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Comune di :
Alberona

PROVINCIA DI FOGGIA

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OPERA

PROGETTO PER IL RIFACIMENTO E POTENZIAMENTO DI UN PARCO EOLICO ESISTENTE NEL COMUNE DI ALBERONA

OGGETTO

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SCHEDA TECNICA AEROGENERATORE

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N° REVISIONE	DATA	OGGETTO DELLA REVISIONE	ELABORAZIONE	APPROVAZIONE
02	Marzo 2024	Revisione progettuale per ottimizzazione layout	Studio Mezzina	IVPC s.r.l.
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00	Settembre 2022	Emissione progetto definitivo	Studio Mezzina	IVPC s.r.l.

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Technical Documentation
Wind Turbine Generator Systems
Cypress 158 - 50/60Hz

WT General Description

Rev. 10 - Doc-0075288 - EN   2022-06-03

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- Original Document -

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Rev.	Date (YYYY/MM/DD)	Affected Pages	Change Description
08	2021/11/19	14	MODIFIED section 2.2 UPDATED Table 5 CHANGED values for B1, D1, D4 and new on the list B3 and B4 UPDATED table chapter 3 table 1 UPDATED CW Temperature range chapter 3.1 table 3
09	2022/03/15	5	ADDED new HH for Japan
		8	ADDED Japan specific lightning protection details
		11, 12	ADDED new HH for Japan in table 3 and table 4
10	2022/06/03	4	ADDED Acronym table
		5	RENAMED section 1
		9	ADDED Nacelle Crane and Rescue Equipment information
		5, 7, 10	UPDATED wordings of section 2, 2.3, 3
		5, 10, 11	ADDED 6.3 configuration
		14	ADDED Reference section

Acronyms and Definitions

Acronym	Definition
SCADA	Supervisory Control and Data Acquisition
LNTE	Low Noise Trailing Edge
CHT	Concrete Hybrid Tower
LEP	Leading Edge Protection
TFB	Tower Flange Bolts
STW	Standard Weather
CW	Cold Weather
HSS	High Speed Shaft
NDE	Non-Drive End
HPU	Hydraulic Power Unit
WTGS	Wind Turbine Generator System

1 Purpose of the Document

The purpose of this document is to summarize the general descriptions and specifications of the Cypress wind turbine and its primary components.

2 General Description of the Wind Turbine and Major Components

Cypress is a three-bladed, upwind, horizontal-axis wind turbine with a rotor diameter of 158 meters. The turbine rotor and machine head are mounted on top of:

- a tubular steel tower with a hub height of 96 m
- a tubular steel tower with a hub height of 101 m (config supports up to 6.1)
- a tubular steel tower with a hub height of 100.4 m (for Japan market only)
- a tubular steel tower with a hub height of 107.4 m
- a tubular steel tower with a hub height of 117 m (config supports up to 6.1)
- a tubular steel tower with a hub height of 120.9 m (config supports up to 6.3)
- a tubular steel tower with a hub height of 125.4 m (config supports up to 6.1)
- a tubular steel tower with a hub height of 141 m
- a concrete hybrid tower with a hub height of 150 m
- a tubular steel tower with a hub height of 151 m
- a concrete hybrid tower with a hub height of 161 m (config supports up to 6.3)

The Cypress wind turbine employs active yaw control (designed to steer the wind turbine with respect to the wind direction), active blade pitch control (to control turbine rotor speed) and a variable speed generator with a power electronic converter system.

The Cypress wind turbine features a modular drivetrain design where the primary drivetrain components, including main shaft bearing, gearbox, generator and yaw drives, are attached to a bedplate.

2.1 Rotor

Rotor speed is regulated by a combination of blade pitch angle adjustment and generator/converter torque control. The rotor spins in a clockwise direction under normal operating conditions when viewed from an upwind location.

Full blade pitch angle range is approximately 90 degrees, with the zero-degree position being with the blade flat to the prevailing wind. Pitching the blades to a full feather pitch angle of approximately 90 degrees accomplishes aerodynamic braking of the rotor, thus reduces the rotor speed.

2.2 Blades

There are three logistics optimized rotor blades used on the Cypress wind turbines. Optionally, the blades can have Leading Edge Protection (LEP).

In order to optimize noise emissions, the rotor blades are attached with Low-Noise-Trailing-Edges (LNTEs) at the pressure side of the blade's rear edge. LNTEs are thin jagged plastic strips. The rotor blades of the Cypress wind turbines are attached with these strips at the factory.

Figure 1: LNTEs at the wind turbine rotor blade

Blade Split

For easy transportation of blade, GE developed a solution with a split blade which has transportation requirements comparable to 137 m rotor product. The two parts of the blade are connected with a mechanical connection which has been extensively tested. The blade is also available in one piece; for turbines with the Ice Mitigation System, it is always one piece.

2.3 Blade Pitch Control System

The rotor uses a pitch system for adjustment of the blade pitch angle during operation.

The active pitch controller enables the wind turbine rotor to control speed. When above rated wind speed, the blade will rotate, or feather, the blade to “spill” aerodynamic lift and slow the rotor. When below rated wind speed, energy from wind gusts is captured as the rotor speeds up.

Independent back up is provided to feather the blades and shut down the wind turbine in the event of a grid line outage or other fault.

2.4 Hub

The hub is used to connect the three rotor blades to the turbine main shaft. The hub also houses the blade pitch system and is mounted directly to the main shaft. To carry out maintenance work, the hub can be entered through one of three hatches at the area nearer to the nacelle roof.

2.5 Gearbox

The gearbox in the wind turbine is designed to transmit torsional power between the low-rpm turbine rotor and high-rpm electric generator. The gearbox is a multi-stage planetary/helical design. The gearbox is mounted to the wind turbine bedplate. The gearbox mounting is designed to decrease vibration and noise transfer to the bedplate. The gearbox is lubricated by a forced, cooled lubrication system and a filter assist to maintain oil cleanliness.

2.6 Bearings

The blade pitch bearing is designed to allow the blade to pitch about a span-wise pitch axis. The inner race of the blade pitch bearing is outfitted with a blade drive gear that enables the blade to pitch.

The spherical roller main bearing supports and aligns the main shaft to the main gearbox and is absorbing radial and axial loads from the rotor.

2.7 Brake System

The blade pitch system acts as the primary braking system for the wind turbine. Braking under usual operating conditions is accomplished by feathering the blades out of the wind. Only two feathered rotor blades are required to slower the rotor safely into idling mode, and each rotor blade has its own backup to move the blade in the event of a grid line loss.

2.8 Generator

The generator is a doubly fed induction generator. It is mounted to the generator frame with a mounting designed to decrease vibration and noise transfer to machine.

2.9 Gearbox/Generator Coupling

For protection of the drive train from excessive torque loads, a special coupling with a torque-limiting device is provided between the generator and gearbox output shaft.

2.10 Yaw System

A bearing positioned between the machine head and tower facilitates yaw motion. Yaw drives mesh with the gear of the yaw bearing and steer the wind turbine to monitor the wind in yaw. The yaw drive system contains an automatic yaw brake. This brake engages when the yaw drive is not operating and prevents the yaw drives from being loaded due to turbulent wind conditions.

The controller activates the yaw drives to align the nacelle to the wind direction based on the wind vane sensor mounted on the top of the nacelle.

The wind turbine records machine head yaw position following excessive rotation in one direction, the controller automatically brings the rotor to a complete stop, untwists the internal cables, and restarts the wind turbine.

2.11 Tower

The wind turbine is mounted on top of a tubular steel tower (or a hybrid tower). Access to the turbine is through a door at the base of the tower. Internal service platforms and interior lighting is included. A ladder provides access to the nacelle and also supports a fall arrest safety system.

Optional climb assist or service lifts are available on request.

2.12 Nacelle

The nacelle houses the primary components of the wind turbine generator. Access from the tower into the nacelle is through the bottom of the nacelle. The nacelle is ventilated and illuminated by electric lights. A hatch provides access to the blades and hub. The nacelle enclosure floor is designed to collect liquids (e.g., oil, grease) in cases of leakage with a safety factor of 1.5. Such function has been proven by a test.

2.13 Wind Sensor and Lightning Rod

An ultrasonic wind sensor and lightning rod are mounted on top of the nacelle housing. Access is accomplished through the hatch in the nacelle.

2.14 Lightning Protection (according to IEC 61400-24 Level I)

The rotor blades have the lightning receptors mounted in the blade. The turbine is grounded and shielded to protect against lightning; however, lightning is an unpredictable force of nature, and it is possible that a lightning strike could damage different components notwithstanding the lightning protection used in the wind turbine.

Cypress Japan configurations (50Hz & 60Hz) have higher lightning protection in line with ‘winter lightning’ as per IEC 61400-24. Please refer to the latest revised edition of Japan specific Lightning protection document for details (Lightning_Protection_Cypress-xxHz_Japan_158m_EN_Doc-0088782).

2.15 Wind Turbine Control System

The wind turbine can be controlled locally. Control signals can also be sent from a remote computer through a Supervisory Control and Data Acquisition System (SCADA), with local lockout function given at the turbine controller.

Service switches at the tower top prevent service personnel at the bottom of the tower from operating specified systems of the turbine while service personnel are in the nacelle. To override any wind turbine operation, emergency-stop buttons located in the tower base and in the nacelle can be activated to stop the turbine in the event of an emergency.

2.16 Power Converter

The wind turbine uses a power converter system that consists of a converter on the rotor side, a DC intermediate circuit, and a power inverter on the grid side.

The converter system consists of a power module and the related electrical equipment.

2.17 Transformer and Medium Voltage Switch Gear

Transformer

The three winding transformer is located at the rear of the nacelle. The transformer is a dry type transformer supporting medium voltage range of 10 - 35 kV range. The transformer is fully separated from the remaining machine head. The transformer is in GE scope, a pad mounted variant is not available.

Medium Voltage Switchgear

The medium voltage switchgear is mounted in the tower entry area.

2.18 Rescue Equipment

The machine head is equipped with rescue equipment as standard to enable the evacuation of up to two persons simultaneously from the machine head. The rescue equipment is designed and installed in accordance with the local regulations of the country of installation.

2.19 Nacelle Crane

The design of the crane is to allow for permanently mounted onboard style crane at the center of the machine head near the top panel as a permanent crane parking position. There are three other defined positions inside the machine head for crane usage to lift/lower the loads.

3 Technical Data for the Cypress Wind Turbines

Turbine	4.2/4.5/4.8/5.0/5.2/5.3/5.5/5.8/6.1/6.3 - 158
Rated output [MW]	4.2/4.5/4.8/5.0/5.2/5.3/5.5/5.8/6.1/6.3
Rotor diameter [m]	158
Number of blades	3
Swept area [m²]	19607
Rotational direction (viewed from an upwind location)	Clockwise
Maximum speed of the blade tips [m/s]	50Hz - 82.0 m/s 60Hz - 83.6 m/s
Orientation	Upwind
Speed regulation	Pitch control
Aerodynamic brake	Full feathering
Color of outer components	RAL 7035 (light grey) and RAL 7023 (concrete grey, for concrete sections of hybrid tower only)
Reflection degree/Gloss degree Steel tower	30 - 60 gloss units measured at 60° as per ISO 2813
Reflection degree/Gloss degree Rotor blades, Nacelle, Hub	60 - 80 gloss units measured at 60° as per ISO 2813
Reflection degree/Gloss degree Hybrid Tower	Concrete gray (similar RAL 7023); gloss matte

Table 1: Technical data Cypress-158 wind turbine

Atmospheric corrosion protection (corrosion categories as defined by ISO 12944 2:2017)	
Tower Shell Coating internal/external	C-2/C-3 (standard)/ C-4/C-5 (enhanced)
Tower Flange Bolts (TFB) internal/external	C-4/C-4 (standard) / C-4/C-4 (enhanced)
Tower Mechanical Fasteners and internals internal/external	C-3/C-3 (standard) / C-3/C-5 (enhanced)
Hub internal/external	C-5/C-5
Nacelle & Hub Fasteners internal/external	C-3/C-5
Automatic Lubrication System, Yaw Drive Bolts internal	C-3
Pitch Motor, Pitch Gearbox internal	C-4
Main Shaft, Pillow Block, Gearbox internal	C-4
Bedplate, Generator Frame internal	C-5

Table 2: Atmospheric corrosion protection

3.1 Operational Limits

Turbine	**4.2/4.5/4.8/5.0/5.2/5.3/5.5/5.8/6.1/6.3 - 158**
Hub height	96 m tubular steel tower (only 50Hz) 100.4 m tubular steel tower (50/60Hz) (Japan market only) 101 m tubular steel tower (50/60Hz) 107.4 m tubular steel tower (only 60Hz) 117 m tubular steel tower (only 60Hz) 120.9 m tubular steel tower (only 50Hz) 125.4 m tubular steel (only 60Hz) 141 m tubular steel tower (only 50Hz) 150 m hybrid tower (only 50Hz) 151 tubular steel tower (only 50Hz) 161 m hybrid tower (only 50Hz)
Wind turbine design standard	* IEC 61400-1, Ed. 3 ** DIBt 2012
Height above sea level	Maximum 1000 m with the maximum standard operational temperature of up to +40 °C. Above 1000 m, the maximum operational temperature is reduced per DIN IEC 60034 1 (e.g., maximum operational temperature reduced up to +30 °C at 2000 m). For installations above 1000 m isolation distances of medium voltage terminals must also be re-evaluated. De-rated operation additionally driven by ambient temperature, power rating or specific grid requirements and conditions may occur. Details on these can be found in Hot Weather High Altitude and the Grid Interconnection documentation.
Standard Weather Option (STW)	Operation from -15 °C up to +40 °C. De-rated operation driven by ambient temperature, power rating or specific grid requirements and conditions may occur. Details on these can be found in Hot Weather High Altitude and Grid Interconnection documentation. Survival temperature of -20 °C to +50 °C without the grid. Survival means turbine not in operation including the heat transfer system due to lack of energy supply by the grid.
Cold Weather Option (CW)	Operation from -30 °C up to +40 °C. De-rated operation driven by ambient temperature, power rating or specific grid requirements and conditions may occur. Details on these can be found in Cold Weather Options, Hot Weather High Altitiude and Grid Interconnection documentation. Survive extreme temperature of -40 °C to +50 °C without the grid. Survive means: turbine not in operation including the heat transfer system due to lack of energy supply by the grid.
Wind class	IEC S + WZ (S)

Table 3: Operational limits

3.2 Cypress Overview Drawing and Dimensions

This chapter presents an overview of the relevant dimensions for the wind energy turbine with 158 m rotor diameter.

The table shown below fits to the GE drawing 450W1333.

Description		Dimension for hub height in [m]										
		96 m (tubular steel tower)	**100.4 m (tubular steel tower-Japan only)**	**101 m (tubular steel tower)**	**107.4 m (tubular steel tower 60Hz only)**	**117m (tubular steel tower 60Hz only)**	**120.9 m (tubular steel tower)**	**125.4 m (tubular steel tower 60Hz only)**	**141 m (tubular steel tower)**	**150 m (hybrid tower)**	**151 m (tubular steel tower)**	**161 m (hybrid tower)**
Hub height [m]	A2	96	100.4	101	107.4	117	120.9	125.4	141	150	151	161
Total height [m]	A3	175	179.4	180	186.4	196	199.9	204.4	220	229	230	240
Height upper daylight identification (Only when required) [m]	A4	-	-	60	60	-	60	60	60	60	-	60
Height lower daylight identification (Only when required) [m]	A5	-	-	40	40	-	40	40	40	40	-	40
Top of soil to top of foundation EU [m]	A6	1.3	-	1.3		-	1.3			1.51		1.31
Top of soil to top of foundation Australia [m]	A6	0.2	-	0.2		-	0.2			-		-
Top of soil to top of foundation Australia & North America [m]	A6	0.745	-	0.745	0.745	0.745	-	0.745	-	-		-
Top of soil to top of foundation Japan [m]			*									
Height aviation light [m]	A7	100 ∓1	104 ∓1	105 ∓1	111.7 ∓1	-	125 ∓1	129 ∓1	145 ∓1	154 ∓1		165 ∓1
Foundation diameter [m]	B2	22	*	22	20-25	20-25	25.8	20-25	25.8	23.5 and 25		23.5 and 25
Distance aviation lights (only when required) [m]	C1		NA	52.5 ∓4	52.5 ∓4	-	62.5 ∓4	62.5 ∓4	72.5 ∓4	77 ∓4		82.5 ∓4
Tower bottom diameter [m]	C7	4.3	4.8	4.3	4.3	4.56	4.3	4.3	5	7.9	5.3	8.5

Table 4: Cypress Dimension Overview

* Depends on customer specific foundation design

General information for all hub heights		
Description	**Parameter**	**Dimension**
Rotor diameter	A1	158 m
Longest chord	A8	4.0 m
Chord at 90% rotor radius	A9	1.35 m
Aviation light spacing on machine head	B1	~ 4.4 m
Blade tip distance in ideal position	C2	9.55 m
Blade tip distance in operation position	C3	5.55 m
Blade tip distance in ideal position	C4	20.48 m
Blade tip distance in operation position	C5	16.53 m
Tower top diameter	C6	3.7 m
Nacelle length (incl. ventilation outlets)	D1	~ 12.8 m (~ 13.2 m)
Distance from Yaw Bearing to Centre line crossing	D2	1.38 m
Aviation marking stripe width	D3	2 m
Nacelle height	D4	~ 3.8 m
Distance tower center - hub center	D5	4.17 m
Overhang	D6	4.18 m
Distance tower top - hub center	D7	1.92 m
Tilt drivetrain	D8	4°
cone angle	D9	85°
Eccentricity area in idle	B3	20314,95 m^2
Eccentricity area in operation	B4	19989,58 m^2

Table 5: General information for all hub heights

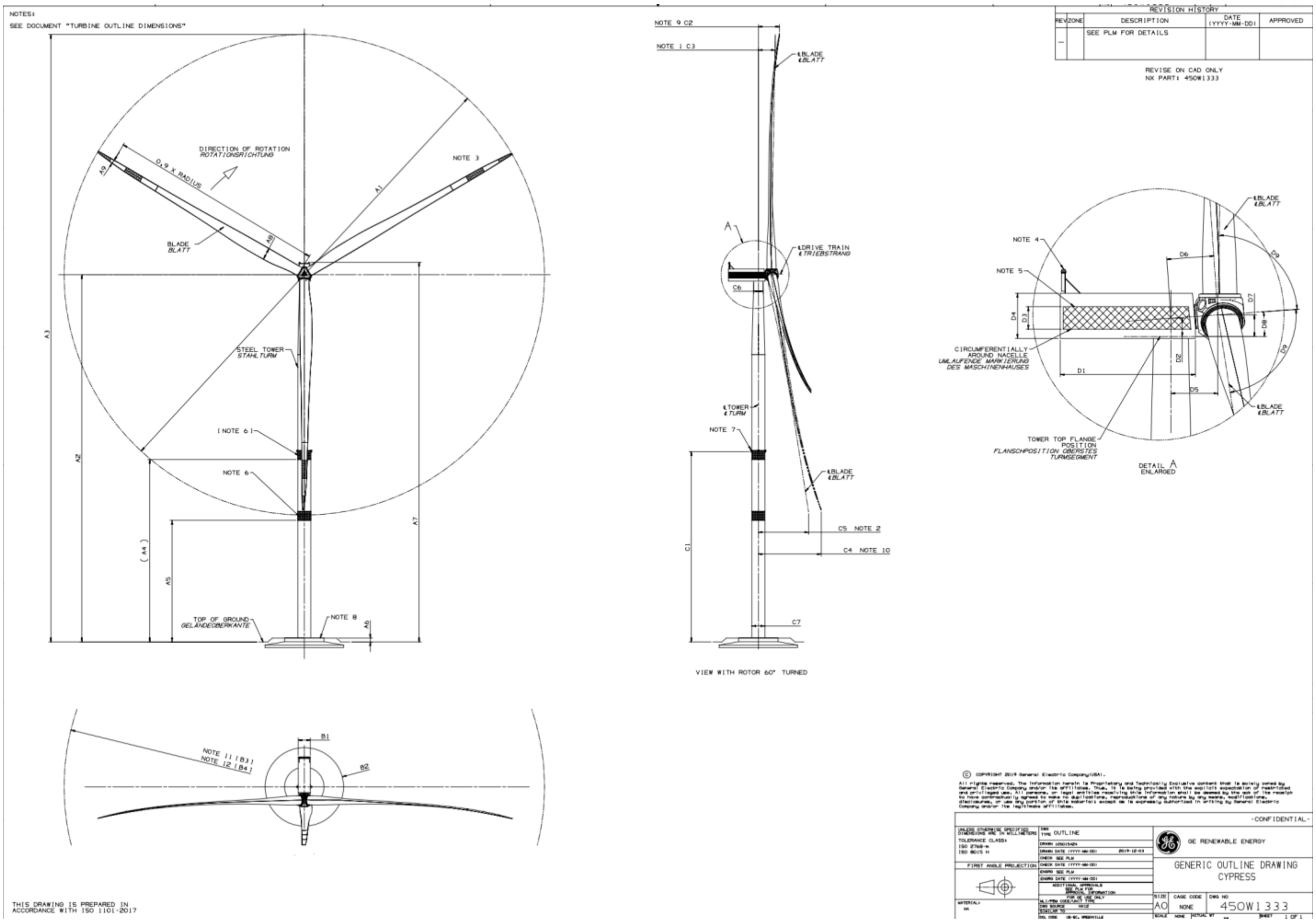

Figure 2: Generic outline drawing Cypress 450W1333

NOTE: Generic outline drawing 450W1333 is attached to this file as a separate document.

4 References

1. IEC 61400-1: Wind turbines Part 1: Design requirements
2. DIBt 2012: Fluid & Energy Engineering
3. IEC 60034 1: Rotating electrical machines – Part 1: Rating and performance
4. ISO 12944 2:2017: Paints and varnishes - Part 2: Corrosion protection of steel structures by protective paint systems - Classification of environments
5. ISO 2813: Paints and varnishes — Determination of gloss value at 20°, 60° and 85°
6. IEC 61400-24: Wind energy generation systems - Part 24: Lightning protection

GE Renewable Energy

- Original Document -

Technical Documentation Wind Turbine Generator Systems 4.x/5.x/6.x-158 - 50 Hz

Product Acoustic Specifications

According to IEC 61400-11

Incl. Octave and 1/3rd Octave Band Spectra

LNTE: Included

Rev. 02 - EN 2022-06-08

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Document Revision Table

Rev.	Date (YYYY/MM/DD)	Affected Pages	Change Description
1	2022/05/13	-	Initial Release
02	2022/06/08	-	ADDED 6.3 rating
		7	ADDED section 4 and section 5
		7	UPDATED section 6

1 Introduction

1.1 General

This document summarizes the acoustic emission characteristics of the 4.x/5.x/6.x-158 50Hz wind turbine for all available modes of operation, including apparent sound power levels $L_{WA,k}$, as well as uncertainty levels associated with the sound power levels, and octave and 1/3rd-octave band apparent sound power levels.

All provided sound power levels are A-weighted.

GE continuously verifies specifications with measurements, including those performed by independent institutes.

1.2 Wind Farm Noise Management (available as an option)

In noise-constrained areas it is often necessary to adapt the wind turbine operation to satisfy far-field noise limits. GE offers a dedicated Farm Noise Management system that provides greater flexibility and higher energy yield than standard turbine controls. This advanced scheme allows to continuously adjust the farm operation based on the environmental variables that influence farm noise emission, essentially wind speed and wind direction.

The Wind Farm Noise Management package includes the following service and hardware:

- Park level noise propagation modeling and optimization of wind farm operation,
- Table with optimum turbine set-points across the park as a function of wind speed and wind sector, and
- Installation and commissioning of the Farm Noise Management Software Package.

2 Overview of Configurations

The following table presents an overview of the configurations associated with each nominal apparent sound power level.

For each nominal sound power level, there is a corresponding nominal rotor speed and in some cases several nominal electrical power levels. For example, 106 dBA can be achieved at 9.7 rpm with nominal electrical power levels from 4800 kW to 6300 kW

The electrical power rating values may vary with actual turbulent conditions on site. More detailed information to the power performance can be found in the NRO power curve documents for this product.

Modes which are not available for 24/7 operation (Noise Reduced Operation modes) are intended and designed to achieve lower peak noise emission levels while optimizing turbine power performance. The main objective is to provide sound power levels aligned with the stricter noise emission requirements typically enforced during limited periods of time only. It is not expected that wind turbines would permanently operate in a given NRO setting, but rather would switch from Normal Operation to Noise Reduced Operation as needed for a fraction of the day. A continuous NRO activity would require a dedicated assessment from GE.

Nominal Sound Power Level (dBA)	Nominal Rotor Speed (rpm)	Nominal Electrical Power (kW) for each Hub Height					
		101.0m	120.9m	141.0m	150.0m	151.0m	161.0m
107.0	9.90	4800 - 6100*	4800 - 6100*	N/A	N/A	4800 - 6100*	4800 - 6100*
106.0	9.70	4800 - 6300*	4800 - 6300*†	4800 - 6300*	4800 - 6300*	4800 - 6300*	4800 - 6300*
105.0	9.35	4800 - 5300	N/A	4800 - 5300	4800 - 5300	4800 - 5300	4800 - 5300
104.0	9.00	4800 - 5100*	N/A	4800 - 5100	4800 - 5100	4800 - 5100	4800 - 5100*
103.0	8.54	4800	4800†	4800†	4800	4800	4800
102.0	8.20	4650	4650	N/A	4650	4650	4650
101.0	7.66	4300	4300	N/A	4300	N/A	4300
100.0	7.22	4042	4042	4042†	4042	N/A	4042
99.0	6.70	3507	3507	3507	3507	3507	3507
98.0	6.26	3098	3098	3098	3098	3098	3098

Table 1: Overview of configurations for each apparent sound power level.

* Available for 24/7 operation.
† Applicability dependent on tower design.

3 Apparent Sound Power Levels as a Function of Wind Speed

The following table presents calculated reference apparent sound power levels as a function of hub height wind speed.

Hub Height Wind Speed (m/s)	107.0 Mode	106.0 Mode	105.0 Mode	104.0 Mode	103.0 Mode	102.0 Mode	101.0 Mode	100.0 Mode	99.0 Mode	98.0 Mode
4	93.8	93.8	93.8	93.8	93.8	93.8	93.8	93.8	93.8	93.8
5	94.5	94.5	94.5	94.5	94.5	94.5	94.5	94.5	94.5	94.5
6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6	97.6
7	101.0	101.0	101.0	101.0	101.0	101.0	101.0	100.0	99.0	98.0
8	103.9	103.9	103.7	103.5	103.0	102.0	101.0	100.0	99.0	98.0
9	106.2	106.0	105.0	104.0	103.0	102.0	101.0	100.0	99.0	98.0
10	107.0	106.0	105.0	104.0	103.0	102.0	101.0	100.0	99.0	98.0
11	107.0	106.0	105.0	104.0	103.0	102.0	101.0	100.0	99.0	98.0
12	107.0	106.0	105.0	104.0	103.0	102.0	101.0	100.0	99.0	98.0
13	107.0	106.0	105.0	104.0	103.0	102.0	101.0	100.0	99.0	98.0
14	107.0	106.0	105.0	104.0	103.0	102.0	101.0	100.0	99.0	98.0
15	107.0	106.0	105.0	104.0	103.0	102.0	101.0	100.0	99.0	98.0

Table 2: Reference apparent sound power levels

4 Sound Power Levels with Leading Edge Protection

In the case where Leading Edge Protection (abbreviated as LEP) is applied to the rotor blades, all the acoustic data provided within this document, namely sound power levels, octave band and one-third octave band spectral levels, must be increased by 1 dB.

5 Sound Power Levels with Sand Protection System

The acoustic data provided in this document do not apply to turbines with sand protection system.

6 Octave Band Spectra and 1/3rd Octave Band Spectra

Octave band and 1/3rd octave band apparent sound power level values are provided in the attached excel-file for all available Noise Reduced Operation modes at different hub height wind speeds.

7 Uncertainty Levels

The apparent sound power levels given above are mean values of representative batches of turbines under evaluation. Uncertainty levels are not included. The uncertainty levels **u_c, σ_P, σ_R** and **σ_T** associated with measurements and mean values are described in IEC 61400-11 and IEC/TS 61400-14.

For GE wind turbines, a typical value of **σ_P** = 0.8 dB can be assumed.

The uncertainties for octave and 1/3rd-octave sound power levels are generally higher than for total sound power levels. Guidance is given in IEC 61400-11.

8 IEC 61400-11 and IEC/TS 61400-14 Terminology

- $L_{WA,K}$ is the wind turbine apparent sound power level (referenced to 10^{-12}W) measured with A-weighting as a function of wind speed. Derived from multiple measurement reports per IEC 61400-11, it is considered to be a mean value.
- u_c is the measurement uncertainty for acoustic testing as defined in IEC 61400-11. It is not a characteristic of the product, but of the measurement, and cannot be specified by GE. For average testing conditions, typical values of u_c are 0.7 dB – 1.0 dB.
- σ_P is the 5.x-158 unit-to-unit product variation according to IEC/TS 61400-14. It is a characteristic of the product and can therefore be specified by GE (see chapter 7).
- σ_R is the overall measurement testing reproducibility as defined in IEC/TS 61400-14. It is not a characteristic of the product, but of the measurements, and cannot be specified by GE. For typical testing according to IEC 61400-11, a value of σ_R = 0.5 dB is widely accepted.
- σ_T is the total standard deviation combining both σ_P and σ_R (see IEC/TS 61400-14).

9 Reference Documents

- IEC 61400-11, wind turbine generator systems part 11: Acoustic noise measurement techniques, ed. 2.1 (2006-11), or ed. 3 (2012-11).
- IEC/TS 61400-14, Wind turbines – part 14: Declaration of apparent sound power level and tonality values, ed. 1 (2005-03).
- MNPT – Machine Noise Performance Test, Technical documentation.