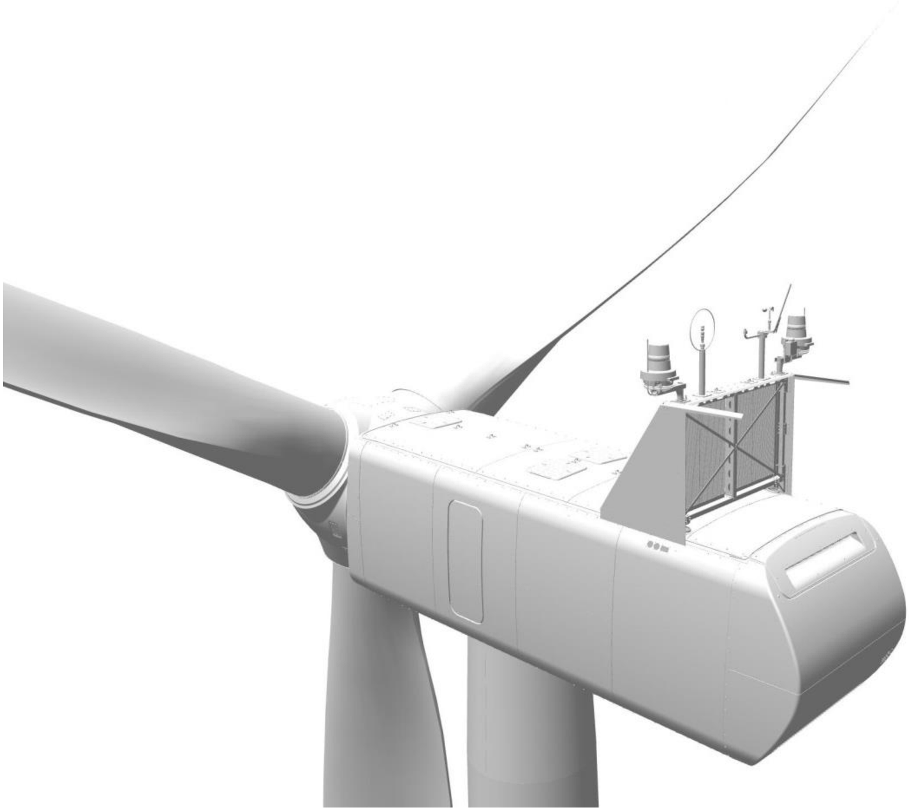
Bijlage 10d: Technische gegevens Vestas

Design & Consultancy
for natural and
built assets

Restricted
Document no.: 0051-0155 V01
2016-06-28

General specification

2.0/2.2MW V100/110 50/60Hz



Vestas Wind Systems A/S · Hedeager 42 · 8200 Aarhus N · Denmark · www.vestas.com

Table of contents

Recipient acknowledges that (i) this General Specification is provided for recipient's information only, and, does not create or constitute a warranty, guarantee, promise, commitment, or other representation (Commitment) by Vestas Wind Systems or any of its affiliated or subsidiary companies (Vestas), all of which are disclaimed by Vestas and (ii) any and all Commitments by Vestas to recipient as to this general specification (or any of the contents herein) are to be contained exclusively in signed written contracts between recipient and Vestas, and not within this document.

See general reservations, notes, and disclaimers to this general specification in section General reservations, notes, and disclaimers, p. 22.

1 Abbreviations and technical terms

Abbreviation	Explanation
AEP	Annual Energy Production
EMC	Electromagnetic Compatibility
HH	Hub Height
HV	High Voltage
LPS	Lightning Protection System
MASL	Meters Above Sea Level
MW	Megawatt
OH&S	Occupational Health & Safety
OVRT	Over Voltage Ride-Through
pu	Per unit
rpm	Revolutions per minute
SSR-P	Sub Synchronous Resonance Protection
UVRT	Under Voltage Ride-Through

Table 1-1: Abbreviations

Term	Explanation
None	

Table 1-2: Explanation of terms

2 General description

The Vestas 2.0MW series wind turbine is a pitch-regulated upwind turbine with active yaw, gearbox and a three-blade rotor. The turbine is available in two rotor diameters 100 or 110m with a generator rated at 2.0 or 2.2MW. 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 output at or near rated power.

Rotor	Rating [MW]	Wind Class [IEC]	Hub Height [m]	
			50Hz	60Hz
V100	2.0	IIB	80, 95	80, 95
		IIC	80	80
	2.2	S	80, 95	80, 95
V110	2.0	IIIA	95	80, 95
	2.0	IIIB	95, 110, 120, 125	95, 110
	2.0	IIIC	80	80
	2.2	S	80, 95 110, 120, 125	80, 95

Table 2-1: Turbine variants and tower heights

3 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 Buyer's 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 3.11 Manuals and warnings for additional guidance.

3.1 Access

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

3.2 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 the outside.

Escape from the service lift is by ladder.

3.3 Rooms/working areas

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

3.4 Climbing facilities

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

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.

3.5 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.

3.6 Lighting

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

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

3.7 Emergency stop buttons

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

3.8 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.

3.9 Fire protection/first aid

A CO_2 (recommended) or ABC fire extinguisher and first aid kit must be available in the nacelle during all service and maintenance activities. A fire blanket must be available nearby for all those activities for which the respective work instruction requires it.

3.10 Warning signs

Additional warning signs inside or on the turbine must be reviewed before operating or servicing the turbine.

3.11 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.

4 Type approvals

The turbine will be type-certified according to the certification standards listed below:

- IEC 61400-22

5 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.

The turbine can be equipped with different power generation components depending on the region which may influence the performance of the turbine. Consult Vestas Wind Systems for further details.

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

5.1 Climate and site conditions

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

Extreme design parameters				
	V100		V110	
	2MW	2.2MW	2MW	2.2MW
	IEC IIB	IEC S	IEC IIIA	IEC S
Ambient temperature range (standard turbine)	-30° to +50°C	-30° to +50°C	-30° to +50°C	-30° to +50°C
Ambient temperature interval (low temperature turbine)	-40° to +50°C	-40° to +50°C	-40° to +50°C	-40° to +50°C
Ambient temperature interval (Special temperature variant)	-5° to +50°C	-5° to +50°C	-5° to +50°C	-5° to +50°C
Extreme wind speed (10-minute average)	42.5 m/s	42.5 m/s	37.5 m/s	37.5 m/s

Extreme design parameters				
	V100		V110	
	2MW	2.2MW	2MW	2.2MW
	IEC IIB	IEC S	IEC IIIA	IEC S
Survival wind speed (3-second gust)	59.5 m/s	59.5 m/s	52.5 m/s	52.5 m/s

Table 5-1: Extreme design parameters

Average design parameters				
	V100		V110	
	2MW	2.2MW	2MW	2.2MW
	IEC IIB	IEC S	IEC IIIA	IEC S
Annual average wind speed	8.5 m/s	7.5 m/s	7.5 m/s	6.5 m/s
Form factor, c	2.0	2.2	2.0	2.0
Turbulence intensity according to IEC 61400-1:2005, including wind farm turbulence (@15 m/s – 90% quartile)	16%	16%	18%	18%
Wind shear	0.20	0.20	0.20	0.20
Inflow angle (vertical)	8°	8°	8°	8°

Table 5-2: Average design parameters

5.1.1 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 the site assessment.

5.1.2 Altitude

The 2.0MW variants of the turbine are designed for use at altitudes up to 1.500 metres above sea level as standard. The 2.2MW variants are restricted in altitude according to Figure 5-2.

With altitudes above 1.500 metres, special considerations must be taken regarding for example HV installations and cooling performance. Consult Vestas for further information.

5.1.3 Wind farm layout

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

5.2 Operational envelope (temperature and wind)

Values refer to hub height and are determined by the sensors and control system of the turbine. Consult Vestas for turbine capabilities for ambient temperatures above 40°C

Operational envelope (temperature and wind)				
	V100		V110	
	2MW	2.2MW	2MW	2.2MW
	IEC IIB	IEC S	IEC IIIA	IEC S
Ambient temperature interval (standard temperature turbine)	-20° to +40°C	-20° to +40°C[1]	-20° to +40°C	-20° to +40°C[1]
Ambient temperature interval (low temperature turbine)[1]	-30° to +40°C	-30° to +40°C[1]	-30° to +40°C	-30° to +40°C[1]
Ambient temperature interval (Special temperature turbine)	0° to +40°C	0° to +40°C[1]	0° to +40°C	0° to +40°C[1]
Cut-in (10 minute average)	3 m/s	3 m/s	3 m/s	3 m/s
Cut-out (10 minute average)	22 m/s	22 m/s	20 m/s	20 m/s
Re-cut in (10 minute average)	20 m/s	20 m/s	18 m/s	18 m/s

Table 5-3: Operational envelope (temperature and wind)

[1] Limitation in high temperature performance will apply for IEC S turbines. See Figure 5-1: Temperature variants

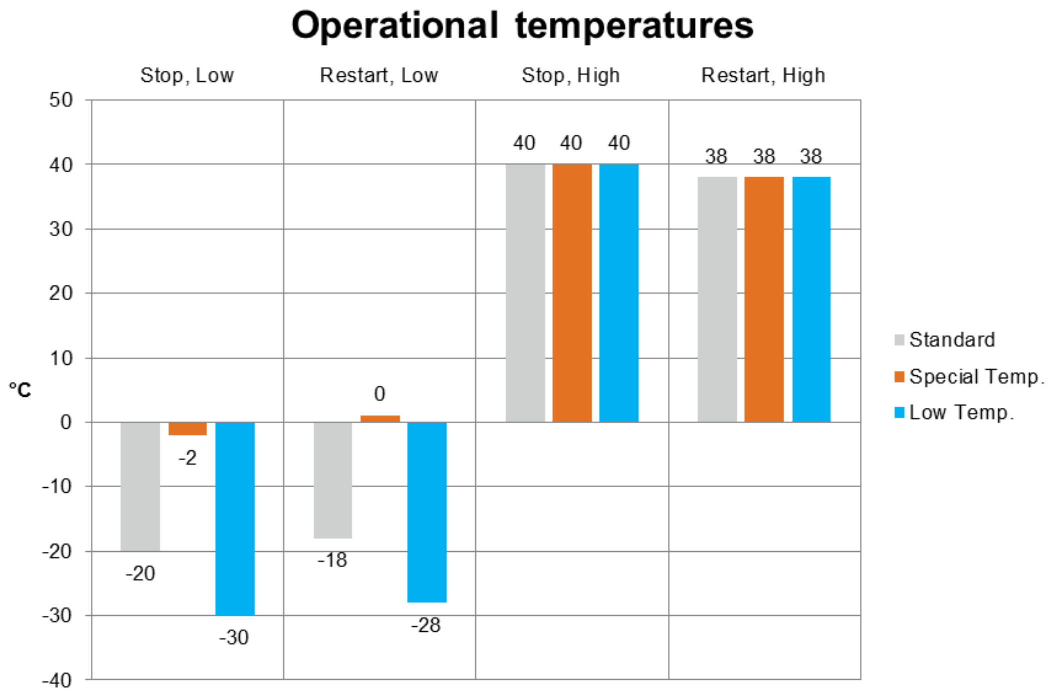


Figure 5-1: Temperature variants

NOTE The special temperature variant is designed for use in stable warm climates. Consult Vestas for specific climate conditions for the special temperature variant.

Restart temperature is where the turbine will initiate the start-up; not resume production.

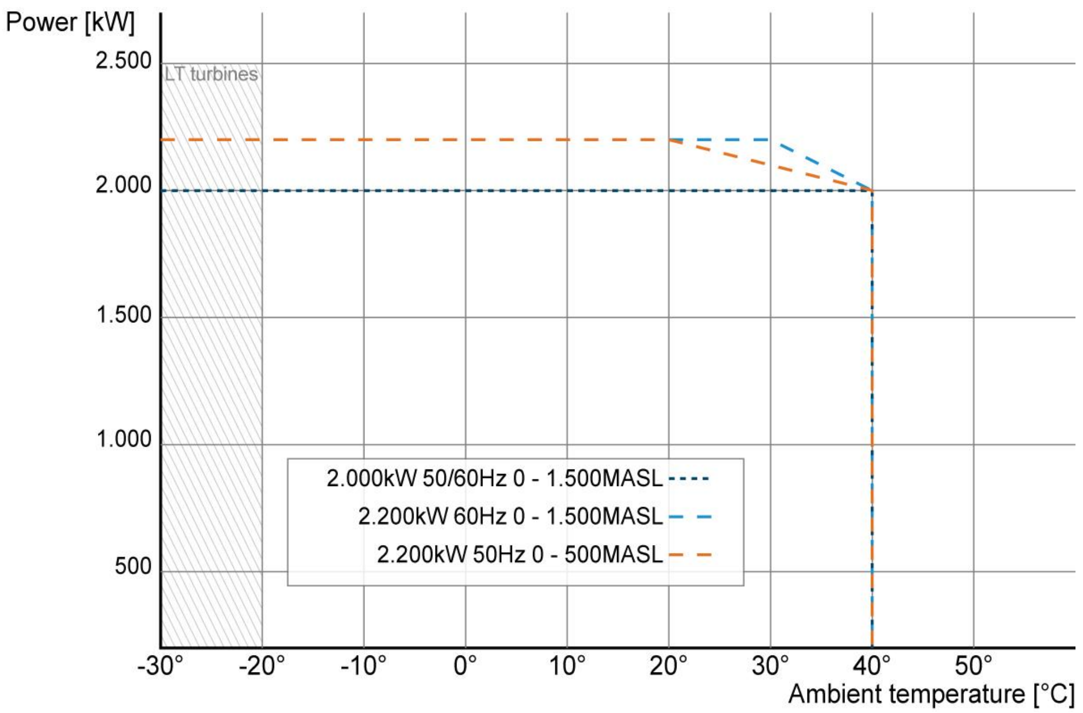


Figure 5-2: Temperature and de-rate curves

5.3 Operational envelope (grid connection)

Operational envelope (grid connection)		
Nominal phase voltage	[U_{NP}]	480 V (Grid inverter) 690 V (Stator)
Nominal frequency	[f_N]	50 / 60Hz
Maximum frequency gradient	±4 Hz/sec.	
Maximum negative sequence voltage	3% *(connection)* 2% *(operation)*	
Minimum required short circuit ratio at turbine HV connection	3[2]	
Maximum short circuit current contribution	4.0 pu *(peak short-circuit current)* 1.5 pu *(steady-state short-circuit current)*	

Table 5-4: Operational envelope (grid connection)

Generator and converter disconnecting values		
	50Hz	**60Hz**
Frequency is above [Hz] for 0.2 Seconds	53 Hz	63,6Hz
Frequency is below [Hz] for 0.2 Seconds	47 Hz	56,4Hz

Table 5-5: 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.

[2] For SCR below 3 the WTG default parameter settings may need modifications. Consult Vestas for further information.

5.4 Reactive power capability

The turbine has a reactive power capability dependent on power rating as illustrated in Figure 5-3 and Figure 5-4.

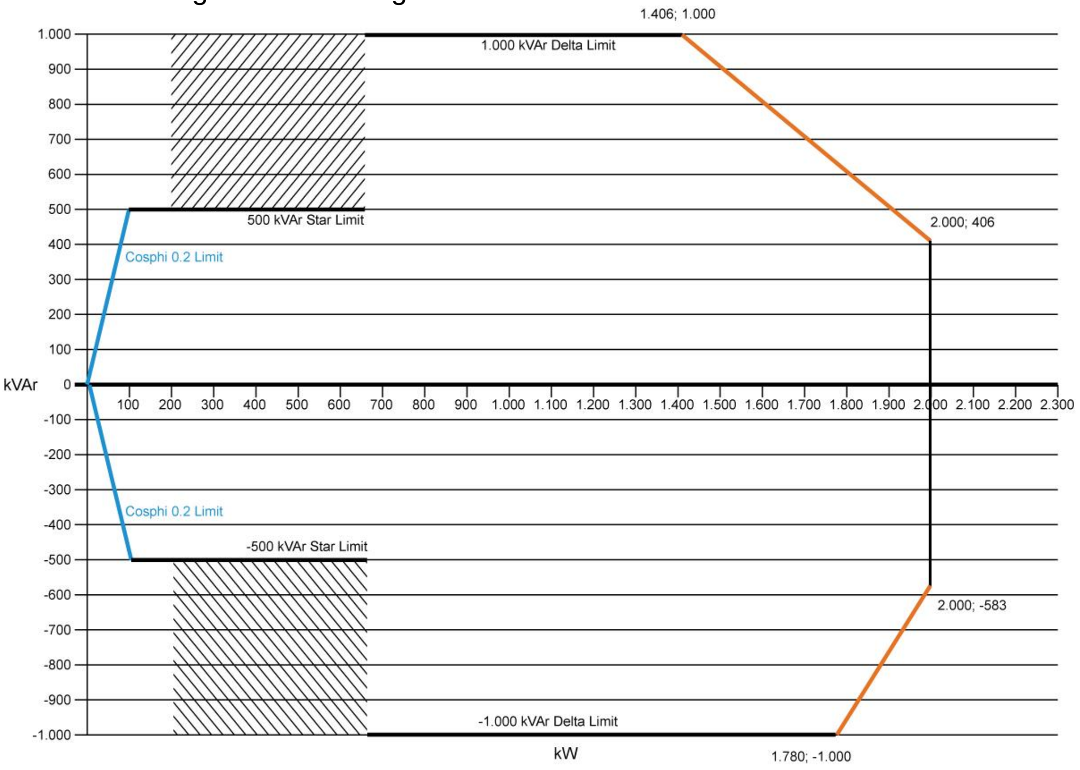


Figure 5-3: Reactive power capability for 2.0MW variants 50 and 60Hz

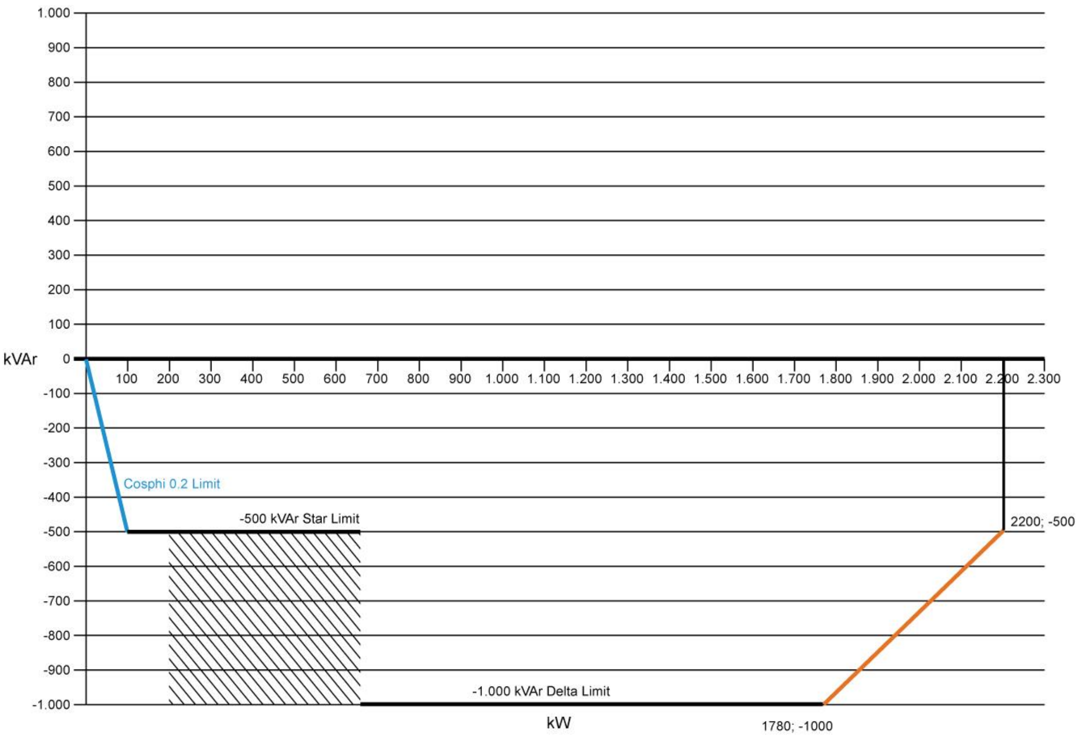


Figure 5-4: Reactive power capability for 2.2MW variants 50 and 60Hz

The above chart applies to the low-voltage side of the HV transformer. The turbine maximises active power or reactive power depending on grid voltage conditions.

5.5 Fault ride through

5.5.1 UVRT

The turbine is equipped with a reinforced converter system in order to gain better control of the generator during grid faults. The turbine control system continues to run 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 UVRT curve in Figure 5-5, p. 13.

Power recovery time	
Power recovery to 90% of pre-fault level	Maximum 2 seconds

Table 5-6: Power recovery time

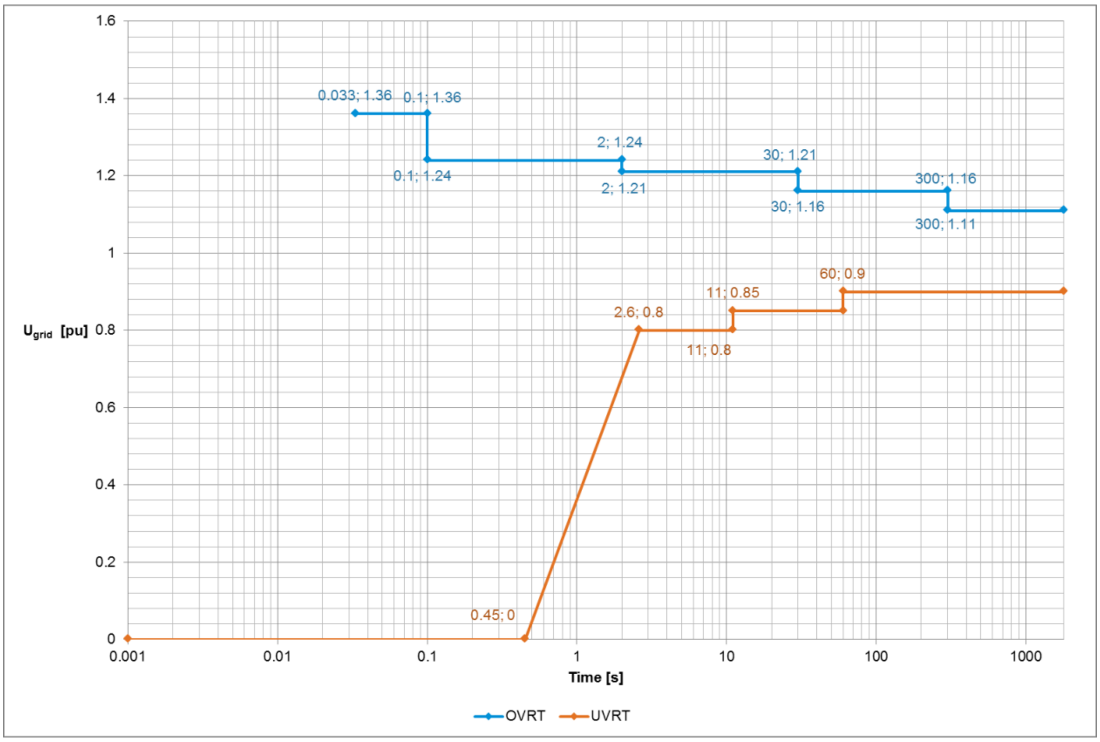


Figure 5-5: OVRT, UVRT curves for symmetrical and asymmetrical faults where U_{grid} represents grid voltage values

The turbine stays connected when the values are above UVRT (and protection) and below OVRT.

5.5.2 OVRT

The turbine is able to run with voltage levels above nominal within restricted time intervals.

The generator and the converter will be disconnected if the voltage level exceeds the OVRT curve shown in Figure 5-5.

5.5.3 Reactive current contribution

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

Symmetrical reactive current contribution

During symmetrical voltage dips the wind farm will inject reactive current to support the grid voltage. The reactive current injected is a function of the voltage measured at the low voltage side of the WTG transformer.

The default value gives a reactive current part of 1 p.u. of the nominal WTG current. Figure 5-6 indicates the reactive current contribution as a function of the voltage. The reactive current contribution is independent from the actual wind conditions and pre-fault power level.

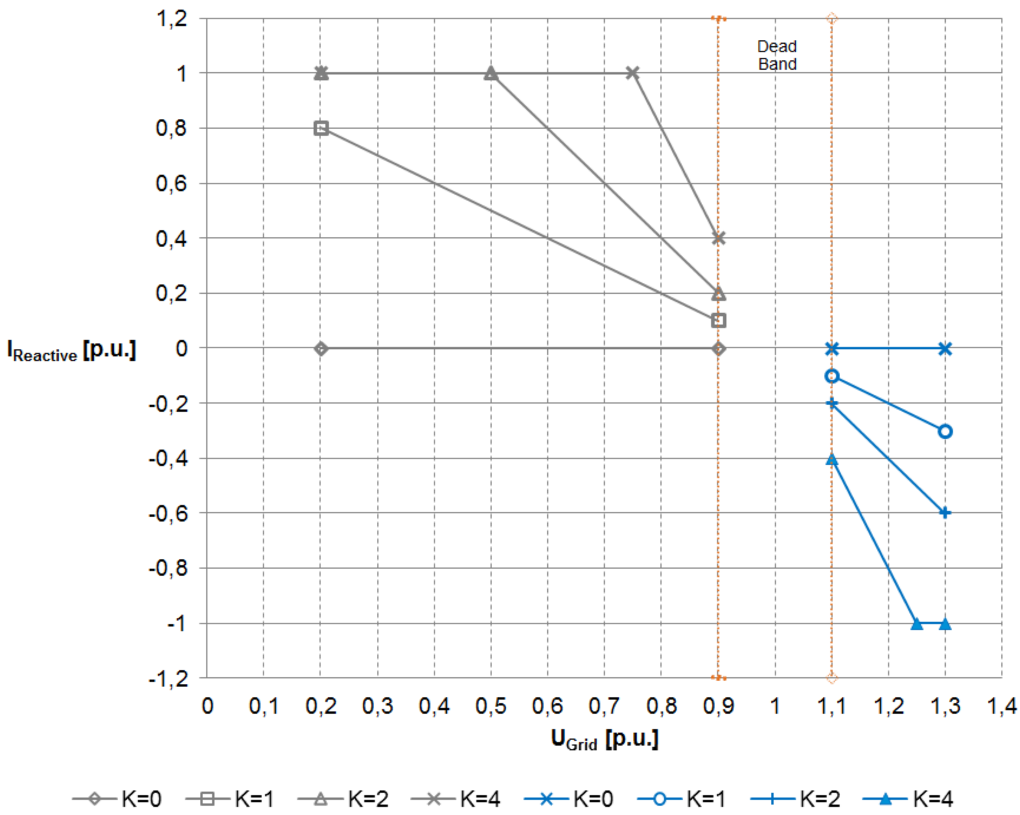


Figure 5-6: Reactive current contribution

Slope (K-factor), offset and dead band can be set freely to fulfil requirements to UVRT current injection.

Asymmetrical reactive current contribution

Current reference values are controlled during asymmetrical faults to ensure ride through.

5.5.4 Sub synchronous resonance protection

Turbine is equipped with fast-acting protection to shield the converter, generator and drivetrain from excessive voltages, currents and torques due to sub-synchronous resonance (SSR) caused by interaction between the turbine and the series-capacitor-compensated transmission lines. The generator and converter will be disconnected upon SSR detection by the turbine controller, according to Table 5-7: SSR protection time. SSR protections availability is depending on grid conditions at the specific sites.

SSR protection time	
Generator and converter disconnect	Maximum 100ms (including breaker response time)

Table 5-7: SSR protection time

5.6 Active and reactive power control

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

Maximum ramp rates for external control	
Active power[3]	0.1 pu/sec
Reactive power[2]	2.5 pu/sec

Table 5-8: Maximum ramp rates for external control data

To protect the turbine, active power cannot be controlled to values below the curve in Figure 5-7, p. 15.

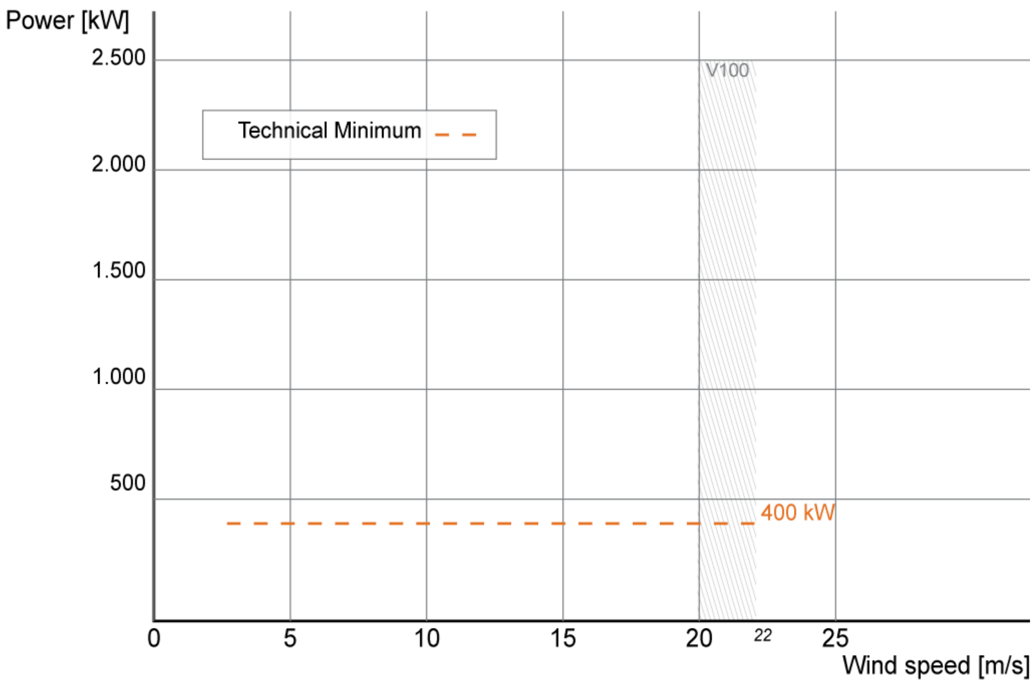


Figure 5-7: Minimum active power output related to wind speed

[3] Limitations in duration of a power ramp may apply.

5.7 Voltage control

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

5.8 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.

5.9 High voltage connection

5.9.1 Transformer

The step-up HV 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.

The transformer comes in different versions depending on the market where it is intended to be installed.

- The transformer is as default designed according to IEC standards for both 50 Hz and 60Hz versions.
- For turbines installed in Member States of the European Union, it is required to fulfil the Ecodesign regulation No 548/2014 set by the European Commission.

5.9.2 HV Switchgear

Vestas delivers a gas insulated switchgear which is installed in the bottom of the tower as an integrated part of the turbine. Its controls are integrated with the turbine safety system which monitors the condition of the switchgear and high voltage safety related devices in the turbine. This ensures all protection devices are fully operational whenever high voltage components in the turbine are energised. The earthing switch of the circuit breaker contains a trapped-key interlock system with its counterpart installed on the access door to the transformer room in order to avoid unauthorized access to the transformer room during live condition.

The switchgear is available in two variants with increasing features – see *Table 5-9 - HV switchgear variants and features*. Beside the increase in features, the switchgear can be configured depending on the number of grid cables planned to enter the individual turbine. The design of the switchgear solution is optimized such grid cables can be connected to the switchgear even before the tower is installed and still maintain its protection toward weather conditions and internal condensation due to a gas tight packing.

The switchgear is available in an IEC version and in an IEEE version. The IEEE version is however only available in the highest voltage class.

HV Switchgear		
Variant	**Basic**	**Streamline**
IEC standards	○	⊙
IEEE standards	⊙	○
Vacuum circuit breaker panel	⊙	⊙
Overcurrent, short-circuit and earth fault protection	⊙	⊙
Disconnector / earthing switch in circuit breaker panel	⊙	⊙
Voltage Presence Indicator System for circuit breaker	⊙	⊙
Voltage Presence Indicator System for grid cables	⊙	⊙
Double grid cable connection	⊙	⊙
Triple grid cable connection	⊙	○
Preconfigured relay settings	⊙	⊙
Turbine safety system integration	⊙	⊙
Redundant trip coil circuits	⊙	⊙
Trip coil supervision	⊙	⊙
Pendant remote control from outside of tower (Option via ground controller)	⊙	⊙
Sequential energisation	⊙	⊙
Reclose blocking function	⊙	⊙
Heating elements	⊙	⊙
Trapped-key interlock system for circuit breaker panel	⊙	⊙
UPS power back-up for protection circuits	⊙	⊙
Motor operation of circuit breaker	⊙	⊙
Cable panel for grid cables (configurable)	○	⊙
Switch disconnector panels for grid cables – max three panels (configurable)	○	⊙
Earthing switch for grid cables	○	⊙
Internal arc classification	○	⊙
Supervision on MCB’s	○	⊙

Table 5-9 - HV switchgear variants and features

5.10 Main contributors to 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:

Main contributors to own consumption	
Hydraulic motor	20 kW
Yaw motors 6 x 1.75 kW	10.5 kW
Oil heating 3 x 0.76 kW	2.3 kW
Air heaters (2 x 6 kW)	12 kW
Oil pump for gearbox lubrication	5.0 kW
Generator fans (included in generator efficiency)	7.0 kW
Average of measured no-load loss of the HV transformer	4.0 kW

Table 5-10: Own consumption data

6 Drawings

6.1 Structural design – illustration of outer dimensions

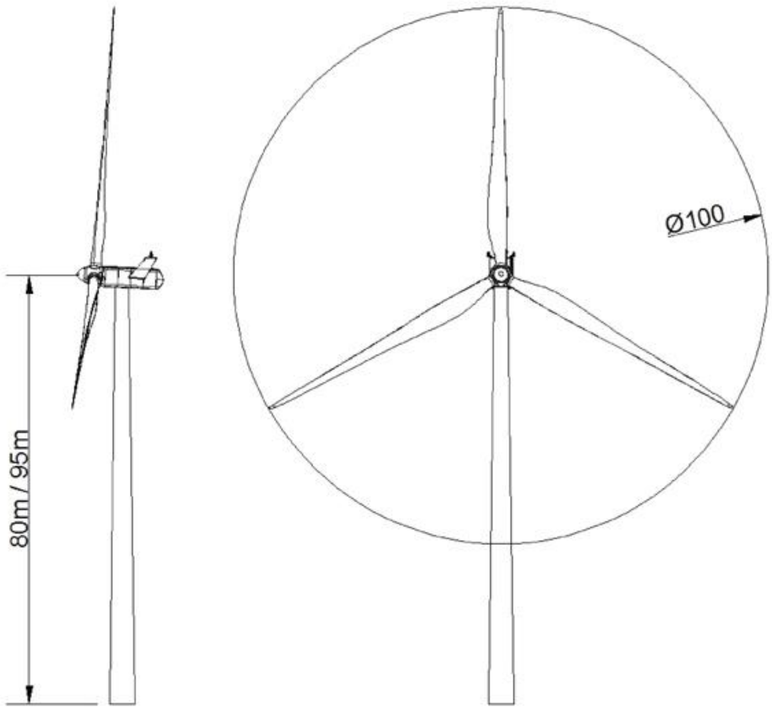


Figure 6-1: Illustration of outer dimensions for a V100 turbine

6.2 Structural design (side-view drawing)

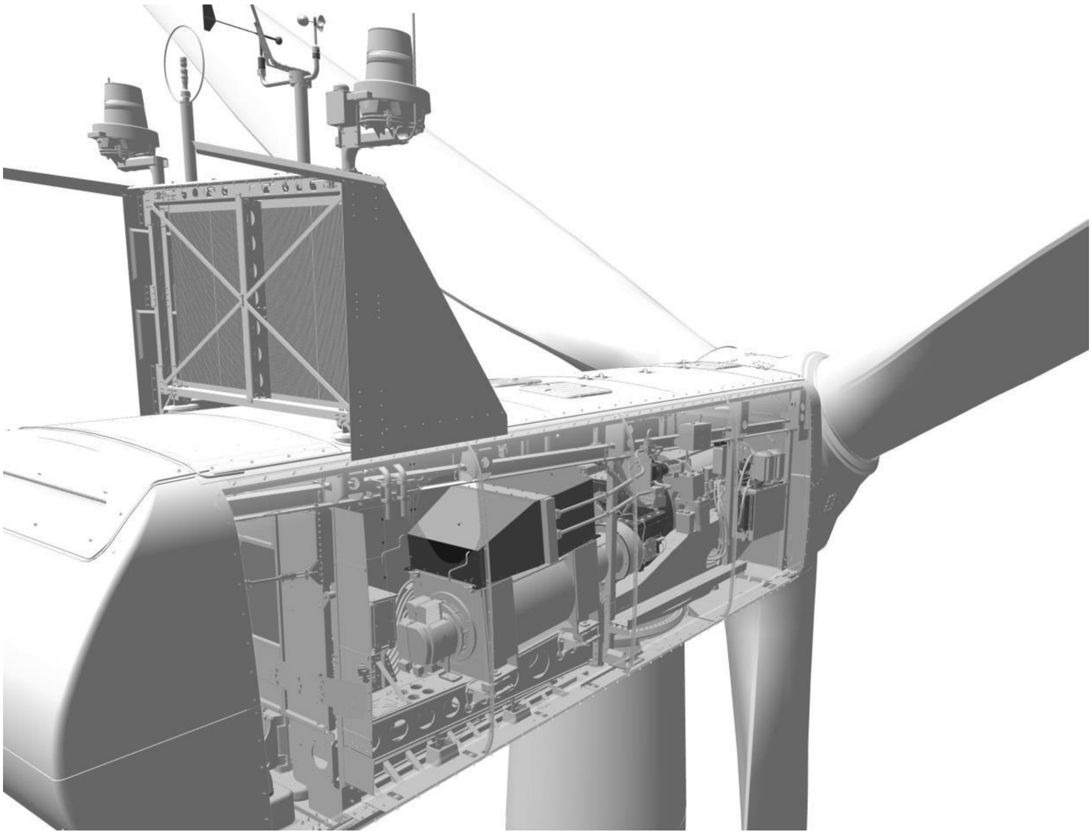


Figure 6-2: Side-view drawing

6.3 Turbine protection systems

6.3.1 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 push buttons.

6.4 Overspeed protection

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

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

6.5 EMC system

The turbine and related equipment must fulfil the EU EMC-directive with later amendments:

- European Parliament Council directive 2004/108/EC of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility.
- The EMC-directive with later amendments.

6.6 Lightning protection system

The LPS consists of three main parts.

- Lightning receptors.
- Down conducting system.
- Earthing system.

NOTE The LPS is designed according to IEC standards.

6.7 Earthing

The Vestas Earthing System is based on foundation earthing.

Document 0000-3388 ‘Vestas Earthing System’ 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 may require additional measures.

7 Environment

7.1 Chemicals

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

- 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.

8 General reservations, notes, and disclaimers

-
- The general specification document here described applies to the present design of the 2.0MW wind turbine series. Updated versions of the wind turbine, which may be manufactured in the future, may have a general specification document that differs from these general specifications. In the event that Vestas supplies an updated version of the wind turbine, Vestas will provide updated general specification 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 an offer for sale, and does not contain any guarantee, warranty, and/or verification of the power curve and noise (including, without limitation, the power curve and noise verification method). Any guarantee, warranty, and/or verification of the power curve and noise (including, without limitation, the power curve and noise verification method) must be agreed to separately in writing.

9 Appendices

9.1 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 61400-1:2005 EN 50308 ANSI/ASSE Z359.1-2007
Bed frame	IEC 61400-1:2005
Tower	IEC 61400-1:2005 Eurocode 3

Table 9-1: Structural design codes

9.2 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 with rules in ISO 81400-4
Blades	DNV-OS-J102 IEC 1024-1 IEC 60721-2-4 IEC 61400 (Part 1, 12, 22 and 23) DEFU R25 ISO 2813 DS/EN ISO 12944-2

Table 9-2: Mechanical equipment design codes

9.3 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

Design codes – electrical equipment	
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 9-3: Electrical equipment design codes

9.4 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 9-4: I/O network system design codes

9.5 Design codes – EMC system

To fulfil EMC requirements the design must be as recommended for lightning protection. See section 9.6 Design codes – lightning , p. 25.

Design codes – EMC system	
Designed according to	IEC 61400-1: 2005
Further robustness requirements according to	TPS 901795

Table 9-5: EMC system design codes

9.6 Design codes – lightning protection

The LPS is designed according to lightning protection level 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 61400-24:2010

Table 9-6: Lightning protection design codes

9.7 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.

9.8 Operational envelope conditions for power curve (at hub height)

Conditions for power curve (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°

Table 9-7: Conditions for power curve

9.9 Power curves, C_t values, and sound power levels

Power curve, C_t values and sound power levels for noise modes are defined in separate performance specifications for each variant. The documents will reference this General Specification to ensure correct traceability between performance data sheet and the General Specification.

The turbine can be equipped with different power generation components depending on the region which may influence the performance of the turbine. Consult Vestas Wind Systems for further details.

The Performance Specifications are listed below:

Performance specifications	Number
V100-2.2MW 50/60Hz	0051-0204
V110-2.2MW 50/60Hz	0051-0205
V100-2.0MW 50/60Hz	0051-0207
V110-2.0MW 50/60Hz	0051-0208

Table 9-8: Performance specifications

V100-2.0 MW IEC IIIA Overview

Table of Contents

1 Abbreviations and Technical Terms

Abbreviation	Spelled-out form / explanation
IEC	International Electrotechnical Commission
IEC IIIA	Wind class IEC IIIA = average wind

Table 1-1: Abbreviations.

Term	Explanation

Table 1-2: Explanation of terms.

2 Hub Height and Rotor Diameter

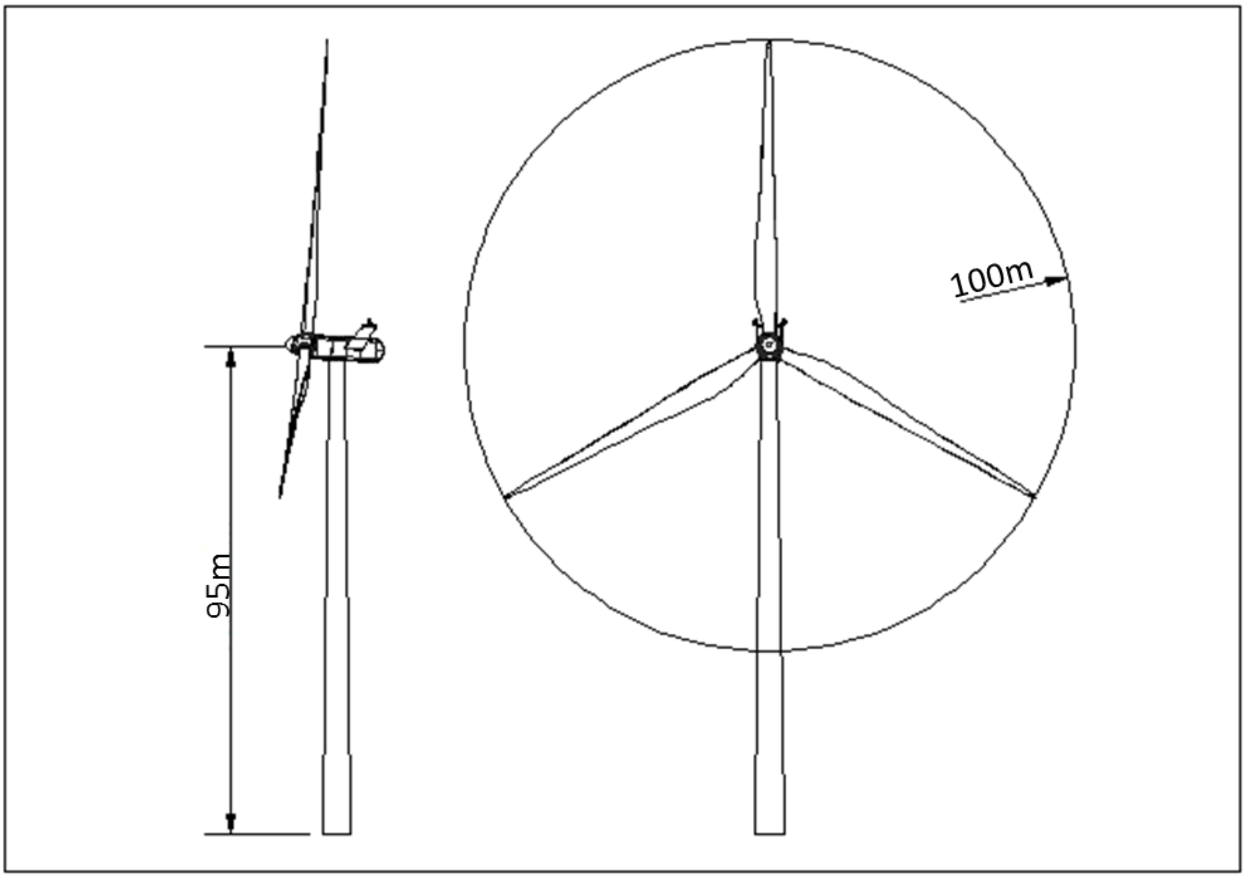
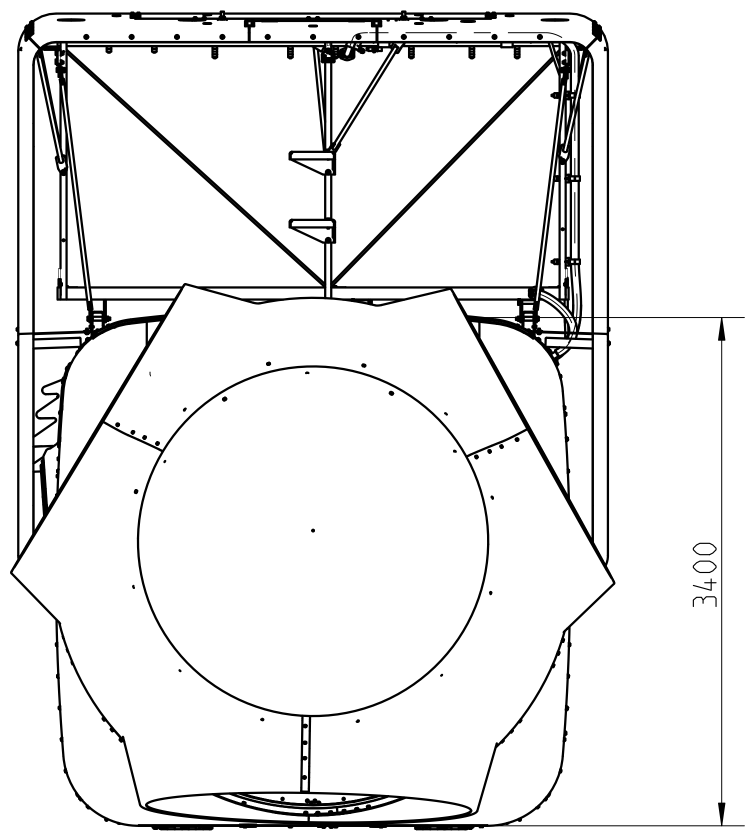
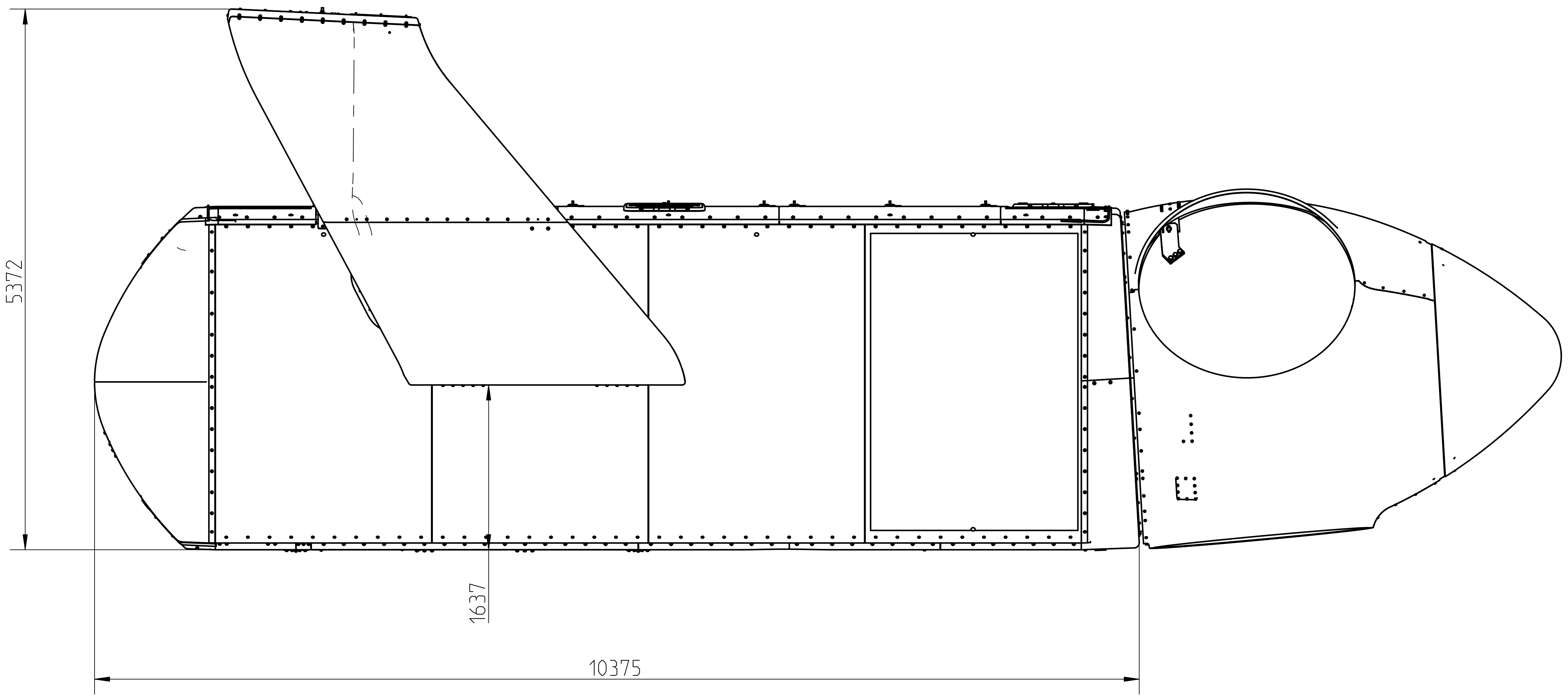
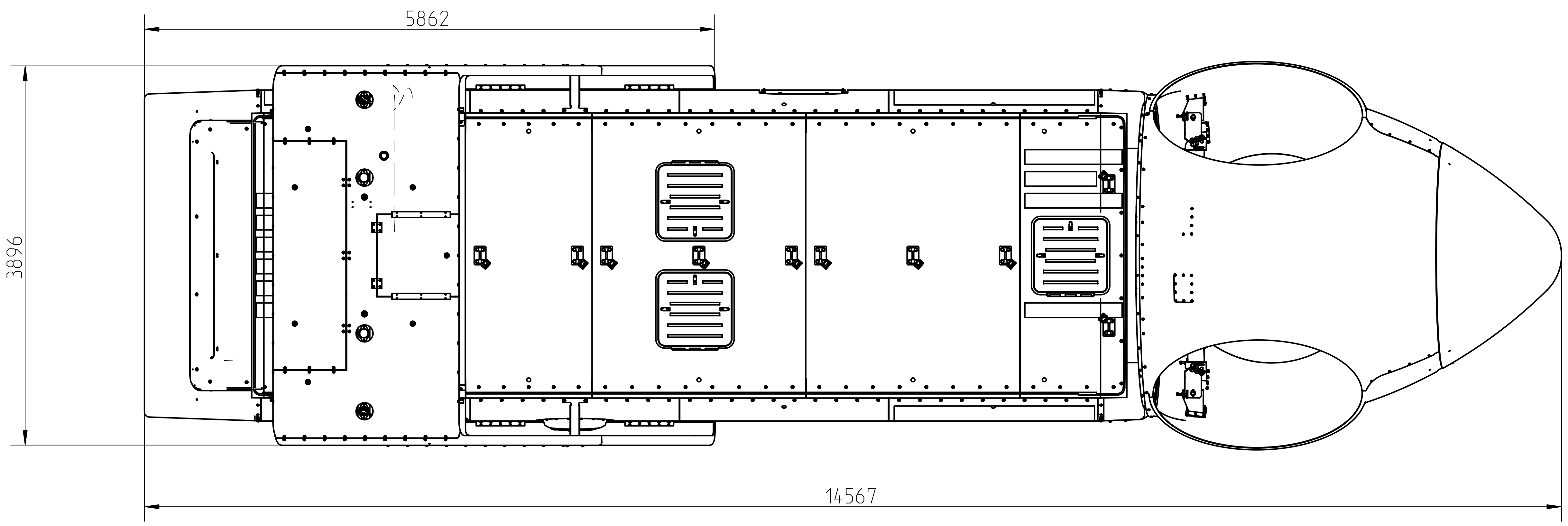


Figure 2-1: Hub height 95 m and rotor diameter 100 m.

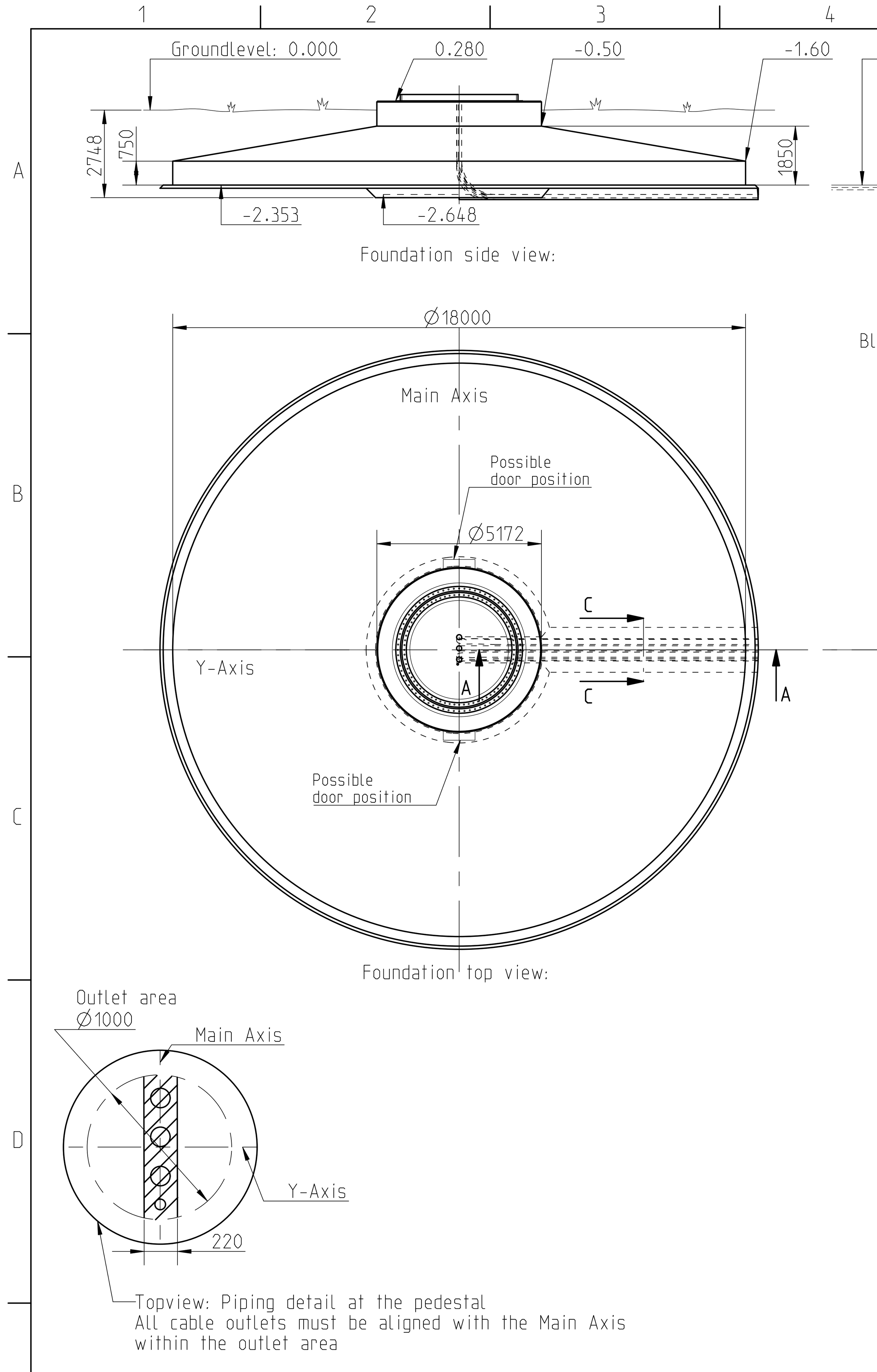


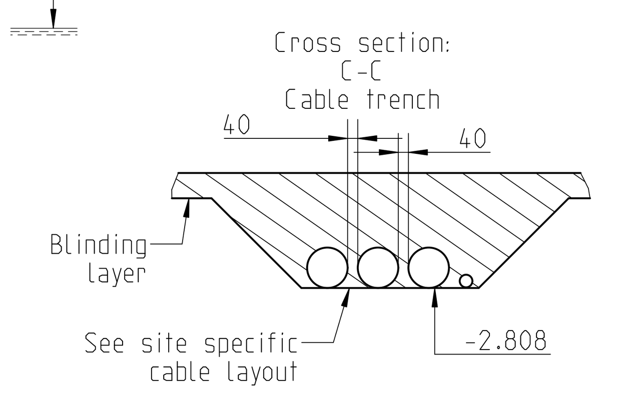


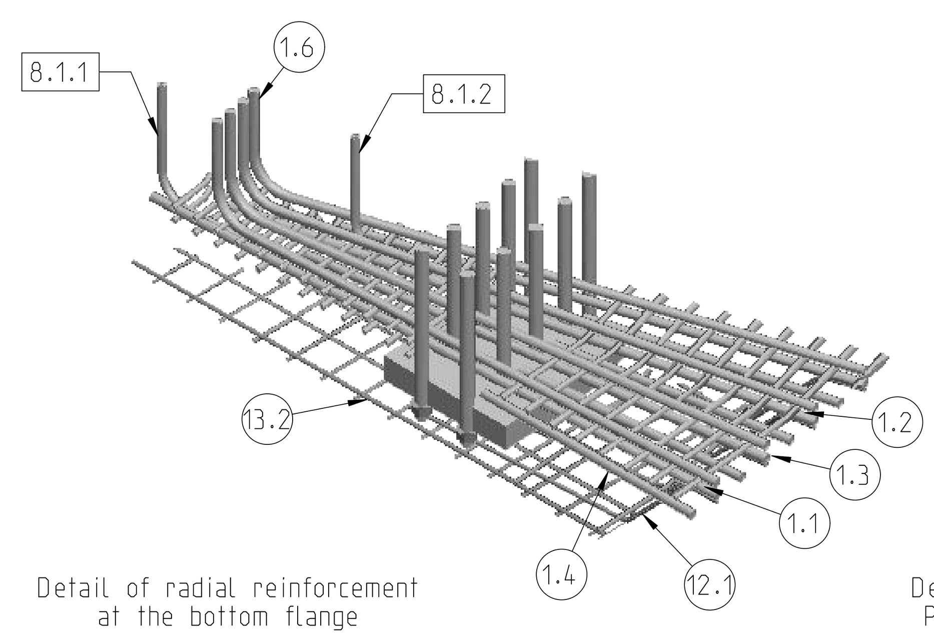


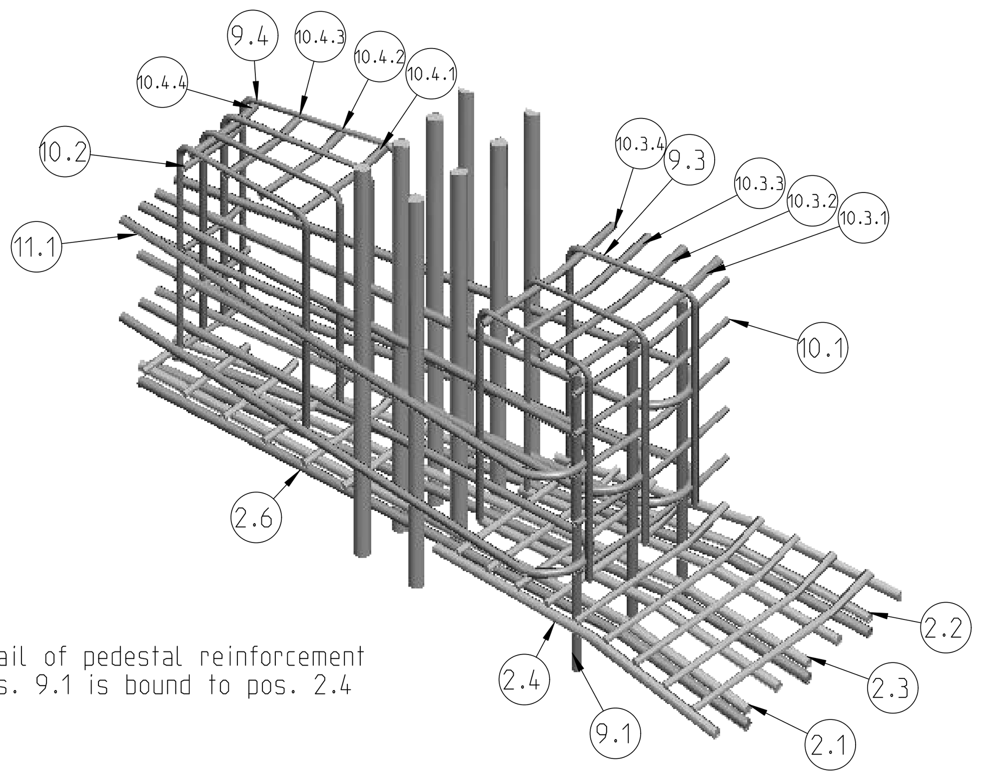
NAC/HUB OUTER DIMNSIONS WITH OUT CoG DETAILS

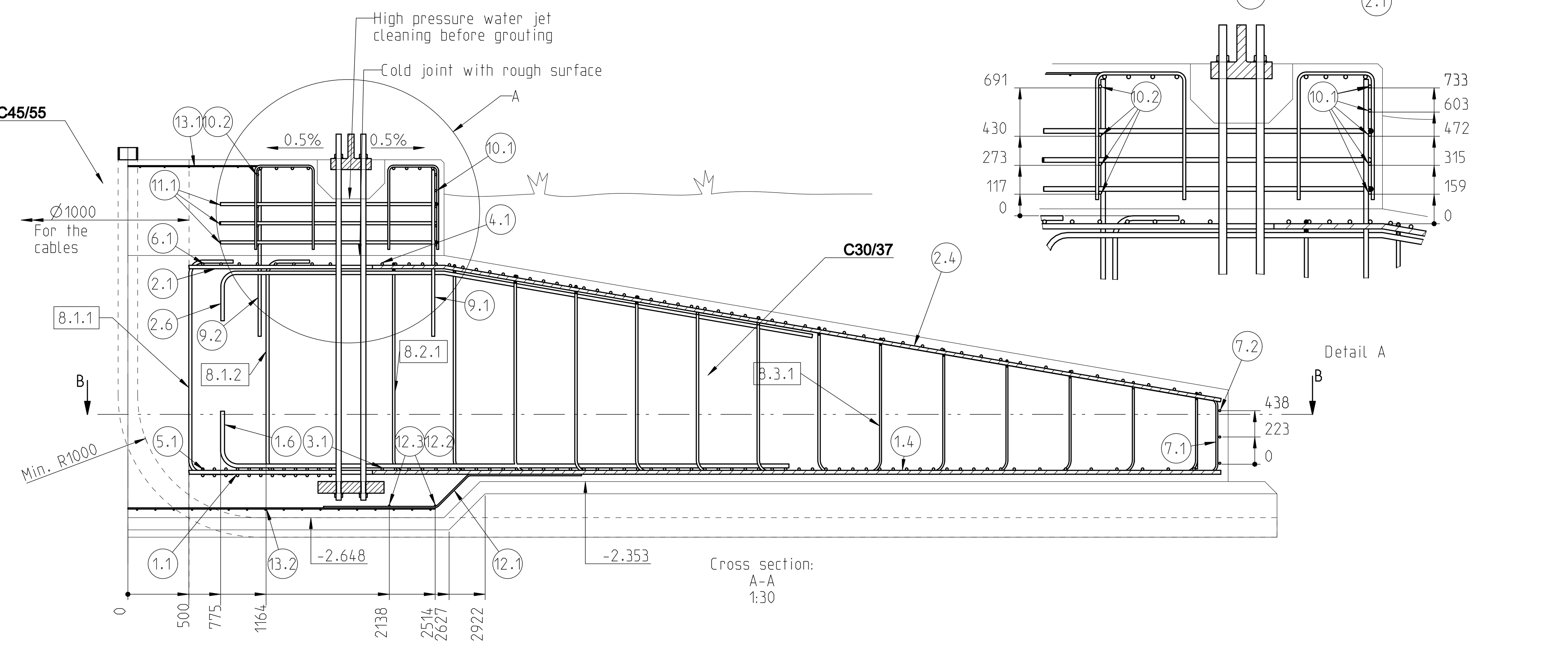
Item no.	Mass (kg)	Certificate	Format	Status	Revised by	Created date	Created by
0037-6533	3591	-	A2	Approved	-	2013-04-04	THGUJ
Material / Specification: - -			Scale: 1:50	Change no.: 358168	PDM ver.: 0.1	Reviewed date: 10.04.2013	Reviewed by: ALM
			Proj. / Pro/E	Item description: 2MW MK10 NAC / HUB DIMENSIONS			
Vestas® vestas.com			Metric. Dimensions shown in mm unless otherwise specified	Replaces: -	Drawing no.: 0037-6533	Ver.: 0	Sheet: 1 of 1

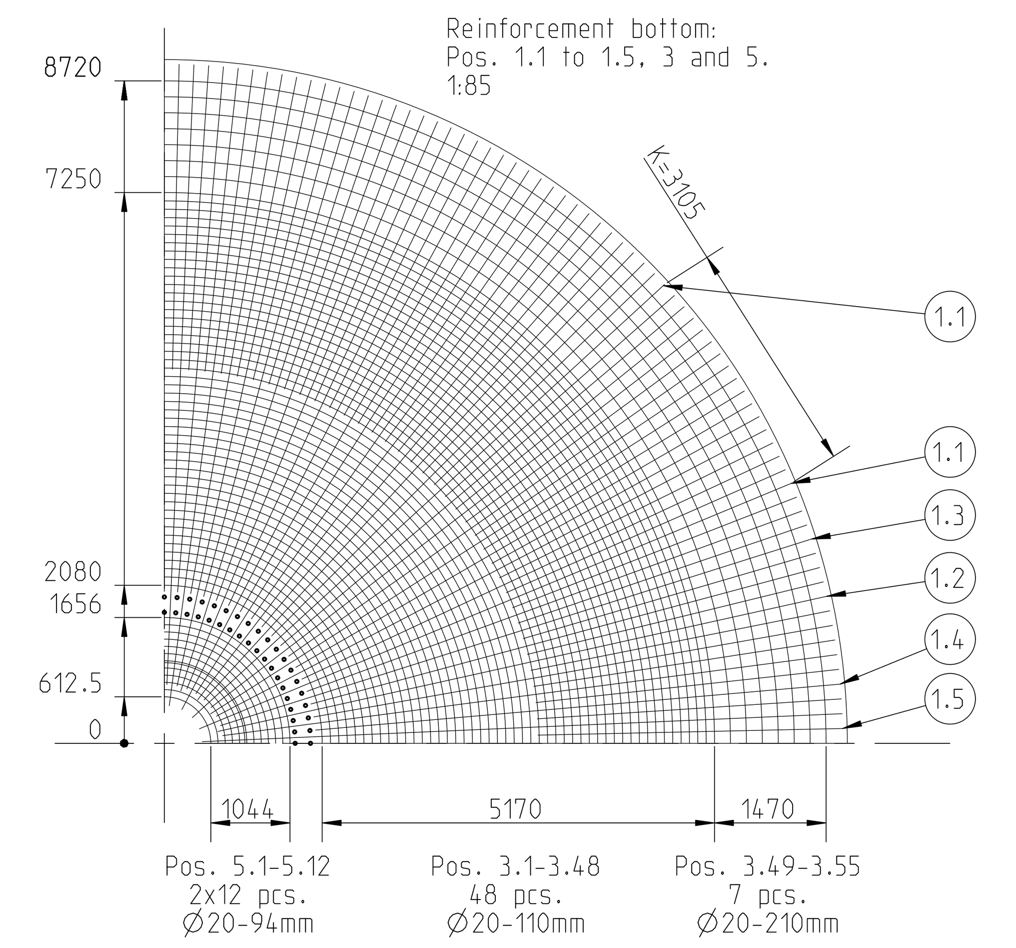


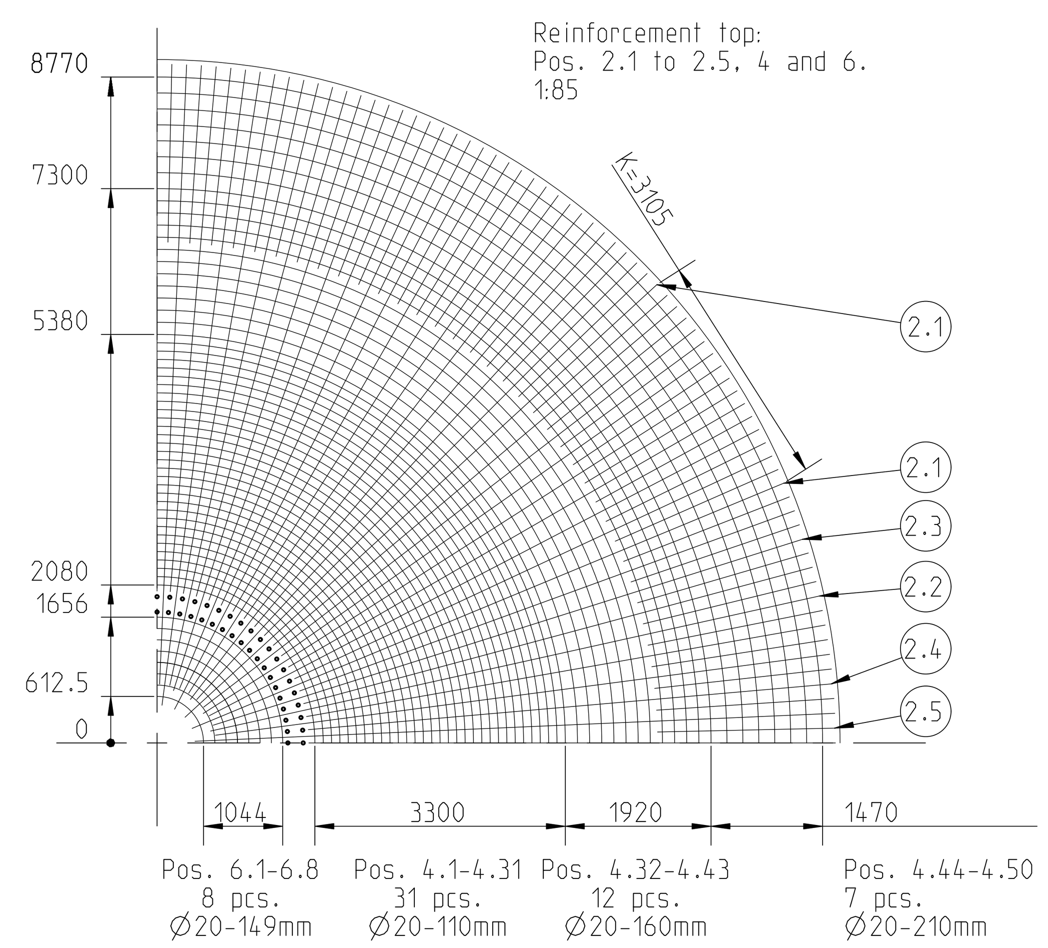


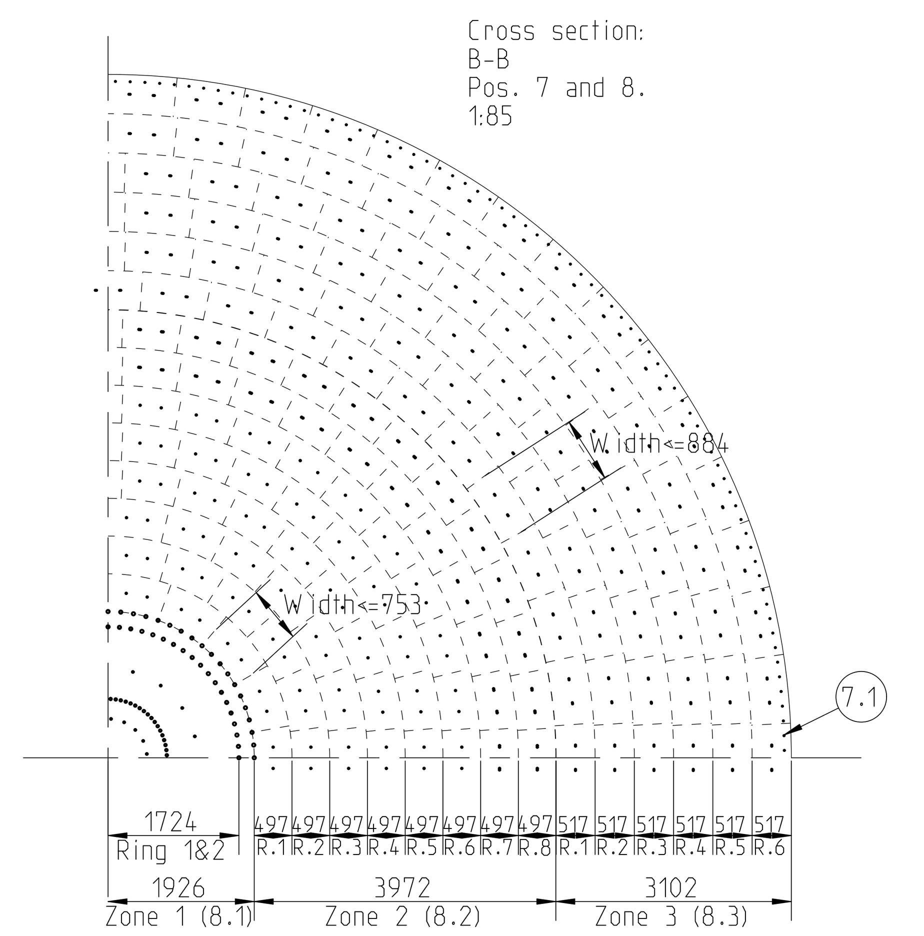


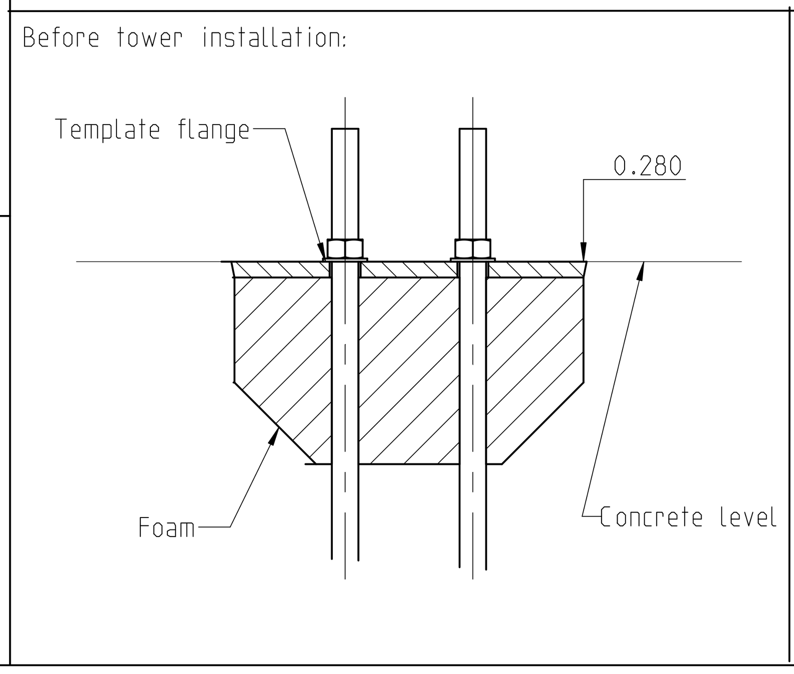


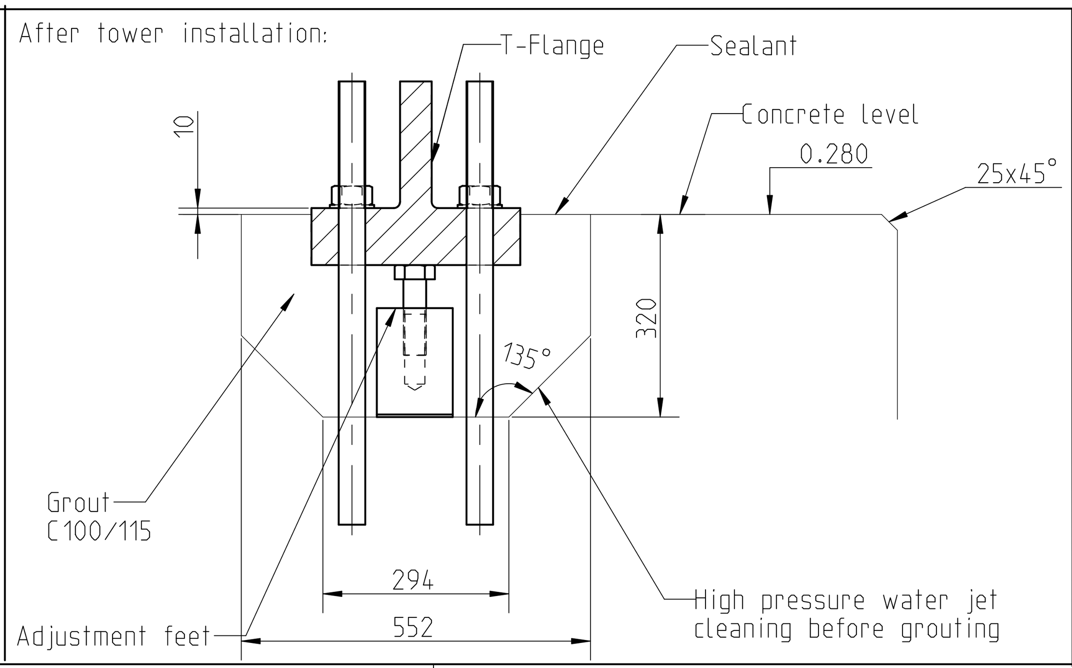


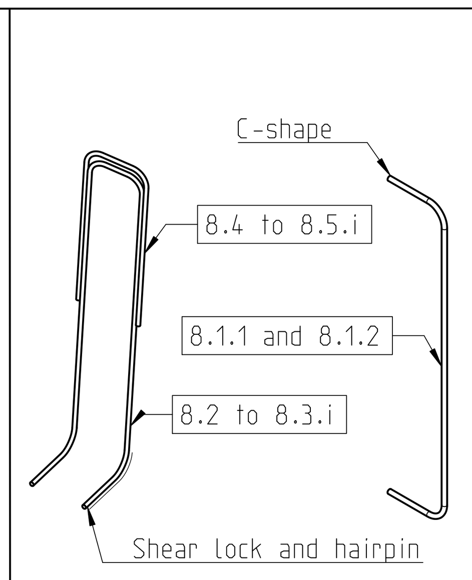












Number and height of C-shaped bars, shear locks and hair pins
(see also Cut and Bending list)

	Zone 1 C-shape Ø25			Zone 2 Ø20					Zone 3 Ø16				
	Number	Pos.	C-shape Height	Number	i	Shear locks Height Pos. 8.2.i	i	Hairpins Height Pos. 8.4.i	Number	i	Shear locks Height Pos. 8.3.i	i	Hairpins Height Pos. 8.5.i
Ring 1	18	8.1.1	1755	18	1	1670	1	881	44	1	1054	1	656
Ring 2	18	8.1.2	1755	22	2	1655	2	881	47	2	965	2	656
Ring 3	-	-		26	3	1570	3	881	51	3	876	3	656
Ring 4	-	-		31	4	1485	4	881	55	4	788	4	656
Ring 5	-	-		35	5	1400	5	881	58	5	699	5	656
Ring 6	-	-		39	6	1315	6	881	62	6	610	6	626
Ring 7	-	-		43	7	1230	7	881	0	-	-	-	-
Ring 8	-	-		47	8	1145	8	881	0	-	-	-	-
Ring 9	-	-		0	-	-	-	-	0	-	-	-	-
Ring 10	-	-		0	-	-	-	-	0	-	-	-	-

Information for design approver:

Loads: 0044-9444, 0044-9445, 0046-3039, 0046-3038, 0046-3036, calculation: 0046-2378

Soil condition to be fulfilled:

Assumed characteristic soil parameters: friction angle 30° or undrained shear strength 60 KN/m².
Min. density of soil 18 / 8 KN/m³, density of back filling 16.2 / 6.2 KN/m³ to 20.7 / 10.7 KN/m³.
Weight of backfilling is included in stability and shall not be removed.
Max. ground water level: 2.353 m under terrain
Drainage must be performed according to local condition and soil composition.
Required rotational stiffness: min. 50 GNm/rad
Max. allowable tilting of the foundation due to permanent settlements: 3 mm/m
Max. plastic design soil pressure: 207 KN/m², constant over substitute area, with a
PSF of 1.1 on wind, 0.9 on tower weight and backfilling, 1.0 on foundation weight
Max. elastic soil pressure 229 KN/m² with PSF equal to 1.0 for all loads.
Soil investigations at the site shall be in accordance with EN 1997-1:2004, section 2-4, and must show compliance with the design assumption.

Specifications:

All works carried out acc. to EN 1992-1-1/AC:2010 Design of Concrete Structures, EN 1997-1/AC:2009" Geotechnical Design, general rules, EN 1997-2/AC:2010 Geotechnical Design, investigation and testing.
General description: 0005-8491. Design life time: 20 years.

Anchor cage, approval drawing 0045-2638:

The anchor cage incl. adjustment feet is provided by Vestas as loose parts or assembled.
The anchor cage shall be set upon the blinding layer and adjusted to the correct position vertically and horizontally by using the adjustment feet at the lower flange. During casting, which must be done simultaneously inside and outside the cage, great care must be taken to ensure that the cage does not displace and that the lower flange is in full contact with compacted concrete, below and above flange. Max. vertical deviation after concreting +/- 4 mm.
Weight of anchor cage, app. 11600 kg total.
Anchors shall be post tensioned according to approval drawing 0045-2638

Concrete:

Concrete works acc. to EN 13670:2009 "Execution of concrete structures".
The concrete must be composed, mixed and prepared according to EN 206-1 in the strength class: C30/37 for plate, C45/55 for pedestal. Exposure class: XC4 / XD1 / XS1 / XF3 / XA1
Maximum aggregate size in the area of the bottom and top reinforcement: 16mm (in other areas max. 32mm)
Blinding layer min. 100 mm.
Low-creeping and low-shrink concrete for exterior buildings units, low heat of hydration
Min. required density of concrete due to stability: 2242 kg/m3.
Covering: Cnom = 60 mm against form work or blinding layer, Cnom = 110 mm against soil (no formwork).
Concrete quality control according to EN 206-1.

Reinforcement:

Steel bars S500 ductility class B or C according to EN 10080 with min Fyk = 500 N/mm².

Grout:

Non-shrink grout, min. compression strength C100/115
Min. compression strength at time of post tension 68 N/mm² and after 1 day: 10 N/mm².
Post tension force: 561 KN equal to 50% of Fuk for the Gr 10.9 anchors and an elongation of 5.6 to 6.5 mm.

Cable conduits (PVC tubes) - NOT a Vestas delivery:

See general discription in "Switchgear installation vs foundation tubes" 0017-5653.
See site specific cable layout for actual number and size of conduits.

Earthing:

See "Vestas Earthing System", esp. description 0019-2575 "Earthing on anchor cage foundation"
incl. copper conductors, bolts, nuts and washers delivered with the anchor cage.

Reinforcement Cut and Bending List: 0046-2380

Radial bars, bottom part:

1.1 18 pcs. Ø32 x 8440 mm, through anchors.
1.2 18 pcs. Ø32 x 8218 mm, through anchors.
1.3 36 pcs. Ø32 x 7863 mm, through anchors.
1.4 72 pcs. Ø32 x 6940 mm, outside anchors.
1.5 144 pcs. Ø16 x 4015 mm, outside anchors.
1.6 72 pcs. Ø32 x 5015 mm, above 1.1-1.3.

Radial bars, top part:

2.1 18 pcs. Ø28 x 8533 mm, through anchors.
2.2 18 pcs. Ø28 x 8311 mm, through anchors.
2.3 36 pcs. Ø28 x 7955 mm, through anchors.
2.4 72 pcs. Ø28 x 7033 mm, outside anchors.
2.5 144 pcs. Ø16 x 2379 mm, outside anchors.
2.6 72 pcs Ø28 x 5202 mm, below 2.1-2.3.

Concentric bars outside anchors, bottom part:

3.1 ø20 ring Ø4160, 3 pcs. L=5169 mm, outer ring no. 1.
3.55 ø20 ring Ø17440, 5 pcs. L=11771 mm, outer ring no. 55.
See table in Cut & Bending List.

Concentric bars outside anchors, top part:

4.1 ø20 ring Ø4160, 3 pcs. L=5518 mm, outer ring no. 1.
4.50 ø20 ring Ø17540, 6 pcs. L=10345 mm, outer ring no. 50.
See table in Cut & Bending List.

Concentric bars inside anchors, bottom part, 1 layer below and 1 layer above pos 1:

5.1 ø20 ring Ø1225, 2 x 1 = 2 pcs. L=4643 mm, ring no. 1.
5.12 ø20 ring Ø3312, 2 x 2 = 4 pcs. L=5997 mm, ring no. 12.
5.i ø20 ring Ø1035 + 190 * i, i = 1-12, ring no. i. Total number of rings: 24. See Cut & Bending list.

Concentric bars inside anchors, top part, 1 layer above pos 2:

6.1 ø20 ring Ø1225, 1 x 1 = 1 pcs. L=4849 mm, ring no. 1.
6.8 ø20 ring Ø3312, 1 x 2 = 2 pcs. L=6203 mm, ring no. 8.
6.i ø20 ring Ø927 + 298 * i, i = 1-8, ring no. i. Total number of rings: 8. See Cut & Bending list.

Vertical bars at edge

7.1 288 pcs ø20 x 1082 mm, vertical bars at outer edge.
7.2 3 rings ø16 x Ø17864, 3 x 5 = 15 pcs L=11785 mm, horizontal rings at outer edge (at pos. 7.1).

Shear locks and hair pins - see Cut and Bending list for correct lengths

8.1 36 pcs ø25 x 2344 mm, shear locks inside anchor cage (zone 1) - C-shaped.
8.2 261 pcs ø20 x approx. 3530 mm (mean value), shear locks in punching zone (zone 2).
8.3 317 pcs ø16 x approx. 2274 mm (mean value), shear locks in shear zone (zone 3).
8.4 261 pcs ø20 x approx. 1874 mm (mean value), hair pins for all zone 2.
8.5 317 pcs ø16 x approx. 1591 mm (mean value), hair pins for zone 3.

Vertical bars and bows in pedestal

9.1 72 pcs ø25 x 1360 mm, vertical bar outside anchors.
9.2 18 pcs ø25 x 1360 mm, vertical bar inside anchors.
9.3 72 pcs ø16 x 1728 mm, outer bows, see Cut & Bending list.
9.4 72 pcs ø16 x 1798 mm, inner bows, see Cut & Bending list.

Horizontal rings in pedestal

10.1 5 rings ø16 x Ø5036, 5 x 3 = 15 pcs L=6074 mm, at outer vertical bars pos 9.1.
10.2 4 rings ø16 x Ø2123, 4 x 1 = 4 pcs L=7470 mm, at inner vertical bars pos 9.2.
10.3.1 1 ring ø20 x Ø4988, 1 x 3 = 3 pcs L=6224 mm, ring 1 under bow pos 9.3.
10.3.2 1 ring ø20 x Ø4775, 1 x 3 = 3 pcs L=6001 mm, ring 2 under bow pos 9.3.
10.3.3 1 ring ø20 x Ø4561, 1 x 3 = 3 pcs L=5777 mm, ring 3 under bow pos 9.3.
10.3.4 1 ring ø20 x Ø4348, 1 x 3 = 3 pcs L=5554 mm, ring 4 under bow pos 9.3.
10.4.1 1 ring ø20 x Ø2952, 1 x 2 = 2 pcs L=5638 mm, ring 1 under bow pos 9.4.
10.4.2 1 ring ø20 x Ø2692, 1 x 2 = 2 pcs L=5229 mm, ring 2 under bow pos 9.4.
10.4.3 1 ring ø20 x Ø2431, 1 x 2 = 2 pcs L=4820 mm, ring 3 under bow pos 9.4.
10.4.4 1 ring ø20 x Ø2171, 1 x 1 = 1 pcs L=7821 mm, ring 4 under bow pos 9.4.

Hooks under grout trench (splitting bars)

11.1 108 pcs ø25 x 3389 mm, bended 184.7 deg., see Cut & Bending list.

Z-Bars under the anchor flange

12.1 72 pcs ø12 x 2217 mm, under base flange, see Cut & Bending list for detailed geometry.
12.2 1 ring ø12 x Ø5027, 1 x 3 = 3 pcs. L=5685mm, ring placed on Z-bows pos. 12.1.
12.3 1 ring ø12 x Ø4276, 1 x 2 = 2 pcs. L=7137mm, ring placed on Z-bows pos. 12.1.

Shrinkage mesh, cut to match cable conduits and adjustment feet

13.1 ø2164 mm top reinforcement mesh ø10 / 150 mm or equivalent with min. 524 mm²/m
13.2 ø5027 mm bottom reinforcement mesh ø10 / 150 mm or equivalent with min 524 mm²/m

Tolerances:

All non specified tolerances: +/- 10 mm

Remarks:

Dimensions in mm. Reinforcement shall be tied with steel wire per 500 mm minimum, no welding permitted.
The anchor cage is rotated to place the door in the right direction.
Basic anchorage length for C30/37: Lb = 35.74 x Ø for good conditions.
Basic anchorage length for C30/37: Lb = 51.06 x Ø for other conditions.
Lap length: Ls = 1.4 x Lb. Bending diameters: 7 x Ø for Ø >= 20 mm, 4 x Ø for Ø < 20 mm.
All overlap of bars shall be staggered.

Bonding- and overlap lengths, bending diameters:

Size	Anchor	Overlap	Bending Ø	Remark
Ø32	994	1391	n.a.	Bottom radial bar (pos 1)
Ø28	1185	1658	550	Top radial bar (pos 2)
Ø20	581	813	140	Bottom concentric ring outside anchors (pos 3)
Ø20	830	1162	140	Top concentric ring outside anchors (pos 4)
Ø20	568	795	140	Bottom concentric ring inside anchors (pos 5)
Ø20	715	1001	140	Top concentric ring inside anchors (pos 6)
Ø16	572	801	64	Concentric ring in pedestal (pos 10)
Ø16	400	560	64	Rings at foundation edge (pos 7.2)

Blinding layer 28 m3, concrete 341 m3, grout 1.53 m3, reinforcement 39 t, reinforcement ratio 113 kg/m3

Item no.	Mass (kg)	Certificate	Format	Status	Revised by	Created date	Created by
0046-2379	0	-	A1	Approved	ANBHM	2014-08-28	ANBHM
Material			Scale	Change no.	PDM ver.	Reviewed date	Reviewed by
- -			1:60		1.1	29.08.2014	CALGO
			Proj. Pro/E	Item description: V100 2MW HH95 MK10AB IEC2B DRW GWL at foundation level			
Vestas® vestas.com			Metric Dimensions shown in mm unless otherwise specified	Replaces: -	Drawing no.: 0046-2379	Ver.: 1	Sheet: 1 of 1

DNV·GL

TYPE CERTIFICATE

Certificate No.:	Issued:	Valid until:
TC-DNVGL-SE-0074-00195-5	2016-12-02	2020-04-29

Issued for:

Vestas V100-2 MW 50 Hz VCS Mk 10

Specified in Annex 1

Issued to:

Vestas Wind Systems A/S

Hedeager 42
8200 Aarhus N
Denmark

According to:

IEC 61400-22:2010-05 Wind turbines – Part 22: Conformity testing and certification

Based on the documents:

DB-DNVGL-SE-0074-00196-4	Design Basis Conformity Statement, dated 2016-12-02
DE-DNVGL-SE-0074-00197-4	Design Evaluation Conformity Statement, dated 2016-12-02
TT-DNVGL-SE-0074-00199-4	Type Test Conformity Statement, dated 2016-12-02
ME-DNVGL-SE-0074-00198-5	Manufacturing Evaluation Conformity Statement, dated 2016-12-02
FER-TC-DNVGL-SE-0074-00195-5	Final Evaluation Report, dated 2016-12-02

Changes of the system design, the production and erection or the manufacturer's quality system are to be approved by DNV GL.

Hamburg, 2016-12-02

For DNV GL Renewables Certification

Fabio Pollicino
Service Line Leader for Project Certification

DAkkS
Deutsche Akkreditierungsstelle
D-ZE-11053-01-00

By DAkkS according DIN EN IEC/ISO 17065 accredited Certification Body for products. The accreditation is valid for the fields of certification listed in the certificate.

Hellerup, 2016-12-02

For DNV GL Renewables Certification

Mark Wollenberg
Project Manager

The accredited certification body is Germanischer Lloyd Industrial Services GmbH, Brooktorkai 18, 20457 Hamburg.
DNV GL Renewables Certification is the trading name of DNV GL's certification business in the renewable energy industry.

DNV·GL

TYPE CERTIFICATE – ANNEX 1

Wind turbine type certification

Basic standard	IEC 61400-1 ed. 3 + A1	
IEC WT class	IEC S (specified below for each configuration ID numbers)	

General

Power regulation	pitch-controlled	
Rotor orientation	upwind	
Rotor tilt	6°	
Cone angle	3°	
Rated power	ID1, ID2, ID3, ID4:	2.0 MW
	ID5, ID6:	2.0-2.2 MW

Note reduced active power capability, reduced grid voltage range and derating of output power from 2.2 MW to 2.0 MW for temperatures above 20°C

Rated wind speed v_r	ID1, ID2, ID3, ID4:	10.0 m/s
	ID5, ID6:	10.3 m/s (2.2MW)
Rotor diameter	100 m	
Hub height(s)	80 m, T2X202, T2X203	
	95 m, T2X221	
Hub height operating wind speed range v_{in} - v_{out}	3 -22 m/s	
Design life time	20 years	
Software version	ID2, ID4:	VMP Global 15.01
	ID1, ID3, ID5, ID6:	VMP Global 16.01

Wind conditions

ID1 to ID2: Wind turbine class S

Annual average wind speed at hub height v_{ave}	8.5 m/s
Reference wind speed v_{ref}	40 m/s
Mean flow inclination	8°
Hub height extreme wind speed v_{e50}	56 m/s
Mean turbulence intensity I_{ref} at v_{hub} = 15 m/s	0.12 (IEC turbulence class C)
Weibull shape factor (k) for wind speed distribution	2.0

ID3 to ID4: Wind turbine class S (IIB except for temperature ranges)

Annual average wind speed at hub height v_{ave}	8.5 m/s
Reference wind speed v_{ref}	42.5 m/s (IEC wind class II)
Mean flow inclination	8°
Hub height extreme wind speed v_{e50}	59.5 m/s
Mean turbulence intensity I_{ref} at v_{hub} = 15 m/s	0.14 (IEC turbulence class B)
Weibull shape factor (k) for wind speed distribution	2.0

ID5: Wind turbine class S

Annual average wind speed at hub height v_{ave}	8.50 m/s at 2.00 MW decreased to 7.50 m/s at 2.20 MW
Reference wind speed v_{ref}	40 m/s
Mean flow inclination	8°
Hub height extreme wind speed v_{e50}	56 m/s
Mean turbulence intensity I_{ref} at v_{hub} = 15 m/s	0.12 (IEC turbulence class C)
Weibull shape factor (k) for wind speed distribution	2.0 (for 2.0 MW) 2.2 (for power > 2.0 MW)

ID6: Wind turbine class S

Annual average wind speed at hub height v_{ave}	8.50 m/s at 2.00 MW decreased to

	7.50 m/s at 2.20 MW
Reference wind speed v_{ref}	42.5 m/s (IEC wind class III)
Mean flow inclination	8°
Hub height extreme wind speed v_{e50}	59.5 m/s
Mean turbulence intensity I_{ref} at v_{hub} = 15 m/s	0.14 (IEC turbulence class B)
Weibull shape factor (k) for wind speed distribution	2.0 (for 2.0 MW) 2.2 (for power > 2.0 MW)

Electrical network conditions

Normal supply voltage and range	10.5 kV-35 kV
Normal supply frequency and range	50 Hz
Voltage imbalance	<3 %
Maximum duration of electrical power network outages	Not dimensioning
Number of electrical network outages	50

Other environmental conditions

Standard temperature turbine (IEC standard temperature range)

Operating temperature	-20°C to +40°C
Extreme temperature, stand still	-30°C to +50°C

Low temperature turbine (LT, turbine components and operating strategy are identical to the standard temperature turbine but additional heating elements are installed for low temperature usage)

Operating temperature	-30°C to +40°C
Extreme temperature, stand still	-40°C to +50°C

Relative humidity of the air	100 % (max 10 % of lifetime)
Air density	1.225 kg/m^3 1.325 kg/m^3

Note for LT: The -30°C minimum operating temperature has been verified for loads and structural integrity by considering an air density of 1.325 kg/m^3

Solar radiation	The turbine shall resist solar radiation (including UV) with 1000 W/m2 and 8000 MJ/m2 per year throughout the design lifetime
Description of lightning protection system	IEC 61400-24:2010, Protection Level 1

Major components

Blade	Type	49m Structural shell
	Manufacturer	Vestas,
	Material	Glass fibre and carbon fibre reinforced epoxy
	Blade length	49 m
	Number of blades	3
	Drawing / Data sheet / Part no.	29021600 (Vestas item number)
Blade bearing	Type	2 row 4-point contact ball bearing
	Manufacturer	Rollix
	Drawing / Data sheet / Part no.	13-1920-02-DD0-5
	Type	2 row 4-point contact ball bearing
	Manufacturer	Liebherr
	Drawing / Data sheet / Part no.	648 VO 802-000
	Type	2 row 4-point contact ball bearing
	Manufacturer	TMB
	Drawing / Data sheet / Part no.	B030.65.1920K

DNV·GL

TYPE CERTIFICATE - ANNEX 1

Pitch system	Type	One cylinder per blade
	Manufacturer	LJM, Glual and Hine
	Controller type	Hydraulic
	Motor / actuator	Hydraulic
Main shaft	Type	Forged hollow trumpet shaft
	Material	42CrMo4
	Drawing / Data sheet / Part no.	76400581
Main bearing	Type	Two double row spherical roller bearing
	Manufacturer	SKF
	Drawing / Data sheet / Part no.	230/630 CA/HM2 W33 24188 ECA/HM2 W33
	Manufacturer	KOYO
	Drawing / Data sheet / Part no.	230/630 RHAW33T 24188 RHAW33
	Manufacturer	FAG
	Drawing / Data sheet / Part no.	F-582558.PRL-WPO F-582559.PRL-WPO
Gearbox	Type	3 stage planetary gearbox
	Manufacturer	Winergy
	Gear Ratio	1:112.2
	Drawing / Data sheet / Part no.	PEAB 4440
	Manufacturer	ZF
	Gear Ratio	1:112.36
	Drawing / Data sheet / Part no.	Atlas 1.2, 1.21
Yaw system	Drive type	Planetary-/worm gear combination, 3 step planetary / 1 step worm gear
	Manufacturer	ABB or Lafert
	Drawing / Data sheet / Part no.	0039-3093.V0 29005012 (Vestas item number)
	Bearing Type	Friction Bearing (PETP slide plate)
	Manufacturer	Vestas Wind System A/S
	Drawing / Data sheet / Part no.	29011239.V1
	Gear Type	Planetary-/worm gear combination, 3 step planetary / 1 step worm gear
	Manufacturer	Bonfiglioli, Comer
	Drawing / Data sheet / Part no.	Bonfiglioli 2T709T4VA79A05/06 Comer PG1603 PR
	Brake Type	Friction brake, motor brake included in the motor unit
	Manufacturer	ABB or Lafert
	Drawing / Data sheet / Part no.	0039-3093.V0 29005012 (Vestas item number)
Generator	Manufacturer	VND (Vestas Nacelles Deutschland)
	Type	DVSG 500/4M (Three phase Asynchronous

		generator with wound rotor)
	Rated power	2000 kW, 2020 kW
	Rated frequency	50 Hz
	Rated speed	1680 rpm
	Rated voltage	690 VAC
	Rated stator current	1505 A or 1530 A
	Rated rotor current	606 A or 610 A
	Insulation class	H/H
	Degree of protection	IP54
	Drawing / Data sheet / Part no.	0048-7754.V2 (2000 kW) 0007-0081.V9 (2020 kW)
	Manufacturer	VND (Vestas Nacelles Deutschland)
	Type	DVSG 500/4M SP. (Three phase Asynchronous generator with wound rotor)
	Rated power	2060 kW or 2260 kW
	Rated frequency	50 Hz
	Rated speed	1680 rpm
	Rated voltage	690 VAC
	Rated stator current	1573 A or 1713 A
	Rated rotor current	610 A or 569 A
	Insulation class	H/H
	Degree of protection	IP54
	Drawing / Data sheet / Part no.	0007-0081.V9 (2060 kW) 0057-1280.V0 (2260kW)
Converter	Manufacturer	Vestas Wind System A/S
	Type	Full quadrant IGBT
	Rated voltage	480 V
	Nominal current (at 2.0 MW)	
	Grid	240 A
	Rotor	592 A
	Nominal current (at 2.2 MW)	
	Grid	256 A
	Rotor	655 A
	Degree of protection	IP 54
Transformer	Manufacturer	Siemens, SGB, JST
	Type	Dry type
	Rated voltage	HV side: 10.5-35.0 [kV] LV side: 690 [V] +/-2% & 480 [V] +/-2%

Tower (tubular steel)	Tower	HH	Sections	Drawing	Configuration ID
	T2X202	80 m	4	0044-9014.V2	ID1, ID2 and ID5
	T2X203	80 m	3	0044-7632.V1	ID3, ID4 and ID6
	T2X221	95 m	4	0044-7224.V2	ID3, ID4 and ID6

Foundation load(s)	Tower	Foundation loads	Configuration ID
	T2X202	0057-5949.V0	ID1
	T2X202	0045-9081.V2	ID2
	T2X202	0057-5955.V0	ID5
	T2X203	0057-5946.V0	ID3
	T2X203	0046-3836.V1	ID4
	T2X203	0057-5956.V0	ID6
	T2X221	0057-5953.V0	ID3

DNV·GL

TYPE CERTIFICATE - ANNEX 1

	T2X221	0046-3039.V2	ID4
	T2X221	0057-5959.V0	ID6
Manuals	O&M manual	See list of manuals 0059-8859.V3	
	Transport manual	See list of manuals 0059-8859.V3	
	Installation / Commissioning manual	See list of manuals 0059-8859.V3	
Service lift (optional)		Not included	
Crane (optional)		Not included	