HGC ENGINEERING

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NOISE ASSESSMENT REPORT

HAF Wind Energy Project

Township of West Lincoln, Ontario

Prepared for:

Vineland Power Inc.
222 Martindale Road
St. Catharines, Ontario, L2R 7A3

Prepared by

Ian R. Bonsma, PEng

and

Brian Howe, MEng, MBA, PEng

February 25, 2014

VERSION CONTROL

HAF Wind Energy Project, Township of West Lincoln, Ontario

Ver.	Date	Version Description	Prepared By
1	December 9, 2010	Original Acoustic Assessment Report supporting an application for a Renewable Energy Approval.	M. Munro
2	September 9, 2011	Acoustic Assessment Report Updated to reflect minor changes to the location of WTG1, WTG2 and WTG3.	M. Munro
3	February 1, 2013	Acoustic Assessment Report updated to add additional receptors and to reflect comments from the MOE.	I. Bonsma
4	March 25, 2013	Acoustic Assessment Report updated to reflect comments from the MOE.	I. Bonsma
5	February 25, 2014	Updated Noise Assessment Report to address typographical corrections in summary tables A5 and A6	I. Bonsma

EXECUTIVE SUMMARY

Howe Gastmeier Chapnik Limited ("HGC Engineering") was retained by IPC Energy on behalf of Vineland Power Inc. to assess the acoustic impact of the proposed HAF Wind Energy Project to be located in the Township of West Lincoln, Ontario. The project will consist of five Vestas V100 wind turbine generators, each rated at 1.8 MW. HGC Engineering has assessed the acoustic impact against the acoustic criteria of the Ontario Ministry of Environment ("MOE"). This report comprises a summary of our assessment and is intended as supporting documentation for an application for a Renewable Energy Approval.

The wind farm site is within the Township of West Lincoln, in the Niagara Region. There are a number of residences located in the vicinity of the project. From an acoustic perspective the area is rural with relatively low ambient sound levels during nighttime hours at all locations. Unattended and attended sound level monitoring were conducted by HGC Engineering from August 26 until September 9, 2010 to gain an understanding of the existing background sound levels at several representative noise sensitive receptors. The criteria of MOE's publication NPC-232 *Sound Level Limits for Stationary Sources in Class 3 Areas (Rural)* are thus relevant. Supplementary guidance is also provided by MOE publication *Noise Guidelines for Wind Farms Interpretation for Applying MOE NPC Technical Publications to Wind Power Generation Facilities.*

The sound power data for the Vestas wind turbine generators has been obtained through IPC Energy. This data has been used in a computer model to predict the sound level impact at the closest residential receptors. The results of the modelling demonstrate compliance with the MOE guidelines when all five turbines are operating over their entire speed range, at all but four receptors locations. These receptor locations have entered into lease agreements with the proponent.

Details of our assessment are provided in the main body of this report. The report is structured around the report format suggested by the MOE for Renewable Energy Approval applications for wind farms, with the required summary tables included as Appendix A.

TABLE OF CONTENTS

Ministry of the Environment | Ministère de l'Environnement

Ontario

NOISE ASSESSMENT REPORT CHECK-LIST

Company Name: Vineland Power Inc.

Company Address: 222 Martindale Road

St. Catharines, Ontario, L2R 7A3

Location of Facility: Township of West Lincoln, Ontario

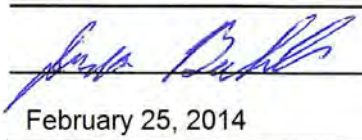
The attached Noise Assessment Report was prepared in accordance with the methods prescribed in the ministry guidance document "Noise Guidelines for Wind Farms Interpretation for Applying MOE NPC Publications to Wind Power Generation Facilities", October 2008.

Company Contact:

Name: Jordan Beekhuis

Title: Project Engineer

Phone Number: 905-684-1111

Signature: 

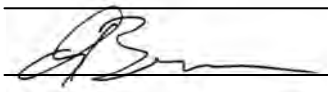
Date: February 25, 2014

Technical Contact:

Name: Ian Bonsma, PEng

Representing: HGC Engineering

Phone Number: 905-826-4044

Signature: 

Date: February 25, 2014

1 INTRODUCTION

Howe Gastmeier Chapnik Limited ("HGC Engineering") was retained by IPC Energy on behalf of Vineland Power Inc. to assess the acoustic impact of the proposed HAF Wind Energy Project. The purpose of this report is to determine the acceptability of the predicted sound levels at the nearby residential receptors resulting from the operation of five, 95 meter hub height, Vestas V100 wind turbine generators, rated at 1.8 MW, in relation to the guidelines of the Ontario Ministry of the Environment ("MOE") including Ontario Regulation 359/09. Based on Ontario Regulation 359/09, the project is considered a Class 4 wind facility.

HGC Engineering conducted background sound level monitoring at a number of representative residences within the influence area of the proposed HAF Wind Energy Project. Unattended sound level monitoring was conducted between August 26 and September 9, 2010. Attended sound level measurements were also conducted during this period.

This report is intended as supporting documentation for a Renewable Energy Approval application for the facility.

UPDATES ADDRESSED IN THIS ASSESSMENT REPORT

This report replaces the *Acoustic Assessment Report HAF Wind Energy Project*, Version 4 dated March 25, 2013 [1]. This update has been prepared to address typographical corrections in Tables A5 and A6. Version 3 of the Report addresses comments from the MOE, while Version 2 included modifications to and the addition of, a number of receptor locations. Table 1 shows the receptor locations and ID's which were modified as part of Version 2.

Table 1: Receptor Modifications

Old Point of Reception ID	UTM Coordinates		New Point of Reception ID	UTM Coordinates		Difference between UTM Coordinates (m)
	Easting	Northing		Easting	Northing	
V10	607871	4774877	R242	607843	4774953	81
V13	608174	4773364	R243	608164	4773488	124
V14	608014	4773320	R244	608024	4773318	11
V15	608076	4773293	R245	608072	4773301	9
V17	607367	4772299	R246	607464	4772330	102
V19	607479	4772131	R247	607470	4772078	54
V21	607117	4772302	R248	607124	4772293	12
V22	607067	4772342	R249	607055	4772362	23
V23	607008	4772370	R250	607002	4772362	10
V24	607016	4772266	R251	607055	4772245	44
V25	607033	4771952	R252	607134	4771769	209
V26	606867	4772428	R253	606898	4772235	196
V34	605062	4771905	R254	605124	4771909	62
V35	605275	4771781	R255	605299	4771766	28
V36	605342	4771759	R256	605349	4771741	19
V37	605462	4771727	R257	605460	4771805	78
V38	606246	4771380	R258	606059	4771413	190

2 GENERAL DESCRIPTION OF WIND TURBINE INSTALLATION SITE AND SURROUNDING ENVIRONMENT

The wind project consists of five wind turbine generators to be located in the Township of West Lincoln, south of Grimsby and east of Hamilton. All of the wind turbine generators will be sited east of Westbrook Road, west of Caistor Centre Road and Abingdon Road, south of 20 Road and north of Concession Road 5. Figure 1a, a wind turbine generator siting drawing prepared by IPC Energy, illustrates the location of the five wind turbine generators, and the location of the nearest residential receptors. Figure 1b, is a scaled location map of the surrounding area.

The area is rural in nature, both acoustically and in general character, with agricultural land uses widely in evidence, including scattered dwellings near the major roadways. Zoning maps obtained from the Township of West Lincoln are included as Appendix B, which illustrate that the project site

areas are zoned for Agricultural use, and that small residential and commercial parcels exist, generally near Abingdon along Regional Road 65.

3 DESCRIPTION OF SOUND SOURCES

Five 1.8 MW Vestas V100 wind turbine generators are proposed for the site. They are three bladed, upwind, horizontal axis wind turbines with a rotor diameter of 100 m. The turbine rotor and nacelle are mounted on top of a 95 meter high tubular tower. The turbines are anticipated to operate continuously whenever wind conditions allow. Additional details are contained in Appendix C, with acoustic information contained in Appendix D. Electronic topology mapping for the area suggests that the turbines will generally be based at an elevation of between about 195 to 200 meters above sea level. Table 2 provides the UTM coordinates (Zone 17) of the five wind turbine generators.

Table 2: Locations of Wind Turbine Generators (WTG) [m]

Source	Easting	Northing
WTG 1	604718	4775553
WTG 2	604889	4775173
WTG 3	606291	4774905
WTG 4	604359	4774307
WTG 5	606233	4773420

Please note that the Vestas V100 wind turbines have nacelle mounted transformers and therefore there will be no ground level transformers part of this project. The sound power level of the wind turbines includes the sound power of the nacelle mounted transformer. This project does not include a larger step-up transformer. The electrical connection for this project will be at a switching station with UTM coordinates presented in Table 3.

Table 3: Location of Switching Station [m]

Source	Easting	Northing
Switching Station	606822	4773919

4 WIND TURBINE NOISE EMISSION RATINGS

Overall sound power data for the Vestas V100 wind turbines as determined in accordance with IEC 61400-11:2002 [2], are provided by Vestas in the document *Sound Power Level Data for the V100-1.8 MW* [3] and in the form of a letter issued to IPC Energy [4]. CAN/CSA-C61400-11-07 standard, referenced by the MOE, is an adoption without modification of the identically titled IEC Standard IEC 61400-11 (edition 2:2002 consolidated with amendment 1:2006). Additionally, a test report completed by DNV Renewables (USA) Inc., *Acoustic Noise Test Report for a Vestas V100 1.8 MW Turbine at Pueblo, Colorado* [5], is also included under Appendix D. The overall A-weighted sound power levels as a function of 10 meter height wind speed are shown in Table 4.

Table 4: 10 Meter Height Wind Speed vs Turbine Sound Power Level, Based on IEC Sound Power Determination Methodology and Wind Shear of 0.2

Wind Speed [m/s] at 10m Height	6	7	8	9	10 – cutout
Wind Turbine Sound Power Level [dBA]	103.3	105.0	105.0	105.0	105.0

Sound power level data determined under IEC 61400-11 is normalized to a standard “roughness length” value of 0.05 meters. The roughness length concept is used to take into account the effect of friction at the ground, which results in lower wind speeds near the ground than at higher elevations. The wind shear exponent quantifies the same concept by describing the rate of change of windspeed with elevation. A roughness length of 0.05 meters is generally held to be equivalent to a wind shear value of about 0.2. Meteorological data near the proposed wind project provided by IPC Energy indicates that the average summer nighttime wind shear was found to be on the order of 0.6 (see Appendix F). This means that a 10 meter height wind speed of 1.8 m/s can occur simultaneously with a 7 m/s wind speed at the hub height of 95 meters, indicating that maximum sound power output may occur during relatively low 10 meter level wind speeds. Consequently the maximum sound power level for the wind turbine (corresponding to a hub height wind speed of 7 m/s) has been used in this analysis.

Table 5 presents the typical octave band spectrum for various 10 meter height wind speeds received from Vestas, also included in Appendix D. The spectral shape shown for the 10 meter height 7 m/s wind speed has been used in the analysis.

Table 5: Wind Turbine Acoustic Emissions Summary

Make and Model:	Vestas V100
Electrical Rating:	1800 kW
Hub Height (m):	95m
Wind Shear Coefficient:	Maximum sound power level utilized to account for average summer nighttime wind shear value of 0.6.

	Octave Band Sound Power Level [dB]									
	Manufacturer's Emission Levels					**Adjusted Emission Level**				
Wind Speed [m/s]	**6**	**7**	**8**	**9**	**10**	**6**	**7**	**8**	**9**	**10**
Frequency [Hz]										
63	111.4	113.6	113.3	112.9	112.8	113.6	113.6	113.6	113.6	113.6
125	105.7	108.1	107.8	107.4	107.5	108.1	108.1	108.1	108.1	108.1
250	101.6	103.3	102.8	102.2	102.1	103.3	103.3	103.3	103.3	103.3
500	98.6	100.3	99.9	99.3	99.3	100.3	100.3	100.3	100.3	100.3
1000	98.2	99.7	99.5	99.0	99.1	99.7	99.7	99.7	99.7	99.7
2000	95.4	97.0	97.2	97.0	97.0	97.0	97.0	97.0	97.0	97.0
4000	93.6	95.6	96.2	97.7	97.6	95.6	95.6	95.6	95.6	95.6
8000	86.5	90.9	91.4	92.5	93.4	90.9	90.9	90.9	90.9	90.9
Overall A-Weighted	103.3	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0

Vestas has indicated that the tonal audibility value for these wind turbines, as per IEC 61400-11-ed2:2002, will be less than 2 dBA. A tonal penalty has not been applied in this assessment. Additionally, Vestas has also indicated that the sound power levels provided have a measurement uncertainty of +/- 2 dBA. The sound level predictions herein are subject to the degree of uncertainty related to the sound power of the turbine, in addition to the uncertainty related to the fluctuations of atmospheric conditions and the accuracy and limitations inherent in the modelling methodology.

5 POINT OF RECEPTION SUMMARY

As shown in Figure 2, there are several residences in the vicinity of the project, generally sited along the major roadways. The closest noise sensitive receptors have been identified on Figure 2. A table of UTM co-ordinates for 294 receptors, including vacant lots, located near the proposed wind turbine generators was received from Vineland Power Inc.. The existing receptors and vacant lots, together with their coordinates are listed in Tables A3 and A4. For the purposes of this report, each of the 294 receptors was represented by a discrete sound prediction location at the dwelling coordinate, with an assumed height of 4.5 meters above the local grade to represent potential second-story windows.

Where vacant lots were identified, the assumed future location of the dwelling was selected to be consistent with the typical building pattern in the area. Vineland Power Inc. has indicated all receptors within the study area are two storey's or less.

A number of the receptors identified have agreements with the developer. These receptors are identified as participating receptors by the MOE. According to the publication *Interpretation for Applying MOE NPC Publications to Wind Power Generation Facilities*, October 2008 ("*Interpretation*") [6], a participating receptor "means a property that is associated with the Wind Farm by means of a legal agreement with the property owner for the installation and operation of wind turbines or related equipment located on that property."

Table A3 includes non-participating receptors while Table A4 includes the details of the participating receptors.

6 ASSESSMENT CRITERIA

The MOE publication NPC-232 *Sound Level Limits for Stationary Sources in Class 3 Areas (Rural)* [7] indicates that the applicable sound level limit for a stationary source of sound is the background sound level. However, where background sound levels are low, exclusionary minimum criteria apply, with an exclusionary limit of 40 dBA specified for quiet night time periods, and 45 dBA specified for quiet daytime periods. To determine if the minimum criteria should apply, an ambient baseline sound study was conducted from August 26 to September 9, 2010. Typical L_{EQ} sound levels on the order of 50 dBA were recorded with ninetieth percentile sound levels (L_{90}) falling as low as 37 dBA during nighttime hours. The L_{90} sound levels indicate that the area is acoustically rural, and that the minimum limits apply.

Because wind turbines generate more sound as the wind speeds increase, and because increasing wind speeds tend to cause greater background sound levels, wind turbine generators have been identified by the MOE as a unique case, and the MOE has provided supplementary guidance for the assessment of wind turbine noise in *Interpretation* . This publication provides criteria for the combined impact of all turbines in an area as a function of 10 metre height wind speed. The criteria are presented in A-weighted decibels, as shown in Table 6.The MOE publication *Noise Guidelines for Wind Farms Interpretation for Applying MOE NPC Publication to Wind Power Generation*

Facilities provides sound level criteria for wind power projects. Because wind turbines generate more sound as the wind speeds increase, and because increasing wind speeds tend to cause greater background sound levels, wind turbine generators have been identified by the MOE as a unique case in comparison to other stationary noise sources. The sound level criteria for wind turbines are provided as a function of 10 meter height wind speed. The criteria are presented in A-weighted decibels in Table 6.

Table 6: Wind Turbine Noise Criteria [dBA]

Wind Speed [m/s] at 10 m Height	4	5	6	7	8	9	10
Wind Turbine Sound Level Limits Class 3 Area, [dBA]	40.0	40.0	40.0	43.0	45.0	49.0	51.0

It should be noted that the MOE guidelines, including NPC-232 and *Interpretation* do not require or imply that a noise source should be inaudible at a point of reception, and inaudibility should not be expected. In fact, even when the sound levels from a source are less than the numeric guideline limits, spectral and temporal characteristics of a sound regularly result in audibility at points of reception. To be clear, wind turbines may be audible at residences even when sound levels are below MOE guidelines noise criteria.

In the case of this assessment, the sound power output is assumed to be constant at the maximum value of 105.0 dBA over the full range of hub height wind speeds due to the summer nighttime wind shear exponent. Thus, this assessment is based on the minimum criteria of 40 dBA and the maximum wind turbine sound power level.

7 IMPACT ASSESSMENT

An acoustic model of the site was created on a computer using Cadna/A (version 4.3.143), a commercial acoustic modeling system. Cadna/A uses the computational procedures of ISO 9613-2, *Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation* [8], which accounts for reduction in sound level with distance due to geometrical spreading, air absorption, ground attenuation and acoustical shielding by intervening structures (or by topography and foliage where applicable). This is the standard that is specified by *Interpretation* to be used in the assessment of wind project noise.

Topographical data for the site and surrounding area was provided by IPC Energy. Ground attenuation was assumed to be spectral for all sources, with the ground factor (G) assumed to be 0.7 globally. The temperature and relative humidity were assumed to be 10° C and 70%, respectively. Stands of foliage were not modelled. There are no known wind projects, outside of the proposed, within 5 km.

All wind turbine generators were modeled as point sources at a height of 95 meters above grade. Figure 2 presents the acoustic model, with the source and receptor locations shown. Figure 3 is a noise contour map of the area surrounding the facility produced by Cadna/A based on the octave band sound power levels corresponding to the overall 105.0 dBA sound power, at a 10 meter height wind speed of 7 m/s. The required summary tables are contained in Appendix A of this report.

Tables A5 and A6 list the sound pressure levels calculated at each of the identified receptor locations. In general, sound levels are predicted to be at or below the 40.0 dBA minimum criterion at all but four participating receptor locations. At these participating receptors, sound levels of up to 42.9 dBA are predicted. The owners of these properties have entered into lease agreements with the proponent and include a wind turbine or related infrastructure on the properties. These receptors are considered herein to be part of the project (i.e. participating receptors) and not sensitive receptors for the purposes of sound level impact. Details of the calculations are provided in Appendix E. The Cadna/A computer model can be provided upon request.

When conducting an acoustic audit of a conventional stationary industrial sound source, the MOE guidelines direct that periods of high wind be excluded. Typically, the noise output of industrial sound sources is independent of wind speed. However, this is not the case for wind plants and there is an intrinsic relationship between wind speed (and therefore ambient noise) and increased sound power levels associated with the wind turbine generators. Complicating matters, there is a large degree of variability related to environmental factors within the wind plant area including, among others, local ground level wind speeds, wind speeds affecting the wind turbine generator blades, the associated wind shear, and the sound power of the wind turbine generators, all of which affect the measured sound levels. Thus, it is not realistic to expect that in practice a single repeatable sound level can or will be measured for a given wind speed at a given setback distance; a simple comparison of single numbers is not sufficient or possible.

8 CONCLUSIONS AND RECOMMENDATIONS

The analysis, performed in accordance with the methods prescribed by the Ontario Ministry of the Environment in publication *Interpretation for Applying MOE NPC Publications to Wind Power Generation Facilities*, October 2008, indicates that the operation of the proposed wind project will comply with the requirements of MOE publication *Noise Guidelines for Wind Farms, Interpretation for Applying MOE NPC Publications to Wind Power Generation Facilities* for all identified non-participating receptor locations.

REFERENCES

1. Howe Gastmeier Chapnik Limited, *Acoustic Assessment Report, HAF Wind Energy Project*, Version 4, March 25, 2013.

2. CAN/CSA-C61400-11-07, *Wind Turbine Generator Systems – Part 11: Acoustic noise measurement techniques*, Edition 2.1, 2006-11.

3. Vestas, *Sound Power Level Data for the V100-1.8MW*

4. Vestas, *Warranted Sound Power Level and Tonality for the Vestas V100-1.8MW for the Vineland Power Inc. and Wainfleet Wind Energy Inc. Projects*, dated December 1, 2010.

5. DNV Renewables (USA) Inc., *Acoustic Noise Test Report for a Vestas V100 1.8MW Turbine at Pueblo, Colorado*, May 11, 2011.

6. Ontario Ministry of the Environment Publication *Noise Guidelines for Wind Farms, Interpretation for Applying MOE NPC Publications to Wind Power Generation Facilities*, October, 2008.

7. Ontario Ministry of the Environment Publication NPC-232, *Sound Level Limits for Stationary Sources in Class 3 Areas (Rural)*, October, 1995.

8. International Organization for Standardization, "Acoustics – Attenuation of Sound during Propagation Outdoors – Part 2: General Method of Calculation," ISO-9613-2, Switzerland, 1996.

9. Google Maps Aerial Imagery, Internet Application: *maps.google.com*

604000

606000

4776000

4774000

Westbrook Road

Westbrook Road

20 Rd

20 Rd

Turbine 1
604718, 4775553

Turbine 2
604889, 4775173

Turbine 3
606291, 4774905

Turbine 4
604359, 4774307

Turbine 5
606233, 4773420

Burns Rd

Burns Rd

Abingdon Rd

Abingdon Rd

Sixteen Rd

Concession Road 5

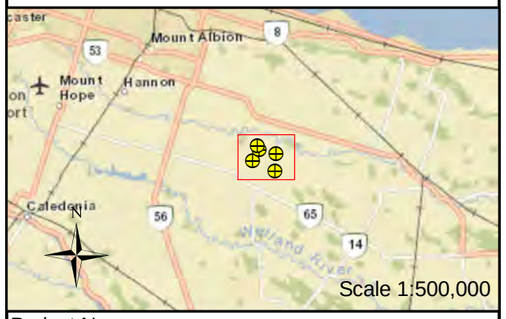
Westbrook Road

Silver St

N

Legend

- Turbines
- AccessRoads
- TapLine
- Streams
- Lakes
- Forests
- Roads
- OptionedProperties
- Switching Station
- Maintenance Building



Project Name:

HAF Energy Wind Power

Project Title:

Alternative Site Plan A
(Draft Representation)

Map Scale:

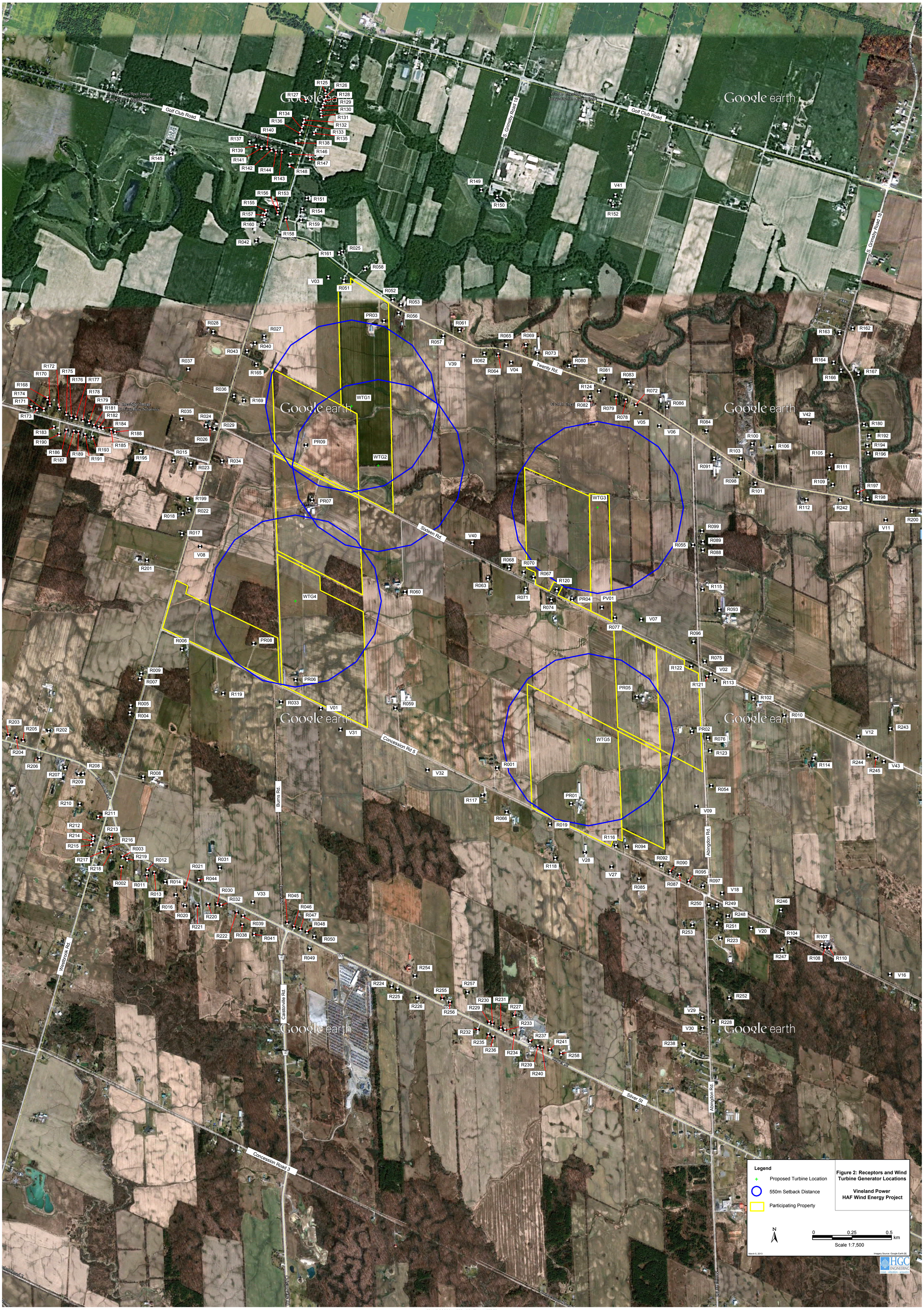
1:15,000

0 125 250 500 750 1,000 Meters

IPC ENERGY

Version 7 dated March 26, 2012
Created by Geoff Bell, IPC Energy
All coordinates are expressed in UTM 17N NAD83

Figure 1b: Key Location Plan


Golf Club Road
S. Grimsby Road 18
Twenty Rd.
Sixteen Rd.
Concession Rd 5
Burns Rd.
Abingdon Rd.
Silver St
Concession Road 3
Caistorville Rd.
Westbrook Rd
WTG1
WTG2
WTG3
WTG4
WTG5
PR01
PR02
PR03
PR04
PR05
PR06
PR07
PR08
PR09
PV01
Legend
Proposed Turbine Location
550m Setback Distance
Participating Property
Figure 2: Receptors and Wind Turbine Generator Locations
Vineland Power
HAF Wind Energy Project
N
0
0.25
0.5
km
Scale 1:7,500
March 5, 2013
Imagery Source: Google Earth [9]
HGC ENGINEERING
noise • vibration • acoustics
FRAME COORDINATES ARE UTM IN METRES


Golf Club Road
S. Grimsby Road 18
Twenty Rd.
Sixteen Rd.
Concession Rd 5
Burns Rd.
Westbrook Rd.
Caistorville Rd.
Abingdon Rd.
Silver St
Concession Road 3
WTG1
WTG2
WTG3
WTG4
WTG5
40 dBA
45 dBA
PR01
PR02
PR03
PR04
PR05
PR06
PR07
PR08
PR09
PV01
Google earth
FRAME COORDINATES ARE UTM IN METRES
Legend
Proposed Turbine Location
40 dBA Sound Contour
Participating Property
N
0
0.25
0.5
km
Scale 1:7,500
Figure 3: Predicted Sound Levels, Leq [dBA]
Vineland Power HAF Wind Energy Project
Sound Level Grid Height Calculated at 4.5m
March 5, 2013
Imagery Source: Google Earth [9]
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APPENDIX A:
ASSESSMENT SUMMARY TABLES

ACOUSTIC ASSESSMENT SUMMARY TABLES

VERSION CONTROL

HAF Wind Energy Project, Township of West Lincoln, Ontario

Ver.	Date	Issued as Part of AAR?	Revision Description	Prepared By
1	December 9, 2010	Y	Original version of tables as part of Ver. 1 of Acoustic Assessment Report	M. Munro
2	September 9, 2011	Y	Updated tables as part of Ver. 2 of the Acoustic Assessment Report	M. Munro
3	February 1, 2013	Y	Updated tables as part of Ver. 3 of the Acoustic Assessment Report	I. Bonsma
4	March 25, 2013	Y	Updated tables as part of Ver. 4 of the Acoustic Assessment Report	I. Bonsma
5	February 25, 2014	Y	Updated tables as part of Ver. 5 of the Acoustic Assessment Report	I. Bonsma

Table A1: Vestas V100 Wind Turbine Acoustic Emissions Summary
Vineland Power, HAF Wind Energy Project

Make and Model:	Vestas V100
Electrical Rating:	1800 kW
Hub Height (m):	95m
Wind Shear Coefficient:	Maximum sound power level utilized to account for average summer nighttime wind shear value of 0.6

	Octave Band Sound Power Level [dB]									
	Manufacturer's Emission Levels					**Adjusted Emission Level**				
Wind Speed [m/s]	**6**	**7**	**8**	**9**	**10**	**6**	**7**	**8**	**9**	**10**
Frequency [Hz]										
63	111.4	113.6	113.3	112.9	112.8	113.6	113.6	113.6	113.6	113.6
125	105.7	108.1	107.8	107.4	107.5	108.1	108.1	108.1	108.1	108.1
250	101.6	103.3	102.8	102.2	102.1	103.3	103.3	103.3	103.3	103.3
500	98.6	100.3	99.9	99.3	99.3	100.3	100.3	100.3	100.3	100.3
1000	98.2	99.7	99.5	99.0	99.1	99.7	99.7	99.7	99.7	99.7
2000	95.4	97.0	97.2	97.0	97.0	97.0	97.0	97.0	97.0	97.0
4000	93.6	95.6	96.2	97.7	97.6	95.6	95.6	95.6	95.6	95.6
8000	86.5	90.9	91.4	92.5	93.4	90.9	90.9	90.9	90.9	90.9
Overall A-Weighted	103.3	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0	105.0

Table A2: Wind Turbine Locations
Vineland Power, HAF Wind Energy Project

Identifier	Equipment Make & Model	UTM Coordinates	
		Easting	Northing
WTG 1	Vestas V100, 95 m Hub Height	604718	4775553
WTG 2	Vestas V100, 95 m Hub Height	604889	4775173
WTG 3	Vestas V100, 95 m Hub Height	606291	4774905
WTG 4	Vestas V100, 95 m Hub Height	604359	4774307
WTG 5	Vestas V100, 95 m Hub Height	606233	4773420

Table A3: Non-Participating Receptor Locations
Vineland Power, HAF Wind Energy Project

Point of Reception ID	Description	UTM Coordinates	
		Easting	Westing
R001	Non-Participating Receptor	605650	4773240
R002	Non-Participating Receptor	603247	4772605
R003	Non-Participating Receptor	603254	4772672
R004	Non-Participating Receptor	603301	4773589
R005	Non-Participating Receptor	603306	4773633
R006	Non-Participating Receptor	603634	4773998
R007	Non-Participating Receptor	603365	4773808
R008	Non-Participating Receptor	603386	4773180
R009	Non-Participating Receptor	603374	4773842
R010	Non-Participating Receptor	607486	4773574
R011	Non-Participating Receptor	603409	4772552
R012	Non-Participating Receptor	603413	4772587
R013	Non-Participating Receptor	603457	4772569
R014	Non-Participating Receptor	603527	4772509
R015	Non-Participating Receptor	603580	4775203
R016	Non-Participating Receptor	603594	4772427
R017	Non-Participating Receptor	603634	4774736
R018	Non-Participating Receptor	603639	4774864
R019	Non-Participating Receptor	605987	4772878
R020	Non-Participating Receptor	603654	4772358
R021	Non-Participating Receptor	603655	4772473
R022	Non-Participating Receptor	603681	4774892
R023	Non-Participating Receptor	603691	4775182
R024	Non-Participating Receptor	603787	4775428
R025	Non-Participating Receptor	604657	4776539
R026	Non-Participating Receptor	603813	4775415
R027	Non-Participating Receptor	604160	4775998
R028	Non-Participating Receptor	603834	4776027
R029	Non-Participating Receptor	603842	4775407
R030	Non-Participating Receptor	603860	4772369
R031	Non-Participating Receptor	603876	4772600
R032	Non-Participating Receptor	603885	4772362
R033	Non-Participating Receptor	604268	4773661
R034	Non-Participating Receptor	603891	4775200
R035	Non-Participating Receptor	603631	4775471
R036	Non-Participating Receptor	603967	4775619
R037	Non-Participating Receptor	603674	4775789
R038	Non-Participating Receptor	604020	4772236
R039	Non-Participating Receptor	604024	4772292
R040	Non-Participating Receptor	604101	4775955
R041	Non-Participating Receptor	604095	4772175
R042	Non-Participating Receptor	604109	4776608
R043	Non-Participating Receptor	604050	4775904
R044	Non-Participating Receptor	603741	4772522
R045	Non-Participating Receptor	604307	4772252
R046	Non-Participating Receptor	604351	4772223

Point of Reception ID	Description	UTM Coordinates	
		Easting	Westing
R047	Non-Participating Receptor	604392	4772210
R048	Non-Participating Receptor	604433	4772192
R049	Non-Participating Receptor	604450	4772079
R050	Non-Participating Receptor	604481	4772159
R051	Non-Participating Receptor	604670	4776353
R052	Non-Participating Receptor	604981	4776234
R053	Non-Participating Receptor	605034	4776201
R054	Non-Participating Receptor	607019	4773125
R055	Non-Participating Receptor	606902	4774665
R056	Non-Participating Receptor	605020	4776145
R057	Non-Participating Receptor	605305	4776000
R058	Non-Participating Receptor	604805	4776430
R059	Non-Participating Receptor	604999	4773621
R060	Non-Participating Receptor	605060	4774364
R061	Non-Participating Receptor	605410	4776037
R062	Non-Participating Receptor	605568	4775888
R063	Non-Participating Receptor	605590	4774451
R064	Non-Participating Receptor	605657	4775882
R065	Non-Participating Receptor	605708	4775943
R066	Non-Participating Receptor	605710	4772959
R067	Non-Participating Receptor	605882	4774457
R068	Non-Participating Receptor	605726	4774519
R069	Non-Participating Receptor	605833	4775945
R070	Non-Participating Receptor	605819	4774490
R071	Non-Participating Receptor	605832	4774384
R072	Non-Participating Receptor	606537	4775561
R073	Non-Participating Receptor	605907	4775894
R074	Non-Participating Receptor	605996	4774315
R075	Non-Participating Receptor	606977	4773918
R076	Non-Participating Receptor	606997	4773430
R077	Non-Participating Receptor	606402	4774198
R078	Non-Participating Receptor	606473	4775589
R079	Non-Participating Receptor	606410	4775612
R080	Non-Participating Receptor	606111	4775809
R081	Non-Participating Receptor	606335	4775728
R082	Non-Participating Receptor	606243	4775609
R083	Non-Participating Receptor	606492	4775703
R084	Non-Participating Receptor	606988	4775394
R085	Non-Participating Receptor	606557	4772527
R086	Non-Participating Receptor	606736	4775546
R087	Non-Participating Receptor	606815	4772555
R088	Non-Participating Receptor	606965	4774631
R089	Non-Participating Receptor	606965	4774686
R090	Non-Participating Receptor	606756	4772576
R091	Non-Participating Receptor	607037	4775217
R092	Non-Participating Receptor	606699	4772616
R093	Non-Participating Receptor	607071	4774252
R094	Non-Participating Receptor	606479	4772736

Point of Reception ID	Description	UTM Coordinates	
		Easting	Westing
R095	Non-Participating Receptor	606874	4772513
R096	Non-Participating Receptor	606905	4774043
R097	Non-Participating Receptor	606965	4772481
R098	Non-Participating Receptor	607195	4775123
R099	Non-Participating Receptor	606960	4774755
R100	Non-Participating Receptor	607281	4775309
R101	Non-Participating Receptor	607301	4775057
R102	Non-Participating Receptor	607288	4773683
R103	Non-Participating Receptor	607207	4775216
R104	Non-Participating Receptor	607517	4772128
R105	Non-Participating Receptor	607787	4775239
R106	Non-Participating Receptor	607405	4775291
R107	Non-Participating Receptor	607726	4772109
R108	Non-Participating Receptor	607747	4772086
R109	Non-Participating Receptor	607796	4775050
R110	Non-Participating Receptor	607774	4772088
R111	Non-Participating Receptor	607774	4775154
R112	Non-Participating Receptor	607627	4774954
R113	Non-Participating Receptor	607043	4773799
R114	Non-Participating Receptor	607673	4773299
R115	Non-Participating Receptor	606963	4774380
R116	Non-Participating Receptor	606409	4772743
R117	Non-Participating Receptor	605556	4773065
R118	Non-Participating Receptor	606021	4772661
R119	Non-Participating Receptor	603898	4773715
R120	Non-Participating Receptor	606031	4774379
R121	Non-Participating Receptor	606992	4773820
R122	Non-Participating Receptor	606891	4773887
R123	Non-Participating Receptor	607011	4773349
R124	Non-Participating Receptor	606301	4775649
R125	Non-Participating Receptor	604552	4777564
R126	Non-Participating Receptor	604554	4777529
R127	Non-Participating Receptor	604427	4777504
R128	Non-Participating Receptor	604543	4777503
R129	Non-Participating Receptor	604535	4777473
R130	Non-Participating Receptor	604522	4777444
R131	Non-Participating Receptor	604525	4777408
R132	Non-Participating Receptor	604415	4777382
R133	Non-Participating Receptor	604409	4777355
R134	Non-Participating Receptor	604401	4777326
R135	Non-Participating Receptor	604479	4777297
R136	Non-Participating Receptor	604389	4777296
R137	Non-Participating Receptor	604067	4777238
R138	Non-Participating Receptor	604364	4777236
R139	Non-Participating Receptor	604107	4777216
R140	Non-Participating Receptor	604178	4777205
R141	Non-Participating Receptor	604143	4777203
R142	Non-Participating Receptor	604207	4777193

Point of Reception ID	Description	UTM Coordinates	
		Easting	Westing
R143	Non-Participating Receptor	604273	4777181
R144	Non-Participating Receptor	604235	4777181
R145	Non-Participating Receptor	603565	4777166
R146	Non-Participating Receptor	604329	4777163
R147	Non-Participating Receptor	604452	4777135
R148	Non-Participating Receptor	604322	4777092
R149	Non-Participating Receptor	605548	4776935
R150	Non-Participating Receptor	605650	4776892
R151	Non-Participating Receptor	604432	4776882
R152	Non-Participating Receptor	606391	4776835
R153	Non-Participating Receptor	604250	4776823
R154	Non-Participating Receptor	604404	4776811
R155	Non-Participating Receptor	604172	4776799
R156	Non-Participating Receptor	604246	4776785
R157	Non-Participating Receptor	604163	4776773
R158	Non-Participating Receptor	604298	4776751
R159	Non-Participating Receptor	604396	4776743
R160	Non-Participating Receptor	604158	4776719
R161	Non-Participating Receptor	604639	4776529
R162	Non-Participating Receptor	607923	4776049
R163	Non-Participating Receptor	607839	4776021
R164	Non-Participating Receptor	607801	4775831
R165	Non-Participating Receptor	604109	4775818
R166	Non-Participating Receptor	607849	4775780
R167	Non-Participating Receptor	607960	4775761
R168	Non-Participating Receptor	602774	4775603
R169	Non-Participating Receptor	604031	4775587
R170	Non-Participating Receptor	602790	4775563
R171	Non-Participating Receptor	602672	4775545
R172	Non-Participating Receptor	602850	4775540
R173	Non-Participating Receptor	602707	4775533
R174	Non-Participating Receptor	602751	4775531
R175	Non-Participating Receptor	602895	4775506
R176	Non-Participating Receptor	602927	4775486
R177	Non-Participating Receptor	602956	4775479
R178	Non-Participating Receptor	603000	4775466
R179	Non-Participating Receptor	603040	4775452
R180	Non-Participating Receptor	607995	4775436
R181	Non-Participating Receptor	603072	4775427
R182	Non-Participating Receptor	603103	4775417
R183	Non-Participating Receptor	602815	4775417
R184	Non-Participating Receptor	603128	4775413
R185	Non-Participating Receptor	603181	4775397
R186	Non-Participating Receptor	602895	4775397
R187	Non-Participating Receptor	602943	4775389
R188	Non-Participating Receptor	603206	4775388
R189	Non-Participating Receptor	602972	4775386
R190	Non-Participating Receptor	602849	4775373

Point of Reception ID	Description	UTM Coordinates	
		Easting	Westing
R191	Non-Participating Receptor	603015	4775367
R192	Non-Participating Receptor	608029	4775362
R193	Non-Participating Receptor	603063	4775353
R194	Non-Participating Receptor	608017	4775300
R195	Non-Participating Receptor	603371	4775265
R196	Non-Participating Receptor	608022	4775251
R197	Non-Participating Receptor	607957	4775000
R198	Non-Participating Receptor	608019	4774960
R199	Non-Participating Receptor	603672	4774958
R200	Non-Participating Receptor	608302	4774881
R201	Non-Participating Receptor	603410	4774567
R202	Non-Participating Receptor	602782	4773478
R203	Non-Participating Receptor	602524	4773450
R204	Non-Participating Receptor	602575	4773430
R205	Non-Participating Receptor	602618	4773418
R206	Non-Participating Receptor	602722	4773300
R207	Non-Participating Receptor	602888	4773238
R208	Non-Participating Receptor	603001	4773201
R209	Non-Participating Receptor	602973	4773198
R210	Non-Participating Receptor	602980	4773007
R211	Non-Participating Receptor	603098	4772925
R212	Non-Participating Receptor	603068	4772801
R213	Non-Participating Receptor	603182	4772793
R214	Non-Participating Receptor	603065	4772774
R215	Non-Participating Receptor	603053	4772748
R216	Non-Participating Receptor	603139	4772728
R217	Non-Participating Receptor	603123	4772704
R218	Non-Participating Receptor	603180	4772703
R219	Non-Participating Receptor	603284	4772656
R220	Non-Participating Receptor	603802	4772366
R221	Non-Participating Receptor	603733	4772357
R222	Non-Participating Receptor	603984	4772315
R223	Non-Participating Receptor	607077	4772150
R224	Non-Participating Receptor	604975	4771842
R225	Non-Participating Receptor	605013	4771824
R226	Non-Participating Receptor	605139	4771768
R227	Non-Participating Receptor	605760	4771658
R228	Non-Participating Receptor	607032	4771618
R229	Non-Participating Receptor	605598	4771613
R230	Non-Participating Receptor	605620	4771606
R231	Non-Participating Receptor	605673	4771576
R232	Non-Participating Receptor	605525	4771567
R233	Non-Participating Receptor	605700	4771563
R234	Non-Participating Receptor	605759	4771535
R235	Non-Participating Receptor	605594	4771535
R236	Non-Participating Receptor	605625	4771517
R237	Non-Participating Receptor	605860	4771491
R238	Non-Participating Receptor	606843	4771471

Point of Reception ID	Description	UTM Coordinates	
		Easting	Westing
R239	Non-Participating Receptor	605910	4771458
R240	Non-Participating Receptor	605936	4771451
R241	Non-Participating Receptor	605987	4771436
R242	Non-Participating Receptor	607843	4774953
R243	Non-Participating Receptor	608164	4773488
R244	Non-Participating Receptor	608024	4773318
R245	Non-Participating Receptor	608072	4773301
R246	Non-Participating Receptor	607464	4772330
R247	Non-Participating Receptor	607470	4772078
R248	Non-Participating Receptor	607124	4772293
R249	Non-Participating Receptor	607055	4772362
R250	Non-Participating Receptor	607002	4772362
R251	Non-Participating Receptor	607055	4772245
R252	Non-Participating Receptor	607134	4771769
R253	Non-Participating Receptor	606898	4772235
R254	Non-Participating Receptor	605124	4771909
R255	Non-Participating Receptor	605299	4771766
R256	Non-Participating Receptor	605349	4771741
R257	Non-Participating Receptor	605460	4771805
R258	Non-Participating Receptor	606059	4771413
V01	Non-Participating Vacant Lot	604522	4773620
V02	Non-Participating Vacant Lot	607016	4773841
V03	Non-Participating Vacant Lot	604570	4776376
V04	Non-Participating Vacant Lot	605739	4775832
V05	Non-Participating Vacant Lot	606566	4775508
V06	Non-Participating Vacant Lot	606686	4775426
V07	Non-Participating Vacant Lot	606571	4774188
V08	Non-Participating Vacant Lot	603750	4774656
V09	Non-Participating Vacant Lot	606924	4772994
V11	Non-Participating Vacant Lot	608134	4774824
V12	Non-Participating Vacant Lot	607960	4773440
V16	Non-Participating Vacant Lot	608161	4771919
V18	Non-Participating Vacant Lot	607088	4772438
V20	Non-Participating Vacant Lot	607274	4772215
V27	Non-Participating Vacant Lot	606381	4772607
V28	Non-Participating Vacant Lot	606210	4772699
V29	Non-Participating Vacant Lot	606963	4771641
V30	Non-Participating Vacant Lot	606963	4771578
V31	Non-Participating Vacant Lot	604648	4773485
V32	Non-Participating Vacant Lot	605204	4773227
V33	Non-Participating Vacant Lot	604087	4772382
V39	Non-Participating Vacant Lot	605435	4775876
V40	Non-Participating Vacant Lot	605491	4774678
V41	Non-Participating Vacant Lot	606406	4776900
V42	Non-Participating Vacant Lot	607644	4775446
V43	Non-Participating Vacant Lot	608122	4773280

Table A4: Non-Participating Receptor Locations
Vineland Power, HAF Wind Energy Project

Point of Reception ID	Description	UTM Coordinates	
		Easting	Westing
PR01	Participating Receptor	606123	4773010
PR02	Participating Receptor	606895	4773470
PR03	Participating Receptor	604926	4776096
PR04	Participating Receptor	606129	4774317
PR05	Participating Receptor	606543	4773695
PR06	Participating Receptor	604361	4773804
PR07	Participating Receptor	604466	4774951
PR08	Participating Receptor	604092	4774034
PR09	Participating Receptor	604426	4775303
PV01	Participating Vacant Lot	606319	4774265

Table A5: Wind Turbine Noise Impact Summary - Points of Reception
Vineland Power, HAF Wind Energy Project

Point of Reception ID	Description	Height [m]	Distance to Nearest HAF Turbine [m]	Nearest Turbine ID	Calculated Sound Level [dBA] at Selected Wind Speeds (m/s)					Sound Level Limit [dBA]				
					6	7	8	9	10	6	7	8	9	10
R001	Non-Participating Receptor	4.5	610	WTG5	36.6	36.6	36.6	36.6	36.6	40.0	43.0	45.0	49.0	51.0
R002	Non-Participating Receptor	4.5	2033	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R003	Non-Participating Receptor	4.5	1973	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R004	Non-Participating Receptor	4.5	1279	WTG4	29.5	29.5	29.5	29.5	29.5	40.0	43.0	45.0	49.0	51.0
R005	Non-Participating Receptor	4.5	1250	WTG4	29.7	29.7	29.7	29.7	29.7	40.0	43.0	45.0	49.0	51.0
R006	Non-Participating Receptor	4.5	788	WTG4	34.2	34.2	34.2	34.2	34.2	40.0	43.0	45.0	49.0	51.0
R007	Non-Participating Receptor	4.5	1112	WTG4	30.9	30.9	30.9	30.9	30.9	40.0	43.0	45.0	49.0	51.0
R008	Non-Participating Receptor	4.5	1489	WTG4	28.1	28.1	28.1	28.1	28.1	40.0	43.0	45.0	49.0	51.0
R009	Non-Participating Receptor	4.5	1089	WTG4	31.1	31.1	31.1	31.1	31.1	40.0	43.0	45.0	49.0	51.0
R010	Non-Participating Receptor	4.5	1262	WTG5	29.8	29.8	29.8	29.8	29.8	40.0	43.0	45.0	49.0	51.0
R011	Non-Participating Receptor	4.5	1996	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R012	Non-Participating Receptor	4.5	1963	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R013	Non-Participating Receptor	4.5	1958	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R014	Non-Participating Receptor	4.5	1981	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R015	Non-Participating Receptor	4.5	1187	WTG4	33.2	33.2	33.2	33.2	33.2	40.0	43.0	45.0	49.0	51.0
R016	Non-Participating Receptor	4.5	2030	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R017	Non-Participating Receptor	4.5	842	WTG4	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
R018	Non-Participating Receptor	4.5	910	WTG4	34.3	34.3	34.3	34.3	34.3	40.0	43.0	45.0	49.0	51.0
R019	Non-Participating Receptor	4.5	595	WTG5	36.5	36.5	36.5	36.5	36.5	40.0	43.0	45.0	49.0	51.0
R020	Non-Participating Receptor	4.5	2073	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R021	Non-Participating Receptor	4.5	1964	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R022	Non-Participating Receptor	4.5	895	WTG4	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
R023	Non-Participating Receptor	4.5	1092	WTG1	34.1	34.1	34.1	34.1	34.1	40.0	43.0	45.0	49.0	51.0
R024	Non-Participating Receptor	4.5	939	WTG1	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
R025	Non-Participating Receptor	4.5	988	WTG1	32.8	32.8	32.8	32.8	32.8	40.0	43.0	45.0	49.0	51.0
R026	Non-Participating Receptor	4.5	915	WTG1	34.8	34.8	34.8	34.8	34.8	40.0	43.0	45.0	49.0	51.0
R027	Non-Participating Receptor	4.5	714	WTG1	35.9	35.9	35.9	35.9	35.9	40.0	43.0	45.0	49.0	51.0
R028	Non-Participating Receptor	4.5	1003	WTG1	32.9	32.9	32.9	32.9	32.9	40.0	43.0	45.0	49.0	51.0
R029	Non-Participating Receptor	4.5	888	WTG1	35.1	35.1	35.1	35.1	35.1	40.0	43.0	45.0	49.0	51.0
R030	Non-Participating Receptor	4.5	2001	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R031	Non-Participating Receptor	4.5	1774	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R032	Non-Participating Receptor	4.5	2002	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R033	Non-Participating Receptor	4.5	652	WTG4	36.0	36.0	36.0	36.0	36.0	40.0	43.0	45.0	49.0	51.0
R034	Non-Participating Receptor	4.5	899	WTG1	35.8	35.8	35.8	35.8	35.8	40.0	43.0	45.0	49.0	51.0
R035	Non-Participating Receptor	4.5	1090	WTG1	33.1	33.1	33.1	33.1	33.1	40.0	43.0	45.0	49.0	51.0
R036	Non-Participating Receptor	4.5	754	WTG1	36.0	36.0	36.0	36.0	36.0	40.0	43.0	45.0	49.0	51.0
R037	Non-Participating Receptor	4.5	1070	WTG1	32.6	32.6	32.6	32.6	32.6	40.0	43.0	45.0	49.0	51.0
R038	Non-Participating Receptor	4.5	2099	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R039	Non-Participating Receptor	4.5	2043	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R040	Non-Participating Receptor	4.5	736	WTG1	35.7	35.7	35.7	35.7	35.7	40.0	43.0	45.0	49.0	51.0
R041	Non-Participating Receptor	4.5	2148	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R042	Non-Participating Receptor	4.5	1218	WTG1	30.7	30.7	30.7	30.7	30.7	40.0	43.0	45.0	49.0	51.0
R043	Non-Participating Receptor	4.5	755	WTG1	35.5	35.5	35.5	35.5	35.5	40.0	43.0	45.0	49.0	51.0
R044	Non-Participating Receptor	4.5	1889	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R045	Non-Participating Receptor	4.5	2056	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R046	Non-Participating Receptor	4.5	2084	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R047	Non-Participating Receptor	4.5	2097	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R048	Non-Participating Receptor	4.5	2116	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R049	Non-Participating Receptor	4.5	2230	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R050	Non-Participating Receptor	4.5	2151	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R051	Non-Participating Receptor	4.5	801	WTG1	34.7	34.7	34.7	34.7	34.7	40.0	43.0	45.0	49.0	51.0
R052	Non-Participating Receptor	4.5	730	WTG1	35.8	35.8	35.8	35.8	35.8	40.0	43.0	45.0	49.0	51.0
R053	Non-Participating Receptor	4.5	721	WTG1	36.0	36.0	36.0	36.0	36.0	40.0	43.0	45.0	49.0	51.0
R054	Non-Participating Receptor	4.5	840	WTG5	33.2	33.2	33.2	33.2	33.2	40.0	43.0	45.0	49.0	51.0
R055	Non-Participating Receptor	4.5	656	WTG3	36.0	36.0	36.0	36.0	36.0	40.0	43.0	45.0	49.0	51.0
R056	Non-Participating Receptor	4.5	665	WTG1	36.8	36.8	36.8	36.8	36.8	40.0	43.0	45.0	49.0	51.0
R057	Non-Participating Receptor	4.5	738	WTG1	36.4	36.4	36.4	36.4	36.4	40.0	43.0	45.0	49.0	51.0
R058	Non-Participating Receptor	4.5	881	WTG1	33.9	33.9	33.9	33.9	33.9	40.0	43.0	45.0	49.0	51.0
R059	Non-Participating Receptor	4.5	938	WTG4	34.3	34.3	34.3	34.3	34.3	40.0	43.0	45.0	49.0	51.0
R060	Non-Participating Receptor	4.5	703	WTG4	37.8	37.8	37.8	37.8	37.8	40.0	43.0	45.0	49.0	51.0
R061	Non-Participating Receptor	4.5	844	WTG1	35.4	35.4	35.4	35.4	35.4	40.0	43.0	45.0	49.0	51.0
R062	Non-Participating Receptor	4.5	914	WTG1	35.4	35.4	35.4	35.4	35.4	40.0	43.0	45.0	49.0	51.0
R063	Non-Participating Receptor	4.5	835	WTG3	36.6	36.6	36.6	36.6	36.6	40.0	43.0	45.0	49.0	51.0
R064	Non-Participating Receptor	4.5	995	WTG1	34.9	34.9	34.9	34.9	34.9	40.0	43.0	45.0	49.0	51.0
R065	Non-Participating Receptor	4.5	1064	WTG1	34.3	34.3	34.3	34.3	34.3	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height [m]	Distance to Nearest HAF Turbine [m]	Nearest Turbine ID	Calculated Sound Level [dBA] at Selected Wind Speeds (m/s)					Sound Level Limit [dBA]				
					6	7	8	9	10	6	7	8	9	10
R066	Non-Participating Receptor	4.5	697	WTG5	35.2	35.2	35.2	35.2	35.2	40.0	43.0	45.0	49.0	51.0
R067	Non-Participating Receptor	4.5	607	WTG3	37.9	37.9	37.9	37.9	37.9	40.0	43.0	45.0	49.0	51.0
R068	Non-Participating Receptor	4.5	684	WTG3	37.3	37.3	37.3	37.3	37.3	40.0	43.0	45.0	49.0	51.0
R069	Non-Participating Receptor	4.5	1136	WTG3	33.8	33.8	33.8	33.8	33.8	40.0	43.0	45.0	49.0	51.0
R070	Non-Participating Receptor	4.5	628	WTG3	37.7	37.7	37.7	37.7	37.7	40.0	43.0	45.0	49.0	51.0
R071	Non-Participating Receptor	4.5	694	WTG3	37.1	37.1	37.1	37.1	37.1	40.0	43.0	45.0	49.0	51.0
R072	Non-Participating Receptor	4.5	701	WTG3	35.4	35.4	35.4	35.4	35.4	40.0	43.0	45.0	49.0	51.0
R073	Non-Participating Receptor	4.5	1061	WTG3	33.9	33.9	33.9	33.9	33.9	40.0	43.0	45.0	49.0	51.0
R074	Non-Participating Receptor	4.5	660	WTG3	37.4	37.4	37.4	37.4	37.4	40.0	43.0	45.0	49.0	51.0
R075	Non-Participating Receptor	4.5	895	WTG5	33.8	33.8	33.8	33.8	33.8	40.0	43.0	45.0	49.0	51.0
R076	Non-Participating Receptor	4.5	764	WTG5	34.3	34.3	34.3	34.3	34.3	40.0	43.0	45.0	49.0	51.0
R077	Non-Participating Receptor	4.5	716	WTG3	37.1	37.1	37.1	37.1	37.1	40.0	43.0	45.0	49.0	51.0
R078	Non-Participating Receptor	4.5	708	WTG3	35.4	35.4	35.4	35.4	35.4	40.0	43.0	45.0	49.0	51.0
R079	Non-Participating Receptor	4.5	717	WTG3	35.3	35.3	35.3	35.3	35.3	40.0	43.0	45.0	49.0	51.0
R080	Non-Participating Receptor	4.5	922	WTG3	34.0	34.0	34.0	34.0	34.0	40.0	43.0	45.0	49.0	51.0
R081	Non-Participating Receptor	4.5	824	WTG3	34.3	34.3	34.3	34.3	34.3	40.0	43.0	45.0	49.0	51.0
R082	Non-Participating Receptor	4.5	706	WTG3	35.7	35.7	35.7	35.7	35.7	40.0	43.0	45.0	49.0	51.0
R083	Non-Participating Receptor	4.5	823	WTG3	34.0	34.0	34.0	34.0	34.0	40.0	43.0	45.0	49.0	51.0
R084	Non-Participating Receptor	4.5	851	WTG3	33.3	33.3	33.3	33.3	33.3	40.0	43.0	45.0	49.0	51.0
R085	Non-Participating Receptor	4.5	950	WTG5	31.8	31.8	31.8	31.8	31.8	40.0	43.0	45.0	49.0	51.0
R086	Non-Participating Receptor	4.5	780	WTG3	34.3	34.3	34.3	34.3	34.3	40.0	43.0	45.0	49.0	51.0
R087	Non-Participating Receptor	4.5	1043	WTG5	30.9	30.9	30.9	30.9	30.9	40.0	43.0	45.0	49.0	51.0
R088	Non-Participating Receptor	4.5	728	WTG3	35.1	35.1	35.1	35.1	35.1	40.0	43.0	45.0	49.0	51.0
R089	Non-Participating Receptor	4.5	709	WTG3	35.3	35.3	35.3	35.3	35.3	40.0	43.0	45.0	49.0	51.0
R090	Non-Participating Receptor	4.5	993	WTG5	31.4	31.4	31.4	31.4	31.4	40.0	43.0	45.0	49.0	51.0
R091	Non-Participating Receptor	4.5	809	WTG3	33.8	33.8	33.8	33.8	33.8	40.0	43.0	45.0	49.0	51.0
R092	Non-Participating Receptor	4.5	929	WTG5	32.0	32.0	32.0	32.0	32.0	40.0	43.0	45.0	49.0	51.0
R093	Non-Participating Receptor	4.5	1017	WTG3	33.1	33.1	33.1	33.1	33.1	40.0	43.0	45.0	49.0	51.0
R094	Non-Participating Receptor	4.5	727	WTG5	34.5	34.5	34.5	34.5	34.5	40.0	43.0	45.0	49.0	51.0
R095	Non-Participating Receptor	4.5	1111	WTG5	30.2	30.2	30.2	30.2	30.2	40.0	43.0	45.0	49.0	51.0
R096	Non-Participating Receptor	4.5	916	WTG5	34.2	34.2	34.2	34.2	34.2	40.0	43.0	45.0	49.0	51.0
R097	Non-Participating Receptor	4.5	1191	WTG5	29.5	29.5	29.5	29.5	29.5	40.0	43.0	45.0	49.0	51.0
R098	Non-Participating Receptor	4.5	930	WTG3	32.5	32.5	32.5	32.5	32.5	40.0	43.0	45.0	49.0	51.0
R099	Non-Participating Receptor	4.5	686	WTG3	35.5	35.5	35.5	35.5	35.5	40.0	43.0	45.0	49.0	51.0
R100	Non-Participating Receptor	4.5	1069	WTG3	31.1	31.1	31.1	31.1	31.1	40.0	43.0	45.0	49.0	51.0
R101	Non-Participating Receptor	4.5	1021	WTG3	31.6	31.6	31.6	31.6	31.6	40.0	43.0	45.0	49.0	51.0
R102	Non-Participating Receptor	4.5	1087	WTG5	31.4	31.4	31.4	31.4	31.4	40.0	43.0	45.0	49.0	51.0
R103	Non-Participating Receptor	4.5	967	WTG3	32.1	32.1	32.1	32.1	32.1	40.0	43.0	45.0	49.0	51.0
R104	Non-Participating Receptor	4.5	1822	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R105	Non-Participating Receptor	4.5	1533	WTG3	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R106	Non-Participating Receptor	4.5	1179	WTG3	30.2	30.2	30.2	30.2	30.2	40.0	43.0	45.0	49.0	51.0
R107	Non-Participating Receptor	4.5	1987	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R108	Non-Participating Receptor	4.5	2018	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R109	Non-Participating Receptor	4.5	1512	WTG3	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R110	Non-Participating Receptor	4.5	2037	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R111	Non-Participating Receptor	4.5	1504	WTG3	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R112	Non-Participating Receptor	4.5	1337	WTG3	29.2	29.2	29.2	29.2	29.2	40.0	43.0	45.0	49.0	51.0
R113	Non-Participating Receptor	4.5	894	WTG5	33.4	33.4	33.4	33.4	33.4	40.0	43.0	45.0	49.0	51.0
R114	Non-Participating Receptor	4.5	1445	WTG5	28.2	28.2	28.2	28.2	28.2	40.0	43.0	45.0	49.0	51.0
R115	Non-Participating Receptor	4.5	853	WTG3	34.2	34.2	34.2	34.2	34.2	40.0	43.0	45.0	49.0	51.0
R116	Non-Participating Receptor	4.5	700	WTG5	34.9	34.9	34.9	34.9	34.9	40.0	43.0	45.0	49.0	51.0
R117	Non-Participating Receptor	4.5	764	WTG5	34.5	34.5	34.5	34.5	34.5	40.0	43.0	45.0	49.0	51.0
R118	Non-Participating Receptor	4.5	788	WTG5	33.8	33.8	33.8	33.8	33.8	40.0	43.0	45.0	49.0	51.0
R119	Non-Participating Receptor	4.5	750	WTG4	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
R120	Non-Participating Receptor	4.5	587	WTG3	38.0	38.0	38.0	38.0	38.0	40.0	43.0	45.0	49.0	51.0
R121	Non-Participating Receptor	4.5	858	WTG5	33.9	33.9	33.9	33.9	33.9	40.0	43.0	45.0	49.0	51.0
R122	Non-Participating Receptor	4.5	807	WTG5	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
R123	Non-Participating Receptor	4.5	781	WTG5	34.0	34.0	34.0	34.0	34.0	40.0	43.0	45.0	49.0	51.0
R124	Non-Participating Receptor	4.5	744	WTG3	35.2	35.2	35.2	35.2	35.2	40.0	43.0	45.0	49.0	51.0
R125	Non-Participating Receptor	4.5	2018	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R126	Non-Participating Receptor	4.5	1983	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R127	Non-Participating Receptor	4.5	1973	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R128	Non-Participating Receptor	4.5	1958	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R129	Non-Participating Receptor	4.5	1929	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R130	Non-Participating Receptor	4.5	1901	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R131	Non-Participating Receptor	4.5	1865	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R132	Non-Participating Receptor	4.5	1854	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height [m]	Distance to Nearest HAF Turbine [m]	Nearest Turbine ID	Calculated Sound Level [dBA] at Selected Wind Speeds (m/s)					Sound Level Limit [dBA]				
					6	7	8	9	10	6	7	8	9	10
R133	Non-Participating Receptor	4.5	1828	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R134	Non-Participating Receptor	4.5	1801	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R135	Non-Participating Receptor	4.5	1760	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R136	Non-Participating Receptor	4.5	1774	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R137	Non-Participating Receptor	4.5	1806	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R138	Non-Participating Receptor	4.5	1720	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R139	Non-Participating Receptor	4.5	1772	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R140	Non-Participating Receptor	4.5	1738	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R141	Non-Participating Receptor	4.5	1747	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R142	Non-Participating Receptor	4.5	1718	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R143	Non-Participating Receptor	4.5	1688	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R144	Non-Participating Receptor	4.5	1698	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R145	Non-Participating Receptor	4.5	1983	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R146	Non-Participating Receptor	4.5	1656	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R147	Non-Participating Receptor	4.5	1604	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R148	Non-Participating Receptor	4.5	1589	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R149	Non-Participating Receptor	4.5	1612	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R150	Non-Participating Receptor	4.5	1631	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R151	Non-Participating Receptor	4.5	1359	WTG1	29.6	29.6	29.6	29.6	29.6	40.0	43.0	45.0	49.0	51.0
R152	Non-Participating Receptor	4.5	1933	WTG3	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R153	Non-Participating Receptor	4.5	1353	WTG1	29.6	29.6	29.6	29.6	29.6	40.0	43.0	45.0	49.0	51.0
R154	Non-Participating Receptor	4.5	1297	WTG1	30.0	30.0	30.0	30.0	30.0	40.0	43.0	45.0	49.0	51.0
R155	Non-Participating Receptor	4.5	1360	WTG1	29.6	29.6	29.6	29.6	29.6	40.0	43.0	45.0	49.0	51.0
R156	Non-Participating Receptor	4.5	1319	WTG1	29.9	29.9	29.9	29.9	29.9	40.0	43.0	45.0	49.0	51.0
R157	Non-Participating Receptor	4.5	1340	WTG1	29.7	29.7	29.7	29.7	29.7	40.0	43.0	45.0	49.0	51.0
R158	Non-Participating Receptor	4.5	1269	WTG1	30.2	30.2	30.2	30.2	30.2	40.0	43.0	45.0	49.0	51.0
R159	Non-Participating Receptor	4.5	1233	WTG1	30.5	30.5	30.5	30.5	30.5	40.0	43.0	45.0	49.0	51.0
R160	Non-Participating Receptor	4.5	1294	WTG1	30.1	30.1	30.1	30.1	30.1	40.0	43.0	45.0	49.0	51.0
R161	Non-Participating Receptor	4.5	979	WTG1	32.8	32.8	32.8	32.8	32.8	40.0	43.0	45.0	49.0	51.0
R162	Non-Participating Receptor	4.5	1993	WTG3	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R163	Non-Participating Receptor	4.5	1908	WTG3	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R164	Non-Participating Receptor	4.5	1771	WTG3	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R165	Non-Participating Receptor	4.5	664	WTG1	36.7	36.7	36.7	36.7	36.7	40.0	43.0	45.0	49.0	51.0
R166	Non-Participating Receptor	4.5	1787	WTG3	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R167	Non-Participating Receptor	4.5	1876	WTG3	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R168	Non-Participating Receptor	4.5	1945	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R169	Non-Participating Receptor	4.5	688	WTG1	36.8	36.8	36.8	36.8	36.8	40.0	43.0	45.0	49.0	51.0
R170	Non-Participating Receptor	4.5	1928	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R171	Non-Participating Receptor	4.5	2046	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R172	Non-Participating Receptor	4.5	1868	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R173	Non-Participating Receptor	4.5	2011	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R174	Non-Participating Receptor	4.5	1967	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R175	Non-Participating Receptor	4.5	1824	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R176	Non-Participating Receptor	4.5	1792	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R177	Non-Participating Receptor	4.5	1764	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R178	Non-Participating Receptor	4.5	1720	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R179	Non-Participating Receptor	4.5	1681	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R180	Non-Participating Receptor	4.5	1785	WTG3	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R181	Non-Participating Receptor	4.5	1651	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R182	Non-Participating Receptor	4.5	1621	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R183	Non-Participating Receptor	4.5	1902	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R184	Non-Participating Receptor	4.5	1596	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R185	Non-Participating Receptor	4.5	1545	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R186	Non-Participating Receptor	4.5	1825	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R187	Non-Participating Receptor	4.5	1782	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R188	Non-Participating Receptor	4.5	1521	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R189	Non-Participating Receptor	4.5	1754	WTG1	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R190	Non-Participating Receptor	4.5	1848	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R191	Non-Participating Receptor	4.5	1712	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R192	Non-Participating Receptor	4.5	1797	WTG3	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R193	Non-Participating Receptor	4.5	1665	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R194	Non-Participating Receptor	4.5	1771	WTG3	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R195	Non-Participating Receptor	4.5	1376	WTG4	31.5	31.5	31.5	31.5	31.5	40.0	43.0	45.0	49.0	51.0
R196	Non-Participating Receptor	4.5	1765	WTG3	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R197	Non-Participating Receptor	4.5	1669	WTG3	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R198	Non-Participating Receptor	4.5	1729	WTG3	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R199	Non-Participating Receptor	4.5	946	WTG4	34.4	34.4	34.4	34.4	34.4	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height [m]	Distance to Nearest HAF Turbine [m]	Nearest Turbine ID	Calculated Sound Level [dBA] at Selected Wind Speeds (m/s)					Sound Level Limit [dBA]				
					6	7	8	9	10	6	7	8	9	10
R200	Non-Participating Receptor	4.5	2011	WTG3	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R201	Non-Participating Receptor	4.5	984	WTG4	32.7	32.7	32.7	32.7	32.7	40.0	43.0	45.0	49.0	51.0
R202	Non-Participating Receptor	4.5	1782	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R203	Non-Participating Receptor	4.5	2025	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R204	Non-Participating Receptor	4.5	1988	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R205	Non-Participating Receptor	4.5	1955	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R206	Non-Participating Receptor	4.5	1922	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R207	Non-Participating Receptor	4.5	1818	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R208	Non-Participating Receptor	4.5	1751	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R209	Non-Participating Receptor	4.5	1775	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R210	Non-Participating Receptor	4.5	1895	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R211	Non-Participating Receptor	4.5	1871	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R212	Non-Participating Receptor	4.5	1984	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R213	Non-Participating Receptor	4.5	1918	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R214	Non-Participating Receptor	4.5	2006	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R215	Non-Participating Receptor	4.5	2034	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R216	Non-Participating Receptor	4.5	1995	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R217	Non-Participating Receptor	4.5	2024	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R218	Non-Participating Receptor	4.5	1991	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R219	Non-Participating Receptor	4.5	1970	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R220	Non-Participating Receptor	4.5	2019	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R221	Non-Participating Receptor	4.5	2048	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R222	Non-Participating Receptor	4.5	2027	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R223	Non-Participating Receptor	4.5	1525	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R224	Non-Participating Receptor	4.5	2018	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R225	Non-Participating Receptor	4.5	2009	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R226	Non-Participating Receptor	4.5	1981	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R227	Non-Participating Receptor	4.5	1824	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R228	Non-Participating Receptor	4.5	1971	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R229	Non-Participating Receptor	4.5	1915	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R230	Non-Participating Receptor	4.5	1915	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R231	Non-Participating Receptor	4.5	1927	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R232	Non-Participating Receptor	4.5	1984	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R233	Non-Participating Receptor	4.5	1932	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R234	Non-Participating Receptor	4.5	1944	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R235	Non-Participating Receptor	4.5	1990	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R236	Non-Participating Receptor	4.5	1998	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R237	Non-Participating Receptor	4.5	1965	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R238	Non-Participating Receptor	4.5	2042	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R239	Non-Participating Receptor	4.5	1988	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R240	Non-Participating Receptor	4.5	1991	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R241	Non-Participating Receptor	4.5	1999	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R242	Non-Participating Receptor	4.5	1553	WTG3	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R243	Non-Participating Receptor	4.5	1932	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R244	Non-Participating Receptor	4.5	1794	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R245	Non-Participating Receptor	4.5	1843	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R246	Non-Participating Receptor	4.5	1644	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R247	Non-Participating Receptor	4.5	1825	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R248	Non-Participating Receptor	4.5	1437	WTG5	27.6	27.6	27.6	27.6	27.6	40.0	43.0	45.0	49.0	51.0
R249	Non-Participating Receptor	4.5	1340	WTG5	28.3	28.3	28.3	28.3	28.3	40.0	43.0	45.0	49.0	51.0
R250	Non-Participating Receptor	4.5	1308	WTG5	28.6	28.6	28.6	28.6	28.6	40.0	43.0	45.0	49.0	51.0
R251	Non-Participating Receptor	4.5	1434	WTG5	27.6	27.6	27.6	27.6	27.6	40.0	43.0	45.0	49.0	51.0
R252	Non-Participating Receptor	4.5	1881	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R253	Non-Participating Receptor	4.5	1359	WTG5	28.2	28.2	28.2	28.2	28.2	40.0	43.0	45.0	49.0	51.0
R254	Non-Participating Receptor	4.5	1874	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R255	Non-Participating Receptor	4.5	1899	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R256	Non-Participating Receptor	4.5	1897	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R257	Non-Participating Receptor	4.5	1790	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
R258	Non-Participating Receptor	4.5	2015	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
V01	Non-Participating Vacant Lot	4.5	706	WTG4	35.5	35.5	35.5	35.5	35.5	40.0	43.0	45.0	49.0	51.0
V02	Non-Participating Vacant Lot	4.5	889	WTG5	33.6	33.6	33.6	33.6	33.6	40.0	43.0	45.0	49.0	51.0
V03	Non-Participating Vacant Lot	4.5	836	WTG1	34.3	34.3	34.3	34.3	34.3	40.0	43.0	45.0	49.0	51.0
V04	Non-Participating Vacant Lot	4.5	1059	WTG1	34.8	34.8	34.8	34.8	34.8	40.0	43.0	45.0	49.0	51.0
V05	Non-Participating Vacant Lot	4.5	662	WTG3	35.9	35.9	35.9	35.9	35.9	40.0	43.0	45.0	49.0	51.0
V06	Non-Participating Vacant Lot	4.5	654	WTG3	35.9	35.9	35.9	35.9	35.9	40.0	43.0	45.0	49.0	51.0
V07	Non-Participating Vacant Lot	4.5	770	WTG3	36.4	36.4	36.4	36.4	36.4	40.0	43.0	45.0	49.0	51.0
V08	Non-Participating Vacant Lot	4.5	702	WTG4	36.0	36.0	36.0	36.0	36.0	40.0	43.0	45.0	49.0	51.0

Point of Reception ID	Description	Height [m]	Distance to Nearest HAF Turbine [m]	Nearest Turbine ID	Calculated Sound Level [dBA] at Selected Wind Speeds (m/s)					Sound Level Limit [dBA]				
					6	7	8	9	10	6	7	8	9	10
V09	Non-Participating Vacant Lot	4.5	812	WTG5	33.4	33.4	33.4	33.4	33.4	40.0	43.0	45.0	49.0	51.0
V11	Non-Participating Vacant Lot	4.5	1844	WTG3	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
V12	Non-Participating Vacant Lot	4.5	1727	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
V16	Non-Participating Vacant Lot	4.5	2443	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
V18	Non-Participating Vacant Lot	4.5	1302	WTG5	28.6	28.6	28.6	28.6	28.6	40.0	43.0	45.0	49.0	51.0
V20	Non-Participating Vacant Lot	4.5	1592	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
V27	Non-Participating Vacant Lot	4.5	826	WTG5	33.2	33.2	33.2	33.2	33.2	40.0	43.0	45.0	49.0	51.0
V28	Non-Participating Vacant Lot	4.5	721	WTG5	34.6	34.6	34.6	34.6	34.6	40.0	43.0	45.0	49.0	51.0
V29	Non-Participating Vacant Lot	4.5	1923	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
V30	Non-Participating Vacant Lot	4.5	1982	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
V31	Non-Participating Vacant Lot	4.5	871	WTG4	33.9	33.9	33.9	33.9	33.9	40.0	43.0	45.0	49.0	51.0
V32	Non-Participating Vacant Lot	4.5	1047	WTG5	32.8	32.8	32.8	32.8	32.8	40.0	43.0	45.0	49.0	51.0
V33	Non-Participating Vacant Lot	4.5	1944	WTG4	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
V39	Non-Participating Vacant Lot	4.5	786	WTG1	36.4	36.4	36.4	36.4	36.4	40.0	43.0	45.0	49.0	51.0
V40	Non-Participating Vacant Lot	4.5	779	WTG2	37.6	37.6	37.6	37.6	37.6	40.0	43.0	45.0	49.0	51.0
V41	Non-Participating Vacant Lot	4.5	1998	WTG3	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0
V42	Non-Participating Vacant Lot	4.5	1457	WTG3	28.2	28.2	28.2	28.2	28.2	40.0	43.0	45.0	49.0	51.0
V43	Non-Participating Vacant Lot	4.5	1894	WTG5	-	-	-	-	-	40.0	43.0	45.0	49.0	51.0

'-' Receptors greater than 1500m from project wind turbine generators.

Table A6: Wind Turbine Noise Impact Summary - Participating Receptor Locations
Vineland Power, HAF Wind Energy Project

Point of Reception ID	Description	Height [m]	Distance to Nearest HAF Turbine [m]	Nearest Turbine ID	Calculated Sound Level [dBA] at Selected Wind Speeds (m/s)				
					6	7	8	9	10
PR01	Participating Receptor	4.5	424	WTG5	39.8	39.8	39.8	39.8	39.8
PR02	Participating Receptor	4.5	664	WTG5	35.6	35.6	35.6	35.6	35.6
PR03	Participating Receptor	4.5	581	WTG1	37.9	37.9	37.9	37.9	37.9
PR04	Participating Receptor	4.5	610	WTG3	37.9	37.9	37.9	37.9	37.9
PR05	Participating Receptor	4.5	414	WTG5	40.2	40.2	40.2	40.2	40.2
PR06	Participating Receptor	4.5	503	WTG4	38.5	38.5	38.5	38.5	38.5
PR07	Participating Receptor	4.5	478	WTG2	41.4	41.4	41.4	41.4	41.4
PR08	Participating Receptor	4.5	382	WTG4	40.9	40.9	40.9	40.9	40.9
PR09	Participating Receptor	4.5	384	WTG1	42.9	42.9	42.9	42.9	42.9
PV01	Participating Vacant Lot	4.5	641	WTG3	37.6	37.6	37.6	37.6	37.6

APPENDIX B:

Zoning Map

TOWNSHIP OF WEST LINCOLN

THIS IS MAP 1 AND KEY MAPS 2-16
TO SCHEDULE 'A', BY-LAW No. 79-14
PASSED THIS 5th DAY OF MARCH 1979.
'C.O. HODGKINS' MAYOR
'J.G. KILLINS' CLERK

TEMPORARY USE

* NIAGARA ROAD 12 LANDFILL SITE - WASTE DISPOSAL FILL AREA

NIAGARA ROAD 12 LANDFILL SITE - BUFFER ZONE

NIAGARA ROAD 12 LANDFILL SITE - BUFFER AND HAZARD LANDS

NIAGARA ROAD 12 LANDFILL SITE - AREA OF POSSIBLE INFLUENCE

SEE BY-LAW 91-52, 91-78

ZONES	SYMBOLS	ZONES	SYMBOLS
RESTRICTED AGRICULTURAL	A1	LOCAL COMMERCIAL	C1
AGRICULTURAL	A2	GENERAL COMMERCIAL	C2
RESIDENTIAL	R1	HIGHWAY COMMERCIAL	C3
RESIDENTIAL	R2	RURAL COMMERCIAL	RC
RESIDENTIAL	R3	INDUSTRIAL	M1
RESIDENTIAL MULTIPLE	RM1	PUBLIC INDUSTRIAL	M2
RESIDENTIAL MULTIPLE	RM2	INSTITUTIONAL	I
RURAL RESIDENTIAL	RuR	PUBLIC	P
DEVELOPMENT	D	OPEN SPACE	O1
TRAILOR CAMP	T2	HAZARD	H

Project Area

Westbrook Road Rural Cluster (By-law No. 2008-118)

New City of Hamilton

Town of Grimsby

Town of Lincoln

Town of Pelham

Town of Haldimand

Town of Dunnville

Township of Wainfleet

SOUTH GRIMSBY

CASTOR

GAINSBOROUGH

B.F.

MAP 1 MAP 2 MAP 3 MAP 4 MAP 5 MAP 6 MAP 7 MAP 8 MAP 9 MAP 10 MAP 11 MAP 12 MAP 13 MAP 14 MAP 15 MAP 16

CASTORVILLE ABINGDON GRIMSBY CENTRE WINSLOW BISMARK WELLANDPORT WARNER ATTERCLIFFE ZUMSTEIN SILVERDALE ST.ANNS EAST GORE EAST BOYLE BOYLE

N

OFFICE CONSOLIDATION

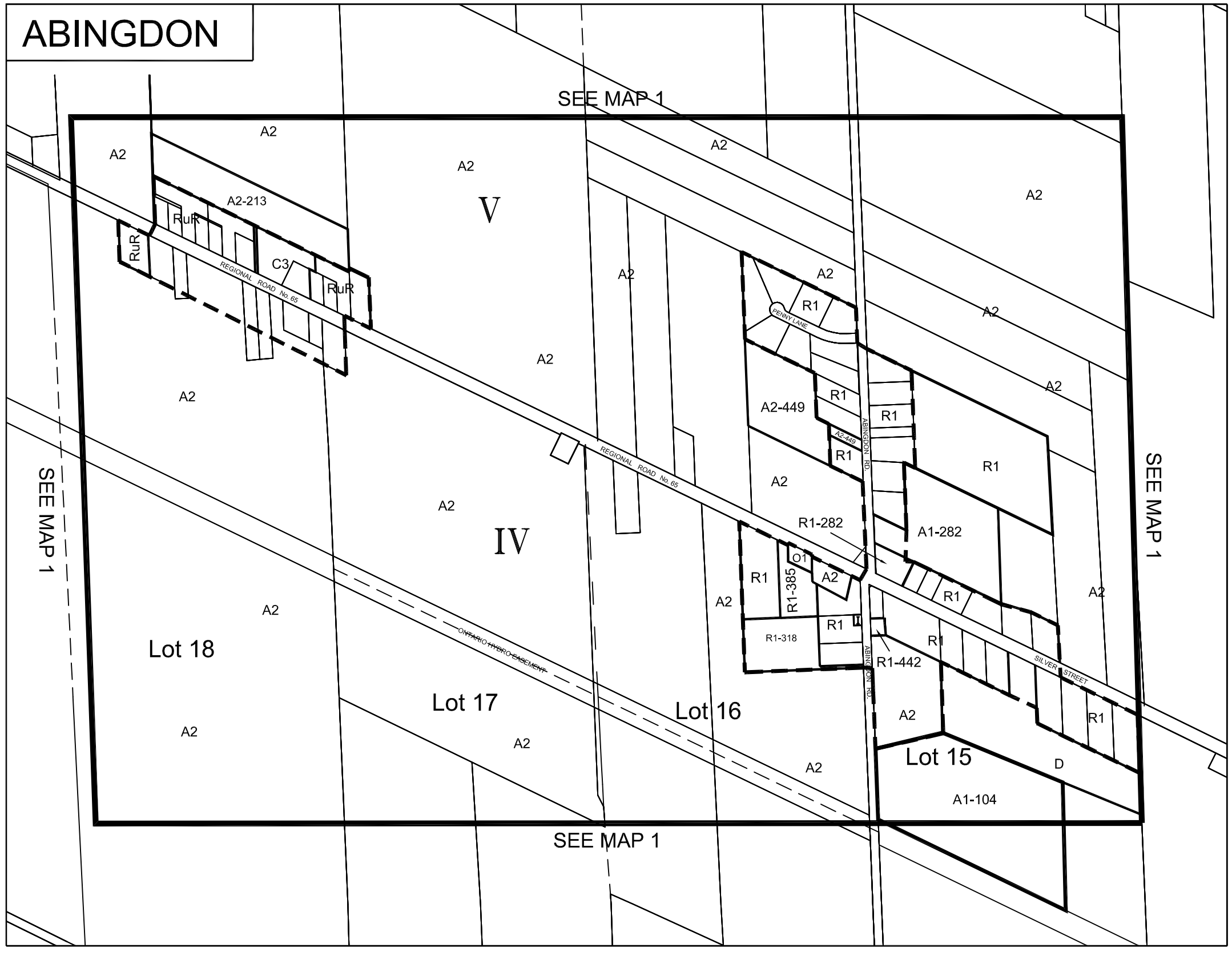
This is an Office Consolidation of Zoning By-law No. 79-14 of the Township of West Lincoln as passed by Council on March 5, 1979.

For accurate reference, recourse should be made to the original Zoning By-law No. 79-14 and amending By-laws.

Consolidated Version November 2009

FOR INFORMATION PURPOSES ONLY.

SCALE N.T.S.



TOWNSHIP OF WEST LINCOLN

THIS IS MAP 8
TO SCHEDULE "A",
BY-LAW No. 79-14
PASSED THIS 5th DAY
OF MARCH 1979.

'C.O. HODGKINS' MAYOR

'J.G. KILLINS' CLERK

ZONES	SYMBOLS
RESTRICTED AGRICULTURAL	A1
AGRICULTURAL	A2
RESIDENTIAL	R1
RESIDENTIAL	R2
RESIDENTIAL MULTIPLE	RM1
RESIDENTIAL MULTIPLE	RM2
RURAL RESIDENTIAL	RuR
DEVELOPMENT	D
TRAILER CAMP	T2
LOCAL COMMERCIAL	C1
GENERAL COMMERCIAL	C2
HIGHWAY COMMERCIAL	C3
RURAL COMMERCIAL	RC
INDUSTRIAL	M1
PUBLIC INDUSTRIAL	M2
INSTITUTIONAL	I
PUBLIC	P
OPEN SPACE	O1
HAZARD	H
SCHEDULE BOUNDARY	
RURAL CLUSTER BOUNDARY (By-Law No. 2008-29 & By-law 2008-115)	

N

FOR INFORMATION PURPOSES ONLY.
MAY NOT BE TO SCALE.

OFFICE CONSOLIDATION

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Consolidated Version
November 2009

APPENDIX C:

VESTAS V100-1.8 MW Wind Turbine Generator Information

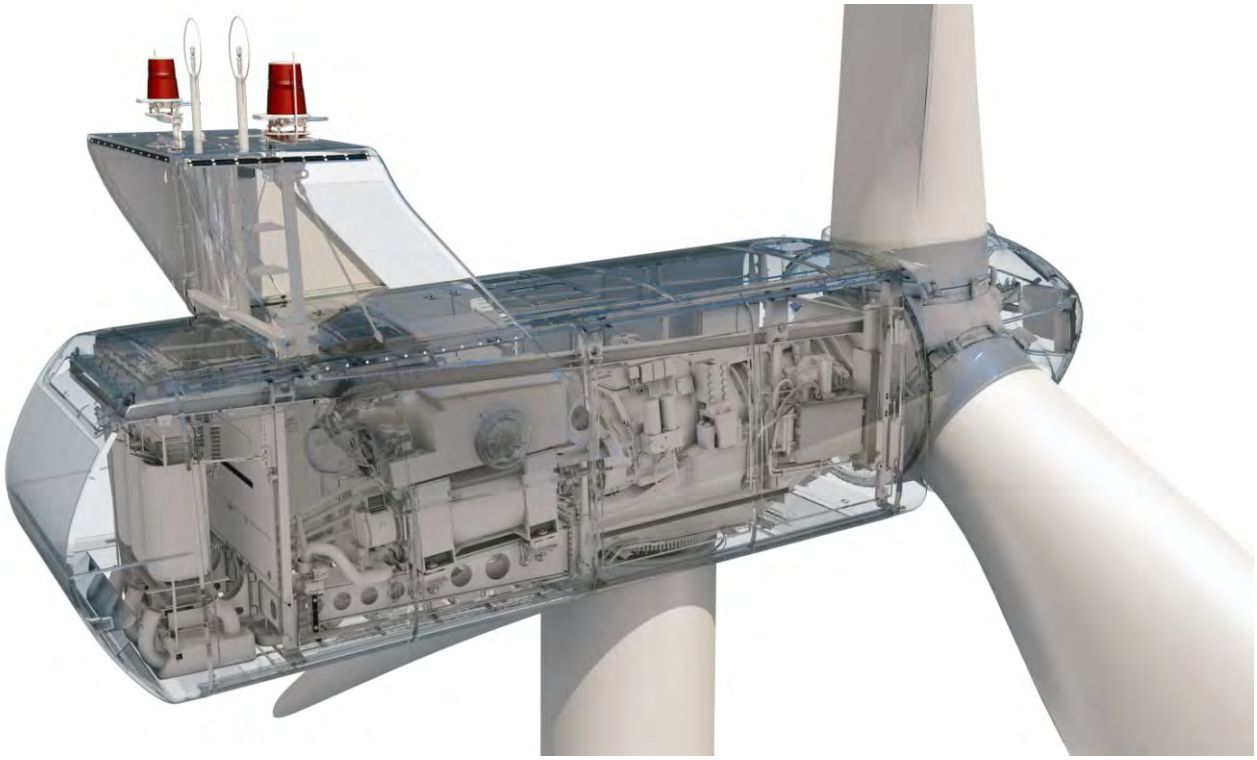
Exhibit D.1.1

General Specification

Class 1
Document no.: 0004-3053 V06
2010-10-06

General Specification

V100–1.8 MW VCUS



Vestas Wind Systems A/S · Alsvej 21 · 8940 Randers SV · Denmark · www.vestas.com

Table of Contents

Buyer acknowledges that these general specifications are for Buyer's informational purposes only and do not create or constitute a warranty, guarantee, promise, commitment, or other representation by supplier, all of which are disclaimed by supplier except to the extent expressly provided by supplier in writing elsewhere.

See section 11 General Reservations, Notes and Disclaimers**, p. 36 for general reservations, notes, and disclaimers applicable to these general specifications.**

1 General Description

The Vestas V100-1.8 MW wind turbine is a pitch regulated upwind turbine with active yaw and a three-blade rotor. The Vestas V100-1.8 MW turbine has a rotor diameter of 100 m with a generator rated at 1.8 MW. The turbine utilizes a microprocessor pitch control system called OptiTip® and the Variable Speed concepts (VCUS: Vestas Converter Unity System). With these features the wind turbine is able to operate the rotor at variable speed (RPM), helping to maintain the output at or near rated power.

2 Mechanical Design

2.1 Rotor

The V100-1.8 MW turbine is equipped with a 100 meter rotor consisting of three blades and the hub. Based on the prevailing wind conditions, the blades are continuously positioned to help optimise the pitch angle.

Rotor	
Diameter	100 m
Swept Area	7850 m^2
Rotational Speed Static, Rotor	14.9 rpm
Speed, Dynamic Operation Range	9.3-16.6 rpm
Rotational Direction	Clockwise (front view)
Orientation	Upwind
Tilt	6°
Hub Coning	2°
Number of Blades	3
Aerodynamic Brakes	Full feathering

Table 2-1: Rotor data.

2.2 Blades

The 49 m Prepreg (PP) blades are made of carbon and fibre glass and consist of two airfoil shells bonded to a supporting beam.

PP Blades	
Type Description	Airfoil shells bonded to supporting beam
Blade Length	49 m
Material	Fibreglass reinforced epoxy and carbon fibres
Blade Connection	Steel roots inserted
Air Foils	RISØ P + FFA –W3
Chord	3.9 m
Blade Root Outer Diameter	1.88 m

PP Blades	
PCD of Steel Root Inserts	1.80 m
R49	0.54 m
Twist (Blade root/blade tip)	24,5°/-0,5°
Approximate Weight	7500 kg

Table 2-2: PP blades data.

2.3 Blade Bearing

The blade bearings are double row 4-point contact ball bearings.

Blade Bearing	
Type	2 row 4-point contact ball bearing
Lubrication	Grease lubrication, automatic lubrication pump

Table 2-3: Blade bearing data.

2.4 Pitch System

The energy input from the wind to the turbine is adjusted by pitching the blades according to the control strategy. The pitch system also works as the primary brake system by pitching the blades out of the wind. This causes the rotor to idle.

Double row 4-point contact ball bearings are used to connect the blades to the hub. The pitch system relies on hydraulics and uses a cylinder to pitch each blade. Hydraulic power is supplied to the cylinder from the hydraulic power unit in the nacelle through the main gearbox and the main shaft via a rotating transfer.

Hydraulic accumulators inside the rotor hub ensure sufficient power to blades in case of failure.

Pitch System	
Type	Hydraulic
Cylinder	Ø125/80 – 760
Number	1 pcs./ blade
Range	-5º to 90º

Table 2-4: Pitch system data.

Hydraulic System	
Pump Capacity	50 l/min
Working Pressure	200-230 bar
Oil Quantity	260 l
Motor	20 kW

Table 2-5: Hydraulic system data.

2.5 Hub

The hub supports the 3 blades and transfers the reaction forces to the main bearing. The hub structure also supports blade bearings and pitch cylinder.

Hub	
Type	Cast ball shell hub
Material	Cast iron EN GJS 400-18U-LT / EN1560

Table 2-6: Hub data.

2.6 Main Shaft

Main Shaft	
Type	Forged, trumpet shaft
Material	42 CrMo4 QT / EN 10083

Table 2-7: Main shaft data.

2.7 Bearing Housing

Bearing Housing	
Type	Cast foot housing with lowered centre
Material	Cast iron EN GJS 400-18U-LT / EN1560

Table 2-8: Bearing housing data.

2.8 Main Bearings

Main Bearings	
Type	Spherical roller bearings
Lubrication	Grease lubrication, manually re-greased

Table 2-9: Main bearings data.

2.9 Gearbox

The main gearbox transmits torque and revolutions from the rotor to the generator.

The main gearbox consists of a planetary stage combined with a two-stage parallel gearbox, torque arms and vibration dampers.

Torque is transmitted from the high-speed shaft to the generator via a flexible composite coupling, located behind the disc brake. The disc brake is mounted directly on the high-speed shaft.

Gearbox	
Type	1 planetary stage + 2 helical stages
Ratio	1:92.8 nominal
Cooling	Oil pump with oil cooler
Oil heater	2 kW
Max Gear Oil Temp	80°C
Oil Cleanliness	-/15/12 ISO 4406

Table 2-10: Gearbox data.

2.10 Generator Bearings

The bearings are greased and grease is supplied continuously from an automatic lubrication unit when the nacelle temperature is above -10°C. The yearly grease flow is approximately 2400 cm³.

2.11 High Speed Shaft Coupling

The flexible coupling transmits the torque from the gearbox high speed output shaft to the generator input shaft. The flexible coupling is designed to compensate misalignments between gearbox and generator. The coupling consists of two composite discs and an intermediate tube with two aluminium flanges and a fibre glass tube. The coupling is fitted to 3-armed hubs on the brake disc and the generator hub.

High Speed Shaft Coupling	
Type Description	VK 420

Table 2-11: High speed shaft coupling data.

2.12 Yaw System

The yaw system is designed to keep the turbine upwind. The nacelle is mounted on the yaw plate, which is bolted to the turbine tower. The yaw bearing system is a plain bearing system with built-in friction. Asynchronous yaw motors with brakes enable the nacelle to rotate on top of the tower.

The turbine controller receives information of the wind direction from the wind sensor. Automatic yawing is deactivated when the mean wind speed is below 3 m/s.

Yaw System	
Type	Plain bearing system with built-in friction
Material	Forged yaw ring heat-treated Plain bearings PETP
Yawing Speed	< 0.5˚/sec.

Table 2-12: Yaw system data.

Yaw Gear	
Type	Non-locking combined worm gear and planetary gearbox Electrical motor brake
Motor	1.5 kW, 6 pole, asynchronous
Number of Yaw Gears	6
Ratio Total (4 Planetary Stages)	1,120: 1
Rotational Speed at Full Load	Approximately 1 rpm at output shaft

Table 2-13: Yaw gear data.

2.13 Crane

The nacelle houses the service crane. The crane is a single system chain hoist.

Crane	
Lifting Capacity	Max. 800 kg

Table 2-14: Crane data.

2.14 Tower Structure

Tubular towers with flange connections, certified according to relevant type approvals, are available in different standard heights. Magnets provide load support in a horizontal direction for tower internals, such as platforms, ladders, etc. Tower internals are supported vertically (i.e. in the gravitational direction) by a mechanical connection.

The hub heights listed include a distance from the foundation section to the ground level of approximately 0.6 m depending on the thickness of the bottom flange and a distance from the tower top flange to the centre of the hub of 1.70 m.

Tower Structure	
Type Description	Conical tubular
Hub Heights (HH)	80 m/95 m
Material	S355 according to EN 10024 A709 according to ASTM
Weight	80 m IEC S 160 metric tonnes* 95 m IEC S 205 metric tonnes**

Table 2-15: Tower structure (Onshore) data.

NOTE */** Typical values. Dependent on wind class, and can vary with site / project conditions.

2.15 Nacelle Bedplate and Cover

The nacelle cover is made of fibre glass. Hatches are positioned in the floor for lowering or hoisting equipment to the nacelle and evacuation of personnel.

The roof is equipped with wind sensors and skylights which can be opened from inside the nacelle to access the roof and from outside to access the nacelle. The nacelle cover is mounted on the girder structure. Access from the tower to the nacelle is through the yaw system.

The nacelle bedplate is in two parts and consists of a cast iron front part and a girder structure rear part. The front of the nacelle bedplate is the foundation for the drive train, which transmits forces from the rotor to the tower, through the yaw system. The bottom surface is machined and connected to the yaw bearing and the yaw-gears are bolted to the front nacelle bedplate.

The nacelle bedplate carries the crane girders through vertical beams positioned along the site of the nacelle. Lower beams of the girder structure are connected at the rear end.

The rear part of the bedplate serves as foundation for controller panels, generator and transformer.

Type Description	Material
Nacelle Cover	GRP
Base Frame Front	Cast iron EN GJS 400-18U-LT / EN1560
Base Frame Rear	Welded grid structure

Table 2-16: Nacelle base-frame and cover data.

2.16 Cooling

The cooling of the main components (gearbox, hydraulic power pack and VCUS converter) in the turbine is done by a water cooling system. The generator is air cooled by nacelle air and the high voltage (HV) transformer is cooled by mainly ambient air.

Component	Cooling Type	Internal Heating at Low temperature
Nacelle	Forced air	Yes
Hub/spinner	Natural air	No (Yes Low Temperature (LT) turbine)
Gearbox	Water/oil	Yes
Generator	Forced air/air	No (heat source)
Slip rings	Forced air/air	Yes
Transformer	Forced air	No (heat source)
VCUS	Forced water/air	Yes
VMP section	Forced air/air	Yes
Hydraulics	Water/oil	Yes

Table 2-17: Cooling, summary.

All other heat generating systems are also equipped with fans and or coolers but are considered as minor contributors to nacelle thermodynamics.

2.17 Water Cooling System

The water cooling system is designed as semi-closed systems (closed system but not under pressure) with a free wind water cooler on the roof of the nacelle. This means that the heat loss from the systems (components) is transferred to the water system and the water system is cooled by ambient air.

The water cooling system has three parallel cooling circuits that cool the gearbox, the hydraulic power unit and the VCUS converter.

The water cooling system is equipped with a 3-way thermostatic valve, which is closed (total water flow is bypassing the water cooler) if the temperature of the cooling water is below 35°C and fully open (total water flow is led to the water cooler) if the temperature is above 43°C.

2.18 Gearbox Cooling

The gearbox cooling system consists of two oil circuits that remove the gearbox losses through two plate heat exchangers (oil coolers). The first circuit is equipped with a mechanical driven oil pump and a plate heat exchanger and the second circuit is equipped with an electrical driven oil pump and a plate heat exchanger. The water circuit of the two plate heat exchangers are coupled in serial.

Gearbox Cooling	
Gear Oil Plate Heat Exchanger 1 (Mechanically driven oil pump)	
Nominal oil flow	50 l/min
Oil inlet temperature	80°C
No. of passes	2
Cooling capacity	24.5 kW
Gear Oil Plate Heat Exchanger 2 (Electrically driven oil pump)	
Nominal oil flow	85 l/min
Oil inlet temperature	80°C
No. of passes	2
Cooling capacity	41.5 kW
Water Circuit	
Nominal water flow	App. 150 l/min (50% glycol)
Water inlet temperature	Max. 54°C
No. of passes	1
Heat load	66 kW

Table 2-18: Cooling, gearbox data.

2.19 Hydraulic Cooling

The hydraulic cooling system consists of a plate heat exchanger which is mounted on the power pack. In the plate heat exchanger the heat from the hydraulics is transferred to the water cooling system.

Hydraulic Cooling	
Hydraulic Oil Plate Heat Exchanger	
Nominal oil flow	40 l/min
Oil inlet temperature	66°C
Cooling capacity	10.28 kW
Water Circuit	
Nominal water flow	App. 45 l/min (50% glycol)
Water inlet temperature	Max. 54°C
Heat load	10.28 kW

Table 2-19: Cooling, hydraulic data.

2.20 VCUS Converter Cooling

The converter cooling system consists of a number of switch modules which is mounted on cooling plates where the cooling water is lead through.

Converter Cooling	
Nominal water flow	Approximately 45 l/min (50% glycol)
Water inlet pressure	Maximum 2.0 bar
Water inlet temperature	Maximum 54ºC
Cooling capacity	10 kW

Table 2-20: Cooling, converter data.

2.21 Generator Cooling

The generator cooling systems consists of an air to air cooler mounted on the top of the generator and two internal and one external fan. All the fans can run at low or high speed.

Generator Cooling	
Air inlet temperature – external	50°C
Nominal air flow – internal	8000 m^3/h
Nominal air flow – external	7500 m^3/h
Cooling capacity	60 kW

Table 2-21: Cooling, generator data.

2.22 HV Transformer Cooling

The transformer is equipped with forced air cooling. The cooling system consists of a central fan, which is located under the service floor, an air distribution manifold and six hoses leading to locations beneath and between the HV and LV windings.

Transformer Cooling	
Nominal air flow	1920 m^3/h
Air inlet temperature	Maximum 40°C

Table 2-22: Cooling, transformer data.

2.23 Nacelle Conditioning

The nacelle conditioning system consists of one fan and two air heaters. There are two main circuits of the nacelle conditioning system:

1. Cooling of the HV transformer.
2. Heating and ventilation of the nacelle.

For both systems, the airflow enters the nacelle through louver dampers in the weather shield underneath the nacelle.

The cooling of the HV transformer is described in section 2.22 HV Transformer Cooling, p. 13.

The heating and ventilation of the nacelle is done by means of two air heaters and one fan. To avoid condensation in the nacelle, the two air heaters keep the nacelle temperature +5°C above the ambient temperature. At start-up in cold conditions, the heaters will also heat the air around the gearbox.
The ventilation of the nacelle is done by means of one fan, removing hot air from the nacelle, which is generated by mechanical and electrical equipment.

Nacelle Cooling	
Nominal air flow	1.2 m^3/s
Air inlet temperature	Maximum 50°C

Table 2-23: Cooling, nacelle data.

Nacelle Heating	
Rated power	2 x 6 kW

Table 2-24: Heating, nacelle data.

3 Electrical Design

3.1 Generator

The generator is a 3-phase asynchronous generator with wound rotor, which is connected to the Vestas Converter Unity System (VCUS) via a slip ring system. The generator is an air-to-air cooled generator with an internal and external cooling circuit. The external circuit uses air from the nacelle and exhausts it out through the rear end of the nacelle.

The generator has six poles. The generator is wound with form windings in both rotor and stator. The stator is connected in star at low power and delta at high power. The rotor is connected in star and is insulated from the shaft. A slip ring is mounted to the rotor for the purpose of the VCUS control.

Generator	
Type Description	Asynchronous with wound rotor, slip rings and VCUS
Rated Power (PN)	1.8 MW
Rated Apparent Power	1.8 MVA (Cosφ = 1.00)
Frequency	60 Hz
Voltage, Generator	690 Vac
Voltage, Converter	480 Vac
Number of Poles	6
Winding Type (Stator/Rotor)	Form/Form
Winding Connection, Stator	Star/Delta
Rated Efficiency (Generator only)	> 96.5%
Power Factor (cos)	1.0
Over Speed Limit acc. to IEC (2 min.)	2400 rpm
Vibration Level	≤ 1.8 mm/s
Weight	Approx. 8,100 kg
Generator Bearing - Temperature	2 PT100 sensors
Generator Stator Windings - Temperature	3 PT100 sensors placed at hot spots and 3 as back-up

Table 3-1: Generator data.

3.2 HV Cables

The high voltage cable runs from the transformer in the nacelle down the tower to the switchgear located in the bottom of the tower (switchgear is not included). The high voltage cable is a 4-core rubber insulated halogen free high voltage cable.

HV Cables	
High Voltage Cable Insulation Compound	Improved ethylene-propylene (EP) based material – EPR or high modulus or hard grade ethylene-propylene rubber – HEPR
Conductor Cross Section	3x70/70 mm^2
Rated Voltage	12/20 kV (24 kV) or 20/35 kV (42 kV) depending on the transformer voltage

Table 3-2: HV cables data.

3.3 Transformer

The transformer is located in a separate locked room in the nacelle with surge arresters mounted on the high voltage side of the transformer. The transformer is a two winding, three-phase dry-type transformer. The windings are delta-connected on the high voltage side unless otherwise specified.

The low voltage windings have a voltage of 690 V and a tapping at 480 V and are star-connected. The 690 V and 480 V systems in the nacelle are a TN-system, which means the star point is connected to earth.

Transformer	
Type Description	Dry-type cast resin
Primary Voltage	6-34.5 kV
Rated Apparent Power	2100 kVA
Secondary Voltage 1	690 V
Rated Power 1 at 690 V	1,900 kVA
Secondary Voltage 2	480 V
Rated Power 2 at 480 V	200 kVA
Vector Group	Dyn5 (option YNyn0)
Frequency	60 Hz
HV-tappings	±2 x 2.5% offload
Insulation Class	F
Climate Class	C2
Environmental Class	E2
Fire Behaviour Class	F1

Table 3-3: Transformer data.

3.4 Converter

The converter controls the energy conversion in the generator. The VCUS converter feeds power from the grid into the generator rotor at sub sync speed and feeds power from the generator rotor to the grid at super sync speed.

Converter	
Rated Slip	12%
Rated RPM	1344 RPM
Rated Rotor Power (@rated slip)	193 kW
Rated Grid Current (@ rated slip, PF = 1 & 480V)	232 A
Rated Rotor Current (@ rated slip & PF = 1)	573 A

Table 3-4: Converter data.

3.5 AUX System

The AUX System is supplied from the 690/480 V socket from the HV transformer. All motors, pumps, fans and heaters are supplied from this system.

All 110 V power sockets are supplied from a 690/110 V transformer.

Power Sockets	
Single Phase	110 V (20 A)
Three Phase	690 V Crane (16 A)

Table 3-5: AUX system data.

3.6 Wind Sensors

The turbine is equipped with two ultrasonic wind sensors with built-in heaters.

Wind Sensors	
Type	FT702LT
Principle	Acoustic Resonance
Built-in Heat	99 W

Table 3-6: Wind sensor data.

3.7 Turbine Controller

The turbine is controlled and monitored by the System 3500 controller hardware and Vestas controller software.

The turbine controller is based on four main processors (Ground, Nacelle, Hub and Converter) which are interconnected by an optical-based 2.5 Mbit ArcNet network.

I/O modules are connected either as rack modules in the System 3500 rack or by CAN.

The turbine control system serves the following main functions:

- Monitoring and supervision of overall operation.
- Synchronizing of the generator to the grid during connection sequence in order to limit the inrush current.
- Operating the wind turbine during various fault situations.
- Automatic yawing of the nacelle.
- OptiTip® - blade pitch control.
- Noise emission control.
- Monitoring of ambient conditions.
- Monitoring of the grid.

The turbine controller hardware is built from the following main modules:

Module	Function	Network
CT3603	Main processor. Control and monitoring (nacelle and hub).	ArcNet, CAN, Ethernet, seriel
CT396	Main processor. Control, monitoring, external communication (ground).	ArcNet, CAN, Ethernet, seriel
CT360	Main processor. Converter control and monitoring.	ArcNet, CAN, Ethernet
CT3218	Counter/encoder module. RPM, Azimuth and wind measurement.	Rack module
CT3133	24 VDC digital input module. 16 channels.	Rack module
CT3153	24 VDC digital output module. 16 channels.	Rack module
CT3320	4 channel analogue input (0-10V, 4-20mA, PT100).	Rack module
CT6061	CAN I/O controller	CAN node
CT6221	3 channel PT100 module	CAN I/O module
CT6050	Blade controller.	CAN node
Balluff	Position transducer	CAN node
Rexroth	Proportional valve	CAN node

Table 3-7: Turbine controller hardware.

3.8 Uninterruptible Power Supply (UPS)

The UPS supplies power to critical wind turbine components.

The actual back up time for the UPS system is proportional to the power consumption. Actual back-up time may vary.

UPS		
Battery Type	Valve-Regulated Lead Acid (VRLA)	
Rated Battery Voltage	2 x 8 x 12 V (192 V)	
Converter Type	Double conversion online	
Rated Output Voltage	230 V AC	
Rated Output Voltage	230 V AC	
Converter Input	230 V ±20%	
Back-up Time*	Controller system	30 seconds
	Safety systems	35 minutes
Re-charging Time	Typical	Approx. 2.5 hours

Table 3-8: UPS data.

NOTE * For alternative back-up times, consult Vestas!

4 Turbine Protection Systems

4.1 Braking Concept

The main brake on the turbine is aerodynamic. Braking the turbine is done by feathering the three blades. During emergency stop all three blades will feather simultaneously to full end stop and thereby slowing the rotor speed.

In addition there is a mechanical disc brake on the high speed shaft of the gearbox. The mechanical brake is only used as a parking brake, and when activating the emergency stop push buttons.

4.2 Short Circuit Protections

Breakers	**Generator / Q8** **ABB E2B 2000** **690 V**	**Controller / Q15** **ABB S3X** **690 V**	**VCS-VCUS / Q7** **ABB S5H 400** **480 V**
Breaking Capacity I_{cu}, I_{cs}	42, 42 kA	75, 75 kA	40, 40 kA
Making Capacity I_{cm} **(415V Data)**	88 kA	440 kA	143 kA
Thermo Release I_{th}	2000 A	100 A	400 A

Table 4-1: Short circuit protection data.

4.3 Overspeed Protection

The generator RPM and the main shaft RPM are registered by inductive sensors and calculated by the wind turbine controller in order to protect against over-speed and rotating errors.

The turbine is also equipped with a VOG (Vestas Overspeed Guard), which is an independent computer module measuring the rotor RPM, and in case of an overspeed situation the VOG activates the emergency feathered position (full feathering) of the three blades.

Overspeed Protection	
VOG Sensors Type	Inductive
Trip Levels	17.3 (Rotor RPM) / 1597 (Generator RPM)

Table 4-2: Overspeed protection data.

4.4 EMC System

The turbine and related equipment must fulfil the EU EMC-Directive with later amendments:

- Council Directive 2004/108/EC of 15 December 2004 on the approximation of the laws of the Member States relating to Electromagnetic Compatibility.
- The (Electromagnetic Compatibility) EMC-Directive with later amendments.

4.5 Lightning System

The Lightning Protection System (LPS) consists of three main parts.

- Lightning receptors.
- Down conducting system.
- Earthing System.

Lightning Protection Design Parameters			**Protection Level I**
Current Peak Value	i_{max}	[kA]	200
Total Charge	Q_{total}	[C]	300
Specific Energy	W/R	[MJ/Ω]	10
Average Steepness	di/dt	[kA/µs]	200

Table 4-3: Lightning design parameters.

NOTE The Lightning Protection System is designed according to IEC standards (see section 7.7 Design Codes – Lightning Protection, p. 27). Lightning strikes are considered force majeure, i.e. damage caused by lightning strikes is not warranted by Vestas.

4.6 Earthing (also known as grounding)

The Vestas Earthing System is based on foundation earthing.

Vestas document no. 0000-3388 contains the list of documents regarding Vestas Earthing System.

Requirements in the Vestas Earthing System specifications and work descriptions are minimum requirements from Vestas and IEC. Local and national requirements may require additional measures.

4.7 Corrosion Protection

Classification of corrosion categories for atmospheric corrosion is according to ISO 9223:1992.

Corrosion Protection	External Areas	Internal Areas
Nacelle	C5	C3 and C4 Climate strategy: Heating the air inside the nacelle compared to the outside air temperature lowers the relative humidity and helps ensure a controlled corrosion level.
Hub	C5	C3
Tower	C5-I	C3

Table 4-4: Corrosion protection data for nacelle, hub and tower.

5 Safety

The safety specifications in this safety section provide limited general information about the safety features of the turbine and are not a substitute for Buyer and its agents taking all appropriate safety precautions, including but not limited to (a) complying with all applicable safety, operation, maintenance, and service agreements, instructions, and requirements, (b) complying with all safety-related laws, regulations, and ordinances, (c) conducting all appropriate safety training and education and (d) reading and understanding all safety-related manuals and instructions. See section 5.13 Manuals and Warnings, p. 23 for additional guidance.

5.1 Access

Access to the turbine from the outside is through the bottom of the tower. The door is equipped with a lock. Access to the top platform in the tower is by a ladder or service lift. Access to the nacelle from the top platform is by ladder. Access to the transformer room in the nacelle is equipped with a lock. Unauthorised access to electrical switch boards and power panels in the turbine is prohibited according to IEC 60204-1 2006.

5.2 Escape

In addition to the normal access routes, alternative escape routes from the nacelle are through the crane hatch.

The hatch in the roof can be opened from both the inside and outside.

Escape from the service lift is by ladder.

5.3 Rooms/Working Areas

The tower and nacelle are equipped with connection points for electrical tools for service and maintenance of the turbine.

5.4 Platforms, Standing and Working Places

The bottom tower section has three platforms. There is one platform at the entrance level (door level), one safety platform approximately three metres above the entrance platform and finally a platform in the top of the tower section.

Each middle tower section has one platform in the top of the tower section.

The top tower section has two platforms. A top platform and a service lift platform - where the service lift stops - below the top platform.

There are places to stand at various locations along the ladder.

The platforms have anti-slip surfaces.

Foot supports are placed in the turbine for maintenance and service purposes.

5.5 Climbing Facilities

A ladder with a fall arrest system (rigid rail or wire system) is mounted through the tower.

Rest platforms are provided at maximum intervals of 9 metres along the tower ladder between platforms.

There are anchorage points in the tower, nacelle, hub and on the roof for attaching a fall arrest equipment (full body harness).

Over the crane hatch there is an anchorage point for the emergency descent equipment. The anchorage point is tested to 22.2 kN.

Anchorage points are coloured yellow and are calculated and tested to 22.2 kN.

5.6 Moving Parts, Guards and Blocking Devices

Moving parts in the nacelle are shielded.

The turbine is equipped with a rotor lock to block the rotor and drive train.

It is possible to block the pitch of the cylinder with mechanical tools in the hub.

5.7 Lighting

The turbine is equipped with light in the tower, nacelle and in the hub.

There is emergency light in case of loss of electrical power.

5.8 Noise

When the turbine is out of operation for maintenance, the sound level in the nacelle is below 80 dB(A). In operation mode ear protection is required.

5.9 Emergency Stop

There are emergency stops in the nacelle and in the bottom of the tower.

5.10 Power Disconnection

The turbine is designed to allow for disconnection from all its power sources during inspection or maintenance. The switches are marked with signs and are located in the nacelle and in the bottom of the tower.

5.11 Fire Protection/First Aid

A 5 kg CO_2 fire extinguisher must be located in the nacelle at the left yaw gear. The location of the fire extinguisher, and how to use it, must be confirmed before operating the turbine.

A first aid kit must be placed by the wall at the back end of the nacelle. The location of the first aid kit, and how to use it, must be confirmed before operating the turbine.

Above the generator there must be a fire blanket which can be used to put out small fires.

5.12 Warning Signs

Additional warning signs inside or on the turbine must be reviewed before operating or servicing of the turbine.

5.13 Manuals and Warnings

Vestas OH&S manual and manuals for operation, maintenance and service of the turbine provide additional safety rules and information for operating, servicing or maintaining the turbine.

6 Environment

6.1 Chemicals

Chemicals used in the turbine are evaluated according to Vestas Wind Systems A/S Environmental system certified according to ISO 14001:2004.

- Anti-freeze liquid to help prevent the cooling system from freezing.
- Gear oil for lubricating the gearbox.
- Hydraulic oil to pitch the blades and operate the brake.
- Grease to lubricate bearings.
- Various cleaning agents and chemicals for maintenance of the turbine.

7 Approvals, Certificates and Design Codes

7.1 Type Approvals

The turbine is type certified according to the certification standards listed below:

Certification	Wind Class	Hub Height
Type Certificate after IEC WT01 and IEC 61400-1:2005	IEC S*	80 m
	IEC S*	95 m

**Refer to section 9.1 Climate and Site Conditions, p. 28 for details.*

Table 7-1: Type approvals.

7.2 Design Codes – Structural Design

The structural design has been developed and tested with regard to, but not limited to, the following main standards.

Design Codes – Structural Design	
Nacelle and Hub	IEC 61400-1:2005 EN 50308 ANSI/ASSE Z359.1-2007
Bedframe	IEC 61400-1:2005
Tower	IEC 61400-1:2005 Eurocode 3 DIBt: Richtlinie für Windenergieanlagen, Einwirkungen und Standsicherheitsnachweise für Turm und Gründung, 4th edition.

Table 7-2: Structural design codes.

7.3 Design Codes – Mechanical Equipment

The mechanical equipment has been developed and tested with regard to, but not limited to, the following main standards:

Design Codes – Mechanical Equipment	
Gear	Designed in accordance to rules in ISO 81400-4
Blades	DNV-OS-J102 IEC 1024-1 IEC 60721-2-4 IEC 61400 (Part 1, 12 and 23) IEC WT 01 IEC DEFU R25 ISO 2813 DS/EN ISO 12944-2

Table 7-3: Mechanical equipment design codes.

7.4 Design Codes – Electrical Equipment

The electrical equipment has been developed and tested with regard to, but not limited to, the following main standards:

Design Codes – Electrical Equipment	
High Voltage AC Circuit Breakers	IEC 60056
High Voltage Testing Techniques	IEC 60060
Power Capacitors	IEC 60831
Insulating Bushings for AC Voltage above 1kV	IEC 60137
Insulation Co-ordination	BS EN 60071
AC Disconnectors and Earth Switches	BS EN 60129
Current Transformers	IEC 60185
Voltage Transformers	IEC 60186
High Voltage Switches	IEC 60265
Disconnectors and Fuses	IEC 60269
Flame Retardant Standard for MV Cables	IEC 60332
Transformer	IEC 60076-11
Generator	IEC 60034
Specification for Sulphur Hexafluoride for Electrical Equipment	IEC 60376
Rotating Electrical Machines	IEC 34

Design Codes – Electrical Equipment	
Dimensions and Output Ratings for Rotating Electrical Machines	IEC 72 & IEC 72A
Classification of Insulation, Materials for Electrical Machinery	IEC 85
Safety of Machinery – Electrical Equipment of Machines	IEC 60204-1

Table 7-4: Electrical equipment design codes.

7.5 Design Codes – I/O Network System

The distributed I/O network system has been developed and tested with regard to, but not limited to, the following main standards:

Design Codes – I/O Network System	
Salt Mist Test	IEC 60068-2-52
Damp Head, Cyclic	IEC 60068-2-30
Vibration Sinus	IEC 60068-2-6
Cold	IEC 60068-2-1
Enclosure	IEC 60529
Damp Head, Steady State	IEC 60068-2-56
Vibration Random	IEC 60068-2-64
Dry Heat	IEC 60068-2-2
Temperature Shock	IEC 60068-2-14
Free Fall	IEC 60068-2-32

Table 7-5: I/O Network system design codes.

7.6 Design Codes – EMC System

To fulfil EMC requirements the design must be as recommended for lightning protection, see section 7.7 Design Codes – Lightning Protection, p. 27.

Design Codes – EMC System	
Designed according to	IEC 61400-1: 2005
Further robustness requirements according to	TPS 901785

Table 7-6: EMC system design codes.

7.7 Design Codes – Lightning Protection

The LPS is designed according to Lightning Protection Level (LPL) I:

Design Codes – Lightning Protection	
Designed according to	IEC 62305-1: 2006 IEC 62305-3: 2006 IEC 62305-4: 2006
Non Harmonized Standard and Technically Normative Documents	IEC/TR 61400-24:2002

Table 7-7: Lightning protection design codes.

7.8 Design Codes – Earthing

The Vestas Earthing System design is based on and complies with the following international standards and guidelines:

- IEC 62305-1 Ed. 1.0: Protection against lightning – Part 1: General principles.
- IEC 62305-3 Ed. 1.0: Protection against lightning – Part 3: Physical damage to structures and life hazard.
- IEC 62305-4 Ed. 1.0: Protection against lightning – Part 4: Electrical and electronic systems within structures.
- IEC/TR 61400-24. First edition. 2002-07. Wind turbine generator systems - Part 24: Lightning protection.
- IEC 60364-5-54. Second edition 2002-06. Electrical installations of buildings - Part 5-54: Selection and erection of electrical equipment – Earthing arrangements, protective conductors and protective bonding conductors.
- IEC 61936-1. First edition. 2002-10. Power installations exceeding 1kV a.c.- Part 1: Common rules.

8 Colour and Surface Treatment

8.1 Nacelle Colour and Surface Treatment

Surface Treatment of Vestas Nacelles	
Standard Nacelle Colours	RAL 7035 (light grey)
Gloss	According to ISO 2813

Table 8-1: Surface treatment, nacelle.

8.2 Tower Colour and Surface Treatment

Surface Treatment of Vestas Tower Section		
	External:	**Internal:**
Tower Colour Variants	RAL 7035 (light grey)	RAL 9001 (cream white)
Gloss	50-75% UV resistant	Maximum 50%

Table 8-2: Surface treatment, tower.

8.3 Blades Colour

Blades Colour	
Blade Colour	RAL 7035 (Light Grey)
Tip-End Colour Variants	RAL 2009 (Traffic Orange), RAL 3000 (Flame Red), RAL 3020 (Traffic Red)
Gloss	< 20%

Table 8-3: Colours, blades.

9 Operational Envelope and Performance Guidelines

Actual climatic and site conditions have many variables and must be considered in evaluating actual turbine performance. The design and operating parameters set forth in this section do not constitute warranties, guarantees, or representations as to turbine performance at actual sites.

NOTE As evaluation of climate and site conditions is complex, it is needed to consult Vestas for every project.

9.1 Climate and Site Conditions

Values refer to hub height:

Extreme Design Parameters	
Wind Climate	**IEC S**
Ambient Temperature Interval (Normal Temperature Turbine)	-30° to +50°C
Extreme Wind Speed (10 min. average)	42.5 m/s
Survival Wind Speed (3 sec. gust)	59.5 m/s

Table 9-1: Extreme design parameters.

Average Design Parameters	
Wind Climate	**IEC S**
Wind Speed	7.5 m/s
A-factor	8.45 m/s
Form Factor, c	2.0
Turbulence Intensity acc. to IEC 61400-1, including Wind Farm Turbulence (@15 m/s – 90% quantile)	18%
Wind Shear	0.20
Inflow Angle (vertical)	8°

Table 9-2: Average design parameters.

9.1.1 Complex Terrain

Classification of complex terrain acc. to IEC 61400-1:2005 Chapter 11.2.

For sites classified as complex appropriate measures are to be included in site assessment.

9.1.2 Altitude

The turbine is designed for use at altitudes up to 1500 m above sea level as standard.

Above 1500 m special considerations must be taken regarding e.g. HV installations and cooling performance. Consult Vestas for further information.

9.1.3 Wind Farm Layout

Turbine spacing is to be evaluated site-specifically. Spacing in any case not below three rotor diameters (3D).

DISCLAIMER

As evaluation of climate and site conditions is complex, consult Vestas for every project. If conditions exceed the above parameters Vestas must be consulted!

9.2 Operational Envelope – Temperature and Wind

Values refer to hub height and as determined by the sensors and control system of the turbine.

Operational Envelope – Temperature and Wind	
Ambient Temperature Interval (Normal Temperature Turbine)	-20° to +40° C
Cut-in (10 min. average)	3 m/s
Cut-out (100 sec. exponential average)	20 m/s
Re-cut in (100 sec. exponential average)	18 m/s

Table 9-3: Operational envelope - temperature and wind.

9.3 Operational Envelope – Grid Connection *

Values refer to hub height and as determined by the sensors and control system of the turbine.

Operational Envelope - Grid Connection		
Nominal Phase Voltage	$U_{P, nom}$	400 V
Nominal Frequency	f_{nom}	60 Hz
Max. Steady State Voltage Jump	±2%	
Max. Frequency Gradient	±4 Hz/sec	
Max. Negative Sequence Voltage	3%	

Table 9-4: Operational envelope - grid connection.

The generator and the converter will be disconnected if:

	U_P	**U_N**
Voltage above 110% of nominal for 60 sec.	440 V	759 V
Voltage above 115% of nominal for 2 sec.	460 V	794 V
Voltage above 120% of nominal for 0.08 sec.	480 V	828 V
Voltage above 125% of nominal for 0.005 sec	500 V	863 V
Voltage below 90% of nominal for 60 sec.	360 V	621 V
Voltage below 85% of nominal for 11 sec.	340 V	586 V
Frequency is above [Hz] for 0.2 sec.	63.6 Hz	
Frequency is below [Hz] for 0.2 sec.	56.4 Hz	

Table 9-5: Generator and converter disconnecting values.

NOTE * Over the turbine lifetime, grid drop-outs are to occur at an average of no more than 50 times a year.

9.4 Performance – Fault Ride Through

The turbine is equipped with a reinforced Vestas Converter System in order to gain better control of the generator during grid faults. The controllers and contactors have a UPS backup system in order to keep the turbine control system running during grid faults.

The pitch system is optimised to keep the turbine within normal speed conditions and the generator speed is accelerated in order to store rotational energy and be able to resume normal power production faster after a fault and keep mechanical stress on the turbine at a minimum.

The turbine is designed to stay connected during grid disturbances within the voltage tolerance curve in Figure 9-1, p. 31.

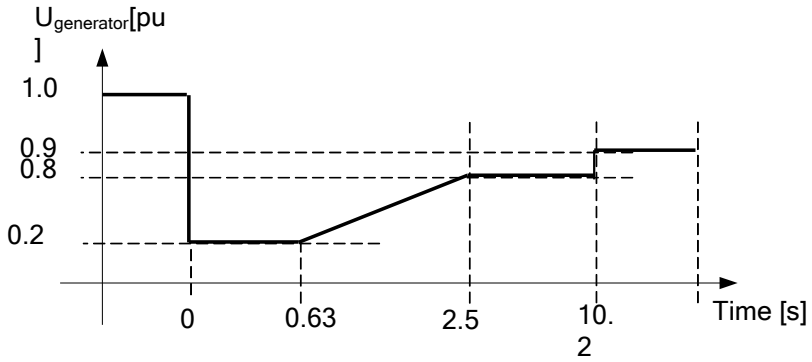


Figure 9-1: Low voltage tolerance curve for symmetrical and asymmetrical faults.

For grid disturbances outside the protection curve in Figure 9-2, p. 31, the turbine will be disconnected from the grid.

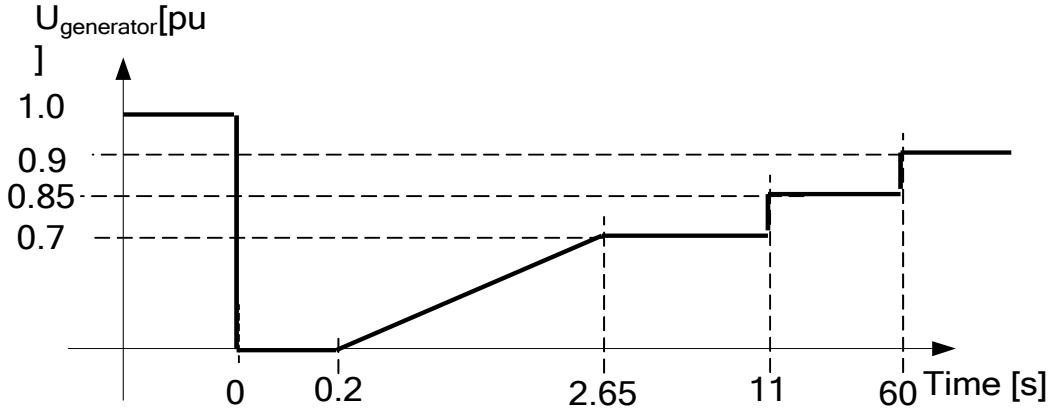


Figure 9-2: Default low voltage protection settings for symmetrical and asymmetrical faults.

Power Recovery Time	
Power recovery to 90% of pre-fault level	Max 1.0 sec

9.5 Current Contribution

During the grid dip the generator is typical magnetized from the converter. The controller setpoints are set to keep the reactive current exchange with the grid close to zero and keep as much torque on the generator as possible.

9.6 Performance – Multiple Voltage Dips

The turbine is designed to handle re-closure events and multiple voltage dips within a short period of time, due to the fact that voltage dips are not evenly distributed during the year. As an example 6 voltage dips of duration of 200 ms down to 20% voltage within 30 minutes will normally not lead to a problem for the turbine.

9.7 Performance – Active Power Control

The turbine is designed for control of active power via the VestasOnline™ SCADA system.

Max. Ramp Rates for External Control	
Active Power	0.1 pu/sec

To protect the turbine active power cannot be controlled to values below the curve in Figure 9-3, p. 32.

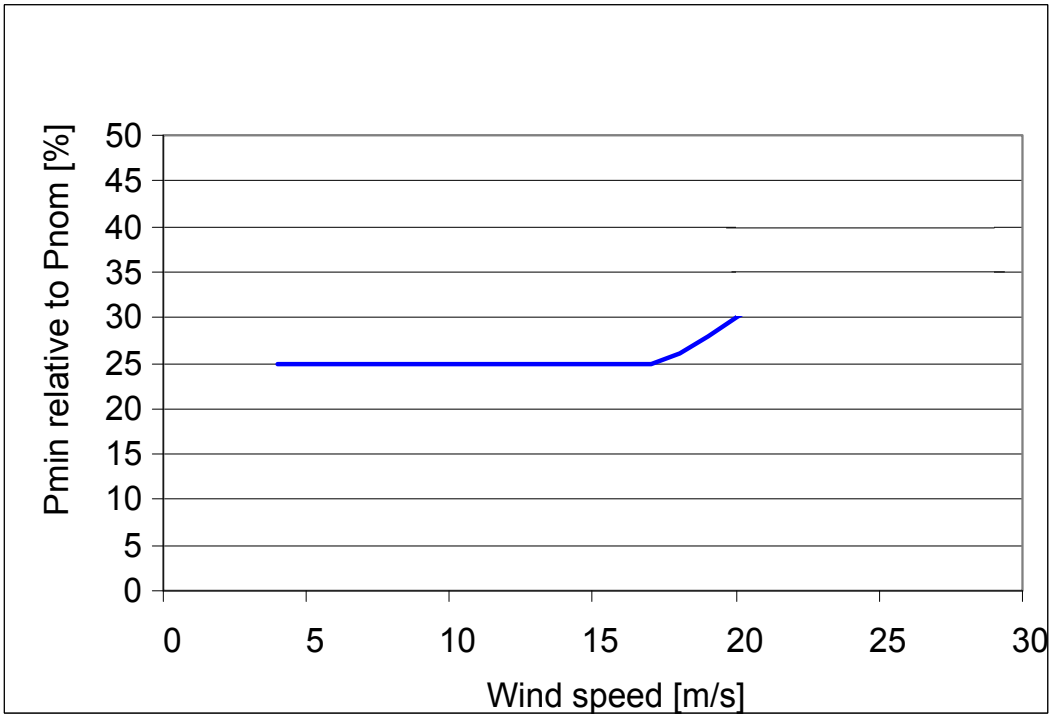


Figure 9-3: Minimum active power output dependant of wind speed.

9.8 Performance – Frequency Control

The turbine can be configured to perform frequency control by decreasing the output power as a linear function of the grid frequency (over frequency).

Dead band and slope for the frequency control function are configurable.

9.9 Performance – Own Consumption

The consumption of electrical power by the wind turbine is defined as consumption when the wind turbine is not producing energy (generator is not connected to the grid). This is defined in the control system as Production Generator (zero).

The following components have the largest influence on the power consumption of the wind turbine:

Own Consumption	
Hydraulic Motor	20 kW
Yaw Motors 6 x 1.75 kW	10.5 kW
Oil Heating 3 x 0.76 kW	2.3 kW
Air Heaters 2 x 6 kW (std) **3 x 6 kW (LT)**	12 kW (Standard) 18 kW (Low Temperature)
Oil Pump for Gearbox Lubrication	3.5 kW
HV Transformer located in the nacelle has a no-load loss of	Max. 3.9 kW

Table 9-6: Own consumption data.

9.10 Operational Envelope Conditions for Power Curve, C_t Values (at Hub Height)

See appendix section 12.1 Mode 0, p. 37, 12.2 Mode 1, p. 41 and 12.3 Mode 2, p. 45 for power curve, C_t values and noise level.

Conditions for Power Curve, C_t Values (at Hub Height)	
Wind Shear	0.10 - 0.16 (10 min. average)
Turbulence Intensity	8 - 12% (10 min. average)
Blades	Clean
Rain	No
Ice/Snow on Blades	No
Leading Edge	No damage
Terrain	IEC 61400-12-1
Inflow Angle (Vertical)	0 ± 2 °
Grid Frequency	60 ± 0.5 Hz

Table 9-7: Conditions for power curve, C_t values.

10 Drawings

10.1 Structural Design – Illustration of Outer Dimensions

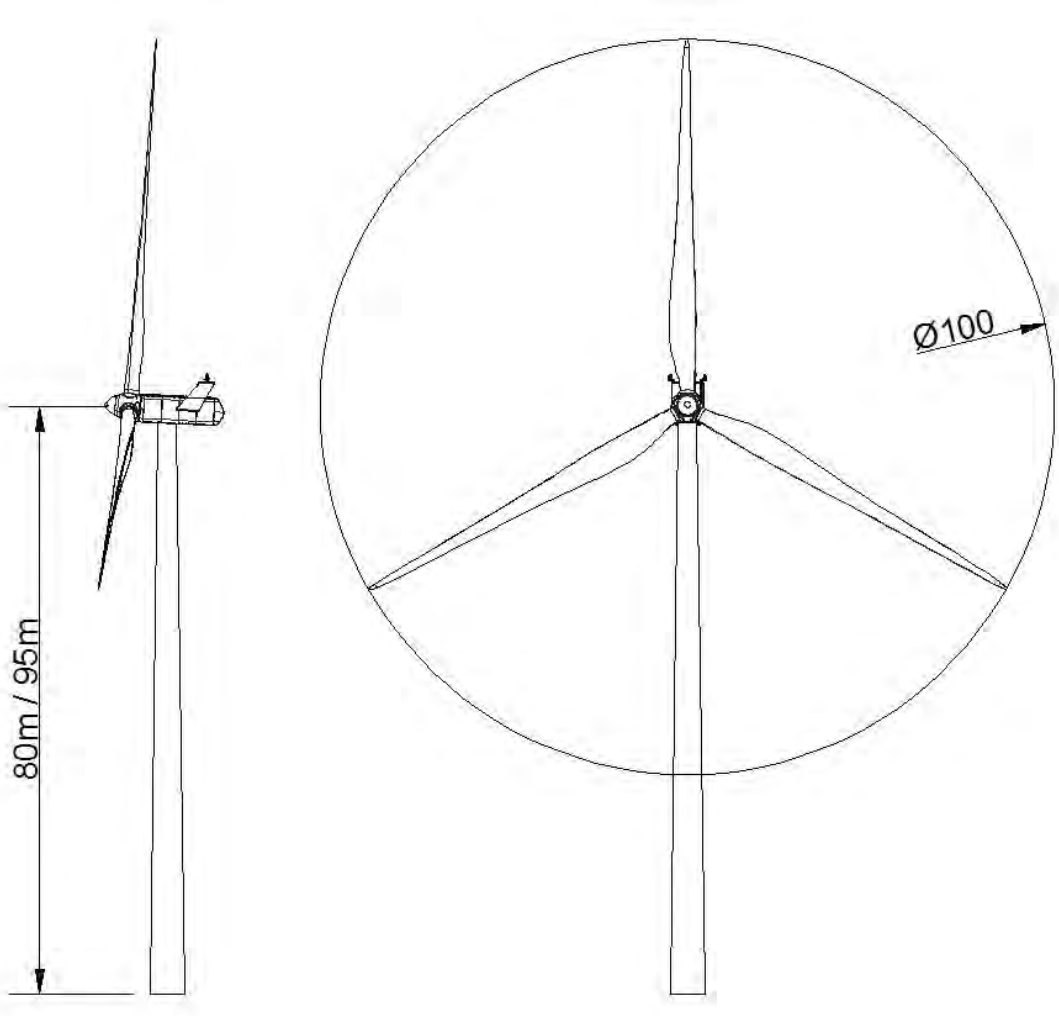


Figure 10-1: Illustration of outer dimensions – structure.

10.2 Structural Design – Side View Drawing

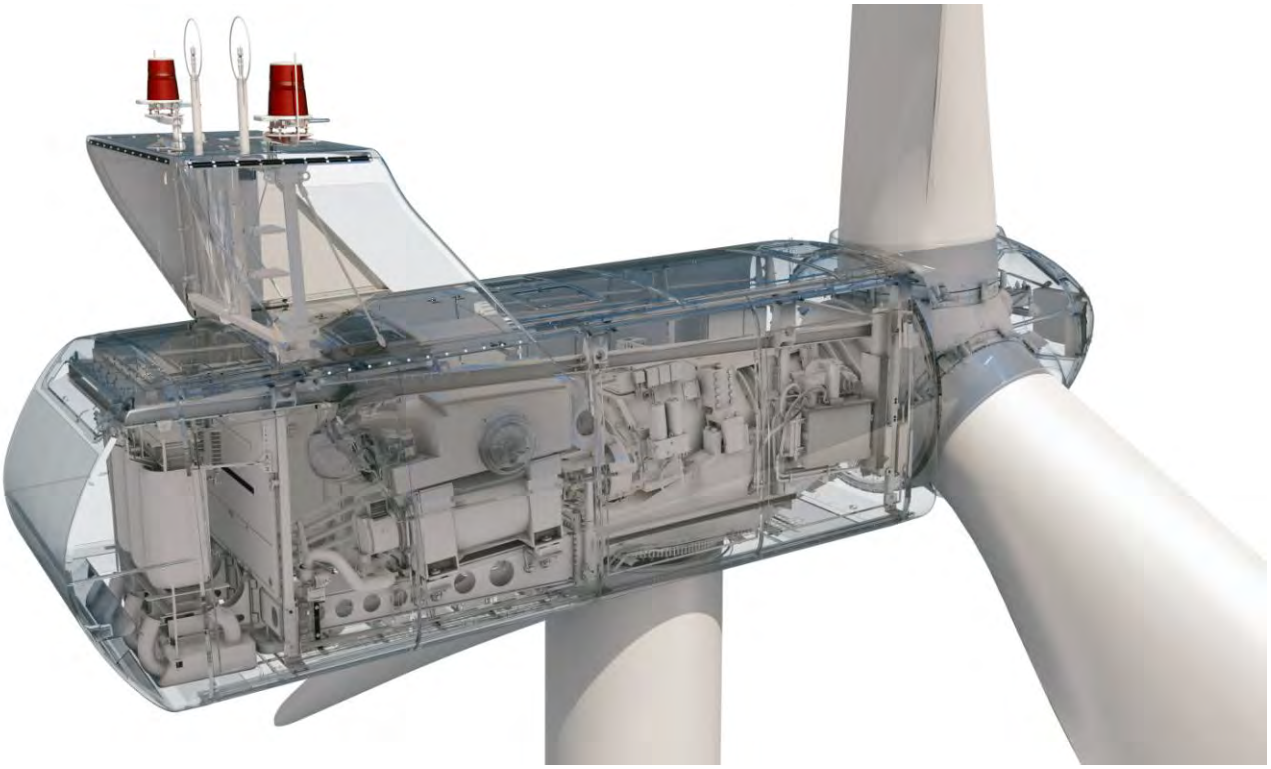


Figure 10-2: Side view drawing.

11 General Reservations, Notes and Disclaimers

- These general specifications apply to the current version of the V100 wind turbine. Updated versions of the V100 wind turbine, which may be manufactured in the future, may have general specifications that differ from these general specifications. In the event that Vestas supplies an updated version of the V100 wind turbine, Vestas will provide updated general specifications applicable to the updated version.
- Periodic operational disturbances and generator power de-rating may be caused by combination of high winds, low voltage or high temperature.
- Vestas recommends that the grid be as close to nominal as possible with little variation in frequency.
- A certain time allowance for turbine warm-up must be expected following grid dropout and/or periods of very low ambient temperature.
- The estimated power curve for the different estimated noise levels (sound power levels) is for wind speeds at 10 minute average value at hub height and perpendicular to the rotor plane.
- All listed start/stop parameters (e. g. wind speeds and temperatures) are equipped with hysteresis control. This can, in certain borderline situations, result in turbine stops even though the ambient conditions are within the listed operation parameters.
- The earthing system must comply with the minimum requirements from Vestas, and be in accordance with local and national requirements, and codes of standards.
- Lightning strikes are considered force majeure, i.e. damage caused by lightning strikes is not warranted by Vestas.
- For the avoidance of doubt, this document ‘General Specifications’ is not, and does not contain, any guarantee, warranty and/or verification of the power curve and noise (including, without limitation, the power curve and noise verification method). Any guarantee, warranty and/or verification of the power curve and noise (including, without limitation, the power curve and noise verification method) must be agreed to separately in writing.

12 Appendices

Power Curve, C_t values and Sound Power Levels for Mode 0 to 2 are defined below.

12.1 Mode 0

12.1.1 Mode 0, Power Curve

Mode 0, Power curve														
	Air density kg/m^3													
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3	**13**	9	9	9	10	10	11	11	11	12	12	13	14	15
3.5	**53**	34	36	38	39	41	43	45	46	48	50	52	55	57
4	**112**	80	83	86	89	92	95	98	101	104	106	109	115	118
4.5	**181**	136	140	144	148	152	156	160	165	169	173	177	185	189
5	**260**	198	203	209	215	220	226	232	237	243	248	254	265	271
5.5	**353**	270	278	285	293	300	308	315	323	330	338	345	360	368
6	**462**	356	365	375	385	395	404	414	424	433	443	453	472	481
6.5	**581**	443	455	468	481	493	506	518	531	544	556	569	594	606
7	**736**	563	579	595	611	626	642	658	673	689	705	720	751	767
7.5	**911**	700	720	739	758	777	796	816	835	854	873	892	930	949
8	**1108**	856	879	902	925	948	971	994	1017	1040	1063	1086	1131	1153
8.5	**1321**	1028	1055	1082	1110	1137	1163	1190	1216	1243	1269	1295	1347	1372
9	**1524**	1212	1243	1273	1304	1335	1363	1392	1421	1449	1474	1499	1547	1570
9.5	**1679**	1397	1429	1460	1491	1522	1547	1572	1597	1622	1641	1660	1695	1710
10	**1766**	1566	1591	1616	1641	1666	1682	1699	1716	1733	1744	1755	1773	1780
10.5	**1800**	1689	1705	1721	1737	1753	1762	1770	1779	1788	1792	1796	1802	1804
11	**1811**	1764	1772	1779	1786	1794	1797	1800	1803	1807	1808	1809	1812	1813
11.5	**1815**	1796	1799	1802	1805	1808	1809	1811	1812	1813	1814	1814	1815	1815
12	**1815**	1808	1810	1811	1812	1814	1814	1814	1815	1815	1815	1815	1815	1815
12.5	**1815**	1813	1814	1814	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
13	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
13.5	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
14	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
14.5	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
15	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
15.5	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
16	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815

Mode 0, Power curve														
	Air density kg/m^3													
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
16.5	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
17	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
17.5	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
18	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
18.5	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
19	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
19.5	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
20	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815

Table 12-1: Mode 0, power curve.

12.1.2 Mode 0, C_t values

Mode 0, C_t values														
	Air density kg/m^3													
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3	**0.874**	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874
3.5	**0.891**	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
4	**0.877**	0.877	0.877	0.877	0.877	0.877	0.877	0.877	0.877	0.877	0.877	0.877	0.877	0.877
4.5	**0.847**	0.847	0.847	0.847	0.847	0.847	0.847	0.847	0.847	0.847	0.847	0.847	0.847	0.847
5	**0.820**	0.820	0.820	0.820	0.820	0.820	0.820	0.820	0.820	0.820	0.820	0.820	0.820	0.820
5.5	**0.806**	0.806	0.806	0.806	0.806	0.806	0.806	0.806	0.806	0.806	0.806	0.806	0.806	0.806
6	**0.802**	0.802	0.802	0.802	0.802	0.802	0.802	0.802	0.802	0.802	0.802	0.802	0.802	0.802
6.5	**0.814**	0.814	0.814	0.814	0.814	0.814	0.814	0.814	0.814	0.814	0.814	0.814	0.814	0.814
7	**0.807**	0.807	0.807	0.807	0.807	0.807	0.807	0.807	0.807	0.807	0.807	0.807	0.807	0.807
7.5	**0.804**	0.804	0.804	0.804	0.804	0.804	0.804	0.804	0.804	0.804	0.804	0.804	0.804	0.804
8	**0.795**	0.800	0.800	0.799	0.799	0.799	0.799	0.798	0.798	0.797	0.796	0.796	0.794	0.793
8.5	**0.768**	0.786	0.784	0.783	0.782	0.780	0.779	0.777	0.776	0.774	0.772	0.770	0.766	0.764
9	**0.716**	0.756	0.754	0.751	0.749	0.746	0.743	0.739	0.736	0.732	0.727	0.721	0.710	0.704
9.5	**0.636**	0.713	0.708	0.703	0.698	0.693	0.685	0.678	0.670	0.663	0.654	0.645	0.627	0.617
10	**0.545**	0.657	0.648	0.639	0.630	0.621	0.610	0.599	0.589	0.578	0.567	0.556	0.535	0.524
10.5	**0.459**	0.587	0.576	0.564	0.552	0.540	0.528	0.517	0.505	0.493	0.482	0.471	0.449	0.439
11	**0.389**	0.514	0.501	0.488	0.475	0.462	0.451	0.440	0.428	0.417	0.408	0.398	0.380	0.372
11.5	**0.333**	0.442	0.430	0.418	0.406	0.395	0.385	0.376	0.366	0.357	0.349	0.341	0.325	0.318
12	**0.288**	0.381	0.370	0.360	0.350	0.340	0.332	0.324	0.316	0.308	0.301	0.294	0.282	0.276
12.5	**0.251**	0.330	0.322	0.313	0.305	0.296	0.289	0.282	0.275	0.269	0.263	0.257	0.246	0.241
13	**0.222**	0.289	0.282	0.275	0.267	0.260	0.254	0.248	0.242	0.236	0.231	0.227	0.217	0.213
13.5	**0.197**	0.256	0.249	0.243	0.237	0.230	0.225	0.220	0.215	0.210	0.206	0.201	0.193	0.189
14	**0.176**	0.227	0.222	0.216	0.211	0.205	0.201	0.196	0.192	0.187	0.184	0.180	0.173	0.169
14.5	**0.158**	0.203	0.199	0.194	0.189	0.184	0.180	0.176	0.172	0.168	0.165	0.161	0.155	0.152
15	**0.142**	0.183	0.178	0.174	0.170	0.165	0.162	0.158	0.155	0.151	0.148	0.145	0.140	0.137
15.5	**0.129**	0.165	0.161	0.157	0.153	0.150	0.146	0.143	0.140	0.137	0.134	0.132	0.127	0.124
16	**0.117**	0.150	0.146	0.143	0.139	0.136	0.133	0.130	0.127	0.125	0.122	0.120	0.115	0.113
16.5	**0.107**	0.137	0.133	0.130	0.127	0.124	0.121	0.119	0.116	0.114	0.112	0.109	0.105	0.103
17	**0.098**	0.125	0.122	0.119	0.116	0.114	0.111	0.109	0.107	0.104	0.102	0.100	0.097	0.095
17.5	**0.091**	0.115	0.112	0.109	0.107	0.104	0.102	0.100	0.098	0.096	0.094	0.092	0.089	0.087
18	**0.084**	0.105	0.103	0.101	0.098	0.096	0.094	0.092	0.090	0.088	0.087	0.085	0.082	0.081
18.5	**0.077**	0.097	0.095	0.093	0.091	0.089	0.087	0.085	0.083	0.082	0.080	0.079	0.076	0.075
19	**0.072**	0.090	0.088	0.086	0.084	0.082	0.081	0.079	0.078	0.076	0.075	0.073	0.071	0.069

Mode 0, C_t values														
	Air density kg/m^3													
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
19.5	**0.067**	0.084	0.082	0.080	0.078	0.077	0.075	0.074	0.072	0.071	0.069	0.068	0.066	0.065
20	**0.062**	0.078	0.076	0.075	0.073	0.071	0.070	0.069	0.067	0.066	0.065	0.063	0.061	0.060

Table 12-2: Mode 0, C_t values.

12.1.3 Mode 0, Sound Power Levels

Sound Power Level at Hub Height, Mode 0		
Conditions for Sound Power Level	**Verification standard: IEC 61400-11 Ed. 2.** **Wind shear 0.15** **Max turbulence at 10 meter height: 16%** **Inflow angle (vertical): 0 ± 2°** **Air density: 1.225 kg/m^3**	
Hub Height	80 m	95 m
LwA @ 3 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	93.8 4.2	93.8 4.3
LwA @ 4 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	96.0 5.6	96.4 5.7
LwA @ 5 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	100.1 7.0	100.7 7.2
LwA @ 6 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	103.9 8.4	104.4 8.6
LwA @ 7 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	105.0 9.8	105.0 10.0
LwA @ 8 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	105.0 11.2	105.0 11.5
LwA @ 9 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	105.0 12.6	105.0 12.9
LwA @ 10 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	105.0 13.9	105.0 14.3
LwA @ 11 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	105.0 15.3	105.0 15.8
LwA @ 12 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	105.0 16.7	105.0 17.2
LwA @ 13 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	105.0 18.1	105.0 18.6

Table 12-3: Sound power level at hub height: Mode 0.

12.2 Mode 1

12.2.1 Mode 1, Power Curves

Mode 1, Power curves														
	Air density kg/m^3													
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3	**13**	9	9	9	10	10	11	11	11	12	12	13	14	15
3.5	**53**	34	36	38	39	41	43	45	46	48	50	52	55	57
4	**112**	80	83	86	89	92	95	98	101	104	106	109	115	118
4.5	**180**	134	139	143	147	151	155	159	163	167	171	175	184	188
5	**256**	195	200	206	211	217	223	228	234	239	245	250	261	267
5.5	**346**	265	273	280	287	295	302	310	317	324	332	339	354	361
6	**453**	349	358	368	377	387	396	406	415	425	434	444	463	472
6.5	**576**	439	451	464	476	489	501	514	526	539	551	564	588	601
7	**728**	558	573	589	604	620	635	651	666	682	697	713	744	759
7.5	**902**	693	712	731	750	769	788	807	826	845	864	883	920	939
8	**1098**	847	870	893	916	939	961	984	1007	1030	1053	1075	1120	1143
8.5	**1312**	1019	1046	1073	1100	1127	1154	1180	1207	1234	1260	1286	1338	1364
9	**1519**	1204	1234	1265	1296	1326	1355	1384	1413	1443	1468	1494	1542	1565
9.5	**1678**	1392	1423	1455	1486	1518	1543	1569	1594	1619	1639	1658	1693	1709
10	**1766**	1562	1588	1613	1638	1664	1681	1698	1715	1732	1743	1754	1773	1780
10.5	**1799**	1687	1703	1720	1736	1753	1761	1770	1779	1788	1791	1795	1801	1803
11	**1811**	1764	1772	1779	1787	1794	1798	1801	1804	1807	1808	1810	1812	1813
11.5	**1814**	1796	1799	1802	1805	1809	1810	1811	1812	1813	1813	1814	1815	1815
12	**1815**	1809	1810	1811	1812	1813	1814	1814	1814	1815	1815	1815	1815	1815
12.5	**1815**	1813	1814	1814	1814	1815	1815	1815	1815	1815	1815	1815	1815	1815
13	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
13.5	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
14	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
14.5	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
15	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
15.5	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
16	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
16.5	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
17	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
17.5	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
18	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815

Mode 1, Power curves														
	Air density kg/m^3													
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
18.5	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
19	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
19.5	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
20	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815

Table 12-4: Mode 1, power curve.

12.2.2 Mode 1, C_t values

Mode 1, C_t values														
	Air density kg/m^3													
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3	**0.874**	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874
3.5	**0.890**	0.890	0.890	0.890	0.890	0.890	0.890	0.890	0.890	0.890	0.890	0.890	0.890	0.890
4	**0.863**	0.863	0.863	0.863	0.863	0.863	0.863	0.863	0.863	0.863	0.863	0.863	0.863	0.863
4.5	**0.809**	0.809	0.809	0.809	0.809	0.809	0.809	0.809	0.809	0.809	0.809	0.809	0.809	0.809
5	**0.764**	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764
5.5	**0.741**	0.741	0.741	0.741	0.741	0.741	0.741	0.741	0.741	0.741	0.741	0.741	0.741	0.741
6	**0.733**	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733
6.5	**0.766**	0.766	0.766	0.766	0.766	0.766	0.766	0.766	0.766	0.766	0.766	0.766	0.766	0.766
7	**0.755**	0.755	0.755	0.755	0.755	0.755	0.755	0.755	0.755	0.755	0.755	0.755	0.755	0.755
7.5	**0.750**	0.749	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
8	**0.748**	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.748	0.748	0.748	0.747
8.5	**0.735**	0.745	0.744	0.744	0.743	0.742	0.741	0.741	0.740	0.739	0.738	0.737	0.734	0.733
9	**0.699**	0.729	0.727	0.726	0.724	0.722	0.720	0.717	0.715	0.712	0.708	0.703	0.694	0.689
9.5	**0.631**	0.699	0.695	0.691	0.687	0.683	0.676	0.669	0.663	0.656	0.648	0.639	0.622	0.613
10	**0.544**	0.652	0.643	0.634	0.626	0.617	0.607	0.597	0.586	0.576	0.565	0.555	0.533	0.522
10.5	**0.458**	0.585	0.574	0.562	0.551	0.539	0.527	0.516	0.504	0.492	0.481	0.470	0.448	0.438
11	**0.388**	0.514	0.501	0.488	0.475	0.462	0.451	0.440	0.428	0.417	0.408	0.398	0.380	0.371
11.5	**0.333**	0.442	0.430	0.418	0.406	0.395	0.385	0.376	0.366	0.356	0.349	0.341	0.325	0.318
12	**0.288**	0.381	0.370	0.360	0.350	0.340	0.332	0.324	0.316	0.308	0.301	0.294	0.282	0.276
12.5	**0.251**	0.331	0.322	0.313	0.305	0.296	0.289	0.282	0.275	0.269	0.263	0.257	0.246	0.241
13	**0.222**	0.289	0.282	0.275	0.267	0.260	0.254	0.248	0.242	0.236	0.231	0.227	0.217	0.213
13.5	**0.197**	0.256	0.249	0.243	0.237	0.230	0.225	0.220	0.215	0.210	0.206	0.201	0.193	0.189
14	**0.176**	0.227	0.222	0.216	0.211	0.205	0.201	0.196	0.192	0.187	0.184	0.180	0.173	0.169

Mode 1, C_t values														
	Air density kg/m^3													
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
14.5	**0.158**	0.203	0.199	0.194	0.189	0.184	0.180	0.176	0.172	0.168	0.165	0.161	0.155	0.152
15	**0.142**	0.183	0.178	0.174	0.170	0.165	0.162	0.158	0.155	0.151	0.148	0.145	0.140	0.137
15.5	**0.129**	0.165	0.161	0.157	0.153	0.150	0.146	0.143	0.140	0.137	0.134	0.132	0.127	0.124
16	**0.117**	0.150	0.146	0.143	0.139	0.136	0.133	0.130	0.127	0.125	0.122	0.120	0.115	0.113
16.5	**0.107**	0.137	0.133	0.130	0.127	0.124	0.121	0.119	0.116	0.114	0.112	0.109	0.105	0.103
17	**0.098**	0.125	0.122	0.119	0.116	0.114	0.111	0.109	0.107	0.104	0.102	0.100	0.097	0.095
17.5	**0.091**	0.115	0.112	0.109	0.107	0.104	0.102	0.100	0.098	0.096	0.094	0.092	0.089	0.087
18	**0.084**	0.105	0.103	0.101	0.098	0.096	0.094	0.092	0.090	0.088	0.087	0.085	0.082	0.081
18.5	**0.077**	0.097	0.095	0.093	0.091	0.089	0.087	0.085	0.083	0.082	0.080	0.079	0.076	0.075
19	**0.072**	0.090	0.088	0.086	0.084	0.082	0.081	0.079	0.078	0.076	0.075	0.073	0.071	0.069
19.5	**0.067**	0.084	0.082	0.080	0.078	0.077	0.075	0.074	0.072	0.071	0.069	0.068	0.066	0.065
20	**0.062**	0.078	0.076	0.075	0.073	0.071	0.070	0.069	0.067	0.066	0.065	0.063	0.061	0.060

Table 12-5: Mode 1, C_t values.

12.2.3 Mode 1, Sound Power Levels

Sound Power Level at Hub Height, Mode 1		
Conditions for Sound Power Level	**Verification standard: IEC 61400-11 Ed. 2.** **Wind shear 0.15** **Max turbulence at 10 meter height: 16%** **Inflow angle (vertical): 0 ± 2°** **Air density: 1.225 kg/m^3**	
Hub Height	80 m	95 m
LwA @ 3 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	93.7 4.2	93.7 4.3
LwA @ 4 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	95.3 5.6	95.7 5.7
LwA @ 5 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	99.1 7.0	99.7 7.2
LwA @ 6 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	102.9 8.4	103.4 8.6
LwA @ 7 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	105.0 9.8	105.0 10.0
LwA @ 8 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	105.0 11.2	105.0 11.5
LwA @ 9 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	105.0 12.6	105.0 12.9
LwA @ 10 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	105.0 13.9	105.0 14.3
LwA @ 11 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	105.0 15.3	105.0 15.8
LwA @ 12 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	105.0 16.7	105.0 17.2
LwA @ 13 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	105.0 18.1	105.0 18.6

Table 12-6: Sound power level at hub height: Mode 1.

12.3 Mode 2

12.3.1 Mode 2, Power Curves

Mode 2, Power curves														
	Air density kg/m^3													
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3	**13**	9	9	9	10	10	11	11	11	12	12	13	14	15
3.5	**53**	34	36	38	39	41	43	45	46	48	50	52	55	57
4	**112**	80	83	86	89	92	95	98	101	104	106	109	115	118
4.5	**181**	136	140	144	148	152	156	160	165	169	173	177	185	189
5	**260**	198	203	209	215	220	226	231	237	243	248	254	265	271
5.5	**353**	270	278	285	293	300	308	315	323	330	338	345	360	367
6	**462**	355	365	375	384	394	404	413	423	433	442	452	471	481
6.5	**581**	443	455	468	480	493	506	518	531	543	556	568	594	606
7	**735**	563	579	594	610	626	642	657	673	688	704	720	751	766
7.5	**908**	697	717	736	755	774	793	812	831	851	870	889	926	945
8	**1090**	840	863	886	909	932	954	977	999	1022	1045	1067	1113	1135
8.5	**1271**	981	1008	1034	1061	1087	1113	1140	1166	1192	1218	1244	1297	1323
9	**1437**	1112	1142	1172	1201	1231	1261	1290	1320	1349	1379	1408	1465	1494
9.5	**1580**	1227	1260	1293	1325	1358	1390	1423	1455	1487	1518	1549	1607	1634
10	**1689**	1331	1367	1402	1437	1473	1506	1540	1573	1607	1634	1661	1709	1729
10.5	**1757**	1425	1462	1499	1536	1573	1604	1635	1666	1697	1717	1737	1768	1780
11	**1792**	1512	1549	1585	1622	1659	1683	1708	1732	1757	1768	1780	1797	1802
11.5	**1805**	1592	1624	1657	1690	1722	1738	1755	1771	1787	1793	1799	1808	1811
12	**1811**	1666	1691	1715	1740	1764	1774	1783	1792	1802	1805	1808	1812	1813
12.5	**1813**	1726	1742	1757	1773	1789	1794	1799	1804	1809	1810	1812	1814	1814
13	**1814**	1765	1774	1784	1793	1802	1805	1807	1810	1812	1813	1814	1815	1815
13.5	**1815**	1786	1791	1797	1803	1808	1810	1811	1813	1814	1815	1815	1815	1815
14	**1815**	1802	1805	1808	1811	1813	1814	1814	1814	1815	1815	1815	1815	1815
14.5	**1815**	1812	1812	1813	1814	1815	1815	1815	1815	1815	1815	1815	1815	1815
15	**1815**	1813	1813	1814	1814	1815	1815	1815	1815	1815	1815	1815	1815	1815
15.5	**1815**	1814	1814	1814	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
16	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
16.5	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
17	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
17.5	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
18	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815

Mode 2, Power curves														
	Air density kg/m^3													
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
18.5	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
19	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
19.5	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815
20	**1815**	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815	1815

Table 12-7: Mode 2, power curve.

12.3.2 Mode 2, C_t values

Mode 2, C_t values														
	Air density kg/m^3													
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3	**0.874**	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874	0.874
3.5	**0.891**	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891	0.891
4	**0.877**	0.877	0.877	0.877	0.877	0.877	0.877	0.877	0.877	0.877	0.877	0.877	0.877	0.877
4.5	**0.847**	0.847	0.847	0.847	0.847	0.846	0.847	0.847	0.847	0.847	0.847	0.847	0.847	0.847
5	**0.818**	0.818	0.818	0.818	0.818	0.817	0.818	0.818	0.818	0.818	0.818	0.818	0.818	0.818
5.5	**0.801**	0.801	0.801	0.801	0.801	0.801	0.801	0.801	0.801	0.801	0.801	0.801	0.801	0.801
6	**0.796**	0.796	0.796	0.796	0.796	0.796	0.796	0.796	0.796	0.796	0.796	0.796	0.796	0.796
6.5	**0.811**	0.811	0.811	0.811	0.811	0.811	0.811	0.811	0.811	0.811	0.811	0.811	0.811	0.811
7	**0.800**	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800
7.5	**0.783**	0.783	0.783	0.783	0.783	0.782	0.783	0.783	0.783	0.783	0.783	0.783	0.783	0.783
8	**0.747**	0.747	0.747	0.747	0.747	0.747	0.747	0.747	0.747	0.747	0.747	0.747	0.747	0.747
8.5	**0.695**	0.695	0.695	0.695	0.695	0.695	0.695	0.695	0.695	0.695	0.695	0.695	0.695	0.695
9	**0.634**	0.634	0.634	0.634	0.634	0.634	0.634	0.634	0.634	0.634	0.634	0.634	0.634	0.634
9.5	**0.569**	0.570	0.570	0.570	0.570	0.570	0.570	0.570	0.570	0.570	0.570	0.569	0.567	0.565
10	**0.505**	0.513	0.513	0.513	0.513	0.513	0.513	0.513	0.512	0.512	0.509	0.507	0.500	0.496
10.5	**0.441**	0.462	0.462	0.462	0.462	0.462	0.460	0.458	0.456	0.454	0.450	0.445	0.435	0.428
11	**0.381**	0.417	0.416	0.415	0.415	0.414	0.410	0.407	0.403	0.400	0.394	0.388	0.375	0.368
11.5	**0.330**	0.377	0.375	0.373	0.371	0.369	0.364	0.359	0.354	0.349	0.342	0.336	0.323	0.317
12	**0.287**	0.342	0.339	0.335	0.331	0.328	0.322	0.316	0.311	0.305	0.299	0.293	0.281	0.275
12.5	**0.251**	0.310	0.305	0.300	0.295	0.290	0.285	0.279	0.273	0.267	0.262	0.257	0.246	0.241
13	**0.222**	0.279	0.274	0.268	0.263	0.258	0.252	0.247	0.241	0.236	0.231	0.226	0.217	0.213
13.5	**0.197**	0.250	0.245	0.240	0.235	0.229	0.224	0.220	0.215	0.210	0.206	0.201	0.193	0.189
14	**0.176**	0.225	0.220	0.215	0.210	0.205	0.201	0.196	0.192	0.187	0.184	0.180	0.173	0.169

Mode 2, C_t values														
	Air density kg/m^3													
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
14.5	**0.158**	0.203	0.198	0.193	0.189	0.184	0.180	0.176	0.172	0.168	0.165	0.161	0.155	0.152
15	**0.142**	0.182	0.178	0.174	0.169	0.165	0.162	0.158	0.155	0.151	0.148	0.145	0.140	0.137
15.5	**0.129**	0.165	0.161	0.157	0.153	0.150	0.146	0.143	0.140	0.137	0.134	0.132	0.127	0.124
16	**0.117**	0.150	0.146	0.143	0.139	0.136	0.133	0.130	0.127	0.125	0.122	0.120	0.115	0.113
16.5	**0.107**	0.137	0.133	0.130	0.127	0.124	0.121	0.119	0.116	0.114	0.112	0.109	0.105	0.103
17	**0.098**	0.125	0.122	0.119	0.116	0.114	0.111	0.109	0.107	0.104	0.102	0.100	0.097	0.095
17.5	**0.091**	0.115	0.112	0.109	0.107	0.104	0.102	0.100	0.098	0.096	0.094	0.092	0.089	0.087
18	**0.084**	0.105	0.103	0.101	0.098	0.096	0.094	0.092	0.090	0.088	0.087	0.085	0.082	0.081
18.5	**0.077**	0.097	0.095	0.093	0.091	0.089	0.087	0.085	0.083	0.082	0.080	0.079	0.076	0.075
19	**0.072**	0.090	0.088	0.086	0.084	0.082	0.081	0.079	0.078	0.076	0.075	0.073	0.071	0.069
19.5	**0.067**	0.084	0.082	0.080	0.078	0.077	0.075	0.074	0.072	0.071	0.069	0.068	0.066	0.065
20	**0.062**	0.078	0.076	0.075	0.073	0.071	0.070	0.069	0.067	0.066	0.065	0.063	0.061	0.060

Table 12-8: Mode 2, C_t values.

12.3.3 Mode 2, Sound Power Levels

Sound Power Level at Hub Height, Mode 2		
Conditions for Sound Power Level	**Verification standard: IEC 61400-11 Ed. 2. Wind shear 0.15 Max turbulence at 10 meter height: 16% Inflow angle (vertical): 0 ± 2° Air density: 1.225 kg/m^3**	
Hub Height	80 m	95 m
LwA @ 3 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	93.8 4.2	93.8 4.3
LwA @ 4 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	96.0 5.6	96.4 5.7
LwA @ 5 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	100.1 7.0	100.7 7.2
LwA @ 6 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	103.0 8.4	103.0 8.6
LwA @ 7 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	103.0 9.8	103.0 10.0
LwA @ 8 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	103.0 11.2	103.0 11.5
LwA @ 9 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	103.0 12.6	103.0 12.9
LwA @ 10 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	103.0 13.9	103.0 14.3
LwA @ 11 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	103.0 15.3	103.0 15.8
LwA @ 12 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	103.0 16.7	103.0 17.2
LwA @ 13 m/s (10 m above ground) [dBA] Wind speed at hh [m/sec]	103.0 18.1	103.0 18.6

Table 12-9: Sound power level at hub height: Mode 2.

APPENDIX D:

VESTAS V100-1.8 MW SOUND POWER DATA

CONFIDENTIAL – These materials have been supplied to the Ontario Ministry of the Environment.

APPENDIX E:
CALCULATION DETAILS

Summary of Calculations - Condensed Overall, dBA Format

R001	Non-Participating Receptor	605650	4773240	209.5												
Src ID	Src Name	X	Y	Z	Lx	Adiv	K0	Dc	Agnd	Abar	Aatm	Afol	Ahous	Cmet	Refl	Lr
WTG1	Vestas V100	604718	4775553	295.0	105	78.9	0	0.0	-0.5	0.0	7.1	0.0	0.0	0.0	0.0	19
WTG2	Vestas V100	604889	4775173	295.0	105	77.4	0	0.0	-0.5	0.0	6.4	0.0	0.0	0.0	0.0	22
WTG3	Vestas V100	606291	4774905	290.0	105	76.0	0	0.0	-0.5	0.0	5.8	0.0	0.0	0.0	0.0	24
WTG4	Vestas V100	604359	4774308	297.1	105	75.5	0	0.0	-0.5	0.0	5.6	0.0	0.0	0.0	0.0	24
WTG5	Vestas V100	606233	4773420	296.5	105	66.8	0	0.0	-0.7	0.0	3.0	0.0	0.0	0.0	0.0	36

R060	Non-Participating Receptor	605060	4774364	204.5												
Src ID	Src Name	X	Y	Z	Lx	Adiv	K0	Dc	Agnd	Abar	Aatm	Afol	Ahous	Cmet	Refl	Lr
WTG1	Vestas V100	604718	4775553	295.0	105	72.9	0	0.0	-0.6	0.0	4.7	0.0	0.0	0.0	0.0	28
WTG2	Vestas V100	604889	4775173	295.0	105	69.4	0	0.0	-0.6	0.0	3.7	0.0	0.0	0.0	0.0	33
WTG3	Vestas V100	606291	4774905	290.0	105	73.6	0	0.0	-0.6	0.0	4.9	0.0	0.0	0.0	0.0	27
WTG4	Vestas V100	604359	4774308	297.1	105	68.0	0	0.0	-0.7	0.0	3.3	0.0	0.0	0.0	0.0	34
WTG5	Vestas V100	606233	4773420	296.5	105	74.6	0	0.0	-0.6	0.0	5.3	0.0	0.0	0.0	0.0	26

R120	Non-Participating Receptor	606031	4774379	202.8												
Src ID	Src Name	X	Y	Z	Lx	Adiv	K0	Dc	Agnd	Abar	Aatm	Afol	Ahous	Cmet	Refl	Lr
WTG1	Vestas V100	604718	4775553	295.0	105	75.9	0	0.0	-0.5	0.0	5.8	0.0	0.0	0.0	0.0	24
WTG2	Vestas V100	604889	4775173	295.0	105	73.9	0	0.0	-0.6	0.0	5.0	0.0	0.0	0.0	0.0	27
WTG3	Vestas V100	606291	4774905	290.0	105	66.5	0	0.0	-0.7	0.0	3.0	0.0	0.0	0.0	0.0	36
WTG4	Vestas V100	604359	4774308	297.1	105	75.5	0	0.0	-0.5	0.0	5.6	0.0	0.0	0.0	0.0	24
WTG5	Vestas V100	606233	4773420	296.5	105	70.9	0	0.0	-0.6	0.0	4.1	0.0	0.0	0.0	0.0	31

R165	Non-Participating Receptor	604109	4775818	204.5												
Src ID	Src Name	X	Y	Z	Lx	Adiv	K0	Dc	Agnd	Abar	Aatm	Afol	Ahous	Cmet	Refl	Lr
WTG1	Vestas V100	604718	4775553	295.0	105	67.5	0	0.0	-0.7	0.0	3.2	0.0	0.0	0.0	0.0	35
WTG2	Vestas V100	604889	4775173	295.0	105	71.1	0	0.0	-0.6	0.0	4.1	0.0	0.0	0.0	0.0	30
WTG3	Vestas V100	606291	4774905	290.0	105	78.5	0	0.0	-0.5	0.0	6.9	0.0	0.0	0.0	0.0	20
WTG4	Vestas V100	604359	4774308	297.1	105	74.7	0	0.0	-0.6	0.0	5.3	0.0	0.0	0.0	0.0	26
WTG5	Vestas V100	606233	4773420	296.5	105	81.1	0	0.0	-0.5	0.0	8.1	0.0	0.0	0.0	0.0	16

Where: Lr = Lx - Adiv + K0 + Dc - Agnd - Abar - Aatm - Afol - Ahous + Cmet + Refl

Summary of Calculations - Octave Band Format

R001	Non-Participating Receptor	605650	4773240	209.5

Src ID	Src Name	Band	X	Y	Z	Lx	Adiv	K0	Dc	Agnd	Abar	Aatm	Afol	Ahous	Cmet	Refl	Lr	Band
WTG1	Vestas V100	63	604718	4775553	295.0	87.4	78.9	0	0.0	-3.0	0.0	0.3	0.0	0.0	0.0	0.0	11.2	63
WTG1	Vestas V100	125	604718	4775553	295.0	92.0	78.9	0	0.0	1.8	0.0	1.0	0.0	0.0	0.0	0.0	10.3	125
WTG1	Vestas V100	250	604718	4775553	295.0	94.7	78.9	0	0.0	0.1	0.0	2.6	0.0	0.0	0.0	0.0	13.1	250
WTG1	Vestas V100	500	604718	4775553	295.0	97.1	78.9	0	0.0	-0.9	0.0	4.8	0.0	0.0	0.0	0.0	14.3	500
WTG1	Vestas V100	1000	604718	4775553	295.0	99.7	78.9	0	0.0	-0.9	0.0	9.1	0.0	0.0	0.0	0.0	12.5	1000
WTG1	Vestas V100	2000	604718	4775553	295.0	98.2	78.9	0	0.0	-0.9	0.0	24.1	0.0	0.0	0.0	0.0	--	2000
WTG1	Vestas V100	4000	604718	4775553	295.0	96.6	78.9	0	0.0	-0.9	0.0	81.8	0.0	0.0	0.0	0.0	--	4000
WTG1	Vestas V100	8000	604718	4775553	295.0	89.8	78.9	0	0.0	-0.9	0.0	291.6	0.0	0.0	0.0	0.0	--	8000
WTG2	Vestas V100	63	604889	4775173	295.0	87.4	77.4	0	0.0	-3.0	0.0	0.3	0.0	0.0	0.0	0.0	12.8	63
WTG2	Vestas V100	125	604889	4775173	295.0	92.0	77.4	0	0.0	1.8	0.0	0.9	0.0	0.0	0.0	0.0	12.0	125
WTG2	Vestas V100	250	604889	4775173	295.0	94.7	77.4	0	0.0	0.1	0.0	2.2	0.0	0.0	0.0	0.0	15.1	250
WTG2	Vestas V100	500	604889	4775173	295.0	97.1	77.4	0	0.0	-0.9	0.0	4.0	0.0	0.0	0.0	0.0	16.6	500
WTG2	Vestas V100	1000	604889	4775173	295.0	99.7	77.4	0	0.0	-0.9	0.0	7.6	0.0	0.0	0.0	0.0	15.6	1000
WTG2	Vestas V100	2000	604889	4775173	295.0	98.2	77.4	0	0.0	-0.9	0.0	20.1	0.0	0.0	0.0	0.0	1.7	2000
WTG2	Vestas V100	4000	604889	4775173	295.0	96.6	77.4	0	0.0	-0.9	0.0	68.1	0.0	0.0	0.0	0.0	--	4000
WTG2	Vestas V100	8000	604889	4775173	295.0	89.8	77.4	0	0.0	-0.9	0.0	243.0	0.0	0.0	0.0	0.0	--	8000
WTG3	Vestas V100	63	606291	4774905	290.0	87.4	76.0	0	0.0	-3.0	0.0	0.2	0.0	0.0	0.0	0.0	14.2	63
WTG3	Vestas V100	125	606291	4774905	290.0	92.0	76.0	0	0.0	1.8	0.0	0.7	0.0	0.0	0.0	0.0	13.5	125
WTG3	Vestas V100	250	606291	4774905	290.0	94.7	76.0	0	0.0	0.1	0.0	1.9	0.0	0.0	0.0	0.0	16.7	250
WTG3	Vestas V100	500	606291	4774905	290.0	97.1	76.0	0	0.0	-0.9	0.0	3.4	0.0	0.0	0.0	0.0	18.5	500
WTG3	Vestas V100	1000	606291	4774905	290.0	99.7	76.0	0	0.0	-0.9	0.0	6.5	0.0	0.0	0.0	0.0	18.0	1000
WTG3	Vestas V100	2000	606291	4774905	290.0	98.2	76.0	0	0.0	-0.9	0.0	17.3	0.0	0.0	0.0	0.0	5.8	2000
WTG3	Vestas V100	4000	606291	4774905	290.0	96.6	76.0	0	0.0	-0.9	0.0	58.5	0.0	0.0	0.0	0.0	--	4000
WTG3	Vestas V100	8000	606291	4774905	290.0	89.8	76.0	0	0.0	-0.9	0.0	208.7	0.0	0.0	0.0	0.0	--	8000
WTG4	Vestas V100	63	604359	4774307	297.1	87.4	75.5	0	0.0	-3.0	0.0	0.2	0.0	0.0	0.0	0.0	14.7	63
WTG4	Vestas V100	125	604359	4774307	297.1	92.0	75.5	0	0.0	1.8	0.0	0.7	0.0	0.0	0.0	0.0	14.0	125
WTG4	Vestas V100	250	604359	4774307	297.1	94.7	75.5	0	0.0	0.1	0.0	1.8	0.0	0.0	0.0	0.0	17.4	250
WTG4	Vestas V100	500	604359	4774307	297.1	97.1	75.5	0	0.0	-0.9	0.0	3.2	0.0	0.0	0.0	0.0	19.3	500
WTG4	Vestas V100	1000	604359	4774307	297.1	99.7	75.5	0	0.0	-0.9	0.0	6.1	0.0	0.0	0.0	0.0	19.0	1000
WTG4	Vestas V100	2000	604359	4774307	297.1	98.2	75.5	0	0.0	-0.9	0.0	16.2	0.0	0.0	0.0	0.0	7.4	2000
WTG4	Vestas V100	4000	604359	4774307	297.1	96.6	75.5	0	0.0	-0.9	0.0	55.0	0.0	0.0	0.0	0.0	--	4000
WTG4	Vestas V100	8000	604359	4774307	297.1	89.8	75.5	0	0.0	-0.9	0.0	196.0	0.0	0.0	0.0	0.0	--	8000
WTG5	Vestas V100	63	606233	4773420	296.5	87.4	66.8	0	0.0	-3.0	0.0	0.1	0.0	0.0	0.0	0.0	23.5	63
WTG5	Vestas V100	125	606233	4773420	296.5	92.0	66.8	0	0.0	1.6	0.0	0.3	0.0	0.0	0.0	0.0	23.4	125
WTG5	Vestas V100	250	606233	4773420	296.5	94.7	66.8	0	0.0	0.1	0.0	0.6	0.0	0.0	0.0	0.0	27.2	250
WTG5	Vestas V100	500	606233	4773420	296.5	97.1	66.8	0	0.0	-0.9	0.0	1.2	0.0	0.0	0.0	0.0	30.0	500
WTG5	Vestas V100	1000	606233	4773420	296.5	99.7	66.8	0	0.0	-0.9	0.0	2.3	0.0	0.0	0.0	0.0	31.6	1000
WTG5	Vestas V100	2000	606233	4773420	296.5	98.2	66.8	0	0.0	-0.9	0.0	6.0	0.0	0.0	0.0	0.0	26.4	2000
WTG5	Vestas V100	4000	606233	4773420	296.5	96.6	66.8	0	0.0	-0.9	0.0	20.2	0.0	0.0	0.0	0.0	10.5	4000
WTG5	Vestas V100	8000	606233	4773420	296.5	89.8	66.8	0	0.0	-0.9	0.0	72.0	0.0	0.0	0.0	0.0	--	8000

Where: Lr = Lx - Adiv + K0 + Dc - Agnd - Abar - Aatm - Afol - Ahous + Cmet + Refl

APPENDIX F:

WIND SHEAR COEFFICIENT SUMMARY

Figure F1: Diurnal Wind Shear, HAF Wind Energy
Calculations based on Wind Speeds Measured Between August 26 and September 9, 2010
at 79 m, 57 m and 39 m Heights