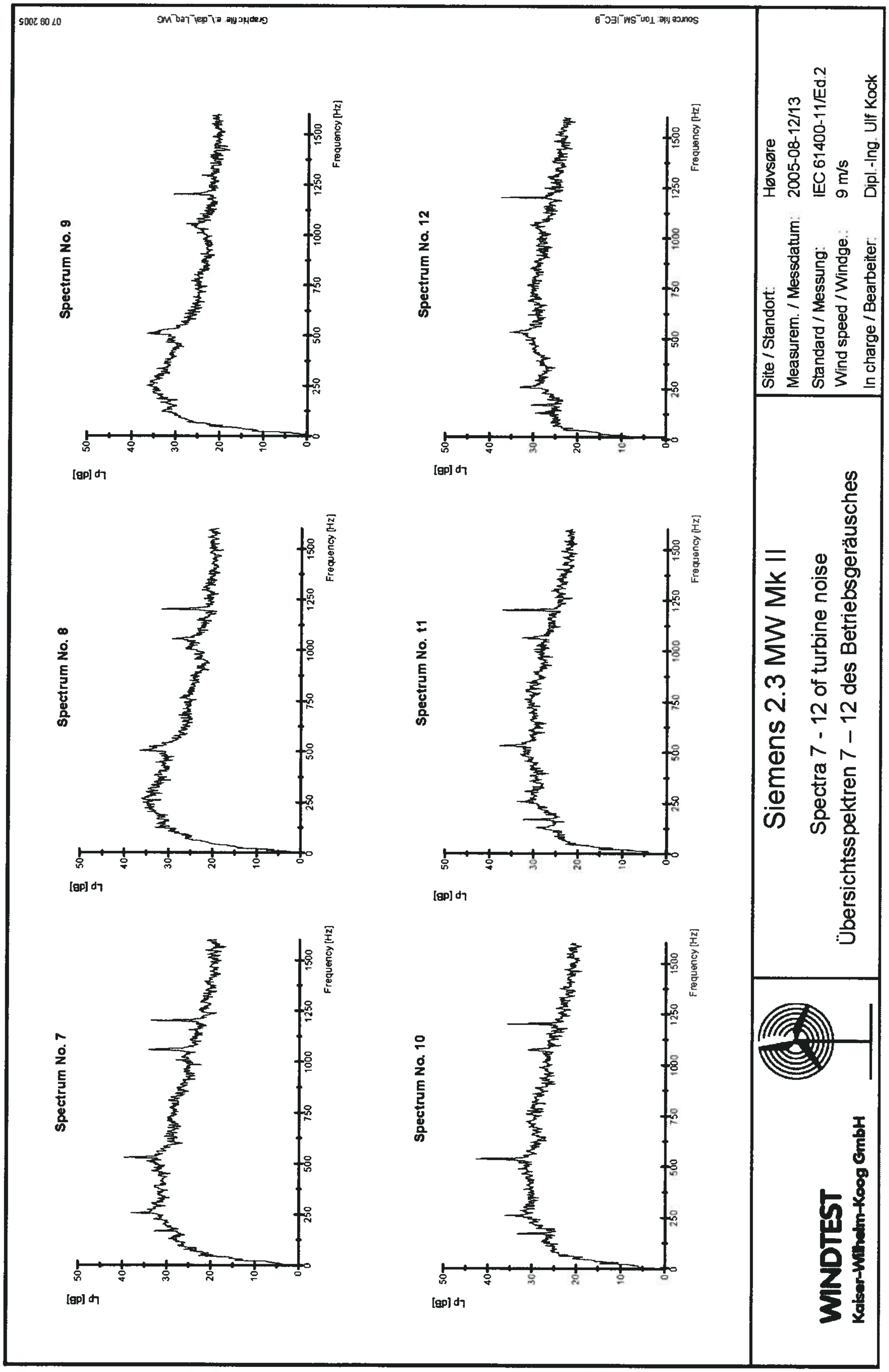
Siemens 2.3 MW Mk II
Analysis of tonality of turbine noise
Tonhaltigkeitsbewertung des Betriebsgeräusches

Site / Standort:	Høvsøre
Measurem. / Messdatum:	2005-08-12/13
Standard / Messung:	IEC 61400-11/Ed.2
Wind speed / Windge.:	8 m/s
In charge / Bearbeiter:	Dipl.-Ing. Ulf Kock

Annex 3.4a: Overview spectra 1-6 of turbine noise at a wind speed of 9 m/s



Annex 3.4b: Overview spectra 7-12 of turbine noise at a wind speed of 9 m/s



Annex 3.4c: Analysis of tonality of turbine noise at a wind speed of 9 m/s

07.09.2005 Graphic file: e:_dat_Leq_WS Source file: Ton_SM_IEC_8

m No.	tone fT [Hz]	delta f [Hz]	Lpn,avg,j,k [dB]	Lpt,j,k [dB]	Lpn,j,k [dB]	delta Ltn,j,k [dB]	La [dB]	delta La,k [dB]
1	1202	2.00	21.21	34.04	39.13	-5.09	-2.99	-2.09
2	1202	2.00	22.59	36.23	40.51	-4.28	-2.99	-1.29
3	1202	2.00	21.36	34.35	39.28	-4.93	-2.99	-1.94
4	1204	2.00	21.53	33.98	39.46	-5.48	-3.00	-2.48
5	1202	2.00	21.56	34.35	39.48	-5.13	-2.99	-2.14
6	1202	2.00	21.44	35.08	39.36	-4.28	-2.99	-1.28
7	1202	2.00	22.59	34.75	40.52	-5.76	-2.99	-2.77
8	1202	2.00	21.53	32.08	39.45	-7.37	-2.99	-4.37
9	1202	2.00	22.20	31.49	40.12	-8.63	-2.99	-5.64
10	1202	2.00	24.50	36.83	42.42	-5.59	-2.99	-2.60
11	1202	2.00	25.28	38.67	43.20	-4.54	-2.99	-1.54
12	1202	2.00	26.09	38.16	44.01	-5.85	-2.99	-2.86

Energetic average of delta Lt (delta Lk) = -5.43 [dB]

Frequency dependant audibility criterion (La) [dB] = -2.99 [dB]

Audibility, delta Lk - La (delta La,k) = -2.43 [dB]

Uncertainty of delta La,k (Ua) = 2.32 [dB]

Audibility greater than or equal to -3.0 dB ?: Yes

WINDTEST Kaiser-Wilhelm-Koog GmbH

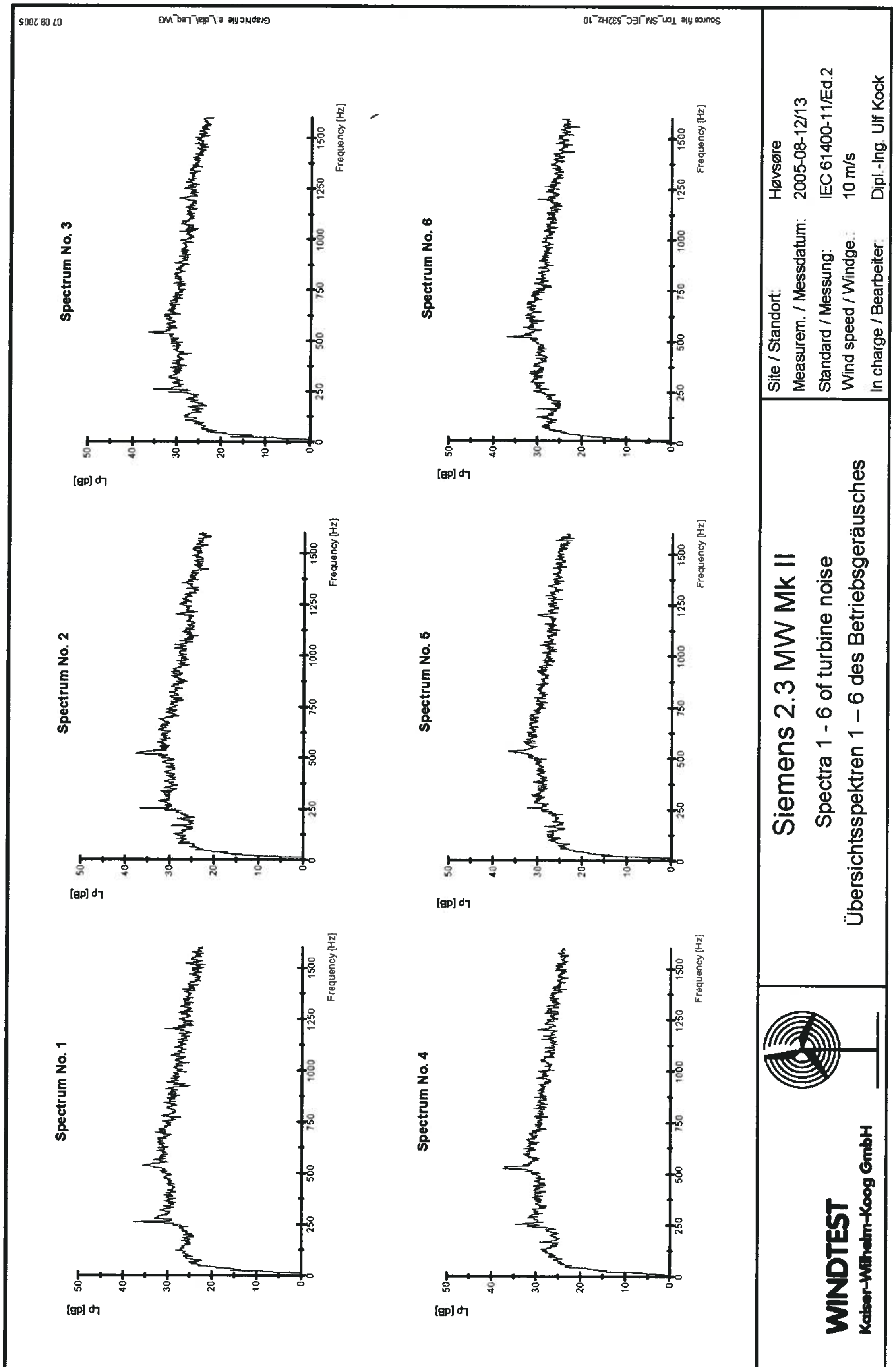
Siemens 2.3 MW Mk II

Analysis of tonality of turbine noise

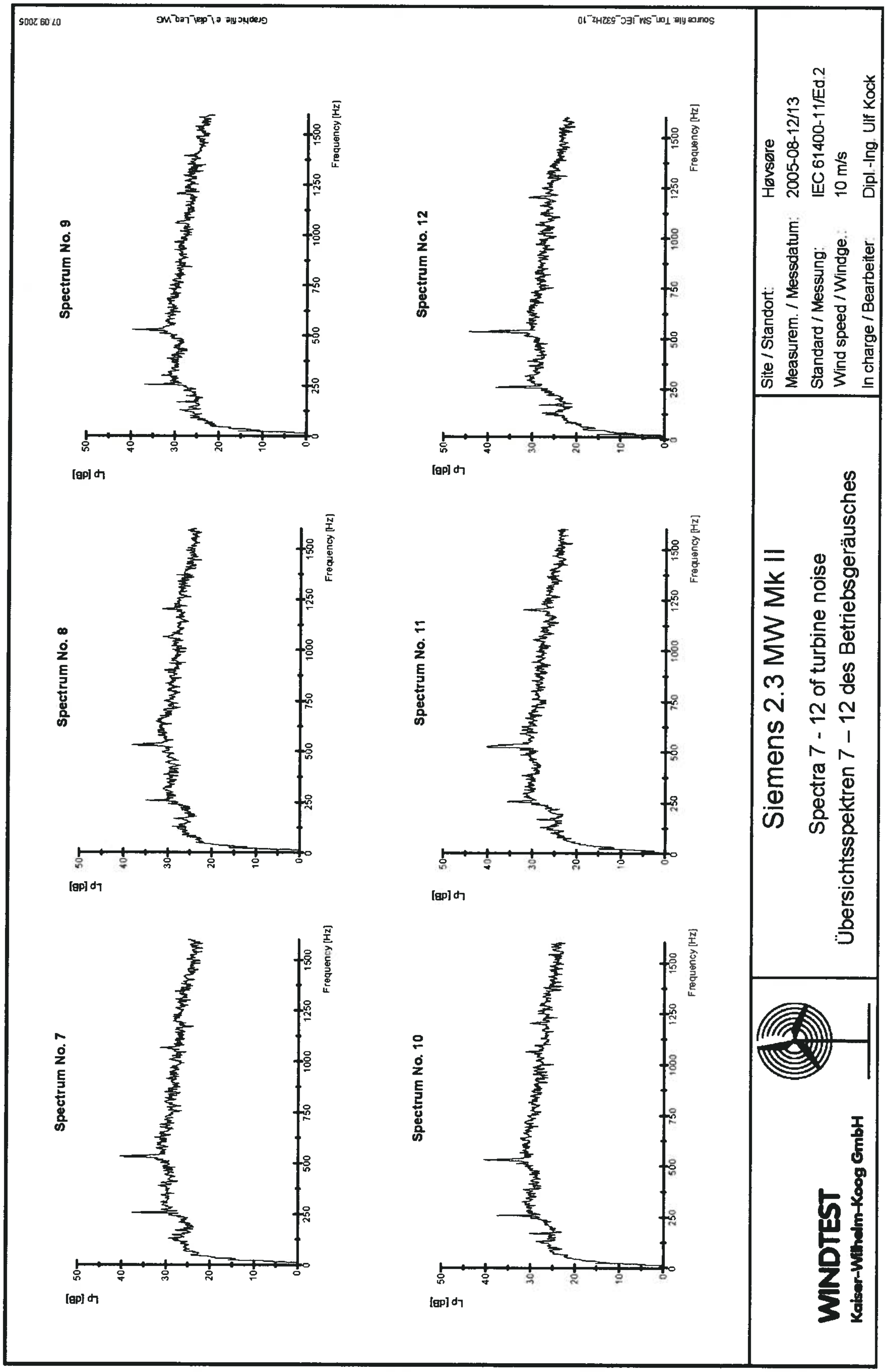
Tonhaltigkeitsbewertung des Betriebsgeräusches

Site / Standort:	Høvsøre
Measurem. / Messdatum:	2005-08-12/13
Standard / Messung:	IEC 61400-11/Ed.2
Wind speed / Windge.:	9 m/s
In charge / Bearbeiter:	Dipl.-Ing. Ulf Kock

Annex 3.5a: Overview spectra 1-6 of turbine noise at a wind speed of 10 m/s



Annex 3.5b: Overview spectra 7-12 of turbine noise at a wind speed of 10 m/s



Annex 3.5c: Analysis of tonality of turbine noise at a wind speed of 10 m/s

m No.	tone fT [Hz]	delta f [Hz]	Lpn,avg,j,k [dB]	Lpt,j,k [dB]	Lpn,j,k [dB]	delta Ltn,j,k [dB]	La [dB]	delta La,k [dB]
1	536	2.00	31.80		47.81	-16.01	-2.34	-13.67
2	520	2.00	31.72		47.69	-15.97	-2.32	-13.65
3	540	2.00	31.75		47.77	-16.02	-2.34	-13.68
4	526	2.00	30.81	41.35	46.79	-5.44	-2.33	-3.12
5	534	2.00	31.98		47.99	-16.00	-2.34	-13.67
6	524	2.00	31.25		47.23	-15.98	-2.32	-13.65
7	534	2.00	31.08	43.89	47.08	-3.19	-2.34	-0.85
8	530	2.00	31.00	39.38	47.00	-7.62	-2.33	-5.29
9	528	2.00	31.53	40.32	47.52	-7.20	-2.33	-4.87
10	530	2.00	31.04	42.17	47.03	-4.87	-2.33	-2.53
11	526	2.00	31.04	44.67	47.03	-2.36	-2.33	-0.03
12	534	2.00	30.39	46.01	46.39	-0.39	-2.34	1.95

Energetic average of delta Lt (delta Lk) = -5.91 [dB]

Frequency dependant audibility criterion (La) [dB] = -2.33 [dB]

Audibility, delta Lk - La (delta La,k) = -3.58 [dB]

Uncertainty of delta La,k (Ua) = 3.13 [dB]

Audibility greater than or equal to -3.0 dB ?: No

07.08.2005

Graphic file: e:_dat_Leq_WG

Source file: Ton_SM_IEC_532Hz_10

WINDTEST
Kaiser-Wilhelm-Koog GmbH

Siemens 2.3 MW Mk II

Analysis of tonality of turbine noise

Tonhaltigkeitsbewertung des Betriebsgeräusches

Site / Standort:	Høvsøre
Measurem. / Messdatum:	2005-08-12/13
Standard / Messung:	IEC 61400-11/Ed.2
Wind speed / Windge.:	10 m/s
In charge / Bearbeiter:	Dipl.-Ing. Ulf Kock

Annex 4.1: A-weighted sound pressure 1/3-octave spectrum at 6 m/s

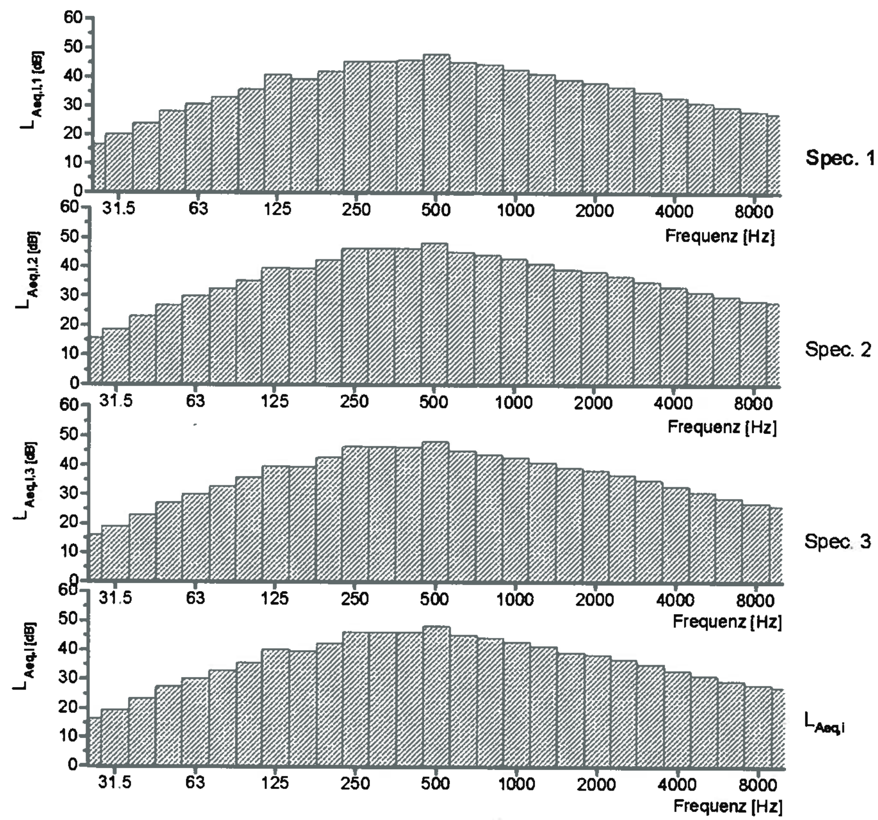
reference sound pressure/
Referenz - Schalldruck - Betrieb $L_{Aeq,c}$ = 55.4 dB

reference sound power
Referenz - Schallleistung L_{WA} = 103.4 dB

reference wind speed
Referenz - Windgeschwindigkeit WS 10m = 6 m/s

reference background sound pressure
Referenz - Schalldruck - Hintergrund $L_{Aeq,n}$ = 37.9 dB

f [Hz]	Spec. 1 [dB]	Spec. 2 [dB]	Spec. 3 [dB]	$L_{Aeq,i}$ [dB]	$L_{WA,i}$ [dB]	U_s [dB]	U_c [dB]
25	16.6	15.8	16.1	16.2	64.1	0.4	2.0
31.5	20.1	18.5	19.0	19.2	67.1	0.8	2.1
40	24.0	23.0	23.0	23.4	71.3	0.5	2.1
50	28.1	26.8	27.1	27.4	75.3	0.7	2.1
63	30.7	30.1	30.0	30.3	78.2	0.4	2.0
80	33.2	32.6	32.8	32.9	80.8	0.3	2.0
100	35.8	35.2	35.8	35.6	83.5	0.4	2.0
125	40.9	39.5	39.9	40.2	88.1	0.7	2.1
160	39.5	39.4	39.5	39.5	87.4	0.1	2.0
200	42.2	42.4	42.6	42.4	90.3	0.2	2.0
250	45.8	46.2	46.4	46.2	94.1	0.3	2.0
315	45.8	46.2	46.4	46.1	94.0	0.3	2.0
400	46.0	46.3	46.2	46.2	94.1	0.1	2.0
500	48.2	48.2	48.1	48.2	96.1	0.1	2.0
630	45.3	45.1	45.1	45.2	93.1	0.1	2.0
800	44.7	44.0	43.8	44.2	92.1	0.5	2.0
1000	42.9	42.8	42.7	42.8	90.7	0.1	2.0
1250	41.5	41.2	41.1	41.3	89.2	0.2	2.0
1600	39.4	39.2	39.1	39.3	87.2	0.2	2.0
2000	38.5	38.4	38.4	38.4	86.3	0.1	2.0
2500	36.9	36.8	36.8	36.8	84.7	0.1	2.0
3150	35.1	35.0	35.0	35.1	83.0	0.1	2.0
4000	33.2	33.1	32.8	33.0	80.9	0.2	2.0
5000	31.3	31.4	30.8	31.2	79.1	0.3	2.0
6300	29.9	30.0	29.0	29.6	77.5	0.6	2.1
8000	28.3	28.5	27.2	28.0	75.9	0.7	2.1
10000	27.6	27.9	26.2	27.3	75.2	0.9	2.2



Graphic file / Grafikdatei: D:_dat\Terz_SM_IEC_6 07.09.2005

Source file / Quelldatei: Terz_SM_IEC_6_.erg

WINDTEST Kaiser-Wilhelm-Koog GmbH	Siemens 2.3 MW Mk II One third octave analysis / Terzanalyse	Site / Standort: Høvsøre Measurem. / Messdatum: 2005-08-12/13 Standard / Messung: FGW / IEC In charge / Bearbeiter: Dipl.-Ing. Ulf Kock

Annex 4.2: A-weighted sound pressure 1/3-octave spectrum at 7 m/s

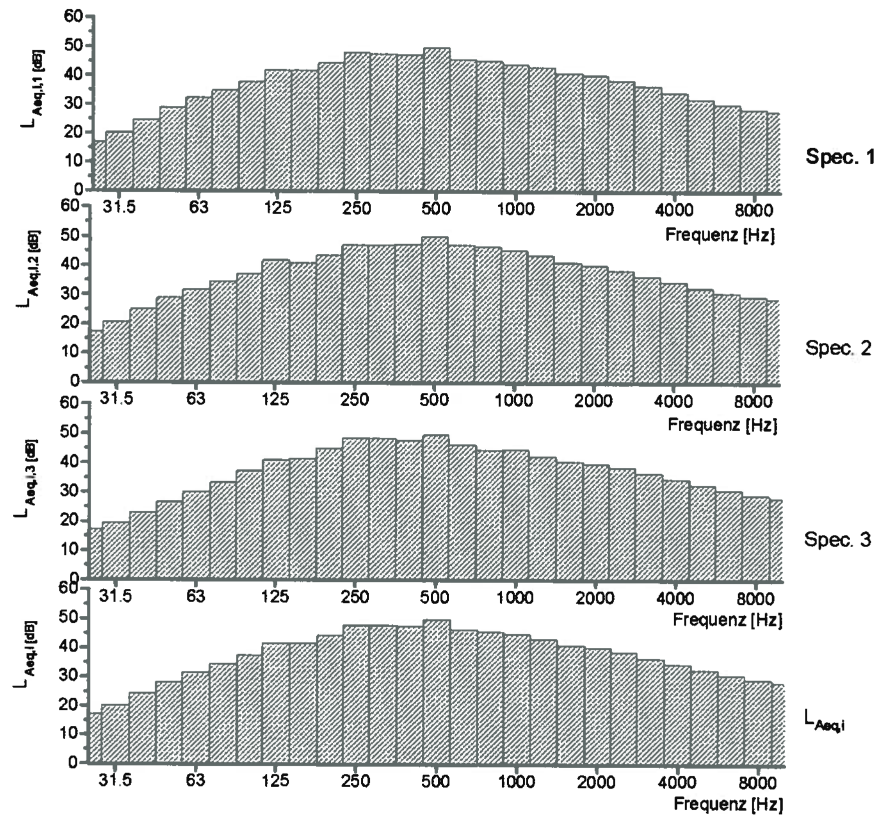
reference sound pressure/
Referenz - Schalldruck - Betrieb $L_{Aeq,c}$ = 57.0 dB

reference background sound pressure
Referenz - Schalldruck - Hintergrund $L_{Aeq,n}$ = 40.2 dB

reference sound power
Referenz - Schallleistung L_{WA} = 104.9 dB

reference wind speed
Referenz - Windgeschwindigkeit WS 10m = 7 m/s

f [Hz]	Spec. 1 [dB]	Spec. 2 [dB]	Spec. 3 [dB]	$L_{Aeq,i}$ [dB]	$L_{WA,i}$ [dB]	U_a [dB]	U_c [dB]
25	16.8	17.3	17.4	17.2	65.0	0.3	2.0
31.5	20.3	20.7	19.4	20.2	68.0	0.6	2.1
40	24.6	25.0	22.9	24.3	72.1	1.2	2.3
50	28.8	28.9	26.8	28.3	76.1	1.2	2.3
63	32.3	31.7	30.1	31.5	79.3	1.2	2.3
80	34.9	34.5	33.4	34.3	82.1	0.8	2.1
100	37.9	37.2	37.3	37.5	85.3	0.4	2.0
125	42.0	41.8	40.9	41.6	89.4	0.6	2.1
160	41.9	40.9	41.6	41.5	89.3	0.5	2.1
200	44.5	43.5	44.9	44.4	92.2	0.7	2.1
250	48.0	47.0	48.5	47.9	95.7	0.8	2.1
315	47.7	47.1	48.4	47.8	95.6	0.7	2.1
400	47.6	47.4	47.7	47.6	95.4	0.2	2.0
500	49.9	50.0	49.6	49.8	97.6	0.2	2.0
630	45.9	47.0	46.1	46.4	94.2	0.5	2.1
800	45.3	46.7	44.5	45.6	93.4	1.1	2.3
1000	44.2	45.4	44.6	44.8	92.6	0.6	2.1
1250	43.2	43.5	42.3	43.0	90.8	0.6	2.1
1600	41.2	41.2	40.6	41.0	88.8	0.3	2.0
2000	40.4	40.1	39.8	40.1	87.9	0.3	2.0
2500	38.6	38.4	38.4	38.5	86.3	0.1	2.0
3150	36.6	36.5	36.6	36.6	84.4	0.1	2.0
4000	34.5	34.3	34.6	34.5	82.3	0.1	2.0
5000	32.2	32.4	32.6	32.4	80.2	0.2	2.0
6300	30.4	30.8	30.8	30.7	78.5	0.2	2.0
8000	28.7	29.5	29.0	29.1	76.9	0.4	2.0
10000	27.9	28.8	28.3	28.3	76.1	0.5	2.0



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WINDTEST
Kaiser-Wilhelm-Koog GmbH

Siemens 2.3 MW Mk II

One third octave analysis / Terzanalyse

Site / Standort:	Høvsøre
Measurem. / Messdatum:	2005-08-12/13
Standard / Messung:	FGW / IEC
In charge / Bearbeiter:	Dipl.-Ing. Ulf Kock

Annex 4.3: A-weighted sound pressure 1/3-octave spectrum at 8 m/s

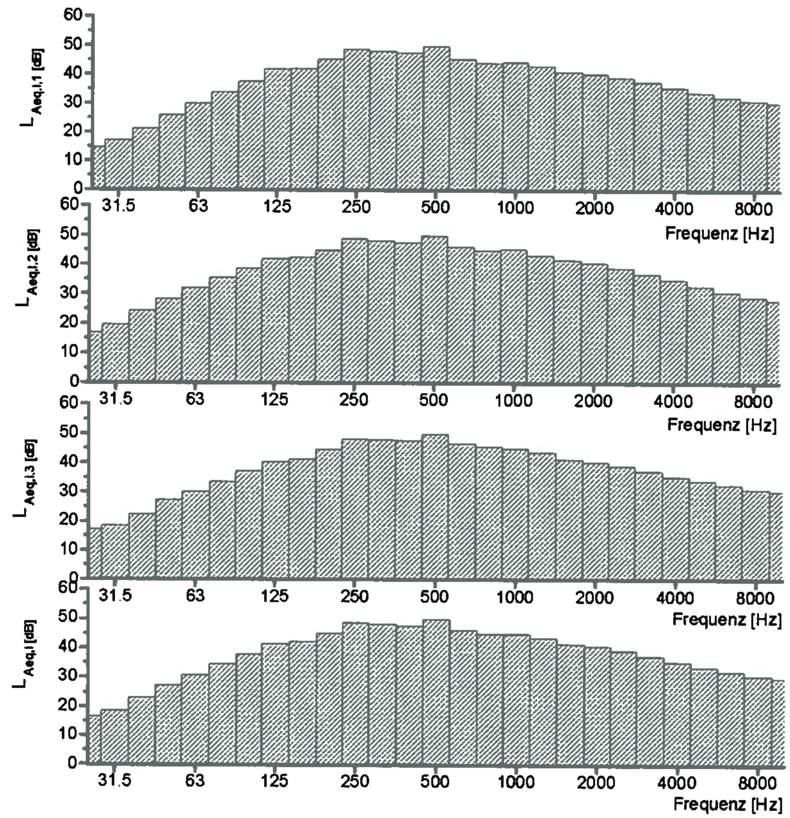
reference sound pressure/
Referenz - Schalldruck - Betrieb $L_{Aeq,c}$ = 57.2 dB

reference background sound pressure
Referenz - Schalldruck - Hintergrund $L_{Aeq,n}$ = 42.6 dB

reference sound power
Referenz - Schallleistung L_{WA} = 105.1 dB

reference wind speed
Referenz - Windgeschwindigkeit WS 10m = 8 m/s

f [Hz]	Spec. 1 [dB]	Spec. 2 [dB]	Spec. 3 [dB]	$L_{Aeq,i}$ [dB]	$L_{WA,i}$ [dB]	U_s [dB]	U_c [dB]
25	14.7	17.0	17.3	16.5	64.3	1.4	2.4
31.5	17.2	19.6	18.5	18.5	66.3	1.2	2.3
40	21.2	24.4	22.6	22.9	70.7	1.6	2.5
50	25.9	28.4	27.3	27.3	75.1	1.3	2.4
63	29.9	32.0	30.0	30.8	78.6	1.2	2.3
80	33.8	35.4	33.7	34.4	82.2	1.0	2.2
100	37.6	38.6	37.3	37.9	85.7	0.6	2.1
125	42.0	41.8	40.3	41.4	89.2	0.9	2.2
160	42.3	42.3	41.3	42.0	89.8	0.6	2.1
200	45.4	44.8	44.8	45.0	92.8	0.3	2.0
250	48.8	48.6	48.3	48.6	96.4	0.2	2.0
315	48.3	48.0	48.0	48.1	95.9	0.2	2.0
400	47.7	47.6	47.7	47.6	95.4	0.0	2.0
500	49.9	49.7	49.8	49.8	97.6	0.1	2.0
630	45.4	46.1	46.7	46.1	93.9	0.6	2.1
800	44.1	45.0	45.6	44.9	92.7	0.7	2.1
1000	44.5	45.2	45.0	44.9	92.7	0.4	2.0
1250	43.3	43.1	43.8	43.4	91.2	0.4	2.0
1600	41.2	41.6	41.3	41.4	89.2	0.2	2.0
2000	40.6	40.7	40.4	40.5	88.3	0.2	2.0
2500	39.2	39.0	39.0	39.1	86.9	0.1	2.0
3150	37.5	37.0	37.2	37.3	85.1	0.3	2.0
4000	35.5	34.9	35.4	35.3	83.1	0.4	2.0
5000	33.7	32.7	34.0	33.5	81.3	0.7	2.1
6300	32.5	30.7	32.6	32.0	79.8	1.1	2.2
8000	31.2	28.9	31.1	30.5	78.3	1.3	2.4
10000	30.4	28.0	30.4	29.7	77.5	1.4	2.4



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Source file / Quelldatei: Terz_SM_IEC_8_erg

WINDTEST
Kaiser-Wilhelm-Koog GmbH

Siemens 2.3 MW Mk II

One third octave analysis / Terzanalyse

Site / Standort:	Høvsøre
Measurem. / Messdatum:	2005-08-12/13
Standard / Messung:	FGW / IEC
In charge / Bearbeiter:	Dipl.-Ing. Ulf Kock

Annex 4.4: A-weighted sound pressure 1/3-octave spectrum at 9 m/s

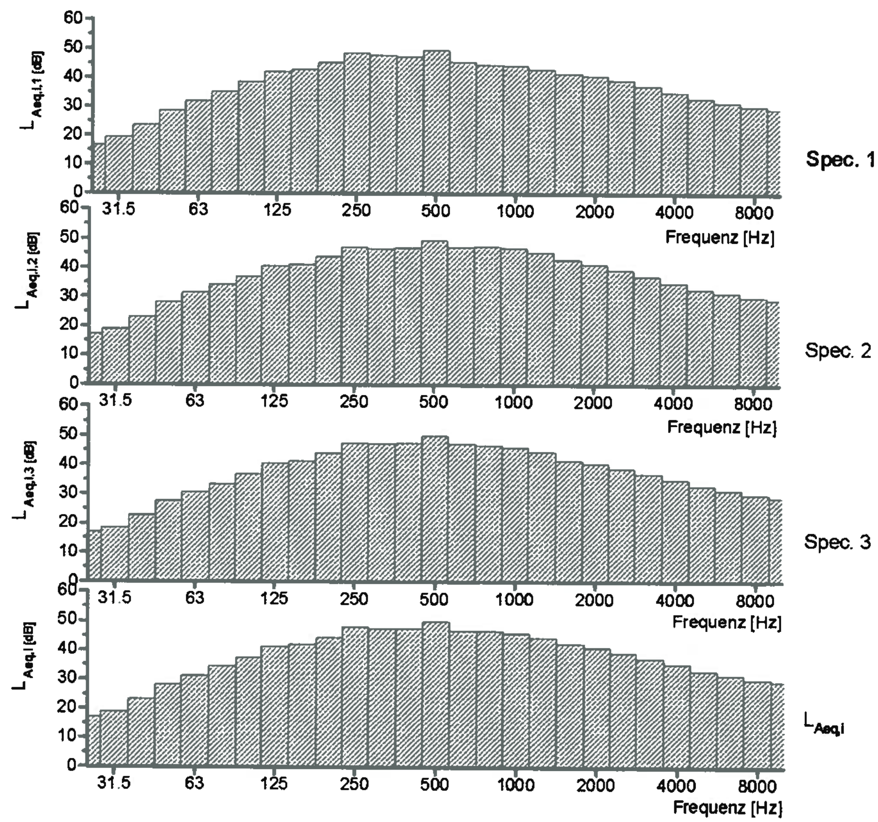
reference sound pressure/
Referenz - Schalldruck - Betrieb $L_{Aeq,c}$ = 57.0 dB

reference background sound pressure
Referenz - Schalldruck - Hintergrund $L_{Aeq,n}$ = 44.9 dB

reference sound power
Referenz - Schallleistung L_{WA} = 105 dB

reference wind speed
Referenz - Windgeschwindigkeit WS 10m = 9 m/s

f [Hz]	Spec. 1 [dB]	Spec. 2 [dB]	Spec. 3 [dB]	$L_{Aeq,i}$ [dB]	$L_{WA,i}$ [dB]	U_a [dB]	U_c [dB]
25	16.6	17.3	17.0	17.0	64.7	0.3	2.0
31.5	19.3	19.0	18.4	18.9	66.6	0.5	2.0
40	23.8	23.2	22.7	23.2	70.9	0.5	2.1
50	28.5	28.1	27.8	28.1	75.8	0.4	2.0
63	31.9	31.4	30.6	31.3	79.0	0.7	2.1
80	35.3	34.2	33.4	34.4	82.1	0.9	2.2
100	38.7	37.1	36.7	37.6	85.3	1.1	2.3
125	42.2	40.6	40.5	41.2	88.9	1.0	2.2
160	42.9	41.1	41.2	41.8	89.5	1.0	2.2
200	45.4	43.8	44.0	44.5	92.2	0.9	2.2
250	48.7	47.2	47.5	47.8	95.5	0.8	2.1
315	48.0	46.7	47.2	47.3	95.0	0.7	2.1
400	47.4	46.7	47.5	47.2	94.9	0.4	2.0
500	49.8	49.6	50.0	49.8	97.5	0.2	2.0
630	45.6	47.0	47.2	46.7	94.4	0.9	2.2
800	44.8	47.4	46.8	46.5	94.2	1.4	2.4
1000	44.3	46.8	45.9	45.8	93.5	1.3	2.4
1250	43.4	45.3	44.4	44.4	92.1	1.0	2.2
1600	41.7	42.9	41.6	42.1	89.8	0.7	2.1
2000	40.9	41.3	40.5	40.9	88.6	0.4	2.0
2500	39.3	39.3	38.9	39.2	86.9	0.2	2.0
3150	37.5	37.3	36.9	37.2	84.9	0.3	2.0
4000	35.3	35.0	34.9	35.1	82.8	0.2	2.0
5000	33.2	32.8	33.0	33.0	80.7	0.2	2.0
6300	31.6	31.3	31.3	31.4	79.1	0.2	2.0
8000	30.3	29.9	29.8	30.0	77.7	0.3	2.0
10000	29.5	29.2	28.8	29.2	76.9	0.3	2.0



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WINDTEST
Kaiser-Wilhelm-Koog GmbH

Siemens 2.3 MW Mk II

One third octave analysis / Terzanalyse

Site / Standort:	Høvsøre
Measurem. / Messdatum:	2005-08-12/13
Standard / Messung:	FGW / IEC
In charge / Bearbeiter:	Dipl.-Ing. Ulf Kock

Annex 4.5: A-weighted sound pressure 1/3-octave spectrum at 10 m/s

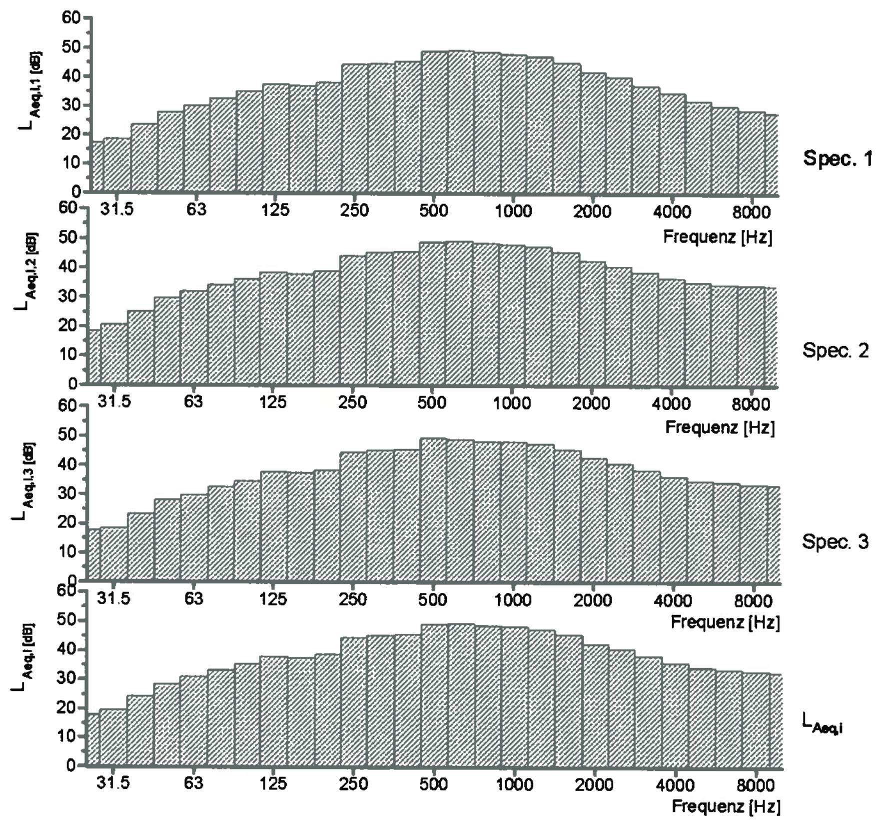
reference sound pressure/
Referenz - Schalldruck - Betrieb $L_{Aeq,c}$ = 57.1 dB

reference background sound pressure
Referenz - Schalldruck - Hintergrund $L_{Aeq,n}$ = 47.3 dB

reference sound power
Referenz - Schallleistung L_{WA} = 105 dB

reference wind speed
Referenz - Windgeschwindigkeit WS 10m = 10 m/s

f [Hz]	Spec. 1 [dB]	Spec. 2 [dB]	Spec. 3 [dB]	$L_{Aeq,i}$ [dB]	$L_{WA,i}$ [dB]	U_a [dB]	U_c [dB]
25	17.5	18.5	17.7	17.9	65.4	0.5	2.1
31.5	18.6	20.8	18.4	19.4	66.9	1.3	2.4
40	23.6	25.2	23.5	24.1	71.6	0.9	2.2
50	27.9	29.7	28.1	28.6	76.1	1.0	2.2
63	30.1	32.1	29.9	30.8	78.3	1.2	2.3
80	32.7	34.3	32.5	33.2	80.7	0.9	2.2
100	35.1	36.3	34.8	35.4	82.9	0.8	2.1
125	37.7	38.4	37.7	37.9	85.4	0.4	2.0
160	37.2	37.9	37.4	37.5	85.0	0.4	2.0
200	38.2	39.1	38.3	38.5	86.0	0.5	2.0
250	44.8	44.0	44.4	44.4	91.9	0.4	2.0
315	45.1	45.2	45.2	45.1	92.6	0.1	2.0
400	45.5	45.5	45.5	45.5	93.0	0.0	2.0
500	49.1	48.7	49.4	49.1	96.6	0.3	2.0
630	49.4	49.3	48.9	49.2	96.7	0.3	2.0
800	48.8	48.5	48.1	48.5	96.0	0.4	2.0
1000	48.3	48.0	48.2	48.2	95.7	0.1	2.0
1250	47.3	47.3	47.6	47.4	94.9	0.1	2.0
1600	45.3	45.5	45.5	45.4	92.9	0.1	2.0
2000	42.2	42.6	42.6	42.5	90.0	0.2	2.0
2500	40.3	40.8	40.8	40.6	88.1	0.3	2.0
3150	37.5	38.8	38.4	38.2	85.7	0.7	2.1
4000	34.8	36.6	36.4	36.0	83.5	1.0	2.2
5000	32.2	35.1	34.9	34.2	81.7	1.6	2.6
6300	30.3	34.5	34.3	33.4	80.9	2.4	3.1
8000	29.0	34.2	33.7	32.8	80.3	2.9	3.5
10000	27.9	34.0	33.4	32.4	79.9	3.4	3.9



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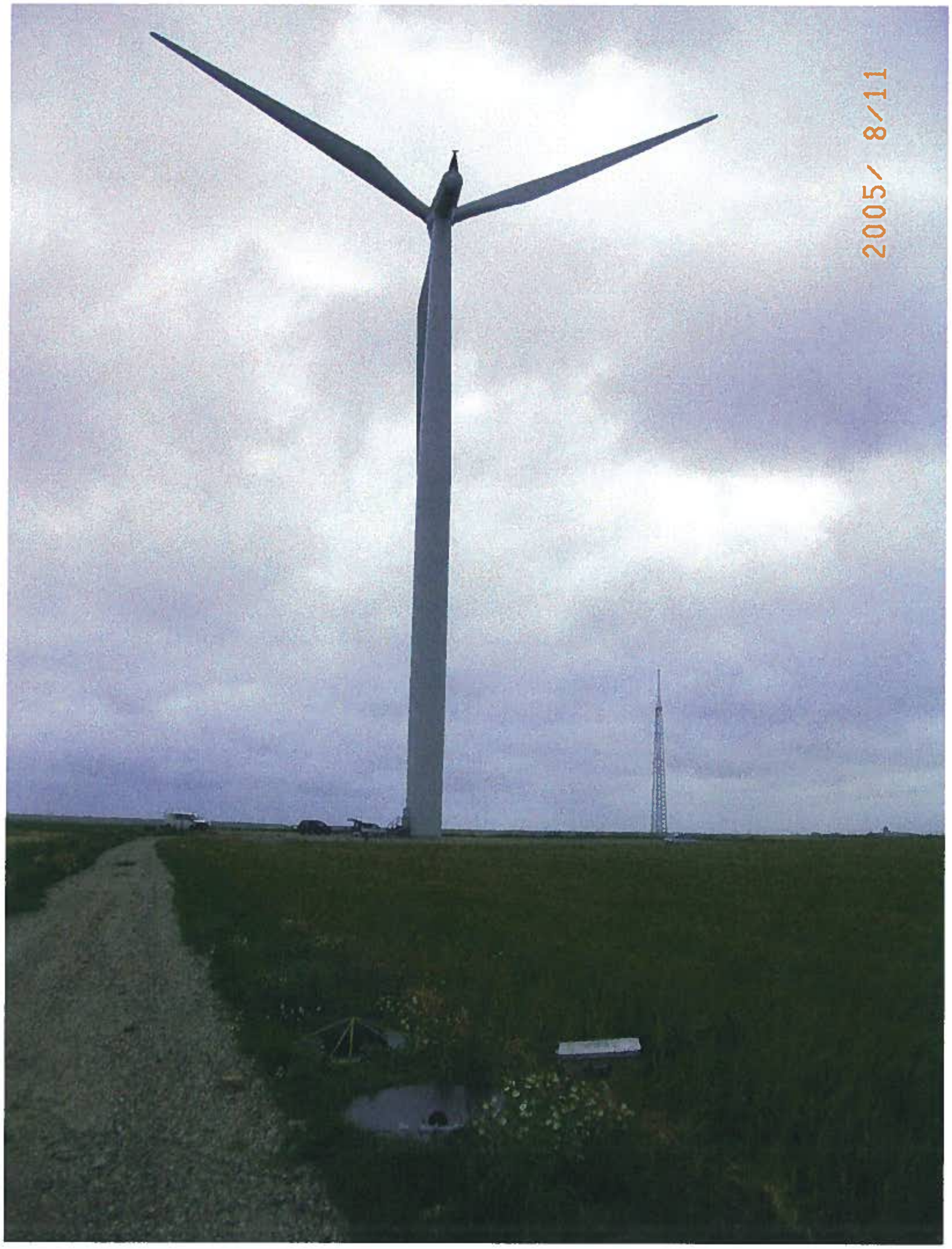
Source file / Quelldatei: Terz_SM_IEC_10_erg

WINDTEST
Kaiser-Wilhelm-Koog GmbH

Siemens 2.3 MW Mk II

One third octave analysis / Terzanalyse

Site / Standort:	Høvsøre
Measurem. / Messdatum:	2005-08-12/13
Standard / Messung:	FGW / IEC
In charge / Bearbeiter:	Dipl.-Ing. Ulf Kock



Picture from the board in direction of the WTGS

Picture of microphone and board

PP 2.3 MW Mk II, 1.225 kgm3 / 30-06-2004

Bonus 2.3 MW Mk II, 1.225 kg/m3
Sales Power Curve, Preliminary

The calculated power curve data are valid for the above air density conditions, clean rotor blades, and horizontal, undisturbed air flow with 10% turbulence intensity.

Wind [m/s]	Power [kW]
0	0
1	0
2	0
3	0
4	65
5	180
6	352
7	590
8	906
9	1308
10	1767
11	2085
12	2234
13	2283
14	2296
15	2299
16	2300
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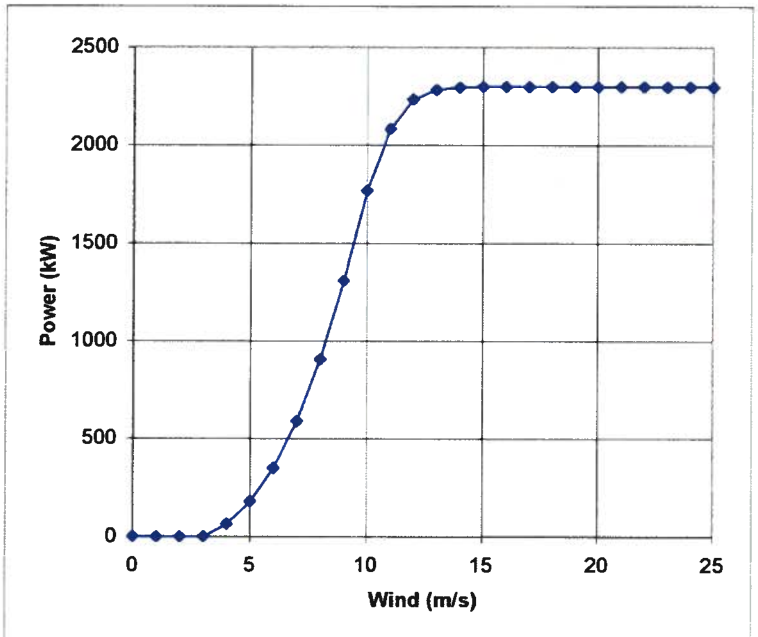
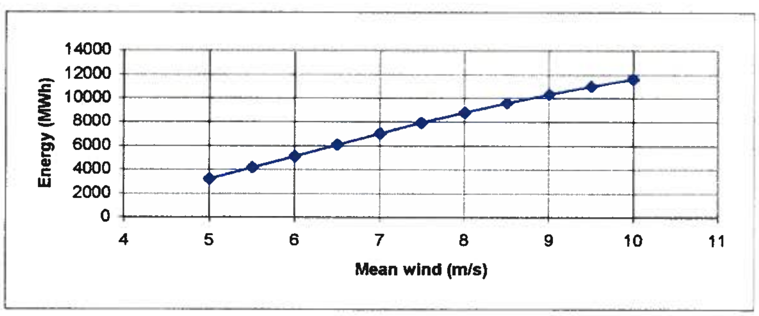
24	2300
25	2300



The annual energy production data for different annual mean wind speeds in hub height are calculated from the above power curve assuming a Rayleigh wind speed distribution, 100 percent availability, and no reductions due to array losses, grid losses, or other external factors affecting the production.

Wind [m/s]	Energy [MWh]
5.0	3238
5.5	4179
6.0	5134
6.5	6089
7.0	7037
7.5	7926
8.0	8792
8.5	9580
9.0	10324
9.5	11002
10.0	11616



HST Bonus Enerav A/S 1 / 1

Herstellerbescheinigung zu spezifischen Daten der Anlage vom Typ
Manufacturer's certificate on specific data of the type of installation

Datum / date: 22/08/2005

1. Allgemeines		**General**
Hersteller	Siemens Wind Power A/S	manufacturer
Anlagenbezeichnung	2.3 MW mkII	type name
Art (horizontale/vertikale Achse)	Horizontal	type (horizontal / vertical axis)
Nennleistung	2300 kW	rated power
Nabenhöhe über Grund	80 m	hub height above ground
Nabenhöhe über Fundamentflansch	80 m	hub height above top of foundation flange
Nennwindgeschwindigkeit	12 m/s	rated wind speed
Ein- und Ausschaltwindgeschwindigkeit	3/25 m/s	cut-in and cut-out wind speed
Beitrag zum Kurzschlussstrom	appr. 2.5 kA	contribution to short circuit current
2. Rotor		**Rotor**
Durchmesser	92.4 m	diameter
Bestrichene Fläche	6706 m²	swept area
Anzahl der Blätter	3	number of blades
Nabenart (pendelnd/starr)	Rigid	kind of hub (teetered/rigid)
Anordnung zum Turm (luv/lee)	Luv	relative position to tower (luv/lee)
Nenndrehzahl / -bereich	6,1-18,4 U/min / rpm	rated speed / speed range
Auslegungsschnellaufzahl	___	design tip speed ratio
Rotorblatteinstellwinkel	-2 to 82° Pitch controlled	rotor blade pitch setting
Konuswinkel	2°	cone angle
Achsneigung	6°	tilt angle
Abstand Rotorflanschmittelpunkt - Turmmittellinie	3.5 m	distance between rotor flange centre and tower centre line
3. Blatt		**Blade**
Hersteller	Siemens Wind Power A/S	manufacturer
Typenbezeichnung	B45	type
Profile innen/außen	FFAW3/ NACA63-6xx	blade section inner/outer
Material	GRE	material
Länge	45 m	length
Profiltiefe max./min.	3.35 m/ 0.7 m	chord length (max./min.)
Zusatzkomponenten (z.B. stall strips, Vortex-Generatoren, Turbulatoren)	Vortex generator	additional components (e.g. stall strips, vortex generators, trip strips)
Extenderlänge	N/A	extender length
4. Getriebe		**Gear**
Hersteller	Flender	manufacturer
Typenbezeichnung	PEAB 4456	type
Ausführung	Planetary/helical	design
Übersetzungsverhältnis	1 : 90.84	speed ratio
5. Generator		**Generator**
Hersteller	ABB	manufacturer
Typenbezeichnung	AMA500L4A	type
Anzahl	1	numbers
Art	Asynchronous	design
Nennleistung(en)	2400 kW	rated power (s)
Nennscheinleistung	2690 kVA	rated apparent power
Nenndrehzahlen oder Drehzahlbereich	600-1800 1/min rpm	rated speed (s)/ speed range
Spannung	750 V @1550rpm	voltage
Frequenz	20-60 Hz	frequency
Nennschlupf	___ %	rated slip
6. Turm		**Tower**
Hersteller		manufacturer
Typenbezeichnung	DSSM04	type
Ausführung (Gitter/Rohr, zyl./kon.)	Tapered turbular	design (lattice/tubular, cylindrical/ conical)
Material	S355	material
Länge	78 m	length

7. Windrichtungsnachführung		Yaw control
Ausführung (aktiv/Passiv)	Active	design (active/passive)
Antriebsart (el./mech./hydr.)	Electrical	drive (electr./mech./hydr.)
Dämpfungssystem während des Betriebes	Friction	damping system during operation
8. Betriebsführung/ Regelung		**Other electric installations**
Art der Leistungsregelung	Pitch control	kind of power control
Antrieb der Leistungsregelung	Blade pitch	actuation of power control
Hersteller der Betriebsführung/ Regelung	KK-electronic	manufacturer of control system
- Typenbezeichnung	WTC 3	- type
- Verwendete Steuerungskurve	____	- applied used control characteristics
9. Sonstige elektrische Komponenten		**Other electric installations**
Anzahl der Kompensationsstufen	Controlled by use of 4 quadrant frequency converter	number of compensation stages
Blindleistung Stufe 1	___ kvar	reactive power stage 1
Art der Netzkopplung	Connected by use of frequency conv.	kind of interconnection
- Hersteller	Alstom	- manufacturer
- Typenbezeichnung	4 quadrant	- type
-	frequency conv.	-
Netzschutzhersteller	KK	mains protective manufacturer
- Typenbezeichnung	______	- type
- Einstellbereiche:		- adjustment ranges:
Spannungssteigerungsschutz	759 V line-line	overvoltage protection
Spannungsrückgangsschutz	621 V line-line for more than 3 sec.	undervoltage protection
Frequenzsteigerungsschutz	51,5 Hz	overfrequency protection
Frequenzrückgangsschutz	47,5 Hz	underfrequency protection
Typenbezeichnung der Abschalteinheit	Short circuit breaker	type of contact break device
Oberschwingungsfilter (Ja/Nein)	Yes	harmonic filter (yes/no)
(Oberschwingungsfilter müssen auf den Netzverknüfpungspunkt ausgelegt sein.)		(harmonic filter have to be designed for the point of common coupling)
10. Bremssystem		**Brake system**
Bremssystem (primär/sekundär)	Blade / Mech. brake	brake system (primary/secondary)
- Aktivierung	Hydraulic	- activation
- Anordnung	Hydraulic	- location
- Bremsenart	Pitch blade/ brake disc	- type
- Betätigung	Active / Passive	- actuation
11. Typenprüfung		**Type test**
Prüfbehörde	DNV	testing authority
Aktenzeichen	____	reference
12. Informativer Teil		**Informative**
Standort der vermessenen WEA	Høvsøre DK	location of measured WTGS
Koordinaten des Standorts	_____	coordinate of location
Seriennummer der WEA	2300439	Serial number of WTGS
der Blätter	1001/ 1002/ 1003	blades
des Getriebes	4803384-020-1	gearbox
des Generators	457691	generator

Anschrift des Herstellers

Address of manufacturer

SIEMENS
Siemens Wind Power A/S
Postbox 171 - Borupvej 16
DK-7330 Brande - Denmark
Tel.: +45 9942 2222

22.8.05 [signature]

Stempel, Unterschrift
stamp, signature

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

The manfacturer of the wind turbine generator system confirms that the WTGS whose noise level, power curve and grid compatability is measured and depicted in the test report xxxxxxx is identical with the above entries with regard to its technical data.

Seite 2 von 2

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Siemens AG
Energy Sector
Freyeslebenstrasse 1
91058 Erlangen, Germany

Siemens Wind Power A/S
Borupvej 16
7330 Brande, Denmark
www.siemens.com/wind

For more information, please contact
our Customer Support Center.
Phone: +49 180 524 70 00
Fax: +49 180 524 24 71
(Charges depending on provider)
E-mail: support.energy@siemens.com

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The new standard for moderate wind conditions

Siemens Wind Turbine SWT-2.3-101

Answers for energy.

SIEMENS

Your trusted partner

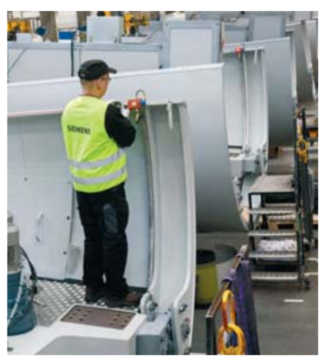
Siemens has been a major driver of innovation in the wind power industry since the early 1980s when wind turbine technology was still in its infancy.

Technology has changed with the times, but Siemens' commitment to providing its customers with proven wind turbine solutions remains the same.

The combination of robust and reliable turbines, highly efficient solutions for power transmission and distribution and a deep understanding of the entire energy market ensures that Siemens will continue to be a leading supplier.

Siemens' record, when it comes to on-time delivery, is impeccable. Long-lasting customer relationships, based on the successful installation of wind turbines, provide for a sound, sustainable and profitable investment.

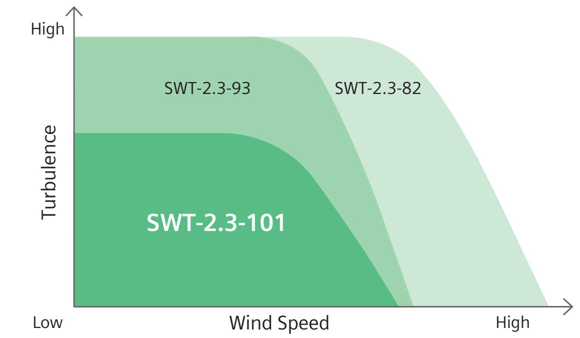
Drawing on 140 years of experience in the energy sector, a strong focus on renewables and a global network of highly skilled and trained employees, Siemens has proven itself to be a trustworthy and reliable business partner. And will continue to be in the future.



Harvest more energy from sites with moderate wind conditions

The Siemens SWT-2.3-101 turbine is designed to deliver unparalleled performance and reliability, making it especially suited to areas with moderate wind conditions.

Siemens has the right turbines for all wind conditions



The SWT-2.3-101 turbine offers low energy production costs, and joins Siemens' 2.3-MW product family, which has proven availabilitity that is among the highest in the industry. The 101-meter rotor is specifically designed to optimize the energy output in areas with moderate wind conditions. The turbine is also ideal for all types of grid connections in most major markets.

The SWT-2.3-101 is designed to last. The robust and reliable design offers a high yield with low maintenance costs. The turbine is backed by advanced condition monitoring and diagnostics, which constantly examine the turbine. Any change in a turbine's performance is promptly addressed by an experienced after-sales service team either remotely or in the field.

If you desire a better return on investment and superior availability, take a closer look at the SWT-2.3-101 turbine.

Superior performance gives higher yields

Optimum energy at moderate wind conditions

Harvesting more energy
The SWT-2.3-101 wind turbine is designed to increase the energy returns from sites with moderate wind conditions. Advanced blade technology also allows for quieter operation. The B49 blade with a rotor diameter of 101 meters and pitch regulation optimizes power output and increases control over the energy output.

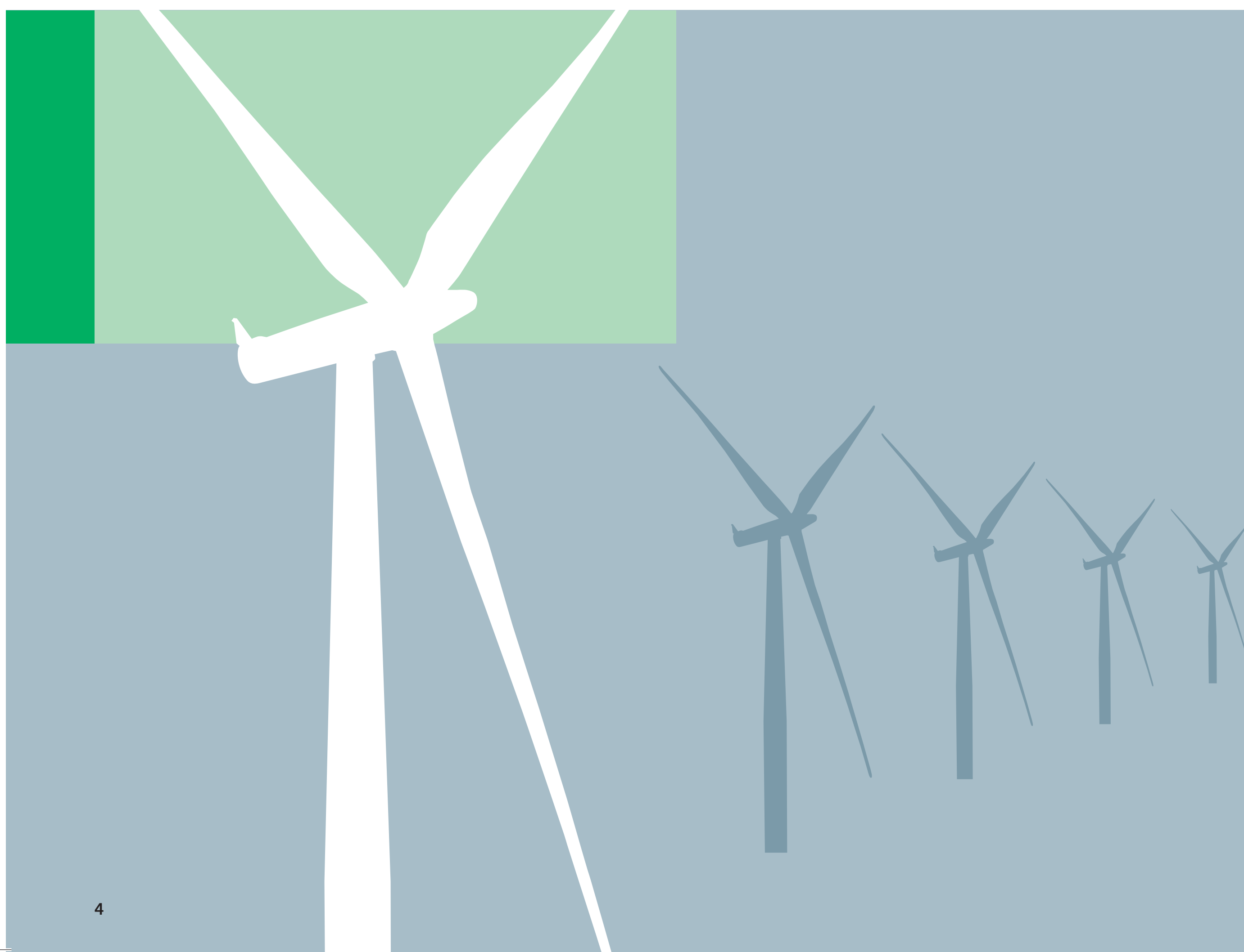
High availability
Currently, the Siemens fleet of 2.3-MW wind turbines sets the industry standard for availability. The SWT-2.3-101 will build on the reputation for reliability that the market has come to expect from a Siemens Wind turbine.

High yield with minimal maintenance
Siemens optimizes the return on investment in its wind turbines through intelligent maintenance that ensures the turbine to deliver high yield with low operational costs.

The rugged structural design, combined with an automatic lubrication system, internal climate control and a generator system without slip rings contributes to exceptional reliability. The innovative design of the SWT-2.3-101 allows for longer service intervals.

Superior grid compliance
The Siemens NetConverter® system is designed for maximum flexibility in the turbine's response to voltage and frequency variations, fault ride-through capability and output adjustment. The advanced wind farm control system provides state-of-the-art fleet management.

Proven track record
Siemens has a proven track record of providing reliable turbines that last. The world's first offshore wind farm in Vindeby, Denmark, was installed in 1991 and is still fully operational. In California, Siemens installed over 1,100 turbines between 1983 and 1990, with 97% still in operation today. Siemens takes its commitment to reliability seriously and prides itself on the long lifespan that its turbines have demonstrated.



No compromise on reliability

SWT-2.3-101: Newest member of the extremely reliable product family

Designed for life
Siemens turbines are designed to last. The robust design of the SWT-2.3-101 allows for trouble-free output throughout the complete lifecycle of the turbine.

The blades are made of fiberglass-reinforced epoxy in Siemens' proprietary IntegralBlade® manufacturing process. The blades are cast in one piece in a closed process, which eliminates the traditional weaknesses found at glue joints in other manufacturers' blades. Like the turbine itself, the blades are designed to last.

Climate control within the turbine protects vital equipment from the outside environment. The turbine also offers controlled-wear strategies for critical components, which results in a further reduction of maintenance costs.

Safety first
Safety is at the heart of all Siemens operations. From production to installation, operation and service, Siemens strives to set the standard in safety.

The fail-to-safe capabilities within a turbine, combined with Siemens' superior lightning protection system, are designed to enhance security for the turbine.

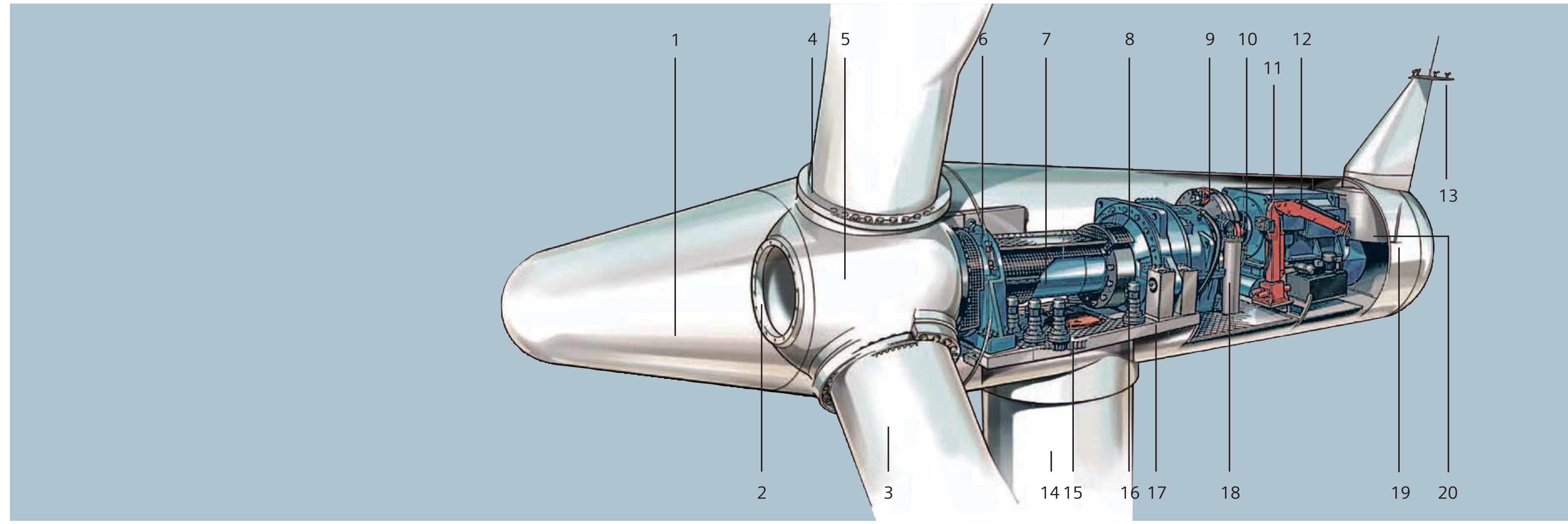
Advanced operations support
Given the logistical challenges associated with servicing wind farms, Siemens has equipped its turbines with a Turbine Condition Monitoring (TCM) system that reduces the need for on-site servicing.

Continuous monitoring of turbines allows for the discovery of small faults before they become major problems.

The TCM system continuously checks the external and internal condition of the wind turbine. Twenty-four hours a day, seven days a week precise measurements are taken of vibrations in the gearbox, the generator and the main shaft bearings. The system instantly detects deviations from normal operating conditions.

Using the knowledge gained from monitoring thousands of turbines over the years, Siemens' experts are exceptionally skilled at analyzing and predicting faults within a turbine. This allows Siemens to proactively plan the service and maintenance of the turbines as each fault can be categorized and prioritized based on the severity of the fault. Siemens can then determine the most appropriate course of action to keep the turbine running at its best.

Technical specifications

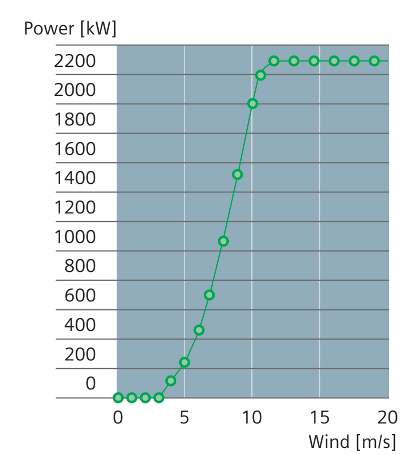


Rotor	
Diameter	101 m
Swept area	8,000 m^2
Rotor speed	6-16 rpm
Power regulation	Pitch regulation with variable speed
Blades	
Type	B49
Length	49 m
Aerodynamic brake	
Type	Full-span pitching
Activation	Active, hydraulic
Transmission system	
Gearbox type	3-stage planetary/helical
Gearbox ratio	1:91
Gearbox oil filtering	Inline and offline
Gearbox cooling	Separate oil cooler
Oil volume	Approximately 400 l
Mechanical brake	
Type	Hydraulic disc brake

Generator	
Type	Asynchronous
Nominal power	2,300 kW
Voltage	690 V
Cooling system	Integrated heat exchanger
Yaw system	
Type	Active
Monitoring system	
SCADA system	WebWPS
Remote control	Full turbine control
Tower	
Type	Cylindrical and/or tapered tubular
Hub height	80 m or site-specific
Operational data	
Cut-in wind speed	3-4 m/s
Rated power at	12-13 m/s
Cut-out wind speed	25 m/s
Maximum 3 s gust	55 m/s (standard version) 60 m/s (IEC version)
Weights	
Rotor	62 tons
Nacelle	82 tons
Tower for 80-m hub height	162 tons

Sales power curve

The calculated power curve data are valid for standard conditions of 15 degrees Celsius air temperature, 1013 hPa air pressure and 1.225 kg/m^3 air density, clean rotor blades and horizontal, undisturbed air flow. The calculated curve data are preliminary.



Nacelle arrangement

1. Spinner
2. Spinner bracket
3. Blade
4. Pitch bearing
5. Rotor hub
6. Main bearing
7. Main shaft
8. Gearbox
9. Brake disc
10. Coupling
11. Generator
12. Service crane
13. Meteorological sensors
14. Tower
15. Yaw ring
16. Yaw gear
17. Nacelle bedplate
18. Oil filter
19. Canopy
20. Generator fan

SWT-2.221-101 Low Noise, Hub Height 99.5 m Acoustic Emission

Sound Power Levels

The warranted sound power levels are presented with reference to the code IEC 61400-11:2002 with amendment 1 dated 2006-05 based on a hub height of 99.5 m and a roughness length of 1.661 m as described in the IEC code. The sound power levels (Lwa) presented are valid for the corresponding wind speeds referenced to a height of 10 m above ground level.

Wind speed [m/s]	4	5	6	7	8	9	10	11	12	Up to cut-out
Sound Power Level	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0

Table 1: Noise emission, Lwa [dB(A) re 1 pW]

Typical Octave Band

Typical, not warranted octave band spectra are tabulated below for 6 and 8 m/s referenced to 10 m height.

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound Power Level	82.6	93.8	97.0	99.5	99.6	97.1	89.3	84.9

Table 2: Typical octave band for 6 m/s

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound Power Level	82.4	93.0	96.0	99.8	100.1	96.5	89.6	85.7

Table 3: Typical octave band for 8 m/s

SWT-2.126-101 Low Noise, Hub Height 99.5 m Acoustic Emission

Sound Power Levels

The warranted sound power levels are presented with reference to the code IEC 61400-11:2002 with amendment 1 dated 2006-05 based on a hub height of 99.5 m and a roughness length of 1.800 m as described in the IEC code. The sound power levels (Lwa) presented are valid for the corresponding wind speeds referenced to a height of 10 m above ground level.

Wind speed [m/s]	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Up to cut-out**
Sound Power Level	104.0	104.0	104.0	104.0	104.0	104.0	104.0	104.0	104.0	104.0

Table 1: Noise emission, Lwa [dB(A) re 1 pW]

Typical Octave Band

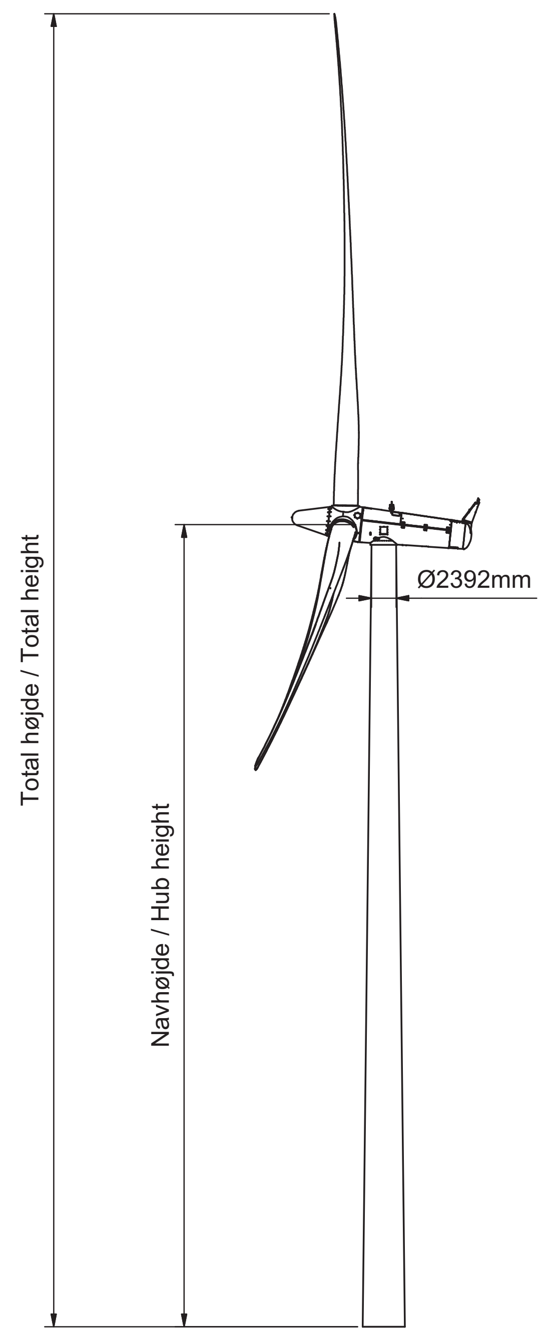
Typical, not warranted octave band spectra are tabulated below for 6 and 8 m/s referenced to 10 m height.

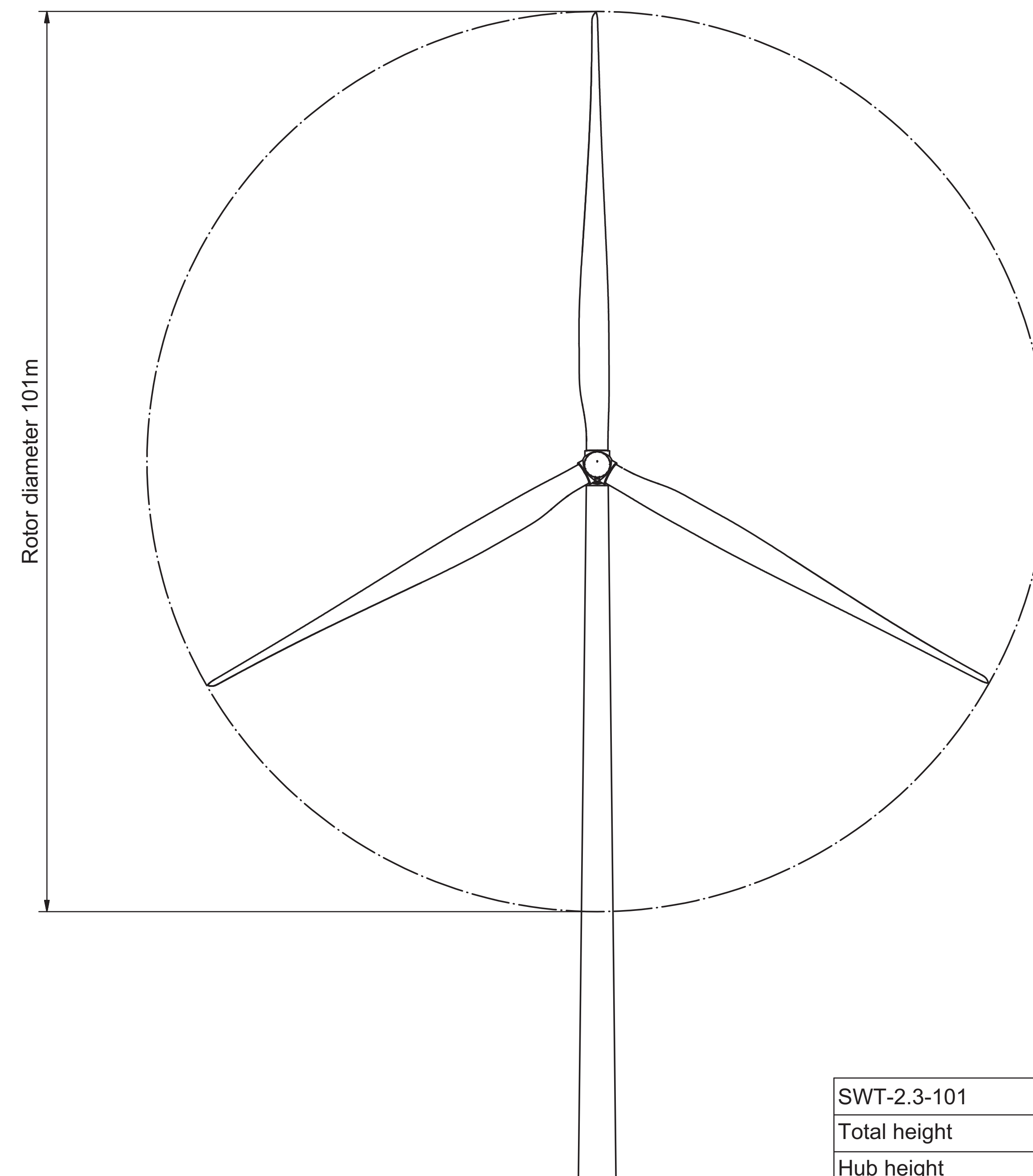
Octave band, centre frequency [Hz]	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Sound Power Level	83.1	94.1	96.6	97.8	97.9	96.5	88.4	84.0

Table 2: Typical octave band for 6 m/s

Octave band, centre frequency [Hz]	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Sound Power Level	82.2	92.5	94.8	98.5	99.1	95.5	89.0	85.1

Table 3: Typical octave band for 8 m/s





SWT-2.3-101			
Total height	130.500m	140.500m	150.000m
Hub height	80.000m	90.000m	99.500m
Tower height	78.540m	88.540m	98.040m
Tower top diameter	2392mm	2392mm	2392mm
Tower bottom diameter	4200mm	4200mm	3960mm

030209	30373	AWO/HAS
Dato: Date:	ECN nr.: ECN no.:	Init: Init:

Vægt ca.:
Weight app.:

Matr.:
Matr.:

Emne:
Part:

Opstalt SWT-2.3-101
Elevation SWT-2.3-101

Tegn. format:
Draw. format:
A2

ISO

SIEMENS

Tegn. skala/Draw. scale:
1:500

Siemens Wind Power A/S
Borupvej 16 DK-7330 Brande
Tel. +45 9942 2222

Tegn. nr./Draw. no.:
1005651