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ASSESSMENT REPORT - **Project: 15002.00**

Bow Lake Wind Project
Acoustic Immission Audit – Phase 2

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Revision History

Revision Number	Description	Date
1	- Phase 2 Receptor Immission Audit Report	01/25/2019

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Executive Summary

Aercoustics Engineering Limited ("Aercoustics") has been retained by Nodin Kitagan L.P. c/o BluEarth Renewables Inc. to complete the acoustic immission audit outlined in the Renewable Energy Approval ("REA") for the Bow Lake Wind Project ("BLWP") and updated audit requirements provided by the Ministry of Environment Conservation and Parks "MECP" in a letter dated March 19, 2018. BLWP operates under REA #8443-9BMG23, issued on December 16, 2013 [1].

This report details the 2nd measurement campaign of the BLWP immission audit. Monitoring near receptors R31 and R34 spanned the following dates:

Location	Monitoring Start Date	Monitoring End Date	Monitoring Duration (weeks)
R31	May 30, 2018	September 20, 2018	16
R34	May 30, 2018	July 22, 2018	8

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 site topography and surrounding dense forest limited the data points collected to wind speeds from 0-1 m/s for R31 and 0-4 m/s for R34. Due to the inherent challenges of acquiring data at this site only two (2) wind bins between 0 m/s and 7 m/s inclusive are required as a minimum reporting requirement as per correspondence with the MECP approvals branch.

The RAM-I sample size requirement was satisfied for receptor R31 and R34, the two wind bins to satisfy the data count requirements were 0 and 1 m/s and 1 and 2m/s respectively.

The filtered RAM-I audit data at 0-2 m/s at both receptor R31 and R34 represent the worst-case scenario i.e. Maximum noise output and downwind conditions, with maximum wind shear conditions (high winds at hub height and low winds at receptor location).

The measured turbine-only noise impact at the audit locations 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 receptors R31 and R34 during the audit.

1 Introduction

Aercoustics Engineering Limited ("Aercoustics") has been retained by Nodin Kitagan L.P. c/o BluEarth Renewables Inc. to complete the acoustic immission audit outlined in the Renewable Energy Approval ("REA") for the Bow Lake Wind Project ("BLWP") and updated audit requirements provided by MECP in a letter dated March 19, 2018 (MECP letter provided in Appendix G). BLWP operates under REA #8443-9BMG23, issued on December 16, 2013 [1].

The report has been prepared to facilitate submission to the MECP, in compliance with acoustic audit conditions outlined in the facility's REA (#8443-9BMG23) section D (Wind Turbine Acoustic Audit – Immission). The audit has been completed as per the methodology outlined in Parts D and E5.5 RAM-I (Revised Assessment Methodology) of the Ontario Ministry of Environment, Conservation and Parks "*MECP Compliance Protocol for Wind Turbine Noise*" (Updated: April 21, 2017) [2]. 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 Bow Lake Wind Project utilizes 36 General Electric GE 1.6 -100 wind turbines for power generation, each having a nameplate capacity of 1.62 MW respectively. Each turbine has a hub height of 96 meters and a rotor diameter of 100 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 receptors R31 and R34[1]. Monitoring at R31 and R34 spanned the following dates, summarized in Table 1.

Table 1: Monitoring Period for Each Receptor

Location	Monitoring Start Date	Monitoring End Date	Monitoring Duration (weeks)
R31	May 30, 2018	September 20, 2018	16
R34	May 30, 2018	July 22, 2018	8

[1] Receptor IDs taken from the Noise Assessment Report by I. Bonsma, P.Eng and B. Howe, P.Eng dated October 4, 2013 [3]

3.1 Test Equipment

The measurement equipment used for the I-audit campaign, both acoustic and environmental, is detailed below. Equipment specifications and measurement positions comply with MOECC 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, mounted at a height of 10 metres above ground level ("10-m AGL").

Table 2 provides the specific model and serial numbers for the measurement equipment used during the measurement campaign.

Table 2: Equipment Details

Location	Equipment	Make/Model	Serial Number
R31	Data Acquisition Card	NI 9234	1C009CD
	Signal Conditioner	PCB 480E09	33659
	Microphone	PCB 377B02	164139 (125633)
	Pre-Amplifier	PCB 426E01	043997
	Weather Anemometer	Vaisala WXT 520	M0410642
R34	Data Acquisition Card	NI 9234	1A5E7FC
	Signal Conditioner	PCB 480E09	33657
	Microphone	PCB 377B02	167926 (125630)
	Pre-Amplifier	PCB 426E01	044003
	Weather Anemometer	Vaisala WXT 520	M4910193

The measurement chain was 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 (LA_{eq}), percentile statistical levels (L90), and 1/3 octave band levels between 20 Hz and 20,000 Hz. 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 LAeq and L90 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 LA_{eq} was no more than 10 dB greater than the L90 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: Bow Lake turbines must be rotating and generating power
- Background: Bow Lake turbines must be parked and not generating power

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)}*

And

> *"Only data when the turbine's electrical output sound power level is approximately equal to or greater than 85% of its rated electrical power output should be included in the analysis. In addition, the turbine should also be operating at approximately*

90% or more of its maximum sound power level; (percentage based on energy / logarithmic calculation). {Section D5.2 (5)}

As such data for Receptor R34 was filtered for times when WTG-36 electrical output is equal to or greater than 85% of the turbine's rated electrical power output and downwind of WTG-36.

The closest turbines to Receptor R31 are WTG-30 and WTG35. WTG-30 and WTG-35 is located approximately 1009m and 1057m from R31 respectively. WTG-30 and WTG-35 are located on opposite sides of R31. As the distance between the closest turbines (WTG-30 and WTG-35) and R31 is comparable, data has been filtered for downwind direction and 85% electrical power for each turbine and presented separately.

3.4 Influence of Flora and Fauna

Contamination of the acoustic data due to the presence of animal calls was noted in the data collected at both monitoring locations. The contaminated acoustic data from animal calls have been verified by listening tests and removed from the analysis.

Contamination of the data due to the presence of insects was noted in data collected. The acoustic energy from insects were present from above 2000Hz and dominated the overall level for both Turbine ON and ambient measurements. The frequency ranges used for this filter was determined based on site-specific conditions to discount the effect of the contaminated insect noise.

3.5 Measurement Location

Monitoring was conducted at Receptors R31 and R34.These locations were chosen based on updated audit requirements provided by the MECP in a letter dated March 19, 2018. R31 and R34 have a predicted impact of 39.9 dBA and 38.4 dBA respectively, as per level predicted from an "As Built" noise model based on the original CadnaA noise prediction model. The following describes the measurement locations in relation to the above listed receptors:

- M31: Measurement equipment was placed approximately 15m west of R31, 1022 m to turbine WTG-30 and 1057m to WTG-35. The predicted level based on the acoustic model at R31 is 39.6 dBA.

- M34: Measurement equipment was placed approximately 35m south-west of R34, 894 m to the nearest turbine WTG-36. The predicted level based on the acoustic model at M34 is 38.2 dBA.

The following table provides a summary of the receptor locations. Detailed site plans showing the receptor and audit locations are attached in Appendix A.

Table 3: Receptor Measurement Locations

	Audit Receptor ID Nearest Turbine ID	R31 WTG-30/WTG-35	R34 WTG-36
Receptor	UTM Coordinates (X,Y)	17T 690036mE 5230677mN	17T 688657mE 5227556mN
	Distance to Nearest Turbine	1009m/1077m	878m
	Predicted Level dBA*	39.9	38.3
Monitor	UTM Coordinates (X,Y)	17T 690011mE 5230686mN	17T 688603mE 5227548mN
	Distance to Nearest Turbine	1022m/1057m	894m
	Predicted Level dBA**	39.9	38.2

* Predicted level from Noise Assessment Report, HGC Engineering, October 4, 2013
** Predicted level from Aercoustics' acoustic model

3.6 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).

The Revised Assessment Methodology for I-Audits (RAM-I) may allow for a lower amount of data points to be used in the analysis, provided that the quality of data remains high. RAM-I analysis was conducted as per Section 5.5 of the Protocol. This methodology is employed in cases where insufficient data is collected despite sound monitoring lasting longer than 6 weeks.

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 for 2 wind speed bins has been satisfied for receptors R31 and R34 in wind speed bins between 1 and 4 m/s (inclusive).

3.7 Operational Conditions

Turbine operational data for the duration of the measurement campaign was supplied by BLWP. Measurement data at each receptor was filtered to include only intervals when all turbines in the immediate vicinity were operational, or, in the case of the ambient noise measurements, were not operational. The turbines included in this study were chosen such that when they are turned off, the partial impact of the remaining turbines was less than 30dBA; 10dB below the sound level limit. The specific turbines parked for ambient measurements were WTG26, WTG27, WTG28, WTG29, WTG30, WTG32, WTG33, WTG34, WTG35, WTG36, WTG37, WTG38, and WTG39.

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 4 below.

Table 4: MECP Sound Level Limits for Wind Turbines

Wind speed at 10m height [m/s]	MECP Sound level limit [dBA]
0	40
1	40
2	40
3	40
4	40

5 Audit Results

Acoustic and weather data measured during the I-audit campaign are summarized in the following section.

5.1 Weather Conditions

General weather conditions measured over the course of the Phase 1 I-audit are summarized in Table 5.

Table 5: General Weather Conditions – Range of Measured Values

	10-m AGL				*Hub height*
	Atmospheric Pressure [hPa]	Wind Speed [m/s]	Relative Humidity [%]	Temperature [°C]	Wind speed [m/s]
Minimum	956	0.0	36	3	0.3
Maximum	985	5.8	96	25	16.4

5.2 Wind Direction

Wind roses representing the recorded wind directions during the audit are reported in Appendix B. Wind direction recorded from the turbine yaw angle, and wind speeds measured from 10-m AGL anemometer, were combined to prepare the wind roses. The wind speeds from 0-4 m/s at 10-m AGL represent the I-audit wind bins as per Section E5.5 of the Protocol.

5.3 Measured Sound Levels

Tables 5-7 detail the sound levels measured at the receptors 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. 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 6: R31 Sound levels measured for Turbine ON and OFF (Downwind - WTG-30)

I-Audit Wind Bins (m/s)	Turbine ON			Turbine OFF		
	Number of Samples	LAeq [dBA]	Std Dev [dBA]	Number of Samples	LAeq [dBA]	Std Dev [dBA]
0	59	41.5	0.2	53	35.7	0.1
1	0	*	*	0	*	*
2	0	*	*	0	*	*
3	0	*	*	0	*	*
4	0	*	*	0	*	*

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

Table 7: Table 6: R31 Sound levels measured for Turbine ON and OFF (Downwind - WTG-35)

I-Audit Wind Bins (m/s)	Turbine ON			Turbine OFF		
	Number of Samples	LAeq [dBA]	Std Dev [dBA]	Number of Samples	LAeq [dBA]	Std Dev [dBA]
0	384	39.8	1.1	2087	30.0	3.4
1	60	40.7	1.4	0	*	*
2	0	*	*	0	*	*
3	0	*	*	0	*	*
4	0	*	*	0	*	*

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

Table 8: R34 Sound levels measured for Turbine ON and OFF

I-Audit Wind Bins (m/s)	Turbine ON			Turbine OFF		
	Number of Samples	LAeq [dBA]	Std Dev [dBA]	Number of Samples	LAeq [dBA]	Std Dev [dBA]
0	118	39.4	0.9	240	19.0	2.3
1	551	39.4	1.0	177	19.1	2.5
2	80	39.9	0.9	0	*	*
3	2	38.8	0.5	0	*	*
4	0	*	*	0	*	*

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

The following figures present the scatter plots showing each valid 1-minute interval measured sound level at R31 and R34 when all the nearby turbines were ON (Turbine ON + Background) and when all the nearby turbines were OFF (Turbine OFF). 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. It should be noted that the turbine ON sound level includes all sounds measured during the interval.

Figure 1: R31 - Measured Sound Levels for Turbine ON and Background vs Wind Speed (Downwind - WTG-30)

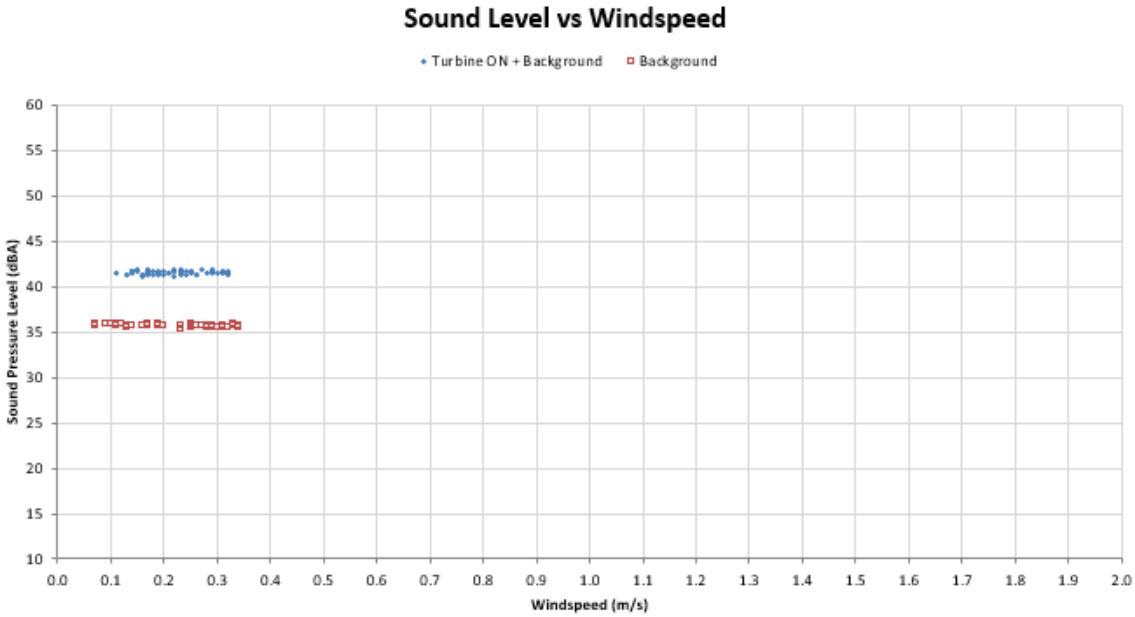


Figure 2: R31 - Measured Sound Levels for Turbine ON and Background vs Wind Speed (Downwind - WTG-35)

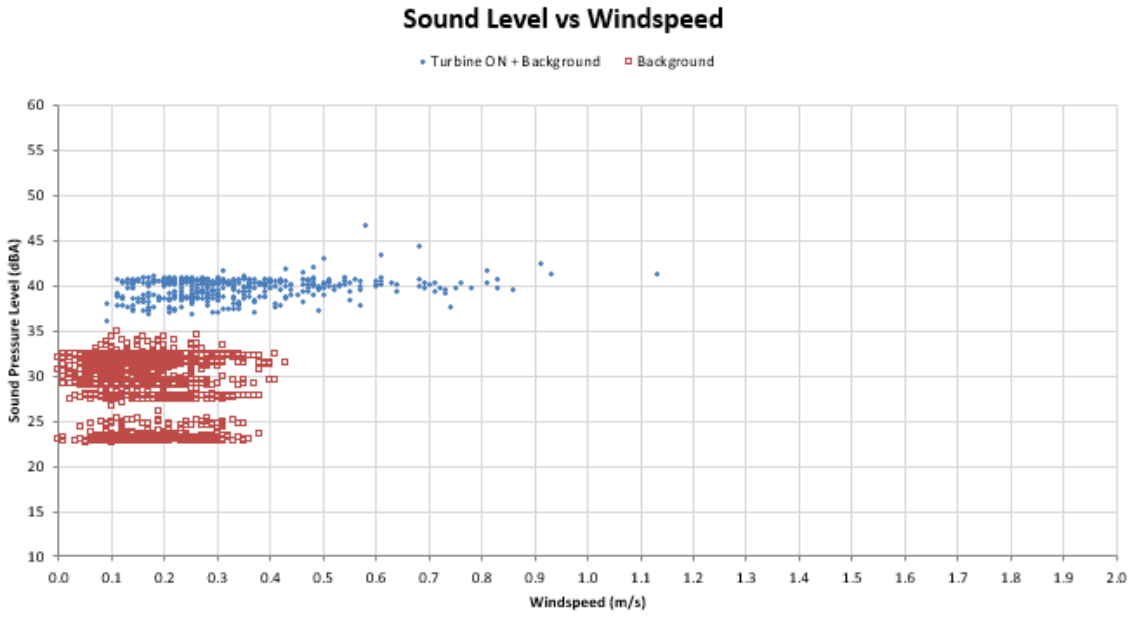
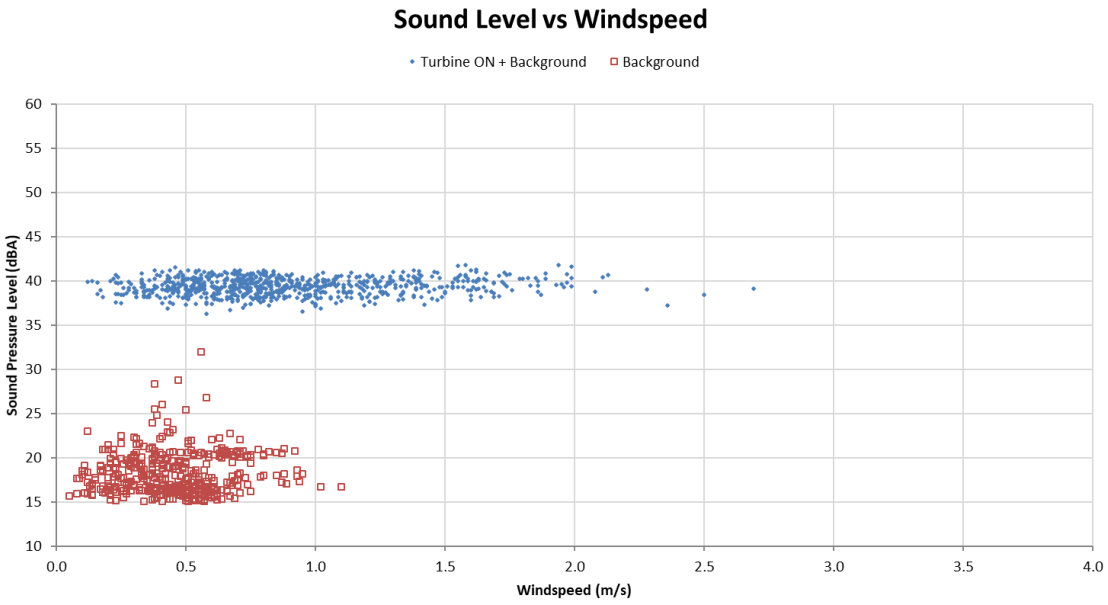


Figure 3: R34 - Measured Sound Levels for Turbine ON and Background vs Wind Speed



6 Discussion

6.1 Effect of Filtering

The measurement data was assessed according to Part D of the Protocol with incorporation of the RAM-I data reduction methodology to produce a higher quality data set suitable for an assessment of compliance. The effect of each filter on the measurement datasets are summarized in Table 9.

Table 9: Effect of Data Filtering on Measurement Dataset

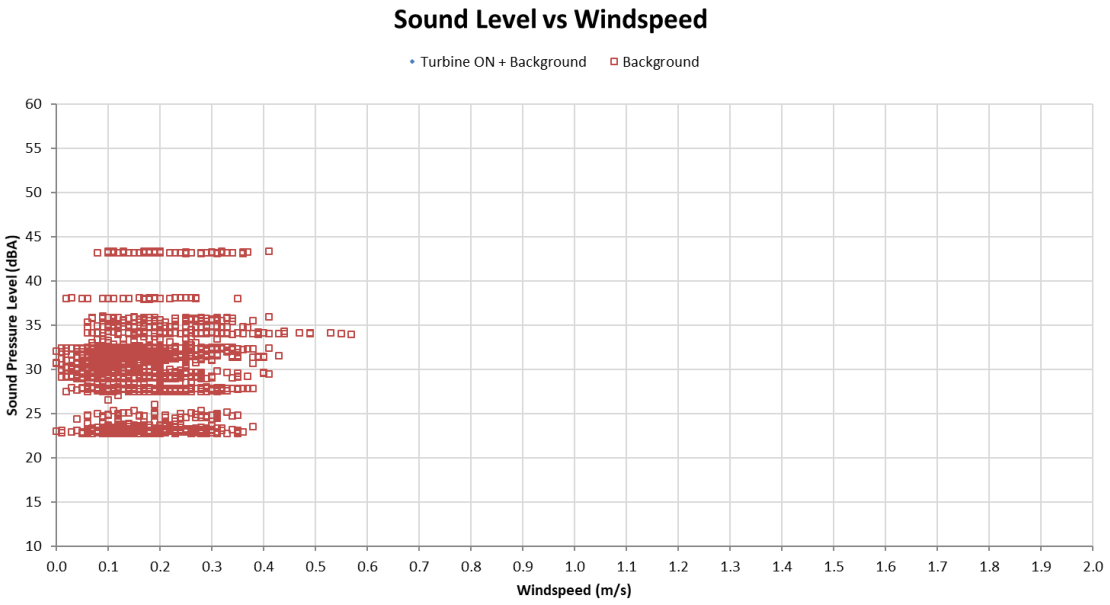
Data Excluded by Filter	R34	R31 (WTG-30)	R31 (WTG-35)
Turbine Power	84%	84%	93%
Wind Direction	57%	82%	67%
Rain	6%	9%	9%
Gusting	0%	0%	0%
Low Temperature	0%	0%	0%
Transient Contamination	0.5%	0.1%	0.1%
Turbine ON	97%	99.8%	98.7%
Background	26%	98.6%	47%

Table 9 illustrates the difficulty in acquiring data under the Protocol; however, it is noted that the data that remains after filtering is of high quality and provides a good basis for an assessment of compliance. In the case of Bow Lake Wind Project, the assessment of compliance is conducted on the worst-case 3.5% percent of the available measurement Turbine ON data.

6.2 Receptor R31 - Ambient Noise from River

The ambient sound level at Receptor R31 was determined to be variable and dependant on the flow noise from a nearby stream. Listening tests confirm that the stream is audible at the measurement location, and the ambient sound level varied between 43 dBA when the stream was full and 23 dBA when the stream was dry. Figure 4 presents the measured sound level at receptor R31 during the Turbine OFF condition.

Figure 4: R31 - Ambient Sound Level from Stream Flow Noise



It can be seen from Figure 4 that the ambient sound level forms distinct bands at 43 dBA 38 dBA, 35dBA, 30 dBA and 23 dBA which corresponds to reducing intensity of flow noise from the nearby stream.

Ambient data collected during periods including the streams maximum flow noise at the 43 dBA and 38 dBA bands have not been included in the analysis.

The background data for the analysis at R31 has been filtered such that representative periods of background noise are applied to calculate the Turbine ONLY for the downwind condition from WTG-30 and WTG-35 i.e. periods of Background data that was collected close to the time of Turbine ON data were grouped together. This is considered a reasonable assessment approach given the variability and unpredictability of the collected ambient data.

For example data filtered for Turbine ON and the downwind condition from WTG-30 occurred during the period of June 18th/19th and the representative Turbine OFF data occurred during the period of June 22nd/23rd.

7 Assessment of Compliance

7.1 Assessment table

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. Calculated Turbine ONLY levels listed were calculated based on unrounded Turbine ON and Turbine OFF values.

The audit at R31 and R34 are considered representative of the sound levels at the properties of receptor R31 and R34 respectively, given the placement of the acoustic monitoring stations.

Table 8 presents the Turbine ON, Turbine OFF and calculated Turbine ONLY sound pressure levels between 0-4 m/s. Wind bins which satisfy the RAM-I sample size requirements are highlighted in grey.

Table 8: Assessment Table

Measurement Location	Wind speed at 10m height [m/s]	0	1	2	3	4
R31 (Downwind of WTG-30)	Turbine ON LAeq [dBA]	41	*	*	*	*
	Turbine OFF LAeq [dBA]	36	*	*	*	*
	Turbine ONLY LAeq [dBA]	40	*	*	*	*
	MECP Limit	40	40	40	40	40
R31 (Downwind of WTG-35)	Turbine ON LAeq [dBA]	40	41	*	*	*
	Turbine OFF LAeq [dBA]	30	30†	*	*	*
	Turbine ONLY LAeq [dBA]	39	40	*	*	*
	MECP Limit	40	40	40	40	40
R34	Turbine ON LAeq [dBA]	39	39	40	*	*
	Turbine OFF LAeq [dBA]	19	19	*	*	*
	Turbine ONLY LAeq [dBA]	39	40	<40**	*	*
	MECP Limit	40	40	40	40	40

† 30 dBA Background correction applied as per Section E5.5 (6) of the Protocol
*Insufficient amount of data points as per RAM-I protocol
** No Background correction applied

The data from Table 8 is plotted in Figures 3 and 4.

Figure 5: R31 Turbine Levels (Downwind of WTG-30) compared to MECP Limits

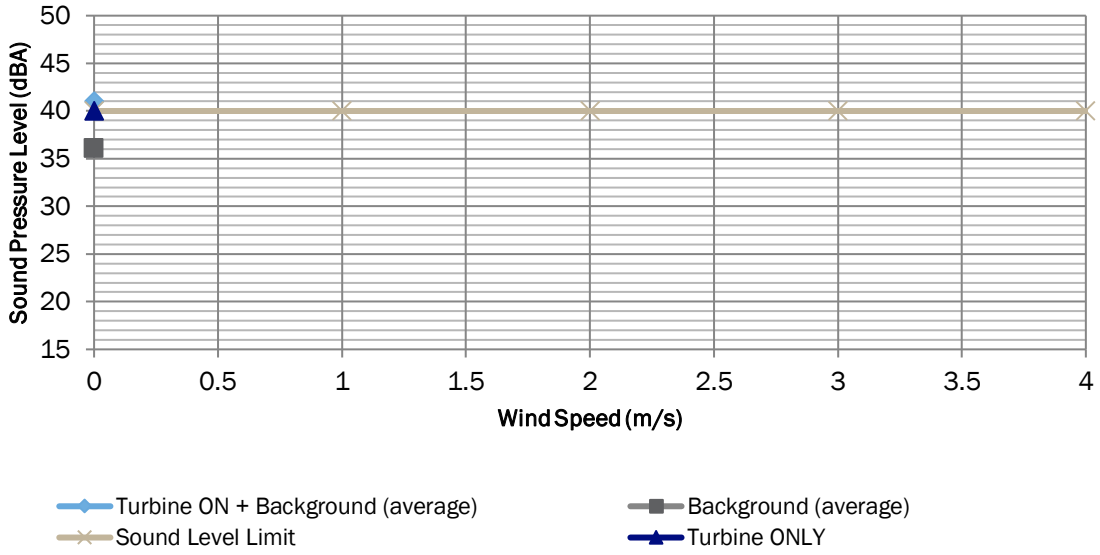


Figure 6: R31 Turbine Levels (Downwind of WTG-35) compared to MECP Limits

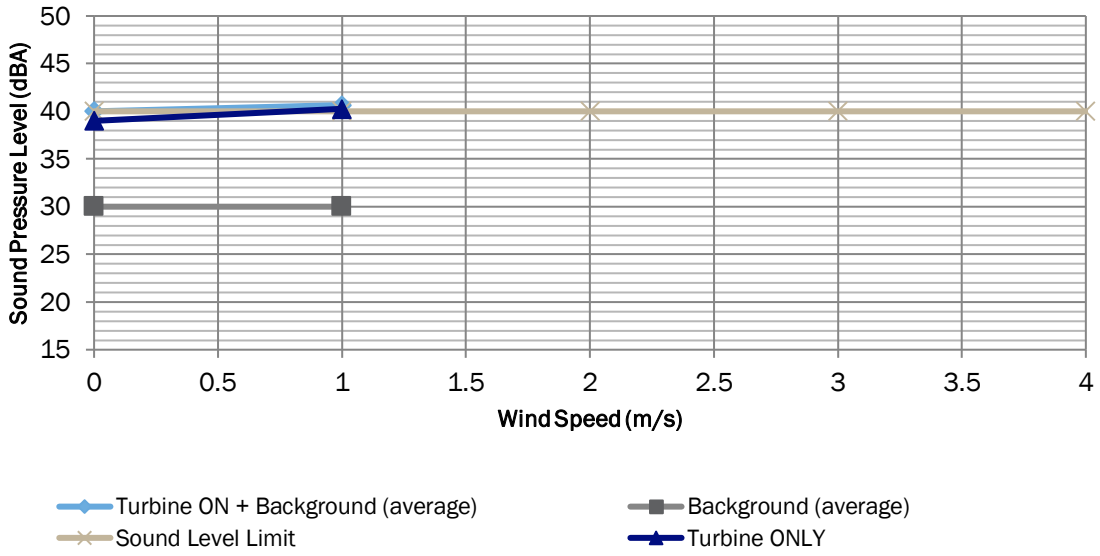
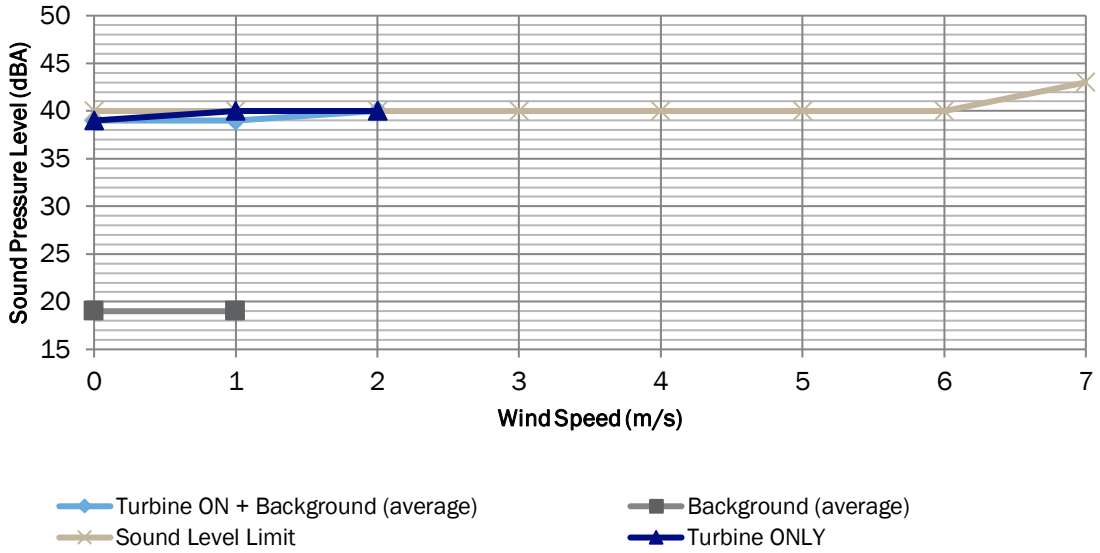


Figure 7: R34 Turbine Levels compared to MECP Limits



7.2 **Tonality**

Objective and in-depth tonality analysis was also completed based on 1-minute narrow band spectra, ranging from 20 Hz to 3000 Hz. The methodology followed that of ISO/PAS 20065:2016 with modifications to adapt the method to wind turbine immission measurements. Specifically, narrowband data was acquired and calculated for each 1-minute interval used in the immission analysis and binned by wind speed. The tonal audibility in each wind bin was then evaluated to determine if a tonal adjustment would be applicable. The tonal adjustment structure was taken from ISO1996-2:2017 Annex J: Table J.1 A 135 Hz tone attributable to the BLWP was observed at receptor R31 for downwind conditions from WTG-T35 and at receptor R34. Tonal assessment summary tables are provided below.

Table 10: Tonality Summary - R31 - Downwind of WTG30 - 135Hz

Wind Speed (m/s)	Turbine ONLY (dBA)	Mean Audibility, ΔL (dB)	Tonal Adjustment, K_T (dB)	Turbine Only + K_T (dBA)	MECP Sound Level Limit (dB)
0	40	-10.0	0	40	40
1	*	*	*	*	40
2	*	*	*	*	40
3	*	*	*	*	40
4	*	*	*	*	40

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

Table 11: Tonality Summary - R31 - Downwind of WTG35 - 135Hz

Wind Speed (m/s)	Turbine ONLY (dBA)	Mean Audibility, ΔL (dB)	Tonal Adjustment, K_T (dB)	Turbine Only + K_T (dBA)	MECP Sound Level Limit (dB)
0	39	-9.3	0	39	40
1	40	-6.9	0	40	40
2	*	*	*	*	40
3	*	*	*	*	40
4	*	*	*	*	40

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

Table 12: Tonality Summary - R34 - 135Hz

Wind Speed (m/s)	Turbine ONLY (dBA)	Mean Audibility, ΔL (dB)	Tonal Adjustment, K_T (dB)	Turbine Only + K_T (dBA)	MECP Sound Level Limit (dB)
0	39	-1.1	0	39	40
1	39	0.8	1	40	40
2	40	-0.4	0	39	40
3	*	*	*	*	40
4	*	*	*	*	40

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

No tonal adjustment was found to be applicable based on detailed tonal audibility analysis at receptor R31.

A tonal adjustment of 1 dB was found to be applicable based on detailed tonal audibility at receptor R34 at wind speed bin 1m/s. The Turbine ONLY sound level with tonal adjustment demonstrates compliance with the MECP sound level limit.

7.3 Statement of Compliance

As shown in Section 7.1 and 7.2, receptors R31 and R34 audits demonstrate compliance with the 40 dBA MECP noise level limit.

8 Conclusion

Aercoustics Engineering Limited has completed the Phase 2 acoustic immission audit outlined in the Renewable Energy Approval for the Bow Lake Wind Project. 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 receptors R31 and R34 during the audit.

References

[1] V. Schroter, “Renewable Energy Approval #8443-9BMG23”, Ontario Ministry of the Environment, Toronto, ON, December 6, 2013.

[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] M. Kozak and R. Nadolny, “Bow Lake Wind Farm Design and Operations Report”, Stantec Consulting Ltd., Guelph, ON, January 2013.

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aercoustics.com

Appendix A
Location Details

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Project #: 15002	**Project Name**
Scale: NTS Drawn by: JM Reviewed by: AM Date: Aug 08, 2018 Revision: 1	Bow Lake Wind Farm Project - 2nd Acoustic Immission Audit
	Figure Title Site Plan

Figure A.01

aercoustics

Project #: 15002	**Project Name**
Scale: NTS Drawn by: JM Reviewed by: AM Date: Aug 08, 2018 Revision: 1	Bow Lake Wind Farm Project - 2nd Acoustic Immission Audit
	Figure Title R31 - Monitor and Receptor Location Details

Figure A.02

aercoustics	Project #: 15002 Scale: NTS Drawn by: JM Reviewed by: AM Date: Aug 08, 2018 Revision: 1	**Project Name** Bow Lake Wind Farm Project - 2nd Acoustic Immission Audit **Figure Title** R34 - Monitor and Receptor Location Details

Figure A.03

aercoustics

Project #: 15002

Scale: NTS
Drawn by: JM
Reviewed by: AM
Date: Aug 08, 2018
Revision: 1

Project Name

Bow Lake Wind Farm Project - 2nd Acoustic Immission Audit

Figure Title

R31 - Site Photos

Figure A.04

aercoustics

Project #: 15002

Scale: NTS
Drawn by: JM
Reviewed by: AM
Date: Aug 08, 2018
Revision: 1

Project Name

Bow Lake Wind Farm Project - 2nd Acoustic Immission Audit

Figure Title

R34 - Site Photos

Figure A.05

aercoustics

Project #: 15002

Scale: NTS
Drawn by: JM
Reviewed by: AM
Date: Dec 05, 2018
Revision: 1

Project Name

Bow Lake Wind Farm Project - 2nd Acoustic Immission Audit

Figure Title

Site Photo - M31 - Ambient River Noise Source

Figure A.06

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Mississauga, ON L4Y 0G1

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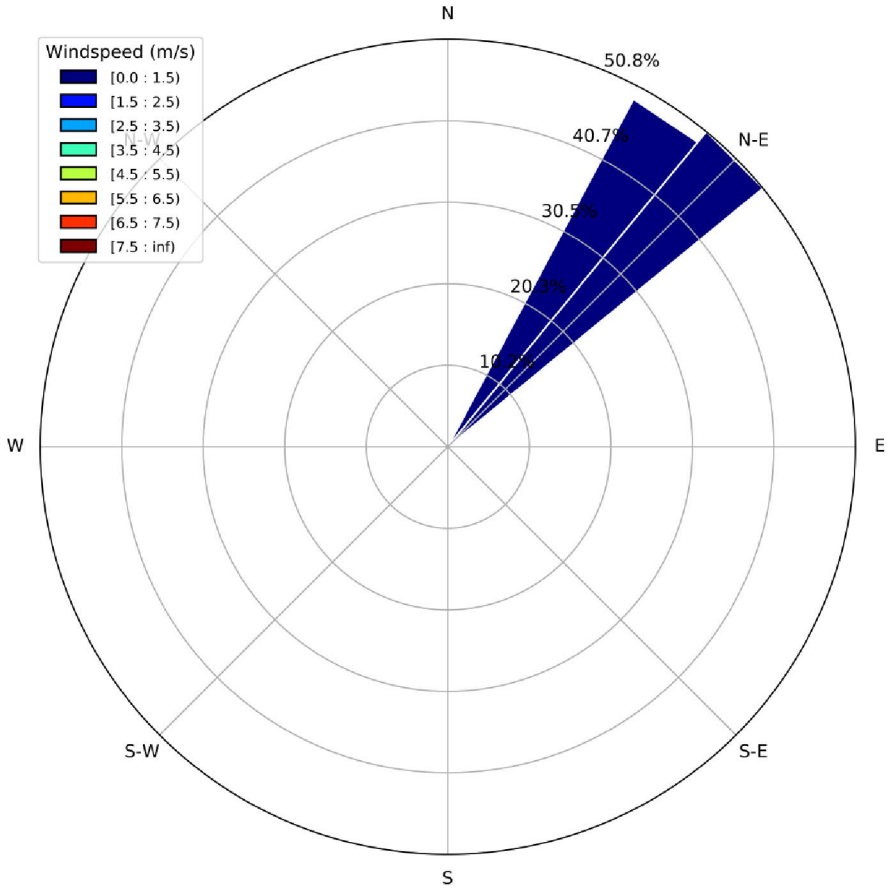
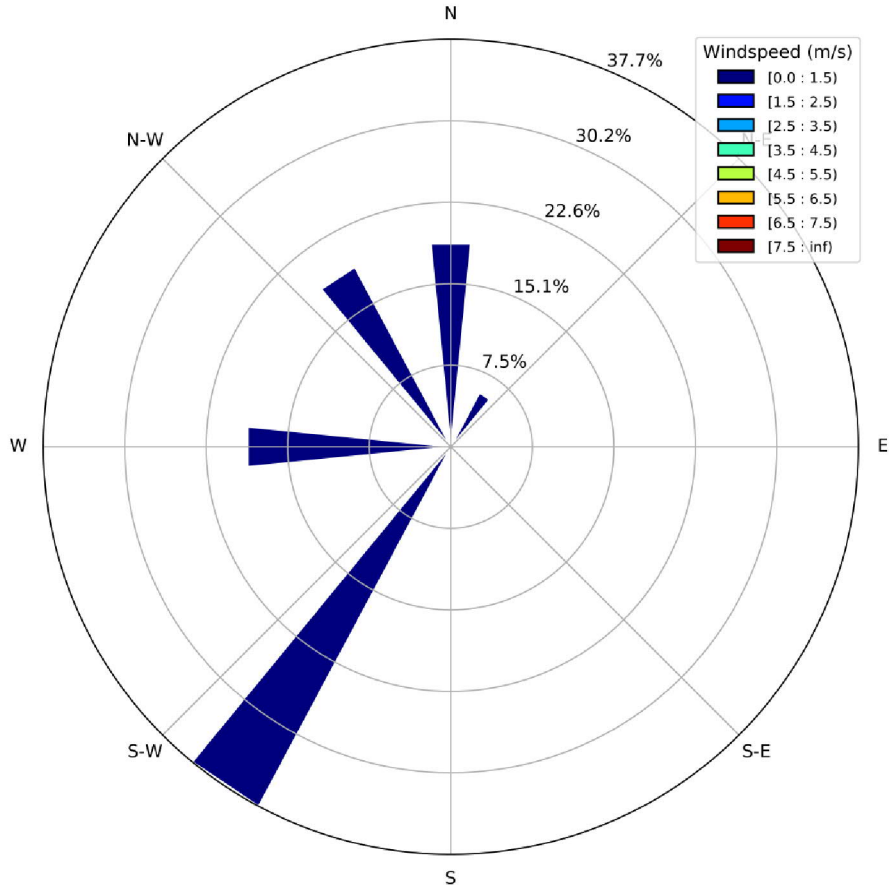
Appendix B
Wind Roses

R31 TON	R31 TOFF





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Project #: 15002

Scale: NTS
Drawn by: JM
Reviewed by: AM
Date: Dec 12, 2018
Revision: 1

Project Name

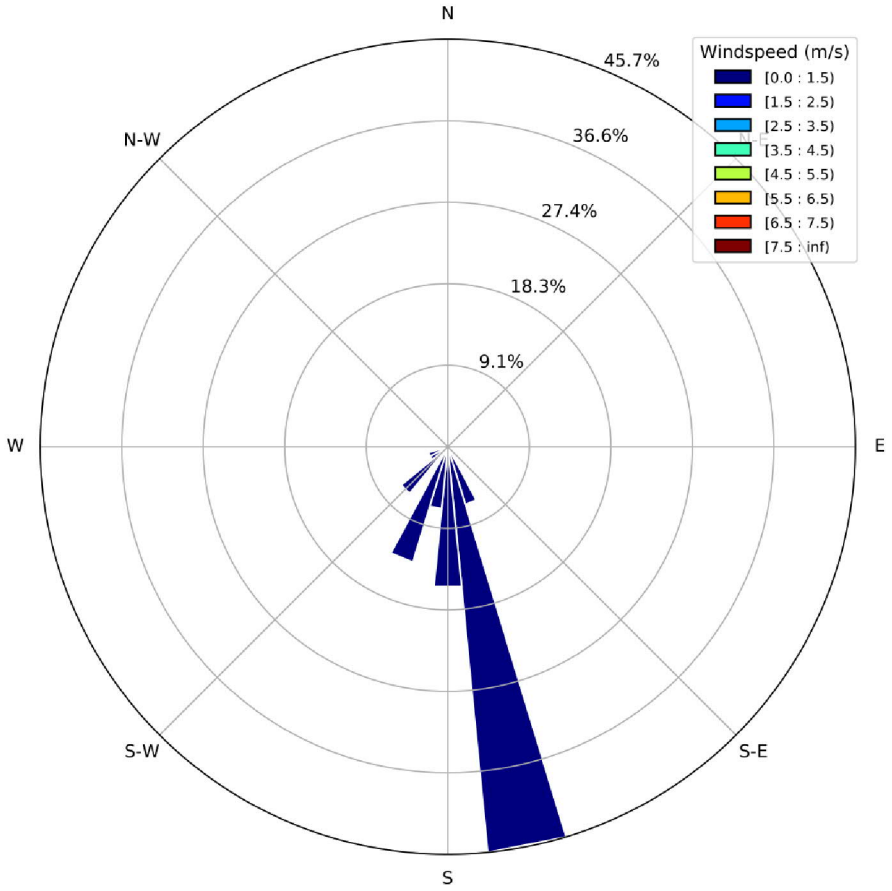
Bow Lake Wind Power Project - 2nd Acoustic Immission Audit

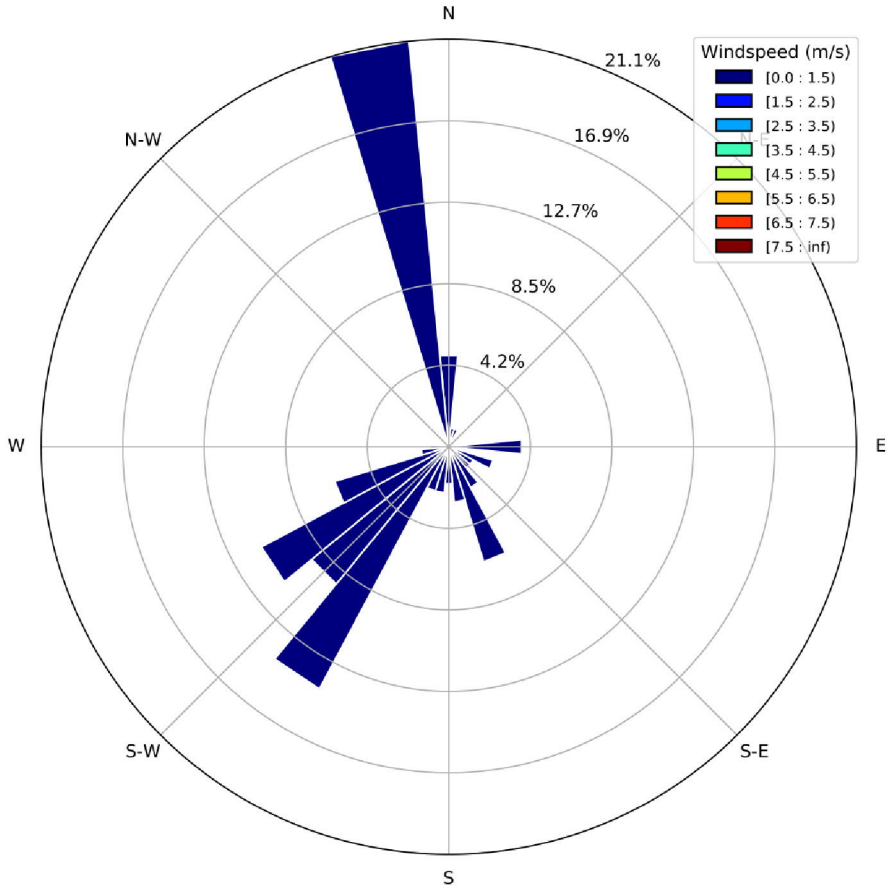
Figure Title

Wind Roses - R31 - Downwind of WTG-30

Figure B.01

R31 TON	R31 TOFF





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Project #: 15002

Scale: NTS
Drawn by: JM
Reviewed by: AM
Date: Dec 12, 2018
Revision: 1

Project Name

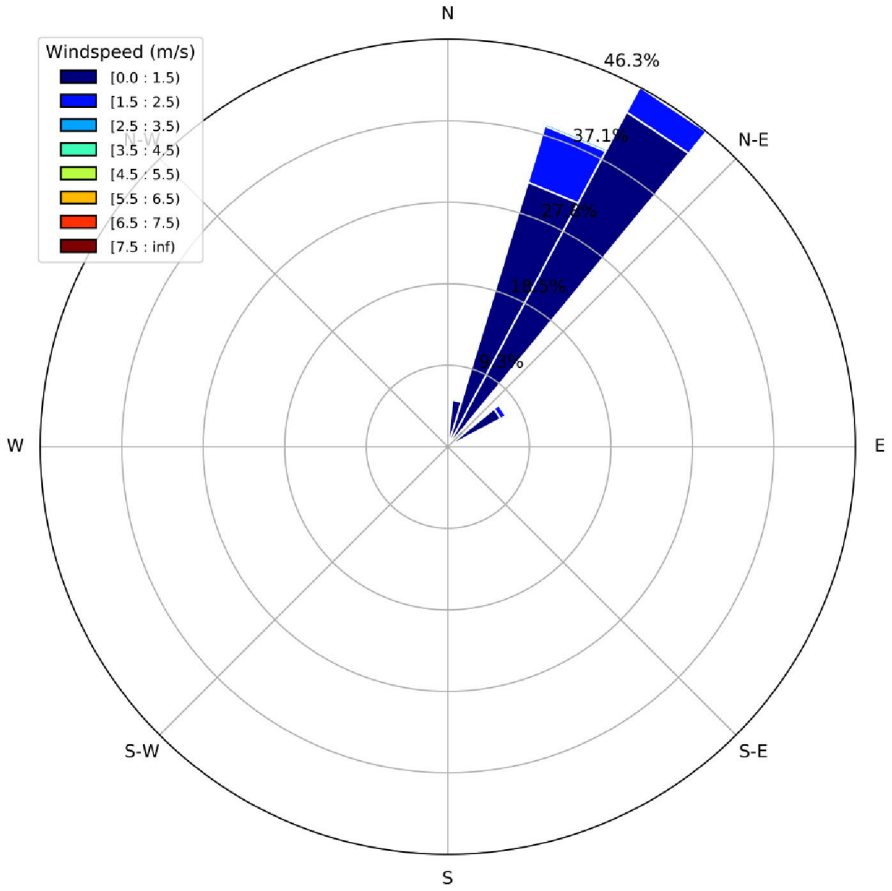
Bow Lake Wind Power Project - 2nd Acoustic Immission Audit

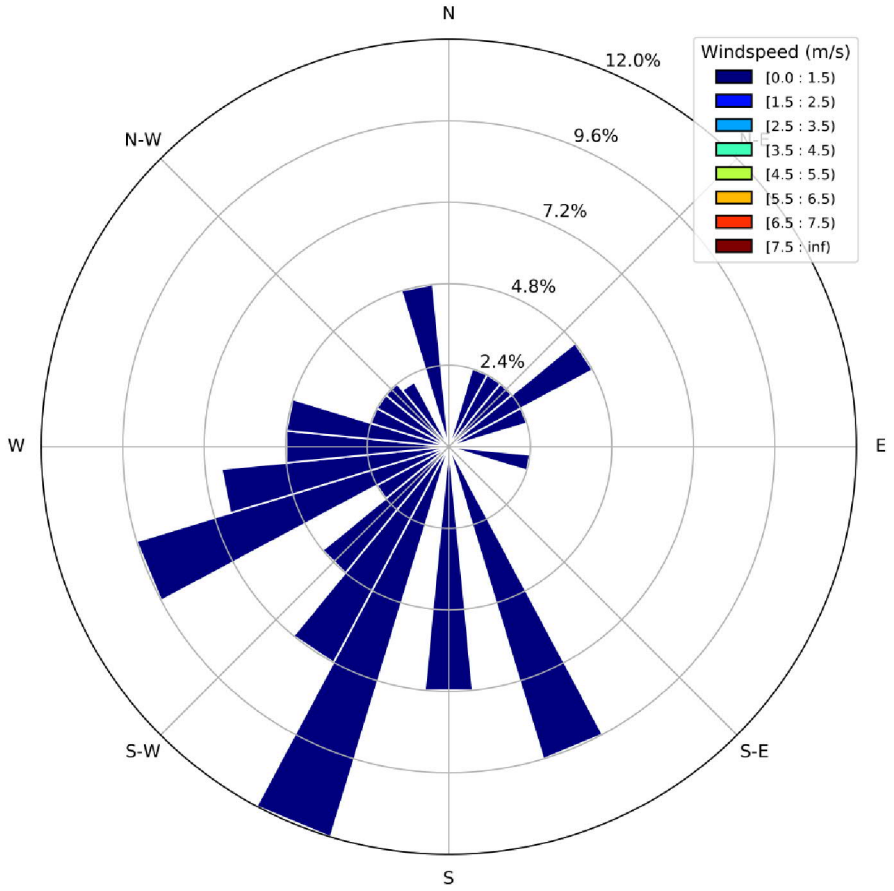
Figure Title

Wind Roses - R31 - Downwind of WTG-35

Figure B.02

R34 TON	R34 TOFF





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Project #: 15002	**Project Name**
Scale: NTS Drawn by: JM Reviewed by: AM Date: Dec 12, 2018 Revision: 1	Bow Lake Wind Power Project - 2nd Acoustic Immission Audit
	Figure Title Wind Roses - R34

Figure B.03

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Toronto, ON M9W 1B3

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Appendix C
Turbine Operational Statement from Operator

BluEarth RENEWABLES

400, 214 - 11 Avenue SW
Calgary, AB T2R 0K1
T 403.668.1575
bluearth.ca

I confirm that the turbines associated with the Bow Lake acoustic emission audit were operating within normal design parameters during the duration of the campaign (except when parked for ambient noise measurements).

Dave Walburger | *Operations Supervisor* BowLake Wind Farm

OFFICE: 587 333 7702

MOBILE: 705 943 1217

EMAIL: dave.walburger@bluearth.ca

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Appendix D
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

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Appendix E
Turbine Status during TON and TOFF

Bow Lake – Turbine Status Matrix for TON and TOFF

Turbine ID	Monitor Locations	
	R31	R34
WTG01		
WTG02		
WTG03		
WTG04		
WTG05		
WTG06		
WTG07		
WTG08		
WTG09		
WTG10		
WTG11		
WTG12		
WTG13		
WTG15		
WTG17		
WTG18		
WTG19		
WTG20		
WTG21		
WTG22		
WTG23		
WTG24		
WTG25		
WTG26	1	1
WTG27	1	1
WTG28	1	1
WTG29	1	1
WTG30	1	1
WTG32	1	1
WTG33	1	1
WTG34	1	1
WTG35	1	1
WTG36	1	1
WTG37	1	1
WTG38	1	1
WTG39	1	1

1 - Turbine ON/OFF
Turbines turned off such that predicted impact at monitor/receptor location is 30 dBA or less

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Appendix F
Calibration Certificates

West Caldwell Calibration Laboratories Inc.

Certificate of Calibration

for

MICROPONE UNIT

Manufactured by:	PCB PIEZOTRONICS
Model No:	378B02
Serial No:	125633
Calibration Recall No:	28351

Submitted By:

Customer:

Company: Aercoustics Engineering Ltd.
Address:

The subject instrument was calibrated to the indicated specification using standards traceable to the National Institute of Standards and Technology or to accepted values of natural physical constants. This document certifies that the instrument met the following specification upon its return to the submitter.

West Caldwell Calibration Laboratories Procedure No. 378B02 PCB PI

Upon receipt for Calibration, the instrument was found to be:

Within (X)

tolerance of the indicated specification. See attached Report of Calibration.
The information supplied relates to the calibrated item listed above.
West Caldwell Calibration Laboratories' calibration control system meets the requirements, ISO 10012-1 MIL-STD-45662A, ANSI/NCSL Z540-1, IEC Guide 25, ISO 9001:2008 and ISO 17025.

Note: With this Certificate, Report of Calibration is included.

Approved by: FC

Calibration Date: 10-Jan-18

Felix Christopher (QA Mgr.)

Certificate No: 28351 - 2

ISO/IEC 17025:2005

ACCREDITED

Calibration Lab. Cert. # 1533.01

West Caldwell Calibration Laboratories, Inc.
uncompromised calibration
1575 State Route 96, Victor, NY 14564, U.S.A.

West Caldwell Calibration Laboratories, Inc.
uncompromised calibration
1575 State Route 96, Victor NY 14564

ISO/IEC 17025: 2005
ACCREDITED
Calibration Lab. Cert. # 1533.01

REPORT OF CALIBRATION

for

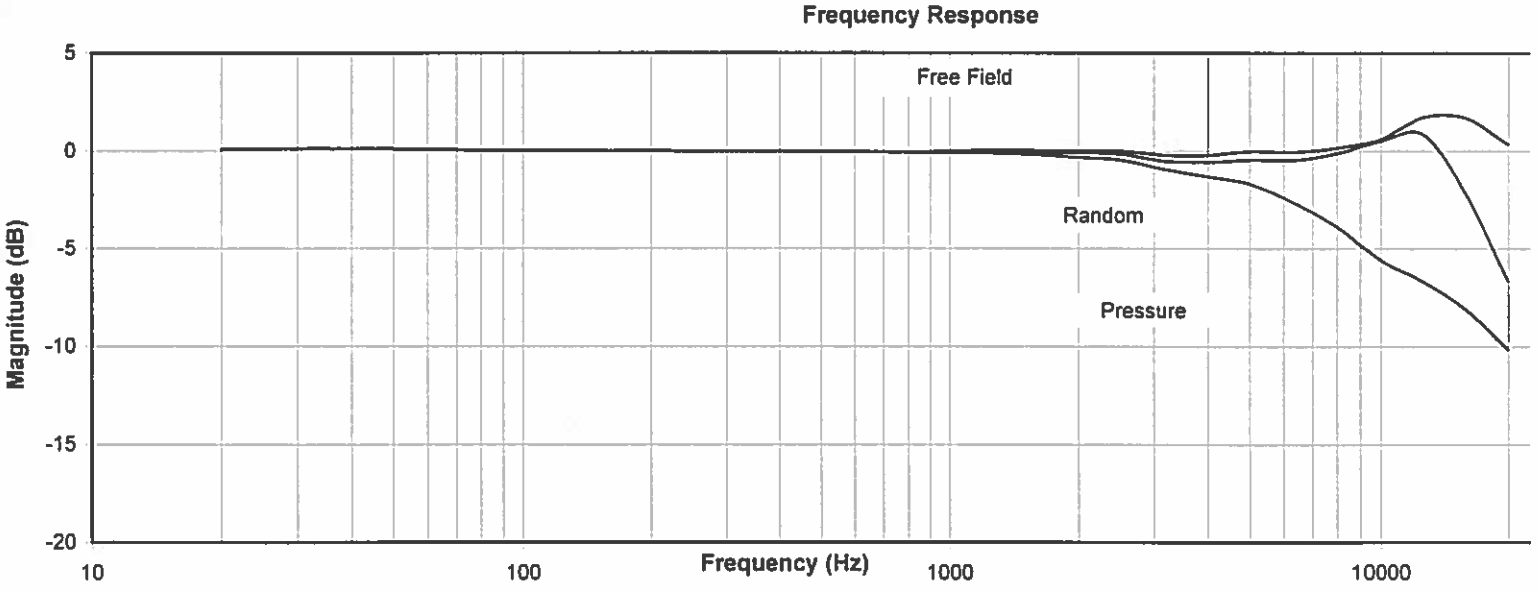
PCB Piezotronics Microphone Unit
Model No.: 378B02 Serial No.: 125633
Mic Model No.: 377B02 Serial No.: 164139
Preamp Model No.: 426E01 Serial No.: 043997
Company: Aercoustics Engineering Ltd. ID No.: XXXX

Calibration results:

Before & after data same: ...X...
Combined Sensitivity @ 250 Hz and pressure of 100.3 kPa
(Sens. with mic. and preamp.) 0 Volts Polarization voltage (External):
-25.96 dB re.1V/Pascal
50.36 mV/Pascal
-0.04 Ko (- dB re 50 mV/Pascal)
Sensitivity: Pass
Freq. Response: Pass
All tests: Pass

Ambient Temperature: 22.3 °C
Ambient Humidity: 30.9 % RH
Ambient Pressure: 100.297 kPa
Calibration Date: 10-Jan-2018
Calibration Due: 10-Jan-2019
Report Number: 28351 -2
Control Number: 28351

The above listed instrument meets or exceeds the tested manufacturer's specifications.
The IEC 651:type 1 and ANSI S1.4 1983 specification passed.
This Calibration is traceable through NIST test numbers: 683/284413-14
The expanded uncertainty of calibration: 0.12 dB at 95% confidence level with a coverage factor of k=2.
The pressure response recorded with electroacoustic method.



The above listed instrument was checked using calibration procedure documented in West Caldwell Calibration Laboratories Inc. procedure : **Rev. 7.0 Jan. 24, 2014 Doc. # 1038 P378B02PCB**
Calibration was performed by West Caldwell Calibration Laboratories Inc. under Operating Procedures intended to implement the requirements of ISO10012-1, IEC Guide 25, ANSI/NCSL Z540-1, (MIL-STD-45662A) and ISO 9001:2008, ISO 17025

Measurements performed by: .....
James Zhu

Calibrated on WCCL system type 9700

West Caldwell Calibration Laboratories Inc.
1575 State Route 96, Victor NY 14564
Tel. (585) 586-3900 FAX (585) 586-4327

Calibration Data Record

for

PCB Piezotronics Microphone Unit **Model No.: 378B02** **Serial No.: 125633**
Company: Aercoustics Engineering Ltd. **ID No.: XXXX**

Frequency Response (Reference = 0 dB @ 250Hz)

Frequency [Hz]	Pressure [dB]	Free Field [dB]	Random [dB]
19.95	0.10	0.10	0.10
25.12	0.13	0.13	0.13
31.62	0.14	0.14	0.14
39.81	0.13	0.13	0.13
50.12	0.12	0.12	0.12
63.10	0.09	0.09	0.09
79.43	0.07	0.07	0.07
100.00	0.05	0.05	0.05
125.89	0.03	0.03	0.03
158.49	0.01	0.01	0.01
199.53	0.01	0.01	0.01
251.19	0.00	0.00	0.00
316.23	-0.01	-0.01	-0.01
398.11	-0.01	-0.01	-0.01
501.19	-0.02	-0.02	-0.02
630.96	-0.03	-0.03	-0.03
794.33	-0.05	-0.05	-0.05
1000.00	-0.09	0.02	-0.09
1258.93	-0.11	0.05	-0.07
1584.89	-0.19	0.04	-0.11
1995.26	-0.31	0.02	-0.11
2511.89	-0.46	0.02	-0.15
3162.28	-0.92	-0.20	-0.51
3981.07	-1.30	-0.20	-0.57
5011.87	-1.68	0.00	-0.44
6309.57	-2.61	-0.03	-0.46
7943.28	-3.83	0.17	-0.12
10000.00	-5.58	0.63	0.51
12589.25	-6.70	1.73	0.84
15848.93	-8.15	1.67	-2.27
19952.62	-10.14	0.36	-6.64

Freq. response: Expanded Uncertainty (dB) with coverage factor K = 2
20 to 63Hz 0.1dB, 63 to 12.5kHz 0.094dB, 12.5k to 16kHz 0.10dB, 16k to 20kHz 0.5dB.

Instruments used for calibration:			Date of Cal.	Traceability No.	Re-cal. Due Date
Brüel & Kjær	4226	S/N 1445428	11-Aug-2017	683/284413-14	11-Aug-2018
Brüel & Kjær	3560	S/N 2241893	11-Aug-2017	683/284413-14	11-Aug-2018
HP	33120A	S/N 36043716	11-Aug-2017	,287708	11-Aug-2018
HP	34401A	S/N 36064102	11-Aug-2017	,287708	11-Aug-2018

Cal. Date: 10-Jan-2018 **Tested by: James Zhu**

Calibrated on WCCL system type 9700

West Caldwell Calibration Laboratories Inc.

Certificate of Calibration

for

MICROPHONE UNIT

Manufactured by:	PCB PIEZOTRONICS
Model No:	378B02
Serial No:	125630
Calibration Recall No:	28284

Submitted By:

Customer:

Company: Aerocoustics Engineering Ltd.
Address:

The subject instrument was calibrated to the indicated specification using standards traceable to the National Institute of Standards and Technology or to accepted values of natural physical constants. This document certifies that the instrument met the following specification upon its return to the submitter.

West Caldwell Calibration Laboratories Procedure No. 378B02 PCB PI

Upon receipt for Calibration, the instrument was found to be:

Within (X)

tolerance of the indicated specification. See attached Report of Calibration.
The information supplied relates to the calibrated item listed above.
West Caldwell Calibration Laboratories' calibration control system meets the following requirements, ISO 10012-1 MIL STD 45662A, ANSI/NCSL Z540-1, IEC Guide 25, ISO 9001:2008 and ISO 17025

Note: With this Certificate, Report of Calibration is included.

Approved by: FC

Calibration Date: 19-Jan-18

Felix Christopher (QA Mgr.)

Certificate No: 28284 - 1

ISO/IEC 17025:2005

ACCREDITED

Calibration Lab. Cert. # 1533.01

West Caldwell Calibration Laboratories, Inc.
uncompromised calibration
1575 State Route 96, Victor, NY 14564, U.S.A.

ISO/IEC 17025: 2005

West Caldwell Calibration Laboratories, Inc.
uncompromised calibration

1575 State Route 96, Victor NY 14564

ACCREDITED
Calibration Lab. Cert. # 1533.01

REPORT OF CALIBRATION

for

PCB Piezotronics Microphone Unit	Model No.: 378B02	Serial No.: 125630
	Mic Model No.: 377B02	Serial No.: 167926
	Preamp Model No.: 426E01	Serial No.: 044003
Company: Aerocoustics Engineering Ltd.		ID No.: XXXX

Calibration results:

After data: ...X...

Combined Sensitivity @ 250 Hz and pressure of 99.063 kPa
(Sens. with mic. and preamp.) 0 Volts Polarization voltage (External):

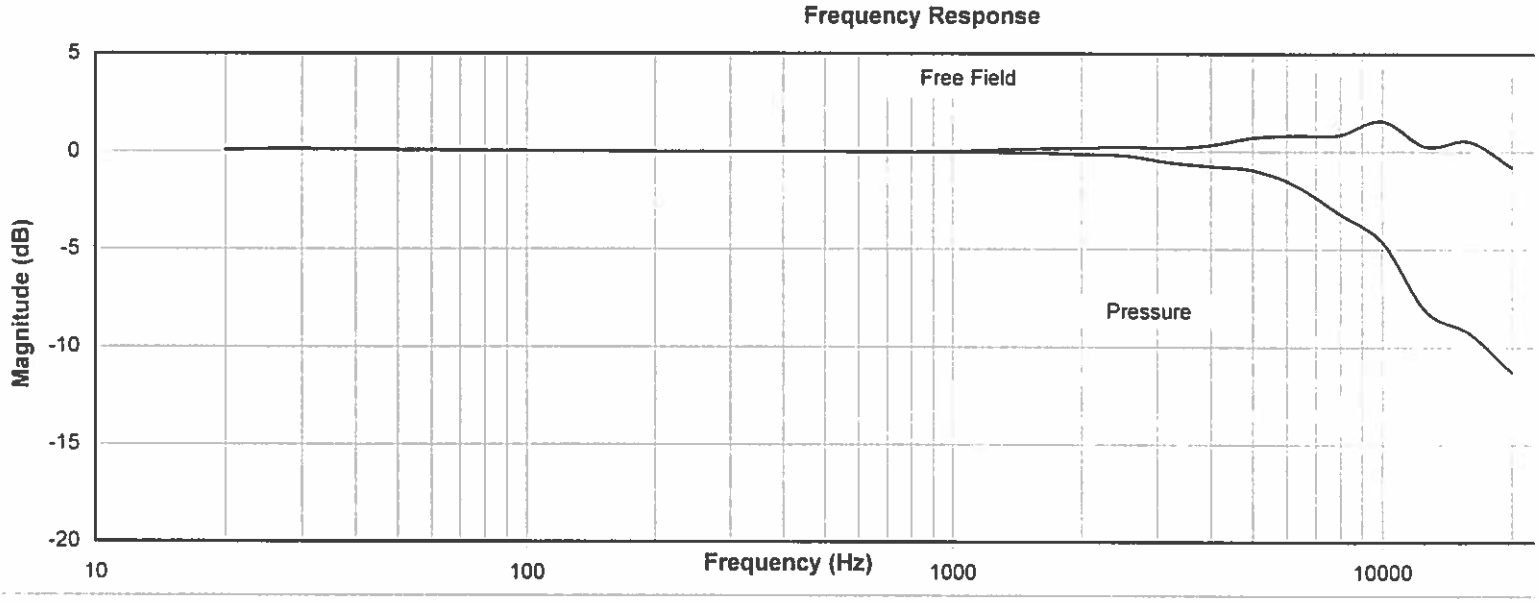
-27.46 dB re.1V/Pascal
42.36 mV/Pascal
1.46 Ko (- dB re 50 mV/Pascal)

Sensitivity: Pass
Freq. Response: Pass
All tests: Pass

Ambient Temperature:	22.0	°C
Ambient Humidity:	30.1	% RH
Ambient Pressure:	99.063	kPa
Calibration Date:	19-Jan-2018	
Calibration Due:	19-Jan-2019	
Report Number:	28284 -1	
Control Number:	28284	

The above listed instrument meets or exceeds the tested manufacturer's specifications.
The IEC 651:type 1 and ANSI S1.4 1983 specification passed.
This Calibration is traceable through NIST test numbers: 683/284413-14
The expanded uncertainty of calibration: 0.12 dB at 95% confidence level with a coverage factor of k=2.

The pressure response recorded with electroacoustic method.



The above listed instrument was checked using calibration procedure documented in West Caldwell Calibration Laboratories Inc. procedure : **Rev. 7.0 Jan. 24, 2014 Doc. # 1038 P378B02PCB**

Calibration was performed by West Caldwell Calibration Laboratories Inc. under Operating Procedures intended to implement the requirements of ISO10012-1, IEC Guide 25, ANSI/NCSL Z540-1, (MIL-STD-45662A) and ISO 9001:2008, ISO 17025

Measurements performed by: .....
Felix Christopher

Calibrated on WCCL system type 9700

West Caldwell Calibration Laboratories Inc.
1575 State Route 96, Victor NY 14564
Tel. (585) 586-3900 FAX (585) 586-4327

Calibration Data Record

for

PCB Piezotronics Microphone Unit **Model No.: 378B02** **Serial No.: 125630**
Company: Aerocoustics Engineering Ltd. **ID No.: XXXX**

Frequency Response (Reference = 0 dB @ 250Hz)

Frequency [Hz]	Pressure [dB]	Free Field [dB]
19.95	0.11	0.11
25.12	0.14	0.14
31.62	0.14	0.14
39.81	0.12	0.12
50.12	0.11	0.11
63.10	0.09	0.09
79.43	0.06	0.06
100.00	0.05	0.05
125.89	0.03	0.03
158.49	0.03	0.03
199.53	0.01	0.01
251.19	0.00	0.00
316.23	0.00	0.00
398.11	-0.01	-0.01
501.19	-0.01	-0.01
630.96	-0.02	-0.02
794.33	-0.02	-0.02
1000.00	-0.04	0.07
1258.93	-0.06	0.10
1584.89	-0.08	0.15
1995.26	-0.14	0.19
2511.89	-0.21	0.27
3162.28	-0.54	0.18
3981.07	-0.74	0.36
5011.87	-0.94	0.74
6309.57	-1.72	0.86
7943.28	-3.13	0.87
10000.00	-4.62	1.59
12589.25	-8.14	0.29
15848.93	-9.27	0.55
19952.62	-11.27	-0.77

Freq. response: Expanded Uncertainty (dB) with coverage factor K = 2
20 to 63Hz 0.1dB, 63 to 12.5kHz 0.094dB, 12.5k to 16kHz 0.10dB, 16k to 20kHz 0.5dB.

Instruments used for calibration:			Date of Cal.	Traceability No	Re-cal. Due Date
Brüel & Kjær	4226	S/N 1445428	11-Aug-2017	683/284413-14	11-Aug-2018
Brüel & Kjær	3560	S/N 2241893	11-Aug-2017	683/284413-14	11-Aug-2018
HP	33120A	S/N 36043716	11-Aug-2017	,287708	11-Aug-2018
HP	34401A	S/N 36064102	11-Aug-2017	,287708	11-Aug-2018

Cal. Date: 19-Jan-2018 **Tested by: Felix Christopher**

Calibrated on WCCL system type 9700

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

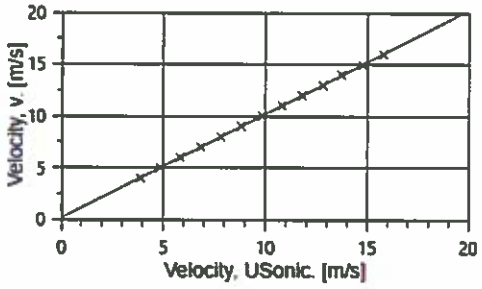
Certificate number: 17.US1.11150 **Date of issue:** December 18, 2017
Type: Vaisala Weather Transmitter, WXT520 **Serial number:** M0410642
Manufacturer: Vaisala, Oyj, Pl 26, FIN-00421 Helsinki, Finland
Client: Aercoustics Engineering Ltd., 1004 Middlegate RD, Suite 1100, S.Tower, Mississauga, ON L4Y 1M4, Canada

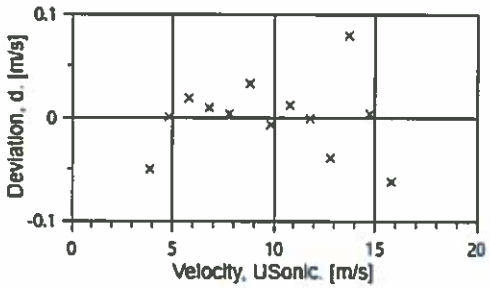
Anemometer received: December 14, 2017 **Anemometer calibrated:** December 15, 2017
Calibrated by: MEJ **Procedure:** MEASNET, IEC 61400-12-1:2017 Annex F
Certificate prepared by: EJF **Approved by:** Calibration engineer, EJF

Calibration equation obtained: v [m/s] = 1.00624 · f [m/s] + 0.12903

Standard uncertainty, slope: 0.00283 **Standard uncertainty, offset:** 0.23103
Covariance: -0.0000793 (m/s)²/m/s **Coefficient of correlation:** ρ = 0.999956
Absolute maximum deviation: 0.079 m/s at 14.014 m/s
Barometric pressure: 1004.1 hPa **Relative humidity:** 10.6%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	d.p. box [°C]	Wind velocity, v. [m/s]	Anemometer Output, f. [m/s]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.40	21.7	25.1	3.983	3.8800	-0.050	0.024
4	14.80	21.7	25.1	4.998	4.8379	0.000	0.025
6	21.34	21.7	25.1	6.001	5.8167	0.019	0.027
8	28.99	21.8	25.1	6.994	6.8133	0.009	0.029
10	37.84	21.8	25.1	7.991	7.8100	0.004	0.032
12	48.28	21.8	25.2	9.027	8.8100	0.033	0.035
13-last	59.46	21.8	25.2	10.018	9.8345	-0.007	0.038
11	71.84	21.8	25.1	11.012	10.8033	0.012	0.041
9	85.15	21.7	25.1	11.988	11.7867	-0.001	0.044
7	99.86	21.7	25.1	12.983	12.8133	-0.039	0.047
5	116.34	21.7	25.1	14.014	13.7200	0.079	0.050
3	132.72	21.7	25.1	14.968	14.7433	0.004	0.053
1-first	151.15	21.6	25.1	15.972	15.8067	-0.062	0.056





ilac-MRA
ANAB ACCREDITED CALIBRATION LABORATORY
AC-1746
SOH Wind Engineering LLC · USA · measnet

EQUIPMENT USED

Serial Number	Description
Njord1	Wind tunnel, blockage factor = 1.0035
2254	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.
DP004	Setra Model 239, 0-1inWC, differential pressure transducer
HY002	Dwyer RHP-2D20, 0-10V Output, humidity transmitter
BP001	Setra Model 278, barometer
PL8	Pitot tube
XB002	Computer Board. 16 bit A/D data acquisition board
9PRZRW1	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 in the 90°output postion.

Certificate number: 17.US1.11150

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

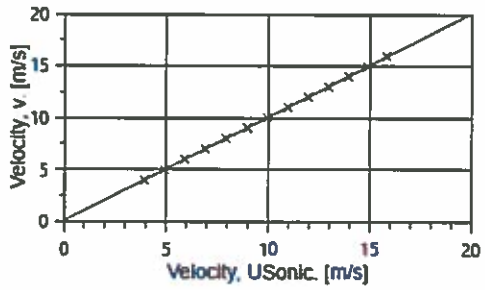
Certificate number: 17.US1.11157 **Date of issue:** December 18, 2017
Type: Vaisala Weather Transmitter, WXT520 **Serial number:** M0410642
Manufacturer: Vaisala, Oyj, Pl 26, FIN-00421 Helsinki, Finland
Client: Aercoustics Engineering Ltd., 1004 Middlegate RD, Suite 1100, S.Tower, Mississauga, ON L4Y 1M4, Canada

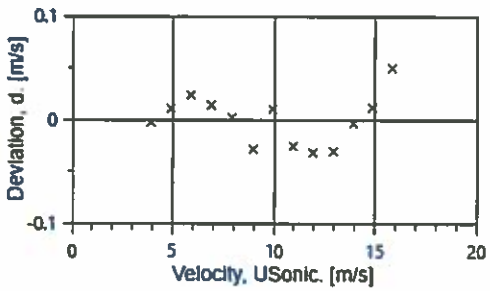
Anemometer received: December 14, 2017 **Anemometer calibrated:** December 15, 2017
Calibrated by: MEJ **Procedure:** MEASNET, IEC 61400-12-1:2017 Annex F
Certificate prepared by: EJF **Approved by:** Calibration engineer, EJF

Calibration equation obtained: v [m/s] = 1.00125 · f [m/s] + 0.05815

Standard uncertainty, slope: 0.00187 **Standard uncertainty, offset:** 0.34229
Covariance: -0.0000350 (m/s)²/m/s **Coefficient of correlation:** ρ = 0.999981
Absolute maximum deviation: 0.050 m/s at 15.968 m/s
Barometric pressure: 1004.0 hPa **Relative humidity:** 10.7%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	Temperature in d.p. box [°C]	Wind velocity, v. [m/s]	Anemometer Output, f. [m/s]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.35	21.5	25.0	3.970	3.9100	-0.003	0.024
4	14.72	21.5	25.1	4.982	4.9069	0.011	0.025
6	21.29	21.5	25.1	5.993	5.9033	0.024	0.027
8	28.95	21.5	25.1	6.988	6.9067	0.014	0.029
10	37.98	21.5	25.1	8.004	7.9333	0.002	0.032
12	48.14	21.5	25.1	9.011	8.9700	-0.029	0.035
13-last	59.47	21.5	25.1	10.016	9.9345	0.010	0.038
11	71.90	21.5	25.1	11.013	10.9667	-0.026	0.041
9	85.19	21.5	25.1	11.988	11.9467	-0.032	0.044
7	100.19	21.5	25.1	13.001	12.9567	-0.030	0.047
5	116.44	21.5	25.1	14.015	13.9433	-0.004	0.050
3	132.88	21.5	25.0	14.972	14.8833	0.012	0.053
1-first	151.18	21.4	25.0	15.968	15.8400	0.050	0.056





AC-1746

EQUIPMENT USED

Serial Number	Description
Njord1	Wind tunnel, blockage factor = 1.0035
2254	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.
DP004	Setra Model 239, 0-1inWC, differential pressure transducer
HY002	Dwyer RHP-2D20, 0-10V Output, humidity transmitter
BP001	Setra Model 278, barometer
PL8	Pitot tube
XB002	Computer Board. 16 bit A/D data acquisition board
9PRZRW1	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 in the 0°output postion.

Certificate number: 17.US1.11157

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

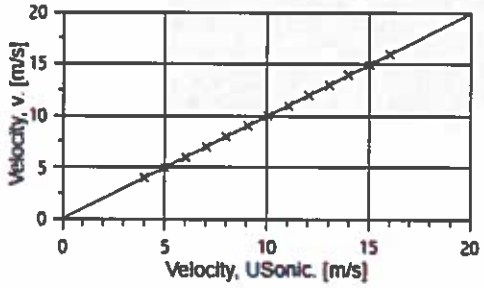
Certificate number: 18.US1.05429 **Date of issue:** October 26, 2018
Type: Vaisala Weather Transmitter, WXT536 **Serial number:** M4910193
Manufacturer: Vaisala, Oyj, Pl 26, FIN-00421 Helsinki, Finland
Client: Aercoustics Engineering Ltd., 1004 Middlegate RD, Suite 1100, S.Tower, Mississauga, ON L4Y 1M4, Canada

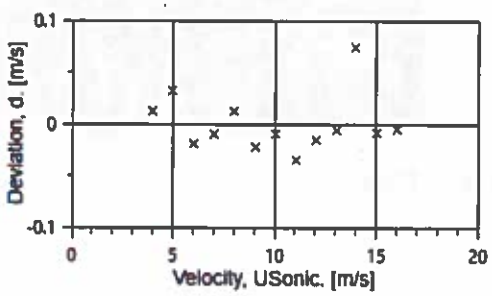
Anemometer received: October 24, 2018 **Anemometer calibrated:** October 24, 2018
Calibrated by: MEJ **Procedure:** MEASNET, IEC 61400-12-1:2017 Annex F
Certificate prepared by: EJF **Approved by:** Calibration engineer, EJF

Calibration equation obtained: v [m/s] = 0.99427 · f [m/s] + -0.00309

Standard uncertainty, slope: 0.00217 **Standard uncertainty, offset:** -7.47829
Covariance: -0.0000468 (m/s)²/m/s **Coefficient of correlation:** ρ = 0.999974
Absolute maximum deviation: 0.074 m/s at 13.961 m/s
Barometric pressure: 1005.3 hPa **Relative humidity:** 29.5%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	d.p. box [°C]	Wind velocity, v. [m/s]	Anemometer Output, f. [m/s]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.31	22.4	28.1	3.970	3.9833	0.012	0.020
4	14.59	22.4	28.1	4.969	4.9690	0.032	0.023
6	20.99	22.4	28.1	5.960	6.0167	-0.019	0.026
8	28.65	22.5	28.1	6.964	7.0167	-0.010	0.029
10	37.48	22.5	28.1	7.965	8.0017	0.012	0.033
12	47.74	22.5	28.1	8.989	9.0667	-0.022	0.037
13-last	58.81	22.5	28.1	9.978	10.0483	-0.010	0.041
11	70.85	22.5	28.1	10.952	11.0533	-0.035	0.045
9	84.43	22.5	28.1	11.956	12.0433	-0.015	0.049
7	99.24	22.4	28.1	12.963	13.0467	-0.006	0.053
5	115.11	22.4	28.1	13.961	13.9700	0.074	0.057
3	131.52	22.4	28.1	14.923	15.0200	-0.008	0.061
1-first	149.84	22.3	28.1	15.927	16.0267	-0.005	0.065





AC-1746

EQUIPMENT USED

Serial Number	Description
Njord1	Wind tunnel, blockage factor = 1.0035
2254	Control cup anemometer
-	Mounting tube, D = 19 mm
TT002	Summit Electronics, 1XPT100, 0-10V Output, wind tunnel temp.
TP001	PR Electronics 5102, 0-10V Output, differential pressure box temp.
DP005	Setra Model 239, 0-1inWC, differential pressure transducer
HY003	Dwyer RHP-2D20, 0-10V Output, humidity transmitter
BP003	Setra M278, 0-5VDC Output, barometer
PL8	Pitot tube
XB002	Computer Board. 16 bit A/D data acquisition board
9PRZRW1	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.

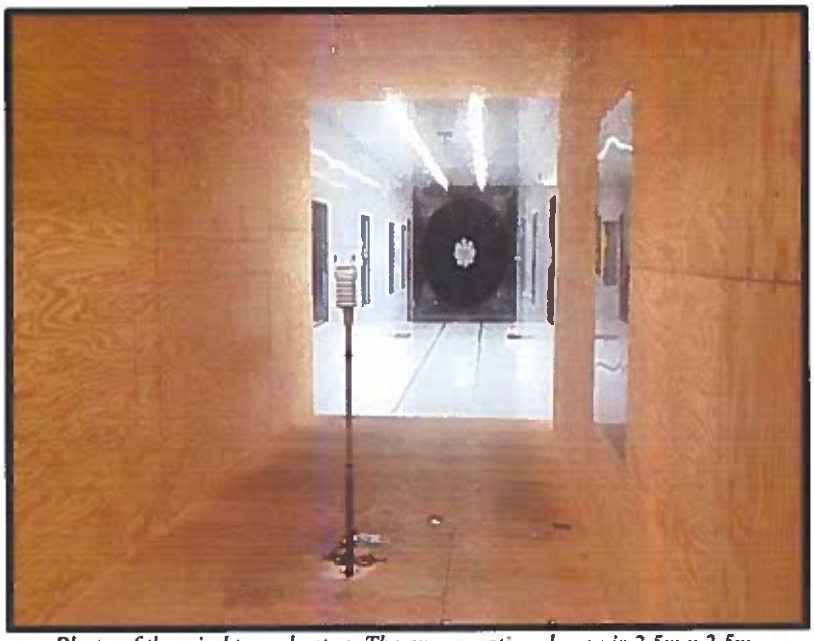


Photo of the wind tunnel setup. The cross-sectional area is 2.5m x 2.5m.

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 0°.

Certificate number: 18.US1.05429

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

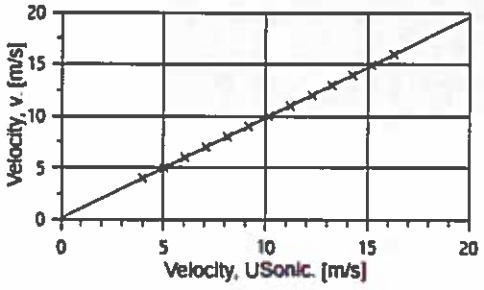
Certificate number: 18.US1.05430 **Date of issue:** October 26, 2018
Type: Vaisala Weather Transmitter, WXT536 **Serial number:** M4910193
Manufacturer: Vaisala, Oyj, Pl 26, FIN-00421 Helsinki, Finland
Client: Aercoustics Engineering Ltd., 1004 Middlegate RD, Suite 1100, S.Tower, Mississauga, ON L4Y 1M4, Canada

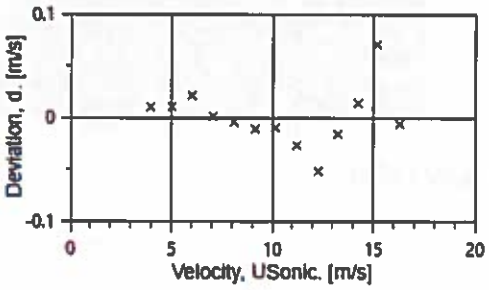
Anemometer received: October 24, 2018 **Anemometer calibrated:** October 24, 2018
Calibrated by: MEJ **Procedure:** MEASNET, IEC 61400-12-1:2017 Annex F
Certificate prepared by: EJF **Approved by:** Calibration engineer, EJF

Calibration equation obtained: v [m/s] = 0.97306 · f [m/s] + 0.08615

Standard uncertainty, slope: 0.00222 **Standard uncertainty, offset:** 0.27161
Covariance: -0.0000472 (m/s)²/m/s **Coefficient of correlation:** ρ = 0.999973
Absolute maximum deviation: 0.071 m/s at 14.937 m/s
Barometric pressure: 1005.6 hPa **Relative humidity:** 29.3%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	d.p. box [°C]	Wind velocity, v. [m/s]	Anemometer Output, f. [m/s]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.24	22.6	28.0	3.956	3.9667	0.010	0.020
4	14.66	22.7	28.0	4.982	5.0207	0.010	0.023
6	21.10	22.7	28.0	5.978	6.0333	0.021	0.026
8	28.68	22.7	28.0	6.970	7.0733	0.001	0.029
10	37.56	22.7	28.0	7.976	8.1133	-0.005	0.033
12	47.60	22.7	28.0	8.978	9.1500	-0.011	0.037
13-last	58.55	22.7	28.0	9.958	10.1552	-0.010	0.041
11	70.93	22.7	28.0	10.961	11.2033	-0.027	0.045
9	84.77	22.7	28.0	11.983	12.2800	-0.052	0.049
7	99.15	22.7	28.0	12.960	13.2467	-0.016	0.053
5	115.08	22.6	28.0	13.963	14.2467	0.014	0.057
3	131.71	22.6	28.0	14.937	15.1900	0.071	0.061
1-first	149.90	22.5	28.1	15.934	16.2933	-0.006	0.065





AC-1746

EQUIPMENT USED

Serial Number	Description
Njord1	Wind tunnel, blockage factor = 1.0035
2254	Control cup anemometer
-	Mounting tube, D = 19 mm
TT002	Summit Electronics, 1XPT100, 0-10V Output, wind tunnel temp.
TP001	PR Electronics 5102, 0-10V Output, differential pressure box temp.
DP005	Setra Model 239, 0-1inWC, differential pressure transducer
HY003	Dwyer RHP-2D20, 0-10V Output, humidity transmitter
BP003	Setra M278, 0-5VDC Output, barometer
PL8	Pitot tube
XB002	Computer Board. 16 bit A/D data acquisition board
9PRZRW1	PC dedicated to data acquisition

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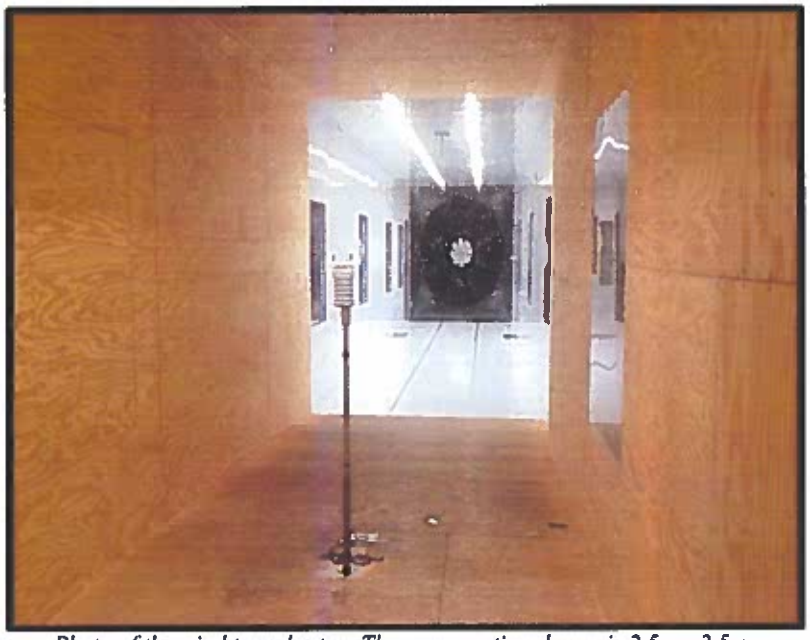

Photo of the wind tunnel setup. The cross-sectional area is 2.5m x 2.5m.

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 90°.

Certificate number: 18.US1.05430

aercoustics

Aercoustics Engineering Ltd.
1004 Middlegate Road, Suite 1100
Mississauga, ON L4Y 0G1

Tel: 416-249-3361
Fax 416-249-3613
aercoustics.com

Appendix G
MECP Letter - March 19, 2018

Ministry of the Environment and Climate Change

Environmental Assessment and Permissions Branch

135 St. Clair Avenue West
1st Floor
Toronto ON M4V 1P5
Tel.: 416 314-8001
Fax: 416 314-8452

Ministère de l'Environnement et de l'Action en matière de changement climatique

Direction des évaluations et des permissions environnementales

135, avenue St. Clair Ouest
Rez-de-chaussée
Toronto ON M4V 1P5
Tél : 416 314-8001
Téléc. : 416 314-8452

Ontario

March19, 2018

Tom Bird
Director, Regulatory
Blue Earth Renewables Inc.

Dear Tom:

Following September 11th meeting, and after further discussion with the Sault Ste. Marie District Office (D.O.), the MOECC has decided on the path forward for the Bow Lake auditing process. The following details:

1. our assessment of data completeness of the I-Audit report prepared by Aercoustics Engineering Ltd. dated May 31, 2017 (Report) , and

2. our updated audit requirements for this project:

Assessment of Data Completeness

A summary of the data acquired in the Report is detailed below:

Receptor ID	Turbine Status	Data Points in Wind Speed Bin		Total
		0 m/s	1 m/s	
R36	Turbine ON	83	286	369
	Turbine OFF	74	51	125
R13	Turbine ON	139	32	171
	Turbine OFF	771	-	771

Section E5.5 (5) of Protocol states that the Ministry requires approximately:

a) 60 data points for Turbine ON measurements, and
b) 30 data points for Turbine OFF measurements.

Receptor R36 fulfilled the minimum data requirements.

Receptor R13 failed to meet the minimum data point for the 1 m/s wind speed bin requirements (both Turbine ON and OFF data were deficient). However the Ministry will exercise its discretion and deem the above report complete from a data perspective as the 1 m/s turbine off measurements were not subtracted from the 1 m/s Turbine On values in Section 6 of the Report.

Our detailed review of the Report will now commence. Please provide the following data by a date not exceeding 15 business days of the date on this document:

I. Input data related to the wind rose diagrams in an Excel spreadsheet.

II. In accordance to Section D5.6, of the Protocol please confirm that a tonal assessment was undertaken. The tonal assessment shall include but not limited to tonal audibility for all valid data records. The average tonal audibility correction, if any, should be added to the final noise contribution of the wind turbine at those wind speeds.

III. A weather report for the duration of the measurement campaign, as well as the turbine-specific weather conditions listed in tabular form (i.e., wind speed at hub height, anemometer wind speed at 10m height, air temperature and pressure and relative humidity).

IV. In an Excel spreadsheet, please provide all unfiltered sound level data collected during the audit measurement, including all accompanying parameters.

V. In an Excel spreadsheet tabular form, please provide operation data (i.e. wind direction, wind speed, rpm, power output), for all turbines within 1000 m from the monitoring location.

Updated Audit Requirements

One (1) new I-Audit campaign (two receptors) shall be conducted for the Bow Lake Wind Project as detailed in Condition D of REA #8443-9BMG23. These audits shall meet the following conditions:

a. Follow the RAM-I audit procedure as detailed in Section E5.5 of the 2017 Compliance Protocol (Protocol). As this is a non-typical site (significant elevation change between the turbines and receptor locations) any deviations from the Protocol must receive EAB approval.

b. The campaign shall be conducted within a unique measurement period (spring or fall). Based on the assessments undertaken by the D.O., many of the main access roads and cabin trails can be accessed throughout the entire year.

c. Contain a detailed overview of the POR selection process. After some analysis, the ministry is of the opinion that receptor R31 (projected sound level 39.9) should be assessed. In addition the D.O. considers receptor R34 to be a viable audit location due to its vicinity to a campsite and location on a well maintained turbine access road. Please conduct a detailed analysis of all receptor locations and provide justification for the two (2) PORs that will be selected, (Refer to Appendix F3 of the Protocol for guidance). In summary if receptor R31 and/or R34 are not selected, please provide rationale(s) why they are not suitable monitoring locations.

Sincerely,

Miroslav Ubovic, P. Eng.
Senior Noise Engineer
Environmental Assessment and Permissions Branch

mu/