WES 18Mk1

COMPLETE DESCRIPTION

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INTRODUCTION

This leaflet describes the main components of the WES18 Mk1 wind turbine.

Where applicable, the specifications of the co-operating Dutch utility companies and the national authorities (NEN 1010 and the NEN 6096) have been a guideline for the design and construction of WES wind turbines. These specifications are accepted and confirmed by many international authorities and belong to the world's most severe and progressive regulations in the field of wind energy.

Before installing a wind turbine, the local authorities, the utility company and possible other affected parties should be contacted.

The design of the WES18 Mk1 is based on the former Lagerwey 18/80 and the LW 11/35 and the LW 15/75. The WES 18/80 is the result of more than 30 years of experience in wind energy and the continuation of the development of an approved concept. More than 500 wind turbines of the type WES18 are installed worldwide.

The WES18 Mk1 - 80 kW turbine is a two bladed rotor upwind of the tower, provided with passive blade-angle adjustment.

MECHANICS

ROTOR

The rotor of the WES18 Mk1 is equipped with two blades and is characterised by the flexible (hinged) way of mounting the blades and the passive blade-angle adjustment. The possibility for the blades to hinge over a small angle has the advantage that the load on the construction will be less. This way of mounting the blades is similar to the teetering hub construction but has the additional advantage that the blades can hinge independently. This allows for a lighter construction.

The operating principle is described as follows:

The pressure of the wind pushes the blades in the direction of the main shaft. Due to the hinges in the rotor hub, the actual position of the blades will be slightly backward.
Instead of a disc perpendicular to the main shaft,

the rotating blades will form a cone with the hub being top. The rotation of the rotor causes centrifugal forces on the blades, forcing the blades to stretch out and come forward to a position more perpendicular to the main shaft. Mentioned opposite forces will come to an equilibrium. Bending moments and forces on the rotor-hub and main shaft are being reduced considerably by this design.

The passive blade-angle adjustment affects the blade-angle. The blade-angle is a major aspect with regard to the efficiency of the rotor and consequently for the generated power.
Rotating the blades around a pitch-shaft can alter the pitch. The blade-angles of both blades are always kept equal by means of a synchronisation mechanism located in the rotor hub.

The pressure on the blades causes a force, which intends to reduce the projected area: increasing the blade-angle. A spring is installed to withstand this force. Wind speeds less than 13 m/s will not affect the blade-angle: it will remain in its most favourable position.
The nominal power output of the turbine is limited to 80 kW by means of the power electronics system. Wind speeds above 13 m/s will increase of the rotor speed since the generator does not absorb the extra power produced by the rotor. However, due to the increased speed and forces at this point, the passive blade-angle adjustment is activated since these forces will exceed the above-mentioned spring forces.
An increased blade angle will reduce the efficiency of the blades. Consequently the rotor speed is reduced. This procedure constitutes the first safety system of the WES18 wind turbine.

BLADES
The blades are made of carbon-fibre reinforced epoxy.
Due to this material composition the blades are light, strong and flexible. They have a taper wise form and a slightly twisted chord. The length is 7.8 metres.
This design has been tested thoroughly both under static and dynamic loads.

Inside the blades is a copper wire netting provided which will protect the blades in case of a lightning attack.

HUB-FRAME
The hub-frame is the connection point of the blades to the main shaft.
In the frame the synchronisation mechanism and the blade-hinges for flexible mounting of the blades are located.
By means of a flanged connection the hub-frame is mounted to the main shaft; being the low speed shaft of the gearbox.

GEARBOX
The gearbox increases the rotor speed. In two stages a ratio of 1:20 is obtained between the rotor speed and the out-coming shaft from the gearbox. Therefore the out-coming shaft, and consequently the generator, will have an effective working range between approximately 1200 and 2400 rounds per minute. The gearbox is provided with a low speed shaft and bearings. A built-in radial bearing and an attached radial/axial bearing allow the rotor to be mounted directly to the gearbox. The high-speed shaft is connected to the generator by means of a flexible coupling. Further, the gearbox is equipped with a brake that prevents the rotor from turning backwards. When the turbine is yawed

120^0 out of the wind, the rotor will have the intention to rotate backward. The above-mentioned brake will be activated and the rotor will stand still. The same procedure is followed during a shut down the turbine.

PARKING BRAKE
For maintenance reasons it is required that the rotor can be blocked. After having yawed the turbine out of the wind, the high-speed shaft can be blocked.

YAW-SYSTEM
The yaw-system turns the position of the nacelle in order to place the rotor in the right position: in the wind or, if required, out of the wind. Contactors control the yaw-system. In case of a grid failure, which causes malfunctioning of the installation, the yaw-motor is directly connected to the generator. The turbine will yaw out of the wind all by itself. In order to avoid that the moments and forces of the rotor, which are passed through to the nacelle, are projected on the yaw-system four friction brakes are mounted. Furthermore

a flexible coupling is mounted between the worm-wheel reduction and the pinion in view of its dampening and shock-absorbing properties.

NACELLE

The nacelle is that part of the turbine that is placed on top of the tower. A yaw bearing allows the nacelle to turn along the horizontal plane. The base plate of the nacelle is made of hot dip galvanised steel, on which the gearbox, generator, yaw-system and part of the control equipment are mounted.

TOWER

The tower consists of three cylindrical parts, mounted to each other by means of a flanged connection. If a heavy lifting crane is not available, or the terrain does not allow access, a specially designed lattice tower (picture) is used.

The standard total height of the tower is 30 metres (as an option a 40-meter tower is also available. The tower has an external ascent, and is provided with a steel cable parallel to the ladder in order to connect the fall-protection gear of the maintenance engineer as a safety measure. The tower is made of hot dip galvanised steel.

FOUNDATION

The detailed design of the foundation depends on the local situation with regard to the strength and composition of the soil. In case of insufficient support, the foundation should be piled. In all cases an anchor of anchor-bolts is bedded into the concrete. The electrical- and control cables are led away through a pipe, which goes from the centre of the anchor to one of the sides of the foundation. Alternatively a one-pole-foundation (steel tube piled in the soil) is possible in cases where the soil allows this.

ELECTRICAL SYSTEM

GENERATOR

The generator is a 4-pole asynchronous generator. The generator is totally enclosed fan cooled; the fan is directly mounted on the shaft. The bearings are provided with nipples for re-greasing. The

reactive current, which is needed to allow the generator to build up a magnetic field, is obtained by a capacitor package.

GRID CONNECTION

The grid connection is achieved by the AC/DC/AC principle. This means that the generated three-phase alternating current is transformed first to a direct current. This direct current is converted to an alternating current, which is synchronous to the grid.

The advantage of this system is that the generator frequency is completely independent of the grid conditions and grid fluctuations. Herewith the rotor speed is variable. The produced power is related to the rotor speed by means of a fully variable power electronics system. This means that the produced power is optimum adjusted to the actual wind speed. Since the generator builds up the voltage smoothly, rough starting

currents do not occur. This is not only an advantage for the electrical components, but the loads on mechanical parts are also reduced. During normal operation the turbine is connected to the grid continuously; power supply to the grid depends on the rotor-speed and the wind speed.

CONTROLLER

The control of the WES18 mk1 is done by a PLC. A terminal is located on the control panel for friendly user interface. The terminal shows the actual wind speed, wind direction, rotor-speed and the generating power. It provides also the cumulative kWh production and the history data of the above-mentioned parameters. The controller and the electrical system are 'fail-safe' designed, which means that in case of a failure the turbine goes in a safe position, depending on the kind of failure. The microprocessor shows detailed information about the failure and will record this. A system for the remote monitoring and remote control of the turbine is available as an optional feature

TECHNICAL SPECIFICATIONS

GENERAL

design acc.	NEN 6096
certified by	CIWI
cut in wind speed	2.7 m/sec.
rated wind speed	13 m/sec.
cut out wind speed	25 m/sec.
survival wind speed	60 m/sec.
nominal power	80 kW
grid voltage	400V ±10%
grid frequency	50/60Hz ±3Hz
specific power	315 W/m2
calculated lifetime	min. 20 years

ROTOR

number of blades	2
rotor position	upwind
angle of the main shaft	7^0 with horizon
diameter	18 m
swept area	254 m2
speed	variable 60 -120 rotations per minute
power regulation	passive: blade-angle adjustment active : fully variable back-to-back system
min. blade-angle	1.0
cone-angle	180 -164^0 (flapping range)
direction	clockwise
location main bearing	attached to gearbox

BLADES

blade length	7,8 m
weight one blade	86kg
chord	500 – 625mm
twist	5^0
material	carbon fibre reinforced epoxy
mounted	flexible

GEARBOX

number of stages	2
weight	700kg
ratio	1:20

GENERATOR

type	asynchronous
nominal power	80 kW
number of poles	4
nominal voltage	230/400 volt
frequency	variable: 40 - 80 Hz.
weight	450kg
protection	IP 55

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GRID-CONNECTION

converter	Back-to-back – IGBT
converter principle	AC - DC – AC
power supply	400 V / 50 or 60 Hz. / 3 phase + neutral (deviating voltage and frequency are available as an option)

TOWER

type	Conical tubular steel or lattice steel
number of sections	3
hub height	Tube: 19, 25, 31, 40m or Lattice: 32 m
material	hot dip galvanised steel
location ascent / ladder	External

CONTROLLER

control by	PLC
remote monitoring & control	yes

YAW-SYSTEM

system	active
signal based on	wind vane
driven by	e-motor with worm-wheel reduction
power yaw-motor	0,55 kW
yaw speed	1,2^{0}/sec.
yaw bearing	crown-bearing; externally geared
yaw-break	constant friction-break; 4 pcs.

SAFETY

first safety system	passive blade pitch
activation	rotor speed (110 rpm)
second safety system	yawing out of the wind
activation	rotor speed (120 rpm) excessive vibrations failure anemometer or wind vane failure in one of PLC's grid failure too high generator or inverter temperature fault in yawing system
blocking system	
rotor blocking system	pin in high speed shaft; for service purposes
activation	manual

WEIGHTS

rotor	900 kg
nacelle including rotor	3000 kg
tower excluding nacelle	10000 kg (30 m. tower) 13000 kg (40 m. tower)

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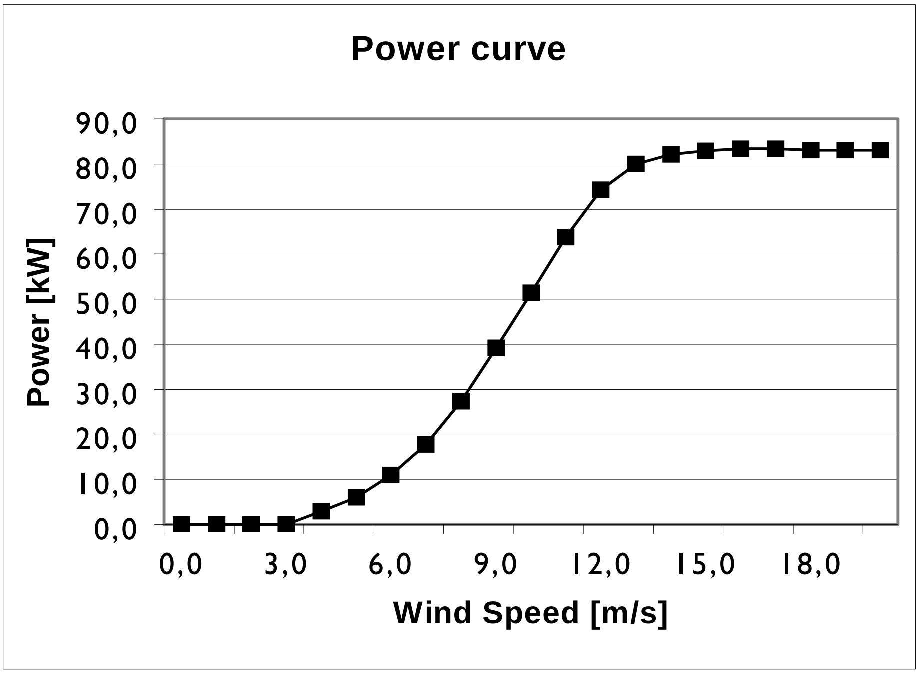
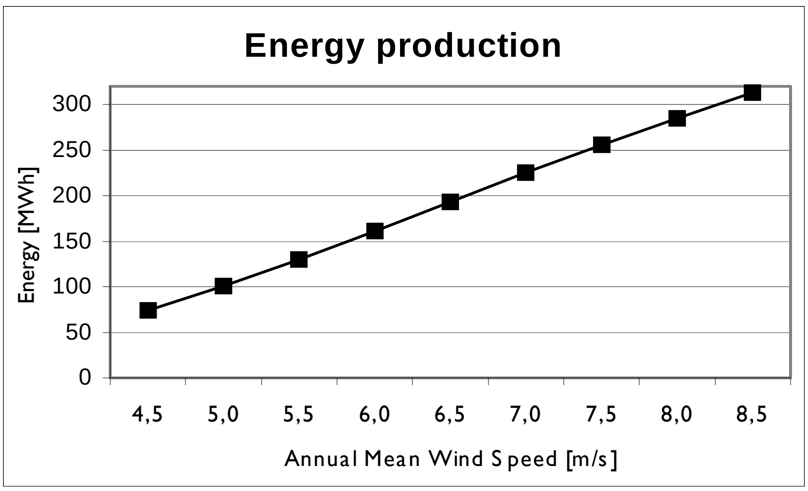
Measured actual power:
The curve data are valid for standard atmospheric conditions of 15° C air temperature, 1013 mbar air pressure and 1.225 kg/m^3 air density, clean rotor blades and horizontal undisturbed air flow.

Wind speed [m/s]	Energy [kW]
0,0	0,0
1,0	0,0
2,0	0,0
3,0	0,0
4,0	2,9
5,0	6,0
6,0	11,0
7,0	17,7
8,0	27,3
9,0	39,2
10,0	51,4
11,0	63,8
12,0	74,2
13,0	79,9
14,0	82,2
15,0	82,9
16,0	83,3
17,0	83,3
18,0	83,0
19,0	83,0
20,0	83,0



Measured production
The annual energy production data for different annual mean wind speeds at hub height are calculated from the above power curve data assuming a Rayleigh wind speed distribution, 100% availability and no reductions due array losses, grid losses, or other external factors effecting the production.

Wind speed [m/s]	Energy [MWh]
4,5	74
5,0	101
5,5	130
6,0	161
6,5	193
7,0	225
7,5	256
8,0	285
8,5	313



WES[18] mk1 on an island near Bali, Indonesia.

2 x WES[18] next to a golf course, the Netherlands.

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WES[18] at a green house business, Canada.

GSM transmitters on a WES[18].

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