WIND TURBINES UK

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WES30

INTRODUCTION

This leaflet describes the main components of the WES30 Mk1 wind turbine. In general the design of the WES30 Mk1 has been carried out in accordance to a number of existing national and international standards.

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

The design of the WES30 Mk1 is based on the wind turbines WES30, LW30/250 and the LW18/80. The WES30 Mk1 is the result of more than 15 years of experience in wind energy and the continuation of the development and up-scaling of an approved concept.

MECHANICS

ROTOR

The rotor of the WES30 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 loads 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 forwards 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. The pitch can be altered by rotating the blades around a pitch shaft. 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 200 kW by means of the back-to-back converter system. Wind speeds above 13 m/s will increase the rotor speed since the extra power produced by the rotor is not absorbed by the generator. 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 wind turbine.

BLADES

The blades are manufactured from carbon fibre reinforced epoxy. Due to the properties of this material the blades are light, strong and flexible. The shape of the blades is based on the NLF 416 airfoil and has a tapered form and a slightly twisted chord. The length is 13.4 metre. The blades are mounted by means of an insert and bolted to the pitch shafts. This design has been tested thoroughly both under static and dynamic loading.

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 rotor speed is increased by the gearbox. In two stages a ratio of 1:26.6 is obtained. Therefore the outgoing shaft, and consequently the generator, will have an effective working range between approximately 530 and 1900 rotations per minute. 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. Furthermore the gearbox is equipped with a brake which prevents the rotor of turning backwards. When the turbine is shut down and yawed 120 degrees out of the wind, the rotor could rotate backwards. The above mentioned brake will be activated and the rotor will be stopped. With this procedure the turbine is being shut down. For maintenance reasons it is required that the rotor can be locked. Therefore the high speed shaft of the gearbox is provided with a disc brake which can be activated manually. After having yawed the turbine out of the wind, the high speed shaft can be locked.

YAW SYSTEM

The yaw system controls the position of the nacelle in order to place the rotor in the required position. The system is driven by two electric motors, each provided with its own reduction. The yaw bearing is externally geared.

The yaw system is controlled by an IPC In case of a failure of the grid, causing malfunctioning of the controller and the electric motors, the yaw motors are directly connected to the generator. The turbine will then yaw out of the wind independently.

In order to avoid the moments and forces of the rotor, which are passed through to the nacelle, being projected on the yaw system, slip couplings and friction brakes are fitted.

NACELLE

The nacelle of the WES30 Mk1 is equipped with a fully detachable canopy. The U-shaped nacelle frame carrying the drive train and some control equipment is constructed from hot dip galvanized steel and is mounted on the turbine tower with a large yaw bearing.

TOWER

The tower consists of cylindrical/conical 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 above right) is used. The lattice tower is designed to avoid critical resonance at the normal rotational speed of the WES30 and ensure the necessary safety against dynamic and extreme loads. Sufficient clearance is provided for the rotor blades to pass the tower. This accounts for the giraffe-like appearance of the WES30.

Safe and sufficient access to the nacelle is provided directly from the tower using an internal ladder arrangement. A full platform is provided close to the top of the tower at an adequate height for safe and easy inspection of the yaw arrangement and for access to the nacelle. The full height of the tower and any working platforms are equipped with clearly identified points to which a fall protection device can be secured.

FOUNDATION
The detailed design of the foundation depends heavily on the site conditions with regard to the material properties of the soil. These are established through probing.

In case of insufficient support, the foundation should be piled.

ELECTRICAL SYSTEM

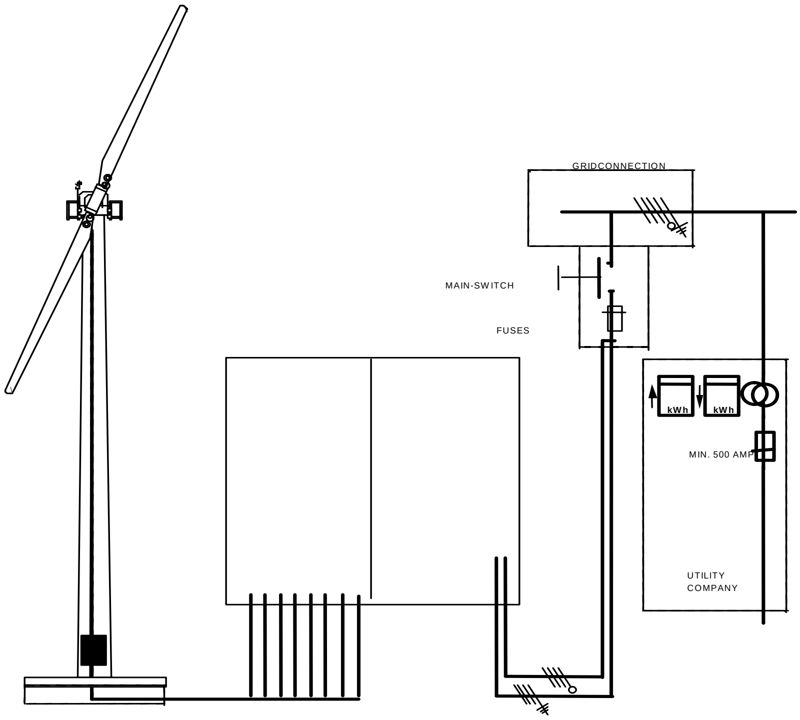
GENERATOR
The generator is a 4-pole asynchronous generator, which is able to generate a nominal power of 200 kW. The generator is totally enclosed fan cooled; the fan is directly mounted on the shaft. The bearings are provided with nipples for lubrication.

GRID CONNECTION
Connection of the turbine to the public grid is normally done by the local utility company. The detailed design of the grid-connection depends on the regulations of the local authorities and utility company. Downstream from the grid connection/control cabinet the generated power is, with regard to the voltage and frequency, suitable for delivery to the grid. Most utility companies take care of installing and connecting the metering system. Two metering devices are normally installed: one for the generated power and one to register the power that is used by the controller, yaw system, lights, etc.

For the cable used for the connection of the generator to the grid connection / control cabinet, the above cross section is also applicable, although, depending on the content of the purchase order this might be part of the delivery from WES.

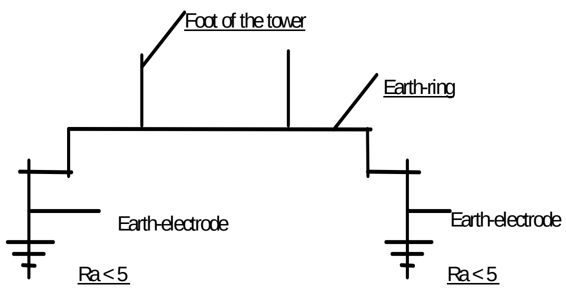
In order to allow grid-connection the generated power is converted according an AC/DC/AC system. This means that the generated 3-phase altering current is converted to a direct current and back to a 3-phase alternating current again. The last mentioned alternating current is suitable for, and synchronous to the public grid. Advantage of this converter system is that the generator speed is completely independent of the grid frequency because of the DC link. Consequently this allows a variable rotor speed.

The 3-phases are converted to a direct current and by means of a back-to-back converter converted to an alternating current conventional 3-phase power signal suitable for grid connection. Harmful higher harmonically currents are filtered out by a major grid filter.



LIGHTNING PROTECTION

On opposite sides of the foundation of the turbine two earth-electrodes are pressed into the ground. The remaining earth resistance of these electrodes should be less than 5 ohm (acc. the Dutch regulations). The earth-electrodes will be connected to the foot of the tower by means of a cupper conductor of 50 mm^2 or an iron bar. An earth ring is situated 0.6 meter under the surface of the earth and will be connects the two earth electrodes.



CONTROL CABINET

The WES30 Mk1 is controlled by a brand new state-of-the-art control cabinet with back-to-back converters (IGBT) and an Embedded PC system (IPC). A bus-coupler is located in the nacelle. Its main function is data collection. The IPC is located in the main control panel. The IPC communicates to the Bus Coupler by means of an industrial Ethernet network". On front of the control panel a Human Machine Interface (HMI) is located. By means of this HMI the turbine can be controlled and production data is visible.. One is located in the nacelle. Its main function is data collection. The other controller is located in the grid connection and control cabinet. This controller initiates the required control actions. Since both controllers are communicating continuously, a complete and accurate control system is obtained. By means of soft touch keys the program of the turbine can always be interrupted. An LCD screen displays the actual status.


State-of-the-Art IGBT Control Cabinets

WES30

Type: **Mк1**

TECHNICAL SPECIFICATIONS

WES30

GENERAL	
cut in wind speed	< 3 m/sec.
rated wind speed	11.5 m/sec.
cut out wind speed	25 m/sec.
survival wind speed	60 m/sec.
nominal power	250 kW
grid voltage	400V ± 10%
grid frequency	50/60Hz ± 3 Hz
specific power	354 W/m2
calculated lifetime	20 years

ROTOR	
number of blades	2
rotor position	upwind
angle of the main shaft	7º with horizon
diameter	30 m
swept area	707 m2
speed	variable 35 – 70 rpm
power regulation	passive: blade-angle adjustment
	active: fully variable back-to-back system
min. blade-angle	1.0
cone-angle	183º – 170.5º (flapping range)
direction	clockwise
location main bearing	attached to gearbox

BLADES	
blade length	13.4 meter
weight one blade	327 kg
shape	linear taper
chord	500 – 1,200 mm
twist	15º
material	carbon fibre reinforced epoxy
mounted	flexible

GEARBOX	
number of stages	2
weight	1850 kg
ratio	1:26.6

GENERATOR	
type	asynchronous
nominal ouput	250 kW
number of poles	4
nominal voltage	230/400 V
frequency	variable 25 - 75 Hz
weight	1550 kg
protection	IP 54

WES30

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

TOWER	
type	conical tubular steel
number of sections	2, 3 or 4
hub height	30 m, 40 m or 50 m
material	Steel
location ascent	Internal
type	Tubular/conical tower & lattice tower, four-legged
hub height	Depending on tower height.
material	Hot dip galvanized steel
location ascent	Internal ladder

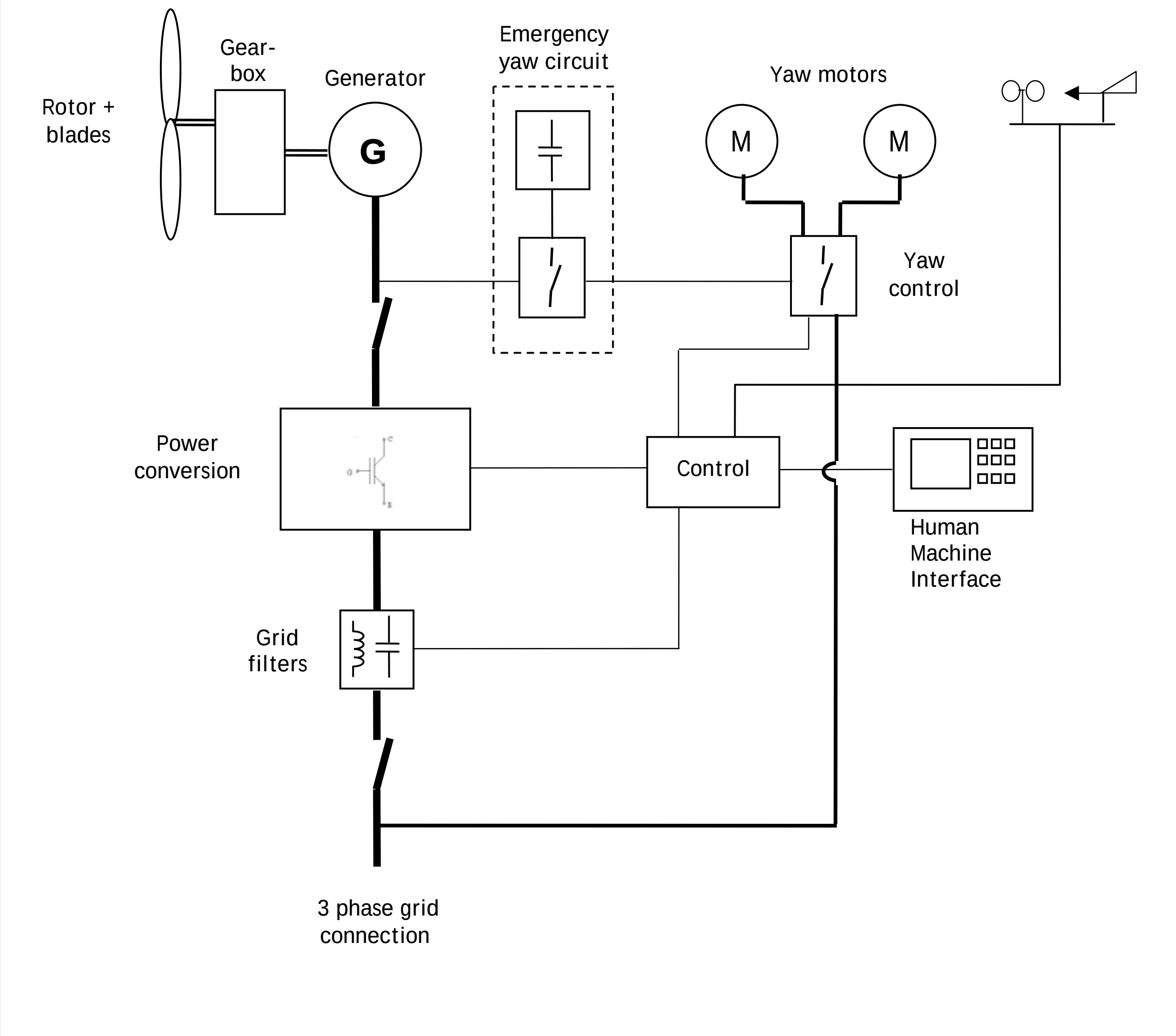
CONTROLLER	
control by	IPC
remote monitoring & control	Included

YAW-SYSTEM	
system	Active
driven by	2 x e-motor with worm wheel reduction
power yaw-motor	2 x 1.5 kW
yaw speed	0.77°/sec.
yaw bearing	crown-bearing; externally geared
yaw-break	constant friction break; 8 pcs.

SAFETY	
first safety system	passive blade pitch
activation	rotor speed (70 rpm)
second safety system	yawing out of the wind
activation	rotor speed (90 rpm)
brake and blocking system	
brake	parking disk brake on high speed shaft of gearbox; for service purposes
rotor blocking system	pin in high speed shaft
activation	both manual

WEIGHTS	
rotor	2500 kg
nacelle including rotor	7500 kg
tower excluding nacelle	14800 + 8500 kg

One line diagram WES30 Mk1



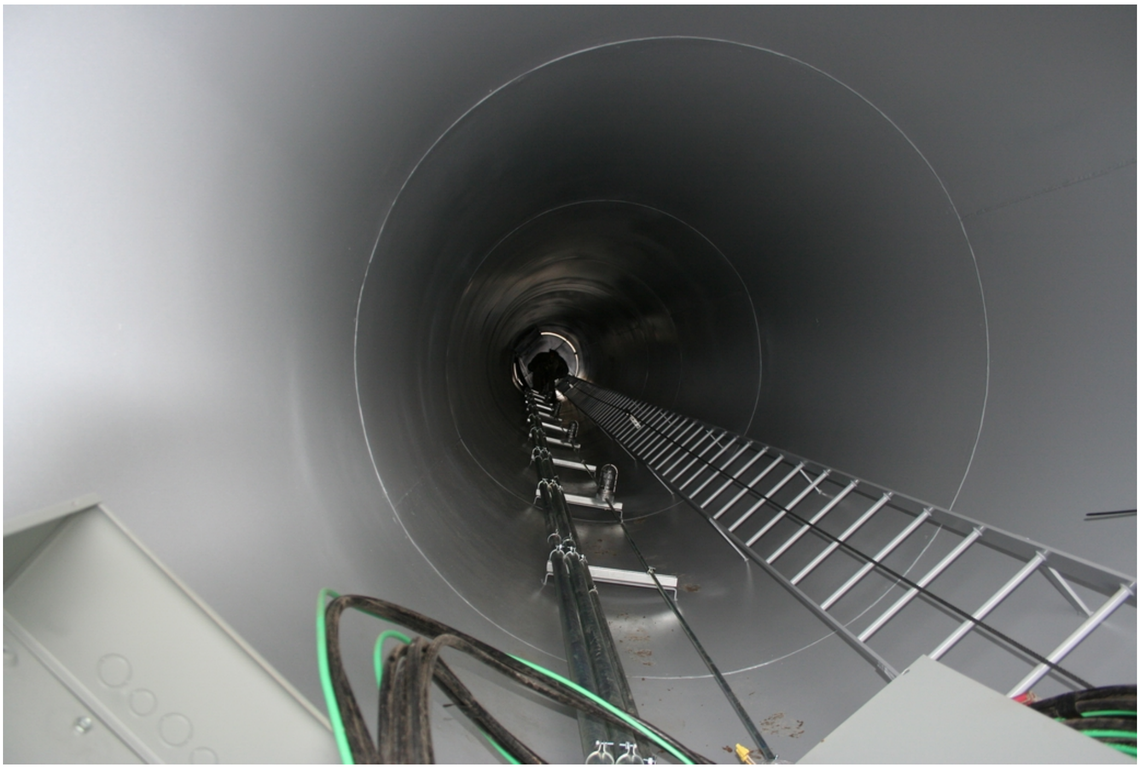
IMAGES

WES30 Mk1 at a dairy farm in Ontario, Canada

WES30

Foundation and anchor for a 50 meter tower.

Foundation and tower foot of a 50 meter tower.



Tower with internal ladder with fall protection.

Four units on the Maasvlakte, the Netherlands

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