

Copy of the NVN 11400-0 certificate



Certification Report

Wind Turbine

*GE Wind Energy 1.5s with Rotor Blade APX 70
or Rotor Blade LM 34.0P*

Tubular Steel Tower

*Hub Height 64.7 m
NVN Type Class II_A*

Report No.: 71674-7

Date 12.07.2002

Germanischer Lloyd WindEnergie GmbH

Manufacturer

GE Wind Energy GmbH
Holsterfeld 5a
48499 Salzbergen/Germany

Documentation by

IDAS GmbH (1)
Mollstraße 18
18209 Bad Doberan / Germany

Pfleiderer AG, Werk Leipzig (2)
Bautzner Straße 65
04347 Leipzig / Germany

GL Wind-Order No.

21123/02

Expert in Charge

L. Krutschinna

Address

Germanischer Lloyd
WindEnergie GmbH
Johannisbollwerk 6-8
20459 Hamburg/Germany



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1 Documentation

1.1 Calculations

"Windkraftanlage Enron Wind 1.5s, Berechnung des 63,10 m Turmes"

168 pages, dated 31.10.2000, prepared by (1)

"Statische Nachweise für Baugruppen des GE Wind Energy 1,5s-64,7m WZ III nach Stückliste S0418R02, Innenpodeste", 14 pages, dated 10.07.2002, prepared by (2)

1.2 Drawings

900564, Rev. (1), dated 24.01.2001,

"Turm 64.7 mNH, Rotor-Ø 70.5m; WZ III", prepared by manufacturer

1.3 Drawings for personal safety (noted)

1S0418-01, Rev. 2, dated 09.10.2001,

"Sektion 1 TW 1,5s NH64,7m WZ III", prepared by (2)

2S0418-02, Rev. 2, dated 23.10.2001,

"Sektion 2 TW 1,5s NH64,7m WZ III", prepared by (2)

1S0418-03, Rev. 2, dated 15.10.2001,

"Sektion 3 TW 1,5s NH64,7m WZ III", prepared by (2)

2 Applied Standards

The evaluation of the tower was based on the

- NVN 11400-0 Dutch Prestandard, "Wind Turbines Part 0: Criteria for type certification – Technical Criteria", 1st edition, April 1999
- International Standard IEC 61400-1 "Wind turbines generator systems – Part 1: Safety requirements", 1999 Edition
- Germanischer Lloyd (GL) "Regulations for the Certification of Wind Energy Conversion Systems", 1999 Edition
- DIN 4131 "Antennentragwerke aus Stahl – Steel radio towers and masts", 1991 Edition.

3 Extent of Examination

The design of the tubular steel tower is checked by independent analysis applying the regulations as stated under item 2 and the extreme loads according to environmental conditions as indicated for a WTGS class II_a system as in NVN 11400-0 and fatigue loads assuming a life time of 20 years. The load figures are verified as indicated in GL Certification Reports No. 70999-1, dated 13.07.2000 and No. 71000-1, Supplement 1, dated

09.06.2000. The tower for NVN class II_A is implicit checked with the certification of the tower for IEC II_A which is certified in the GL-Wind Certification Report No. 71351-7, dated 25.01.2001.

4 Remarks on Examination

4.1 Description of the tower design

The tower for the GE Wind Energy 1.5s is designed as three sectional modular tower for the hub height $H = 64.70$ m over ground level. The tower length is 63.10 m. The length of the upper tower section is 22.80 m, of the intermediate and the lower tower section 20.15 m respectively.

The outer diameter on top and bottom are 2.556 and 3.750 m respectively. The wall thickness at top and bottom are 10 mm and 25 mm respectively.

The sections are joined together by pretensioned bolted ring flanges with an outer diameter of 3.383 m with 116 M 36 grade 10.9 and with an outer diameter of 3.016 m with 96 M 36 grade 10.9 bolts according to DIN 6914-16 respectively. The top of the tower is a ring flange as a support for the nacelle which is joined to the tower by 64 M 30 grade 10.9 pretensioned bolts.

The material of the shell plate is S355J0, the flange material is S355JJ2G3-Z25 for all flanges.

A door opening is in the lower section as shown on the tower drawing. The material of the door stiffener is S355J0.

4.2 Connection between tower and foundation

The tower will be mounted to a reinforced concrete foundation by $2 \times 60 = 120$ M 36 grade 8.8 pretensioned anchor bolts. The T-flange connection with the anchor bolts has to be calculated with subject to the foundation which is not included into this report.

4.3 Verification of the tower design

The design of the tower is verified for extreme and fatigue loads assuming a life time of 20 years. The action of vortex induced vibrations on the tower is investigated assuming a logarithmic damping decrement of $\delta=0,015$.

The state of the totally erected tower with turbine out of operation is calculated for a time period of one year. It is to be insured that the erection of the tower and nacelle does not take more than 2-3 days. During longer periods of installation (tower without nacelle), maintenance or repair conditions where the nacelle is dismantled from the tower, additional measures have to be taken to protect the tower from vortex induced vibrations.

Effects of earthquake or extreme temperatures are not considered in the tower design.

4.4 *Dynamic behaviour*

The first natural frequency of the tower (including nacelle) has been calculated by GE Wind Energy to $f_0 = 0.405$ Hz on rigid foundation and $f_0 = 0.384$ Hz on a foundation with a spring constant for rocking of $K = 2.5 \cdot 10^{10}$ Nm/rad. The normal rotor speed is 0.33 Hz. The rotor speed in load operation is 0.20 to 0.37 Hz. This fact has been taken into account in the load calculations.

The natural frequency is determined for a mass of the nacelle (including rotor blades) of 81.500 kg.

4.5 *Obligation*

Soil survey has to be done to ensure the spring constant for rocking as mentioned under item 4.5.

The weldseams of the door opening have to be toe grinded according to DIN EN 25817, quality level B.

4.6 *Corrosion protection*

All fatigue and strength calculations are conditional upon an effective corrosion protection system – particularly for the sections exposed to fatigue, such as flanges and connection to foundation – being provided, checked at regular intervals and renewed in the event of damage.

4.7 *Personal Safety*

The design of the tower and its inner parts is verified for personnel safety according to NVN 11400-0. Deviating from NVN 11400-0 clefts between floors and tower shell with a width of up to 20 mm instead of 5 mm are accepted.

5 *Final Remarks*

The design of the tower fulfils the requirements according to the applied standards as mentioned under item 2. If the remarks (items 4.2 to 4.7) will be observed there are no objections to construction and operation of the units.

LKr

Germanischer Lloyd
WindEnergie GmbH

L. Krutschinna
L. Krutschinna
Expert in Charge

Type Certificate



Germanischer Lloyd
WindEnergie GmbH

GL-Wind Type Certificate No.: TZ 006A-2001, Revision 1

We hereby certify that the wind turbine

GE Wind Energy 1.5s

designed and manufactured by GE Wind Energy GmbH
Holsterfeld 16
48499 Salzbergen
Germany

with hub heights 64.7m, 85m and rotor blades APX 70 has been assessed by Germanischer Lloyd WindEnergie GmbH concerning the system design, the prototype testing and the manufacturer's quality system.

The Type Certificate is based on the indicated documents as follows:

WEC 00-009A-2000, Rev. 1 Statement of Compliance for the Design Assessment dated 16th July 2002

WT 01-004A-2001 Statement of Compliance for the Prototype Testing dated 26th June 2001

Cert-11595-2002-AQ-ESN-TGA DNV Zertifizierung und Umweltgutachter GmbH, Certificate of Approval acc. to EN ISO 9001:2000, valid until 31st January 2005

Normative references: Dutch Prestandard NVN 11400-0 "Wind Turbines - Part 0: Criteria for type certification "Technical Criteria", first edition, dated April 1999, for wind turbine class IIa

Changes of the system design or the manufacturer's quality system are to be approved by Germanischer Lloyd WindEnergie GmbH, otherwise the Type Certificate loses its validity.

This Type Certificate is valid until 25th June 2003, if the validity of the certificate for the Quality Management system is maintained.

Hamburg, 16th July 2002
Dal/Blun

Germanischer Lloyd
WindEnergie GmbH

Chr. Nath

By DAP German Accreditation System for Testing
accredited Certification Body for products
The accreditation is valid for the fields of certification
listed in the certificate

i.V. P. Dalhoff



Germanischer Lloyd WindEnergie GmbH
Johannisbollwerk 6-8
20469 Hamburg
Germany



Statement of Compliance

Germanischer Lloyd
WindEnergie GmbH

GL-Wind Statement No.: WEC 00-009A-2000, Revision 1

This Statement of Compliance for the Design Assessment of the Wind Turbine

GE Wind Energy 1.5s

is issued to

GE Wind Energy GmbH
Holsterfeld 16
48499 Salzbergen / Germany

The Design Assessment is based on the calculations and fabrication drawings listed in the relevant certification reports referenced below and the characteristic data given in the attached Annex.

Certification Report numbers and titles:

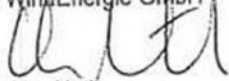
71000-1	dated 15-05-2000	Load Assumptions IEC 61400-1 and NVN 11400-0 class IIa, Hub Height 85 m
71169-2	dated 19-05-2000	Safety System and Manuals
71182	dated 19-04-2000	Rotor Blade APX 70
71169-4, Rev. 2	dated 18-07-2001	Machinery Components
71169-6	dated 29-05-2000	Electrical Equipment
71169-7	dated 31-05-2000	Tubular Steel Tower, NVN 11400-0 class IIa, Hub Height 85 m
71674-7	dated 12-07-2002	Tubular Steel Tower, NVN 11400-0 class IIa, Hub Height 64.7 m


Normative references: Dutch Prestandard NVN 11400-0 "Wind Turbines – Part 0: Criteria for type certification "Technical Criteria", first edition, dated April 1999, for wind turbine class IIa.

Changes in design are to be approved by Germanischer Lloyd WindEnergie GmbH, otherwise this statement loses its validity. Fabrication surveillance is not part of this Statement of Compliance for the Design Assessment.

Hamburg, 16th July 2002
Dal/Blun

Germanischer Lloyd
WindEnergie GmbH


Chr. Nath


i.V. P. Dalhoff

By DAP German Accreditation System for Testing
accredited Certification Body for products
The accreditation is valid for the fields of certification
listed in the certificate



Germanischer Lloyd WindEnergie GmbH
Johannisbollwerk 6-8
20459 Hamburg
Germany

The latest edition of the "General Terms and Conditions of Germanischer Lloyd WindEnergie GmbH" is applicable. German law applies.



Annex

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GL-Wind Statement No.: WEC 00-009A-2000, Revision 1

Characteristic Data GE Wind Energy 1.5s

General

Type: horizontal axis wind turbine
with variable rotor speed
independent electromechanical pitch
system for each blade

Power regulation:

Rated power: 1500 kW

Hub height: 85 m

Rated rotational speed: 20 rpm

Operating range rotational speed: 12... 22.25 rpm

Cut-in wind speed: 3 m/s

Rated wind speed: 11.6 m/s

Cut-out-wind speed (30 s mean): 25 m/s

Extreme wind speed (50-year-gust): 59.5 m/s

Annual average wind speed: 8.5 m/s

IEC 61400-1-Type class: IIa

Nacelle

Manufacturer: GE Wind Energy GmbH

Drawing No.: 900078 (0)

Rotor

Diameter: 70.5 m

Number of blades: 3

Orientation: upwind

Blade type: APX 70

Blade material: glass fibre reinforced epoxy

Manufacturer: Aerpac B.V.

Drawing No.: T1-34.001, Rev. 1

Rotor Hub

Type: cast

Material: EN-GJS-400-18-LT

Drawing No.: 900014-3



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GL-Wind Statement No.: WEC 00-009A-2000, Revision 1

Main Shaft	Type: Material: Drawing No.:	forged 42 CrMos4 900033, Rev. 3
Main Braking System	Design: Drawing No. pitch drive: Pitch gear:	see power regulation 1/6169/5146/0 Lohmann + Stolterfoht GmbH, type GFB 17 T3
Auxiliary Braking System	Design: Location: Assembly drawing No.: Brake calliper: Hydraulic unit:	spring applied disc brake with 1 brake calliper at high speed shaft 490 1299-001 Svendborg Brakes, Type BSFH 360 MS EE Svendborg Brakes, Type PU 300-XX-331
Generator	Design: Rated power: Rated voltage: Rated speed: Degree of protection: Type:	double fed induction generator 1500 kW 690 V 1800 rpm IP 54 IFRA-560LB-4, Coher AG, or DASAA 5023-4U, VEM, or ASL500M46-04RB+LLK, LDW
Main Carrier	Type: Material: Drawing No.:	welded S355J2G3 40.03.039-3
Gear Box	Type:	PEAS 4390 (i=90.3), Flender AG, or GPV 450, Lohmann + Stolterfoht, or CPNHZ-195 (i=90.3), Eickhoff

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Statement of Compliance



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GL-Wind Statement No.: WEC 00-009A-2000, Revision 1

Yaw System	Design:	3 active electric yaw drives with brake motor and slewing ring
	Drawing No. yaw drive:	68 471 4000 00 000, Liebherr
	Drawing No. slewing ring:	091.45.2334/01.113701.2, Hoesch Rothe Erde
Tower 85m Hub Height	Design:	tubular steel tower with 3 sections
	Length:	76.785 m
	Drawing No.:	900458(0)
Tower 64.7m Hub Height	Design:	tubular steel tower with 3 sections
	Length:	63.10 m
	Drawing No.:	900564, Rev. 1
Control and Safety System	Manufacturer:	GE Wind Energy GmbH SSB Antriebstechnik

End of Annex

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Wind Energie



GL-Wind Statement No.: WT 01-004A-2001

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This Statement of Compliance for the Prototype Testing of the wind turbine

Enron Wind 1.5s, alternative designation TW 1.5s

is issued to

Enron Wind GmbH
Holsterfeld 5a
48499 Salzbergen
Germany

For the wind turbine Enron Wind 1.5s measurements of power curve, noise emissions and electrical characteristics have been performed.

The power curve of the Enron Wind 1.5s was measured by

DEWI Deutsches Windenergie-Institut

and is documented in Report PV 0001-01 "Leistungskurvenmessung an der Windenergieanlage Tacke TW 1.5s, Standort Wilhelmshaven nach IEC 61400-12", dated 2000-02-03.

The noise emission of the EnronWind 1.5s was measured by

WINDTEST Kaiser-Wilhelm-Koog

and is documented in Report WT 1326/00 "Schallemission der Windenergieanlage (WEA) vom Typ TW 1.5s mit einer Nabenhöhe von 65 m" (Measurement of the noise emission of the wind turbine of the type TW 1.5s), dated 2000-03-14.

The electrical characteristics were measured by

WINDTEST Kaiser-Wilhelm-Koog

and are documented in report WT 1352/00 „Messung der elektrischen Eigenschaften hinsichtlich der Netzanbindung der Tacke TW 1.5s“, dated 2000-02-14.

The rotor parameters were checked after manufacturing of the rotor blades by

Aerpac B.V. Almelo

and are documented in the record "3.1.B Inspection certificate" for rotor blade Nos. 1104, 1106 and 1092, 4 pages, dated 2000-07-03.

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GL-Wind Statement No.: WT 01-004A-2001

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The personal safety aspects were inspected by

ECN Wind Energy, NL

and are documented in certification evaluation report No. 840036-C-00-01.1
"Evaluation Tower 85 m - HH of Tacke TW 1.5s wind turbine", dated 2000-05-19.

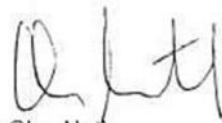
Normative references: Dutch Prestandard NVN 11400-0 "Wind turbines – Part 0: Criteria for type-certification – Technical criteria", 1st edition, April 1999.

The reports and the results of the measurements were reviewed by Germanischer Lloyd. WindEnergie GmbH. The turbine behaviour meets the assumptions with respect to Type Certification within technical tolerances. Among others the following results were determined:

- The energy output factor of the test specimen according to NVN 11400-0 was greater than 2.7 for an annual average wind speed of 6.3 m/s.
- The immission-relevant source strength of the test specimen was determined for reference wind speeds from 6 m/s to 9 m/s at 10 m height to values from 101.5 dB(A) to 103.9 dB(A). This is below the maximum permissible source strength of 109.7 dB(A) for 70.5 m rotor diameter according to NVN 11400-0.

Hamburg, 26th June 2001
Dal/LoMe

Germanischer Lloyd
WindEnergie GmbH


Chr. Nafh


i.V. P. Dalhoff