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ASSESSMENT REPORT - **Project: 14284.04**

Grand Renewable Wind Farm
Acoustic Immission Audit – Additional Measurements

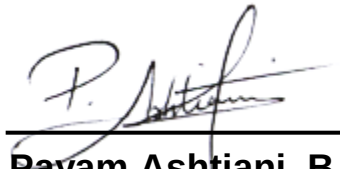
Prepared for:

Grand Renewable Wind LP
2050 Derry Road West, 2nd Floor
Mississauga, Ontario
L5N 0B9

Prepared by:

Ibbtida Khan

Addie Denison, B.A.Sc.



Payam Ashtiani, B.A.Sc., P.Eng.

1 October 2019

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Executive Summary

Aercoustics Engineering Limited ("Aercoustics") has been retained by Grand Renewable Wind L.P. to complete the acoustic immission audit requirements outlined in the Renewable Energy Approval ("REA") for the Grand Renewables Wind Farm ("GRWF"). GRWF operates under REA #0300-8UQPKR, issued on June 15, 2012.

The Ministry of Environment, Conservation and Parks ("MECP") requested a single additional immission audit at receptor R2956; this report details the results of that audit. The additional monitoring near receptor R2956 spanned the following dates:

Location	Monitoring Start Date	Monitoring End Date	Monitoring Duration (weeks)
R2956	February 21, 2019	April 25, 2019	9

The audit has been completed as per the methodology outlined in Parts D and E5.5 RAM-I (Revised Assessment Methodology) of the "*MECP Compliance Protocol for Wind Turbine Noise*" (Updated: April 21, 2017).

The measured turbine-only noise impact at the audit location was compared to the MECP sound level limits. The measured turbine-only levels were found to be in compliance with the applicable sound level limits at the monitoring location during the audit.

1 Introduction

Aercoustics Engineering Limited ("Aercoustics") has been retained by Grand Renewable Wind L.P. to conduct an additional acoustic immission audit to support the completion of the requirements outlined in Section F of the Renewable Energy Approval ("REA") for the Grand Renewables Wind Farm ("GRWF"). GRWF operates under REA #0300-8UQPKR, issued on June 15, 2012, further modified on May 15, 2015 [1].

Acoustic immission audits have been previously conducted at receptors R2885, R2956, and V3276 for GRWF. The results of these measurements have been submitted to the Ontario Ministry of Environment, Conservation and Parks (MECP) in the following reports:

- ASSESSMENT REPORT -Project: 14284.00, Grand Renewable Wind Farm – 1st Immission Audit, Receptor Measurements, dated December 12, 2015

- ASSESSMENT REPORT -Project: 14284.00, Grand Renewable Wind Farm – 2nd Immission Audit, Receptor Measurements, dated April 18, 2016

In a letter dated October 9, 2018, the MECP confirmed that two of the three measurement locations were deemed complete, but that one location, R2956, required additional measurements to support the determination of compliance. Therefore, one more I-Audit has been completed, in the vicinity of Receptor R2956.

The audit has been conducted as per the methodology outlined in Parts D and E5.5 RAM-I (Revised Assessment Methodology) of the "*MECP Compliance Protocol for Wind Turbine Noise*" (Updated: April 21, 2017). This report outlines the measurement methodology, results, and a comparison of the turbine-only sound contribution to the MECP sound level limits.

2 Facility Description

The GRWF utilizes 67 Siemens SWT-101 wind turbines for power generation, each having a nameplate capacity of either 2.221MW or 2.126MW. Each turbine has a hub height of 99.5 meters and a rotor diameter of 101 meters. The facility operates 24 hours per day, 7 days per week.

An overall site plan is provided in Figure A.01.

3 Audit Details

The acoustic audit was conducted at receptor R2956[1] and spanned from February 21, 2019 to April 25, 2019.

[1] Receptor ID taken from the Noise Assessment Report by Zephyr North, dated May 29, 2012 [3]

The following sections detail the test equipment, measurement methodology, measurement location, and environmental conditions during the audit.

3.1 Test Equipment

The equipment, both acoustic and non-acoustic, used at the audit location for the measurement campaign is detailed below. Equipment specifications and measurement positions comply with MECP Compliance Protocol sections *D2 – Instrumentation* and *D3 – Measurement* Procedure, respectively. Each remote monitoring unit is comprised of the following:

- One (1) Type 1 sound level meter, with microphone and pre-amplifier mounted at a height of 4.5 meters, at least 5 meters from any large reflecting surfaces.
- One (1) primary and one (1) secondary windscreen for the microphone. The 1/3 octave band insertion loss of the secondary windscreen has been tested and was accounted for in the data analysis.
- One (1) anemometer programmed to sample weather data every 0.5 seconds. The anemometer was located 10m above grade.

The following table lists the specific model and serial numbers for the equipment used during the measurement campaign.

Table 1: Equipment Details

Location	Equipment	Serial Number
M1153	Brüel & Kjær 2250	3004431 (2250-5)
	Brüel & Kjær 4189 Microphone	2888684
	Brüel & Kjær ZC0032 Pre-Amplifier	20151
	Vaisala WXT 520	L0910579

The sound level meter, microphone, and pre-amplifier were calibrated before and after the measurement campaign using a type 4231 Brüel & Kjær acoustic calibrator.

3.2 Measurement Methodology

For the duration of the measurement campaign, acoustic and anemometer data was logged simultaneously in one-minute intervals. The acoustic data included A-weighted overall equivalent sound levels (L_{Aeq}), percentile statistical levels (L_{90}), and 1/3 octave band levels between 20 Hz and 20,000 Hz. The microphone was placed at a measurement height of 4.5 m above grade at least 5 metres away from any large reflecting surfaces, in direct line of sight to the nearest turbines, and as far away as practically possible from trees or other foliage. The recorded weather data included average wind direction, wind speed, temperature, relative humidity, and atmospheric pressure. The maximum wind speed for each one-minute interval was also stored.

To account for the effect of wind speed on the measured sound level, measurement intervals are sorted into integer wind bins based on the measured 10 m wind speeds. Each bin ranges from 0.5 m/s below to 0.5 m/s above each respective wind bin (i.e. 5 m/s wind bin represents all intervals with average wind speeds between 4.5 m/s and 5.5 m/s).

3.3 Data Reduction and Filtering

The data reduction procedures used on the measurement data to remove invalid data points from the assessment are detailed below. These procedures are in accordance with Section D5.2 of the Protocol and in accordance with the measurement equipment specifications. An additional filter based on the difference between L_{Aeq} and L_{90} level is included to automatically exclude transient noise contamination.

A measurement interval is excluded if any one of the following criteria are not satisfied:

- The interval occurred between 10pm – 5am
- No precipitation was detected 60 minutes before and 60 minutes after the interval
- The ambient temperature was above -10˚C
- The measured L_{Aeq} was no more than 10 dB greater than the L_{90} value

The purpose of the filters listed above is to exclude intervals where the data quality is reduced due to extraneous events (such as vehicle pass-bys), unusable environmental conditions (such as rain), or equipment operating outside of its specifications. Intervals that pass the filtering criteria listed above are sorted into Turbine ON or Background periods based according to the conditions listed below. If neither Turbine ON or Background conditions are met, the data point is excluded.

- Turbine ON: Relevant GRWF turbines must be rotating and generating power, and the closest wind turbine must be producing approximately 85% or more of its rated power output. The list of turbines confirmed operational for Turbine ON measurements is provided in Section 3.7.
- Turbine OFF: Relevant GRWF turbines must be parked and not generating power. The list of turbines parked for ambient measurements is provided in Section 3.7.

The Protocol also requires additional criteria be met by each Turbine ON data point based on the conditions of the nearest turbine to each receptor. Specifically,

> "*Only downwind data will be considered in the analysis. With reference to the Turbine location, downwind directions are ±45 degrees from the line of sight between the Turbine and receptor/measurement location*." *{Section D5.2 (4)}*

3.4 Measurement Location

Receptor R2956 was selected based on the feedback received from the MECP in the letter dated October 9, 2018. The receptor is located in the predominant downwind direction from the nearest wind turbine, T54. R2956 has a predicted impact of 39.8dBA as per data provided in the Acoustic Assessment Report [3].

The monitor location was selected in consultation with the MECP Approvals Branch to ensure sufficient distance from nearby foliage that contaminated the measured sound levels collected during the previous measurement campaigns. As such, measurement equipment was placed in an open field, 116 m south of R2956, 721 m to the nearest turbine and 155 m west of a nearby group of trees.

The following table provides a summary of the receptor and monitor location. A detailed site plan showing the receptor and audit location is attached in Appendix A.2.

Table 2: Receptor Measurement Location

	Audit Receptor ID Nearest Turbine ID	R2956 T54
Receptor	UTM Coordinates (X,Y)	17T 608109mE 4746658mN
	Distance to Nearest Turbine	783 m
	Predicted Level dBA*	39.6
Monitor	UTM Coordinates (X,Y)	17T 608077mE 4746539mN
	Distance to Nearest Turbine	720.5m
	Predicted Level dBA**	39.7

*Predicted level from Noise Assessment Report – Zephyr North [3]
** Predicted level from Aercoustics' acoustic model

3.5 Sample size Reporting Requirements

As per Section D3.8 of the MECP protocol, at least 120 data points in each wind bin are required for Turbine ON measurements, and 60 data points for the ambient measurements between 4-7 m/s integer wind speeds inclusively (10m height).

Alternatively, RAM-I analysis, described in Section E5.5 of the Protocol, can be employed in cases where insufficient data is collected after an extended monitoring campaign lasting six weeks or more. The Spring 2019 monitoring campaign at GRWF R2956 lasted longer than six weeks and therefore RAM-I analysis was applied.

3.5.1 RAM-I Sample Size Requirements

The RAM-I assessment methodology reduces the sample size requirements, the Protocol states:

> "*The Ministry may accept a reduced number of data points for each wind speed bin with appropriate justification. […] The acceptable number of data points will be influenced by the quality of the data (standard deviation)" {Section E 5.5 (5)}*
>
> The threshold of 60 data points for Turbine ON measurements and 30 data points for Turbine OFF measurements is used in this assessment.

The range of wind bins which may be used to assess compliance is expanded to include a minimum of one of the following conditions as outlined in Section E 5.5(1):

a. "*Three (3) of the wind speed bins between 1 and 7 m/s (inclusive), or*

b. *Two (2) of the wind speed bins between 1 and 4 m/s (inclusive)"*

The RAM-I sample size requirement of 60 data points for Turbine ON and 30 data points for the ambient measurements for has been satisfied for receptor R2956 in three wind speed bins between 1 and 7 m/s.

3.6 **Weather Conditions**

Ambient conditions encountered over the measurement campaign were as follows:

- Ambient Humidity: 31% to 91%
- Ambient Temperature: -14˚C to 13˚C
- 10m Wind Speed: 0 m/s to 24 m/s

Historically, the predominant wind direction is from the southwest for this site. The wind direction varied over the course of the audit campaign. Wind roses have been provided in Appendix B that show the measured 10m height wind speeds and wind directions at R2956 for valid Turbine ON and Ambient measurement intervals. Wind directions shown on the wind roses indicate the direction the wind is coming from.

3.7 **Operational Conditions**

Turbine operational data for the duration of the measurement campaign was supplied by GRWF. For "Turbine On" measurements, data at each receptor was filtered to include only intervals when all turbines within 3 kilometres of the monitor were operational. For "Turbine Off" (ambient) measurements, turbines were parked such the partial impact of the remaining turbines was less than 30dBA; 10dB below the sound level limit. The specific turbines that were confirmed to be operational for Turbine On measurements were T01, T02, T03, T06, T07, T08, T26, T54 and T69. The specific turbines parked for ambient measurements were T01, T03, T07, T08, T54 and T69.

4 Sound Level Limits

The purpose of the sound measurements was to confirm whether the sound emitted by the wind facility is in compliance with the MECP allowable sound level limits. The MECP sound level limits for wind turbines vary with wind speed defined at a 10 m height. The details of the sound level limits are presented in Table 3 below.

Table 3: MECP Sound Level Limits for Wind Turbines

Wind speed at 10m height [m/s]	MECP Sound level limit [dBA]
≤ 4	40
5	40
6	40
7	43

As per section D6 of the MECP Protocol, if the background sound levels are greater than the applicable exclusion limits then the applicable limits are the background sound levels without extraneous noise sources.

5 Audit Results

The following table details the sound levels measured at the receptor R2956 noise monitor when all the nearby turbines were on (Turbine ON) and when all the nearby turbines were off (Turbine OFF). Wind bins which satisfy the RAM-I sample size requirements are highlighted in grey in Table 4.The Turbine ON sound level presented was filtered such that only data when the closest turbine was generating 85% power or greater and the receptor was in a downwind condition from the closest turbine was included.

Table 4: R2956 Sound levels measured for Turbine ON and OFF

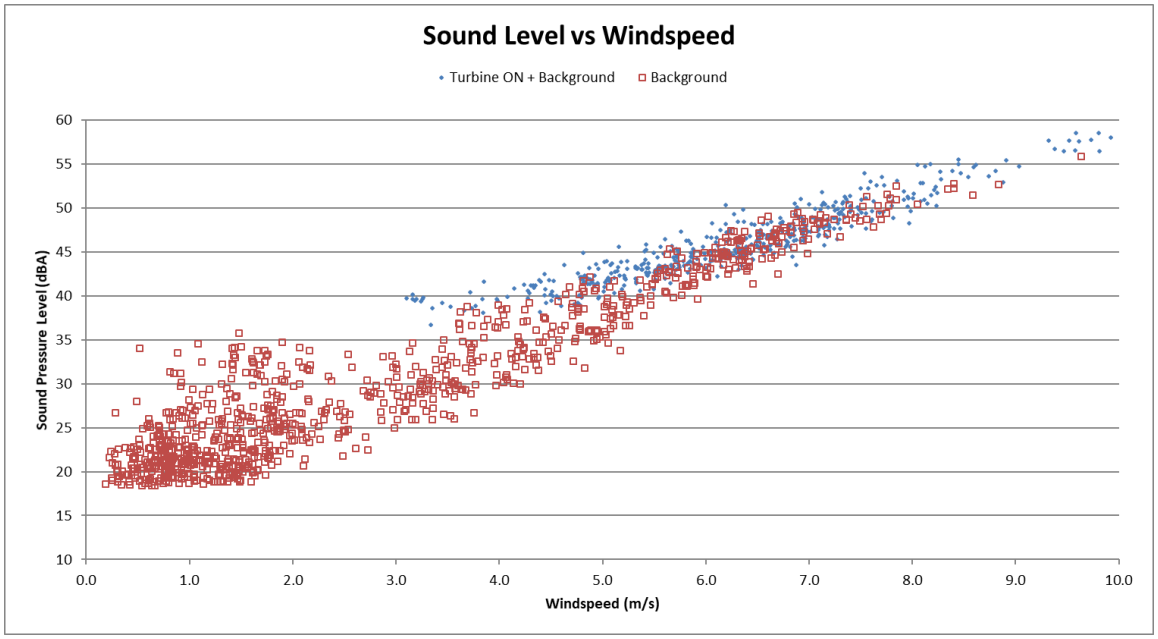
Wind Speed at 10m Height (m/s)	Turbine ON			Turbine OFF		
	Number of Samples	L_{Aeq} [dBA]	Std Dev [dBA]	Number of Samples	L_{Aeq} [dBA]	Std Dev [dBA]
0	0	*	*	42	21.4	2.0
1	0	*	*	304	24.9	3.6
2	0	*	*	159	27.8	3.9
3	11	39.3	0.9	78	29.9	2.7
4	29	40.4	1.2	88	34.5	3.2
5	93	42.4	1.5	77	38.4	2.4
6	136	45.2	1.7	85	44.1	1.8
7	139	48.3	1.7	55	47.6	1.6

*Insufficient amount of data points as per RAM-I protocol

The following figure presents the scatter plot showing each valid 1-minute interval measured sound level at R2956 when all the nearby turbines were ON (Turbine ON +

Background) and when all the nearby turbines were OFF (Turbine OFF). The Turbine ON and Turbine OFF sound level presented was using the filter outlined in section 3.3.

Figure 1: R2956 - Measured Sound Levels for Turbine ON and Background vs Wind Speed



6 Discussion

6.1 Overall Sound Level

The turbine-only component of the sound level was derived from a logarithmic subtraction of the ambient noise from that of the sound level measured with the turbines operating. The resulting sound level can be attributed to the turbines. It should be noted that all values in Table 4 have been rounded to one decimal point. Calculated Turbine ONLY levels listed were calculated based on unrounded Turbine ON and Turbine OFF values.

The audit at R2956 is considered representative of the sound levels at Receptor R2956 given the placement of the acoustic monitoring station.

To ensure conservative results and improved signal to noise, the monitor was erected in a location that was closer to the nearest turbine than receptor R2956 and had a higher overall predicted level.

Table 10 presents the Turbine ON, Turbine OFF and calculated Turbine ONLY sound pressure levels between 0-7 m/s. Wind bins which satisfy the RAM-I sample size requirements are highlighted in grey.

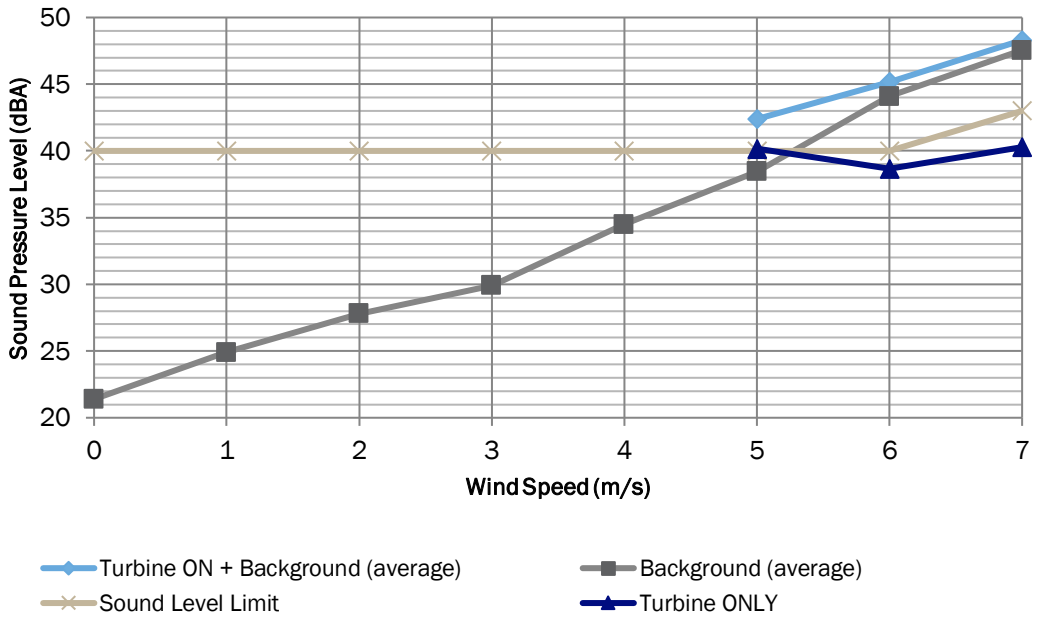
Table 5: Assessment Table

Measurement Location	Wind speed at 10m height [m/s]	0	1	2	3	4	5	6	7
R2956	Turbine ON L_{Aeq} [dBA]	*	*	*	39	40	42	45	48
	Turbine OFF L_{Aeq} [dBA]	21	25	28	30	35	38	44**	48**
	Turbine ONLY L_{Aeq} [dBA]	*	*	*	*	*	40	39†	40†
MECP Limit [dBA]		40	40	40	40	40	40	40	43
Compliance? [Y/N]		-	-	-	-	-	Y	Y	Y

† Higher uncertainty on calculated Turbine ONLY levels in cases where the measured ambient sound level (Turbine OFF) is within 1 dB of the measured Turbine ON level
*Insufficient amount of data points to calculate Turbine ONLY level as per RAM-I protocol
** Background sound level is greater than the applicable exclusion limit

The data from Table 10 is plotted in Figure 2.

Figure 2: R2956 Turbine Levels compared to MECP Limits



6.2 Tonality

The tonality analysis results of the Emission audit measurements for T10, T58, T60 and T63 were used as a basis for tones at receptors which were likely to have been generated by the closest turbine rather than an external source.

Based on discussions with Grand Renewable Wind L.P. it was determined that to be consistent with Sections 3.8.3 and Section 5.1 of the Compliance protocol, the tonal assessment should be completed using IEC 61400-11 Ed. 3.0, with modifications to adapt the method to immission measurements and the tonal penalty structure taken from ISO 1996-2:2007 Annex C. Namely, Section 5.1 of the compliance protocol states:

> *If a tonal assessment … indicates a tonal audibility value that exceeds 4 dB, the Ministry will require that a tonal penalty be applied at all Receptors in accordance with the penalties described in Annex C of ISO 1996-2, Reference [2]*

For the tonal assessment, narrowband data was acquired and calculated for each 1-minute interval used in the immission analysis and binned by wind speed. Each minute was analysed in order to detect any tones with tonal audibility greater than -3 dB at any of the measured frequencies. Similar to the methodology in IEC 61400-11, a tone would have to be present in at least 20% of the sample to be deemed as relevant. This reduces the possibility of intermittent tones related to either the unsteady operation of the turbines, or from other contaminating sources, being attributed to the steady state operation of the turbines. The tonal audibility for the most prominent tones in each wind bin were then evaluated to determine if a tonal penalty would be applicable. The penalty structure was taken from ISO1996-2 Annex C: namely that the tonal penalty would be a positive number between 0 dB and 6 dB based on the degree of tonal audibility of the worst-case tone. A tonal penalty is calculated as L_{ta} - 4 dB. i.e. a tonal audibility of 6.5 would incur a penalty of 2.5 dBA on the overall Turbine Only level.

No relevant tones were present in the valid data intervals, and so no tonal penalty was found to be applicable.

7 Assessment of Compliance

Based on the calculated turbine-only component indicated in Table 5 and Figure 2, the Grand Renewables Wind Farm Project was found to be compliant with MECP limits at receptor R2956 during the audit.

8 Conclusion

Aercoustics Engineering Limited has completed the additional measurements of the acoustic immission audit as requested in the letter dated October 9, 2018 by the MECP. The audit was completed as per the methodology outlined in Parts D and E of the "*MECP Compliance Protocol for Wind Turbine Noise*."

The measured levels were compared to the MECP limits, and the facility was determined to be in compliance at receptor R2956 during the audit.

9 References

[1] V. Schroter, "Renewable Energy Approval #0300-8UQPKR", Ontario Ministry of the Environment, Toronto, ON, June 15, 2012 and further modified on May 15, 2015.

[2] Ministry of the Environment and Climate Change, *"Compliance Protocol for Wind Turbine Noise"*, Ontario Ministry of the Environment, Toronto, ON, April 21, 2017.

[3] C.F. Brothers, J.R. Salmon and S.J. Corby., "Grand Renewable Energy Park Noise Assessment Report" Zephyr North, Burlington, ON, Rev. 2, May 29, 2012.

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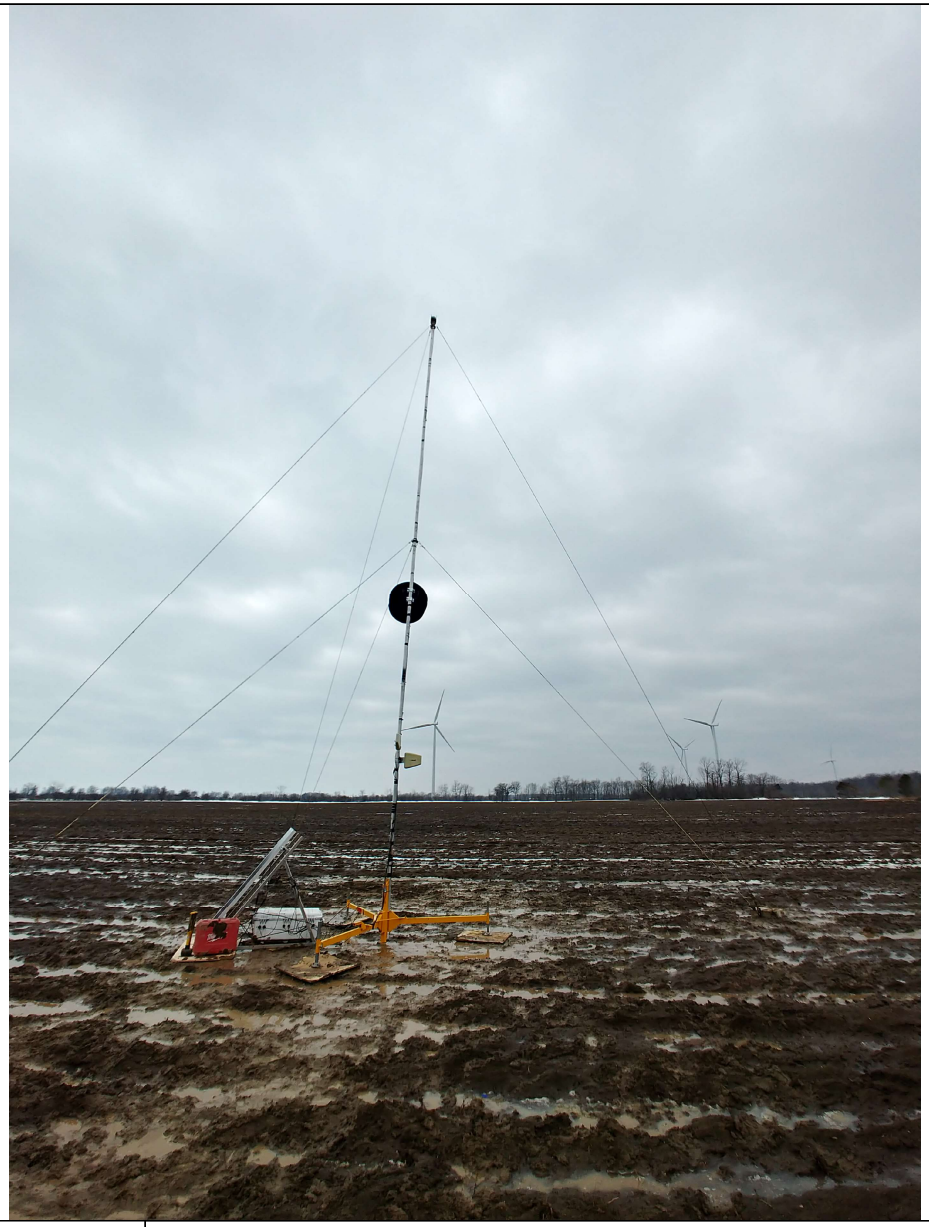
Appendix A
Location Details

aercoustics	14284.04 Scale: NTS Drawn by: IK Reviewed by: MAD Date: May 21, 2019 Revision: 1	**Project Name** Grand Renewable Wind LP - Additional Acoustic Immission Audit **Figure Title** Site Plan

Figure A.01

aercoustics	14284.04	**Project Name**
	Scale: NTS Drawn by: IK Reviewed by: MAD Date: May 21, 2019 Revision: 1	Grand Renewable Wind LP - Additional Acoustic Immission Audit
		Figure Title Monitor and Receptor Location Details
		Figure A.02



aercoustics	14284.04 Scale: NTS Drawn by: IK Reviewed by: MAD Date: May 21, 2019 Revision: 1	**Project Name** Grand Renewable Wind LP - Additional Acoustic Immission Audit **Figure Title** Site Photo - R2956 Monitor

Figure A.03

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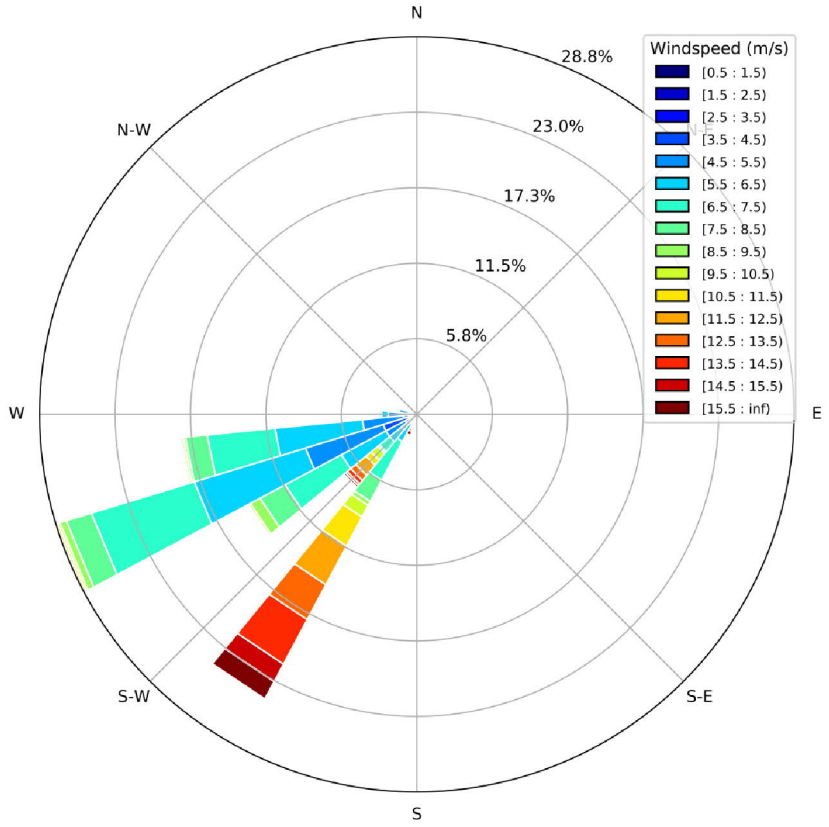
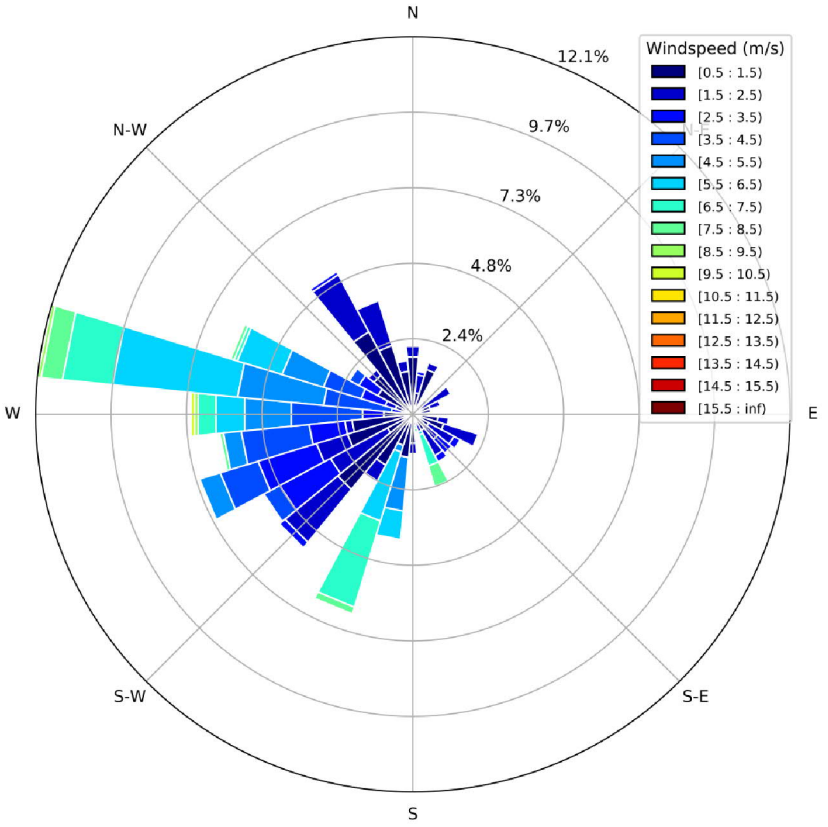
Appendix B
Wind Roses

R2956 TON	R2956 TOFF
	

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14284.04

Scale: NTS
Drawn by: IK
Reviewed by: MAD
Date: May 17, 2019
Revision: 1

Project Name

Grand Renewable Wind LP- Additional Acoustic Immission Audit

Figure Title

Wind Roses 10m height - R2956

Figure B.01

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Appendix C
Turbine Operational Statement from Operator

Grand Renewable Wind LP
2788 Haldimand Rd. 20
Haldimand, ON N0A 1E0
www.grandrenewablewind.ca

September 24th, 2019

Director, Environmental Approvals Access and Service Integration Branch
Ministry of the Environment
2 St.Clair Avenue West, Floor 12A
Toronto ON M4V1L5

Subject: Grand Renewable Wind LP Renewable Energy Approval number REA-0300-8UQPKR
Condition-Receptor audit imission R2956

Dear Director

Please accept this letter as confirmation that all turbines tested during the spring audit of 2019 acoustics measurement campaign conducted by Aercoustics LTD. from February 21 to April 25 2019 were operating normally for the duration of the campaign, with the exception of specific time periods during which the turbines were placed in remote owner stop to facilitate ambient noise measurements. The turbines for ambient noise measurements were T01, T03, T07, T08, T54 and T69. The turbines verified for operational measurements were T01, T02, T03, T06, T07, T08, T26, T54 and T69.

Sincerely,

Phillip Legroulx
Facility Manager

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Appendix D
Tonality Assessment

Appendix D - Tonality Assessment Summary

Project: Grand Renewable Wind LP - Additional Acoustic Immission Audit

Report ID: 14284.04

Created on: 2019-05-24

R2956 Tonality Summary							
Wind Speed (m/s)	Data Count	Tone Count	Tonal Presence (%)	Turbine ONLY (dBA)	MECP Sound Level Limit (dBA)	Mean Tonal Audability (dB)	Applicable Tonal Penalty (dB)
0	0	0	**	**	40	*	0
1	0	0	**	**	40	*	0
2	0	0	**	**	40	*	0
3	11	0	0%	*	40	NA	0
4	30	0	0%	*	40	NA	0
5	93	0	0%	40	40	NA	0
6	136	0	0%	39	40	NA	0
7	139	0	0%	40	43	NA	0

* Insufficient amount of data points as per RAM-I protocol

** No data points at wind speed

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Appendix E
Calibration Certificates

CERTIFICATE of CALIBRATION

Make :	Bruel & Kjaer	Reference # :	153516
Model :	2250	Customer :	Aercoustics Engineering Ltd Mississauga, ON
Descr. :	Sound Level Meter Type 1		
Serial # :	3004431	P. Order :	2018.07.31C
Asset # :	00039		

Cal. status : Received in spec's, no adjustment made.

Navair Technologies certifies that the above listed instrument was calibrated on date noted and was released from this laboratory performing in accordance with the specifications set forth by the manufacturer.

Unless otherwise noted in the calibration report a 4:1 accuracy ratio was maintained for this calibration.

Our calibration system complies with the requirements of ISO-9001-2008 and is registered under certificate CA96/269, working standards used for calibration are certified by or traceable to the National Research Council of Canada or the National Institute of Standards and Technology.

Calibrated : Aug 03, 2018 By : Petro Onasko

Cal. Due : Aug 03, 2020

Temperature : 23 °C ± 2 °C Relative Humidity : 30% to 70%

Standards used : J-216 J-303 J-512

Navair Technologies

REPAIR AND CALIBRATION TRACEABLE TO NRC AND NIST

6375 Dixie Rd. Mississauga, ON, L5T 2E7
Phone : 905 565 1584 Fax: 905 565 8325
http: // www.navair.com
e-Mail: service @ navair.com

NT NAVAIR TECHNOLOGIES

6375 Dixie Rd Unit# 7,
Mississauga, ON L5T 2E7
Tel: (905)565-1583
Fax: (905)565-8325

Form: BK2250	Approved by: JR	May-09	ver 1.0

Calibration Report part of Certificate: 153516

Make	Model	Serial	Asset
Brüel & Kjær	2250	3004431	00039

With mike 4189 S# 2888684 & preamp ZC0032 S# 20151

TYPE 1 Specs

Test	Min	Reading	Max	In/Out
Freq.Response Tested with dummy mike WTG Curve Check		IEC61672-1 limits		
		dBA		
31.5 Hz	72.6	74.6	76.6	In
63 Hz	86.3	87.8	89.3	In
125 Hz	96.4	97.8	99.4	In
250 Hz	103.9	105.4	106.8	In
500 Hz	109.4	110.8	112.2	In
1 kHz	112.9	114.0	115.1	In
2 kHz	113.6	115.2	116.8	In
4 kHz	113.4	115.0	116.6	In
8 kHz	109.8	112.9	115.0	In
12.5 kHz	103.7	109.3	112.7	In
		dBC		
31.5 Hz	109.0	111.0	113.0	In
63 Hz	111.7	113.2	114.7	In
125 Hz	112.3	113.9	115.3	In
250 Hz	112.5	114.0	115.4	In
500 Hz	112.6	114.0	115.4	In
1 kHz	112.9	114.0	115.1	In
2 kHz	112.2	113.9	115.4	In
4 kHz	111.6	113.2	114.8	In
8 kHz	107.9	111.0	113.1	In
12.5 kHz	101.8	107.4	110.8	In

NAVAIR TECHNOLOGIES

6375 Dixie Rd Unit# 7,
Mississauga, ON L5T 2E7
Tel: (905)565-1583
Fax: (905)565-8325

Test	Min	Reading	Max	In/Out
		dBZ		
31.5 Hz	112.0	114.1	116.0	In
63 Hz	112.5	114.0	115.5	In
125 Hz	112.5	114.0	115.5	In
250 Hz	112.5	114.0	115.4	In
500 Hz	112.6	114.0	115.4	In
1 kHz	112.9	114.0	115.1	In
2 kHz	112.4	114.0	115.6	In
4 kHz	112.4	114.0	115.6	In
8 kHz	110.9	114.0	116.1	In
12.5 kHz	108.0	113.6	117.0	In
Scale Test with microphone Scale dBc @1kHz I/P dB 20 - 140dB Range				
114	113.5	114.0	114.5	In
104	103.5	104.0	104.5	In
94	93.5	94.0	94.5	In
Impulse Test				Pass
Fast/Slow				Pass
AC O/P				Pass
Source operation				Pass

SOH Wind Engineering LLC
141 Leroy Road · Williston, VT 05495 · USA
Tel 802.316.4368 · Fax 802.735.9106 · www.sohwind.com

CERTIFICATE FOR CALIBRATION OF SONIC ANEMOMETER

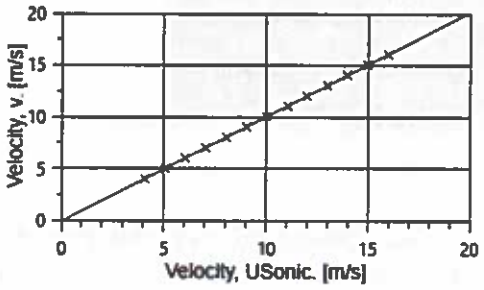
Certificate number: 19.US2.01179 **Date of issue:** January 29, 2019
Type: Vaisala Weather Transmitter, WXT520 **Serial number:** L0910579
Manufacturer: Vaisala, Oyj, Pl 26, FIN-00421 Helsinki, Finland
Client: Aercoustics Engineering Ltd., 1004 Middlegate RD, Suite 1100, S.Tower, Mississauga, ON L4Y 1M4, Canada

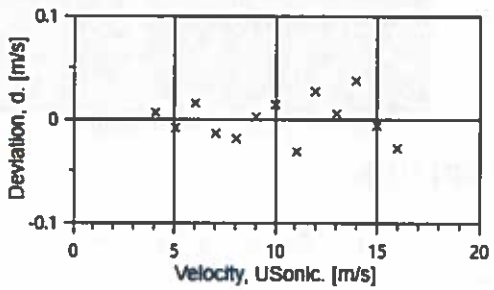
Anemometer received: January 24, 2019 **Anemometer calibrated:** January 29, 2019
Calibrated by: MEJ **Procedure:** MEASNET, IEC 61400-12-1:2017 Annex F
Certificate prepared by: EJF **Approved by:** Calibration engineer, EJF

Calibration equation obtained: v [m/s] = 1.01104 · U [m/s] + -0.10667

Standard uncertainty, slope: 0.00158 **Standard uncertainty, offset:** -0.16044
Covariance: -0.0000257 (m/s)²/m/s **Coefficient of correlation:** ρ = 0.999986
Absolute maximum deviation: 0.037 m/s at 14.051 m/s
Barometric pressure: 1000.5 hPa **Relative humidity:** 7.2%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	d.p. box [°C]	Wind velocity, v. [m/s]	Anemometer Output, U. [m/s]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.45	22.4	26.8	4.005	4.0600	0.006	0.024
4	14.73	22.5	26.8	4.999	5.0586	-0.008	0.028
6	21.30	22.5	26.8	6.012	6.0367	0.015	0.032
8	28.89	22.5	26.8	7.002	7.0450	-0.014	0.037
10	37.89	22.5	26.9	8.020	8.0567	-0.019	0.042
12	47.99	22.5	26.9	9.025	9.0300	0.002	0.046
13-last	59.20	22.5	26.9	10.025	10.0069	0.014	0.051
11	71.80	22.5	26.9	11.041	11.0567	-0.032	0.056
9	85.19	22.5	26.9	12.026	11.9733	0.027	0.061
7	100.19	22.5	26.8	13.042	13.0000	0.005	0.065
5	116.30	22.5	26.8	14.051	13.9667	0.037	0.070
3	133.28	22.4	26.8	15.042	14.9900	-0.007	0.075
1-first	151.32	22.3	26.8	16.025	15.9833	-0.028	0.079





AC-1746

EQUIPMENT USED

Serial Number	Description
Njord2	Wind tunnel, blockage factor = 1.0035
13924	Control cup anemometer
-	Mounting tube, D = 19 mm
TT003	Summit Electronics, 1XPT100, 0-10V Output, wind tunnel temp.
TP001	PR Electronics 5102, 0-10V Output, differential pressure box temp.
DP008	Setra Model 239, 0-1inWC, differential pressure transducer
HY002	Dwyer RHP-2D20, 0-10V Output, humidity transmitter
BP001	Setra Model 278, barometer
PL3	Pitot tube
XB001	Computer Board. 16 bit A/D data acquisition board
66GSPS1	PC dedicated to data acquisition

Traceable calibrations of the equipment are carried out by external accredited institutions: Atlantic Scale, Essco Calibration Labs & Furness Controls. A real-time analysis module within the data acquisition software detects pulse frequency.

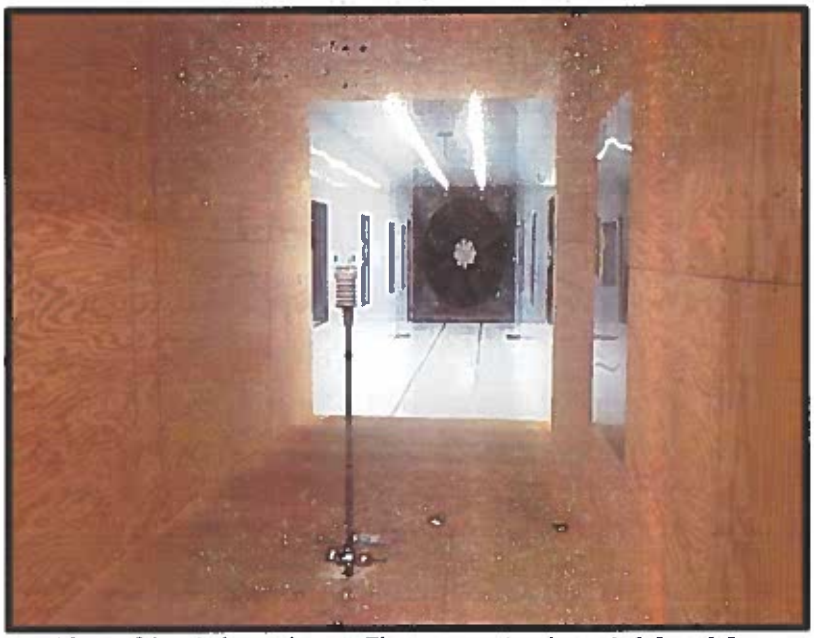


Photo of the wind tunnel setup. The cross-sectional area is 2.5m x 2.5m.

UNCERTAINTIES

The documented uncertainty is the total combined uncertainty at 95% confidence level (k=2) in accordance with EA-4/02. The uncertainty at 10 m/s comply with the requirements in the IEC 61400-12-1:2005 procedure. See Document US.12.01.004 for further details.

COMMENTS

This sensor was calibrated at the 0° position.

Certificate number: 19.US2.01179

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Tel 802.316.4368 · Fax 802.735.9106 · www.sohwind.com

CERTIFICATE FOR CALIBRATION OF SONIC ANEMOMETER

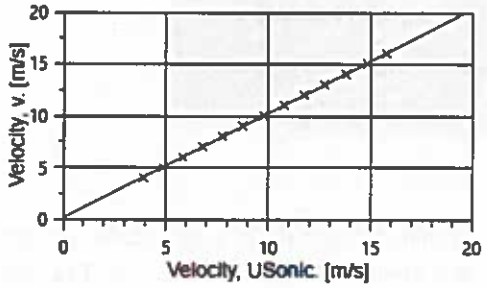
Certificate number: 19.US2.01180 **Date of issue:** January 29, 2019
Type: Vaisala Weather Transmitter, WXT520 **Serial number:** L0910579
Manufacturer: Vaisala, Oyj, PI 26, FIN-00421 Helsinki, Finland
Client: Aercoustics Engineering Ltd., 1004 Middlegate RD, Suite 1100, S.Tower, Mississauga, ON L4Y 1M4, Canada

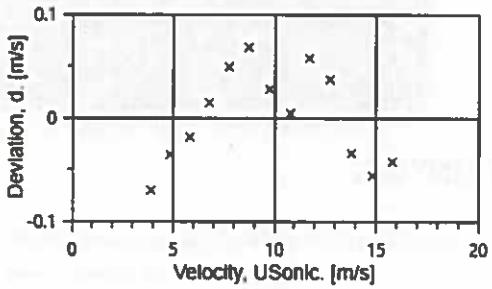
Anemometer received: January 24, 2019 **Anemometer calibrated:** January 29, 2019
Calibrated by: MEJ **Procedure:** MEASNET, IEC 61400-12-1:2017 Annex F
Certificate prepared by: EJF **Approved by:** Calibration engineer, EJF

Calibration equation obtained: v [m/s] = 1.00961 · U [m/s] + 0.14257

Standard uncertainty, slope: 0.00354 **Standard uncertainty, offset:** 0.26280
Covariance: -0.0001253 (m/s)²/m/s **Coefficient of correlation:** ρ = 0.999931
Absolute maximum deviation: -0.070 m/s at 4.003 m/s
Barometric pressure: 1000.4 hPa **Relative humidity:** 7.3%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	d.p. box [°C]	Wind velocity, v. [m/s]	Anemometer Output, U. [m/s]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.44	22.6	27.0	4.003	3.8933	-0.070	0.024
4	14.71	22.6	27.0	4.998	4.8448	-0.036	0.028
6	21.27	22.6	27.0	6.010	5.8300	-0.019	0.032
8	28.92	22.6	27.0	7.009	6.7867	0.015	0.037
10	37.96	22.6	27.0	8.030	7.7633	0.049	0.042
12	47.98	22.6	27.0	9.028	8.7333	0.068	0.046
13-last	59.22	22.6	27.1	10.030	9.7655	0.028	0.051
11	71.71	22.6	27.0	11.037	10.7867	0.004	0.056
9	85.32	22.6	27.0	12.039	11.7267	0.057	0.061
7	100.02	22.6	27.0	13.035	12.7333	0.037	0.065
5	115.87	22.6	27.0	14.031	13.7900	-0.034	0.070
3	133.37	22.6	27.0	15.053	14.8233	-0.056	0.075
1-first	151.57	22.5	26.9	16.045	15.7933	-0.043	0.080





AC-1746

EQUIPMENT USED

Serial Number	Description
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-	Mounting tube, D = 19 mm
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BP001	Setra Model 278, barometer
PL3	Pitot tube
XB001	Computer Board. 16 bit A/D data acquisition board
66GSPS1	PC dedicated to data acquisition

Traceable calibrations of the equipment are carried out by external accredited institutions: Atlantic Scale, Essco Calibration Labs & Furness Controls. A real-time analysis module within the data acquisition software detects pulse frequency.

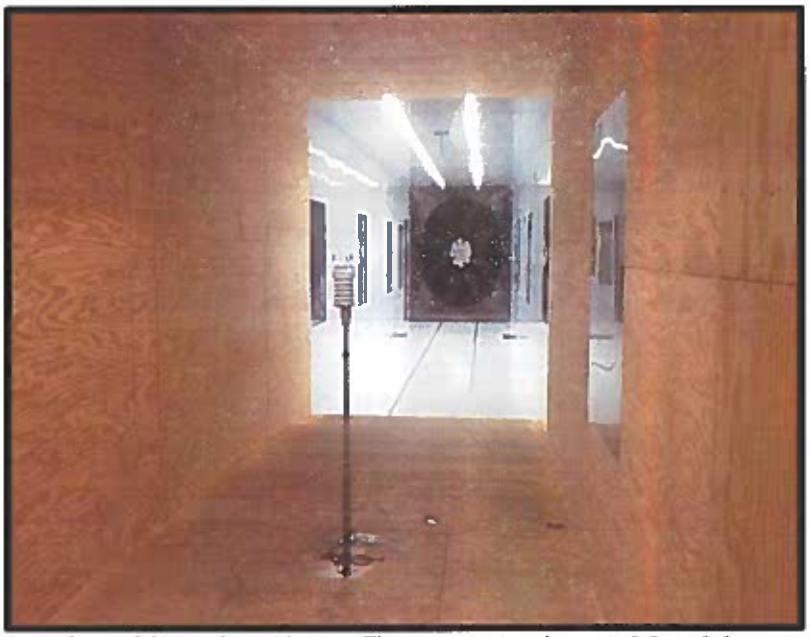

Photo of the wind tunnel setup. The cross-sectional area is 2.5m x 2.5m.

UNCERTAINTIES

The documented uncertainty is the total combined uncertainty at 95% confidence level (k=2) in accordance with EA-4/02. The uncertainty at 10 m/s comply with the requirements in the IEC 61400-12-1:2005 procedure. See Document US.12.01.004 for further details.

COMMENTS

This sensor was calibrated at the 90° position.

Certificate number: 19.US2.01180

aercoustics

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Appendix F
I-Audit Checklist

Appendix F7: I-Audit checklist

Wind Energy Project – Screening Document – Acoustic Audit Report – Immission

Information Required in the Acoustic Audit Report – Immission

Item	Description	Complete?	Comment
1	Did the Sound level Meter meet the Type 1 Sound level meter requirements according to the IEC standard 61672-1 Sound level Meters, Part 1: Specifications? Section D2.1.1	✓	
2	Was the complete sound measurement system, including any recording, data logging or computing systems calibrated immediately before and after the measurement session at one or more frequencies using an acoustic calibrator on the microphone (must not exceed +0.5dB)? Section D2.1.3	✓	
3	Are valid calibration certificate(s) of the noise monitoring equipment and calibration traceable to a qualified laboratory? Is the validity duration of the calibration stated for each item of equipment? Section D2.3	✓	
4	Was the predictable worst case parameters such as high wind shear and wind direction toward the Receptor considered? Section D3.2	✓	
5	Is there a Wind Rose showing the wind directions at the site? Section D7 (1e)	✓	
6	Did the results cover a wind speed range of at least 4-7 m/s as outlined in section D 3.8.?	✓	
7	Was the weather report during the measurement campaign included in the report? Section D7 (1c)	✓	
8	Did the audit state there was compliance with the limits at each wind speed category? Section D6	✓	
9	Are pictures of the noise measurement setup near Point of reception provided? Section D3.3.2 & D3.4	✓	
10	Was there justification of the Receptor location choice(s) prior to commencement of the I-Audit? Section D4.1	✓	
11	Was there sufficient valid data for different wind speeds? Section D5.2 # 3	✓	
12	Was the turbine (operational) specific information during the measurement campaign in tabular form (i.e. wind speed at hub height, anemometer wind speed at 10 m height, air temperature and pressure and relative humidity) Section D3.7	✓	
13	Were all the calculated standard deviations at all relevant integer wind speeds provided? Section D7 (2d)	✓	
14	Compliance statement	✓	
15	All data included in an Excel spreadsheet	✓	
16	If deviations from standard; was justification of the deviations provided	⊘	No Deviations