Appendix D

Turbine Specifications

SIEMENS

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Canada

Subject: Wolfe Island Wind Park, Ontario, Canada

MR. Keating:

This letter confirms that Canadian Hydro Developers, Inc. has purchased SWT 2.3-93 turbines from Siemens. This is the only wind turbine model that Siemens has offered to the North American market. Please note that the SWT 2.3-93 was previously known as the Siemens 2.3 MW Mk II, as we recently announced to re-name PG products and services under a common nomenclature structure that is consistent with Siemens global communication standards.

It is important to note that while the names of our products have changed, all else about them remains the same.

Sincerely,

Dany St-Pierre
Marketing Manager – Americas
Siemens Wind Power
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Siemens Power Generation, Inc.

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2.3 MW Mk II 60 Hz
Technical Description

General
The 2.3 MW Mk II wind turbine is a variable speed version of the well-known 2.3 MW type typically preferred by major utilities and developers for large onshore and offshore wind power stations.

General Design
The basic design of the 2.3 MW Mk II is similar to the design of the 2.3 MW turbine type. However, due to the increased requirements for noise and grid control at high penetration of wind power the Mk II version has a number of new features.

The rotor has a larger rotor with variable speed and pitch regulation. Due to aerodynamic advances this arrangement has reduced aerodynamic noise output even at rated power.

The generator is connected to the MV transformer with Siemens' new NetConverter® power conversion system. This system provides maximum flexibility in the turbine response to voltage and frequency control, fault conditions, etc. and meets the requirements of all applicable grid codes.

Even though many other manufacturers use similar concepts, specific design features distinguish Siemens turbines from the rest – features which have characterised all Siemens models during the last two decades.

Major components such as the rotor hub, the main shaft, the gearbox, the yaw system, etc., are all of particularly heavy dimensions. The main shaft is long and has the reaction supports located optimally for transfer of bending moments to the yaw system and tower. The turbine has two truly independent safety systems consisting of the blade pitch system and the mechanical brake. The two-stage mechanical brake system use reduced torque in normal shutdown situations and full torque in emergency shutdown only.

All details are designed with a view to the best engineering practice. Bolt extenders are used on all dynamically loaded bolts, vibration-proof cable clamps are used in the electrical system, and all fitting surfaces for machine elements are machined.

Rotor
The 2.3 MW Mk II rotor is a three-bladed cantilevered construction, mounted upwind of the tower. The power output is controlled by pitch regulation. The rotor speed is variable in order to maximise the aerodynamic efficiency, and the speed compliance during power regulation minimises the dynamic loads on the transmission system.

Blades
The B45 blades are made of fibreglass-reinforced epoxy in Siemens' proprietary IntegralBlade® manufacturing process. In this process the blades are cast in one piece, providing optimum quality and eliminating weaker areas at glue joints. The aerodynamic design represents state-of-the-art wind turbine technology, and the structural design has the usual Siemens safety factors on top of all type approval requirements. This concept has been thoroughly verified by static and dynamic testing of both prototype and serial production blades.

The blades are mounted on pitch bearings and can be feathered 80 degrees for shutdown purposes. Each blade has its own independent failsafe pitching mechanism capable of feathering the blade under any operating condition.

The blade pitch arrangement allows optimising of the power output throughout the operating range, and the blades are feathered to minimise wind loads during standstill under extreme wind conditions.

Rotor hub
The rotor hub is cast in nodular cast iron and is fitted to the main shaft with a flange connection. The hub is sufficiently large to provide a comfortable working environment for two service technicians during maintenance of blade roots and pitch bearings from inside the structure.

Main shaft and bearing
The main shaft is forged in alloy steel and is hollow for the transfer of power and signals to the blade pitching system.

The main shaft is supported by a large self-aligning double spherical roller bearing shrunk onto the main shaft. The bearing is grease lubricated and the bearing seals are labyrinth seals requiring no maintenance.

Gearbox
The gearbox is a custom-built three-stage planetary-helical design. The first, high torque stage is of helical planetary design, providing a compact high-performance construction. The two high-speed stages are of normal helical design, providing the offset of the high speed shaft that is needed to allow passage of power and control signals to the pitch systems.

The gearbox is shaft-mounted and the main shaft torque is transferred to the gearbox by a shrink disk connection. The gearbox is supported on the nacelle with flexible rubber bushings, thereby reducing structural noise transfer.

The gearbox is fitted with an oil conditioning system that maintains optimum operating conditions. All bearings are lubricated with oil fed directly from a large in-line filter, and as an additional feature the oil is continuously cleaned by an off-line filter unit. The cooling system maintains an operating temperature at normal ambient conditions between 40 and 50 degrees C irrespective of the gearbox loading.

The gearbox is fitted with monitoring of temperature, oil pressure and vibration levels.

Generator
The generator is a fully enclosed asynchronous generator. The generator has a squirrel-cage rotor without slip-rings. The generator rotor construction and stator winding is specially designed for high efficiency at partial loads. The generator is protected with thermal switches and analogue temperature measurement.

The generator is fitted with a separate thermostat-controlled ventilation arrangement. Air is recirculated internally in the generator and heat is transferred through an air-to-air heat exchanger that efficiently separates the internal environment in the generator from the ambient air.

Mechanical brake
The mechanical brake is fitted to the gearbox high-speed shaft. It is failsafe and has three hydraulic calipers. The brake application system has two stages; one for normal shutdown and the other for emergency shutdown in case of malfunctioning pitch systems.

Yaw system
The yaw bearing is an externally geared slewing ring with a friction bearing acting as a yaw brake. Eight electric planetary gear motors drive the yawing.

Tower
The 2.3 MW Mk II turbine is mounted on a tapered tubular steel tower. The tower can be fitted with a personnel hoist as an option.

Controller
The turbine controller is a microprocessor-based industrial controller; similar to the type used in other Siemens wind turbines. The controller is complete with switchgear, protection devices, etc. It is self-diagnosing and has a keyboard and display for easy readout of status and for adjustment of settings. Remote control is easily installed.

The NetConverter® power conversion system allows generator operation at variable speed, frequency and voltage while supplying power at constant frequency and voltage to the MV transformer. The power conversion system is of modular arrangement for easy maintenance and is water cooled.

The 2.3 MW Mk II turbine can be adapted to comply with all currently valid grid code requirements on relevant markets. The power factor can be controlled over a wide range, and the turbine has ride-through capability for all normal faults. Voltage and frequency control and other grid-related adjustments can be implemented by the integrated Park Pilot facility in the WebWPS SCADA system.

SCADA
The 2.3 MW Mk II turbine is equipped with Siemens' WebWPS SCADA system. This system offers long-distance control and a variety of status views and useful reports from a standard internet web browser. The status views present information such as electrical and mechanical data, operation and fault status, meteorological data and grid station data.

Primary-level users can be granted access to key server features, including any control over the turbine needed for grid compliance.

Turbine Condition Monitoring
In addition to the WebWPS SCADA system, the 2.3 MW Mk II turbine is equipped with Siemens' unique WebCMS condition monitoring system. This system continuously monitors the vibration level of the main turbine components and compares the present vibration spectra with a set of reference spectra established previously on the same turbine. Result review, detailed analysis and reprogramming can all be carried out using a standard web browser.

Operation and Safety Systems
The wind turbine operates automatically, self-starting when the wind reaches an average speed of about 3–5 m/s. The output increases approximately linearly with the wind speed until the wind reaches 13–14 m/s. At that point the power is regulated at rated power.

If the average wind speed exceeds the maximum operational limit of 25 m/s the turbine is shut down by feathering of the blades. When the wind drops back below the restart speed the safety systems reset automatically.

2.3 MW Mk II 60 Hz
Technical Specifications

Rotor

Type	3-bladed, horizontal axis
Position	Upwind
Diameter	93 m
Swept area	6800 m²
Synchronous rotor speed	6-16 rpm
Power regulation	Pitch regulation
Rotor tilt	6 degrees

Blade

Type	Self-supporting
Blade length	45 m
Tip chord	0.8 m
Root chord	3.5 m
Aerodynamic profile	NACA 63.xxx, FFAxxx
Material	GRE
Surface gloss	Semi-mat, < 30 / ISO2813
Surface colour	Light grey, RAL 7035

Aerodynamic brake

Type	Full span pitching
Activation	Active, fail-safe

Load supporting parts

Hub	Nodular cast iron
Main bearing	Spherical roller bearing
Main shaft	Alloy steel
Nacelle bed plate	Steel

Transmission system

Coupling hub - shaft	Flange
Coupling shaft – gearbox	Shrink disc
Gearbox type	3-stage planetary/helical
Gearbox ratio	1 : 91
Gearbox lubrication	Splash / forced lubrication
Oil volume	Approx. 400 l
Gearbox cooling	Separate oil cooler
Gearbox designation	PEAB 4456
Gearbox manufacturer	Flender AG
Coupling gear - generator	Double flexible coupling

Mechanical brake

Type	Fail-safe disc brake
Position	High speed shaft
Number of callipers	2

Canopy

Type	Totally enclosed
Material	Steel

Generator

Type	Asynchronous
Nominal power	2300 kW
Protection	IP 54
Cooling	Integrated heat exchanger
Insulation class	F
Generator designation	AMA 500L4 BAYH
Generator manufacturer	ABB

Grid terminals (LV)

Nominal power	2300 kW
Voltage	690 V
Frequency	60 Hz

Yaw system

Type	Active
Yaw bearing	Externally geared slewring
Yaw drive	Eight electric gear motors
Yaw brake	Passive friction brake + eight brake motors

Controller

Type	Microprocessor
SCADA system	WPS via modem
Controller designation	KK WTC 3.0
Controller manufacturer	KK Electronic A/S

Tower

Type	Cylindrical or tapered tubular
Hub height	60 m, 80 m or site specific
Corrosion protection	Painted
Surface gloss	Silk mat, 30-40 / ISO2813
Colour	Light grey, RAL 7035

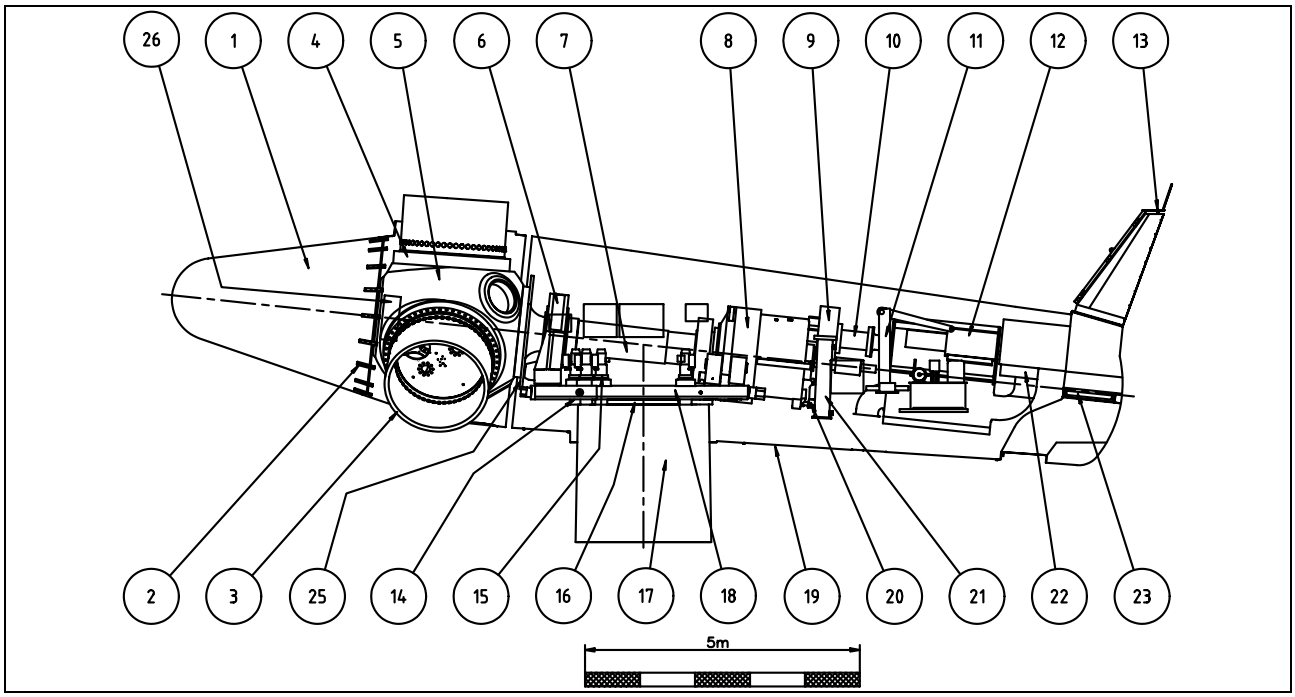
Operational data

Cut-in wind speed.	4 m/s
Nominal power at.	13-14 m/s
Cut-out wind speed	25 m/s
Maximum 2 s gust	55 m/s (standard version) 60-80 m/s (special version)

Weights (approximately)

Rotor	60,000 kg
Nacelle	82,000 kg
Tower for 60 m hub height	81.000 kg
Tower for 60 m hub height (off-shore)	98.000 kg
Tower for 80 m hub height.	158.000 kg

2.3 MW Mk II 60 Hz
Nacelle Arrangement



Dansk

1. Spinner
2. Spinner beslag
3. Vinge
4. Pitchleje
5. Rotornav
6. Hovedleje
7. Hovedaksel
8. Hovedgear
9. Bremseskive
10. Kobling
11. Service kran
12. Generator
13. Meteorologiske sensorer
14. Krøjeleje
15. Krøjegear
16. Krøjering
17. Tårn
18. Maskinramme
19. Maskinskærm
20. Olie filter
21. Olie filter
22. Generatorblæser
23. Olie køler
25. Rotorlås
26. Navboks

English

1. Spinner
2. Spinner bracket
3. Blade
4. Pitch bearing
5. Rotor hub
6. Main bearing
7. Main shaft
8. Gearbox
9. Brake disc
10. Coupling
11. Service crane
12. Generator
13. Meteorological sensors
14. Yaw bearing
15. Yaw gear
16. Yaw ring
17. Tower
18. Nacelle bedplate
19. Canopy
20. Oil filter
21. Oil filter
22. Generator fan
23. Oil cooler
25. Rotor lock
26. Hub controller box

Deutsch

1. Spinner
2. Spinner beschlag
3. Rotorblatt
4. Pitchlager
5. Nabe
6. Hauptlager
7. Hauptwelle
8. Getriebe
9. Scheibenbremse
10. Kupplung
11. Kran
12. Generator
13. Windfane und Anemometer
14. Gleitführung
15. Windnachführung
16. Verzahnte Kranz
17. Turm
18. Maschinenrahmen
19. Gondel
20. Öl Filter
21. Öl Filter
22. Generator Kühlung
23. Öl Kühlung
25. Rotor Arretirung
26. Nabe controller box