Grand Bend Wind Farm

Wind Turbine Specifications Draft Report

Grand Bend Wind Limited Partnership,

c/o Northland Power Inc.

NORTHLAND POWER

NEEGAN BURNSIDE

August 2012

Grand Bend Wind Farm
Wind Turbine Specifications Draft Report

Prepared By:

Neegan Burnside Ltd.
292 Speedvale Avenue West Unit 20 Guelph ON N1H 1C4

Prepared for:

Grand Bend Wind Limited Partnership
c/o Northland Power Inc.

August 2012

File No: PIA 019991

Record of Revisions

Revision	Date	Description
0	August 24, 2012	Initial Submission to the Ministry of the Environment, Municipalities, and Aboriginal Communities
0	August 27, 2012	Initial Draft Submission to Municipal and Aboriginal Communities as well as Selected Government Agencies

Executive Summary

This Wind Turbine Specification Report is one component of the REA Application for the Project, and has been prepared in accordance with Item 14, Table 1 of O.Reg 359/09 which sets out specific content requirements as follows:

- The make, model, name plate capacity, hub height above grade, rotational speeds.
- The acoustic emissions data, determined and reported in accordance with standard CAN/CSA-C61400-11-07, "Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques", dated October 2007, including overall sound power level, measurement uncertainty value, octave-band sound power levels (linear weighted) and tonality and tonal audibility.

The Project is proposed to consist of up to 48 turbines with a total electricity generation capacity of 100 MW making this a class 4 wind facility (as defined in O.Reg. 359/09). Subject to availability and pricing, Siemens SWT-2.3-113 wind turbines will be utilized.

The fundamental components of each turbine are included in the report. Acoustic emissions data have been supplied by Siemens and included in an appendix to the report. Further detail on acoustic emissions and associated turbine models is provided in the Environmental Noise Impact Assessment provided under a separate cover.

Table of Contents

Tables

Appendices

1.0 Introduction

1.1 Background

Grand Bend Wind Limited Partnership, c/o Northland Power Inc. ("Northland") is proposing to develop, construct and operate a 100 MW wind facility located north of Grand Bend, Ontario. An application for approval is being prepared under Ontario Regulation 359/09 of the *Environmental Protection Act*. The project is classified as a Class 4 Wind facility under the Regulation. The Grand Bend Wind Farm ("the Project") is located in Huron County, spanning the lower-tier municipalities of Bluewater and Huron South. Portions of the transmission line also traverse the municipality of Huron East and municipality of West Perth in Perth County. The project location and study area is outlined in the Project Description Report under a separate cover.

The basic project components will include up to 48 turbines (Siemens SWT-2.3-113 direct drive wind turbine generators with a total name plate capacity of 100 MW), turbine access roads, a 36 kV electrical collection system, substation, a new transmission line within municipal road right-of ways ("ROWs") along Rodgerville Road, Line 17 and Road 183 with connection to the provincial power grid at the 230 kV transmission line south of the Seaforth Transformer Station. During construction temporary components will include access roads and work/storage areas at the turbine locations and transmission connections.

1.2 Objective

This Wind Turbine Specification Report is one component of the REA Application for the Project, and has been prepared in accordance with Item 14, Table 1 of O.Reg. 359/09 which sets out specific content requirements as provided in **Table 1.1**.

Table 1.1 Wind Turbine Specification Report Requirements

Required Documentation	Requirement Met	Location in Submission
Provide specifications of each wind turbine, including:		
1. The make, model, name plate capacity, hub height above grade, rotational speeds	Yes	Section 2.0 and Appendix A
2. The acoustic emissions data, determined and reported in accordance with standard CAN/CSA-C61400-11-07, "Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques", dated October 2007, including overall sound power level, measurement uncertainty value, octave-band sound power levels (linear weighted) and tonality and tonal audibility	Yes	Appendix A

2.0 Wind Turbine Specifications

The Project is proposed to consist of up to 48 turbines with a total electricity generation capacity of 100 MW making this a class 4 wind facility (as defined in O.Reg. 359/09). Subject to availability and pricing, Siemens SWT-2.3-113 wind turbines will be utilized.

The fundamental components of each turbine include the following:

- A reinforced concrete spread footing foundation (approximately 3 m deep and 18 to 22 m in diameter, depending on subsurface conditions);
- Five steel tower sections (resulting in a hub height of 99.5 m);
- Hub (central component of rotor assembly);
- Three glass-fibre reinforced epoxy-resin rotor blades;
- Nacelle (gearbox, electrical generator, brake assembly and housing);
- Meteorological instruments (anemometer and wind vane);
- a step-up Transformer adjacent to each tower at the base;
- Electrical wiring and grounding; and,
- Tower lighting (in accordance with NAV Canada Regulations).

Table 2.1 provides a summary of the relevant turbine specifications required for this report. **Appendix A** contains further technical specifications provided by Siemens.

Table 2.1 Siemens SWT-2.3-113 Specifications

Manufacturer	Siemens
Model	Varies Based on Power Rating – Refer to Appendix A
Nameplate Capacity	Varies Based on Power Rating – Refer to Appendix A
Hub Height Above Grade	99.5m
Blade Length	55m
Rotor Diameter	113m
Rotor Sweep Area	10,000m^2
Rotational Speed Range	6-13 rpm
Overall Sound Power Level	Refer to Appendix A
Measurement Uncertainty Value	Data pending from Siemens
Octave-band Sound Power Levels (Linear Weighted)	Refer to Appendix A
Tonality and Tonal Audibility	Data pending from Siemens

3.0 Acoustic Emissions Data

Acoustic emissions data have been supplied by Siemens and included in Appendix A. For further detail on acoustic emissions and associated turbine models, refer to the Environmental Noise Impact Assessment provided under a separate cover.

4.0 Conclusion

Neegan Burnside (Burnside) has prepared the Grand Bend Wind Farm Turbine Specifications Report for The Grand Bend Wind Limited Partnership in accordance with O.Reg. 359/09. This report has been prepared by Burnside for the sole benefit of Northland Power Inc., and may not be re-produced by any third party without the express written consent of Northland Power Inc.

Respectfully submitted,

Neegan Burnside Ltd.

Prepared by:

Chris Shilton, P.Eng, LEED®AP
Project Engineer

Reviewed by:

Lyle Parsons, BES
Project Manager

Approved by:

Jim Mulvale, Manager, EH&S
Northland Power Inc.

NEEGAN BURNSIDE

Appendix A
Turbine Specifications from Siemens

SIEMENS

SWT-2.3-113

Turning moderate wind into maximum results

At the leading edge of evolution

The new Siemens SWT-2.3-113 wind turbine is the ultimate choice for low to moderate wind conditions. The revolutionary direct drive generator and the new, optimized Quantum Blade are paired to extract as much energy as possible from the wind.

Efficient. Quiet. Robust and reliable. The Siemens SWT-2.3-113 is the new benchmark wind turbine for low to medium wind speeds. As a result of more than 30 years of research and development, it is designed to harvest more energy out of moderate wind conditions than anyone thought possible.

Proven design

The SWT-2.3-113 is built around the same revolutionizing direct drive generator as the SWT-3.0-101. The direct drive turbine offers exceptional reliability and efficiency – with only 50% of the parts normally required for a conventional wind turbine.
By using the same proven design and sharing the majority of components with its larger sibling, production costs and lead times can be kept down.

Unique aerodynamics

The Quantum Blade combines exceptional aerodynamic performance with patented manufacturing technology. Based on innovative aerodynamic solutions in the root and tip sections, the Quantum Blade offers maximum efficiency at low to medium wind speeds.

Maximum availability

Simplicity is the ultimate sophistication. With the simple and robust direct drive concept with 50% fewer parts, the SWT-2.3-113 wind turbine is designed for maximum availability. Furthermore, the spacious nacelle and the ergonomic working conditions facilitate serviceability and contribute to minimizing downtime for scheduled maintenance.


“You cannot change the wind.
It may be strong, it may be light.
This leaves it up to us to extract
as much energy as we can from it.
Anne Schannong Vinther, Quality Engineer
DRAFT

Innovation for efficiency

Siemens direct drive technology and the new Quantum Blade represent groundbreaking wind turbine design and technology. The result of these two key innovations is a turbine with maximum efficiency and reliability, which helps to enable a solid return on investment.

Maximized performance with 50% fewer parts

The Siemens direct drive design incorporates a permanent magnet generator with fewer moving parts than ever before.

The simple permanent magnet design offers increased efficiency directly by minimizing energy losses and indirectly by reducing maintenance needs. The outer rotor arrangement leads to a more compact and lightweight generator, making transportation and installation easier and faster.

The B55 Quantum Blade

The new generation of Siemens wind turbine blades is lighter than previous designs but retains the superior strength known from earlier generations of blades. Thanks to unique airfoils and redesigned tip and root sections, the blade offers superior performance at low to medium wind speeds. The root section uses Siemens "flatback" profiles to minimize root leakage and provide higher lift. The tip has also undergone a fine-tuning process to give enhanced lift and acoustic performance.

One-piece moulding

Like other Siemens blades, the new Quantum Blades are manufactured in Siemens proprietary IntegralBlade® process. Each blade is moulded in one single production step from fiberglass-reinforced epoxy resin, resulting in a stronger, lighter blade without any joints.

Lower noise

With a low 105 dB noise level, the SWT-2.3-113 is one of the quietest wind turbines on the market. As a result, this turbine type has an extremely high ratio of energy output per noise affected area, resulting in fewer disturbances to people and wildlife.

Superior grid compliance

The Siemens NetConverter® is designed for maximum flexibility in the turbine's response to voltage and frequency variations, fault ride-through capability and output adjustment. The advanced wind farm control system provides state-of-the-art fleet management.

Technical specification

Rotor

- Type: 3-bladed, horizontal axis
- Position: Upwind
- Diameter: 113 m
- Swept area: 10,000 m²
- Speed range: 6–13 rpm
- Power regulation: Pitch regulation with variable speed
- Rotor tilt: 6 degrees

Blade

- Type: Self-supporting
- Blade length: 55 m
- Tip chord: 0.63 m
- Root chord: 4.2 m
- Aerodynamic profile: NB 1-7, SWPNA1_XX12, FFAxxx
- Material: GRE
- Surface gloss: Semi-mat, <30 / ISO2813
- Surface colour: Light grey, RAL 7035

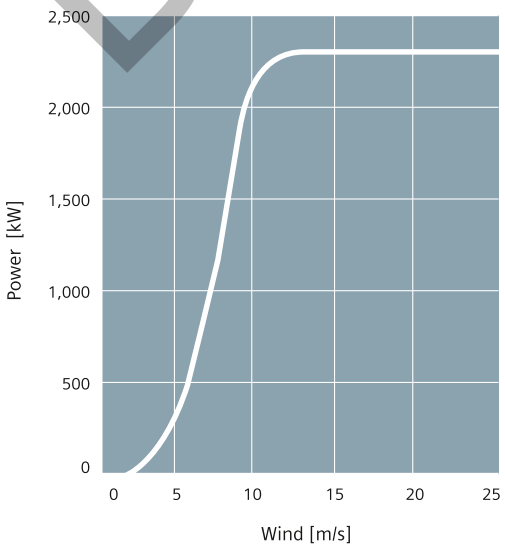
Aerodynamic brake

- Type: Full span pitching
- Activation: Active, hydraulic

Load-supporting parts

- Hub: Nodular cast iron
- Main shaft: Cast
- Nacelle bed plate: Cast

Sales power curve



Mechanical brake

- Type: Hydraulic disc brake
- Position: Generator rear end
- Number of callipers: 3

Canopy

- Type: Totally enclosed
- Surface gloss: Silk mat, 30–40 / ISO2813
- Colour: Light grey, RAL 7035

Generator

- Type: Synchronous, PMG
- Nominal power: 2,300 kW

Grid terminals (LV)

- Nominal power: 2,300 kW
- Voltage: 690 V
- Frequency: 50 Hz or 60 Hz

Yaw system

- Type: Active
- Yaw bearing: Externally geared
- Yaw drive: 8 (optional 10) electric gear motors
- Yaw brake: Passive friction brake

Controller

- Type: Microprocessor
- SCADA system: WPS
- Controller designation: SWTC, STC-1, SCS-1

Tower

- Type: Cylindrical and/or tapered tubular
- Hub height: 99.5 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: 3 m/s
- Nominal power at: 12–13 m/s
- Cut-out wind speed: 25 m/s
- Maximum 3 s gust: 59.5 m/s (IEC version)

Weights (approximately)

- Rotor: 66,700 kg
- Nacelle: 73,000 kg
- Tower: Site-specific

1 Quantum Blade

- Unique design and manufacturing process
- IntegralBlade® one-piece moulding for maximum strength
- Optimized aerodynamics for low to medium wind conditions
- Increased length for higher energy yield
- Blade root – designed for minimized root leakage and increased lift

2 Direct drive generator

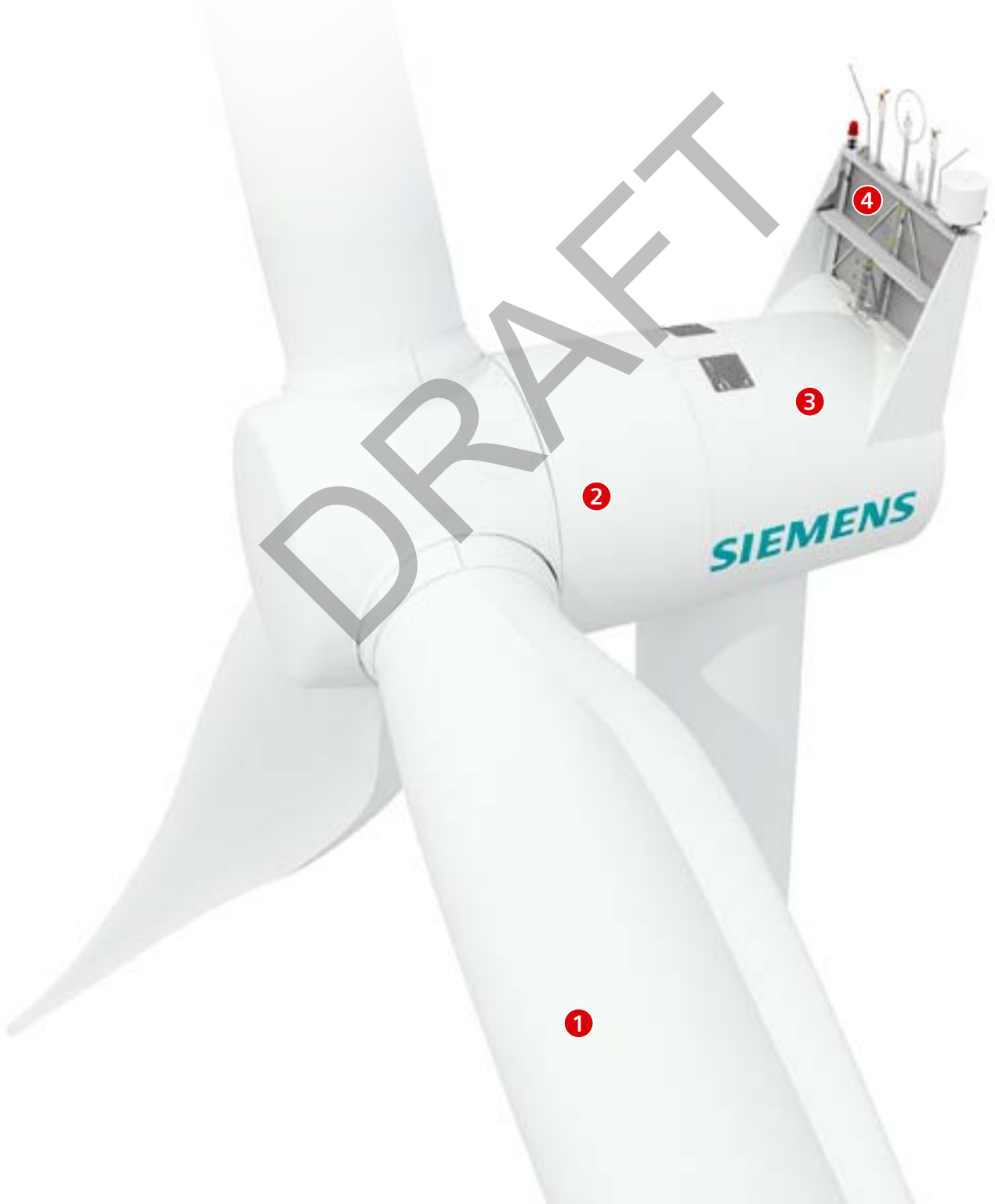
- Permanent magnet design
- Totally enclosed, easy to handle and lightweight design
- Optimum reliability and efficiency

3 Nacelle

- Solid, compact and lightweight structure
- Spacious, ergonomic design – maximum serviceability
- 50% fewer parts compared to geared turbines

4 Cooling

- Simple and robust LiquidLink® water cooling system
- Top-mounted passive cooling radiators
- High-efficient two-stage cooling as function of power



Published by and copyright © 2011:
Siemens AG
Energy Sector
Freyeslebenstrasse 1
91058 Erlangen, Germany

Siemens Wind Power A/S
Borupvej 16
7330 Brande, Denmark
www.siemens.com/wind

For more information, please contact
our Customer Support Center.
Phone: +49 180 524 70 00
Fax: +49 180 524 24 71
(Charges depending on provider)
E-mail: support.energy@siemens.com

Renewable Energy Division
Order No. E50001-W310-A174-X-4A00
Printed in Germany
Dispo 34804, c4bs No. 7491
LN 13982 WS 03113.0

Printed on elementary chlorine-free
bleached paper.

www.siemens.com/energy

SWT-2.3-113, Max Power 1824 kW
Contract Acoustic Emission, Hub Height 99.5m

Sound Power Levels

The warranted sound power level is presented with reference to the code IEC 61400-11:2002 with amendment 1 dated 2006-05 based on a hub height of 99.5 m and a roughness length of 0.05 m as described in the IEC code. The sound power levels (L_{WA}) presented are valid for the corresponding wind speeds referenced to a height of 10 m above ground level.

Wind speed [m/s]	4	5	6	7	8	9	10	11	12	Up to cut-out
Sound power level	96.0	99.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 1: Noise emission, L_{WA} [dB(A) re 1 pW]

Typical Octave Band

Typical, not warranted octave band spectra are tabulated below for 6 and 8 m/s referenced to 10 m height.

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	83.9	89.4	94.0	92.1	94.1	92.9	83.5	66.7

Table 2: Typical octave band for 6 m/s, L_{WA} [dB(A) re 1 pW]

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	82.7	87.3	92.8	92.9	94.1	93.3	88.2	72.1

Table 3: Typical octave band for 8 m/s, L_{WA} [dB(A) re 1 pW]

SWT-2.3-113 rev 1, Max Power 1903kW
Contract Acoustic Emission, Hub Height 99.5

Sound Power Levels

The warranted sound power level is presented with reference to the code IEC 61400-11:2002 with amendment 1 dated 2006-05 based on a hub height of 99.5 m and a roughness length of 0.05 m as described in the IEC code. The sound power levels (L_{WA}) presented are valid for the corresponding wind speeds referenced to a height of 10 m above ground level.

Wind speed [m/s]	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Up to cut-out**
Sound power level	96.2	100.4	101.0	101.0	101.0	101.0	101.0	101.0	101.0	101.0

Table 1: Noise emission, L_{WA} [dB(A) re 1 pW]

Typical Octave Band

Typical, not warranted octave band spectra are tabulated below for 6 and 8 m/s referenced to 10 m height.

Octave band, centre frequency [Hz]	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Sound power level	84.1	89.8	95.2	93.6	95.0	93.6	83.6	66.7

Table 2: Typical octave band for 6 m/s, L_{WA} [dB(A) re 1 pW]

Octave band, centre frequency [Hz]	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Sound power level	82.9	87.7	94.0	94.2	95.1	94.3	88.8	72.6

Table 3: Typical octave band for 8 m/s, L_{WA} [dB(A) re 1 pW]

SWT-2.3-113 rev 1, Max Power 2030kW
Contract Acoustic Emission, Hub Height 99.5

Sound Power Levels

The warranted sound power level is presented with reference to the code IEC 61400-11:2002 with amendment 1 dated 2006-05 based on a hub height of 99.5 m and a roughness length of 0.05 m as described in the IEC code. The sound power levels (L_{WA}) presented are valid for the corresponding wind speeds referenced to a height of 10 m above ground level.

Wind speed [m/s]	4	5	6	7	8	9	10	11	12	Up to cut-out
Sound power level	96.4	101.3	102.0	102.0	102.0	102.0	102.0	102.0	102.0	102.0

Table 1: Noise emission, L_{WA} [dB(A) re 1 pW]

Typical Octave Band

Typical, not warranted octave band spectra are tabulated below for 6 and 8 m/s referenced to 10 m height.

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	84.3	90.2	96.4	95.2	96.0	94.4	83.8	66.9

Table 2: Typical octave band for 6 m/s, L_{WA} [dB(A) re 1 pW]

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	83.1	88.1	95.1	95.5	96.1	95.2	89.3	73.1

Table 3: Typical octave band for 8 m/s, L_{WA} [dB(A) re 1 pW]

SWT-2.3-113, Max Power 2126 kW
Contract Acoustic Emission, Hub Height 99.5m

Sound Power Levels

The warranted sound power level is presented with reference to the code IEC 61400-11:2002 with amendment 1 dated 2006-05 based on a hub height of 99.5 m and a roughness length of 0.05 m as described in the IEC code. The sound power levels (L_{WA}) presented are valid for the corresponding wind speeds referenced to a height of 10 m above ground level.

Wind speed [m/s]	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Up to cut-out**
Sound power level	96.5	102.3	103.0	103.0	103.0	103.0	103.0	103.0	103.0	103.0

Table 1: Noise emission, L_{WA} [dB(A) re 1 pW]

Typical Octave Band

Typical, not warranted octave band spectra are tabulated below for 6 and 8 m/s referenced to 10 m height.

Octave band, centre frequency [Hz]	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Sound power level	84.6	90.6	97.0	96.7	97.4	95.0	84.0	66.3

Table 2: Typical octave band for 6 m/s, L_{WA} [dB(A) re 1 pW]

Octave band, centre frequency [Hz]	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Sound power level	83.3	88.5	96.3	97.0	97.0	96.0	89.3	73.0

Table 3: Typical octave band for 8 m/s, L_{WA} [dB(A) re 1 pW]

SWT-2.3-113, Max Power 2221 kW
Contract Acoustic Emission, Hub Height 99.5m

Sound Power Levels

The warranted sound power level is presented with reference to the code IEC 61400-11:2002 with amendment 1 dated 2006-05 based on a hub height of 99.5 m and a roughness length of 0.05 m as described in the IEC code. The sound power levels (L_{WA}) presented are valid for the corresponding wind speeds referenced to a height of 10 m above ground level.

Wind speed [m/s]	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Up to cut-out**
Sound power level	96.6	102.6	104.0	104.0	104.0	104.0	104.0	104.0	104.0	104.0

Table 1: Noise emission, L_{WA} [dB(A) re 1 pW]

Typical Octave Band

Typical, not warranted octave band spectra are tabulated below for 6 and 8 m/s referenced to 10 m height.

Octave band, centre frequency [Hz]	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Sound power level	84.8	90.9	97.6	98.2	98.8	95.6	84.1	65.6

Table 2: Typical octave band for 6 m/s, L_{WA} [dB(A) re 1 pW]

Octave band, centre frequency [Hz]	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Sound power level	83.5	88.8	97.2	97.8	98.0	97.1	90.8	74.5

Table 3: Typical octave band for 8 m/s, L_{WA} [dB(A) re 1 pW]

SWT-2.3-113, Hub Height 99.5 m
Acoustic Emission

Sound Power Levels

The warranted sound power level is presented with reference to the code IEC 61400-11:2002 with amendment 1 dated 2006-05 based on a hub height of 99.5 m and a roughness length of 0.05 m as described in the IEC code. The sound power levels (L_{WA}) presented are valid for the corresponding wind speeds referenced to a height of 10 m above ground level.

Wind speed [m/s]	**6**	**7**	**8**	**9**	**10**
Sound power level	104.5	105.0	105.0	105.0	105.0

Table 1: Noise emission, L_{WA} [dB(A) re 1 pW]

Typical Octave Band

Typical, not warranted octave band spectra are tabulated below for 6 and 8 m/s referenced to 10 m height.

Octave band, centre frequency [Hz]	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Sound power level	77.0	90.1	97.0	99.1	99.9	95.5	85.1	67.6

Table 2: Typical octave band for 6 m/s, L_{WA} [dB(A) re 1 pW]

Octave band, centre frequency [Hz]	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Sound power level	79.1	92.1	98.3	99.2	98.8	97.8	90.7	74.3

Table 3: Typical octave band for 8 m/s, L_{WA} [dB(A) re 1 pW]

Noise Restricted Operation

Lower sound power levels can be achieved with the SWT-2.3-113 wind turbine by controlling the turbine in noise restricted operation. This noise restricted mode of operation will, depending on the mode, have an impact on the power output of the turbine. Please contact Siemens for further information on this option.