

GE Renewable Energy



Crookwell Wind Farm

Noise Compliance Strategy

May 2018

Document	Rev.	Release Date	Change
Noise Compliance Strategy	00	2018-05-22	First issue
		YYYY-MM-DD	See appendix

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1. Introduction

In accordance with the executed Supply and Install Contract (clause 8.8 and Annex V) and the Development Approval, this report addresses how noise compliance will be achieved at Crookwell 2 Wind Farm.

2. Wind Turbine Specifications

Rated output [MW]	3.43
Hub height [m]	95
Rotor diameter [m]	130
Total turbines	28

The above table provides a summary of the GE 3.4-130 wind turbine generator (WTG) at Crookwell 2. Please refer to Annex D of the executed Supply and Install Contract for further technical specifications.

The noise emitted by the 3.4-130 WTG is predominantly determined by the aerodynamic noise of the rotor blades, which is directly dependent on the circumferential or blade tip speed.

The sound power level can be lowered by reducing the rotor speed and thus lowering and limiting the tip speed. The rated power level is reduced accordingly. In addition the noise can be reduced by pitching the blade.

Due the proximity of the WTG's to noise receptors, the WTG's at Crookwell will operate in Noise Reduced Operation (NRO) in certain wind conditions as defined in Annex V of the Contract. This will ensure that the noise limits set out in the Development Approval are met.

Please refer to the attached NRO document and tables for further information.

3. Testing Requirements

GE has engaged acoustic consultant SLR Consulting to perform noise monitoring in accordance with the requirements of Section 4 of Annex V of the Supply and Install Contract. The relevant operational noise criteria which form the Acoustic Guarantee are given by Table 2 of Item 48 of the Development Approval:

Table 2: Noise criteria dB(A)

Residence	Criteria (dB(A)) Referenced to Hub Height Wind Speed (m/s)									
	3 or less	4	5	6	7	8	9	10	11	12 or more
R1, 1a, 8	35	35	35	35	35	35	36	38	41	45
R19	35	35	35	35	35	35	37	38	41	43
R20, 117, 118, 119	35	35	35	35	35	35	36	38	41	43
R58, 59	35	35	35	35	35	36	38	39	41	42
R60, 61, 62	35	35	35	35	35	36	38	40	43	45
R64, 65	35	35	35	35	35	38	41	43	46	48
R69, 70	35	35	35	35	35	35	38	40	44	46
R71, 73	35	35	35	35	35	37	40	42	45	48
R106	37	38	39	40	42	44	45	47	49	51
R120, 123, 130, 131	35	35	35	36	37	38	39	41	42	44
All other residences not associated with the development and wind speeds > 12m/s	The higher of 35 dB(A) or the existing background noise level plus 5 dB(A)									

Note: To identify the residences referred to in Table 2, see the applicable figure in Appendix 2.

Clause 3.5 of Annex V of the Supply and Install Contract requires Operational Noise Testing at Test Locations to be conducted within 3 months of the Practical Completion Date for the Wind Farm. The Development Approval has the same requirement to determine whether the development is complying with relevant conditions of the project consent.

4. Scope

The testing consists of two stages: **Baseline Noise Monitoring** and **Compliance Noise Monitoring**, which will commence within 3 months after final practical completion. SLR Consulting will receive and review all relevant documentation including: wind farm layout and receptor co-ordinates, Noise Impact Assessment Report completed for the planning application, resident contact details etc. SLR's scope consists broadly of two stages as follows:

Stage 1: Baseline Noise Monitoring

- Deploy up to 10 noise monitors and data loggers at up to 10 identified locations
- Noise monitoring for 4 weeks
- Analyse the monitored baseline data to develop the relevant noise criteria using a statistical regression analysis. This data will then be compared against historically derived regression curves to evaluate if there has been any significant change in baseline noise conditions for the location
- Produce Baseline Noise Report

Stage 2: Compliance Noise Testing

- Produce noise monitoring test plan
- Deploy up to 10 noise monitors and data loggers at up to 10 identified locations from Stage 1
- Noise monitoring for up to 6 weeks
- Produce final Noise Compliance Assessment Report

5. Methodology

The noise monitoring methodology for both stages takes into account the following factors to ensure the accuracy and integrity of results.

Deployment of Monitoring Equipment

The monitored parameters at all sites (10 in total) will include the LA1, LA10, LA90, LA95 and LAeq noise levels. Unattended weather monitoring station will also be deployed, capable of recording local wind speed and direction, temperature, RH and rainfall. This data will be used to assess monitored noise data validity.

The noise monitoring shall also include simultaneous C weighted noise levels which will facilitate the 60 dBC Low Frequency Noise special audible characteristic (SAC) of the assessment of NSW Wind Energy: Noise Assessment Bulletin ABO2. The position of the baseline noise monitoring sites shall be selected with due consideration of the requirements of SA EPA Guidelines, previous monitoring undertaken (if any) and other factors including direction of exposure from future wind farm, shelter from wind, presence of extraneous noise sources and solar access etc. The baseline noise monitoring sites will be documented through extensive photographs and GPS location. Monitoring shall extend for 4 weeks.

Data Analysis and Baseline Noise Report submission

Analysis of collected data shall include the removal of data collected during periods of invalid conditions (e.g. heavy rain, high local wind, high extraneous noise sources etc.), which will ensure the integrity of the collected data. Wind data can be obtained from a suitable nearby monitoring mast to provide additional meteorological information, i.e. hub height wind speed, wind direction, throughout the monitoring period.

The relevant baseline noise curve can then be developed using a statistical regression analysis of the valid monitored data which feeds into the final **Baseline Noise Report**, suitable for submission to the project proponent.

Compliance Noise Monitoring

As per the Baseline Noise Monitoring period, meteorological conditions are evaluated during the survey period to determine if the 500 intervals of worst case wind direction requirement have been fulfilled. During the site visit a short term attended noise survey will be completed at each monitoring site to subjectively scrutinise the presence (or otherwise) of any Special Audible Characteristics e.g. tonality, that may require further detailed objective evaluation.

Following a comprehensive analysis of data, a complete detailed **Noise Compliance Assessment Report** will be prepared, demonstrating compliance to the Development Approval requirements, suitable for submission to the project proponent.

6. Schedule

A high level schedule is below to illustrate the timings of the background and operational noise monitoring periods:

Activity	Start	Finish
Baseline Noise Monitoring	20/04/2018	18/05/2018
Produce Baseline Noise Report	21/05/2018	18/06/2018
Compliance Noise Monitoring (within 3 months of PC)	Approx. August 2018	Approx. September 2018
Produce Compliance Noise Report	Approx. September 2018	Approx. October 2018

7. Appendix A – NRO Technical Document

Technical Documentation Wind Turbine Generator Systems 3.4-130 - 50 Hz



Product Acoustic Specifications

Noise-Reduced Operation according to IEC
Incl. Octave and 1/3rd Octave Band Spectra

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1 Introduction

Thanks to its plant control system, the 3.4-130 WTGS is able to enter noise-reduced operating mode (NRO = Noise-Reduced Operation) without any manual intervention. This is not a compulsory fixed operating point, but a range below 'normal' nominal operation that can be defined by means of parameter settings.

With the aid of the control system the turbine can be switched to noise-reduced mode, usually depending on the time of day, e.g. NRO at nighttime and normal operation at daytime.

The noise emitted by the 3.4-130 is predominantly determined by the aerodynamic broadband noise of the rotor blades, which is directly dependent on the circumferential or blade tip speed.

The sound power level can be lowered by reducing the rotor speed and thus lowering and limiting the tip speed. The rated power level is reduced accordingly. In addition the noise can be reduced by pitching the blade. The NRO modes use these two techniques to get the optimal energy yield while meeting the noise target.

In the upper wind speed range at the benefit of lower noise levels, there is some loss in energy yield because of the reduction in power level.

Controller parameter settings determine at which maximum noise emission level the turbine operates. Reference values for various reduced sound power levels are given further on in the document.

It is always possible to determine compliance of the actual operating mode with the set operating mode as the control system constantly records the operating data on the system computer. This could be useful in meeting possible requirements issued by the monitoring authorities.

Noise-reduced operation (NRO) is enabled in a time-controlled manner via a leaded time switch. The most significant data are:

P_Act 10 minutes mean value of electrical active power

N_Rot 10 minutes mean value of rotor speed

The two stored parameter values thus provide clear and traceable evidence of the noise-reduced operational mode. A retrospective check of the installed system can be carried out by evaluating up to three months of recorded data.

2 Wind Farm Noise Management (available as an option)

In noise-constrained areas it is often necessary to adapt the wind turbine operation to satisfy far-field noise limits. GE offers a dedicated Farm Noise Management system that provides greater flexibility and higher energy yield than standard turbine controls. This advanced scheme allows to continuously adjust the farm operation based on the environmental variables that influence farm noise emission, essentially wind speed and wind direction.

The Wind Farm Noise Management package includes the following service and hardware:

- Park level noise propagation modeling and optimization of wind farm operation,
- Table with optimum turbine set-points across the park as a function of wind speed and wind sector,
- Installation and commissioning of the Farm Noise Management Software Package.

3 Sound Power Levels

Following are 10 minute mean values of nominal power and rotor speed for the 3.4-130 turbine at different sound power levels (L_{WA}):

NRO label	Nominal power (kW)	Nominal rotor speed (rpm)	Reduced reference value L_{WA} (dB)
Normal Operation	3430	12.1	106.5
NRO 106	3370	11.8	106.0
NRO105	3230	11.3	105.0
NRO104	3085	10.8	104.0
NRO103	2900	10.3	103.0
NRO102	2700	9.8	102.0
NRO101	2540	9.4	101.0
NRO100	2200	8.9	100.0

Table 1: Noise-reduced operation modes

4 Sound Power Level as a Function of Wind Speed

The following table presents calculated reference sound power levels as a function of hub height wind.

Wind speed at hub height (m/s)	Normal Operation 106.5 LWA (dB)	NRO 106 LWA (dB)	NRO 105 LWA (dB)	NRO 104 LWA (dB)	NRO 103 LWA (dB)	NRO 102 LWA (dB)	NRO 101 LWA (dB)	NRO 100 LWA (dB)
4	95.7	95.7	95.7	95.7	95.7	95.7	95.7	95.7
5	96.3	96.3	96.3	96.3	96.3	96.3	96.3	96.3
6	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.7
7	102.0	102.0	102.0	102.0	102.0	101.8	100.9	100.0
8	104.7	104.6	104.6	104.0	103.0	102.0	101.0	100.0
9	106.4	105.8	105.0	104.0	103.0	102.0	101.0	100.0
10	106.5	106.0	105.0	104.0	103.0	102.0	101.0	100.0
11	106.5	106.0	105.0	104.0	103.0	102.0	101.0	100.0
12	106.5	106.0	105.0	104.0	103.0	102.0	101.0	100.0
13	106.5	106.0	105.0	104.0	103.0	102.0	101.0	100.0
14	106.5	106.0	105.0	104.0	103.0	102.0	101.0	100.0

Table 2: Reference sound power levels

The corresponding wind speed at 10 m height depends on hub height. It can be calculated for a given surface roughness using a logarithmic trend for wind shear:

$$V_{10m\ height} = V_{hub} \frac{\ln\left(\frac{10m}{z_0}\right)}{\ln\left(\frac{hub\ height}{z_0}\right)} *$$

Typical values for on land surface roughness (z_0) are 0.05 m, depending on terrain conditions.

5 Uncertainty Levels

The apparent sound power levels given above are mean values from turbines under evaluation. Uncertainty levels u_C , σ_P , σ_R and σ_T associated with measurements and mean values are described in IEC 61400-11 and IEC/TS 61400-14.

For GE wind turbines, a typical value of $\sigma_P = 0.8$ dB can be assumed.

The uncertainties for octave and 1/3rd-octave sound power levels are generally higher than for total sound power levels. Guidance is given in IEC 61400-11.

6 Tonality

The tonal audibility ($\Delta L_{\alpha,k}$), when measured in accordance with the IEC 61400-11 standard, for the 3.4-130 is less than or equal to 4 dB.

* Simplified from IEC 61400-11: 2006 equation 7

7 IEC 61400-11 and IEC/TS 61400-14 Terminology

- $L_{WA,k}$ is wind turbine apparent sound power level (referenced to $10^{-12}W$) measured with A-weighting as function of wind speed. Derived from multiple measurement reports per IEC 61400-11, it is considered as a mean value
- u_c is the measurement uncertainty for acoustic testing as defined in IEC 61400-11.
- σ_P is the 3.4-130 unit-to-unit product variation according to IEC/TS 61400-14.
- σ_R is the overall measurement testing reproducibility as defined in IEC/TS 61400-14;
- σ_T is the total standard deviation combining both σ_P and σ_R
- $\Delta L_{a,k}$ is the tonal audibility according to IEC 61400-11, described as potentially audible narrow band sound

8 Octave Band Spectra and 1/3rd Octave Band Spectra

The tables in Annex I are showing octave band values for different noise-reduced operational modes at different wind speeds.

The tables in Annex II are showing the 1/3rd octave band values for different noise-reduced operational modes at different wind speeds.

9 References

- IEC 61400-11, wind turbine generator systems part 11: Acoustic noise measurement techniques, ed. 2.1 (2006-11), or ed. 3 (2012-11)
- IEC/TS 61400-14, Wind turbines – part 14: Declaration of apparent sound power level and tonality values, ed. 1 (2005-03)
- MNPT – Machine Noise Performance Test, Technical documentation

Annex I – Octave Band Spectra

NRO 106 – A-weighted Octave Spectra (dB)												
Hub Height Wind Speed [m/s]	4	5	6	7	8	9	10	11	12	13	14.0-cut out	
Wind speed at 10 m height for a hub height of 85 m [m/s]	2.8	3.6	4.3	5.0	5.7	6.4	7.1	7.8	8.5	9.3	10-cut out	
Wind speed at 10 m height for a hub height of 110 m [m/s]	2.8	3.4	4.1	4.8	5.5	6.2	6.9	7.6	8.3	8.9	9.6-cut out	
Wind speed at 10 m height for a hub height of 164.5 m [m/s]	2.6	3.3	3.9	4.6	5.2	5.9	6.5	7.2	7.9	8.5	9.2-cut out	
Frequency [Hz]	16	49.2	49.9	53.3	56.4	59.2	61.1	61.2	61.4	61.4	61.4	61.3
	32	64.8	65.3	68.1	71.1	73.6	75.1	75.2	75.6	75.6	75.6	75.5
	63	77.3	78.0	80.4	83.4	85.7	86.9	87.0	87.3	87.3	87.3	87.2
	125	86.5	87.0	89.1	92.2	94.5	95.3	95.5	95.8	95.7	95.6	95.6
	250	89.2	89.7	92.1	95.4	98.0	99.0	99.2	99.0	98.7	98.7	98.7
	500	89.3	89.9	92.4	95.9	98.7	100.0	100.2	100.0	100.1	100.1	100.2
	1000	89.6	90.1	92.5	95.9	98.6	100.0	100.1	100.2	100.4	100.6	100.7
	2000	87.3	88.4	90.5	93.6	96.0	97.3	97.4	97.8	97.9	97.8	97.5
	4000	78.5	80.3	82.9	85.9	88.1	89.2	89.5	89.1	88.5	87.6	87.0
8000	60.1	61.3	63.6	66.6	68.8	70.1	70.2	68.3	67.0	66.2	65.2	
Total Sound Power Level [dB]	95.7	96.3	98.7	102.0	104.6	105.8	106.0	106.0	106.0	106.0	106.0	

Table 3: NRO 106 Octave Band Sound Power Levels as a function of wind speeds

NRO 105 – A-weighted Octave Spectra (dB)												
Hub Height Wind Speed [m/s]	4	5	6	7	8	9	10	11	12	13	14.0-cut out	
Wind speed at 10 m height for a hub height of 85 m [m/s]	2.8	3.6	4.3	5.0	5.7	6.4	7.1	7.8	8.5	9.3	10-cut out	
Wind speed at 10 m height for a hub height of 110 m [m/s]	2.8	3.4	4.1	4.8	5.5	6.2	6.9	7.6	8.3	8.9	9.6-cut out	
Wind speed at 10 m height for a hub height of 164.5 m [m/s]	2.6	3.3	3.9	4.6	5.2	5.9	6.5	7.2	7.9	8.5	9.2-cut out	
Frequency [Hz]	16	49.2	49.9	53.3	56.4	59.2	60.6	60.7	60.8	60.8	60.7	60.6
	32	64.8	65.3	68.1	71.1	73.6	74.6	74.7	74.9	74.9	74.9	74.8
	63	77.3	78.0	80.4	83.4	85.7	86.3	86.3	86.5	86.5	86.5	86.5
	125	86.5	87.0	89.1	92.2	94.5	94.7	94.8	94.9	94.7	94.7	94.7
	250	89.2	89.7	92.1	95.4	98.0	98.2	98.2	97.9	97.8	97.7	97.8
	500	89.3	89.9	92.4	95.9	98.7	99.1	99.0	99.0	99.1	99.2	99.2
	1000	89.6	90.1	92.5	95.9	98.6	99.1	99.1	99.3	99.5	99.6	99.7
	2000	87.3	88.4	90.5	93.6	96.0	96.6	96.6	96.8	96.8	96.6	96.2
	4000	78.5	80.3	82.9	85.9	88.1	88.3	88.3	87.9	86.9	86.1	85.8
	8000	60.1	61.3	63.6	66.6	68.8	68.4	67.9	66.7	65.3	64.7	64.0
Total Sound Power Level [dB]	95.7	96.3	98.7	102.0	104.6	105.0	105.0	105.0	105.0	105.0	105.0	

Table 4: NRO 105 Octave Band Sound Power Levels as a function of wind speeds

NRO 104 – A-weighted Octave Spectra (dB)												
Hub Height Wind Speed [m/s]	4	5	6	7	8	9	10	11	12	13	14.0-cut out	
Wind speed at 10 m height for a hub height of 85 m [m/s]	2.8	3.6	4.3	5.0	5.7	6.4	7.1	7.8	8.5	9.3	10-cut out	
Wind speed at 10 m height for a hub height of 110 m [m/s]	2.8	3.4	4.1	4.8	5.5	6.2	6.9	7.6	8.3	8.9	9.6-cut out	
Wind speed at 10 m height for a hub height of 164.5 m [m/s]	2.6	3.3	3.9	4.6	5.2	5.9	6.5	7.2	7.9	8.5	9.2-cut out	
Frequency [Hz]	16	49.2	49.9	53.3	56.4	59.1	59.4	59.4	59.6	59.6	59.6	59.5
	32	64.8	65.3	68.1	71.1	73.3	73.4	73.5	73.8	73.9	73.8	73.8
	63	77.3	78.0	80.4	83.4	85.2	85.2	85.2	85.5	85.5	85.5	85.5
	125	86.5	87.0	89.1	92.2	93.9	93.9	93.9	94.0	93.9	93.9	93.9
	250	89.2	89.7	92.1	95.4	97.4	97.5	97.4	97.0	96.9	96.9	96.9
	500	89.3	89.9	92.4	95.9	98.0	98.1	98.1	97.9	98.1	98.2	98.3
	1000	89.6	90.1	92.5	95.9	97.9	97.9	98.0	98.2	98.4	98.4	98.5
	2000	87.3	88.4	90.5	93.6	95.4	95.4	95.4	95.9	95.7	95.4	95.0
	4000	78.5	80.3	82.9	85.9	87.5	87.5	87.5	86.8	85.6	84.7	84.8
8000	60.1	61.3	63.6	66.6	68.2	68.3	68.2	65.5	64.3	63.7	63.2	
Total Sound Power Level [dB]	95.7	96.3	98.7	102.0	104.0	104.0	104.0	104.0	104.0	104.0	104.0	

Table 5: NRO 104 Octave Band Sound Power Levels as a function of wind speeds

NRO 103 – A-weighted Octave Spectra (dB)												
Hub Height Wind Speed [m/s]	4	5	6	7	8	9	10	11	12	13	14.0-cut out	
Wind speed at 10 m height for a hub height of 85 m [m/s]	2.8	3.6	4.3	5.0	5.7	6.4	7.1	7.8	8.5	9.3	10-cut out	
Wind speed at 10 m height for a hub height of 110 m [m/s]	2.8	3.4	4.1	4.8	5.5	6.2	6.9	7.6	8.3	8.9	9.6-cut out	
Wind speed at 10 m height for a hub height of 164.5 m [m/s]	2.6	3.3	3.9	4.6	5.2	5.9	6.5	7.2	7.9	8.5	9.2-cut out	
Frequency [Hz]	16	49.2	49.9	53.3	56.4	58.9	59.2	59.3	59.4	59.4	59.4	59.3
	32	64.8	65.3	68.1	71.1	72.8	73.0	73.0	73.3	73.4	73.3	73.3
	63	77.3	78.0	80.4	83.4	84.5	84.5	84.5	84.8	84.8	84.8	84.7
	125	86.5	87.0	89.1	92.2	92.9	92.9	92.9	93.0	92.9	92.9	92.9
	250	89.2	89.7	92.1	95.4	96.4	96.5	96.4	96.0	95.9	95.9	95.9
	500	89.3	89.9	92.4	95.9	97.1	97.1	97.1	96.9	97.1	97.2	97.3
	1000	89.6	90.1	92.5	95.9	97.0	96.9	97.0	97.2	97.4	97.4	97.5
	2000	87.3	88.4	90.5	93.6	94.4	94.4	94.4	94.9	94.7	94.4	94.0
	4000	78.5	80.3	82.9	85.9	86.5	86.5	86.5	85.8	84.6	83.7	83.8
	8000	60.1	61.3	63.6	66.6	67.2	67.3	67.2	64.5	63.3	62.7	62.2
Total Sound Power Level [dB]	95.7	96.3	98.7	102.0	103.0	103.0	103.0	103.0	103.0	103.0	103.0	

Table 6: NRO 103 Octave Band Sound Power Levels as a function of wind speeds

NRO 102 – A-weighted Octave Spectra (dB)												
Hub Height Wind Speed [m/s]	4	5	6	7	8	9	10	11	12	13	14.0-cut out	
Wind speed at 10 m height for a hub height of 85 m [m/s]	2.8	3.6	4.3	5.0	5.7	6.4	7.1	7.8	8.5	9.3	10-cut out	
Wind speed at 10 m height for a hub height of 110 m [m/s]	2.8	3.4	4.1	4.8	5.5	6.2	6.9	7.6	8.3	8.9	9.6-cut out	
Wind speed at 10 m height for a hub height of 164.5 m [m/s]	2.6	3.3	3.9	4.6	5.2	5.9	6.5	7.2	7.9	8.5	9.2-cut out	
Frequency [Hz]	16	49.2	49.9	53.3	56.4	57.4	57.5	57.5	57.7	57.7	57.6	57.6
	32	64.8	65.3	68.1	71.0	71.6	71.6	71.7	72.0	72.0	72.0	72.0
	63	77.3	78.0	80.4	83.2	83.4	83.4	83.4	83.7	83.8	83.8	83.7
	125	86.5	87.0	89.1	92.0	92.2	92.2	92.2	92.3	92.2	92.2	92.2
	250	89.2	89.7	92.1	95.2	95.5	95.5	95.5	95.2	95.1	95.2	95.2
	500	89.3	89.9	92.4	95.6	95.9	95.9	95.9	95.9	96.0	96.2	96.3
	1000	89.6	90.1	92.5	95.6	95.9	95.8	95.9	96.0	96.2	96.3	96.3
	2000	87.3	88.4	90.5	93.4	93.6	93.5	93.5	93.8	93.6	93.0	92.6
	4000	78.5	80.3	82.9	85.7	85.9	85.9	85.9	84.6	83.1	82.6	82.6
8000	60.1	61.3	63.6	66.4	66.5	66.4	66.2	63.9	62.3	61.4	60.0	
Total Sound Power Level [dB]	95.7	96.3	98.7	101.8	102.0	102.0	102.0	102.0	102.0	102.0	102.0	

Table 7: NRO 102 Octave Band Sound Power Levels as a function of wind speeds

NRO 101 – A-weighted Octave Spectra (dB)												
Hub Height Wind Speed [m/s]	4	5	6	7	8	9	10	11	12	13	14.0-cut out	
Wind speed at 10 m height for a hub height of 85 m [m/s]	2.8	3.6	4.3	5.0	5.7	6.4	7.1	7.8	8.5	9.3	10-cut out	
Wind speed at 10 m height for a hub height of 110 m [m/s]	2.8	3.4	4.1	4.8	5.5	6.2	6.9	7.6	8.3	8.9	9.6-cut out	
Wind speed at 10 m height for a hub height of 164.5 m [m/s]	2.6	3.3	3.9	4.6	5.2	5.9	6.5	7.2	7.9	8.5	9.2-cut out	
Frequency [Hz]	16	49.2	49.9	53.3	56.3	56.6	56.6	56.7	56.8	56.8	56.8	56.7
	32	64.8	65.3	68.1	70.6	70.8	70.8	70.8	71.1	71.2	71.2	71.1
	63	77.3	78.0	80.4	82.5	82.6	82.6	82.6	82.8	82.9	82.9	82.9
	125	86.5	87.0	89.1	91.2	91.3	91.3	91.3	91.4	91.3	91.3	91.4
	250	89.2	89.7	92.1	94.4	94.5	94.5	94.5	94.3	94.2	94.3	94.4
	500	89.3	89.9	92.4	94.8	94.9	94.9	94.9	94.8	95.0	95.2	95.4
	1000	89.6	90.1	92.5	94.8	94.9	94.8	94.8	95.0	95.2	95.2	95.3
	2000	87.3	88.4	90.5	92.6	92.6	92.6	92.6	92.8	92.5	91.9	91.4
	4000	78.5	80.3	82.9	84.9	85.1	85.0	84.9	83.4	82.1	81.4	81.4
	8000	60.1	61.3	63.6	65.6	65.7	65.7	65.0	62.9	61.8	60.1	58.8
Total Sound Power Level [dB]	95.7	96.3	98.7	100.9	101.0	101.0	101.0	101.0	101.0	101.0	101.0	

Table 8: NRO 101 Octave Band Sound Power Levels as a function of wind speeds

NRO 100 – A-weighted Octave Spectra (dB)												
Hub Height Wind Speed [m/s]	4	5	6	7	8	9	10	11	12	13	14.0-cut out	
Wind speed at 10 m height for a hub height of 85 m [m/s]	2.8	3.6	4.3	5.0	5.7	6.4	7.1	7.8	8.5	9.3	10-cut out	
Wind speed at 10 m height for a hub height of 110 m [m/s]	2.8	3.4	4.1	4.8	5.5	6.2	6.9	7.6	8.3	8.9	9.6-cut out	
Wind speed at 10 m height for a hub height of 164.5 m [m/s]	2.6	3.3	3.9	4.6	5.2	5.9	6.5	7.2	7.9	8.5	9.2-cut out	
Frequency [Hz]	16	49.2	49.9	53.3	55.4	55.5	55.6	55.7	55.8	55.8	55.8	55.7
	32	64.8	65.3	68.1	69.7	69.8	69.8	69.9	70.1	70.2	70.2	70.1
	63	77.3	78.0	80.4	81.7	81.6	81.7	81.7	81.9	82.0	82.0	82.0
	125	86.5	87.0	89.1	90.3	90.4	90.4	90.4	90.5	90.5	90.5	90.5
	250	89.2	89.7	92.1	93.5	93.5	93.5	93.4	93.4	93.3	93.4	93.5
	500	89.3	89.9	92.4	93.8	93.8	93.8	93.8	93.8	94.0	94.2	94.3
	1000	89.6	90.1	92.5	93.8	93.8	93.8	93.8	93.9	94.1	94.2	94.2
	2000	87.3	88.4	90.5	91.6	91.6	91.7	91.7	91.8	91.4	90.7	90.3
	4000	78.5	80.3	82.9	84.1	84.1	84.0	83.8	82.5	80.8	80.3	80.3
8000	60.1	61.3	63.6	64.8	64.7	64.3	63.6	62.5	60.3	59.2	57.8	
Total Sound Power Level [dB]	95.7	96.3	98.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	

Table 9: NRO 100 Octave Band Sound Power Levels as a function of wind speeds

Annex II – 1/3rd Octave Band Spectra

NRO 106 – 1/3 rd -Octave Spectra [dB]												
Hub Height Wind Speed [m/s]	4	5	6	7	8	9	10	11	12	13	14-cut out	
Wind speed at 10 m height for a hub height of 85 m [m/s]	2.8	3.6	4.3	5.0	5.7	6.4	7.1	7.8	8.5	9.3	10-cut out	
Wind speed at 10 m height for a hub height of 110 m [m/s]	2.8	3.4	4.1	4.8	5.5	6.2	6.9	7.6	8.3	8.9	9.6-cut out	
Wind speed at 10 m height for a hub height of 164.5 m [m/s]	2.6	3.3	3.9	4.6	5.2	5.9	6.5	7.2	7.9	8.5	9.2-cut out	
Frequency [Hz]	12.5	34.5	35.6	39.4	42.7	45.6	47.9	48.0	48.1	48.1	48.0	47.9
	16	42.0	42.8	46.4	49.6	52.4	54.4	54.6	54.7	54.7	54.6	54.5
	20	48.1	48.8	52.1	55.2	57.9	59.8	59.9	60.1	60.1	60.1	60.0
	25	53.6	54.1	57.3	60.3	62.9	64.7	64.8	65.0	65.1	65.0	64.9
	32	58.6	59.1	62.0	65.0	67.6	69.2	69.3	69.6	69.7	69.6	69.5
	40	63.1	63.6	66.3	69.3	71.8	73.3	73.4	73.8	73.8	73.8	73.7
	50	66.9	67.4	70.0	72.9	75.4	76.7	76.8	77.2	77.2	77.2	77.2
	63	71.4	72.0	74.5	77.5	79.8	81.1	81.2	81.5	81.5	81.5	81.4
	80	75.5	76.2	78.5	81.5	83.8	84.9	85.0	85.4	85.4	85.3	85.3
	100	78.8	79.5	81.6	84.6	86.9	87.9	88.0	88.4	88.4	88.3	88.3
	125	81.7	82.3	84.3	87.3	89.5	90.3	90.5	90.9	90.8	90.7	90.7
	160	83.4	83.9	86.1	89.2	91.6	92.4	92.6	92.8	92.6	92.5	92.5
	200	84.1	84.5	86.9	90.1	92.6	93.4	93.6	93.6	93.3	93.2	93.2
	250	84.7	85.1	87.5	90.8	93.4	94.4	94.6	94.4	94.0	94.0	94.0
	315	84.6	85.1	87.5	91.0	93.7	94.8	95.1	94.7	94.4	94.4	94.4
	400	84.5	85.0	87.5	91.0	93.8	95.1	95.3	94.9	94.9	94.8	94.9
	500	84.5	85.1	87.6	91.1	93.9	95.3	95.5	95.2	95.3	95.4	95.4
	630	84.7	85.3	87.8	91.2	94.0	95.4	95.6	95.5	95.7	95.8	95.8
	800	84.9	85.4	87.8	91.3	94.0	95.4	95.5	95.6	95.8	96.0	96.1
	1000	84.8	85.3	87.7	91.1	93.8	95.2	95.4	95.5	95.7	95.9	96.0
1250	84.7	85.3	87.6	90.9	93.6	95.0	95.1	95.3	95.5	95.6	95.7	
1600	83.9	84.8	86.9	90.1	92.7	94.0	94.1	94.5	94.7	94.7	94.6	
2000	82.7	83.7	85.8	88.9	91.2	92.4	92.6	93.1	93.1	93.0	92.6	
2500	80.2	81.8	83.9	86.9	89.2	90.3	90.5	90.9	90.8	90.3	89.7	
3150	76.7	78.6	81.3	84.2	86.4	87.5	87.8	87.7	87.3	86.3	85.7	
4000	72.7	74.2	76.7	79.9	82.2	83.1	83.4	82.6	81.5	80.6	80.4	
5000	67.4	68.9	71.2	74.3	76.7	77.9	78.1	76.3	75.0	74.4	74.0	
6300	59.8	61.0	63.3	66.3	68.5	69.8	69.9	68.0	66.7	65.9	64.9	
8000	48.2	49.3	51.7	54.9	57.0	58.2	58.3	56.3	55.2	53.8	52.5	
10000	32.5	33.9	36.6	40.2	42.7	44.1	44.3	42.4	40.9	39.4	38.5	
Total Sound Power Level [dB]	95.7	96.3	98.7	102.0	104.6	105.8	106.0	106.0	106.0	106.0	106.0	

Table 10: NRO 106 1/3rd-Octave Band Sound Power Levels as a function of wind speeds

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NRO 105 – 1/3 rd -Octave Spectra [dB]												
Hub Height Wind Speed [m/s]	4	5	6	7	8	9	10	11	12	13	14-cut out	
Wind speed at 10 m height for a hub height of 85 m [m/s]	2.8	3.6	4.3	5.0	5.7	6.4	7.1	7.8	8.5	9.3	10-cut out	
Wind speed at 10 m height for a hub height of 110 m [m/s]	2.8	3.4	4.1	4.8	5.5	6.2	6.9	7.6	8.3	8.9	9.6-cut out	
Wind speed at 10 m height for a hub height of 164.5 m [m/s]	2.6	3.3	3.9	4.6	5.2	5.9	6.5	7.2	7.9	8.5	9.2-cut out	
Frequency [Hz]	12.5	34.5	35.6	39.4	42.7	45.6	47.4	47.5	47.5	47.5	47.5	47.3
	16	42.0	42.8	46.4	49.6	52.4	53.9	54.0	54.1	54.1	54.0	53.9
	20	48.1	48.8	52.1	55.2	57.9	59.3	59.4	59.5	59.5	59.4	59.3
	25	53.6	54.1	57.3	60.3	62.9	64.2	64.3	64.4	64.4	64.4	64.3
	32	58.6	59.1	62.0	65.0	67.6	68.7	68.8	68.9	69.0	68.9	68.9
	40	63.1	63.6	66.3	69.3	71.8	72.8	72.9	73.1	73.1	73.1	73.0
	50	66.9	67.4	70.0	72.9	75.4	76.2	76.3	76.5	76.5	76.5	76.4
	63	71.4	72.0	74.5	77.5	79.8	80.5	80.5	80.7	80.7	80.7	80.7
	80	75.5	76.2	78.5	81.5	83.8	84.4	84.4	84.6	84.5	84.5	84.5
	100	78.8	79.5	81.6	84.6	86.9	87.3	87.4	87.6	87.5	87.4	87.4
	125	81.7	82.3	84.3	87.3	89.5	89.8	89.9	89.9	89.8	89.8	89.8
	160	83.4	83.9	86.1	89.2	91.6	91.7	91.8	91.8	91.6	91.6	91.6
	200	84.1	84.5	86.9	90.1	92.6	92.7	92.7	92.5	92.3	92.3	92.3
	250	84.7	85.1	87.5	90.8	93.4	93.5	93.5	93.2	93.1	93.0	93.1
	315	84.6	85.1	87.5	91.0	93.7	93.9	93.9	93.6	93.5	93.4	93.5
	400	84.5	85.0	87.5	91.0	93.8	94.1	94.1	93.9	93.9	93.9	93.9
	500	84.5	85.1	87.6	91.1	93.9	94.4	94.3	94.3	94.3	94.4	94.4
	630	84.7	85.3	87.8	91.2	94.0	94.5	94.4	94.5	94.7	94.8	94.9
	800	84.9	85.4	87.8	91.3	94.0	94.5	94.5	94.7	94.9	95.0	95.1
	1000	84.8	85.3	87.7	91.1	93.8	94.4	94.4	94.5	94.7	94.9	95.0
1250	84.7	85.3	87.6	90.9	93.6	94.2	94.2	94.4	94.5	94.6	94.6	
1600	83.9	84.8	86.9	90.1	92.7	93.3	93.3	93.5	93.6	93.6	93.4	
2000	82.7	83.7	85.8	88.9	91.2	91.8	91.8	92.1	92.0	91.7	91.3	
2500	80.2	81.8	83.9	86.9	89.2	89.7	89.8	89.8	89.5	88.9	88.3	
3150	76.7	78.6	81.3	84.2	86.4	86.7	86.7	86.6	85.7	84.8	84.4	
4000	72.7	74.2	76.7	79.9	82.2	82.3	82.1	81.0	79.8	79.4	79.3	
5000	67.4	68.9	71.2	74.3	76.7	76.6	76.0	74.5	73.7	73.1	72.6	
6300	59.8	61.0	63.3	66.3	68.5	68.1	67.6	66.4	65.0	64.4	63.7	
8000	48.2	49.3	51.7	54.9	57.0	57.0	56.1	54.8	53.6	52.0	51.3	
10000	32.5	33.9	36.6	40.2	42.7	42.7	42.2	40.9	39.6	37.5	36.5	
Total Sound Power Level [dB]	95.7	96.3	98.7	102.0	104.6	105.0	105.0	105.0	105.0	105.0	105.0	

Table 11: NRO 105 1/3rd-Octave Band Sound Power Levels as a function of wind speeds

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NRO 104 – 1/3 rd -Octave Spectra [dB]												
Hub Height Wind Speed [m/s]	4	5	6	7	8	9	10	11	12	13	14-cut out	
Wind speed at 10 m height for a hub height of 85 m [m/s]	2.8	3.6	4.3	5.0	5.7	6.4	7.1	7.8	8.5	9.3	10-cut out	
Wind speed at 10 m height for a hub height of 110 m [m/s]	2.8	3.4	4.1	4.8	5.5	6.2	6.9	7.6	8.3	8.9	9.6-cut out	
Wind speed at 10 m height for a hub height of 164.5 m [m/s]	2.6	3.3	3.9	4.6	5.2	5.9	6.5	7.2	7.9	8.5	9.2-cut out	
Frequency [Hz]	12.5	34.5	35.6	39.4	42.7	45.6	46.1	46.2	46.3	46.3	46.2	46.1
	16	42.0	42.8	46.4	49.6	52.3	52.7	52.8	52.9	52.9	52.8	52.7
	20	48.1	48.8	52.1	55.2	57.8	58.1	58.1	58.3	58.3	58.3	58.2
	25	53.6	54.1	57.3	60.3	62.7	63.0	63.0	63.3	63.3	63.2	63.2
	32	58.6	59.1	62.0	65.0	67.3	67.5	67.6	67.8	67.9	67.8	67.8
	40	63.1	63.6	66.3	69.3	71.5	71.6	71.7	72.0	72.1	72.0	72.0
	50	66.9	67.4	70.0	72.9	75.0	75.1	75.1	75.4	75.5	75.5	75.4
	63	71.4	72.0	74.5	77.5	79.4	79.4	79.4	79.7	79.7	79.7	79.7
	80	75.5	76.2	78.5	81.5	83.3	83.3	83.3	83.6	83.6	83.6	83.6
	100	78.8	79.5	81.6	84.6	86.3	86.3	86.4	86.7	86.6	86.6	86.6
	125	81.7	82.3	84.3	87.3	88.9	88.9	88.9	89.1	89.0	89.0	89.0
	160	83.4	83.9	86.1	89.2	90.9	91.0	91.0	90.9	90.8	90.8	90.8
	200	84.1	84.5	86.9	90.1	91.9	92.0	91.9	91.6	91.5	91.5	91.5
	250	84.7	85.1	87.5	90.8	92.8	92.9	92.8	92.4	92.2	92.2	92.3
	315	84.6	85.1	87.5	91.0	93.1	93.2	93.1	92.7	92.6	92.6	92.6
	400	84.5	85.0	87.5	91.0	93.2	93.3	93.2	92.9	92.9	93.0	93.0
	500	84.5	85.1	87.6	91.1	93.3	93.4	93.3	93.2	93.4	93.4	93.5
	630	84.7	85.3	87.8	91.2	93.3	93.4	93.4	93.4	93.7	93.8	93.9
	800	84.9	85.4	87.8	91.3	93.4	93.4	93.4	93.5	93.8	93.9	94.1
	1000	84.8	85.3	87.7	91.1	93.2	93.2	93.2	93.4	93.6	93.7	93.8
1250	84.7	85.3	87.6	90.9	92.9	92.9	93.0	93.3	93.4	93.4	93.4	
1600	83.9	84.8	86.9	90.1	92.0	92.0	92.1	92.6	92.6	92.4	92.1	
2000	82.7	83.7	85.8	88.9	90.6	90.6	90.6	91.1	90.9	90.5	90.0	
2500	80.2	81.8	83.9	86.9	88.6	88.6	88.6	88.9	88.4	87.6	87.1	
3150	76.7	78.6	81.3	84.2	85.8	85.8	85.8	85.5	84.4	83.4	83.4	
4000	72.7	74.2	76.7	79.9	81.5	81.6	81.6	79.8	78.6	78.1	78.4	
5000	67.4	68.9	71.2	74.3	76.1	76.2	76.2	73.6	72.6	71.8	71.7	
6300	59.8	61.0	63.3	66.3	67.9	68.0	67.9	65.2	64.0	63.4	62.9	
8000	48.2	49.3	51.7	54.9	56.4	56.5	56.4	54.1	52.4	51.3	50.5	
10000	32.5	33.9	36.6	40.2	42.1	42.1	42.0	39.9	38.2	36.5	35.5	
Total Sound Power Level [dB]	95.7	96.3	98.7	102.0	104.0	104.0	104.0	104.0	104.0	104.0	104.0	

Table 12: NRO 104 1/3rd-Octave Band Sound Power Levels as a function of wind speeds

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NRO 103 – 1/3 rd -Octave Spectra [dB]												
Hub Height Wind Speed [m/s]	4	5	6	7	8	9	10	11	12	13	14-cut out	
Wind speed at 10 m height for a hub height of 85 m [m/s]	2.8	3.6	4.3	5.0	5.7	6.4	7.1	7.8	8.5	9.3	10-cut out	
Wind speed at 10 m height for a hub height of 110 m [m/s]	2.8	3.4	4.1	4.8	5.5	6.2	6.9	7.6	8.3	8.9	9.6-cut out	
Wind speed at 10 m height for a hub height of 164.5 m [m/s]	2.6	3.3	3.9	4.6	5.2	5.9	6.5	7.2	7.9	8.5	9.2-cut out	
Frequency [Hz]	12.5	34.5	35.6	39.4	42.7	45.6	46.1	46.2	46.3	46.3	46.2	46.1
	16	42.0	42.8	46.4	49.6	52.2	52.6	52.7	52.8	52.8	52.7	52.6
	20	48.1	48.8	52.1	55.2	57.6	57.9	57.9	58.1	58.1	58.1	58.0
	25	53.6	54.1	57.3	60.3	62.4	62.7	62.7	63.0	63.0	62.9	62.9
	32	58.6	59.1	62.0	65.0	66.9	67.1	67.1	67.4	67.5	67.4	67.4
	40	63.1	63.6	66.3	69.3	71.0	71.1	71.2	71.5	71.6	71.5	71.5
	50	66.9	67.4	70.0	72.9	74.4	74.4	74.5	74.8	74.9	74.9	74.8
	63	71.4	72.0	74.5	77.5	78.7	78.7	78.7	79.0	79.0	79.0	79.0
	80	75.5	76.2	78.5	81.5	82.5	82.5	82.5	82.8	82.8	82.8	82.7
	100	78.8	79.5	81.6	84.6	85.4	85.4	85.5	85.8	85.7	85.7	85.7
	125	81.7	82.3	84.3	87.3	87.9	87.9	87.9	88.1	88.0	88.0	88.0
	160	83.4	83.9	86.1	89.2	90.0	90.0	90.0	89.9	89.8	89.8	89.8
	200	84.1	84.5	86.9	90.1	90.9	91.0	90.9	90.6	90.5	90.5	90.5
	250	84.7	85.1	87.5	90.8	91.8	91.9	91.8	91.3	91.2	91.2	91.3
	315	84.6	85.1	87.5	91.0	92.1	92.2	92.1	91.6	91.6	91.6	91.6
	400	84.5	85.0	87.5	91.0	92.2	92.3	92.2	91.9	91.9	92.0	92.0
	500	84.5	85.1	87.6	91.1	92.3	92.3	92.3	92.2	92.3	92.4	92.5
	630	84.7	85.3	87.8	91.2	92.4	92.4	92.4	92.4	92.7	92.8	92.9
	800	84.9	85.4	87.8	91.3	92.4	92.4	92.4	92.5	92.8	92.9	93.1
	1000	84.8	85.3	87.7	91.1	92.2	92.2	92.2	92.4	92.6	92.7	92.8
1250	84.7	85.3	87.6	90.9	92.0	91.9	92.0	92.3	92.4	92.4	92.4	
1600	83.9	84.8	86.9	90.1	91.1	91.0	91.1	91.6	91.6	91.4	91.1	
2000	82.7	83.7	85.8	88.9	89.6	89.6	89.6	90.1	89.9	89.5	89.0	
2500	80.2	81.8	83.9	86.9	87.6	87.6	87.6	87.9	87.4	86.6	86.1	
3150	76.7	78.6	81.3	84.2	84.8	84.8	84.8	84.5	83.3	82.4	82.4	
4000	72.7	74.2	76.7	79.9	80.6	80.6	80.6	78.8	77.6	77.1	77.4	
5000	67.4	68.9	71.2	74.3	75.1	75.2	75.2	72.6	71.6	70.8	70.7	
6300	59.8	61.0	63.3	66.3	66.9	67.0	66.9	64.2	63.0	62.4	61.9	
8000	48.2	49.3	51.7	54.9	55.4	55.5	55.4	53.1	51.4	50.3	49.5	
10000	32.5	33.9	36.6	40.2	41.1	41.1	41.0	38.9	37.2	35.5	34.5	
Total Sound Power Level [dB]	95.7	96.3	98.7	102.0	103.0	103.0	103.0	103.0	103.0	103.0	103.0	

Table 13: NRO 103 1/3rd-Octave Band Sound Power Levels as a function of wind speeds

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NRO 102 – 1/3 rd -Octave Spectra [dB]												
Hub Height Wind Speed [m/s]	4	5	6	7	8	9	10	11	12	13	14-cut out	
Wind speed at 10 m height for a hub height of 85 m [m/s]	2.8	3.6	4.3	5.0	5.7	6.4	7.1	7.8	8.5	9.3	10-cut out	
Wind speed at 10 m height for a hub height of 110 m [m/s]	2.8	3.4	4.1	4.8	5.5	6.2	6.9	7.6	8.3	8.9	9.6-cut out	
Wind speed at 10 m height for a hub height of 164.5 m [m/s]	2.6	3.3	3.9	4.6	5.2	5.9	6.5	7.2	7.9	8.5	9.2-cut out	
Frequency [Hz]	12.5	34.5	35.6	39.4	42.7	44.0	44.2	44.2	44.3	44.3	44.2	44.1
	16	42.0	42.8	46.4	49.6	50.7	50.8	50.8	50.9	50.9	50.9	50.8
	20	48.1	48.8	52.1	55.2	56.1	56.2	56.2	56.4	56.4	56.3	56.3
	25	53.6	54.1	57.3	60.3	61.1	61.1	61.2	61.4	61.4	61.4	61.3
	32	58.6	59.1	62.0	64.9	65.6	65.7	65.7	66.0	66.0	66.0	65.9
	40	63.1	63.6	66.3	69.2	69.8	69.8	69.9	70.2	70.2	70.2	70.2
	50	66.9	67.4	70.0	72.8	73.2	73.2	73.3	73.6	73.7	73.7	73.6
	63	71.4	72.0	74.5	77.3	77.6	77.6	77.6	77.9	78.0	78.0	77.9
	80	75.5	76.2	78.5	81.3	81.5	81.5	81.5	81.8	81.8	81.8	81.8
	100	78.8	79.5	81.6	84.4	84.6	84.6	84.6	84.9	84.9	84.8	84.9
	125	81.7	82.3	84.3	87.1	87.2	87.2	87.3	87.4	87.3	87.3	87.3
	160	83.4	83.9	86.1	89.0	89.2	89.2	89.3	89.2	89.1	89.1	89.1
	200	84.1	84.5	86.9	89.9	90.1	90.1	90.1	89.9	89.8	89.8	89.8
	250	84.7	85.1	87.5	90.6	90.9	90.9	90.9	90.5	90.4	90.5	90.5
	315	84.6	85.1	87.5	90.8	91.1	91.1	91.1	90.8	90.7	90.8	90.9
	400	84.5	85.0	87.5	90.8	91.1	91.1	91.1	90.9	91.0	91.1	91.2
	500	84.5	85.1	87.6	90.8	91.2	91.2	91.2	91.2	91.3	91.5	91.6
	630	84.7	85.3	87.8	90.9	91.2	91.2	91.2	91.3	91.5	91.7	91.9
	800	84.9	85.4	87.8	91.0	91.3	91.3	91.3	91.3	91.6	91.8	91.9
	1000	84.8	85.3	87.7	90.9	91.1	91.0	91.1	91.3	91.4	91.6	91.6
1250	84.7	85.3	87.6	90.6	90.9	90.8	90.9	91.1	91.3	91.3	91.1	
1600	83.9	84.8	86.9	89.9	90.1	90.1	90.1	90.4	90.5	90.2	89.8	
2000	82.7	83.7	85.8	88.7	88.8	88.8	88.7	89.1	88.8	88.1	87.5	
2500	80.2	81.8	83.9	86.7	86.9	86.8	86.9	86.8	86.1	85.1	84.6	
3150	76.7	78.6	81.3	84.0	84.2	84.2	84.2	83.4	81.7	81.2	81.3	
4000	72.7	74.2	76.7	79.7	79.9	80.0	80.0	77.6	76.4	76.1	75.8	
5000	67.4	68.9	71.2	74.0	74.4	74.4	74.2	71.8	70.6	69.8	69.0	
6300	59.8	61.0	63.3	66.1	66.2	66.1	65.9	63.6	62.0	61.1	59.8	
8000	48.2	49.3	51.7	54.6	54.9	54.6	54.4	52.3	50.3	49.2	47.0	
10000	32.5	33.9	36.6	40.0	40.2	40.0	39.9	38.1	36.2	34.7	32.2	
Total Sound Power Level [dB]	95.7	96.3	98.7	101.8	102.0	102.0	102.0	102.0	102.0	102.0	102.0	

Table 14: NRO 102 1/3rd-Octave Band Sound Power Levels as a function of wind speeds

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NRO 101 – 1/3 rd -Octave Spectra [dB]												
Hub Height Wind Speed [m/s]	4	5	6	7	8	9	10	11	12	13	14-cut out	
Wind speed at 10 m height for a hub height of 85 m [m/s]	2.8	3.6	4.3	5.0	5.7	6.4	7.1	7.8	8.5	9.3	10-cut out	
Wind speed at 10 m height for a hub height of 110 m [m/s]	2.8	3.4	4.1	4.8	5.5	6.2	6.9	7.6	8.3	8.9	9.6-cut out	
Wind speed at 10 m height for a hub height of 164.5 m [m/s]	2.6	3.3	3.9	4.6	5.2	5.9	6.5	7.2	7.9	8.5	9.2-cut out	
Frequency [Hz]	12.5	34.5	35.6	39.4	42.7	43.2	43.3	43.4	43.5	43.5	43.4	43.3
	16	42.0	42.8	46.4	49.5	49.8	49.9	50.0	50.1	50.1	50.0	49.9
	20	48.1	48.8	52.1	55.0	55.3	55.3	55.4	55.5	55.5	55.5	55.4
	25	53.6	54.1	57.3	60.0	60.2	60.3	60.3	60.5	60.5	60.5	60.4
	32	58.6	59.1	62.0	64.6	64.8	64.8	64.9	65.1	65.2	65.1	65.1
	40	63.1	63.6	66.3	68.8	69.0	69.0	69.0	69.3	69.4	69.4	69.3
	50	66.9	67.4	70.0	72.3	72.4	72.4	72.4	72.7	72.8	72.8	72.8
	63	71.4	72.0	74.5	76.7	76.8	76.7	76.8	77.0	77.1	77.1	77.1
	80	75.5	76.2	78.5	80.6	80.7	80.7	80.7	80.9	80.9	80.9	80.9
	100	78.8	79.5	81.6	83.7	83.8	83.8	83.8	84.0	84.0	84.0	84.0
	125	81.7	82.3	84.3	86.3	86.3	86.4	86.4	86.5	86.5	86.5	86.5
	160	83.4	83.9	86.1	88.2	88.3	88.3	88.3	88.3	88.2	88.2	88.3
	200	84.1	84.5	86.9	89.1	89.1	89.2	89.1	89.0	88.9	88.9	89.0
	250	84.7	85.1	87.5	89.8	89.9	89.9	89.9	89.6	89.5	89.6	89.7
	315	84.6	85.1	87.5	90.0	90.0	90.1	90.0	89.8	89.8	89.9	90.0
	400	84.5	85.0	87.5	90.0	90.0	90.0	90.0	89.9	90.0	90.2	90.3
	500	84.5	85.1	87.6	90.0	90.1	90.1	90.1	90.1	90.3	90.5	90.6
	630	84.7	85.3	87.8	90.1	90.2	90.2	90.2	90.2	90.5	90.7	90.9
	800	84.9	85.4	87.8	90.2	90.3	90.2	90.3	90.3	90.5	90.7	90.9
1000	84.8	85.3	87.7	90.0	90.1	90.0	90.0	90.2	90.4	90.5	90.5	
1250	84.7	85.3	87.6	89.8	89.9	89.8	89.8	90.1	90.3	90.2	90.0	
1600	83.9	84.8	86.9	89.1	89.1	89.1	89.1	89.4	89.4	89.1	88.6	
2000	82.7	83.7	85.8	87.8	87.9	87.9	87.8	88.1	87.7	87.0	86.3	
2500	80.2	81.8	83.9	85.9	86.1	85.9	86.0	85.9	84.9	83.9	83.6	
3150	76.7	78.6	81.3	83.2	83.4	83.3	83.3	82.1	80.7	80.0	80.2	
4000	72.7	74.2	76.7	78.9	79.1	79.0	78.8	76.6	75.4	74.8	74.4	
5000	67.4	68.9	71.2	73.2	73.4	73.3	72.8	70.9	69.3	68.8	67.7	
6300	59.8	61.0	63.3	65.3	65.4	65.4	64.7	62.6	61.5	59.8	58.5	
8000	48.2	49.3	51.7	53.8	53.9	53.8	53.3	51.5	50.0	47.6	46.4	
10000	32.5	33.9	36.6	39.2	39.2	39.1	38.8	37.2	35.3	33.4	31.7	
Total Sound Power Level [dB]	95.7	96.3	98.7	100.9	101.0	101.0	101.0	101.0	101.0	101.0	101.0	

Table 15: NRO 101 1/3rd-Octave Band Sound Power Levels as a function of wind speeds

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NRO 100 – 1/3 rd -Octave Spectra [dB]												
Hub Height Wind Speed [m/s]	4	5	6	7	8	9	10	11	12	13	14-cut out	
Wind speed at 10 m height for a hub height of 85 m [m/s]	2.8	3.6	4.3	5.0	5.7	6.4	7.1	7.8	8.5	9.3	10-cut out	
Wind speed at 10 m height for a hub height of 110 m [m/s]	2.8	3.4	4.1	4.8	5.5	6.2	6.9	7.6	8.3	8.9	9.6-cut out	
Wind speed at 10 m height for a hub height of 164.5 m [m/s]	2.6	3.3	3.9	4.6	5.2	5.9	6.5	7.2	7.9	8.5	9.2-cut out	
Frequency [Hz]	12.5	34.5	35.6	39.4	41.9	42.1	42.2	42.3	42.4	42.4	42.3	42.2
	16	42.0	42.8	46.4	48.6	48.8	48.9	48.9	49.0	49.0	49.0	48.9
	20	48.1	48.8	52.1	54.1	54.2	54.3	54.4	54.5	54.5	54.5	54.4
	25	53.6	54.1	57.3	59.1	59.2	59.3	59.3	59.4	59.5	59.5	59.4
	32	58.6	59.1	62.0	63.7	63.8	63.8	63.9	64.1	64.1	64.1	64.1
	40	63.1	63.6	66.3	67.9	68.0	68.0	68.1	68.3	68.4	68.4	68.3
	50	66.9	67.4	70.0	71.4	71.4	71.5	71.5	71.7	71.8	71.9	71.8
	63	71.4	72.0	74.5	75.8	75.8	75.8	75.9	76.0	76.2	76.2	76.2
	80	75.5	76.2	78.5	79.8	79.7	79.8	79.8	80.0	80.0	80.0	80.0
	100	78.8	79.5	81.6	82.8	82.9	82.9	82.9	83.1	83.1	83.1	83.1
	125	81.7	82.3	84.3	85.4	85.5	85.5	85.5	85.6	85.6	85.6	85.6
	160	83.4	83.9	86.1	87.3	87.4	87.4	87.4	87.4	87.4	87.4	87.4
	200	84.1	84.5	86.9	88.2	88.2	88.2	88.1	88.1	88.0	88.0	88.1
	250	84.7	85.1	87.5	88.9	88.9	88.9	88.8	88.7	88.6	88.7	88.8
	315	84.6	85.1	87.5	89.0	89.0	89.0	88.9	88.9	88.9	89.0	89.1
	400	84.5	85.0	87.5	89.0	89.0	89.0	88.9	88.9	89.0	89.2	89.3
	500	84.5	85.1	87.6	89.0	89.0	89.0	89.0	89.0	89.2	89.5	89.6
	630	84.7	85.3	87.8	89.1	89.1	89.1	89.2	89.1	89.4	89.7	89.8
	800	84.9	85.4	87.8	89.2	89.2	89.2	89.2	89.2	89.4	89.7	89.8
	1000	84.8	85.3	87.7	89.0	89.0	89.0	89.0	89.2	89.3	89.4	89.4
1250	84.7	85.3	87.6	88.8	88.8	88.9	88.9	89.0	89.3	89.2	88.9	
1600	83.9	84.8	86.9	88.1	88.1	88.2	88.2	88.4	88.4	87.9	87.5	
2000	82.7	83.7	85.8	86.9	86.9	86.9	86.9	87.1	86.6	85.8	85.3	
2500	80.2	81.8	83.9	85.1	85.1	85.1	85.2	84.9	83.8	82.7	82.4	
3150	76.7	78.6	81.3	82.4	82.4	82.4	82.3	81.1	79.3	79.0	79.1	
4000	72.7	74.2	76.7	78.1	78.1	77.9	77.5	75.8	74.4	73.4	73.4	
5000	67.4	68.9	71.2	72.4	72.5	72.1	71.5	70.0	68.2	67.3	66.9	
6300	59.8	61.0	63.3	64.5	64.4	64.0	63.3	62.2	60.0	58.9	57.6	
8000	48.2	49.3	51.7	52.8	52.7	52.5	52.0	50.9	49.0	46.8	45.0	
10000	32.5	33.9	36.6	38.2	38.1	37.9	37.5	36.4	34.5	32.5	30.5	
Total Sound Power Level [dB]	95.7	96.3	98.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	

Table 16: NRO 100 1/3rd-Octave Band Sound Power Levels as a function of wind speeds

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8. Appendix B – NRO Tables



NRO modes for turbine 5 with Farm noise optimization

Wind Direction [°]	30	60	90	120	150	180	210	240	270	300	330
Wind speed @ HH [m/s]	0	0	0	0	0	0	0	0	0	0	0
3.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
7.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
8.0	NRO104	NRO104	NRO106	NO	NO	NRO104	NRO104	NRO104	NRO104	NRO104	NO
9.0	NRO105	NRO105	NRO105	NO	NO	NRO105	NRO105	NRO105	NRO105	NRO105	NO
10.0	NO	NRO106	NO	NO	NO	NO	NRO106	NO	NO	NO	NO
11.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
12.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
13.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
14.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
15.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
16.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
17.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
18.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
19.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
20.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
21.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
22.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
23.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
24.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
25.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

NRO modes for turbine 6 with Farm noise optimization

Wind Direction [°]	30	60	90	120	150	180	210	240	270	300	330
Wind speed @ HH [m/s]	0	0	0	0	0	0	0	0	0	0	0
3.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
7.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
8.0	NRO106	NRO106	NO	NO	NO	NRO104	NRO104	NRO106	NRO106	NRO106	NO
9.0	NRO106	NO	NRO106	NO	NO	NRO106	NRO106	NRO106	NRO106	NRO106	NO
10.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
11.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
12.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
13.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
14.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
15.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
16.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
17.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
18.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
19.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
20.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
21.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
22.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
23.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
24.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
25.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

DSM

DSA
L3

NRO modes for turbine 7 with Farm noise optimization

Wind Direction [°]	30	60	90	120	150	180	210	240	270	300	330
Wind speed @ 0 MM @ highest HH [m/s]	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
7.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
8.0	NRO104	NRO103	NRO103	NO	NO	NRO104	NRO104	NRO103	NRO103	NO	NO
9.0	NRO105	NRO104	NRO104	NO	NO	NRO105	NRO105	NRO104	NRO104	NO	NO
10.0	NO	NRO106	NRO106	NO	NO	NRO106	NRO106	NRO106	NRO106	NO	NO
11.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
12.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
13.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
14.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
15.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
16.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
17.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
18.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
19.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
20.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
21.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
22.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
23.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
24.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
25.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

NRO modes for turbine 8 with Farm noise optimization

Wind Direction [°]	30	60	90	120	150	180	210	240	270	300	330
Wind speed @ 0 MM @ highest HH [m/s]	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
7.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
8.0	NRO104	NRO103	NRO103	NO	NO	NRO106	NRO104	NRO104	NRO104	NO	NO
9.0	NRO106	NRO104	NRO104	NO	NO	NRO106	NRO105	NRO105	NRO105	NO	NO
10.0	NO	NRO106	NRO106	NO	NO	NRO106	NRO106	NRO106	NRO106	NO	NO
11.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
12.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
13.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
14.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
15.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
16.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
17.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
18.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
19.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
20.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
21.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
22.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
23.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
24.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
25.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO



DSA 19

NRO modes for turbine 19 with Farm noise optimization

Wind Direction [°]	30	60	90	120	150	180	210	240	270	300	330
Wind speed @ MM @ highest HH [m/s]	0	0	0	0	0	0	0	0	0	0	0
3.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
7.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
8.0	NO	NRO104	NO	NO	NO	NO	NRO104	NRO104	NRO106	NO	NO
9.0	NRO106	NRO105	NRO106	NO	NO	NO	NRO106	NRO106	NRO106	NO	NO
10.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
11.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
12.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
13.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
14.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
15.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
16.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
17.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
18.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
19.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
20.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
21.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
22.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
23.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
24.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
25.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

NRO modes for turbine 2NO with Farm noise optimization

Wind Direction [°]	30	60	90	120	150	180	210	240	270	300	330
Wind speed @ MM @ highest HH [m/s]	0	0	0	0	0	0	0	0	0	0	0
3.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
7.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
8.0	NO	NRO106	NRO104	NO	NO	NO	NRO104	NRO104	NRO106	NRO106	NRO106
9.0	NRO106	NRO106	NO	NO	NO	NO	NRO106	NRO106	NRO106	NRO106	NRO106
10.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
11.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
12.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
13.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
14.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
15.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
16.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
17.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
18.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
19.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
20.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
21.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
22.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
23.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
24.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
25.0	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO



