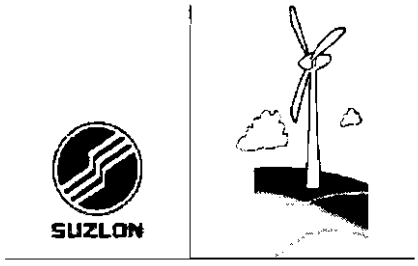

Technical Documentation

TECHNICAL DATA

S88-2.1 MW / ALL TURBINE TYPES

Project:	Standard WTG	
Document Number:	WD00121	
Document Class:	2	[3, 4 = Confidential]
Issue:	02	[01/06/2007]

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Overview Technical Documentation – Manuals

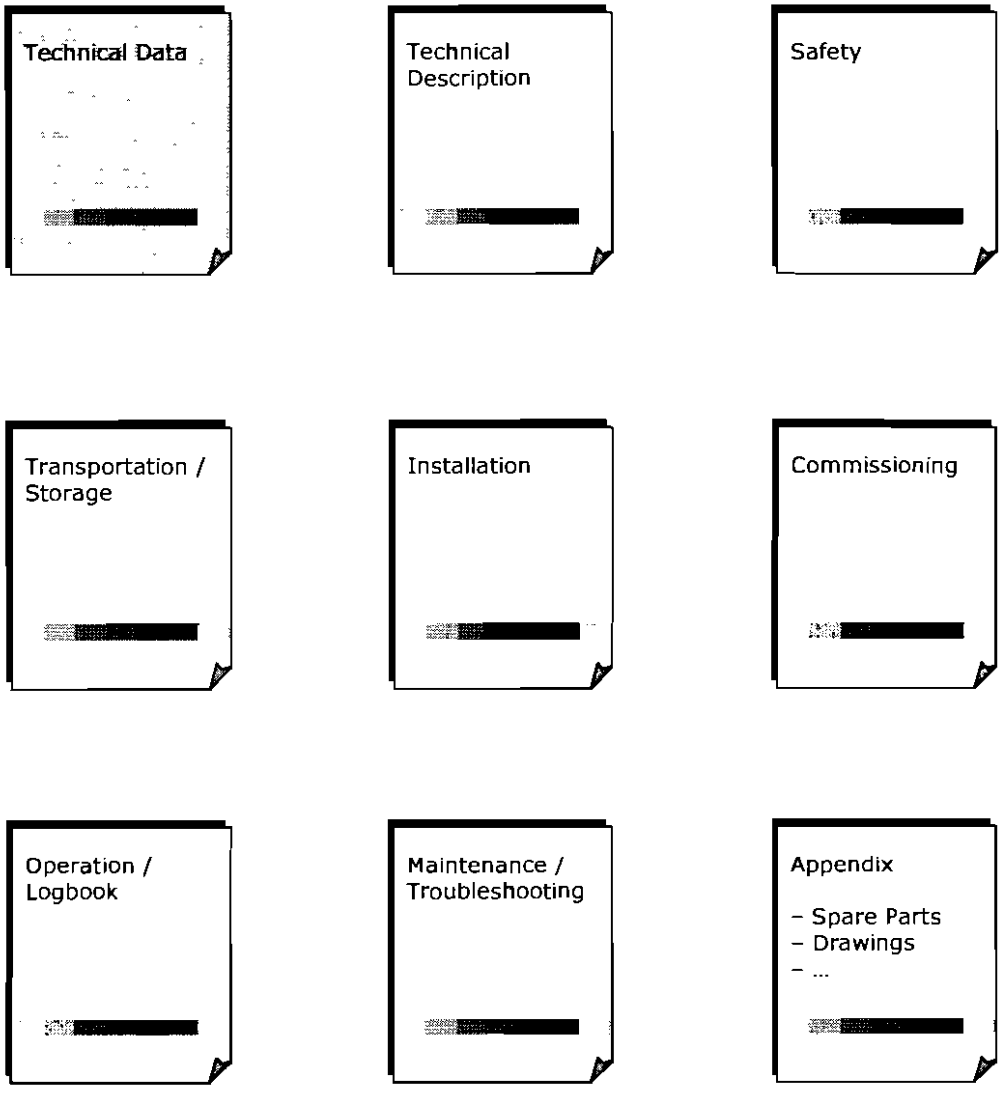

Table of Contents – Technical Data

1 Notes on Manuals

This document shows the technical data of the wind turbine generator (WTG). The manual is part of the system's Technical Documentation.

The Manual is meant for potential customers, project developers, bankers, authorities and other parties to give an overview of the technical data of the WTG.

The text contains abbreviations. The abbreviated terms are written in full notation when they are used first time in a chapter. The used abbreviation is written (in brackets) behind the full notation term.

For example: Wind Turbine Generator (WTG).

Pages, tables and figures are numbered consecutively.

The text contains cross references intended to guide the reader to further or more detailed information.

This documentation contains no safety instructions. Information about safety can be found in separate "Safety Manuals" (WD00060 and WD00061).

As the Suzlon WTGs are continually improved and further developed, we reserve the right of modifications.

1.1 Scope

This manual is valid for the S88-2.1 MW WTG in following variants:

- 50 Hz
- 60 Hz
- Standard Temperatue Version (STV)
- Low Temperature Version (LTV)
- Suzlon Control System (SCS)

1.2 Copyright

Adress of the manufacturer:

Suzlon Energy Ltd

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9 Koregaon Park Rd.

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www.suzlon.com | info@suzlon.com

2 Main Data

Description	All
Nominal Power	2.1 MW
Rotor diameter	88.0 m
Swept area	6,082 m²
Rotor height	79.0 m
Tower height	77.5 m
Foundation Level	Project specific (see Figure 2-1 on page 6)
Hub height	Project specific (Rotor height plus Foundation Level)
Rotational speed	15.0 to 17.6 rpm

2.1 Operational Parameters

Description	All
Cut in wind speed	4 m/s
High cut-out wind speed	25 m/s
Re-start wind speed	23 m/s

2.2 Illustration

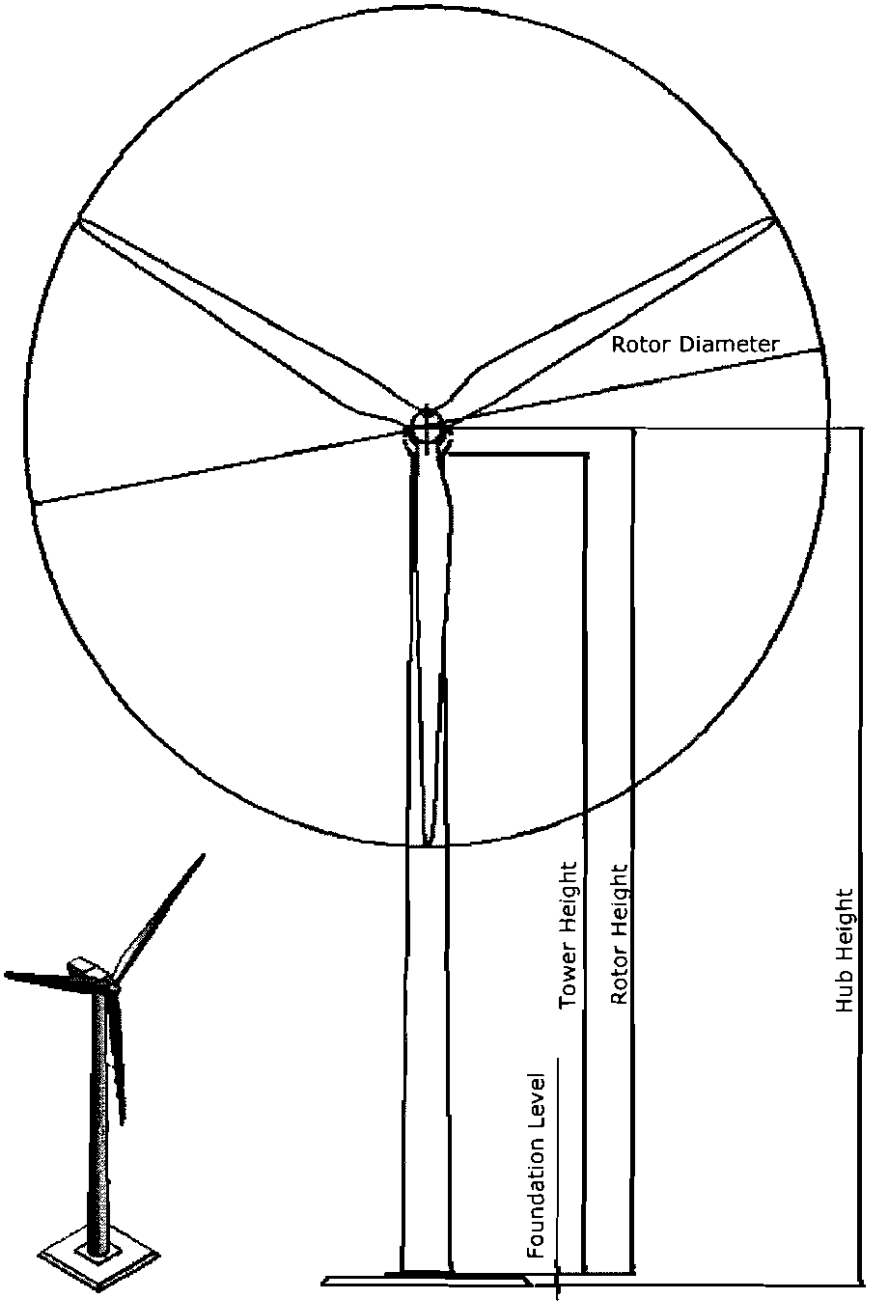

Figure 2-1: Suzlon WTG

3 Tower

Description	All
Material	Welded steel plate
Corrosion protection	– Double anticorrosion paint inside – Triple anticorrosion paint outside
Access	Internal, safety harness, ladder, elevator optional

4 Nacelle

4.1 Main Frame

Description	STV	LTV
Type description	Cast frame	
Material	EN-GJS-400-18U-LT	EN-GJS-350-22U-LT
Corrosion protection	Anticorrosion paint	

4.2 Main Bearing

Description	All
Type description	Spherical roller bearing
Number of	1

4.3 Main Bearing Housing

Description	STV	LTV
Type description	Cast housing, flanged feet	
Material	EN-GJS-400-18U-LT	EN-GJS-350-22U-LT
Number of	1	

4.4 Gear Box

Description	50 Hz	60 Hz
Type description	1 planetary stage, 2 helical stages	
Gear house material	Cast	
Ratio	1 : 98.8	1 : 118.1
Mechanical power	2.310 MW	
Shaft seals	Maintenance-free labyrinth	

4.5 Oil Pump

Description	50 Hz	60 Hz
Voltage (phase to phase)	3 × 690 V	3 × 600 V

4.6 Mechanical Brake

(for maintenance purposes only)

Description	All
Type description	– Hydraulic disc brake, activated by hydraulic pressure – Mechanical rotor lock, activated by hydraulic pressure
Brake disc	Steel, mounted on high speed shaft
Number of callipers	1

4.6.1 Hydraulic Power Unit for Mechanical Brake

Description	50 Hz	60 Hz
Voltage (phase to phase)	3 × 690 V	3 × 600 V
Maximum operation pressure	8 MPa (according to 80 bar)	
Oil capacity	0.0045 m^3 (according to 4.5 litre)	

4.7 Coupling

Description	All
Type description	Flexible coupling

4.8 Yaw System

4.8.1 Bearing

Description	All
Type description	Slide bearing with gear ring, automatic greasing system

4.8.2 Yaw Gear and Motors

Description	50 Hz	60 Hz
Type description	Electric motor with brake, gearbox and pinion	
Number of units	3	
Yaw speed	22.8 °/min	27.4 °/min
Voltage (phase to phase)	3 x 690 V	3 x 600 V

4.9 Generator System

Description	50 Hz	60 Hz
Type description	Single fed induction generator with slip rings, variable rotor resistance via SUZLON-FLEXISLIP System	
Rated power	2.100 MW	
Voltage stator (phase to phase)	690 V	600 V
Frequency	50 Hz	60 Hz
Number of poles	4	
Synchronous speed	1,500 rpm	1,800 rpm
Speed at rated power rotor short-circuited	1,511 rpm	1,812 rpm
Operation speed range with SUZLON-FLEXISLIP	1,489 to 1,511 rpm	1,800 to 2,100 rpm
Speed range for constant power with SUZLON-FLEXISLIP	1,512 to 1,750 rpm	1,836 to 2,100 rpm
Reference speed SUZLON-FLEXISLIP	1,545 rpm	1,860 rpm
Max. rotor slip	16.7%	
Power factor (uncompensated)	0.92	
Nominal current	1,895 A	2,190 A
Winding connection of stator	Delta (△)	
Winding connection of rotor	Wye (Y)	
Protection class (Generator)	IP54	
Protection class (Slip ring unit)	IP23	
Thermal classification	Class H	
SUZLON-FLEXISLIP rated power	60 kW	
SUZLON-FLEXISLIP peak power	300 kW	

5 Rotor

Description	All
Number of blades	3
Rotor cone angle	5°
Rotor diameter	88.0 m
Swept area	6,082 m²
Rotor speed (at rated power)	15.47 rpm
Tip speed (at rated power)	71.0 m/s
Rotor shaft tilt	4°
Power regulation	Pitch / SUZLON-FLEXISLIP SYSTEM
Rotor orientation	Upwind

5.1 Hub

Description	STV	LTV
Type description	Cast spherical hub	
Material	EN-GJS-400-18U-LT	EN-GJS-350-22U-LT
Corrosion protection	Anticorrosion paint	

5.2 Rotor Blades

Description	All
Type description	AE43-V3-R07
Blade length	43.25 m
Material	Fibre glass / Epoxy
Type of rotor air brake	Pitch / Full blade
Blade profiles	TU Delft family / NACA

5.3 Rotor Shaft

Description	STV	LTV
Type description	Forged shaft and flange	
Material	42CrMoS4	34CrNiMo6
Corrosion protection	Anticorrosion paint	

5.4 Pitch System

Description	All
Type description	Electrical
Drives	1 electric motor with gearbox and electrical brake per blade
Backup system	1 battery set per blade
Pitch angle range	95°
Pitch speed	0.1 to 10.0 °/s

6 Wind Turbine Main Panel / CPU Panel

Description	50 Hz	60 Hz
Voltage (phase to phase)	3 x 690 V	3 x 600 V
Frequency	50 Hz	60 Hz
Cut-in system	Soft-starters using thyristors	

7 Electrical Grid Connection

Description	50 Hz	60 Hz
Maximum voltage increasing continuously	+10%	
Maximum voltage decreasing continuously	-10%	
Continuous frequency variations	-6% to +5%	
Maximum asymmetric current of nominal current	5%	
Maximum asymmetric voltage (phase to ground) for 60 s	2%	
Maximum short circuit current (phase to phase)	27 kA at 690 V	27 kA at 600 V
Turbine will shut down immediately when parameters above are exceeded		
Switch off time due to main switch delay	100 ms	

7.1 Specified *EXTERNAL* transformer data (*option 1*)

Description	50 Hz	60 Hz
Type	Oil Hermetic Transformer	
Cooling	ONAN	
Connection	Delta / Star (Δ / Y)	
Vector group	Dyn5 / Dyn11 (dependent on grid)	
Nominal apparent power	2,500 kVA	
Nominal winding ratio	(XX) kV / 0.69 kV	(XX) kV / 0.6 kV
	(voltage level of primary side is project specific)	
Tapping	At HV ±5% in 2.5% steps	
Reactance	6%	
Losses at no load	About 2,500 W	
Losses at full load	26,500 W	

7.2 Specified *INTERNAL* transformer data (*option 2*)

Description	50 Hz	60 Hz
Type	BIO-SLIM Transformer	
Cooling	KNAN	
Connection	Delta / Star (Δ / Y)	
Vector group	Dyn5 / Dyn11 (dependent on grid)	
Nominal apparent power	2,500 kVA	
Nominal winding ratio	(XX) kV / 0.69 kV	(XX) kV / 0.6 kV
	(voltage level of primary side is project specific)	
Tapping	At HV ±5% in 2.5% steps	

Description	50 Hz	60 Hz
Reactance	6%	
Losses at no load	About 2,400 W	
Losses at full load at 75°	19,600 W	
Losses at full load at 120°	22,000 W	
MV switchgear appending to INTERNAL Transformer	Appending to internal transformer only	
Type	SF6-switchgear	
Max. service voltage	12 kV / 24 kV / 36 kV (dependent on grid)	
Rated current bus bars	1,250 A	
Rated current feeder	630 A / 1,250 A	
Rated short time current	16 kA / 20 kA	
Rated short circuit duration	3 s	
Rated making current	40 kA / 50 kA	
Rated lightning impulse withstand voltage	75 kA / 125 kA / 170 kA	
Rated power frequency withstand voltage	28 kA / 50 kA / 70 kA	
Rated frequency	50 Hz / 60 Hz	
Degree of protection of primary section	IP 65	
Degree of protection of secondary section	IP 40	
Rated SF6 pressure abs.	136 kPa	
Service SF6 pressure abs.	120 kPa	
Feeder 1 / 2 / (3)	Load break switch panel 630 A / earth switch Capacity Voltage Indicators	
Feeder 4	Circuit breaker 630 A / earth switch Protection Equipment Transformer Capacity Voltage Indicators	

8 Power Factor Compensation

Description	50 Hz	60 Hz
Type	Switched capacitor banks	
Voltage	3 × 690 V	3 × 600 V
Capacity	14 × 75 kvar	14 × 68.1 kvar
Power factor	Adjustable via software, default value = 0.99	
Range	0.92 lagging to 0.997 leading	0.92 lagging to 0.9995 leading

9 Climate and Site Conditions

Description	STV	LTV
Regarding structural design: Wind Class IIa, according to GL Wind Guidelines 1.0, Edition 2003, supplemented by GL Wind Guidelines 1.1, Edition 2004		
Life expectancy of design	20 years	
Temperature range – operation	-10 °C to +40 °C	-30 °C to +40 °C
Temperature range – structure	-20 °C to +50 °C	-40 °C to +50 °C
A-factor	9.59 m/s	
Form factor, c	2.0	
Annual average wind speed	8.5 m/s	
Vertical wind shear exponent	0.2	
Extreme wind speed	42.5 m/s	
Survival wind speed	59.5 m/s	
Automatic stop limit	25 m/s	
Characteristic turbulence intensity acc. to IEC 61400-1 (15 m/s)	18.0%	
Air density	1.225 kg/m³	
Ice/snow on blades (for calculation of structural design)	Yes	

9.1 Humidity conditions

Description	All
Allowable relative ambient humidity	30 to 99%
Allowable relative humidity during operation outside cabinet inside turbine	30 to 99% (no precipitation)
Allowable relative humidity during operation inside cabinet	20 to 80% (no precipitation)

9.2 Level of installation

Description	All
Maximum height of installation	1000 m over sea level

10 Power Curve / Acoustic Emission

Description	All
Guaranteed Power, C_p and C_t Curves	See separate documentation WD90005-02-00
Sound Power Level	See separate documentation WD90012-02-00