GE Energy

# Technical Documentation
# Wind Turbine Generator Systems
# GE 2.5/88

## Technical Data

GE imagination at work

GE Energy

Gepower.com

Visit us at
www.gewindenergy.com

All technical data is subject to change in line with ongoing technical development!

**Copyright and patent rights**

This document is to be treated confidentially. It may only be made accessible to authorized persons. It may only be made available to third parties with the express written consent of GE Energy.

All documents are copyrighted within the meaning of the Copyright Act. The transmission and reproduction of the documents, also in extracts, as well as the exploitation and communication of the contents are not allowed without express written consent. Contraventions are liable to prosecution and compensation for damage. We reserve all rights for the exercise of commercial patent rights.

© 2005 GE Energy. All rights reserved.

GE imagination at work

# Table of Contents



CONFIDENTIAL - Proprietary Information.
DO NOT COPY without written consent from GE Energy.
© 2005 GE Energy. All rights reserved.

# 1 Tower

| | |
|---|---|
| Type: | Tubular steel tower |
| Wind zone: | DIBt WZ III / IEC TC IIa |
| Hub height: | 85 m |
| Diameter top: | 3075 mm |
| Diameter bottom: | 4300 mm |

# 2 Rotor

| | |
|---|---|
| Diameter: | 88 m |
| Number of rotor blades: | 3 |
| Swept area: | 6082 $m^2$ |
| Rotor speed range: | 5.5 – 16.5 $min^{-1}$ |
| Rotational direction: | Clockwise looking downwind |
| Maximum speed of the blade tips: | 76 m/s |
| Orientation: | Upwind |
| Speed regulation: | Pitch-controlled |
| Aerodynamic brake: | Blades in feathering position |
| Cone angle: | 3° |
| Inclination angle of rotor axis: | 4° |

# 3 Rotor Blades

| | |
|---|---|
| Design: | GE Energy |
| Length (blade root – tip): | 42.7 m |
| Material: | Fiber glass – epoxy resin |

CONFIDENTIAL - Proprietary Information.
DO NOT COPY without written consent from GE Energy.
© 2005 GE Energy. All rights reserved.

# 4 Pitch System

| | |
|---|---|
| Principle: | Single blade pitch control |
| Drive system, motor type: | Electric, DC motors |
| Redundant safety feature: | Battery system |
| Pitch drive: | Planetary gear |
| Pitch bearing: | Double-row four-point contact bearing |

# 5 Hub

| | |
|---|---|
| Material: | Ductile cast iron, EN-GJS-400-18U-LT |
| Corrosion protection: | Sandblasted, multilayer paint system C5-M-long to DIN EN ISO 12944-2 |

# 6 Main Bearing

| | |
|---|---|
| Housing: | Ductile cast iron, EN-GJS-400-18U-LT |
| Thrust bearing: | Double row taper roller bearing |
| Floating bearing: | Cylindrical roller bearing |
| Lubrication: | Grease-lubricated |

# 7 Main Gearbox

| | |
|---|---|
| Rated power: | 2750 kW |
| Type: | Multi-stage system consisting of at least 2 planetary stages and one helical gear stage |
| Gear ratio: | ≈ 1:100 |
| Lubrication: | 1 mechanical and 1 electrical pump |
| Fluid volume: | ≈ 500 liters (gearbox incl. cooling system) |
| Cooling: | Oil cooler mounted in the nacelle enclosure |

CONFIDENTIAL - Proprietary Information.
DO NOT COPY without written consent from GE Energy.
© 2005 GE Energy. All rights reserved.

# 8 Yaw System

| | |
|---|---|
| Number of yaw drives: | 4 |
| Drive system, motor type: | electrical, asynchronous |
| Voltage: | 690 V / 575 V |
| Frequency: | 50 Hz / 60 Hz |
| Yaw rate: | 0.5 °/sec |
| Yaw gear: | Multi-stage planetary gear |

# 9 Brake System

| | |
|---|---|
| Primary brake system: | Single blade pitch control (battery back-up) |
| Secondary brake system: | Single blade pitch control (battery back-up) |
| Holding brake: | Hydraulically driven brake caliper on high-speed shaft |

# 10 Generator

| | |
|---|---|
| Type: | Electrically excited synchronous machine |
| Rated output: | 2.64 MW |
| Rated speed: | 1650 $min^{-1}$ |
| Rated voltage: | 690 V |
| Apparent power: | 2780 kVA |
| Frequency at rated output: | 82.5 Hz |
| Protection class: | IP54 |
| Insulation class: | F |
| Function type: | S1 |
| Standard: | EN 60034-1 |
| Cooling system: | Air-to-air heat exchanger |

CONFIDENTIAL - Proprietary Information.
DO NOT COPY without written consent from GE Energy.
© 2005 GE Energy. All rights reserved.

# 11 Converter System

| | |
|---|---|
| Type: | 4-quadrant IGBT converter<br>for electrically excited synchronous generators |
| Maximum stator current: | 2450 A |
| Maximum line current: | 2620 A |
| Rated voltage, line side: | 690 V +/-10 % |
| Rated frequency: | 50 Hz / 60 Hz |
| cos φ: | 0.90 inductive to capacitive |
| Protection class of the electronics: | IP54 |
| Switching rate: | approx. 2.5 kHz |
| Cooling system: | Water cooling with water-to-air heat exchanger r<br>or air cooling |

# 12 Conditions for Grid Connection

| | |
|---|---|
| Rated grid voltage: | 10,000 – 24,000 V (optionally up to 36,000 V) |
| Rated voltage on the converter side: | 690 V +/-10 % |
| Rated grid frequency: | 50 Hz / 60 Hz |
| Permissible tolerance of the grid frequency: | +/- 5% |
| Tolerances of the grid voltage: | +15 % to +20 % for 0.1 sec<br>+10 % to +15 % for 1 sec<br>+/-10% continuously<br>-10 % to –15 % for 10 min<br>-15 % to –25 % for 10 sec<br>-25 % to –30 % for 1 sec |
| Impedance of the transformer for the grid connection: | 6 % |
| Transformer connection: | Dyn5 or Dyn11 |
| Transformer power: | 2800 kVA |

CONFIDENTIAL - Proprietary Information.
DO NOT COPY without written consent from GE Energy.
© 2005 GE Energy. All rights reserved.

# 13 Design Limits

| | |
|---|---|
| Design guideline and wind class: | DIBt WZ III / IEC TC IIa |
| Rotor diameter: | 88 m |
| Hub height: | 85 m |
| Average wind speed at hub height: | 8.5 m/s |
| Turbulence intensity (normal wind turbulence model): | 18 % |
| Survival wind speed: | 59.5 m/s |
| Cut-in wind speed: | 3.5 m/s |
| Cut-out wind speed: | 25 m/s |
| Rated power output (at medium voltage level): | 2.5 MW |
| Minimum ambient temperature operation / survival: | - 10 °C / - 20 °C |
| Maximum ambient temperature operation and survival: | + 40 °C |
| Noise emission (at 95 % of rated power) | < 106 dB(A) |
| Noise reduced operation: | < 105 dB(A) |

# 14 Permissible Ambient Temperatures

| | **Operation:** | **Survival:** | |
|---|---|---|---|
| Standard conditions: | - 10 °C < t < + 40 °C | - 20 °C < t | |
| Cold weather operation: | - 30 °C < t < + 40 °C | - 40 °C < t | (optional) |
| Hot weather operation: | - 10 °C < t < + 50 °C | | (optional) |

CONFIDENTIAL - Proprietary Information.
DO NOT COPY without written consent from GE Energy.
© 2005 GE Energy. All rights reserved.

# 15 Weights (approx.)

| | |
|---|---|
| Single rotor blade: | 8,300 kg |
| Nacelle with main bearing and yaw system: | < 55,000 kg |
| Gearbox: | 20,000 kg |
| Generator: | 9,000 kg |
| Hub (without blades): | 26,000 kg |

# 16 Oils and Greases used

## Drive Train:

| | |
|---|---|
| **Grease lubrication of main bearing:** | FAG Arcanol LOAD 400<br>approx. 20 kg |

**Gearbox:**

| | |
|---|---|
| Type of oil and quantity: | Optimol Optigear Synthetic A 320<br>500 liters (gearbox incl. cooling system) |
| Filters: | 2 combination filters 10/25 µm |

**Hydraulic system for brake:**

| | |
|---|---|
| Type of oil and quantity: | Mobil DTE 25<br>approx. 2.5 liters |

**Hydraulic system for rotor lock:**

| | |
|---|---|
| Type of oil and quantity: | Mobil DTE 25<br>approx. 35 liters |

CONFIDENTIAL - Proprietary Information.
DO NOT COPY without written consent from GE Energy.
© 2005 GE Energy. All rights reserved.

## Yaw System:

| | |
|---|---|
| **Gear:** | Planetary gear train of SMEI, Zollern, Liebherr |
| Type of oil and quantity: | Mobil SHC 630<br>approx. 15 liters |
| **Grease lubrication of yaw bearing:** | Fuchs Gleitmo 585 K |
| **Grease lubrication of gear ring and pinion:** | Ceplattyn BL / Fuchs Gleitmo 585 K |
| **Hydraulic system of brake:** | |
| Type of oil and quantity: | Mobil DTE 25<br>approx. 10 liters |

## Pitch System:

| | |
|---|---|
| **Gear:** | Planetary gear train of SMEI, Zollern, Liebherr |
| Type of oil and quantity: | Mobil Mobilgear SHC XMP 460<br>approx. 3.5 liters |
| **Grease lubrication of pitch bearing:** | Avia Avilub CTK (white) |
| **Grease lubrication of gear ring and pinion:** | Ceplattyn BL/ Avia Avilub CTK (white) |

## Generator:

| | |
|---|---|
| **Grease lubrication of the bearing:** | ESSO Unirex S2 |

## Transformer:

| | |
|---|---|
| **Silicone oil transformer:**<br>(transformer in the tower) | Dow Corning 561 Silicone Transformer Liquid<br>approx. 1250 l |
| **Oil-immersed transformer:**<br>(transformer in separate transformer station) | Nytro 10 GBN<br>approx. 1690 l |

CONFIDENTIAL - Proprietary Information.
DO NOT COPY without written consent from GE Energy.
© 2005 GE Energy. All rights reserved.