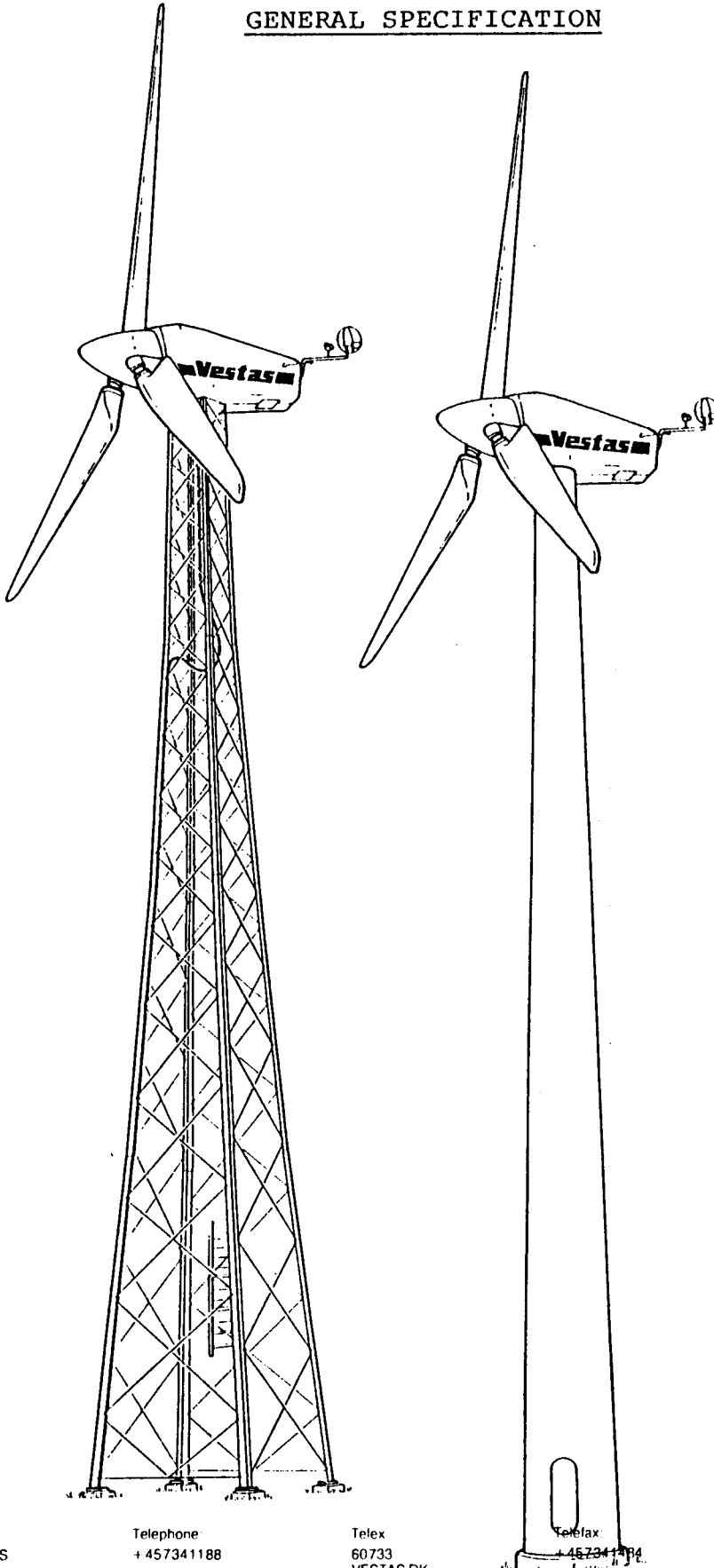


GENERAL SPECIFICATION



GENERAL SPECIFICATION

VESTAS 200 kW Wind Turbine, Type V25-200, 60 Hz

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1.0 TURBINE DESCRIPTION

The VESTAS V25 is an upwind wind turbine with an active yaw and a three bladed low speed variable pitch type rotor.

Through an independently supported main shaft the power is transmitted to the main or the small generator through a two stage speed increasing gearbox. The generators are induction type direct grid connected and are placed in line. The rotor has two different speeds depending on which generator is operating in order to achieve the maximum performance both at low and high wind speeds.

The wind turbine is monitored and controlled by a micro-process control unit and the pitch variations are performed by a hydraulic system which also operates the brake system.

The nacelle is fully inclosed in a fibreglass nacelle cover and is accessed through a central opening independent of the orientation of the nacelle in relation to the tower.

The tower is a conic tubular tower or a lattice tower with internal ladder.

2.0 SPECIFICATIONS

2.1 ROTOR

Diameter	25 m/82 ft
Swept area	491 m ² /5285 sq ft
Rotational speed, main generator	44 r.p.m.
Rotational speed, small generator	33 r.p.m.
Rotational direction	Clockwise
Orientation	Upwind
Number of blades	3
Aerodynamic brakes	Full feathering

2.2 BLADES

Material	Fibreglass reinforced polyester
Airfoil	NACA 44

2.3 TOWER

Type	Tubular tower
Height	28,7 m
Surface	2 sections hot galvanized and painted. Bottom section painted.
OR	
Type	Lattice mast
Height	28,7 m - 94 feet
Surface	Hot galvanized

2.4 GENERATORS

Type	Asynchronous
Main generator 6 Palet	200 kW
Rotational speed (synchronous)	1200 1000 r.p.m. (1000 50 Hz)
Small generator 4 Palet	30 kW
Rotational speed (synchronous)	900 750 r.p.m. (750 50 Hz)
Voltage	480 V AC
Frequency	60 Hz

2.5 GEARBOX

Type	Two stage, parallel shafts
Gear ratio	23:1

2.6 YAW SYSTEM

Type	Active yaw
Control	Windvane
Yawing speed	1 deg./sec.

2.7 OPERATIONAL DATA

Cut-in wind speed	9 mph/3,8 m/s +/- 10%
Rated wind speed (200 kW)	31 mph/13,8 m/s
Cut-off wind speed	56 mph/25,0 m/s +/- 5% (more than 5 sec.)
Survival wind speed	125 mph/56,0 m/s (measured at hub height)

2.8 WEIGHTS AND HEIGHTS

Lattice tower:

Tower (excl. foundation bolts)	8.200 kg	18.061 lbs
Nacelle	7.100 kg	15.638 lbs
Rotor	3.200 kg	7.048 lbs
Total	18.500 kg	40.748 lbs
Hub height	30 m	98 ft
Free height	18,5 m	61 ft
Highest point	41,5 m	136 ft

Tubular tower:

Tower (excl. foundation bolts)	11.500 kg	25.329 lbs
Nacelle	7.100 kg	15.638 lbs
Rotor	3.200 kg	7.048 lbs
Total	21.800 kg	40.748 lbs
Hub height	30 m	98 ft
Free height	18,5 m	61 ft
Highest point	41,5 m	136 ft

3.0 COMPONENTS OF THE WIND TURBINE

3.1 GEARBOX

Nominal power (AGMA)	350 kW
Ratio	27:1 23:1
Type	Two stage, parallel shafts
Oil	Hansen 73 l/Flender 40 l
High torque shaft	Hollow shaft
Manufacturer	Hansen RTH5AI-BNC or Flender SZAK 1400

3.2 YAW GEAR

Numbers	2 pieces
Type	Plantary and worm gear
Rated torque	5.500 Nm
Manufacturer	Bonfiglioli/Transmit T2/MVF62/FL-735 705 5.500 Nm

3.3 YAW MOTOR

Type	Induction
Rotational speed	1.750 r.p.m. 1450
Rated power	0,75 kW
Voltage	480 V AC
Frequency	60 Hz

3.4 GENERATORS

3.4.1 Main generator Siemens
 Rated power 200 kW
 Nominal power 200 kW
 Voltage 480 V AC 380
 Frequency 60 Hz 50
 Class of isolation F (windings) F
 Rotational speed (200 kW) 1.215 r.p.m. 1012
 Mounted capacitor 75 kVAR (60)
 Consumed reactive power 129 kVAR at 1/1 load
 100 kVAR at 3/4 load (111)
 91 kVAR at 1/2 load
 87 kVAR at 1/4 load (76 v 380v)

3.4.2 Small generator Siemens
 Design power 36 kW 30
 Nominal power 36 kW 30
 Voltage 480 V AC 380
 Frequency 60 Hz 50
 Class of isolation F (windings) F
 Rotational speed (36 kW) 929 r.p.m. 775
 Mounted capacitor 25 kVAR 20
 Consumed reactive power 34 kVAR at 1/1 load 26
 30 kVAR at 3/4 load 20
 27 kVAR at 1/2 load 17
 24 kVAR at 1/4 load 15

3.5 ROTOR SHAFT ASSEMBLY

Shaft material Steel 52.3
 Front bearing Spherical roller bear.
 Rear bearing Spherical roller bear.
 Casing and bearing VESTAS
 Hub connection Forged, part of shaft

3.6 ROTOR

3.6.1 Blades:
 Weight 3 pieces 1.300 kg
 Blade material Fibreglass reinforced polyester
 Air foil NACA 44
 Chord length, tip 429 mm at R = 12.500 mm
 16,9" at R = 41 ft
 Chord length, root 1.150 mm at R = 2.340 mm
 45,3" at R = 8 ft
 Twist 10,2 degrees
 Tip angle 0 - 90 degrees
 Manufacturer VESTAS

3.6.2 Blade console:

Weight	400 kg
Type	Cast
Material	Modular cast iron

3.7 TOWER

3.7.1 Type

No. of sections	Tubular steel tower
Height	3
Manufacturer	28,7 m - 94 feet
Surface treatment	E. Roug
	Hot galvanized
	and painted
Weight	11.500 kg 25.329 lbs

3.7.2 Type

No. of sections	Lattice tower
Height	4
Manufacturer	28,7 m - 94 feet
Surface treatment	Carl C. Jensen
Weight	Hot galvanized
	8.200 kg 18.061 lbs

3.8 CONTROL UNIT

VESTAS design, based on microprocessors

3.9 ANEMOMETER

Type Optoelectrical
Manufacturer VESTAS

3.10 WINDVANE

Type Optoelectrical
Manufacturer VESTAS

3.11 BRAKE

Type Disc brake
Diameter 600 mm
Disc material Modular cast iron
Calipers 2 hydraulically activ.
Manufacturer, calipers Brembo

3.12 HYDRAULIC UNIT

Pump capacity 4 l/min - 1,1 gpm
Max. pressure 50 bar - 710 psi
Brake pressure 25 bar - 298 psi
Pressure switches Piezoelectrical
Oil 30 l - 8 gal.
Manufacturer Vickers

3.13 TRANSMISSION JOINTS

3.13.1 Main shaft - gear:
Type Conical shrink disc

3.13.2 Gear - generator:
Type Rubber coupling

3.13.3 Main - small generator:
Type Rubber coupling

4.0 INSTALLATION

4.1 TERRAIN

If the terrain within a 100 m radius of the wind turbine has a slope of more than 30%, the cut-off wind velocity will have to be decreased.

4.2 CLIMATIC CONDITIONS

The turbine is a standard designed for an ambient temperature range from -10° C to $+40^{\circ}$ C. Outside this range special precautions must be taken.

The wind turbine is designed for a mean air density of 1.06 kg/m^3 . The operational data in section 2.7 are given at this density. If the mean air density differs more than $\pm 5\%$ from this value the data will be changed as well as the power curve.

4.3 MAIN CONNECTION

Intermittent or rapid fluctuations of utility grid frequencies may cause serious damage to the wind turbine. Steady variations within $\pm 1/-3$ Hz are acceptable. The voltage may have a max. variation of $\pm 10\%$.

VESTAS recommend that the wind turbine is connected directly to the transformer. At the transformer the connected load at the three phases must maximum be 10% asymmetric.

The short circuit power must in most cases be at least 10 times the rated power of the generator in order to fulfill this requirement.

A ground connection of max. 10 ohm must be present. In the case of small independent grids it is necessary to check the actual conditions.

4.4. MISCELLANEOUS

During transport over long distances the turbine will be subjected to great vibrations. It may therefore be necessary to take special precautions to avoid damage on bearings. The above will normally be necessary during railway transport only. Likewise unauthorised persons should not get closer than 100 m to the turbine.

For safety and noise reasons the turbine should not be placed close to areas with people. Therefore it is recommendable not to place turbines closer than 200 m from populated and busy areas.

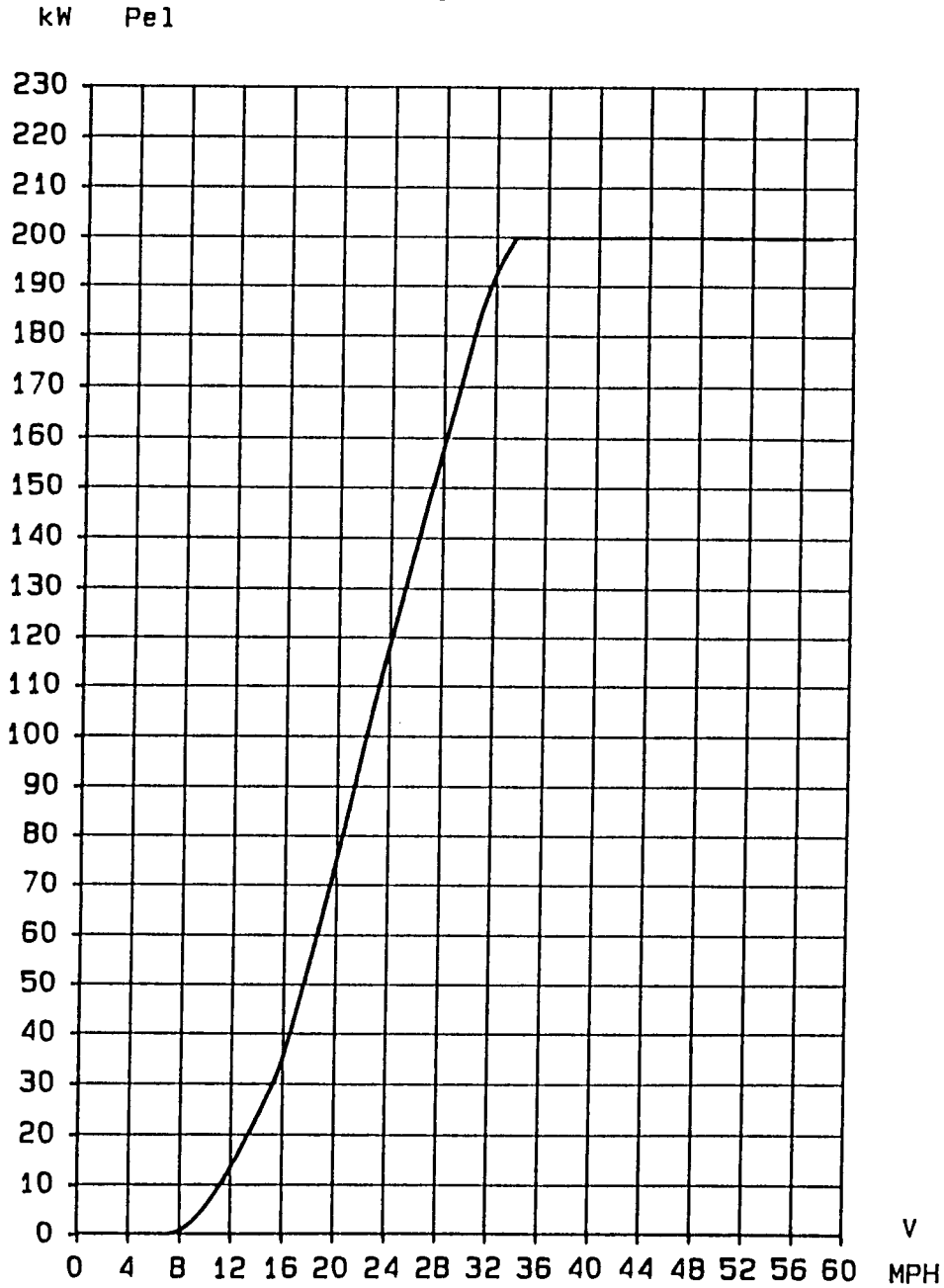
If the turbine is to be placed in an area with many strikes of lightning it may be necessary to take precautions to prevent damages on the turbine.

The VESTAS wind turbine is corrosion protected against most environmental influences. If placed in a strongly corrosive environment, i.e. very close to the sea or in a polluted atmosphere it can be necessary to give extra corrosion protection.

Power curve for Vestas V25-200 kW.

Air density 1.06 kg/m³

Pitchregulation.



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POWER CURVE FOR VESTAS V25-200 KW

Power curve calculated on the basis of measurements on Vestas V25-200.

Parameters for the calculated curve:

Rotor diameter : 25.0 m
Rotor speed (synchronous) : 44.0/33.0 rpm
Pitch angle : 0 Pitch regulated
Airdensity : 1.06 kg/m³

Wind velocity v (MPH)	El-power output Pel (kW)
8	0.0
9	3.1
10	6.5
11	10.0
12	14.5
13	19.1
14	24.4
15	30.0
16	37.0
17	45.8
18	55.0
19	65.5
20	75.8
21	86.6
22	97.3
23	107.4
24	117.5
25	127.4
26	136.8
27	146.4
28	155.8
29	165.3
30	174.2
31	183.2
32	192.5
33	200.0
34	200.0
35	200.0
36	200.0
37	200.0
38	200.0
39	200.0

Wind velocity v (MPH)	El-power output Pel (kW)
40	200.0
41	200.0
42	200.0
43	200.0
44	200.0
45	200.0
46	200.0
47	200.0
48	200.0
49	200.0
50	200.0
51	200.0
52	200.0
53	200.0
54	200.0
55	200.0
56	200.0

The wind speed is measured at hub height perpendicular to rotor plane.

Effektkurve for V25-200

Effektkurven er udregnet på basis af målinger foretaget på Vestas V25-200.

Parameter for den beregnede kurve:

Rotordiameter:	25.0 m
Rotorhastighed:	32.2/42.9 omdr./min.
Tipvinkel:	Pitchreguleret
Luftmassefylde:	1.23 kg/m ³

Vindhastighed (m/s)	Afgiven effekt Pel (kW)	Afvigelse +/- Pel (kW)
3.0	0.0	2.0
4.0	3.6	2.0
5.0	12.3	3.0
6.0	24.4	3.0
7.0	39.9	3.0
8.0	63.4	3.0
9.0	90.2	3.0
10.0	118.9	3.0
11.0	145.7	3.0
12.0	171.2	2.9
13.0	195.1	2.5
14.0	200.1	2.0
15.0	200.0	2.0
16.0	200.0	2.0
17.0	200.0	2.0
18.0	200.0	2.0
19.0	200.0	2.0
20.0	200.0	2.0
21.0	200.0	2.0
22.0	200.0	2.0
23.0	200.0	2.0
24.0	200.0	2.0
25.0	200.0	2.0

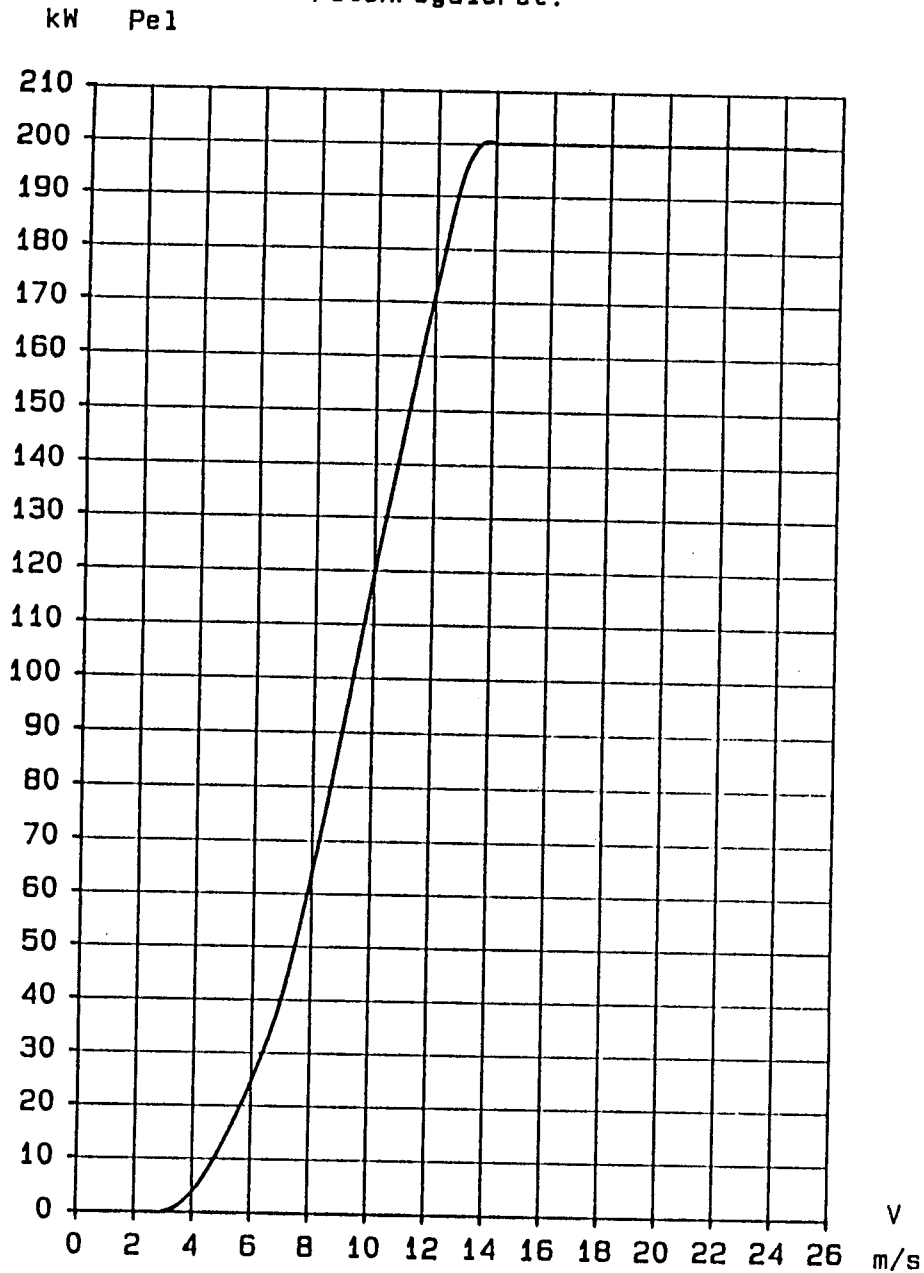
Afvigelse i effekten ved en given vindhastighed fremgår af kolonnen +/- Pel.

Vindhastigheden er målt i navhøjde lodret på rotorplanet.

Effektkurve for Vestas V25-200 kW.

Luftmassefylde 1.23 kg/m³

Pitchreguleret.

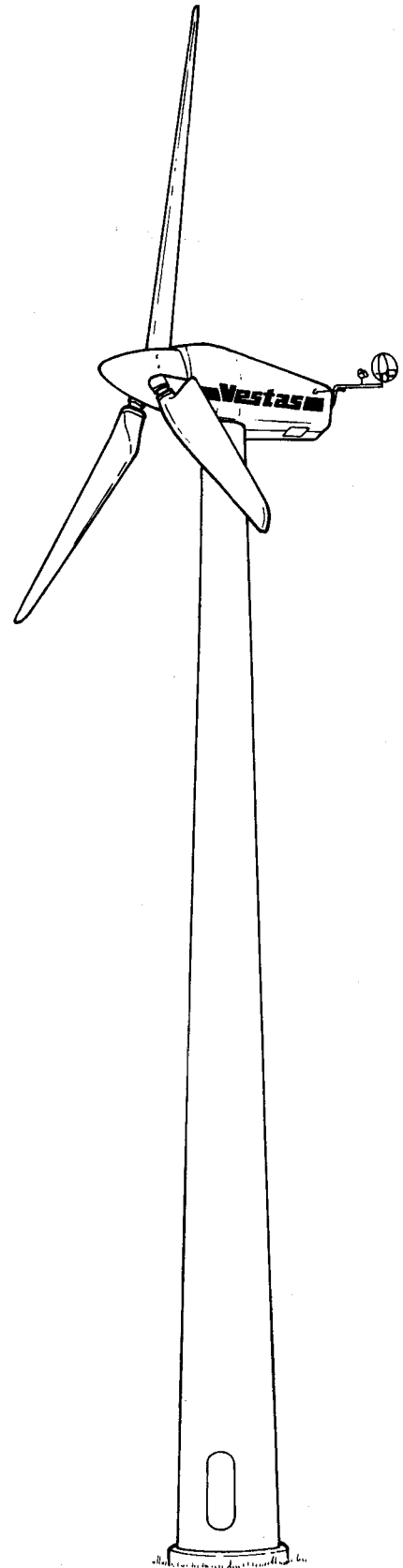
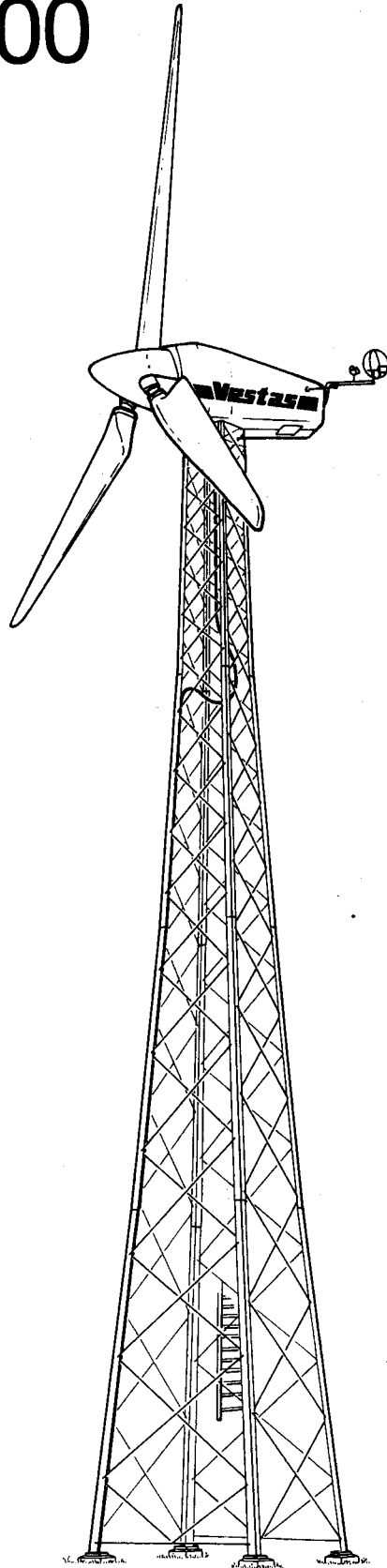


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Vestas

VESTAS WIND SYSTEMS A/S

Electrical data V 25-200



Choice of location of the cabinet for the control unit

With turbines installed on a tubular tower the control unit should be placed inside the tower. In the event of lattice towers the control unit should be installed in a shed or the like, and placed between the legs of the lattice tower or immediately next to it (max. distance 1,5 m). The shed must be minimum 2×2 m and must not have direct contact with the lattice tower.

The control unit cabinet

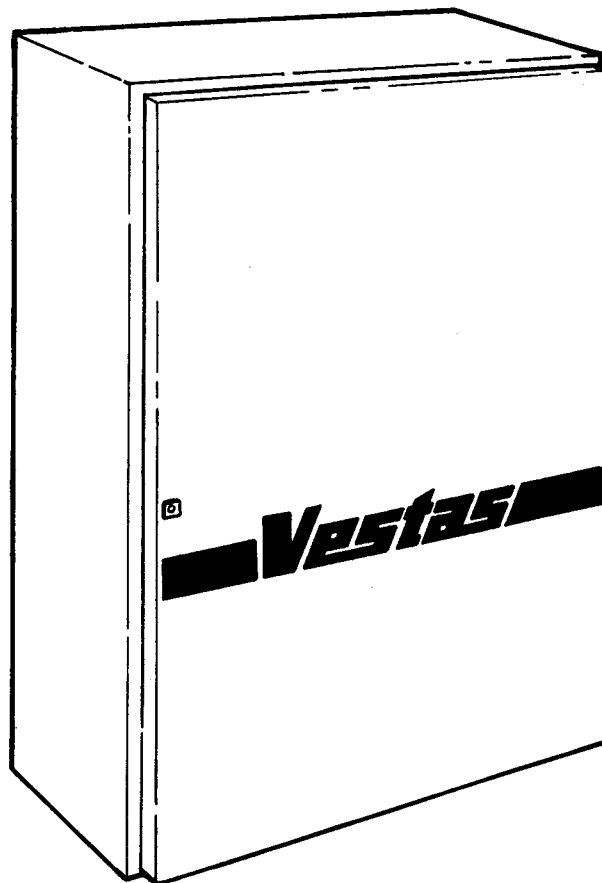
Dimensions for the control unit cabinet.

Depth 400 mm, height 1200 mm, width 800 mm.

Distance between fixing points: Vertical 1280 mm, horizontal 760 mm.

A minimum gap of 800 mm must be left below the control unit cabinet to allow cables to be installed.

The control unit of the wind turbine (the control unit cabinet) is constructed in a metal cabinet.



Connection to the utility grid

VESTAS emphasizes that the required entry switch for V25-200 is not included in the delivery.

The connection to the public utility grid is done by copper or aluminium cables through a lockable main switch with DIN fuses, 400 A diode fuses (140.000 A²S). Recommended main switch LK NES QSA 400A. The main switch is a safety switch and thus a necessary requirement.

VESTAS Wind Systems A/S recommend that the windturbine is connected directly to the transformer. At the transformer the connected load at the three phases must not be more than 10 per cent asymmetrical.

The entry main switch is placed next to the control unit cabinet inside the tower or in the shed for the control unit.

The terminals in the control unit are copper with a possibility of connection with cable eyes with 12 mm holes, cable entry in the bottom of the control unit cabinet is through two screwed glands PG 48.

Light in the tower and shed

»Arbejdstilsynet« (the factory inspection authorities) demands the installation of light in tubular towers. Therefore at the board for the main switch must feature two 10A 220V groups for supply of light and power in the tower. Exit cables from the groups must be connected to the terminal row at the bottom of the board. An earth-fault relay must be installed in front of the groups.

Note: Connection must be done before the entry main switch through a fuse in order to secure light in the tower when the turbine is disconnected.

Meter arrangement

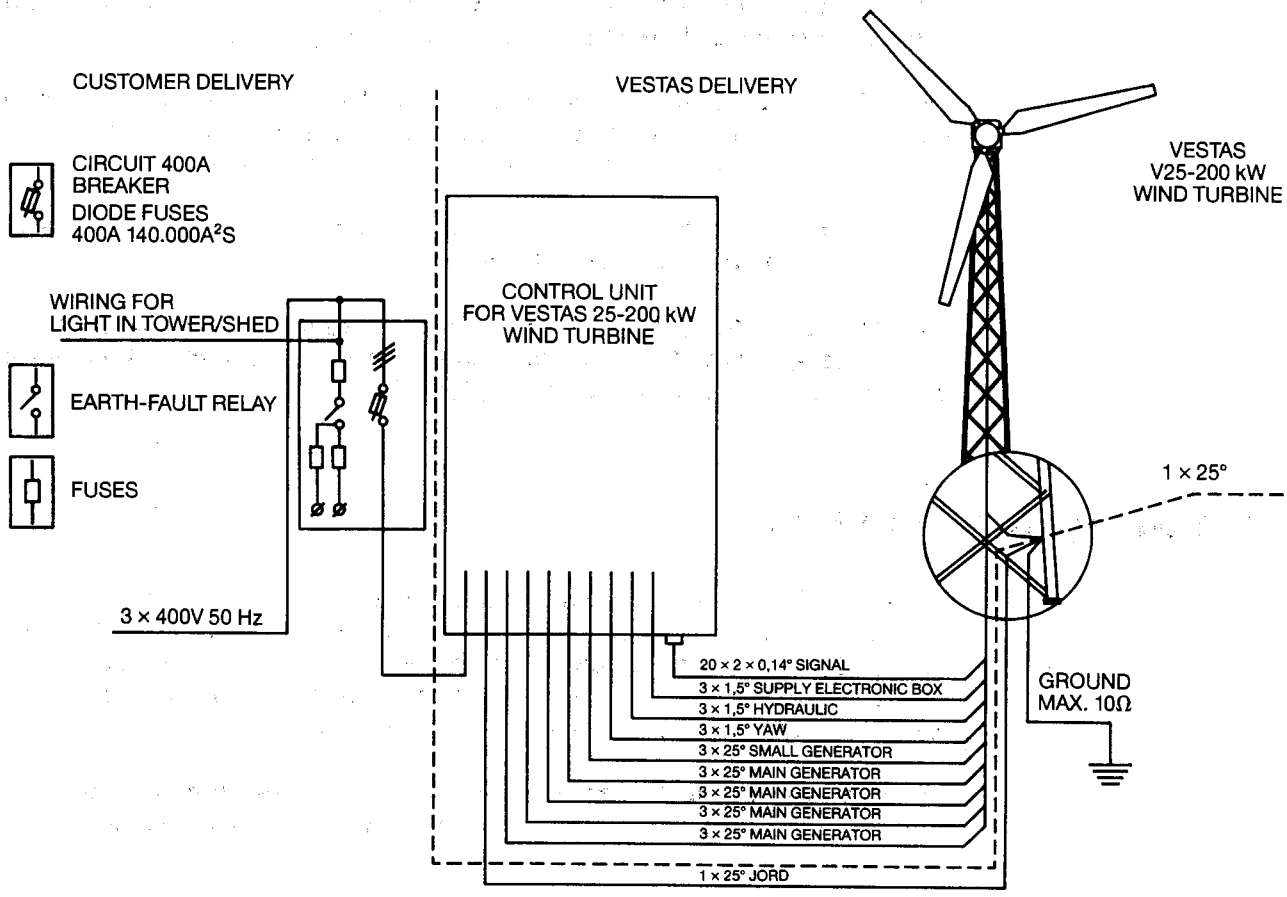
The meter arrangement can frequently be installed at the main switch, but in each individual situation this should be discussed with the electricity supply company. In case of a production meter this should be placed in connection with the main switch.

Field of responsibility

VESTAS emphasizes that connection of the control unit to the grid is the responsibility of the manager/electrician in question. The requirements of the power regulations and joint regulations must be complied with.

VESTAS would like to draw the attention to the fact that a wind turbine produces electricity and therefore a responsible and acknowledged manager is required. Application for manager must be submitted minimum 14 days before the connection of the turbine to the public utility grid.

VESTAS is naturally at your service with further information and guidance.



Cable dimensioning

The listed lengths and cable dimensions may be used provided the zero-load voltage of the transformer does not exceed 235V.

Cable length from trafo to wind turbine	Cable dimension
111 metres	2 pcs. 4x 95 mm ² aluminium
143 metres	1 pc. 4x240 mm ² aluminium
198 metres	2 pcs. 4x150 mm ² aluminium
265 metres	2 pcs. 4x240 mm ² aluminium

Electrical V 25-200 kW pitch regulated

Description	Main generator	Small generator
Design type/size	355	250
Output kW (max.)	200	30
Current Amp	345	58
Cos phi	0,85	0,75
Voltage	400 (415)	400 (415)
Coupling	Triangle (Delta)	Triangle (Delta)
Frequency Hz	50	50
Consumed reactive power		
0-load (kVAr)	63	27
full load (kVAr)	108	37
R.p.m. (max. kW)	1012	775
Efficiency	0,95	0,90
Insulation classification	F	F
Temperature classification	PT 100 (130 gr. C)	PT 100 (130 gr. C)

The control unit contains current limiting switching equipment (soft-starter) for small generator and main generator.

The generators are connected to the grid via 3 sets of thyristor-diode modules.

The inrush current main generator is max. 345 A, typically 320 A.

The control unit contains no automatic wind upstart as the wind turbine is equipped with pitch regulated blades.

Reactive compensation on small generator	v. 400 V 50 Hz	20 kVar
Reactive compensation on main generator	v. 400 V 50 Hz	60 kVar
Resulting Cos phi at 200 kW		0,93
Resulting current at 200 kW		310 A

VESTAS reserves the right to adjust the above data to comply with any future requirements.

Andret: 10.08.88

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Behandlet af: Gst/lj

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UDVIKLINGSAFD. *ll*

VÆGTSKEMA FOR V-25.

Spinner incl. beslag	80	kg
Vinger 3 stk	1300	kg
Vingelejring komplet	2540	kg
Vingekonsol	400	kg
Lejerør (1 stk.)	250	kg
Ståldorn (1 stk.)	300	kg
Traversrør komplet	55	kg
Lejer (2 sæt)	75	kg
Lejeholder	42	kg
Dæksler (2 stk.)	13	kg
Momentarm	15	kg
Akselleje arr. komplet	925	kg
Hovedaksel	382	kg
Lejehus	355	kg
Lejer (2 stk)	75	kg
Lejedæksler (2 stk)	32	kg
Cylinderarr.	58	kg
Gearkassen komplet mont. klar (HANSEN) <i>72 liter</i>	1980	kg
Gearkasse komplet mont. klar (FLENDER) <i>38 liter</i>	1740	kg
Bremseskive	60	kg
Bremsecaliperplade incl. calipre	67	kg
Momentstagsplader højre + venstre	35	kg
Koblingsflange	25	kg
Gearstag komplet (- plader på gear)	55	kg
Gummikobliger (2 stk) komplette (st. 30 kg)	35	kg
Skridkobling komplet	40	kg
Krøjegear	116	kg
Krøjekrans (til rørtårn)	462	kg
Krøjeklodser komplette	150	kg
Forreste maskinfundament	920	kg
Bageste maskinfundament	500	kg
Beslag til glasfiberskærm komplet	100	kg
Glasfiberskærm	280	kg
Store generator (SIEMENS)	1580	kg
Stor generator (AEG) <i>VARM</i>	1800	kg
Lille generator (SIEMENS)	450	kg
Lille generator (AEG)	400	kg
Hydraulikstation	100	kg
Eludstyr i møllehat (- kabler)	40	kg
Kabler (heraf 150 kg placeret i møllehat)	500	kg

TOTALVÆGTE

* Maskinkabine komplet med FLENDER gear og SIEMENS Generatorer samt 150 kg kabler:	7701	kg
* Maskinkabine komplet med Hansen gear og AEG generatorer samt 150 kg kabler:	8111	kg
* Kabler placeret udenfor maskinkabine:	350	kg
* Rotor komplet incl. spinner+beslag	3920	kg
* Gittermast	8500	kg
* Rørtårn	11500	kg

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I alt 20,881
Beslag ca 500
Styring 250
Kabler ca 400
Kabiner 4000
26031 + kros + Dca

24,900