BEFORE THE
OHIO POWER SITING BOARD

In the Matter of the Application of Grover Hill Wind, LLC to Amend its Certificate Issued in Case No. 20-417-EL-BGN.	)))	Case No. 23-459-EL-BGA

SECOND SUPPLEMENT TO THE APPLICATION FOR AN AMENDMENT TO THE GROVER HILL WIND, LLC CERTIFICATE APPROVED DECEMBER 15, 2022, IN CASE NO. 20-417-EL-BGN

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I. Background and Procedural Overview

Grover Hill Wind, LLC ("Applicant"), is certified to construct the Grover Hill Wind Project, a wind-powered electric generating facility to be located in Paulding County, Ohio ("Project"). The original application for a certificate of environmental compatibility and public need was filed on May 3, 2021, as supplemented, in Case No. 20-417-EL-BGN ("Initial Application"). The Ohio Power Siting Board ("Board") issued an Opinion, Order, and Certificate in Case No. 20-417-EL-BGN on December 15, 2022, adopting the Stipulation filed on October 7, 2022, and authorizing the Applicant to construct a 150-megawatt ("MW") wind-powered electric generating facility in Paulding County, Ohio ("Certificate").

The Initial Application presented five turbine models being considered for the facility, which were presented in Table 2 of the Initial Application.

On May 3, 2023, the Applicant filed an Amendment in this matter proposing the relocation of two turbines within the layout approved in the Initial Application case ("Amendment").

To finalize the turbine model selection for the Project, the Applicant has been working with General Electric ("GE") evaluating the GE Cypress 6.1-158 turbine model that may prove more efficient or cost effective than the turbine models previously approved for the Project in the Initial Application case.

Through this Supplement to the Amendment, the Applicant requests approval to include the new GE Cypress 6.1-158 turbine model on the list of turbines authorized for this Project ("Supplement"). The GE Cypress 6.1-158 turbine model will not exceed the maximum tip height, blade length, rotor diameter, or rated power of turbine models certificated in the Initial Application case. Further, the Applicant affirms that, with the new proposed turbine model, the total Project will not exceed the 150 MWs permitted under the Certificate. This Supplement does not change the Applicant's commitment to comply with all Certificate conditions and commitments approved by the Board in the Initial Application case.

The below information on the GE Cypress 6.1-158 turbine model is being submitted in accordance with Ohio Administrative Code Chapter 4906-4. The only change to the Project through this Supplement would be the addition of the GE Cypress 6.1-158 turbine model, with its maximum 117-meter hub height, to the list of possible turbines that may be used for the Project. All other information regarding the Project previously submitted to the Board in the Initial

Application and the Amendment (i.e., the facility description, the site selection process, the location of the turbines, the location of all associated facilities, the principal environmental considerations, the microwave paths, the construction plan, the transportation plan, the road use agreement, and the Project schedule) remains unchanged.

II. Impact of the Supplement to Certificated Project

As stated above, the sole purpose of this Supplement is to seek Board approval for the inclusion of the GE Cypress 6.1-158 turbine model in the list of possible models to be used for the Project. No other aspect of the certificated Project are being modified.

The foundation design and equipment manuals attributable to the GE Cypress 6.1-158 turbine model are provided in Attachment A to this Supplement.

Westwood Professional Services ("Westwood") previously conducted an analytic review of Noise Propagation, Shadow Flicker, Ice Throw, and Setback Distances to determine levels of compliance for each turbine model under consideration with applicable regulations, requirements, and guidelines established by the Board, which were filed on May 3, 2021 in support of the Initial Application and the Amendment. These prior analyses were conducted utilizing the worst-case turbine being considered at that time with respect to the turbine data corresponding to each of the factors being analyzed.

In addition, updated ice throw, sound and shadow flicker analyses were conducted for purposes of this Supplement and the memoranda are attached hereto. Allowing the Applicant to use the GE Cypress 6.1-158 turbine model would contribute to the same or lower impacts for ice throw, sound, and shadow flicker.

Finally, the Applicant notes that this Supplement in no way impacts the Applicant's commitment to comply with all Certificate conditions and commitments approved by the Board in the Initial Application case.

III. Proposed GE Cypress 6.1-158 turbine model

A. Overview of New Turbine Model

The technical specifications for the GE Cypress 6.1-158 turbine model turbine are listed in Tables 2 and 3 below. Tables 2 and 3 are from the Initial Application and are updated below to include the new proposed turbine. All other information is the same as in the Initial Application Tables 2 and 3.

Table 2[1]: Approximate Turbine Dimensions by Model

Turbine Model	Rated Power	Hub Height	Rotor Diameter	Blade Length	Tip Height
GE 3.03-140	3.0 MW	98.0 m (321 ft)	140.0 m (459 ft)	70 m (230 ft)	168.0 m (551 ft)
Vestas V150-4.5	4.5 MW	105.0 m (344 ft)	150.0 m (492 ft)	75 m (246 ft)	180.0 m (590 ft)
Vestas V150-4.5	4.5 MW	120.0 m (394 ft)	150.0 m (492 ft)	75 m (246 ft)	195.0 m (640 ft)
Siemens Gamesa SG 5.0-145	5.0 MW	102.5 m (335 ft)	145.0 m (476 ft)	72.5 m (238 ft)	174.5 m (573 ft)
Vestas -6.2	**6.2 MW**	**119.0 m (390 ft)**	**162.0m (531 ft)**	**81 m (266 ft)**	**200.0 m (656 ft)**
GE 6.1-158	**6.1 MW**	**117m (386 ft)**	**158.0 m (518 ft)**	**79 m (259 ft)**	**196 m (647 ft)**

Table 3[2]: Turbine Operations Specifications by Model

Turbine Model	Cut-In Wind Speed	Cut-Out Wind Speed	Re-Cut-In Wind Speed	Min Temp	Max Temp
GE 3.03-140	NA	30m/sec	27m/sec	-4°F / -20°C	122°F / 50°C
Vestas V150-4.5 (105m Hub)	3m/sec	24.5m/sec	22.5m/sec	-22°F / -30°C	113°F / 45°C

[1] Table 2 replaces and supersedes Table 2 in the Initial Application. See Fourth Supplement to the Initial Application filed on May 26, 2022.

[2] Table 3 replaces and supersedes Table 3 in the Initial Application. See Fourth Supplement to the Initial Application filed on May 26, 2022.

Vestas V150-4.5 (120m Hub)	3m/sec	24.5m/sec	22.5m/sec	-22°F / -30°C	113°F / 45°C
Siemens Gamesa SG 5.0-145	3m/sec	27m/sec	24m/sec	-4°F / -20°C	113°F / 45°C
Vestas -6.2	**3m/sec**	**24m/sec**	**22m/sec**	**-22°F / -30°C**	**122°F / 50°C**
GE 6.1-158	**3m/sec**	**25m/sec**	**22m/sec**	**-22°F / -30°C**	**104°F / 40°C**

Tables 2 and 3 above compare the technical characteristics of the turbine model considered for the Project. As stated in the Initial Application, the models and calculations to determine the impact of these turbines were conducted by using the Vestas -6.2 considered the worst-case scenario compared with the other turbine models.

1. 4906-4-08(A)(3)(b) Operational Sound Levels

The Applicant commits that the turbine model(s) that will be used for the Project will comply with the sound requirements approved by the Board in the Initial Application case.

As set forth in the Initial Application, the sound studies were based on the GE 3.03 turbine model, which is the worst-case scenario. The GE 3.0-140 turbine model was utilized for the sound analysis due to that model having the highest unmitigated sound power level (108 A-weighted decibels ["dBA"]).

Table 8 below sets forth the information reading the sound levels for the turbines approved in the Initial Application case and the new GE Cypress 6.1-158 turbine model proposed in this Supplement. Table 8 is from the Initial Application and is updated below to include the new proposed turbine. All other information is the same as in the Initial Application Table 8.

Table 8[3]: Maximum Turbine Sound Levels

Turbine Model	dB(A)
GE 3.03-140 3.0 MW (98 m hub, 140 m rd)	**108**
Vestas V150-4.5 MW (105 m hub, 150 m rd)	104.9
Vestas V150-4.5 MW (120 m hub, 150 m rd)	104.9
Siemens Gamesa GS 5.0-145 5.0 MW (102 m hub, 145 m rd)	106.3
Vestas 6.2 MW (119 m hub, 162 m rd)	102
GE 6.1-158-6.1 MW (117 m hub, 158 m rd)	**107.5**

[3] Table 8 replaces and supersedes Table 8 in the Initial Application. See Fourth Supplement to the Initial Application filed on May 26, 2022. hub: Hub height in meters. rd: rotor diameter in meters

As reflected in Table 8, the sound level for the new GE Cypress 6.1-158 turbine model **(107.5 dBA) is less than** the worst-case scenario sound level for the certificated GE 3.03 turbine model **(108 dBA)**. Thus, there is no need for new noise modeling to introduce this new model as the Applicant commits to comply with the noise requirements approved by the Board in the Initial Application case. The turbine model under consideration has a maximum sound power level of 107.5 dBA, a hub height of 117 meters, and a rotor diameter of 158 meters. This change of a 1 dBA sound power reduction, 2-meter height decrease, and 4-meter rotor diameter reduction will have a negligible effect on the results of the most recent sound study, which was filed with the Initial Application on May 3, 2021. This indicates that the selection of the GE Cypress 6.1-158 turbine model would not propagate sound levels greater than those presented in the Initial Application. A memorandum from Westwood comparing the sound analysis is provided as Attachment B.

2. 4906-4-08(A)(6) Wind Velocity

International standards for wind turbines are developed by working groups of Technical Committee-88 of the International Electrotechnical Commission ("IEC"), a world-recognized body for standards development. All turbines under consideration for the Project are designed to meet the standards of the IEC-61400 series and are rated to specific IEC wind classes. The GE Cypress 6.1-158 6.1 MW proposed in this Supplement is certified for IEC Class S winds, which is the same class as the already certificated GE 3.03-140 3.0 MW and the Vestas -6.0 MW. The IEC Class S winds are user defined parameters, which are documented to be an annual average speed of 7.4 meters/second (27kmph or 17mph), an extreme wind speed of 51.9 meters/second (187kmph or 116mph). The current values are not available.

The Vestas V150-4.5 MW is certified for IEC IIIB winds which have an annual average speed of 7.5 meters/second (27kmph or 17mph), an extreme wind speed of 52.5 meters/second (189kmph or 117mph). The Siemens Gamesa GS 5.0-145 5.0 MW is certified for IEC IIB winds which have an annual average speed of 8.5 meters/second (31kmph or 19mph), an extreme wind speed of 59.5 meters/second (214kmph or 133mph).

3. 4906-4-08(A)(8) Ice Throw

The GE Cypress 6.1-158 turbine model has a shorter blade length (79m/259ft) than the Vestas V162 (81m/266ft) used in the analysis presented in the Initial Application. The shorter blade length of the GE Cypress 6.1-158 turbine model suggests that the smaller rotor sweep would produce a smaller ice-throw area. A memorandum from Westwood comparing the ice throw analysis is provided as Attachment C.

4. 4906-4-08(A)(8) Shadow Flicker

The Applicant commits that the turbine model(s) that are used for the Project will comply with the shadow flicker requirements approved by the Board in the Initial Application case.

The GE Cypress 6.1-158 turbine model has a shorter blade length (79m/259ft) than the Vestas V162 (81m/266ft) used in the analysis presented in the Initial Application. The shorter blade length of the GE Cypress 6.1-158 turbine model suggests that the smaller rotor sweep would produce a smaller shadow flicker effect. A memorandum from Westwood comparing the shadow flicker analysis is provided as Attachment D.

5. 4906-4-08(C)(2) Wind Farm Maps (Constraints)

The GE Cypress turbine has a hub height of 117 meters (386ft), and a blade length of 79 meters (259ft). The tip height for the model is 196 meters (647ft) which makes it nearly the exact height of the Vestas V162 used in prior analyses. The comparable height indicates that, when placed in the currently established turbine locations, the model would comply with all setback distances previously approved in the Initial Application case.

V. Conclusion

The Applicant appreciates the Board's consideration of this Supplement and respectfully requests that the Board review this request as expeditiously as possible. The Applicant is available at the Board's convenience to answer any questions the Board or its staff may have.

Respectfully submitted,

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CERTIFICATE OF SERVICE

The Ohio Power Siting Board's e-filing system will electronically serve notice of the filing of this document on the parties referenced in the service list of the docket card who have electronically subscribed to these cases. In addition, the undersigned certifies that a copy of the foregoing document is also being served upon the persons below this 4th day of August, 2023.

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Grover Hill Wind, LLC
Second Supplement
Case No. 23-459-EL-BGA

Attachment A
GE Cypress 6.1-158
Foundation Design and Equipment Manual

GE Renewable Energy

DICKINSON WRIGHT PLLC

GE Renewable Energy

- Original Document -

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

WT General Description

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

Attachments to this pdf can be found by clicking the paper clip icon (📎) commonly found on the left-hand side when using Adobe Acrobat.

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Document Revision Table

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 [m^2]	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

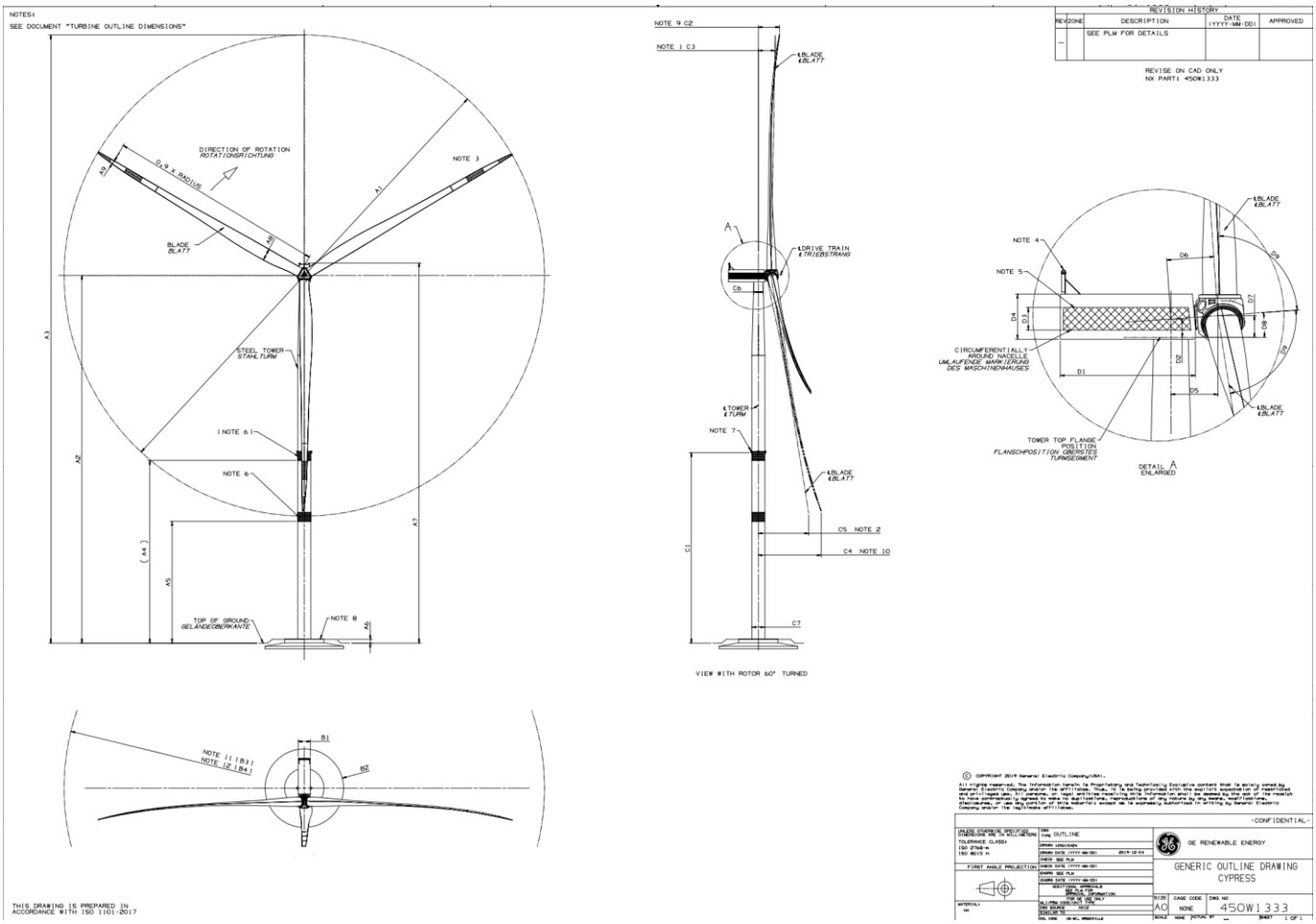

Figure 2: Generic outline drawing Cypress 450W1333

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
Cypress 158 Platform - 50/60 Hz

Technical Description and Data
Weights and Dimensions

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Document Revision Table

Rev.	Date (YYYY/MM/DD)	Affected Pages	Change Description
05	2021-02-01	7	EDITED Table 2
		5	ADDED 151 HH in Table 1.
		6 & 7	ADDED new tower description in Table 2
		Various	REPLACED Nordics with IEC CWE
06	2021-08-16	7	ADDED row no 23 in table 2
		18	ADDED table No.24
		41	ADDED table No.46
07	2021-11-19	50	ADDED new row in Section 5.2.
		VARIOUS	ADDED new configurations in Section 2
		46	UPDATED table 53 according to new configs

1 Introduction

This document provides estimated weights and dimensions of the GE Wind turbines Cypress Platform with 158m rotor. The weights and dimensions herein do not include shipping frames/fixtures. Actual weights may vary depending on the final configuration. All weights must be verified prior to installation and transportation.

2 Tower

Tower configurations for the Cypress 158m rotor platform.

Turbine	Hub Height									
	96m	101m	107.4m	117m	120.9 m	125.4m	141m	150 m	151m	161 m
Cypress 50Hz	X	X			X		X	X	X	X
Cypress 60Hz		X	X	X		X				

Table 1: Tower configuration related to hub height and grid frequency

The following table provides a basic description of the different sections required for each available tower configuration.

#	Tower Description	Structural Code	Top Section	Mid Section A	Mid Section B	Mid Section C	Mid Section D	Mid Section E	Door Section	Concrete Section
1	96m Tubular Steel Tower 4.3 m OD with TBR IEC STW	LC_WT19_96_449W3604	X	X	X				X	
2	96m Tubular Steel Tower 4.3 m OD without TBR IEC STW	LC_WT19_96_449W3604	X	X	X				X	
3	101 m Tubular Steel Tower 4.3 m OD with TBR IEC	LC_WT19_101_449W9389	X	X	X	X			X	
4	101 m Tubular Steel Tower 4.3 m OD without TBR IEC	LC_WT19_101_449W9389	X	X	X	X			X	
5	101 m Tubular Steel Tower 4.3 m OD CWE with TBR IEC	LC_WT19_101_448W8256	X	X	X	X			X	
6	101 m Tubular Steel Tower 4.3 m OD CWE without TBR IEC	LC_WT19_101_448W8256	X	X	X	X			X	
7	101 m Tubular Steel 4 section Tower 4.3 m OD without TBR	LC_WT19_101_449W5216	X	X	X	N/A	N/A	N/A	X	N/A
8	107.4 m Tubular Steel Tower 4.3 m OD without TBR STW IEC	LC_WT19_107.5_447W2844	X	X	X	X			X	
9	120.9 m Tubular Steel Tower 4.3 m OD with TBR soft DIBt	LC_WT19_120.9_449W6623	X	X	X	X	X		X	
10	120.9 m Tubular Steel Tower 4.3 m OD with TBR soft IEC STW	LC_WT19_120.9_449W0461	X	X	X	X	X		X	
11	120.9 m Tubular Steel Tower 4.3 m OD without TBR soft IEC STW	LC_WT19_120.9_449W0461	X	X	X	X	X		X	
12	120.9 m Tubular Steel Tower 4.3 m OD without TBR soft AUSTRALIA STW	LC_WT19_120.9_447W9836	X	X	X	X			X	
13	120.9 m Tubular Steel Tower 4.3 m OD with TBR soft IEC CWE	LC_WT19_120.9_449W6624	X	X	X	X			X	
14	120.9 m Tubular Steel Tower 4.3 m OD without TBR soft IEC CWE	LC_WT19_120.9_449W6624	X	X	X	X			X	
15	125.4 m Tubular Steel Tower 4.3 m OD without TBR soft 6 section STW	LC_WT19_126_448W0972	X	X	X	X	X		X	

#	Tower Description	Structural Code	Top Section	Mid Section A	Mid Section B	Mid Section C	Mid Section D	Mid Section E	Door Section	Concrete Section
16	125.4 m Tubular Steel Tower 4.3 m OD without TBR soft 5 section STW	LC_WT19_126_449W9155	X	X	X	X			X	
17	125.4 m Tubular Steel Tower 4.3 m OD without TBR soft 5 section strong STW	LC_WT19_126_449W9393	X	X	X	X			X	
18	141 m Tubular Steel Tower 5.0 m OD without TBR soft CWE	LC_WT19_141_448W8260	X	X	X	X	X	X	X	
19	141 m Tubular Steel Tower 5.3 m OD without TBR soft for AUS STW	LC_WT19_141_447W9837	X	X	X	X	X		X	
20	150 m Concrete Hybrid Tower STW DIBt	LC_WT19_150_447W0237	X	X	X					X
21	151 m Tubular Steel Tower 5.3 m OD without TBR soft IEC CWE	LC_WT19_151_448W8262	X	X	X	X	X	x	X	
22	161 m Concrete Hybrid Tower STW DIBt	LC_WT19_161_446W7589	X	X	X					X
23	161 m Concrete Hybrid Tower IEC CWE	LC_WT19_161_450W7952	X	X	X	N/A	N/A	N/A	N/A	N/A
24	120.9 m Tubular Steel Tower 4.3 m OD without TBR soft IEC 5 section	LC_WT19_120.9_449W0461	X	X	X	X	N/A	N/A	X	N/A
25	120.9 m Tubular Steel Tower 4.29 m OD without TBR soft IEC	LC_WT19_120.9_450W9907	X	X	X	X	X	N/A	X	N/A
26	120.9 m Tubular Steel Tower 4.29 m OD with TBR soft IEC	LC_WT19_120.9_450W9907	X	X	X	X	X	N/A	X	N/A
27	117 m Tubular Steel Tower 4.3 m OD without TBR	LC_WT19_117.0_452W3871	X	X	X	X	N/A	N/A	X	N/A

Table 2 : Tower sections overview

The Table 3 to Table 23 gives the weights and dimensions of the tower sections in each of the configurations in Table 2, excluding anchor ring and tower base ring.

The concrete part of the tower is built out of segmented rings which can be transported using standard transportation equipment.

	Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m) top/bottom	Width (ft) top/bottom
Top Section	44700	98547	28.07	92	3.6/4.3	12.0/14.1
Mid Section A	50600	111554	25.20	83	4.3/4.3	14.1/14.1
Mid Section B	64900	143080	23.80	78	4.3/4.3	14.1/14.1
Door Section	60600	133600	14.53	48	4.3/4.3	14.1/14.1

Table 3 : Weights and dimensions of the tower sections - 96m Tubular Steel Tower 4.3 m OD with TBR IEC STW. (LC_WT19_96_449W3604)

	Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m) top/bottom	Width (ft) top/bottom
Top Section	44700	98547	28.07	92	3.6/4.3	12.0/14.1
Mid Section A	50600	111554	25.20	83	4.3/4.3	14.1/14.1
Mid Section B	64900	143080	23.80	78	4.3/4.3	14.1/14.1
Door Section	68200	150355	15.68	51	4.3/4.804	14.1/15.0

Table 4 : Weights and dimensions of the tower sections - 96m Tubular Steel Tower 4.3 m OD without TBR IEC STW. (LC_WT19_96_449W3604)

	Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m) top/bottom	Width (ft) top/bottom
Top Section	45500	100310	28.06	92	3.6/4.3	12.0/14.1
Mid Section A	51700	113979	25.20	83	4.3/4.3	14.1/14.1
Mid Section B	49500	109129	18.20	60	4.3/4.3	14.1/14.1
Mid Section C	53600	118168	14.84	49	4.3/4.3	14.1/14.1
Door Section	53800	118609	10.33	34	4.3/4.3	14.1/14.1

Table 5 : Weights and dimensions of the tower sections - 101 m Tubular Steel Tower 4.3 m OD CWE with TBR IEC. (LC_WT19_101_448W8256)

	Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m) top/bottom	Width (ft) top/bottom
Top Section	45500	100310	28.06	92	3.6/4.3	12.0/14.1
Mid Section A	51700	113979	25.20	83	4.3/4.3	14.1/14.1
Mid Section B	49500	109129	18.20	60	4.3/4.3	14.1/14.1
Mid Section C	53600	118168	14.84	49	4.3/4.3	14.1/14.1
Door Section	62000	136686	11.48	38	4.3/4.81	14.1/15.8

Table 6 : Weights and dimensions of the tower sections - 101 m Tubular Steel Tower 4.3 m OD without TBR IEC (LC_WT19_101_448W8256)

	Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m) top/bottom	Width (ft) top/bottom
Top Section	48500	106924	29.75	98	3.6/4.3	12.0/14.1
Mid Section A	65100	143521	29.96	98	4.3/4.3	14.1/14.1
Mid Section B	71900	158512	23.80	78	4.3/4.3	14.1/14.1
Door Section	75300	166008	14.84	49	4.3/4.556	14.1/15.0

Table 7: Weights and dimensions of the tower sections - 101 m Tubular Steel 4 section Tower 4.3 m OD without TBR (LC_WT19_101_449W5216)

	Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m) top/bottom	Width (ft) top/bottom
Top Section	45000	99208	28.06	92	3.6/4.3	12.0/14.1
Mid Section A	51300	113097	25.20	83	4.3/4.3	14.1/14.1
Mid Section B	50400	111113	18.20	60	4.3/4.3	14.1/14.1
Mid Section C	55000	121254	14.84	49	4.3/4.3	14.1/14.1
Door Section	55600	122577	10.33	34	4.3/4.3	14.1/14.1

Table 8 : Weights and dimensions of the tower sections - 101 m Tubular Steel Tower 4.3 m OD with TBR IEC. (LC_WT19_101_449W9389)

	Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m) top/bottom	Width (ft) top/bottom
Top Section	45000	99208	28.06	92	3.6/4.3	12.0/14.1
Mid Section A	51300	113097	25.20	83	4.3/4.3	14.1/14.1
Mid Section B	50400	111113	18.20	60	4.3/4.3	14.1/14.1
Mid Section C	55000	121254	14.84	49	4.3/4.3	14.1/14.1
Door Section	63200	139332	11.48	38	4.3/4.81	14.1/15.8

Table 9 : Weights and dimensions of the tower sections -101 m Tubular Steel Tower 4.3 m OD without TBR IEC. (LC_WT19_101_449W9389

	Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m) top/bottom	Width (ft) top/bottom
Top Section	48500	106924	29.75	98	3.6/4.3	12.0/14.1
Mid Section A	65100	143521	29.96	98	4.3/4.3	14.1/14.1
Mid Section B	71900	158512	23.80	78	4.3/4.3	14.1/14.1
Door Section	75300	166008	14.84	49	4.3/4.556	14.1/15.0

Table 10 : Weights and dimensions of the tower sections – 101 m Tubular Steel 4 section Tower 4.3 m OD without TBR. (LC_WT19_101_449W5216)

	Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m) top/bottom	Width (ft) top/bottom
Top Section	47900	105601	29.75	98	3.6/4.3	12.0/14.1
Mid Section A	51100	112656	25.20	83	4.3/4.3	14.1/14.1
Mid Section B	63800	140655	23.80	78	4.3/4.3	14.1/14.1
Mid Section C	56100	123679	14.84	49	4.3/4.3	14.1/14.1
Door Section	64000	141096	11.20	37	4.3/4.556	14.1/15.0

Table 11 : Weights and dimensions of the tower sections - 107.4 m Tubular Steel Tower 4.3 m OD without TBR (LC_WT19_107.5_447W2844)

	Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m) top/bottom	Width (ft) top/bottom
Top Section	49700	109570	28.06	92	3.6/4.3	12.0/14.1
Mid Section A	52500	115743	25.20	83	4.3/4.3	14.1/14.1
Mid Section B	53900	118829	19.88	65	4.3/4.3	14.1/14.1
Mid Section C	55700	122797	18.20	60	4.3/4.3	14.1/14.1
Mid Section D	59200	130514	14.84	49	4.3/4.3	14.1/14.1
Door Section	65000	143300	10.33	34	4.3/4.3	14.1/14.1

Table 12 : Weights and dimensions of the tower sections - 120.9 m Tubular Steel Tower 4.3 m OD with TBR soft DIBt. (LC_WT19_120.9_449W6623)

	Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m) top/bottom	Width (ft) top/bottom
Top Section	47000	103617	28.06	92	3.6/4.3	12.0/14.1
Mid Section A	52800	116404	25.20	83	4.3/4.3	14.1/14.1
Mid Section B	51500	113538	19.88	65	4.3/4.3	14.1/14.1
Mid Section C	58200	128309	18.20	60	4.3/4.3	14.1/14.1
Mid Section D	59900	132057	14.84	49	4.3/4.3	14.1/14.1
Door Section	58500	128970	10.33	34	4.3/4.3	14.1/14.1

Table 13 : Weights and dimensions of the tower sections -120.9 m Tubular Steel Tower 4.3 m OD with TBR soft IEC. (LC_WT19_120.9_449W0461)

	Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m) top/bottom	Width (ft) top/bottom
Top Section	47000	103617	28.06	92	3.6/4.3	12.0/14.1
Mid Section A	52800	116404	25.20	83	4.3/4.3	14.1/14.1
Mid Section B	51500	113538	19.88	65	4.3/4.3	14.1/14.1
Mid Section C	58200	128309	18.20	60	4.3/4.3	14.1/14.1
Mid Section D	59900	132057	14.84	49	4.3/4.3	14.1/14.1
Door Section	66700	147048	11.48	38	4.3/4.81	14.1/15.8

Table 14 : Weights and dimensions of the tower sections - 120.9 m Tubular Steel Tower 4.3 m OD without TBR soft IEC. (LC_WT19_120.9_449W0461)

	Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m) top/bottom	Width (ft) top/bottom
Top Section	50400	111113	29.75	98	3.6/4.3	12.0/14.1
Mid Section A	63900	140875	29.96	98	4.3/4.3	14.1/14.1
Mid Section B	75800	167110	26.60	87	4.3/4.3	14.1/14.1
Mid Section C	77700	171299	19.88	65	4.3/4.3	14.1/14.1
Door Section	72200	159174	12.60	41	4.3/4.81	14.1/15.7

Table 15 : Weights and dimensions of the tower sections - 120.9 m Tubular Steel Tower 4.3 m OD without TBR soft AUSTRALIA. (LC_WT19_120.9_447W9836)

	Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m) top/bottom	Width (ft) top/bottom
Top Section	49500	109129	29.75	98	3.6/4.3	12.0/14.1
Mid Section A	64300	141757	29.96	98	4.3/4.3	14.1/14.1
Mid Section B	75500	166449	26.60	87	4.3/4.3	14.1/14.1
Mid Section C	76800	169315	19.88	65	4.3/4.3	14.1/14.1
Door Section	55800	123018	10.33	34	4.3/4.3	14.1/14.1

Table 16 : Weights and dimensions of the tower sections - 120.9 m Tubular Steel Tower 4.3 m OD with TBR soft IEC CWE. (; 91 LC_WT19_120.9_449W6624.

	Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m) top/bottom	Width (ft) top/bottom
Top Section	49500	109129	29.75	98	3.6/4.3	12.0/14.1
Mid Section A	64300	141757	29.96	98	4.3/4.3	14.1/14.1
Mid Section B	75500	166449	26.60	87	4.3/4.3	14.1/14.1
Mid Section C	76800	169315	19.88	65	4.3/4.3	14.1/14.1
Door Section	61800	136246	11.48	38	4.3/4.804	14.1/15.0

Table 17 : Weights and dimensions of the tower sections - 120.9 m Tubular Steel Tower 4.3 m OD without TBR soft IEC CWE. (LC_WT19_120.9_449W6624)

	Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m) top/bottom	Width (ft) top/bottom
Top Section	49500	109129	29.75	98	3.6/4.3	12.0/14.1
Mid Section A	53000	116845	25.20	83	4.3/4.3	14.1/14.1
Mid Section B	67100	147930	23.80	78	4.3/4.3	14.1/14.1
Mid Section C	67700	149253	18.20	60	4.3/4.3	14.1/14.1
Mid Section D	70100	154544	14.84	49	4.3/4.3	14.1/14.1
Door Section	75900	167331	10.92	36	4.3/4.81	14.1/15.7

Table 18 : Weights and dimensions of the tower sections - 125.4 m Tubular Steel Tower 4.3 m OD without TBR soft 6 section. (LC_WT19_126_448W0972)

	Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m) top/bottom	Width (ft) top/bottom
Top Section	48900	107806	29.75	98	3.6/4.3	12.0/14.1
Mid Section A	72700	160276	32.76	107	4.3/4.3	14.1/14.1
Mid Section B	79600	175488	28.00	92	4.3/4.3	14.1/14.1
Mid Section C	79700	175708	20.72	68	4.3/4.3	14.1/14.1
Door Section	78100	172181	11.48	38	4.3/4.81	14.1/15.7

Table 19 : Weights and dimensions of the tower sections - 125.4 m Tubular Steel Tower 4.3 m OD without TBR soft 5 section. ((125.4 m - low loads) (LC_WT19_126_449W9155)

	Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m) top/bottom	Width (ft) top/bottom
Top Section	49100	108247	29.75	98	3.6/4.3	12.0/14.1
Mid Section A	74900	165126	32.76	107	4.3/4.3	14.1/14.1
Mid Section B	85300	188054	28.00	92	4.3/4.3	14.1/14.1
Mid Section C	85900	189377	20.72	68	4.3/4.3	14.1/14.1
Door Section	79600	175488	11.48	38	4.3/4.81	14.1/15.7

Table 20 : Weights and dimensions of the tower sections - 125.4 m Tubular Steel Tower 4.3 m OD without TBR soft 5 section strong. (LC_WT19_126_449W9393)

	Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m) top/bottom	Width (ft) top/bottom
Top Section	50100	110451	29.75	98	3.6/4.3	12.0/14.1
Mid Section A	67000	147710	29.96	98	4.3/4.3	14.1/14.1
Mid Section B	73300	161599	23.80	78	4.3/4.3	14.1/14.1
Mid Section C	69700	153662	18.20	60	4.3/4.55	14.1/14.9
Mid Section D	71700	158071	14.84	49	4.55/4.55	14.9/14.9
Mid Section E	77300	170417	12.60	41	4.55/4.55	14.9/14.9
Door Section	75600	166669	9.80	32	4.55/5.00	14.9/16.4

Table 21 : Weights and dimensions of the tower sections – 141 m Tubular Steel Tower 5.0 m OD without TBR soft CWE. (LC_WT19_141_448W8260)

	Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m) top/bottom	Width (ft) top/bottom
Top Section	49700	109570	29.75	98	3.6/4.3	12.0/14.1
Mid Section A	72100	158953	32.76	107	4.3/4.3	14.1/14.1
Mid Section B	77900	171740	26.60	87	4.3/4.3	14.1/14.1
Mid Section C	74300	163803	20.72	68	4.3/4.85	14.1/15.9
Mid Section D	73300	161599	17.36	57	4.85/4.85	15.9/15.9
Door Section	79000	174165	11.20	37	4.85/5.30	15.9/17.4

Table 22 : Weights and dimensions of the tower sections – 141 m Tubular Steel Tower 5.3 m OD without TBR soft for AUS. (LC_WT19_141_447W9837)

	Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m) top/bottom	Width (ft) top/bottom
Top Section	48000	105840	28.06	92	3.6/4.3	12.0/14.1
150 m hybrid						
161 m hybrid						
Mid Section A	56500	124583	25.20	83	4.3/4.3	14.1/14.1
150 m hybrid						
161 m hybrid						
Mid Section B	70100	154571	23.80	78	4.3/4.3	14.1/14.1
150 m hybrid						
161 m hybrid						

Table 23 : Weights and dimensions of the tower sections – 150 m (77 LC_WT19_150_447W0237) Concrete Hybrid Tower and 161 m Concrete Hybrid Tower (LC_WT19_161_446W7589)

	Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m) top/bottom	Width (ft) top/bottom
Top Section	49900	110011	29.75	98	3.6/4.3	12.0/14.1
Mid Section A	68200	150355	29.96	98	4.3/4.3	14.1/14.1
Mid Section B	71500	157630	23.80	78	4.3/4.3	14.1/14.1
Mid Section C	79200	174606	21.84	72	4.3/4.85	14.1/15.9
Mid Section D	78400	172842	18.20	60	4.85/4.85	15.9/15.9
Mid Section E	79500	175267	14.28	47	4.85/4.85	15.9/15.9
Door Section	79700	175708	10.92	36	4.85/5.3	15.9/17.4

Table 24 : Weights and dimensions of the tower sections – 151 m Tubular Steel Tower 5.3 m OD without TBR soft for IEC CWE. (LC_WT19_151_448W8262)

	Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m) top/bottom	Width (ft) top/bottom
Top Section	61600	135805	29.75	98	3.6/4.3	12.0/14.1
Mid Section A	64700	142639	29.96	98	4.3/4.3	14.1/14.1
Mid Section B	74800	164906	26.60	87	4.3/4.3	14.1/14.1
Mid Section C	73000	160937	19.88	65	4.3/4.3	14.1/14.1
Door Section	70200	154764	12.60	41	4.3/4.81	14.1/15.7

Table 25 : Weights and dimensions of the tower sections – 120.9 m Tubular Steel Tower 4.3 m OD without TBR soft IEC 5 section. (LC_WT19_120.9_449W0461)

	Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m) top/bottom	Width (ft) top/bottom
Top Section	46400	102294	28.06	92	3.68/4.26	12.0/14.1
Mid Section A	51900	114420	25.20	83	4.26/4.27	14.1/14.1
Mid Section B	51000	112436	19.88	65	4.27/4.27	14.1/14.1
Mid Section C	58800	129632	18.20	60	4.27/4.28	14.1/14.1
Mid Section D	59500	131175	14.84	49	4.28/4.28	14.1/14.1
Door Section	66000	145505	11.48	38	4.28/4.81	14.1/15.8

Table 26: Weights and dimensions of the tower sections – 120.9 m Tubular Steel Tower 4.29 m OD without TBR soft IEC (LC_WT19_120.9_450W9907)

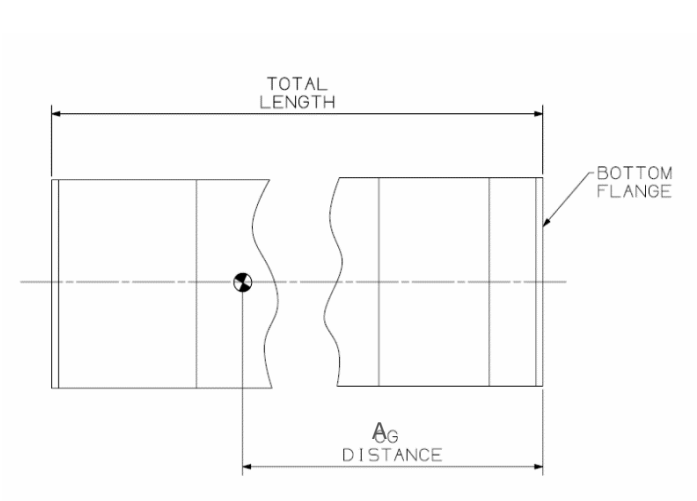
	Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m) top/bottom	Width (ft) top/bottom
Top Section	46400	102294	28.06	92	3.68/4.26	12.0/14.1
Mid Section A	51900	114420	25.20	83	4.26/4.27	14.1/14.1
Mid Section B	51000	112436	19.88	65	4.27/4.27	14.1/14.1
Mid Section C	58800	129632	18.20	60	4.27/4.28	14.1/14.1
Mid Section D	59500	131175	14.84	49	4.28/4.28	14.1/14.1
Door Section	57800	127427	10.33	34	4.28/4.29	14.1/15.8

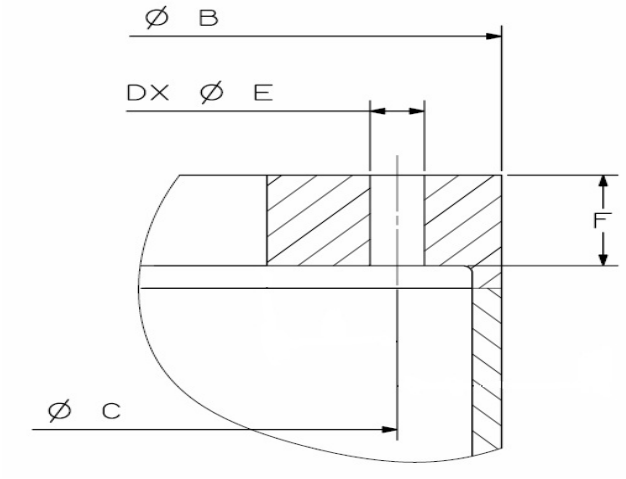
Table 27: Weights and dimensions of the tower sections – 120.9 m Tubular Steel Tower 4.29 m OD with TBR soft IEC (LC_WT19_120.9_450W9907)

	Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m) top/bottom	Width (ft) top/bottom
Top Section	57200	126104	32.55	107	3.68/3.4	12.0/11.1
Mid Section A	61400	135364	28.28	93	3.4/4.3	11.1/14.1
Mid Section B	67500	148812	23.80	78	4.3/4.3	14.1/14.1
Mid Section C	66800	147269	18.20	60	4.3/4.3	14.1/14.1
Door Section	67400	148591	11.48	38	4.3/4.56	14.1/15.0

Table 28: Weights and dimensions of the tower sections –117 m Tubular Steel Tower 4.3 m OD without TBR (LC_WT19_117.0_452W3871)

2.1 Tower Flange Dimensions





Section	"A" Distance to CG	"B" Shell Ø	"C" Bolt circle Ø	"D" Numbers of holes	"E" Bolt hole Ø	"F" Flange thick-ness
	(mm)	(mm)	(mm)		(mm)	(mm)
Top Section – Top Flange		3684	3534	86	39	150
Top Section – Bottom Flange	13954	4300	4153	114	39	75
Mid Section A – Top Flange		4300	4153	114	39	75
Mid Section A – Bottom Flange	12143	4300	4118	121	52	80
Mid Section B – Top Flange		4300	4118	121	52	80
Mid Section B – Bottom Flange	11272	4300	4093	104	61	110
Door Section– Top Flange		4300	4093	104	61	110
Door Section– BottomFlange	6566	4300	4032	108	70	190

Table 29 : Tower internals physical specification - 96m Tubular Steel Tower 4.3 m OD with TBR IEC STW

Section	"A" Distance to CG	"B" Shell Ø	"C" Bolt circle Ø	"D" Numbers of holes	"E" Bolt hole Ø	"F" Flange thick-ness
	(mm)	(mm)	(mm)		(mm)	(mm)
Top Section – Top Flange		3684	3534	86	39	150
Top Section – Bottom Flange	13954	4300	4153	114	39	75
Mid Section A – Top Flange		4300	4153	114	39	75
Mid Section A – Bottom Flange	12143	4300	4101	121	52	80
Mid Section B – Top Flange		4300	4101	121	52	80
Mid Section B – Bottom Flange	11272	4300	4093	104	61	110
Door Section– Top Flange		4300	4093	104	61	110
Door Section– Bottom T-Flange	6803	4804	3924/4564	152	55	130

Table 30 : Tower internals physical specification - 96m Tubular Steel Tower 4.3 m OD without TBR IEC STW

Section	"A" Distance to CG	"B" Shell Ø	"C" Bolt circle Ø	"D" Numbers of holes	"E" Bolt hole Ø	"F" Flange thick-ness
	(mm)	(mm)	(mm)		(mm)	(mm)
Top Section – Top Flange		3684	3534	86	39	150
Top Section – Bottom Flange	13921	4300	4154	144	39	75
Mid Section A – Top Flange		4300	4154	144	39	75
Mid Section A – Bottom Flange	12132	4300	4110	120	52	91
Mid Section B – Top Flange		4300	4110	120	52	91
Mid Section B – Bottom Flange	8759	4300	4106	136	52	120
Mid Section C – Top Flange		4300	4106	136	52	120
Mid Section C – Bottom Flange	7240	4300	4080	120	61	140
Door Section– Top Flange		4300	4080	120	61	140
Door Section– Bottom Flange	4960	4300	4035	108	70	190

Table 31 : Tower internals physical specification - 101 m Tubular Steel Tower 4.3 m OD CWE with TBR IEC

Section	"A" Distance to CG	"B" Shell Ø	"C" Bolt circle Ø	"D" Numbers of holes	"E" Bolt hole Ø	"F" Flange thick-ness
	(mm)	(mm)	(mm)		(mm)	(mm)
Top Section – Top Flange		3684	3534	86	39	150
Top Section – Bottom Flange	13921	4300	4154	144	39	75
Mid Section A – Top Flange		4300	4154	144	39	75
Mid Section A – Bottom Flange	12132	4300	4110	120	52	91
Mid Section B – Top Flange		4300	4110	120	52	91
Mid Section B – Bottom Flange	8759	4300	4106	136	52	120
Mid Section C – Top Flange		4300	4106	136	52	120
Mid Section C – Bottom Flange	7240	4300	4080	120	61	140
Door Section– Top Flange		4300	4080	120	61	140
Door Section– Bottom T-Flange	5221	4804	3924/4564	152	55	150

Table 32 : Tower internals physical specification - 101 m Tubular Steel Tower 4.3 m OD without TBR IEC

Section	"A" Distance to CG (mm)	"B" Shell Ø (mm)	"C" Bolt circle Ø (mm)	"D" Numbers of holes	"E" Bolt hole Ø (mm)	"F" Flange thick-ness (mm)
Top Section – Top Flange		3684	3534	86	39	150
Top Section – Bottom Flange	14664	4300	4154	130	39	75
Mid Section A – Top Flange		4300	4154	130	39	75
Mid Section A – Bottom Flange	14133	4300	4110	118	52	120
Mid Section B – Top Flange		4300	4110	118	52	120
Mid Section B – Bottom Flange	11069	4300	4087	114	61	140
Door Section– Top Flange		4300	4087	114	61	140
Door Section– Bottom T-Flange	6816	4556	3838/4378	152	55	110

Table 33: Tower internals physical specification - 101 m Tubular Steel 4 section Tower 4.3 m OD without TBR

Section	"A" Distance to CG	"B" Shell Ø	"C" Bolt circle Ø	"D" Numbers of holes	"E" Bolt hole Ø	"F" Flange thick-ness
	(mm)	(mm)	(mm)		(mm)	(mm)
Top Section – Top Flange		3684	3534	86	39	150
Top Section – Bottom Flange	13973	4300	4155	155	39	75
Mid Section A – Top Flange		4300	4155	155	39	75
Mid Section A – Bottom Flange	11976	4300	4110	121	52	91
Mid Section B – Top Flange		4300	4110	121	52	91
Mid Section B – Bottom Flange	8745	4300	4110	138	52	120
Mid Section C – Top Flange		4300	4110	138	52	120
Mid Section C – Bottom Flange	7251	4300	4097	120	61	140
Door Section– Top Flange		4300	4097	120	61	140
Door Section– Bottom Flange	4900	4300	4035	109	70	205

Table 34 : Tower internals physical specification - 101 m Tubular Steel Tower 4.3 m OD with TBR IEC

Section	"A" Distance to CG	"B" Shell Ø	"C" Bolt circle Ø	"D" Numbers of holes	"E" Bolt hole Ø	"F" Flange thick-ness
	(mm)	(mm)	(mm)		(mm)	(mm)
Top Section – Top Flange		3684	3534	86	39	150
Top Section – Bottom Flange	13973	4300	4155	155	39	75
Mid Section A – Top Flange		4300	4155	155	39	75
Mid Section A – Bottom Flange	11976	4300	4110	121	52	91
Mid Section B – Top Flange		4300	4110	121	52	91
Mid Section B – Bottom Flange	8745	4300	4110	138	52	120
Mid Section C – Top Flange		4300	4110	138	52	120
Mid Section C – Bottom Flange	7251	4300	4097	120	61	140
Door Section– Top Flange		4300	4097	120	61	140
Door Section– Bottom T-Flange	5224	4804	3924/4564	152	55	150

Table 35 : Tower internals physical specification - 101 m Tubular Steel Tower 4.3 m OD without TBR IEC

Section	"A"	"B"	"C" Bolt circle Ø	"D"	"E"	"F"
	Distance to CG	Shell Ø		Numbers of holes	Bolt hole Ø	Flange thick-ness
	(mm)	(mm)	(mm)		(mm)	(mm)
Top Section – Top Flange		3684	3534	86	39	150
Top Section – Bottom Flange	14664	4300	4154	130	39	75
Mid Section A – Top Flange		4300	4154	130	39	75
Mid Section A – Bottom Flange	14133	4300	4110	118	52	120
Mid Section B – Top Flange		4300	4110	118	52	120
Mid Section B – Bottom Flange	11069	4300	4087	114	61	140
Door Section– Top Flange		4300	4087	114	61	140
Door Section– Bottom T-Flange	6816	4556	3838/4378	152	55	110

Table 36 : Tower internals physical specification - 101 m Tubular Steel 4 section Tower 4.3 m OD without TBR

Section	"A" Distance to CG	"B" Shell Ø	"C" Bolt circle Ø	"D" Numbers of holes	"E" Bolt hole Ø	"F" Flange thick-ness
	(mm)	(mm)	(mm)		(mm)	(mm)
Top Section – Top Flange		3684	3534	86	39	150
Top Section – Bottom Flange	14728	4300	4154	122	39	91
Mid Section A – Top Flange		4300	4154	122	39	91
Mid Section A – Bottom Flange	12222	4300	4110	121	52	91
Mid Section B – Top Flange		4300	4110	121	52	91
Mid Section B – Bottom Flange	10959	4300	4087	100	61	140
Mid Section C – Top Flange		4300	4087	100	61	140
38Mid Section C – Bottom Flange	7213	4300	4053	92	70	190
Door Section– Top Flange		4300	4053	92	70	190
Door Section– Bottom T-Flange	5411	4556	3838/4378	152	55	110

Table 37 : Tower internals physical specification - 107.4 m Tubular Steel Tower 4.3 m OD without TBR

Section	"A" Distance to CG	"B" Shell Ø	"C" Bolt circle Ø	"D" Numbers of holes	"E" Bolt hole Ø	"F" Flange thick-ness
	(mm)	(mm)	(mm)		(mm)	(mm)
Top Section – Top Flange		3684	3534	86	39	150
Top Section – Bottom Flange	14487	4300	4154	130	39	75
Mid Section A – Top Flange		4300	4154	130	39	75
Mid Section A – Bottom Flange	12139	4300	4110	121	52	91
Mid Section B – Top Flange		4300	4110	121	52	91
Mid Section B – Bottom Flange	9704	4300	4121	136	52	120
Mid Section C – Top Flange		4300	4121	136	52	120
38Mid Section C – Bottom Flange	8943	4300	4097	121	61	140
Mid Section D – Top Flange		4300	4097	121	61	140
Mid Section D – Bottom Flange	7127	4300	4058	109	70	190
Door Section– Top Flange		4300	4058	109	70	190
Door Section– Bottom Flange	4776	4300	4035	109	70	205

Table 38 : Tower internals physical specification - 120.9 m Tubular Steel Tower 4.3 m OD with TBR soft DIBt

Section	"A" Distance to CG (mm)	"B" Shell Ø (mm)	"C" Bolt circle Ø (mm)	"D" Numbers of holes	"E" Bolt hole Ø (mm)	"F" Flange thick-ness (mm)
Top Section – Top Flange		3684	3534	86	39	150
Top Section – Bottom Flange	13806	4300	4154	144	39	75
Mid Section A – Top Flange		4300	4154	144	39	75
Mid Section A – Bottom Flange	12319	4300	4121	121	52	91
Mid Section B – Top Flange		4300	4121	121	52	91
Mid Section B – Bottom Flange	9620	4300	4110	117	61	120
Mid Section C – Top Flange		4300	4110	117	61	120
38Mid Section C – Bottom Flange	8943	4300	4077	105	70	140
Mid Section D – Top Flange		4300	4077	105	70	140
Mid Section D – Bottom Flange	7123	4300	4064.3	110	70	190
Door Section– Top Flange		4300	4064.3	110	70	190
Door Section– Bottom Flange	4905	4300	4051	109	70	215

Table 39 : Tower internals physical specification - 120.9 m Tubular Steel Tower 4.3 m OD with TBR soft IEC

Section	"A" Distance to CG	"B" Shell Ø	"C" Bolt circle Ø	"D" Numbers of holes	"E" Bolt hole Ø	"F" Flange thick-ness
	(mm)	(mm)	(mm)		(mm)	(mm)
Top Section – Top Flange		3684	3534	86	39	150
Top Section – Bottom Flange	13806	4300	4154	144	39	75
Mid Section A – Top Flange		4300	4154	144	39	75
Mid Section A – Bottom Flange	12319	4300	4121	121	52	91
Mid Section B – Top Flange		4300	4121	121	52	91
Mid Section B – Bottom Flange	9620	4300	4110	117	61	120
Mid Section C – Top Flange		4300	4110	117	61	120
38Mid Section C – Bottom Flange	8943	4300	4077	105	70	140
Mid Section D – Top Flange		4300	4077	105	70	140
Mid Section D – Bottom Flange	7125	4300	4064.3	110	70	190
Door Section– Top Flange		4300	4064.3	110	70	190
Door Section– Bottom T- Flange	5224	4804	3924/4564	152	55	150

Table 40 : Tower internals physical specification - 120.9 m Tubular Steel Tower 4.3 m OD without TBR soft IEC

Section	"A" Distance to CG	"B" Shell Ø	"C" Bolt circle Ø	"D" Numbers of holes	"E" Bolt hole Ø	"F" Flange thick-ness
	(mm)	(mm)	(mm)		(mm)	(mm)
Top Section – Top Flange		3684	3534	86	39	150
Top Section – Bottom Flange	14678	4300	4153.4	118	39	91
Mid Section A – Top Flange		4300	4153.4	118	39	91
Mid Section A – Bottom Flange	14316	4300	4110	121	52	120
Mid Section B – Top Flange		4300	4110	121	52	120
Mid Section B – Bottom Flange	12646	4300	4095	121	61	120
Mid Section C – Top Flange		4300	4095	121	61	120
38Mid Section C – Bottom Flange	9487	4300	4057.2	109	70	165
Door Section– Top Flange		4300	4057.2	109	70	165
Door Section– Bottom T- Flange	5939	4804	3924/4564	152	55	150

Table 41 : Tower internals physical specification - 120.9 m Tubular Steel Tower 4.3 m OD without TBR soft AUSTRALIA

Section	"A"	"B"	"C" Bolt circle Ø	"D"	"E"	"F"
	Distance to CG	Shell Ø		Numbers of holes	Bolt hole Ø	Flange thick-ness
	(mm)	(mm)	(mm)		(mm)	(mm)
Top Section – Top Flange		3684	3534	86	39	150
Top Section – Bottom Flange	14661	4300	4154	132	39	75
Mid Section A – Top Flange		4300	4154	132	39	75
Mid Section A – Bottom Flange	14490	4300	4127	130	52	91
Mid Section B – Top Flange		4300	4127	130	52	91
Mid Section B – Bottom Flange	12446	4300	4100	121	61	140
Mid Section C – Top Flange		4300	4100	121	61	140
38Mid Section C – Bottom Flange	9413	4300	4060	108	70	190
Door Section– Top Flange		4300	4060	108	70	190
Door Section– Bottom Flange	4939	4300	4052	109	70	225

Table 42 : Tower internals physical specification - 120.9 m Tubular Steel Tower 4.3 m OD with TBR soft IEC CWE

Section	"A" Distance to CG	"B" Shell Ø	"C" Bolt circle Ø	"D" Numbers of holes	"E" Bolt hole Ø	"F" Flange thick-ness
	(mm)	(mm)	(mm)		(mm)	(mm)
Top Section – Top Flange		3684	3534	86	39	150
Top Section – Bottom Flange	14661	4300	4154	132	39	75
Mid Section A – Top Flange		4300	4154	132	39	75
Mid Section A – Bottom Flange	14490	4300	4127	130	52	91
Mid Section B – Top Flange		4300	4127	130	52	91
Mid Section B – Bottom Flange	12446	4300	4100	121	61	140
Mid Section C – Top Flange		4300	4100	121	61	140
38Mid Section C – Bottom Flange	9413	4300	4060	108	70	190
Door Section– Top Flange		4300	4060	108	70	190
Door Section– Bottom T-Flange	5377	4804	3924/4564	152	55	150

Table 43 : Tower internals physical specification - 120.9 m Tubular Steel Tower 4.3 m OD without TBR soft IEC CWE

Section	"A" Distance to CG	"B" Shell Ø	"C" Bolt circle Ø	"D" Numbers of holes	"E" Bolt hole Ø	"F" Flange thick-ness
	(mm)	(mm)	(mm)		(mm)	(mm)
Top Section – Top Flange		3684	3534	86	39	150
Top Section – Bottom Flange	14595	4300	4154	122	39	91
Mid Section A – Top Flange		4300	4154	122	39	91
Mid Section A – Bottom Flange	12060	4300	4110	120	52	91
Mid Section B – Top Flange		4300	4110	120	52	91
Mid Section B – Bottom Flange	11211	4300	4095	100	61	140
Mid Section C – Top Flange		4300	4095	100	61	140
38Mid Section C – Bottom Flange	9032	4300	4099.1	121	70	140
Mid Section D – Top Flange		4300	4099.1	121	70	140
Mid Section D – Bottom Flange	7157	4300	4053	109	70	190
Door Section– Top Flange		4300	4053	109	70	190
Door Section– Bottom T-Flange	4975	4804	3924/4564	152	55	150

Table 44 : Tower internals physical specification - 125.4 m Tubular Steel Tower 4.3 m OD without TBR soft 6 section

Section	"A" Distance to CG	"B" Shell Ø	"C" Bolt circle Ø	"D" Numbers of holes	"E" Bolt hole Ø	"F" Flange thick-ness
	(mm)	(mm)	(mm)		(mm)	(mm)
Top Section – Top Flange		3684	3534	86	39	150
Top Section – Bottom Flange	14707	4300	4156	120	39	91
Mid Section A – Top Flange		4300	4156	120	39	91
Mid Section A – Bottom Flange	15465	4300	4125	121	52	105
Mid Section B – Top Flange		4300	4125	121	52	105
Mid Section B – Bottom Flange	13261	4300	4094	121	61	130
Mid Section C – Top Flange		4300	4094	121	61	130
38Mid Section C – Bottom Flange	10032	4300	4050	109	70	165
Door Section– Top Flange		4300	4050	109	70	165
Door Section– Bottom T-Flange	5261	4804	3924/4564	152	55	150

Table 45 : Tower internals physical specification - 125.4 m Tubular Steel Tower 4.3 m OD without TBR soft 5 section

Section	"A" Distance to CG (mm)	"B" Shell Ø (mm)	"C" Bolt circle Ø (mm)	"D" Numbers of holes	"E" Bolt hole Ø (mm)	"F" Flange thick-ness (mm)
Top Section – Top Flange		3684	3534	86	39	150
Top Section – Bottom Flange	14552	4300	4155.2	126	39	91
Mid Section A – Top Flange		4300	4155.2	126	39	91
Mid Section A – Bottom Flange	15233	4300	4110	136	52	120
Mid Section B – Top Flange		4300	4110	136	52	120
Mid Section B – Bottom Flange	13342	4300	4091.3	121	61	140
Mid Section C – Top Flange		4300	4091.3	121	61	140
38Mid Section C – Bottom Flange	10154	4300	4048.4	109	70	180
Door Section– Top Flange		4300	4048.4	109	70	180
Door Section– Bottom T-Flange	5260	4804	3924/4564	152	55	150

Table 46 : Tower internals physical specification - 125.4 m Tubular Steel Tower 4.3 m OD without TBR soft 5 section strong

Section	"A" Distance to CG (mm)	"B" Shell Ø (mm)	"C" Bolt circle Ø (mm)	"D" Numbers of holes	"E" Bolt hole Ø (mm)	"F" Flange thick-ness (mm)
Top Section – Top Flange		3684	3534	86	39	150
Top Section – Bottom Flange	14771	4300	4154	144	39	75
Mid Section A – Top Flange		4300	4154	144	39	75
Mid Section A – Bottom Flange	13858	4300	4110	121	52	120
Mid Section B – Top Flange		4300	4110	121	52	120
Mid Section B – Bottom Flange	11476	4300	4094	121	61	120
Mid Section C – Top Flange		4300	4094	121	61	120
38Mid Section C – Bottom Flange	8969	4550	4303	109	70	140
Mid Section D – Top Flange		4550	4303	109	70	140
Mid Section D – Bottom Flange	7188	4550	4285	116	70	165
Mid Section E – Top Flange		4550	4285	116	70	165
Mid Section E – Bottom Flange	6064	4550	4266	115	70	205
Door Section– Top Flange		4550	4266	115	70	205

Section	"A"	"B"	"C" Bolt circle Ø	"D"	"E"	"F"
	Distance to CG	Shell Ø		Numbers of holes	Bolt hole Ø	Flange thick-ness
	(mm)	(mm)	(mm)		(mm)	(mm)
Door Section– Bottom T-Flange	4875	5000	4225/4765	168	55	140

Table 47 : Tower internals physical specification - 141 m Tubular Steel Tower 5.0 m OD without TBR soft CWE

Section	"A"	"B"	"C" Bolt circle Ø	"D"	"E"	"F"
	Distance to CG	Shell Ø		Numbers of holes	Bolt hole Ø	Flange thick-ness
	(mm)	(mm)	(mm)		(mm)	(mm)
Top Section – Top Flange		3684	3534	86	39	150
Top Section – Bottom Flange	14731	4300	4153	144	39	75
Mid Section A – Top Flange		4300	4153	144	39	75
Mid Section A – Bottom Flange	15659	4300	4110	121	52	120
Mid Section B – Top Flange		4300	4110	121	52	120
Mid Section B – Bottom Flange	12752	4300	4098	121	61	140
Mid Section C – Top Flange		4300	4098	121	61	140
38Mid Section C – Bottom Flange	10273	4850	4598	120	70	150
Mid Section D – Top Flange		4850	4598	120	70	150
Mid Section D – Bottom Flange	8452	4850	4600	120	70	150
Door Section–		4850	4600	120	70	150

Section	"A" Distance to CG	"B" Shell Ø	"C" Bolt circle Ø	"D" Numbers of holes	"E" Bolt hole Ø	"F" Flange thick-ness
	(mm)	(mm)	(mm)		(mm)	(mm)
Top Flange						
Door Section–	5008	5300	5065/4525	176	55	140
Bottom T-Flange						

Table 48 :Tower internals physical specification - 141 m Tubular Steel Tower 5.3 m OD without TBR soft for AUS

Section	"A" Distance to CG	"B" Shell Ø	"C" Bolt circle Ø	"D" Numbers of holes	"E" Bolt hole Ø	"F" Flange thickness
	(mm)	(mm)	(mm)		(mm)	(mm)
Top Section – 150 m/161 m hybrid - Top Flange		3684	3534	86	39	150
Top Section – 150 m/161 m hybrid - Bottom Flange	14410	4300	4154	130	39	91
Mid Section A – 150 m/161 m hybrid - Top Flange		4300	4154	130	39	91
Mid Section A – 150 m/161 m hybrid - Bottom Flange	11952	4300	4110	121	52	91
Mid Section B – 150 m/161 m hybrid Top Flange		4300	4110	121	52	91
Mid Section B – 150 m/161 m hybrid Bottom Flange	11327	4300	4108.5	96	61	120

Table 49 : Tower internals physical specification - 150 m Concrete Hybrid Tower and 161 m Concrete Hybrid Tower

Section	"A" Distance to CG (mm)	"B" Shell Ø (mm)	"C" Bolt circle Ø (mm)	"D" Numbers of holes	"E" Bolt hole Ø (mm)	"F" Flange thick-ness (mm)
Top Section – Top Flange		3684	3534	86	39	150
Top Section – Bottom Flange	14485	4300	4154	144	39	75
Mid Section A – Top Flange		4300	4154	144	39	75
Mid Section A – Bottom Flange	14261	4300	4110	121	52	120
Mid Section B – Top Flange		4300	4110	121	52	120
Mid Section B – Bottom Flange	11320	4300	4087	121	61	150
Mid Section C – Top Flange		4300	4087	121	61	150
Mid Section C – Bottom Flange	10912	4850	4605	109	70	140
Mid Section D – Top Flange		4850	4605	109	70	140
Mid Section D – Bottom Flange	8719	4850	4593	116	70	180
Mid Section E – Top Flange		4850	4593	116	70	180
Mid Section E – Bottom Flange	6857	4850	4575	115	70	215
Door Section– Top Flange		4850	4575	115	70	215
Door Section– Bottom T-Flange	5386	5300	5065/4525	168	55	140

Table 50 : Tower internals physical specification : 151 m Tubular Steel Tower 5.3 m OD without TBR soft for IEC CWE

Section	"A" Distance to CG (mm)	"B" Shell Ø (mm)	"C" Bolt circle Ø (mm)	"D" Numbers of holes	"E" Bolt hole Ø (mm)	"F" Flange thick-ness (mm)
Top Section – Top Flange		3684	3534	86	39	150
Top Section – Bottom Flange	16143	4300	4154	118	39	91
Mid Section A – Top Flange		4300	4154	118	39	91
Mid Section A – Bottom Flange	14472	4300	4117	120	52	120
Mid Section B – Top Flange		4300	4117	120	52	120
Mid Section B – Bottom Flange	12855	4300	4100	120	61	130
Mid Section C – Top Flange		4300	4100	120	61	130
38Mid Section C – Bottom Flange	9606	4300	4064	110	70	165
Door Section– Top Flange		4300	4064	110	70	165
Door Section– Bottom T- Flange	5675	4804	3924/4564	152	55	150

Table 51: Tower internals physical specification : 120.9 m Tubular Steel Tower 4.3 m OD without TBR soft IEC 5 section

Section	"A" Distance to CG (mm)	"B" Shell Ø (mm)	"C" Bolt circle Ø (mm)	"D" Numbers of holes	"E" Bolt hole Ø (mm)	"F" Flange thick-ness (mm)
Top Section – Top Flange		3684	3534	86	39	150
Top Section – Bottom Flange	14047	4261	4118	149	39	75
Mid Section A – Top Flange		4261	4118	149	39	75
Mid Section A – Bottom Flange	12307	4265	4085	120	52	91
Mid Section B – Top Flange		4265	4085	120	52	91
Mid Section B – Bottom Flange	9687	4270	4080	120	61	120
Mid Section C – Top Flange		4271	4080	120	61	120
38Mid Section C – Bottom Flange	8836	4276	4050	109	70	140
Mid Section D – Top Flange		4276	4050	109	70	140
Mid Section D – Bottom Flange	7131	4283	4045	109	70	180
Door Section– Top Flange		4283	4045	109	70	180
Door Section– Bottom Flange	5308	4291	3924/4564	152	55	150

Table 52: Tower internals physical specification : 120.9 m Tubular Steel Tower 4.29 m OD without TBR soft IEC

Section	"A"	"B"	"C" Bolt circle Ø	"D"	"E"	"F"
	Distance to CG	Shell Ø		Numbers of holes	Bolt hole Ø	Flange thick-ness
	(mm)	(mm)	(mm)		(mm)	(mm)
Top Section – Top Flange		3684	3534	86	39	150
Top Section – Bottom Flange	14047	4261	4118	149	39	75
Mid Section A – Top Flange		4261	4118	149	39	75
Mid Section A – Bottom Flange	12307	4265	4085	120	52	91
Mid Section B – Top Flange		4265	4085	120	52	91
Mid Section B – Bottom Flange	9687	4270	4080	120	61	120
Mid Section C – Top Flange		4271	4080	120	61	120
38Mid Section C – Bottom Flange	8836	4276	4050	109	70	140
Mid Section D – Top Flange		4276	4050	109	70	140
Mid Section D – Bottom Flange	7131	4283	4045	109	70	180
Door Section– Top Flange		4283	4045	109	70	180
Door Section– Bottom Flange	4958	4295	4040	108	70	205

Table 53: Tower internals physical specification : 120.9 m Tubular Steel Tower 4.29 m OD with TBR soft IEC

Section	"A"	"B"	"C" Bolt circle Ø	"D"	"E"	"F"
	Distance to CG	Shell Ø		Numbers of holes	Bolt hole Ø	Flange thick-ness
	(mm)	(mm)	(mm)		(mm)	(mm)
Top Section – Top Flange		3684	3534	86	39	150
Top Section – Bottom Flange	16345	3400	3215	94	52	105
Mid Section A – Top Flange		3400	3215	94	52	105
Mid Section A – Bottom Flange	13795	4300	4099	105	61	110
Mid Section B – Top Flange		4300	4099	105	61	110
Mid Section B – Bottom Flange	11432	4300	4100	121	61	130
Mid Section C – Top Flange		4300	4100	121	61	130
38Mid Section C – Bottom Flange	8849	4300	4065	110	70	165
Door Section– Top Flange		4300	4065	110	70	165
Door Section– Bottom T-Flange	5234	4556	3838/4378	152	55	110

Table 54: Tower internals physical specification 117 m Tubular Steel Tower 4.3 m OD without TBR

2.2 Tower Base Ring

This section gives the weights and dimensions of the tower base ring.

	Top / Bottom Flange							
Config #[1]	**Weight (kg)**	**Weight (lbs)**	**Length (m)**	**Length (ft)**	**Width (m)**	**Width (ft)**	**Height (m)**	**Height (ft)**
1	16800	37038	4.3/4.8	14.1/15.9	4.3/4.8	14.1/15.9	1.15	3.77
3	19400	42770	4.3/4.8	14.1/15.9	4.3/4.8	14.1/15.9	1.15	3.77
5	17600	38801	4.3/4.8	14.1/15.9	4.3/4.8	14.1/15.9	1.15	3.77
9	19500	42990	4.3/4.8	14.1/15.9	4.3/4.8	14.1/15.9	1.15	3.77
10	19000	41888	4.3/4.8	14.1/15.9	4.3/4.8	14.1/15.9	1.15	3.77
13	18600	41006	4.3/4.8	14.1/15.9	4.3/4.8	14.1/15.9	1.15	3.77
26	18700	41226	4.3/4.8	14.1/15.9	4.3/4.8	14.1/15.9	1.15	3.77

Table 55: Weight and dimensions of the tower base ring.

[1] Please refer to Table 2 for tower configurations

2.3 Sail Area

			Cypress Towers												
HH (m)	**101**	**101**	**101**	**107.4**	**117**	**120.9**	**120.9**	**120.9**	**125.4**	**125.4**	**141**	**161m**	**150m**	**151m**	**161m**
	Tubular												**Hybrid**		
Number of sections	**5**	**5**	**4**	**5**	**5**	**6**	**6**	**5**	**6**	**5**	**7**	**8**	**3**	**7**	**3**
Frequency (Hz)	**50**	**50**	**60**	**60**	**60**	**50**	**50**	**50**	**60**	**60**	**50**	**50**	**50**	**50**	**50**
Top Section (m^2)	114.5	114.5	114.5	118.8	115.3	114.5	114.5	118.8	118.8	118.8	118.8	237.5	114.5	118.8	114.5
Mid Section A (m^2)	108.4	108.4	129.0	108.4	108.9	108.4	108.4	128.9	108.4	140.9	128.9	257.7	108.4	128.9	108.4
Mid Section B (m^2)	78.3	78.3	102.3	102.7	102.3	85.5	85.5	114.4	102.3	120.4	102.3	216.7	102.3	102.3	102.3
Mid Section C (m^2)	63.8	63.8	N/A	63.8	78.3	78.3	78.3	85.5	78.3	89.1	78.3	145.3	N/A	99.9	N/A
Mid Section D (m^2)	N/A	N/A	N/A	N/A	N/A	63.8	63.8	N/A	63.8	N/A	63.8	127.4	N/A	88.3	N/A
Mid Section E (m^2)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	54.2	127.4	N/A	69.3	N/A
Mid Section F (m2)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	100.6	N/A	N/A	N/A
Bottom/Door Section (m^2)	44.4	49.4	63.8	48.2	48.5	44.4	49.4	54.2	47.0	49.4	42.1	78.0	N/A	55.4	N/A
TBR (m^2)	N/A	5.0	N/A	N/A	N/A	N/A	5.0	N/A	N/A	N/A	N/A	6.2	N/A	N/A	N/A

Table 56 : Sail area of tower sections

3 Hub Assembly

This section gives the weights and dimensions of the hub and excludes the bolts that are used to attach the blades to the hub.

Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m)	Width (ft)	Height (m)	Height (ft)
~ 50000	~ 110000	3.5	11.6	4.0	13.1	3.8	12.5

4 Blades

This section gives the weight of a single blade (type LM 77.4p) including bolts but the dimensions are for the blade only.

	Weight		Length		Maximum chord		Chord at 0.9 x rotor diameter		Blade root outer diameter	
Rotor Diameter	(kg)	(lbs)	(m)	(ft)	(m)	(ft)	(m)	(ft)	(m)	(ft)
158 m	~ 20000	~ 44000	77.4	253.9	4.0	13.1	1.3	4.2	3.2	10.5

Table 57: Weight and dimensions of a single blade

5 Machine Head

This section gives the weights and dimensions of the machine head subassemblies and their internal components and excludes the hub and blades. There are two version of the Cypress machine head: Series 1 and Series 2.

5.1 Machine Head - Series 1

Subassemblies	Weight (t)	Weight (lbs)	Length (m)	Length (ft)	Width (m)	Width (ft)	Height (m)	Height (ft)
Complete machine head Series1 fully installed on tower top (excluding hub and blades) including drive train	168	~ 369600	14.3	46.9	5.5	18.1	6.6	21.8
Complete machine head Series 1 assembled (excluding drive train, without hub and blades)	94	~ 206800	14.3	46.9	5.5	18.1	6.6	21.8
Machine head Series1 shipping mass including generator, transformer and transport roof, including shipping fixture No drive train, gearbox, machine head roof, machine head side extensions, machine head height extension and roof top cooler installed	90	~ 198500	14.0	46.1	3.9	12.8	3.8	12.5
Machine head Series1 shipping mass including generator, and transport roof, including shipping fixture No drive train, gearbox, machine head roof, machine head side extensions, machine head height extension and roof top cooler installed Excluding transformer	78.3	~172300	14.0	46.1	3.9	12.8	3.8	12.5
Machine head Series1 shipping mass front end only without trafo rear section and without generator (US/CANADA shipping)	63	138900	12.4	40.6	3.98	13	3.45	11.3
Machine head Series1 roof, side extensions, external roof top cooler	10	~ 22000	12.0	39.3	3.8	12.5	3	9.8
Drivetrain with Gearbox	75	~ 165000	7.4	24.2	3.3	10.8	3.2	10.4
Drivetrain with Gearbox including shipping fixture	79	~ 174000	7.4	24.2	3.3	10.8	3.2	10.4
Gearbox including torque support (US/CANADA shipping)	46	~ 101200	N/A	N/A	N/A	N/A	N/A	N/A
Front end of drive train including main bearing and main shaft (US/CANADA shipping)	33	~ 72600	N/A	N/A	N/A	N/A	N/A	N/A
Drive train with gearbox and drive train roof section Series1 without shipping fixture (installation mass)	77	~ 169400	N/A	N/A	N/A	N/A	N/A	N/A
Gearbox including torque support and elastomer elements	45.5	~ 100000	4.0	13.1	3.3	10.8	2.9	9.5
Generator	14.4	~ 32000	3.4	10.6	1.8	6.0	2.6	8.5
Transformer	14	~ 32000	3.2	10.4	1.2	3.9	2.5	8.3

Table 58: Weight and dimensions of the machine head Series1

5.2 Machine Head - Series 2

Subassemblies	Weight (t)	Weight (lbs)	Length (m)	Length (ft)	Width (m)	Width (ft)	Height (m)	Height (ft)
Complete machine head (excluding hub and blades) including drive train	158	~ 347600	12.8	42.15	4.3	14.1	3.8	12.5
Complete machine head assembled (excluding drive train, without hub and blades) including Shipping fixtures[2]	89	~ 196600	12.8	42.15	4.3	14.1	3.8	12.5
Machine head Series 2 shipping mass front end only without trafo and without generator (US/CANADA shipping) including shipping fixture	62.5	~ 137789	13.4	43.98	4.3	14.16	3.9	12.81
Passive roof cooler	2	~ 4400	3.9	12.8	2.0	6.5	0.4	1.4
Drivetrain with Gearbox	75	~ 165000	7.4	24.2	3.4	11.2	3.2	10.4
Drivetrain with Gearbox Including shipping fixture	79	~ 174000	7.4	24.2	3.98	13.1	3.2	10.4
Gearbox including torque support (US shipping)	46	~ 101200	4.1	13.5	3.98	13.1	3.2	10.4
Front end of drive train including main bearing and main shaft (US shipping)	33	~ 72600	3.6	11.8	3.3	10.8	3.2	10.4
Gearbox including torque support and elastomer elements	45.5	~ 100000	4.0	13.1	3.4	11.2	2.9	9.5
Generator	14.4	~ 32000	3.4	10.6	1.8	6.0	2.6	8.5
Transformer	14	~ 32000	3.2	10.4	1.2	3.9	2.5	8.3

Table 59: Weight and dimensions of the machine head Series2

6 Downtower Assembly Components

This section gives the weights and dimensions of the downtower assembly components.

Component	Weight (kg)	Weight (lbs)	Length (m)	Length (ft)	Width (m)	Width (ft)	Height (m)	Height (ft)
Controller level	~ 4300	~ 9000	3.1	10.2	3.0	9.1	3.2	10.6

Table 60: Weight and dimensions of the downtower assembly components

[2] Regional variations to mass and size are available due to different transportation fixtures and transport options

GE Renewable Energy

– Original Document–

Technical Documentation
Wind Turbine Generator Systems
All Turbine Types - Onshore

Codes and Standards

Rev.05 - EN 2019-01-23

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Table of Contents

1 Introduction

This document describes GE Wind's approach to compliance and certification for 1&2MW/3MW/5MW Platform, 50 Hz & 60 Hz wind turbines.

2 Certification

GE wind turbines with ratings less than 2.0MW are certified to the Germanischer Lloyd guideline for the Certification of Wind Turbines (Edition 2003 with supplement 2004) using IEC 61400-1 loads (Editions 2).

All other GE wind turbines currently being offered for sale are certified according to IEC 61400-22 testing and certification scheme in combination with IEC 61400-1 Edition 3 wind turbine design requirements. Each turbine model may have additional certifications as listed in the Operational Limits section of the Technical Description and Data document for that model.

3 Compliance

3.1 50 Hz

The GE 50 Hz wind turbines are designed to meet the following EU directives:

- 2006/42/EC Machinery Safety Directive
- 2014/35/EU (formerly 2006/95/EC) Low Voltage Directive
- 2014/30/EU (formerly 2004/108/EC EMC) directive
- Fixed installations such as wind turbines are not required under the EMC directive to be either CE marked or be provided with a declaration to the EMC directive. However, some subassemblies or components of apparatus may have their own declaration of conformity.

3.2 60 Hz

The GE 60 Hz wind turbines are designed to meet the following North American codes & standards:

- National Electric Code (NEC) - valid for all US States & Territories
  Electrical components are third party listed to appropriate US Standards
- Canadian Electric Code (CEC) – valid for all Canadian Provinces & Territories
  Electrical components are third party listed to appropriate Canadian Standards
- Occupational Safety & Health Administration (OSHA) guidelines
  29 CFR part 1910 – General Industry

4 Quality Assurance

GE manufacturing locations are certified based on the requirements found in ISO 9001: 2008.

Grover Hill Wind, LLC
Second Supplement
Case No. 23-459-EL-BGA

Attachment B
Operational Sound Level Analysis

Westwood

August 3, 2023

DICKINSON WRIGHT PLLC

Westwood

August 3, 2023

Lotus Infrastructure Partners
5 Greenwich Office Park 2nd floor
Greenwich, CT 06831

Re: Grover Hill Wind Project: Updated Turbine Selection Noise Compliance

This memo is a response to the most recent proposed turbine selection for the Grover Hill Wind Project. Westwood previously conducted a noise impact analysis to determine compliance with applicable regulations and requirements set by the OPSB. The most recent analysis was conducted assuming the GE 3.0-140 turbine model. Grover Hill Wind filed an application, Case Number 20-417-EL-BGN, with the OPSB on May 3, 2021. The project received the certificate on December 15, 2022. As part of the certificate, OPSB stipulated that project noise would not exceed the existing measured ambient level by 5 dBA.

Following the analysis conducted with the GE 3.0-140 turbine model and corresponding NRO layout design to meet noise level limits at adjacent residences, the GE Cypress 6.1-158 turbine was selected. A comparison of these two turbines is shown in the following table:

Turbine Model	Hub Height	Maximum Sound Power Level
GE 3.0-140	120 m	108 dBA
GE Cypress 6.1-158	117 m	107.5 dBA

The 1 dBA sound power reduction and 2 m hub height decrease from the GE 3.0-140 to the GE Cypress 6.1-158 will have a negligible effect on the results of the last study. Westwood completed an analysis within WindPRO modeling software for the GE 3.0-140 turbine and determined compliance; utilizing the GE Cypress 6.1-158 turbine, the same or lower impacts are anticipated. No updated model is required at this time.

Sincerely,

WESTWOOD PROFESSIONAL SERVICES, INC.

Andrew Schad

Andrew Schad
Noise Control and Acoustics Team Lead
andrew.schad@westwoodps.com

Grover Hill Wind, LLC
Second Supplement
Case No. 23-459-EL-BGA

Attachment C
Ice Throw Analysis

Westwood

August 3, 2023

DICKINSON WRIGHT PLLC

Westwood

August 3, 2023

Lotus Infrastructure Partners
5 Greenwich Office Park 2nd floor
Greenwich, CT 06831

Re: Grover Hill Wind Project: Updated Turbine Selection Ice Throw Compliance

This memo is a response to the most recent proposed turbine selection for the Grover Hill Wind Project. Westwood previously conducted an ice throw analysis to determine compliance with applicable regulations and requirements set by the OPSB. The most recent analysis was conducted assuming the Vestas V162 turbine model. Grover Hill Wind filed an application, Case Number 20-417-EL-BGN, with the OPSB on May 3, 2021. The project received the certificate on December 15, 2022.

The regulations for the state of Ohio required that:

- The risk of ice throw be reported at the property boundary and public road that are nearest to a wind turbine.
- The probability of a 1-kg fragment of ice landing beyond the statutory property line setback (turbine blade length plus 1,125 ft which equals 1,391 ft or 424 m) for each turbine location is less than one percent per year.

Following the analysis conducted with the Vestas V162 turbine model, the GE Cypress 6.1-158 turbine was selected. A comparison of these two turbines is shown in the following table:

Turbine Model	Hub Height	Rotor Diameter	Tip Speed
Vestas V162	119 m	162 m	92.5 m/s
GE Cypress 6.1-158	117 m	158 m	83.6 m/s

With the 2 m hub height decrease and 4 m rotor diameter reduction, in addition to the reduction in tip speed from the Vestas V162 to the GE Cypress 6.1-158, it is unlikely that an ice fragment would travel farther than the estimated in the last study. Westwood completed the analysis within a Monte Carlo simulation involving 1,000,000 iterations for the Vestas V162 turbine and determined compliance. Utilizing the GE Cypress 6.1-158 turbine, the same or lower results are anticipated. No updated model is required at this time.

Sincerely,

WESTWOOD PROFESSIONAL SERVICES, INC.

Anthony Schrader
Wind Resource Analyst
anthony.schrader@westwoodps.com

Grover Hill Wind, LLC
Second Supplement
Case No. 23-459-EL-BGA

Attachment D
Shadow Flicker Analysis

Westwood

August 3, 2023

DICKINSON WRIGHT PLLC

Westwood

August 3, 2023

Lotus Infrastructure Partners
5 Greenwich Office Park 2nd floor
Greenwich, CT 06831

Re: Grover Hill Wind Project: Updated Turbine Selection Shadow Flicker Compliance

This memo is a response to the most recent proposed turbine selection for the Grover Hill Wind Project. Westwood previously conducted shadow flicker impact analysis to determine compliance with applicable regulations and requirements set by the OPSB. The most recent analysis was conducted assuming the Vestas V162 turbine model. Grover Hill Wind filed an application, Case Number 20-417-EL-BGN, with the OPSB on May 3, 2021. The project received the certificate on December 15, 2022.

According to Ohio Adm. Code Section 4906-4-09, "The facility shall be designed to avoid unreasonable adverse shadow flicker effect at any non-participating sensitive receptor within one thousand meters of any turbine. At a minimum, the facility shall be operated so that shadow flicker levels do not exceed thirty hours per year at any such receptor. Non-participating, as used in this context, refers to a property for which the owner has not signed a waiver or otherwise agreed to be subject to a higher shadow flicker level."

Following the analysis conducted with the Vestas V162 turbine model, the GE Cypress 6.1-158 turbine was selected. A comparison of these two turbines is shown in the following table:

Turbine Model	Hub Height	Rotor Diameter	Cut-in Speed	Cut-out Speed
Vestas V162	119 m	162 m	3 m/s	24 m/s
GE Cypress 6.1-158	117 m	158 m	3 m/s	25 m/s

The 2 m hub height decrease and 4 m rotor diameter reduction, in addition to the small increase in cut-out speed from the Vestas V162 to the GE Cypress 6.1-158 will have a negligible effect on the results of the last study. Westwood completed an analysis using WindPRO modeling software for the Vestas V162 turbine; utilizing the GE Cypress 6.1-158 turbine, the same or lower impacts are anticipated. No updated model is required at this time.

Sincerely,

WESTWOOD PROFESSIONAL SERVICES, INC.

Anthony Schrader
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Summary: Notice - SECOND SUPPLEMENT TO THE APPLICATION FOR AN AMENDMENT TO THE GROVER HILL WIND, LLC CERTIFICATE electronically filed by Christine M.T. Pirik on behalf of Grover Hill Wind, LLC.