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Technical description

Nordex N100/2500

Version gamma

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Technical description

Nordex N100/2500

Version gamma

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1. Design

The Nordex N100/2500 wind turbine is a speed-variable wind turbine with a rotor diameter of 99.8 m and a nominal power of 2 500 kW. The wind turbine is designed for 50 Hz or 60 Hz. The machine and the rotor blades are designed for class 2a according to IEC 61400-1.

The wind turbine is part of the proven turbine family Nordex N80/2500, N90/2500, N100/2500 and N117/2400.

Wind turbines are integrated in wind farms for economic and technical reasons and operated as a unit. In addition, met masts and a substation are often part of the wind farm. Depending on the topology of the area, a wind farm layout is created that aims to achieve minimum investments, maximum yield and minimized loads caused by turbulences. In order to ensure the safety of the wind turbines, this wind farm layout must be agreed to with Nordex beforehand.

1.1 Climatic design data

The tower, nacelle, and rotor blades are certified according to national and international standards for wind turbines.

- Ambient temperatures **NCV** (Normal Climate Version):
 - Survival: -20 °C...+50 °C
 - Nominal power:-10 °C...+40 °C
 - Standstill: -10 °C, restart at -8 °C

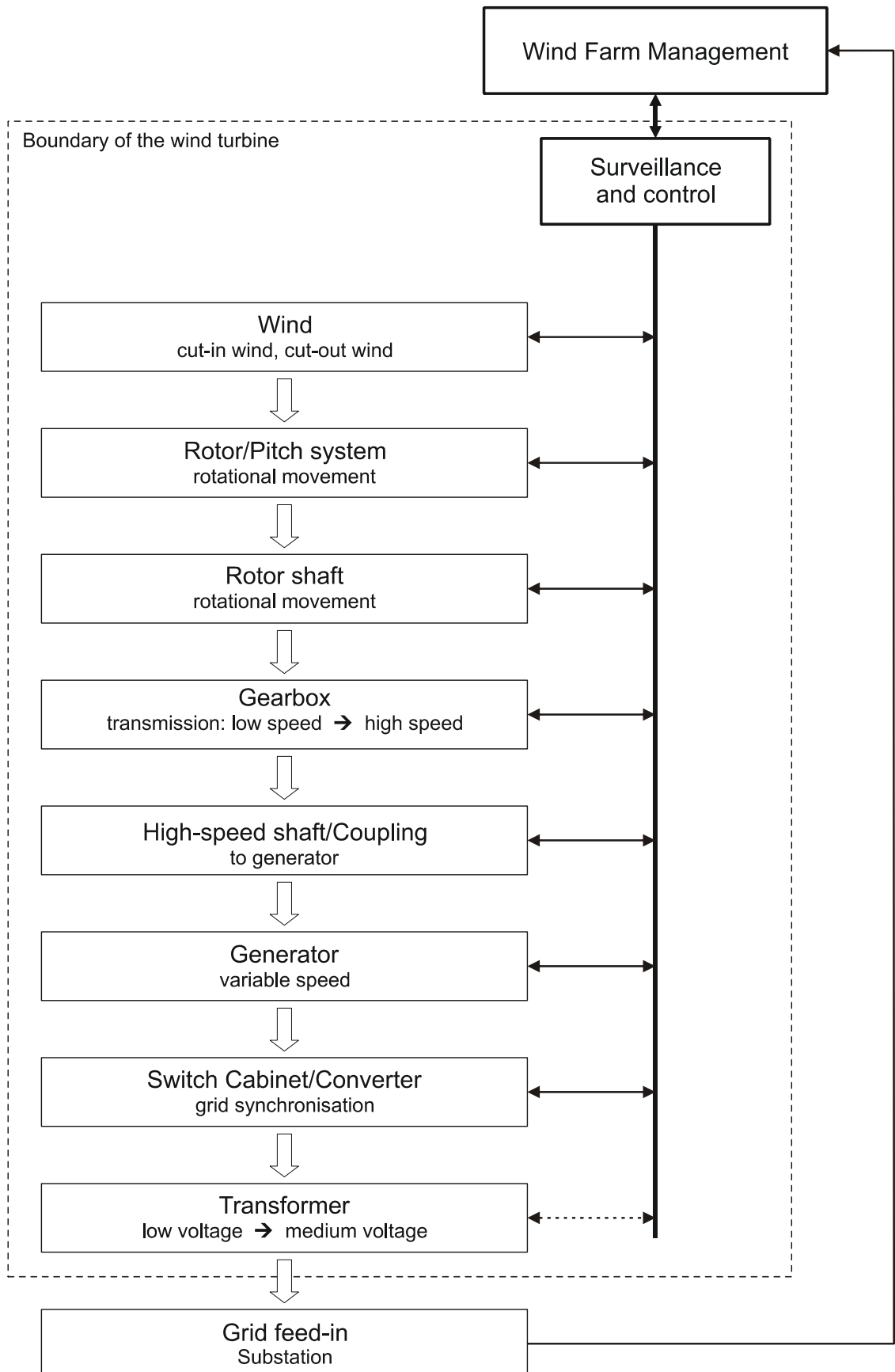
* As an option, the standard turbine can be installed so that it produces nominal output power even at ambient temperatures of -20°C. Then, the restart of the turbine is at -18 °C.

- Ambient temperatures **CCV** (Cold Climate version):
 - Survival: -40 °C...+50 °C
 - Rated power*:-30 °C...+40 °C
 - Standstill: -30 °C, restart at -28 °C
- The wind turbine is designed for location on altitudes up to 1000 m. Under certain circumstances, erection altitudes of up to 2000 m above MSL are feasible. In such cases the nominal power of the wind turbine is reduced because the cooling power drops at high ambient temperatures.

The ambient temperature for the wind turbine design is based on standard meteorological measurements (taken in shade 2 m above the ground). The ambient temperature required by the control system is measured outside the nacelle at the height of the rotor hub.

* Refer to chapter “Special operating states and modes”, page 36.

1.2 Energy flow diagram of a wind turbine



1.3 Structure of a wind turbine

A wind turbine consists of the following main components:

- Rotor, consisting of rotor hub, three rotor blades and the pitch system
- Nacelle with drive train, generator and yaw system
- Tubular tower with foundation
- Transformer and medium-voltage switchgear

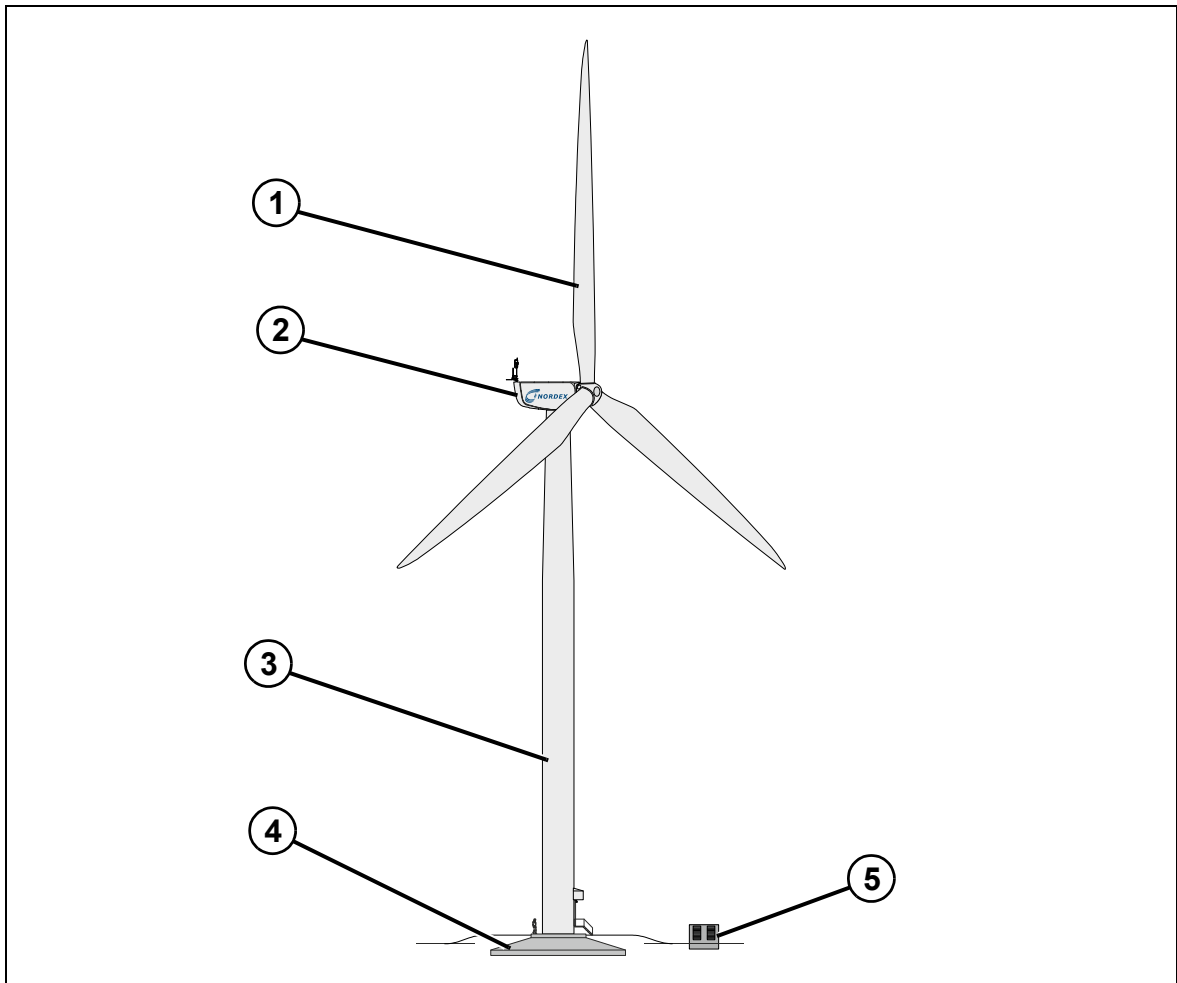


Fig. 1 Main components of a wind turbine

1. Rotor
2. Nacelle
3. Tower
4. Foundation
5. Transformer substation (optional)

A separate layout drawing with the most important dimensions for each hub height is available.

Functioning principle of a wind turbine

The nacelle with the rotor can rotate on the tower. The nacelle is oriented automatically into the main wind direction by the control system using the yaw system. The rotor has an up-wind design.

The conversion of the wind energy absorbed from the rotor to electrical energy is achieved using a double-fed asynchronous generator. Its stator is directly and its rotor via a specially controlled frequency converter connected to the wind farm network. The main advantages are that the frequency converter must be dimensioned at only approx. 30 % of the generator power and that the generator can be operated within a certain speed range around its synchronous rotational speed.

The power is limited by changing the rotor blade angle. The so-called pitch system consists of three independent control units and drives, one for each rotor blade.

The support structure of the nacelle consists of a cast machine frame, a welded generator frame and a steel framework as a bearing race for the on-board crane. At the same time, the steel framework is the mount for the nacelle housing. The cabin is made of glass-reinforced plastics.

The interior is designed on a generous scale so that the roof can remain closed during work. Several roof hatches offer access to the rotor hub or to the exterior roof assemblies. The redundantly-designed wind measuring system and optionally the day and night lights (obstacle lights) or other optional sensors are installed on the roof.

Sectional view of the nacelle

The nacelle contains essential mechanical and electronic components of the wind turbine.

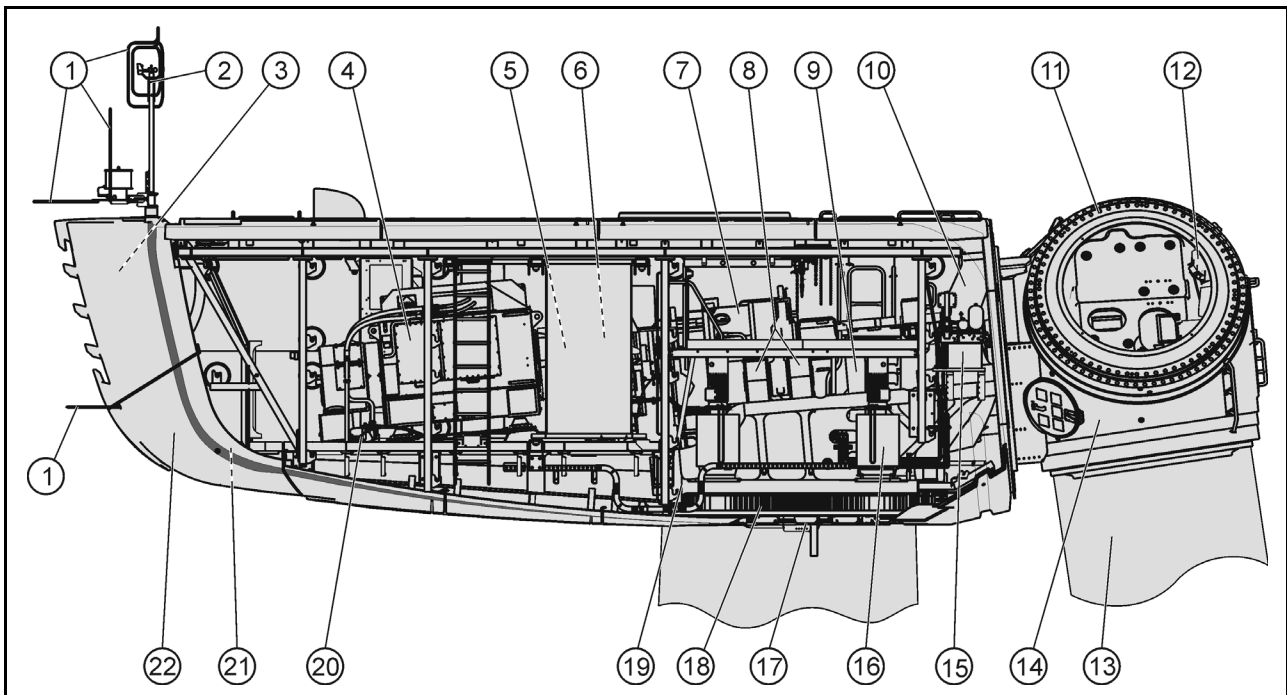


Fig. 2 Nacelle layout drawing

1. Lightning rod
2. Wind sensors
3. Heat exchanger
4. Generator
5. Coupling
6. Rotor brake
7. Gearbox
8. Gearbox support
9. Rotor shaft
10. Rotor bearing
11. Pitch bearing
12. Pitch drive
13. Rotor blade
14. Rotor hub
15. Hydraulic unit
16. Yaw drive
17. Yaw brakes
18. Yaw bearing
19. Machine frame
20. Cooling water pump
21. Hatch for on-board crane
22. Cabin

Sectional view of the tower base

This section through the bottom tower section shows schematically the essential components in the tower base.

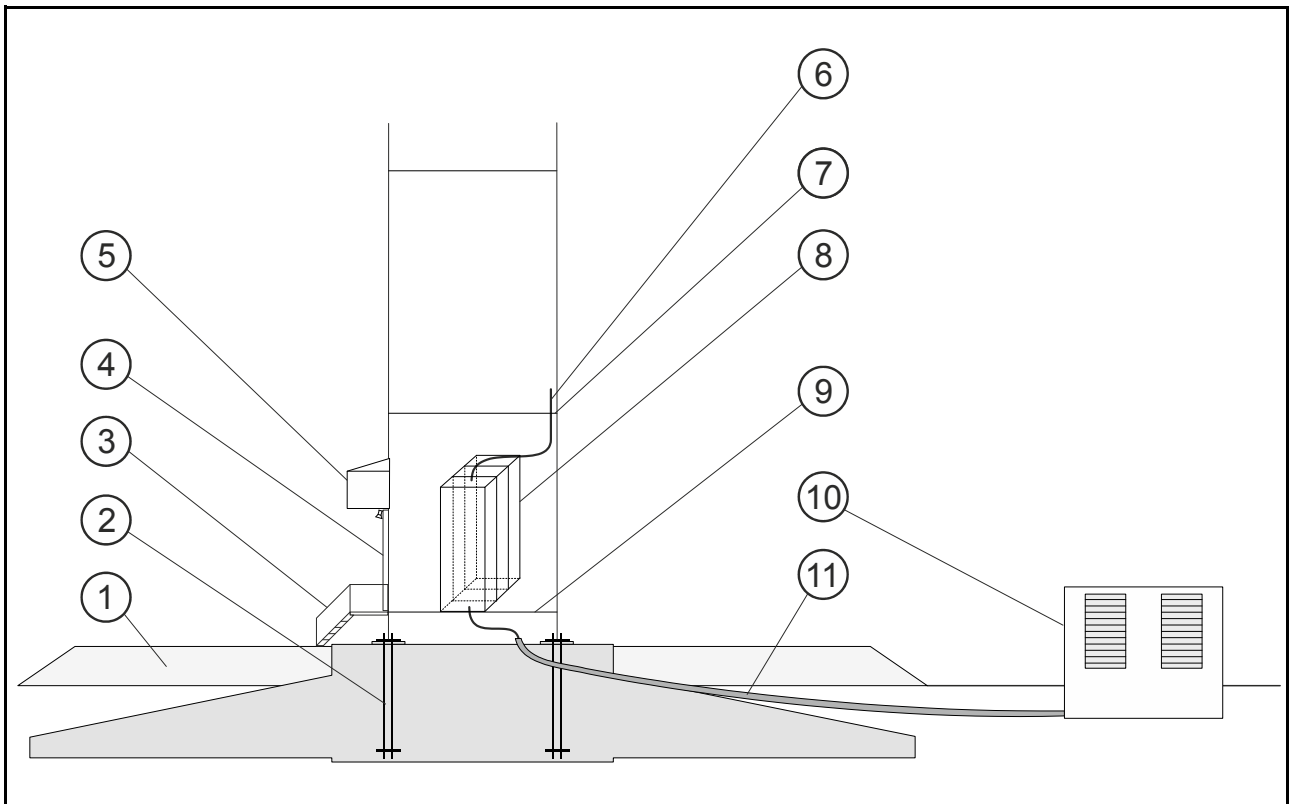


Fig. 3 Section through the tower base, variant with separate transformer substation

1. Soil backfill
2. Tower anchoring
3. Stairs
4. Tower door
5. Ventilation/cooling
6. Power cables
7. 2nd tower platform
8. Switch cabinet
9. 1st tower platform
10. Transformer substation
11. Conduits

This section through the bottom tower section shows schematically the tower base option with transformer inside the tower.

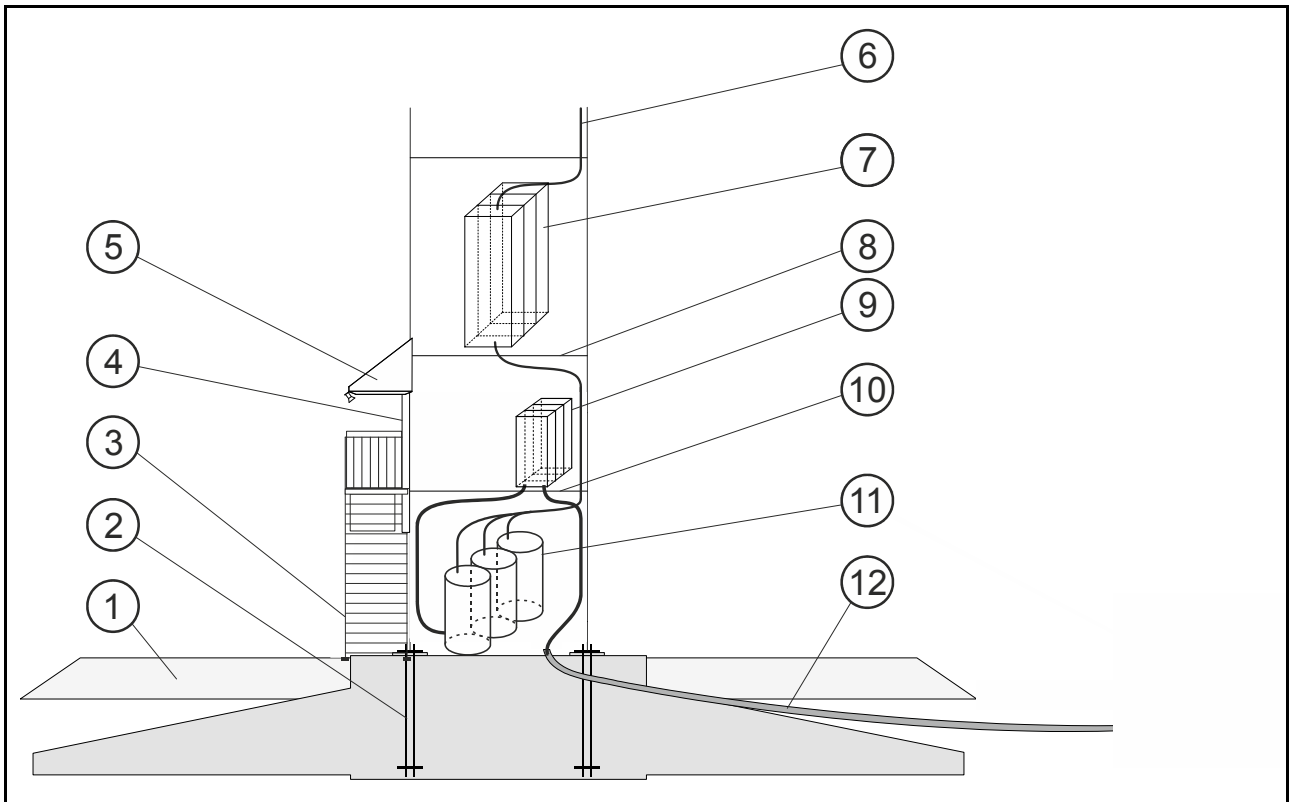


Fig. 4 Section through the tower base, variant with transformer inside the tower

1. Soil backfill
2. Tower anchoring
3. Stairs
4. Tower door
5. Ventilation/cooling
6. Power cables
7. Switch cabinet
8. 2nd tower platform
9. Medium-voltage switchgear
10. 1st tower platform
11. Transformer
12. Conduits

2. Rotor

The kinetic energy of the wind is transmitted from the rotor blades via the rotor hub to the drive train. Wind energy is transformed into rotational movement. With its rotor diameter of just under 100 m, the N100/2500 is optimally designed for inland locations.

The rotor consists of three rotor blades, the rotor hub, three pitch bearings and three pitch drives for rotor blade adjustment.

The rotor blades are made from high-quality glass-reinforced plastics (GRP). They are equipped with a lightning protection system including several lightning receptors that conduct the lightning to the rotor hub.

The pitch system moves the rotor blades to the positions defined by the control system. Each rotor blade is controlled and driven independently. The pitch system is the main brake of the wind turbine.

For braking the rotor blades are rotated by 90°. This interrupts the aerodynamic lift and at the same time creates a very strong air drag which stops the rotor (aerodynamic brake).

2.1 Rotor hub

The rotor hub has a modular and stiff cast structure. The base frame accommodates all components of the pitch drive. The pitch bearing and the rotor blade are assembled to the cast base frame. To strengthen the bearing load capacity of the rotor blade a blade stiffening ring is assembled between the pitch bearing and the blade stiffening ring.

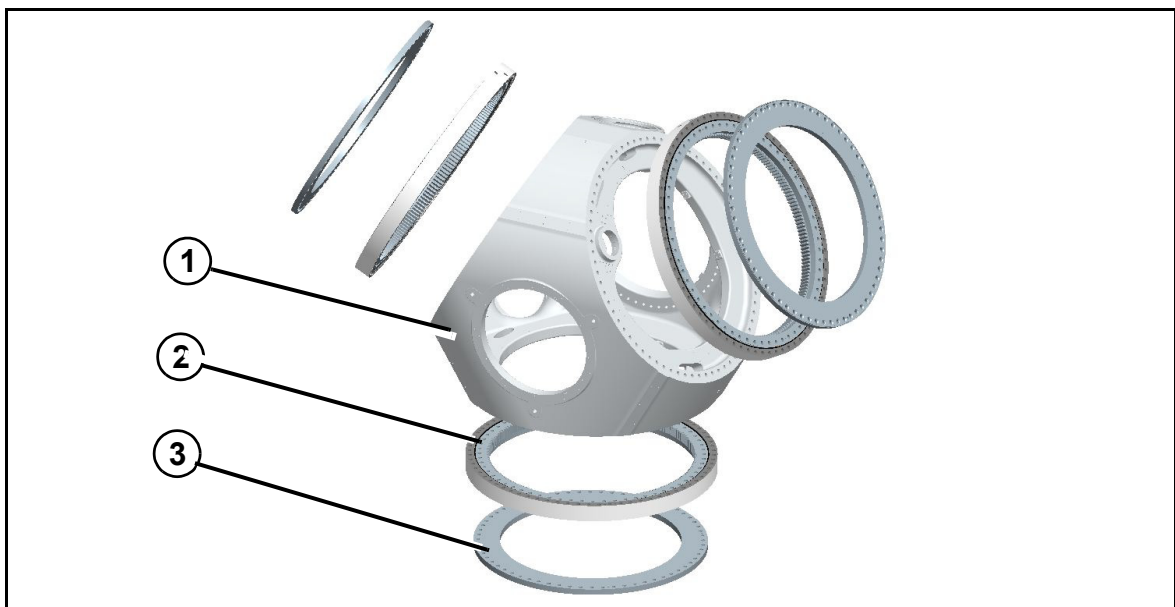


Fig. 5 Structure of the rotor hub

1. Rotor hub base frame
2. Pitch bearing
3. Rotor blade stiffening ring

The rotor hub can be accessed through a lockable opening that can be reached directly from the roof of the nacelle.



Fig. 6 Accessing the rotor hub

The integration of the slip ring into the rotor shaft allows for more working space. Daylight can shine into the rotor hub through the transparent opening in the front. Anti-slip material is applied to all tread surfaces.

2.2 Rotor blade

Prepared glass fiber layers are laid in a mold and then soaked with epoxy resin in a vacuum infusion process. In this way a high quality fiber-reinforced plastic is produced. A rotor blade is glued from two parts. Balsa wood and PET foam are the core material of the multilayer structure. Longitudinal beams reinforce the rotor blade structure. The rotor blade root is closed with a plate. The rotor blade can be entered through a manhole. The manhole is closed by a plate.



Fig. 7 Blade root and rotor blade

The aerodynamic profile of the rotor blades is not sensitive to dirt and ice and thus it reduces power loss. In addition, the geometry of the profile offers advantages in the critical process of gluing the trailing edge.

In accordance with the guidelines IEC TS 61400-23 and GL IV-1 (2004), the rotor blade was statically and dynamically tested with loads that are beyond the design specification. The blade material is subject to comprehensive tests in regular intervals. These intensive test programs ensure the durability and stability of the rotor blades over the entire service life.

If required, each rotor blade can be locked in any position to make assembly and maintenance work easier.

2.3 Pitch system

For each individual rotor blade, the pitch system comprises an electromechanical drive with 3-phase motor, planetary gear and drive pinion, as well as a control unit with frequency converter and emergency power supply.

The pitch system controls the angles of the rotor blades. It can rotate the rotor blades around their longitudinal axes. During operation these blade angles are optimized so that energy is taken from the wind in the most efficient way and then converted into rotational movement. From nominal wind speed level on, the pitch system mainly serves for power limitation to nominal power.

Gusts of wind are compensated by the pitch system which also serves as the aerodynamic main brake of the rotor by rotating the rotor blades to approx. 90°.

Each rotor blade is controlled and driven independently of the other blades and thus forms a redundant safety system. The adjusting movements of the rotor blades are synchronized electronically. In addition, each pitch drive is provided with a separate emergency power supply. The emergency power supply enables

the rotor blade to be safely moved out of the wind in case of power failure. After that the rotor idles.

Signal transfer and power supply is achieved by a slip ring that is integrated in the rotor shaft.

3. Drive train

The drive train transmits the rotational movement of the rotor to the generator. The speed increases until the required value is reached. The drive train consists of the following main components:

- Rotor shaft
- Gearbox
rotor shaft is connected to the gearbox with a shrink disk.
- Coupling
- Generator

The following figure shows the drive train including rotor hub and machine frame.

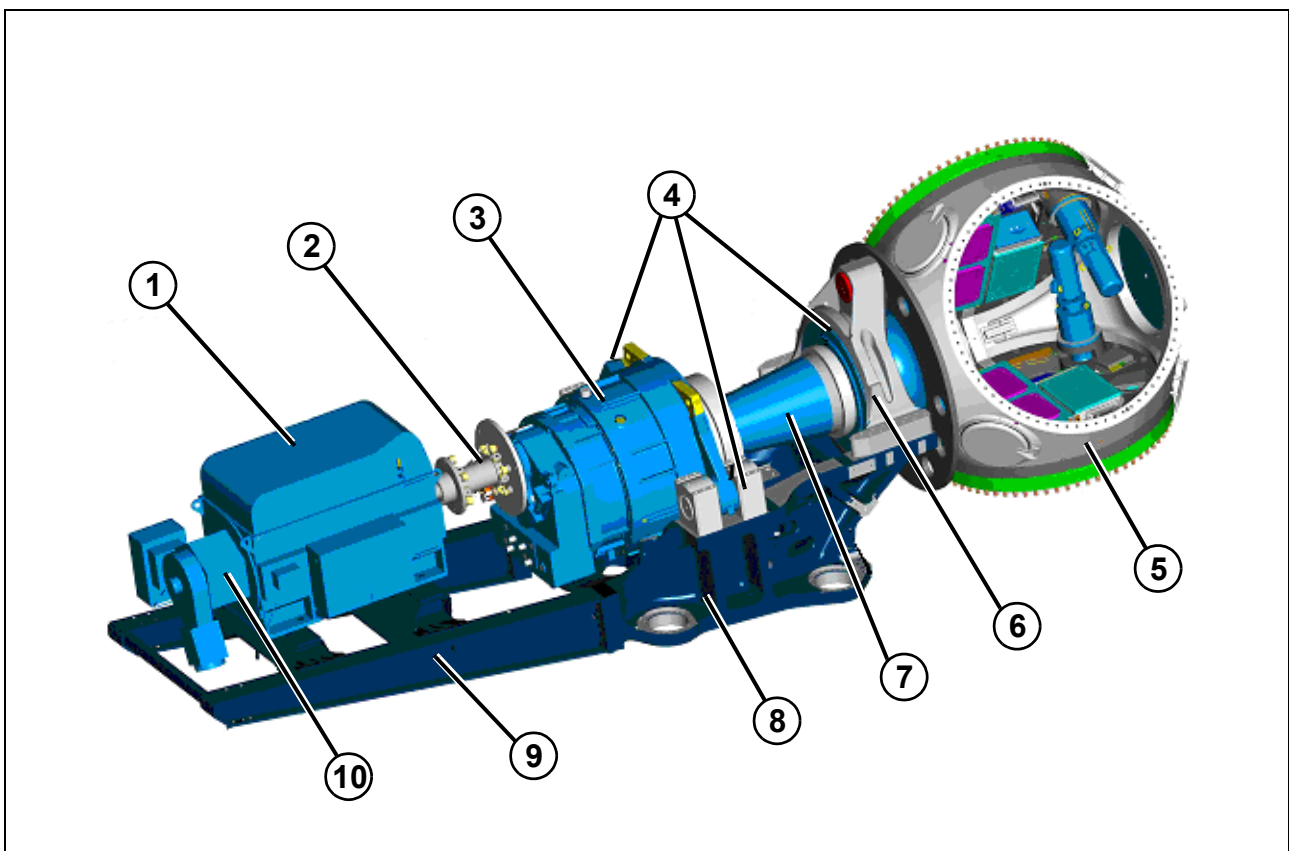


Fig. 8 Components of the drive train

1. Generator
2. Coupling
3. Gearbox
4. Three-point bearing
5. Rotor hub
6. Rotor bearing
7. Rotor shaft
8. Machine frame
9. Generator frame
10. Slip ring for power transmission

3.1 Rotor shaft

The rotor shaft is mounted on the rotor bearing in the nacelle. The rotor bearing transmits the rotational and axial forces of the rotor to the machine frame. A hydraulic locking mechanism for the rotor is integrated into the rotor bearing. The slip ring for signal and voltage transmission to the hub is integrated in the rotor shaft.

3.2 Gearbox

The gearbox speed is increased until it reaches the speed required for the generator. There are 2 different types of proven gearboxes. On the one hand, a multi-stage planetary gear with one-stage spur gear stage and on the other hand, a differential gear. The gearbox is cooled through an oil-air cooling circuit with stepped cooling capacity. The bearings and gearings are continuously lubricated with cooled oil. The gear oil used for lubrication also serves for cooling the gearbox. The temperatures of the gearbox bearings and the oil are continuously monitored.

3.3 Coupling

The coupling is located between the gearbox brake disk and the generator. It compensates the offset between gearbox and generator. An overload protection (with defined torque limitation) is mounted on the generator shaft. It prevents the transmission of torque impacts which may occur in the generator due to grid failures. The coupling is electrically isolated.

3.4 Generator

The generator is a double-fed asynchronous machine. The generator is kept in its optimum temperature range by a cooling circuit. The generator is cooled by a coolant.

4. Brakes

The aerodynamic brake consists of three rotor blades which are controlled independently and redundantly. The rotor blades can be rotated by 90° around the longitudinal axis. A safety system monitors the pitch system. In case of unintended grid failure, the pitch is automatically connected to the emergency power supply in order to turn the blades by 90° (perpendicular to the rotation direction of the rotor).

Additionally the wind turbine is equipped with a mechanical brake system. This brake supports the aerodynamic brake and stops the rotor as soon as the speed is lower than specified. The brake power is controlled by several brake programs, depending on the cause that initiates the braking process. Peak loads are avoided by these brake programs. After the rotor has come to a complete standstill, the brake can idle or be locked.

5. Yawing (yaw system)

The wind direction is continually monitored at hub height by two independent sensors. One of these sensors is a heated ultrasonic anemometer.

Upon exceeding a permissible limit value of the wind direction, the nacelle is actively yawed. Yawing is effected by four yaw drives. The yaw drives are located on the machine frame of the nacelle. A yaw drive consists of an electric motor, multi-stage planetary gear and drive pinion. The drive pinions mesh with the external gearing of the yaw bearing.

If the nacelle is not being yawed, the yaw brakes are applied. There are two different yaw brakes that are controlled simultaneously. The hydraulically actuated brakes are distributed over the hole circumference of the yaw bearing and act on the brake disk. The electrically actuated brakes are located on the high-speed side of the yaw drive and act on the shaft of the electric motor.

To save energy, automatic yawing is deactivated at wind speeds below cut-in wind speed.

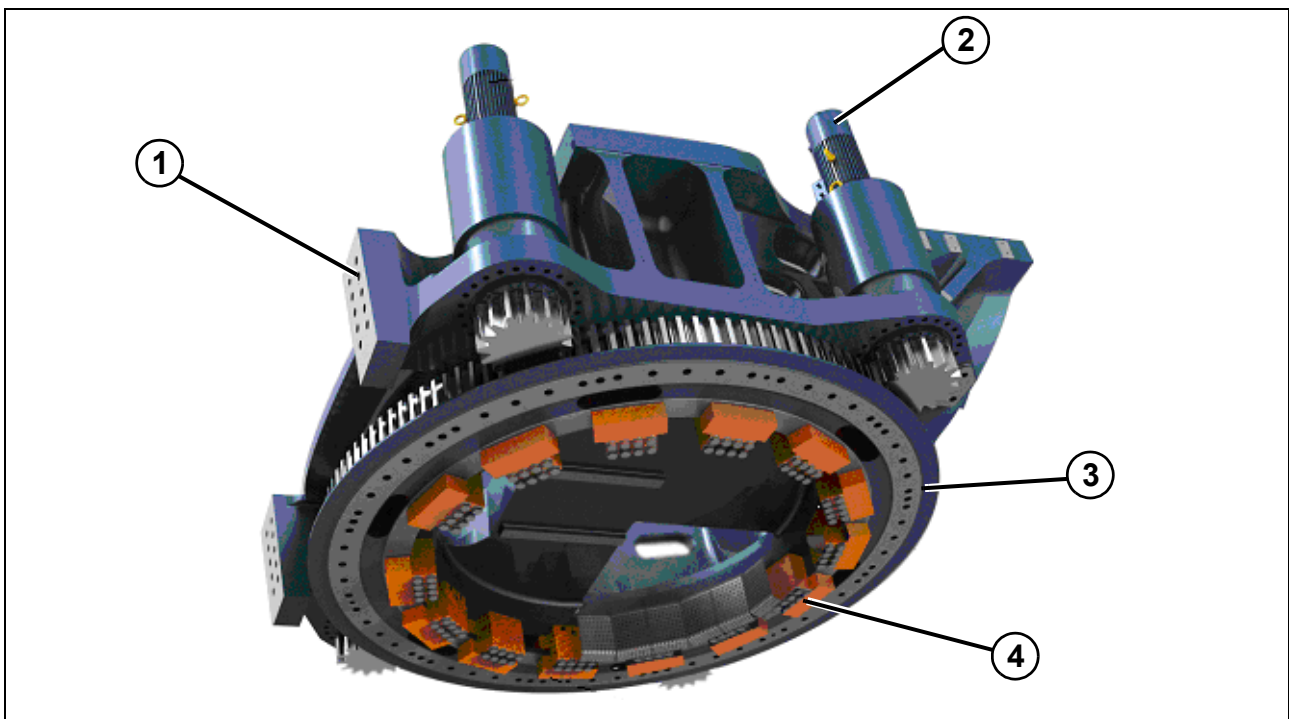


Fig. 9 Components of the yaw system

1. Machine frame
2. 4 x yaw drive at N100/2500
3. Yaw bearing
4. Brake caliper

6. Tower and foundation

Tubular steel tower

The Nordex N100/2500 is erected on tubular steel towers for different rotor hub heights and wind zones.

The hub height is defined as the height of the rotor hub above the ground. The tower height differs. It is reduced by the height of the foundation top edge above ground (usually 1.1 m) and by the vertical distance between the tower top edge and the center of the rotor hub (1.99 m).

The tower is a cylindrical tubular steel tower, where only its top section is conical. Depending on the hub height, it consists of three to five sections.

Corrosion protection of the tubular steel tower is ensured by a tower surface coating system according to ISO 12944.

A service lift, the vertical ladder with fall protection system as well as resting and working platforms inside the tower allow for a weather-protected ascent to the nacelle.

Depending on the requirements, the wind turbine must be equipped with a separate transformer substation. This is located several meters away from the tower. In particular, the transformer substation accommodates the medium-voltage transformer and the medium-voltage switchgear. Power cables to the wind turbine and to the local grid are laid underground.

If no separate transformer substation is provided, the medium-voltage transformer and the medium-voltage switchgear are installed in the tower (optional), see Fig. 4, Page 10.

Foundation

The foundation depends on the ground conditions at the intended site. An anchor cage is embedded in the foundation for anchoring the tower. Tower and anchor cage are screwed together, compare “Structure of a wind turbine”, page 6.

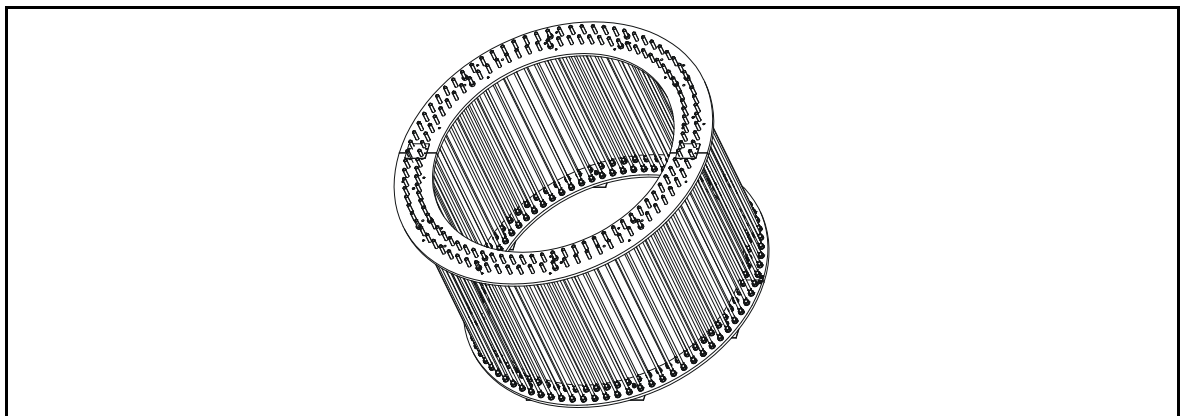
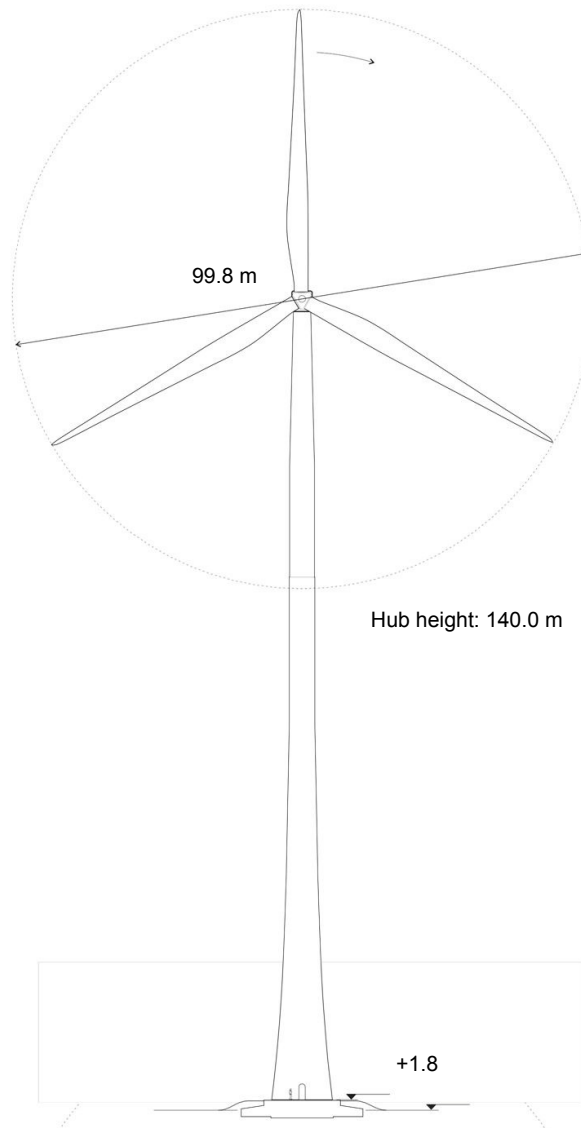


Fig. 10 Anchor cage for anchoring the tower

Hybrid tower

The Nordex N100/2500 turbine is also erected on a hybrid tower. The bottom part of the hybrid tower consists of in-situ or precast concrete tower and the top part of a tubular steel tower. Both tower parts are connected by an adapter.

The transformer is accommodated in a separate room in the tower base or in a separate building outside of the tower.



7. Auxiliary systems

7.1 Cooling and filtration

The gearbox, generator and converter of the wind turbine have cooling systems which are independent from each other.

All systems are designed to achieve optimum operating temperatures even at high ambient temperatures. The temperatures of some gearbox bearings, the gear oil, the generator windings, the generator bearings and the coolant are monitored continually by the control system, in parts also redundant.

7.1.1 Gearbox cooling

The heat is dissipated from the gearbox via the oil circuit to an oil/air cooler. A 2-stage pump pushes the gear oil through a combined filter element into the cooling circuit. Coarse and fine-mesh filters remove solids from the oil. The control system monitors the level of contamination of the filter elements (differential pressure measurement). Optionally, an additional offline filtration (super fine filter 5 μm) and a metal particle counter can be installed.

When the optimum operating temperature is not reached yet, a thermal bypass shorts the circuit and conducts the preheated oil back to the gearbox. As soon as the optimum operating temperature is exceeded, the active oil/air cooler starts and cools down the oil. In addition, each cooler is equipped with a 2-stage fan, which is switched on or off depending on the oil temperature.

The cooled-down oil is pumped via a pipe system inside the gearbox to highly temperature-affected parts.

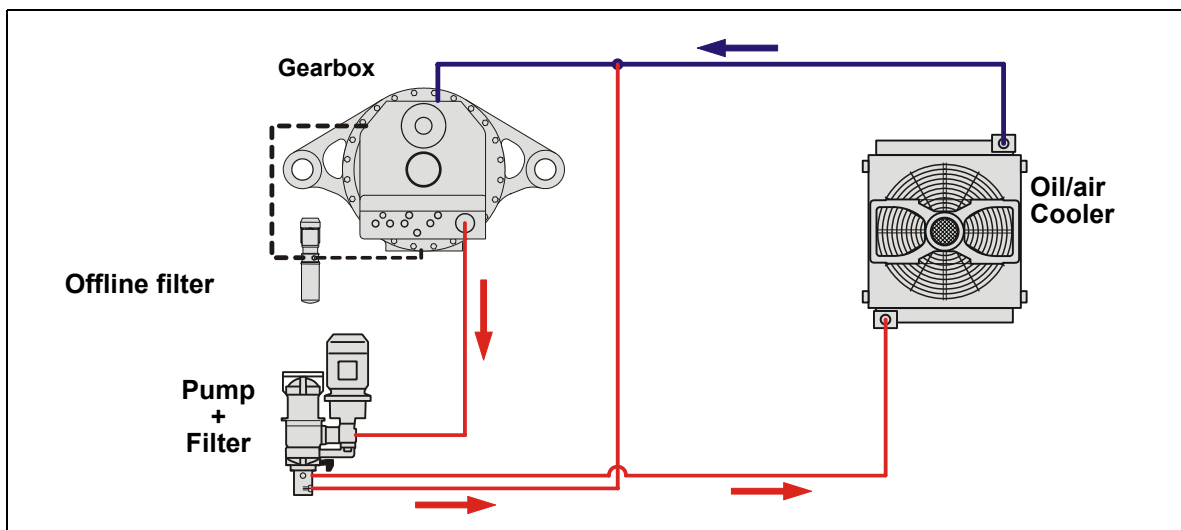


Fig. 11 Schematic drawing of the gearbox cooling

7.1.2 Generator cooling system

The heat is dissipated from the generator by a cooling water circuit. The coolant is a frost-proof water/glycol mixture. The heat is dissipated via an internal air

cooling to the cooling water. This is conducted by a maintenance-free rotary pump to a water/air heat exchanger.

The pump starts automatically as soon as the temperature of the generator components exceeds a defined value and cools down the cooling water and thus the generator to the optimum operating temperature. In addition, the heat exchanger is equipped with a 2-stage fan, which is switched on or off depending on the oil temperature.

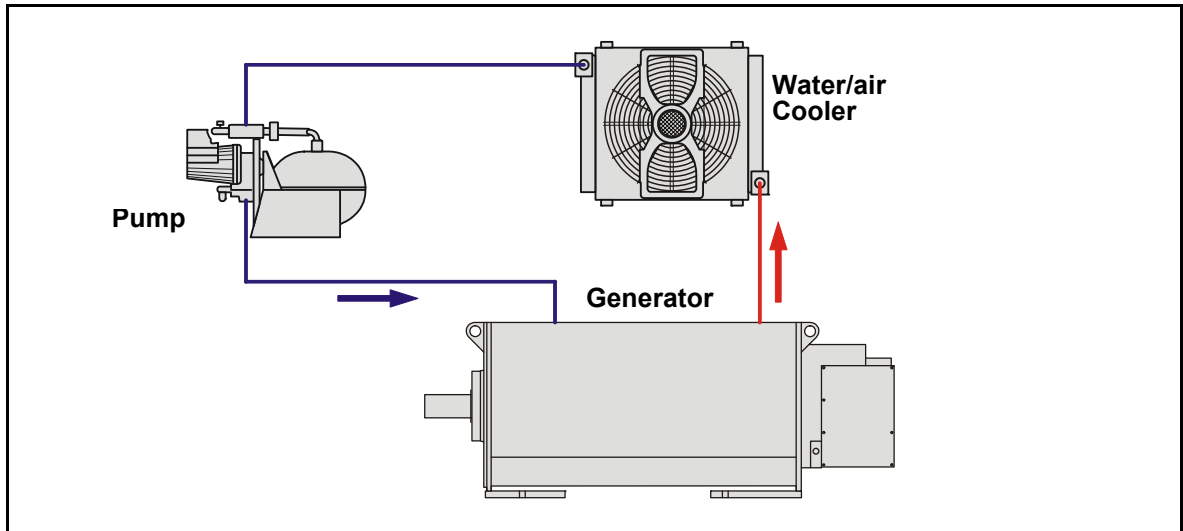


Fig. 12 Schematic drawing of the generator cooling

7.1.3 Converter cooling

The wind turbine main converter is integrated in the switch cabinet at the tower base. It is located inside the tower on a special platform. The main converter is both air and water cooled. The coolant is a frost-proof water/glycol mixture. The pump conveys the cooling water through the internal cooling system of the main converter. The heated cooling water is then passed on to a water/air heat exchanger. The pump switches on when the temperature of the converter components exceeds a defined value and dissipates the heat to the surroundings. In addition, the heat exchanger is equipped with a 2-stage fan which is switched on depending on the water temperature.

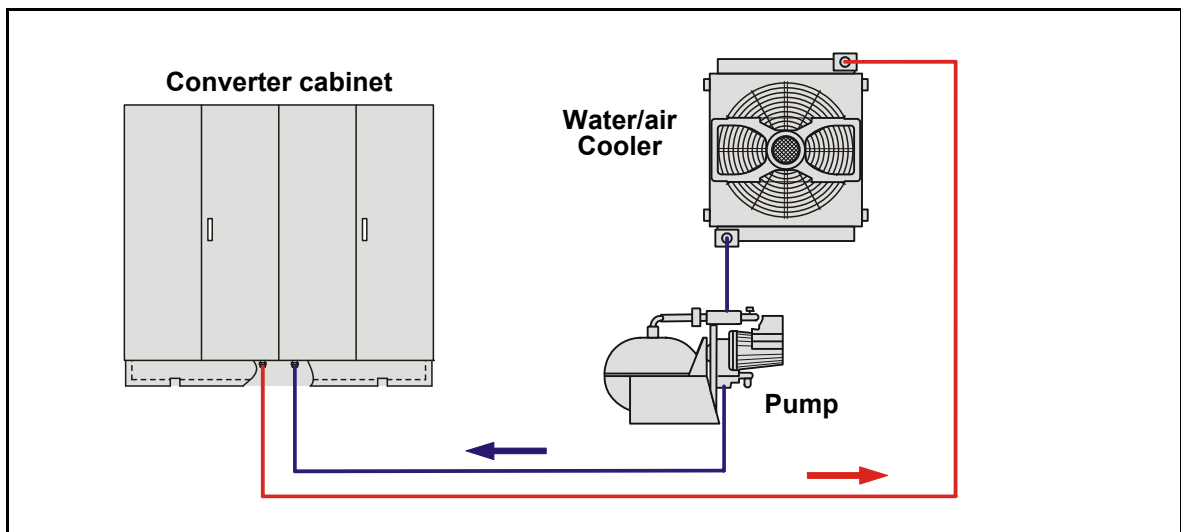


Fig. 13 Schematic drawing of the converter cooling

7.2 Hydraulic system

The hydraulic system provides the oil pressure for operation of the yaw brakes, rotor brake. The hydraulic rotor lock and also the nacelle roof are lifted or closed manually.

7.3 Lubrication systems

The following components are equipped with independent, automatic lubrication units which supply the necessary lubricant:

- Rotor bearing
- Gearbox
- Both bearings of the generator
- The gearing of the three pitch bearings
- The gearing of the yaw bearing

This ensures sufficient and continuous lubrication and enables easy maintenance.

In the gearbox, the oil circuit ensures the cooling as well as the forced-feed lubrication of the gearings and bearings. The oil is transported via the pipe system within the gearbox to components which are subject to high thermal and mechanical stresses.

The gearing of the pitch bearings is supplied with lubricant through a separate lubrication pinion each.

7.4 Air-conditioning

The switch cabinets in the rotor hub, in the nacelle and in the tower base of the wind turbine are equipped with temperature sensors. Upon shortfall or exceeding of defined temperature thresholds heaters/air-conditioning units are triggered to keep the air temperature inside the switch cabinets within operating range.

7.5 Heaters

If the wind turbine has cooled down at low ambient temperatures, some components must be warmed up before they can go into operation. The following components are equipped with heaters that switch on automatically if required:

- Gearbox
- Generator
- Hydraulic unit
- Various switch cabinets
- Nacelle

7.6 On-board cranes

A chain hoist is installed firmly in the nacelle which is used for lifting tools, components and other work materials from the ground into the nacelle. A second, movable overhead crane is used for carrying the materials within the nacelle.

The load bearing capacity of each of the two onboard cranes is at most 1000 kg depending on the tower height.

7.7 Service lift

A ladder-guided service lift is installed in the wind turbine tower. It is intended to transport persons and material from the access platform right up to the space under the nacelle. The service lift serves both, personal safety and efficiency, over the entire service life of the wind turbine.

8. Control and safety system

8.1 Turbine control

The wind turbine is controlled by a operating control computer and the software Nordex Control 2 (NC2). The turbine control operates fully automatic. It continually queries data from all connected sensors, analyses them and derives the control parameters for the wind turbine.

The wind turbine operates with two measuring instruments for capturing the wind data. One instrument is used to control the wind turbine; the second instrument monitors the first one. In case one instrument fails, the second is used for further system control.

On a PC monitor, inside the wind turbine and from remote, all operational data can be followed and checked and a number of functions, such as starting, stopping and yawing can be controlled.

Remote monitoring of the wind turbine is provided. Errors can be reported from the wind turbine to one of the control centers. The data and signal transfer only requires a network connection and a web browser. Once every night the remote monitoring system queries the data of the wind turbine saved during the day.

The wind turbine is equipped with an uninterruptible power supply (UPS). In case of a grid failure, the UPS together with the batteries of the pitch system guarantess for a safe shutdown of the wind turbine. The UPS ensures the operation of the turbine control system (including data storage) and external communication for approx. 10 minutes. However, depending on the brake program, it takes just one or two minutes to stop the wind turbine from nominal speed. This ensures continuous monitoring of the wind turbine status and further data transfer of the turbine control for later analysis until the wind turbine is shut down.

8.2 Safety systems

Nordex wind turbines are furnished with manifold equipment and devices to provide for personal and turbine safety and thus continuous and safe operation.

All safety-relevant functions are monitored redundantly to ensure that, in case of error, an emergency stop can be triggered - even without operation control computer and external power supply - via the higher-level safety functions which are superior to the operation control. The emergency stop switches are also integrated in the safety functions.

The rotor blade adjustment serves as a primary brake system. The pitch system comprises three pitch drives, which are independent from each other. Even if one pitch drive fails, the wind turbine could be brought into a safe condition.

The operation parameters are adjusted in such a way that the mechanical and electrical loads on the wind turbine are kept as low as possible and at the same time the customer obtains the maximum possible yield and service life.

Anti-slip material is applied to all tread surfaces. The safety equipment of the employees is inspected regularly and kept up-to-date. All safety devices of the wind turbine are checked regularly. In this way, a safe and ergonomic workplace is provided for service employees.

Nordex Remote Monitoring is online 24 hours a day, 7 days a week. Several times a day the wind turbine sends information on its operating state per email. If necessary, Remote Monitoring staff is able to intervene directly or inform the local Service.

Approx. every 6 months a preventive maintenance is scheduled.

8.2.1 Safety devices

Emergency stop switch

There is a total of seven emergency stop switches in the wind turbine. They serve to stop the wind turbine as quickly as possible in hazardous situations.

Emergency stop switches are located at the following points:

- At the front and rear side of the switch cabinet in the tower base
- At the right side of the gearbox
- At the manual control unit of the switch cabinet in the nacelle
- At the front side of the switch cabinet in the nacelle
- At the access opening to the nacelle

An emergency braking is triggered by the emergency stop switch, i.e. the rotor blades run into 90° position, converter and generator are disconnected from the grid, the main switch moves to the OFF position and the rotor brake is activated.

Safety functions

The safety functions consist of different monitoring devices. If one of these monitoring devices is triggered, the wind turbine will be shut down immediately.

In addition to the emergency stop switches, the following devices are part of the safety functions:

- Overcurrent release of the main switch (thermal or magnetic trigger)
- Speed monitor for rotor and generator speed
- Two vibration monitors (tower vibrations)

Triggering of the safety functions will lead to a braking of the wind turbine. However, the two devices mentioned last do not trigger a switch-off of the main switch.

Cable twisting protection

There is a twist protection for the cables that run from the nacelle into the tower. In automatic mode, the operation control continuously checks the position of the nacelle relative to the tower. After approx. 2 rotations the nacelle automatically rotates back.

This automatism is protected by an additional limit switch. As soon as a certain cable twist is exceeded, the power supply of the yaw drives is interrupted and an error message generated.

Gearbox run-in stage

The rolling elements and the tooth flanks in the gearbox bearings must run in first to ensure a permanently safe and long-life operation. During commissioning, the power is limited in accordance with the yield. The gearbox run-in stage takes – depending on the wind – several days.

Contact protection/protective tread

All rotating parts of the drive train are protected against contact using covers. These are the rotor lock disk, rotor shaft, brake disk and coupling.

All components at risk, especially in the access area of the nacelle, are protected against damage. This means they are located below tread plates or are protected against damage by individual covers. These are the sensors, hydraulic pipes, electric cables and single units like grease pump, grease pinion, lights, etc.

Electrical components and cables are accommodated in closed switch cabinets or cable trays.

Further safety devices:

Some safety devices are described more detailed in other chapters:

- Uninterrupted power supply of the control system
 - Refer to see "Turbine control" page 24
- Emergency power supply of the pitch drives
 - Refer to "Pitch system", page 13
- Rotor lock
 - Refer to "Rotor shaft", page 16
- Grounding and lightning protection
 - Refer to "Grounding", page 29 and see "Lightning protection" page 26
- Automatic lubrication systems
 - Refer to "Lubrication systems", page 22
- Fall protection equipment, attachment points
- Escape route/descender

- Fire extinguisher, first-aid kit, emergency lighting, noise protection, etc.
- Fire protection

8.2.2 Lightning protection

During the development of the wind turbine, the utmost attention has been devoted to lightning protection. For all components, a most reliable protection has been achieved. The lightning and overvoltage protection of the wind turbine is based on the lightning protection zone concept and meets the IEC 61400-24 standard. The lightning protection system meets the requirements of lightning protection class I.

9. Electrical system

The wind turbine is equipped with a speed-variable generator/converter system. The speed-variable drive train in connection with the electrical rotor blade adjustment offers best results in terms of mechanical loads and electrical grid quality. Power surges and peak loads are prevented by the system as far as possible. Smooth power output at very few fluctuations during part-load operation is facilitated by the operation control. During nominal load operation, the wind turbine can be operated at constant power.

The most important electronic components are located in the switch cabinet in the tower base. Separated in different panels, the switch cabinet contains frequency converter, operation control computer, control screen, main switch, fuses and connections for communication and power cables.

9.1 Generator and converter

The generator is designed as double-fed asynchronous generator with slip ring rotor, including a converter to recover the slip power. Independent of the rotor speed, voltage and frequency are kept at constant rate. This enables a speed-variable operation and at the same time low grid perturbation.

The optional ability to create reactive power also allows for a direct reactive power management. The reactive power compensation can thus be omitted.

During part-load operation and with fixed blade angles, the wind turbine operates in a single speed range. In this process, the speed/torque characteristic of the generator system is predefined. At wind speeds higher than the nominal wind speed the wind turbine is operated with a combined control for the generator system and the blade angle adjustment. Here the generator is always kept at constant torque and the resulting speed variations are compensated by the blade adjustment. For this a speed range is available.

In case of safety shutdowns (e.g. grid error), the wind turbine disconnects from the grid and the rotor blades are moved out of the wind.

9.2 Grid type

There are two low-voltage grids in the wind turbine. The 660 V grid transports the generated power via the medium-voltage transformer to the point of supply of the supply grid. The 400 V grid is used for all electrical wind turbine systems.

The generator low-voltage grid (660 V) is designed as an insulated network without neutral conductor (IT network) and the auxiliary low-voltage grid (400 V) as a TN-S network.

For protection, an insulation monitor is used.

9.3 Medium-voltage transformer and medium-voltage switchgear

A medium-voltage transformer and a medium-voltage switchgear are required for the grid connection of each wind turbine.

A medium-voltage substation is the point of supply to the grid.

Depending on the number of wind turbines, additional substations are installed and connected to each other on the corresponding voltage level of the supply grid. The required measuring instruments including the inverters must be designed to match the local grid codes, it forms the property boundary at the substation.

The equipment of the substation and the technical design of the point of supply depend on the individual project. Equipment and design of the substation are coordinated with the grid operator if Nordex is in charge of the execution.

With transformers installed inside the tower (=optional), a dry-type transformer is used. Usually an oil transformer is used in external transformer substations. The technical data of both, the transformer and the medium-voltage switchgear, may differ, depending on manufacturer, required voltage level and ambient conditions.

9.4 Cabling

Conduits are embedded in the foundation to lay the power, communication and control cables. Usually all cables inside the wind farm are laid underground.

Flexible low-voltage power cables are laid in the tower between switch cabinet in the tower base and transformer in the tower. Low-voltage control cables for the transmission of signals from the transformer to the wind turbine can be laid on demand.

9.5 Grounding

The grounding system is required for the equipotential bonding between the parts of the electrical system and is a vital part of the lightning protection system.

The grounding system is made according to the standard and the foundation drawings.

The grounding system covers both the wind turbine and the separated transformer substation, where available. The ground resistance of the wind turbine should not exceed 10 Ω . It is measured and documented. The resulting grounding protocol must be submitted to the grid operator prior to the commissioning of the wind turbine.

9.6 Grid connection

Electrical energy is usually fed into the medium-voltage grid of the regional grid operator. Unfavorable grid conditions or high feed-in power may require the

connection to the high-voltage distribution system and thus the construction of a substation.

The wind turbine is connected to the wind farm distribution system by means of an IGBT converter based on the principle of the double-fed asynchronous generator. By preselecting the parameters in the IGBT converter, the power factor correction ($\cos \varphi$ control) can be freely adjusted in a certain range under specific conditions. With this system, the starting current ratio for the grid connection can be limited to a value of about 1, i.e. the connection to the grid will be absolutely synchronous and therefore bumpless.

The wind turbine can be equipped with an extended grid connection package. For this, separate documents are available for different grid codes.

9.7 Grid monitoring

The wind turbine is equipped with various safety devices.

- The grid protection relay has an overvoltage and undervoltage monitoring, it also recognizes frequency increases and decreases and monitors the vector jump
- The short-circuit and overload protection is realized by the main switch

Trigger values and trigger times can be parameterized and will be adapted to the respective grid code requirements by Nordex.

In case of exceeding or shortfall of defined limit values the wind turbine will be disconnected from the grid and stopped by the control system.

As soon as grid errors are removed, the wind turbine will continue in automatic mode.

9.8 Auxiliary power of the wind turbine

The power required by the wind turbine in 'stand-by mode' calculates from the single consumption of the following components:

- Control system (operation control computer and converter)
- Yaw system
- Pitch system
- Hydraulic unit
- Circulation pumps of the cooling systems
- Heaters and fans
- Auxiliary systems (service lift, obstacle lights, options, etc.)

Based on the existing operating experience, a coincidence factor of 0.5 and a power factor (cos phi) of 0.85 can be assumed.

The connected load is rated at a maximum value of 55 kW under consideration of the factors mentioned above. If an anti-icing system is installed the connected load is higher than 55 kW.

The annual energy consumption (power supply from the grid) at locations with average wind speeds amounts to approx. 15000 kWh/year. However, the annual energy consumption highly depends on the location and should be determined specifically.

9.9 Communication

Communication inside a wind turbine

The operation control computer is connected to the main converter and the pitch system via an Interbus system. The signal exchange for all essential functions of the operation control is performed in cycles of 10 ms. This includes, amongst others, the converter control and the signal acquisition.

Inside the wind turbine, the signal exchange between tower base and nacelle takes place via Ethernet using fiber optic cables. This prevents electromagnetic interference.

Communication inside a wind farm

As in most cases several wind turbines form a wind farm, the outside communication of the wind turbine is always realized using the „Wind Farm Portal“[®]. This is a farm server to which all wind turbines of a wind farm are radially connected. The farm server functions as SCADA system (**S**upervisory **C**ontrol **A**nd **D**ata **A**cquisition). It serves for monitoring, control, analysis, data storage, operation and remote monitoring of a wind farm. This also includes further systems installed on a project-specific basis such as met masts, substation, compensation units, etc.

Inside the wind farm, the signal exchange takes place via Ethernet using fiber optic cables (mono mode).

External communication

The communication between a wind turbine or a wind farm and external locations, e.g., Remote Monitoring or customer, is internet-based and independent of location. No special software is required. Communication takes place via at least one DSL connection. To ensure safe operation of the wind farm, it should be equipped with at least two communication connections.

Customers can be provided with separate IP addresses for wind farm communication. Nordex will assign login names and passwords. The personal access rights to the wind farm are determined by these login data.

Data exchange

All operating data of a wind turbine are saved locally over the entire service life. The most important data are continually sent to and stored on the farm server. Each wind turbine can send a data email to a defined address every 24 hours, e.g., to the Remote Monitoring. Such data email contains 10 minute average values, alarm logs, event messages and many values for the statistical analysis of the operating performance. In this way, the production figures can be displayed and the wind turbine's performance history analyzed.

Authorized persons can as well access their wind turbines using the Wind Farm Portal[®] to export production figures, error messages, operating states, weather data, etc., as required.

10. Operation control

10.1 Operation control of the wind turbine

The main task of the operation control (operation control computer + Nordex Control 2 software) is to constantly keep the operation parameters within the set range as stored in the WT control system. To achieve this, a real-time control system is used, which permanently queries and processes relevant data. The parameters are provided by Nordex and adapted to the respective site. The objective is to maintain a safe and automatic operation of the wind turbine in all situations.

When the wind speed is lower than the cut-in wind speed, the wind turbine remains at a standstill (energy save modus), i.e. only the operation control computer remains in operation capturing (weather) data. All other systems are switched on only if required and thus do not consume any energy. Exceptions are the safety related functions, e.g. the brake system (hydraulic pump). The rotor idles.

When the cut-in wind speed is reached, the wind turbine changes to 'Ready for operation' mode. Now all systems are tested and the nacelle aligns to the wind direction. If the wind increases, the rotor accelerates. When a certain speed is reached, the generator is connected to the grid and the wind turbine starts producing electricity.

During operation, the nacelle follows the wind direction. But if the limit for tower cable twist is exceeded the wind turbine stops and the nacelle automatically turns back, i.e., the tower cables are untwisted (see "Yawing (yaw system)", page 16 and "Cable twisting protection", page 25). Afterwards the wind turbine starts again automatically.

At low wind speeds the wind turbine operates on turndown level. In doing so, the rotor blades remain fully turned into the wind. In this way, the rotor blades are always in the best aerodynamic position and operate at optimum efficiency. The rotor speed remains below nominal speed. The power produced by the WT now depends on the wind speed.

When the nominal wind speed is reached, the wind turbine changes over to the nominal operational mode. If the wind speed increases the control system adjusts the angle of the rotor blades in such a way that the rotor speed is kept at nominal speed as far as possible. Thus the wind turbine constantly generates nominal power.

Once the cut-out wind speed is exceeded, the wind turbine shuts down, i.e. the rotor blades turn by approx. 90° into feathering position. The rotor slows down and idles until the wind speed falls to the limit where the turbine can be cut-in again. In this way, the loads acting on the wind turbine in stormy weather can be significantly reduced.

Sensors are installed on all systems and many components of the wind turbine, reporting the current state to the control. There are setpoints (operation

parameters) for each measuring point. They must be kept. If the actual value deviates from the setpoint, the control system reacts correspondingly.

Upon exceeding a certain temperature limit value, at first the pump of the cooling circuit, for example, is switched on. If the temperature falls below the setpoint again, the pump is switched off. If another limit value is exceeded, a warning message is sent to Nordex Remote Monitoring.

On evaluation of all current operating data Nordex Remote Monitoring decides how to proceed. If the temperature again falls below a temperature limit value, the warning message disappears. When exceeding a third temperature limit value, the wind turbine is stopped immediately. This third limit value is defined such that any damage to the wind turbine can be prevented.

In this example six limit values belong to one temperature measuring point, three high and three low temperature limit values.

When exceeding certain parameters for safe operation, e.g. values above cut-out wind speed or pressure drop in the hydraulic system, the wind turbine is switched off immediately. A soft braking procedure is triggered in case of external disturbances, e.g. too high wind speed or grid failure. In case of safety critical disturbances an emergency stop is triggered to ensure that the rotor slows down as fast as possible.

From the wind data, the control system calculates 3 second average values. These values are then used to generate a 30 second average value and in turn a 10 minute average value. The operation of the wind turbine is based on these values. The 10 minute average wind speed is used for control to prevent the wind turbine from shutting down too early or too frequently due to the turbulences of the wind. As strong gusts coming up short-term, but causing damage may be overseen in the calculation, the 3 second average value is also taken into account. Consequently, the wind turbine is shut down when the 10 minute average wind speed exceeds 25m/s or when the 3 second average value exceeds 32m/s. This gives the wind turbine comprehensive protection against storms.

For safety reasons, a certain delay must be kept after every shut down before the wind turbine starts again.

At low temperatures, the wind turbine will only restart once the individual components have reached their relevant start-up temperature. The duration of this warm-up phase varies depending on the temperature of the components before the warm-up phase begins. The less the single components have cooled down, the shorter the warm-up phase. A temperature-controlled start-up procedure reduces the stress on the components during turbine start-up until the optimum operating temperature is reached.

There is a program called "Fast idling" to keep the wind turbine warm during low ambient temperatures. It enables the drive train to rotate at very low speed. The power loss of the mechanical components is used to prevent the turbine from cooling down and to accelerate restart.

All relevant turbine components possess maximum operating temperatures which are monitored. Before one of these temperature limits is reached, the wind turbine will reduce its power output and can continue to operate.

10.2 Operation control of the wind farm

In the wind farm, the Wind Farm Portal[®] Nordex Control 2 is used. It offers comprehensive options to monitor and control a wind farm (see “Communication”, page 31).

The two essential objectives of a wind farm control are:

- The optimum fulfillment of the grid operator feed-in regulations
- Ensuring output of the maximum possible power from the wind farm in case of error (internal or external)

The above-mentioned objectives can, among other things, be implemented by the following measures:

- Starting and stopping the individual wind turbines in a staggered sequence
- Active power limitation¹
- Reactive power management¹
- Intelligent setpoint distribution, i.e., the setpoint specified for active power limitation, for example, is distributed among all wind turbines depending on the available power of the wind turbines according to defined rules.

1. Setpoints are specified according to defined values or by an external signal input.

11. Additional notes

Nordex is certified according to ISO 9001 quality standards. Our quality management system and thus also the production processes fulfill the requirements of ISO 9001.

For all main components Nordex co-operates with a number of qualified suppliers.

In connection with the continuous development and improvement of our wind turbines, we reserve the right to make technical changes without prior notice.

11.1 Special operating states and modes

Deviations from the conditions above may have an adverse impact on the operation of the wind turbine. In particular, reduction of output may occur.

Should icing occur on the rotor blades, the wind turbine must be stopped.

If the wind turbine is to be operated at nominal power during temperatures beyond the ambient temperature limits of the standard version, additional technical enhancements are available.

Due to higher air density at very low temperatures the loads in the wind turbine increase. To meet the design restraints of the wind turbine, if necessary, nominal power and cut-out wind speed can slightly be reduced. This adaptation only becomes effective below a manually set temperature limit. This temperature limit is site-specific, depends on the installation altitude and is below $-10\text{ }^{\circ}\text{C}$.

Power-reduced operation is possible at temperatures beyond the temperature limits, depending on the ambient conditions at the site and the thermal load of individual components.

Specific combinations of high wind speeds and extreme temperatures, air densities or voltages can result in reduction of performance due to the design restraints of individual components of the wind turbine.

Depending on the wind farm's specific requirements, individual technical or regulatory specifications to the operation control can be made. These can be partial reductions or shutdowns. For example, the wind turbine can be operated noise-optimized or its output can be limited if the feed-in power of the grid is reduced. Optimized modes of operation based on a defined time schedule or depending on the wind direction (e.g. protection against shadow flicker) are also possible.

11.2 Coloring of the outside components

Component	Coloring
• Tower	RAL 7035 (light gray)
• Nacelle	RAL 7035 (light gray)
• Rotor hub	RAL 7035 (light gray)
• Rotor blades	RAL 7035 (light gray)

For prescribed day-time marking on the rotor blades the following colors are available as an option:

Colors from the blade tip to the inside:

6 m	RAL 3020 (traffic red)
6 m	RAL 7035 (light gray)
6 m	RAL 3020 (traffic red)
Rest	RAL 7035 (light gray)

Other markings are available on request.

11.3 Degree of reflection

All colors used for the rotor blades have a gloss level (reflection ratio) below 30 %. This specifies them as mat or silk mat.

12. Technical data

Climatic design data	
Ambient temperature survival	Standard -20 °C...+50 °C CCV -40 °C...+50 °C
Nominal power	Standard -10 °C...+40 °C CCV* -30 °C...+40 °C
Standstill	Standard -10 °C, restart at -8 °C CCV -30 °C, restart at -28 °C
Max. height above MSL	1000 m (optional up to 2000 m) **
Certificate	Class 2a according to IEC 61400-1

* As an option, the standard turbine can be installed so that it produces output power even at ambient temperatures of -20°C. Then the restart of the turbine is at -18 °C.

* see Page 36

** The nominal power of the turbine is reduced on erection heights > 1000 m.

Design	
Type	3-blade rotor with horizontal axis Up-wind turbine
Power control	Active single blade adjustment
Nominal power	2 500 kW
Nominal power starting at wind speeds of (at air density of 1.225 kg/m ³)	Approx. 13.0 m/s
Speed range of rotor	9.6...16.8 rpm
Cut-in wind speed	Approx. 3 m/s
Cut-out wind speed*	25 m/s
Cut-back-in wind speed	22 m/s
Calculated service life	20 years

* see Page 36

Rotor	
Rotor diameter	99.8 m
Swept area	7823 m ²
Nominal power/area	320 W/m ²
Rotor shaft inclination angle	5°
Blade cone angle	3.5°
Total weight	Approx. 58 t or 61 t (depending on manufacturer)

Rotor hub	
Material	Spheroidal graphite cast iron EN-GJS-400-18-LT
Total weight, incl. pitch system	Approx. 28.6 t

Rotor blade	
Material	Glass-reinforced plastics
Total length	48.7 m
Total weight per blade	Approx. 9.8 t or 11.2 t (depending on manufacturer)

Rotor shaft/rotor bearing	
Type	Forged hollow shaft
Material	42CrMo4 or 34CrNiMo6
Weight	Approx. 10.3 t
Bearing type	Spherical roller bearing
Lubrication	Continuous and automatic with lubricating grease
Rotor bearing housing material	Spheroidal graphite cast iron EN-GJS-400-18-LT

Gearbox	
Type	Multi-stage planetary + spur gear stage or linkage with differential gears
Nominal power	2 775 kW
Gear ratio	50 Hz: 1: 77.5 60 Hz: 1: 93.2
Lubrication	Forced-feed lubrication
Oil quantity including cooling circuit	Approx. 450-550 l (depending on manufacturer)
Oil type	CLP-HC (PAO) acc. to DIN 51517-3 viscosity ISO VG 320
Max. oil temperature	75 °C
Oil change	Semi-annual check, change as required
Weight	Approx. 18.5 t ... 20.0 t (depending on vendor)

Electrical system	
Nominal power P_{nG}	2 500 kW ^{a)}
Nominal voltage	3 x AC 660 V ± 10 %
Nominal current I_{nG} at S_{nG}	2300 A
Nominal apparent power S_{nG} at P_{nG}	2 630 kVA
Power factor at P_{nG}	1.00 as default setting 0.95 underexcited (inductive) up to 0.95 overexcited (capacitive) possible
Frequency	50 or 60 Hz

a) The nominal power is subject to system-specific tolerances. At nominal power, they are ±75 kW. Practice has shown that negative deviations occur rarely and in most cases are <20 kW. For precisely complying with external power specifications the nominal power of the individual wind turbine can be parameterized accordingly. Alternatively, the wind farm can be parameterized accordingly using the Wind Farm Portal[®].

Generator	
Degree of protection	IP 54
Nominal power	2500 kW
Nominal voltage	3 x AC 660 V ± 10 %
Frequency	50 or 60 Hz
Speed range	50 Hz: 740...1300 rpm 60 Hz: 890...1560 rpm
Poles	6
Weight	Approx. 10 t

Gearbox cooling and filtration	
Type	Oil circuit with oil/air heat exchanger and thermal bypass
Gear oil pump, 2-stage	Standard: 50 Hz: 3.0/4.5 kW 60 Hz: 3.5/5.2 kW CCV: 50 Hz: 3.5/6.0 kW 60 Hz: 4.2/7.2 kW
Flow rate	Stage 1: Approx. 52 l/min Stage 2: Approx. 105 l/min
Fan on heat exchanger, 2-stage	50 Hz: 0.8/3.0 kW 60 Hz: 1.1/4.1 kW
Filter	Coarse filter 50 µm Fine filter 10 µm
Offline filter (optional)	5 µm

Generator cooling	
Type	Water circuit with water/air heat exchanger
Cooling water pump	50 Hz: 1.3 kW: 60 Hz: 1.1 kW:
Flow rate	Approx. 70 l/min
Coolant	Varidos FSK 45, USA: Intercool LCE-50
Fan on heat exchanger, 2-stage	50 Hz: 0.8/3.0 kW 60 Hz: 1.1/4.1 kW

Converter cooling	
Type	Water circuit with water/air heat exchanger and thermal bypass
Flow rate	Approx. 50 l/min
Coolant	Varidos FSK 45, USA: Intercool LCE-50
Fan on heat exchanger, 2-stage	50 Hz: 1.1/1.8 kW 60 Hz: 1.4/2.2 kW

Aerodynamic brake	
Type	Single blade adjustment
Activation	Electromechanical

Mechanical brake	
Type	Actively actuated disk brake
Location	On the high-speed shaft
Disk diameter	1030 mm
Number of brake calipers	1
Brake pad material	Sintered metal

Pitch system	
Rotor blade bearing	Double-row four-point contact bearing
Lubrication	Automatic lubrication unit with grease
Drive system	3-phase motor incl. spring-actuated brake and Multi-stage planetary gear
Emergency power supply	Lead-acid batteries

Hydraulic system	
Hydraulic oil	VG 32
Oil quantity	Approx. 20 l
Nominal power of the hydraulic pump	1.5 kW:
Thermal protection	Integrated PT100

Machine frame material	
Machine frame	Spheroidal graphite cast iron EN-GJS-400-18U-LT
Material of generator frame and steel framework	Structural steel S235JR
Cabin material	Glass-reinforced plastics (GRP)

Yaw bearing	
Type	Ball bearing
Material	42CrMo4
Weight	Approx. 2.3 t

Yaw drive	
Motor	Asynchronous motor
Gearbox	4-stage planetary gear
Number of drives	4
Lubrication	Oil, ISO VG 620
Oil quantity	Approx. 21 l
Yaw speed	Approx. 0.5 °/s

Yaw brake	
1st type	Disk brake with hydraulic brake calipers
Brake pad material	Organic
Number of brake calipers	14
2nd type	Electric spring-actuated brake on every driving motor

Hub height*	80 m	100 m
Wind class/turbulence intensity	IEC 3a	DIBt 2, IEC 3a
Number of tower sections	4	5
Weight with installed equipment [t], approx.	182.3	295.2

Hub height*	75 m	80 m	100 m
Wind class/turbulence intensity	IEC 2a	IEC 2a	IEC 2a
Number of tower sections	4	4	5
Weight with installed equipment [t], approx.		189.8	294.0

Hub height	140 m (RB)	140 m (PH)
Wind class/turbulence intensity	DIBt 2, IEC 3a	DIBt 2
Number of tower sections	3 + adapter	2
Weight with installed equipment [t], approx.	141.0*: including adapter	78.7*:

RB: Hybrid tower (in-situ concrete + tubular steel)* Only tubular steel tower:

PH: Hybrid tower (precast concrete + tubular steel)

Tubular steel tower	
Material	EU: S355 USA: A709/A572-50
Corrosion protection	Multilayer epoxy resin coating
Anchor cage	Anchor cage cast in concrete foundation

Hybrid tower (concrete part)	
Material - Precast concrete - In-situ concrete	Reinforced concrete with external preloading, tendons inside the tower
Tower base in-situ concrete	Foundation and concrete tower as a monolithic structure
Tower base in-situ concrete	Foundation and concrete rings fixed by tendons
Hybrid tower (tubular steel part)	
Material	S355
Corrosion protection	Multilayer epoxy resin coating
Anchor cage	Adapter flange screwed to concrete tower top using anchor bolts

Control system		
Type	Hardware Software	Remote field controller/PLC Nordex Control 2
Automatic restart:		
- After grid failure		Yes
- After cut-out wind		Yes

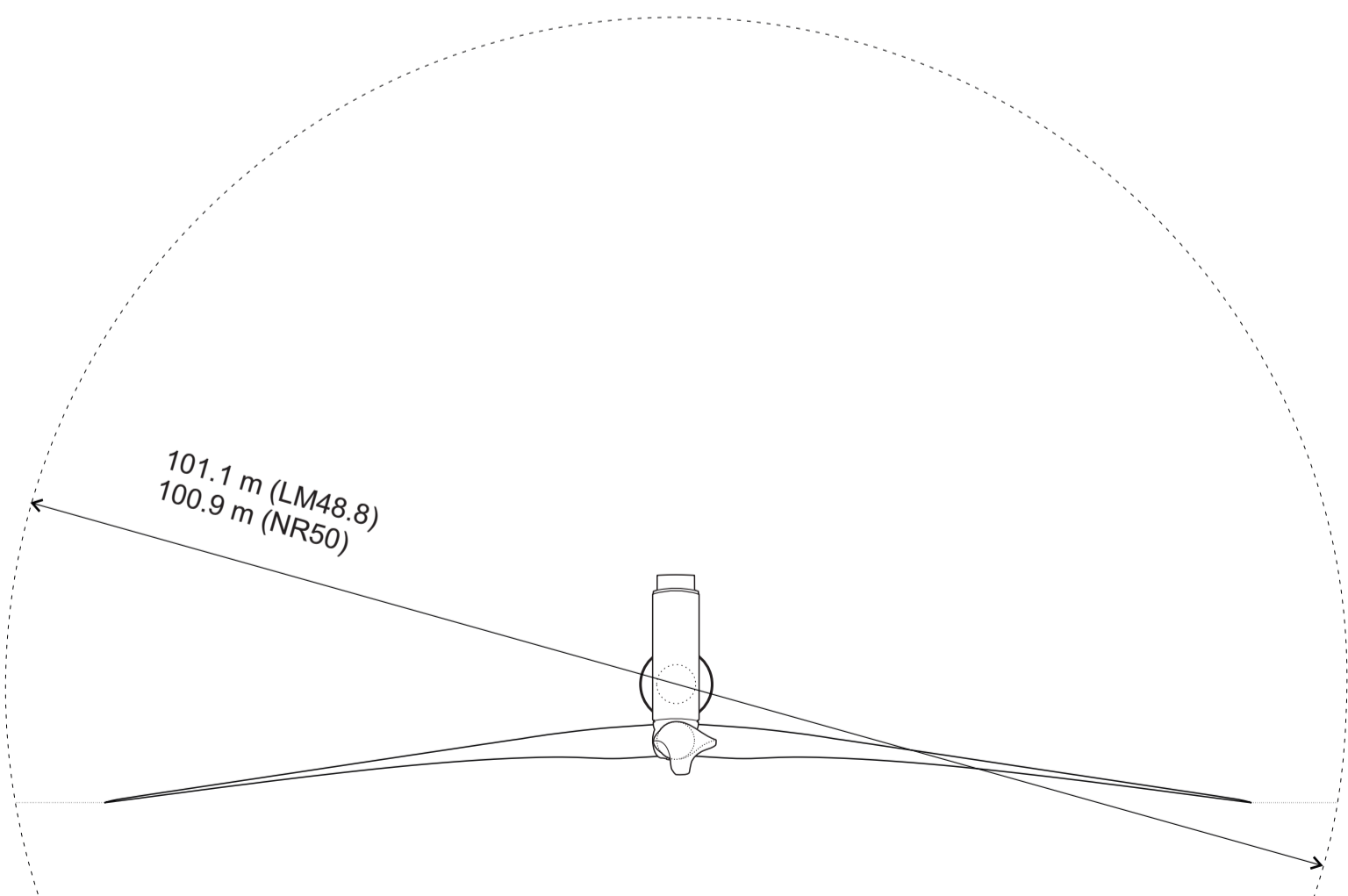
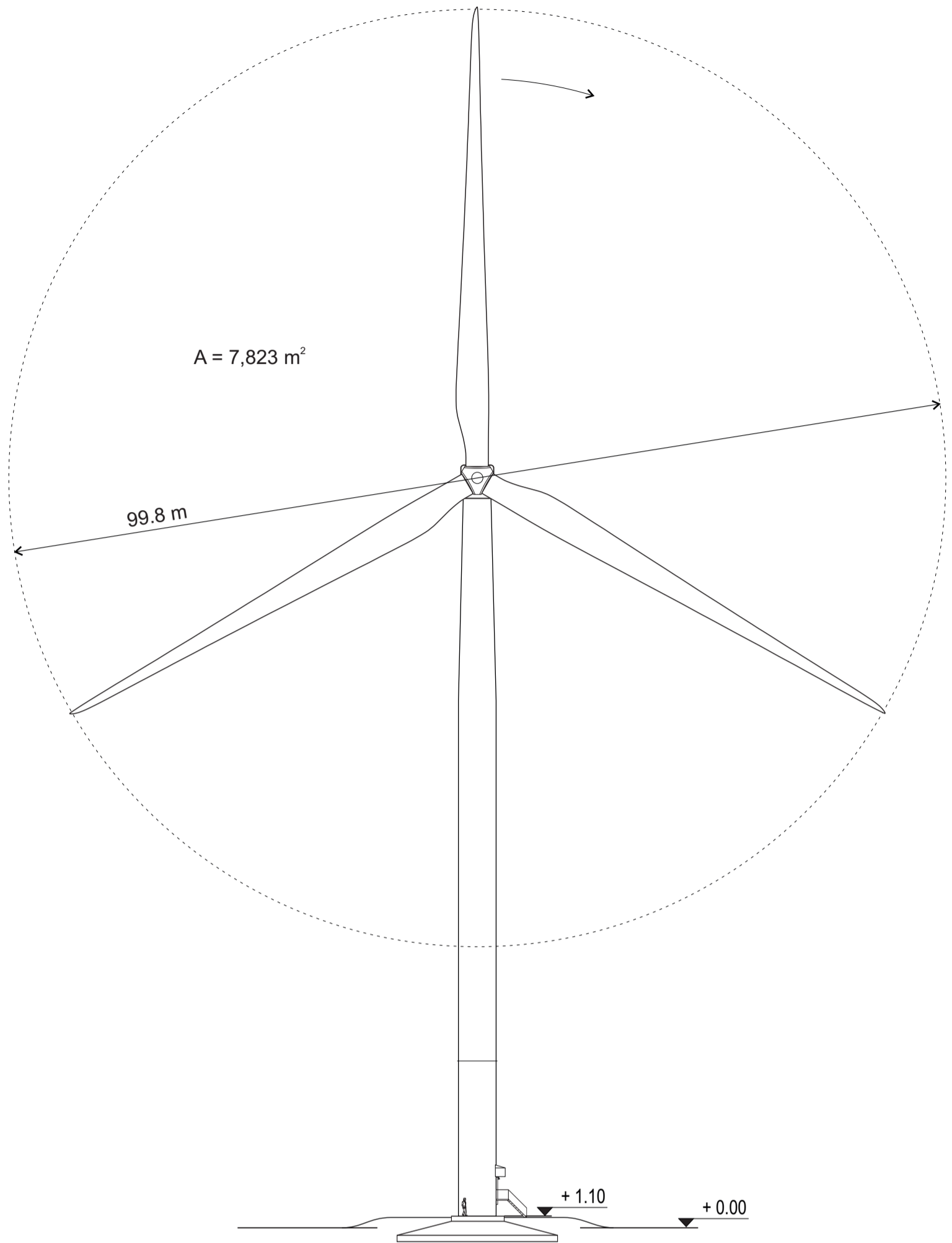
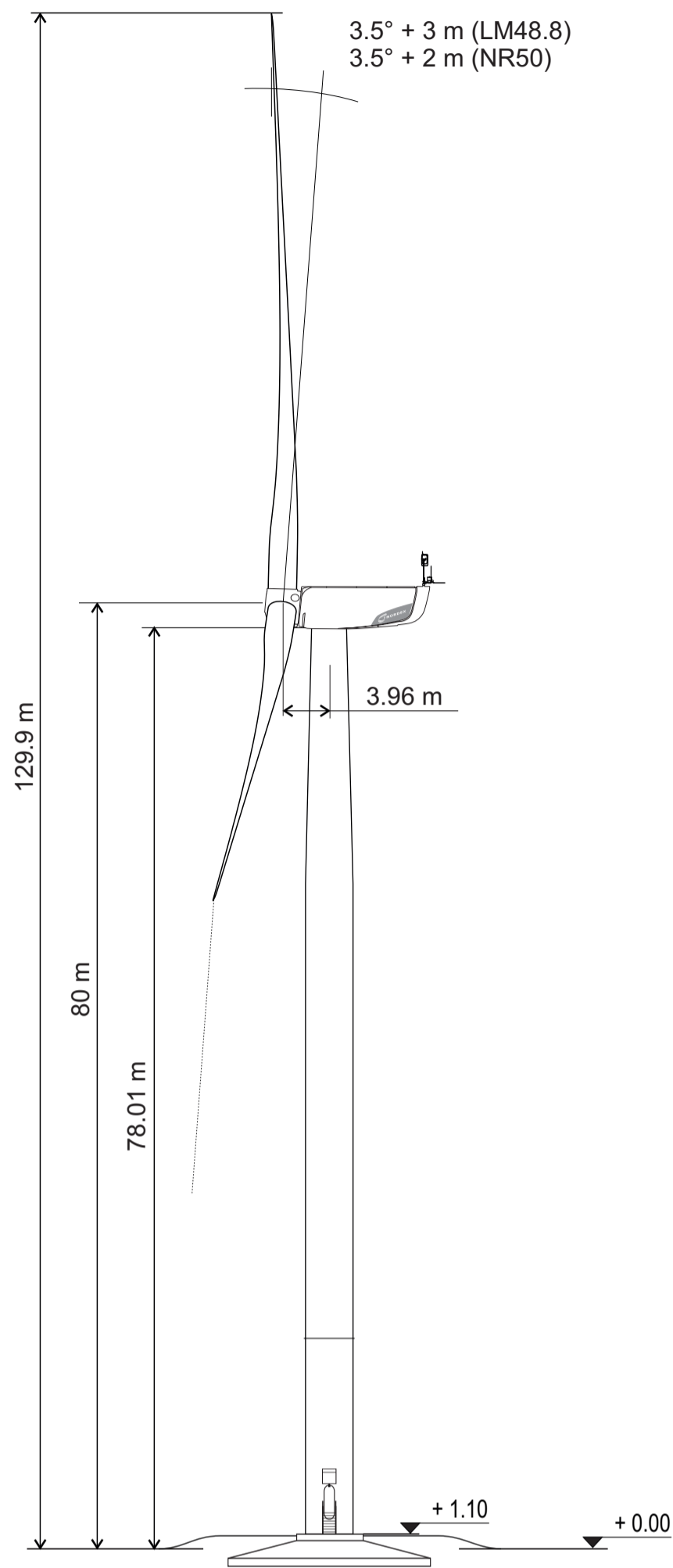


Overview drawing

Nordex N100/2500, Hub height 80 m,
Version gamma, Tower generation 5, IEC 2a

This document is a translation from German. In case of doubt, the German text shall prevail.
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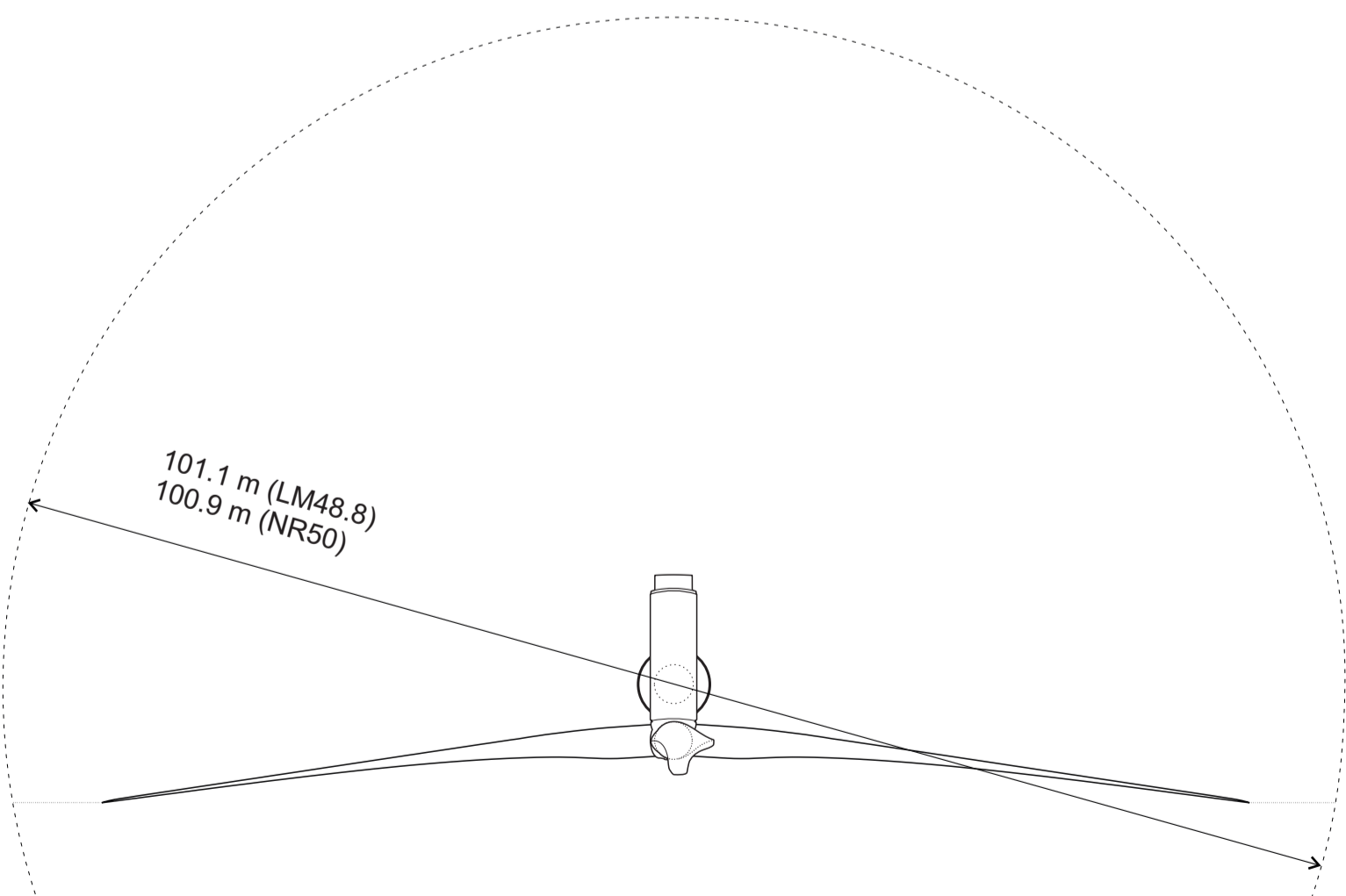
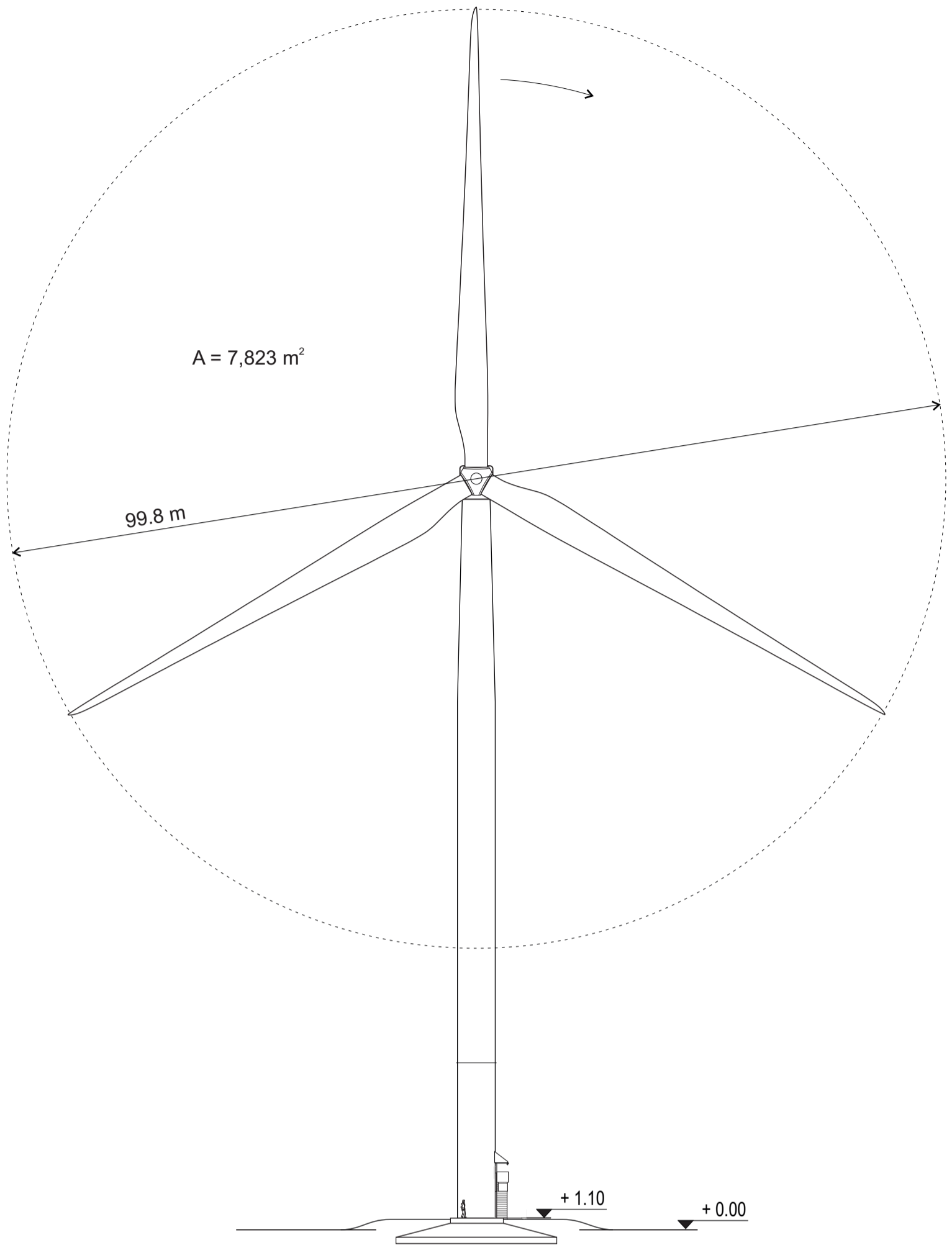
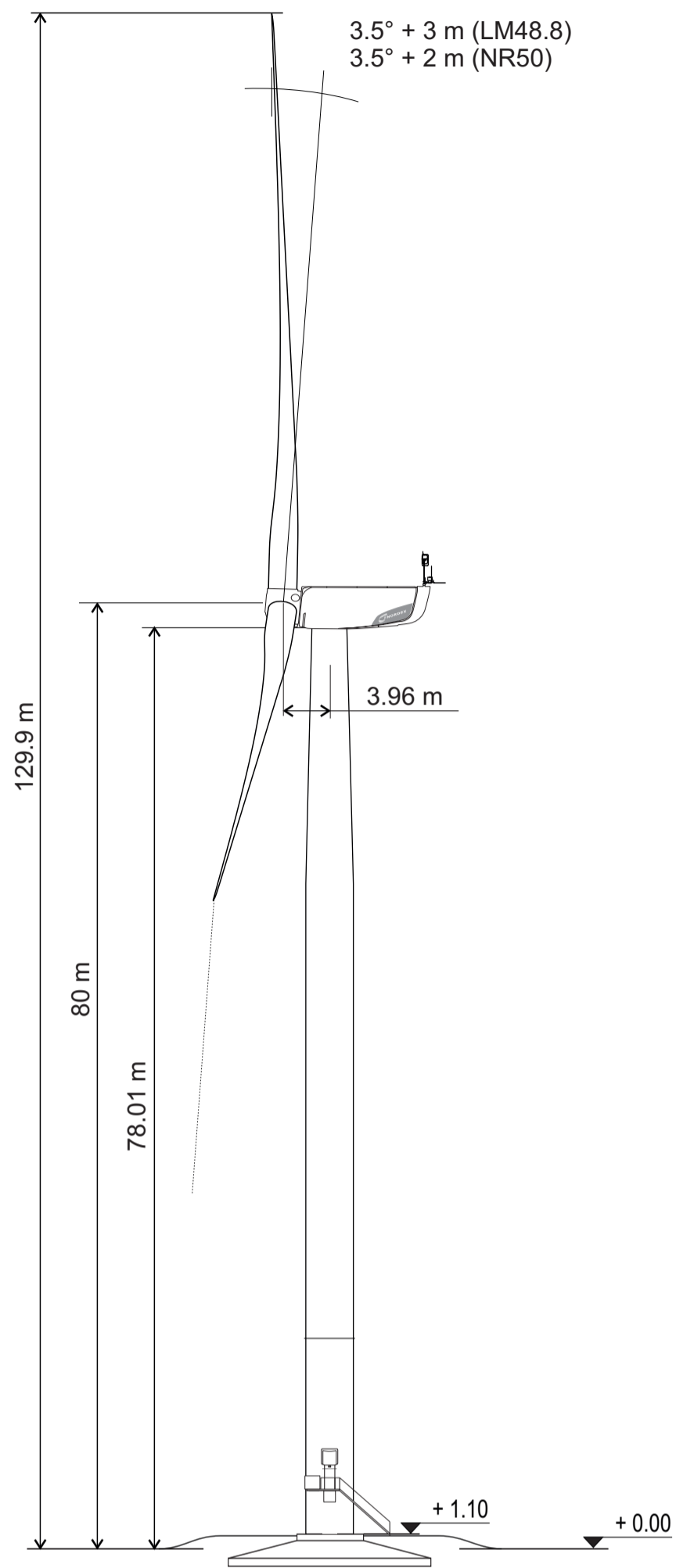


External transformer



Nordex N100/2500
 Hub height: 80 m

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 Date: 2012-08-29
 Scale: 1 : 500
 Format: DIN A2

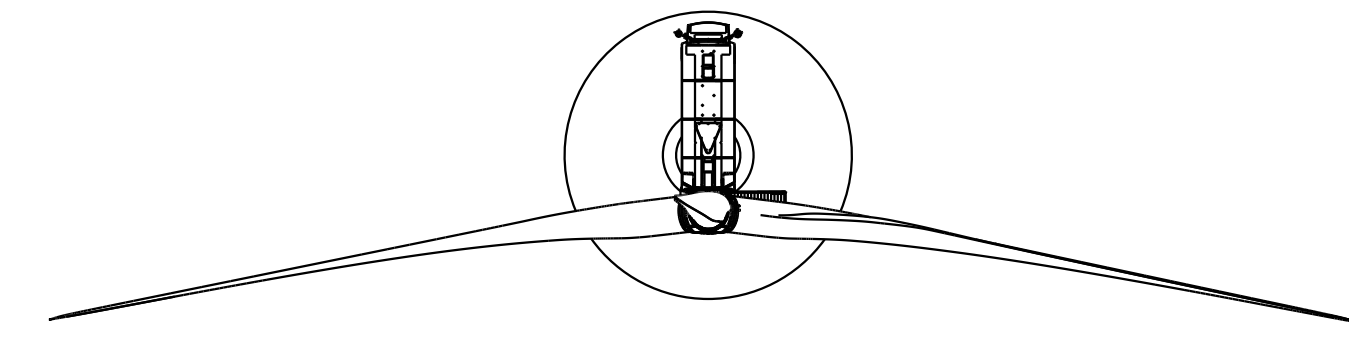
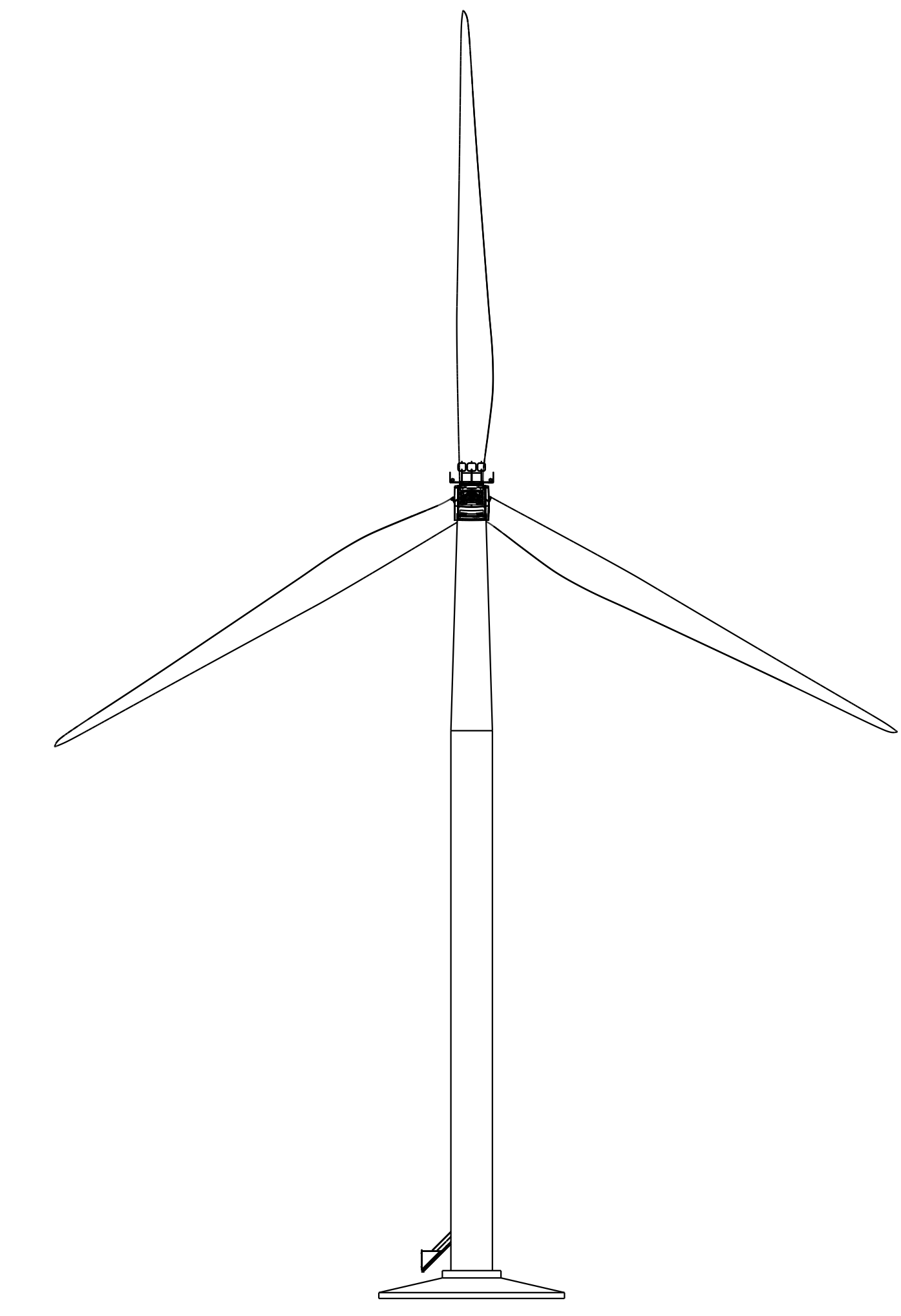
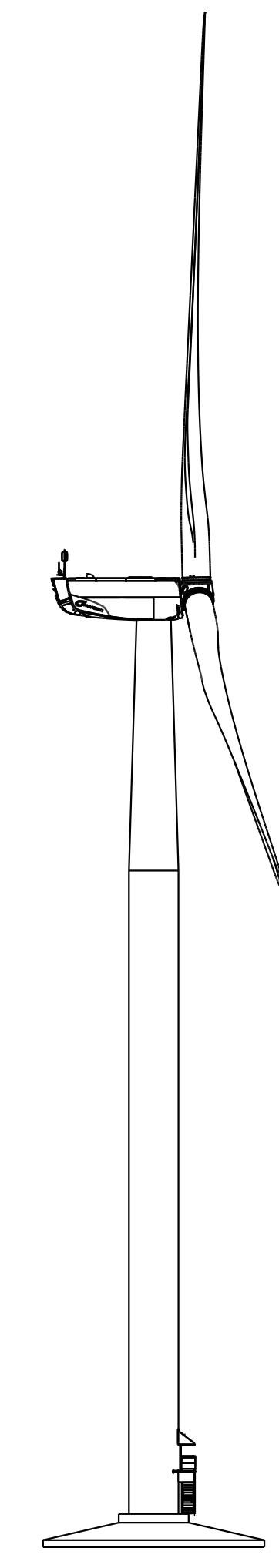
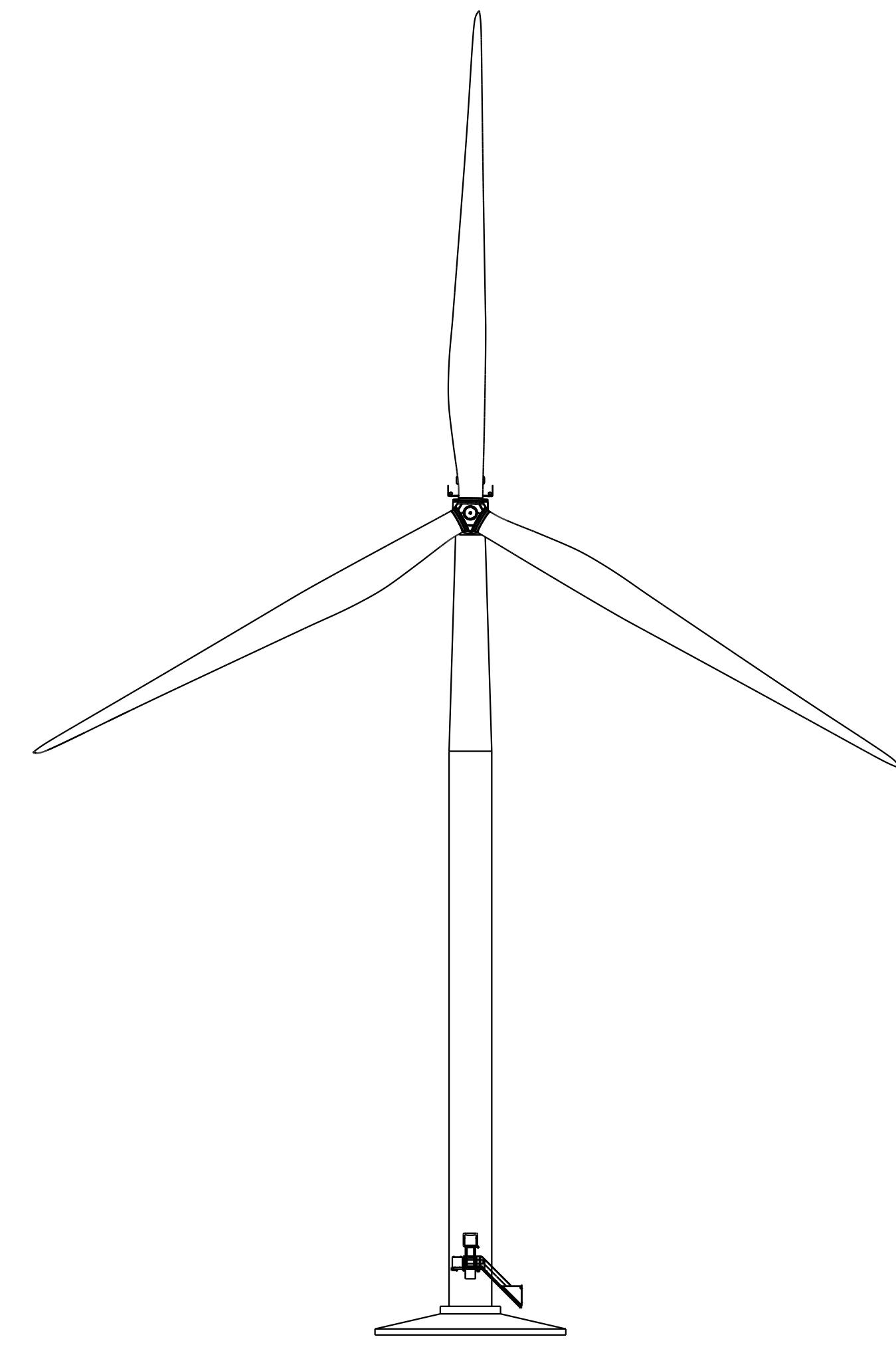
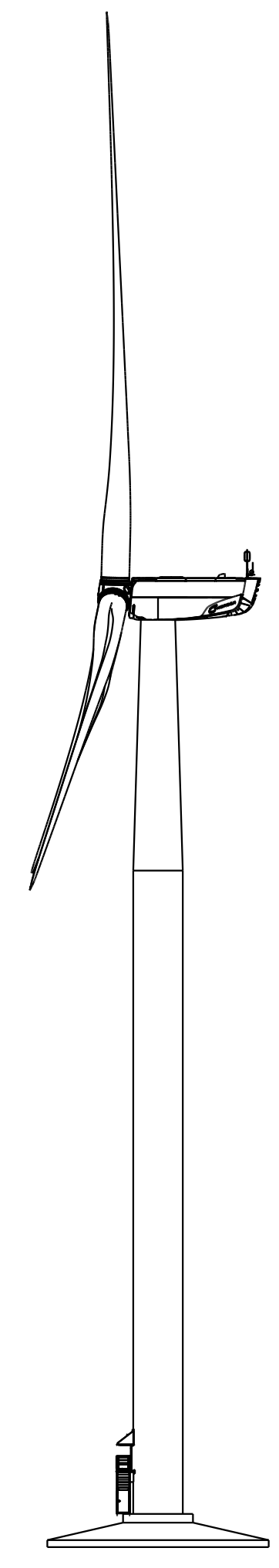


Transformer inside the tower



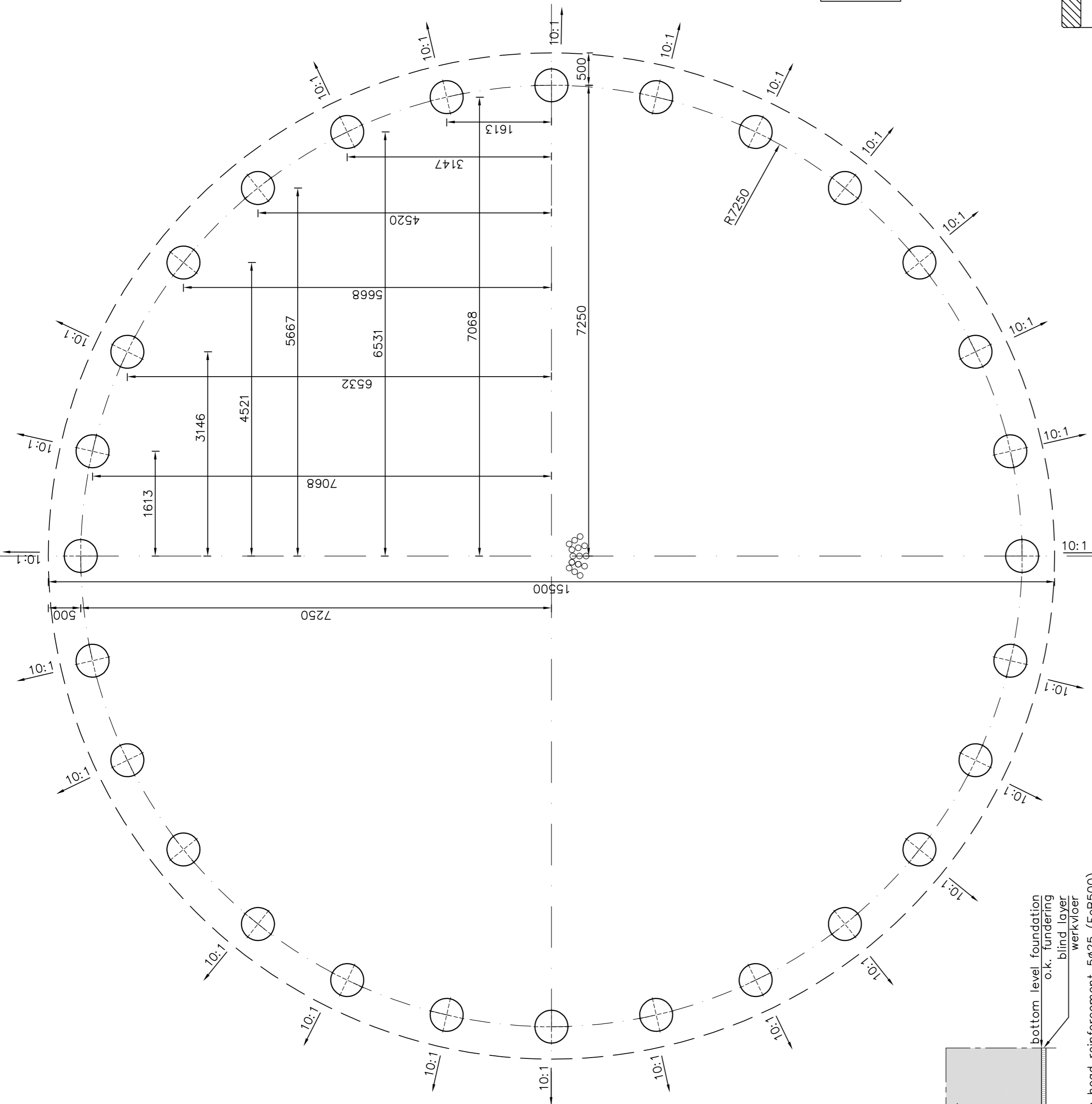
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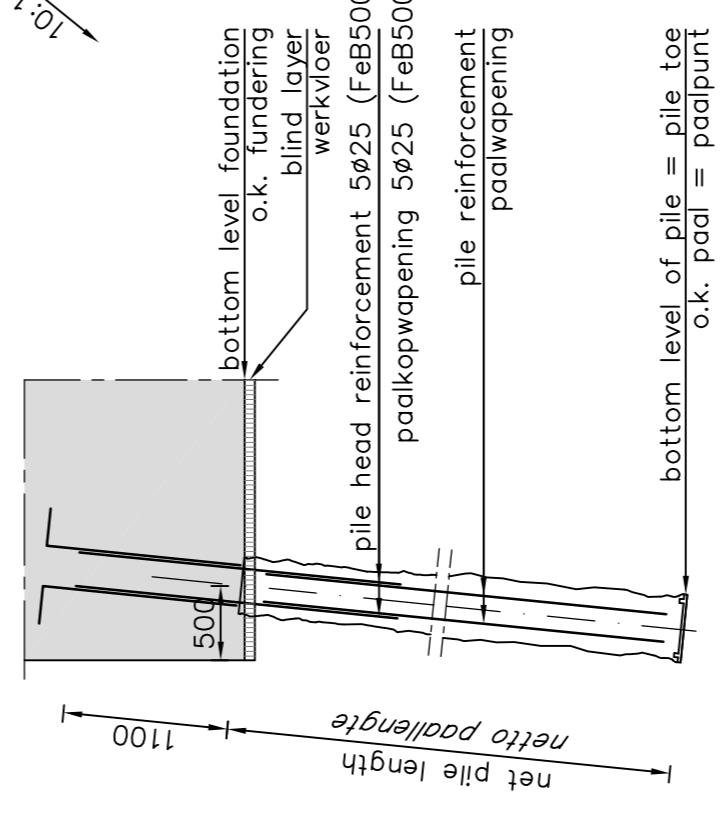


Transformator im Turm

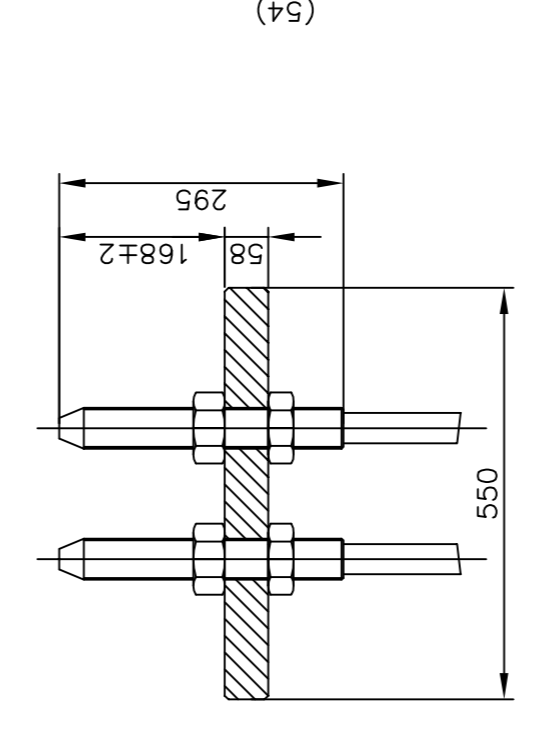
<p>Verwendung in Anlagenklasse in Lärmbildung</p> <p>Verwendung in Systemkategorie in System</p> <p>Alle Rechte vorbehalten. Verwehrt ist die Kopie, Verbreitung oder Nutzung für Zwecke, die nicht im Rahmen der geltenden Gesetze zum Ausdruck kommen.</p> <p>Alle Rechte vorbehalten. Verwehrt ist die Kopie, Verbreitung oder Nutzung für Zwecke, die nicht im Rahmen der geltenden Gesetze zum Ausdruck kommen.</p> <p>Nordex Energy GmbH Langenhörn Chaussee 600 22419 Hamburg Germany</p>	<p>Abgrenzungsskizzen/General boundaries ISO 2768-MK</p> <p>Abgrenzungsskizzen/General boundaries ISO 15715</p> <p>Produktname Name Produkt Name Produkt Name Produkt Name</p> <p>Abgrenzungsskizzen/General boundaries ISO 2768-MK</p> <p>Abgrenzungsskizzen/General boundaries ISO 15715</p>	<p>Multiplan: 15000</p> <p>Skizzennummer: 1032242.6_k1</p> <p>Skizzenart: 1</p> <p>Skizzenname: WEA vereinfacht</p> <p>Skizzennummer: N100 R80 MT TiT IEC 2a</p> <p>Skizzenname: windturbine simplified</p> <p>Skizzennummer: N100 R80 MT TiT IEC 2a</p> <p>Skizzenname: Nordex Energy GmbH</p> <p>Skizzennummer: 1032242.6_k1</p> <p>Skizzenname: Nordex Energy GmbH</p> <p>Skizzennummer: 1032242.6_k1</p>
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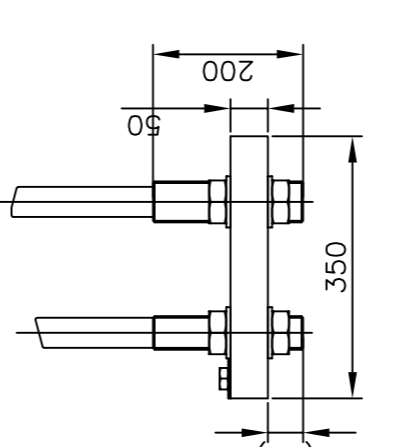
pile plan
paalplan
scale / schaal 1:50



general pile detail
algemeen paaldetail
scale / schaal 1:50

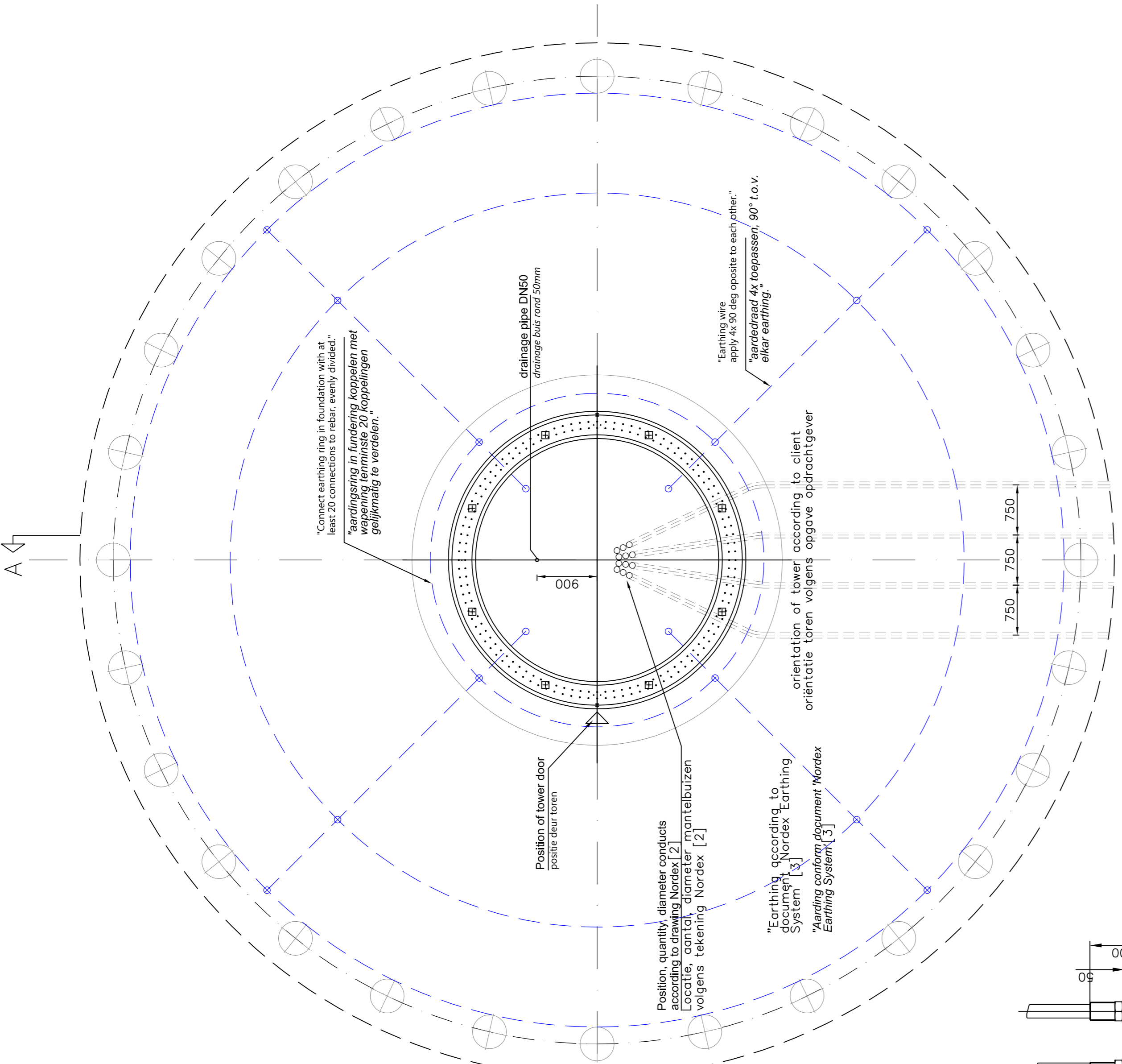


Detail 1
scale / schaal 1:10



Detail 2
scale / schaal 1:10

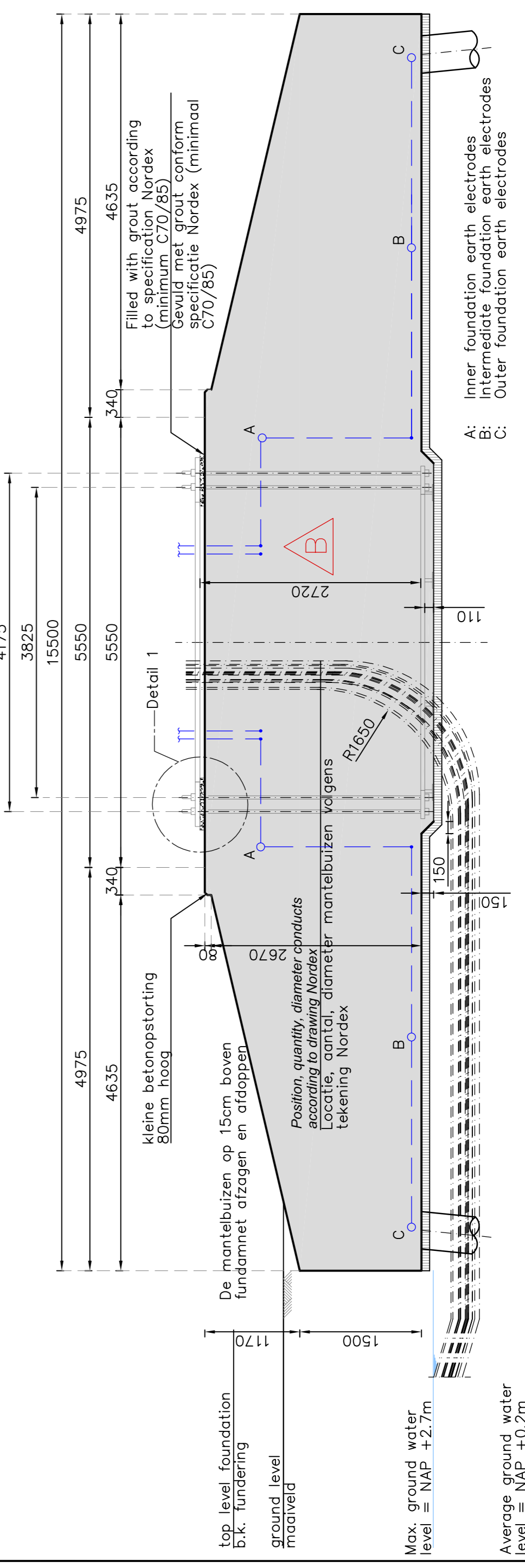
Pile calculation according to annex 5,
structural calculation foundation block
Paalberekening maken aan de hand van bijlage 5,
constructieve berekening funderingsblok



foundation section, conducts and earthing system
ankerbuis, mantelbuizen en aardingvoorziening
scale / schaal 1:50

Reference drawings & documents Nordex:
 [1] Assembly anchor cage drawing 2x80xM4x2990--8,8,
 drawing number 01510-1001461 R8
 [2] Position Conduit Lines foundation with 2x80 anchor bolt TAT,
 drawing number 01500-1031266 R1
 [3] WT Earthing Systems, document no. NALL01_008521_EN R4

[NOTE] Upon completion of the works the exposed threaded sections of the anchor bolts are to be wire brushed and protected from rust i.e. application of rust inhibitor and covered with polythene."



section A-A
doorsnede A-A
scale / schaal 1:50

Location (CPT / locatie)	Top foundation level (m-NAP)	Bottom foundation level (m-NAP)	Net pile length (m)	Anchorage length (m)	Bruto pile length (m)	Size (mm)				
WT32	DKM32-1	DKM32-2	5,80	6,87	4,20	-16,00	20,00	1,10	21,3	508/550
WT33	DKM33-1	DKM33-2	ca. 4,3	5,47	2,80	-26,00	28,80	1,10	29,9	508/550

Detail 1
Grout Detail
scale / schaal 1:10



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Supplier/leverancier: Nordex
 Client/opdrachtgever: Winvest
 project: Windpark Kreekraksluis - Noordzijde
 type: 2x N100 2,5MM - HH80m IEC 2a - (NCV)
 part/orderdeel: Pile plan and foundation block / Paalplan en funderingsblok
 project no.: 101
 sub no.: 150
 scale/schaal: A1
 size/maat: A1
 project manager: M. Roos
 project leader: J. van Sjoen
 structural engineer: J. van Sjoen

C/U

rev.	date / datum	phase / fase	description / omschrijving
0	28-03-2015	C/U	3 nu for approval/voor goedkeuring
1	16-03-2016	C/U	3 nu final/definitief
2	23-05-2016	C/U	3 nu changed anchor cage height

phase description	VO=Voorbereiding	PD=Preliminary Design	DO=Definitive Offer	T= Tender	C=Construction
status description	1=intern	2=concept	3=valid	4=approved	5=contract
statusverklaring	1=intern	2=concept	3=geldend	4=goedgekeurd	5=contract

V

NC 101 02

Type Certificate

Registration-No.

44 220 12487041-TC-IEC, Rev. 3

Name and address of customer

NORDEX Energy GmbH
Langenhorner Chaussee 600
22419 Hamburg
GERMANY

Wind Turbine

N100/2500 50/60Hz

with the characteristic data given in the "Design Evaluation Conformity Statements" and the attached "Annex to Design Evaluation Conformity Statement" referenced below (without NGC gearboxes) has been assessed by TÜV NORD concerning the design, testing and manufacture.

Assessed according to

**IEC IIA (NCV),
IEC SA (Option NCV -20°C, CCV, HCV)**

The Type Certification is based on the indicated documents as follows:

- | | |
|--|---|
| 44 220 13394519-D-IEC-b, Rev. 1 | Design Evaluation Conformity Statement of the Wind Turbine NORDEX N100/2500, 50/60 Hz, NCV, Option NCV -20°C, CCV, HCV, TÜV NORD, dated 2014-12-04. |
| 44 220 12451690-1-D-IEC, Rev. 0 | Design Evaluation Conformity Statement of the Wind Turbine NORDEX N100 HCV (50 Hz), TÜV NORD, dated 2012-12-28. |
| 44 220 12487041-M-IEC, Rev. 4 | Manufacturing Conformity Statement for the Wind Turbine Platform K08 Gamma, TÜV NORD, dated 2014-12-17. |
| 44 220 12487041-T-IEC, Rev. 3 | Type Test Conformity Statement for the Wind Turbine NORDEX N100 Gamma, TÜV NORD, dated 2014-12-17. |
| 8108487041-20, Rev.4 | Final Evaluation Report NORDEX N100 Gamma, TÜV NORD, dated 2014-12-17. |

Normative references:

Certification scheme:
IEC 61400-22 "Wind turbines – Part 22: Conformity testing and certification", First edition, 2010-05
in combination with
IEC 61400-1, Wind Turbine Generator Systems Part 1: Design Requirements, Third Edition, 2005-08 and Amendment 1, 2010-10

Any change in the design has to be approved by TÜV NORD. Without approval the Type Certificate loses its validity.

This Type Certificate is valid until: 2017-04-03.

under the condition of regular maintenance according to chapter 6.5.2, IEC 61400-22

TÜV NORD CERT GmbH
Certification Body for
Wind Turbines

Dipl.-Ing. Christian Hering



Deutsche
Akkreditierungsstelle
D-ZE-12007-01-02

Essen, 17th December 2014

Nordex Acciona Windpower Product Range for the Benelux (25-01-2017)	Office Benelux: Marconiweg 14 NL 8501 XM Joure 0031-513-412354 www.nordex-online.com	Sales contacts : Erik de Graaf edegraaf@nordex-online.com 0031-653761769 Pascal Collin pcollin2@nordex-online.com 0031-615941545

Nordex Gamma Generation (HB: Hybrid Tower / STE: Serrated Traling Edge)

Type (IEC-Class nacelle)	Generator capacity	Rotor diameter	Hub height (m) (IEC-Class tower)	Noise level max dB(A)
N90 (1a)	2,500 kW	90 m	65 (1a) 70 (1a) 80 (1a)	105.5
N100 (2a)	2,500 kW	100 m	75 (2a) 80 (2a) 100 (2a)	106.0
N117 (3a)	2,400 kW	117 m	91 (3a) 120 (3a) 140-141 HB (3a)	105.0 102.0 STE

Nordex Delta Generation (HB: Hybrid Tower / STE: Serrated Traling Edge)

Type (IEC / DIBt -Class nacelle)	Generator capacity	Rotor diameter	Hub height (m) (IEC / DIBt-Class tower)	Noise level max dB(A)
N100 (1a)	3,300 kW	100 m	75 (1a) 85 (1a) 100 (1a)	105.5 103.0 STE
N117 (2a)	3,000 kW	117 m	91 (2a) 120 (2a) 140-141 HB (3a)	103.5 STE
N117 (2a)	3,600 kW	117 m	91 (2a) 106 (2a) 120 (2a)	103.5 STE
N131 (3a)	3,000 kW	131 m	99 (3a) 114 (3a) 134 HB (3a)	101.5 STE
N131 (3a / DIBt2)	3,300 kW	131 m	84 (3a) 106 (3a) 120 (3a) 134 HB (DIBt2) / DE 164 HB (DIBt2) / DE	103.0 STE
N131 (2s)	3,600 kW	131 m	84 (2s) 106 (2s) 112 (2s) 120 (2s) 134 HB (development)	104.9 STE
N131 (3s)	3900 kW	131 m	84 (3s) 120 (3s) 134 HB (development)	106.2 STE