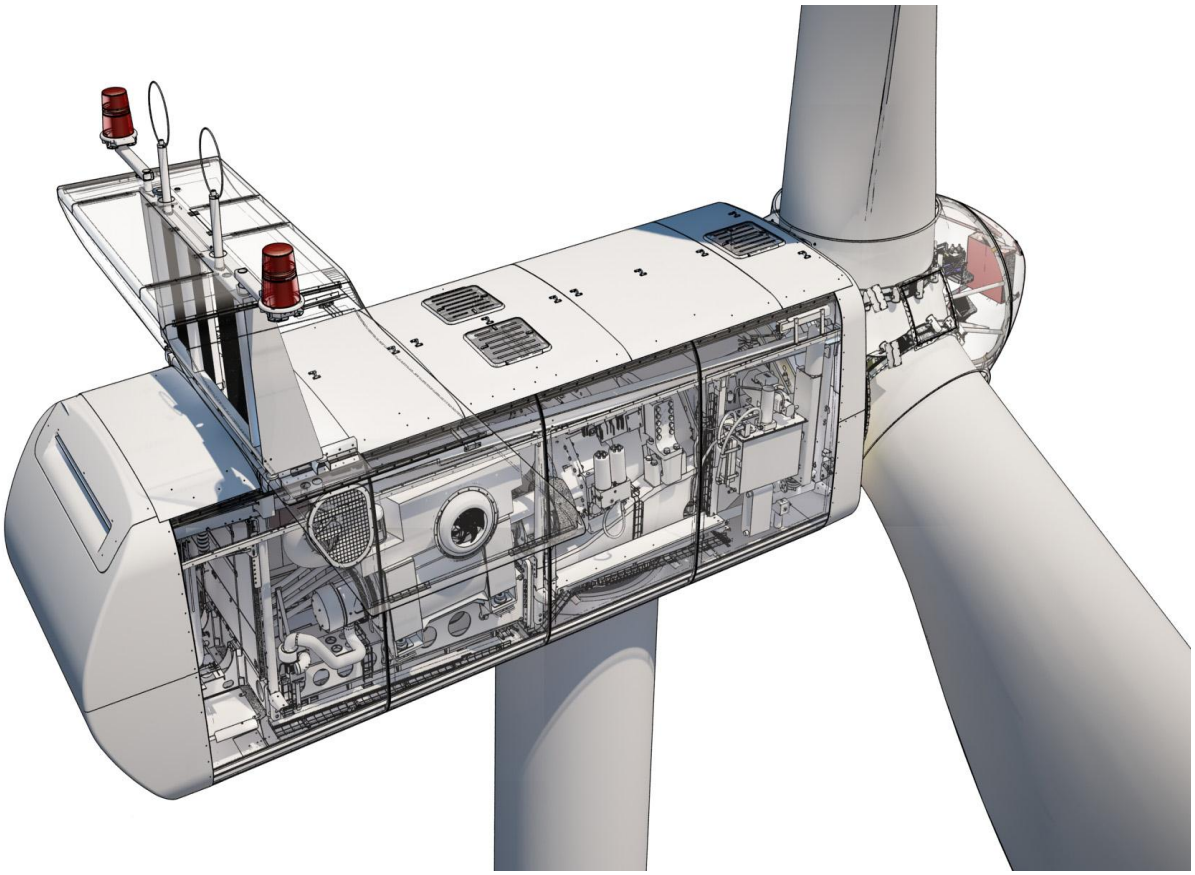
Restricted
Document no.: 0004-6207 V14
2013-09-24

General Specification

V90–1.8/2.0 MW 50 Hz VCS



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See section 11 General Reservations, Notes, and Disclaimers**, p. 41 for general reservations, notes, and disclaimers applicable to these general specifications.**

1 General Description

The Vestas V90-1.8/2.0 MW wind turbine is a pitch regulated upwind turbine with active yaw and a three-blade rotor. The Vestas V90-1.8/2.0 MW turbine has a rotor diameter of 90 m with a generator rated at 1.8 MW or 2.0 MW, depending on wind conditions. The turbine utilises a microprocessor pitch control system called OptiTip® and the OptiSpeed™ (variable speed) feature. With these features, the wind turbine is able to operate the rotor at variable speed (rpm), helping to maintain the output at or near rated power.

2 Mechanical Design

2.1 Rotor

The V90-1.8/2.0 MW is equipped with a 90-metre rotor consisting of three blades and the hub. Based on the prevailing wind conditions, the blades are continuously positioned to help optimise the pitch angle.

Rotor	
Diameter	90 m
Swept Area	6362 m^2
Rotational Speed Static, Rotor	14.9 rpm
Speed, Dynamic Operation Range	9.6-17.0 rpm
Rotational Direction	Clockwise (front view)
Orientation	Upwind
Tilt	6°
Hub Coning	2°
Number of Blades	3
Aerodynamic Brakes	Full feathering

Table 2-1: Rotor data

2.2 Blades

The 44 m Prepreg (PP) blades are made of carbon and fibreglass. They consist of two airfoil shells bonded to a supporting beam.

PP Blades	
Type Description	Airfoil shells bonded to supporting beam
Blade Length	44 m
Material	Fibreglass reinforced epoxy and carbon fibres
Blade Connection	Steel roots inserts
Air Foils	RISØ P + FFA – W3

PP Blades	
Maximum Chord	3.512 m
Blade Tip (R44.5)	0.391 m
Twist (blade root / blade tip)	27°
Approximate Weight	6750 kg

Table 2-2: PP blades data

2.3 Blade Bearing

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

Blade Bearing	
Type	Double-row four-point contact ball bearing
Lubrication	Grease lubrication, manually re-greased

Table 2-3: Blade bearing data

2.4 Pitch System

The energy input from the wind to the turbine is adjusted by pitching the blades according to the control strategy. The pitch system also works as the primary brake system by pitching the blades out of the wind. This causes the rotor to idle.

Double-row four-point contact ball bearings are used to connect the blades to the hub. The pitch system relies on hydraulics and uses a cylinder to pitch each blade. Hydraulic power is supplied to the cylinder from the hydraulic power unit in the nacelle through the main gearbox and the main shaft via a rotating transfer.

Hydraulic accumulators inside the rotor hub ensure sufficient power to pitch the turbine in case of failure.

Pitch System	
Type	Hydraulic
Cylinder	Ø 125/80-760
Number	1 piece/blade
Range	-5° to 90°

Table 2-4: Pitch system data

Hydraulic System	
Pump Capacity	44 l/min.
Working Pressure	180-200 bar
Oil Quantity	260 l
Motor	18.5 kW

Table 2-5: Hydraulic system data

2.5 Hub

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

Hub	
Type	Cast ball shell hub
Material	Cast iron EN GJS 400-18U-LT / EN 1560

Table 2-6: Hub data

2.6 Main Shaft

Main Shaft	
Type	Forged, trumpet shaft
Material	42 CrMo4 QT / EN 10083

Table 2-7: Main shaft data

2.7 Bearing Housing

Bearing Housing	
Type	Cast foot housing with lowered centre
Material	Cast iron EN-GJS-400-18U-LT / EN 1560

Table 2-8: Bearing housing data

2.8 Main Bearings

Main Bearings	
Type	Spherical roller bearings
Lubrication	Grease lubrication, manually re-greased

Table 2-9: Main bearings data

2.9 Gearbox

The main gearbox transmits rotational torque from the rotor to the generator.

The main gearbox consists of a planetary stage combined with a two-stage parallel gearbox, torque arms, and vibration dampers.

Torque is transmitted from the high-speed shaft to the generator via a flexible composite coupling, located behind the disc brake. The disc brake is installed directly on the high-speed shaft.

Gearbox	
Type	1 planetary stage + 2 helical stages
Ratio	1:112.8 nominal
Cooling	Oil pump with oil cooler
Oil Heater	2 kW
Maximum Gear Oil Temp	80°C
Oil Cleanliness	-/15/12 ISO 4406

Table 2-10: Gearbox data

2.10 Generator Bearings

The bearings are greased and grease is supplied continuously from an automatic lubrication unit when the nacelle temperature is above -10°C. The yearly grease flow is approximately 2400 cm³.

2.11 High-Speed Shaft Coupling

The flexible coupling transmits the torque from the gearbox high-speed output shaft to the generator input shaft. The flexible coupling is designed to compensate misalignments between gearbox and generator. The coupling consists of two composite discs and an intermediate tube with two aluminium flanges and a fibreglass tube. The coupling is fitted to three-armed hubs on the brake disc and the generator hub.

High-Speed Shaft Coupling	
Type Description	VK 420

Table 2-11: High-speed shaft coupling data

2.12 Yaw System

The yaw system is designed to keep the turbine upwind. The nacelle is installed on the yaw plate, which is bolted to the turbine tower. The yaw bearing system is a plain bearing system with built-in friction. Asynchronous yaw motors with brakes enable the nacelle to rotate on top of the tower.

The turbine controller receives information about the wind direction from the wind sensor. Automatic yawing is deactivated when the mean wind speed is below 3 m/s.

Yaw System	
Type	Plain bearing system with built-in friction
Material	Forged yaw ring heat-treated Plain bearings PETP
Yawing Speed	< 0.5°/second

Table 2-12: Yaw system data

Yaw Gear	
Type	Non-locking combined worm gear and planetary gearbox Electrical motor brake
Motor	1.5 kW, 6 poles, asynchronous
Number of Yaw Gears	6
Ratio Total (Three Planetary Stages + Worm Gear)	1,120 : 1
Rotational Speed at Full Load	Approximately 1 rpm at output shaft

Table 2-13: Yaw gear data

2.13 Crane

The nacelle houses the service crane. The crane is a single system chain hoist.

Crane	
Lifting Capacity	Maximum 800 kg

Table 2-14: Crane data

2.14 Tower Structure

Tubular towers with flange connections, certified according to relevant type approvals, are available in different standard heights. Magnets provide load support in a horizontal direction and internals, such as platforms and ladders, are supported vertically (that is in the gravitational direction) by mechanical connections.

The hub heights listed include a distance from the foundation top to the ground level of approximately 0.2 m and a distance from the tower top flange to the centre of the hub of 1.7 m.

Tower Structure	
Type Description	Conical tubular
Hub Heights	80 m/95 m/105 m/125 m
Material	S355 according to EN 10024 A709 according to ASTM
Weight	80 m IEC IIA, 117 metric tonnes* 95 m IEC IIA/DIBt II, 215 metric tonnes* 105 m IEC IIA/DIBt II, 202 metric tonnes* 125 m DIBt II, 284 metric tonnes*

Table 2-15: Tower structure data

NOTE * Typical values. Dependent on wind class, and can vary with site/project conditions.

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 is equipped with wind sensors and skylights that can be opened from inside the nacelle to access the roof and from outside to access the nacelle. The nacelle cover is installed on the girder structure. 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 yaw gears are bolted to the front nacelle bedplate.

The nacelle bedplate carries the crane girders through vertical beams positioned along the site of the nacelle. Lower beams of the girder structure are connected at the rear end.

The rear part of the bedplate serves as foundation for controller panels, the generator, and transformer.

Type Description	Material
Nacelle Cover	GRP
Bedplate Front	Cast iron EN-GJS-400-18U-LT / EN 1560
Bedplate Rear	Welded grid structure

Table 2-16: Nacelle bedplate and cover data

2.16 Cooling

The cooling of the main components (gearbox, hydraulic power pack and VCS converter) in the turbine is done by a water cooling system. The generator is air cooled by nacelle air and the high-voltage (HV) transformer is cooled by mainly ambient air.

Component	Cooling Type	Internal Heating at Low Temperature
Nacelle	Forced air	Yes
Hub/Spinner	Natural air	No (Yes for low-temperature (LT) turbine)
Gearbox	Water/oil	Yes
Generator	Forced air/air	No (heat source)
Slip Rings	Forced air/air	Yes

Component	Cooling Type	Internal Heating at Low Temperature
Transformer	Forced air	No (heat source)
VCS	Forced water/air	Yes
VMP Section	Forced air/air	Yes
Hydraulics	Water/oil	Yes

Table 2-17: Cooling, summary

All other heat generating systems are also equipped with fans and/or coolers but are considered as minor contributors to nacelle thermodynamics.

2.17 Water Cooling System

The water cooling system is designed as a semi-closed system (closed system but not under pressure) with a free wind water cooler on the roof of the nacelle. This means that the heat loss from the systems (components) is transferred to the water system and the water system is cooled by ambient air.

The water cooling system has three parallel cooling circuits that cool the gearbox, the hydraulic power unit, and the VCS converter.

The water cooling system is equipped with a three-way thermostatic valve. The valve is closed (total water flow bypassing the water cooler) if the temperature of the cooling water is below 35°C and fully open (total water flow led to the water cooler) if the temperature is above 43°C.

2.18 Gearbox Cooling

The gearbox cooling system consists of two oil circuits that remove the gearbox losses through two plate heat exchangers (oil coolers). The first circuit is equipped with a mechanically driven oil pump and a plate heat exchanger. The second circuit is equipped with an electrically driven oil pump and a plate heat exchanger. The water circuit of the two plate heat exchangers is coupled in serial.

Gearbox Cooling	
Gear Oil Plate Heat Exchanger 1 (Mechanically Driven Oil Pump)	
Nominal Oil Flow	50 l/min.
Oil Inlet Temperature	80°C
Number of Passes	2
Cooling Capacity	24.5 kW
Gear Oil Plate Heat Exchanger 2 (Electrically Driven Oil Pump)	
Nominal Oil Flow	85 l/min.
Oil Inlet Temperature	80°C
Number of Passes	2

Gearbox Cooling	
Cooling Capacity	41.5 kW
Water Circuit	
Nominal Water Flow	Approximately 150 l/min. (50% glycol)
Water Inlet Temperature	Maximum 54°C
Number of Passes	1
Heat Load	66 kW

Table 2-18: Cooling, gearbox data

2.19 Hydraulic Cooling

The hydraulic cooling system consists of a plate heat exchanger that is installed on the power pack. In the plate heat exchanger, the heat from the hydraulics is transferred to the water cooling system.

Hydraulic Cooling	
Hydraulic Oil Plate Heat Exchanger	
Nominal Oil Flow	40 l/min.
Oil Inlet Temperature	66°C
Cooling Capacity	10.28 kW
Water Circuit	
Nominal Water Flow	Approximately 45 l/min. (50% glycol)
Water Inlet Temperature	Maximum 54°C
Heat Load	10.28 kW

Table 2-19: Cooling, hydraulic data

2.20 VCS Converter Cooling

The converter cooling system consists of a number of switch modules that are installed on cooling plates where the cooling water is led through.

Converter Cooling	
Nominal Water Flow	Approximately 45 l/min. (50% glycol)
Water Inlet Pressure	Maximum 2.0 bar
Water Inlet Temperature	Maximum. 54ºC
Cooling Capacity	10 kW

Table 2-20: Cooling, converter data

2.21 Generator Cooling

The generator cooling systems consists of an air-to-air cooler installed on the top of the generator, two internal fans and one external fan. All the fans can run at low or high speed.

Generator Cooling	
Air Inlet Temperature: External	50°C
Nominal Air Flow: Internal	8000 m^3/h
Nominal Air Flow: External	7500 m^3/h
Cooling Capacity	60 kW

Table 2-21: Cooling, generator data

2.22 HV Transformer Cooling

The transformer is equipped with forced air cooling. The cooling system consists of a central fan that is located under the service floor, an air distribution manifold, and six hoses leading to locations beneath and between the HV and LV windings.

Transformer Cooling	
Nominal Air Flow	1920 m^3/h
Air Inlet Temperature	Maximum 40°C

Table 2-22: Cooling, transformer data

2.23 Nacelle Conditioning

The nacelle conditioning system consists of one fan and two air heaters. There are two main circuits of the nacelle conditioning system:

1. Cooling of the HV transformer.
2. Heating and ventilation of the nacelle.

For both systems, the airflow enters the nacelle through louver dampers in the weather shield underneath the nacelle.

The cooling of the HV transformer is described in section 2.22 HV Transformer Cooling, p. 13.

The heating and ventilation of the nacelle is done by means of two air heaters and one fan. To avoid condensation in the nacelle, the two air heaters keep the nacelle temperature +5°C above the ambient temperature. At start-up in cold conditions, the heaters will also heat the air around the gearbox.

The ventilation of the nacelle is done by means of one fan that removes hot air from the nacelle generated by mechanical and electrical equipment.

Nacelle Cooling	
Nominal Air Flow	1.2 m^3/s
Air Inlet Temperature	Maximum 50°C

Table 2-23: Cooling, nacelle data

Nacelle Heating	
Rated Power	2 x 6 kW

Table 2-24: Heating, nacelle data

3 Electrical Design

3.1 Generator

The generator is a three-phase asynchronous generator with wound rotor that is connected to the Vestas Converter System (VCS) via a slip ring system. The generator is an air-to-air cooled generator with an internal and external cooling circuit. The external circuit uses air from the nacelle and expels it as exhaust out the rear end of the nacelle.

The generator has four poles. The generator is wound with form windings in both rotor and stator. The stator is connected in Star at low power and Delta at high power. The rotor is connected in Star and is insulated from the shaft.

Generator V90-1.8 MW	
Type Description	Asynchronous with wound rotor, slip rings and VCS
Rated Power (PN)	1.8 MW
Rated Apparent Power	2.0 MVA (Cosφ = 0.9)
Frequency	50 Hz
Voltage, Generator	690 Vac
Voltage, Converter	480 Vac
Number of Poles	4
Winding Type (Stator/Rotor)	Random/Form
Winding Connection, Stator	Star/Delta
Rated Efficiency (Generator only)	> 97%
Power Factor (cos)	0.90 ind-0.95 cap
Overspeed Limit According to IEC (2 Minute)	2900 rpm
Vibration Level	≤ 1.8 mm/s
Weight	Approximately 7500 kg

Generator V90-1.8 MW	
Generator Bearing - Temperature	2 PT100 sensors
Generator Stator Windings - Temperature	3 PT100 sensors placed at hot spots and 3 as backup

Table 3-1: Generator data for V90-1.8 MW

Generator V90-2.0 MW	
Type Description	Asynchronous with wound rotor, slip rings and VCS
Rated Power (PN)	2.0 MW
Rated Apparent Power	2.08 MVA (Cosφ = 0.96)
Frequency	50 Hz
Voltage, Generator	690 Vac
Voltage, Converter	480 Vac
Number of Poles	4
Winding Type (Stator/Rotor)	Random/Form
Winding Connection, Stator	Star/Delta
Rated Efficiency (Generator Only)	> 97%
Power Factor (cos)	0.96 ind-0.98 cap
Overspeed Limit According to IEC (2 Minute)	2900 rpm
Vibration Level	≤ 1.8 mm/s
Weight	Approximately 7500 kg
Generator Bearing - Temperature	2 PT100 sensors
Generator Stator Windings - Temperature	3 PT100 sensors placed at hot spots and 3 as backup

Table 3-2: Generator data for V90-2.0 MW

3.2 HV Cables

The high-voltage cable runs from the transformer in the nacelle down the tower to the switchgear located in the bottom of the tower (switchgear is not included). 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
Rated Voltage	12/20 kV (24 kV) or 20/35 kV (42 kV) depending on the transformer voltage

Table 3-3: HV cables data

3.3 Transformer

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

Transformer	
Type Description	Dry-type cast resin transformer
Basic Layout	3 phase, 2 winding transformer with a tap on low voltage winding
Applied Standards	IEC 60076-11, IEC 60076-16, Cenelec HD 637:S1
Cooling Method	AF
Rated Power HV / LV1 / LV2	2100 / 1900 / 200 kVA
Nominal Voltage, Turbine Side LV1 / LV2	
U_m 1.1 kV	0.690 / 0.480 kV
Nominal Voltage, Grid Side	
U_m 12.0 kV	6.0-11.0 kV
U_m 24.0 kV	11.1-22.0 kV
U_m 36.0 kV	22.1-33.0 kV
U_m 41.5 kV	33.1-35.0 kV
Insulation Level AC / LI / LIC	
U_m 1.1 kV	3[1] / - / - kV
U_m 12.0 kV	28[1] / 75 / 75 kV
U_m 24.0 kV	50[1] / 125 / 125 kV
U_m 36.0 kV	70[1] / 170 / 170 kV
U_m 41.5 kV	80[1] / 170 / 170 kV
Off-Circuit Tap Changer	±2 x 2.5 %

[1] @1000m. According to IEC 60076-11, AC test voltage is altitude dependent.

Transformer	
Frequency	50 Hz
Vector Group	Dyn5 / YNyn0
No-Load Loss[2]	4.0 kW
Load Loss @ Rated Power HV, 120°C[2]	19.0 kW
No-Load Reactive Power[3]	16 kVAr
Full Load Reactive Power [3]	220 kVAr
Positive Sequence Short-Circuit Impedance @ Rated Power LV1, 120°C[4]	
U_m 12.0-36.0 kV	7.8%
U_m 41.5 kV	9.0%
Positive Sequence Short-Circuit Resistance @ Rated Power LV1, 120°C [3]	
U_m 12.0-36.0 kV	0.8%
U_m 41.5 kV	0.9%
Zero Sequence Short-Circuit Impedance @ Rated Power LV1, 120°C [3]	
U_m 12.0-36.0 kV	7.3%
U_m 41.5 kV	8.5%
Zero Sequence Short-Circuit Resistance @ Rated Power LV1, 120°C [3]	
U_m 12.0-36.0 kV	0.8%
U_m 41.5 kV	0.8%
Inrush Peak Current [3]	
Dyn5	6-9 x $\hat{I}_n$
YNyn0	8-12 x $\hat{I}_n$
Half Crest Time [3]	~ 0.7 s
Sound Power Level	≤ 83 dB(A)
Average Temperature Rise @ 1000m	≤ 80 K
Max Altitude[5]	2100 m

[2] Based on an average of measured values during qualification tests across voltages and manufacturers.

[3] Based on an average of calculated values across voltages and manufacturers.

[4] Subject to standard IEC tolerances.

Transformer	
Insulation Class	155 (F)
Environmental Class	E2
Climatic Class	C2
Fire Behaviour Class	F1
Corrosion Class	C4
Weight	≤ 5500 kg
Temperature Monitoring	PT100 sensors in LV windings
Overvoltage Protection	Surge arresters on HV terminals
Temporary Earthing	3 x Ø20mm earthing ball points

Table 3-4: Transformer data

3.4 Converter

The converter controls the energy conversion in the generator. The VCS converter feeds power from the grid into the generator rotor at sub-sync speed and feeds power from the generator rotor to the grid at super-sync speed.

Converter V90-1.8 MW	
Rated Slip	12%
Rated rpm	1680 rpm
Rated Rotor Power (@ rated slip)	193 kW
Rated Grid Current (@ rated slip, PF = 1 and 480 V)	232 A
Rated Rotor Current (@ rated slip and PF = 1)	573 A

Table 3-5: Converter data V90-1.8 MW

Converter V90-2.0 MW	
Rated Slip	12%
Rated rpm	1680 rpm
Rated Rotor Power (@ rated slip)	214 kW
Rated Grid Current (@ rated slip, PF = 1 and 480 V)	258 A
Rated Rotor Current (@ rated slip and PF = 1)	636 A

Table 3-6: Converter data V90-2.0 MW

[5] Maximum hub height altitude will depend on site location.

3.5 AUX System

The AUX System is supplied from the 690/480 V socket from the HV transformer. All motors, pumps, fans, and heaters are supplied from this system.

All 230 V power sockets are supplied from a 690/230 V transformer.

Power Sockets	
Single Phase	230 V (13 A)
Three Phase	690 V (16 A)

Table 3-7: AUX system data

3.6 Wind Sensors

The turbine is equipped with two ultrasonic wind sensors with built-in heaters.

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

Table 3-8: Wind sensor data

3.7 Turbine Controller

The turbine is controlled and monitored by the System 3500 controller hardware and Vestas VMP Global™ controller software.

The turbine controller is based on four main processors (ground, nacelle, hub, and converter) which are interconnected by an optically based 2.5 Mbit ARCNET network.

I/O modules are connected either as rack modules in the System 3500 rack or by CAN.

The turbine control system serves the following main functions:

- Monitoring and supervision of overall operation.
- Synchronizing of the generator to the grid during connection sequence in order to limit the inrush current.
- Operating the wind turbine during various fault situations.
- Automatic yawing of the nacelle.
- OptiTip® - blade pitch control.
- Noise emission control.
- Monitoring of ambient conditions.
- Monitoring of the grid.

The turbine controller hardware is built from the following main modules:

Module	Function	Network
CT3603	Main processor. Control and monitoring (nacelle and hub)	ARCNET, CAN, Ethernet, serial
CT396	Main processor. Control, monitoring, external communication (ground)	ARCNET, CAN, Ethernet, serial
CT360	Main processor. Converter control and monitoring	ARCNET, CAN, Ethernet
CT3218	Counter/encoder module. RPM, azimuth and wind measurement	Rack module
CT3133	24 VDC digital input module. 16 channels	Rack module
CT3153	24 VDC digital output module. 16 channels	Rack module
CT3320	4 channel analogue input (0-10 V, 4-20 mA, PT100)	Rack module
CT6061	CAN I/O controller	CAN node
CT6221	Three-channel PT100 module	CAN I/O module
CT6050	Blade controller	CAN node
Balluff	Position transducer	CAN node
Rexroth	Proportional valve	CAN node

Table 3-9: Turbine controller hardware

3.8 Uninterruptible Power Supply (UPS)

The UPS supplies power to critical wind turbine components.

The actual 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 online	
Rated Output Voltage	230 VAC	
Converter Input	230 V ±20%	
Backup Time*	Controller system	30 seconds
	Safety systems	35 minutes
Re-Charging Time	Typical	Approximately 2.5 hours

Table 3-10: 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 feathering the three blades. During emergency stop, all three blades will feather simultaneously to full end stop, thereby slowing the rotor speed.

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

4.2 Short Circuit Protections

Breakers	**Generator / Q8 ABB E2B 2000 690 V**	**Controller / Q15 ABB S3X 690 V**	**VCS-VCUS / Q7 ABB S5H 400 480 V**
Breaking Capacity I_{cu}, I_{cs}	42, 42 kA	75, 75 kA	40, 40 kA
Making Capacity I_{cm} (415 V Data)	88 kA	440 kA	143 kA
Thermo Release I_{th}	2000 A	100 A	400 A

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 in order to protect against overspeed and rotating errors.

The turbine is also equipped with a VOG (Vestas Overspeed Guard), which is an independent computer module that measures the rotor rpm. In case of an overspeed situation, the VOG activates the emergency feathered position (full feathering) of the three blades.

Overspeed Protection	
VOG Sensors Type	Inductive
Trip Levels	17.8 (Rotor rpm) / 2013 (Generator rpm)

Table 4-2: Overspeed protection data

4.4 EMC System

- The turbine and related equipment must fulfil the EU Electromagnetic Compatibility (EMC)-Directive with later amendments, including Council Directive 2004/108/EC of December 2004 on the approximation of the laws of the Member States relating to Electromagnetic Compatibility.

4.5 Lightning Protection System

The Lightning Protection System (LPS) consists of three main parts.

- Lightning receptors
- Down conducting system
- Earthing system

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

Table 4-3: Lightning design parameters

NOTE The Lightning Protection System is designed according to IEC standards.
See section 7.7 Design Codes – Lightning Protection, p. 28.

4.6 Earthing

The Vestas Earthing System is based on foundation earthing.

Vestas document no. 0000-3388 contains the list of documents pertaining to the Vestas Earthing System.

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 categories for atmospheric corrosion is according to ISO 9223:1992.

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

5 Safety

The safety specifications in this safety 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, (c) conducting all appropriate safety training and education, and (d) reading and understanding all safety-related manuals and instructions. See section 5.13 Manuals and Warnings, p. 25 for additional guidance.

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 switch boards 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.

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

Escape from the service lift is by ladder.

5.3 Rooms/Working Areas

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

5.4 Platforms, Standing, and Working Places

The bottom tower section has two platforms. There is one platform at the entrance level (door level), and a platform in the top of the tower section.

Each middle tower section has one platform in the top of the tower section.

The top tower section has two platforms, a top platform and a service lift platform, where the service lift stops, below the top platform.

There are places to stand at various locations along the ladder.

The platforms have anti-slip surfaces.

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

5.5 Climbing Facilities

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

Rest platforms are provided at intervals of 9 metres along the tower ladder between platforms.

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

Over the crane hatch there is an anchor point for the emergency descent equipment. The anchor point is tested to 22.2 kN.

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

5.6 Moving Parts, Guards, and Blocking Devices

Moving parts in the nacelle are shielded.

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

It is possible to block the pitch of the cylinder with mechanical tools in the hub.

5.7 Lighting

The turbine is equipped with lighting in the tower, nacelle, and in the hub.

There is emergency lighting in case of loss of electrical power.

5.8 Noise

When the turbine is out of operation for maintenance, the sound level in the nacelle is below 80 dB(A). Ear protection is required during operation mode.

5.9 Emergency Stop

There are emergency stops in the nacelle and in the bottom of the tower.

5.10 Power Disconnection

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

5.11 Fire Protection/First Aid

A 5 kg CO_2 fire extinguisher must be located in the nacelle at the left yaw gear. The location of the fire extinguisher, and how to use it, must be confirmed before operating the turbine.

A first aid kit must be placed by the wall at the back end of the nacelle. The location of the first aid kit, and how to use it, must be confirmed before operating the turbine.

Above the generator there must be a fire blanket which can be used to put out small fires.

5.12 Warning Signs

Warning signs inside or on the turbine must be reviewed before operating or servicing of 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 Vestas Wind Systems A/S Environmental System certified according to ISO 14001:2004.

- Anti-freeze liquid 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, Certificates, and Design Codes

7.1 Type Approvals

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

V90-1.8 MW

Certification	Wind Class	Hub Height
IEC WT-01	IEC IIA	80 m
		95 m
		105 m

Table 7-1: Type approval data for V90-1.8 MW

V90-2.0 MW

Certification	Wind Class	Hub Height
IEC WT-01	IEC IIIA	80 m
		95 m
		105 m
		125 m
Typenprüfung	DIBt II	95 m
		105 m
		125 m

Table 7-2: Type approval data for V90-2.0 MW

7.2 Design Codes – Structural Design

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

Design Codes – Structural Design	
Nacelle and Hub	IEC 61400-1:1999 EN 50308 ANSI/ASSE Z359.1-2007
Bed Frame	IEC 61400-1:2005
Tower	IEC 61400-1:2005 Eurocode 3 DIBt: Richtlinie für Windenergieanlagen, Einwirkungen und Standsicherheitsnachweise für Turm und Gründung, 4th edition.

Table 7-3: Structural design codes

7.3 Design Codes – Mechanical Equipment

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

Design Codes – Mechanical Equipment	
Gear	Designed in accordance to rules in ISO 81400-4
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

Table 7-4: Mechanical equipment design codes

7.4 Design Codes – Electrical Equipment

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

Design Codes – Electrical Equipment	
High-Voltage AC Circuit Breakers	IEC 60056
High-Voltage Testing Techniques	IEC 60060
Power Capacitors	IEC 60831
Insulating Bushings for AC Voltage above 1 kV	IEC 60137
Insulation Coordination	BS EN 60071
AC Disconnectors and Earth Switches	BS EN 60129
Current Transformers	IEC 60185
Voltage Transformers	IEC 60186
High-Voltage Switches	IEC 60265
Disconnectors and Fuses	IEC 60269
Flame Retardant Standard for MV Cables	IEC 60332
Transformer	IEC 60076-11
Generator	IEC 60034
Specification for Sulphur Hexafluoride for Electrical Equipment	IEC 60376
Rotating Electrical Machines	IEC 34
Dimensions and Output Ratings for Rotating Electrical Machines	IEC 72 and IEC 72A
Classification of Insulation, Materials for Electrical Machinery	IEC 85
Safety of Machinery – Electrical Equipment of Machines	IEC 60204-1

Table 7-5: Electrical equipment design codes

7.5 Design Codes – I/O Network System

The distributed I/O network system has been developed and tested with regard to, but not limited to, the following main standards:

Design Codes – I/O Network System	
Salt Mist Test	IEC 60068-2-52
Damp Head, Cyclic	IEC 60068-2-30
Vibration Sinus	IEC 60068-2-6
Cold	IEC 60068-2-1
Enclosure	IEC 60529
Damp Head, Steady State	IEC 60068-2-56
Vibration Random	IEC 60068-2-64
Dry Heat	IEC 60068-2-2
Temperature Shock	IEC 60068-2-14
Free Fall	IEC 60068-2-32

Table 7-6: I/O Network system design codes

7.6 Design Codes – EMC System

To fulfil EMC requirements the design must be as recommended for lightning protection. See section 7.7 Design Codes – Lightning Protection, p. 28.

Design Codes – EMC System	
Designed According to	IEC 61400-1: 2005
Further Robustness Requirements According to	TPS 901795

Table 7-7: EMC system design codes

7.7 Design Codes – Lightning Protection

The LPS is designed according to Lightning Protection Level (LPL) I:

Design Codes – Lightning Protection	
Designed According to	IEC 62305-1: 2006 IEC 62305-3: 2006 IEC 62305-4: 2006
Non-Harmonized Standard and Technically Normative Documents	IEC/TR 61400-24:2002

Table 7-8: Lightning protection design codes

7.8 Design Codes – Earthing

The Vestas Earthing System design is based on and complies with the following international standards and guidelines:

- IEC 62305-1 Ed. 1.0: Protection against lightning – Part 1: General principles.
- IEC 62305-3 Ed. 1.0: Protection against lightning – Part 3: Physical damage to structures and life hazard.
- IEC 62305-4 Ed. 1.0: Protection against lightning – Part 4: Electrical and electronic systems within structures.
- IEC/TR 61400-24. First edition. 2002-07. Wind turbine generator systems - Part 24: Lightning protection.
- IEC 60364-5-54. Second edition 2002-06. Electrical installations of buildings - Part 5-54: Selection and erection of electrical equipment – Earthing arrangements, protective conductors and protective bonding conductors.
- IEC 61936-1. First edition. 2002-10. Power installations exceeding 1kV a.c.- Part 1: Common rules.

8 Colour and Surface Treatment

8.1 Nacelle Colour and Surface Treatment

Surface Treatment of Vestas Nacelles	
Standard Nacelle Colours	RAL 7035 (light grey)
Gloss	According to ISO 2813

Table 8-1: Surface treatment, nacelle

8.2 Tower Colour and Surface Treatment

Surface Treatment of Vestas Tower Section		
	External	**Internal**
Tower Colour Variants	RAL 7035 (light grey)	RAL 9001 (cream white)
Gloss	50-75% UV resistant	Maximum 50%

Table 8-2: Surface treatment, tower.

8.3 Blades Colour

Blades Colour	
Blade Colour	RAL 7035 (light grey)
Tip-End Colour Variants	RAL 2009 (traffic orange), RAL 3000 (flame red), RAL 3020 (traffic red)
Gloss	< 30%

Table 8-3: Colours, blades

9 Operational Envelope and Performance Guidelines

Actual climate and site conditions have many variables and must 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.

NOTE As evaluation of climate and site conditions is complex, it is necessary to consult Vestas for every project.

9.1 Climate and Site Conditions

Values refer to hub height:

Extreme Design Parameters		
Wind Climate	**IEC IIA**	**IEC IIIA**
Ambient Temperature Interval (Standard Temperature Turbine)	-30°C to +50°C	
Extreme Wind Speed (10 Minute Average)	42.5 m/s	37.5 m/s
Survival Wind Speed (3 Second Gust)	59.5 m/s	52.5 m/s

Table 9-1: Extreme design parameters

Average Design Parameters		
Wind Climate	**IEC IIA**	**IEC IIIA**
Wind Speed	8.5 m/s	7.5 m/s
A-Factor	9.59 m/s	8.46 m/s
Form Factor, c	2.0	2.0
Turbulence Intensity According to IEC 61400-1, Including Wind Farm Turbulence (@15 m/s – 90% quantile)	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.

9.1.2 Altitude

The turbine is designed for use at altitudes up to 1500 m above sea level as standard.

Above 1500 m, special considerations must be taken regarding, for example, HV installations and cooling performance. Consult Vestas for further information.

9.1.3 Wind Farm Layout

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

DISCLAIMER

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 (10 Minute Average)	4 m/s
Cut-Out (100 Seconds Exponential Average)	25 m/s
Re-Cut In (100 Seconds Exponential Average)	20 m/s

Table 9-3: Operational envelope - temperature and wind

9.3 Operational Envelope – Grid Connection*

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

Operational Envelope – Grid Connection		
Nominal Phase Voltage	$U_{P,\ nom}$	400 V
Nominal Frequency	f_{nom}	50 Hz
Maximum Steady State Voltage Jump	± 2%	
Maximum Frequency Gradient	± 4 Hz/s	
Maximum Negative Sequence Voltage	3%	

Table 9-4: Operational envelope - grid connection

The generator and the converter will be disconnected if:

	U_P	U_N
Voltage Above 110% of Nominal for 60 Seconds	440 V	759 V
Voltage Above 115% of Nominal for 2 Seconds	460 V	794 V
Voltage Above 120% of Nominal for 0.08 Seconds	480 V	828 V
Voltage Above 125% of Nominal for 0.005 Seconds	500 V	863 V
Voltage Below 90% of Nominal for 60 Seconds	360 V	621 V
Voltage Below 85% of Nominal for 11 Seconds	340 V	586 V
Frequency is Above [Hz] for 0.2 Seconds	53 Hz	
Frequency is Below [Hz] for 0.2 Seconds	47 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 dependent on power rating as illustrated in Figure 9-1, p. 33.

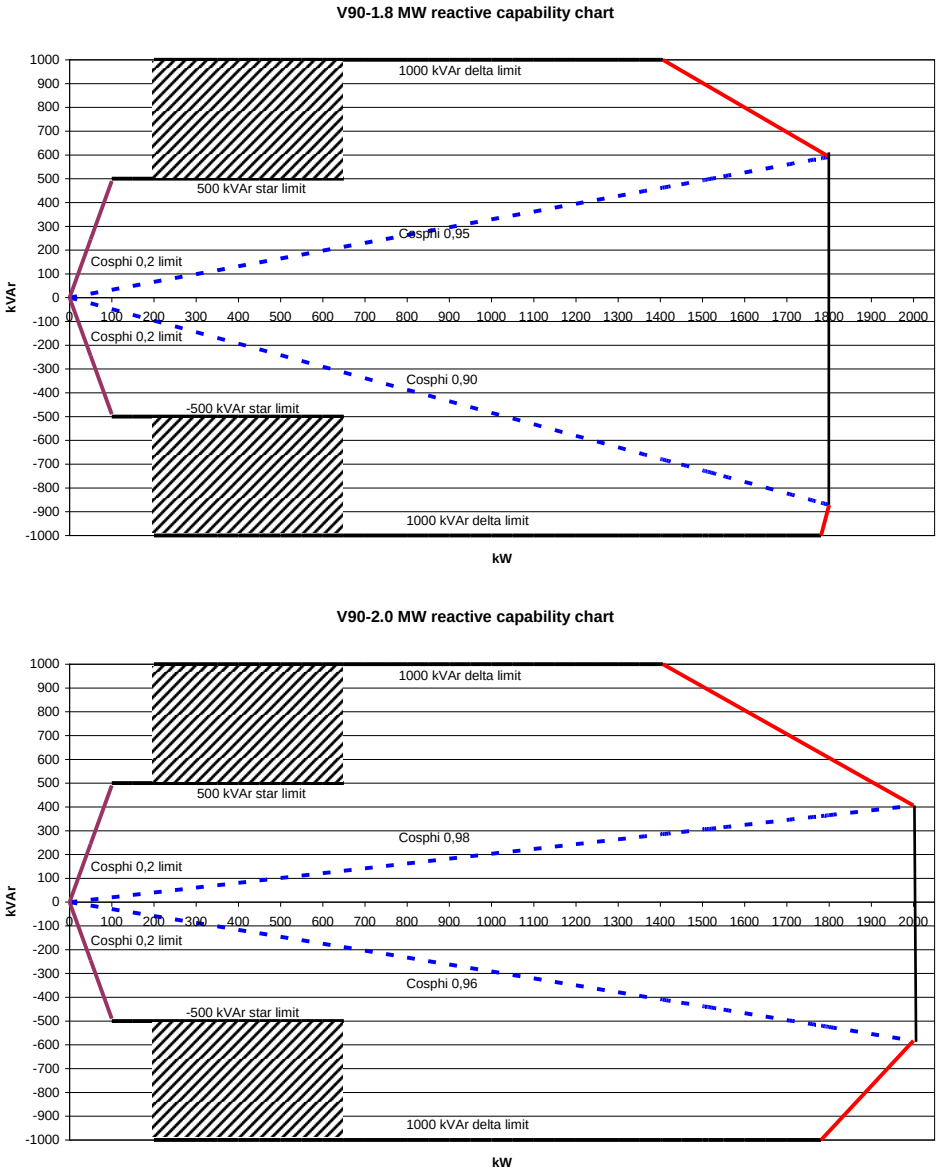

Figure 9-1: Reactive power capability

The above chart applies at the low-voltage side of the HV transformer. Reactive power is produced by the rotor converter, and therefore traditional capacitors are not used in the turbine.

At maximum active and reactive power, the turbine reduces either active or reactive power depending on which type of power has priority (for example if reactive power has priority, the active power is reduced).

9.5 Performance – Fault Ride Through

The turbine is equipped with a reinforced Vestas Converter System to gain better control of the generator during grid faults. The controllers and contactors have a UPS backup system to keep the turbine control system running during grid faults.

The pitch system is optimised to keep the turbine within normal speed conditions and the generator speed is accelerated in order to store rotational energy and be able to resume normal power production faster after a fault and keep mechanical stress on the turbine at a minimum.

The turbine is designed to stay connected during grid disturbances within the voltage tolerance curve in Figure 9-2, p. 34.

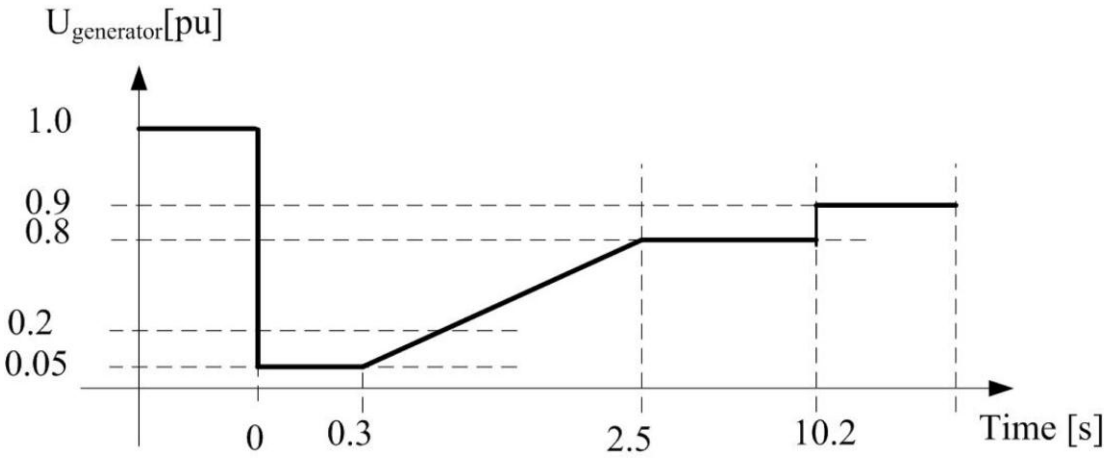

Figure 9-2: Low-voltage tolerance curve for symmetrical and asymmetrical faults

For grid disturbances outside the protection curve in Figure 9-3, p. 34, the turbine will be disconnected from the grid.

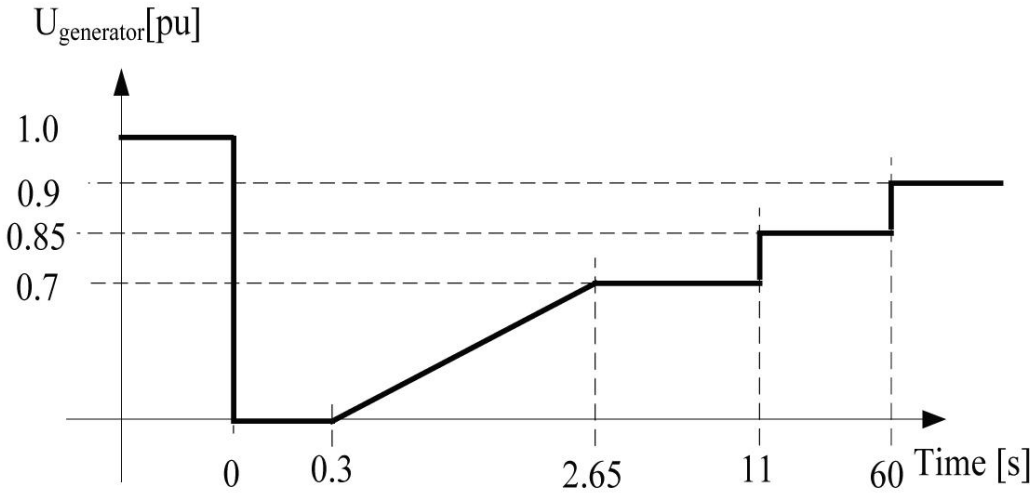

Figure 9-3: Default low voltage protection settings for symmetrical and asymmetrical faults

Power Recovery Time	
Power Recovery to 90% of Pre-Fault Level	Maximum 1.0 second

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 voltage dips, the turbine is switched from normal active and reactive power control to rotor current control. This enables the turbine to perform voltage control by supplying reactive current to the grid. The reactive current at the generator terminals is set according to the voltage level at the generator terminals.

The default value gives a reactive current part of 1 pu of the rated turbine current at the generator terminals. Figure 9-4, p. 35 indicates the reactive current contribution as a function of the voltage at the generator terminals for Star and Delta operation. The reactive current contribution is independent from the actual wind conditions and pre-fault power level.

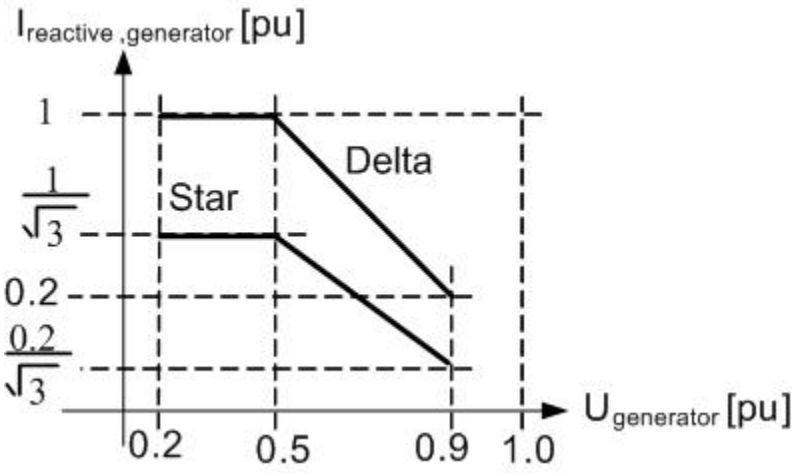

Figure 9-4: Reactive current contribution in Star and Delta drawn for 100% reactive current contribution

In Star connection, the reactive current contribution is lowered by a factor 1/√3 compared to the Delta connection. Turbines may be operated in forced Delta connection. This ensures full current injection by low wind.

During faults in the grid, high-voltage step (du/dt) in the grid voltage can occur which may pause the rotor current control for up to 50 ms before the rotor current control is resumed. During these 50 ms the generator can draw a low magnetization current from the grid.

9.6.2 Asymmetrical Reactive Current Contribution

Current reference values are reduced during asymmetrical faults to ensure ride through. The current reference values are reduced from the symmetrical case with the following reduction factor on the current references:

$$1-(u_{pu\_high} - u_{pu\_low})$$

With 'u_{pu_high}' as the highest phase-to-phase or phase-to-ground RMS per unit voltage measured and 'u_{pu_low}' as the lowest phase-to-phase or phase-to-ground RMS per unit voltage.

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. As an example, six voltage dips of duration of 200 ms down to 20% voltage within 30 minutes will normally not lead to a problem for the turbine.

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/s
Reactive Power	2.5 pu/s

Table 9-7: Maximum ramp rates for external control

To protect the turbine, active power cannot be controlled to values below the curve in Figure 9-5, p. 37.

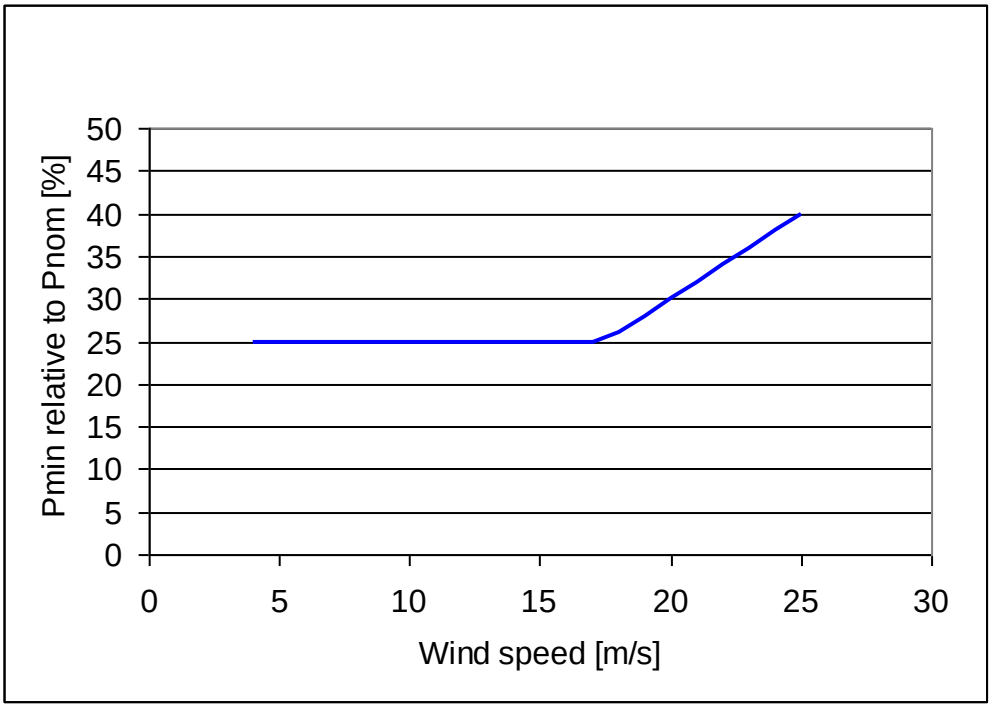

Figure 9-5: Minimum active power output dependent on wind speed

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 consumption when the wind turbine is not producing energy (generator is not connected to the grid). This is defined in the control system as Production Generator (zero).

The following components have the largest influence on the power consumption of the wind turbine:

Own Consumption		
Hydraulic Motor		20 kW
Yaw Motors 6 x 1.5 kW		9 kW
Oil Heating 3 x 0.76 kW		2.3 kW
Air Heaters	**2 x 6 kW (Standard)**	12 kW (Standard)
	3 x 6 kW (Low Temperature)	18 kW (Low Temperature)

Own Consumption	
Oil Pump for Gearbox Lubrication	3.5 kW
Average of measured no-load loss of the HV Transformer	4.0 kW

Table 9-8: Own consumption data

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

See appendix section 12.1 Performance – V90-1.8 MW, p. 42 for power curve, C_t value, and sound power level data for the V90-1.8 MW. See appendix section 12.2 Performance – V90-2.0 MW, p. 62 for power curve, C_t value, and sound power level data for the V90-2.0 MW.

Conditions for Power Curve, 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
Leading Edge	No damage
Terrain	IEC 61400-12-1
Inflow Angle (Vertical)	0 ±2°
Grid Frequency	50 ±0.5 Hz

Table 9-9: Conditions for power curve, C_t values

10 Drawings

10.1 Structural Design – Illustration of Outer Dimensions

For information on hub heights, see section 2.14 Tower Structure, p. 9.

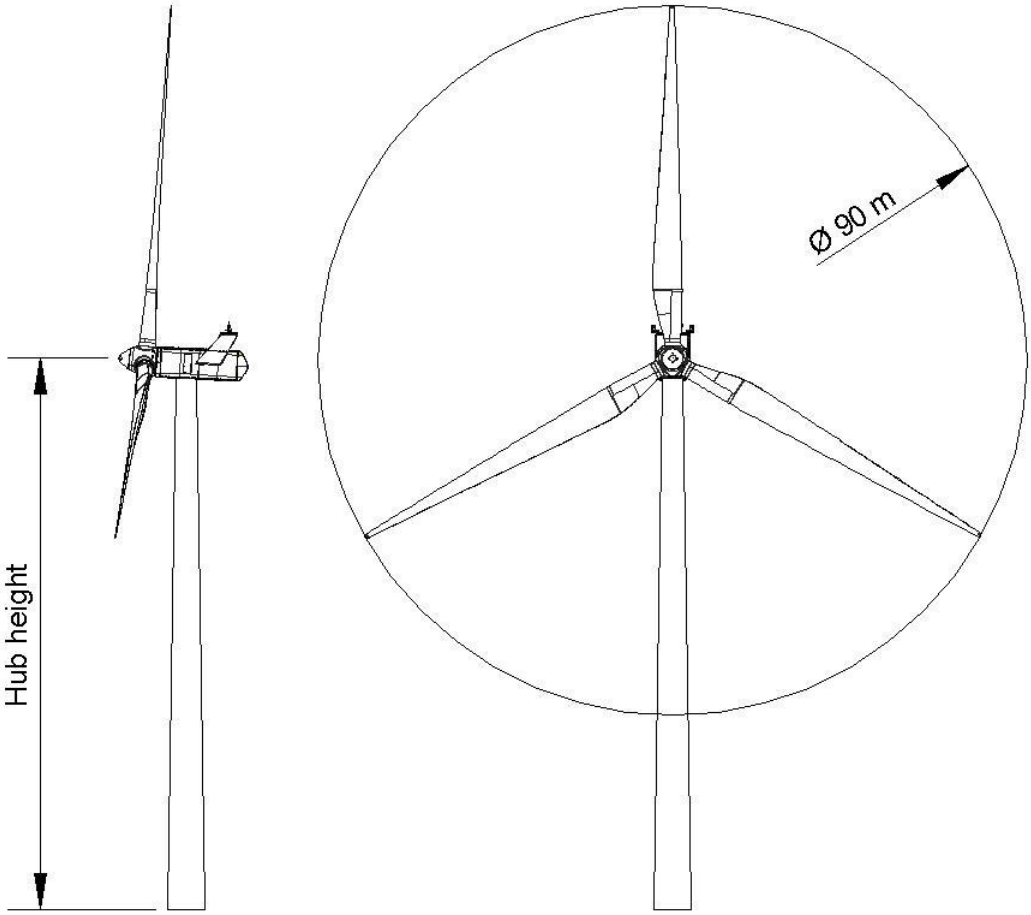

Figure 10-1: Illustration of outer dimensions: structure

10.2 Structural Design – Side View Drawing

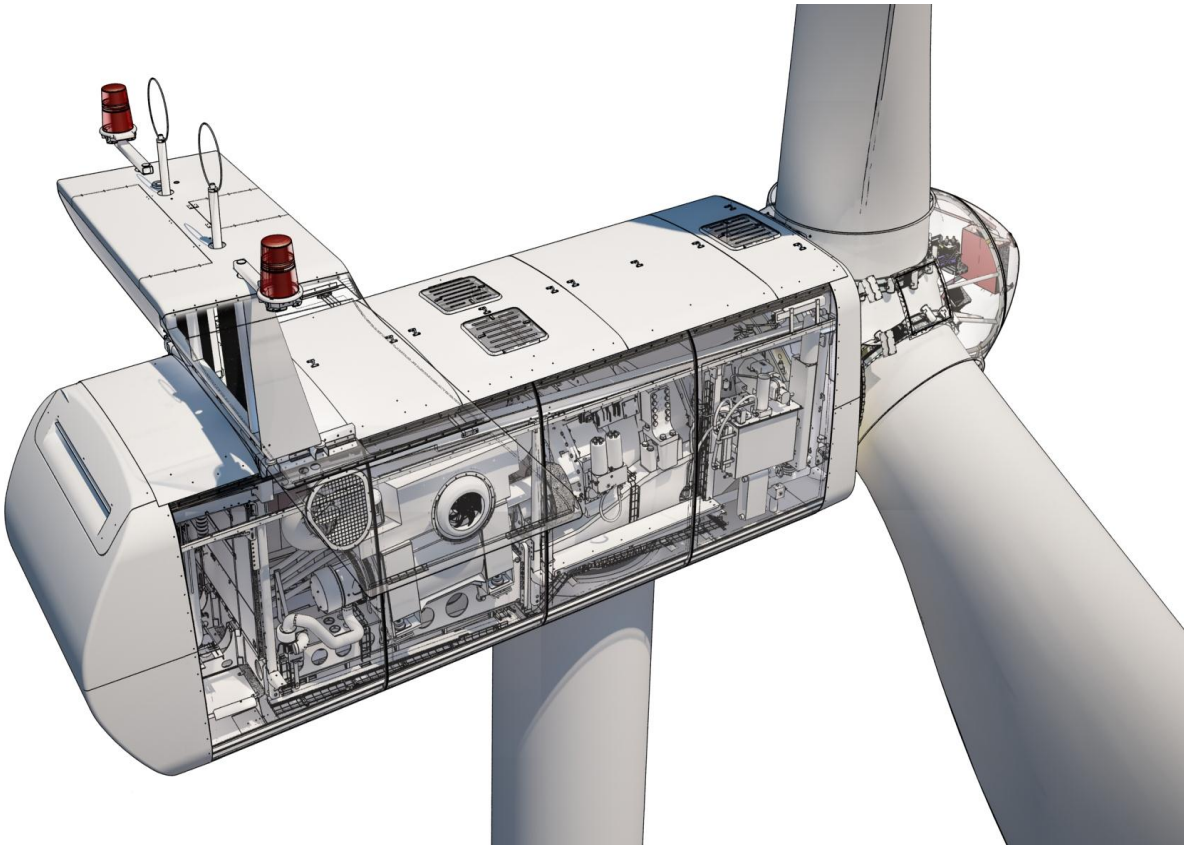

Figure 10-2: Side-view drawing

11 General Reservations, Notes, and Disclaimers

- The general specifications described in this document apply to the current version of the V90-1.8/2.0 MW wind turbine. Updated versions of the V90-1.8/2.0 MW wind turbine, which may be manufactured in the future, may have general specifications that differ from these general specifications. In the event that Vestas supplies an updated version of the V90-1.8/2.0 MW wind turbine, Vestas will provide updated general specifications applicable to the updated version.
- Vestas recommends that the grid be as close to nominal as possible with little variation in frequency.
- A certain time allowance for turbine warm-up must be expected following grid dropout and/or periods of very low ambient temperature.
- The estimated power curve for the different estimated noise levels (sound power levels) is for wind speeds at 10 minute average value at hub height and perpendicular to the rotor plane.
- All listed start/stop parameters (for example 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 Specifications’, is not, 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 Performance – V90-1.8 MW

12.1.1 V90-1.8 MW Power Curves

V90-1.8 MW Power Curves, Noise Mode 0

V90-1.8 MW 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**
4	**89**	63	66	68	70	73	75	78	80	82	85	87	92	94
4.5	**142**	105	108	112	115	119	122	125	129	132	136	139	146	149
5	**204**	154	158	163	167	172	177	181	186	191	195	200	209	213
5.5	**279**	211	217	224	230	236	242	248	254	260	266	272	285	291
6	**368**	280	288	296	304	312	320	328	336	344	352	360	376	383
6.5	**470**	356	366	377	387	398	408	418	429	439	449	459	480	490
7	**594**	453	465	478	491	504	517	530	542	555	568	581	606	619
7.5	**736**	563	579	595	611	626	642	658	673	689	705	720	751	767
8	**896**	688	707	726	745	764	783	802	821	840	858	877	915	933
8.5	**1069**	823	846	868	890	913	935	957	979	1002	1024	1046	1091	1113
9	**1247**	963	989	1015	1041	1067	1093	1118	1144	1170	1196	1222	1273	1298
9.5	**1423**	1104	1134	1163	1193	1223	1252	1281	1310	1339	1367	1395	1450	1477
10	**1578**	1241	1274	1307	1339	1372	1403	1434	1465	1497	1524	1551	1601	1623
10.5	**1689**	1374	1409	1444	1478	1513	1541	1570	1599	1627	1648	1668	1704	1720
11	**1765**	1504	1538	1572	1606	1640	1662	1685	1707	1730	1741	1753	1771	1778
11.5	**1787**	1618	1644	1671	1698	1725	1737	1749	1761	1773	1778	1783	1790	1793
12	**1796**	1704	1721	1737	1753	1769	1774	1780	1785	1790	1792	1794	1797	1798
12.5	**1799**	1756	1764	1772	1780	1788	1790	1793	1795	1797	1798	1799	1799	1800
13	**1800**	1781	1785	1788	1792	1796	1797	1798	1799	1800	1800	1800	1800	1800
13.5	**1800**	1794	1795	1797	1798	1799	1800	1800	1800	1800	1800	1800	1800	1800
14	**1800**	1798	1799	1799	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
14.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
15	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
15.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
16	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
16.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
17	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800

V90-1.8 MW 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**
17.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
18	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
18.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
19	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
19.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
20	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
20.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
21	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
21.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
22	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
22.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
23	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
23.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
24	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
24.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
25	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800

Table 12-1: V90-1.8 MW power curves, noise mode 0

V90-1.8 MW Power Curves, Noise Mode 1

V90-1.8 MW Power Curves, 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**
4	**89**	63	66	68	70	73	75	77	80	82	85	87	92	94
4.5	**142**	105	108	112	115	119	122	125	129	132	136	139	146	149
5	**204**	153	158	163	167	172	177	181	186	190	195	200	209	213
5.5	**278**	211	217	223	229	236	242	248	254	260	266	272	284	291
6	**367**	280	288	296	304	312	320	328	336	344	352	360	375	383
6.5	**470**	356	366	377	387	397	408	418	428	439	449	459	480	490
7	**594**	453	466	478	491	504	517	530	543	555	568	581	606	619
7.5	**736**	563	579	595	610	626	642	658	673	689	705	720	751	767
8	**895**	687	706	725	744	763	782	800	819	838	857	876	913	932
8.5	**1063**	819	841	863	886	908	930	952	975	997	1019	1041	1085	1107
9	**1233**	952	977	1003	1029	1055	1080	1106	1131	1157	1182	1208	1259	1284
9.5	**1399**	1083	1112	1141	1170	1199	1228	1257	1286	1315	1343	1371	1426	1453
10	**1549**	1209	1241	1274	1306	1338	1369	1400	1431	1462	1491	1520	1574	1599
10.5	**1665**	1332	1367	1401	1436	1470	1501	1532	1563	1594	1618	1641	1683	1701
11	**1750**	1454	1490	1525	1561	1597	1623	1650	1677	1703	1719	1735	1760	1769
11.5	**1782**	1569	1600	1631	1662	1693	1710	1727	1744	1760	1768	1775	1786	1789
12	**1794**	1665	1687	1709	1730	1752	1760	1769	1777	1785	1788	1791	1796	1797
12.5	**1799**	1732	1744	1756	1768	1780	1784	1788	1791	1795	1796	1797	1799	1800
13	**1800**	1769	1775	1781	1787	1793	1794	1796	1797	1799	1799	1799	1800	1800
13.5	**1800**	1787	1790	1793	1795	1798	1799	1799	1800	1800	1800	1800	1800	1800
14	**1800**	1796	1797	1798	1799	1800	1800	1800	1800	1800	1800	1800	1800	1800
14.5	**1800**	1799	1799	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
15	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
15.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
16	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
16.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
17	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
17.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
18	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
18.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
19	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
19.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800

V90-1.8 MW Power Curves, 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**
20	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
20.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
21	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
21.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
22	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
22.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
23	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
23.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
24	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
24.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
25	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800

Table 12-2: V90-1.8 MW power curves, noise mode 1

V90-1.8 MW Power Curves, Noise Mode 2

V90-1.8 MW Power Curves, 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**
4	**89**	63	66	68	70	73	75	77	80	82	85	87	92	94
4.5	**142**	105	108	112	115	119	122	125	129	132	136	139	146	149
5	**204**	153	158	163	167	172	177	181	186	190	195	200	209	213
5.5	**278**	211	217	223	230	236	242	248	254	260	266	272	284	291
6	**368**	280	288	296	304	312	320	328	336	344	352	360	375	383
6.5	**470**	356	367	377	387	398	408	418	429	439	449	460	480	490
7	**594**	453	466	479	492	504	517	530	543	556	568	581	607	619
7.5	**732**	560	576	591	607	623	638	654	669	685	701	716	747	763
8	**874**	671	690	708	727	745	764	782	801	819	838	856	893	911
8.5	**1014**	781	802	823	845	866	887	909	930	951	972	993	1036	1057
9	**1150**	886	910	934	959	983	1007	1030	1054	1078	1102	1126	1174	1198
9.5	**1284**	991	1017	1044	1071	1098	1124	1151	1178	1204	1231	1257	1310	1336
10	**1411**	1091	1121	1150	1179	1209	1238	1267	1296	1326	1354	1382	1438	1466
10.5	**1528**	1191	1223	1255	1287	1319	1349	1380	1411	1442	1471	1500	1554	1579
11	**1631**	1290	1324	1358	1392	1427	1458	1490	1522	1553	1579	1605	1650	1669
11.5	**1698**	1388	1423	1458	1494	1529	1558	1586	1614	1643	1661	1679	1708	1719
12	**1733**	1484	1518	1551	1585	1618	1639	1660	1681	1703	1713	1723	1738	1744
12.5	**1751**	1574	1601	1629	1657	1685	1698	1711	1724	1737	1741	1746	1753	1756
13	**1760**	1650	1669	1688	1707	1727	1733	1740	1747	1754	1756	1758	1761	1762
13.5	**1767**	1704	1716	1728	1740	1752	1755	1758	1762	1765	1766	1767	1767	1768
14	**1773**	1740	1747	1754	1760	1767	1768	1769	1771	1772	1772	1772	1773	1773
14.5	**1778**	1764	1767	1770	1773	1776	1777	1777	1778	1778	1778	1778	1778	1778
15	**1784**	1778	1779	1781	1782	1783	1784	1784	1784	1784	1784	1784	1784	1784
15.5	**1789**	1787	1787	1788	1788	1789	1789	1789	1789	1789	1789	1789	1789	1789
16	**1793**	1792	1792	1793	1793	1793	1793	1793	1793	1793	1793	1793	1793	1793
16.5	**1796**	1796	1796	1796	1796	1796	1796	1796	1796	1796	1796	1796	1796	1796
17	**1798**	1798	1798	1798	1798	1798	1798	1798	1798	1798	1798	1798	1798	1798
17.5	**1799**	1799	1799	1799	1799	1799	1799	1799	1799	1799	1799	1799	1799	1799
18	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
18.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
19	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
19.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800

V90-1.8 MW Power Curves, 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**
20	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
20.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
21	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
21.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
22	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
22.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
23	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
23.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
24	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
24.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
25	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800

Table 12-3: V90-1.8 MW power curves, noise mode 2

V90-1.8 MW Power Curves, Noise Mode 3

V90-1.8 MW Power Curves, 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**
4	**89**	63	66	68	70	73	75	77	80	82	85	87	92	94
4.5	**142**	105	108	112	115	119	122	126	129	132	136	139	146	149
5	**203**	153	157	162	167	171	176	180	185	189	194	198	208	212
5.5	**276**	209	215	221	227	234	240	246	252	258	264	270	282	288
6	**363**	277	285	293	301	309	316	324	332	340	348	355	371	379
6.5	**469**	356	366	376	387	397	407	417	428	438	448	458	479	489
7	**591**	451	464	476	489	502	515	527	540	553	565	578	603	616
7.5	**730**	559	575	590	606	622	637	653	668	684	699	715	746	761
8	**884**	679	698	716	735	754	772	791	810	828	847	865	902	921
8.5	**1049**	808	830	852	874	896	918	940	961	983	1005	1027	1071	1092
9	**1223**	944	970	995	1021	1046	1072	1097	1122	1148	1173	1198	1248	1274
9.5	**1402**	1087	1116	1146	1175	1204	1232	1261	1290	1318	1346	1374	1428	1455
10	**1563**	1229	1261	1293	1326	1358	1389	1420	1451	1481	1509	1536	1586	1608
10.5	**1679**	1366	1400	1435	1469	1504	1532	1561	1589	1618	1638	1659	1695	1711
11	**1762**	1498	1532	1566	1600	1634	1657	1680	1702	1725	1737	1749	1768	1775
11.5	**1786**	1614	1641	1668	1695	1722	1735	1747	1759	1771	1776	1781	1789	1791
12	**1796**	1703	1719	1736	1752	1768	1774	1779	1784	1790	1792	1794	1797	1798
12.5	**1799**	1756	1764	1772	1779	1787	1790	1792	1795	1797	1798	1798	1799	1800
13	**1800**	1781	1785	1788	1792	1796	1797	1798	1799	1800	1800	1800	1800	1800
13.5	**1800**	1794	1795	1797	1798	1799	1800	1800	1800	1800	1800	1800	1800	1800
14	**1800**	1798	1799	1799	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
14.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
15	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
15.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
16	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
16.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
17	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
17.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
18	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
18.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
19	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
19.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800

V90-1.8 MW Power Curves, 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**
20	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
20.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
21	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
21.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
22	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
22.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
23	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
23.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
24	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
24.5	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
25	**1800**	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800

Table 12-4: V90-1.8 MW power curves, noise mode 3

12.1.2 V90-1.8 MW C_t Values

V90-1.8 MW C_t Values, Noise Mode 0

V90-1.8 MW C_t Values, 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**
4	**0.838**	0.837	0.837	0.837	0.837	0.837	0.837	0.837	0.837	0.837	0.838	0.838	0.838	0.838
4.5	**0.819**	0.818	0.818	0.818	0.818	0.818	0.818	0.818	0.818	0.818	0.818	0.818	0.819	0.819
5	**0.808**	0.807	0.808	0.808	0.808	0.808	0.808	0.808	0.808	0.808	0.808	0.808	0.809	0.809
5.5	**0.804**	0.803	0.803	0.803	0.803	0.803	0.804	0.804	0.804	0.804	0.804	0.804	0.804	0.804
6	**0.804**	0.803	0.803	0.803	0.803	0.803	0.804	0.804	0.804	0.804	0.804	0.804	0.804	0.804
6.5	**0.807**	0.806	0.806	0.806	0.806	0.806	0.806	0.806	0.806	0.807	0.807	0.807	0.807	0.807
7	**0.807**	0.805	0.805	0.806	0.806	0.806	0.806	0.806	0.807	0.807	0.807	0.807	0.807	0.807
7.5	**0.801**	0.799	0.799	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.801	0.801	0.801
8	**0.784**	0.783	0.783	0.783	0.783	0.783	0.783	0.783	0.784	0.784	0.784	0.784	0.784	0.784
8.5	**0.755**	0.754	0.754	0.754	0.754	0.755	0.755	0.755	0.755	0.755	0.755	0.755	0.755	0.755
9	**0.717**	0.716	0.716	0.716	0.717	0.717	0.717	0.717	0.717	0.717	0.717	0.717	0.717	0.717
9.5	**0.672**	0.674	0.674	0.674	0.674	0.674	0.674	0.674	0.674	0.673	0.673	0.672	0.670	0.669
10	**0.618**	0.629	0.629	0.629	0.629	0.629	0.628	0.627	0.626	0.625	0.623	0.620	0.613	0.608
10.5	**0.552**	0.586	0.585	0.584	0.584	0.583	0.580	0.577	0.573	0.570	0.564	0.558	0.544	0.537
11	**0.483**	0.546	0.543	0.541	0.539	0.536	0.530	0.524	0.517	0.511	0.502	0.493	0.473	0.463
11.5	**0.414**	0.503	0.497	0.492	0.486	0.481	0.471	0.462	0.453	0.443	0.434	0.424	0.405	0.396
12	**0.357**	0.456	0.448	0.439	0.431	0.422	0.412	0.402	0.393	0.383	0.374	0.366	0.349	0.341
12.5	**0.310**	0.407	0.397	0.388	0.378	0.368	0.359	0.351	0.342	0.333	0.325	0.318	0.303	0.297
13	**0.272**	0.359	0.350	0.341	0.332	0.323	0.315	0.307	0.299	0.291	0.285	0.278	0.266	0.260
13.5	**0.240**	0.318	0.310	0.301	0.293	0.285	0.278	0.271	0.264	0.257	0.252	0.246	0.235	0.230
14	**0.214**	0.282	0.274	0.267	0.260	0.252	0.246	0.240	0.235	0.229	0.224	0.219	0.210	0.205
14.5	**0.191**	0.251	0.244	0.238	0.232	0.225	0.220	0.215	0.210	0.204	0.200	0.196	0.188	0.184
15	**0.172**	0.225	0.219	0.213	0.208	0.202	0.197	0.193	0.188	0.184	0.180	0.176	0.169	0.165
15.5	**0.156**	0.202	0.197	0.192	0.187	0.182	0.178	0.174	0.170	0.166	0.162	0.159	0.153	0.149
16	**0.141**	0.183	0.178	0.174	0.169	0.165	0.161	0.158	0.154	0.150	0.147	0.144	0.138	0.136
16.5	**0.129**	0.166	0.162	0.158	0.154	0.150	0.147	0.143	0.140	0.137	0.134	0.131	0.126	0.124
17	**0.118**	0.152	0.148	0.144	0.141	0.137	0.134	0.131	0.128	0.125	0.123	0.120	0.115	0.113
17.5	**0.108**	0.138	0.135	0.132	0.128	0.125	0.122	0.120	0.117	0.114	0.112	0.110	0.106	0.103
18	**0.099**	0.127	0.124	0.121	0.118	0.115	0.113	0.110	0.108	0.105	0.103	0.101	0.097	0.095
18.5	**0.091**	0.117	0.114	0.111	0.109	0.106	0.104	0.101	0.099	0.097	0.095	0.093	0.090	0.088
19	**0.085**	0.108	0.106	0.103	0.101	0.098	0.096	0.094	0.092	0.090	0.088	0.087	0.083	0.082

V90-1.8 MW C_t Values, 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**
19.5	**0.079**	0.100	0.098	0.096	0.093	0.091	0.089	0.087	0.085	0.083	0.082	0.080	0.077	0.076
20	**0.073**	0.093	0.091	0.089	0.087	0.085	0.083	0.081	0.079	0.078	0.076	0.075	0.072	0.070
20.5	**0.068**	0.087	0.085	0.083	0.081	0.079	0.077	0.075	0.074	0.072	0.071	0.069	0.067	0.066
21	**0.064**	0.081	0.079	0.077	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.065	0.062	0.061
21.5	**0.060**	0.076	0.074	0.072	0.070	0.069	0.067	0.066	0.065	0.063	0.062	0.061	0.059	0.057
22	**0.056**	0.071	0.069	0.068	0.066	0.064	0.063	0.062	0.060	0.059	0.058	0.057	0.055	0.054
22.5	**0.052**	0.066	0.065	0.063	0.062	0.060	0.059	0.058	0.057	0.056	0.054	0.053	0.052	0.051
23	**0.049**	0.062	0.061	0.059	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.048	0.047
23.5	**0.046**	0.058	0.057	0.056	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.045	0.045
24	**0.044**	0.055	0.054	0.053	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043	0.042
24.5	**0.041**	0.052	0.051	0.050	0.048	0.047	0.046	0.045	0.045	0.044	0.043	0.042	0.041	0.040
25	**0.039**	0.049	0.048	0.047	0.046	0.045	0.044	0.043	0.042	0.041	0.040	0.040	0.038	0.038

Table 12-5: V90-1.8 MW C_t values, noise mode 0

V90-1.8 MW C_t Values, Noise Mode 1

V90-1.8 MW 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**
4	**0.838**	0.837	0.837	0.837	0.837	0.837	0.837	0.837	0.837	0.837	0.837	0.838	0.838	0.838
4.5	**0.817**	0.816	0.816	0.816	0.817	0.817	0.817	0.817	0.817	0.817	0.817	0.817	0.817	0.817
5	**0.806**	0.805	0.805	0.805	0.805	0.805	0.805	0.806	0.806	0.806	0.806	0.806	0.806	0.806
5.5	**0.801**	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.801	0.801	0.801	0.801	0.801
6	**0.801**	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.801	0.801	0.801
6.5	**0.804**	0.803	0.803	0.803	0.803	0.803	0.804	0.804	0.804	0.804	0.804	0.804	0.805	0.805
7	**0.804**	0.803	0.803	0.803	0.803	0.803	0.804	0.804	0.804	0.804	0.804	0.804	0.804	0.805
7.5	**0.797**	0.796	0.796	0.796	0.796	0.796	0.796	0.797	0.797	0.797	0.797	0.797	0.797	0.797
8	**0.778**	0.776	0.776	0.777	0.777	0.777	0.777	0.777	0.777	0.777	0.777	0.778	0.778	0.778
8.5	**0.744**	0.743	0.743	0.743	0.743	0.743	0.743	0.743	0.744	0.744	0.744	0.744	0.744	0.744
9	**0.699**	0.698	0.698	0.699	0.699	0.699	0.699	0.699	0.699	0.699	0.699	0.699	0.699	0.699
9.5	**0.649**	0.650	0.650	0.650	0.650	0.650	0.650	0.650	0.650	0.650	0.650	0.650	0.649	0.648
10	**0.596**	0.602	0.602	0.602	0.602	0.602	0.601	0.601	0.601	0.600	0.599	0.598	0.593	0.591
10.5	**0.536**	0.557	0.557	0.556	0.556	0.556	0.554	0.552	0.551	0.549	0.545	0.541	0.531	0.525
11	**0.476**	0.517	0.516	0.515	0.514	0.513	0.509	0.505	0.501	0.497	0.490	0.483	0.467	0.459
11.5	**0.411**	0.479	0.476	0.473	0.469	0.466	0.459	0.452	0.445	0.438	0.429	0.420	0.403	0.394
12	**0.356**	0.440	0.434	0.428	0.421	0.415	0.407	0.398	0.389	0.381	0.372	0.364	0.348	0.340
12.5	**0.310**	0.398	0.390	0.382	0.374	0.365	0.357	0.349	0.340	0.332	0.325	0.317	0.303	0.296
13	**0.272**	0.355	0.347	0.338	0.330	0.321	0.314	0.306	0.299	0.291	0.285	0.278	0.266	0.260
13.5	**0.240**	0.316	0.308	0.300	0.292	0.284	0.277	0.271	0.264	0.257	0.252	0.246	0.235	0.230
14	**0.214**	0.281	0.274	0.267	0.259	0.252	0.246	0.240	0.234	0.229	0.224	0.219	0.210	0.205
14.5	**0.191**	0.251	0.244	0.238	0.231	0.225	0.220	0.215	0.210	0.204	0.200	0.196	0.188	0.184
15	**0.172**	0.225	0.219	0.213	0.208	0.202	0.197	0.193	0.188	0.184	0.180	0.176	0.169	0.165
15.5	**0.156**	0.202	0.197	0.192	0.187	0.182	0.178	0.174	0.170	0.166	0.162	0.159	0.153	0.149
16	**0.141**	0.183	0.178	0.174	0.169	0.165	0.161	0.158	0.154	0.150	0.147	0.144	0.138	0.136
16.5	**0.129**	0.166	0.162	0.158	0.154	0.150	0.147	0.143	0.140	0.137	0.134	0.131	0.126	0.124
17	**0.118**	0.152	0.148	0.144	0.141	0.137	0.134	0.131	0.128	0.125	0.123	0.120	0.115	0.113
17.5	**0.108**	0.138	0.135	0.132	0.128	0.125	0.122	0.120	0.117	0.114	0.112	0.110	0.106	0.103
18	**0.099**	0.127	0.124	0.121	0.118	0.115	0.113	0.110	0.108	0.105	0.103	0.101	0.097	0.095
18.5	**0.091**	0.117	0.114	0.111	0.109	0.106	0.104	0.101	0.099	0.097	0.095	0.093	0.090	0.088
19	**0.085**	0.108	0.106	0.103	0.101	0.098	0.096	0.094	0.092	0.090	0.088	0.087	0.083	0.082
19.5	**0.079**	0.100	0.098	0.096	0.093	0.091	0.089	0.087	0.085	0.083	0.082	0.080	0.077	0.076

V90-1.8 MW 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**
20	**0.073**	0.093	0.091	0.089	0.087	0.085	0.083	0.081	0.079	0.078	0.076	0.075	0.072	0.070
20.5	**0.068**	0.087	0.085	0.083	0.081	0.079	0.077	0.075	0.074	0.072	0.071	0.069	0.067	0.066
21	**0.064**	0.081	0.079	0.077	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.065	0.062	0.061
21.5	**0.060**	0.076	0.074	0.072	0.070	0.069	0.067	0.066	0.065	0.063	0.062	0.061	0.059	0.057
22	**0.056**	0.071	0.069	0.068	0.066	0.064	0.063	0.062	0.060	0.059	0.058	0.057	0.055	0.054
22.5	**0.052**	0.066	0.065	0.063	0.062	0.060	0.059	0.058	0.057	0.056	0.054	0.053	0.052	0.051
23	**0.049**	0.062	0.061	0.059	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.048	0.047
23.5	**0.046**	0.058	0.057	0.056	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.045	0.045
24	**0.044**	0.055	0.054	0.053	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043	0.042
24.5	**0.041**	0.052	0.051	0.050	0.048	0.047	0.046	0.045	0.045	0.044	0.043	0.042	0.041	0.040
25	**0.039**	0.049	0.048	0.047	0.046	0.045	0.044	0.043	0.042	0.041	0.040	0.040	0.038	0.038

Table 12-6: V90-1.8 MW C_t values, noise mode 1

V90-1.8 MW C_t Values, Noise Mode 2

V90-1.8 MW 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**
4	**0.838**	0.837	0.837	0.837	0.837	0.837	0.837	0.837	0.837	0.837	0.837	0.838	0.838	0.838
4.5	**0.817**	0.816	0.816	0.816	0.817	0.817	0.817	0.817	0.817	0.817	0.817	0.817	0.817	0.817
5	**0.806**	0.805	0.805	0.805	0.805	0.805	0.805	0.806	0.806	0.806	0.806	0.806	0.806	0.806
5.5	**0.801**	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.801	0.801	0.801	0.801
6	**0.800**	0.799	0.799	0.799	0.799	0.799	0.799	0.799	0.799	0.800	0.800	0.800	0.800	0.800
6.5	**0.800**	0.798	0.798	0.798	0.798	0.798	0.799	0.799	0.799	0.799	0.799	0.799	0.800	0.800
7	**0.789**	0.787	0.787	0.787	0.788	0.788	0.788	0.788	0.788	0.788	0.788	0.788	0.789	0.789
7.5	**0.762**	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.762	0.762	0.762	0.762
8	**0.719**	0.718	0.718	0.718	0.718	0.718	0.718	0.718	0.718	0.719	0.719	0.719	0.719	0.719
8.5	**0.666**	0.665	0.665	0.665	0.665	0.665	0.665	0.665	0.666	0.666	0.666	0.666	0.666	0.666
9	**0.612**	0.611	0.611	0.611	0.611	0.611	0.611	0.611	0.612	0.612	0.612	0.612	0.612	0.612
9.5	**0.562**	0.561	0.561	0.561	0.561	0.561	0.561	0.561	0.561	0.561	0.561	0.561	0.561	0.561
10	**0.516**	0.515	0.516	0.516	0.516	0.516	0.516	0.516	0.516	0.516	0.516	0.516	0.515	0.514
10.5	**0.472**	0.476	0.476	0.476	0.476	0.476	0.476	0.476	0.475	0.475	0.474	0.473	0.471	0.469
11	**0.431**	0.441	0.441	0.441	0.441	0.441	0.440	0.440	0.439	0.438	0.436	0.433	0.427	0.422
11.5	**0.385**	0.410	0.409	0.409	0.408	0.408	0.406	0.404	0.401	0.399	0.394	0.390	0.379	0.373
12	**0.340**	0.381	0.380	0.378	0.377	0.375	0.371	0.367	0.363	0.358	0.352	0.346	0.334	0.327
12.5	**0.299**	0.354	0.351	0.348	0.345	0.341	0.336	0.330	0.324	0.319	0.312	0.306	0.293	0.287
13	**0.264**	0.327	0.322	0.317	0.312	0.307	0.301	0.295	0.289	0.282	0.276	0.270	0.259	0.253
13.5	**0.235**	0.299	0.293	0.287	0.281	0.276	0.270	0.263	0.257	0.251	0.246	0.240	0.230	0.225
14	**0.210**	0.271	0.265	0.259	0.253	0.247	0.241	0.236	0.230	0.224	0.219	0.215	0.205	0.201
14.5	**0.188**	0.245	0.239	0.234	0.228	0.222	0.217	0.211	0.206	0.201	0.197	0.193	0.184	0.181
15	**0.170**	0.222	0.216	0.211	0.205	0.200	0.195	0.191	0.186	0.181	0.178	0.174	0.167	0.163
15.5	**0.154**	0.201	0.196	0.191	0.186	0.181	0.177	0.172	0.168	0.164	0.161	0.157	0.151	0.148
16	**0.140**	0.182	0.178	0.173	0.169	0.164	0.160	0.157	0.153	0.149	0.146	0.143	0.137	0.135
16.5	**0.128**	0.166	0.162	0.158	0.154	0.149	0.146	0.143	0.140	0.136	0.134	0.131	0.125	0.123
17	**0.117**	0.151	0.148	0.144	0.140	0.137	0.134	0.131	0.128	0.125	0.122	0.120	0.115	0.113
17.5	**0.107**	0.138	0.135	0.132	0.128	0.125	0.122	0.120	0.117	0.114	0.112	0.110	0.105	0.103
18	**0.099**	0.127	0.124	0.121	0.118	0.115	0.112	0.110	0.107	0.105	0.103	0.101	0.097	0.095
18.5	**0.091**	0.117	0.114	0.111	0.109	0.106	0.104	0.101	0.099	0.097	0.095	0.093	0.090	0.088
19	**0.085**	0.108	0.106	0.103	0.101	0.098	0.096	0.094	0.092	0.090	0.088	0.086	0.083	0.082
19.5	**0.079**	0.100	0.098	0.096	0.093	0.091	0.089	0.087	0.085	0.083	0.082	0.080	0.077	0.076

V90-1.8 MW 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**
20	**0.073**	0.093	0.091	0.089	0.087	0.085	0.083	0.081	0.079	0.077	0.076	0.075	0.072	0.070
20.5	**0.068**	0.087	0.085	0.083	0.081	0.079	0.077	0.075	0.074	0.072	0.071	0.069	0.067	0.066
21	**0.064**	0.081	0.079	0.077	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.065	0.062	0.061
21.5	**0.060**	0.076	0.074	0.072	0.070	0.069	0.067	0.066	0.065	0.063	0.062	0.061	0.059	0.057
22	**0.056**	0.071	0.069	0.068	0.066	0.064	0.063	0.062	0.060	0.059	0.058	0.057	0.055	0.054
22.5	**0.052**	0.066	0.065	0.063	0.062	0.060	0.059	0.058	0.057	0.056	0.054	0.053	0.052	0.051
23	**0.049**	0.062	0.061	0.059	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.048	0.047
23.5	**0.046**	0.058	0.057	0.056	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.045	0.045
24	**0.044**	0.055	0.054	0.053	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043	0.042
24.5	**0.041**	0.052	0.051	0.050	0.048	0.047	0.046	0.045	0.045	0.044	0.043	0.042	0.041	0.040
25	**0.039**	0.049	0.048	0.047	0.046	0.045	0.044	0.043	0.042	0.041	0.040	0.040	0.038	0.038

Table 12-7: V90-1.8 MW C_t values, noise mode 2

V90-1.8 MW C_t Values, Noise Mode 3

V90-1.8 MW 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**
4	**0.836**	0.835	0.835	0.835	0.835	0.835	0.835	0.835	0.835	0.835	0.835	0.835	0.836	0.836
4.5	**0.800**	0.799	0.799	0.799	0.799	0.799	0.799	0.799	0.799	0.799	0.800	0.800	0.800	0.800
5	**0.766**	0.766	0.766	0.766	0.766	0.766	0.766	0.766	0.766	0.766	0.766	0.766	0.767	0.767
5.5	**0.748**	0.747	0.747	0.747	0.747	0.747	0.748	0.748	0.748	0.748	0.748	0.748	0.748	0.748
6	**0.745**	0.744	0.744	0.745	0.745	0.745	0.745	0.745	0.745	0.745	0.745	0.745	0.745	0.745
6.5	**0.765**	0.764	0.764	0.764	0.764	0.764	0.765	0.765	0.765	0.765	0.765	0.765	0.765	0.766
7	**0.758**	0.756	0.756	0.756	0.756	0.757	0.757	0.757	0.757	0.757	0.757	0.757	0.758	0.758
7.5	**0.748**	0.746	0.747	0.747	0.747	0.747	0.747	0.748	0.748	0.748	0.748	0.748	0.748	0.748
8	**0.731**	0.730	0.730	0.730	0.730	0.731	0.731	0.731	0.731	0.731	0.731	0.731	0.731	0.731
8.5	**0.707**	0.706	0.706	0.706	0.706	0.706	0.707	0.707	0.707	0.707	0.707	0.707	0.707	0.707
9	**0.680**	0.679	0.679	0.679	0.679	0.679	0.679	0.679	0.679	0.679	0.680	0.680	0.679	0.679
9.5	**0.646**	0.648	0.648	0.648	0.649	0.649	0.648	0.648	0.648	0.648	0.648	0.647	0.645	0.644
10	**0.604**	0.615	0.615	0.614	0.614	0.614	0.613	0.613	0.612	0.611	0.609	0.606	0.599	0.595
10.5	**0.544**	0.578	0.577	0.577	0.576	0.575	0.572	0.569	0.566	0.563	0.557	0.551	0.537	0.530
11	**0.481**	0.541	0.539	0.537	0.535	0.533	0.527	0.520	0.514	0.508	0.499	0.490	0.471	0.461
11.5	**0.413**	0.501	0.495	0.490	0.485	0.479	0.470	0.461	0.452	0.442	0.433	0.423	0.404	0.395
12	**0.356**	0.456	0.447	0.439	0.430	0.422	0.412	0.402	0.392	0.383	0.374	0.365	0.349	0.341
12.5	**0.310**	0.407	0.397	0.387	0.378	0.368	0.359	0.350	0.342	0.333	0.325	0.318	0.303	0.297
13	**0.272**	0.359	0.350	0.341	0.332	0.322	0.315	0.307	0.299	0.291	0.285	0.278	0.266	0.260
13.5	**0.240**	0.318	0.310	0.301	0.293	0.284	0.278	0.271	0.264	0.257	0.252	0.246	0.235	0.230
14	**0.214**	0.282	0.274	0.267	0.260	0.252	0.246	0.240	0.235	0.229	0.224	0.219	0.210	0.205
14.5	**0.191**	0.251	0.244	0.238	0.232	0.225	0.220	0.215	0.210	0.204	0.200	0.196	0.188	0.184
15	**0.172**	0.225	0.219	0.213	0.208	0.202	0.197	0.193	0.188	0.184	0.180	0.176	0.169	0.165
15.5	**0.156**	0.202	0.197	0.192	0.187	0.182	0.178	0.174	0.170	0.166	0.162	0.159	0.153	0.149
16	**0.141**	0.183	0.178	0.174	0.169	0.165	0.161	0.158	0.154	0.150	0.147	0.144	0.138	0.136
16.5	**0.129**	0.166	0.162	0.158	0.154	0.150	0.147	0.143	0.140	0.137	0.134	0.131	0.126	0.124
17	**0.118**	0.152	0.148	0.144	0.141	0.137	0.134	0.131	0.128	0.125	0.123	0.120	0.115	0.113
17.5	**0.108**	0.138	0.135	0.132	0.128	0.125	0.122	0.120	0.117	0.114	0.112	0.110	0.106	0.103
18	**0.099**	0.127	0.124	0.121	0.118	0.115	0.113	0.110	0.108	0.105	0.103	0.101	0.097	0.095
18.5	**0.091**	0.117	0.114	0.111	0.109	0.106	0.104	0.101	0.099	0.097	0.095	0.093	0.090	0.088
19	**0.085**	0.108	0.106	0.103	0.101	0.098	0.096	0.094	0.092	0.090	0.088	0.087	0.083	0.082
19.5	**0.079**	0.100	0.098	0.096	0.093	0.091	0.089	0.087	0.085	0.083	0.082	0.080	0.077	0.076

V90-1.8 MW 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**
20	**0.073**	0.093	0.091	0.089	0.087	0.085	0.083	0.081	0.079	0.078	0.076	0.075	0.072	0.070
20.5	**0.068**	0.087	0.085	0.083	0.081	0.079	0.077	0.075	0.074	0.072	0.071	0.069	0.067	0.066
21	**0.064**	0.081	0.079	0.077	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.065	0.062	0.061
21.5	**0.060**	0.076	0.074	0.072	0.070	0.069	0.067	0.066	0.065	0.063	0.062	0.061	0.059	0.057
22	**0.056**	0.071	0.069	0.068	0.066	0.064	0.063	0.062	0.060	0.059	0.058	0.057	0.055	0.054
22.5	**0.052**	0.066	0.065	0.063	0.062	0.060	0.059	0.058	0.057	0.056	0.054	0.053	0.052	0.051
23	**0.049**	0.062	0.061	0.059	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.048	0.047
23.5	**0.046**	0.058	0.057	0.056	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.045	0.045
24	**0.044**	0.055	0.054	0.053	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043	0.042
24.5	**0.041**	0.052	0.051	0.050	0.048	0.047	0.046	0.045	0.045	0.044	0.043	0.042	0.041	0.040
25	**0.039**	0.049	0.048	0.047	0.046	0.045	0.044	0.043	0.042	0.041	0.040	0.040	0.038	0.038

Table 12-8: V90-1.8 MW C_t values, noise mode 3

12.1.3 V90-1.8 MW Sound Power Level at Hub Height

V90-1.8 MW Sound Power Level at Hub Height, Noise Mode 0

V90-1.8 MW 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	**80 m**	**95 m**	**105 m**
L_{WA} @ 3 m/s (10 m above ground) [dBA]	92.6	92.8	92.9
Wind speed at hub height [m/s]	4.2	4.3	4.4
L_{WA} @ 4 m/s (10 m above ground) [dBA]	95.6	96.1	96.4
Wind speed at hub height [m/s]	5.6	5.7	5.8
L_{WA} @ 5 m/s (10 m above ground) [dBA]	99.8	100.3	100.6
Wind speed at hub height [m/s]	7.0	7.2	7.3
L_{WA} @ 6 m/s (10 m above ground) [dBA]	102.8	103.0	103.1
Wind speed at hub height [m/s]	8.4	8.6	8.7
L_{WA} @ 7 m/s (10 m above ground) [dBA]	103.7	103.8	103.8
Wind speed at hub height [m/s]	9.8	10.0	10.2
L_{WA} @ 8 m/s (10 m above ground) [dBA]	104.0	104.0	104.0
Wind speed at hub height [m/s]	11.2	11.5	11.7
L_{WA} @ 9 m/s (10 m above ground) [dBA]	104.0	104.0	104.0
Wind speed at hub height [m/s]	12.6	12.9	13.1
L_{WA} @ 10 m/s (10 m above ground) [dBA]	104.0	104.0	104.0
Wind speed at hub height [m/s]	13.9	14.3	14.6
L_{WA} @ 11 m/s (10 m above ground) [dBA]	104.0	104.0	104.0
Wind speed at hub height [m/s]	15.3	15.8	16.0
L_{WA} @ 12 m/s (10 m above ground) [dBA]	104.0	104.0	104.0
Wind speed at hub height [m/s]	16.7	17.2	17.5
L_{WA} @ 13 m/s (10 m above ground) [dBA]	104.0	104.0	104.0
Wind speed at hub height [m/s]	18.1	18.6	18.9

Table 12-9: V90-1.8 MW sound power level at hub height, noise mode 0

V90-1.8 MW Sound Power Level at Hub Height, Noise Mode 1

V90-1.8 MW 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	**80 m**	**95 m**	**105 m**
L_{wA} @ 3 m/s (10 m above ground) [dBA]	92.6	92.8	92.9
Wind speed at hub height [m/s]	4.2	4.3	4.4
L_{wA} @ 4 m/s (10 m above ground) [dBA]	95.6	96.1	96.4
Wind speed at hub height [m/s]	5.6	5.7	5.8
L_{wA} @ 5 m/s (10 m above ground) [dBA]	99.8	100.3	100.6
Wind speed at hub height [m/s]	7.0	7.2	7.3
L_{wA} @ 6 m/s (10 m above ground) [dBA]	102.7	102.9	103.0
Wind speed at hub height [m/s]	8.4	8.6	8.7
L_{wA} @ 7 m/s (10 m above ground) [dBA]	103.0	103.0	103.0
Wind speed at hub height [m/s]	9.8	10.0	10.2
L_{wA} @ 8 m/s (10 m above ground) [dBA]	103.0	103.0	103.0
Wind speed at hub height [m/s]	11.2	11.5	11.7
L_{wA} @ 9 m/s (10 m above ground) [dBA]	103.0	103.0	103.0
Wind speed at hub height [m/s]	12.6	12.9	13.1
L_{wA} @ 10 m/s (10 m above ground) [dBA]	103.0	103.0	103.0
Wind speed at hub height [m/s]	13.9	14.3	14.6
L_{wA} @ 11 m/s (10 m above ground) [dBA]	103.0	103.0	103.0
Wind speed at hub height [m/s]	15.3	15.8	16.0
L_{wA} @ 12 m/s (10 m above ground) [dBA]	103.0	103.0	103.0
Wind speed at hub height [m/s]	16.7	17.2	17.5
L_{wA} @ 13 m/s (10 m above ground) [dBA]	103.0	103.0	103.0
Wind speed at hub height [m/s]	18.1	18.6	18.9

Table 12-10: V90-1.8 MW sound power level at hub height, noise mode 1

V90-1.8 MW Sound Power Level at Hub Height, Noise Mode 2

V90-1.8 MW 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	**80 m**	**95 m**	**105 m**
L_{wA} @ 3 m/s (10 m above ground) [dBA]	92.6	92.8	92.9
Wind speed at hub height [m/s]	4.2	4.3	4.4
L_{wA} @ 4 m/s (10 m above ground) [dBA]	95.6	96.1	96.4
Wind speed at hub height [m/s]	5.6	5.7	5.8
L_{wA} @ 5 m/s (10 m above ground) [dBA]	99.8	100.1	100.2
Wind speed at hub height [m/s]	7.0	7.2	7.3
L_{wA} @ 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	8.7
L_{wA} @ 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	10.2
L_{wA} @ 8 m/s (10 m above ground) [dBA]	101.0	101.0	101.0
Wind speed at hub height [m/s]	11.2	11.5	11.7
L_{wA} @ 9 m/s (10 m above ground) [dBA]	101.0	101.0	101.0
Wind speed at hub height [m/s]	12.6	12.9	13.1
L_{wA} @ 10 m/s (10 m above ground) [dBA]	101.0	101.0	101.0
Wind speed at hub height [m/s]	13.9	14.3	14.6
L_{wA} @ 11 m/s (10 m above ground) [dBA]	101.0	101.0	101.0
Wind speed at hub height [m/s]	15.3	15.8	16.0
L_{wA} @ 12 m/s (10 m above ground) [dBA]	101.0	101.0	101.0
Wind speed at hub height [m/s]	16.7	17.2	17.5
L_{wA} @ 13 m/s (10 m above ground) [dBA]	101.0	101.0	101.0
Wind speed at hub height [m/s]	18.1	18.6	18.9

Table 12-11: V90-1.8 MW sound power level at hub height, noise mode 2

V90-1.8 MW Sound Power Level at Hub Height, Noise Mode 3

V90-1.8 MW 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/m3**		
Hub Height	**80 m**	**95 m**	**105 m**
L_{wA} @ 3 m/s (10 m above ground) [dBA]	92.5	92.5	92.6
Wind speed at hub height [m/s]	4.2	4.3	4.4
L_{wA} @ 4 m/s (10 m above ground) [dBA]	94.6	95.0	95.3
Wind speed at hub height [m/s]	5.6	5.7	5.8
L_{wA} @ 5 m/s (10 m above ground) [dBA]	98.8	99.3	99.6
Wind speed at hub height [m/s]	7.0	7.2	7.3
L_{wA} @ 6 m/s (10 m above ground) [dBA]	101.8	102.0	102.1
Wind speed at hub height [m/s]	8.4	8.6	8.7
L_{wA} @ 7 m/s (10 m above ground) [dBA]	103.5	103.8	103.8
Wind speed at hub height [m/s]	9.8	10.0	10.2
L_{wA} @ 8 m/s (10 m above ground) [dBA]	104.0	104.0	104.0
Wind speed at hub height [m/s]	11.2	11.5	11.7
L_{wA} @ 9 m/s (10 m above ground) [dBA]	104.0	104.0	104.0
Wind speed at hub height [m/s]	12.6	12.9	13.1
L_{wA} @ 10 m/s (10 m above ground) [dBA]	104.0	104.0	104.0
Wind speed at hub height [m/s]	13.9	14.3	14.6
L_{wA} @ 11 m/s (10 m above ground) [dBA]	104.0	104.0	104.0
Wind speed at hub height [m/s]	15.3	15.8	16.0
L_{wA} @ 12 m/s (10 m above ground) [dBA]	104.0	104.0	104.0
Wind speed at hub height [m/s]	16.7	17.2	17.5
L_{wA} @ 13 m/s (10 m above ground) [dBA]	104.0	104.0	104.0
Wind speed at hub height [m/s]	18.1	18.6	18.9

Table 12-12: V90-1.8 MW sound power level at hub height, noise mode 3

12.2 Performance – V90-2.0 MW

12.2.1 V90-2.0 MW Power Curves

V90-2.0 MW Power Curves, Noise Mode 0

V90-2.0 MW 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**
4	**89**	63	66	68	70	73	75	78	80	82	85	87	92	94
4.5	**142**	105	108	112	115	119	122	125	129	132	136	139	146	149
5	**204**	154	158	163	167	172	177	181	186	191	195	200	209	213
5.5	**279**	211	217	224	230	236	242	248	254	260	266	272	285	291
6	**368**	280	288	296	304	312	320	328	336	344	352	360	376	383
6.5	**470**	356	366	377	387	398	408	418	429	439	449	459	480	490
7	**594**	453	465	478	491	504	517	530	542	555	568	581	606	619
7.5	**736**	563	579	595	611	626	642	658	673	689	705	720	751	767
8	**896**	688	707	726	745	764	783	802	821	840	858	877	915	933
8.5	**1069**	823	846	868	890	913	935	957	979	1002	1024	1046	1091	1113
9	**1247**	963	989	1015	1041	1067	1093	1118	1144	1170	1196	1222	1273	1299
9.5	**1428**	1104	1134	1163	1193	1223	1252	1281	1311	1340	1370	1399	1457	1485
10	**1599**	1241	1274	1307	1340	1374	1406	1439	1472	1505	1536	1568	1629	1660
10.5	**1753**	1375	1412	1448	1484	1521	1555	1590	1625	1660	1691	1722	1780	1806
11	**1881**	1506	1545	1585	1624	1664	1698	1733	1767	1802	1828	1855	1900	1919
11.5	**1951**	1633	1672	1711	1751	1790	1818	1847	1875	1903	1919	1935	1960	1969
12	**1981**	1752	1786	1820	1854	1889	1906	1924	1942	1959	1967	1974	1985	1989
12.5	**1994**	1852	1876	1900	1924	1949	1957	1966	1975	1984	1987	1990	1995	1997
13	**1998**	1923	1937	1951	1964	1978	1982	1986	1990	1994	1996	1997	1999	1999
13.5	**2000**	1962	1969	1977	1985	1992	1994	1996	1997	1999	1999	2000	2000	2000
14	**2000**	1984	1988	1991	1994	1998	1998	1999	1999	2000	2000	2000	2000	2000
14.5	**2000**	1994	1996	1997	1998	2000	2000	2000	2000	2000	2000	2000	2000	2000
15	**2000**	1998	1998	1999	1999	2000	2000	2000	2000	2000	2000	2000	2000	2000
15.5	**2000**	1999	1999	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
16	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
16.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
17	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
17.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
18	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000

V90-2.0 MW 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**
18.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
19	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
19.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
20	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
20.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
21	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
21.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
22	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
22.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
23	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
23.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
24	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
24.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
25	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000

Table 12-13: V90-2.0 MW power curves, noise mode 0

V90-2.0 MW Power Curves, Noise Mode 1

V90-2.0 MW Power Curves, 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**
4	**89**	63	66	68	70	73	75	77	80	82	85	87	92	94
4.5	**142**	105	108	112	115	119	122	125	129	132	136	139	146	149
5	**204**	153	158	163	167	172	177	181	186	190	195	200	209	213
5.5	**278**	211	217	223	229	236	242	248	254	260	266	272	284	291
6	**367**	280	288	296	304	312	320	328	336	344	352	360	375	383
6.5	**470**	356	366	377	387	397	408	418	428	439	449	459	480	490
7	**594**	453	466	478	491	504	517	530	543	555	568	581	606	619
7.5	**736**	563	579	595	610	626	642	658	673	689	705	720	751	767
8	**895**	687	706	725	744	763	782	800	819	838	857	876	913	932
8.5	**1063**	819	841	863	886	908	930	952	975	997	1019	1041	1085	1107
9	**1233**	952	977	1003	1029	1055	1080	1106	1131	1157	1182	1208	1259	1284
9.5	**1401**	1082	1111	1140	1169	1199	1227	1256	1285	1314	1343	1372	1429	1458
10	**1561**	1209	1241	1273	1306	1338	1370	1402	1434	1467	1498	1529	1591	1622
10.5	**1710**	1332	1368	1403	1439	1474	1509	1543	1578	1613	1645	1677	1739	1768
11	**1842**	1455	1493	1531	1570	1608	1644	1680	1717	1753	1783	1812	1866	1890
11.5	**1928**	1575	1615	1655	1695	1735	1768	1800	1832	1865	1886	1907	1941	1954
12	**1971**	1693	1730	1768	1806	1843	1867	1890	1914	1937	1948	1960	1976	1982
12.5	**1989**	1800	1830	1860	1890	1920	1933	1947	1960	1974	1979	1984	1992	1994
13	**1996**	1886	1905	1925	1944	1963	1970	1976	1983	1989	1992	1994	1997	1999
13.5	**1999**	1938	1950	1961	1973	1984	1988	1991	1994	1997	1998	1999	2000	2000
14	**2000**	1971	1977	1983	1989	1995	1996	1997	1998	1999	2000	2000	2000	2000
14.5	**2000**	1989	1991	1994	1996	1999	1999	1999	2000	2000	2000	2000	2000	2000
15	**2000**	1996	1997	1998	1998	2000	2000	2000	2000	2000	2000	2000	2000	2000
15.5	**2000**	1998	1999	1999	1999	2000	2000	2000	2000	2000	2000	2000	2000	2000
16	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
16.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
17	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
17.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
18	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
18.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
19	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
19.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000

V90-2.0 MW Power Curves, 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**
20	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
20.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
21	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
21.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
22	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
22.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
23	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
23.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
24	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
24.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
25	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000

Table 12-14: V90-2.0 MW power curves, noise mode 1

V90-2.0 MW Power Curves, Noise Mode 2

V90-2.0 MW Power Curves, 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**
4	**89**	63	66	68	70	73	75	77	80	82	85	87	92	94
4.5	**142**	105	108	112	115	119	122	125	129	132	136	139	146	149
5	**204**	153	158	163	167	172	177	181	186	190	195	200	209	213
5.5	**278**	211	217	223	230	236	242	248	254	260	266	272	284	291
6	**368**	280	288	296	304	312	320	328	336	344	352	360	375	383
6.5	**470**	356	367	377	387	398	408	418	429	439	449	460	480	490
7	**594**	453	466	479	492	504	517	530	543	556	568	581	607	619
7.5	**732**	560	576	591	607	623	638	654	669	685	701	716	747	763
8	**874**	671	690	708	727	745	764	782	801	819	838	856	893	911
8.5	**1014**	781	802	823	845	866	887	909	930	951	972	993	1036	1057
9	**1150**	886	910	934	959	983	1007	1030	1054	1078	1102	1126	1174	1198
9.5	**1284**	991	1017	1044	1071	1098	1124	1151	1178	1204	1231	1257	1310	1337
10	**1413**	1091	1121	1150	1179	1209	1238	1267	1297	1326	1355	1384	1442	1471
10.5	**1539**	1191	1223	1255	1287	1319	1350	1382	1414	1446	1477	1508	1569	1599
11	**1662**	1290	1324	1359	1393	1427	1461	1496	1530	1564	1596	1629	1692	1721
11.5	**1768**	1388	1425	1461	1498	1535	1571	1606	1642	1677	1707	1738	1793	1817
12	**1849**	1486	1525	1564	1603	1642	1675	1709	1742	1776	1800	1824	1865	1882
12.5	**1899**	1585	1624	1662	1701	1740	1768	1796	1824	1852	1867	1883	1908	1918
13	**1927**	1683	1718	1753	1788	1823	1842	1862	1881	1901	1909	1918	1931	1936
13.5	**1944**	1772	1800	1827	1854	1882	1894	1906	1918	1930	1935	1940	1946	1948
14	**1955**	1845	1864	1883	1903	1922	1929	1936	1943	1950	1951	1953	1955	1956
14.5	**1963**	1900	1912	1925	1937	1949	1952	1955	1958	1962	1962	1963	1964	1964
15	**1973**	1939	1946	1953	1960	1967	1968	1969	1970	1972	1972	1972	1973	1973
15.5	**1980**	1965	1968	1972	1975	1978	1979	1979	1980	1980	1980	1980	1980	1980
16	**1987**	1981	1982	1983	1985	1986	1986	1986	1987	1987	1987	1987	1987	1987
16.5	**1992**	1989	1990	1990	1991	1991	1991	1992	1992	1992	1992	1992	1992	1992
17	**1995**	1994	1994	1995	1995	1995	1995	1995	1995	1995	1995	1995	1995	1995
17.5	**1998**	1998	1998	1998	1998	1998	1998	1998	1998	1998	1998	1998	1998	1998
18	**1999**	1999	1999	1999	1999	1999	1999	1999	1999	1999	1999	1999	1999	1999
18.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
19	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
19.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000

V90-2.0 MW Power Curves, 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**
20	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
20.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
21	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
21.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
22	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
22.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
23	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
23.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
24	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
24.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
25	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000

Table 12-15: V90-2.0 MW power curves, noise mode 2

V90-2.0 MW Power Curves, Noise Mode 3

V90-2.0 MW Power Curves, 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**
4	**89**	63	66	68	70	73	75	77	80	82	85	87	92	94
4.5	**142**	105	108	112	115	119	122	126	129	132	136	139	146	149
5	**203**	153	157	162	167	171	176	180	185	189	194	198	208	212
5.5	**276**	209	215	221	227	234	240	246	252	258	264	270	282	288
6	**363**	277	285	293	301	309	316	324	332	340	348	355	371	379
6.5	**469**	356	366	376	387	397	407	417	428	438	448	458	479	489
7	**591**	451	464	476	489	502	515	527	540	553	565	578	603	616
7.5	**730**	559	575	590	606	622	637	653	668	684	699	715	746	761
8	**884**	679	698	716	735	754	772	791	810	828	847	865	902	921
8.5	**1049**	808	830	852	874	896	918	940	961	983	1005	1027	1071	1092
9	**1224**	944	970	995	1021	1046	1072	1097	1122	1148	1173	1198	1249	1274
9.5	**1407**	1087	1116	1146	1175	1204	1233	1262	1291	1320	1349	1378	1435	1463
10	**1583**	1229	1261	1294	1327	1360	1392	1424	1457	1489	1521	1552	1613	1643
10.5	**1743**	1367	1403	1439	1475	1511	1546	1581	1615	1650	1681	1712	1769	1795
11	**1876**	1499	1539	1578	1617	1656	1691	1726	1761	1796	1822	1849	1895	1915
11.5	**1949**	1628	1668	1707	1747	1786	1815	1843	1871	1900	1916	1932	1958	1967
12	**1980**	1749	1783	1818	1852	1886	1904	1922	1940	1958	1965	1973	1984	1988
12.5	**1993**	1851	1875	1899	1923	1948	1956	1965	1974	1983	1986	1990	1995	1996
13	**1998**	1922	1936	1950	1964	1977	1982	1986	1990	1994	1995	1997	1999	1999
13.5	**2000**	1961	1969	1977	1985	1992	1994	1996	1997	1999	1999	2000	2000	2000
14	**2000**	1984	1987	1991	1994	1998	1998	1999	1999	2000	2000	2000	2000	2000
14.5	**2000**	1994	1996	1997	1998	1999	1999	2000	2000	2000	2000	2000	2000	2000
15	**2000**	1998	1998	1999	1999	2000	2000	2000	2000	2000	2000	2000	2000	2000
15.5	**2000**	1999	1999	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
16	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
16.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
17	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
17.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
18	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
18.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
19	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
19.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000

V90-2.0 MW Power Curves, 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**
20	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
20.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
21	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
21.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
22	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
22.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
23	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
23.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
24	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
24.5	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
25	**2000**	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000

Table 12-16: V90-2.0 MW power curves, noise mode 3

12.2.2 V90-2.0 MW C_t Values

V90-2.0 MW C_t Values, Noise Mode 0

V90-2.0 MW C_t Values, 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**
4	**0.838**	0.837	0.837	0.837	0.837	0.837	0.837	0.837	0.837	0.837	0.838	0.838	0.838	0.838
4.5	**0.819**	0.818	0.818	0.818	0.818	0.818	0.818	0.818	0.818	0.818	0.818	0.818	0.819	0.819
5	**0.808**	0.807	0.808	0.808	0.808	0.808	0.808	0.808	0.808	0.808	0.808	0.808	0.809	0.809
5.5	**0.804**	0.803	0.803	0.803	0.803	0.803	0.804	0.804	0.804	0.804	0.804	0.804	0.804	0.804
6	**0.804**	0.803	0.803	0.803	0.803	0.803	0.804	0.804	0.804	0.804	0.804	0.804	0.804	0.804
6.5	**0.807**	0.806	0.806	0.806	0.806	0.806	0.806	0.806	0.806	0.807	0.807	0.807	0.807	0.807
7	**0.807**	0.805	0.805	0.806	0.806	0.806	0.806	0.806	0.807	0.807	0.807	0.807	0.807	0.807
7.5	**0.801**	0.799	0.799	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.801	0.801	0.801
8	**0.784**	0.783	0.783	0.783	0.783	0.783	0.783	0.783	0.784	0.784	0.784	0.784	0.784	0.784
8.5	**0.755**	0.754	0.754	0.754	0.754	0.755	0.755	0.755	0.755	0.755	0.755	0.755	0.755	0.755
9	**0.717**	0.716	0.716	0.716	0.717	0.717	0.717	0.717	0.717	0.717	0.717	0.717	0.717	0.717
9.5	**0.674**	0.674	0.674	0.674	0.674	0.674	0.674	0.674	0.674	0.674	0.674	0.674	0.674	0.674
10	**0.628**	0.629	0.629	0.630	0.630	0.630	0.630	0.630	0.629	0.629	0.629	0.628	0.627	0.626
10.5	**0.578**	0.586	0.586	0.586	0.586	0.586	0.586	0.585	0.585	0.584	0.582	0.580	0.575	0.571
11	**0.525**	0.546	0.546	0.546	0.546	0.546	0.544	0.542	0.541	0.539	0.534	0.530	0.519	0.512
11.5	**0.463**	0.508	0.507	0.506	0.505	0.504	0.499	0.494	0.490	0.485	0.478	0.470	0.454	0.445
12	**0.402**	0.472	0.469	0.465	0.462	0.458	0.451	0.443	0.436	0.428	0.419	0.411	0.393	0.384
12.5	**0.349**	0.435	0.428	0.422	0.416	0.409	0.401	0.392	0.383	0.374	0.366	0.358	0.342	0.334
13	**0.306**	0.395	0.387	0.378	0.370	0.362	0.353	0.345	0.336	0.328	0.321	0.313	0.299	0.292
13.5	**0.270**	0.354	0.345	0.337	0.329	0.320	0.312	0.305	0.297	0.289	0.283	0.276	0.264	0.258
14	**0.239**	0.316	0.308	0.300	0.292	0.284	0.277	0.270	0.263	0.256	0.251	0.245	0.234	0.229
14.5	**0.214**	0.282	0.275	0.267	0.260	0.253	0.247	0.241	0.235	0.229	0.224	0.219	0.209	0.205
15	**0.192**	0.252	0.246	0.239	0.233	0.226	0.221	0.216	0.210	0.205	0.201	0.196	0.188	0.184
15.5	**0.173**	0.227	0.221	0.215	0.209	0.204	0.199	0.194	0.190	0.185	0.181	0.177	0.170	0.166
16	**0.157**	0.205	0.200	0.194	0.189	0.184	0.180	0.176	0.172	0.168	0.164	0.161	0.154	0.151
16.5	**0.143**	0.186	0.181	0.177	0.172	0.167	0.164	0.160	0.156	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	0.142	0.139	0.136	0.133	0.128	0.126
17.5	**0.119**	0.154	0.151	0.147	0.143	0.139	0.136	0.133	0.130	0.127	0.124	0.122	0.117	0.115
18	**0.110**	0.142	0.138	0.135	0.131	0.128	0.125	0.122	0.120	0.117	0.114	0.112	0.108	0.106
18.5	**0.101**	0.130	0.127	0.124	0.121	0.118	0.115	0.113	0.110	0.108	0.105	0.103	0.099	0.097
19	**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

V90-2.0 MW C_t Values, 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**
19.5	**0.087**	0.112	0.109	0.106	0.104	0.101	0.099	0.097	0.095	0.092	0.091	0.089	0.085	0.084
20	**0.081**	0.103	0.101	0.099	0.096	0.094	0.092	0.090	0.088	0.086	0.084	0.082	0.079	0.078
20.5	**0.075**	0.096	0.094	0.092	0.089	0.087	0.085	0.083	0.082	0.080	0.078	0.077	0.074	0.072
21	**0.070**	0.089	0.087	0.085	0.083	0.081	0.079	0.078	0.076	0.074	0.073	0.072	0.069	0.068
21.5	**0.066**	0.084	0.082	0.080	0.078	0.076	0.074	0.073	0.071	0.070	0.068	0.067	0.065	0.063
22	**0.062**	0.078	0.076	0.075	0.073	0.071	0.070	0.068	0.067	0.065	0.064	0.063	0.060	0.059
22.5	**0.058**	0.073	0.072	0.070	0.068	0.067	0.065	0.064	0.063	0.061	0.060	0.059	0.057	0.056
23	**0.054**	0.069	0.067	0.065	0.064	0.062	0.061	0.060	0.059	0.057	0.056	0.055	0.053	0.052
23.5	**0.051**	0.064	0.063	0.062	0.060	0.059	0.057	0.056	0.055	0.054	0.053	0.052	0.050	0.049
24	**0.048**	0.061	0.059	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.047	0.046
24.5	**0.045**	0.057	0.056	0.055	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044
25	**0.043**	0.054	0.053	0.052	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.044	0.042	0.041

Table 12-17: V90-2.0 MW C_t values, noise mode 0

V90-2.0 MW C_t Values, Noise Mode 1

V90-2.0 MW 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**
4	**0.838**	0.837	0.837	0.837	0.837	0.837	0.837	0.837	0.837	0.837	0.837	0.838	0.838	0.838
4.5	**0.817**	0.816	0.816	0.816	0.817	0.817	0.817	0.817	0.817	0.817	0.817	0.817	0.817	0.817
5	**0.806**	0.805	0.805	0.805	0.805	0.805	0.805	0.806	0.806	0.806	0.806	0.806	0.806	0.806
5.5	**0.801**	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.801	0.801	0.801	0.801	0.801
6	**0.801**	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.801	0.801
6.5	**0.804**	0.802	0.802	0.802	0.803	0.803	0.803	0.803	0.803	0.803	0.803	0.804	0.804	0.804
7	**0.802**	0.800	0.800	0.800	0.801	0.801	0.801	0.801	0.801	0.801	0.801	0.802	0.802	0.802
7.5	**0.793**	0.791	0.791	0.792	0.792	0.792	0.792	0.792	0.792	0.792	0.793	0.793	0.793	0.793
8	**0.773**	0.771	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.772	0.773	0.773
8.5	**0.740**	0.739	0.739	0.739	0.739	0.739	0.740	0.740	0.740	0.740	0.740	0.740	0.740	0.740
9	**0.697**	0.696	0.696	0.696	0.696	0.697	0.697	0.697	0.697	0.697	0.697	0.697	0.697	0.697
9.5	**0.649**	0.648	0.648	0.649	0.649	0.649	0.649	0.649	0.649	0.649	0.649	0.649	0.649	0.649
10	**0.601**	0.601	0.601	0.601	0.601	0.601	0.601	0.602	0.602	0.602	0.601	0.601	0.600	0.600
10.5	**0.554**	0.557	0.557	0.557	0.557	0.557	0.557	0.557	0.556	0.556	0.555	0.554	0.552	0.550
11	**0.507**	0.517	0.518	0.518	0.518	0.518	0.517	0.516	0.516	0.515	0.512	0.510	0.503	0.498
11.5	**0.453**	0.481	0.481	0.481	0.480	0.480	0.477	0.474	0.472	0.469	0.464	0.458	0.446	0.439
12	**0.398**	0.448	0.447	0.445	0.443	0.441	0.436	0.431	0.425	0.420	0.413	0.405	0.390	0.382
12.5	**0.348**	0.416	0.412	0.408	0.404	0.400	0.393	0.385	0.378	0.371	0.363	0.356	0.341	0.333
13	**0.305**	0.383	0.377	0.370	0.364	0.357	0.350	0.342	0.334	0.327	0.319	0.312	0.299	0.292
13.5	**0.270**	0.347	0.340	0.333	0.325	0.318	0.311	0.303	0.296	0.289	0.282	0.276	0.264	0.258
14	**0.239**	0.313	0.305	0.298	0.290	0.283	0.276	0.270	0.263	0.256	0.251	0.245	0.234	0.229
14.5	**0.214**	0.281	0.274	0.267	0.259	0.252	0.246	0.241	0.235	0.229	0.224	0.219	0.209	0.205
15	**0.192**	0.252	0.245	0.239	0.232	0.226	0.221	0.216	0.210	0.205	0.201	0.196	0.188	0.184
15.5	**0.173**	0.227	0.221	0.215	0.209	0.204	0.199	0.194	0.190	0.185	0.181	0.177	0.170	0.166
16	**0.157**	0.205	0.200	0.194	0.189	0.184	0.180	0.176	0.172	0.168	0.164	0.161	0.154	0.151
16.5	**0.143**	0.186	0.181	0.177	0.172	0.167	0.164	0.160	0.156	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	0.142	0.139	0.136	0.133	0.128	0.126
17.5	**0.119**	0.154	0.151	0.147	0.143	0.139	0.136	0.133	0.130	0.127	0.124	0.122	0.117	0.115
18	**0.110**	0.142	0.138	0.135	0.131	0.128	0.125	0.122	0.120	0.117	0.114	0.112	0.108	0.106
18.5	**0.101**	0.130	0.127	0.124	0.121	0.118	0.115	0.113	0.110	0.108	0.105	0.103	0.099	0.097
19	**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
19.5	**0.087**	0.112	0.109	0.106	0.104	0.101	0.099	0.097	0.095	0.092	0.091	0.089	0.085	0.084

V90-2.0 MW 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**
20	**0.081**	0.103	0.101	0.099	0.096	0.094	0.092	0.090	0.088	0.086	0.084	0.082	0.079	0.078
20.5	**0.075**	0.096	0.094	0.092	0.089	0.087	0.085	0.083	0.082	0.080	0.078	0.077	0.074	0.072
21	**0.070**	0.089	0.087	0.085	0.083	0.081	0.079	0.078	0.076	0.074	0.073	0.072	0.069	0.068
21.5	**0.066**	0.084	0.082	0.080	0.078	0.076	0.074	0.073	0.071	0.070	0.068	0.067	0.065	0.063
22	**0.062**	0.078	0.076	0.075	0.073	0.071	0.070	0.068	0.067	0.065	0.064	0.063	0.060	0.059
22.5	**0.058**	0.073	0.072	0.070	0.068	0.067	0.065	0.064	0.063	0.061	0.060	0.059	0.057	0.056
23	**0.054**	0.069	0.067	0.065	0.064	0.062	0.061	0.060	0.059	0.057	0.056	0.055	0.053	0.052
23.5	**0.051**	0.064	0.063	0.062	0.060	0.059	0.057	0.056	0.055	0.054	0.053	0.052	0.050	0.049
24	**0.048**	0.061	0.059	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.047	0.046
24.5	**0.045**	0.057	0.056	0.055	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044
25	**0.043**	0.054	0.053	0.052	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.044	0.042	0.041

Table 12-18: V90-2.0 MW C_t values, noise mode 1

V90-2.0 MW C_t Values, Noise Mode 2

V90-2.0 MW 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**
4	**0.838**	0.837	0.837	0.837	0.837	0.837	0.837	0.837	0.837	0.837	0.837	0.838	0.838	0.838
4.5	**0.817**	0.816	0.816	0.816	0.817	0.817	0.817	0.817	0.817	0.817	0.817	0.817	0.817	0.817
5	**0.806**	0.805	0.805	0.805	0.805	0.805	0.805	0.806	0.806	0.806	0.806	0.806	0.806	0.806
5.5	**0.801**	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.801	0.801	0.801	0.801
6	**0.800**	0.799	0.799	0.799	0.799	0.799	0.799	0.799	0.799	0.800	0.800	0.800	0.800	0.800
6.5	**0.800**	0.798	0.798	0.798	0.798	0.798	0.799	0.799	0.799	0.799	0.799	0.799	0.800	0.800
7	**0.789**	0.787	0.787	0.787	0.788	0.788	0.788	0.788	0.788	0.788	0.788	0.788	0.789	0.789
7.5	**0.762**	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.761	0.762	0.762	0.762	0.762
8	**0.719**	0.718	0.718	0.718	0.718	0.718	0.718	0.718	0.718	0.719	0.719	0.719	0.719	0.719
8.5	**0.666**	0.665	0.665	0.665	0.665	0.665	0.665	0.665	0.666	0.666	0.666	0.666	0.666	0.666
9	**0.612**	0.611	0.611	0.611	0.611	0.611	0.611	0.611	0.612	0.612	0.612	0.612	0.612	0.612
9.5	**0.562**	0.561	0.561	0.561	0.561	0.561	0.561	0.561	0.561	0.561	0.561	0.561	0.562	0.562
10	**0.516**	0.515	0.516	0.516	0.516	0.516	0.516	0.516	0.516	0.516	0.516	0.516	0.516	0.516
10.5	**0.476**	0.476	0.476	0.476	0.476	0.476	0.476	0.476	0.476	0.476	0.476	0.476	0.476	0.475
11	**0.440**	0.441	0.441	0.441	0.441	0.441	0.441	0.441	0.441	0.441	0.441	0.441	0.439	0.438
11.5	**0.404**	0.409	0.410	0.410	0.410	0.410	0.409	0.409	0.409	0.409	0.407	0.405	0.401	0.398
12	**0.366**	0.382	0.382	0.382	0.381	0.381	0.380	0.379	0.377	0.376	0.373	0.370	0.362	0.357
12.5	**0.329**	0.357	0.356	0.356	0.355	0.354	0.351	0.349	0.346	0.343	0.338	0.333	0.323	0.317
13	**0.292**	0.334	0.332	0.330	0.329	0.327	0.322	0.318	0.314	0.309	0.304	0.298	0.287	0.281
13.5	**0.261**	0.312	0.309	0.305	0.302	0.299	0.293	0.288	0.283	0.278	0.272	0.266	0.256	0.250
14	**0.233**	0.289	0.285	0.280	0.276	0.271	0.266	0.260	0.255	0.249	0.244	0.238	0.228	0.223
14.5	**0.209**	0.267	0.261	0.256	0.251	0.245	0.240	0.235	0.229	0.224	0.219	0.214	0.205	0.201
15	**0.189**	0.244	0.238	0.233	0.227	0.222	0.217	0.212	0.207	0.202	0.197	0.193	0.185	0.181
15.5	**0.171**	0.223	0.217	0.212	0.206	0.201	0.196	0.192	0.187	0.183	0.179	0.175	0.168	0.164
16	**0.156**	0.203	0.198	0.193	0.188	0.183	0.178	0.174	0.170	0.166	0.163	0.159	0.152	0.149
16.5	**0.142**	0.185	0.180	0.176	0.171	0.166	0.163	0.159	0.155	0.151	0.148	0.145	0.139	0.136
17	**0.130**	0.169	0.165	0.160	0.156	0.152	0.149	0.145	0.142	0.139	0.136	0.133	0.127	0.125
17.5	**0.119**	0.154	0.150	0.147	0.143	0.139	0.136	0.133	0.130	0.127	0.124	0.122	0.117	0.114
18	**0.110**	0.141	0.138	0.135	0.131	0.128	0.125	0.122	0.119	0.117	0.114	0.112	0.107	0.105
18.5	**0.101**	0.130	0.127	0.124	0.121	0.118	0.115	0.113	0.110	0.108	0.105	0.103	0.099	0.097
19	**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
19.5	**0.087**	0.112	0.109	0.106	0.104	0.101	0.099	0.097	0.095	0.092	0.091	0.089	0.085	0.084

V90-2.0 MW 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**
20	**0.081**	0.103	0.101	0.099	0.096	0.094	0.092	0.090	0.088	0.086	0.084	0.082	0.079	0.078
20.5	**0.075**	0.096	0.094	0.092	0.089	0.087	0.085	0.083	0.082	0.080	0.078	0.077	0.074	0.072
21	**0.070**	0.089	0.087	0.085	0.083	0.081	0.079	0.078	0.076	0.074	0.073	0.072	0.069	0.068
21.5	**0.066**	0.084	0.082	0.080	0.078	0.076	0.074	0.073	0.071	0.070	0.068	0.067	0.065	0.063
22	**0.062**	0.078	0.077	0.075	0.073	0.071	0.070	0.068	0.067	0.065	0.064	0.063	0.060	0.059
22.5	**0.058**	0.073	0.072	0.070	0.068	0.067	0.065	0.064	0.063	0.061	0.060	0.059	0.057	0.056
23	**0.054**	0.069	0.067	0.065	0.064	0.062	0.061	0.060	0.059	0.057	0.056	0.055	0.053	0.052
23.5	**0.051**	0.064	0.063	0.062	0.060	0.059	0.057	0.056	0.055	0.054	0.053	0.052	0.050	0.049
24	**0.048**	0.061	0.059	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.047	0.046
24.5	**0.045**	0.057	0.056	0.055	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044
25	**0.043**	0.054	0.053	0.052	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.044	0.042	0.041

Table 12-19: V90-2.0 MW C_t values, noise mode 2

V90-2.0 MW C_t Values, Noise Mode 3

V90-2.0 MW 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**
4	**0.836**	0.835	0.835	0.835	0.835	0.835	0.835	0.835	0.835	0.835	0.835	0.835	0.836	0.836
4.5	**0.800**	0.799	0.799	0.799	0.799	0.799	0.799	0.799	0.799	0.799	0.800	0.800	0.800	0.800
5	**0.766**	0.766	0.766	0.766	0.766	0.766	0.766	0.766	0.766	0.766	0.766	0.766	0.767	0.767
5.5	**0.748**	0.747	0.747	0.747	0.747	0.747	0.748	0.748	0.748	0.748	0.748	0.748	0.748	0.748
6	**0.745**	0.744	0.744	0.745	0.745	0.745	0.745	0.745	0.745	0.745	0.745	0.745	0.745	0.745
6.5	**0.765**	0.764	0.764	0.764	0.764	0.764	0.765	0.765	0.765	0.765	0.765	0.765	0.765	0.766
7	**0.758**	0.756	0.756	0.756	0.756	0.757	0.757	0.757	0.757	0.757	0.757	0.757	0.758	0.758
7.5	**0.748**	0.746	0.747	0.747	0.747	0.747	0.747	0.748	0.748	0.748	0.748	0.748	0.748	0.748
8	**0.731**	0.730	0.730	0.730	0.730	0.731	0.731	0.731	0.731	0.731	0.731	0.731	0.731	0.731
8.5	**0.707**	0.706	0.706	0.706	0.706	0.706	0.707	0.707	0.707	0.707	0.707	0.707	0.707	0.707
9	**0.680**	0.679	0.679	0.679	0.679	0.679	0.679	0.679	0.679	0.679	0.680	0.680	0.680	0.680
9.5	**0.649**	0.648	0.648	0.648	0.649	0.649	0.649	0.649	0.649	0.649	0.649	0.649	0.649	0.648
10	**0.613**	0.615	0.615	0.615	0.615	0.615	0.615	0.615	0.615	0.615	0.614	0.614	0.612	0.611
10.5	**0.571**	0.579	0.579	0.579	0.579	0.578	0.578	0.577	0.577	0.576	0.574	0.573	0.567	0.563
11	**0.522**	0.542	0.542	0.542	0.542	0.542	0.540	0.538	0.537	0.535	0.531	0.526	0.516	0.509
11.5	**0.461**	0.506	0.505	0.504	0.503	0.502	0.497	0.493	0.488	0.484	0.476	0.469	0.453	0.444
12	**0.401**	0.471	0.468	0.464	0.461	0.457	0.450	0.442	0.435	0.428	0.419	0.410	0.393	0.384
12.5	**0.349**	0.434	0.428	0.422	0.415	0.409	0.400	0.392	0.383	0.374	0.366	0.358	0.342	0.334
13	**0.306**	0.395	0.386	0.378	0.370	0.362	0.353	0.345	0.336	0.328	0.321	0.313	0.299	0.292
13.5	**0.270**	0.354	0.345	0.337	0.329	0.320	0.312	0.305	0.297	0.289	0.283	0.276	0.264	0.258
14	**0.239**	0.316	0.308	0.300	0.292	0.284	0.277	0.270	0.263	0.256	0.251	0.245	0.234	0.229
14.5	**0.214**	0.282	0.275	0.267	0.260	0.253	0.247	0.241	0.235	0.229	0.224	0.219	0.209	0.205
15	**0.192**	0.252	0.246	0.239	0.233	0.226	0.221	0.216	0.210	0.205	0.201	0.196	0.188	0.184
15.5	**0.173**	0.227	0.221	0.215	0.209	0.204	0.199	0.194	0.190	0.185	0.181	0.177	0.170	0.166
16	**0.157**	0.205	0.200	0.194	0.189	0.184	0.180	0.176	0.172	0.168	0.164	0.161	0.154	0.151
16.5	**0.143**	0.186	0.181	0.177	0.172	0.167	0.164	0.160	0.156	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	0.142	0.139	0.136	0.133	0.128	0.126
17.5	**0.119**	0.154	0.151	0.147	0.143	0.139	0.136	0.133	0.130	0.127	0.124	0.122	0.117	0.115
18	**0.110**	0.142	0.138	0.135	0.131	0.128	0.125	0.122	0.120	0.117	0.114	0.112	0.108	0.106
18.5	**0.101**	0.130	0.127	0.124	0.121	0.118	0.115	0.113	0.110	0.108	0.105	0.103	0.099	0.097
19	**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
19.5	**0.087**	0.112	0.109	0.106	0.104	0.101	0.099	0.097	0.095	0.092	0.091	0.089	0.085	0.084

V90-2.0 MW 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**
20	**0.081**	0.103	0.101	0.099	0.096	0.094	0.092	0.090	0.088	0.086	0.084	0.082	0.079	0.078
20.5	**0.075**	0.096	0.094	0.092	0.089	0.087	0.085	0.083	0.082	0.080	0.078	0.077	0.074	0.072
21	**0.070**	0.089	0.087	0.085	0.083	0.081	0.079	0.078	0.076	0.074	0.073	0.072	0.069	0.068
21.5	**0.066**	0.084	0.082	0.080	0.078	0.076	0.074	0.073	0.071	0.070	0.068	0.067	0.065	0.063
22	**0.062**	0.078	0.076	0.075	0.073	0.071	0.070	0.068	0.067	0.065	0.064	0.063	0.060	0.059
22.5	**0.058**	0.073	0.072	0.070	0.068	0.067	0.065	0.064	0.063	0.061	0.060	0.059	0.057	0.056
23	**0.054**	0.069	0.067	0.065	0.064	0.062	0.061	0.060	0.059	0.057	0.056	0.055	0.053	0.052
23.5	**0.051**	0.064	0.063	0.062	0.060	0.059	0.057	0.056	0.055	0.054	0.053	0.052	0.050	0.049
24	**0.048**	0.061	0.059	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.047	0.046
24.5	**0.045**	0.057	0.056	0.055	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044
25	**0.043**	0.054	0.053	0.052	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.044	0.042	0.041

Table 12-20: V90-2.0 MW C_t values, noise mode 3

12.2.3 V90-2.0 MW Sound Power Level at Hub Height

V90-2.0 MW Sound Power Level at Hub Height, Noise Mode 0

V90-2.0 MW 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	**80 m**	**95 m**	**105 m**	**125 m**
L_{WA} @ 3 m/s (10 m above ground) [dBA]	92.6	92.8	92.9	93.0
Wind speed at hub height [m/s]	4.2	4.3	4.4	4.5
L_{WA} @ 4 m/s (10 m above ground) [dBA]	95.6	96.1	96.4	96.9
Wind speed at hub height [m/s]	5.6	5.7	5.8	6.0
L_{WA} @ 5 m/s (10 m above ground) [dBA]	99.8	100.3	100.6	101.2
Wind speed at hub height [m/s]	7.0	7.2	7.3	7.5
L_{WA} @ 6 m/s (10 m above ground) [dBA]	102.8	103.0	103.1	103.3
Wind speed at hub height [m/s]	8.4	8.6	8.7	9.0
L_{WA} @ 7 m/s (10 m above ground) [dBA]	103.7	103.8	103.8	103.8
Wind speed at hub height [m/s]	9.8	10.0	10.2	10.5
L_{WA} @ 8 m/s (10 m above ground) [dBA]	104.0	104.0	104.0	104.0
Wind speed at hub height [m/s]	11.2	11.5	11.7	12.0
L_{WA} @ 9 m/s (10 m above ground) [dBA]	104.0	104.0	104.0	104.0
Wind speed at hub height [m/s]	12.6	12.9	13.1	13.5
L_{WA} @ 10 m/s (10 m above ground) [dBA]	104.0	104.0	104.0	104.0
Wind speed at hub height [m/s]	13.9	14.3	14.6	15.0
L_{WA} @ 11 m/s (10 m above ground) [dBA]	104.0	104.0	104.0	104.0
Wind speed at hub height [m/s]	15.3	15.8	16.0	16.5
L_{WA} @ 12 m/s (10 m above ground) [dBA]	104.0	104.0	104.0	104.0
Wind speed at hub height [m/s]	16.7	17.2	17.5	18.0
L_{WA} @ 13 m/s (10 m above ground) [dBA]	104.0	104.0	104.0	104.0
Wind speed at hub height [m/s]	18.1	18.6	18.9	19.5

Table 12-21: V90-2.0 MW sound power level at hub height, noise mode 0

V90-2.0 MW Sound Power Level at Hub Height, Noise Mode 1

V90-2.0 MW 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	**80 m**	**95 m**	**105 m**	**125 m**
L_{wA} @ 3 m/s (10 m above ground) [dBA]	92.6	92.8	92.9	93.0
Wind speed at hub height [m/s]	4.2	4.3	4.4	4.5
L_{wA} @ 4 m/s (10 m above ground) [dBA]	95.6	96.1	96.4	96.9
Wind speed at hub height [m/s]	5.6	5.7	5.8	6.0
L_{wA} @ 5 m/s (10 m above ground) [dBA]	99.8	100.3	100.6	101.1
Wind speed at hub height [m/s]	7.0	7.2	7.3	7.5
L_{wA} @ 6 m/s (10 m above ground) [dBA]	102.7	102.9	103.0	103.0
Wind speed at hub height [m/s]	8.4	8.6	8.7	9.0
L_{wA} @ 7 m/s (10 m above ground) [dBA]	103.0	103.0	103.0	103.0
Wind speed at hub height [m/s]	9.8	10.0	10.2	10.5
L_{wA} @ 8 m/s (10 m above ground) [dBA]	103.0	103.0	103.0	103.0
Wind speed at hub height [m/s]	11.2	11.5	11.7	12.0
L_{wA} @ 9 m/s (10 m above ground) [dBA]	103.0	103.0	103.0	103.0
Wind speed at hub height [m/s]	12.6	12.9	13.1	13.5
L_{wA} @ 10 m/s (10 m above ground) [dBA]	103.0	103.0	103.0	103.0
Wind speed at hub height [m/s]	13.9	14.3	14.6	15.0
L_{wA} @ 11 m/s (10 m above ground) [dBA]	103.0	103.0	103.0	103.0
Wind speed at hub height [m/s]	15.3	15.8	16.0	16.5
L_{wA} @ 12 m/s (10 m above ground) [dBA]	103.0	103.0	103.0	103.0
Wind speed at hub height [m/s]	16.7	17.2	17.5	18.0
L_{wA} @ 13 m/s (10 m above ground) [dBA]	103.0	103.0	103.0	103.0
Wind speed at hub height [m/s]	18.1	18.6	18.9	19.5

Table 12-22: V90-2.0 MW noise mode 1, sound power level at hub height

V90-2.0 MW Sound Power Level at Hub Height, Noise Mode 2

V90-2.0 MW 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	**80 m**	**95 m**	**105 m**	**125 m**
L_{wA} @ 3 m/s (10 m above ground) [dBA]	92.6	92.8	92.9	93.0
Wind speed at hub height [m/s]	4.2	4.3	4.4	4.5
L_{wA} @ 4 m/s (10 m above ground) [dBA]	95.6	96.1	96.4	96.9
Wind speed at hub height [m/s]	5.6	5.7	5.8	6.0
L_{wA} @ 5 m/s (10 m above ground) [dBA]	99.8	100.1	100.2	100.5
Wind speed at hub height [m/s]	7.0	7.2	7.3	7.5
L_{wA} @ 6 m/s (10 m above ground) [dBA]	101.0	101.0	101.0	101.0
Wind speed at hub height [m/s]	8.4	8.6	8.7	9.0
L_{wA} @ 7 m/s (10 m above ground) [dBA]	101.0	101.0	101.0	101.0
Wind speed at hub height [m/s]	9.8	10.0	10.2	10.5
L_{wA} @ 8 m/s (10 m above ground) [dBA]	101.0	101.0	101.0	101.0
Wind speed at hub height [m/s]	11.2	11.5	11.7	12.0
L_{wA} @ 9 m/s (10 m above ground) [dBA]	101.0	101.0	101.0	101.0
Wind speed at hub height [m/s]	12.6	12.9	13.1	13.5
L_{wA} @ 10 m/s (10 m above ground) [dBA]	101.0	101.0	101.0	101.0
Wind speed at hub height [m/s]	13.9	14.3	14.6	15.0
L_{wA} @ 11 m/s (10 m above ground) [dBA]	101.0	101.0	101.0	101.0
Wind speed at hub height [m/s]	15.3	15.8	16.0	16.5
L_{wA} @ 12 m/s (10 m above ground) [dBA]	101.0	101.0	101.0	101.0
Wind speed at hub height [m/s]	16.7	17.2	17.5	18.0
L_{wA} @ 13 m/s (10 m above ground) [dBA]	101.0	101.0	101.0	101.0
Wind speed at hub height [m/s]	18.1	18.6	18.9	19.5

Table 12-23: V90-2.0 MW sound power level at hub height, noise mode 2

V90-2.0 MW Sound Power Level at Hub Height, Noise Mode 3

V90-2.0 MW 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/m3**			
Hub Height	**80 m**	**95 m**	**105 m**	**125 m**
LwA @ 3 m/s (10 m above ground) [dBA]	92.5	92.5	92.6	92.7
Wind speed at hub height [m/s]	4.2	4.3	4.4	4.5
LwA @ 4 m/s (10 m above ground) [dBA]	94.6	95.0	95.3	95.7
Wind speed at hub height [m/s]	5.6	5.7	5.8	6.0
LwA @ 5 m/s (10 m above ground) [dBA]	98.8	99.3	99.6	100.1
Wind speed at hub height [m/s]	7.0	7.2	7.3	7.5
LwA @ 6 m/s (10 m above ground) [dBA]	101.8	102.0	102.1	102.3
Wind speed at hub height [m/s]	8.4	8.6	8.7	9.0
LwA @ 7 m/s (10 m above ground) [dBA]	103.5	103.8	103.8	103.8
Wind speed at hub height [m/s]	9.8	10.0	10.2	10.5
LwA @ 8 m/s (10 m above ground) [dBA]	103.6	104.0	104.0	104.0
Wind speed at hub height [m/s]	11.2	11.5	11.7	12.0
LwA @ 9 m/s (10 m above ground) [dBA]	104.0	104.0	104.0	104.0
Wind speed at hub height [m/s]	12.6	12.9	13.1	13.5
LwA @ 10 m/s (10 m above ground) [dBA]	104.0	104.0	104.0	104.0
Wind speed at hub height [m/s]	13.9	14.3	14.6	15.0
LwA @ 11 m/s (10 m above ground) [dBA]	104.0	104.0	104.0	104.0
Wind speed at hub height [m/s]	15.3	15.8	16.0	16.5
LwA @ 12 m/s (10 m above ground) [dBA]	104.0	104.0	104.0	104.0
Wind speed at hub height [m/s]	16.7	17.2	17.5	18.0
LwA @ 13 m/s (10 m above ground) [dBA]	104.0	104.0	104.0	104.0
Wind speed at hub height [m/s]	18.1	18.6	18.9	19.5

Table 12-24: V90-2.0 MW sound power level at hub height, noise mode 3