TECHNICAL DESCRIPTION

GETDANWIN 27/II-NH30/40

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Version 01.29-P.220493E

The **GETDANWIN** wind turbine combines modern technology with beautiful simplicity in design.
On the following pages we present the **GETDANWIN** wind turbines in facts and figures. **GETDANWIN** wind turbine has been approved by Germanischer Lloyd.
The **GETDANWIN** turbines are manufactured under a co-operation agreement by Preussag owned HDW-Nobiskrug GmbH in Rendsburg, Germany.

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Version : 01.29-P.220493E dated 22-4-1993 by Lind

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01	07-07-93	PL
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Reference conditions

The conditions for the power curve of the **GETDANWIN 27/IIP** refer to:

"Recommendation for Wind Turbine Power Curve Measurements"

18 September 1992

Risö Test Station.

The anemometer calibration correponds to the specification of the same date from the

"Danish Maritine Institute".

The data are valid for:

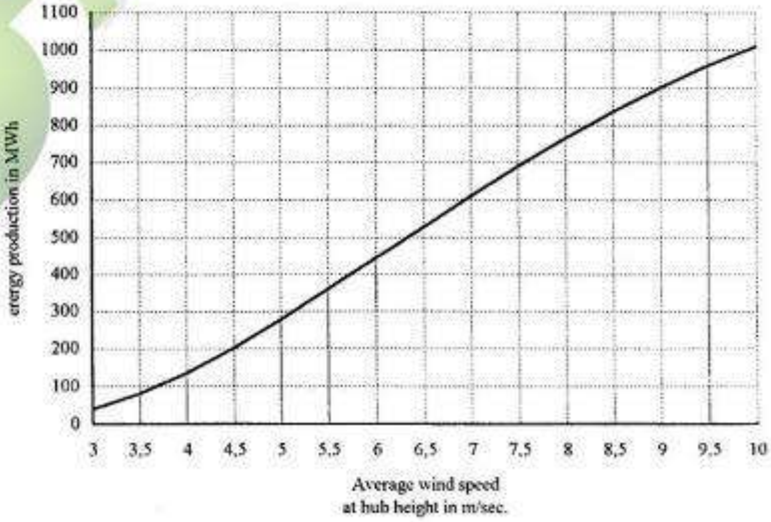
- an air density of 1225 kg/m³
- wind speed at hub height
- tolerance ± 5%.

The data for the annual energy production are based on a Weibull wind distribution with a shape parameter k = 2,0.

Annual energy production of GETDANWIN 27/IIP

Average wind speed m/s	mph	Energy production in MWh
3,0	6,7	39,5
3,5	7,8	79,8
4,0	8,9	134,8
4,5	10,1	201,8
5,0	11,2	277,6
5,5	12,3	359,0
6,0	13,4	443,1
6,5	14,5	527,5
7,0	15,7	610,2
7,5	16,8	689,9
8,0	17,9	765,2
8,5	19,0	835,3
9,0	20,1	899,7
9,5	21,3	957,8
10,0	22,4	1009,4

Energy production curve



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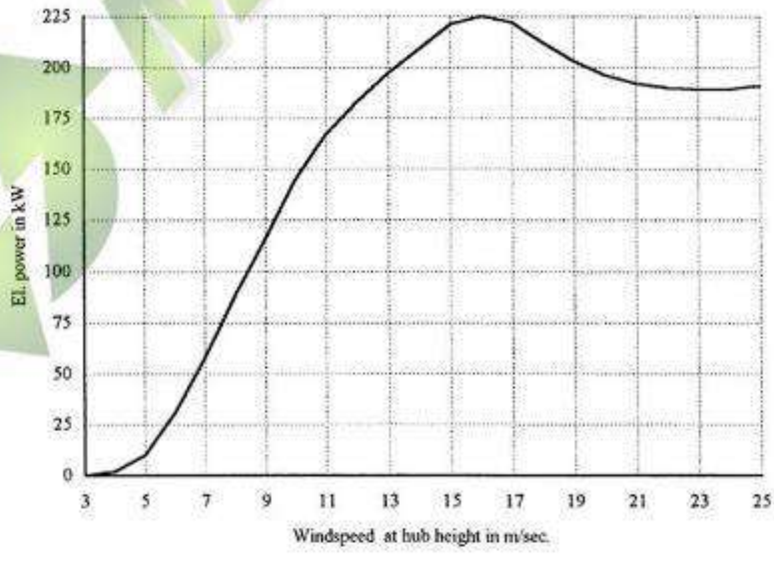
Electric power of
GETDANWIN 27/IIP

Windspeed m/sec	Windspeed mph	El. power kW el
4	8,9	2
5	11,2	10
6	13,4	31
7	15,7	58
8	17,9	88
9	20,1	116
10	22,4	145
11	24,6	167
12	26,8	183
13	29,1	197
14	31,3	209
15	33,6	221
16	35,8	225
17	38,0	222
18	40,3	212
19	42,5	203
20	44,7	196
21	47,0	192
22	49,2	190
23	51,4	189
24	53,7	189
25	55,9	191

Power curve



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Key data of
GETDANWIN 27/IIP

Rotor diameter:	29 m (95,2 ft)
Swept area:	661 m² (7110sq ft)
Rotor placement:	upwind of tower
Rotor rpm synchronous: rated output:	 37.56 rpm 37,94 rpm
Rated power:	225 kW el
Power control:	stall
Blade type:	LM 13.4
No. of blades:	3
Aerodynamic brake:	turnable blade tip
Hub height:	30 m (98 ft) (alt. 40 m = 131 ft)
Gear box:	3-stage helical
Gear ratio:	1 : 39,93
Ttl. moment of inertia (rotor, main shaft, gear and generator):	11 980 kgm²
Mechanical brake:	brake disk at the high speed shaft of the gear box
Brake torque:	brake torque decreases as rotor rpm reduces
Calipers:	2 hydraulic negative calipers (fail-safe)
Yawing system:	electric yawing system with 2 azimuth drives. 3 hydraulic brakes lock nacelle when not yawing
Bearing:	slide bearing
Tower type:	2-part conical steel tower
Control system:	computerized, can be connected with telephone net

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Generator cut-in:	thyristor-controlled gradual cut-in
Generator type:	asynchronous, 4 poles
enclosure:	IP 54
rpm:	1500
slip:	1%
voltage:	50 Hz grid: 400 V or 690 V 60 Hz grid: 480 V
Safety system:	2 separate systems
activated by:	- rotor overspeed - grid failure - nacelle vibratition - emergency switch-off

Cut-in wind speed:	4.0 m/s	(9 mph)
Cut-out wind speed:	25 m/s	(56 mph)
Survival wind speed:	67 m/s	(150 mph)

Weights (approx.):	**GETDANWIN 27/II** NH30	**NH40**
nacelle excl. rotor:	7 630 kg	7 630 kg
complete rotor:	5 288 kg	5 288 kg
nacelle totally :	12 918 kg	12 918 kg
tower:	13 250 kg	20 700 kg
turbine totally:	26 168 kg	33 618 kg

Colour:	rotor, nacelle and tower unique RAL 7035 light gray

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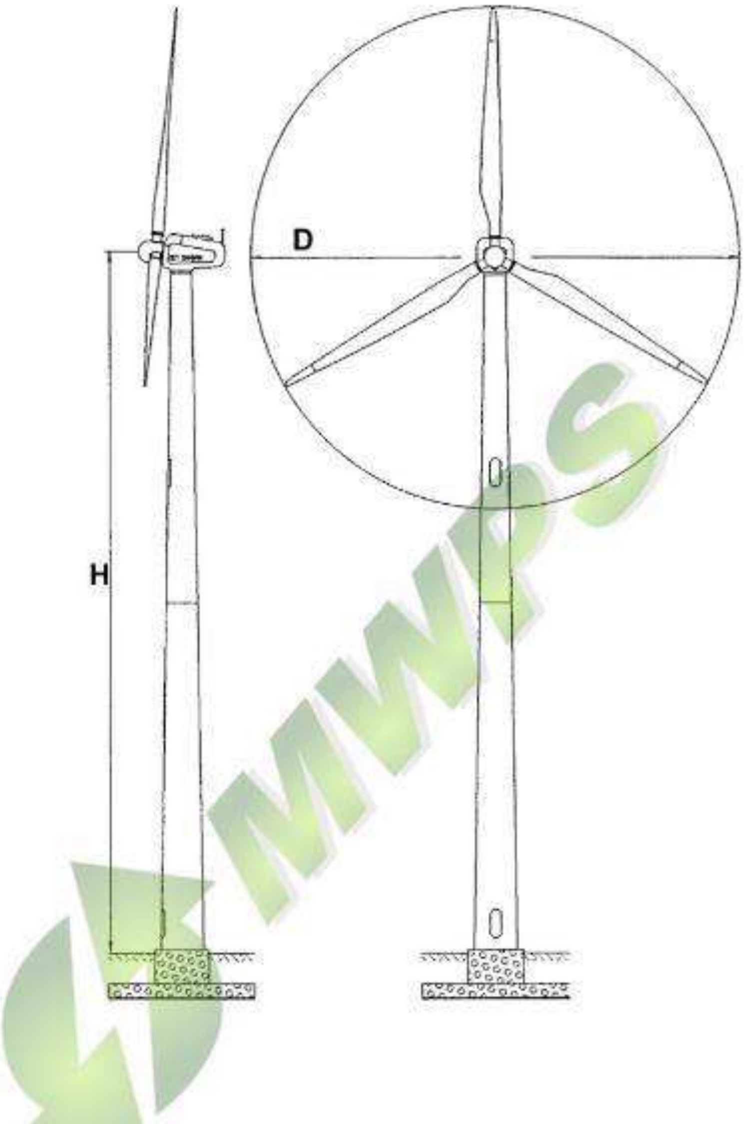
Key dimensions of
GETDANWIN 27/IIP



Type of plant	Hub-height **H**	Rotor ∅ **D**
GETDANWIN 27/IIP-NH30	30 m (98 ft)	29 m (95,2 ft)
GETDANWIN 27/IIP-NH40	40 m (131 ft)	29 m (95,2 ft)

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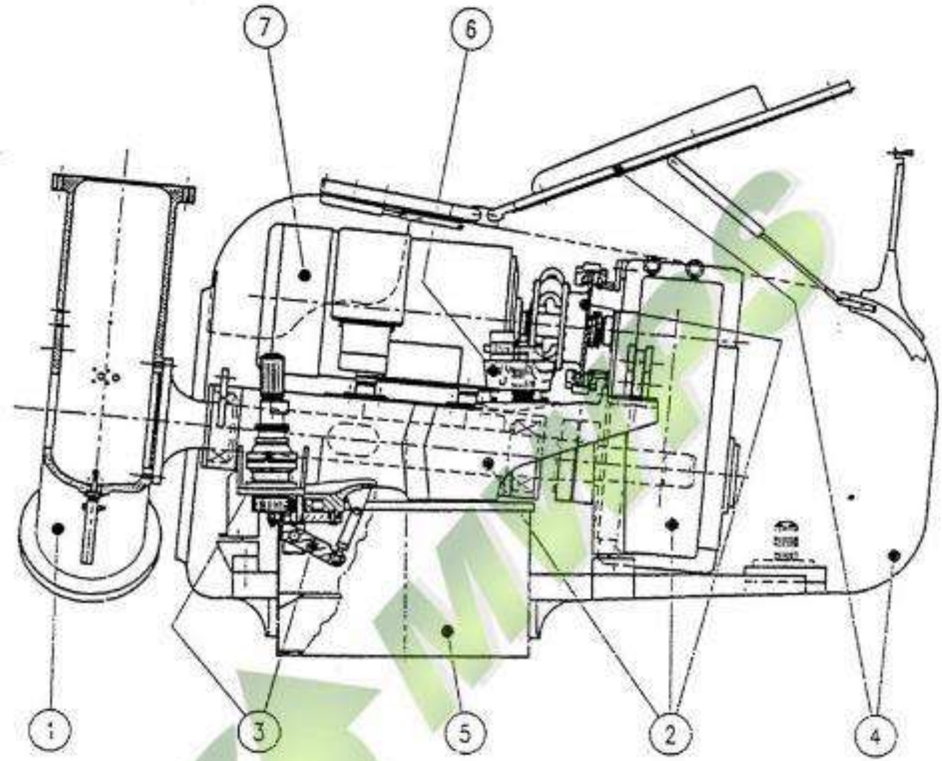
View of the nacelle



1. Rotor system
2. Mechanical transmission
3. Yaw system
4. Nacelle cover
5. Tower
6. Hydraulic
7. Electric system

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A pleasure to behold - inside and out

Tower, nacelle, and blades are painted in the same unifying colour. This is one of the several reasons that the **GETDANWIN** wind turbine creates such a striking, simple silhouette in the landscape - with the beauty of a sculpture. The interior has other, complementary virtues. For instance, a door that can be locked securely so that no outsider has access to its control unit which is located at the base of the tower.

An aluminium ladder with safety railings leads to the nacelle. The interior is fully lit, and there are rest platforms along the way. Hatches allow for inspection of blade tips, without use of a lift or hoist. The tower is a tube tower and it stands as a smooth, unbroken conical column. The steel sections are bolted together interiorly, and all joints are welded using the submerged arc welding technique for maximum fatigue strength.

Nacelle: elbowroom for two

GETDANWIN wind turbines put an end to cramped crawling about on exterior ladders and bridges. Up through the tower and straight into the nacelle, whether the wind turbine is operating or not.

The nacelle is spacious enough for two to be working at a time. There is interior lighting and standard service checks can be accomplished without ever opening the hatches. Meaning that work can go on, whatever the weather.

All by design

The nacelle and the spinner are made of fiberglass and kept in the same colour as the wings and tower. This material creates both a harmonious visual transition out from the tower to the wings and protection of the wind turbines' machinery from the ravages of inhospitable weather conditions.

Rotor: Heart of the matter

The rotor is responsible for capturing the wind's energy. Thus, no wind turbine is better than its rotor's capabilities.

The rotor's rpm is determined by its gear ratio. With that in mind, **GETDANWIN** has specially manufactured gears designed with the ideal gear ratio for the relevant rotor diameter, generator size, and wind distribution factored into its design.

Blades

GETDANWIN wind turbines' great effectiveness is partly based on its blades which are of top quality with optimal gear ratio and blade tip angle. The blades are manufactured for **GETDANWIN** by LM Fiberglass, one of the world's largest producers of wind turbine blades.

The fiberglass reinforced polyester yields superior strength and a smooth surface.

Safety brake

The blades have integrated air brakes which are of the turnable tip type. The braking action occurs on the actual surface of the blades, where energy is captured. The blade brakes operate in reverse principle, i. e. the tips are fixed in the operational position by a hydraulic cylinder and are only activated when the pressure is released.

Energy from 4 m/s

GETDANWIN wind turbines start producing energy already at a wind speed of 4 m/s. This is possible because of a generator with an extremely high efficency level at very low resistance.

Main frame: simple, solid T-construction

GETDANWIN distinguishes itself from its competitors largely because of its wind turbine's main frame. In general, the main frame is a heavy, steel construction lacking an efficient transmission of forces. Beyond its heavy weight, it inhibits access to the nacelle.

GETDANWIN, however, builds the main frame in a T-construcion cast in SG-iron. The main bearings are mounted in integrated surfaces of support at each end of the main tube, i.e. the main shaft is placed inside the tube. Force is transferred to the tower through three strong slide claws, performing an ideal distribution of forces which allows for both a light and very rigid construction.

The main frame is machined to produce exact surfaces of support for bearings, generator, yawing gear and slide claws. The simple construction provides direct access to the nacelle from the closed tower.

Yawing system: protection from battering conditions

A cogged ring is bolted to the exterior of the top of the tower. Attached to this are the three, strong slide claws which secure the main frame. They also maintain its horizontal position. The wearing surfaces can be easily and inexpensively replaced, not requiring the main frame to be dismounted.

The nacelle is secured by three hydraulic yaw brakes, when not yawing. This ensures that random and rough conditions will not affect the yaw gear. Before yawing begins, the brake is released.

Yawing movement is activated by two identical yaw drives. Each consists of an electrical motor. A powerful gear turns a smaller cog wheel which, in turn, engages the large cogged ring. Yawing is initiated by a wind vane via the control system. A slight delay has been programmed to prevent sudden, minor shifts in wind direction from triggering yawing.

Independent main shaft and bearing protect the gear box

GETDANWIN wind turbines have an independent main shaft and bearings. In contrast to a construction with an integrated main shaft, bearing and gears, side loads from the rotor are not transferred to the gear box. Thereby, the gear box is free to absorb only the torque from the rotor alone.

The main shaft is a forged shaft, made of a special chrome/nickel/molybdenum compound steel. It runs through the main frame's central tube and is mounted on two strong, double spherical roller bearings.

The bearings have frictionless labyrinth seals. They have no sliding parts, require neither maintenance nor replacement.

In lubrication, fresh grease is forced into the bearings' center. Hence, the new forces the old out. Periodic dismantling and cleansing is thus not necessary.

The hub

GETDANWIN wind turbines employ a cast hub of SG-iron (spherical-graphite), type GGG-40 (DIN 1693).

Specially designed gears

As optimal productivity depends on the gear ratio, **GETDANWIN** uses no ordinary industrial gear but those which have been designed especially for **GETDANWIN** by the leading gear manufacturers in Europe.

The **GETDANWIN** gear box is a powerful, 3-stage hollow shaft gear mounted directly onto the main shaft. This ensures automatic centering.

No wear on the main shaft

The torque is transferred from the main shaft by means of a shrink disc. Concentrations of tension that typically arise with standard tongue and groove connections are avoided - and thus the standard risk of fatigue breaks. **GETDANWIN** mounts the shrink disc on the side of the gear box facing the main shaft. In this position, there is no danger of slippage or wear and tear on the shaft where it enters the gear box.

No slack

The gear box's torque rod has link bearings at both ends. The gears' motions are absorbed without slack or internal tensions on the rod. The bearings are tightened with labyrinth seals. They do not chafe and, therefore, are maintenance-free.

Less energy loss

Pressure lubrication of the gear reduces the amount of oil in the gear box. Meaning that the oil is not whipped to the same degree and thus energy loss is minimal.

The oil pump is powered by an electric motor. Thereby, the gear is lubricated before start and the rotor can run freely at low rpm and still be well-lubricated.

Longevity

The gear box has been designed according to the West German standard DIN 3990, with its safety factor as recommended by the classification societies Det Norske Veritas and Germanischer Lloyd. These guidelines assure a lifetime of 20 years - but there is every reason to expect it to last considerably longer.

Beware

Not infrequently, the "effect factor" or safety factor is abandoned for a standard gear box.

The catalogue value of the gear's power is divided by the wind turbine's maximum power. A very unreliable computation, as there are great differences in the definition of the various catalogues' maximum power. It is torque, not power, that is decisive for the gear box's strength.

A gear given as 450 kW in a catalogue will not necessarily be able to meet the described calculations.

The unique GETDANWIN induction generator with increased productivity

The unique characteristic of the **GETDANWIN** generator is its unusually high productivity at low loads.

Generally, a generator has its greatest productivity at full load. **GETDANWIN** has its maximum at approx. 60% load where the main wind energy is present. A specially treated steel as laminate and a unique winding yield this especially high effectiveness.

Closed generator

The generator is cooled on its surface, not through the windings. By this the windings are not exposed to humidity and contamination in the cooling air. As a further prevention against humidity during standstill, the generator is equipped with heating elements.

The generator is further protected against overload by two different winding temperature monitoring systems. A double, flexible clutch has been mounted between the generator shaft and the gear box's high-speed shaft in order to protect the gear box from damage in case of a short circuit failure in the generator.

Doubly-secured brake system

The two symmetrically placed calipers have a reverse action, i.e. hydraulic pressure inhibits - rather than activates the brakes. A break-down in the hydraulic system will activate the brake and not lead to a brake failure.

The cast steel brake disc has been placed on the gear box's high-speed shaft. This has been taken into account in calculations regarding the gear box.

At most, one daily braking occasion takes place over the 20 years. This would stress the gear box with force from the braking action of less than 8 hours. Eight hours out of an accumulated operation time of over 150,000 hours.

The brake is equipped with a soft brake device, i.e. the brake torque is released slowly and will be at standstill normally only 60% of the maximum torque. In case of grid failure out or overspeed, the brake will deliver full torque immediately.

Electronic supervision of operation and production

GET does not regard the delivery, assembly and installation of a complete wind turbine to be necessarily sufficient. We ensure that our wind turbines also deliver the optimal energy production and reliable operation.

This occurs via our optional computerized monitoring system which has direct contact with each **GETDANWIN** wind turbine. A computer screen is connected with the telephone network. All that might be necessary for surveillance and remote control of the wind turbine can be communicated through a telephone plug. GET's computerized surveillance is an extra service, contracted on an individual basis, which ensures maximum security, productivity and longevity.

Electronic surveillance of four types:

- Control of the wind turbine's operation
- Safety/Security surveillance
- Registration of the turbine's operational data
- Optimization of the turbines energy production

Electronic control of the wind turbines' operation comprises yawing the turbine according to wind direction, start (if necessary) by means of motor when the windspeed is sufficient, and cut-in and cut-out of the generator.

The cut-in and cut-out procedures of the generator are carried out by means of thyristors which ensure a gradual connection to and from the grid. (Soft cut-in).

Safety surveillance will monitor possible faults in the turbine or disfavourable conditions and, if necessary, bring the turbine to a standstill.

Should the wind turbine come to a standstill due to some unacceptable condition, it will start up automatically when proper conditions have been restored, e.g., after grid failure. When faults require service, e.g. worn brakes, the turbine will, naturally, not be able to start up again until the fault has been corrected.

Electronic supervision monitors the following:

- Wind direction
- Wind speed
- Ambient temperature
- Grid voltage, frequency, and phases
- Hydraulic oil level
- Rpm of generator shaft
- Gear box temperature
- Generator temperature, two measuring points in every angle/twist
- Brakelining temperature and wear
- Oil pressure in gear
- Twisting of cable (automatic untwisting)
- Nacelle vibration

Monitoring of operational data comprises:

- Generator running hours
- Total kWh production
- Relevant operational data, e.g. current rpm, power,wind-speed and temperatures
- Cause of stop
- Error list, which contains all errors from the start-up of the turbine

Easily accessed data

All the data can be read from a display in the control unit, placed, well-protected, at the base of the tower. In the control unit are also the manual control functions:

- start
- stop
- motor start
- yawing

Identical control options also exist in the nacelle, which can be of great value during start-up and servicing.

The individual norms that the control system works with can be reprogrammed directly into the control panel or by means of **GETDANWIN**'s surveillance system.

Operating modus

The turbine is working according to the following operating strategy :

- safety precautions
- optimal energy production
- longevity.

Under normal circumstances the turbine works in steps 1-3 as shown in the functional diagram on the next page.

Following functions are possible :

operating phase 1 : stand-by, free wheeling

The windspeed is too low to produce energy, but the brakes are released and the generator is cut-in as soon as energy production is possible.
The yawing system is activated at windspeed 3,4 m/s.

operationg phase 2 : production

The generator is connected with the grid and produces energy. When windspeed changes near cut-in windspeed, the power may be negative short-time (the generator works as motor) to avoid cutting-in and -out of the generator too often.

operating phase 3 : stand-by, stopped

There are conditions which do not allow production, e.g. the windspeed is too high. As soon as the conditions have changed an automatic start is possible.

operating phase 4 : standstill

There is either an emergency-off or manual stop of the turbine. The rotor stands still and the mechanical brake is locked. Start is only possible by hand.

Operating phase 5 : standstill and grid failure

The rotor stands still and the mechanical brake is activated. After grid failure is finished the turbine goes to operating phase 3 (automatic start is possible).

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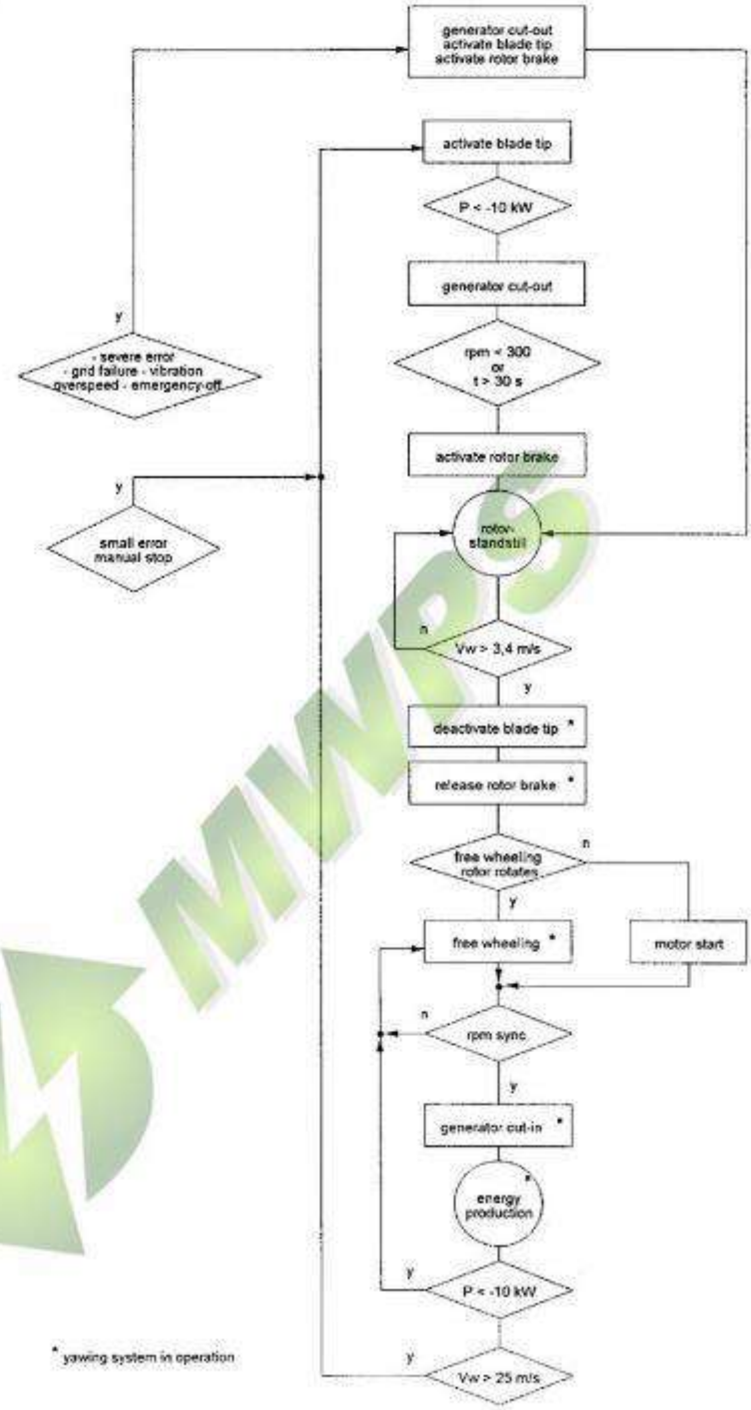
Functional diagram



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Safety conception

The safety conception is based on the fail-safe principle. Two separate rotor brakes are used - one brake disc and turnable blade tips. They can be released by two independent safety-chains.

Brake disc
The brake works hydraulic negative with two symmetrically placed calipers.

Turnable blade tips
They are activated by the control unit. Hydraulic pressure keeps them in neutral position. The valve is surveyed contionously by the directly wired safety system and the control unit. In case of fault they are activated by releasing the pressure.

Safety-chains
If one of the safety-chains is interrupted, an emergency-switch-off takes place by activating both mechanical and air brakes immediately at the same time.

Directly wired safety system

The directly wired safety system is activated in case of failure of the electronic system. It activates the rotor brakes by switching-off the hydraulic valve and the emergency system of the control unit. It works in case of

- grid failure
- nacelle vibration
- overspeed (10% over rated speed, measured on the main shaft)

safety system of the control unit

The control unit registers an emergency situation in following cases :

- grid failure
- using of one of the three emergency-stops
- nacelle vibration
- overspeed (5% over rated speed, measured on the transmission shaft.

Abnormal operating conditions

A normal stop-operation is initiated as soon as abnormal operating conditions are registered such as

wind :
- windspeed too high
- indefinable signals of wind direction

gear-box :
- too high/low temperatures *
- oil pressure too low in the gear-box
- oil level too low in the gear-box
- overload of the oil pump for the gear-box

Brake disc :
- brake lining is worn
- too many stop-operations in one period

Yawing system :
- overload of the azimuth motors *
- too many turns in one direction *
- overtwisting of the cable harness

Hydraulic system :
- overload of the hydraulic pump
- leakage in the hydraulic system
- max. pumping time of hydraulic pump exceeded
- oil level in the hydraulic tank too low

Generator :
- temperature in the windings too high

Electric system :
- generator output too high *
- current too high or asymmetric
- voltage too high / low *
- net frequency too high / low *
- wrong series of phases
- thyristors defective
- transfer error in the computer system
- wrong signals of the rev.transmitter

Control error by :
- power switch
- motor / hydraulic unit
- motor / azimuth drives
- motor / gear oil pump

* = after time release or restoring of normal condition automatic start can begin.
All other faults need attention before a new start is possible.

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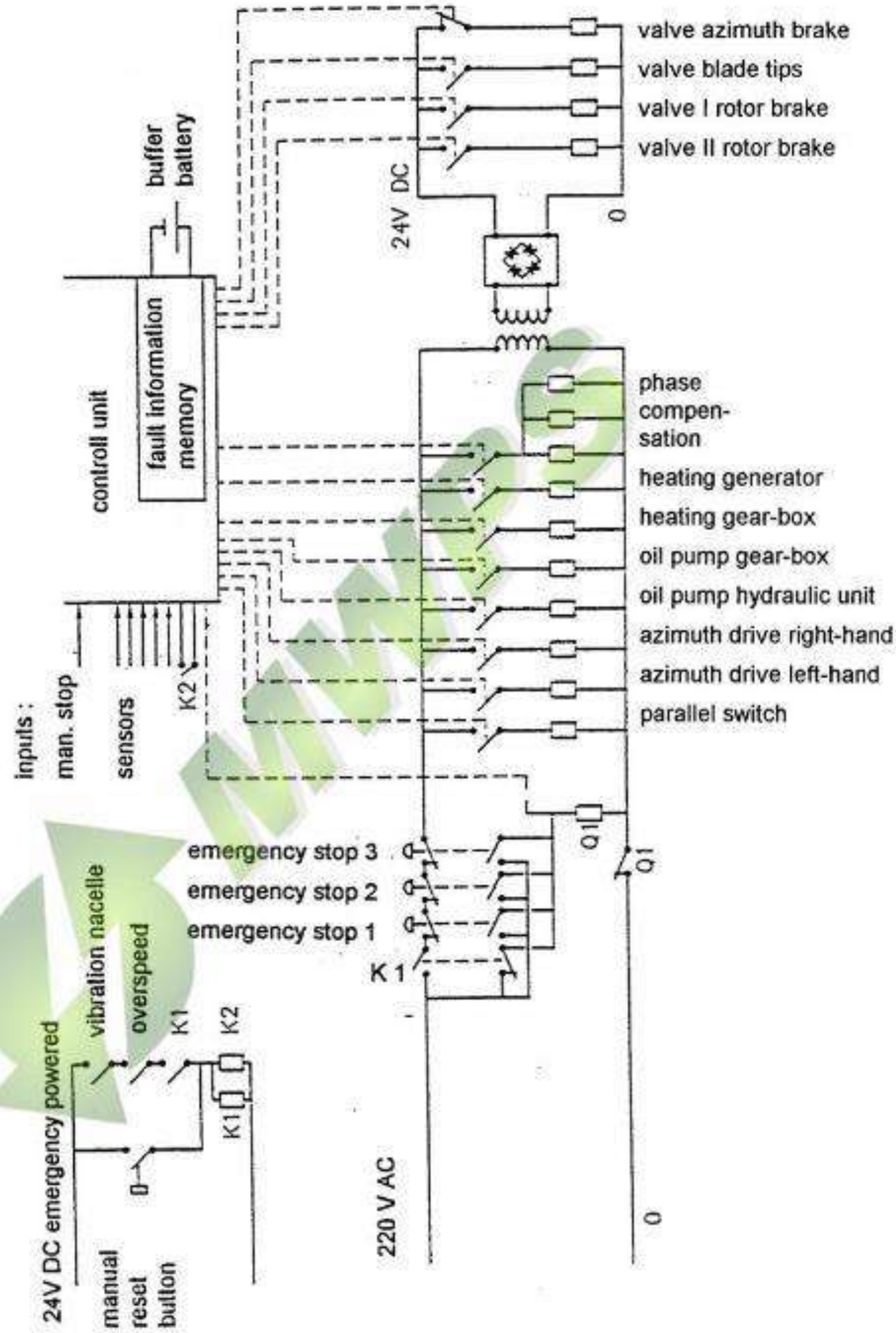
Safety wiring scheme



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