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General Specification

V112–3.0 MW 50/60 Hz



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Refer to section 11 General Reservations, Notes and Disclaimers, p. 31 for general reservations, notes, and disclaimers applicable to these general specifications.

1 General Description

The Vestas V112-3.0 MW wind turbine is a pitch regulated upwind turbine with active yaw and a three-blade rotor. The Vestas V112-3.0 MW turbine has a rotor diameter of 112 m and a rated output power of 3.075 MW. The turbine utilises the OptiTip® concept and a power system based on a permanent magnet generator and full-scale converter. With these features, the wind turbine is able to operate the rotor at variable speed and thereby maintaining 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.

2 Mechanical Design

2.1 Rotor

The V112-3.0 MW is equipped with a 112-metre 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	
Diameter	112 m
Swept Area	9852 m ²
Rotational Speed Static, Rotor	13.6 rpm
Speed, Dynamic Operation Range	6.2-17.7
Rotational Direction	Clockwise (front view)
Orientation	Upwind
Tilt	6°
Blade Coning	4°
Number of Blades	3
Aerodynamic Brakes	Full feathering

Table 2-1: Rotor data.

2.2 Blades

The blades are made of carbon and fibreglass and consist of two airfoil shells bonded to a supporting beam.

Blades	
Type Description	Airfoil shells bonded to supporting beam
Blade Length	54.65 m
Material	Fibreglass reinforced epoxy and carbon fibres

Blades	
Blade Connection	Steel roots inserted
Airfoils	High-lift profile
Maximum Chord	4.0 m

Table 2-2: Blades data.

2.3 Blade Bearing

The blade bearings are double-row four-point contact ball bearings.

Blade Bearing	
Lubrication	Grease, automatic lubrication pump

Table 2-3: Blade bearing data.

2.4 Pitch System

The turbine is equipped with a pitch system for each blade and a distributor block, all located in the hub. Each pitch system is connected to the distributor block with flexible hoses. The distributor block is connected to the pipes of the hydraulic rotating transfer unit in the hub by means of three hoses (pressure line, return line and drain line).

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

Pitch System	
Type	Hydraulic
Number	1 per blade
Range	-9° to 90°

Table 2-4: Pitch system data.

Hydraulic System	
Main Pump	Two redundant internal-gear oil pumps
Pressure	260 bar
Filtration	3 µm (absolute)

Table 2-5: Hydraulic system data.

2.5 Hub

The hub supports the three blades and transfers the reaction forces to the main bearing and the torque to the gearbox. The hub structure also supports blade bearings and pitch cylinder.

Hub	
Type	Cast ball shell hub
Material	Cast iron

Table 2-6: Hub data.

2.6 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 2-7: Main shaft data.

2.7 Main Bearing Housing

The main bearing housing covers the main bearing and is the first connection point for the drive train system to the bedplate.

Main Bearing Housing	
Material	Cast iron

Table 2-8: Main bearing housing data.

2.8 Main Bearing

The main bearing carries all thrust loads.

Main Bearing	
Type	Double-row spherical roller bearing
Lubrication	Automatic grease lubrication

Table 2-9: Main bearing data.

2.9 Gearbox

The main gear converts the low-speed rotation of the rotor to high-speed generator rotation.

The gearbox is a four-stage differential gearbox where the first three stages are planetary stages and the fourth stage is a helical stage.

The disc brake is mounted on the high-speed shaft. The gearbox lubrication system is a pressure-fed system.

Gearbox	
Type	Differential, three planetary stages + one helical stage
Gear House Material	Cast
Ratio	1:113.2
Mechanical Power	3300 kW
Lubrication System	Pressure oil lubrication
Backup Lubrication System	Oil sump filled from external gravity tank
Total Gear Oil Volume	Approximately 1170 l
Oil Cleanliness Codes	ISO 4406-/15/12
Shaft Seals	Labyrinth

Table 2-10: Gearbox data.

2.10 Generator Bearings

The bearings are grease lubricated and grease is supplied continuously from an automatic lubrication unit.

2.11 High-Speed Shaft Coupling

The coupling transmits the torque of the gearbox high-speed output shaft to the generator input shaft.

The coupling consists of two 4-link laminate packages and a fibreglass intermediate tube with two metal flanges. The coupling is fitted to two-armed hubs on the brake disc and the generator hub.

2.12 Yaw System

The yaw system is an active system based on a robust pre-tensioned plain yaw-bearing concept with PETP as friction material.

The yaw gears are three planetary stages with one worm stage and a torque limiter.

Yaw System	
Type	Plain bearing system
Material	Forged yaw ring heat-treated. Plain bearings PETP
Yawing Speed (50 Hz)	0.46°/sec.
Yawing Speed (60 Hz)	0.6°/sec.

Table 2-11: Yaw system data.

Yaw Gear	
Type	Three planetary stages and one worm stage
Number of Yaw Gears	8
Ratio Total	944:1
Rotational Speed at Full Load	1.4 rpm at output shaft

Table 2-12: Yaw gear data.

2.13 Crane

The nacelle houses the internal safe working load (SWL) service crane. The crane is a single system chain hoist.

Crane	
Lifting Capacity	Maximum 990 kg
Power Supply	3 x 400 V, 10 A

Table 2-13: Crane data.

2.14 Towers

Tubular towers with flange connections, certified according to relevant type approvals, are available in different standard heights. The towers are designed with the majority of internal welded connections replaced by magnet supports to create a predominantly smooth-walled tower. Magnets provide load support in a horizontal direction and internals, such as platforms, ladders, etc., are supported vertically (i.e. in the gravitational direction) by a mechanical connection. The smooth tower design reduces the required steel thickness, rendering the tower lighter compared to one with all internals welded to the tower shells.

The hub heights listed include a distance from the foundation section to the ground level of approximately 0.2 m depending on the thickness of the bottom flange and a distance from the tower top flange to the centre of the hub of 2.2 m.

Towers	
Type	Cylindrical/conical tubular
Hub Heights	84 m/94 m/119 m/140 m
Hub Heights (North America)	84 m/96 m
Maximum Diameter	4.2 m (standard)/4.45 m (119 m DIBt 2)
Material	Steel

Table 2-14: Tower structure data.

2.15 Nacelle Bedplate and Cover

The nacelle cover is made of fibreglass. Hatches are positioned in the floor for lowering or hoisting equipment to the nacelle and evacuation of personnel. The roof section is equipped with wind sensors and skylights. The skylights can be

opened from both inside the nacelle to access the roof and from outside to access the nacelle. Access from the tower to the nacelle is through the yaw system.

The nacelle bedplate is in two parts and consists of a cast iron front part and a girder structure rear part. The front of the nacelle bedplate is the foundation for the drive train and transmits forces from the rotor to the tower through the yaw system. The bottom surface is machined and connected to the yaw bearing and the eight yaw gears are bolted to the front nacelle bedplate.

The crane girders are attached to the top structure. The lower beams of the girder structure are connected at the rear end. The rear part of the bedplate serves as the foundation for controller panels, the cooling system and transformer. The nacelle cover is mounted on the nacelle bedplate.

Type Description	Material
Nacelle Cover	GRP
Bedplate Front	Cast iron
Bedplate Rear	Girder structure

Table 2-15: Nacelle bedplate and cover data.

2.16 Thermal Conditioning System

The thermal conditioning system consists of a few robust components:

- The Vestas CoolerTop® located on top of the rear end of the nacelle. The CoolerTop® is a free flow cooler, thus ensuring that there are no electrical components in the thermal conditioning system located outside the nacelle.
- The Liquid Cooling System I, which serves the gearbox and hydraulic systems, driven by a single electrical pump.
- The Liquid Cooling System II, which serves the generator and converter systems, driven by a single electrical pump.
- The transformer forced air cooling comprised of an electrical fan.
- The nacelle forced air cooling comprised of two electrical fans.

2.16.1 Generator and Converter Cooling

The generator and converter cooling systems operate in parallel. A dynamic flow valve mounted in the generator cooling circuit divides the cooling liquid flow. The cooling liquid removes heat from the generator and converter unit using a free-air flow radiator placed on the top of the nacelle. In addition to the generator, converter unit and radiator, the circulation system includes an electrical pump and a three-way thermostatic valve.

2.16.2 Gearbox and Hydraulic Cooling

The gearbox and hydraulic cooling systems are coupled in parallel. A dynamic flow valve mounted in the gearbox cooling circuit divides the cooling flow. The cooling liquid removes heat from the gearbox and the hydraulic power unit through heat exchangers and a free-air flow radiator placed on the top of the

nacelle. In addition to the heat exchangers and the radiator, the circulation system includes an electrical pump and a three-way thermostatic valve.

2.16.3 Transformer Cooling

The transformer is equipped with forced-air cooling. The ventilator system consists of a central fan, located below the service floor and an air duct leading the air to locations beneath and between the high voltage and low voltage windings of the transformer.

2.16.4 Nacelle Cooling

Hot air generated by mechanical and electrical equipment is removed from the nacelle by two fans located on each side of the nacelle. The airflow enters the nacelle through an air intake in the bottom of the nacelle. The fans can run at low or high speed depending on the temperature in the nacelle.

3 Electrical Design

3.1 Generator

The generator is a three-phase synchronous generator with a permanent magnet rotor that is connected to the grid through a full scale converter.

The generator housing is built with a cylindrical jacket and channels. The channels circulate cooling liquid around the generator internal stator housing.

Generator	
Type	Synchronous with permanent magnets
Rated Power [P_N]	3.3 MW
Rated Apparent Power [S_N]	3880 kVA ($\cos\varphi = 0.85$)
Frequency [f_N]	154 Hz
Voltage, Stator [U_{NS}]	3 x 710 V (@ 1540 rpm)
Number of Poles	12
Winding Type	Form with VPI (Vacuum Pressurized Impregnation)
Winding Connection	Star
Rated Efficiency (Generator only)	98%
Rated rpm	1540 rpm
Overspeed Limit According to IEC (2 minutes)	2400 rpm
Vibration Level	≤ 1.8 mm/s
Generator Bearing	Hybrid/ceramic
Temperature Sensors, Stator	3 PT100 sensors placed at hot spots and 3 as back-up

Generator	
Temperature Sensors, Bearings	1 per bearing and 1 backup per bearing
Insulation Class	H (3 kV)
Enclosure	IP54

Table 3-1: Generator data.

3.2 Converter

The converter is a full-scale converter system controlling both the generator and the power quality delivered to the grid.

The converter consists of four converter units operating in parallel with a common controller.

The converter controls conversion of variable frequency 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 650 V. The generator side voltage rating is up to 710 V dependent on generator speed.

Converter	
Rated Apparent Power [S_N]	3800 kVA
Rated Grid Voltage	650 V
Rated Generator Voltage	710 V
Rated Current	3440 A

Table 3-2: Converter data.

3.3 HV Transformer

The step-up transformer is located in a separate locked room in the nacelle with surge arresters mounted on the high voltage side of the transformer. The transformer is a two-winding, three-phase, dry-type transformer that is self-extinguishing. The windings are delta-connected on the high voltage side unless otherwise specified.

The low voltage winding is star connected. The low voltage system from the generator via the converters is a TN-S system, which means the star point is connected to earth.

The transformer is equipped with 6 PT100 temperature sensors for measuring the core and winding temperatures in the three phases.

The nacelle auxiliary power supply is supplied from a separate 650/400 V transformer located in the nacelle.

HV Transformer	
Type Description	Dry-type cast resin
Primary Voltage [U_N]	10-35 kV

HV Transformer	
Secondary Voltage [U_{NS}]	3 x 650 V
Rated Apparent Power [S_N]	3450 kVA
No Load Loss [P_0] (IEC tolerances)	6.6 kW
Load Losses (@ 120° C) [P_N] (IEC tolerances)	24.5 kW
No Load Reactive Power [Q_0]	12 kVAr *
Full Load Reactive Power [Q_N]	285 kVAr *
Vector Group	Dyn5
Frequency [f_N]	50 Hz
HV-tappings	±2 x 2.5% offload
Inrush Current	5-10 x \hat{I}_n depending on type.
Half Crest Time	~0.8 s
Short-Circuit Impedance (IEC tolerances)	8% @ 650 V, 3450 kVA, 120°C
Positive Sequence Short Circuit Impedance Voltage [$U_{k\ p-s1}$]	8.0% *
Positive Sequence Short Circuit Impedance Voltage (Resistive) [$U_{kr\ p-s1}$]	0.7% *
Zero Sequence Short Circuit Impedance Voltage [$U_{k0\ p-s1}$]	7.7% *
Zero Sequence Short Circuit Impedance Voltage (Resistive) [$U_{kr0\ p-s1}$]	0.7% *
Insulation Class	F
Climate Class	C2
Environmental Class	E2
Fire Behaviour Class	F1

Table 3-3: Transformer data.

NOTE * : Typical values. May change depending on actual nominal voltage, manufacturer etc.

3.4 HV Cables

The high voltage cable runs from the transformer in the nacelle down the tower to the switchgear located at the bottom of the tower. The high voltage cable is a four-core, rubber-insulated, halogen-free, high voltage cable.

HV Cables	
High Voltage Cable Insulation Compound	Improved ethylene-propylene (EP) based material-EPR or high modulus or hard grade ethylene-propylene rubber-HEPR
Conductor Cross Section	3 x 70 / 70 mm ²
Maximum Voltage	24 kV for 10-22 kV rated voltage 42 kV for 22.1-35 kV rated voltage

Table 3-4: HV cables data.

3.5 HV Switchgear

The high voltage switchgear is located in the bottom of the tower.

HV Switchgear			
Type	Gas insulated SF6		
Nominal Frequency	50/60 Hz		
Nominal Rated Voltage	10–22 kV	22.1–33 kV	33.1–35 kV
Maximum Voltage	24 kV	36 kV	40.5 kV
Maximum Short Circuit Current (1 second)	20 kA	25 kA	25 kA

Table 3-5: HV switchgear data.

3.6 AUX System

The AUX system is supplied from a separate 650/400 V transformer located in the nacelle. All motors, pumps, fans and heaters are supplied from this system.

All 230 V consumers are supplied from a 400/230 V transformer located in the tower base.

Power Sockets	
Single Phase (Nacelle and Tower Platforms)	230 V (16 A)/110 V (16 A)/ 2 x 55 V (16 A)
Three Phase (Nacelle and Tower Base)	3 x 400 V (16 A)

Table 3-6: AUX system data.

3.7 Wind Sensors

The turbine is equipped with two ultrasonic wind sensors with no movable parts. The sensors have built-in heaters to minimise interference from ice and snow. The wind sensors are redundant, and the turbine is able to operate with one sensor only.

Wind Sensors	
Type	FT702LT
Principle	Acoustic resonance
Built-In Heat	99 W

Table 3-7: Wind sensor data.

3.8 Vestas Multi Processor (VMP) Controller

The turbine is controlled and monitored by the VMP6000 control system.

VMP6000 is a multiprocessor control system comprised of four main processors (ground, nacelle, hub and converter) interconnected by an optically based 2.5 Mbit ArcNet network.

In addition to the four main processors, the VMP6000 consists of a number of distributed I/O modules interconnected by a 500 kbit CAN network.

I/O modules are connected to CAN interface modules by a serial digital bus, CTBus.

The VMP6000 controller 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.

3.9 Uninterruptible Power Supply (UPS)

The UPS is equipped with an AC/DC, DC/AC converter (double conversions) and battery cells placed in the same cabinet as the converter. During grid outage, the UPS will supply specific components with 230 V AC.

The backup time for the UPS system is proportional to the power consumption. Actual backup time may vary.

UPS	
Battery Type	Valve-Regulated Lead Acid (VRLA)
Rated Battery Voltage	2 x 8 x 12 V (192 V)
Converter Type	Double conversion
Converter Input	230 V +/-20%
Rated Output Voltage	230 Vac

UPS		
Backup Time*	Controller system	15 minutes
	Switchgear function (motor release/activation)	15 minutes
	Remote control system	15 minutes
	Internal light in tower and nacelle	1 hour (supplied by built-in batteries)
	Aviation obstruction light	1 hour
Re-charging Time	80%	Approximately 3 hours
	100%	Approximately 8 hours

Table 3-8: UPS data.

NOTE * For alternative backup times, consult Vestas.

4 Turbine Protection Systems

4.1 Braking Concept

The main brake on the turbine is aerodynamic. Braking the turbine is done by full feathering the three blades (individually turning each blade). Each blade has a hydraulic accumulator to supply power for turning the blade. Braking of the turbine is further supported by a braking resistor that is connected to the permanent magnet generator during shut down. This ensures that torque is maintained in, for example, grid loss situations.

In addition, there is a mechanical disc brake on the high-speed shaft of the gearbox with a dedicated hydraulic system. The mechanical brake is only used as a parking brake and when activating the emergency stop push buttons.

4.2 Short Circuit Protections

Breakers	Breaker for Aux. Power. T4L 250A TMD 4P 690 V	Breaker for Converter Modules T7M1200L PR332/P LSIG 1000 A 3P 690 V
Breaking Capacity, Icu, Ics	70 kA @690 V	50 kA @690 V
Making Capacity, Icm	154 kA @690 V	105 kA @690 V

Table 4-1: Short circuit protection data.

4.3 Overspeed Protection

The generator rpm and the main shaft rpm are registered by inductive sensors and calculated by the wind turbine controller to protect against overspeed and rotating errors.

In addition, the turbine is equipped with a safety PLC, an independent computer module that measures the rotor rpm. In case of an overspeed situation, the safety PLC activates the emergency feathered position (full feathering) of the three blades independently of the turbine controller.

Overspeed Protection	
Sensors Type	Inductive
Trip Level	17.66 (rotor rpm)/2000 (generator rpm)

Table 4-3: Overspeed protection data.

4.4 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:

- Lightning receptors.
- 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 over-voltage and over-current.
- 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
Long Duration Charge	Q_{long}	[C]	200
Total Charge	Q_{total}	[C]	300
Specific Energy	W/R	[MJ/Ω]	10
Average Steepness	di/dt	[kA/μs]	200

Table 4-4: Lightning protection design parameters.

NOTE The Lightning Protection System is designed according to IEC standards (see section 7, page 22).

4.5 EMC System

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

- DIRECTIVE 2004/108/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC.

4.6 Earthing

The Vestas Earthing System consists of a number 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.

4.7 Corrosion Protection

Classification of corrosion protection is according to ISO 12944-2.

Corrosion Protection	External Areas	Internal Areas
Nacelle	C5	C3 and C4 Climate strategy: Heating the air inside the nacelle compared to the outside air temperature lowers the relative humidity and helps ensure a controlled corrosion level.
Hub	C5	C3
Tower	C5-I	C3

Table 4-5: Corrosion protection data for nacelle, hub and tower.

5 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.

5.1 Access

Access to the turbine from the outside is through the bottom of the tower. The door is equipped with a lock. Access to the top platform in the tower is by a ladder or service lift. Access to the nacelle from the top platform is by ladder. Access to the transformer room in the nacelle is controlled with a lock. Unauthorised access to electrical switchboards and power panels in the turbine is prohibited according to IEC 60204-1 2006.

5.2 Escape

In addition to the normal access routes, alternative escape routes from the nacelle are through the crane hatch, from the spinner by opening the nose cone, or from the roof of the nacelle. Rescue equipment is placed in the nacelle.

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

Escape from the service lift is by ladder.

An emergency response plan, placed in the turbine, describes evacuation and escape routes.

5.3 Rooms/Working Areas

The tower and nacelle are equipped with power sockets for electrical tools for service and maintenance of the turbine.

5.4 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 9 metres along the tower ladder between platforms.

Foot supports are placed in the turbine for maintenance and service purposes.

5.5 Service Lift

The V112-3.0 MW turbine is delivered with a service lift installed as standard.

5.6 Climbing Facilities

A ladder with a fall arrest system (rigid rail) is mounted through the tower.

There are anchor points in the tower, nacelle and hub, and on the roof for attaching fall arrest equipment (full body harness).

Over the crane hatch there is an anchor point for the emergency descent equipment.

Anchor points are coloured yellow and are calculated and tested to 22.2 kN.

5.7 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 drive train.

Blocking the pitch of the cylinder can be done with mechanical tools in the hub.

5.8 Lights

The turbine is equipped with lights in the tower, nacelle, transformer room and hub.

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

5.9 Emergency Stop

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

5.10 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.

5.11 Fire Protection/First Aid

A handheld 5-6 kg CO₂ fire extinguisher, first aid kit and fire blanket are required to be located in the nacelle during service and maintenance.

- A handheld 5-6 kg CO₂ fire extinguisher is required only during service and maintenance activities, unless a permanently mounted fire extinguisher located in the nacelle is mandatorily required by authorities.
- First aid kits are required only during service and maintenance activities.
- Fire blankets are required only during non-electrical hot work activities.

5.12 Warning Signs

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

5.13 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.

6 Environment

6.1 Chemicals

Chemicals used in the turbine are evaluated according to the Vestas Wind Systems A/S Environmental System certified according to ISO 14001:2004. The following chemicals are used in the turbine:

- Anti-freeze to help prevent the cooling system from freezing.
- Gear oil for lubricating the gearbox.
- Hydraulic oil to pitch the blades and operate the brake.
- Grease to lubricate bearings.
- Various cleaning agents and chemicals for maintenance of the turbine.

7 Approvals and Design Codes

7.1 Type Approvals

The turbine is type certified according to the certification standards listed below:

Certification	Wind Class	Hub Height
IEC61400-22	IEC IIA	84 m / 94 m / 96 m
	IEC IIIA	119 m / 140 m
DIBt Anlage 2.7/10	DIBt II	94 m / 119 m / 140 m
	DIBt III	94 m / 119 m

Table 7-1: Type approvals data.

7.2 Design Codes – Structural Design

The turbine design has been developed and tested with regard to, but not limited to, the following main standards:

Design Codes	
Nacelle and Hub	IEC 61400-1 Edition 3 EN 50308
Tower	IEC 61400-1 Edition 3 Eurocode 3
Blades	DNV-OS-J102 IEC 1024-1 IEC 60721-2-4 IEC 61400 (Part 1, 12 and 23) IEC WT 01 IEC DEFU R25 ISO 2813 DS/EN ISO 12944-2
Gearbox	ISO 81400-4

Design Codes	
Generator	IEC 60034
Transformer	IEC 60076-11 CENELEC HD637 S1
Lightning Protection	IEC 62305-1: 2006 IEC 62305-3: 2006 IEC 62305-4: 2006 IEC/TR 61400-24:2002
Rotating Electrical Machines	IEC 34
Safety of Machinery, Safety-related Parts of Control Systems	IEC 13849-1
Safety of Machinery – Electrical Equipment of Machines	IEC 60204-1

Table 7-2: Design codes.

8 Colours

8.1 Nacelle Colour

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

Table 8-1: Colour, nacelle.

8.2 Tower Colour

Colour of Vestas Tower Section		
	External:	Internal:
Standard Tower Colour	RAL 7035 (light grey)	RAL 9001 (cream white)

Table 8-2: Colour, tower.

8.3 Blades Colour

Blades Colour	
Standard Blade Colour	RAL 7035 (light grey)
Tip-End Colour Variants	RAL 2009 (traffic orange), RAL 3020 (traffic red)
Gloss	< 30% DS/EN ISO 2813

Table 8-3: Colour, blades.

9 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.

9.1 Climate and Site Conditions

Values refer to hub height:

Extreme Design Parameters	
Wind Climate	IEC IIA
Ambient Temperature Interval (Standard Temperature Turbine)	-40° to +50°C
Extreme Wind Speed (10 Minute Average)	42.5 m/s
Survival Wind Speed (3 Second Gust)	59.5 m/s

Table 9-1: Extreme design parameters.

Average Design Parameters	
Wind Climate	IEC IIA
Wind Speed	8.5 m/s
A-Factor	9.59 m/s
Form Factor, c	2.0
Turbulence Intensity According to IEC 61400-1, Including Wind Farm Turbulence (@15 m/s – 90% quartile)	18%
Wind Shear	0.20
Inflow Angle (vertical)	8°

Table 9-2: Average design parameters.

9.1.1 Complex Terrain

Classification of complex terrain according to IEC 61400-1:2005 Chapter 11.2.

For sites classified as complex, appropriate measures are to be included in site assessment.

Positioning of each turbine must be verified via the Vestas Site Check programme.

9.1.2 Altitude

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

NOTE At altitudes above 1500 m, the maximum ambient temperature with full production is reduced (max. +37.5°C@2000 m).

9.1.3 Wind Power Plant Layout

Turbine spacing is to be evaluated site-specifically. Spacing, in any case, must not be below three rotor diameters (3D).

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.

9.2 Operational Envelope – Temperature and Wind

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

Operational Envelope – Temperature and Wind	
Ambient Temperature Interval (Standard Temperature Turbine)	-20° to +40°C
Cut-In	3 m/s
Cut-Out (10 Minute Average)	25 m/s
Re-Cut In (10 Minute Average)	23 m/s

Table 9-3: Operational envelope – temperature and wind.

NOTE At ambient temperatures above +40°C, the turbine will maintain production, but maximum power output will be derated as a function of the temperature (max. 1.0 MW @+45°C).

9.3 Operational Envelope – Grid Connection

Values are determined by the sensors and control system of the turbine.

Operational Envelope – Grid Connection		
Nominal Phase Voltage	[U _{NP}]	650 V
Nominal Frequency	[f _N]	50/60 Hz
Maximum Steady State Voltage Jump	±2% (from turbine) ±4% (from grid)	
Maximum Frequency Gradient	±4 Hz/sec.	
Maximum Negative Sequence Voltage	3% (connection) 2% (operation)	

Operational Envelope – Grid Connection	
Minimum Short Circuit Level	15 MVA
Maximum Short Circuit Current Contribution	1.05 p.u. (continuous) 1.45 p.u. (peak)

Table 9-4: Operational envelope – grid connection.

The generator and the converter will be disconnected if*:

Protection Settings	
Voltage Above 110% of Nominal for 60 Seconds	715 V
Voltage Above 115% of Nominal for 2 Seconds	748 V
Voltage Above 120% of Nominal for 0.08 Seconds	780 V
Voltage Above 125% of Nominal for 0.005 Seconds	812 V
Voltage Below 90% of Nominal for 60 Seconds	585 V
Voltage Below 85% of Nominal for 11 Seconds	552 V
Frequency is Above 106% of Nominal for 0.2 Seconds	53/63.6 Hz
Frequency is Below 94% of Nominal for 0.2 Seconds	47/56.4 Hz

Table 9-5: 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.

9.4 Operational Envelope – Reactive Power Capability

The turbine has a reactive power capability as illustrated:

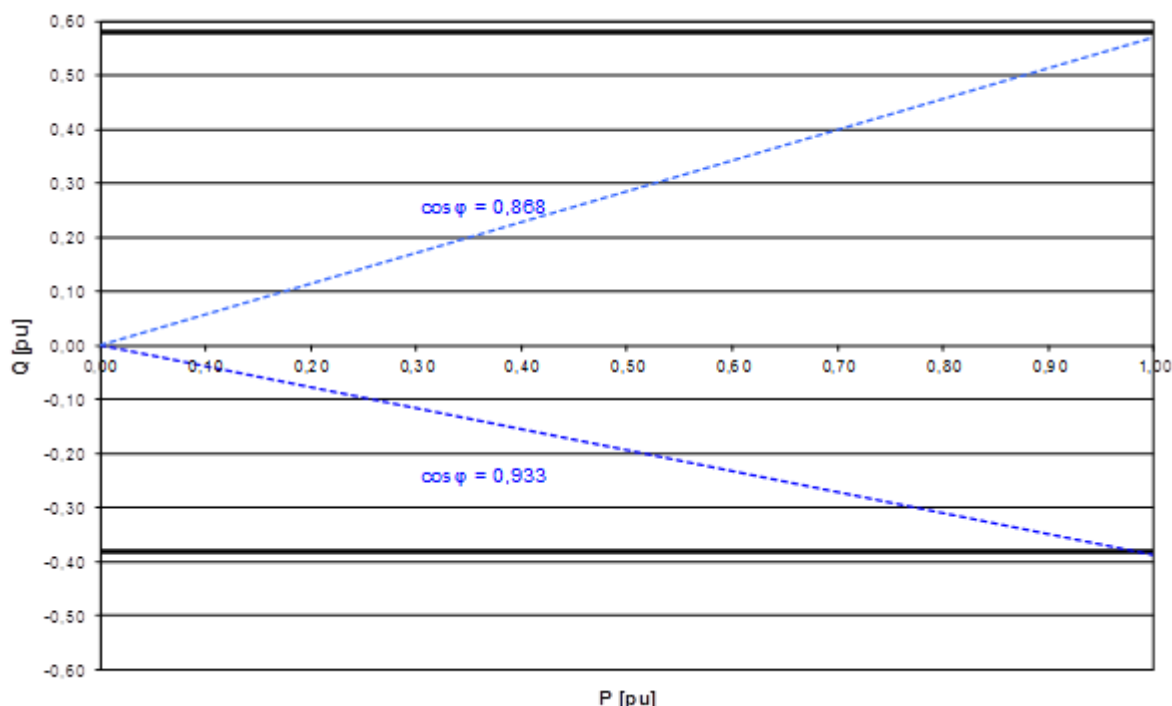


Figure 9-1: Reactive power capability.

The above chart applies at the low voltage side of the HV transformer at nominal voltage $\pm 10\%$ and nominal frequency $\pm 6\%$.

Reactive power capability at full load on high voltage side of the HV transformer is approx: $\cos \phi = 0.90/0.90$ capacitive/inductive.

Reactive power is produced by the full-scale converter. Traditional capacitors are, therefore, not used in the turbine.

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

9.5 Performance – Fault Ride Through

The turbine is equipped with a full-scale converter to gain better control of the wind turbine during grid faults. The turbine control system continues to run during grid faults.

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

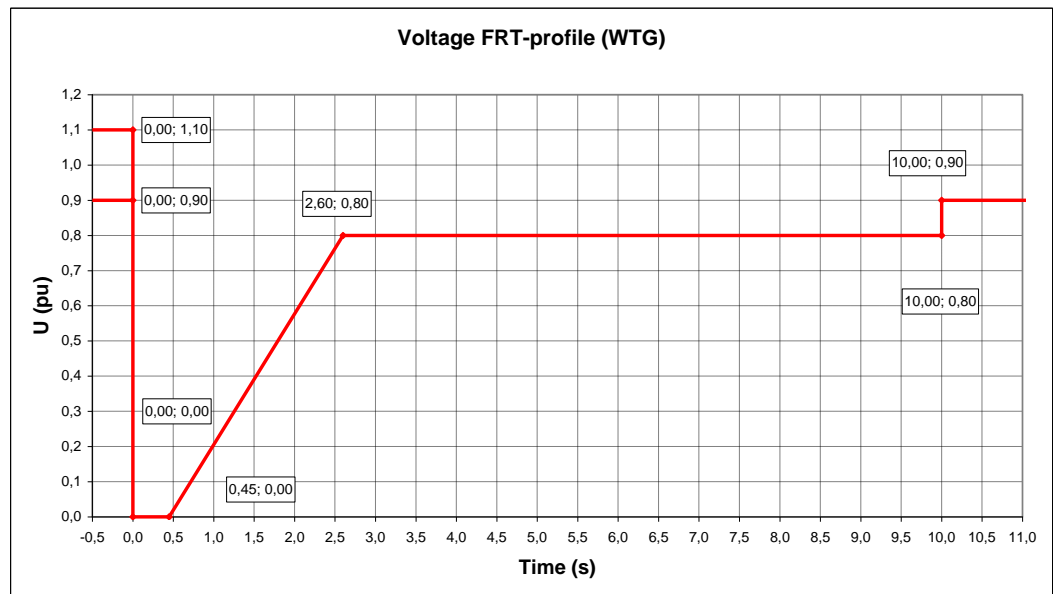


Figure 9-2: Low voltage tolerance curve for symmetrical and asymmetrical faults.

For grid disturbances outside the protection curve in Figure 9-2, p. 28 the turbine will be disconnected from the grid.

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

Table 9-6: Power recovery time.

9.6 Performance – Reactive Current Contribution

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

9.6.1 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 pu of the rated active current at the high voltage side of the HV transformer. Figure 9-3, p. 29 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 9-3, p. 29, 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.

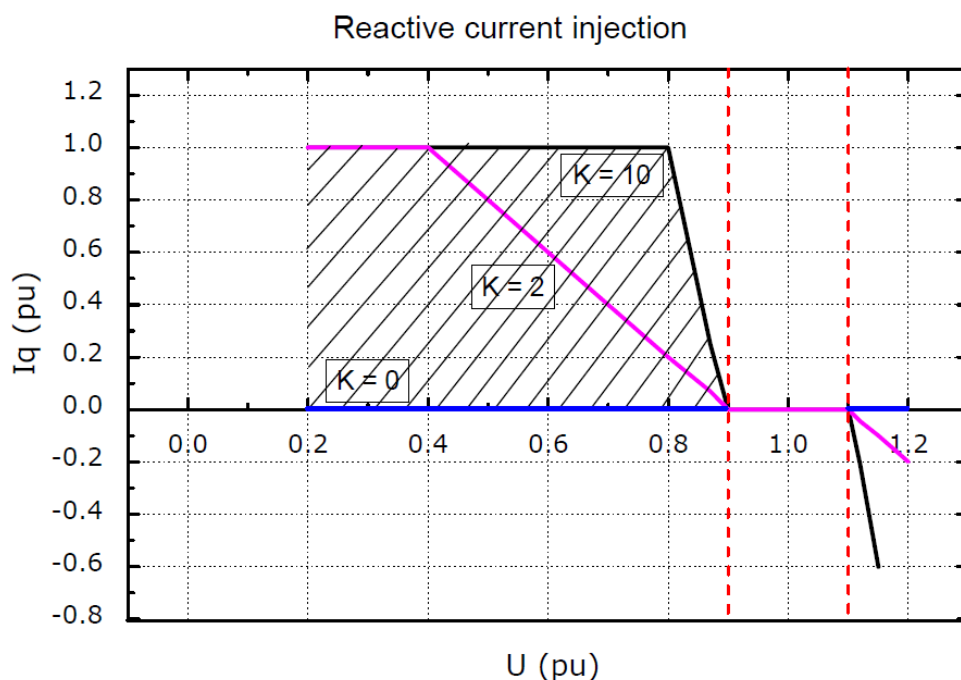


Figure 9-3: Reactive current injection.

9.6.2 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 pu to limit the potential voltage increase on the healthy phases.

9.7 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.

9.8 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 pu/sec. (300 kW/sec.)
Reactive Power	20 pu/sec. (60 MVar/sec.)

Table 9-7: 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.

9.9 Performance – Voltage Control

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

9.10 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.

9.11 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 following components have the largest influence on the own consumption of the wind turbine (the average own consumption depends on the actual conditions, the climate, the wind turbine output, the cut-off hours, etc.):

Own Consumption	
Hydraulic Motor	2 x 15 kW (master/slave)
Yaw Motors 8 x 2.2 kW	17.6 kW
Water Heating	10 kW
Water Pumps	2.2 + 5.5 kW
Oil Heating	7.9 kW
Oil Pump for Gearbox Lubrication	10 kW
Controller Including Heating Elements for the Hydraulics and all Controllers	Maximum approximately 3 kW
HV Transformer No-load Loss	Maximum 6.6 kW

Table 9-8: Own consumption data.

9.12 Operational Envelope – Conditions for Power Curve and C_t Values (at Hub Height)

Consult section 12 Appendices, p. 36 for power curves, C_t values, and noise levels.

Conditions for Power Curve and C_t Values (at Hub Height)	
Wind Shear	0.00-0.30 (10 minute average)
Turbulence Intensity	6-12% (10 minute average)
Blades	Clean
Rain	No
Ice/Snow on Blades	No

Conditions for Power Curve and C_t Values (at Hub Height)	
Leading Edge	No damage
Terrain	IEC 61400-12-1
Inflow Angle (Vertical)	$0 \pm 2^\circ$
Grid Frequency	Nominal Frequency ± 0.5 Hz

Table 9-9: Conditions for power curve, C_t values, and noise levels.

10 Drawings

10.1 Structural Design – Illustration of Outer Dimensions

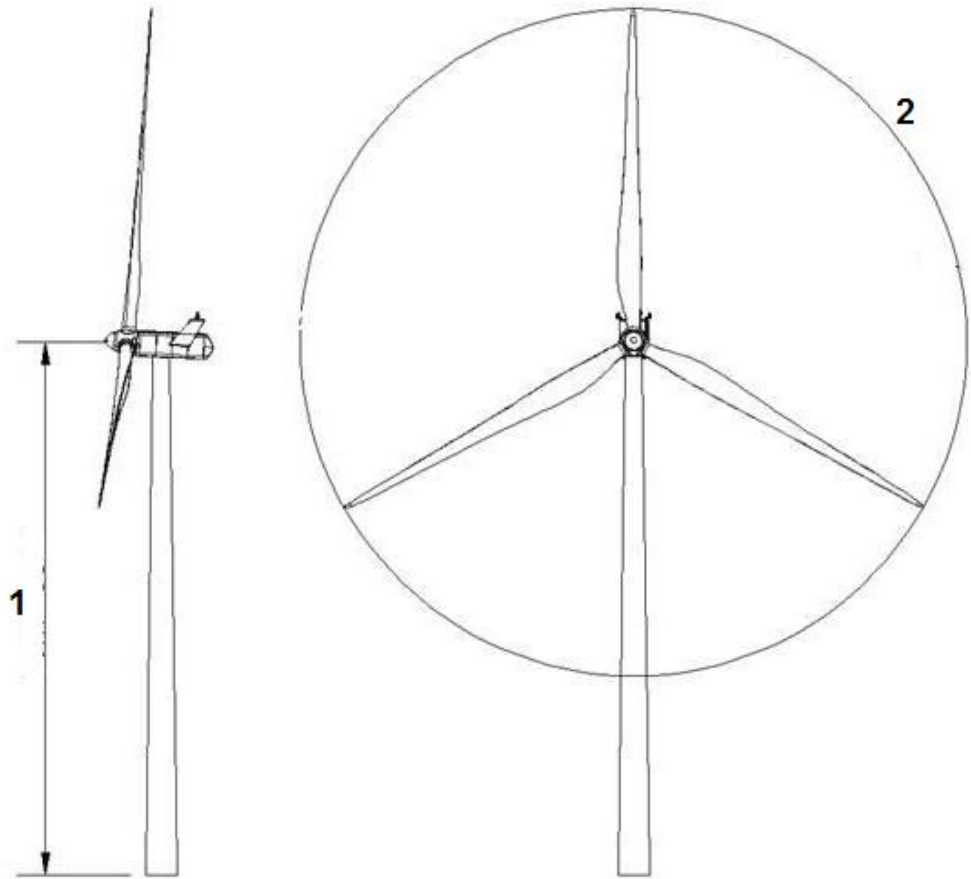


Figure 10-1: Illustration of outer dimensions – structure.

1 Hub height

2 Diameter: 112 m

10.2 Structural Design – Side View Drawing



Figure 10-2: Side-view drawing.

10.3 Electrical Design – Main Wiring

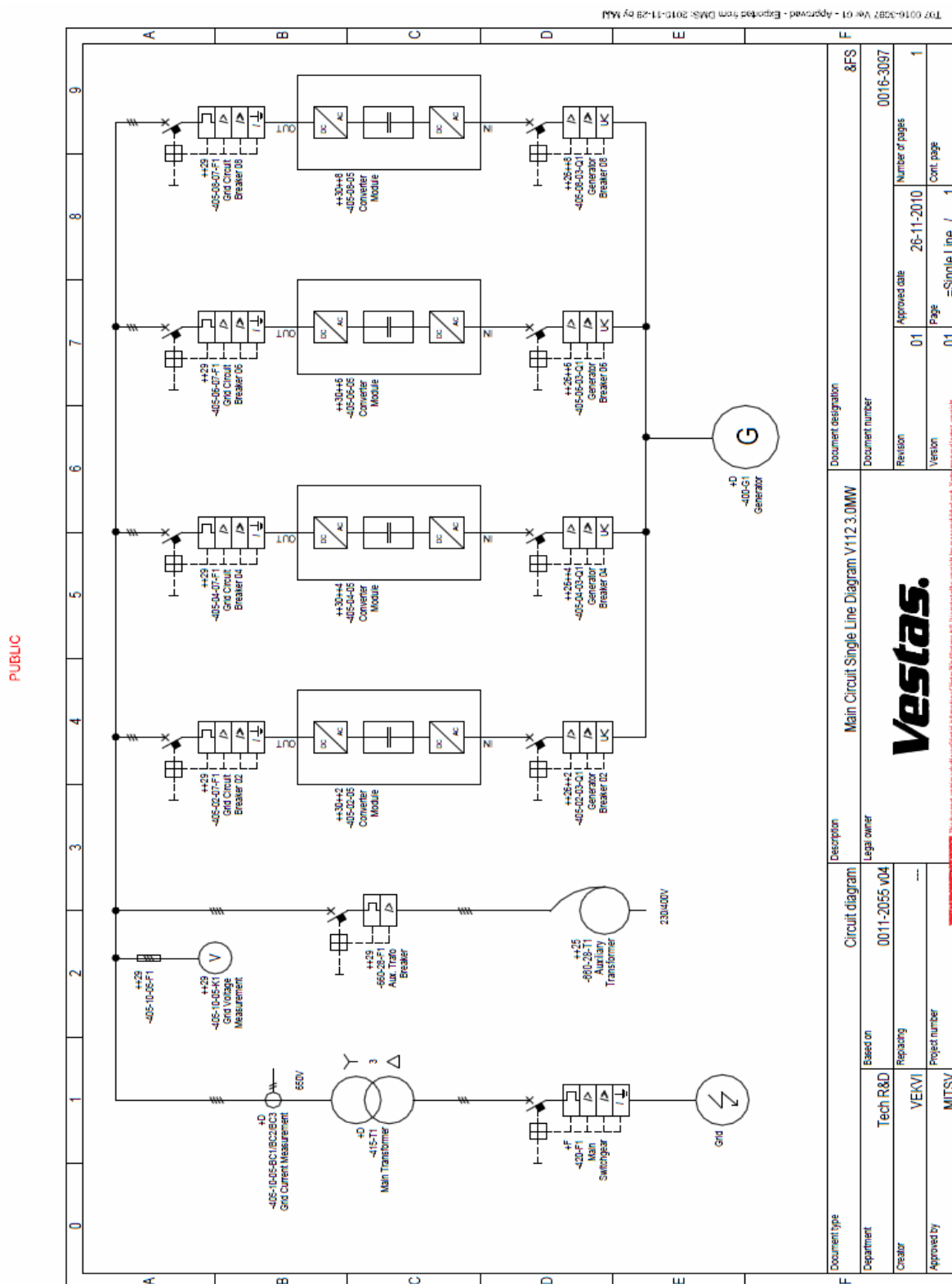


Figure 10-3: Main wiring diagram.

11 General Reservations, Notes and Disclaimers

- The general specifications described in this document apply to the current version of the V112-3.0 MW wind turbine. Updated versions of the V112-3.0 MW wind turbine, which may be manufactured in the future, may differ from these general specifications. In the event that Vestas supplies an updated version of the V112-3.0 MW wind turbine, Vestas will provide an updated general specification applicable to the updated version.
- The 60 Hz variant will be available in the USA in Spring 2011 and in Canada in Spring 2012.
- Vestas recommends that the grid 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 Specification, 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.

12 Appendices

12.1 Mode 0

12.1.1 Power Curves, Noise Mode 0

Air density [kg/m ³]														
Wind speed [m/s]	1.225	0.95	0.975	1.0	1.025	1.05	1.075	1.1	1.125	1.15	1.175	1.2	1.25	1.275
3	26	11	12	13	15	16	17	19	20	22	23	25	27	29
3.5	73	45	48	50	53	55	58	60	63	65	68	70	75	78
4	133	92	95	99	103	107	110	114	118	121	125	129	136	140
4.5	207	150	155	161	166	171	176	181	187	192	197	202	213	218
5	302	223	230	237	244	251	259	266	273	280	287	294	309	316
5.5	416	312	321	331	340	350	359	369	378	388	397	407	426	435
6	554	418	431	443	455	468	480	493	505	517	530	542	567	579
6.5	717	544	560	576	591	607	623	638	654	670	686	701	733	749
7	907	691	711	730	750	769	789	809	828	848	867	887	926	946
7.5	1126	860	884	908	932	956	981	1005	1029	1053	1077	1102	1150	1174
8	1375	1053	1082	1112	1141	1170	1200	1229	1258	1287	1316	1346	1404	1433
8.5	1652	1270	1305	1340	1375	1410	1445	1480	1514	1549	1583	1618	1687	1721
9	1958	1510	1551	1592	1633	1674	1715	1755	1796	1837	1877	1917	1997	2037
9.5	2282	1774	1821	1868	1915	1963	2009	2055	2101	2148	2192	2237	2325	2368
10	2585	2044	2097	2149	2202	2254	2303	2353	2402	2451	2496	2541	2625	2666
10.5	2821	2314	2368	2423	2478	2532	2578	2624	2670	2716	2751	2786	2849	2877
11	2997	2571	2624	2678	2731	2784	2821	2858	2895	2932	2953	2975	3010	3023
11.5	3050	2790	2830	2870	2910	2950	2969	2988	3007	3027	3034	3042	3054	3059
12	3067	2943	2965	2987	3009	3030	3037	3044	3051	3059	3061	3064	3069	3071
12.5	3074	3024	3033	3042	3050	3059	3062	3065	3067	3070	3071	3073	3074	3075
13	3075	3055	3059	3063	3066	3070	3071	3072	3073	3074	3075	3075	3075	3075
13.5	3075	3070	3071	3072	3074	3075	3075	3075	3075	3075	3075	3075	3075	3075
14	3075	3074	3074	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
14.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
15	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
15.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
16	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
16.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
17	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
17.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
18	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
18.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
19	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
19.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
20	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
20.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
21	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
21.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
22	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
22.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
23	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
23.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
24	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
24.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
25	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075

Table 12-1: Power curve, noise mode 0.

12.1.2 C_t Values, Noise Mode 0

Wind speed [m/s]	Air density kg/m ³													
	1.225	0.95	0.975	1.0	1.025	1.05	1.075	1.1	1.125	1.15	1.175	1.2	1.25	1.275
3	0.897	0.899	0.899	0.899	0.899	0.899	0.898	0.898	0.898	0.898	0.898	0.898	0.897	0.897
3.5	0.846	0.848	0.848	0.848	0.847	0.847	0.847	0.847	0.847	0.847	0.847	0.846	0.846	0.846
4	0.819	0.820	0.820	0.820	0.820	0.820	0.819	0.819	0.819	0.819	0.819	0.819	0.819	0.818
4.5	0.810	0.812	0.812	0.812	0.812	0.812	0.811	0.811	0.811	0.811	0.811	0.811	0.810	0.810
5	0.807	0.810	0.810	0.809	0.809	0.809	0.809	0.808	0.808	0.808	0.808	0.807	0.807	0.807
5.5	0.808	0.810	0.810	0.810	0.810	0.810	0.809	0.809	0.809	0.809	0.809	0.808	0.808	0.807
6	0.805	0.808	0.808	0.808	0.807	0.807	0.807	0.806	0.806	0.806	0.805	0.805	0.804	0.804
6.5	0.801	0.806	0.806	0.805	0.805	0.804	0.804	0.803	0.803	0.802	0.802	0.802	0.801	0.800
7	0.798	0.804	0.803	0.803	0.802	0.802	0.801	0.801	0.800	0.800	0.799	0.798	0.797	0.797
7.5	0.793	0.800	0.800	0.799	0.799	0.798	0.797	0.797	0.796	0.795	0.795	0.794	0.793	0.792
8	0.788	0.796	0.796	0.795	0.794	0.793	0.793	0.792	0.791	0.791	0.790	0.789	0.787	0.786
8.5	0.781	0.791	0.790	0.789	0.788	0.787	0.787	0.786	0.785	0.784	0.783	0.782	0.780	0.779
9	0.771	0.782	0.781	0.780	0.779	0.778	0.777	0.776	0.775	0.774	0.773	0.772	0.770	0.768
9.5	0.748	0.766	0.765	0.764	0.763	0.761	0.760	0.758	0.756	0.755	0.752	0.750	0.745	0.742
10	0.705	0.740	0.738	0.736	0.734	0.732	0.729	0.726	0.722	0.719	0.714	0.709	0.698	0.692
10.5	0.637	0.704	0.700	0.696	0.693	0.689	0.683	0.676	0.670	0.664	0.655	0.646	0.627	0.617
11	0.560	0.661	0.654	0.648	0.642	0.636	0.626	0.616	0.606	0.596	0.584	0.572	0.547	0.535
11.5	0.476	0.606	0.596	0.586	0.575	0.565	0.552	0.539	0.526	0.513	0.501	0.488	0.464	0.453
12	0.406	0.543	0.530	0.516	0.503	0.490	0.477	0.464	0.451	0.439	0.428	0.417	0.397	0.387
12.5	0.351	0.476	0.462	0.449	0.435	0.422	0.411	0.400	0.389	0.378	0.369	0.360	0.343	0.335
13	0.307	0.413	0.402	0.390	0.378	0.366	0.357	0.348	0.339	0.329	0.322	0.314	0.300	0.293
13.5	0.271	0.363	0.353	0.342	0.332	0.322	0.314	0.306	0.298	0.290	0.284	0.277	0.265	0.259
14	0.240	0.319	0.310	0.302	0.293	0.284	0.278	0.271	0.264	0.257	0.252	0.246	0.235	0.231
14.5	0.215	0.283	0.276	0.268	0.261	0.253	0.247	0.241	0.236	0.230	0.225	0.220	0.211	0.206
15	0.193	0.253	0.246	0.240	0.233	0.227	0.222	0.216	0.211	0.206	0.202	0.198	0.189	0.186
15.5	0.175	0.227	0.222	0.216	0.210	0.204	0.200	0.195	0.191	0.186	0.182	0.178	0.171	0.168
16	0.159	0.205	0.200	0.195	0.190	0.185	0.181	0.177	0.173	0.169	0.165	0.162	0.156	0.152
16.5	0.145	0.187	0.182	0.177	0.173	0.168	0.165	0.161	0.157	0.154	0.151	0.148	0.142	0.139
17	0.132	0.170	0.166	0.162	0.158	0.154	0.150	0.147	0.144	0.141	0.138	0.135	0.130	0.127
17.5	0.121	0.156	0.152	0.148	0.144	0.141	0.138	0.135	0.132	0.129	0.126	0.124	0.119	0.117
18	0.112	0.143	0.139	0.136	0.133	0.129	0.127	0.124	0.121	0.119	0.116	0.114	0.110	0.108
18.5	0.103	0.132	0.129	0.125	0.122	0.119	0.117	0.114	0.112	0.109	0.107	0.105	0.101	0.100
19	0.096	0.122	0.119	0.116	0.113	0.111	0.108	0.106	0.104	0.101	0.100	0.098	0.094	0.092
19.5	0.089	0.113	0.110	0.108	0.105	0.103	0.100	0.098	0.096	0.094	0.092	0.091	0.087	0.086
20	0.083	0.105	0.102	0.100	0.098	0.095	0.093	0.091	0.090	0.088	0.086	0.084	0.081	0.080
20.5	0.077	0.098	0.095	0.093	0.091	0.089	0.087	0.085	0.083	0.082	0.080	0.079	0.076	0.075
21	0.072	0.091	0.089	0.087	0.085	0.083	0.081	0.080	0.078	0.076	0.075	0.074	0.071	0.070
21.5	0.068	0.085	0.083	0.082	0.080	0.078	0.076	0.075	0.073	0.072	0.070	0.069	0.067	0.066
22	0.064	0.080	0.078	0.076	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.065	0.063	0.062
22.5	0.060	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.065	0.063	0.062	0.061	0.059	0.058
23	0.056	0.070	0.069	0.067	0.066	0.064	0.063	0.062	0.061	0.059	0.058	0.057	0.055	0.054
23.5	0.053	0.066	0.065	0.063	0.062	0.061	0.059	0.058	0.057	0.056	0.055	0.054	0.052	0.051
24	0.050	0.062	0.061	0.060	0.059	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.049	0.049
24.5	0.047	0.059	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046
25	0.045	0.056	0.055	0.054	0.052	0.051	0.050	0.049	0.048	0.047	0.047	0.046	0.045	0.044

Table 12-2: C_t values, noise mode 0.

12.1.3 Noise Curve, Noise Mode 0

Sound Power Level at Hub Height, Noise Mode 0			
Conditions for Sound Power Level:	Measurement standard IEC 61400-11 ed. 2 2002 Wind shear: 0.16 Maximum turbulence at 10 metre height: 16% Inflow angle (vertical): 0 ±2° Air density: 1.225 kg/m³		
Hub Height	84 m	94/96 m	119 m
LwA @ 3 m/s (10 m above ground) [dBA]	94.5	94.5	94.7
Wind speed at hub height [m/s]	4.2	4.3	4.5
LwA @ 4 m/s (10 m above ground) [dBA]	97.3	97.5	98.1
Wind speed at hub height [m/s]	5.6	5.7	5.9
LwA @ 5 m/s (10 m above ground) [dBA]	100.9	101.2	101.9
Wind speed at hub height [m/s]	7.0	7.2	7.4
LwA @ 6 m/s (10 m above ground) [dBA]	104.3	104.6	105.1
Wind speed at hub height [m/s]	8.4	8.6	8.9
LwA @ 7 m/s (10 m above ground) [dBA]	106.5	106.5	106.5
Wind speed at hub height [m/s]	9.8	10.0	10.4
LwA @ 8 m/s (10 m above ground) [dBA]	106.5	106.5	106.5
Wind speed at hub height [m/s]	11.2	11.4	11.9
LwA @ 9 m/s (10 m above ground) [dBA]	106.5	106.5	106.5
Wind speed at hub height [m/s]	12.7	12.9	13.4
LwA @ 10 m/s (10 m above ground) [dBA]	106.5	106.5	106.5
Wind speed at hub height [m/s]	14.1	14.3	14.9
LwA @ 11 m/s (10 m above ground) [dBA]	106.5	106.5	106.5
Wind speed at hub height [m/s]	15.5	15.7	16.3
LwA @ 12 m/s (10 m above ground) [dBA]	106.5	106.5	106.5
Wind speed at hub height [m/s]	16.9	17.2	17.8
LwA @ 13 m/s (10 m above ground) [dBA]	106.5	106.5	106.5
Wind speed at hub height [m/s]	18.3	18.6	19.3

Table 12-3: Noise curve, noise mode 0

12.2 Mode 1

12.2.1 Power Curves, Noise Mode 1

Wind speed [m/s]	Air density [kg/m^3]													
	1.225	0.95	0.975	1.0	1.025	1.05	1.075	1.1	1.125	1.15	1.175	1.2	1.25	1.275
3	26	11	12	13	15	16	17	19	20	22	23	25	27	29
3.5	73	45	48	50	53	55	58	60	63	65	68	70	75	78
4	131	91	94	98	102	105	109	113	116	120	124	127	135	138
4.5	202	146	151	156	161	166	172	177	182	187	192	197	207	212
5	291	215	222	229	236	243	250	256	263	270	277	284	298	305
5.5	402	301	310	319	329	338	347	356	365	374	384	393	411	420
6	537	406	418	430	442	454	466	478	490	502	513	525	549	561
6.5	699	531	546	561	577	592	607	622	638	653	668	684	714	729
7	888	677	696	715	734	753	773	792	811	830	849	868	907	926
7.5	1106	845	869	893	916	940	964	987	1011	1034	1058	1082	1129	1153
8	1355	1039	1068	1096	1125	1154	1183	1212	1240	1269	1298	1326	1384	1412
8.5	1634	1257	1291	1326	1360	1395	1429	1463	1498	1532	1566	1600	1668	1702
9	1940	1498	1538	1579	1619	1660	1700	1740	1780	1820	1860	1900	1979	2019
9.5	2267	1761	1808	1855	1902	1949	1995	2041	2087	2133	2177	2222	2310	2353
10	2575	2032	2085	2137	2189	2242	2291	2341	2390	2440	2485	2530	2615	2655
10.5	2813	2303	2358	2413	2468	2523	2569	2616	2662	2708	2743	2778	2841	2869
11	2988	2562	2616	2669	2723	2776	2813	2850	2887	2924	2945	2966	3000	3012
11.5	3044	2784	2825	2865	2905	2945	2964	2983	3002	3022	3029	3037	3048	3052
12	3065	2941	2963	2984	3006	3028	3035	3042	3049	3056	3059	3062	3066	3068
12.5	3072	3023	3032	3040	3049	3058	3061	3064	3066	3069	3070	3071	3073	3073
13	3074	3055	3058	3062	3066	3069	3070	3072	3073	3074	3074	3074	3074	3074
13.5	3075	3070	3071	3072	3073	3075	3075	3075	3075	3075	3075	3075	3075	3075
14	3075	3074	3074	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
14.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
15	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
15.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
16	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
16.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
17	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
17.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
18	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
18.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
19	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
19.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
20	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
20.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
21	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
21.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
22	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
22.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
23	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
23.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
24	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
24.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
25	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075

Table 12-4: Power curve, noise mode 1.

12.2.2 C_t Values, Noise Mode 1

Air density [kg/m^3]														
Wind speed [m/s]	1.225	0.95	0.975	1.0	1.025	1.05	1.075	1.1	1.125	1.15	1.175	1.2	1.25	1.275
3	0.890	0.892	0.892	0.892	0.892	0.892	0.892	0.891	0.891	0.891	0.891	0.891	0.890	0.890
3.5	0.816	0.818	0.817	0.817	0.817	0.817	0.817	0.817	0.817	0.816	0.816	0.816	0.816	0.816
4	0.763	0.764	0.764	0.764	0.764	0.763	0.763	0.763	0.763	0.763	0.763	0.763	0.762	0.762
4.5	0.727	0.729	0.729	0.728	0.728	0.728	0.728	0.728	0.728	0.728	0.728	0.727	0.727	0.727
5	0.713	0.715	0.715	0.714	0.714	0.714	0.714	0.714	0.713	0.713	0.713	0.713	0.713	0.712
5.5	0.711	0.713	0.713	0.713	0.713	0.712	0.712	0.712	0.712	0.712	0.712	0.711	0.711	0.711
6	0.717	0.719	0.719	0.719	0.719	0.718	0.718	0.718	0.718	0.717	0.717	0.717	0.716	0.716
6.5	0.723	0.727	0.726	0.726	0.726	0.725	0.725	0.725	0.724	0.724	0.724	0.723	0.723	0.722
7	0.730	0.734	0.734	0.734	0.733	0.733	0.732	0.732	0.731	0.731	0.731	0.730	0.729	0.729
7.5	0.736	0.742	0.742	0.741	0.741	0.740	0.740	0.739	0.739	0.738	0.738	0.737	0.736	0.735
8	0.744	0.751	0.750	0.750	0.749	0.749	0.748	0.747	0.747	0.746	0.746	0.745	0.744	0.743
8.5	0.750	0.757	0.757	0.756	0.756	0.755	0.754	0.753	0.753	0.752	0.751	0.750	0.749	0.748
9	0.748	0.758	0.757	0.756	0.755	0.755	0.754	0.753	0.752	0.751	0.750	0.749	0.747	0.746
9.5	0.733	0.748	0.747	0.746	0.745	0.744	0.743	0.741	0.740	0.739	0.737	0.735	0.731	0.728
10	0.697	0.727	0.725	0.723	0.722	0.720	0.718	0.715	0.712	0.710	0.705	0.701	0.691	0.685
10.5	0.633	0.695	0.692	0.688	0.685	0.682	0.676	0.670	0.664	0.659	0.650	0.641	0.623	0.613
11	0.557	0.656	0.650	0.644	0.638	0.632	0.623	0.613	0.603	0.593	0.581	0.569	0.544	0.531
11.5	0.474	0.604	0.594	0.584	0.574	0.564	0.551	0.538	0.525	0.512	0.499	0.486	0.462	0.451
12	0.406	0.543	0.529	0.516	0.502	0.489	0.476	0.464	0.451	0.438	0.427	0.416	0.396	0.387
12.5	0.351	0.476	0.462	0.449	0.435	0.422	0.411	0.400	0.389	0.378	0.369	0.360	0.343	0.335
13	0.306	0.413	0.401	0.390	0.378	0.366	0.357	0.348	0.339	0.329	0.322	0.314	0.300	0.293
13.5	0.271	0.363	0.353	0.342	0.332	0.322	0.314	0.306	0.298	0.290	0.284	0.277	0.265	0.259
14	0.240	0.319	0.310	0.302	0.293	0.284	0.278	0.271	0.264	0.257	0.252	0.246	0.235	0.231
14.5	0.215	0.283	0.276	0.268	0.261	0.253	0.247	0.241	0.236	0.230	0.225	0.220	0.211	0.206
15	0.193	0.253	0.246	0.240	0.233	0.227	0.222	0.216	0.211	0.206	0.202	0.198	0.189	0.186
15.5	0.175	0.227	0.222	0.216	0.210	0.204	0.200	0.195	0.191	0.186	0.182	0.178	0.171	0.168
16	0.159	0.205	0.200	0.195	0.190	0.185	0.181	0.177	0.173	0.169	0.165	0.162	0.156	0.152
16.5	0.145	0.187	0.182	0.177	0.173	0.168	0.165	0.161	0.157	0.154	0.151	0.148	0.142	0.139
17	0.132	0.170	0.166	0.162	0.158	0.154	0.150	0.147	0.144	0.141	0.138	0.135	0.130	0.127
17.5	0.121	0.156	0.152	0.148	0.144	0.141	0.138	0.135	0.132	0.129	0.126	0.124	0.119	0.117
18	0.112	0.143	0.139	0.136	0.133	0.129	0.127	0.124	0.121	0.119	0.116	0.114	0.110	0.108
18.5	0.103	0.132	0.129	0.125	0.122	0.119	0.117	0.114	0.112	0.109	0.107	0.105	0.101	0.100
19	0.096	0.122	0.119	0.116	0.113	0.111	0.108	0.106	0.104	0.101	0.100	0.098	0.094	0.092
19.5	0.089	0.113	0.110	0.108	0.105	0.103	0.100	0.098	0.096	0.094	0.092	0.091	0.087	0.086
20	0.083	0.105	0.102	0.100	0.098	0.095	0.093	0.091	0.090	0.088	0.086	0.084	0.081	0.080
20.5	0.077	0.098	0.095	0.093	0.091	0.089	0.087	0.085	0.083	0.082	0.080	0.079	0.076	0.075
21	0.072	0.091	0.089	0.087	0.085	0.083	0.081	0.080	0.078	0.076	0.075	0.074	0.071	0.070
21.5	0.068	0.085	0.083	0.082	0.080	0.078	0.076	0.075	0.073	0.072	0.070	0.069	0.067	0.066
22	0.064	0.080	0.078	0.076	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.065	0.063	0.062
22.5	0.060	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.065	0.063	0.062	0.061	0.059	0.058
23	0.056	0.070	0.069	0.067	0.066	0.064	0.063	0.062	0.061	0.059	0.058	0.057	0.055	0.054
23.5	0.053	0.066	0.065	0.063	0.062	0.061	0.059	0.058	0.057	0.056	0.055	0.054	0.052	0.051
24	0.050	0.062	0.061	0.060	0.059	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.049	0.049
24.5	0.047	0.059	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046
25	0.045	0.056	0.055	0.054	0.052	0.051	0.050	0.049	0.048	0.047	0.047	0.046	0.045	0.044

Table 12-5: C_t values, noise mode 1.

12.2.3 Noise Curve, Noise Mode 1

Sound Power Level at Hub Height, Noise Mode 1			
Conditions for Sound Power Level:	Measurement standard IEC 61400-11 ed. 2 2002 Wind shear: 0.16 Maximum turbulence at 10 metre height: 16% Inflow angle (vertical): 0 ±2° Air density: 1.225 kg/m³		
Hub Height	84 m	94/96 m	119 m
LwA @ 3 m/s (10 m above ground) [dBA]	94.3	94.3	94.4
Wind speed at hub height [m/s]	4.2	4.3	4.5
LwA @ 4 m/s (10 m above ground) [dBA]	96.5	96.5	97.0
Wind speed at hub height [m/s]	5.6	5.7	5.9
LwA @ 5 m/s (10 m above ground) [dBA]	99.8	100.2	100.9
Wind speed at hub height [m/s]	7.0	7.2	7.4
LwA @ 6 m/s (10 m above ground) [dBA]	103.3	103.6	104.4
Wind speed at hub height [m/s]	8.4	8.6	8.9
LwA @ 7 m/s (10 m above ground) [dBA]	106.5	106.5	106.5
Wind speed at hub height [m/s]	9.8	10.0	10.4
LwA @ 8 m/s (10 m above ground) [dBA]	106.5	106.5	106.5
Wind speed at hub height [m/s]	11.2	11.4	11.9
LwA @ 9 m/s (10 m above ground) [dBA]	106.5	106.5	106.5
Wind speed at hub height [m/s]	12.7	12.9	13.4
LwA @ 10 m/s (10 m above ground) [dBA]	106.5	106.5	106.5
Wind speed at hub height [m/s]	14.1	14.3	14.9
LwA @ 11 m/s (10 m above ground) [dBA]	106.5	106.5	106.5
Wind speed at hub height [m/s]	15.5	15.7	16.3
LwA @ 12 m/s (10 m above ground) [dBA]	106.5	106.5	106.5
Wind speed at hub height [m/s]	16.9	17.2	17.8
LwA @ 13 m/s (10 m above ground) [dBA]	106.5	106.5	106.5
Wind speed at hub height [m/s]	18.3	18.6	19.3

Table 12-6: Noise curve, noise mode 1.

12.3 Mode 2

12.3.1 Power Curves

Wind speed [m/s]	Air density [kg/m ³]													
	1.225	0.95	0.975	1.0	1.025	1.05	1.075	1.1	1.125	1.15	1.175	1.2	1.25	1.275
3	26	11	12	14	15	16	17	19	20	22	23	25	27	29
3.5	73	45	48	50	53	55	58	60	63	65	68	70	75	78
4	132	92	95	99	103	107	110	114	118	121	125	129	136	140
4.5	207	150	155	161	166	171	176	181	187	192	197	202	213	218
5	302	223	230	237	244	251	259	266	273	280	287	294	309	316
5.5	416	311	321	331	340	350	359	369	378	388	397	407	426	435
6	554	418	431	443	455	468	480	492	505	517	529	542	567	579
6.5	717	544	560	575	591	607	622	638	654	669	685	701	732	748
7	905	690	709	729	748	768	788	807	827	846	866	885	925	944
7.5	1121	856	880	904	928	952	976	1000	1024	1048	1072	1096	1145	1169
8	1360	1042	1071	1100	1129	1158	1187	1216	1245	1274	1302	1331	1389	1417
8.5	1614	1242	1276	1310	1344	1378	1412	1446	1479	1513	1547	1581	1648	1681
9	1870	1444	1483	1522	1561	1600	1639	1677	1716	1755	1793	1831	1908	1946
9.5	2111	1641	1684	1728	1772	1816	1859	1902	1945	1988	2029	2070	2149	2188
10	2314	1823	1871	1918	1966	2014	2060	2105	2151	2196	2235	2275	2346	2378
10.5	2456	1991	2042	2092	2143	2194	2237	2279	2322	2365	2395	2425	2478	2500
11	2549	2147	2198	2248	2299	2350	2385	2420	2455	2490	2509	2529	2559	2570
11.5	2590	2296	2339	2383	2427	2470	2494	2517	2540	2563	2572	2581	2594	2598
12	2620	2436	2468	2500	2532	2564	2575	2587	2599	2611	2614	2617	2621	2623
12.5	2658	2558	2578	2598	2617	2637	2641	2646	2650	2654	2656	2657	2658	2659
13	2708	2666	2675	2684	2692	2701	2703	2704	2706	2708	2708	2708	2708	2708
13.5	2767	2748	2752	2756	2761	2765	2765	2766	2766	2767	2767	2767	2767	2767
14	2831	2826	2827	2829	2830	2831	2831	2831	2831	2831	2831	2831	2831	2831
14.5	2894	2893	2893	2894	2894	2894	2894	2894	2894	2894	2894	2894	2894	2894
15	2950	2950	2950	2950	2950	2950	2950	2950	2950	2950	2950	2950	2950	2950
15.5	2991	2991	2991	2991	2991	2991	2991	2991	2991	2991	2991	2991	2991	2991
16	3020	3020	3020	3020	3020	3020	3020	3020	3020	3020	3020	3020	3020	3020
16.5	3041	3041	3041	3041	3041	3041	3041	3041	3041	3041	3041	3041	3041	3041
17	3055	3055	3055	3055	3055	3055	3055	3055	3055	3055	3055	3055	3055	3055
17.5	3067	3067	3067	3067	3067	3067	3067	3067	3067	3067	3067	3067	3067	3067
18	3071	3071	3071	3071	3071	3071	3071	3071	3071	3071	3071	3071	3071	3071
18.5	3073	3073	3073	3073	3073	3073	3073	3073	3073	3073	3073	3073	3073	3073
19	3073	3073	3073	3073	3073	3073	3073	3073	3073	3073	3073	3073	3073	3073
19.5	3074	3074	3074	3074	3074	3074	3074	3074	3074	3074	3074	3074	3074	3074
20	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
20.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
21	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
21.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
22	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
22.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
23	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
23.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
24	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
24.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
25	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075

Table 12-7: Power curve, noise mode 2.

12.3.2 C_t Values, Noise Mode 2

Air density [kg/m ³]														
Wind speed [m/s]	1.225	0.95	0.975	1.0	1.025	1.05	1.075	1.1	1.125	1.15	1.175	1.2	1.25	1.275
3	0.895	0.897	0.896	0.896	0.896	0.896	0.896	0.896	0.895	0.895	0.895	0.895	0.895	0.894
3.5	0.839	0.841	0.840	0.840	0.840	0.840	0.840	0.840	0.840	0.839	0.839	0.839	0.839	0.839
4	0.814	0.815	0.815	0.815	0.815	0.815	0.815	0.815	0.815	0.814	0.814	0.814	0.814	0.814
4.5	0.807	0.809	0.809	0.809	0.809	0.809	0.808	0.808	0.808	0.808	0.808	0.808	0.807	0.807
5	0.805	0.807	0.807	0.807	0.806	0.806	0.806	0.806	0.805	0.805	0.805	0.805	0.804	0.804
5.5	0.804	0.806	0.806	0.806	0.805	0.805	0.805	0.805	0.805	0.805	0.805	0.805	0.804	0.804
6	0.802	0.805	0.805	0.805	0.805	0.804	0.804	0.804	0.803	0.803	0.803	0.802	0.802	0.801
6.5	0.798	0.802	0.802	0.801	0.801	0.800	0.800	0.800	0.799	0.799	0.798	0.798	0.797	0.797
7	0.791	0.796	0.796	0.795	0.795	0.794	0.794	0.793	0.793	0.792	0.792	0.791	0.790	0.790
7.5	0.781	0.787	0.787	0.786	0.786	0.785	0.785	0.784	0.784	0.783	0.783	0.782	0.781	0.780
8	0.765	0.771	0.771	0.770	0.770	0.769	0.769	0.768	0.767	0.767	0.766	0.766	0.764	0.764
8.5	0.736	0.743	0.742	0.742	0.741	0.741	0.740	0.740	0.739	0.738	0.738	0.737	0.736	0.735
9	0.696	0.703	0.702	0.701	0.701	0.700	0.700	0.699	0.699	0.698	0.697	0.697	0.695	0.694
9.5	0.647	0.656	0.656	0.655	0.655	0.654	0.653	0.653	0.652	0.651	0.650	0.648	0.644	0.642
10	0.588	0.608	0.607	0.606	0.606	0.605	0.604	0.602	0.601	0.599	0.596	0.592	0.582	0.576
10.5	0.520	0.560	0.559	0.558	0.557	0.556	0.552	0.548	0.544	0.541	0.534	0.527	0.512	0.503
11	0.450	0.515	0.512	0.510	0.507	0.505	0.498	0.492	0.485	0.478	0.469	0.460	0.441	0.431
11.5	0.387	0.473	0.467	0.462	0.457	0.451	0.443	0.434	0.425	0.416	0.406	0.397	0.378	0.369
12	0.336	0.432	0.424	0.416	0.408	0.400	0.391	0.381	0.371	0.362	0.353	0.344	0.328	0.320
12.5	0.296	0.391	0.382	0.372	0.363	0.354	0.345	0.336	0.327	0.318	0.311	0.303	0.289	0.282
13	0.264	0.353	0.344	0.334	0.325	0.315	0.308	0.300	0.292	0.284	0.277	0.271	0.259	0.253
13.5	0.239	0.319	0.310	0.302	0.293	0.284	0.277	0.270	0.263	0.256	0.251	0.245	0.234	0.229
14	0.218	0.289	0.281	0.274	0.266	0.258	0.252	0.246	0.240	0.234	0.229	0.223	0.214	0.209
14.5	0.200	0.264	0.257	0.250	0.243	0.236	0.230	0.225	0.219	0.214	0.209	0.205	0.196	0.192
15	0.184	0.241	0.235	0.228	0.222	0.216	0.211	0.206	0.201	0.196	0.192	0.188	0.180	0.177
15.5	0.169	0.220	0.214	0.209	0.203	0.198	0.193	0.189	0.185	0.180	0.176	0.173	0.166	0.162
16	0.155	0.201	0.196	0.191	0.186	0.181	0.177	0.173	0.169	0.165	0.162	0.159	0.152	0.149
16.5	0.143	0.184	0.180	0.175	0.171	0.166	0.163	0.159	0.155	0.152	0.149	0.146	0.140	0.137
17	0.131	0.169	0.165	0.161	0.157	0.153	0.149	0.146	0.143	0.140	0.137	0.134	0.129	0.126
17.5	0.121	0.155	0.151	0.148	0.144	0.140	0.137	0.134	0.131	0.128	0.126	0.123	0.119	0.116
18	0.112	0.143	0.139	0.136	0.133	0.129	0.127	0.124	0.121	0.118	0.116	0.114	0.110	0.107
18.5	0.103	0.131	0.128	0.125	0.122	0.119	0.117	0.114	0.112	0.109	0.107	0.105	0.101	0.099
19	0.096	0.122	0.119	0.116	0.113	0.110	0.108	0.106	0.104	0.101	0.100	0.098	0.094	0.092
19.5	0.089	0.113	0.110	0.108	0.105	0.102	0.100	0.098	0.096	0.094	0.092	0.091	0.087	0.086
20	0.083	0.105	0.102	0.100	0.098	0.095	0.093	0.091	0.090	0.088	0.086	0.084	0.081	0.080
20.5	0.077	0.098	0.095	0.093	0.091	0.089	0.087	0.085	0.083	0.082	0.080	0.079	0.076	0.075
21	0.072	0.091	0.089	0.087	0.085	0.083	0.081	0.080	0.078	0.076	0.075	0.074	0.071	0.070
21.5	0.068	0.085	0.083	0.082	0.080	0.078	0.076	0.075	0.073	0.072	0.070	0.069	0.067	0.066
22	0.064	0.080	0.078	0.076	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.065	0.063	0.062
22.5	0.060	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.065	0.063	0.062	0.061	0.059	0.058
23	0.056	0.070	0.069	0.067	0.066	0.064	0.063	0.062	0.061	0.059	0.058	0.057	0.055	0.054
23.5	0.053	0.066	0.065	0.063	0.062	0.061	0.059	0.058	0.057	0.056	0.055	0.054	0.052	0.051
24	0.050	0.062	0.061	0.060	0.059	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.049	0.049
24.5	0.047	0.059	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046
25	0.045	0.056	0.055	0.054	0.052	0.051	0.050	0.049	0.048	0.047	0.047	0.046	0.045	0.044

Table 12-8: C_t values, noise mode 2.

12.3.3 Noise Curve, Noise Mode 2

Sound Power Level at Hub Height, Noise Mode 2			
Conditions for Sound Power Level:	Measurement standard IEC 61400-11 ed. 2 2002 Wind shear: 0.16 Maximum turbulence at 10 metre height: 16% Inflow angle (vertical): 0 ±2° Air density: 1.225 kg/m³		
Hub Height	84 m	94/96 m	119 m
LwA @ 3 m/s (10 m above ground) [dBA]	94.5	94.5	94.7
Wind speed at hub height [m/s]	4.2	4.3	4.5
LwA @ 4 m/s (10 m above ground) [dBA]	97.3	97.5	98.1
Wind speed at hub height [m/s]	5.6	5.7	5.9
LwA @ 5 m/s (10 m above ground) [dBA]	100.9	101.2	101.9
Wind speed at hub height [m/s]	7.0	7.2	7.4
LwA @ 6 m/s (10 m above ground) [dBA]	103.5	103.5	103.7
Wind speed at hub height [m/s]	8.4	8.6	8.9
LwA @ 7 m/s (10 m above ground) [dBA]	104.5	104.5	104.5
Wind speed at hub height [m/s]	9.8	10.0	10.4
LwA @ 8 m/s (10 m above ground) [dBA]	104.5	104.5	104.5
Wind speed at hub height [m/s]	11.2	11.4	11.9
LwA @ 9 m/s (10 m above ground) [dBA]	104.5	104.5	104.5
Wind speed at hub height [m/s]	12.7	12.9	13.4
LwA @ 10 m/s (10 m above ground) [dBA]	104.5	104.5	104.5
Wind speed at hub height [m/s]	14.1	14.3	14.9
LwA @ 11 m/s (10 m above ground) [dBA]	104.5	104.5	104.5
Wind speed at hub height [m/s]	15.5	15.7	16.3
LwA @ 12 m/s (10 m above ground) [dBA]	104.5	104.5	104.5
Wind speed at hub height [m/s]	16.9	17.2	17.8
LwA @ 13 m/s (10 m above ground) [dBA]	104.5	104.5	104.5
Wind speed at hub height [m/s]	18.3	18.6	19.3

Table 12-9: Noise curve, noise mode 2.

12.4 Mode 3

12.4.1 Power Curves, Noise Mode 3

Wind speed [m/s]	Air density [kg/m ³]													
	1.225	0.95	0.975	1.0	1.025	1.05	1.075	1.1	1.125	1.15	1.175	1.2	1.25	1.275
3	26	11	12	14	15	16	17	19	20	22	23	25	27	29
3.5	73	45	48	50	53	55	58	60	63	65	68	70	75	78
4	132	92	95	99	103	107	110	114	118	121	125	129	136	140
4.5	207	150	155	161	166	171	176	181	187	192	197	202	213	218
5	302	223	230	237	244	251	259	266	273	280	287	294	309	316
5.5	416	311	321	331	340	350	359	369	378	388	397	407	426	435
6	554	418	431	443	455	468	480	492	505	517	529	542	567	579
6.5	717	544	560	575	591	607	622	638	654	670	685	701	732	748
7	906	690	710	730	749	769	788	808	827	847	867	886	925	945
7.5	1124	859	883	907	931	955	979	1003	1028	1052	1076	1100	1148	1172
8	1369	1049	1079	1108	1137	1166	1195	1224	1253	1282	1311	1340	1398	1427
8.5	1633	1258	1292	1326	1361	1395	1429	1464	1498	1532	1566	1599	1667	1701
9	1904	1474	1513	1553	1592	1632	1671	1710	1749	1788	1827	1866	1943	1981
9.5	2177	1691	1736	1781	1825	1870	1914	1958	2002	2047	2090	2134	2220	2263
10	2439	1906	1955	2005	2055	2104	2153	2201	2250	2298	2345	2392	2485	2530
10.5	2683	2125	2179	2233	2287	2341	2392	2443	2494	2545	2591	2637	2723	2763
11	2891	2351	2409	2466	2524	2582	2631	2680	2729	2778	2816	2853	2920	2949
11.5	3007	2582	2635	2688	2742	2795	2832	2869	2906	2942	2964	2986	3019	3032
12	3052	2788	2828	2868	2908	2948	2968	2988	3008	3028	3036	3044	3056	3061
12.5	3067	2938	2960	2983	3005	3028	3035	3043	3051	3058	3061	3064	3069	3071
13	3073	3020	3029	3039	3048	3057	3060	3063	3066	3069	3071	3072	3074	3074
13.5	3075	3053	3057	3061	3066	3070	3071	3072	3074	3075	3075	3075	3075	3075
14	3075	3069	3070	3072	3073	3075	3075	3075	3075	3075	3075	3075	3075	3075
14.5	3075	3074	3074	3074	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
15	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
15.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
16	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
16.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
17	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
17.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
18	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
18.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
19	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
19.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
20	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
20.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
21	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
21.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
22	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
22.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
23	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
23.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
24	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
24.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
25	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075

Table 12-10: Power curve, noise mode 3.

12.4.2 C_t Values, Noise Mode 3

Air density kg/m ³														
Wind speed [m/s]	1.225	0.95	0.975	1.0	1.025	1.05	1.075	1.1	1.125	1.15	1.175	1.2	1.25	1.275
3	0.895	0.897	0.896	0.896	0.896	0.896	0.896	0.896	0.895	0.895	0.895	0.895	0.895	0.894
3.5	0.838	0.839	0.839	0.839	0.839	0.839	0.839	0.839	0.838	0.838	0.838	0.838	0.838	0.838
4	0.813	0.814	0.814	0.814	0.814	0.814	0.814	0.814	0.813	0.813	0.813	0.813	0.813	0.813
4.5	0.807	0.809	0.809	0.809	0.809	0.808	0.808	0.808	0.808	0.808	0.808	0.807	0.807	0.807
5	0.804	0.807	0.807	0.807	0.806	0.806	0.806	0.806	0.805	0.805	0.805	0.805	0.804	0.804
5.5	0.804	0.806	0.806	0.806	0.805	0.805	0.805	0.805	0.805	0.805	0.805	0.805	0.804	0.804
6	0.801	0.804	0.804	0.804	0.804	0.803	0.803	0.802	0.802	0.802	0.801	0.801	0.800	0.800
6.5	0.797	0.802	0.801	0.801	0.800	0.800	0.799	0.799	0.798	0.798	0.798	0.797	0.796	0.795
7	0.791	0.797	0.796	0.796	0.796	0.795	0.795	0.794	0.794	0.793	0.792	0.792	0.791	0.790
7.5	0.785	0.792	0.791	0.791	0.790	0.789	0.789	0.788	0.787	0.787	0.786	0.785	0.784	0.783
8	0.772	0.780	0.780	0.779	0.778	0.777	0.777	0.776	0.775	0.775	0.774	0.773	0.771	0.771
8.5	0.748	0.757	0.757	0.756	0.755	0.754	0.753	0.753	0.752	0.751	0.750	0.749	0.747	0.747
9	0.711	0.721	0.720	0.719	0.718	0.717	0.717	0.716	0.715	0.714	0.713	0.712	0.710	0.709
9.5	0.667	0.677	0.676	0.675	0.674	0.673	0.672	0.672	0.671	0.670	0.669	0.668	0.666	0.665
10	0.620	0.631	0.630	0.630	0.629	0.628	0.627	0.626	0.625	0.624	0.623	0.621	0.618	0.617
10.5	0.572	0.591	0.589	0.588	0.587	0.586	0.585	0.583	0.582	0.580	0.577	0.575	0.568	0.565
11	0.522	0.556	0.554	0.553	0.551	0.550	0.547	0.544	0.540	0.537	0.532	0.527	0.515	0.509
11.5	0.462	0.525	0.521	0.518	0.514	0.511	0.505	0.499	0.492	0.486	0.478	0.470	0.453	0.444
12	0.402	0.491	0.485	0.478	0.471	0.465	0.456	0.447	0.438	0.430	0.420	0.411	0.393	0.385
12.5	0.350	0.450	0.441	0.432	0.423	0.413	0.404	0.394	0.385	0.375	0.366	0.358	0.342	0.334
13	0.306	0.404	0.394	0.384	0.373	0.363	0.354	0.346	0.337	0.328	0.321	0.314	0.300	0.293
13.5	0.271	0.359	0.349	0.340	0.330	0.321	0.313	0.306	0.298	0.290	0.284	0.277	0.265	0.259
14	0.240	0.318	0.310	0.301	0.293	0.284	0.277	0.271	0.264	0.257	0.252	0.246	0.235	0.231
14.5	0.215	0.283	0.275	0.268	0.261	0.253	0.247	0.241	0.236	0.230	0.225	0.220	0.211	0.206
15	0.193	0.253	0.246	0.240	0.233	0.227	0.222	0.216	0.211	0.206	0.202	0.198	0.189	0.186
15.5	0.175	0.227	0.222	0.216	0.210	0.204	0.200	0.195	0.191	0.186	0.182	0.178	0.171	0.168
16	0.159	0.205	0.200	0.195	0.190	0.185	0.181	0.177	0.173	0.169	0.165	0.162	0.156	0.152
16.5	0.145	0.187	0.182	0.177	0.173	0.168	0.165	0.161	0.157	0.154	0.151	0.148	0.142	0.139
17	0.132	0.170	0.166	0.162	0.158	0.154	0.150	0.147	0.144	0.141	0.138	0.135	0.130	0.127
17.5	0.121	0.156	0.152	0.148	0.144	0.141	0.138	0.135	0.132	0.129	0.126	0.124	0.119	0.117
18	0.112	0.143	0.139	0.136	0.133	0.129	0.127	0.124	0.121	0.119	0.116	0.114	0.110	0.108
18.5	0.103	0.132	0.129	0.125	0.122	0.119	0.117	0.114	0.112	0.109	0.107	0.105	0.101	0.100
19	0.096	0.122	0.119	0.116	0.113	0.111	0.108	0.106	0.104	0.101	0.100	0.098	0.094	0.092
19.5	0.089	0.113	0.110	0.108	0.105	0.103	0.100	0.098	0.096	0.094	0.092	0.091	0.087	0.086
20	0.083	0.105	0.102	0.100	0.098	0.095	0.093	0.091	0.090	0.088	0.086	0.084	0.081	0.080
20.5	0.077	0.098	0.095	0.093	0.091	0.089	0.087	0.085	0.083	0.082	0.080	0.079	0.076	0.075
21	0.072	0.091	0.089	0.087	0.085	0.083	0.081	0.080	0.078	0.076	0.075	0.074	0.071	0.070
21.5	0.068	0.085	0.083	0.082	0.080	0.078	0.076	0.075	0.073	0.072	0.070	0.069	0.067	0.066
22	0.064	0.080	0.078	0.076	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.065	0.063	0.062
22.5	0.060	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.065	0.063	0.062	0.061	0.059	0.058
23	0.056	0.070	0.069	0.067	0.066	0.064	0.063	0.062	0.061	0.059	0.058	0.057	0.055	0.054
23.5	0.053	0.066	0.065	0.063	0.062	0.061	0.059	0.058	0.057	0.056	0.055	0.054	0.052	0.051
24	0.050	0.062	0.061	0.060	0.059	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.049	0.049
24.5	0.047	0.059	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046
25	0.045	0.056	0.055	0.054	0.052	0.051	0.050	0.049	0.048	0.047	0.047	0.046	0.045	0.044

Table 12-11: C_t values, noise mode 3.

12.4.3 Noise Curve, Noise Mode 3

Sound Power Level at Hub Height, Noise Mode 3			
Conditions for Sound Power Level:	Measurement standard IEC 61400-11 ed. 2 2002 Wind shear: 0.16 Maximum turbulence at 10 metre height: 16% Inflow angle (vertical): 0 ±2° Air density: 1.225 kg/m ³		
Hub Height	84 m	94/96 m	119 m
LwA @ 3 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	94.5 4.2	94.5 4.3	94.7 4.5
LwA @ 4 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	97.3 5.6	97.5 5.7	98.1 5.9
LwA @ 5 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	100.9 7.0	101.2 7.2	101.9 7.4
LwA @ 6 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	104.3 8.4	104.6 8.6	105.1 8.9
LwA @ 7 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	105.5 9.8	105.5 10.0	105.5 10.4
LwA @ 8 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	105.5 11.2	105.5 11.4	105.5 11.9
LwA @ 9 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	105.5 12.7	105.5 12.9	105.5 13.4
LwA @ 10 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	105.5 14.1	105.5 14.3	105.5 14.9
LwA @ 11 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	105.5 15.5	105.5 15.7	105.5 16.3
LwA @ 12 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	105.5 16.9	105.5 17.2	105.5 17.8
LwA @ 13 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	105.5 18.3	105.5 18.6	105.5 19.3

Table 12-12: Noise curve, noise mode 3

12.5 Mode 4

12.5.1 Power Curves, Noise Mode 4

Wind speed [m/s]	Air density [kg/m ³]													
	1.225	0.95	0.975	1.0	1.025	1.05	1.075	1.1	1.125	1.15	1.175	1.2	1.25	1.275
3	26	11	12	13	15	16	17	19	20	22	23	25	27	29
3.5	72	44	47	49	52	54	57	59	62	64	67	69	74	76
4	127	88	91	95	98	102	106	109	113	116	120	124	131	134
4.5	192	138	143	148	153	158	163	168	172	177	182	187	197	201
5	272	200	207	213	220	226	233	239	246	252	259	265	278	285
5.5	375	280	289	298	306	315	323	332	341	349	358	366	384	392
6	507	383	394	405	416	428	439	450	462	473	484	495	518	529
6.5	666	505	520	535	549	564	578	593	607	622	637	651	680	695
7	853	650	668	687	705	724	742	761	779	798	816	834	871	890
7.5	1065	815	838	861	884	906	929	952	974	997	1020	1043	1088	1111
8	1310	1005	1032	1060	1088	1116	1144	1171	1199	1227	1254	1282	1337	1365
8.5	1584	1220	1253	1286	1320	1353	1386	1419	1452	1485	1518	1551	1617	1649
9	1884	1456	1495	1534	1574	1613	1652	1690	1729	1768	1807	1845	1922	1960
9.5	2204	1712	1757	1802	1848	1893	1938	1983	2028	2072	2116	2160	2246	2288
10	2511	1971	2022	2074	2125	2177	2227	2276	2326	2375	2420	2465	2550	2589
10.5	2758	2229	2285	2341	2397	2453	2502	2551	2600	2649	2685	2722	2785	2813
11	2939	2480	2536	2593	2649	2706	2747	2788	2829	2871	2893	2916	2951	2963
11.5	3014	2709	2756	2803	2850	2897	2920	2943	2966	2989	2997	3006	3018	3022
12	3048	2887	2916	2945	2974	3003	3012	3021	3030	3039	3042	3045	3049	3050
12.5	3063	2997	3009	3021	3034	3046	3050	3053	3056	3060	3061	3062	3063	3063
13	3070	3044	3049	3054	3059	3064	3065	3067	3068	3069	3069	3069	3070	3070
13.5	3074	3064	3066	3068	3070	3073	3073	3073	3074	3074	3074	3074	3074	3074
14	3075	3072	3073	3073	3074	3075	3075	3075	3075	3075	3075	3075	3075	3075
14.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
15	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
15.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
16	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
16.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
17	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
17.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
18	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
18.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
19	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
19.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
20	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
20.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
21	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
21.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
22	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
22.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
23	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
23.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
24	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
24.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
25	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075

Table 12-13: Power curve, noise mode 4.

12.5.2 C_t Values, Noise Mode 4

Air density [kg/m ³]														
Wind speed [m/s]	1.225	0.95	0.975	1.0	1.025	1.05	1.075	1.1	1.125	1.15	1.175	1.2	1.25	1.275
3	0.861	0.863	0.862	0.862	0.862	0.862	0.862	0.861	0.861	0.861	0.861	0.861	0.860	0.860
3.5	0.777	0.778	0.778	0.778	0.778	0.778	0.778	0.777	0.777	0.777	0.777	0.777	0.777	0.776
4	0.712	0.713	0.713	0.713	0.713	0.713	0.713	0.712	0.712	0.712	0.712	0.712	0.712	0.711
4.5	0.661	0.662	0.662	0.662	0.661	0.661	0.661	0.661	0.661	0.661	0.661	0.661	0.660	0.660
5	0.633	0.634	0.634	0.634	0.634	0.633	0.633	0.633	0.633	0.633	0.633	0.633	0.633	0.633
5.5	0.630	0.631	0.631	0.631	0.631	0.631	0.630	0.630	0.630	0.630	0.630	0.630	0.630	0.631
6	0.642	0.643	0.643	0.643	0.643	0.643	0.643	0.643	0.642	0.642	0.642	0.642	0.642	0.641
6.5	0.656	0.658	0.658	0.658	0.658	0.658	0.657	0.657	0.657	0.657	0.656	0.656	0.656	0.656
7	0.667	0.671	0.670	0.670	0.670	0.670	0.669	0.669	0.669	0.669	0.668	0.668	0.667	0.667
7.5	0.675	0.679	0.679	0.679	0.678	0.678	0.678	0.677	0.677	0.676	0.676	0.675	0.675	0.674
8	0.683	0.688	0.688	0.687	0.687	0.687	0.686	0.686	0.685	0.685	0.684	0.684	0.683	0.682
8.5	0.690	0.696	0.696	0.695	0.695	0.694	0.693	0.693	0.692	0.692	0.691	0.691	0.689	0.689
9	0.691	0.698	0.698	0.697	0.697	0.696	0.695	0.695	0.694	0.693	0.693	0.692	0.690	0.690
9.5	0.682	0.691	0.691	0.690	0.689	0.689	0.688	0.687	0.686	0.685	0.684	0.683	0.680	0.678
10	0.656	0.674	0.673	0.672	0.671	0.670	0.669	0.667	0.666	0.665	0.662	0.659	0.651	0.646
10.5	0.605	0.646	0.645	0.643	0.642	0.640	0.637	0.633	0.630	0.626	0.619	0.612	0.596	0.587
11	0.540	0.613	0.610	0.607	0.604	0.601	0.594	0.587	0.580	0.573	0.562	0.551	0.528	0.516
11.5	0.466	0.572	0.566	0.559	0.553	0.546	0.535	0.524	0.513	0.502	0.490	0.478	0.455	0.444
12	0.402	0.523	0.513	0.502	0.492	0.481	0.469	0.458	0.446	0.434	0.423	0.412	0.392	0.383
12.5	0.349	0.467	0.455	0.443	0.431	0.419	0.408	0.397	0.387	0.376	0.367	0.358	0.341	0.333
13	0.306	0.410	0.399	0.388	0.376	0.365	0.356	0.347	0.338	0.328	0.321	0.313	0.299	0.292
13.5	0.271	0.361	0.351	0.341	0.331	0.322	0.314	0.306	0.298	0.290	0.283	0.277	0.265	0.259
14	0.240	0.319	0.310	0.301	0.293	0.284	0.277	0.271	0.264	0.257	0.252	0.246	0.235	0.231
14.5	0.215	0.283	0.276	0.268	0.261	0.253	0.247	0.241	0.236	0.230	0.225	0.220	0.211	0.206
15	0.193	0.253	0.246	0.240	0.233	0.227	0.222	0.216	0.211	0.206	0.202	0.198	0.189	0.186
15.5	0.175	0.227	0.222	0.216	0.210	0.204	0.200	0.195	0.191	0.186	0.182	0.178	0.171	0.168
16	0.159	0.205	0.200	0.195	0.190	0.185	0.181	0.177	0.173	0.169	0.165	0.162	0.156	0.152
16.5	0.145	0.187	0.182	0.177	0.173	0.168	0.165	0.161	0.157	0.154	0.151	0.148	0.142	0.139
17	0.132	0.170	0.166	0.162	0.158	0.154	0.150	0.147	0.144	0.141	0.138	0.135	0.130	0.127
17.5	0.121	0.156	0.152	0.148	0.144	0.141	0.138	0.135	0.132	0.129	0.126	0.124	0.119	0.117
18	0.112	0.143	0.139	0.136	0.133	0.129	0.127	0.124	0.121	0.119	0.116	0.114	0.110	0.108
18.5	0.103	0.132	0.129	0.125	0.122	0.119	0.117	0.114	0.112	0.109	0.107	0.105	0.101	0.100
19	0.096	0.122	0.119	0.116	0.113	0.111	0.108	0.106	0.104	0.101	0.100	0.098	0.094	0.092
19.5	0.089	0.113	0.110	0.108	0.105	0.103	0.100	0.098	0.096	0.094	0.092	0.091	0.087	0.086
20	0.083	0.105	0.102	0.100	0.098	0.095	0.093	0.091	0.090	0.088	0.086	0.084	0.081	0.080
20.5	0.077	0.098	0.095	0.093	0.091	0.089	0.087	0.085	0.083	0.082	0.080	0.079	0.076	0.075
21	0.072	0.091	0.089	0.087	0.085	0.083	0.081	0.080	0.078	0.076	0.075	0.074	0.071	0.070
21.5	0.068	0.085	0.083	0.082	0.080	0.078	0.076	0.075	0.073	0.072	0.070	0.069	0.067	0.066
22	0.064	0.080	0.078	0.076	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.065	0.063	0.062
22.5	0.060	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.065	0.063	0.062	0.061	0.059	0.058
23	0.056	0.070	0.069	0.067	0.066	0.064	0.063	0.062	0.061	0.059	0.058	0.057	0.055	0.054
23.5	0.053	0.066	0.065	0.063	0.062	0.061	0.059	0.058	0.057	0.056	0.055	0.054	0.052	0.051
24	0.050	0.062	0.061	0.060	0.059	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.049	0.049
24.5	0.047	0.059	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046
25	0.045	0.056	0.055	0.054	0.052	0.051	0.050	0.049	0.048	0.047	0.047	0.046	0.045	0.044

Table 12-14: C_t values, noise mode 4.

12.5.3 Noise Curve, Noise Mode 4

Sound Power Level at Hub Height, Noise Mode 4			
Conditions for Sound Power Level:	Measurement standard IEC 61400-11 ed. 2 2002 Wind shear: 0.16 Maximum turbulence at 10 metre height: 16% Inflow angle (vertical): 0 ±2° Air density: 1.225 kg/m³		
Hub Height	84 m	94/96 m	119 m
LwA @ 3 m/s (10 m above ground) [dBA]	94.1	94.1	94.2
Wind speed at hub height [m/s]	4.2	4.3	4.5
LwA @ 4 m/s (10 m above ground) [dBA]	95.4	95.5	96.0
Wind speed at hub height [m/s]	5.6	5.7	5.9
LwA @ 5 m/s (10 m above ground) [dBA]	98.8	99.2	99.9
Wind speed at hub height [m/s]	7.0	7.2	7.4
LwA @ 6 m/s (10 m above ground) [dBA]	102.3	102.6	103.3
Wind speed at hub height [m/s]	8.4	8.6	8.9
LwA @ 7 m/s (10 m above ground) [dBA]	105.0	105.4	105.9
Wind speed at hub height [m/s]	9.8	10.0	10.4
LwA @ 8 m/s (10 m above ground) [dBA]	106.5	106.5	106.5
Wind speed at hub height [m/s]	11.2	11.4	11.9
LwA @ 9 m/s (10 m above ground) [dBA]	106.5	106.5	106.5
Wind speed at hub height [m/s]	12.7	12.9	13.4
LwA @ 10 m/s (10 m above ground) [dBA]	106.5	106.5	106.5
Wind speed at hub height [m/s]	14.1	14.3	14.9
LwA @ 11 m/s (10 m above ground) [dBA]	106.5	106.5	106.5
Wind speed at hub height [m/s]	15.5	15.7	16.3
LwA @ 12 m/s (10 m above ground) [dBA]	106.5	106.5	106.5
Wind speed at hub height [m/s]	16.9	17.2	17.8
LwA @ 13 m/s (10 m above ground) [dBA]	106.5	106.5	106.5
Wind speed at hub height [m/s]	18.3	18.6	19.3

Table 12-15: Noise curve, noise mode 4.

12.6 Mode 5

12.6.1 Power Curves, Noise Mode 5

Wind speed [m/s]	Air density [kg/m ³]													
	1.225	0.95	0.975	1.0	1.025	1.05	1.075	1.1	1.125	1.15	1.175	1.2	1.25	1.275
3	26	11	12	14	15	16	17	19	20	22	23	25	27	29
3.5	73	45	48	50	53	55	58	60	63	65	68	70	75	78
4	132	92	95	99	103	107	110	114	118	121	125	129	136	140
4.5	207	150	155	161	166	171	176	181	187	192	197	202	213	218
5	302	223	230	237	244	251	259	266	273	280	287	294	309	316
5.5	416	311	321	331	340	350	359	369	378	388	397	407	426	435
6	554	418	431	443	455	468	480	492	505	517	529	542	567	579
6.5	716	544	559	575	591	606	622	638	654	669	685	701	732	748
7	903	689	708	728	747	767	786	806	825	845	864	884	923	943
7.5	1114	851	875	899	923	946	970	994	1018	1042	1066	1090	1137	1161
8	1340	1027	1056	1084	1113	1141	1169	1198	1226	1255	1283	1311	1368	1396
8.5	1570	1208	1241	1274	1307	1341	1373	1406	1439	1472	1505	1537	1602	1635
9	1794	1385	1422	1460	1497	1535	1572	1609	1646	1683	1720	1757	1830	1867
9.5	2005	1555	1597	1638	1680	1721	1762	1804	1845	1886	1926	1965	2044	2083
10	2194	1714	1759	1805	1850	1895	1939	1983	2027	2071	2112	2153	2231	2267
10.5	2349	1864	1912	1961	2009	2058	2102	2147	2192	2237	2274	2311	2377	2405
11	2459	2004	2054	2105	2155	2205	2247	2288	2330	2372	2401	2430	2477	2495
11.5	2524	2139	2188	2237	2286	2335	2369	2403	2438	2472	2489	2507	2532	2540
12	2558	2266	2309	2353	2396	2439	2463	2486	2509	2533	2541	2550	2562	2565
12.5	2577	2378	2412	2446	2480	2514	2527	2540	2553	2565	2569	2573	2578	2580
13	2587	2468	2490	2513	2535	2557	2564	2570	2576	2582	2584	2585	2587	2587
13.5	2592	2523	2537	2550	2564	2578	2581	2584	2587	2590	2591	2591	2592	2592
14	2594	2559	2567	2574	2581	2589	2590	2591	2593	2594	2594	2594	2594	2594
14.5	2595	2579	2583	2586	2590	2594	2594	2594	2595	2595	2595	2595	2595	2595
15	2595	2588	2590	2591	2593	2594	2595	2595	2595	2595	2595	2595	2595	2595
15.5	2596	2592	2593	2594	2594	2595	2595	2595	2596	2596	2596	2596	2596	2596
16	2596	2595	2595	2595	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596
16.5	2596	2595	2595	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596
17	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596
17.5	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596
18	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596
18.5	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596
19	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596
19.5	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596
20	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596
20.5	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596
21	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596
21.5	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596
22	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596
22.5	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596
23	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596
23.5	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596
24	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596
24.5	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596
25	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596

Table 12-16: Power curve, noise mode 5.

12.6.2 C_t Values, Noise Mode 5

Air density [kg/m ³]														
Wind speed [m/s]	1.225	0.95	0.975	1.0	1.025	1.05	1.075	1.1	1.125	1.15	1.175	1.2	1.25	1.275
3	0.895	0.897	0.896	0.896	0.896	0.896	0.896	0.896	0.895	0.895	0.895	0.895	0.895	0.894
3.5	0.838	0.839	0.839	0.839	0.839	0.839	0.839	0.839	0.838	0.838	0.838	0.838	0.838	0.838
4	0.813	0.814	0.814	0.814	0.814	0.814	0.814	0.814	0.813	0.813	0.813	0.813	0.813	0.813
4.5	0.807	0.809	0.809	0.809	0.809	0.808	0.808	0.808	0.808	0.808	0.808	0.807	0.807	0.807
5	0.804	0.807	0.807	0.807	0.806	0.806	0.806	0.806	0.805	0.805	0.805	0.805	0.804	0.804
5.5	0.804	0.806	0.806	0.806	0.805	0.805	0.805	0.805	0.805	0.805	0.805	0.805	0.804	0.804
6	0.802	0.805	0.805	0.805	0.804	0.804	0.804	0.803	0.803	0.803	0.802	0.802	0.801	0.801
6.5	0.796	0.801	0.800	0.800	0.799	0.799	0.799	0.798	0.798	0.797	0.797	0.797	0.796	0.795
7	0.784	0.789	0.789	0.789	0.788	0.788	0.787	0.787	0.786	0.786	0.785	0.785	0.784	0.783
7.5	0.764	0.769	0.769	0.768	0.768	0.767	0.767	0.766	0.766	0.765	0.765	0.764	0.763	0.762
8	0.731	0.737	0.736	0.736	0.735	0.735	0.734	0.734	0.733	0.733	0.732	0.732	0.731	0.730
8.5	0.689	0.695	0.694	0.694	0.693	0.693	0.692	0.692	0.691	0.691	0.690	0.690	0.689	0.688
9	0.641	0.646	0.645	0.645	0.645	0.644	0.644	0.643	0.643	0.642	0.642	0.641	0.640	0.639
9.5	0.590	0.596	0.595	0.595	0.595	0.594	0.594	0.593	0.593	0.592	0.591	0.591	0.589	0.587
10	0.538	0.547	0.546	0.546	0.545	0.545	0.544	0.544	0.543	0.542	0.541	0.539	0.535	0.532
10.5	0.483	0.501	0.500	0.500	0.499	0.499	0.497	0.496	0.495	0.493	0.490	0.487	0.478	0.473
11	0.427	0.459	0.458	0.457	0.456	0.455	0.452	0.449	0.446	0.443	0.438	0.433	0.420	0.413
11.5	0.374	0.420	0.418	0.416	0.415	0.413	0.408	0.404	0.399	0.395	0.388	0.381	0.366	0.359
12	0.327	0.385	0.382	0.379	0.376	0.372	0.366	0.360	0.354	0.348	0.341	0.334	0.319	0.312
12.5	0.286	0.353	0.348	0.343	0.339	0.334	0.327	0.320	0.313	0.307	0.300	0.293	0.280	0.274
13	0.252	0.322	0.316	0.310	0.304	0.298	0.291	0.284	0.277	0.271	0.264	0.258	0.247	0.241
13.5	0.224	0.291	0.284	0.278	0.271	0.265	0.259	0.252	0.246	0.240	0.235	0.229	0.219	0.215
14	0.200	0.262	0.255	0.249	0.243	0.236	0.231	0.225	0.220	0.214	0.209	0.205	0.196	0.192
14.5	0.179	0.235	0.229	0.223	0.217	0.211	0.206	0.201	0.197	0.192	0.187	0.183	0.176	0.172
15	0.161	0.212	0.206	0.201	0.195	0.190	0.185	0.181	0.177	0.172	0.169	0.165	0.158	0.155
15.5	0.146	0.191	0.186	0.181	0.176	0.171	0.168	0.164	0.160	0.156	0.153	0.149	0.143	0.140
16	0.133	0.173	0.169	0.164	0.160	0.155	0.152	0.149	0.145	0.142	0.139	0.136	0.130	0.128
16.5	0.121	0.157	0.153	0.149	0.146	0.142	0.138	0.135	0.132	0.129	0.126	0.124	0.119	0.117
17	0.111	0.144	0.140	0.137	0.133	0.129	0.127	0.124	0.121	0.118	0.116	0.113	0.109	0.107
17.5	0.102	0.131	0.128	0.125	0.122	0.119	0.116	0.113	0.111	0.108	0.106	0.104	0.100	0.098
18	0.094	0.121	0.118	0.115	0.112	0.109	0.107	0.104	0.102	0.100	0.098	0.096	0.092	0.090
18.5	0.087	0.111	0.109	0.106	0.103	0.101	0.099	0.096	0.094	0.092	0.090	0.089	0.085	0.084
19	0.080	0.103	0.101	0.098	0.096	0.093	0.091	0.089	0.087	0.085	0.084	0.082	0.079	0.078
19.5	0.075	0.095	0.093	0.091	0.089	0.087	0.085	0.083	0.081	0.079	0.078	0.076	0.073	0.072
20	0.070	0.089	0.087	0.085	0.082	0.080	0.079	0.077	0.075	0.074	0.072	0.071	0.068	0.067
20.5	0.065	0.083	0.081	0.079	0.077	0.075	0.073	0.072	0.070	0.069	0.068	0.066	0.064	0.063
21	0.061	0.077	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.064	0.063	0.062	0.060	0.059
21.5	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
22	0.054	0.068	0.066	0.065	0.063	0.062	0.060	0.059	0.058	0.057	0.056	0.055	0.053	0.052
22.5	0.050	0.063	0.062	0.061	0.059	0.058	0.057	0.056	0.054	0.053	0.052	0.051	0.049	0.049
23	0.047	0.060	0.058	0.057	0.056	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046
23.5	0.045	0.056	0.055	0.054	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043
24	0.042	0.053	0.052	0.051	0.049	0.048	0.047	0.046	0.045	0.044	0.043	0.042	0.041	0.041
24.5	0.040	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043	0.042	0.041	0.041	0.039	0.039
25	0.038	0.047	0.046	0.045	0.044	0.043	0.042	0.041	0.041	0.040	0.039	0.038	0.037	0.037

Table 12-17: C_t values, noise mode 5.

12.6.3 Noise Curve, Noise Mode 5

Sound Power Level at Hub Height, Noise Mode 5			
Conditions for Sound Power Level:	Measurement standard IEC 61400-11 ed. 2 2002 Wind shear: 0.16 Maximum turbulence at 10 metre height: 16% Inflow angle (vertical): 0 ±2° Air density: 1.225 kg/m³		
Hub Height	84 m	94/96 m	119 m
LwA @ 3 m/s (10 m above ground) [dBA]	94.5	94.5	94.7
Wind speed at hub height [m/s]	4.2	4.3	4.5
LwA @ 4 m/s (10 m above ground) [dBA]	97.3	97.5	98.1
Wind speed at hub height [m/s]	5.6	5.7	5.9
LwA @ 5 m/s (10 m above ground) [dBA]	100.9	101.2	101.9
Wind speed at hub height [m/s]	7.0	7.2	7.4
LwA @ 6 m/s (10 m above ground) [dBA]	102.5	102.5	102.5
Wind speed at hub height [m/s]	8.4	8.6	8.9
LwA @ 7 m/s (10 m above ground) [dBA]	102.5	102.5	102.5
Wind speed at hub height [m/s]	9.8	10.0	10.4
LwA @ 8 m/s (10 m above ground) [dBA]	102.5	102.5	102.5
Wind speed at hub height [m/s]	11.2	11.4	11.9
LwA @ 9 m/s (10 m above ground) [dBA]	102.5	102.5	102.5
Wind speed at hub height [m/s]	12.7	12.9	13.4
LwA @ 10 m/s (10 m above ground) [dBA]	102.5	102.5	102.5
Wind speed at hub height [m/s]	14.1	14.3	14.9
LwA @ 11 m/s (10 m above ground) [dBA]	102.5	102.5	102.5
Wind speed at hub height [m/s]	15.5	15.7	16.3
LwA @ 12 m/s (10 m above ground) [dBA]	102.5	102.5	102.5
Wind speed at hub height [m/s]	16.9	17.2	17.8
LwA @ 13 m/s (10 m above ground) [dBA]	102.5	102.5	102.5
Wind speed at hub height [m/s]	18.3	18.6	19.3

Table 12-18: Noise curve, noise mode 5.

12.7 Mode 6

12.7.1 Power Curves, Noise Mode 6

Wind speed [m/s]	Air density [kg/m ³]													
	1.225	0.95	0.975	1.0	1.025	1.05	1.075	1.1	1.125	1.15	1.175	1.2	1.25	1.275
3	26	11	12	14	15	16	17	19	20	22	23	25	27	29
3.5	73	45	48	50	53	55	58	60	63	65	68	70	75	78
4	132	92	95	99	103	107	110	114	118	121	125	129	136	140
4.5	207	150	155	161	166	171	176	181	187	192	197	202	213	218
5	302	223	230	237	244	251	259	266	273	280	287	294	309	316
5.5	416	311	321	330	340	350	359	369	378	388	397	407	426	435
6	553	417	430	442	455	467	479	492	504	516	529	541	566	578
6.5	713	541	557	572	588	603	619	635	650	666	682	697	729	744
7	893	681	700	719	739	758	777	797	816	835	855	874	913	932
7.5	1088	832	855	879	902	925	948	971	994	1017	1041	1064	1111	1134
8	1284	985	1012	1039	1067	1094	1121	1148	1175	1203	1230	1257	1311	1338
8.5	1471	1132	1163	1194	1225	1256	1287	1318	1348	1379	1410	1441	1502	1532
9	1646	1269	1304	1338	1373	1407	1441	1476	1510	1544	1578	1612	1680	1713
9.5	1810	1401	1439	1476	1514	1552	1589	1626	1664	1701	1737	1774	1846	1882
10	1958	1525	1565	1606	1646	1687	1727	1767	1806	1846	1884	1921	1993	2028
10.5	2089	1643	1687	1730	1773	1817	1857	1898	1938	1979	2016	2052	2121	2152
11	2191	1756	1801	1845	1890	1934	1973	2013	2052	2091	2124	2158	2217	2244
11.5	2276	1868	1912	1957	2001	2045	2083	2120	2158	2195	2222	2249	2291	2307
12	2330	1975	2019	2063	2107	2151	2183	2215	2247	2279	2296	2313	2337	2345
12.5	2361	2081	2121	2162	2202	2243	2266	2289	2312	2335	2344	2352	2365	2370
13	2381	2180	2213	2246	2279	2312	2326	2340	2354	2368	2372	2377	2383	2385
13.5	2396	2265	2288	2311	2333	2356	2364	2373	2381	2389	2391	2393	2396	2397
14	2409	2331	2345	2360	2374	2389	2393	2398	2402	2407	2407	2408	2409	2409
14.5	2424	2380	2389	2398	2407	2416	2418	2419	2421	2423	2423	2424	2424	2424
15	2443	2418	2423	2428	2433	2439	2439	2440	2441	2442	2442	2443	2443	2443
15.5	2465	2452	2455	2458	2460	2463	2463	2464	2464	2464	2464	2464	2465	2465
16	2487	2481	2483	2484	2485	2486	2486	2486	2487	2487	2487	2487	2487	2487
16.5	2508	2506	2507	2507	2508	2508	2508	2508	2508	2508	2508	2508	2508	2508
17	2528	2528	2528	2528	2528	2528	2528	2528	2528	2528	2528	2528	2528	2528
17.5	2547	2547	2547	2547	2547	2547	2547	2547	2547	2547	2547	2547	2547	2547
18	2561	2561	2561	2561	2561	2561	2561	2561	2561	2561	2561	2561	2561	2561
18.5	2573	2572	2572	2572	2572	2572	2572	2572	2572	2572	2572	2572	2573	2573
19	2580	2580	2580	2580	2580	2580	2580	2580	2580	2580	2580	2580	2580	2580
19.5	2585	2585	2585	2585	2585	2585	2585	2585	2585	2585	2585	2585	2585	2585
20	2589	2589	2589	2589	2589	2589	2589	2589	2589	2589	2589	2589	2589	2589
20.5	2592	2592	2592	2592	2592	2592	2592	2592	2592	2592	2592	2592	2592	2592
21	2593	2593	2593	2593	2593	2593	2593	2593	2593	2593	2593	2593	2593	2593
21.5	2594	2594	2594	2594	2594	2594	2594	2594	2594	2594	2594	2594	2594	2594
22	2595	2595	2595	2595	2595	2595	2595	2595	2595	2595	2595	2595	2595	2595
22.5	2595	2595	2595	2595	2595	2595	2595	2595	2595	2595	2595	2595	2595	2595
23	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596
23.5	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596
24	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596
24.5	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596
25	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596	2596

Table 12-19: Power curve, noise mode 6.

12.7.2 C_t Values, Noise Mode 6

Air density [kg/m ³]														
Wind speed [m/s]	1.225	0.95	0.975	1.0	1.025	1.05	1.075	1.1	1.125	1.15	1.175	1.2	1.25	1.275
3	0.895	0.897	0.896	0.896	0.896	0.896	0.896	0.896	0.895	0.895	0.895	0.895	0.895	0.894
3.5	0.838	0.839	0.839	0.839	0.839	0.839	0.839	0.839	0.838	0.838	0.838	0.838	0.838	0.838
4	0.813	0.814	0.814	0.814	0.814	0.814	0.814	0.814	0.813	0.813	0.813	0.813	0.813	0.813
4.5	0.807	0.809	0.809	0.809	0.809	0.808	0.808	0.808	0.808	0.808	0.808	0.807	0.807	0.807
5	0.804	0.807	0.807	0.807	0.806	0.806	0.806	0.806	0.805	0.805	0.805	0.805	0.804	0.804
5.5	0.803	0.805	0.804	0.804	0.804	0.803	0.803	0.803	0.803	0.803	0.803	0.803	0.802	0.802
6	0.794	0.797	0.797	0.797	0.796	0.796	0.796	0.796	0.795	0.795	0.794	0.794	0.793	0.793
6.5	0.778	0.782	0.782	0.781	0.781	0.781	0.780	0.780	0.779	0.779	0.779	0.778	0.777	0.777
7	0.753	0.758	0.757	0.757	0.757	0.756	0.756	0.755	0.755	0.755	0.754	0.754	0.753	0.752
7.5	0.719	0.723	0.723	0.723	0.722	0.722	0.721	0.721	0.721	0.720	0.720	0.719	0.718	0.718
8	0.672	0.676	0.676	0.676	0.675	0.675	0.675	0.674	0.674	0.673	0.673	0.673	0.672	0.671
8.5	0.619	0.622	0.622	0.622	0.622	0.621	0.621	0.620	0.620	0.620	0.619	0.619	0.618	0.618
9	0.564	0.568	0.568	0.567	0.567	0.567	0.566	0.566	0.566	0.565	0.565	0.565	0.564	0.564
9.5	0.514	0.518	0.518	0.517	0.517	0.517	0.516	0.516	0.516	0.515	0.515	0.514	0.513	0.513
10	0.466	0.472	0.472	0.472	0.471	0.471	0.471	0.470	0.470	0.469	0.468	0.467	0.464	0.463
10.5	0.421	0.431	0.431	0.430	0.430	0.430	0.429	0.428	0.427	0.426	0.424	0.423	0.418	0.414
11	0.375	0.394	0.394	0.393	0.392	0.392	0.390	0.388	0.386	0.384	0.381	0.378	0.371	0.367
11.5	0.334	0.362	0.360	0.359	0.358	0.356	0.354	0.351	0.349	0.346	0.342	0.338	0.328	0.323
12	0.296	0.332	0.330	0.328	0.327	0.325	0.321	0.318	0.314	0.311	0.306	0.301	0.290	0.284
12.5	0.261	0.306	0.303	0.301	0.298	0.296	0.291	0.287	0.282	0.278	0.272	0.267	0.256	0.251
13	0.232	0.282	0.279	0.275	0.272	0.268	0.263	0.258	0.253	0.248	0.242	0.237	0.227	0.222
13.5	0.207	0.260	0.255	0.251	0.246	0.242	0.237	0.232	0.226	0.221	0.217	0.212	0.203	0.198
14	0.185	0.238	0.233	0.228	0.223	0.218	0.213	0.208	0.203	0.198	0.194	0.190	0.182	0.178
14.5	0.167	0.217	0.212	0.207	0.202	0.197	0.193	0.188	0.183	0.179	0.175	0.171	0.164	0.160
15	0.152	0.198	0.193	0.188	0.183	0.179	0.175	0.170	0.166	0.162	0.159	0.155	0.149	0.146
15.5	0.139	0.181	0.176	0.172	0.167	0.163	0.159	0.155	0.152	0.148	0.145	0.142	0.136	0.133
16	0.127	0.166	0.161	0.157	0.153	0.149	0.146	0.142	0.139	0.136	0.133	0.130	0.125	0.122
16.5	0.117	0.152	0.148	0.144	0.141	0.137	0.134	0.131	0.128	0.125	0.122	0.120	0.115	0.113
17	0.108	0.140	0.136	0.133	0.129	0.126	0.123	0.121	0.118	0.115	0.113	0.110	0.106	0.104
17.5	0.100	0.129	0.126	0.123	0.119	0.116	0.114	0.111	0.109	0.106	0.104	0.102	0.098	0.096
18	0.093	0.119	0.116	0.113	0.111	0.108	0.105	0.103	0.101	0.098	0.096	0.095	0.091	0.089
18.5	0.086	0.110	0.108	0.105	0.102	0.100	0.098	0.096	0.093	0.091	0.090	0.088	0.084	0.083
19	0.080	0.102	0.100	0.097	0.095	0.093	0.091	0.089	0.087	0.085	0.083	0.082	0.079	0.077
19.5	0.074	0.095	0.093	0.091	0.088	0.086	0.084	0.083	0.081	0.079	0.077	0.076	0.073	0.072
20	0.069	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
20.5	0.065	0.082	0.080	0.079	0.077	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.064	0.063
21	0.061	0.077	0.075	0.073	0.072	0.070	0.068	0.067	0.066	0.064	0.063	0.062	0.060	0.059
21.5	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
22	0.054	0.068	0.066	0.065	0.063	0.062	0.060	0.059	0.058	0.057	0.056	0.055	0.053	0.052
22.5	0.050	0.063	0.062	0.061	0.059	0.058	0.057	0.056	0.054	0.053	0.052	0.051	0.049	0.049
23	0.047	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
23.5	0.045	0.056	0.055	0.054	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043
24	0.042	0.053	0.052	0.051	0.049	0.048	0.047	0.046	0.045	0.044	0.043	0.042	0.041	0.041
24.5	0.040	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043	0.042	0.041	0.041	0.039	0.039
25	0.038	0.047	0.046	0.045	0.044	0.043	0.042	0.041	0.041	0.040	0.039	0.038	0.037	0.037

Table 12-20: C_t values, noise mode 6.

12.7.3 Noise Curve, Noise Mode 6

Sound Power Level at Hub Height, Noise Mode 6			
Conditions for Sound Power Level:	Measurement standard IEC 61400-11 ed. 2 2002 Wind shear: 0.16 Maximum turbulence at 10 metre height: 16% Inflow angle (vertical): 0 ±2° Air density: 1.225 kg/m³		
Hub Height	84 m	94/96 m	119 m
LwA @ 3 m/s (10 m above ground) [dBA]	94.5	94.5	94.7
Wind speed at hub height [m/s]	4.2	4.3	4.5
LwA @ 4 m/s (10 m above ground) [dBA]	97.3	97.5	98.1
Wind speed at hub height [m/s]	5.6	5.7	5.9
LwA @ 5 m/s (10 m above ground) [dBA]	100.9	101.0	101.0
Wind speed at hub height [m/s]	7.0	7.2	7.4
LwA @ 6 m/s (10 m above ground) [dBA]	101.0	101.0	101.0
Wind speed at hub height [m/s]	8.4	8.6	8.9
LwA @ 7 m/s (10 m above ground) [dBA]	101.0	101.0	101.0
Wind speed at hub height [m/s]	9.8	10.0	10.4
LwA @ 8 m/s (10 m above ground) [dBA]	101.0	101.0	101.0
Wind speed at hub height [m/s]	11.2	11.4	11.9
LwA @ 9 m/s (10 m above ground) [dBA]	101.0	101.0	101.0
Wind speed at hub height [m/s]	12.7	12.9	13.4
LwA @ 10 m/s (10 m above ground) [dBA]	101.0	101.0	101.0
Wind speed at hub height [m/s]	14.1	14.3	14.9
LwA @ 11 m/s (10 m above ground) [dBA]	101.0	101.0	101.0
Wind speed at hub height [m/s]	15.5	15.7	16.3
LwA @ 12 m/s (10 m above ground) [dBA]	101.0	101.0	101.0
Wind speed at hub height [m/s]	16.9	17.2	17.8
LwA @ 13 m/s (10 m above ground) [dBA]	101.0	101.0	101.0
Wind speed at hub height [m/s]	18.3	18.6	19.3

Table 12-21: Noise curve, noise mode 6.

12.8 Mode 7

12.8.1 Power Curves, Noise Mode 7

Wind speed [m/s]	Air density [kg/m ³]													
	1.225	0.95	0.975	1.0	1.025	1.05	1.075	1.1	1.125	1.15	1.175	1.2	1.25	1.275
3	26	11	12	14	15	16	17	19	20	22	23	25	27	29
3.5	73	45	48	50	53	55	58	60	63	65	68	70	75	78
4	132	92	95	99	103	107	110	114	118	121	125	129	136	140
4.5	207	150	155	161	166	171	176	181	187	192	197	202	213	218
5	302	223	230	237	244	251	259	266	273	280	287	294	309	316
5.5	416	311	321	331	340	350	359	369	378	388	397	407	426	435
6	554	418	430	443	455	467	480	492	505	517	529	542	566	579
6.5	715	543	559	574	590	606	621	637	653	668	684	700	731	747
7	899	685	705	724	744	763	782	802	821	841	860	879	918	938
7.5	1098	840	863	887	910	934	957	980	1004	1027	1051	1074	1121	1144
8	1307	1003	1031	1058	1086	1114	1142	1169	1197	1225	1252	1280	1334	1362
8.5	1526	1175	1207	1239	1271	1304	1335	1367	1399	1431	1463	1494	1557	1589
9	1756	1357	1393	1430	1467	1503	1539	1576	1612	1648	1684	1720	1791	1827
9.5	1994	1550	1591	1632	1674	1715	1755	1796	1836	1876	1915	1955	2031	2069
10	2217	1744	1789	1835	1881	1926	1969	2012	2055	2099	2138	2177	2251	2286
10.5	2402	1942	1991	2039	2088	2136	2179	2221	2263	2305	2337	2369	2426	2451
11	2564	2148	2198	2248	2297	2347	2384	2422	2459	2497	2519	2541	2577	2590
11.5	2664	2368	2413	2457	2501	2546	2569	2592	2615	2638	2647	2656	2668	2673
12	2750	2589	2619	2648	2677	2707	2716	2724	2733	2742	2745	2747	2752	2753
12.5	2833	2766	2779	2792	2806	2819	2822	2825	2827	2830	2831	2832	2833	2834
13	2906	2885	2889	2894	2898	2902	2903	2904	2905	2906	2906	2906	2906	2906
13.5	2967	2960	2961	2963	2965	2966	2966	2967	2967	2967	2967	2967	2967	2967
14	3010	3009	3009	3010	3010	3010	3010	3010	3010	3010	3010	3010	3010	3010
14.5	3040	3040	3040	3040	3040	3040	3040	3040	3040	3040	3040	3040	3040	3040
15	3053	3053	3053	3053	3053	3053	3053	3053	3053	3053	3053	3053	3053	3053
15.5	3064	3064	3064	3064	3064	3064	3064	3064	3064	3064	3064	3064	3064	3064
16	3070	3070	3070	3070	3070	3070	3070	3070	3070	3070	3070	3070	3070	3070
16.5	3073	3073	3073	3073	3073	3073	3073	3073	3073	3073	3073	3073	3073	3073
17	3074	3074	3074	3074	3074	3074	3074	3074	3074	3074	3074	3074	3074	3074
17.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
18	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
18.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
19	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
19.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
20	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
20.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
21	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
21.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
22	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
22.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
23	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
23.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
24	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
24.5	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
25	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075

Table 12-22: Power curve, noise mode 7.

12.8.2 C_t Values, Noise Mode 7

Air density [kg/m^3]														
Wind speed [m/s]	1.225	0.95	0.975	1.0	1.025	1.05	1.075	1.1	1.125	1.15	1.175	1.2	1.25	1.275
3	0.895	0.897	0.896	0.896	0.896	0.896	0.896	0.896	0.895	0.895	0.895	0.895	0.895	0.894
3.5	0.838	0.839	0.839	0.839	0.839	0.839	0.839	0.839	0.838	0.838	0.838	0.838	0.838	0.838
4	0.813	0.814	0.814	0.814	0.814	0.814	0.814	0.814	0.813	0.813	0.813	0.813	0.813	0.813
4.5	0.807	0.809	0.809	0.809	0.809	0.808	0.808	0.808	0.808	0.808	0.808	0.807	0.807	0.807
5	0.804	0.807	0.807	0.807	0.806	0.806	0.806	0.806	0.805	0.805	0.805	0.805	0.804	0.804
5.5	0.804	0.806	0.806	0.806	0.805	0.805	0.805	0.805	0.805	0.805	0.805	0.805	0.804	0.804
6	0.799	0.802	0.802	0.802	0.801	0.801	0.801	0.800	0.800	0.800	0.799	0.799	0.798	0.798
6.5	0.788	0.792	0.792	0.791	0.791	0.791	0.790	0.790	0.789	0.789	0.789	0.788	0.787	0.787
7	0.764	0.770	0.769	0.769	0.768	0.768	0.767	0.767	0.766	0.766	0.765	0.765	0.764	0.763
7.5	0.727	0.733	0.732	0.732	0.731	0.731	0.730	0.730	0.729	0.729	0.728	0.728	0.727	0.726
8	0.684	0.690	0.689	0.689	0.688	0.688	0.687	0.687	0.686	0.686	0.685	0.685	0.684	0.683
8.5	0.643	0.648	0.648	0.647	0.647	0.646	0.646	0.645	0.645	0.644	0.644	0.643	0.642	0.642
9	0.606	0.612	0.611	0.611	0.611	0.610	0.610	0.609	0.609	0.608	0.608	0.607	0.606	0.605
9.5	0.573	0.581	0.580	0.580	0.579	0.579	0.578	0.577	0.577	0.576	0.575	0.574	0.571	0.570
10	0.537	0.552	0.551	0.550	0.550	0.549	0.548	0.546	0.545	0.544	0.542	0.539	0.533	0.530
10.5	0.493	0.525	0.524	0.523	0.521	0.520	0.517	0.514	0.511	0.508	0.503	0.498	0.486	0.480
11	0.448	0.502	0.500	0.498	0.495	0.493	0.487	0.482	0.477	0.471	0.464	0.456	0.439	0.431
11.5	0.397	0.481	0.476	0.471	0.466	0.461	0.452	0.443	0.434	0.426	0.416	0.406	0.388	0.379
12	0.353	0.458	0.449	0.440	0.431	0.422	0.411	0.401	0.390	0.380	0.371	0.362	0.345	0.337
12.5	0.317	0.424	0.413	0.402	0.390	0.379	0.370	0.360	0.350	0.341	0.333	0.325	0.310	0.303
13	0.286	0.384	0.373	0.362	0.352	0.341	0.332	0.324	0.315	0.307	0.300	0.293	0.279	0.273
13.5	0.259	0.346	0.336	0.327	0.317	0.307	0.300	0.292	0.285	0.277	0.271	0.265	0.253	0.248
14	0.234	0.310	0.302	0.293	0.285	0.277	0.270	0.264	0.257	0.250	0.245	0.240	0.229	0.225
14.5	0.212	0.279	0.271	0.264	0.257	0.249	0.244	0.238	0.232	0.226	0.222	0.217	0.208	0.203
15	0.192	0.250	0.244	0.238	0.231	0.225	0.220	0.214	0.209	0.204	0.200	0.196	0.188	0.184
15.5	0.174	0.226	0.221	0.215	0.209	0.203	0.199	0.194	0.190	0.185	0.181	0.178	0.170	0.167
16	0.158	0.205	0.200	0.195	0.190	0.185	0.181	0.177	0.173	0.168	0.165	0.162	0.155	0.152
16.5	0.144	0.186	0.182	0.177	0.173	0.168	0.165	0.161	0.157	0.154	0.151	0.147	0.142	0.139
17	0.132	0.170	0.166	0.162	0.158	0.154	0.150	0.147	0.144	0.141	0.138	0.135	0.130	0.127
17.5	0.121	0.156	0.152	0.148	0.144	0.141	0.138	0.135	0.132	0.129	0.126	0.124	0.119	0.117
18	0.112	0.143	0.139	0.136	0.133	0.129	0.127	0.124	0.121	0.119	0.116	0.114	0.110	0.108
18.5	0.103	0.132	0.129	0.125	0.122	0.119	0.117	0.114	0.112	0.109	0.107	0.105	0.101	0.100
19	0.096	0.122	0.119	0.116	0.113	0.111	0.108	0.106	0.104	0.101	0.100	0.098	0.094	0.092
19.5	0.089	0.113	0.110	0.108	0.105	0.103	0.100	0.098	0.096	0.094	0.092	0.091	0.087	0.086
20	0.083	0.105	0.102	0.100	0.098	0.095	0.093	0.091	0.090	0.088	0.086	0.084	0.081	0.080
20.5	0.077	0.098	0.095	0.093	0.091	0.089	0.087	0.085	0.083	0.082	0.080	0.079	0.076	0.075
21	0.072	0.091	0.089	0.087	0.085	0.083	0.081	0.080	0.078	0.076	0.075	0.074	0.071	0.070
21.5	0.068	0.085	0.083	0.082	0.080	0.078	0.076	0.075	0.073	0.072	0.070	0.069	0.067	0.066
22	0.064	0.080	0.078	0.076	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.065	0.063	0.062
22.5	0.060	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.065	0.063	0.062	0.061	0.059	0.058
23	0.056	0.070	0.069	0.067	0.066	0.064	0.063	0.062	0.061	0.059	0.058	0.057	0.055	0.054
23.5	0.053	0.066	0.065	0.063	0.062	0.061	0.059	0.058	0.057	0.056	0.055	0.054	0.052	0.051
24	0.050	0.062	0.061	0.060	0.059	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.049	0.049
24.5	0.047	0.059	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046
25	0.045	0.056	0.055	0.054	0.052	0.051	0.050	0.049	0.048	0.047	0.047	0.046	0.045	0.044

Table 12-23: C_t values, noise mode 7.

12.8.3 Noise Curve, Noise Mode 7

Sound Power Level at Hub Height, Noise Mode 7			
Conditions for Sound Power Level:	Measurement standard IEC 61400-11 ed. 2 2002 Wind shear: 0.16 Maximum turbulence at 10 metre height: 16% Inflow angle (vertical): 0 ±2° Air density: 1.225 kg/m³		
Hub Height	84 m	94/96 m	119 m
LwA @ 3 m/s (10 m above ground) [dBA]	94.5	94.5	94.7
Wind speed at hub height [m/s]	4.2	4.3	4.5
LwA @ 4 m/s (10 m above ground) [dBA]	97.3	97.5	98.1
Wind speed at hub height [m/s]	5.6	5.7	5.9
LwA @ 5 m/s (10 m above ground) [dBA]	100.9	101.2	101.9
Wind speed at hub height [m/s]	7.0	7.2	7.4
LwA @ 6 m/s (10 m above ground) [dBA]	101.9	102.0	102.2
Wind speed at hub height [m/s]	8.4	8.6	8.9
LwA @ 7 m/s (10 m above ground) [dBA]	102.9	103.0	103.3
Wind speed at hub height [m/s]	9.8	10.0	10.4
LwA @ 8 m/s (10 m above ground) [dBA]	103.9	104.0	104.0
Wind speed at hub height [m/s]	11.2	11.4	11.9
LwA @ 9 m/s (10 m above ground) [dBA]	105.0	105.0	105.0
Wind speed at hub height [m/s]	12.7	12.9	13.4
LwA @ 10 m/s (10 m above ground) [dBA]	105.0	105.0	105.0
Wind speed at hub height [m/s]	14.1	14.3	14.9
LwA @ 11 m/s (10 m above ground) [dBA]	105.0	105.0	105.0
Wind speed at hub height [m/s]	15.5	15.7	16.3
LwA @ 12 m/s (10 m above ground) [dBA]	105.0	105.0	105.0
Wind speed at hub height [m/s]	16.9	17.2	17.8
LwA @ 13 m/s (10 m above ground) [dBA]	105.0	105.0	105.0
Wind speed at hub height [m/s]	18.3	18.6	19.3

Table 12-24: Noise curve, noise mode 7.