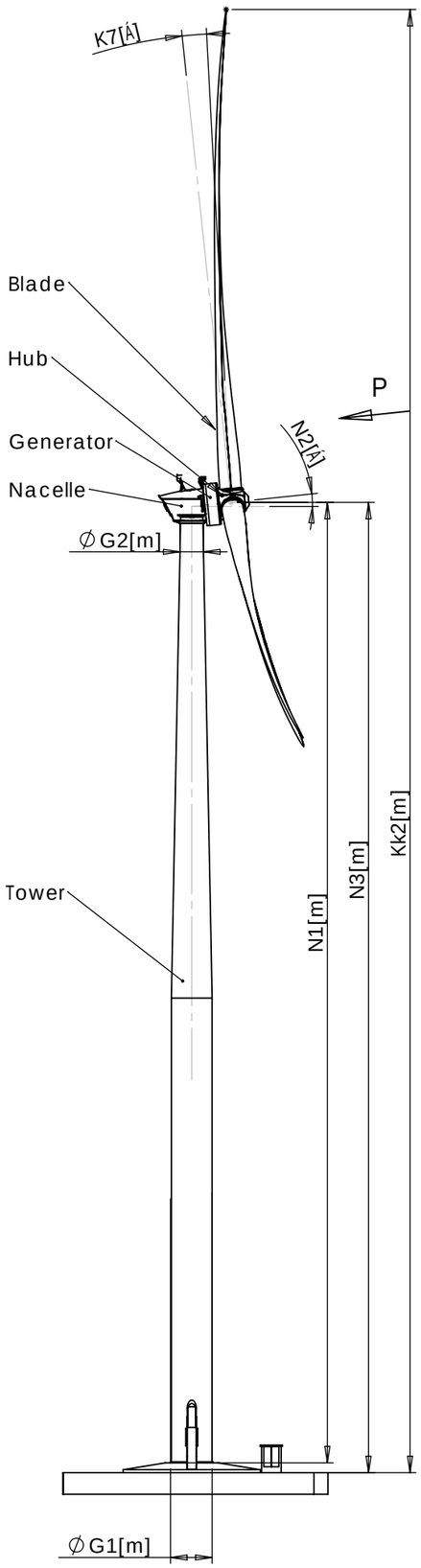
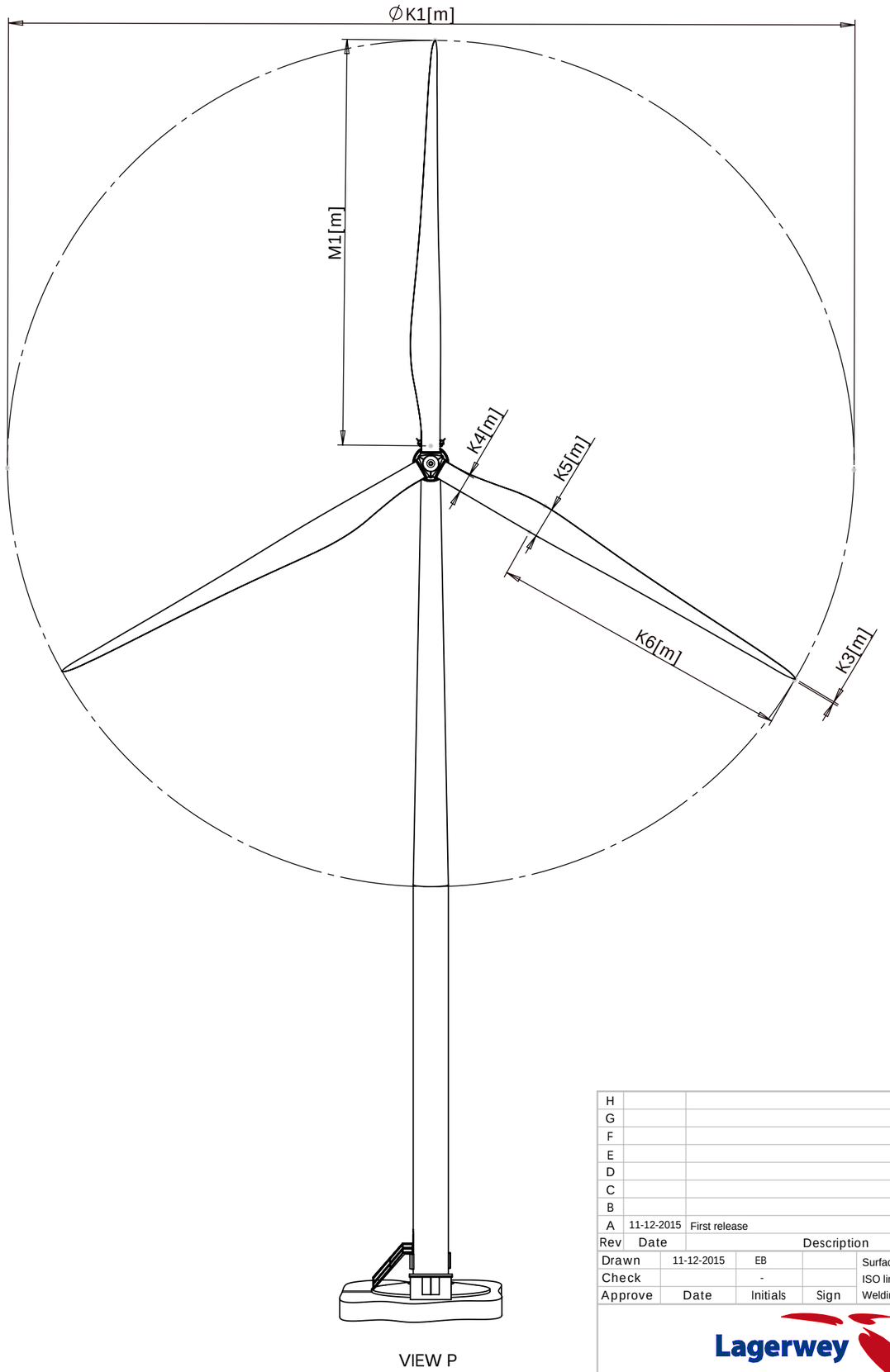
Bijlage 10b: Technische gegevens Lagerwey





VIEW P

Item	Symbol	Value
Tower bottom diameter	G1	4.2
Tower top diameter	G2	2,3
Rotor diameter	K1	100
Total height *)	K2	149.5±0.5
Blade tip width	K3	0,2
Blade root width	K4	2,2
Max blade width	K5	3,6
Distance tip - widest	K6	36
Cone angle	K7	3
Hub height	N1	98
Slope angle hub axis	N2	6
Hub height above ground level *)	N3	99±0.5
Height above generator	M1	48.4

*) Depending on foundation design

Rev	Date	Description	Init.
H			
G			
F			
E			
D			
C			
B			
A	11-12-2015	First release	EB

Drawn	11-12-2015	EB		Surface roughness ISO 4287
Check		-		ISO limits and fits NEN-ISO 286-2
Approve	Date	Initials	Sign	Welding symbolic ISO 2553

Surf.treatment: Coating in RAL7035

Material: -

NEN-ISO 1101

Gen. Tol. NEN-ISO 2768-c

ISO 1302

American proj.

units mm

size A3

Module: Turbine

Description: L100 2.5MW - Hub height 98m

Drawing no.: 20-000132

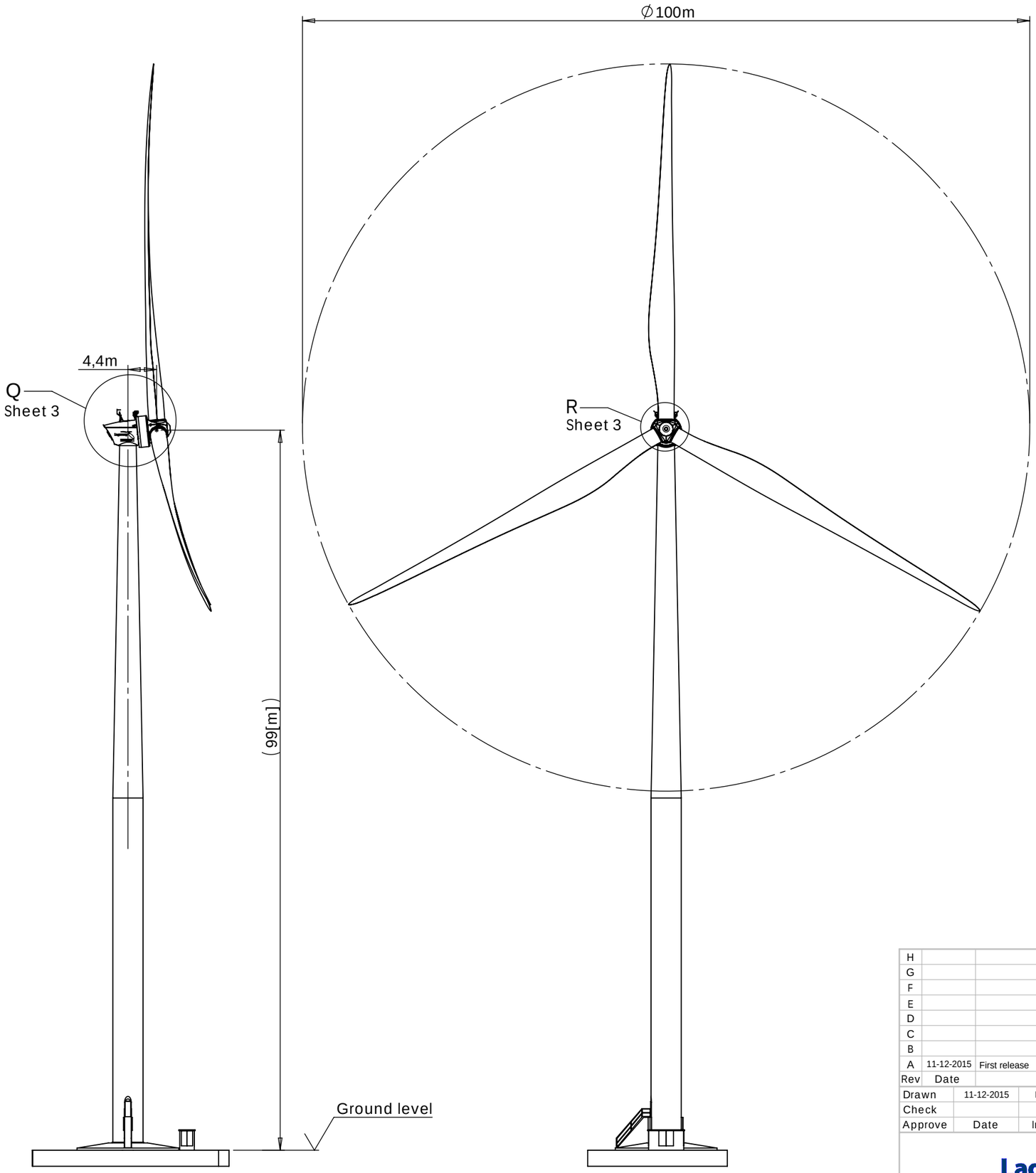
Rev. A

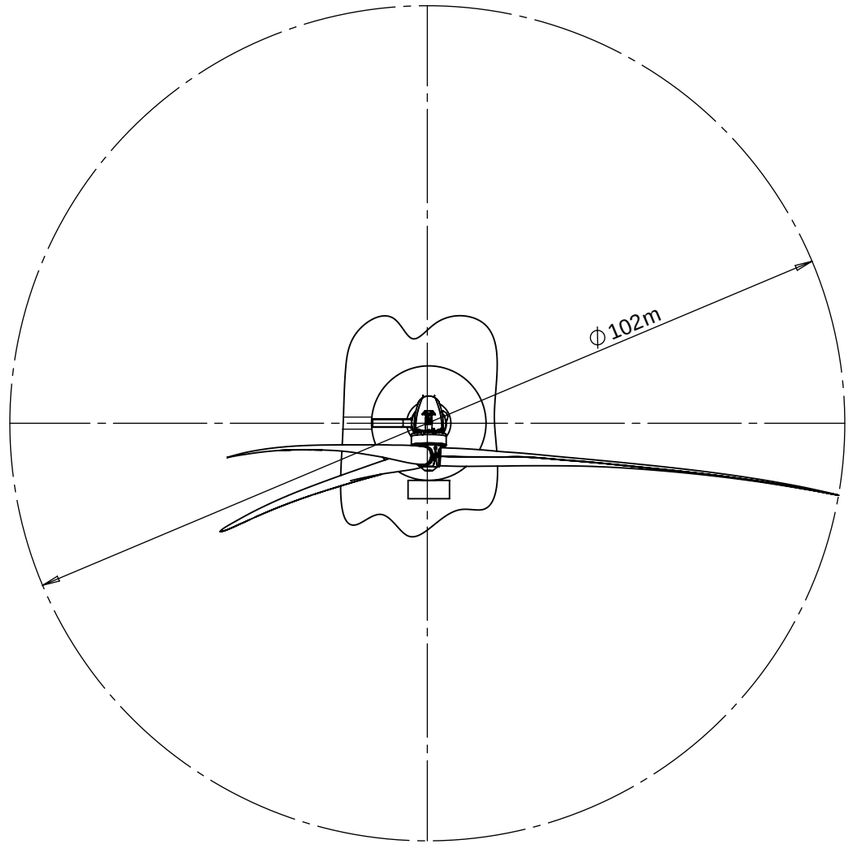
Document class no. M00-C7

Weight: - kg

Scale: 1:600

Sheets: 1 of 3





Top view with one blade horizontal
Circumscribed circle relative to tower center
Scale 1:750

Rev	Date	Description	Init.
H			
G			
F			
E			
D			
C			
B			
A	11-12-2015	First release	EB

Drawn	11-12-2015	EB		Surface roughness ISO 4287
Check		-		ISO limits and fits NEN-ISO 286-2
Approve	Date	Initials	Sign	Welding symbolic ISO 2553

Surf.treatment: Coating in RAL7035

Material: -

NEN-ISO 1101

Gen. Tol. NEN-ISO 2768-c

ISO 1302

American proj.

units mm

size A3

Module: Turbine

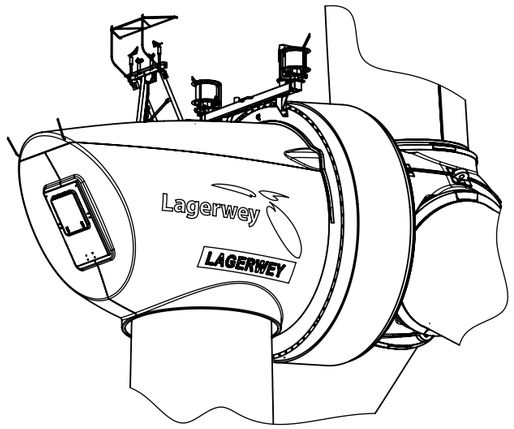
Description: L100 2.5MW - Hub height 98m

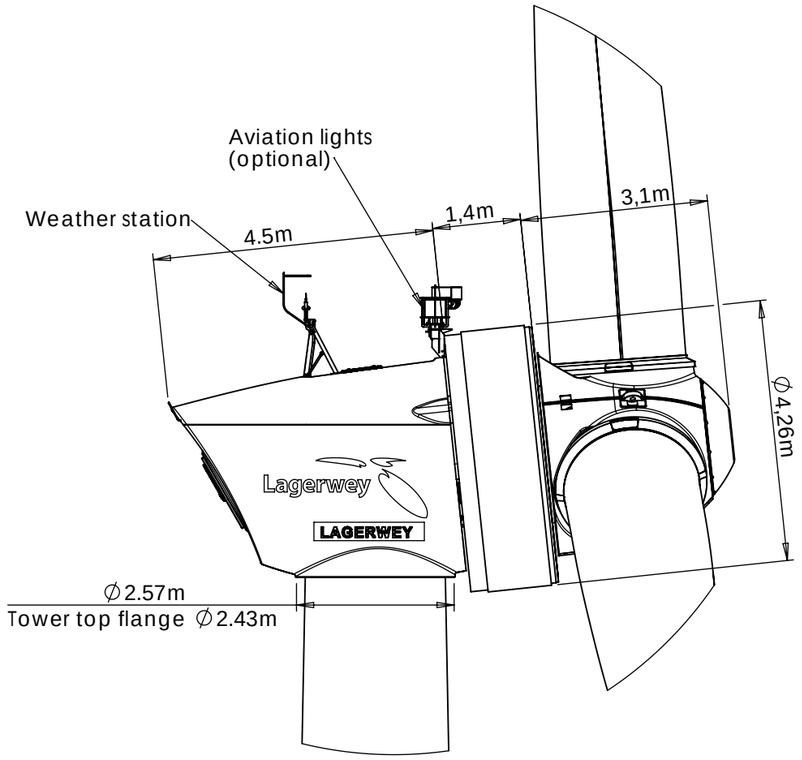
Drawing no.:	Rev.	Document class no.
20-000132	A	M00-C7

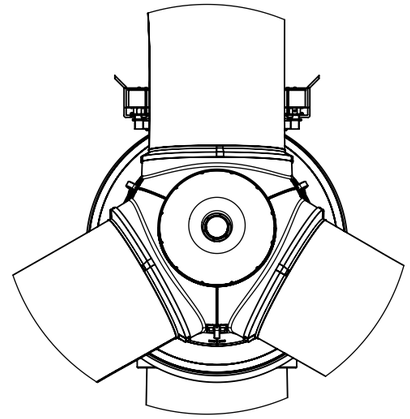
Weight: - kg

Scale: 1:600

Sheets: 2 of 3

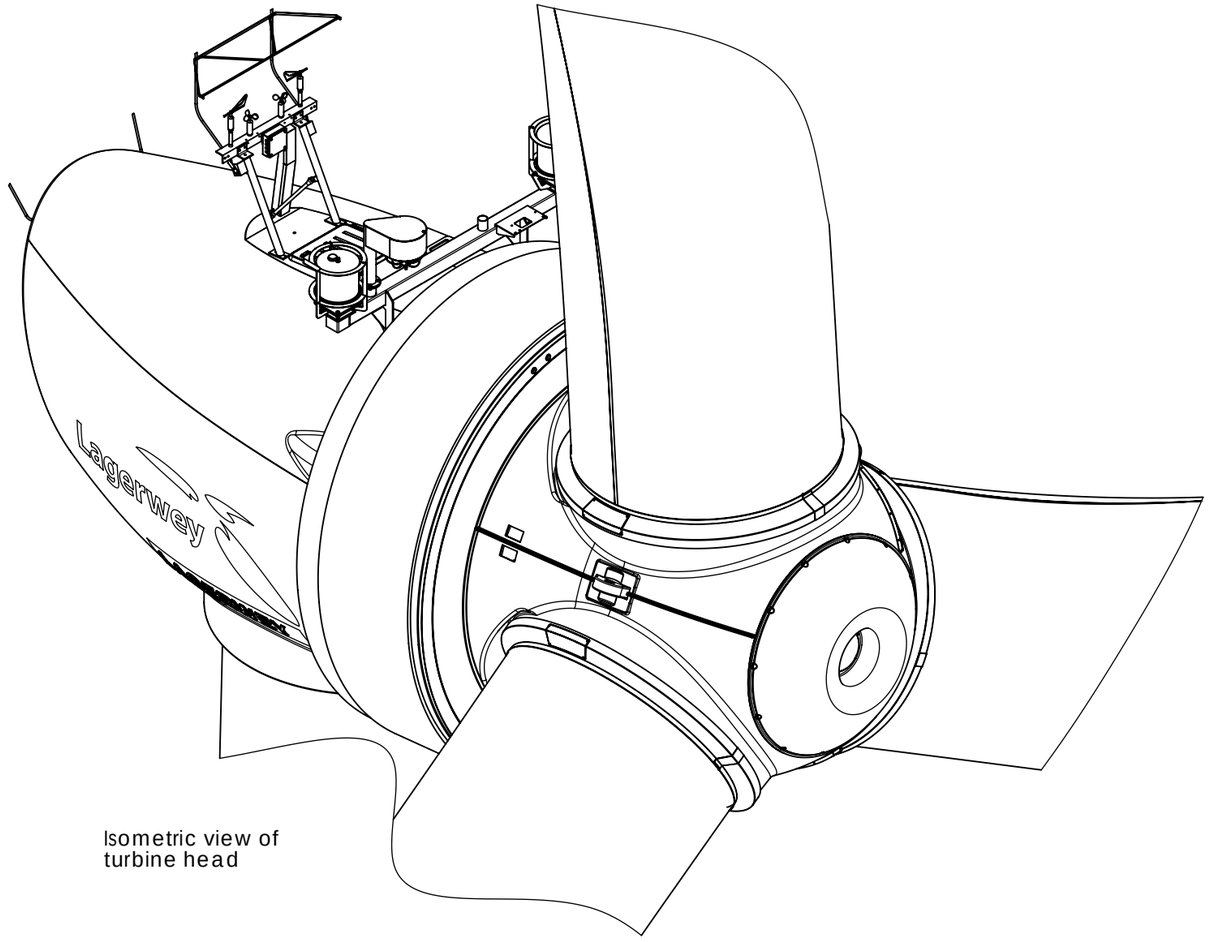






DETAIL R

DETAIL Q



Isometric view of
turbine head

Rev	Date	Description	Init.
H			
G			
F			
E			
D			
C			
B			
A	11-12-2015	First release	EB

Drawn	11-12-2015	EB		Surface roughness ISO 4287
Check		-		ISO limits and fits NEN-ISO 286-2
Approve	Date	Initials	Sign	Welding symbolic ISO 2553

Surf.treatment: Coating in RAL7035

Material: -

NEN-ISO 1101 A A

Gen. Tol. NEN-ISO 2768-c

ISO 1302

American proj.

units mm

size A3

Module:
Turbine

Description:
L100 2.5MW - Hub height 98m

Drawing no.:	Rev.	Document class no.
20-000132	A	M00-C7

Weight: - kg

Scale: 1:100

Sheets: 3 of 3

General specification Lagerwey

L100-2.5MW Wind Turbine Generator

Document number: SD116ENR4

This document contains the general specifications of the Lagerwey L100-2.5MW wind turbine generator.

	Name	Initials	Signature	Date
Author	Gert van der Weijden	GvdW		20/10/2015
Co-author				
Checked by	Mark Van Doorn	MvD		20/10/2015
Approved by	Albert Waaijenberg	AW		20/10/2015

Content

1 Wind turbine generator description

The L100-2.5MW is equipped with an 100m rotor and is designed for IEC IIIa wind class conditions. The concept is based on the gearless principle of direct drive permanent magnet power generation and a full IGBT power converter. The wind turbine generator (WTG) delivers 2.5 Megawatt at rated power and is very effective at low wind speeds. The passive cooling concept makes it very suitable for harsh climatic conditions.

Generator

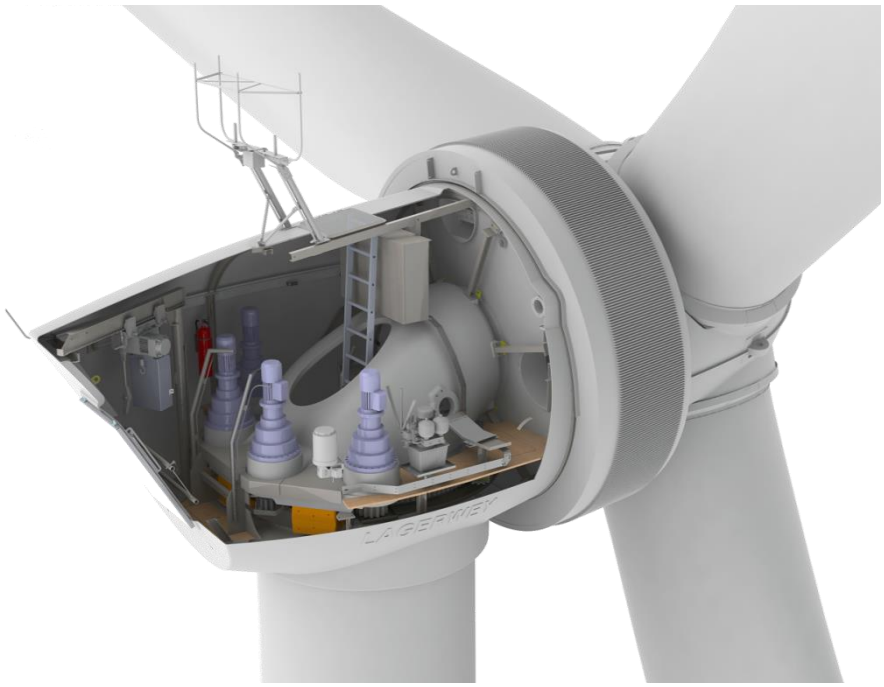
The direct drive generator has an outside stator and an inside rotor structure which only carries the torque and 'internal' generator loads, not the forces from the blades. The permanent magnets in the generator rotor and the stiff copper windings in the stator are vacuum impregnated with high quality resin, ensuring lifetime durability of the machine.

Passive cooling

The L100-2.5MW is cooled by the natural airflow around the stator (passive cooling). Heat is exchanged by direct conduction from the copper coils of the stator to the cooling fins at the outside surface (±18 m^2). At higher loads an additional small cooling fan is switched on to contribute (approx. 10% additional capacity) to the heat exchange in the inner part.

Rotor

The rotor blades are made of glass fibre reinforced epoxy. The blades have an internal beam which carries the forces into the cast iron rotor hub. The blade is pitched around its axis by a 4 point ball bearing with outside gearing teeth. All the bearings and geared teeth are equipped with an automatic greasing system that is software controlled.



Lagerwey L100-2.5MW platform, nacelle internals

Hub
The special hollow casted hub transfers the blade forces and torque trough a stiff double main bearing into the hollow main shaft. The shaft is directly connected to the main frame and ensures optimal load transfer into the tower. The rotor hub can easily be entered through the hollow shaft to facilitate maintenance. It houses four electrical yaw gears and three hydraulic yaw brakes that take care of the automatic yaw control.

Main Bearing
The Lagerwey hollow main bearing design consists of two rows of dual tapered bearings. The compact bearing has a high stiffness and is oil lubricated, ensuring smooth operation in all circumstances. The main bearing is designed by Lagerwey in collaboration with renowned bearing manufacturers.

Nacelle
The glass fibre nacelle cover protects all components inside the nacelle against the environment. The nacelle houses two hatches that have a transparent cover to let daylight into the nacelle. One hatch in the top provides access to the wind station sensors, one hatch at the backside enables hoisting trough the outside by an internal 500 kg strong service crane.

Control- and safety system
All functions and sensors of the WTG will be monitored and controlled 24/7 by the Lagerwey Turbine Controller. The main control system unit is located in the nacelle and is connected to the power converter by glass fibre optical cable.

The Lagerwey rotor speed control system monitors and automatically adjusts the rotor speed and blade pitch for optimal and safe operation. The system works independently per blade and is fully synchronised. For safe operation, the second safety stop system is handled by three independent battery units. An additional parking brake controls the double locking pins used to block the rotor.

Power converter
The power conversion is located in the bottom of the tower and consists off a water cooled back to back converter running by IGBT’s.

Lagerwey Tower Solutions
Lagerwey uses standard Tubular Steel Towers (TST) for hub heights up to 99 meters. From 99m on, we provide our Modular Steel Tower. The MST is a cost-effective, lightweight and easy to transport solution for reaching higher hub heights. The building blocks of the MST are pre-bend steel sheets, each measuring about 11 meters in height. The tower is transported in crates of stacked sheets on standard trucks.

An access door is constructed at the tower base and an internal ladder with climbing protection and service elevator is fitted inside. Each tower segment has emergency lighting. The generator cables, nacelle power cables and communication lines are guided to the tower top by cable supports

2 Technical component data

2.1 General:

Design standards	According IEC 61400-1 edition 3
Design lifetime	20 years
Component Colour	RAL 7035 30% Gloss

2.2 Operational and design data:

Cut in wind speed	2.3 m/s
Cut out wind speed	25 m/s (10 minutes average)
Wind speed at nominal power	12 m/s
Design wind class	Wind class III, turbulence A (18%) According IEC 61400-1 edition 2
Survival wind speed Ve50 =1,4 x Vref	52,5 m/s (IEC wind class III)
Wind elevation	8° according IEC 61400-1
Temperature range operational	Standard -10 °C, +40 °C Cold Climate -30 °C , +30 °C
Temperature range standby	Standard -20 °C , +50 °C Cold Climate -40 °C , +30 °C
Noise at 8 m/s at 10 m height	Calculated 105 dB(A)

2.3 Blade:

Blade length	48,8 m
Blade (hub) mounting base radius	1,26 m
Rotational direction	Clockwise
Mass	7.950 kg
Material	Glass fibre and epoxy

2.4 Rotor:

Type	3-bladed, horizontal axis
Position	Up wind
Diameter	100 meter
Swept area	7854 m²
Rotor speed	Variable speed
Rotor speed at rated power	15,0 rpm
Rotor speed at cut in power	8 rpm
Power regulation	Pitch control
Hub material	Cast iron (EN-GJS-400-18U-LT)
Hub mass	19 tons

2.5 Generator:

Type	Multi pole synchronous
Nominal speed	15,0 rpm
Voltage	Low Voltage
Field excitation	Permanent magnet
Generator mass	49,5 ton
Protection	IP 54
Cooling	Natural airflow based (cooling fins)
Diameter	4,2 m
Temperature sensors	PT-100 / PTC
Service brake	Hydraulic brake system
Turbine main shaft	Hollow shaft + main bearing unit
Connections to nacelle and hub	High strength bolts

2.6 Nacelle:

Support structure material	Cast iron (EN-GJS-400-18U-LT)
Nacelle total mass	15 tons (without generator)
Yaw bearing	Slewing ring
Yaw drive	Electric motors and gear drives
Yaw brake	Active brake calipers
Wind speed and vane sensors	Heated wind vane and cup anemometer
Connections to tower and nacelle	High strength bolts
Service equipment	Winch 500 Kg

2.7 Tower

Type	Tapered tubular tower
Hub height	Standard: 75m / 98 m* / 99m / 135 m* *: Modular Steel Tower
Bottom diameter	4,2 m (MST 9.5 m)
Top diameter	2,3 m
Connections	Flanges bolted with high strength bolts

3 Electrical and control data

The Lagerwey wind turbine generator is monitored, and controlled via the Lagerwey wind turbine Controller. The wind turbine controller soft- and hardware is designed by Lagerwey and ensure safe and effective operation.

3.1 Control processes

3.1.1 Torque control

The turbine is variable speed controlled. The difference between the aerodynamic and the electromechanical torque determines the rotor speed during partial load. The counter torque is optimized according to the wind speed and incoming torque and follows an optimal tip speed ratio. During full load conditions the output power is kept constant by means of torque control. The counter torque produced by the generator is controlled by the converter.

3.1.2 Pitch control

The turbine has three independent pitch drive systems to control the blade angles. The blade control ensures the turbine speed and loads are within the design limits. Below the rated rotor speed the blade angle is fixed to the working position most of the time. This ensures optimum tip speed to power production ratio.

3.1.3 Yaw control

The yaw mechanism contains a geared slewing ring and 4 yaw drives. To avoid slipping of the system when the rotor is in position, an active actuated yaw brake is applied. This brake is lifted during yawing. The turbine controller takes care of the yawing process, it uses the wind sensors and the twist sensor for input. The controller minimizes yaw loads and yaw actions.

3.1.4 Park and lock control

The turbine has a hydraulic service brake to stop the turbine in a standstill position. The rotor should always be locked when entering the hub. The turbine has two locking devices integrated in the generator which is manually operated. The locking device is connected to the controller by sensors.

3.2 Turbine control and safety system

The Lagerwey Controller monitors and controls the wind turbine operational functioning. The system is build up in a modular way. The control and safety functions take place locally, close to the processes. Field busses facilitate communication between the local intelligence and the control systems. This ensures direct control and safe operations under all conditions.

The main function of the rotor-control system is to control the rotor speed within a specified range. This function is realized using 3 independent blade pitch motors and drives. The three blade angles are synchronized during operation.

The safety system (emergency/protection system) is built around the same three independent pitch systems. When the control system fails, for each blade a simple and robust relay connects a battery directly to the additional DC pitch motor and moves simultaneously each independent blade into a safe position.

If one blade pitch system fails, the other two ensure control. The batteries are continuously monitored for deterioration during operation. Before each start-up the safety system is checked by means of pitching the rotor blades by use of the DC pitch motor and battery pack to ensure the system operates. The system hardware is located in the main control cabinets, placed in the rotor hub, nacelle and tower base. The controllers are mutually connected by a communication line.

3.3 Grid connection

Grid side turbine Voltage	690 V
Voltage level	Medium voltage, nominal ±10%
Voltage imbalance	Ratio negative to positive sequence max 2%
Frequency level	50 or 60 Hz ±2%
Maximum harmonic voltage distortion on point of common coupling (POCC) without turbine	According to IEC 61400-1

3.4 Converter

The generator power with variable frequency is rectified and converted to a constant 50 Hz or 60Hz frequency (AC-DC-AC conversion) and fed into the grid. A full size converter is used to optimize the quality of the frequency and voltage in order to minimize harmonic currents. The converter controls the power as a function of the rotational speed of the turbine and keeps it constant at nominal power.

Type	IGBT
Cooling	Water/air cooled
Grid coupling	AC-DC-AC
Grid side type	3 phase
Grid side connection	Motor operated main circuit breaker
Grid filter topology	LCL
Control mode	Torque reference
Power factor standard	Controllable between 0.92 and 1.00 leading or lagging
Power quality	THD <4%
Energy measurement	+ and – kWh
Protection	Surge arrestors 10 kA
Protection class	IP 54
Inrush current at start up	No inrush
Grid side Voltage	690 V

3.5 Pitch system:

Type	Electrically actuated
Principle	3 independent blade pitch systems
Blade angle range	0 to 90°
Emergency	DC motors + battery backup

3.6 Control system:

Main controller type	PLC controller
Rotor control	Pitch drive control and over speed protection
Nacelle control	Rotor speed control / alarm handling / yaw control / wind, temperature, acceleration, cable twist and other measurements / data logging
Tower base control	MMI operating control panel
Internal communication	fibre optics
External communication	Internet connection

3.7 Foundation earthing

The main earthing back-bone begins with blade lightning arrestors, through the non-rotating generator support to the nacelle and the tower into the foundation earthing electrodes. The foundation reinforcement and earthing electrodes together form the wind turbine central earthing point, to which all earthing connections are linked. The earthing of the foundation depends on local soil conditions. The resistance to neutral earthing is according the requirements of the local authorities. The maximum resistance should not be higher than 2.5 Ohm.

Conductor ring: the outside reinforcement at 1m height is welded together (minimum 50 mm^2 steel) as the first step of the ring conductor. The second ring consists of a closed copper conductor ring of 50 mm^2 at a distance of 1 m from the foundation and 1 m below ground level. This ring is connected to the first ring of reinforcement steel. The copper ring conductor is connected to at least 2 copper coated earthing electrodes. The rod length depends on the resistance you can achieve.

3.8 Lightning protection

All the important components such as blades, bearings, and electronic devices are protected against lightning. The lightning protection of the blades is connected to the main steel construction to get around the main bearings by 3 copper brush arrestors. The wind station support and aviation beams have lightning arrestors as well, all connected to the nacelle, tower and foundation. The electronic equipment and sensors are well connected to the earthing system and are isolated in steel bars and housings through the entire electric system.

4 Human safety

During construction and in the operational phase, Lagerwey follows all local health and safety regulations.

4.1 Installation and service

The turbine will be installed and serviced by trained people. The installation and service will be conducted according to Lagerwey requirements. The Installation – and Service manual describes all the human and turbine safety equipment and rules. During installation local HSE requirements imposed by the local authorities will be followed.

5 Options

Lagerwey offers the following options (more options available on request).

5.1 Ice detection

Ice detection can be installed as an option. A special ice detector, placed on the nacelle top, is able to detect forming of ice. This will bring the turbine in a normal stop condition, avoiding the risk of ice throw. This can be required by the authorities, following local rules in icing sensitive areas.

5.2 Lagerwey Monitoring System

Remote control software under the name of LMS, Lagerwey Monitoring System, can be supplied as an option for customers. This system is accessible via the internet and can provide variant levels of information and/or control of the turbine functioning.

5.3 Aviation Lights

Aviation lights can be added as an option to ensure local requirements are met. Aviation lights can be placed at the top of the generator. In a park layout the lights can be synchronised.

5.4 Blade shadow mitigation system

Lagerwey provides its own blade shadow mitigation system, which is flexible and effective. The system can be configured to specific customer needs and/or local regulations.

5.5 Cold Climate Packages

Lagerwey turbines are in their basic configuration well suited for cold and hot regions. The small amount of oil for the main bearing can be brought to the desired temperature if needed. In case of a cold start-up in a cold environment the generator and main bearing are warmed up by slowly pitching the blades and by controlling the turbine output.

We recommend Cold Climate Packages in conditions where -20°C for more than 1 hour in 9 days per year can be expected. For the more extreme cold climate regions (-30°C operational, -40°C standby), Lagerwey developed three grades of site specific cold weather packages:

Grade	Solutions
Grade 1 'Mild Cold'	Ice detection system Additional heating in controller cabinets Appropriate material selection such as the steel quality for low temperatures (impact strength) Heated anemometer and wind vane Heaters for electrical cabinets
Grade 2 'Medium Cold'	Measures of grade one, plus: Extra protection for electronic devices Jackets for pitch- and yaw drives Heating of Slip ring, controller/control cabinet and batteries Low temperature lubricants Yaw brake and service brake hydraulic oil heating
Grade 3 'Severe Cold'	Measures of grade two, plus: Special alloyed ductile iron for hub, machine frame and tower. Heating of the main bearing with induction mats Heating of the pitch and yaw bearing lubricants Dark coloured blades to minimize ice built up.

Design Evaluation
Conformity Statement

Registration-No.
44 220 14463967-D-IEC, Rev. 5

This Conformity Statement is issued to

Lagerwey Wind BV
Nijverheidspleni 21
3771 MR Barneveld
The Netherlands

For the wind turbine **L100-2.5MW, 50 Hz**

WT Class **IEC IIIA**

This Conformity Statement attests compliance with the below cited standards concerning the Design according to the listed standards. It is based on the following evaluation reports:

TÜV NORD	Report No. 8109 735 063-0 E	Design Basis	Rev.4	dated 2016-11-09
TÜV NORD	Report No. 8110 226 337-1 E I	Load assum. WINDblade488-2.0 T98	Rev.0	dated 2014-05-19
TÜV NORD	Report No. 8110 226 337-1 E II	Load assum. WINDblade488-2.0 T135	Rev.0	dated 2014-06-05
TÜV NORD	Report No. 8113 605 552-1 E I	Load assumptions LM49.1P T75m	Rev.0	dated 2016-07-29
TÜV NORD	Report No. 8112 220 248-1 E I	Load assumptions LM49.1P T98	Rev.0	dated 2015-05-05
TÜV NORD	Report No. 8112 220 248-1 E II	Load assumptions LM49.1P T135	Rev.0	dated 2015-05-05
TÜV NORD	Report No. 8109 735 063-2 E	Safety System and Manuals	Rev.4	dated 2016-11-10
TÜV NORD	Report No. 8110 226 337-3 E	Rotor Blade WINDblade 488-2.0	Rev.1	dated 2014-09-02
TÜV NORD	Report No. 8112 220 248-3 E	Rotor Blade LM49.1P	Rev.1	dated 2016-09-09
TÜV NORD	Report No. 8109 735 063-4 E	Machinery Components	Rev.4	dated 2016-11-10
TÜV NORD	Report No. 8113 010 118-5 E	Electrical Components 50 Hz	Rev.1	dated 2016-11-10
TÜV NORD	Report No. 8113 605 552-6 E	Tubular steel tower T75 m	Rev.0	dated 2016-10-14
TÜV NORD	Report No. 8110 463 967-6 E I	Tubular steel tower HH 98 m	Rev.1	dated 2015-07-01
TÜV NORD	Report No. 8110 463 967-6 E II	Tubular steel tower HH 135 m	Rev.1	dated 2015-07-10
TÜV NORD	Report No. 8113 605 552-8 E	Tower Internals HH 75 m	Rev.0	dated 2016-11-09
TÜV NORD	Report No. 8110 463 967-8 E	Tower Internals HH 98 m	Rev.1	dated 2015-07-30
TÜV NORD	Report No. 8110 463 967-8 E II	Tower Internals HH 135 m	Rev.1	dated 2016-07-27
TÜV NORD	Report No. 8109 735 063-10 E	Manufacturing Process	Rev.1	dated 2016-05-10

Normative references:

Certification scheme:
IEC 61400-22 "Wind turbines - Part 22: Conformity testing and certification", Edition 1.0, 2010-05
in combination with:
IEC 61400-1 "Wind Turbines - Part 1: Design requirements", Third Edition, 2005-08 and Amendment 1, 2010-10

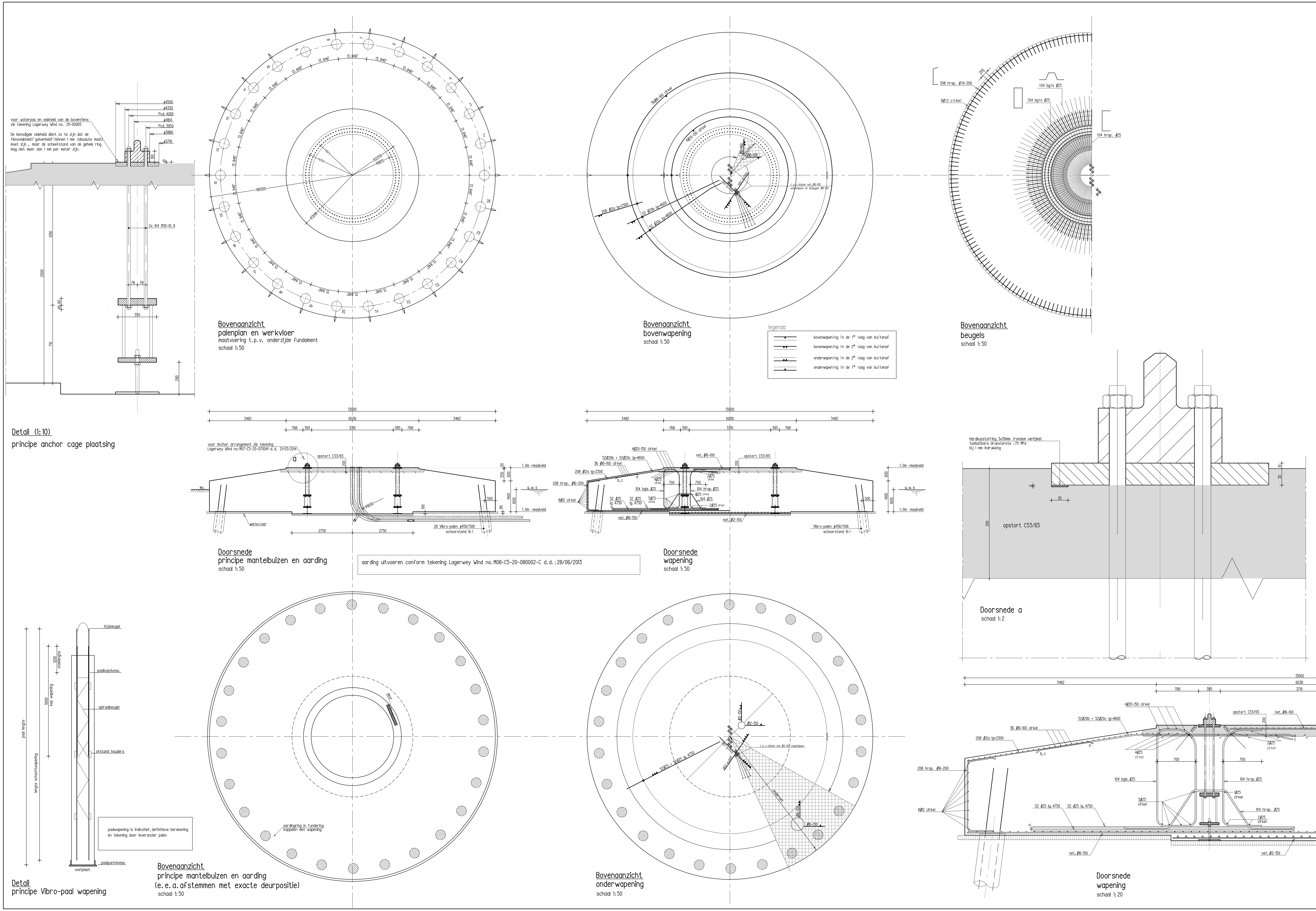
The wind turbine type is specified on page 2 - 7 of this Conformity Statement.

Any change in the design is to be approved by TÜV NORD CERT GmbH. Without approval this Statement loses its validity.

TÜV NORD CERT GmbH
Certification Body
Wind Energy
Dipl. Technomath. K. Götz

DAkkS
Deutsche
Akkreditierungsstelle
D-ZE-12007-01-02

Essen, 2016- November-14

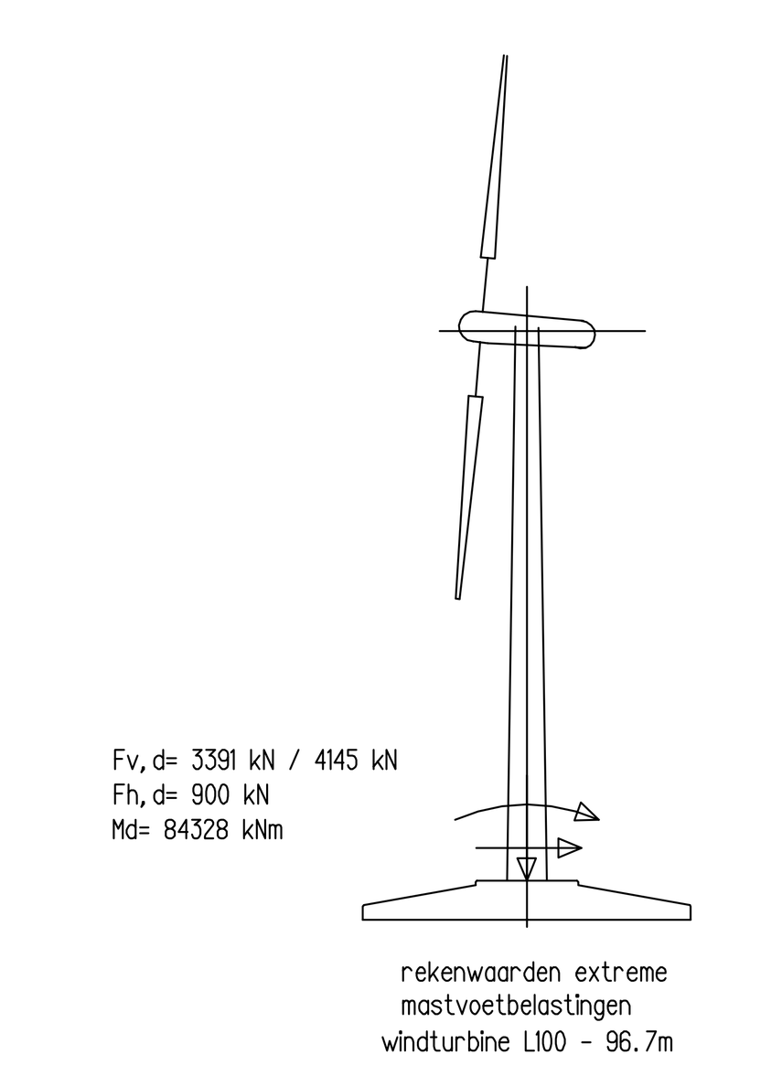


palen op trek en druk belast:
- rekenwaarde voor de maximale verticale drukkracht 1460 kN.
- additioneel kopmoment 80 kNm.
- additionele horizontale belasting met trekwaarde 75 kN.
- rekenwaarde voor de maximale verticale trekkracht 773 kN.

ingen
palen:
- 26 stuks Vibropalen ϕ456/506; schoor 8:1
ing te verwijderen door terughe

- Toren verankering conform Lagerwey Wind documenten
- Ankers levering opdrachtgever.
- Uitvoeringsontwerp conform ABT rapport.

- LASSEN AAN WAPENINGSSTAAL EN/OF ANKERS IS NIET TOEGESTAAN.



Betondekking (op buitenste wapening)

	vloer/wand	balk/console	kolom/poer
			40

afwijkende dekking, zie tekening ◇

ϕ25 minimale dekking 30 mm
ϕ32 minimale dekking 40 mm

bij storten op werkvloer dekking met +10 mm verhogen
bij storten direct op grond/mv dekking met +50 mm verhogen
(toegevoegde dekking als betonvulling aan de onderzijde toevoegen)

Grindbeton Sterkteklasse : C30/37- C53/65

milieuklasse : XF3/XC4
afwerkingsklasse zie bestek
brandwerendheid : -
betonstaal : B500B
buigkern 5ϕk (tenzij anders aangegeven)

Wapeningsgegevens

diameter	8	10	12	14	16	20	25	32
Verankeringslengte l_{bd} (niet voor staafbundels)								
algemeen	300	400	450	550	600	750	900	1150
bovenstaaf	450	550	650	750	850	1050	1300	1650
Overlappingslengte l_0 (niet voor staafbundels)								
algemeen	450	550	650	800	900	1100	1350	1750
bovenstaaf	650	800	950	1100	1250	1550	1950	2500

Beugelvorm

Diam.	D:	B:
8	300	125
10	375	150
12	425	175

indien "a" > 50mm, verankerings- of overlappingslengte verhogen met maat "a"

>0,3*lo

lassen verspringend aanbrengen

overzicht

status: **voorlopig**

uitgifte/wijziging

omschrijving wijziging	getek.	gecontr.	beoord.	wijzig.	datum
haarspelden					
				-	

werkcode: 14064 formaat schaal :

onderwerp: **Uitvoeringsontwerp windturbinefundering WT1**

werk

opdrachtgever: Lagerwey

architect

civiele techniek