PROGETTO PER LA REALIZZAZIONE DI UN IMPIANTO PER LA PRODUZIONE DI ENERGIA MEDIANTE LO SFRUTTAMENTO DEL VENTO NEL TERRITORIO COMUNALE DI MESAGNE, BRINDISI E CELLINO SAN MARCO IN LOC. LO SPECCHIONE (BR)
POTENZA NOMINALE 79,2 MW

PROGETTO DEFINITIVO - SIA

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R.3.1 Scheda tecnica aerogeneratore

REV.	DATA	DESCRIZIONE

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General Description

EnVentus™

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Classification: Restricted

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1 Introduction

This *General Description* document contains data and general descriptions of the EnVentus™ wind turbine range. The EnVentus™ turbine range consists of various turbine variants, with different rotors and ratings.

For turbine variant specific information related to wind class definitions and performance details, please refer to the accompanying Performance Specification document.

2 General Description

A wind turbine within the EnVentus™ turbine range is a pitch regulated upwind turbine with active yaw and a three-blade rotor.

The wind turbine utilises the OptiTip® concept and a power system based on a permanent magnet generator and full-scale converter. With these features, the wind turbines are able to operate the rotor at variable speed and thereby maintain the power output at or near rated power even in high wind speed. At low wind speed, the OptiTip® concept and the power system work together to maximise the power output by operating at the optimal rotor speed and pitch angle.

3 Mechanical Design

3.1 Rotor

The wind turbine is equipped with a rotor consisting of three blades and a hub. The blades are controlled by the microprocessor pitch control system OptiTip®. Based on the prevailing wind conditions, the blades are continuously positioned to optimise the pitch angle.

Rotor	V162	V172
Diameter	162 m	172 m
Swept Area	20612 m^2	23235 m^2
Speed, Dynamic Operation Range	4.3 -12.1 rpm	
Rotational Direction	Clockwise (front view)	
Orientation	Upwind	
Tilt	6°	
Hub Coning	6°	
No. of Blades	3	
Aerodynamic Brakes	Full feathering	

Table 3-1: Rotor data

3.2 Blades

The blades are made of carbon and fibreglass and consist of two airfoil shells with embedded structure.

Blades	V162	V172
Blade Length	79.35 m	84.35 m
Maximum Chord	4.3 m	4.3 m
Chord at 90% blade radius	1.68 m	1.25 m
Type Description	Structural airfoil shell	
Material	Fibreglass reinforced epoxy, carbon fibres and Solid Metal Tip (SMT)	Fibreglass reinforced polyester, carbon fibres and metallic diverter strips
Blade Connection	Steel roots inserted	
Airfoils	High-lift profile	

Table 3-2: Blade data

3.3 Blade Bearing

The blade bearings allow the blades to operate at varying pitch angles.

Blade Bearing	
Blade bearing type	High-capacity slewing bearing
Lubrication	Manual grease lubrication

Table 3-3: Blade bearing data

3.4 Pitch System

The turbine is equipped with a hydraulic, individual pitch system for each blade. Each pitch system is connected to the hydraulic rotating transfer unit in the nacelle by means of distributed hydraulic hoses and pipes. The hydraulic power unit is positioned in the nacelle.

Each pitch system consists of a hydraulic cylinder mounted to the hub and a piston rod mounted to the blade bearing. Valves facilitating operation of the pitch cylinder are installed on a pitch block bolted directly onto the cylinder.

Pitch System	
Type	Hydraulic
Number	1 cylinder per blade
Range	-5° to 95°

Table 3-4: Pitch system data

Hydraulic System	
Main Pump	Redundant internal-gear oil pumps
Pressure	Max. 260 bar
Filtration	3 µm (absolute) 40 µm in line

Table 3-5: Hydraulic system data.

3.5 Hub

The hub supports the three blades and transfers the reaction forces and the torque to the Main Shaft. The hub structure also supports blade bearings and pitch cylinders.

Hub	
Type	Ball shell hub
Material	Cast iron

Table 3-6: Hub data

3.6 Main Shaft

The main shaft transfers the reaction forces to the main bearing and the torque to the gearbox.

Main Shaft	
Type Description	Hollow shaft
Material	Cast iron

Table 3-7: Main shaft data

3.7 Main Bearing Housing

The main bearing housing carries the main bearings and is the connection point for the drive train system to the nacelle structure.

Main Bearing Housing	
Material	Cast iron

Table 3-8: Main bearing housing data

3.8 Main Bearing

The main bearings constitute the main load transfer path for the rotor and drivetrain to the nacelle structure.

Main Bearing	
Type	Rolling bearings
Lubrication	Oil circulation

Table 3-9: Main bearing data

3.9 Gearbox

The main gear converts the rotation of the rotor to generator rotation.

Gearbox	
Type	2 Planetary stages
Gear House Material	Cast
Lubrication System	Pressure oil lubrication
Total Gear Oil Volume	900-1100 L
Oil Cleanliness Codes	ISO 4406-/15/12

Table 3-10: Gearbox data

3.10 Generator Bearings

Generator bearings ensures a constant airgap between the generator rotor and stator. The bearings are arranged in an assembly that allows for up-tower service.

Generator Bearing	
Type	Rolling bearings
Lubrication	Oil circulation

Table 3-11: Generator bearing data

3.11 Yaw System

The yaw system is an active system based on a pre-tensioned plain bearing.

Yaw System	
Type	Plain bearing system
Material	Forged yaw ring heat-treated. Plain bearings PETP
Yaw gear type	Multiple stages planetary gear
Yawing Speed (50 Hz)	Approx. 0.4°/sec.
Yawing Speed (60 Hz)	Approx. 0.5°/sec.

Table 3-12: Yaw system data

3.12 Crane

The nacelle is equipped with an internal service crane (single system hoist).

Crane	
Lifting Capacity	Max 800 kg

Table 3-13: Crane data

3.13 Towers

Tubular Steel Towers and Concrete Hybrid Towers (CHT) are available as standard for several WTG configuration and hub height options.

Tubular steel towers consist of flange joined steel sections.

Concrete Hybrid Towers consists of a concrete bottom part with a transition piece towards a tubular steel top. The concrete part is made of precast high strength concrete rings, and the tubular steel top is made of flange joined steel sections.

Towers includes modular internals, which are certified to relevant type approvals.

Available hub heights are listed in the Performance Specification for each turbine variant. Designated hub heights include a distance from tower top flange to centre of the hub of approximately 2.5m. For steel towers the designated hub height also includes a distance from the foundation section to the ground level of approximately 0.2 m depending on the thickness of the bottom flange.

For steel towers, raised foundations of up to 3 m can be made available on a site-specific basis subject to soil and project conditions which raises the hub height also by up to 3m.

Further WTG configuration and hub height options are developed as non-standard products on site-specific basis.

Towers	
Type	Tubular steel towers Concrete Hybrid Towers

Table 3-14: Tower structure data

3.14 Modularized Nacelle

The modularized nacelle consists of three main elements. A cast iron front part, the base frame, and two modularized structures, the main nacelle house and the side-compartment. The base frame is the foundation for the power train and transmits loads from the rotor to the tower through the yaw system. The bottom surface is machined and connected to the yaw bearing and the yaw gears are bolted to the base frame. The base frame also includes a heavy-duty interface on each side. One interface is used to carry the HV transformer in the side-compartment. The additional interface can be used for several purposes, for example attaching a service crane for main component exchange operations.

The main nacelle house hosts the power train, hydraulic power unit, cooling systems and main control panels. The main nacelle house has an internal crane rail system that allows service and maintenance operations inside the main nacelle house.

The side-compartment structure hosts and integrates the main power production components as converter and HV transformer.

Both main nacelle house and side-compartment structures act as enclosures. The main nacelle house has a hatch positioned in the floor for lowering or hoisting equipment and evacuation of personnel.

The roof section is equipped with skylights, which can be opened both from inside out, and outside in. Access from the tower to the main nacelle house is through the base frame.

Type Description	Material
Main nacelle house and side compartment structure	Sheet metal structure. GRP components in roof dome and front cover.
Base frame	Cast iron

Table 3-15: Nacelle structure and cover data

3.15 Thermal Conditioning System

The thermal conditioning system consists of:

- A Liquid Cooling System
- The Vestas Cooler Top®
- Air cooling of the internal main nacelle house and side-compartment
- Air cooling of the converter including a filter function

3.15.1 Liquid Cooling

The liquid cooling system removes heat losses from gearbox, generator, hydraulic power unit, converter and the HV transformer.

The liquid cooling system pump unit includes a set of dynamic flow valves securing the right flow to the different systems. The pump unit also includes an electrical controlled valve for controlling the liquid temperature and a bypass filter for removal of particles in the cooling liquid.

3.15.2 Cooler Top®

The Vestas Cooler Top® located on top of the rear end of the nacelle main house. The Cooler Top® is a free flow cooler, thus ensuring that there are no electrical components in the thermal conditioning system located outside the nacelle. The Cooler Top® serves as base for the wind sensors, and the optional ice detection-, precipitation- and visibility sensors as well as aviation lights.

3.15.3 Main Nacelle House Conditioning

Hot air generated by mechanical and electrical equipment is dissipated from the main nacelle house by a fan system located in the nacelle main house structure. The conditioning system is taking ambient air into the main nacelle house and exhaust the hot air in the end of the main nacelle house.

3.15.4 Converter and Side-Compartment Air Cooling

The converter is both liquid and air cooled. The converter air cooling system comprises an air-to-air heat exchanger, which separates ambient air from converter internal air. The ambient air flow is provided by fan units delivering ambient air to the air-to-air heat exchanger through a filter. Fans on the internal side of the air-to-air exchanger provides the converter internal air circulation. The converter air cooling also provides air flow cooling to the side-compartment which is redirected by ducts to the critical spots.

4 Electrical Design

4.1 Generator

The generator is a three-phase permanent magnet generator connected to the grid through a full-scale converter. The generator housing allows the circulation of cooling air within the stator and rotor.

The heat generated by the losses is removed by an air-to-water heat exchanger.

Generator	
Type	Permanent Magnet Synchronous generator
Rated Power [P_N]	Up to 7600 kW (depending on turbine variant)
Frequency range [f_N]	0-126 Hz
Voltage, Stator [U_{NS}]	3 x 800 V (at rated speed)
Number of Poles	36
Winding Type	Form with Vacuum Pressurized Impregnation
Winding Connection	Star
Operational speed range	0-420 rpm
Overspeed Limit (2 minutes)	660 rpm
Temperature Sensors, Stator	PT100 sensors placed in the stator hot spots.
Insulation Class	H
Enclosure	IP54

Table 4-1: Generator data

4.2 Converter

The converter is a full-scale converter system controlling both the generator and the power delivered to the grid. The converter consists of 4 machine-side converter units and 4 line-side converter units operating in parallel with a common controller.

The converter controls conversion of variable frequency AC power from the generator into fixed frequency AC power with desired active and reactive power levels (and other grid connection parameters) suitable for the grid.

The converter is located in the nacelle and has a grid side voltage rating of 720 V. The generator side voltage rating is nominally 800 V but depends on generator speed.

Converter	
Nominal Apparent Power [S_N] @ 1.0 p.u. voltage	7750 kVA
Nominal Grid Voltage	3 x 720 V
Rated Generator Voltage	3 x 800 V
Rated Grid Current @ 1.0 p.u. voltage	6488 A
Enclosure	IP54

Table 4-2: Converter data

4.3 HV Transformer

The transformer is a three-phase, three limb, two-winding, liquid immersed transformer. The transformer is equipped with an external water-cooling circuit. The insulation liquid used is environmentally friendly and low flammable.

The HV transformer is in the side-compartment, located in a separate transformer room with access through an interlock system.

The transformer is designed according to IEC standards and is available in the following version:

- Eco-design complying to Tier 2 of European Eco-design regulation No 548/2014 and No 2019/1783 set by the European Commission. Refer to Table 4-3.

4.3.1 General transformer data

Transformer	
Type description	Eco-design liquid immersed transformer
Basic layout	3 phase, 2 winding transformer
Applied standards	IEC 60076-1, IEC 60076-16, IEC 61936-1 Commission Regulation No 548/2014 Commission Regulation No 2019/1783
Cooling method	KF/WF
Rated power	8400 kVA
Expansion system	Sealed
Insulation liquid, Type/Fire point	Natural ester, biodegradable/ K-class (>300°C)
No-load reactive power	~21 kVar [1]
Full load reactive power	~882 kVar [1]

Transformer	
No-load current	~ 0.25 % [1]
Positive sequence short-circuit impedance @ rated power, 95°C	9.9 % [2]
Positive sequence short-circuit resistance@ rated power, 95°C	~0.9 % [1]
Zero sequence short-circuit impedance@ rated power, 95°C	~9.4 % [1]
Zero sequence short-circuit resistance@ rated power, 95°C	~0.9 % [1]
Rated voltage, turbine side	
U_m 1.1kV	0.720 kV
Rated voltage, grid side	
U_m 24.0kV	20.0-22.0 kV
U_m 36.0kV	22.1-33.0 kV
U_m 40.5kV	33.1-36.0 kV
Insulation level AC / LI / LIC	
U_m 1.1kV	3 / - / - kV
U_m 24.0kV	50 / 125 / 138 kV
U_m 36.0kV	70 / 170 / 187 kV
U_m 40.5kV	80 / 200 / 220 kV
Optional off-circuit tap changer	2±2 x 2.5 %
Frequency	50 Hz / 60 Hz
Vector group	Dyn11
Inrush peak current	<4 x $\hat{I}_n$ [1] (for Um=24.0kV) <8 x $\hat{I}_n$ [1] (for Um=36.0-40.5kV)
Half crest time	~ 0.5 s [1]
Sound power level	≤ 80 dB(A)
Average winding temperature rise	Class 120 (E) ≤65 K Class 130 (B) ≤75 K
Max altitude	3500 m
Insulation system	Hybrid insulation system Winding insulation: 120 (E), Thermally Upgrader Paper 130 (B), High temperature insulation Other materials can have different class.
Insulation liquid, Amount	≤ 3500 kg
Corrosion class	C3
Weight	≤15000 kg
Overvoltage protection	Plug-in surge arresters on HV bushings
High voltage bushings	Outer cone, interface C1

Table 4-3: General transformer data.

4.3.2 Eco-design – IEC 50 Hz/60 Hz version

The transformer loss limits are given at rated power as combination of load loss and no-load loss which shall fulfil the Peak Efficiency Index (PEI) of the Eco-design requirement.
The maximum losses are described by the PEI limit section of Figure 4-1 and stretch over a range between Loss variant 1 and Loss variant 2.
The loss variant values are selected based on energy loss optimization with the turbine user profile, hence the energy loss of transformers between Loss variant 1 and Loss variant 2 are comparable.

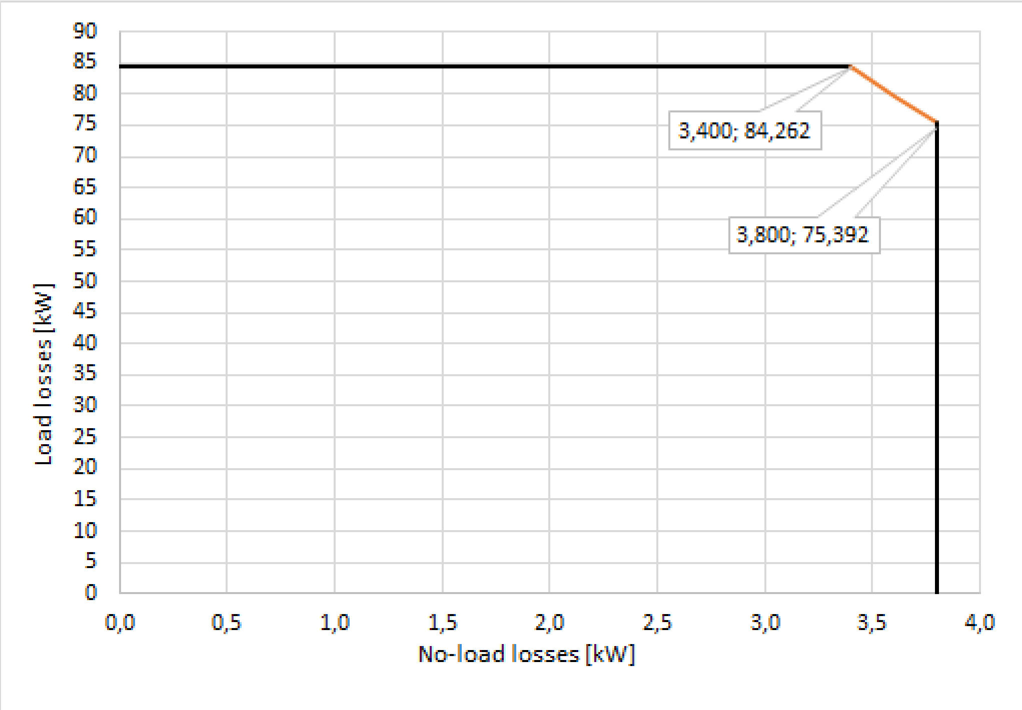


Figure 4-1: Transformer losses allowable area for 8400kVA

The actual load losses vary depending on the operational mode of the turbine, hence in *Table 4-4*, the load losses are provided at different operational modes for the two loss variants. For further recalculation of load losses at different operation modes, refer to Figure 4-2.

Transformer losses (rated power 8400kVA)				
Applied standards	Commission Regulation No 2019/1783			
Peak Efficiency Index (PEI)	≥ 99.597			
Loss variant 1				
No-load loss	3.40 kW			
Load loss @ power, 95°C	**@8400kVA**	**@7200kVA**	**@6800kVA**	**@6000kVA**
	≤84.262kW	≤61.91kW [3]	≤55.22kW [3]	≤42.99kW [3]
Loss variant 2				
No-load loss	3.80 kW			
Load loss @ power, 95°C	**@8400kVA**	**@7200kVA**	**@6800kVA**	**@6000kVA**
	≤75.32kW	≤55.34kW[3]	≤49.36kW[3]	≤38.43kW[3]

Table 4-4: Transformer losses for 8400kVA

Figure 4-2: Transformer load losses scaling

NOTE

[1] Based on an average of calculated values across voltages and manufacturers.
[2] Subjected to standard IEC tolerances.
[3] Informative non-binding values based on operation mode.

4.4 HV Cables

The high-voltage cable runs from the transformer in the side-compartment down the tower to the HV switchgear located at the bottom of the tower. The high-voltage cable will be constructed as:

- A three-core, rubber-insulated, halogen-free, high-voltage cable with a three-core split earth conductor.

HV Cables	
High-Voltage Cable Insulation Compound	Improved ethylene-propylene (EP) based material-EPR or high modulus or hard grade ethylene-propylene rubber-HEPR
Pre-terminated	T-Connector Type-C in transformer end. T-Connector Type-C in switchgear end.
Maximum Voltage (Um)	24 kV for 20-24.3 kV rated voltage 42 kV for 24.4-36.0 kV rated voltage
Conductor Cross Sections	Um: 42kV with 3x70 + 3x70/3 mm^2 Um: 24kV with 3x95 + 3x95/3 mm^2

Table 4-5: HV cables data

4.5 HV Switchgear

A gas insulated switchgear is installed in the bottom of the tower as an integrated part of the turbine. Its controls are integrated with the turbine safety system, which monitors the condition of the switchgear and high voltage safety related devices in the turbine. This system is named ‘Ready to Protect’ and ensures all protection devices are operational, whenever high voltage components in the turbine are energised. To ensure that the switchgear is always ready to trip, it is equipped with redundant trip circuits consisting of an active trip coil and an undervoltage trip coil.

In case of grid outage, the circuit breaker will disconnect the turbine from the grid after an adjustable time.

When grid returns, all relevant protection devices will automatically be powered up via UPS.

When all the protection devices are operational, the circuit breaker will re-close after an adjustable time. The re-close functionality can furthermore be used to implement a sequential energization of a wind park, to avoid simultaneous inrush currents from all turbines once grid returns after an outage.

In case the circuit breaker has tripped due to a fault detection, the circuit breaker will be blocked for re-connection until a manual reset is performed.

To avoid unauthorized access to the transformer room during live condition, the earthing switch of the circuit breaker, contains a trapped-key interlock system with its counterpart installed on the access door to the transformer room.

The switchgear is available in three variants with increasing features, see Table 4-6. Beside the increase in features, the switchgear can be configured depending on the number of grid cables planned to enter the individual turbine. The design of the switchgear solution is optimized such grid cables can be connected to the switchgear even before the tower is installed and still maintain its protection toward weather conditions and internal condensation due to a gas tight packing.

The switchgear is available in an IEC version and in an IEEE version. The IEEE version is however only available in the highest voltage class. The electrical parameters of the switchgear are seen in Table 4-7 for the IEC version and in Table 4-8 for the IEEE version.

HV Switchgear			
Variant	**Basic**	**Streamline**	**Standard**
IEC standards	○	⦿	⦿
IEEE standards	⦿	○	⦿
Vacuum circuit breaker panel	⦿	⦿	⦿
Overcurrent, short-circuit and earth fault protection	⦿	⦿	⦿
Disconnector / earthing switch in circuit breaker panel	⦿	⦿	⦿
Voltage Presence Indicator System for circuit breaker	⦿	⦿	⦿
Voltage Presence Indicator System for grid cables	⦿	⦿	⦿
Double grid cable connection	⦿	⦿	⦿
Triple grid cable connection	⦿	○	○
Preconfigured relay settings	⦿	⦿	⦿
Turbine safety system integration	⦿	⦿	⦿
Redundant trip coil circuits	⦿	⦿	⦿

HV Switchgear			
Variant	**Basic**	**Streamline**	**Standard**
Trip coil supervision	⦿	⦿	⦿
Pendant remote control from outside of tower	⦿	⦿	⦿
Sequential energization	⦿	⦿	⦿
Reclose blocking function	⦿	⦿	⦿
Heating elements	⦿	⦿	⦿
Trapped-key interlock system for circuit breaker panel	⦿	⦿	⦿
Motor operation of circuit breaker	⦿	⦿	⦿
Cable panel for grid cables (configurable)	○	⦿	⦿
Switch disconnector panels for grid cables – max three panels (configurable)	○	⦿	⦿
Earthing switch for grid cables	○	⦿	⦿
Internal arc classification	○	⦿	⦿
Supervision on MCB’s	○	⦿	⦿
Motor operation of switch disconnector	○	○	⦿
SCADA operation and feedback of circuit breaker	○	○	⦿
SCADA operation and feedback of switch disconnector	○	○	⦿

Table 4-6: HV switchgear variants and features

4.5.1 IEC 50/60Hz version

HV Switchgear	
Type description	Gas Insulated Switchgear
Applied standards	IEC 62271-103 IEC 62271-1, 62271-100, 62271-102, 62271-200
Insulation medium	SF_6
Rated voltage	
U_r 24.0kV	20.0-22.0 kV
U_r 36.0kV	22.1-33.0 kV
U_r 40.5kV	33.1-36.0 kV
Rated insulation level AC // LI **Common value / across isolation distance**	
U_r 24.0kV	50 / 60 // 125 / 145 kV
U_r 36.0kV	70 / 80 // 170 / 195 kV
U_r 40.5kV	85 / 90 // 185 / 215 kV
Rated frequency	50 Hz / 60 Hz
Rated normal current	630 A
Rated Short-time withstand current	
U_r 24.0kV	20 kA
U_r 36.0kV	25 kA

HV Switchgear	
U_r 40.5kV	25 kA
Rated peak withstand current 50 / 60 Hz	
U_r 24.0kV	50 / 52 kA
U_r 36.0kV	62.5 / 65 kA
U_r 40.5kV	62.5 / 65 kA
Rated duration of short-circuit	1 s
Internal arc classification (option)	
U_r 24.0kV	IAC A FLR 20 kA, 1 s
U_r 36.0kV	IAC A FLR 25 kA, 1 s
U_r 40.5kV	IAC A FLR 25 kA, 1 s
Connection interface	Outside cone plug-in bushings, IEC interface C1.
Loss of service continuity category	LSC2
Ingress protection	
Gas tank	IP 65
Enclosure	IP 2X
LV cabinet	IP 3X
Corrosion class	C3

Table 4-7: HV switchgear data for IEC version

4.5.2 IEEE 60Hz version

HV Switchgear	
Type description	Gas Insulated Switchgear
Applied standards	IEEE 37.20.3, IEEE C37.20.4, IEC 62271-200, ISO 12944.
Insulation medium	SF_6
Rated voltage	
U_r 38.0kV	33.1-36.0 kV
Rated insulation level AC / LI	70 / 150 kV
Rated frequency	60 Hz
Rated normal current	600 A
Rated Short-time withstand current	25 kA
Rated peak withstand current	65 kA
Rated duration of short-circuit	1 s
Internal arc classification (option)	IAC A FLR 25 kA, 1 s
Connection interface grid cables	Outside cone plug-in bushings, IEEE 386 interface type dead break, 600A.
Ingress protection	
Gas tank	NEMA 4X / IP 65
Enclosure	NEMA 2 / IP 2X
LV cabinet	NEMA 2 / IP 3X
Corrosion class	C3

Table 4-8: HV switchgear data for IEEE version

4.6 AUX System

The AUX system is supplied from a separate 720/400 V transformer located in the main nacelle house. The supply to this transformer primary side is provided from the converter cabinet. All auxiliary loads in the turbine such as motors, pumps, fans and heaters are supplied from this system.

The control system (DCN's) is also supplied from the Auxiliary Power System in all areas of the turbine.

The 400 V supply from the main nacelle house is transferred to tower controller cabinet, which is placed at the entrance platform of the turbine. This supply is then distributed for various 400 & 230 V loads such as service lift, working light system, additional / optional features & general-purpose loads, cabinet internal heating & ventilation. There is a 400/230 V control transformer placed inside the tower cabinet which provides supply to the Light Box/UPS (LBUPS) cabinet which is placed very near to the tower cabinet.

There is a 400 V service inlet provided in the tower control cabinet to connect an external power source that allows some of the systems to operate during installation & maintenance / service activities.

The working & emergency light system in Tower & Nacelle is supplied from the LBUPS cabinet which is placed in the entrance platform just beside the turbine entrance door. It is possible to add an optional battery cabinet to the LBUPS cabinet if extended back-up time is needed. The internal light in the hub is fed from built-in batteries in the light armature.

Power Sockets	
Single Phase (Nacelle)	230 V (16 A) (standard) 110 V (16 A) (option)
Single Phase (Tower Platforms)	230 V (10 A) (standard) 110 V (16 A) (option)
Three Phase (Nacelle and Tower base)	3 x 400 V (20 A)

Table 4-9: AUX system data

4.7 Wind Sensors

The turbine is equipped with one ultrasonic wind sensor and one mechanical wind vane. The sensors have built-in heaters to minimise interference from ice and snow.

The turbine software will automatically detect and inform when a wind sensor is worn and needs to be replaced. The turbine will continue to operate using the other wind sensor without any production loss until the worn wind sensor is replaced.

4.8 Vestas Multi Processor (VMP) Controller

The turbine is controlled and monitored by the VMP8000 control system.

VMP8000 is a multiprocessor control system comprised of main controller, distributed control nodes, distributed IO nodes and ethernet switches and other network equipment. The main controller is placed in the tower bottom of the turbine. It runs the control algorithms of the turbine, as well as all IO communication.

The communications network is a time triggered Ethernet network (TTEthernet).

The VMP8000 control system serves the following main functions:

- Monitoring and supervision of overall operation.
- Synchronizing of the generator to the grid during connection sequence.
- Operating the wind turbine during various fault situations.
- Automatic yawing of the nacelle.
- OptiTip® - blade pitch control.
- Reactive power control and variable speed operation.
- Noise emission control.
- Monitoring of ambient conditions.
- Monitoring of the grid.
- Monitoring of the smoke detection system.

4.9 Uninterruptible Power Supply (UPS)

During grid outage, an UPS system will ensure power supply for specific components.

The UPS system consists of 3 subsystems:

1. 230V AC UPS for all power backup to nacelle and hub control systems
2. 24V DC UPS for power backup to tower base control systems and ready to protect
3. 230V AC UPS for power backup to internal lights in tower, main nacelle house, side-compartment and hub

Backup Time	Standard	Optional
Control System* **(230V AC and 24V DC UPS)**	Up to 30 min	Up to 19.5 hours**
Emergency Lights (230V AC UPS)	30 min	60 min***
Ready to protect (24V DC UPS)	7 days	37 days****

Table 4-10: UPS data

NOTE *The control system includes: Turbine controller (VMP8000), HV switchgear functions, and remote-control system
**Requires upgrade of the 230V UPS for control system with extra batteries
***Requires upgrade of the 230V UPS for internal light with extra batteries
****Requires upgrade of the 24V DC UPS with extra batteries

NOTE For alternative backup times, contact Vestas.

5 Turbine Protection Systems

5.1 Braking Concept

The main brake on the turbine is aerodynamic. Stopping the turbine is done by full feathering the three blades (individually pitching of each blade). Each blade has a hydraulic accumulator to supply power for pitching the blade.

In addition, there is a hydraulic activated mechanical disc brake integrated into the generator. The mechanical brake is only used as a parking brake and when activating the emergency stop buttons.

5.2 Short Circuit Protections

Breakers	Breaker for Aux. Power.	Breaker 1 for Converter Modules	Breaker 2 for Converter Modules
Breaking Capacity Icu, Ics	Icu 91 kA Ics 75% Icu	Icu 91 kA Ics 50% Icu	91 kA Ics 50% Icu
Making Capacity Icm	223 kA	223 kA	223 kA

Table 5-1: Short circuit protection data

5.3 Overspeed Protection

The safety system integrated in the VMP8000 control system monitors the rotor speed, using a combination of sensors in the hub. In case of an overspeed situation, the safety system activates the hydraulic safety pitch system, which will feather the blades and bring the turbine to standstill.

Overspeed Protection	
Sensor Type	MEMS
Trip Level	Variant dependent

Table 5-2: Overspeed protection data

5.4 Arc Detection

The turbine is equipped with an Arc Detection system including multiple optical arc detection sensors placed in the HV transformer compartment and the converter cabinet. The Arc Detection system is connected to the turbine safety system via a dedicated arc detection relay ensuring immediate opening of the HV switchgear if an arc is detected.

5.5 Smoke Detection

The turbine is equipped with a Smoke Detection system including multiple smoke detection sensors placed in the main nacelle house, in the side-compartment, in the transformer compartment, in main electrical cabinets both in nacelle and in the tower base. The Smoke Detection system is connected to the turbine control system ensuring immediate opening of the HV switchgear if smoke is detected.

5.6 Lightning Protection of Blades, Nacelle, Hub and Tower

The Lightning Protection System (LPS) helps protect the wind turbine against the physical damage caused by lightning strikes. The LPS consists of five main parts:

- Air termination system e.g. lightning receptors, diverter strips, and SMTs
- Down conducting system (a system to conduct the lightning current down through the wind turbine to help avoid or minimise damage to the LPS itself or other parts of the wind turbine)
- Protection against overvoltage and overcurrent
- Shielding against magnetic and electrical fields
- Earthing system

Lightning Protection Design Parameters			**Protection Level I**
Current Peak Value	I_{max}	[kA]	200
Impulse Charge	$Q_{impulse}$	[C]	100
Total Charge	Q_{total}	[C]	300
Specific Energy	W/R	[MJ/Ω]	10
Average Steepness	di/dt	[kA/μs]	200

Table 5-3: Lightning protection design parameters (IEC)

5.7 EMC

The turbine and related equipment fulfil the EU Electromagnetic Compatibility (EMC) legislation:

- DIRECTIVE 2014/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility.

The EMC performance is based on fulfilment of following standards:

Emission

- IEC/CISPR 11 at wind turbine level
- IEC 61000-6-4 for telecommunications

Immunity

- IEC 61000-6-2 for electronics installed
- IEC 61400-24 for lightning protection of electronics installed

Beside DIRECTIVE 2014/30/EU, electronics related to the functional safety evaluation shall fulfil

- IEC 62061 Safety on machinery (Directive 2006/42/EU Machinery)

5.8 RED (Radio Equipment Directive)

Related radio equipment installed in the turbine fulfil the EU legislation:

DIRECTIVE 2014/53/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 April 2014.

5.9 EMF (ElectroMagnetic Fields)

Electromagnetic fields in the wind turbine are identified to ensure safe stay for personnel during design, production, operation and service.

The following directive is basis for ensuring minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents.

DIRECTIVE 2013/35/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 June 2013.

5.10 Earthing

The Vestas Earthing System consists of individual earthing electrodes interconnected as one joint earthing system.

The Vestas Earthing System includes the TN-system and the Lightning Protection System for each wind turbine. It works as an earthing system for the medium voltage distribution system within the wind farm.

The Vestas Earthing System is adapted for the different types of turbine foundations. A separate set of documents describe the earthing system in detail, depending on the type of foundation.

In terms of lightning protection of the wind turbine, Vestas has no separate requirements for a certain minimum resistance to remote earth (measured in ohms) for this system. The earthing for the lightning protection system is based on the design and construction of the Vestas Earthing System.

A primary part of the Vestas Earthing System is the main earth bonding bar placed where all cables enter the wind turbine. All earthing electrodes are connected to this main earth bonding bar. Additionally, equipotential connections are made to all cables entering or leaving the wind turbine.

Requirements in the Vestas Earthing System specifications and work descriptions are minimum requirements from Vestas and IEC. Local and national requirements, as well as project requirements, may require additional measures.

5.11 Corrosion Protection

The turbine is as standard designed to withstand below corrosion environments according to ISO 12944-2:

Corrosion Protection	External Areas	Internal Areas
Nacelle	C5	C3
Hub	C5	C3
Tower	C5	C3

Table 5-5: Corrosion protection data for nacelle, hub, and tower

As an option, the turbine can be protected to withstand alternative external corrosion environments – consult Vestas for further details.

6 Safety

The safety specifications in this section provide limited general information about the safety features of the turbine and are not a substitute for Buyer and its agents taking all appropriate safety precautions, including but not limited to (a) complying with all applicable safety, operation, maintenance, and service agreements, instructions, and requirements, (b) complying with all safety-related laws, regulations, and ordinances, and (c) conducting all appropriate safety training and education.

6.1 Access

Access to the turbine from the outside is through a door located at the entrance platform approximately 3 meters above ground level. The door is equipped with a lock. Access from the entrance platform to the tower top is by a ladder with fall arrest system or service lift. From the tower top there is two separate access routes to the nacelle main house, both via a ladder.

The nacelle consists of the main nacelle house which hosts the power train, and a side-compartment, which hosts converter and high voltage transformer. Access to the transformer room is controlled with an interlock.

Inside the nacelle main house, there are walkways along either side of the power train and in the rear end of the nacelle main house. The side-compartment has two access openings, one in the front and one in the back.

Access to the rotor is restricted with fixed or moveable guard with interlock.

6.2 Evacuation and Rescue

The basic principle for evacuation is inside and down via the normal access routes. From the centre of the nacelle main house there are two separate exit points to the tower, one on each side of the power train. The evacuation route to the tower is on fixed ladders with fall arrest system.

With two separate evacuation routes from the nacelle main house to the tower, it is the intention to avoid escape by means of descent device.

However, the turbine design still enables the possibility to descent directly from nacelle to ground via the service hatch in the bottom of the nacelle main house. Dedicated attachment points for a descent device are provided above the hatch.

It is a prerequisite that one or more descent devices are available in the turbine when there are people present in the turbine.

For rescue the normal access routes can be used, in addition to this it is possible to lower an injured person to the ground through the service hatch, one of the hatches in the spinner or from the roof.

The skylights in the roof can be opened from both the inside and outside.

Evacuation from the service lift is by ladder.

6.3 Rooms/Working Areas

The tower, nacelle main house and side-compartment are equipped with power sockets for electrical tools for service and maintenance of the turbine.

6.4 Floors, Platforms, Standing, and Working Places

All floors have anti-slip surfaces. There is one floor per tower section.

Rest platforms are provided at intervals of 12 metres along the tower ladder between platforms.

6.5 Service Lift

Towers for the EnVentus turbines are as standard delivered with a service lift. But for lower hub heights, towers without a service lift can be provide as an option. Please contact Vestas for additional details.

6.6 Work restraint and fall arrest

The tower ladder is equipped with a fall arrest system, either a rail or a wire.

The service areas in the turbines are equipped with yellow coloured anchor points. The anchor point may be used for work positioning, fall restraint, fall arrest and to attach a descent device to perform rescue or escape from the turbine.

The strength of the anchor point is verified by static and dynamic tests. The minimum required static test load is 22.5 kN.

6.7 Moving Parts, Guards, and Blocking Devices

All moving parts in the nacelle are shielded.

The turbine is equipped with a rotor lock to block the rotor and power train.

Blocking the pitch of the blade can be done both automatically and manually with a mechanical blade lock.

6.8 Lights

The turbine is equipped with lights in the tower, nacelle main house, side-compartment and hub.

There is emergency light in case of the loss of electrical power.

6.9 Emergency Stop

There are emergency stop buttons in the nacelle, hub and tower.

6.10 Power Disconnection

The turbine is equipped with breakers to allow for disconnection from all power sources during inspection or maintenance. The switches are marked with signs and are located in the nacelle and bottom of the tower.

6.11 Fire Protection/First Aid

When there are people present in the turbine, following fire and safety equipment must be available. In the nacelle: A first aid kit, a handheld fire extinguisher, and a fire blanket. In the tower a handheld fire extinguisher and a fire blanket at the entrance platform.

6.12 Warning Signs

Warning signs placed inside or on the turbine must be reviewed before operating or servicing the turbine.

6.13 Manuals and Warnings

The Vestas Corporate OH&S Manual and manuals for operation, maintenance and service of the turbine provide additional safety rules and information for operating, servicing or maintaining the turbine.

7 Environment

7.1 Chemicals

Chemicals used in the turbine are evaluated according to the Vestas Wind Systems A/S Environmental System certified according to ISO 14001:2015. The following chemicals are used in the turbine:

- Anti-freeze to help prevent the cooling system from freezing.
- Gear oil for lubricating the main bearing, gearbox and generator
- Hydraulic oil to pitch the blades, operate the brake and operate the rotor lock
- Grease for yaw system lubrication
- Transformer insulation liquid for HV transformer
- Various cleaning agents and chemicals for maintenance of the turbine.

8 Design Codes

8.1 Design Codes – Structural Design

The turbine design has been developed and verified in accordance with, but not limited to, the following main standards:

Design Codes	
Nacelle and Hub	IEC 61400-1 Edition 4 EN 50308
Tower (IEC)	IEC 61400-1 Edition 4 IEC 61400-6 Edition 1
Tower (DIBt)	Richtlinie für Windenergieanlagen, DIBt, Ausgabe: Oktober 2012
Blades	IEC 61400-5:2020 IEC 1024-1 IEC 60721-2-4 IEC 61400 (Part 1, 12 and 23) DEFU R25 DS/EN ISO 12944-2
Gearbox	IEC 61400-4
Generator	IEC 60034 (relevant parts)
Transformer	IEC 60076-11 IEC 60076-16 CENELEC HD637 S1
Lightning Protection	IEC 61400-24:2019
Safety of Machinery, Safety-related Parts of Control Systems	EN ISO 13849-1:2015
Safety of Machinery – Electrical Equipment of Machines	EN 60204-1:2018

Table 8-1: Design codes

9 Colours

9.1 Nacelle Colour

Colour of Vestas Nacelles	
Standard Nacelle Colour	RAL 7035 (light grey)
Standard Logo	Vestas

Table 9-1: Colour, nacelle

9.2 Tower Colour

Colour of Vestas Tower Section		
	External:	**Internal:**
Standard Steel Tower	RAL 7035 (light grey)	RAL 9001 (cream white)
Standard Concrete Hybrid Tower	**Concrete part:** Unpainted concrete, corresponds approx. to RAL 7023 (concrete grey) **Steel part:** RAL 7035 (light grey)	**Concrete part:** Unpainted concrete, corresponds approx. to RAL 7023 (concrete grey) **Steel part**: RAL 9001 (cream white)
Option for Concrete Hybrid Tower	Concrete part can be painted with RAL 7035 (light grey)	

Table 9-2: Colour, tower

9.3 Blade Colour

Blade Colour	
Standard Blade Colour	RAL 7035 (light grey). All lightning receptor surfaces on the blades are unpainted, excluding the Solid Metal Tips (SMT).
Tip-End Colour Variants	RAL 2009 (traffic orange), RAL 3020 (traffic red)
Gloss	< 30% ISO 2813

Table 9-3: Colour, blades

10 Operational Envelope and Performance Guidelines

Actual climate and site conditions have many variables and should be considered in evaluating actual turbine performance. The design and operating parameters set forth in this section do not constitute warranties, guarantees, or representations as to turbine performance at actual sites.

10.1 Climate and Site Conditions

Values refer to hub height:

Extreme Design Parameters	
Wind Climate	**All**
Ambient Temperature Interval (Standard Temperature Turbine)	-40° to +50°C

Table 10-1: Extreme design parameters

10.2 Operational Envelope – Temperature and Altitude

Values below refer to hub height and are determined by the sensors and control system of the turbine.

Operational Envelope – Temperature	
Ambient Temperature Interval	-20° to +45°C
Ambient Temperature Interval (Low Temperature Operation)	-30° to +45°C

Table 10-2: Operational envelope – temperature

NOTE

The wind turbine will stop producing power at ambient temperatures above 45°C.

For turbine variant specific information related to power performance within the operational envelope, please refer to turbine variant specific Performance Specifications.

For the low temperature operation of the wind turbine, consult Vestas for site specific evaluation.

The turbine is designed for use at altitudes up to 1000 m above sea level as standard and optional up to 2000 m above sea level.

10.3 Operational Envelope – Grid Connection

Operational Envelope – Grid Connection		
Nominal Phase Voltage	[U_{NP}]	720 V
Nominal Frequency	[f_N]	50/60 Hz
Maximum Frequency Gradient	±4 Hz/sec.	
Maximum Negative Sequence Voltage	3% (connection) 2.5% (operation)	
Minimum Required Short Circuit Ratio at Turbine HV Connection	5.0 (contact Vestas for lower SCR levels)	
Maximum Short Circuit Current Contribution	Contact Vestas for details	

Table 10-3: Operational envelope – grid connection

The generator and the converter will be disconnected if*:

Protection Settings	
Voltage Above 110% of Nominal for 1800 Seconds**	792 V
Voltage Above 116% of Nominal for 60 Seconds	835 V
Voltage Above 125% of Nominal for 2 Seconds	900 V
Voltage Above 136% of Nominal for 0.150 Seconds	979 V
Voltage Below 90% of Nominal for 180 Seconds (FRT)**	648 V
Voltage Below 85% of Nominal for 12 Seconds (FRT)	612 V
Voltage Below 80% of Nominal for 4.8 Seconds (FRT)	576 V
Frequency is Above 106% of Nominal for 120 Seconds	53/63.6 Hz
Frequency is Above 110% of Nominal for 0.2 Seconds	55/66 Hz
Frequency is Below 94% of Nominal for 0.2 Seconds	47/56.4 Hz

Table 10-4: Generator and converter disconnecting values

NOTE

* Over the turbine lifetime, grid drop-outs are to occur at an average of no more than 50 times a year.

** The turbine may be configured for continuous operation @ +/- 13 % voltage.

10.4 Operational Envelope – Reactive Power Capability

For turbine variant specific reactive power capability, please refer to the variant specific Performance Specification.

10.5 Performance – Fault Ride Through

The turbine is designed to stay connected during grid disturbances within the voltage tolerance curve as illustrated below:

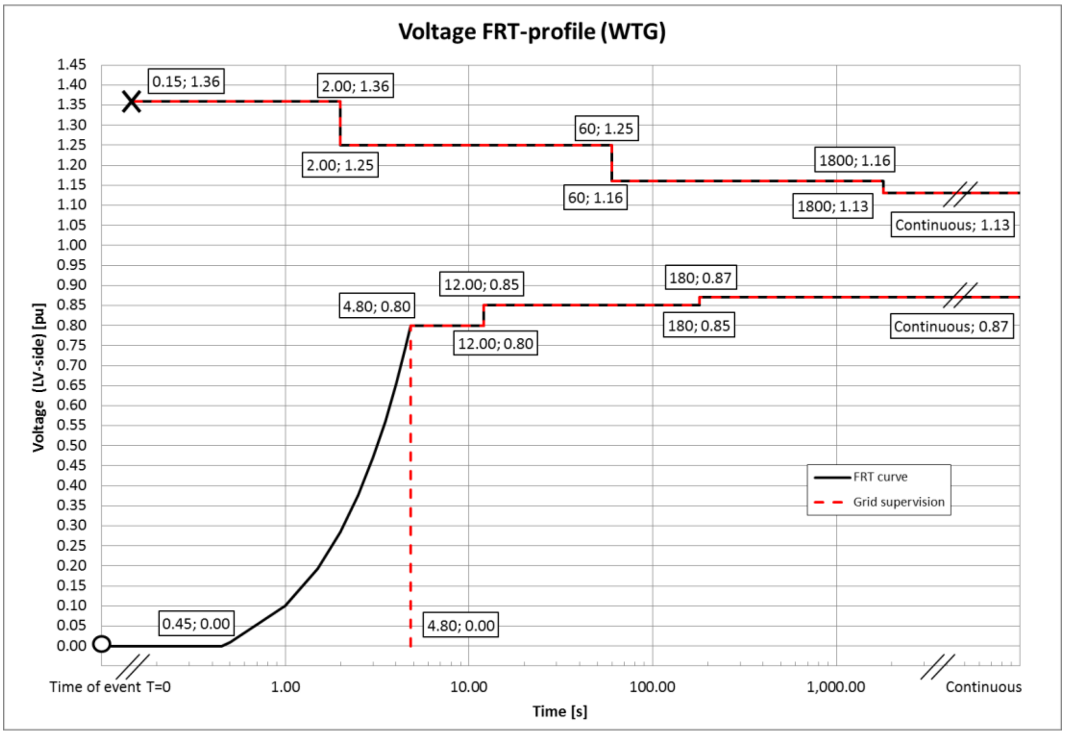


Figure 10-1: Voltage tolerance curve for symmetrical and asymmetrical faults, where U represents voltage as measured on the grid.

For grid disturbances outside the tolerance curve in Figure 10-1, the turbine will be disconnected from the grid.

Power Recovery Time	
Power Recovery to 90% of Pre-Fault Level	Maximum 0.1 seconds

Table 10-5: Power recovery time

10.6 Performance – Reactive Current Contribution

The reactive current contribution depends on whether the fault applied to the turbine is symmetrical or asymmetrical.

10.6.1 Symmetrical Reactive Current Contribution

During symmetrical voltage dips, the wind farm will inject reactive current to support the grid voltage. The reactive current injected is a function of the measured grid voltage.

The default value gives a reactive current part of 1 p.u. of the rated active current at the high voltage side of the HV transformer. Figure 10-2, indicates the reactive current contribution as a function of the voltage. The reactive current contribution is independent from the actual wind conditions and pre-fault power level. As seen in Figure 10-2, the default current injection slope is 2% reactive current increase per 1% voltage decrease. The slope can be parameterized between 0 and 10 to adapt to site specific requirements.

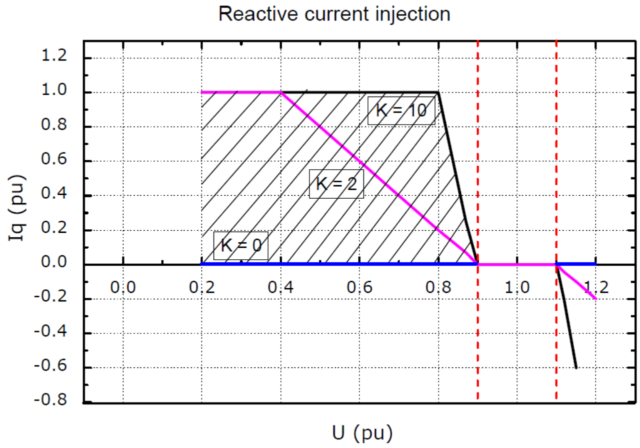


Figure 10-2: Reactive current injection

10.6.2 Asymmetrical Reactive Current Contribution

The injected current is based on the measured positive sequence voltage and the used K-factor. During asymmetrical voltage dips, the reactive current injection is limited to approximate 0.4 p.u. to limit the potential voltage increase on the healthy phases.

10.7 Performance – Multiple Voltage Dips

The turbine is designed to handle re-closure events and multiple voltage dips within a short period of time due to the fact that voltage dips are not evenly distributed during the year. For example, the turbine is designed to handle 10 voltage dips of duration of 200 ms, down to 20% voltage, within 30 minutes.

10.8 Performance – Active and Reactive Power Control

The turbine is designed for control of active and reactive power via the VestasOnline® SCADA system.

Maximum Ramp Rates for External Control	
Active Power	0.1 p.u./sec for max. power level change of 0.3 p.u. 0.3 p.u./sec for max. power level change of 0.1 p.u.
Reactive Power	20 p.u./sec

Table 10-6: Active/reactive power ramp rates

To support grid stability the turbine is capable to stay connected to the grid at active power references down to 10 % of nominal power for the turbine. For active power references below 10 % the turbine may disconnect from the grid.

10.9 Performance – Voltage Control

The turbine is designed for integration with VestasOnline® voltage control by utilising the turbine reactive power capability.

10.10 Performance – Frequency Control

The turbine can be configured to perform frequency control by decreasing the output power as a linear function of the grid frequency (over frequency). Dead band and slope for the frequency control function are configurable.

10.11 Distortion – Immunity

The turbine is able to connect with a pre-connection (background) voltage distortion level at the grid interface of 8% and operate with a post-connection voltage distortion level of 8%.

10.12 Main Contributors to Own Consumption

The consumption of electrical power by the wind turbine is defined as the power used by the wind turbine when it is not providing energy to the grid. This is defined in the control system as Production Generator 0 (zero).

The VMP8000 control system has a hibernate mode that reduces own consumption when possible. Similarly, cooling pumps may be turned off when the turbine idles.

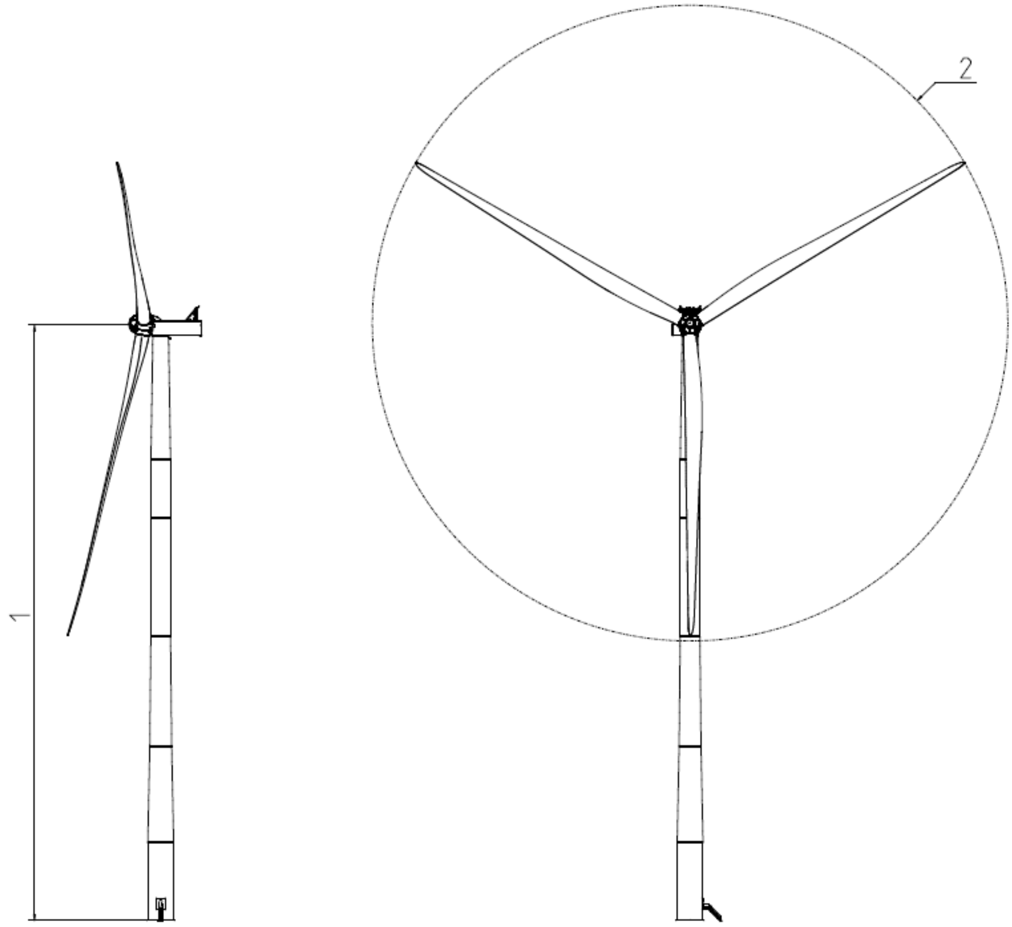
The components in Table 10-7 have the largest influence on the own consumption of the wind turbine. The values given are maximum component consumption, but the average consumption can be lower depending on the actual conditions, the climate, the wind turbine output, the cut-off hours, etc.

Main contributors to Own Consumption	V162	V172
Hydraulic Motor	3 x 18.5 kW	3 x 22 kW
Yaw Motors	35/42 kW for 50/60 Hz	
Generator Cooling Fans	4 x 4 kW	
Water Pumps	15 kW (max)	
Oil Pump for Gearbox Lubrication	7.5 kW	
Controller Including Heating Elements for the Hydraulics and all Controllers	Approximately 4 kW	
HV Transformer No-load Loss	See section 4.3 HV Transformer	

Table 10-7: Main contributors to own consumption data.

11 Drawings

11.1 Structural Design – Illustration of Outer Dimensions



1: Hub heights: See Performance Specification   2: Rotor diameter: 162/172 m

Figure 11-1: Illustration of outer dimensions – structure

12 General Reservations, Notes and Disclaimers

-
- The general descriptions in this document apply to the current version of the EnVentus™ turbines. Updated versions of the EnVentus™ turbines, which may be manufactured in the future, may differ from this general description. In the event that Vestas supplies an updated version of the EnVentus™ turbine, Vestas will provide an updated general description applicable to the updated version.
- Vestas recommends that the grid shall be as close to nominal as possible with limited variation in frequency and voltage.
- A certain time allowance for turbine warm-up must be expected following grid dropout and/or periods of very low ambient temperature.
- All listed start/stop parameters (e.g. wind speeds and temperatures) are equipped with hysteresis control. This can, in certain borderline situations, result in turbine stops even though the ambient conditions are within the listed operation parameters.
- The earthing system must comply with the minimum requirements from Vestas and be in accordance with local and national requirements and codes of standards.
- This document, General Description, is not an offer for sale, and does not contain any guarantee, warranty and/or verification of the power curve and noise (including, without limitation, the power curve and noise verification method). Any guarantee, warranty and/or verification of the power curve and noise (including, without limitation, the power curve and noise verification method) must be agreed to separately in writing.

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Document no.: 0127-1584 V01
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Performance Specification

EnVentus™

V172-7.2 MW 50/60 Hz

Table of contents

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See general reservations, notes and disclaimers (including, Section 5, p. 15) to this Performance Specification.

1 General Description

The Vestas V172-7.2 MW is a wind turbine variant within the EnVentus™ turbine range. It is a pitch regulated upwind turbine with active yaw and a three-blade rotor. The V172-7.2 MW turbine has a rotor diameter of 172 m and a rated power of 7.2 MW.

2 Type Approvals and Available Hub Heights

The standard turbine is type certified according to the certification standards and available hub heights listed below:

Certification	Wind Class	Hub Height
IECRE OD-501	IEC S	166 / 150 / 117 / 114 m
DIBt 2012	DIBt S	175 / 164 m

3 Operational Envelope and Performance Guidelines

Actual climate and site conditions have many variables and should be considered in evaluating actual turbine performance. The design and operating parameters set forth in this section do not constitute warranties, guarantees, or representations as to turbine performance at actual sites.

3.1 Climate and Site Conditions

The standard turbine is designed for the wind climate conditions listed below. Values refer to hub height.

	DIBt towers		IEC towers			
Wind Class	**DIBt S**	**DIBt S**	**IEC S**	**IEC S**	**IEC S**	**IEC S**
Hub Height	**CHT* 175m**	**CHT* 164m**	**166m**	**150m**	**117m**	**114m**
Power Rating	**7.2 MW**	**7.2 MW**	**7.2 MW**	**7.2 MW**	**7.2 MW**	**7.2 MW**
Average design parameters						
Wind Speed (10 min average), V_{ave}	7.2 m/s	7.2 m/s	7.4 m/s	8.0 m/s	7.4 m/s	7.2 m/s
Weibull Scale Factor, *C*	8.1 m/s	8.1 m/s	8.3 m/s	9.0 m/s	8.3 m/s	8.1 m/s
Weibull Shape Factor, *k*	2.00	2.00	2.48	2.50	2.50	2.10
I_{ref} acc. to IEC 61400-1	S	S	15%	13%	14%	11%
Turbulence Intensity, I_{90} (90% quant.)	S	S	16.90%	14.60%	15.73%	12.69%
Wind Shear, α	0.27	0.27	0.30	0.21	0.22	0.15
Inflow Angle	8°	8°	8°	8°	8°	8°
Extreme design parameters						
Extr Wind Speed (10 min average), V_{50}	38.0 m/s	39.5 m/s	35.0 m/s	41.0 m/s	39.5 m/s	40.0 m/s
Survival Wind Speed (3 s gust), V_{e50}	53.2 m/s	55.3 m/s	49.0 m/s	57.4 m/s	55.3 m/s	56.0 m/s
Turbulence intensity, $I_{v(z)}$	11.10%	11.10%	11.00%	11.00%	11.00%	11.00%

*CHT refers to Concrete Hybrid Tower

NOTE The turbine is intended for low to medium wind speed sites and is classified as DIBt S and IEC S. Please contact Vestas Wind Systems A/S for further information if needed.

Climatic conditions for turbines with the optional Vestas Anti-icing System (VAS) may vary from above. Please contact Vestas Wind Systems A/S for further information.

3.1.1 Wind Power Plant Layout

Turbine spacing is to be evaluated site-specifically. Spacing below two rotor diameters (2D) may require sector-wise curtailment.

NOTE As evaluation of climate and site conditions is complex, consult Vestas for every project. If conditions exceed the above parameters, Vestas must be consulted.

3.2 Operational Envelope – Wind

Values refer to hub height and are determined by the sensors and control system of the turbine.

Wind Climate	DIBt S, IEC S
	PO7200
Cut-In, V_{in}	3 m/s
Cut-Out (10 min exponential avg.), V_{out}	25 m/s
Re-Cut In (10 min exponential avg.)	23 m/s

3.3 Operational Envelope – Temperature and Altitude

Values below refer to hub height and are determined by the sensors and control system of the turbine.

Operational Envelope – Temperature	
Ambient Temperature Interval	-20° to +45°C
Ambient Temperature Interval (Low Temperature operation)	-30° to +45°C

NOTE

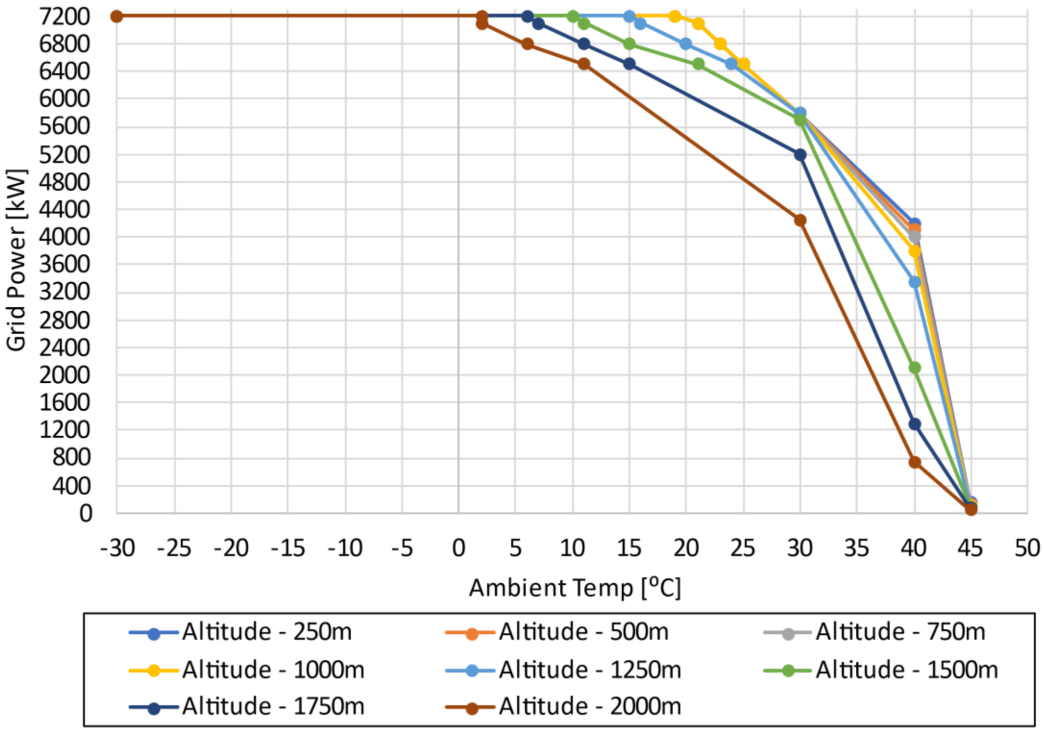
The wind turbine will stop producing power at ambient temperatures above 45°C.
For the low temperature operation of the wind turbine please consult Vestas.

The turbine is designed for use at altitudes up to 1000 m above sea level as standard and optional up to 2000 m above sea level. Contact Vestas for more details.

3.3.1 Temperature dependent operation

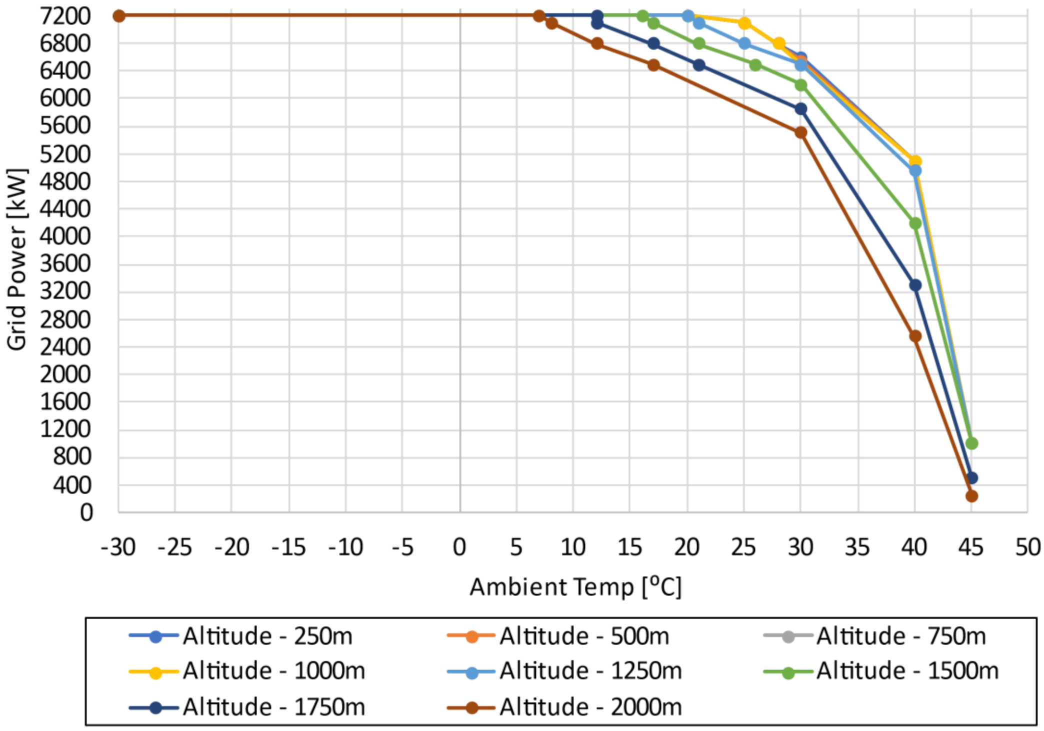
Values below refer to hub height and are determined by the sensors and control system of the turbine. At ambient temperatures above the thresholds shown for each operating mode, the turbine will maintain derated production.

The turbine will be available with two temperature performance steps a standard configuration (Performance Step 0, PS0) and an optional configuration (Performance Step 1, PS1).



Temperature derate points for Standard Cooler top, V172-7.2MW														
Altitude [m]	**[°C]**	**[kW]**	**[°C]**	**[kW]**	**[°C]**	**[kW]**	**[°C]**	**[kW]**	**[°C]**	**[kW]**	**[°C]**	**[kW]**	**[°C]**	**[kW]**
<250	19	7200	21	7100	23	6800	25	6500	30	5800	40	4200	45	150
250-500	19	7200	21	7100	23	6800	25	6500	30	5800	40	4100	45	125
500-750	19	7200	21	7100	23	6800	25	6500	30	5800	40	4000	45	115
750-1000	19	7200	21	7100	23	6800	25	6500	30	5800	40	3800	45	100
1000-1250	15	7200	16	7100	20	6800	24	6500	30	5800	40	3350	45	90
1250-1500	10	7200	11	7100	15	6800	21	6500	30	5700	40	2100	45	80
1500-1750	6	7200	7	7100	11	6800	15	6500	30	5200	40	1300	45	70
1750-2000	2	7200	2	7100	6	6800	11	6500	30	4250	40	750	45	50

Figure 3-1: *Temperature dependant derated operation – Standard cooler top (PS0)*



Temperature derate points for Optional Cooler top, V172-7.2MW														
Altitude [m]	**[°C]**	**[kW]**	**[°C]**	**[kW]**	**[°C]**	**[kW]**	**[°C]**	**[kW]**	**[°C]**	**[kW]**	**[°C]**	**[kW]**	**[°C]**	**[kW]**
<250	20	7200	25	7100	28	6800	30	6600	-	-	40	5100	45	1000
250-500	20	7200	25	7100	28	6800	30	6550	-	-	40	5100	45	1000
500-750	20	7200	25	7100	28	6800	30	6500	-	-	40	5100	45	1000
750-1000	20	7200	25	7100	28	6800	30	6500	-	-	40	5100	45	1000
1000-1250	20	7200	21	7100	25	6800	30	6500	-	-	40	4950	45	1000
1250-1500	16	7200	17	7100	21	6800	26	6500	30	6200	40	4200	45	1000
1500-1750	12	7200	12	7100	17	6800	21	6500	30	5850	40	3300	45	500
1750-2000	7	7200	8	7100	12	6800	17	6500	30	5500	40	2550	45	250

Figure 3-2: Temperature dependant derated operation – Optional cooler top (PS1)

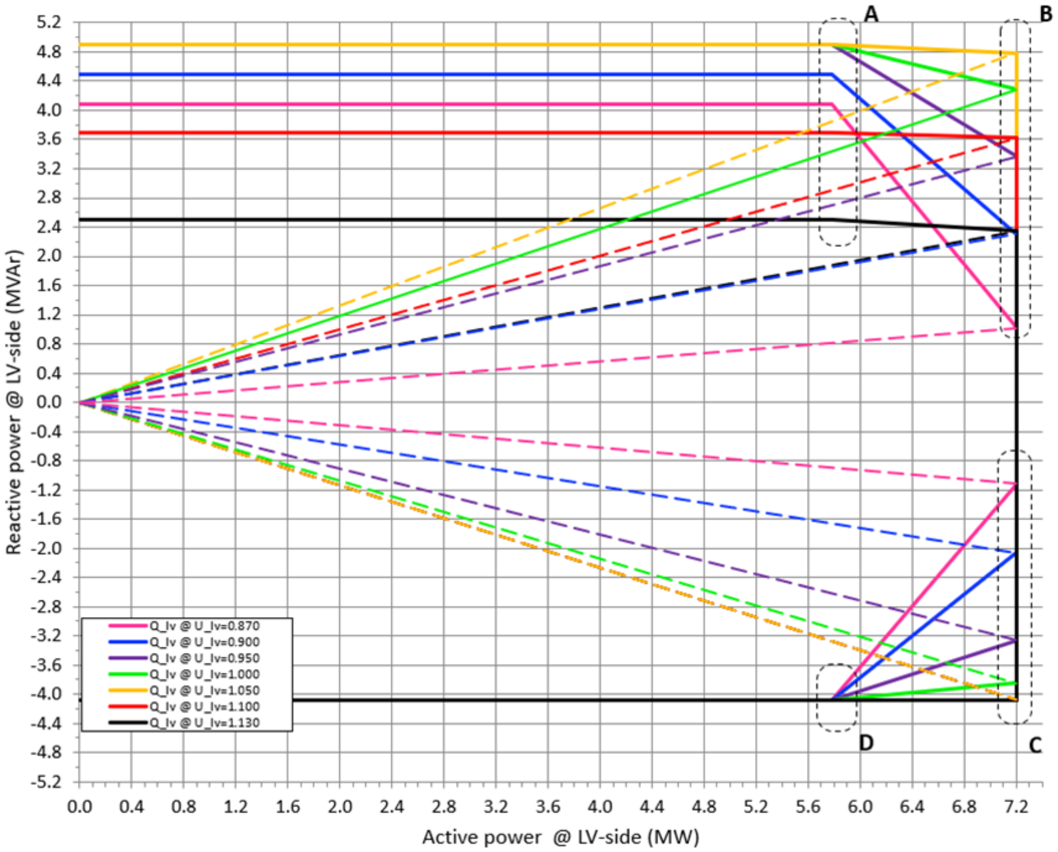
3.4 Operational Envelope – Conditions for Power Curve and Ct Values (at Hub Height)

Please consult section 6 and subsequent, for power curves and C_t values.

Conditions for Power Curve and C_t Values (at Hub Height)	
Wind Shear, *α*	0.00-0.30 (10-minute average)
Turbulence Intensity, *I*	6-12% (10-minute average)
Blades	Clean
Rain	No
Ice/Snow on Blades	No
Leading Edge	No damage
Terrain	IEC 61400-12-1
Inflow Angle (Vertical)	0 ±2°
Grid Voltage	Nominal Voltage ±2.5%
Grid Frequency	Nominal Frequency ±0.5 Hz
Grid Active Power (LV-side)	Per tabulated values in Section 6 and following sections
Grid Reactive Power (LV-side)	Power Factor 1.0

3.5 Operational Envelope – Reactive Power Capability

The turbine has a reactive power capability on the low voltage side of the HV transformer as illustrated in Figure 3-3:



		Coordinates								Power factor	
	Point:	A		B		C		D		B (Capacitive)	C (Inductive)
	Coordinate:	x (P)	y (Q)	x (P)	y (Q)	x (P)	y (Q)	x (P)	y (Q)		
	Reactive power [kVAr] @ LV side @ U_lv = 0.870 p.u. voltage	5.780	4.080	7.200	1.020	7.200	-1.116	5.780	-4.080	0.990	0.988
	Reactive power [kVAr] @ LV side @ U_lv = 0.900 p.u. voltage	5.780	4.488	7.200	2.299	7.200	-2.064	5.780	-4.080	0.953	0.961
	Reactive power [kVAr] @ LV side @ U_lv = 0.950 p.u. voltage	5.780	4.896	7.200	3.362	7.200	-3.262	5.780	-4.080	0.906	0.911
	Reactive power [kVAr] @ LV side @ U_lv = 1.000 p.u. voltage	5.780	4.896	7.200	4.283	7.200	-3.846	5.780	-4.080	0.859	0.882
	Reactive power [kVAr] @ LV side @ U_lv = 1.050 p.u. voltage	5.780	4.896	7.200	4.783	7.200	-4.080	5.780	-4.080	0.833	0.870
	Reactive power [kVAr] @ LV side @ U_lv = 1.100 p.u. voltage	5.780	3.697	7.200	3.621	7.200	-4.080	5.780	-4.080	0.893	0.870
	Reactive power [kVAr] @ LV side @ U_lv = 1.130 p.u. voltage	5.780	2.499	7.200	2.346	7.200	-4.080	5.780	-4.080	0.951	0.870

Figure 3-3: Reactive power capability.

The turbine is able to maintain the reactive power capability at low wind with no active power production.

3.5.1 Temperature dependent reactive power capability

The reactive power capability shown in Figure 3-3 is valid for ambient temperatures at which no active power derate is needed according to Figure 3-1 and Figure 3-2.

For ambient temperatures up to 40°C, where active power is derated below 6.8 MW because of ambient temperature, the shape of the PQ chart corresponding to 6.8 MW (Figure 3-4: A, B, C and D points) is maintained. The active power for the A, B, C and D points is however adjusted according to the overall WTG active power derate according to Figure 3-1 and Figure 3-2.

For ambient temperatures between 40°C and 45°C, reactive power is derated proportional to the active power derate.

Figure 3-4 shows an illustrative example of the reactive power derate.

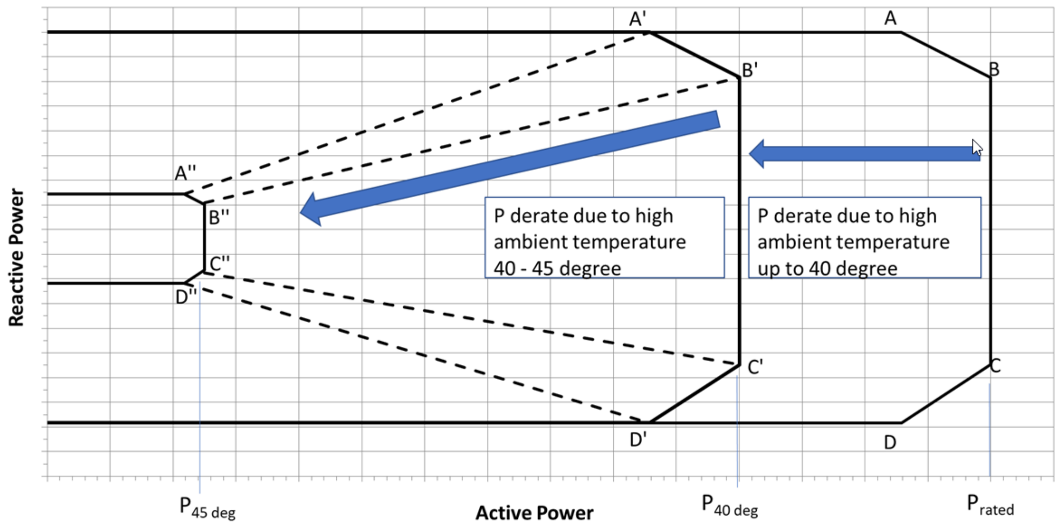


Figure 3-4 Reactive power capability temperature dependency. Illustrative example.

3.6 Operational Modes

The operational modes listed below are available for the turbine.

Sound modes			
Mode No.	**Maximum Sound Level**	**Serrated trailing edges**	**Available hub heights**
PO7200	106.9 dBA	Yes (standard)	175 / 166 / 164 / 150 / 117 / 114 m
PO7200-0S	110.1 dBA	No (option)	175 / 166 / 164 / 150 / 117 / 114 m

In addition, Sound Optimized (SO) modes as listed below are available as options for the turbine.

Sound Optimized (SO) modes			
Mode No.	**Maximum Sound Level**	**Serrated trailing edges**	**Available hub heights**
SO1	105 dBA	Yes (standard)	175 / 166 / 164 / 150 / 117 / 114 m
SO2	104 dBA	Yes (standard)	175 / 166 / 164 / 150 / 117 / 114 m
SO3	103 dBA	Yes (standard)	175 / 166 / 164 / 150 / 117 / 114 m
SO4	102 dBA	Yes (standard)	175 / 166 / 164 / 150 / 117 / 114 m
SO5	101 dBA	Yes (standard)	175 / 166 / 164 / 150 / 117 / 114 m
SO6	100 dBA	Yes (standard)	175 / 166 / 164 / 150 / 117 / 114 m
SO7	99 dBA	Yes (standard)	175 / 166 / 164 / 150 / 117 / 114 m
SO8	98 dBA	Yes (standard)	175 / 166 / 164 / 150 / 117 / 114 m

NOTE Sound Optimized (SO) modes are only available with serrated trailing edges on the blades. For further details on sound performance and in case of specific requests, please contact Vestas Wind Systems A/S.

The operational modes listed below are available as options for the turbine. These modes are designed to reduce wake impact in a park layout. Sound performance remains identical to PO7200 and PO7200-0S.

Ct modes		
Mode No.	**Ct Level @ 8m/s**	**Available hub heights**
PO7200-Ct74	0.74	175 / 166 / 164 / 150 / 117 / 114 m

4 Drawings

Overview drawings describing the wind turbines, tower and foundation are shown in these documents.

V172 HH175 (DiBt) – 0114-1754
V172 HH164 (DiBt) – 0114-1757
V172 HH166 (IEC) – 0120-2603
V172 HH150 (IEC) – 0120-2640
V172 HH117 (IEC) – 0114-1759
V172 HH114 (IEC) – 0128-6274

NOTE For detailed drawings, please contact Vestas Wind Systems A/S.

4.1 Turbine visual impression – side view

5 General Reservations, Notes and Disclaimers

-
- The performance specifications described in this document apply to the current version of the V172-7.2 MW wind turbine. Updated versions of the V172-7.2 MW wind turbine, which may be manufactured in the future, may differ from these performance specifications. In the event that Vestas supplies an updated version of the V172-7.2 MW wind turbine, Vestas will provide an updated performance specification applicable to the updated version.
- All listed start/stop parameters (e.g. wind speeds) are equipped with hysteresis control. This can, in certain borderline situations, result in turbine stops even though the ambient conditions are within the listed operation parameters.
- This document, Performance Specification, is not an offer for sale, and does not contain any guarantee, warranty and/or verification of the power curve and sound (including, without limitation, the power curve and sound verification method). Any guarantee, warranty and/or verification of the power curve and sound (including, without limitation, the power curve and sound verification method) must be agreed to separately in writing.

6 Power Curves, Ct Values and Sound Curves, Mode PO7200

6.1 Power Curves, Mode PO7200

	Air density [kg/m³]													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**32**	15	16	18	19	21	22	24	26	27	29	30	34	35
3.5	**129**	78	83	87	91	95	100	105	109	114	119	124	134	140
4.0	**288**	195	204	213	221	230	238	246	255	263	271	279	296	304
4.5	**481**	346	359	371	383	395	407	420	432	444	457	469	493	506
5.0	**715**	529	546	563	580	597	614	631	648	665	682	698	732	749
5.5	**999**	748	770	793	816	839	862	885	907	930	953	976	1022	1045
6.0	**1340**	1011	1041	1071	1101	1131	1160	1190	1220	1250	1280	1310	1370	1400
6.5	**1739**	1322	1360	1398	1436	1475	1512	1550	1588	1626	1663	1701	1776	1814
7.0	**2203**	1686	1733	1781	1828	1875	1922	1969	2016	2063	2109	2156	2249	2296
7.5	**2729**	2100	2158	2215	2273	2330	2387	2444	2502	2559	2616	2672	2785	2842
8.0	**3324**	2569	2639	2708	2777	2847	2915	2984	3052	3121	3189	3256	3391	3459
8.5	**3986**	3098	3180	3262	3344	3426	3507	3587	3668	3748	3827	3907	4061	4137
9.0	**4685**	3685	3780	3875	3969	4064	4155	4246	4337	4427	4513	4599	4737	4788
9.5	**5314**	4287	4388	4488	4589	4689	4781	4874	4966	5058	5143	5229	5335	5357
10.0	**5904**	4863	4964	5066	5168	5270	5363	5456	5550	5643	5730	5817	5909	5914
10.5	**6441**	5389	5494	5598	5703	5808	5904	6000	6096	6192	6275	6358	6441	6440
11.0	**6854**	5886	5993	6099	6205	6312	6399	6486	6574	6661	6725	6789	6850	6847
11.5	**7078**	6361	6456	6551	6646	6741	6800	6860	6920	6980	7012	7045	7076	7074
12.0	**7160**	6756	6820	6885	6949	7013	7040	7067	7094	7121	7134	7147	7159	7158
12.5	**7195**	7008	7038	7068	7098	7129	7140	7152	7164	7176	7182	7188	7194	7194
13.0	**7200**	7119	7133	7148	7162	7177	7182	7187	7193	7198	7199	7199	7200	7200
13.5	**7200**	7166	7173	7179	7186	7192	7194	7196	7198	7199	7200	7200	7200	7200
14.0	**7200**	7188	7191	7194	7196	7199	7199	7200	7200	7200	7200	7200	7200	7200
14.5	**7200**	7197	7198	7199	7199	7200	7200	7200	7200	7200	7200	7200	7200	7200
15.0	**7200**	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200
15.5	**7200**	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200
16.0	**7200**	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200
16.5	**7200**	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200
17.0	**7200**	7199	7199	7199	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200
17.5	**7194**	7179	7180	7182	7183	7185	7186	7187	7189	7190	7191	7192	7195	7196
18.0	**7124**	7064	7069	7074	7078	7083	7089	7094	7100	7106	7112	7118	7130	7136
18.5	**6959**	6887	6892	6897	6903	6908	6915	6922	6929	6935	6943	6951	6967	6976
19.0	**6789**	6719	6724	6730	6735	6740	6747	6754	6760	6767	6774	6782	6797	6806
19.5	**6630**	6561	6567	6572	6578	6584	6589	6595	6601	6607	6615	6622	6637	6645
20.0	**6472**	6384	6392	6399	6407	6414	6422	6431	6439	6448	6456	6464	6481	6490
20.5	**6262**	6129	6140	6151	6163	6174	6187	6200	6212	6225	6238	6250	6275	6287
21.0	**5946**	5762	5777	5793	5809	5825	5842	5859	5876	5893	5911	5928	5964	5983
21.5	**5538**	5328	5345	5362	5379	5396	5416	5435	5454	5474	5495	5516	5558	5579
22.0	**5069**	4864	4880	4897	4913	4930	4950	4971	4991	5011	5031	5050	5090	5110
22.5	**4597**	4402	4419	4436	4453	4471	4487	4504	4521	4538	4558	4577	4614	4631
23.0	**4121**	3930	3947	3963	3979	3996	4013	4030	4047	4064	4083	4102	4136	4150
23.5	**3636**	3468	3484	3500	3515	3531	3545	3559	3572	3586	3603	3619	3651	3666
24.0	**3169**	3020	3034	3048	3062	3076	3089	3102	3115	3127	3141	3155	3184	3199
24.5	**2718**	2589	2602	2615	2627	2640	2653	2665	2678	2690	2699	2709	2734	2750
25.0	**2328**	2223	2232	2242	2252	2262	2271	2280	2289	2298	2308	2318	2335	2343

6.2 Ct Values, Mode PO7200

	Air density kg/m³													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**0.969**	0.980	0.979	0.978	0.977	0.976	0.975	0.974	0.973	0.972	0.971	0.970	0.968	0.967
3.5	**0.885**	0.893	0.892	0.892	0.891	0.890	0.889	0.889	0.888	0.887	0.886	0.886	0.884	0.883
4.0	**0.834**	0.846	0.845	0.844	0.843	0.842	0.840	0.839	0.838	0.836	0.836	0.835	0.832	0.831
4.5	**0.818**	0.827	0.826	0.824	0.823	0.821	0.821	0.820	0.819	0.819	0.818	0.818	0.817	0.816
5.0	**0.812**	0.812	0.812	0.812	0.812	0.812	0.812	0.812	0.812	0.812	0.812	0.812	0.812	0.812
5.5	**0.815**	0.814	0.814	0.814	0.815	0.815	0.815	0.815	0.815	0.815	0.815	0.815	0.814	0.814
6.0	**0.814**	0.816	0.816	0.816	0.816	0.816	0.815	0.815	0.815	0.815	0.814	0.814	0.813	0.813
6.5	**0.810**	0.816	0.815	0.815	0.815	0.814	0.814	0.813	0.813	0.812	0.811	0.811	0.809	0.809
7.0	**0.805**	0.814	0.813	0.812	0.812	0.811	0.810	0.809	0.808	0.808	0.807	0.806	0.804	0.803
7.5	**0.797**	0.810	0.809	0.808	0.807	0.806	0.804	0.803	0.802	0.801	0.800	0.798	0.796	0.794
8.0	**0.788**	0.804	0.803	0.802	0.800	0.799	0.797	0.796	0.794	0.793	0.791	0.790	0.787	0.785
8.5	**0.777**	0.798	0.796	0.794	0.793	0.791	0.789	0.787	0.785	0.783	0.781	0.779	0.774	0.770
9.0	**0.750**	0.789	0.786	0.784	0.781	0.779	0.775	0.771	0.768	0.764	0.759	0.755	0.734	0.719
9.5	**0.690**	0.756	0.751	0.745	0.740	0.734	0.728	0.722	0.715	0.709	0.703	0.696	0.669	0.649
10.0	**0.628**	0.703	0.696	0.689	0.682	0.675	0.668	0.661	0.654	0.647	0.641	0.634	0.609	0.590
10.5	**0.571**	0.644	0.637	0.630	0.623	0.616	0.610	0.603	0.597	0.591	0.584	0.578	0.555	0.538
11.0	**0.513**	0.590	0.584	0.577	0.571	0.564	0.557	0.550	0.544	0.537	0.529	0.521	0.499	0.486
11.5	**0.451**	0.543	0.536	0.529	0.521	0.514	0.505	0.496	0.488	0.479	0.470	0.460	0.440	0.429
12.0	**0.392**	0.496	0.487	0.478	0.468	0.459	0.449	0.439	0.429	0.419	0.410	0.401	0.382	0.373
12.5	**0.341**	0.445	0.435	0.424	0.413	0.403	0.393	0.384	0.375	0.365	0.357	0.349	0.334	0.326
13.0	**0.299**	0.393	0.383	0.373	0.363	0.353	0.345	0.337	0.328	0.320	0.313	0.306	0.292	0.286
13.5	**0.264**	0.347	0.338	0.329	0.321	0.312	0.304	0.297	0.290	0.282	0.276	0.270	0.259	0.253
14.0	**0.235**	0.308	0.300	0.292	0.284	0.276	0.270	0.263	0.257	0.251	0.245	0.240	0.230	0.225
14.5	**0.210**	0.274	0.267	0.260	0.253	0.246	0.241	0.235	0.229	0.224	0.219	0.214	0.206	0.202
15.0	**0.188**	0.245	0.239	0.233	0.226	0.220	0.215	0.211	0.206	0.201	0.197	0.193	0.185	0.181
15.5	**0.170**	0.220	0.215	0.209	0.204	0.199	0.194	0.190	0.186	0.181	0.178	0.174	0.167	0.164
16.0	**0.155**	0.199	0.194	0.190	0.185	0.180	0.176	0.172	0.168	0.164	0.161	0.158	0.152	0.149
16.5	**0.141**	0.181	0.177	0.172	0.168	0.164	0.160	0.157	0.153	0.150	0.147	0.144	0.138	0.136
17.0	**0.129**	0.165	0.161	0.157	0.153	0.149	0.146	0.143	0.140	0.137	0.134	0.132	0.127	0.124
17.5	**0.119**	0.151	0.148	0.144	0.141	0.137	0.134	0.132	0.129	0.126	0.124	0.121	0.117	0.114
18.0	**0.108**	0.137	0.134	0.131	0.128	0.124	0.122	0.120	0.117	0.115	0.112	0.110	0.106	0.105
18.5	**0.098**	0.123	0.120	0.117	0.115	0.112	0.110	0.108	0.105	0.103	0.101	0.100	0.096	0.094
19.0	**0.088**	0.110	0.108	0.105	0.103	0.100	0.099	0.097	0.095	0.093	0.091	0.089	0.086	0.085
19.5	**0.080**	0.100	0.097	0.095	0.093	0.091	0.089	0.088	0.086	0.084	0.083	0.081	0.078	0.077
20.0	**0.073**	0.090	0.088	0.086	0.084	0.083	0.081	0.079	0.078	0.076	0.075	0.074	0.071	0.070
20.5	**0.066**	0.081	0.079	0.077	0.076	0.074	0.073	0.072	0.070	0.069	0.068	0.067	0.065	0.064
21.0	**0.058**	0.071	0.070	0.068	0.067	0.066	0.065	0.063	0.062	0.061	0.060	0.059	0.058	0.057
21.5	**0.052**	0.062	0.061	0.060	0.059	0.057	0.056	0.056	0.055	0.054	0.053	0.052	0.051	0.050
22.0	**0.045**	0.053	0.052	0.052	0.051	0.050	0.049	0.048	0.047	0.047	0.046	0.045	0.044	0.044
22.5	**0.039**	0.046	0.045	0.044	0.044	0.043	0.042	0.042	0.041	0.040	0.040	0.039	0.038	0.038
23.0	**0.033**	0.039	0.039	0.038	0.037	0.037	0.036	0.036	0.035	0.035	0.034	0.034	0.033	0.033
23.5	**0.028**	0.033	0.033	0.032	0.032	0.031	0.031	0.030	0.030	0.030	0.029	0.029	0.028	0.028
24.0	**0.024**	0.028	0.028	0.027	0.027	0.026	0.026	0.026	0.025	0.025	0.025	0.025	0.024	0.024
24.5	**0.020**	0.024	0.023	0.023	0.023	0.022	0.022	0.022	0.021	0.021	0.021	0.021	0.020	0.020
25.0	**0.017**	0.020	0.020	0.019	0.019	0.019	0.019	0.018	0.018	0.018	0.018	0.018	0.017	0.017

6.3 Sound Curves, Mode PO7200

Sound Power Level at Hub Height		
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3** **Maximum turbulence at hub height: 30%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m³**	
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA]** **Mode PO7200** **(Blades with serrated trailing edge)**	**Sound Power Level at Hub Height [dBA]** **Mode PO7200-0S** **(Blades without serrated trailing edge)**
3	94.6	97.8
4	94.6	97.8
5	95.2	98.4
6	98.6	101.8
7	102.2	105.4
8	105.6	108.8
9	106.9	110.1
10	106.9	110.1
11	106.9	110.1
12	106.9	110.1
13	106.9	110.1
14	106.9	110.1
15	106.9	110.1

7 Power Curves, Ct Values and Sound Curves, Park Modes

7.1 Power Curves, Mode PO7200-Ct74

	Air density [kg/m³]												
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**33**	16	17	18	20	21	23	25	26	28	30	31	35	36
3.5	**129**	78	82	87	91	95	100	105	109	114	119	124	134	139
4.0	**285**	194	203	211	220	228	236	244	253	261	269	277	294	302
4.5	**476**	343	355	367	379	391	403	415	427	439	451	464	488	500
5.0	**707**	523	540	556	573	590	607	624	640	657	674	690	724	741
5.5	**988**	739	762	784	807	829	852	875	897	920	942	965	1010	1033
6.0	**1324**	1000	1029	1059	1088	1118	1147	1177	1206	1236	1265	1295	1353	1383
6.5	**1717**	1307	1345	1382	1420	1457	1494	1531	1569	1606	1643	1680	1754	1790
7.0	**2173**	1666	1712	1759	1805	1851	1897	1943	1989	2035	2081	2127	2218	2263
7.5	**2688**	2073	2129	2185	2242	2298	2354	2410	2466	2522	2577	2632	2743	2798
8.0	**3269**	2533	2600	2668	2736	2803	2870	2937	3004	3071	3137	3203	3334	3399
8.5	**3914**	3051	3130	3210	3290	3370	3449	3527	3605	3684	3761	3837	3989	4064
9.0	**4625**	3632	3725	3818	3911	4004	4094	4184	4274	4364	4451	4538	4688	4751
9.5	**5290**	4251	4352	4452	4553	4654	4747	4841	4934	5028	5115	5203	5318	5346
10.0	**5898**	4849	4951	5054	5157	5259	5353	5447	5541	5635	5723	5811	5905	5912
10.5	**6439**	5385	5489	5594	5699	5804	5901	5997	6093	6189	6272	6356	6439	6439
11.0	**6854**	5886	5993	6099	6205	6312	6399	6486	6574	6661	6725	6789	6850	6847
11.5	**7078**	6361	6456	6551	6646	6741	6800	6860	6920	6980	7012	7045	7076	7074
12.0	**7160**	6756	6820	6885	6949	7013	7040	7067	7094	7121	7134	7147	7159	7158
12.5	**7195**	7008	7038	7068	7098	7129	7140	7152	7164	7176	7182	7188	7194	7194
13.0	**7200**	7119	7133	7148	7162	7177	7182	7187	7193	7198	7199	7199	7200	7200
13.5	**7200**	7166	7173	7179	7186	7192	7194	7196	7198	7199	7200	7200	7200	7200
14.0	**7200**	7188	7191	7194	7196	7199	7199	7200	7200	7200	7200	7200	7200	7200
14.5	**7200**	7197	7198	7199	7199	7200	7200	7200	7200	7200	7200	7200	7200	7200
15.0	**7200**	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200
15.5	**7200**	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200
16.0	**7200**	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200
16.5	**7200**	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200
17.0	**7200**	7199	7199	7199	7200	7200	7200	7200	7200	7200	7200	7200	7200	7200
17.5	**7194**	7179	7180	7182	7183	7185	7186	7187	7189	7190	7191	7192	7195	7196
18.0	**7124**	7064	7069	7074	7078	7083	7089	7094	7100	7106	7112	7118	7130	7136
18.5	**6959**	6887	6892	6897	6903	6908	6915	6922	6929	6935	6943	6951	6967	6976
19.0	**6789**	6719	6724	6730	6735	6740	6747	6754	6760	6767	6774	6782	6797	6806
19.5	**6630**	6561	6567	6572	6578	6584	6589	6595	6601	6607	6615	6622	6637	6645
20.0	**6472**	6384	6392	6399	6407	6414	6422	6431	6439	6448	6456	6464	6481	6490
20.5	**6262**	6129	6140	6151	6163	6174	6187	6200	6212	6225	6238	6250	6275	6287
21.0	**5946**	5762	5777	5793	5809	5825	5842	5859	5876	5893	5911	5928	5964	5983
21.5	**5538**	5328	5345	5362	5379	5396	5416	5435	5454	5474	5495	5516	5558	5579
22.0	**5069**	4864	4880	4897	4913	4930	4950	4971	4991	5011	5031	5050	5090	5110
22.5	**4597**	4402	4419	4436	4453	4471	4487	4504	4521	4538	4558	4577	4614	4631
23.0	**4121**	3930	3947	3963	3979	3996	4013	4030	4047	4064	4083	4102	4136	4150
23.5	**3636**	3468	3484	3500	3515	3531	3545	3559	3572	3586	3603	3619	3651	3666
24.0	**3169**	3020	3034	3048	3062	3076	3089	3102	3115	3127	3141	3155	3184	3199
24.5	**2718**	2589	2602	2615	2627	2640	2653	2665	2678	2690	2699	2709	2734	2750
25.0	**2328**	2223	2232	2242	2252	2262	2271	2280	2289	2298	2308	2318	2335	2343

7.2 Ct Values, Mode PO7200-Ct74

Air density kg/m³														
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**0.942**	0.953	0.952	0.951	0.951	0.950	0.949	0.948	0.947	0.946	0.945	0.944	0.941	0.940
3.5	**0.863**	0.871	0.870	0.869	0.869	0.868	0.867	0.867	0.866	0.865	0.864	0.864	0.862	0.861
4.0	**0.807**	0.819	0.818	0.817	0.816	0.815	0.813	0.812	0.811	0.810	0.809	0.808	0.807	0.806
4.5	**0.782**	0.790	0.788	0.787	0.786	0.785	0.785	0.784	0.783	0.783	0.782	0.782	0.781	0.780
5.0	**0.770**	0.770	0.770	0.770	0.770	0.770	0.770	0.770	0.770	0.770	0.770	0.770	0.770	0.770
5.5	**0.768**	0.768	0.768	0.768	0.768	0.768	0.768	0.768	0.768	0.768	0.768	0.768	0.768	0.767
6.0	**0.766**	0.769	0.769	0.769	0.769	0.769	0.768	0.768	0.768	0.767	0.767	0.767	0.766	0.765
6.5	**0.763**	0.768	0.768	0.768	0.767	0.767	0.766	0.766	0.765	0.765	0.764	0.763	0.762	0.761
7.0	**0.757**	0.766	0.765	0.765	0.764	0.763	0.763	0.762	0.761	0.760	0.759	0.758	0.756	0.755
7.5	**0.750**	0.762	0.761	0.760	0.759	0.758	0.757	0.756	0.755	0.753	0.752	0.751	0.749	0.747
8.0	**0.741**	0.756	0.755	0.754	0.753	0.751	0.750	0.749	0.747	0.746	0.744	0.743	0.740	0.738
8.5	**0.732**	0.750	0.748	0.747	0.745	0.744	0.742	0.740	0.739	0.737	0.735	0.733	0.729	0.727
9.0	**0.720**	0.745	0.743	0.741	0.739	0.737	0.735	0.732	0.730	0.728	0.725	0.722	0.710	0.701
9.5	**0.679**	0.730	0.726	0.722	0.718	0.714	0.709	0.704	0.700	0.695	0.690	0.684	0.662	0.645
10.0	**0.626**	0.695	0.688	0.682	0.676	0.669	0.663	0.657	0.650	0.644	0.638	0.632	0.607	0.589
10.5	**0.570**	0.642	0.635	0.628	0.621	0.615	0.608	0.602	0.596	0.590	0.583	0.577	0.554	0.538
11.0	**0.513**	0.590	0.584	0.577	0.571	0.564	0.557	0.550	0.544	0.537	0.529	0.521	0.499	0.486
11.5	**0.451**	0.543	0.536	0.529	0.521	0.514	0.505	0.496	0.488	0.479	0.470	0.460	0.440	0.429
12.0	**0.392**	0.496	0.487	0.478	0.468	0.459	0.449	0.439	0.429	0.419	0.410	0.401	0.382	0.373
12.5	**0.341**	0.445	0.435	0.424	0.413	0.403	0.393	0.384	0.375	0.365	0.357	0.349	0.334	0.326
13.0	**0.299**	0.393	0.383	0.373	0.363	0.353	0.345	0.337	0.328	0.320	0.313	0.306	0.292	0.286
13.5	**0.264**	0.347	0.338	0.329	0.321	0.312	0.304	0.297	0.290	0.282	0.276	0.270	0.259	0.253
14.0	**0.235**	0.308	0.300	0.292	0.284	0.276	0.270	0.263	0.257	0.251	0.245	0.240	0.230	0.225
14.5	**0.210**	0.274	0.267	0.260	0.253	0.246	0.241	0.235	0.229	0.224	0.219	0.214	0.206	0.202
15.0	**0.188**	0.245	0.239	0.233	0.226	0.220	0.215	0.211	0.206	0.201	0.197	0.193	0.185	0.181
15.5	**0.170**	0.220	0.215	0.209	0.204	0.199	0.194	0.190	0.186	0.181	0.178	0.174	0.167	0.164
16.0	**0.155**	0.199	0.194	0.190	0.185	0.180	0.176	0.172	0.168	0.164	0.161	0.158	0.152	0.149
16.5	**0.141**	0.181	0.177	0.172	0.168	0.164	0.160	0.157	0.153	0.150	0.147	0.144	0.138	0.136
17.0	**0.129**	0.165	0.161	0.157	0.153	0.149	0.146	0.143	0.140	0.137	0.134	0.132	0.127	0.124
17.5	**0.119**	0.151	0.148	0.144	0.141	0.137	0.134	0.132	0.129	0.126	0.124	0.121	0.117	0.114
18.0	**0.108**	0.137	0.134	0.131	0.128	0.124	0.122	0.120	0.117	0.115	0.112	0.110	0.106	0.105
18.5	**0.098**	0.123	0.120	0.117	0.115	0.112	0.110	0.108	0.105	0.103	0.101	0.100	0.096	0.094
19.0	**0.088**	0.110	0.108	0.105	0.103	0.100	0.099	0.097	0.095	0.093	0.091	0.089	0.086	0.085
19.5	**0.080**	0.100	0.097	0.095	0.093	0.091	0.089	0.088	0.086	0.084	0.083	0.081	0.078	0.077
20.0	**0.073**	0.090	0.088	0.086	0.084	0.083	0.081	0.079	0.078	0.076	0.075	0.074	0.071	0.070
20.5	**0.066**	0.081	0.079	0.077	0.076	0.074	0.073	0.072	0.070	0.069	0.068	0.067	0.065	0.064
21.0	**0.058**	0.071	0.070	0.068	0.067	0.066	0.065	0.063	0.062	0.061	0.060	0.059	0.058	0.057
21.5	**0.052**	0.062	0.061	0.060	0.059	0.057	0.056	0.056	0.055	0.054	0.053	0.052	0.051	0.050
22.0	**0.045**	0.053	0.052	0.052	0.051	0.050	0.049	0.048	0.047	0.047	0.046	0.045	0.044	0.044
22.5	**0.039**	0.046	0.045	0.044	0.044	0.043	0.042	0.042	0.041	0.040	0.040	0.039	0.038	0.038
23.0	**0.033**	0.039	0.039	0.038	0.037	0.037	0.036	0.036	0.035	0.035	0.034	0.034	0.033	0.033
23.5	**0.028**	0.033	0.033	0.032	0.032	0.031	0.031	0.030	0.030	0.030	0.029	0.029	0.028	0.028
24.0	**0.024**	0.028	0.028	0.027	0.027	0.026	0.026	0.026	0.025	0.025	0.025	0.025	0.024	0.024
24.5	**0.020**	0.024	0.023	0.023	0.023	0.022	0.022	0.022	0.021	0.021	0.021	0.021	0.020	0.020
25.0	**0.017**	0.020	0.020	0.019	0.019	0.019	0.019	0.018	0.018	0.018	0.018	0.018	0.017	0.017

8 Power Curves, Ct Values and Sound Curves, Sound Optimized Modes

8.1 Power Curves, Sound Optimized Mode SO1

	Air density [kg/m³]												
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**32**	15	16	18	19	21	22	24	26	27	29	30	34	35
3.5	**129**	78	82	87	91	95	100	105	109	114	119	124	134	140
4.0	**288**	196	204	213	221	230	238	246	255	263	271	279	296	304
4.5	**481**	346	359	371	383	395	407	420	432	444	457	469	493	506
5.0	**715**	529	546	563	580	597	614	631	648	665	681	698	732	749
5.5	**999**	748	770	793	816	839	862	884	907	930	953	976	1022	1045
6.0	**1340**	1011	1041	1071	1101	1131	1160	1190	1220	1250	1280	1310	1370	1400
6.5	**1739**	1323	1360	1398	1436	1474	1512	1550	1588	1626	1663	1701	1776	1814
7.0	**2202**	1686	1733	1780	1828	1875	1922	1969	2016	2063	2109	2156	2249	2295
7.5	**2729**	2100	2157	2215	2272	2330	2387	2444	2502	2559	2616	2672	2785	2842
8.0	**3325**	2569	2639	2708	2777	2847	2915	2984	3053	3121	3189	3257	3392	3459
8.5	**3976**	3088	3170	3252	3333	3415	3496	3576	3657	3738	3817	3896	4054	4131
9.0	**4625**	3612	3705	3799	3892	3986	4078	4170	4262	4354	4444	4534	4705	4785
9.5	**5232**	4109	4213	4318	4423	4527	4630	4732	4835	4937	5035	5134	5299	5366
10.0	**5788**	4604	4720	4835	4951	5066	5175	5284	5394	5503	5598	5693	5835	5882
10.5	**6232**	5116	5239	5361	5484	5607	5707	5807	5907	6007	6082	6157	6260	6288
11.0	**6552**	5642	5758	5874	5990	6107	6184	6261	6338	6416	6461	6506	6566	6580
11.5	**6719**	6141	6231	6321	6412	6502	6542	6582	6622	6662	6681	6700	6724	6730
12.0	**6785**	6509	6556	6602	6649	6696	6712	6728	6744	6760	6768	6777	6787	6789
12.5	**6800**	6711	6727	6743	6759	6775	6780	6785	6790	6795	6797	6798	6800	6800
13.0	**6800**	6769	6775	6781	6787	6793	6795	6797	6798	6800	6800	6800	6800	6800
13.5	**6800**	6787	6790	6793	6796	6799	6799	6799	6800	6800	6800	6800	6800	6800
14.0	**6800**	6796	6797	6798	6799	6800	6800	6800	6800	6800	6800	6800	6800	6800
14.5	**6800**	6799	6799	6800	6800	6800	6800	6800	6800	6800	6800	6800	6800	6800
15.0	**6800**	6800	6800	6800	6800	6800	6800	6800	6800	6800	6800	6800	6800	6800
15.5	**6797**	6795	6795	6796	6796	6796	6796	6796	6796	6796	6796	6797	6797	6797
16.0	**6783**	6779	6779	6780	6780	6780	6780	6781	6781	6782	6782	6783	6784	6784
16.5	**6759**	6753	6753	6753	6754	6754	6755	6755	6756	6756	6757	6758	6759	6760
17.0	**6728**	6721	6721	6722	6722	6723	6723	6724	6725	6725	6726	6727	6729	6730
17.5	**6698**	6690	6690	6691	6692	6692	6693	6694	6695	6695	6696	6697	6699	6700
18.0	**6669**	6659	6659	6660	6661	6662	6662	6663	6664	6665	6666	6668	6670	6670
18.5	**6642**	6630	6630	6631	6632	6632	6633	6634	6635	6636	6638	6640	6641	6641
19.0	**6614**	6595	6596	6598	6599	6600	6602	6603	6604	6606	6609	6611	6614	6614
19.5	**6560**	6520	6523	6527	6530	6533	6537	6540	6543	6547	6551	6555	6562	6564
20.0	**6453**	6378	6385	6391	6397	6404	6411	6418	6425	6432	6439	6446	6459	6465
20.5	**6260**	6129	6140	6151	6162	6174	6186	6199	6211	6223	6236	6248	6272	6284
21.0	**5947**	5763	5779	5794	5810	5826	5843	5860	5876	5893	5911	5929	5964	5982
21.5	**5536**	5327	5345	5362	5380	5397	5416	5435	5455	5474	5495	5515	5557	5578
22.0	**5068**	4862	4880	4898	4916	4935	4953	4971	4989	5007	5027	5048	5091	5114
22.5	**4596**	4404	4420	4437	4453	4470	4488	4505	4523	4541	4559	4578	4614	4632
23.0	**4121**	3932	3949	3965	3982	3999	4015	4032	4049	4066	4084	4103	4136	4151
23.5	**3634**	3466	3483	3499	3515	3531	3546	3560	3575	3589	3604	3619	3650	3666
24.0	**3171**	3019	3032	3046	3059	3072	3085	3097	3110	3123	3139	3155	3184	3197
24.5	**2721**	2585	2599	2612	2626	2639	2651	2662	2673	2685	2697	2709	2736	2750
25.0	**2322**	2222	2231	2241	2250	2260	2268	2277	2285	2293	2303	2312	2335	2349

8.2 Ct Values, Sound Optimized Mode SO1

Air density kg/m^3													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**0.969**	0.980	0.979	0.978	0.977	0.976	0.975	0.974	0.973	0.972	0.971	0.970	0.968	0.967
3.5	**0.885**	0.893	0.892	0.892	0.891	0.890	0.889	0.889	0.888	0.887	0.886	0.886	0.884	0.883
4.0	**0.831**	0.845	0.844	0.843	0.841	0.840	0.839	0.838	0.837	0.835	0.834	0.833	0.830	0.828
4.5	**0.817**	0.824	0.823	0.822	0.821	0.820	0.819	0.819	0.818	0.818	0.818	0.817	0.816	0.816
5.0	**0.812**	0.811	0.811	0.812	0.812	0.812	0.812	0.812	0.812	0.812	0.812	0.812	0.812	0.812
5.5	**0.814**	0.814	0.814	0.814	0.814	0.815	0.815	0.815	0.815	0.815	0.815	0.815	0.814	0.814
6.0	**0.814**	0.816	0.816	0.816	0.816	0.816	0.815	0.815	0.815	0.815	0.814	0.814	0.813	0.813
6.5	**0.810**	0.816	0.815	0.815	0.815	0.814	0.814	0.813	0.813	0.812	0.811	0.811	0.809	0.809
7.0	**0.805**	0.814	0.813	0.812	0.812	0.811	0.810	0.809	0.808	0.807	0.807	0.806	0.804	0.803
7.5	**0.797**	0.810	0.809	0.808	0.807	0.805	0.804	0.803	0.802	0.801	0.800	0.798	0.796	0.794
8.0	**0.789**	0.804	0.803	0.802	0.800	0.799	0.798	0.796	0.795	0.793	0.792	0.790	0.787	0.785
8.5	**0.771**	0.789	0.787	0.786	0.784	0.783	0.781	0.779	0.778	0.776	0.774	0.772	0.768	0.766
9.0	**0.726**	0.743	0.741	0.740	0.738	0.737	0.735	0.734	0.732	0.731	0.729	0.727	0.721	0.716
9.5	**0.668**	0.685	0.683	0.682	0.681	0.680	0.678	0.677	0.675	0.674	0.672	0.670	0.659	0.650
10.0	**0.610**	0.633	0.632	0.631	0.629	0.628	0.626	0.624	0.623	0.621	0.617	0.613	0.598	0.587
10.5	**0.547**	0.591	0.589	0.587	0.585	0.584	0.579	0.575	0.571	0.567	0.560	0.554	0.535	0.523
11.0	**0.485**	0.555	0.552	0.548	0.544	0.540	0.533	0.526	0.519	0.512	0.503	0.494	0.474	0.462
11.5	**0.423**	0.520	0.513	0.506	0.499	0.492	0.482	0.472	0.462	0.452	0.442	0.433	0.413	0.403
12.0	**0.367**	0.475	0.465	0.454	0.444	0.434	0.424	0.414	0.404	0.393	0.385	0.376	0.359	0.351
12.5	**0.319**	0.423	0.412	0.401	0.390	0.379	0.370	0.361	0.352	0.343	0.335	0.327	0.312	0.305
13.0	**0.280**	0.371	0.361	0.351	0.341	0.332	0.324	0.316	0.308	0.300	0.293	0.286	0.274	0.268
13.5	**0.247**	0.327	0.318	0.309	0.301	0.292	0.285	0.279	0.272	0.265	0.259	0.253	0.242	0.237
14.0	**0.220**	0.289	0.282	0.274	0.267	0.259	0.253	0.247	0.241	0.235	0.230	0.225	0.216	0.211
14.5	**0.197**	0.257	0.251	0.244	0.238	0.231	0.226	0.221	0.215	0.210	0.206	0.201	0.193	0.189
15.0	**0.177**	0.230	0.224	0.219	0.213	0.207	0.202	0.198	0.193	0.189	0.185	0.181	0.174	0.170
15.5	**0.160**	0.207	0.202	0.197	0.192	0.187	0.183	0.179	0.174	0.170	0.167	0.163	0.157	0.154
16.0	**0.145**	0.187	0.182	0.178	0.173	0.169	0.165	0.162	0.158	0.154	0.151	0.148	0.142	0.140
16.5	**0.132**	0.169	0.165	0.161	0.157	0.153	0.150	0.147	0.143	0.140	0.137	0.135	0.129	0.127
17.0	**0.120**	0.154	0.150	0.146	0.143	0.139	0.136	0.133	0.130	0.127	0.125	0.123	0.118	0.116
17.5	**0.110**	0.141	0.137	0.134	0.131	0.128	0.125	0.122	0.120	0.117	0.115	0.112	0.108	0.106
18.0	**0.101**	0.129	0.126	0.123	0.120	0.117	0.114	0.112	0.110	0.107	0.105	0.103	0.099	0.097
18.5	**0.093**	0.118	0.115	0.113	0.110	0.107	0.105	0.103	0.101	0.098	0.097	0.095	0.091	0.090
19.0	**0.085**	0.108	0.106	0.103	0.101	0.098	0.096	0.094	0.092	0.090	0.089	0.087	0.084	0.082
19.5	**0.079**	0.099	0.097	0.095	0.092	0.090	0.088	0.087	0.085	0.083	0.082	0.080	0.077	0.076
20.0	**0.072**	0.090	0.088	0.086	0.084	0.082	0.081	0.079	0.078	0.076	0.075	0.074	0.071	0.070
20.5	**0.066**	0.081	0.079	0.077	0.076	0.074	0.073	0.072	0.070	0.069	0.068	0.067	0.065	0.064
21.0	**0.059**	0.071	0.070	0.068	0.067	0.066	0.065	0.063	0.062	0.061	0.060	0.059	0.058	0.057
21.5	**0.051**	0.062	0.061	0.060	0.059	0.057	0.056	0.056	0.055	0.054	0.053	0.052	0.051	0.050
22.0	**0.045**	0.053	0.052	0.052	0.051	0.050	0.049	0.048	0.047	0.047	0.046	0.045	0.044	0.044
22.5	**0.039**	0.046	0.045	0.044	0.044	0.043	0.042	0.042	0.041	0.040	0.040	0.039	0.038	0.038
23.0	**0.033**	0.039	0.039	0.038	0.037	0.037	0.036	0.036	0.035	0.035	0.034	0.034	0.033	0.033
23.5	**0.028**	0.033	0.033	0.032	0.032	0.031	0.031	0.030	0.030	0.030	0.029	0.029	0.028	0.028
24.0	**0.024**	0.028	0.028	0.027	0.027	0.026	0.026	0.026	0.025	0.025	0.025	0.024	0.024	0.024
24.5	**0.020**	0.024	0.023	0.023	0.023	0.022	0.022	0.022	0.021	0.021	0.021	0.021	0.020	0.020
25.0	**0.017**	0.020	0.020	0.019	0.019	0.019	0.019	0.018	0.018	0.018	0.018	0.018	0.017	0.017

8.3 Sound Curves, Sound Optimized Mode SO1

Sound Power Level at Hub Height	
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3** **Maximum turbulence at hub height: 30%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m³**
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA]** **Sound Optimized Mode SO1 (Blades with serrated trailing edge)**
3	93.9
4	94.0
5	94.9
6	97.9
7	101.3
8	104.2
9	105.0
10	105.0
11	105.0
12	105.0
13	105.0
14	105.0
15	105.0

8.4 Power Curves, Sound Optimized Mode SO2

	Air density [kg/m³]													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**32**	15	16	18	19	21	22	24	26	27	29	30	34	35
3.5	**129**	78	82	87	91	95	100	105	109	114	119	124	134	140
4.0	**288**	196	204	213	221	230	238	246	255	263	271	279	296	304
4.5	**481**	346	358	371	383	395	407	420	432	444	456	469	493	506
5.0	**715**	529	546	563	580	597	614	631	648	664	681	698	732	749
5.5	**999**	748	770	793	816	839	861	884	907	930	953	976	1022	1045
6.0	**1340**	1011	1041	1071	1101	1131	1160	1190	1220	1250	1280	1310	1369	1399
6.5	**1739**	1323	1360	1398	1436	1474	1512	1550	1588	1626	1663	1701	1776	1813
7.0	**2202**	1686	1733	1780	1827	1875	1922	1969	2016	2063	2109	2156	2249	2295
7.5	**2729**	2100	2157	2215	2273	2331	2388	2445	2502	2559	2616	2672	2786	2842
8.0	**3320**	2566	2635	2704	2773	2843	2911	2980	3048	3117	3185	3252	3387	3455
8.5	**3925**	3050	3131	3211	3292	3373	3452	3531	3611	3690	3769	3847	4003	4080
9.0	**4505**	3517	3608	3699	3790	3881	3971	4060	4150	4240	4328	4417	4592	4679
9.5	**5048**	3958	4059	4161	4262	4363	4462	4561	4661	4760	4856	4952	5139	5230
10.0	**5552**	4407	4518	4630	4741	4852	4958	5063	5169	5274	5367	5459	5628	5704
10.5	**5946**	4865	4983	5101	5219	5338	5436	5534	5632	5730	5802	5874	5998	6051
11.0	**6223**	5327	5440	5554	5668	5781	5859	5937	6014	6092	6136	6179	6249	6274
11.5	**6403**	5777	5871	5964	6057	6151	6198	6246	6293	6340	6361	6382	6416	6429
12.0	**6538**	6162	6223	6285	6347	6409	6433	6456	6480	6503	6515	6527	6545	6553
12.5	**6623**	6430	6462	6494	6525	6557	6570	6582	6595	6607	6612	6618	6624	6626
13.0	**6653**	6562	6579	6595	6611	6627	6633	6639	6644	6650	6651	6652	6653	6653
13.5	**6656**	6615	6623	6631	6640	6648	6650	6652	6654	6656	6656	6656	6656	6657
14.0	**6646**	6629	6633	6637	6641	6644	6645	6645	6645	6646	6646	6646	6646	6647
14.5	**6623**	6617	6618	6619	6620	6621	6621	6621	6621	6622	6622	6623	6623	6624
15.0	**6588**	6586	6586	6586	6586	6586	6586	6587	6587	6587	6588	6588	6589	6590
15.5	**6552**	6548	6548	6549	6549	6549	6549	6549	6550	6550	6551	6551	6552	6553
16.0	**6517**	6513	6513	6513	6513	6514	6514	6514	6515	6515	6516	6516	6518	6519
16.5	**6485**	6480	6480	6481	6481	6481	6482	6482	6483	6483	6484	6484	6486	6487
17.0	**6455**	6449	6449	6449	6450	6450	6451	6451	6452	6453	6453	6454	6456	6457
17.5	**6426**	6419	6419	6420	6420	6421	6421	6422	6423	6423	6424	6425	6427	6427
18.0	**6399**	6392	6392	6393	6393	6394	6395	6395	6396	6397	6397	6398	6400	6400
18.5	**6374**	6367	6367	6368	6368	6369	6370	6370	6371	6372	6373	6374	6375	6376
19.0	**6347**	6338	6339	6339	6340	6341	6342	6343	6343	6344	6345	6346	6348	6349
19.5	**6319**	6309	6310	6311	6311	6312	6313	6314	6315	6316	6317	6318	6321	6322
20.0	**6286**	6258	6261	6263	6266	6269	6271	6274	6276	6279	6281	6283	6288	6290
20.5	**6179**	6089	6097	6105	6113	6121	6130	6138	6146	6155	6163	6171	6187	6195
21.0	**5918**	5758	5771	5784	5798	5811	5826	5841	5857	5872	5887	5902	5932	5947
21.5	**5527**	5328	5345	5361	5378	5394	5413	5432	5451	5470	5489	5508	5547	5566
22.0	**5070**	4864	4881	4897	4914	4931	4949	4968	4987	5005	5027	5049	5091	5111
22.5	**4596**	4402	4419	4436	4453	4470	4488	4505	4523	4540	4559	4578	4613	4630
23.0	**4123**	3933	3949	3965	3982	3998	4014	4030	4047	4063	4083	4103	4140	4157
23.5	**3635**	3467	3483	3499	3515	3531	3545	3560	3574	3589	3604	3619	3650	3666
24.0	**3171**	3019	3032	3046	3059	3072	3085	3097	3110	3123	3139	3155	3184	3197
24.5	**2721**	2585	2599	2612	2626	2639	2651	2662	2673	2685	2697	2709	2736	2750
25.0	**2322**	2222	2231	2241	2250	2260	2268	2277	2285	2293	2303	2312	2335	2349

8.5 Ct Values, Sound Optimized Mode SO2

	Air density kg/m³													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**0.969**	0.980	0.979	0.978	0.977	0.976	0.975	0.974	0.973	0.972	0.971	0.970	0.968	0.967
3.5	**0.885**	0.893	0.892	0.892	0.891	0.890	0.889	0.889	0.888	0.887	0.886	0.886	0.884	0.883
4.0	**0.832**	0.845	0.844	0.843	0.842	0.841	0.840	0.838	0.837	0.836	0.834	0.833	0.830	0.828
4.5	**0.816**	0.825	0.823	0.822	0.821	0.820	0.819	0.819	0.818	0.818	0.817	0.817	0.816	0.816
5.0	**0.812**	0.811	0.811	0.811	0.811	0.812	0.812	0.812	0.812	0.812	0.812	0.812	0.812	0.812
5.5	**0.814**	0.814	0.814	0.814	0.814	0.815	0.815	0.815	0.815	0.815	0.815	0.814	0.814	0.814
6.0	**0.814**	0.816	0.816	0.816	0.816	0.816	0.815	0.815	0.815	0.815	0.814	0.814	0.813	0.813
6.5	**0.810**	0.816	0.815	0.815	0.815	0.814	0.814	0.813	0.813	0.812	0.811	0.811	0.809	0.809
7.0	**0.805**	0.814	0.813	0.812	0.812	0.811	0.810	0.809	0.808	0.807	0.806	0.806	0.804	0.803
7.5	**0.797**	0.810	0.809	0.808	0.807	0.806	0.804	0.803	0.802	0.801	0.800	0.798	0.796	0.795
8.0	**0.785**	0.800	0.799	0.798	0.796	0.795	0.794	0.792	0.791	0.790	0.788	0.787	0.784	0.782
8.5	**0.744**	0.759	0.758	0.757	0.755	0.754	0.752	0.751	0.750	0.748	0.747	0.745	0.742	0.741
9.0	**0.685**	0.698	0.697	0.696	0.695	0.694	0.693	0.691	0.690	0.689	0.688	0.686	0.684	0.683
9.5	**0.627**	0.639	0.638	0.637	0.636	0.635	0.634	0.633	0.632	0.631	0.629	0.628	0.625	0.622
10.0	**0.572**	0.590	0.590	0.589	0.588	0.587	0.585	0.584	0.582	0.581	0.578	0.575	0.567	0.562
10.5	**0.513**	0.549	0.548	0.547	0.545	0.544	0.540	0.537	0.533	0.530	0.524	0.518	0.505	0.498
11.0	**0.453**	0.514	0.511	0.508	0.505	0.502	0.496	0.490	0.484	0.478	0.470	0.461	0.444	0.436
11.5	**0.398**	0.479	0.474	0.468	0.463	0.457	0.449	0.441	0.432	0.424	0.415	0.407	0.390	0.381
12.0	**0.351**	0.442	0.434	0.426	0.418	0.410	0.401	0.393	0.384	0.375	0.367	0.359	0.343	0.336
12.5	**0.309**	0.401	0.392	0.383	0.373	0.364	0.356	0.348	0.339	0.331	0.324	0.317	0.303	0.296
13.0	**0.273**	0.357	0.348	0.340	0.331	0.322	0.314	0.307	0.299	0.292	0.286	0.279	0.267	0.261
13.5	**0.242**	0.317	0.309	0.301	0.293	0.285	0.278	0.272	0.265	0.258	0.253	0.247	0.237	0.232
14.0	**0.215**	0.281	0.274	0.267	0.260	0.253	0.247	0.241	0.235	0.229	0.224	0.220	0.210	0.206
14.5	**0.192**	0.250	0.244	0.237	0.231	0.225	0.220	0.214	0.209	0.204	0.200	0.196	0.188	0.184
15.0	**0.171**	0.222	0.217	0.211	0.206	0.200	0.196	0.191	0.187	0.182	0.179	0.175	0.168	0.165
15.5	**0.154**	0.199	0.194	0.189	0.185	0.180	0.176	0.172	0.168	0.164	0.161	0.157	0.151	0.148
16.0	**0.139**	0.179	0.175	0.171	0.166	0.162	0.158	0.155	0.151	0.148	0.145	0.142	0.136	0.134
16.5	**0.126**	0.162	0.158	0.154	0.151	0.147	0.144	0.140	0.137	0.134	0.131	0.129	0.124	0.122
17.0	**0.115**	0.147	0.144	0.140	0.137	0.133	0.131	0.128	0.125	0.122	0.120	0.117	0.113	0.111
17.5	**0.106**	0.135	0.132	0.129	0.125	0.122	0.120	0.117	0.115	0.112	0.110	0.108	0.104	0.102
18.0	**0.097**	0.123	0.121	0.118	0.115	0.112	0.110	0.107	0.105	0.103	0.101	0.099	0.095	0.093
18.5	**0.089**	0.113	0.111	0.108	0.106	0.103	0.101	0.099	0.097	0.094	0.093	0.091	0.088	0.086
19.0	**0.082**	0.104	0.101	0.099	0.097	0.094	0.092	0.091	0.089	0.087	0.085	0.084	0.080	0.079
19.5	**0.076**	0.096	0.094	0.091	0.089	0.087	0.085	0.084	0.082	0.080	0.079	0.077	0.074	0.073
20.0	**0.070**	0.088	0.086	0.084	0.082	0.081	0.079	0.077	0.076	0.074	0.073	0.072	0.069	0.068
20.5	**0.065**	0.080	0.078	0.077	0.075	0.073	0.072	0.071	0.069	0.068	0.067	0.066	0.063	0.062
21.0	**0.058**	0.071	0.070	0.068	0.067	0.065	0.064	0.063	0.062	0.061	0.060	0.059	0.057	0.056
21.5	**0.051**	0.062	0.061	0.060	0.058	0.057	0.056	0.055	0.055	0.054	0.053	0.052	0.051	0.050
22.0	**0.045**	0.053	0.052	0.052	0.051	0.050	0.049	0.048	0.047	0.047	0.046	0.045	0.044	0.044
22.5	**0.039**	0.046	0.045	0.044	0.044	0.043	0.042	0.042	0.041	0.040	0.040	0.039	0.038	0.038
23.0	**0.033**	0.039	0.039	0.038	0.037	0.037	0.036	0.036	0.035	0.035	0.034	0.034	0.033	0.033
23.5	**0.028**	0.033	0.033	0.032	0.032	0.031	0.031	0.030	0.030	0.030	0.029	0.029	0.028	0.028
24.0	**0.024**	0.028	0.028	0.027	0.027	0.026	0.026	0.026	0.025	0.025	0.025	0.024	0.024	0.024
24.5	**0.020**	0.024	0.023	0.023	0.023	0.022	0.022	0.022	0.021	0.021	0.021	0.021	0.020	0.020
25.0	**0.017**	0.020	0.020	0.019	0.019	0.019	0.019	0.018	0.018	0.018	0.018	0.018	0.017	0.017

8.6 Sound Curves, Sound Optimized Mode SO2

Sound Power Level at Hub Height	
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3** **Maximum turbulence at hub height: 30%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA]** **Sound Optimized Mode SO2 (Blades with serrated trailing edge)**
3	93.9
4	94.0
5	94.9
6	97.9
7	101.3
8	103.7
9	104.0
10	104.0
11	104.0
12	104.0
13	104.0
14	104.0
15	104.0

8.7 Power Curves, Sound Optimized Mode SO3

	Air density [kg/m³]													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**32**	15	16	18	19	21	23	24	26	27	29	30	34	35
3.5	**129**	78	82	87	91	95	100	105	109	114	119	124	134	140
4.0	**288**	196	204	213	221	230	238	246	255	263	271	279	296	304
4.5	**481**	346	358	371	383	395	407	420	432	444	456	469	493	506
5.0	**715**	529	546	563	580	597	614	631	648	664	681	698	732	749
5.5	**999**	748	770	793	816	839	861	884	907	930	953	976	1022	1045
6.0	**1340**	1011	1041	1071	1100	1130	1160	1190	1220	1250	1280	1310	1369	1399
6.5	**1739**	1323	1360	1398	1436	1474	1512	1550	1588	1626	1663	1701	1776	1813
7.0	**2202**	1686	1733	1780	1828	1875	1922	1969	2015	2062	2109	2156	2248	2295
7.5	**2728**	2099	2156	2214	2272	2329	2386	2444	2501	2558	2615	2671	2784	2841
8.0	**3292**	2545	2614	2682	2751	2819	2887	2955	3023	3091	3158	3225	3358	3425
8.5	**3838**	2982	3061	3140	3219	3297	3375	3453	3531	3608	3685	3762	3914	3990
9.0	**4344**	3388	3476	3564	3652	3740	3827	3914	4000	4087	4173	4258	4428	4513
9.5	**4825**	3778	3875	3972	4069	4166	4261	4357	4452	4548	4640	4733	4914	5003
10.0	**5282**	4177	4283	4389	4495	4601	4703	4805	4907	5009	5100	5191	5357	5433
10.5	**5652**	4590	4704	4817	4931	5044	5142	5239	5337	5434	5507	5579	5707	5762
11.0	**5931**	5018	5130	5242	5354	5466	5546	5627	5707	5788	5835	5883	5959	5986
11.5	**6115**	5450	5546	5643	5740	5837	5889	5941	5993	6045	6068	6091	6129	6143
12.0	**6248**	5833	5900	5968	6036	6104	6131	6158	6185	6211	6224	6236	6256	6263
12.5	**6334**	6112	6149	6187	6224	6261	6274	6288	6302	6316	6322	6328	6336	6338
13.0	**6367**	6259	6278	6298	6317	6336	6343	6350	6357	6363	6365	6366	6367	6368
13.5	**6375**	6322	6332	6343	6353	6363	6366	6369	6371	6374	6374	6374	6375	6375
14.0	**6370**	6345	6350	6356	6361	6367	6367	6368	6369	6369	6369	6369	6370	6370
14.5	**6353**	6343	6345	6348	6350	6352	6352	6352	6352	6353	6353	6353	6353	6354
15.0	**6327**	6324	6324	6325	6325	6325	6325	6325	6325	6326	6326	6326	6327	6327
15.5	**6297**	6295	6295	6295	6295	6296	6296	6296	6296	6296	6297	6297	6298	6298
16.0	**6267**	6264	6264	6264	6264	6264	6265	6265	6266	6266	6267	6267	6268	6269
16.5	**6237**	6232	6232	6232	6233	6233	6233	6234	6234	6235	6235	6236	6237	6238
17.0	**6206**	6201	6201	6201	6202	6202	6203	6203	6204	6204	6205	6205	6207	6208
17.5	**6177**	6171	6172	6172	6173	6173	6174	6174	6175	6175	6176	6176	6178	6179
18.0	**6149**	6143	6144	6144	6144	6145	6145	6146	6147	6147	6148	6149	6150	6151
18.5	**6124**	6117	6118	6118	6119	6119	6120	6120	6121	6122	6122	6123	6124	6125
19.0	**6100**	6092	6093	6093	6094	6095	6095	6096	6097	6097	6098	6099	6100	6101
19.5	**6074**	6065	6066	6067	6067	6068	6069	6070	6071	6072	6072	6073	6075	6076
20.0	**6045**	6033	6034	6035	6036	6037	6038	6039	6040	6041	6042	6044	6046	6047
20.5	**5991**	5949	5953	5957	5961	5965	5968	5972	5976	5979	5983	5987	5994	5997
21.0	**5817**	5708	5718	5727	5737	5747	5757	5768	5778	5789	5798	5808	5828	5839
21.5	**5497**	5331	5345	5360	5374	5389	5405	5421	5438	5454	5469	5483	5515	5532
22.0	**5062**	4876	4891	4905	4920	4935	4953	4971	4989	5006	5025	5043	5080	5099
22.5	**4596**	4404	4421	4438	4454	4471	4488	4506	4523	4541	4559	4577	4615	4634
23.0	**4118**	3934	3950	3966	3982	3998	4014	4031	4048	4065	4082	4100	4135	4153
23.5	**3635**	3468	3483	3498	3512	3527	3542	3556	3571	3586	3602	3618	3653	3671
24.0	**3173**	3019	3031	3044	3057	3069	3084	3099	3113	3128	3143	3158	3186	3200
24.5	**2721**	2585	2599	2612	2626	2639	2651	2662	2673	2685	2697	2709	2736	2750
25.0	**2322**	2222	2231	2241	2250	2260	2268	2277	2285	2293	2303	2312	2335	2349

8.8 Ct Values, Sound Optimized Mode SO3

Air density kg/m³														
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**0.969**	0.980	0.979	0.978	0.977	0.976	0.975	0.974	0.973	0.972	0.971	0.970	0.968	0.967
3.5	**0.885**	0.893	0.892	0.892	0.891	0.890	0.889	0.889	0.888	0.887	0.886	0.886	0.884	0.883
4.0	**0.831**	0.846	0.844	0.843	0.842	0.841	0.840	0.839	0.837	0.836	0.834	0.833	0.830	0.828
4.5	**0.816**	0.825	0.823	0.822	0.821	0.820	0.819	0.819	0.818	0.818	0.817	0.817	0.816	0.816
5.0	**0.812**	0.811	0.811	0.811	0.811	0.812	0.812	0.812	0.812	0.812	0.812	0.812	0.812	0.812
5.5	**0.814**	0.814	0.814	0.814	0.814	0.815	0.815	0.815	0.815	0.815	0.815	0.814	0.814	0.814
6.0	**0.814**	0.816	0.816	0.816	0.816	0.816	0.815	0.815	0.815	0.815	0.814	0.814	0.813	0.813
6.5	**0.810**	0.816	0.815	0.815	0.815	0.814	0.814	0.813	0.812	0.812	0.811	0.811	0.809	0.809
7.0	**0.805**	0.814	0.813	0.812	0.812	0.811	0.810	0.809	0.808	0.807	0.807	0.806	0.804	0.803
7.5	**0.796**	0.808	0.807	0.806	0.805	0.804	0.803	0.802	0.801	0.800	0.799	0.797	0.795	0.794
8.0	**0.766**	0.780	0.779	0.778	0.776	0.775	0.774	0.772	0.771	0.770	0.768	0.767	0.764	0.763
8.5	**0.706**	0.718	0.717	0.716	0.715	0.714	0.713	0.712	0.711	0.709	0.708	0.707	0.705	0.704
9.0	**0.640**	0.651	0.650	0.649	0.648	0.647	0.646	0.645	0.644	0.643	0.642	0.641	0.639	0.638
9.5	**0.584**	0.594	0.593	0.592	0.591	0.590	0.590	0.589	0.588	0.587	0.586	0.585	0.582	0.581
10.0	**0.532**	0.547	0.546	0.545	0.545	0.544	0.543	0.542	0.541	0.540	0.537	0.535	0.528	0.525
10.5	**0.479**	0.508	0.507	0.506	0.505	0.504	0.502	0.499	0.496	0.494	0.489	0.484	0.473	0.467
11.0	**0.427**	0.476	0.474	0.471	0.469	0.467	0.462	0.457	0.453	0.448	0.441	0.434	0.419	0.411
11.5	**0.376**	0.446	0.442	0.437	0.433	0.429	0.422	0.415	0.408	0.400	0.392	0.384	0.369	0.361
12.0	**0.333**	0.414	0.408	0.401	0.394	0.388	0.379	0.371	0.363	0.355	0.348	0.340	0.326	0.319
12.5	**0.294**	0.378	0.370	0.362	0.354	0.345	0.338	0.330	0.322	0.314	0.308	0.301	0.288	0.282
13.0	**0.260**	0.339	0.331	0.322	0.314	0.306	0.299	0.292	0.285	0.278	0.272	0.266	0.254	0.249
13.5	**0.230**	0.302	0.294	0.287	0.279	0.272	0.265	0.259	0.253	0.246	0.241	0.236	0.226	0.221
14.0	**0.205**	0.268	0.261	0.255	0.248	0.241	0.236	0.230	0.225	0.219	0.214	0.210	0.201	0.197
14.5	**0.183**	0.239	0.233	0.227	0.221	0.215	0.210	0.205	0.200	0.195	0.191	0.187	0.180	0.176
15.0	**0.164**	0.213	0.208	0.203	0.197	0.192	0.188	0.183	0.179	0.175	0.171	0.168	0.161	0.158
15.5	**0.148**	0.191	0.187	0.182	0.177	0.172	0.169	0.165	0.161	0.157	0.154	0.151	0.145	0.142
16.0	**0.134**	0.172	0.168	0.164	0.160	0.156	0.152	0.149	0.145	0.142	0.139	0.136	0.131	0.129
16.5	**0.121**	0.156	0.152	0.149	0.145	0.141	0.138	0.135	0.132	0.129	0.126	0.124	0.119	0.117
17.0	**0.110**	0.142	0.138	0.135	0.132	0.128	0.126	0.123	0.120	0.117	0.115	0.113	0.108	0.106
17.5	**0.101**	0.130	0.127	0.124	0.121	0.118	0.115	0.113	0.110	0.108	0.106	0.104	0.100	0.098
18.0	**0.093**	0.119	0.116	0.113	0.110	0.108	0.105	0.103	0.101	0.099	0.097	0.095	0.091	0.090
18.5	**0.086**	0.109	0.106	0.104	0.101	0.099	0.097	0.095	0.093	0.091	0.089	0.087	0.084	0.083
19.0	**0.079**	0.100	0.098	0.095	0.093	0.091	0.089	0.087	0.085	0.083	0.082	0.080	0.077	0.076
19.5	**0.073**	0.092	0.090	0.088	0.086	0.084	0.082	0.081	0.079	0.077	0.076	0.074	0.072	0.070
20.0	**0.068**	0.085	0.083	0.081	0.080	0.078	0.076	0.075	0.073	0.071	0.070	0.069	0.066	0.065
20.5	**0.063**	0.078	0.077	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.065	0.064	0.061	0.060
21.0	**0.057**	0.070	0.069	0.067	0.066	0.065	0.063	0.062	0.061	0.060	0.059	0.058	0.056	0.055
21.5	**0.051**	0.062	0.061	0.060	0.058	0.057	0.056	0.055	0.054	0.053	0.053	0.052	0.050	0.049
22.0	**0.045**	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.046	0.045	0.044	0.043
22.5	**0.039**	0.046	0.045	0.044	0.044	0.043	0.042	0.041	0.041	0.040	0.040	0.039	0.038	0.038
23.0	**0.033**	0.039	0.039	0.038	0.037	0.037	0.036	0.036	0.035	0.035	0.034	0.034	0.033	0.033
23.5	**0.028**	0.033	0.033	0.032	0.032	0.031	0.031	0.030	0.030	0.030	0.029	0.029	0.028	0.028
24.0	**0.024**	0.028	0.028	0.027	0.027	0.026	0.026	0.026	0.025	0.025	0.025	0.025	0.024	0.024
24.5	**0.020**	0.024	0.023	0.023	0.023	0.022	0.022	0.022	0.021	0.021	0.021	0.021	0.020	0.020
25.0	**0.017**	0.020	0.020	0.019	0.019	0.019	0.019	0.018	0.018	0.018	0.018	0.018	0.017	0.017

8.9 Sound Curves, Sound Optimized Mode SO3

Sound Power Level at Hub Height	
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3** **Maximum turbulence at hub height: 30%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA]** **Sound Optimized Mode SO3 (Blades with serrated trailing edge)**
3	93.9
4	94.0
5	94.9
6	97.9
7	101.3
8	103.0
9	103.0
10	103.0
11	103.0
12	103.0
13	103.0
14	103.0
15	103.0

8.10 Power Curves, Sound Optimized Mode SO4

	Air density [kg/m³]													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**32**	15	17	18	20	21	23	24	26	27	29	31	34	35
3.5	**129**	78	83	87	91	95	100	105	110	114	119	124	134	140
4.0	**288**	196	204	213	221	230	238	246	255	263	271	279	296	304
4.5	**481**	346	358	371	383	395	407	420	432	444	456	469	493	506
5.0	**715**	529	546	563	580	597	614	631	648	664	681	698	732	749
5.5	**999**	748	770	793	816	839	861	884	907	930	953	976	1022	1045
6.0	**1340**	1011	1041	1071	1100	1130	1160	1190	1220	1250	1280	1310	1369	1399
6.5	**1739**	1323	1360	1398	1436	1474	1512	1550	1588	1626	1663	1701	1776	1813
7.0	**2202**	1686	1733	1780	1827	1874	1921	1968	2015	2062	2109	2155	2249	2295
7.5	**2715**	2089	2146	2203	2261	2318	2375	2432	2489	2546	2602	2658	2771	2827
8.0	**3228**	2497	2564	2631	2698	2765	2831	2898	2964	3031	3097	3163	3294	3359
8.5	**3713**	2884	2960	3036	3112	3189	3264	3339	3415	3490	3564	3639	3787	3860
9.0	**4171**	3250	3335	3420	3504	3589	3673	3756	3840	3923	4006	4088	4252	4334
9.5	**4606**	3601	3694	3787	3880	3973	4065	4156	4248	4339	4428	4517	4693	4779
10.0	**5019**	3954	4055	4156	4257	4358	4456	4554	4652	4750	4839	4929	5094	5170
10.5	**5358**	4318	4426	4535	4643	4752	4848	4945	5041	5138	5211	5285	5415	5472
11.0	**5621**	4696	4806	4915	5024	5133	5217	5300	5383	5467	5518	5570	5652	5683
11.5	**5799**	5092	5191	5291	5390	5490	5547	5604	5661	5719	5746	5772	5815	5830
12.0	**5935**	5467	5542	5618	5693	5769	5800	5831	5862	5893	5907	5921	5943	5952
12.5	**6033**	5764	5810	5855	5901	5946	5963	5979	5995	6012	6019	6026	6036	6040
13.0	**6084**	5945	5969	5994	6019	6044	6052	6060	6069	6077	6079	6082	6084	6085
13.5	**6100**	6029	6042	6055	6068	6082	6086	6089	6093	6097	6098	6099	6100	6100
14.0	**6094**	6060	6067	6074	6082	6089	6090	6091	6093	6094	6094	6094	6094	6094
14.5	**6076**	6059	6063	6067	6071	6075	6075	6075	6075	6076	6076	6076	6076	6076
15.0	**6052**	6049	6050	6050	6051	6051	6051	6051	6052	6052	6052	6052	6053	6053
15.5	**6026**	6024	6024	6024	6024	6024	6024	6025	6025	6025	6025	6026	6026	6027
16.0	**5998**	5995	5995	5995	5995	5995	5996	5996	5996	5996	5997	5997	5998	5999
16.5	**5968**	5964	5964	5964	5965	5965	5965	5966	5966	5967	5967	5967	5968	5969
17.0	**5938**	5933	5933	5933	5934	5934	5934	5935	5935	5936	5936	5937	5938	5939
17.5	**5908**	5904	5904	5904	5904	5905	5905	5906	5906	5907	5907	5908	5909	5910
18.0	**5881**	5875	5876	5876	5876	5877	5877	5878	5878	5879	5879	5880	5881	5882
18.5	**5855**	5849	5850	5850	5850	5851	5851	5852	5852	5853	5853	5854	5855	5856
19.0	**5830**	5824	5824	5825	5825	5825	5826	5827	5827	5828	5829	5829	5831	5831
19.5	**5806**	5799	5799	5800	5800	5801	5801	5802	5803	5803	5804	5805	5806	5807
20.0	**5779**	5772	5772	5773	5773	5774	5775	5775	5776	5777	5778	5779	5780	5781
20.5	**5749**	5731	5732	5734	5736	5737	5739	5741	5742	5744	5746	5747	5750	5751
21.0	**5659**	5596	5602	5608	5613	5619	5625	5631	5637	5643	5648	5654	5664	5670
21.5	**5425**	5313	5323	5333	5342	5352	5363	5374	5384	5395	5405	5415	5437	5448
22.0	**5042**	4878	4891	4903	4916	4929	4945	4961	4977	4994	5010	5026	5057	5073
22.5	**4574**	4396	4412	4428	4443	4459	4475	4491	4507	4523	4540	4557	4591	4607
23.0	**4097**	3923	3938	3953	3968	3983	3999	4016	4032	4049	4065	4081	4113	4128
23.5	**3631**	3468	3483	3498	3513	3528	3543	3557	3571	3586	3601	3616	3649	3667
24.0	**3171**	3018	3032	3045	3059	3072	3086	3100	3113	3127	3142	3156	3185	3199
24.5	**2720**	2586	2599	2613	2626	2640	2652	2664	2676	2688	2699	2709	2736	2752
25.0	**2322**	2221	2231	2240	2250	2260	2269	2278	2287	2296	2305	2313	2334	2346

8.11 Ct Values, Sound Optimized Mode SO4

Air density kg/m³														
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**0.969**	0.980	0.979	0.978	0.977	0.976	0.975	0.974	0.973	0.972	0.971	0.970	0.968	0.967
3.5	**0.885**	0.893	0.892	0.892	0.891	0.890	0.889	0.889	0.888	0.887	0.886	0.886	0.884	0.883
4.0	**0.831**	0.846	0.844	0.843	0.842	0.841	0.840	0.839	0.837	0.836	0.834	0.833	0.830	0.828
4.5	**0.816**	0.825	0.824	0.822	0.821	0.820	0.819	0.819	0.818	0.818	0.817	0.817	0.816	0.816
5.0	**0.812**	0.811	0.811	0.811	0.811	0.812	0.812	0.812	0.812	0.812	0.812	0.812	0.812	0.812
5.5	**0.814**	0.814	0.814	0.814	0.814	0.815	0.815	0.815	0.815	0.815	0.815	0.814	0.814	0.814
6.0	**0.814**	0.816	0.816	0.816	0.816	0.816	0.815	0.815	0.815	0.815	0.814	0.814	0.813	0.813
6.5	**0.810**	0.816	0.815	0.815	0.815	0.814	0.814	0.813	0.813	0.812	0.811	0.811	0.809	0.809
7.0	**0.805**	0.814	0.813	0.812	0.811	0.811	0.810	0.809	0.808	0.807	0.806	0.806	0.804	0.803
7.5	**0.785**	0.797	0.796	0.795	0.794	0.793	0.792	0.791	0.789	0.788	0.787	0.786	0.784	0.782
8.0	**0.728**	0.740	0.739	0.738	0.737	0.736	0.735	0.733	0.732	0.731	0.730	0.729	0.727	0.726
8.5	**0.661**	0.670	0.669	0.669	0.668	0.667	0.666	0.665	0.664	0.663	0.662	0.661	0.660	0.659
9.0	**0.599**	0.607	0.607	0.606	0.605	0.604	0.604	0.603	0.602	0.601	0.601	0.600	0.598	0.598
9.5	**0.546**	0.554	0.553	0.553	0.552	0.551	0.551	0.550	0.549	0.549	0.548	0.547	0.545	0.544
10.0	**0.498**	0.508	0.508	0.507	0.506	0.506	0.505	0.504	0.504	0.503	0.501	0.499	0.494	0.491
10.5	**0.448**	0.470	0.470	0.469	0.468	0.468	0.466	0.464	0.462	0.460	0.456	0.452	0.443	0.438
11.0	**0.400**	0.439	0.438	0.436	0.435	0.433	0.429	0.426	0.422	0.418	0.412	0.406	0.393	0.386
11.5	**0.354**	0.412	0.409	0.406	0.403	0.399	0.393	0.388	0.382	0.376	0.368	0.361	0.347	0.340
12.0	**0.314**	0.385	0.380	0.374	0.369	0.364	0.356	0.349	0.342	0.335	0.328	0.321	0.307	0.301
12.5	**0.279**	0.355	0.348	0.340	0.333	0.326	0.319	0.312	0.305	0.298	0.291	0.285	0.273	0.267
13.0	**0.247**	0.320	0.313	0.306	0.298	0.291	0.284	0.278	0.271	0.264	0.259	0.253	0.242	0.237
13.5	**0.220**	0.287	0.280	0.273	0.266	0.259	0.253	0.247	0.241	0.235	0.230	0.225	0.215	0.211
14.0	**0.196**	0.256	0.249	0.243	0.237	0.230	0.225	0.220	0.214	0.209	0.205	0.200	0.192	0.188
14.5	**0.175**	0.228	0.222	0.217	0.211	0.205	0.201	0.196	0.191	0.187	0.183	0.179	0.171	0.168
15.0	**0.157**	0.204	0.199	0.194	0.189	0.183	0.179	0.175	0.171	0.167	0.164	0.160	0.154	0.151
15.5	**0.141**	0.183	0.179	0.174	0.169	0.165	0.161	0.158	0.154	0.150	0.147	0.144	0.138	0.136
16.0	**0.128**	0.165	0.161	0.157	0.153	0.149	0.146	0.142	0.139	0.136	0.133	0.130	0.125	0.123
16.5	**0.116**	0.149	0.146	0.142	0.139	0.135	0.132	0.129	0.126	0.123	0.121	0.118	0.114	0.112
17.0	**0.106**	0.136	0.132	0.129	0.126	0.123	0.120	0.117	0.115	0.112	0.110	0.108	0.104	0.102
17.5	**0.097**	0.124	0.121	0.118	0.115	0.112	0.110	0.108	0.105	0.103	0.101	0.099	0.095	0.093
18.0	**0.089**	0.114	0.111	0.108	0.106	0.103	0.101	0.099	0.097	0.094	0.093	0.091	0.087	0.086
18.5	**0.082**	0.104	0.102	0.100	0.097	0.095	0.093	0.091	0.089	0.087	0.085	0.084	0.080	0.079
19.0	**0.075**	0.096	0.093	0.091	0.089	0.087	0.085	0.083	0.082	0.080	0.078	0.077	0.074	0.073
19.5	**0.070**	0.088	0.086	0.084	0.082	0.080	0.079	0.077	0.075	0.074	0.072	0.071	0.068	0.067
20.0	**0.065**	0.082	0.080	0.078	0.076	0.074	0.073	0.071	0.070	0.068	0.067	0.066	0.063	0.062
20.5	**0.060**	0.076	0.074	0.072	0.071	0.069	0.068	0.066	0.065	0.063	0.062	0.061	0.059	0.058
21.0	**0.055**	0.069	0.068	0.066	0.065	0.063	0.062	0.061	0.060	0.058	0.057	0.056	0.054	0.054
21.5	**0.050**	0.062	0.060	0.059	0.058	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.049	0.049
22.0	**0.044**	0.053	0.052	0.051	0.050	0.049	0.049	0.048	0.047	0.046	0.046	0.045	0.044	0.043
22.5	**0.038**	0.046	0.045	0.044	0.043	0.043	0.042	0.041	0.041	0.040	0.039	0.039	0.038	0.037
23.0	**0.033**	0.039	0.039	0.038	0.037	0.037	0.036	0.036	0.035	0.034	0.034	0.034	0.033	0.032
23.5	**0.028**	0.033	0.033	0.032	0.032	0.031	0.031	0.030	0.030	0.029	0.029	0.029	0.028	0.028
24.0	**0.024**	0.028	0.028	0.027	0.027	0.026	0.026	0.026	0.025	0.025	0.025	0.024	0.024	0.024
24.5	**0.020**	0.024	0.023	0.023	0.023	0.022	0.022	0.022	0.021	0.021	0.021	0.021	0.020	0.020
25.0	**0.017**	0.020	0.020	0.019	0.019	0.019	0.019	0.018	0.018	0.018	0.018	0.018	0.017	0.017

8.12 Sound Curves, Sound Optimized Mode SO4

Sound Power Level at Hub Height	
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3** **Maximum turbulence at hub height: 30%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA]** **Sound Optimized Mode SO4 (Blades with serrated trailing edge)**
3	93.9
4	94.0
5	94.9
6	97.9
7	101.2
8	102.0
9	102.0
10	102.0
11	102.0
12	102.0
13	102.0
14	102.0
15	102.0

8.13 Power Curves, Sound Optimized Mode SO5

	Air density [kg/m³]													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**32**	15	17	18	20	21	23	24	26	27	29	31	34	35
3.5	**129**	78	83	87	91	95	100	105	110	114	119	124	134	140
4.0	**288**	196	204	213	221	230	238	246	255	263	271	279	296	304
4.5	**481**	346	358	371	383	395	407	420	432	444	456	469	493	506
5.0	**715**	529	546	563	580	597	614	631	648	664	681	698	732	749
5.5	**999**	748	770	793	816	839	861	884	907	930	953	976	1022	1045
6.0	**1340**	1011	1041	1071	1100	1130	1160	1190	1220	1250	1280	1310	1369	1399
6.5	**1739**	1322	1360	1398	1436	1474	1512	1550	1588	1626	1663	1701	1776	1814
7.0	**2197**	1682	1729	1776	1823	1870	1917	1964	2011	2058	2104	2151	2244	2290
7.5	**2674**	2059	2116	2172	2228	2284	2340	2396	2452	2508	2563	2619	2729	2785
8.0	**3128**	2420	2484	2549	2614	2679	2743	2808	2872	2937	3001	3064	3192	3255
8.5	**3553**	2757	2830	2903	2976	3050	3122	3194	3267	3339	3410	3482	3624	3695
9.0	**3961**	3081	3162	3243	3324	3405	3485	3565	3645	3724	3803	3882	4039	4117
9.5	**4347**	3390	3479	3567	3655	3743	3830	3917	4004	4090	4176	4261	4429	4512
10.0	**4725**	3708	3803	3898	3994	4089	4183	4276	4369	4463	4550	4637	4801	4877
10.5	**5058**	4042	4144	4247	4350	4453	4548	4643	4738	4833	4908	4983	5117	5177
11.0	**5333**	4397	4503	4608	4714	4820	4905	4990	5076	5161	5218	5276	5368	5404
11.5	**5521**	4769	4870	4971	5072	5173	5237	5301	5365	5429	5460	5490	5540	5558
12.0	**5650**	5114	5197	5281	5365	5449	5487	5525	5564	5602	5618	5634	5660	5669
12.5	**5742**	5403	5460	5517	5575	5632	5653	5674	5695	5717	5725	5733	5746	5751
13.0	**5803**	5612	5645	5679	5712	5746	5757	5768	5779	5790	5794	5798	5804	5805
13.5	**5828**	5725	5744	5763	5781	5800	5806	5812	5817	5823	5825	5826	5828	5829
14.0	**5829**	5778	5788	5798	5808	5818	5820	5823	5825	5828	5828	5828	5829	5829
14.5	**5812**	5785	5791	5797	5803	5810	5810	5811	5812	5812	5812	5812	5812	5812
15.0	**5791**	5786	5787	5788	5789	5791	5791	5791	5791	5791	5791	5791	5791	5792
15.5	**5769**	5767	5767	5767	5767	5768	5768	5768	5768	5768	5768	5768	5769	5769
16.0	**5746**	5743	5743	5743	5743	5744	5744	5744	5744	5745	5745	5745	5746	5746
16.5	**5719**	5716	5716	5716	5716	5716	5717	5717	5717	5718	5718	5719	5720	5720
17.0	**5690**	5687	5687	5687	5687	5687	5687	5688	5688	5688	5689	5689	5691	5691
17.5	**5661**	5657	5657	5657	5658	5658	5658	5659	5659	5660	5660	5661	5662	5662
18.0	**5629**	5623	5624	5624	5624	5625	5625	5626	5626	5627	5628	5628	5630	5631
18.5	**5596**	5591	5591	5592	5592	5592	5593	5593	5594	5594	5595	5596	5597	5598
19.0	**5570**	5565	5565	5566	5566	5566	5567	5567	5568	5569	5569	5570	5571	5571
19.5	**5547**	5543	5543	5543	5544	5544	5544	5545	5545	5546	5546	5547	5548	5549
20.0	**5527**	5522	5522	5523	5523	5524	5524	5525	5525	5526	5526	5527	5528	5529
20.5	**5505**	5498	5498	5499	5500	5500	5501	5502	5502	5503	5504	5505	5506	5506
21.0	**5460**	5433	5435	5438	5440	5443	5445	5448	5450	5453	5455	5458	5462	5465
21.5	**5304**	5228	5235	5241	5248	5255	5261	5268	5274	5280	5288	5296	5310	5317
22.0	**4994**	4865	4877	4889	4901	4914	4925	4937	4948	4960	4971	4982	5007	5020
22.5	**4545**	4397	4410	4423	4436	4449	4462	4474	4487	4499	4514	4529	4557	4569
23.0	**4095**	3941	3954	3968	3982	3996	4008	4020	4033	4045	4062	4078	4106	4117
23.5	**3633**	3484	3497	3510	3523	3537	3551	3565	3579	3593	3606	3619	3646	3660
24.0	**3166**	3024	3036	3049	3061	3074	3088	3102	3116	3130	3142	3154	3180	3195
24.5	**2724**	2589	2602	2614	2627	2640	2650	2661	2672	2683	2696	2710	2735	2747
25.0	**2321**	2224	2233	2242	2251	2260	2269	2277	2285	2294	2303	2312	2335	2350

8.14 Ct Values, Sound Optimized Mode SO5

Wind speed [m/s]	Air density kg/m³													
	1.225	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**0.969**	0.980	0.979	0.978	0.977	0.976	0.975	0.974	0.973	0.972	0.971	0.970	0.968	0.967
3.5	**0.885**	0.893	0.892	0.892	0.891	0.890	0.889	0.889	0.888	0.887	0.886	0.886	0.884	0.883
4.0	**0.831**	0.846	0.844	0.843	0.842	0.841	0.840	0.839	0.837	0.836	0.834	0.833	0.830	0.828
4.5	**0.816**	0.825	0.824	0.822	0.821	0.820	0.819	0.819	0.818	0.818	0.817	0.817	0.816	0.816
5.0	**0.812**	0.811	0.811	0.811	0.811	0.812	0.812	0.812	0.812	0.812	0.812	0.812	0.812	0.812
5.5	**0.814**	0.814	0.814	0.814	0.814	0.815	0.815	0.815	0.815	0.815	0.815	0.814	0.814	0.814
6.0	**0.814**	0.816	0.816	0.816	0.816	0.816	0.815	0.815	0.815	0.815	0.814	0.814	0.813	0.813
6.5	**0.810**	0.816	0.815	0.815	0.814	0.814	0.813	0.813	0.812	0.812	0.811	0.811	0.809	0.809
7.0	**0.800**	0.809	0.808	0.807	0.807	0.806	0.805	0.804	0.804	0.803	0.802	0.801	0.799	0.798
7.5	**0.753**	0.763	0.762	0.761	0.760	0.760	0.759	0.758	0.757	0.756	0.755	0.754	0.752	0.751
8.0	**0.681**	0.690	0.690	0.689	0.688	0.687	0.686	0.686	0.685	0.684	0.683	0.682	0.680	0.680
8.5	**0.614**	0.621	0.620	0.620	0.619	0.618	0.618	0.617	0.616	0.616	0.615	0.614	0.613	0.612
9.0	**0.556**	0.562	0.562	0.561	0.561	0.560	0.560	0.559	0.558	0.558	0.557	0.557	0.555	0.555
9.5	**0.506**	0.511	0.511	0.510	0.510	0.509	0.509	0.508	0.508	0.507	0.507	0.506	0.505	0.504
10.0	**0.462**	0.469	0.468	0.468	0.468	0.467	0.467	0.466	0.466	0.465	0.464	0.463	0.459	0.457
10.5	**0.419**	0.434	0.434	0.434	0.433	0.433	0.432	0.430	0.429	0.428	0.425	0.422	0.414	0.410
11.0	**0.377**	0.407	0.406	0.405	0.404	0.403	0.400	0.397	0.395	0.392	0.387	0.382	0.371	0.365
11.5	**0.336**	0.383	0.381	0.378	0.376	0.374	0.369	0.364	0.360	0.355	0.348	0.342	0.329	0.323
12.0	**0.297**	0.358	0.354	0.350	0.346	0.342	0.336	0.329	0.323	0.317	0.310	0.304	0.291	0.285
12.5	**0.264**	0.331	0.325	0.319	0.314	0.308	0.302	0.295	0.288	0.282	0.276	0.270	0.259	0.253
13.0	**0.235**	0.302	0.295	0.289	0.282	0.276	0.270	0.263	0.257	0.251	0.246	0.240	0.230	0.225
13.5	**0.210**	0.272	0.266	0.259	0.253	0.246	0.241	0.235	0.230	0.224	0.219	0.214	0.205	0.201
14.0	**0.187**	0.244	0.238	0.232	0.226	0.220	0.215	0.210	0.205	0.200	0.195	0.191	0.183	0.179
14.5	**0.167**	0.218	0.212	0.207	0.202	0.196	0.192	0.187	0.183	0.178	0.175	0.171	0.164	0.160
15.0	**0.150**	0.195	0.190	0.185	0.180	0.176	0.172	0.168	0.164	0.160	0.156	0.153	0.147	0.144
15.5	**0.135**	0.175	0.171	0.167	0.162	0.158	0.154	0.151	0.147	0.144	0.141	0.138	0.132	0.130
16.0	**0.122**	0.158	0.154	0.151	0.147	0.143	0.140	0.136	0.133	0.130	0.128	0.125	0.120	0.118
16.5	**0.111**	0.143	0.140	0.136	0.133	0.129	0.127	0.124	0.121	0.118	0.116	0.114	0.109	0.107
17.0	**0.101**	0.130	0.127	0.124	0.121	0.118	0.115	0.113	0.110	0.108	0.106	0.103	0.099	0.098
17.5	**0.093**	0.119	0.116	0.114	0.111	0.108	0.106	0.103	0.101	0.099	0.097	0.095	0.091	0.090
18.0	**0.085**	0.109	0.107	0.104	0.101	0.099	0.097	0.095	0.093	0.091	0.089	0.087	0.084	0.082
18.5	**0.078**	0.100	0.098	0.095	0.093	0.091	0.089	0.087	0.085	0.083	0.082	0.080	0.077	0.076
19.0	**0.072**	0.092	0.090	0.087	0.085	0.083	0.082	0.080	0.078	0.076	0.075	0.073	0.071	0.069
19.5	**0.067**	0.085	0.083	0.081	0.079	0.077	0.075	0.074	0.072	0.071	0.069	0.068	0.065	0.064
20.0	**0.062**	0.078	0.077	0.075	0.073	0.071	0.070	0.068	0.067	0.066	0.064	0.063	0.061	0.060
20.5	**0.058**	0.073	0.071	0.070	0.068	0.066	0.065	0.064	0.062	0.061	0.060	0.059	0.057	0.056
21.0	**0.053**	0.067	0.066	0.064	0.063	0.061	0.060	0.059	0.058	0.057	0.056	0.054	0.053	0.052
21.5	**0.049**	0.061	0.059	0.058	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.050	0.048	0.047
22.0	**0.044**	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.047	0.046	0.045	0.044	0.043	0.042
22.5	**0.038**	0.046	0.045	0.044	0.043	0.042	0.042	0.041	0.040	0.040	0.039	0.038	0.037	0.037
23.0	**0.033**	0.039	0.039	0.038	0.037	0.036	0.036	0.035	0.035	0.034	0.034	0.033	0.032	0.032
23.5	**0.028**	0.033	0.033	0.032	0.032	0.031	0.031	0.030	0.030	0.029	0.029	0.029	0.028	0.028
24.0	**0.024**	0.028	0.028	0.027	0.027	0.026	0.026	0.026	0.025	0.025	0.025	0.024	0.024	0.024
24.5	**0.020**	0.024	0.023	0.023	0.023	0.022	0.022	0.022	0.021	0.021	0.021	0.021	0.020	0.020
25.0	**0.017**	0.020	0.020	0.019	0.019	0.019	0.019	0.018	0.018	0.018	0.018	0.018	0.017	0.017

8.15 Sound Curves, Sound Optimized Mode SO5

Sound Power Level at Hub Height	
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3** **Maximum turbulence at hub height: 30%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA]** **Sound Optimized Mode SO5 (Blades with serrated trailing edge)**
3	93.9
4	94.0
5	94.9
6	97.9
7	100.7
8	101.0
9	101.0
10	101.0
11	101.0
12	101.0
13	101.0
14	101.0
15	101.0

8.16 Power Curves, Sound Optimized Mode SO6

	Air density [kg/m³]												
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**32**	15	17	18	20	21	23	24	26	27	29	31	34	35
3.5	**129**	78	83	87	91	95	100	105	110	114	119	124	134	140
4.0	**288**	196	204	213	221	230	238	246	255	263	271	279	296	304
4.5	**481**	346	358	371	383	395	407	420	432	444	456	469	493	506
5.0	**715**	529	546	563	580	597	614	631	648	664	681	698	732	749
5.5	**999**	748	770	793	816	839	861	884	907	930	953	976	1022	1045
6.0	**1340**	1011	1041	1071	1100	1130	1160	1190	1220	1250	1280	1310	1369	1399
6.5	**1736**	1321	1358	1396	1434	1472	1510	1548	1586	1623	1661	1698	1773	1811
7.0	**2175**	1666	1713	1759	1806	1852	1899	1945	1991	2037	2083	2129	2221	2267
7.5	**2601**	2004	2058	2113	2168	2222	2277	2331	2385	2439	2493	2547	2654	2708
8.0	**2997**	2317	2380	2442	2504	2566	2628	2690	2751	2813	2874	2936	3058	3119
8.5	**3383**	2623	2692	2762	2832	2901	2970	3040	3109	3178	3246	3315	3451	3519
9.0	**3748**	2911	2988	3065	3142	3219	3295	3371	3447	3523	3598	3673	3822	3897
9.5	**4090**	3183	3266	3350	3433	3517	3599	3681	3764	3846	3927	4008	4169	4248
10.0	**4425**	3458	3548	3638	3728	3818	3906	3994	4083	4171	4256	4340	4502	4580
10.5	**4732**	3744	3840	3936	4032	4128	4221	4313	4406	4498	4576	4654	4795	4857
11.0	**4993**	4043	4145	4246	4348	4450	4536	4623	4710	4797	4863	4928	5037	5081
11.5	**5193**	4369	4471	4572	4673	4775	4849	4922	4996	5070	5111	5152	5217	5240
12.0	**5341**	4703	4795	4888	4980	5072	5123	5173	5223	5273	5296	5319	5354	5366
12.5	**5449**	5013	5084	5156	5227	5299	5327	5356	5384	5413	5425	5437	5456	5462
13.0	**5521**	5256	5302	5348	5393	5439	5455	5470	5486	5502	5508	5514	5523	5525
13.5	**5556**	5400	5428	5457	5485	5514	5522	5530	5538	5546	5549	5552	5556	5557
14.0	**5567**	5489	5503	5518	5532	5547	5551	5556	5560	5565	5566	5566	5567	5568
14.5	**5560**	5520	5528	5536	5544	5552	5554	5556	5558	5559	5559	5559	5560	5560
15.0	**5540**	5528	5530	5533	5536	5539	5539	5539	5539	5539	5539	5539	5540	5540
15.5	**5513**	5509	5510	5510	5511	5512	5512	5512	5512	5512	5512	5513	5513	5513
16.0	**5486**	5484	5484	5484	5485	5485	5485	5485	5485	5485	5485	5486	5486	5486
16.5	**5463**	5461	5461	5461	5461	5462	5462	5462	5462	5462	5462	5463	5463	5463
17.0	**5441**	5439	5439	5439	5439	5439	5440	5440	5440	5440	5441	5441	5442	5442
17.5	**5417**	5414	5414	5415	5415	5415	5415	5415	5416	5416	5416	5417	5418	5418
18.0	**5388**	5384	5385	5385	5385	5385	5386	5386	5386	5387	5387	5388	5389	5389
18.5	**5358**	5354	5354	5354	5354	5355	5355	5355	5356	5356	5357	5357	5358	5359
19.0	**5329**	5325	5325	5326	5326	5326	5327	5327	5327	5328	5328	5329	5330	5331
19.5	**5304**	5300	5300	5300	5301	5301	5302	5302	5302	5303	5303	5304	5305	5305
20.0	**5283**	5278	5279	5279	5279	5280	5280	5280	5281	5281	5282	5282	5283	5283
20.5	**5262**	5257	5258	5258	5258	5259	5259	5260	5260	5261	5261	5262	5263	5263
21.0	**5238**	5227	5228	5229	5230	5231	5232	5233	5233	5234	5235	5237	5239	5240
21.5	**5149**	5099	5103	5107	5111	5115	5120	5125	5130	5135	5140	5145	5153	5156
22.0	**4918**	4830	4838	4846	4854	4862	4869	4876	4882	4889	4899	4909	4924	4929
22.5	**4532**	4411	4421	4430	4439	4448	4459	4470	4481	4492	4505	4519	4542	4553
23.0	**4071**	3942	3953	3964	3975	3987	3998	4009	4021	4032	4045	4058	4085	4099
23.5	**3604**	3470	3480	3490	3500	3511	3524	3537	3551	3564	3578	3591	3618	3631
24.0	**3127**	3002	3013	3024	3035	3046	3059	3073	3087	3100	3109	3118	3142	3157
24.5	**2695**	2573	2583	2593	2603	2614	2624	2634	2644	2654	2667	2681	2705	2714
25.0	**2316**	2224	2231	2238	2245	2253	2261	2270	2279	2288	2297	2307	2325	2334

8.17 Ct Values, Sound Optimized Mode SO6

Wind speed [m/s]	Air density kg/m^3													
	1.225	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**0.969**	0.980	0.979	0.978	0.977	0.976	0.975	0.974	0.973	0.972	0.971	0.970	0.968	0.967
3.5	**0.885**	0.893	0.892	0.892	0.891	0.890	0.889	0.889	0.888	0.887	0.886	0.886	0.884	0.883
4.0	**0.831**	0.846	0.844	0.843	0.842	0.841	0.840	0.839	0.837	0.836	0.834	0.833	0.830	0.828
4.5	**0.816**	0.825	0.824	0.822	0.821	0.820	0.819	0.819	0.818	0.818	0.817	0.817	0.816	0.816
5.0	**0.812**	0.811	0.811	0.811	0.811	0.812	0.812	0.812	0.812	0.812	0.812	0.812	0.812	0.812
5.5	**0.814**	0.814	0.814	0.814	0.814	0.815	0.815	0.815	0.815	0.815	0.815	0.814	0.814	0.814
6.0	**0.814**	0.816	0.816	0.816	0.816	0.816	0.815	0.815	0.815	0.815	0.814	0.814	0.813	0.813
6.5	**0.807**	0.813	0.812	0.812	0.812	0.811	0.811	0.810	0.810	0.809	0.809	0.808	0.807	0.806
7.0	**0.777**	0.786	0.785	0.784	0.783	0.783	0.782	0.781	0.780	0.779	0.779	0.778	0.776	0.775
7.5	**0.706**	0.715	0.714	0.713	0.712	0.711	0.711	0.710	0.709	0.708	0.708	0.707	0.705	0.704
8.0	**0.632**	0.639	0.638	0.638	0.637	0.636	0.636	0.635	0.634	0.634	0.633	0.632	0.631	0.630
8.5	**0.571**	0.577	0.576	0.576	0.575	0.575	0.574	0.573	0.573	0.572	0.572	0.571	0.570	0.569
9.0	**0.516**	0.522	0.521	0.521	0.520	0.520	0.519	0.519	0.518	0.518	0.517	0.517	0.516	0.516
9.5	**0.469**	0.473	0.473	0.472	0.472	0.471	0.471	0.471	0.470	0.470	0.469	0.469	0.468	0.468
10.0	**0.427**	0.432	0.432	0.431	0.431	0.431	0.430	0.430	0.430	0.429	0.429	0.428	0.426	0.424
10.5	**0.389**	0.398	0.398	0.398	0.398	0.397	0.397	0.396	0.395	0.395	0.393	0.391	0.385	0.382
11.0	**0.351**	0.371	0.370	0.370	0.369	0.369	0.367	0.365	0.364	0.362	0.358	0.355	0.347	0.342
11.5	**0.315**	0.348	0.346	0.345	0.344	0.343	0.340	0.337	0.333	0.330	0.325	0.320	0.309	0.303
12.0	**0.281**	0.327	0.324	0.322	0.319	0.317	0.312	0.307	0.302	0.298	0.292	0.286	0.275	0.269
12.5	**0.250**	0.305	0.301	0.297	0.293	0.289	0.284	0.278	0.272	0.267	0.261	0.256	0.245	0.240
13.0	**0.223**	0.282	0.277	0.271	0.266	0.261	0.255	0.250	0.244	0.238	0.233	0.228	0.219	0.214
13.5	**0.199**	0.257	0.251	0.245	0.240	0.234	0.229	0.224	0.218	0.213	0.209	0.204	0.195	0.191
14.0	**0.178**	0.232	0.226	0.221	0.215	0.209	0.205	0.200	0.195	0.191	0.186	0.182	0.175	0.171
14.5	**0.160**	0.208	0.203	0.198	0.193	0.188	0.183	0.179	0.175	0.171	0.167	0.163	0.157	0.153
15.0	**0.143**	0.187	0.182	0.178	0.173	0.168	0.164	0.160	0.157	0.153	0.150	0.146	0.140	0.138
15.5	**0.129**	0.168	0.164	0.160	0.155	0.151	0.148	0.144	0.141	0.138	0.135	0.132	0.127	0.124
16.0	**0.117**	0.152	0.148	0.144	0.140	0.137	0.134	0.131	0.128	0.125	0.122	0.119	0.115	0.112
16.5	**0.106**	0.138	0.134	0.131	0.127	0.124	0.121	0.119	0.116	0.113	0.111	0.109	0.104	0.102
17.0	**0.097**	0.125	0.122	0.119	0.116	0.113	0.110	0.108	0.106	0.103	0.101	0.099	0.095	0.093
17.5	**0.089**	0.115	0.112	0.109	0.106	0.104	0.101	0.099	0.097	0.095	0.093	0.091	0.087	0.086
18.0	**0.082**	0.105	0.102	0.100	0.097	0.095	0.093	0.091	0.089	0.087	0.085	0.083	0.080	0.079
18.5	**0.075**	0.096	0.094	0.092	0.089	0.087	0.085	0.083	0.082	0.080	0.078	0.077	0.074	0.072
19.0	**0.069**	0.088	0.086	0.084	0.082	0.080	0.078	0.077	0.075	0.073	0.072	0.070	0.068	0.067
19.5	**0.064**	0.081	0.079	0.078	0.076	0.074	0.072	0.071	0.069	0.068	0.066	0.065	0.063	0.062
20.0	**0.059**	0.075	0.074	0.072	0.070	0.068	0.067	0.066	0.064	0.063	0.062	0.060	0.058	0.057
20.5	**0.055**	0.070	0.068	0.067	0.065	0.064	0.062	0.061	0.060	0.058	0.057	0.056	0.054	0.053
21.0	**0.051**	0.065	0.063	0.062	0.061	0.059	0.058	0.057	0.056	0.054	0.053	0.052	0.051	0.050
21.5	**0.048**	0.059	0.058	0.057	0.056	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046
22.0	**0.043**	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.044	0.042	0.042
22.5	**0.038**	0.046	0.045	0.044	0.043	0.042	0.041	0.041	0.040	0.039	0.039	0.038	0.037	0.037
23.0	**0.032**	0.039	0.038	0.038	0.037	0.036	0.036	0.035	0.035	0.034	0.033	0.033	0.032	0.032
23.5	**0.028**	0.033	0.032	0.032	0.031	0.031	0.030	0.030	0.029	0.029	0.029	0.028	0.027	0.027
24.0	**0.024**	0.028	0.027	0.027	0.026	0.026	0.026	0.025	0.025	0.025	0.024	0.024	0.023	0.023
24.5	**0.020**	0.023	0.023	0.023	0.022	0.022	0.022	0.021	0.021	0.021	0.021	0.020	0.020	0.020
25.0	**0.017**	0.020	0.020	0.019	0.019	0.019	0.019	0.018	0.018	0.018	0.018	0.017	0.017	0.017

8.18 Sound Curves, Sound Optimized Mode SO6

Sound Power Level at Hub Height	
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3** **Maximum turbulence at hub height: 30%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA]** **Sound Optimized Mode SO6 (Blades with serrated trailing edge)**
3	93.9
4	94.0
5	94.9
6	97.8
7	100.0
8	100.0
9	100.0
10	100.0
11	100.0
12	100.0
13	100.0
14	100.0
15	100.0

8.19 Power Curves, Sound Optimized Mode SO7

Wind speed [m/s]	Air density [kg/m³] 1.225	0.950	0.975	1.000	1.025	1.050	1.075	1.100	1.125	1.150	1.175	1.200	1.250	1.275
3.0	**32**	15	17	18	20	21	23	24	26	27	29	31	34	35
3.5	**129**	78	83	87	91	95	100	105	110	114	119	124	134	140
4.0	**288**	196	204	213	221	230	238	246	255	263	271	279	296	304
4.5	**481**	346	358	371	383	395	407	420	432	444	456	469	493	506
5.0	**715**	529	546	563	580	597	614	631	648	664	681	698	732	749
5.5	**999**	748	770	793	816	839	861	884	907	930	953	976	1022	1045
6.0	**1339**	1011	1040	1070	1100	1130	1160	1190	1220	1250	1280	1309	1369	1399
6.5	**1725**	1312	1350	1388	1425	1463	1500	1538	1575	1613	1650	1688	1762	1799
7.0	**2130**	1632	1677	1723	1768	1814	1859	1904	1949	1995	2040	2085	2174	2219
7.5	**2503**	1928	1980	2033	2086	2139	2191	2243	2295	2347	2399	2451	2555	2606
8.0	**2857**	2208	2267	2327	2386	2446	2505	2564	2622	2681	2740	2799	2915	2974
8.5	**3197**	2475	2541	2607	2673	2740	2805	2871	2936	3002	3067	3132	3262	3326
9.0	**3517**	2727	2800	2872	2945	3017	3089	3160	3232	3304	3375	3446	3587	3658
9.5	**3820**	2967	3045	3124	3202	3280	3358	3435	3513	3590	3667	3743	3895	3971
10.0	**4124**	3210	3295	3379	3463	3548	3630	3713	3796	3879	3961	4042	4200	4277
10.5	**4414**	3461	3551	3641	3731	3821	3909	3997	4085	4174	4254	4334	4479	4544
11.0	**4667**	3726	3822	3918	4013	4109	4196	4282	4369	4455	4526	4596	4719	4772
11.5	**4886**	4020	4119	4217	4315	4413	4493	4572	4652	4732	4783	4835	4917	4948
12.0	**5047**	4334	4428	4523	4617	4712	4773	4835	4897	4959	4988	5017	5064	5081
12.5	**5163**	4634	4716	4797	4879	4961	4999	5037	5075	5113	5130	5146	5172	5181
13.0	**5236**	4886	4945	5005	5064	5123	5145	5167	5189	5211	5219	5228	5241	5245
13.5	**5278**	5053	5094	5135	5176	5217	5229	5240	5252	5263	5268	5273	5279	5281
14.0	**5302**	5177	5200	5223	5246	5269	5275	5282	5289	5296	5298	5300	5302	5302
14.5	**5307**	5243	5256	5268	5280	5292	5295	5299	5302	5306	5306	5307	5307	5307
15.0	**5298**	5273	5278	5284	5290	5296	5296	5297	5297	5298	5298	5298	5298	5298
15.5	**5279**	5271	5273	5274	5276	5278	5278	5278	5278	5278	5279	5279	5279	5279
16.0	**5254**	5250	5251	5252	5252	5253	5253	5253	5253	5253	5253	5254	5254	5254
16.5	**5225**	5223	5223	5223	5223	5223	5224	5224	5224	5224	5224	5225	5225	5225
17.0	**5194**	5193	5193	5193	5193	5193	5193	5193	5193	5193	5194	5194	5195	5195
17.5	**5165**	5162	5162	5162	5163	5163	5163	5164	5164	5164	5164	5165	5166	5166
18.0	**5137**	5135	5135	5135	5135	5135	5135	5135	5135	5136	5136	5137	5137	5138
18.5	**5111**	5108	5108	5108	5108	5108	5108	5109	5109	5110	5110	5110	5111	5112
19.0	**5085**	5082	5082	5082	5082	5082	5082	5083	5083	5084	5084	5085	5085	5086
19.5	**5061**	5057	5058	5058	5058	5058	5059	5059	5059	5060	5060	5061	5062	5062
20.0	**5039**	5035	5036	5036	5036	5037	5037	5037	5038	5038	5038	5039	5039	5040
20.5	**5019**	5016	5016	5016	5016	5016	5017	5017	5017	5018	5018	5018	5019	5020
21.0	**4999**	4995	4995	4995	4995	4996	4996	4996	4997	4997	4998	4998	4999	5000
21.5	**4962**	4943	4944	4946	4947	4949	4951	4952	4954	4956	4958	4960	4963	4965
22.0	**4805**	4752	4756	4761	4765	4770	4775	4780	4785	4790	4795	4800	4810	4816
22.5	**4512**	4413	4423	4432	4442	4452	4460	4468	4476	4484	4493	4503	4523	4534
23.0	**4063**	3946	3957	3968	3978	3989	3998	4008	4017	4026	4039	4051	4075	4086
23.5	**3583**	3464	3477	3489	3501	3514	3525	3536	3547	3559	3567	3575	3599	3615
24.0	**3126**	3004	3015	3025	3035	3046	3056	3066	3077	3087	3100	3113	3138	3150
24.5	**2696**	2599	2608	2617	2626	2636	2645	2654	2663	2673	2681	2688	2707	2717
25.0	**2347**	2260	2266	2273	2280	2287	2295	2302	2310	2317	2327	2337	2355	2364

8.20 Ct Values, Sound Optimized Mode SO7

	Air density kg/m³													
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**0.969**	0.980	0.979	0.978	0.977	0.976	0.975	0.974	0.973	0.972	0.971	0.970	0.968	0.967
3.5	**0.885**	0.893	0.892	0.892	0.891	0.890	0.889	0.889	0.888	0.887	0.886	0.886	0.884	0.883
4.0	**0.831**	0.846	0.844	0.843	0.842	0.841	0.840	0.839	0.837	0.836	0.834	0.833	0.830	0.828
4.5	**0.816**	0.825	0.824	0.822	0.821	0.820	0.819	0.819	0.818	0.818	0.817	0.817	0.816	0.816
5.0	**0.812**	0.811	0.811	0.811	0.811	0.812	0.812	0.812	0.812	0.812	0.812	0.812	0.812	0.812
5.5	**0.814**	0.814	0.814	0.814	0.814	0.815	0.815	0.815	0.815	0.815	0.815	0.814	0.814	0.814
6.0	**0.813**	0.816	0.815	0.815	0.815	0.815	0.815	0.815	0.814	0.814	0.814	0.813	0.813	0.812
6.5	**0.794**	0.799	0.799	0.798	0.798	0.798	0.797	0.797	0.796	0.795	0.795	0.794	0.793	0.792
7.0	**0.735**	0.742	0.742	0.741	0.740	0.740	0.739	0.738	0.738	0.737	0.736	0.735	0.734	0.733
7.5	**0.656**	0.662	0.662	0.661	0.661	0.660	0.660	0.659	0.658	0.658	0.657	0.656	0.655	0.655
8.0	**0.587**	0.593	0.592	0.592	0.591	0.591	0.590	0.590	0.589	0.589	0.588	0.588	0.587	0.586
8.5	**0.529**	0.533	0.533	0.533	0.532	0.532	0.531	0.531	0.530	0.530	0.530	0.529	0.528	0.528
9.0	**0.477**	0.481	0.481	0.480	0.480	0.480	0.479	0.479	0.478	0.478	0.478	0.477	0.477	0.476
9.5	**0.432**	0.436	0.435	0.435	0.435	0.434	0.434	0.434	0.434	0.433	0.433	0.433	0.432	0.432
10.0	**0.395**	0.398	0.397	0.397	0.397	0.397	0.396	0.396	0.396	0.396	0.395	0.395	0.394	0.393
10.5	**0.360**	0.365	0.365	0.365	0.365	0.364	0.364	0.364	0.364	0.363	0.362	0.361	0.358	0.355
11.0	**0.327**	0.339	0.339	0.338	0.338	0.338	0.337	0.336	0.335	0.334	0.332	0.329	0.324	0.320
11.5	**0.295**	0.318	0.317	0.316	0.316	0.315	0.313	0.311	0.309	0.307	0.303	0.299	0.291	0.286
12.0	**0.265**	0.300	0.298	0.297	0.295	0.294	0.290	0.286	0.283	0.279	0.275	0.270	0.260	0.255
12.5	**0.237**	0.282	0.279	0.276	0.274	0.271	0.266	0.261	0.257	0.252	0.247	0.242	0.232	0.228
13.0	**0.212**	0.263	0.258	0.254	0.250	0.246	0.241	0.236	0.231	0.226	0.221	0.217	0.207	0.203
13.5	**0.190**	0.241	0.236	0.232	0.227	0.222	0.217	0.212	0.207	0.203	0.198	0.194	0.186	0.182
14.0	**0.170**	0.220	0.215	0.210	0.205	0.199	0.195	0.191	0.186	0.182	0.178	0.174	0.167	0.163
14.5	**0.153**	0.199	0.194	0.189	0.184	0.179	0.175	0.171	0.167	0.163	0.160	0.156	0.150	0.147
15.0	**0.137**	0.179	0.175	0.170	0.166	0.161	0.158	0.154	0.150	0.146	0.143	0.140	0.135	0.132
15.5	**0.124**	0.162	0.158	0.154	0.149	0.145	0.142	0.139	0.135	0.132	0.129	0.127	0.121	0.119
16.0	**0.112**	0.146	0.142	0.139	0.135	0.131	0.128	0.125	0.122	0.120	0.117	0.115	0.110	0.108
16.5	**0.102**	0.132	0.129	0.126	0.122	0.119	0.116	0.114	0.111	0.108	0.106	0.104	0.100	0.098
17.0	**0.093**	0.120	0.117	0.114	0.111	0.108	0.106	0.103	0.101	0.099	0.097	0.095	0.091	0.089
17.5	**0.085**	0.110	0.107	0.105	0.102	0.099	0.097	0.095	0.093	0.091	0.089	0.087	0.084	0.082
18.0	**0.078**	0.101	0.098	0.096	0.093	0.091	0.089	0.087	0.085	0.083	0.081	0.080	0.077	0.075
18.5	**0.072**	0.092	0.090	0.088	0.086	0.083	0.082	0.080	0.078	0.076	0.075	0.073	0.071	0.069
19.0	**0.066**	0.084	0.082	0.081	0.079	0.077	0.075	0.073	0.072	0.070	0.069	0.067	0.065	0.064
19.5	**0.061**	0.078	0.076	0.074	0.073	0.071	0.069	0.068	0.066	0.065	0.064	0.062	0.060	0.059
20.0	**0.057**	0.072	0.071	0.069	0.067	0.066	0.064	0.063	0.062	0.060	0.059	0.058	0.056	0.055
20.5	**0.053**	0.067	0.065	0.064	0.062	0.061	0.060	0.058	0.057	0.056	0.055	0.054	0.052	0.051
21.0	**0.049**	0.062	0.061	0.059	0.058	0.057	0.056	0.054	0.053	0.052	0.051	0.050	0.048	0.048
21.5	**0.046**	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.045	0.044
22.0	**0.042**	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043	0.043	0.041	0.041
22.5	**0.037**	0.046	0.045	0.044	0.043	0.042	0.041	0.041	0.040	0.039	0.039	0.038	0.037	0.036
23.0	**0.032**	0.039	0.038	0.038	0.037	0.036	0.036	0.035	0.034	0.034	0.033	0.033	0.032	0.031
23.5	**0.027**	0.033	0.032	0.032	0.031	0.031	0.030	0.030	0.029	0.029	0.028	0.028	0.027	0.027
24.0	**0.023**	0.028	0.027	0.027	0.026	0.026	0.025	0.025	0.025	0.024	0.024	0.024	0.023	0.023
24.5	**0.020**	0.023	0.023	0.023	0.022	0.022	0.022	0.021	0.021	0.021	0.020	0.020	0.020	0.019
25.0	**0.017**	0.020	0.020	0.019	0.019	0.019	0.018	0.018	0.018	0.018	0.018	0.017	0.017	0.017

8.21 Sound Curves, Sound Optimized Mode SO7

Sound Power Level at Hub Height	
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3** **Maximum turbulence at hub height: 30%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA]** **Sound Optimized Mode SO7 (Blades with serrated trailing edge)**
3	93.9
4	94.0
5	94.9
6	97.7
7	99.0
8	99.0
9	99.0
10	99.0
11	99.0
12	99.0
13	99.0
14	99.0
15	99.0

8.22 Power Curves, Sound Optimized Mode SO8

	Air density [kg/m³]												
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**32**	15	17	18	20	21	23	24	26	27	29	31	34	35
3.5	**129**	78	83	87	91	95	100	105	110	114	119	124	134	140
4.0	**288**	196	204	213	221	230	238	246	255	263	271	279	296	304
4.5	**481**	346	358	371	383	395	407	420	432	444	456	469	493	506
5.0	**715**	529	546	563	580	597	614	631	648	664	681	698	732	749
5.5	**999**	748	770	793	816	839	861	884	907	930	953	976	1022	1045
6.0	**1336**	1008	1038	1067	1097	1127	1157	1187	1216	1246	1276	1306	1365	1395
6.5	**1698**	1292	1329	1366	1403	1441	1477	1514	1551	1588	1625	1662	1735	1771
7.0	**2052**	1572	1616	1660	1704	1748	1791	1835	1879	1922	1966	2009	2095	2139
7.5	**2376**	1829	1879	1929	1979	2029	2079	2129	2178	2228	2277	2327	2425	2475
8.0	**2687**	2073	2129	2186	2242	2298	2354	2409	2465	2521	2576	2631	2742	2797
8.5	**2987**	2310	2372	2434	2495	2557	2619	2680	2742	2803	2864	2926	3048	3108
9.0	**3276**	2537	2604	2672	2740	2807	2874	2942	3009	3076	3142	3209	3342	3408
9.5	**3550**	2752	2825	2898	2971	3045	3117	3190	3262	3335	3406	3478	3621	3692
10.0	**3820**	2966	3044	3123	3201	3280	3357	3435	3512	3590	3666	3743	3894	3968
10.5	**4088**	3186	3269	3353	3437	3521	3603	3686	3768	3851	3930	4009	4158	4228
11.0	**4323**	3413	3502	3591	3680	3769	3853	3938	4022	4107	4179	4251	4383	4444
11.5	**4545**	3661	3755	3848	3942	4036	4117	4197	4278	4359	4421	4483	4587	4629
12.0	**4725**	3940	4034	4127	4220	4314	4385	4457	4529	4600	4642	4683	4748	4770
12.5	**4856**	4230	4318	4406	4493	4581	4633	4684	4735	4787	4810	4833	4870	4885
13.0	**4951**	4495	4568	4641	4714	4787	4818	4850	4881	4912	4925	4938	4958	4965
13.5	**5003**	4695	4749	4802	4856	4909	4928	4946	4965	4983	4990	4996	5007	5011
14.0	**5036**	4842	4878	4915	4951	4988	4997	5006	5015	5024	5028	5032	5037	5038
14.5	**5046**	4936	4956	4977	4998	5019	5024	5030	5035	5041	5043	5044	5046	5046
15.0	**5042**	4991	5002	5014	5025	5037	5038	5039	5040	5041	5041	5041	5042	5042
15.5	**5027**	5000	5006	5013	5019	5025	5025	5026	5026	5026	5026	5026	5027	5027
16.0	**5004**	4992	4995	4998	5000	5003	5003	5003	5003	5003	5003	5004	5004	5004
16.5	**4976**	4967	4969	4971	4973	4976	4976	4976	4976	4976	4976	4976	4977	4977
17.0	**4948**	4943	4944	4945	4946	4948	4948	4948	4948	4948	4948	4948	4948	4949
17.5	**4924**	4916	4917	4919	4921	4923	4923	4923	4923	4923	4923	4924	4924	4924
18.0	**4899**	4893	4894	4895	4897	4898	4898	4898	4898	4899	4899	4899	4900	4900
18.5	**4873**	4866	4867	4868	4869	4870	4871	4871	4871	4871	4872	4872	4873	4873
19.0	**4844**	4841	4841	4841	4841	4841	4842	4842	4842	4842	4843	4843	4844	4845
19.5	**4815**	4812	4812	4812	4812	4813	4813	4813	4813	4814	4814	4815	4816	4816
20.0	**4791**	4788	4788	4788	4789	4789	4789	4789	4790	4790	4790	4790	4791	4791
20.5	**4773**	4771	4771	4771	4771	4771	4772	4772	4772	4772	4772	4772	4773	4773
21.0	**4759**	4757	4757	4757	4757	4758	4758	4758	4758	4758	4759	4759	4759	4759
21.5	**4739**	4735	4735	4736	4736	4737	4737	4737	4737	4738	4738	4739	4740	4741
22.0	**4664**	4630	4633	4636	4638	4641	4644	4647	4651	4654	4657	4661	4666	4669
22.5	**4440**	4382	4386	4391	4395	4400	4405	4411	4417	4423	4428	4434	4445	4450
23.0	**4055**	3963	3971	3978	3986	3994	4001	4008	4016	4023	4034	4045	4062	4069
23.5	**3598**	3501	3509	3517	3525	3533	3541	3549	3557	3565	3576	3587	3607	3616
24.0	**3155**	3063	3070	3077	3084	3090	3099	3108	3117	3126	3136	3145	3164	3174
24.5	**2744**	2662	2669	2676	2683	2690	2698	2706	2714	2722	2729	2737	2755	2765
25.0	**2395**	2309	2316	2324	2331	2338	2346	2355	2363	2372	2380	2387	2403	2412

8.23 Ct Values, Sound Optimized Mode SO8

Wind speed [m/s]	Air density kg/m³												
	1.225	**0.950**	**0.975**	**1.000**	**1.025**	**1.050**	**1.075**	**1.100**	**1.125**	**1.150**	**1.175**	**1.200**	**1.250**	**1.275**
3.0	**0.969**	0.980	0.979	0.978	0.977	0.976	0.975	0.974	0.973	0.972	0.971	0.970	0.968	0.967
3.5	**0.885**	0.893	0.892	0.892	0.891	0.890	0.889	0.889	0.888	0.887	0.886	0.886	0.884	0.883
4.0	**0.831**	0.846	0.844	0.843	0.842	0.841	0.840	0.839	0.837	0.836	0.834	0.833	0.830	0.828
4.5	**0.816**	0.825	0.824	0.822	0.821	0.820	0.819	0.819	0.818	0.818	0.817	0.817	0.816	0.816
5.0	**0.812**	0.811	0.811	0.811	0.811	0.812	0.812	0.812	0.812	0.812	0.812	0.812	0.812	0.812
5.5	**0.814**	0.814	0.814	0.814	0.814	0.815	0.815	0.815	0.815	0.815	0.814	0.814	0.814	0.814
6.0	**0.808**	0.811	0.811	0.811	0.811	0.810	0.810	0.810	0.810	0.809	0.809	0.809	0.808	0.808
6.5	**0.763**	0.769	0.768	0.768	0.767	0.767	0.766	0.766	0.765	0.764	0.764	0.763	0.762	0.761
7.0	**0.681**	0.688	0.687	0.686	0.686	0.685	0.685	0.684	0.684	0.683	0.682	0.682	0.681	0.680
7.5	**0.604**	0.609	0.609	0.608	0.608	0.607	0.607	0.606	0.606	0.605	0.605	0.605	0.604	0.603
8.0	**0.540**	0.544	0.544	0.544	0.543	0.543	0.543	0.542	0.542	0.541	0.541	0.541	0.540	0.539
8.5	**0.486**	0.489	0.489	0.489	0.488	0.488	0.488	0.487	0.487	0.487	0.486	0.486	0.485	0.485
9.0	**0.439**	0.442	0.442	0.441	0.441	0.441	0.441	0.440	0.440	0.440	0.439	0.439	0.439	0.438
9.5	**0.398**	0.401	0.401	0.400	0.400	0.400	0.400	0.399	0.399	0.399	0.399	0.398	0.398	0.398
10.0	**0.363**	0.365	0.365	0.365	0.364	0.364	0.364	0.364	0.364	0.363	0.363	0.363	0.362	0.362
10.5	**0.332**	0.334	0.334	0.334	0.334	0.334	0.333	0.333	0.333	0.333	0.333	0.332	0.330	0.329
11.0	**0.302**	0.309	0.309	0.309	0.308	0.308	0.308	0.307	0.307	0.306	0.305	0.304	0.300	0.297
11.5	**0.275**	0.288	0.288	0.288	0.288	0.287	0.286	0.285	0.284	0.282	0.280	0.277	0.271	0.268
12.0	**0.248**	0.272	0.271	0.270	0.270	0.269	0.267	0.264	0.262	0.260	0.256	0.252	0.244	0.240
12.5	**0.224**	0.257	0.256	0.254	0.253	0.251	0.247	0.244	0.240	0.237	0.232	0.228	0.219	0.215
13.0	**0.201**	0.243	0.240	0.237	0.234	0.231	0.227	0.222	0.218	0.214	0.209	0.205	0.197	0.193
13.5	**0.180**	0.225	0.221	0.218	0.214	0.210	0.206	0.201	0.197	0.192	0.188	0.184	0.177	0.173
14.0	**0.162**	0.207	0.203	0.199	0.194	0.190	0.186	0.181	0.177	0.173	0.169	0.166	0.159	0.155
14.5	**0.146**	0.189	0.184	0.180	0.175	0.171	0.167	0.163	0.159	0.156	0.152	0.149	0.143	0.140
15.0	**0.131**	0.171	0.167	0.163	0.158	0.154	0.151	0.147	0.143	0.140	0.137	0.134	0.128	0.126
15.5	**0.118**	0.155	0.151	0.147	0.143	0.139	0.136	0.133	0.129	0.126	0.124	0.121	0.116	0.114
16.0	**0.107**	0.140	0.136	0.133	0.129	0.126	0.123	0.120	0.117	0.114	0.112	0.110	0.105	0.103
16.5	**0.097**	0.127	0.124	0.120	0.117	0.114	0.111	0.109	0.106	0.104	0.102	0.099	0.096	0.094
17.0	**0.089**	0.115	0.112	0.109	0.106	0.104	0.101	0.099	0.097	0.094	0.093	0.091	0.087	0.085
17.5	**0.082**	0.106	0.103	0.100	0.098	0.095	0.093	0.091	0.089	0.087	0.085	0.083	0.080	0.078
18.0	**0.075**	0.097	0.094	0.092	0.089	0.087	0.085	0.083	0.081	0.080	0.078	0.076	0.073	0.072
18.5	**0.069**	0.089	0.086	0.084	0.082	0.080	0.078	0.077	0.075	0.073	0.072	0.070	0.068	0.066
19.0	**0.063**	0.081	0.079	0.077	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.065	0.062	0.061
19.5	**0.058**	0.075	0.073	0.071	0.069	0.068	0.066	0.065	0.063	0.062	0.061	0.060	0.057	0.056
20.0	**0.054**	0.069	0.067	0.066	0.064	0.063	0.061	0.060	0.059	0.057	0.056	0.055	0.053	0.052
20.5	**0.050**	0.064	0.063	0.061	0.060	0.058	0.057	0.056	0.055	0.053	0.052	0.051	0.050	0.049
21.0	**0.047**	0.060	0.058	0.057	0.056	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.046	0.045
21.5	**0.044**	0.056	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.043	0.043
22.0	**0.041**	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043	0.042	0.042	0.040	0.039
22.5	**0.037**	0.046	0.045	0.044	0.043	0.042	0.041	0.040	0.039	0.039	0.038	0.037	0.036	0.036
23.0	**0.032**	0.039	0.039	0.038	0.037	0.036	0.036	0.035	0.034	0.034	0.033	0.033	0.032	0.031
23.5	**0.027**	0.033	0.033	0.032	0.031	0.031	0.030	0.030	0.029	0.029	0.028	0.028	0.027	0.027
24.0	**0.023**	0.028	0.027	0.027	0.026	0.026	0.026	0.025	0.025	0.024	0.024	0.024	0.023	0.023
24.5	**0.020**	0.024	0.023	0.023	0.022	0.022	0.022	0.021	0.021	0.021	0.020	0.020	0.020	0.019
25.0	**0.017**	0.020	0.020	0.019	0.019	0.019	0.019	0.018	0.018	0.018	0.018	0.017	0.017	0.017

8.24 Sound Curves, Sound Optimized Mode SO8

Sound Power Level at Hub Height	
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 3** **Maximum turbulence at hub height: 30%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**
Wind speed at hub height [m/s]	**Sound Power Level at Hub Height [dBA]** **Sound Optimized Mode SO8 (Blades with serrated trailing edge)**
3	93.9
4	94.0
5	94.9
6	97.5
7	98.0
8	98.0
9	98.0
10	98.0
11	98.0
12	98.0
13	98.0
14	98.0
15	98.0