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NATION RISE WIND FARM

Specifications Report, Wind Facility

Nation Rise Wind Farm Limited Partnership

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D	26 September 2017	Update for completeness review	A. Danaitis	A. Nercessian	G. Constantin

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Abbreviation	Meaning
EPA	Ontario *Environmental Protection Act*
IESO	Independent Electricity System Operator
MOECC	Ontario Ministry of Environment and Climate Change
MW	Megawatt
NIA	Noise Impact Assessment
O. Reg	Ontario Regulation
REA	Renewable Energy Approval
SR	Specifications Report
STE	Serrated Trailing Edge

1 PREAMBLE

Nation Rise Wind Farm Limited Partnership (the "Proponent") is proposing to develop the Nation Rise Wind Farm (the "Project") which is subject to *Ontario Regulation* (*O. Reg*.) *359/09* (Renewable Energy Approvals (REA) [1] under Part V.0.1 of the Ontario *Environmental Protection Act* (EPA)), as amended. The Proponent was awarded a contract for this Project in March 2016 from the Independent Electricity System Operator (IESO) under the Large Renewable Procurement (LRP), and is seeking a Renewable Energy Approval (REA) from the Ontario Ministry of the Environment and Climate Change (MOECC). The Project will be owned and operated by Nation Rise Wind Farm Limited Partnership, a wholly-owned subsidiary of EDP Renewables Canada Ltd.

This Specifications Report, Wind Facility (SR) has been prepared in accordance with Table 1 of *O. Reg 359/09* and the Technical Guide to Renewable Energy Approvals, Chapter 9: Additional reports that may be required as part of an REA application, Section 13 Specifications Report Wind Facility (Not Class 2) [3]. Table 1-1 below presents the corresponding sections for each SR requirement.

Table 1-1: Specification Report Requirement and Corresponding Sections

Requirement	Section
Provide specifications of each wind turbine, including make, model, name plate capacity, hub height above grade, rotational speeds and acoustic emission data, including the sound power level and frequency spectrum, in terms of octave –band sound power levels.	2 and 3

2 TECHNICAL SPECIFICATIONS

This Project, with a total nameplate capacity of approximately 100 megawatts (MW), is considered to be a Class 4 wind facility. A total of 33 wind turbine locations are being permitted and the Proponent is currently evaluating different wind turbine technologies for the Project. The technology selected is likely to be a 3.0 to 3.6 MW turbine model and for the purposes of reference throughout this REA application, the Vestas V136-3.45 MW Serrated Trailing Edge (STE) turbine model has been considered, although an acoustically equivalent wind turbine model may be selected.

The turbine rotors and nacelle will be placed on a tower with a hub-height of 132 m in height consisting of up to seven steel sections. The maximum combined sound power level of the proposed turbines is 105.5 dBA. A summary of technical specifications is provided below in Table 2-1.

Table 2-1: Summary of Turbine Technical Specifications

Model	**Vestas V136 STE**
Design	Steel, tubular; up to 7 sections
Rated Power	3.45 MW
Hub height	132 m
Rotor diameter	136 m
Number of blades	3
Rotational Speed (rpm)	5.6-15.3
Cut-in wind speed	3 m/s
Cut-out wind speed	22.5 m/s
Nominal wind speed	11.5 m/s
Maximum sound power level	105.7 dBA (Noise Mode 0)

Additional technical information on Vestas V136-3.45 MW is presented in Appendix A of this report. Moreover, a Wind Turbine Specifications Checklist is included in Appendix B.

3 ACOUSTIC EMISSIONS DATA

Broadband and octave-band sound power levels for all relevant noise operation modes of the Vestas V136 -3.45 MW wind turbine were provided by the manufacturer as shown in Appendix A.

The octave band sound power levels used for the model in the Noise Impact Assessment (NIA) [4] are those stated for each octave band centre frequency in Table 3-1.

Table 3-1: Vestas V136 Mode 0 STE wind turbine acoustic emission summary

Make and Model:	**Vestas V136 3.45 MW STE mode 0**																										
Electrical Rating:	**3450 kW**																										
Hub Height (m):	**132**																										
	Octave Band Sound Power Level (dB)																										
	Manufacturer's Emission Levels at bin centre wind speeds at hub height																								**(A) Manufacturer's Worst Case Spectrum (dB)**	**(B) Positive Overall Adjustment* (dB)**	**(A+B) Maximum Sound Power Level (dB)**
Wind Speeds at hub height (m/s)	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5	20.0			
Frequency (Hz)																												
31.5	115.0	116.1	117.2	117.3	117.3	117.5	117.6	117.7	117.8	117.9	117.9	117.9	118.0	118.0	118.1	118.1	118.1	118.1	118.1	118.1	118.2	118.2	118.2	118.2	118.2	118.2	0	118.2
63	112.9	113.7	114.3	114.4	114.4	114.4	114.4	114.5	114.6	114.6	114.5	114.6	114.6	114.6	114.6	114.6	114.6	114.6	114.6	114.6	114.7	114.7	114.7	114.7	114.7	114.7	0	114.7
125	108.1	108.9	109.6	109.7	109.7	109.7	109.8	109.8	109.9	109.9	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.1	110.1	110.1	110.1	110.1	110.1	110.1	110.1	0.1	110.2
250	104.3	105.2	106.1	106.2	106.2	106.4	106.5	106.7	106.8	106.8	106.8	106.9	106.9	107.0	107.0	107.0	107.0	107.0	107.1	107.1	107.2	107.2	107.2	107.2	107.2	107.2	0	107.2
500	100.0	101.1	102.3	102.4	102.4	102.3	102.3	102.3	102.2	102.2	102.2	102.1	102.1	102.1	102.1	102.1	102.1	102.1	102.1	102.1	102.0	102.0	102.0	102.0	102.0	102.0	0	102.0
1,000	98.1	99.1	100.0	100.1	100.1	100.1	100.0	100.0	100.0	100.0	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.8	99.8	99.8	99.8	99.8	99.8	99.8	99.8	0	99.8
2,000	95.8	96.9	97.9	98.0	98.0	98.0	98.0	97.9	97.9	97.9	97.8	97.8	97.7	97.7	97.7	97.7	97.7	97.7	97.7	97.7	97.7	97.7	97.7	97.7	97.7	97.7	0	97.7
4,000	88.2	89.3	90.3	90.4	90.5	90.6	90.6	90.7	90.7	90.7	90.7	90.7	90.8	90.8	90.8	90.8	90.8	90.8	90.8	90.8	90.8	90.8	90.8	90.8	90.8	90.8	2.1	92.9
8,000	71.1	72.0	72.8	72.9	73.0	73.3	73.7	73.9	74.1	74.3	74.4	74.6	74.7	74.8	74.8	74.8	74.9	75.0	75.1	75.2	75.3	75.3	75.3	75.3	75.3	75.3	7.9	83.2
Overall A-weighted (dBA)	103.6	104.6	105.6	105.7	105.7	105.7	105.7	105.7	105.7	105.7	105.7	105.7	105.7	105.7	105.7	105.7	105.7	105.7	105.7	105.7	105.7	105.7	105.7	105.7	105.7	105.7	N/A	105.8

*In accordance to the Transition Rules for LRP 1 projects in the Noise Guidelines, no overall uncertainty was added to the turbine sound power levels. Instead, the Proponent has chosen to include upward adjustments at certain octave bands to consider an acoustically equivalent turbine.

3.1 Tonal audibility

Vestas states in a guarantee letter dated 30 June 2017 [5], that the typical tonal audibility for the Vestas wind turbine generators has not exceeded 3 dBA as determined in accordance with the methods described in standard IEC 61400-11, Ed.3, 2012 [5][6].

The acoustic emissions data and technical specifications for the Vestas V136 3.45 MW Mode 0 STE are presented in Appendix A.

4 REFERENCES

[1] Ontario Regulation 359/09, made under the Environmental Protection Act, Renewable Energy Approvals under Part 1.0 of the Act.

[2] Ontario Regulation 521/10, made under the Environmental Protection Act, Renewable Energy Approvals under Part 1.0 of the Act.

[3] Technical Guide to Renewable Energy Approvals, Ontario Ministry of the Environment and Climate Change, 2017.

[4] DNV GL, Noise Impact Assessment, Nation Rise Wind Farm, 26 September 2017.

[5] Gomez, Miguel G. Technical Bid Specialist Vestas, RE: Maximum Sound Power Level and Tonal Audibility Level Warranty, 30 June 2017.

[6] IEC 61400 – 11 Ed. 3.0 Wind turbines– Part 11: Acoustic noise measurement techniques. 58 p.

[7] Vestas 3 MW Platform Brochure. 2017.

[8] DMS 0069-3308_V03, "V136-3.45 MW (CAN) octave band noise emission" received from the Proponent to DNV GL, 26 Sep 2017.

APPENDIX A – VESTAS V136-3.45 MODE 0 STE SPECIFICATIONS

This appendix contains the following supporting documentation for the Vestas V136 3.45 MW Turbine models:

1. General specifications for V136-3.45 MW [7]
2. Calculated octave band sound power levels provided by Vestas [8]

V136-3.45 MW™ IEC IIB/IEC IIIA

Facts & figures

POWER REGULATION	Pitch regulated with variable speed

OPERATING DATA

Rated power	3,450 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	22.5 m/s
Re cut-in wind speed	20 m/s
Wind class	IEC IIB/IEC IIIA

Standard operating temperature range from -20°C* to +45°C with de-rating above 30°C

*subject to different temperature options

SOUND POWER
(Noise modes dependent on site and country)

ROTOR

Rotor diameter	136 m
Swept area	14,527 m²
Air brake	full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency	50/60 Hz
Converter	full scale

GEARBOX

Type	two planetary stages and one helical stage

TOWER
Hub heights 82 m (IEC IIB/IEC IIIA), 105 m (IEC IIIA), 112 m (IEC IIB/IEC IIIA), 132 m (IEC IIB/IEC IIIA/ DIBt2), 142 m (IEC IIIA), 149 m (DIBtS), and 166 m (DIBtS)

NACELLE DIMENSIONS

Height for transport	3.4 m
Height installed (incl. CoolerTop®)	6.9 m
Length	12.8 m
Width	4.2 m

HUB DIMENSIONS

Max. transport height	3.8 m
Max. transport width	3.8 m
Max. transport length	5.5 m

BLADE DIMENSIONS

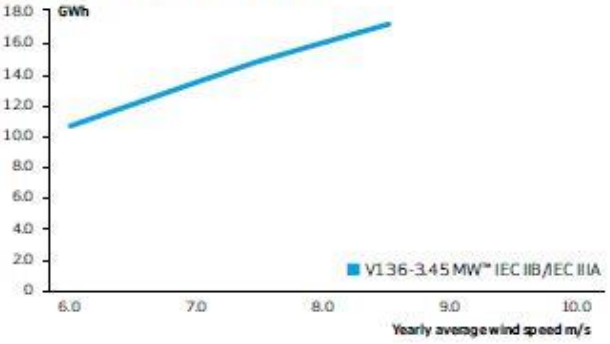
Length	66.7 m
Max. chord	4.1 m

Max. weight per unit for transportation	70 metric tonnes

TURBINE OPTIONS

- High Wind Operation
- Power Optimised Mode
- Condition Monitoring System
- Service Personnel Lift
- Vestas Ice Detection
- Vestas De-Icing
- Low Temperature Operation to -30°C
- Fire Suppression
- Shadow detection
- Increased Cut-In
- Nacelle Hatch for Air Inlet
- Aviation Lights
- Aviation Markings on the Blades
- Obstacle Collision Avoidance System (OCAS™)

ANNUAL ENERGY PRODUCTION



Assumptions
One wind turbine, 100% availability, 0% losses, k factor = 2, Standard air density = 1.225, windspeed at hub height

Frequency	Hub height wind speeds [m/s]																	
	3 m/s	3.5 m/s	4 m/s	4.5 m/s	5 m/s	5.5 m/s	6 m/s	6.5 m/s	7 m/s	7.5 m/s	8 m/s	8.5 m/s	9 m/s	9.5 m/s	10 m/s	10.5 m/s	11 m/s	11.5 m/s
8 Hz	29.9	29.6	29.3	30.4	31.6	33.4	35.2	36.9	38.6	40.4	42.1	43.4	44.6	44.7	44.9	45.1	45.3	45.4
16 Hz	49.5	49.3	49.1	50.2	51.3	53.1	54.8	56.5	58.1	59.8	61.5	62.6	63.8	63.9	64	64.2	64.5	64.6
31.5 Hz	63.3	63.3	63.2	64.4	65.6	67.2	68.9	70.6	72.2	73.8	75.4	76.5	77.6	77.7	77.7	77.9	78.0	78.1
63 Hz	78.6	78.9	79.1	79.8	80.5	81.5	82.4	83.5	84.5	85.5	86.5	87.2	87.9	88.0	88.0	88.0	88.0	88.1
125 Hz	83.4	83.3	83.2	84.0	84.8	86.0	87.1	88.3	89.5	90.7	91.8	92.6	93.3	93.4	93.4	93.4	93.5	93.5
250 Hz	86.5	86.3	86.1	86.9	87.7	89.0	90.3	91.5	92.8	94.1	95.5	96.4	97.3	97.4	97.4	97.6	97.7	97.9
500 Hz	82.0	82.4	82.8	84.3	85.8	87.6	89.5	91.4	93.3	94.9	96.6	97.7	98.9	99.0	99.0	98.9	98.9	98.9
1 kHz	86.9	87.2	87.5	88.4	89.4	90.7	92.1	93.6	95.2	96.6	97.9	98.9	99.8	99.9	99.9	99.9	99.8	99.8
2 kHz	83.2	83.6	84.1	85.4	86.8	88.4	90.1	91.9	93.7	95.2	96.8	97.9	98.9	99.0	99.0	99.0	99.0	98.9
4 kHz	77.0	77.2	77.3	78.4	79.5	81.1	82.7	84.3	86.0	87.5	89.0	90.1	91.1	91.2	91.3	91.4	91.4	91.5
8 kHz	66.0	65.7	65.4	65.3	65.2	65.7	66.3	67.0	67.7	68.8	69.8	70.6	71.5	71.6	71.7	72.0	72.4	72.6
A-wgt	92.2	92.4	92.5	93.5	94.5	96.0	97.4	99.0	100.5	102.0	103.4	104.4	105.4	105.5	105.5	105.5	105.5	105.5

Table 3: V136-3.45 MW, 3 – 11.5 m/s, expected 1/3 octave band performance,
Mode 0 & Mode 0 (HWO) - (Blades with serrated trailing edge)

Frequency	Hub height wind speeds [m/s]																
	12 m/s	12.5 m/s	13 m/s	13.5 m/s	14 m/s	14.5 m/s	15 m/s	15.5 m/s	16 m/s	16.5 m/s	17 m/s	17.5 m/s	18 m/s	18.5 m/s	19 m/s	19.5 m/s	20 m/s
8 Hz	45.6	45.7	45.8	45.8	45.9	46	46	46.1	46.1	46.1	46.1	46.2	46.2	46.2	46.2	46.3	46.3
16 Hz	64.7	64.8	64.9	64.9	65	65	65	65	65.1	65.1	65.2	65.2	65.3	65.2	65.2	65.2	65.3
31.5 Hz	78.2	78.3	78.3	78.3	78.4	78.4	78.5	78.5	78.5	78.5	78.5	78.5	78.6	78.6	78.6	78.6	78.6
63 Hz	88.2	88.2	88.1	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.2	88.3	88.3	88.3	88.3	88.3
125 Hz	93.6	93.6	93.7	93.7	93.7	93.7	93.7	93.7	93.7	93.7	93.8	93.8	93.8	93.8	93.8	93.8	93.8
250 Hz	98.0	98.0	98.0	98.1	98.1	98.2	98.2	98.2	98.2	98.2	98.3	98.3	98.4	98.4	98.4	98.4	98.4
500 Hz	98.8	98.8	98.8	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.6	98.6	98.6	98.6	98.6
1 kHz	99.8	99.8	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.7	99.6	99.6	99.6	99.6	99.6	99.6	99.6
2 kHz	98.9	98.9	98.8	98.8	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.7	98.7
4 kHz	91.5	91.5	91.5	91.5	91.6	91.6	91.6	91.6	91.6	91.6	91.6	91.6	91.6	91.6	91.6	91.6	91.6
8 kHz	72.8	73.0	73.1	73.3	73.4	73.5	73.5	73.5	73.6	73.7	73.8	73.9	74.0	74.0	74.0	74.0	74.0
A-wgt	105.5	105.5	105.5	105.5	105.5	105.5	105.5	105.5	105.5	105.5	105.5	105.5	105.5	105.5	105.5	105.5	105.5

Table 4: V136-3.45 MW, 12 – 20 m/s, expected 1/3 octave band performance,
Mode 0 & Mode 0 (HWO) - (Blades with serrated trailing edge)

APPENDIX B – WIND TURBINE SPECIFICATIONS CHECKLIST

Specifications	Details
Wind Turbine Information	
Manufacturer	Vestas
Model	V136 3.45 MW Mode 0
Hub Height (m)	132 m
Operation Information	
Speed regulation	Pitch Control – Pitch regulated with variable speed
Rotational Speed (rpm)	5.6 – 15.3 rpm
Version Software for control of wind turbine	VOB
Rotor Information	
Type (Default is a 3 blade, horizontal, upwind turbine)	3 blade, horizontal, upwind turbine
Horizontal Distance from rotor centre to tower axis (m)	2.4 m
Diameter of Rotor (m)	136 m
Rotor Control Devices	microprocessor pitch control system OptiTip®
Blade Modifications	Trailing Edge Serrations
Blade Length (m)	66.7 m
Gearbox Information (expected)	
Type	two planetary stages and one helical stage
Manufacturer	ZF Wind Power
Model Number	Not known at this time.
Generator Information (expected)	
Manufacturer	Vestas (VND)
Model Number	DASG 560/6M
Nominal Power (MW)	3.45
Sound Data for tested wind turbine	**Mode 0**
Overall sound power level IEC61400-11 test at hub height	At 7.5 m/s: 102.7 dBA
	At 8.0 m/s: 103.4 dBA
	At 8.5 m/s: 104.9 dBA
	At 9.0 m/s: 105.5 dBA
	At 9.5 m/s: 105.7 dBA
	At 10.0 m/s: 105.6 dBA
	At 10.5 m/s: 105.5 dBA
	At 11.0 m/s: 105.3 dBA
	At 11.5 m/s: 105.1 dBA
	At 12.0 m/s: 105.2 dBA
	At 12.5 m/s: 105.2 dBA
	At 13.0 m/s: 105.2 dBA
	At 13.5 m/s: 105.1 dBA
	At 14.0 m/s: 104.5 dBA

	At 14.5 m/s: 104.6 dBA
	At 15.0 m/s: 104.8 dBA
	At 15.5 m/s: 104.3 dBA
Measurement Uncertainty (dB)	0.9 to 1.2
Grid Terminal Frequency of Tester	N/A
Additional Specifications	Details
Operating Information	
Swept Area (m^2)	14,527 m^2
Rated Power Output (MW)	3.45 MW
Aerodynamic Brakes	Full blade feathering with 3 pitch cylinders
Cut-in Wind Speed (m/s)	3 m/s
Cut-out Wind Speed (m/s)	22.5 m/s
Nominal Power Wind Speed (m/s)	11.5 m/s
Rotor Information	
Aerodynamic Profile of Blade	N/A
Sound Data for tested wind turbine	
Maximum tonal audibility (dB)	See section 3.1
Provide a Power Curve for each wind turbine proposed for the Project	N/A

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