DESCRIPTION OF THE

LW 18/80

WINDTURBINE

INTRODUCTION

This brochure describes the main components of the LAGERWEY 18/80 windturbine.

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 Lagerwey windturbines. 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 windenergy.

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

INDEX

1. GENERAL

The design of the LW 18/80 is based on the LW 11/35 and the LW 15/75. The LW 18/80 is the result of more than 15 years of experience in wind energy and the continuation of the development of an approved concept.

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

2. ROTOR

The rotor of the LAGERWEY 18/80 (LW 18/80) is provided with two blades and is characterised by the flexible (hinged) way of mounting the blades and the passive blade-angle adjustment. The possibility that the blades can hinge over a small angle has the advantage that the load on the construction in its entirety will be less. This way of mounting the blades is similar to the tittering hub construction but has the advantage that the blades can hinge independently. This allows a lighter construction.

The working 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 mainshaft, 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 mainshaft.

The above mentioned opposite forces will come to an equilibrium. Bending moments (movements?) and forces on the rotor-hub and mainshaft 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. 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. Windspeeds less than 13 m/s will not affect the blade-angle: it will remain in its most favourable position. The power output of the turbine is limited to 80 kW by means of the mutator system. Windspeeds above 13 m/s will cause an increase of the rotorspeed 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 springforces. An increased blade angle will reduce the efficiency of the blades. Consequently the rotorspeed is reduced. The LW 18/80 is always under control, amongst others by the blade-angle adjustment.

3. BLADES

The blades are constructed from carbon-fibre reinforced epoxy. Due to this material composition the blades are light, strong and flexible. They have a taperwise form and a slightly twisted chord. The length is 7.8 metre. The blades are mounted by means of mounting plates and bolted to the pitch-shafts. 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.

4. 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.

5. GEARBOX

The gearbox increases the rotorspeed. In two stages a ratio of 1:20 is obtained between the rotorspeed 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 which 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. This same procedure is followed during a shut down the turbine.

6. 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.

7. 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 built up a magnetic field, is obtained by a capacitor package (Please refer to the Electro-technical description of the LW 18/80).

8. 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 it's dampening and shock-absorbing properties.

9. 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 baseplate of the nacelle is made of hot dip galvanised steel, on which the gearbox, generator, yaw-system and a part of the control equipment is mounted.

To reduce the sound from the operation of the turbine, optional (not included in standard equipment configuration) fittings such as vibration absorbing mounting pads and sound dampening insulation can be used.

10. TOWER

The tower consists of three cylindrical parts, mounted to each other by means of a flanged connection.

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

11. 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. Besides a concrete foundation is a one-pole-foundation possible in cases that the local soil this will allow. A one-pole-foundation exist of a steel tube which is piled into the soil.

12. ELECTRICAL SYSTEM

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 can be variable. The produced power is related to the rotorspeed by means of a fully variable mutator system. This means that the produced power is optimum adjusted to the actual windspeed. 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.

13. CONTROLLER

The control of the LAGERWEY 18/80 is done by a microprocessor. On the microprocessor is a terminal located for friendly user interface. The microprocessor shows the actual windspeed, 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.

ENCLOSURE A: TECHNICAL DATA OF THE LAGERWEY 18/80 WINDTURBINE

GENERAL

design according to	NEN 6096
certified by	CIWI (ECN) - Holland
cut in windspeed	3 m/sec.
nom. windspeed	12 m/sec.
cut out operating windspeed	25 m/sec.
max. survive windspeed	60 m/sec.
nominal power	80 kW
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 mutator system
min. blade-angle	$6{,}3^{0}$
cone-angle	180 -164^{0}
direction	clockwise
location main bearing	attached to gearbox

BLADES

blade length	7,8 m
chord	500 - 625 mm
twist	5^{0}
material	carbon fibre reinforced epoxy
mounted	flexible
manufacturer	A.T.V., Marseilles, France

GEARBOX

number of stages	2
ratio	1:20
nominaal torque	8050 Nm
manufacturer	Flender, Germany

GENERATOR

type	asynchrony
nominal power	80 kW

number of poles	4
nominal voltage	400 volt
frequency	variable: 40 – 80 Hz.
protection	IP 55
manufacturer	ABB or equal quality

GRID-CONNECTION

converter	diodebridge – mutator
converter principle	AC – DC – AC
powersupply	400 V / 3 fase / 50 Hz.

TOWER

type	cylindrical pipe
number of sections	3
hub height	31 m or 41 m
material	hot dip galvanised steel
location ascent	external

YAW-SYSTEM

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

CONTROLLER

control by	Microprocessor
remote monitoring	optional; typically via the public telecommunications network

SAFETY

aerodynamic break	by aerodynamic torque
safety measures	– passive blade-angle adjustment, – (emergency) yawing out of the wind at a windspeed above 25 m/sec.

MASSES

Rotor	900 kg
nacelle including rotor	3.000 kg
tower excluding nacelle	10.000 kg