

IMMISSION AUDIT REPORT – Project: 16227.07

Niagara Region Wind Farm Acoustic Immission Audit – Phase 5 Receptor O0085

Prepared for:

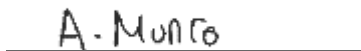
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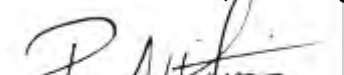
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Revision History

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2	Initial Report	HF, AM	PA	August 27, 2021

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Executive Summary

Aercoustics Engineering Limited (Aercoustics) has been retained by 1021702 B.C. Ltd as general partner for and on behalf of FWRN L.P. to complete acoustic immission audit (I-audit) measurements at the Niagara Region Wind Farm (NRWF), for the Ministry of the Environment, Conservation and Parks (MECP). NRWF operates under Renewable Energy Approval (REA) #4353-9HMP2R, issued on November 6, 2014 [1].

A Noise Abatement Action Plan (NAAP) was implemented at NRWF to address the non-compliant cumulative sound impact calculated at receptor O0085 during Phase 2 of the prior I-audit campaign [2]. In order to verify that the NAAP is effective, I-audit testing was completed at receptor O0085 and proved compliance in the I-audit report issued by Aercoustics on February 3, 2021 [3]. Following concerns from the MECP regarding daytime compliance at this receptor, NRWF proposed an additional I-audit testing campaign in order to assess daytime turbine sound impact detailed in the Daytime Immission Audit Measurement Plan [4].

This report summarises the results of daytime I-audit testing completed at receptor O0085.

Daytime monitoring near receptor O0085 spanned the following dates:

Location	Monitoring Start Date	Monitoring End Date	Monitoring Duration (weeks)
O0085	May 25, 2021	June 18, 2021	3*

*monitoring campaign was ended approximately 3 weeks into the measurement campaign due to contamination noise from corn in the field.

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) with the exception of the deviation from Section D5.2 of the Protocol to collect and analyse measurement data during daytime hours, between 05:00 and 22:00 [5].

Based on the results presented in Section 6.2 of this report, the cumulative daytime- sound impact calculated at O0085 complies with the MECP sound level limits at all wind bins having sufficient data for assessment.

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Supplemental Information

1 Introduction

Aercoustics Engineering Limited (Aercoustics) has been retained by 1021702 B.C. Ltd as general partner for and on behalf of FWRN L.P. to complete daytime acoustic immission audit (I-audit) measurements at the Niagara Region Wind Farm (NRWF), for the Ministry of the Environment, Conservation and Parks (MECP). NKWPP operates under Renewable Energy Approval (REA) #4353-9HMP2R, issued on November 6, 2014 [1].

A Noise Abatement Action Plan (NAAP) was implemented at NRWF to address the non-compliant cumulative sound impact calculated at receptor O0085 during Phase 2 of the prior I-audit campaign [2]. Although compliance with the sound level limits was demonstrated during night-time hours through an I-audit at O0085 [3], the MECP indicated concern that the daytime sound impact at receptor O0085 may not be compliant.

To evaluate whether the turbine sound impact is compliant during daytime hours, Aercoustics has conducted an additional I-audit campaign at O0085 to assess the daytime turbine sound impact, as proposed by NRWF.

The daytime I-audit methodology was based on unattended measurements and was conducted per the Immission Audit Measurement Plan [4] and the Compliance Protocol for Wind Turbine Noise (the Protocol), with the exception of the deviation from Section D5.2 of the Protocol to collect and analyse measurement data during daytime hours, between 05:00 and 22:00. [5].

2 Facility Description

The Niagara Region Wind Farm Project utilizes 77 Enercon turbines (Model E 101) wind turbines for power generation, each having a nameplate capacity ranging from 2.9MW and 3.0MW respectively. Each turbine has a hub height of 124 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.

As per the NAAP issued on June 4, 2019 [6], turbine T08 operates on a reduced noise mode with a capacity of 1500 kW for the following conditions:

- The curtailment applies during then night-time from 22:00 – 5:00
- The curtailment applies for the wind direction range of 150° to 240° only, referencing North with 0°.

3 Audit Location

The monitoring equipment, and details regarding the monitoring locations are provided in this section.

3.1 Monitoring Location

Receptor O0085 was originally chosen to be representative of the worst-case impact of the facility. The location was one of five locations that were chosen based on the MECF selection requirements communicated in the NRWF REA. The receptor is located in the predominant downwind direction of the facility. O0085 has a predicted impact of 39.5 dBA as per the sound pressure level predicted from an “As Built” noise model based on the original CadnaA noise prediction model. The following describes the measurement location M0085 in relation to the receptor:

- M0085: Measurement equipment was placed in an open field to the west of O0085, 540 m to the closest turbine (T08), on the south side of Concession Road Three. The predicted level based on the acoustic model at M0085 is 39.7 dBA.

The following table provides a summary of the receptor location.

Table 1: Receptor Measurement Locations

Audit Receptor ID Nearest Turbine ID		O0085 T08
Receptor	UTM Coordinates (X,Y)	17T 614752mE 4765425mN
	Distance to Nearest Turbine	554m
	Predicted Level dBA*	39.5
Monitor	UTM Coordinates (X,Y)	17T 614682mE 4765434mN
	Distance to Nearest Turbine	540m
	Predicted Level dBA**	39.7

* Predicted level from Sound Level Prediction Results, [Modified Model for As-built] 77 WTGs – Stantec [3]

** Predicted level from Aercoustics’ acoustic model

Site plans and photographs of the monitoring equipment are provided in Appendix A. Details regarding the monitoring equipment are provided in Section 4.1.

3.2 Ambient Environment

Niagara Region Wind Farm is located in a rural (Class III) area. Ambient noise in rural areas is typically driven by a mixture of flora, fauna, traffic, and nearby industry. Each of these sources and their impacts on the ambient environment are discussed in this section. If the ambient noise is extraneous – such as a short-duration event, or noise concentrated at specific frequencies – then filtering is employed to reduce or remove it (see Section 4.3.2). If the ambient noise is not extraneous, then efforts are made to ensure that the

noise is equally represented in both *Total Noise* and *Background* periods (see Section 4.3.3).

In addition to ambient noise sources, self-generated noise from the monitoring equipment will typically be present in the measurement data at high wind speeds. This noise is minimized by the usage of a primary and secondary wind screen installed around the microphone. The larger secondary wind screen meets the requirements of Section D2.1.4 of the Compliance Protocol and the insertion loss of the wind screen is tested and accounted for in the analysis. Self-generated noise is assumed to be equally present in *Total Noise* and *Background* periods for a given wind speed.

3.2.1 Flora

The area surrounding Niagara Region Wind Farm is a mix of shelter belts surrounding farmers fields. The noise generated from these features is proportional to wind speed – both ground level and hub-height – with higher wind speeds generating increased amounts of noise.

Noise from flora was found to be insignificant at the start of the I-audit. However, noise from flora became significant as the corn planted in the field surrounding the monitor increased in height. The campaign was ended when the noise from corn was determined to be contaminating the audit measurements. A site photograph showing the monitoring equipment and corn in the field after 6 weeks is provided in Appendix A.05.

3.2.2 Fauna

Noise from fauna refers to noise typically arising from the activity of insects, birds, livestock, or dogs. Noise of this nature may be concentrated at high frequencies (such as crickets chirping) or limited to short-term events (such as dogs barking). Noise from fauna is considered extraneous noise.

Animal activity contributed significantly to the ambient noise in the area around receptor O0085, specifically insect noise and birds. Bird noise was prominent throughout the campaign, particularly during early morning periods.

3.2.3 Traffic

Noise from traffic was found to be an occasional source of extraneous noise during the I-audit. Roadways near the project include Concession Road 3. Intervals influenced by car passes were removed from the dataset whenever possible (see Section 4.3.2).

3.2.4 Industry

Noise from farming activities were found to be present during the I-audit. Farming activity was removed from the dataset.

3.2.5 Other Sources

No significant contamination from other sources was found in the measurement dataset.

4 Audit Methodology

For the duration of the I-audit, acoustic and weather data are logged simultaneously in one-minute intervals at the monitoring location. Analysis and filtering are conducted per Section D5.2 and E5.5 of the Compliance Protocol with additional filters applied as needed – following the guidance of the Compliance Protocol – to remove or reduce extraneous ambient noise (see Section 4.3.2) and ensure representative ambient conditions (see Section 4.3.3).

Intervals that pass the filtering criteria are sorted into integer wind bins¹ depending on the measured wind speed and classified as either *Total Noise* or *Background* depending on the operation of the nearby Niagara Region Wind Farm turbines (see Section 4.3.1). The *Turbine-Only* sound level at each wind bin is then determined by logarithmically subtracting the average *Background* level from the *Total Noise* level in wind bins having sufficient data for assessment. Minimum thresholds for sufficient data are discussed in Section 4.4.1.

4.1 Monitoring Equipment

The following acoustic and non-acoustic monitoring equipment was installed at the monitoring location.

- One (1) Type 1 sound level meter with microphone and pre-amplifier, installed at receptor height
- One (1) primary and one (1) secondary² windscreen for the microphone.
- One (1) anemometer installed 10 metres above ground level (“10m-AGL”).

The monitoring equipment was configured to log one-minute equivalent sound levels (L_{eq}) in A-weighted broadband and 1/3rd octave band frequencies. The microphone was installed at least 5 meters away from any large reflecting surfaces, as far away as practically possible from trees and other foliage, and in direct line of sight to the nearest Niagara Region Wind Farm turbines.

¹ An integer wind bin spans 1 m/s, centred on each integer wind speed, open at the low end and closed at the high end.

² The 1/3 octave band insertion loss of the secondary windscreen has been tested and has been accounted for in the data analysis.

Table 2 lists the specific make, model, and serial number for the monitoring equipment used at the audit receptor.

Table 2: Monitoring Equipment Details

Audit Receptor	Equipment	Make/Model	Serial Number	Date of Last Calibration
O0085	Sound Level Meter	NI 9234	1E2B19A	August 21, 2020
	Microphone	PCB 377B02	155526	August 17, 2020
	Pre-amplifier	PCB 426E01	039194	August 17, 2020
	Signal Conditioner	PCB 480E09	37184	August 6, 2020
	Weather Station	Vaisala WXT520	J3040014	August 28, 2019

The measurement chain was calibrated before, during, and after the measurement period using a type 4231 Brüel & Kjær acoustic calibrator. The monitoring equipment is also verified by laboratory calibration per the requirements in Section D2.3 of the Compliance Protocol; calibration certificates are provided in Appendix B.

4.2 Measurement Parameters

The monitoring equipment is configured to run during the daytime from approximately 4am to 11pm, local time. The measurement parameters acquired and used in the audit are listed in Table 3.

Table 3: Measurement parameters used for the I-audit

Parameter Group	Measurement Parameters	Notes
Acoustic (microphone height)	L _{Aeq}	dBA
	L ₉₀	dBA
	1/3 rd Octave Band	dBA (20 Hz–10 kHz)
	Signal Recording	Uncompressed raw files
Weather (10m height)	Wind Speed	m/s
	Wind Direction	0-360°
	Temperature	°C
	Humidity	0-100%
	Precipitation	mm
Turbine (hub height)	Wind Speed	Provided by operator
	Yaw Angle	Provided by operator
	Power Output	Provided by operator
	Rotational Speed	Provided by operator

Turbine operational information was obtained from the facility SCADA system and provided to Aercoustics by NRWF.

4.3 Filtering Criteria

Analyses and filtering of the intervals in the measurement dataset are conducted per the requirements outlined in Section D5.2 and E5.5 of the Compliance Protocol. Intervals are included or excluded from analysis depending on several filtering criteria. Some of these criteria apply to all intervals and some apply only for *Total Noise* or *Background* intervals. Measurement intervals are first passed through the *All-Intervals* filters, after which they are sorted into either *Total Noise* or *Background* categories based on the operation of the nearby turbines. Intervals that fail to meet the applicable filtering criteria are excluded from analysis.

All Intervals

- Have occurred between 5am – 10pm
- Have no precipitation within one hour before or after
- Have an ambient temperature above -20°C
- Have minimal influence from extraneous ambient noise (see Section 4.3.2)

Total Noise Intervals

- Have all nearby turbines operating (see Section 4.3.1)
- Have primary turbine generating at least 85% of its maximum rated power output
- Have a downwind wind direction (primary turbine to monitor, +/- 45°)

Background Intervals

- Have all nearby turbines parked (see Section 4.3.1)
- Have ambient conditions representative of Total Noise periods (Section 4.3.3)

Measurement intervals that pass the filtering criteria above form the assessment dataset for the I-audit.

4.3.1 Turbines in Study Area

As noted above, several filtering criteria are applied based on the operation of the primary turbine or the turbines in the surrounding area. To verify the operation of these turbines, information from the facility SCADA system is examined.

In order for a measurement interval to be considered for the *Total Noise* or *Background* periods, all the turbines in the study area must be operating or parked, respectively. The minimum number of turbines included in the study area for the receptor is selected based on the guidance of Section D3.5.2 of the Compliance Protocol:

D3.5.2 Acoustic measurements with wind turbines parked

“Ambient noise measurements shall be carried out at a point of reception with all turbines in the vicinity of the point of reception parked. The prediction model will be used to determine the number of turbines that require parking in order for the predicted noise contribution of the wind facility to fall to 30 dBA or 10 dB less than the applicable criterion.”

The Niagara Region Wind Farm turbines in the audit study area for the receptor is listed in Table 4 and conform to the Compliance Protocol requirements listed above. All turbines were confirmed to be operating for Total Noise periods and parked for Background periods.

Table 4: Turbines included in the study area

Audit Receptor	Turbines verified for Total Noise Measurements	Turbines verified for Background Measurements
O0085	T08, T52, T53	T08, T52, T53

Parked turbines do not rotate or generate power. There is some idling of the blades (~1 rpm or less), but the acoustic impact of the turbines in this condition is negligible at the receptor. The turbines in the study area were confirmed to be running in their normal operating mode for the duration of the monitoring campaign, see Appendix C for a statement from the operator.

4.3.2 Removal of Extraneous Noise

‘Extraneous noise’ is noise unrelated to the operation of the wind facility that is not part of the typical ambient environment in the area. It is typically noise that is short-duration (i.e. transient) or noise that is limited to specific frequencies. Extraneous noise is considered acoustic contamination and should be removed from the measurement dataset wherever possible. The Compliance Protocol provides the following guidance regarding extraneous noise:

C2.4.7 Extraneous noise sources³

“Measurements are to be inhibited when the sound level is affected by noise from extraneous sources such as vehicle noise, dogs barking and wind gusts (i.e. other than wind turbine sound).”

³ It is acknowledged that the measurements in this report follow Part D and Part E of the Compliance Protocol and this guidance is from Part C. Nevertheless, the guidance regarding the removal of extraneous noise in Part C is applicable here as the requirement to remove contamination from the measurement dataset follows good engineering principles for noise measurements.

The same result can also be achieved by digitally recording the sound level time history and later editing out the extraneous events and recalculating the descriptors such as Leq. This should address measurement situations where extraneous sounds were not inhibited.

D3.5 Acoustic measurements

“[...] In addition, 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.”

D5.3 Effects of insects and fauna

“The analysis shall identify the influence of any insects, fauna, or other extraneous but constant sources of noise and verify them through sound recordings. Noise from insects can be removed from the 1/3rd octave spectra of each measurement. It has to be shown, however, that the contribution of the wind turbine noise in those frequencies is minimal.”

D6 Assessment of compliance

“[...] However, if the background sound levels are greater than the applicable exclusion limits then the applicable limits are now the background sound levels without extraneous noise sources.”

Extraneous noise can be steady or transient. Steady extraneous noise, such as the noise from crickets or other insects, may be removed via filtering of specific 1/3rd octave bands affected by the contamination (see Protocol section D5.3).

The exclusion of this high-frequency data contaminated with insect noise allows for the assessment of measurement intervals which would otherwise be manually invalidated and does so while accounting for the acoustical impact of the relevant wind turbine facilities. The high frequency acoustical contribution from the relevant wind facilities is small – this is because high frequency sound is more easily absorbed by the atmosphere as it propagates across long distances.

The contribution from NRWF at these excluded frequencies was predicted at the monitoring location using the as-built turbine model and was found to be 25 dBA at the monitor location. This contribution was then added logarithmically to the calculated Turbine-Only sound level at the monitor location.

Transient extraneous noise, such as the noise from car passes, dogs, or wind gusts, may be removed via a combination of automatic and manual filtering techniques. Automatic filtering of transient extraneous noise is achieved by removing points where the measured L_{Aeq} is significantly greater than the measured L_{90} for the same interval. Manual filtering of extraneous noise is conducted via listening tests to identify intervals having audible contamination.

4.3.3 Representative Ambient Conditions

The ambient conditions present in the *Total Noise* and *Background* periods should be similar. Section D3.8.2 of the Compliance Protocol specifically states that weather and wind shear conditions should be similar:

D3.8.2 Overall equivalent sound level – wind turbines parked

“Ambient noise measurements should be performed with the turbines parked and conducted within the same general measurement period and with the same weather and wind shear conditions. Measurements of ambient noise obtained during other periods are not recommended and should only be used with great caution to ensure that they represent the “current” ambient noise.”

Note: turbine shutdowns were conducted periodically throughout the I-audit to ensure similar weather conditions between Total Noise and Background periods.

4.4 Compliance Criteria

The criteria for an assessment of compliance per the Compliance Protocol are detailed in this section.

4.4.1 Sample Size Requirements

This audit follows the requirements of the Revised Assessment Methodology – Immission (“RAM-I”). Analysis parameters for RAM-I are detailed in Section E5.5 of the Compliance Protocol. Relevant sections regarding sample size requirements as they pertain to this I-audit are also copied below:

E5.5(1): “The objective of the RAM I-Audit is to assess the acoustic immission at the measurement location at wind speeds between 1 and 7 m/s (inclusive). At a minimum, data must be acquired to satisfy the requirements of at least one of the following:

- 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).”*

E5.5(5): “The Ministry may accept a reduced number of data points for each wind speed bin with appropriate justification (i.e. 60 data points in place of 120 for turbine operational measurements and 30 data points in place of 60 data points for ambient measurements). The acceptable number of data points will be influenced by the quality of the data (standard deviation).”

E5.5(6): “If the measurement campaign is unable to acquire the minimum number of ambient sound level data, the owner/operator of the wind facility will be permitted to use one of the provisions described below:

- a. use the ambient sound level data from a lower wind speed bin to represent a higher wind speed bin (i.e., if 6m/s data is unavailable, the owner/operator is permitted to use 5 m/s data to represent the 6 m/s data bin), or*
- b. Use a value of 30 dBA”*

In this study, a wind bin is considered complete if there are at least 60 valid *Total Noise* and 30 valid *Background* intervals. For Background wind bins with less than 30 valid intervals the ambient sound level data from a lower wind speed bin has been used to represent the higher wind speed bin.

4.4.2 Sound Level Limits

The area surrounding Niagara Region Wind Farm has been designated as Class III. Exclusion limits for a Class III area are summarized in Table 5 below.

Table 5: MECP Exclusion Limits (Class III)

Wind speed at 10m height (m/s)	Sound Level Exclusion Limit (dBA)
≤ 6	40
7	43

Sections D3.5 and D6 of the Compliance Protocol state that where the measured *Background* sound level exceeds the exclusion limits, the sound level limit for that wind bin is the *Background* sound level without extraneous noise sources.

4.4.3 Tonality

A tonality assessment of the measurement data has been conducted due to prominent tones being observed in the measurement data. The calculation of the mean tonal audibility attributable to the Niagara Region Wind Farm turbines is determined in accordance the IEC 61400-11:2012 standard. Frequencies of interest were identified from the available previous immission audit reports to be 116 Hz. Calculations were conducted using narrowband spectra calculated using the measurement intervals from the assessment dataset. Tonal audibility penalties, if applicable, for each wind bin are calculated according to Annex C of ISO 1996-2:2007 and Section E5.5.2 of the Compliance Protocol.

Applicable tonal penalties are determined using the mean tonal audibility, the calculation method of the tonal penalty is summarized in Table 6. Tonal penalties are applied to the turbine-only sound level.

Table 6: Calculation of Applicable Tonal Penalty

Mean Audibility, ΔL	Tonal Adjustment, K_T
$\Delta L \leq 4$ dB	0 dB
4 dB $< \Delta L \leq 10$ dB	$\Delta L - 4$ dB
10 dB $< \Delta L$	6 dB

4.5 Deviations

Any deviations from the methods prescribed in the Compliance Protocol are discussed in this section.

4.5.1 Hourly Time Filter

As per section D5.2 of the Protocol, intervals are to be measured between 22:00 and 05:00 (i.e. nighttime only). As noted in section 4.5.1, the hourly time filter deviated from the Protocol requirements and intervals were measured during the hours of 05:00 – 22:00 as per the Immission Audit Measurement Plan [4].

5 Audit Results

Measurement results of the I-audit are summarized in the following sections. Sound levels presented here are rounded to the nearest integer, whereas all calculations are conducted using un-rounded values.

5.1 Audit Duration

The length of monitoring time is summarized below in Table 7. Noise from corn became significant as the corn planted in the field surrounding the monitor increased in height. The campaign was ended when the noise from corn was determined to be contaminating the audit measurements.

Table 7: Length of monitoring campaign

Audit Receptor	Audit Start Date	Audit End Date	Monitoring Duration (weeks)
O0085	May 25, 2021	June 18, 2021	3

5.2 Weather Conditions

The range of weather parameters measured during the I-audit are summarized in Table 8. These values show the range in weather conditions measured in the assessment dataset.

Table 8: Range of weather conditions in assessment dataset

Audit Receptor	Atmospheric Pressure (hPa)	10m-AGL Wind Speed (m/s)	Relative Humidity (%)	Temperature (°C)	Hub-Height Wind Speed (m/s)
O0085	988 - 1001	0 - 11	36 - 76	11 – 29	0 - 15

A wind rose showing the measured wind directions are provided in Figure 1. This data represents the range of wind directions for all measurement data collected during the audit, not just the assessment dataset. Note that wind directions shown on the wind roses indicate the direction the wind is coming from, and the purple shaded area represent the downwind angle for the receptor.

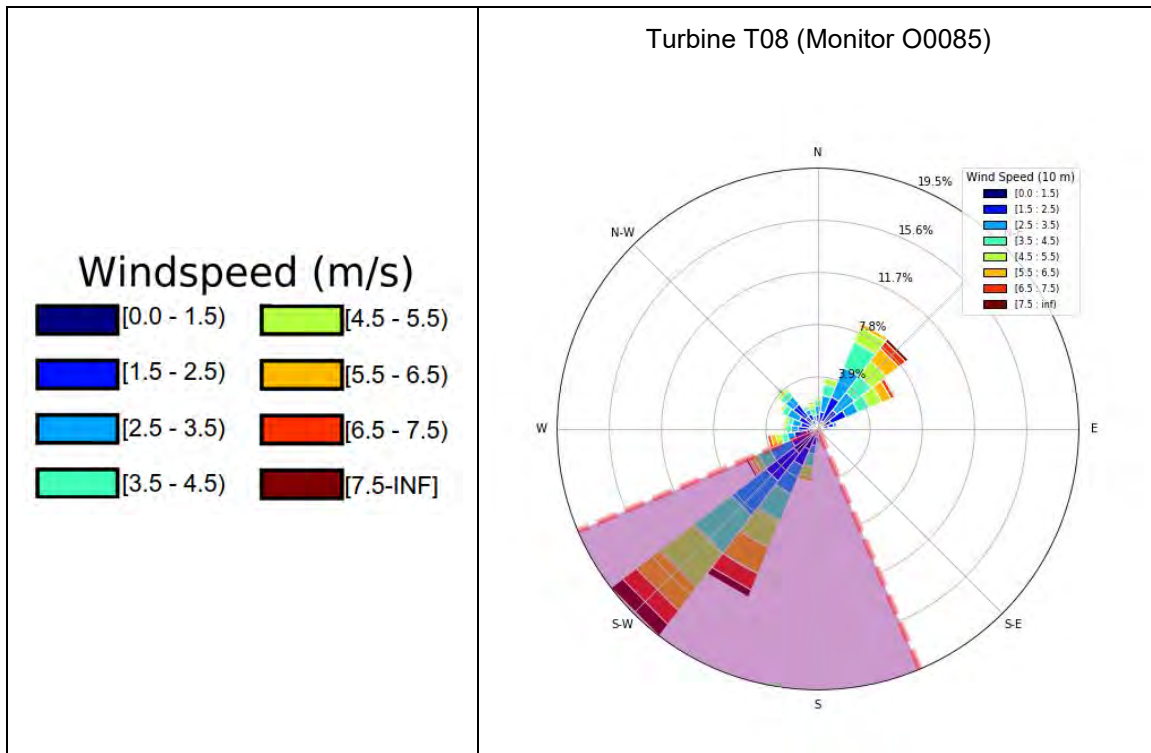


Figure 1: Wind Rose – all measured data.

From Figure 1, the distribution of wind directions observed during the I-audit is similar to what was expected based on the historical wind patterns.

5.3 Data Excluded due to Filtering Criteria

A range of wind and weather conditions were measured over the course of the I-audit. The Compliance Protocol requires that assessment data be counted only during downwind and high-power conditions, both of which vary independently with time. As a measure of how often the minimum suitable conditions materialized during the audit, the total proportion of measurement time where these two conditions were satisfied is presented in Table 9. This data shows how often during the I-audit the minimum assessment requirements in the Compliance Protocol were met at the audit receptor.

Table 9: Prevalence of Occurrence of Suitable Turbine Conditions

Audit Receptor	Primary Turbine	Prevalence of Downwind	Prevalence of Downwind and High Output
O0085	T08	45%	3%

It should be noted that the proportion of measurement data indicated above in Table 9 represents the maximum available data for assessment. Additional filters applied to remove contaminated or otherwise unsuitable measurement data (as discussed in Section 4.3.2) will further reduce the assessment dataset.

5.4 Measured Sound Levels

Valid measurement intervals that pass the filtering criteria are logarithmically averaged and sorted by wind bin into *Total Noise* and *Background* datasets. These average sound levels are presented below in Table 10.

Table 10: Average measured sound levels at the monitoring Location

Audit Receptor	Period	Measurement Parameter	Wind Bin (m/s)						
			1	2	3	4	5	6	7
O0085	Total Noise	Number of Samples	0	1	109	80	42	70	100
		Average L _{Aeq} [dBA]	-	-	40.0	40.6	-	43.8	46.3
		Standard Deviation [dB]	-	-	0.7	0.7	-	1.2	1.4
	Background	Number of Samples	74	40	35	1	4	30	44
		Average L _{Aeq} [dBA]	32.3	35.4	37.7	-	-	42.4	43.7
		Standard Deviation [dB]	3.5	4.7	1.5	-	1.9	1.8	1.1

- Minimum sample size not met in this wind bin, sound levels not reported

Measurement data points from Table 10 are also plotted in the following figures.

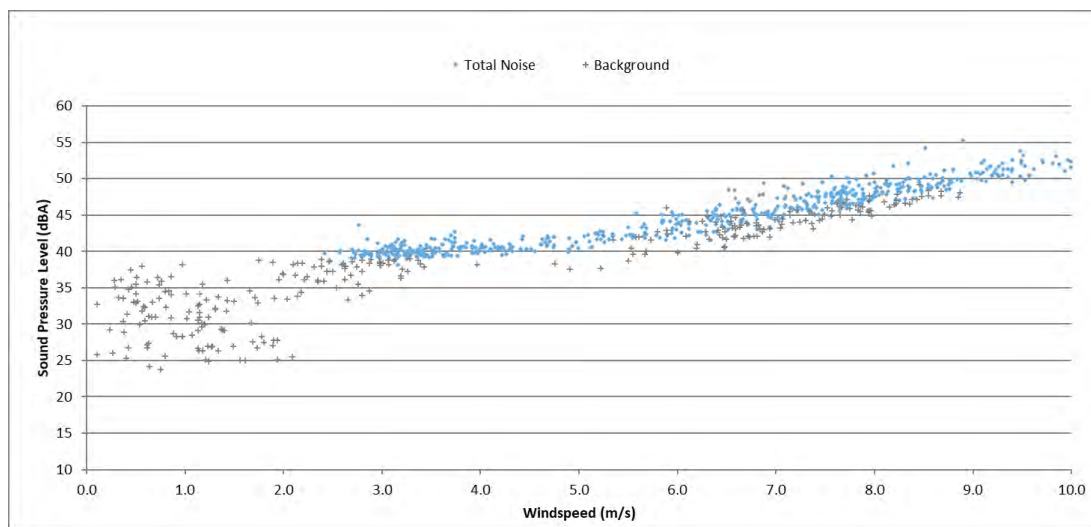


Figure 2: All valid Total Noise and Background intervals measured at O0085 Monitor

5.5 Sound Level Adjustments

The following sections detail any adjustments made to the sound levels presented in Section 5.4.

5.5.1 Tonal Adjustment

No penalties were found to be applicable.

Table 11: Tonality Assessment Table – 116 Hz

Audit Receptor	Tonality Parameter	Wind Bin (m/s)						
		1	2	3	4	5	6	7
O0085	Data Points in Wind Bin	0	1	109	80	42	70	100
	Data Points with Tone	0	1	84	60	30	35	32
	Tonal Presence	0%	100%	77%	75%	71%	50%	32%
	Tonal Audibility, ΔL [dB]	-	-6.7	-4.6	-4.2	-4.5	-6.8	-4.4
	Tonal Adjustment, K_T [dB]	0	0	0	0	0	0	0

From the results in Table 11, no tones were detected that exceeded the threshold for tonal penalties.

5.6 Turbine-Only Sound Levels

The average *Total Noise* and *Background* sound levels by wind bin at the monitoring location are presented in Table 12. Any sound level adjustments used to determine the Turbine-Only sound level at the audit receptor (Point of Reception) are also presented.

Table 12: Calculated Turbine-Only Sound Levels

Audit Receptor	Measurement Period	Wind Bin (m/s)						
		1	2	3	4	5	6	7
O0085	Total Noise (dBA)	-	-	40.0	40.6	-	43.8	46.3
	Background (dBA)	32.3	35.4	37.7	37.7*	-	42.4	43.7
	Signal to Noise (dBA)	-	-	2.3	2.9	-	1.4	2.5
	Turbine-Only (dBA) [monitor location]	-	-	37	37	-	38	43
	Tonal Adjustment	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Turbine-Only (dBA) [Point of Reception]	-	-	37	37	-	38	43

- Minimum sample size not met in this wind bin, sound levels not reported

* ambient sound level data from a lower wind speed bin to represent a higher wind speed bin

An assessment compliance of the Turbine-Only sound levels at the Point of Reception is provided in Table 13.

6 Assessment of Compliance

This section provides the results of the measurements and calculations as they pertain to the determination of compliance of the facility. Section 4.4 details the criteria used to evaluate compliance.

6.1 Assessment Table

Final Turbine-Only sound levels at the audit receptor (Point of Reception) are compared to the exclusion limits and Background sound levels in Table 13. Turbine-Only sound levels at the audit receptor are calculated by taking the Turbine-Only sound level at the monitoring location and applying any applicable adjustments as indicated in Table 12.

Table 13: Assessment Table

Audited Receptor	Wind speed at 10m-AGL [m/s]	1	2	3	4	5	6	7
O0085	Turbine-Only Sound Level (Point of Reception) [dBA]	-	-	37	37	-	38	43
	Background Sound Level [dBA]	32	35	38	38	-	42	44
MECP Exclusion Limit [dBA]		40	40	40	40	40	40	43
Compliance? (Y/N)		-	-	Y	Y	-	Y	Y

- Minimum sample size not met in this wind bin, sound levels not reported

6.2 Statement of Compliance

Based on the results presented in Table 13, the Turbine-Only sound levels at the audit receptor for Niagara Region Wind Farm are in compliance with the applicable sound level limits.

7 Conclusion

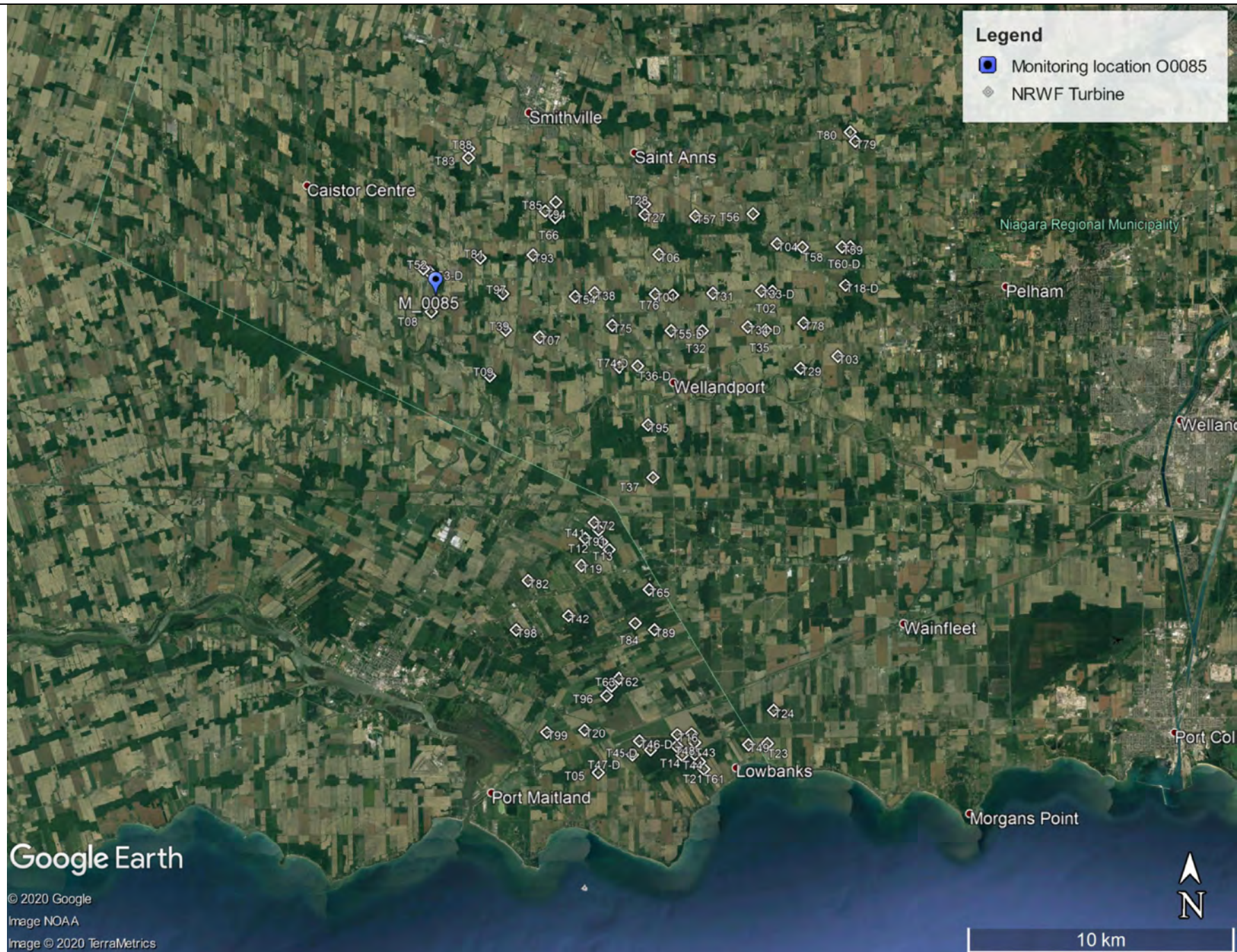
An acoustic immission audit per the requirements of the MECP Compliance Protocol for Wind Turbine Noise was conducted at Niagara Region Wind Farm receptor O0085 per the results presented in this report and summarized in Table 13, the noise impacts at the receptor was found to be in compliance with the applicable sound level limits.

8 References

- [1] V. Schroter, “Renewable Energy Approval #4353-9HMP2R,” Ontario Ministry of the Environment, Toronto, ON, November 06, 2014.
- [2] I. Khan, A. Munro and P. Ashtiani, “Niagara Region Wind Farm Project Acoustic Immission Audit - Phase 2,” Aercoustics Engineering Ltd., Mississauga, ON, July 02, 2019.
- [3] H. Fung, A. Munro and P. Ashtiani, “Niagara Region Wind Farm Project Acoustic Immission Audit - Phase 4 Receptor O0085,” Aercoustics Engineering Ltd., Mississauga, ON, February 3, 2021.
- [4] A. Munro, “Niagara Region Wind Farm Daytime Immission Audit Measurement Plan,” Aercoustics, Mississauga, ON, 2021.
- [5] Ministry of the Environment and Climate Change, “Compliance Protocol for Wind Turbine Noise,” Government of Ontario, Toronto, 2017.
- [6] A. Pouliot, “Niagara Region Wind Farm - REA No. 4353-9HMP2R - Acoustic Audit - Immission - Phase 2 - Action Plan and Interim Noise Abatement Measures,” Boralex, Kingsey Falls, QC, June 04, 2019.

Appendix A

Site Details



16227.07

Scale: NTS
Drawn by: HF
Reviewed by: AM
Date: Aug, 2021
Revision: 1

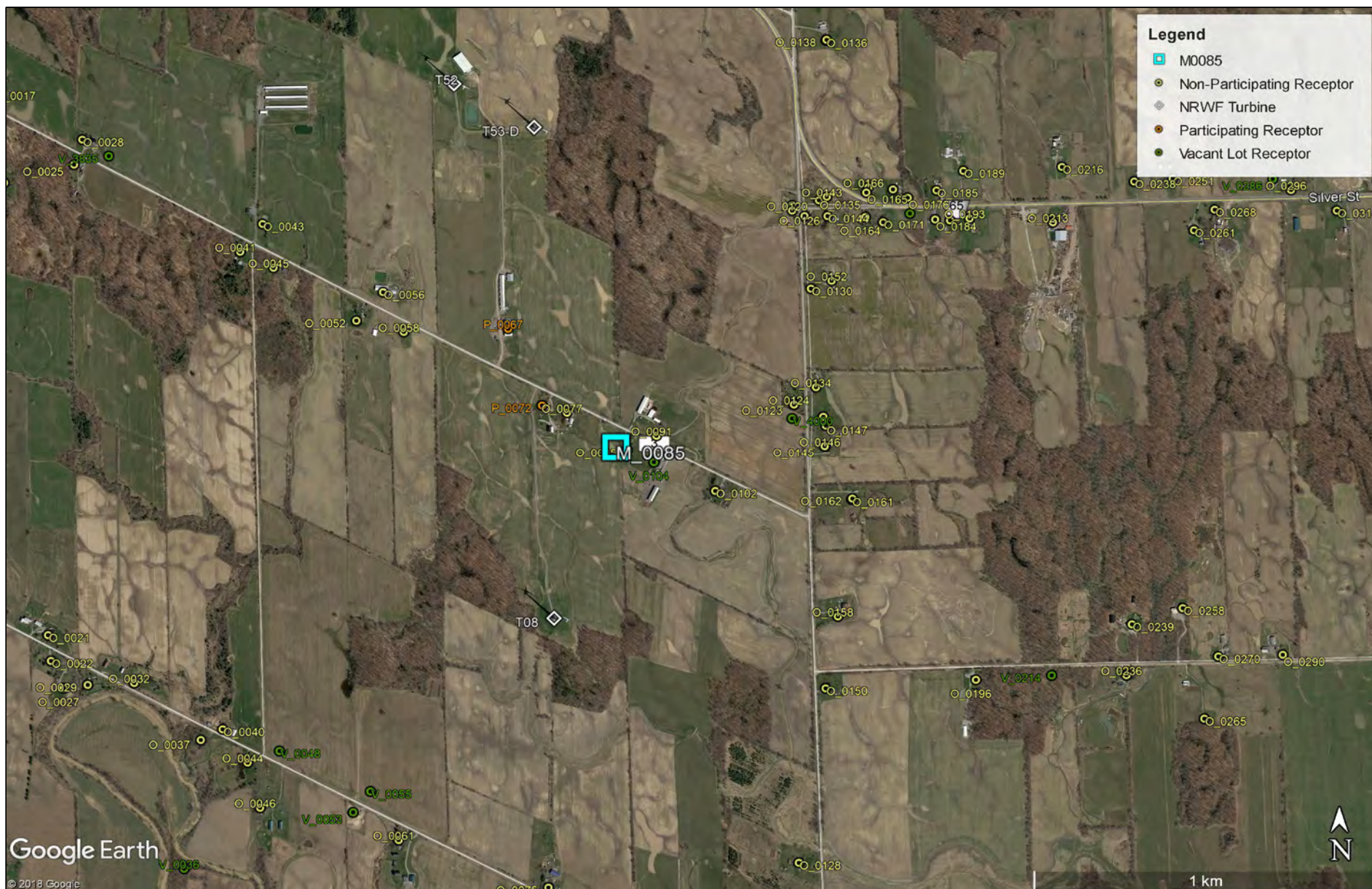
Project Name

Niagara Region Wind Farm Project - Daytime Acoustic Immission Audit

Figure Title

Site Plan

Figure A.01



	16227.07	Project Name	
	Scale: NTS Drawn by: HF Reviewed by: AM Date: Aug, 2021 Revision: 1	Niagara Region Wind Farm Project - Daytime Acoustic Immission Audit	
		Figure Title	
		M0085 - Monitor and Receptor Location Details	Figure A.02







	16227.07	Project Name	
	Scale: NTS Drawn by: HF Reviewed by: AM Date: Aug, 2021 Revision: 1	Niagara Region Wind Farm Project - Daytime Acoustic Immission Audit	
Figure Title			Figure A.05
Site Photos - M0085 and influence of corn (approx. 6 weeks after deployment)			

Appendix B

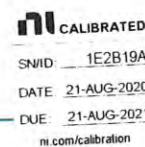
Calibration Certificates

Monitoring Equipment Details

Table B.01: Monitoring Equipment Details

Audit Receptor	Equipment	Make/Model	Serial Number	Date of Last Calibration
O0085	Sound Level Meter	NI 9234	1E2B19A	August 21, 2020
	Microphone	PCB 377B02	155526	August 17, 2020
	Pre-amplifier	PCB 426E01	039194	August 17, 2020
	Signal Conditioner	PCB 480E09	37184	August 6, 2020
	Weather Station	Vaisala WXT520	J3040014	August 28, 2019

Compliant Calibration Certificate



Certificate Number:	6490461.1	OE Number:	21970516
Date Printed:	24-AUG-2020	Page:	1 of 14
Customer:	Aercooustics Engineering Ltd (CA) 5335 Lucas Court ONTARIO Mississauga, L4Z 4A9 CANADA		
Manufacturer:	National Instruments	Model:	NI 9234
Serial Number:	1E2B19A		
Part Number:	195551D-01L	Description:	MODULE ASSY, NI 9234, 4 AI CONFIGURABLE
Calibration Date:	21-AUG-2020	Issued Date:	24-AUG-2020
Procedure Name:	NI 9234	Recommended Calibration Due:	21-AUG-2021
Procedure Version:	3.6.1.0	Verification Results:	As Found: Passed As Left: Passed
Lab Technician:	Rogelio Gaytan	Calibration Executive Version:	5.2.0.0
		Driver Info:	NI-DAQmx:19.0.0
Temperature:	23.0° C	Humidity:	43.8% RH

The data found in this certificate must be interpreted as:

- As Found** The calibration data of the unit as received by National Instruments, if the unit is functional.
As Left The calibration data of the unit when returned from National Instruments.

The As Found and As Left readings are identical for units not adjusted or repaired.

This calibration conforms to ANSI/NC SL Z540.1 requirement.

The TUR (Test Uncertainty Ratio) of this calibration is maintained at a ratio of 4:1 or greater, unless otherwise indicated in the measurements. A TUR determination is not possible for singled sided specification limits and therefore the absence of a value should not be interpreted as a TUR of 4:1 or greater, but rather undetermined. When provided, the expanded measurement uncertainty is calculated according to the Guide to the Expression of Uncertainty in Measurement (GUM) for a confidence level of approximately 95%.

Measured values greater than the Manufacturer's specification limits are marked as 'Failed', measured values within the Manufacturer's specifications are marked as 'Passed'. NI Service Labs do not consider uncertainties when making statements of compliance to a specification.

This certificate applies exclusively to the item identified above and shall not be reproduced except in full, without National Instruments written authorization. Calibration certificates without signatures are not valid.

The Calibration Certificate can be viewed or downloaded online at www.ni.com/calibration/. To request a hard copy, contact NI Customer Service at Tel:(800) 531-5066 or Email orders@ni.com.

Ted Talley
Technical Manager

NI Calibration Services Austin
Building A
11500 N MoPac Expwy
AUSTIN, TX 78759-3504
USA
Tel: (800) 531-5066



Calibration Notes

Type	Note
Asset	Verification and adjustment were performed.

Standards Used

Manufacturer	Model	Type	Tracking Number	Calibration Due	Notes
FLUKE	5700A	Calibrator	2554	19-SEP-2020	
National Instruments	PXI-4461	Function generator	9383	05-MAY-2021	
National Instruments	PXI-4071	Digital multimeter	9433	28-AUG-2020	
National Instruments	PXI-4132	SMU	9166	19-MAY-2021	

The standards used in this calibration are traceable to NIST and/or other National Measurement Institutes (NMI's) that are signatories of the International Committee of Weights and Measures (CIPM) mutual recognition agreement (MRA).

Calibration Results**As Found****Verify Accuracy**

Lower Range	Upper Range	Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
-5 V	5 V	0	4.00000 V	3.99520 V	4.00002 V	4.00480 V	Passed	
-5 V	5 V	0	0.00000 V	-0.00120 V	-0.00009 V	0.00120 V	Passed	
-5 V	5 V	0	-4.00000 V	-4.00480 V	-4.00016 V	-3.99520 V	Passed	
-5 V	5 V	1	4.00000 V	3.99520 V	4.00015 V	4.00480 V	Passed	
-5 V	5 V	1	0.00000 V	-0.00120 V	-0.00002 V	0.00120 V	Passed	
-5 V	5 V	1	-4.00000 V	-4.00480 V	-4.00018 V	-3.99520 V	Passed	
-5 V	5 V	2	4.00000 V	3.99520 V	4.00014 V	4.00480 V	Passed	
-5 V	5 V	2	0.00000 V	-0.00120 V	0.00004 V	0.00120 V	Passed	
-5 V	5 V	2	-4.00000 V	-4.00480 V	-4.00008 V	-3.99520 V	Passed	
-5 V	5 V	3	4.00000 V	3.99520 V	4.00026 V	4.00480 V	Passed	
-5 V	5 V	3	0.00000 V	-0.00120 V	0.00003 V	0.00120 V	Passed	
-5 V	5 V	3	-4.00000 V	-4.00480 V	-4.00016 V	-3.99520 V	Passed	

As Found

Verify Gain Matching

Max Gain Difference for Channel	Rate	Samples per Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	10240	10240	4 V	-0.040 dB	-0.000 dB	0.040 dB	Passed	
1	10240	10240	4 V	-0.040 dB	0.000 dB	0.040 dB	Passed	
2	10240	10240	4 V	-0.040 dB	-0.000 dB	0.040 dB	Passed	
3	10240	10240	4 V	-0.040 dB	0.000 dB	0.040 dB	Passed	



As Found

Verify Phase Matching

Max Phase Difference for Channel	Rate	Samples per Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	16384	1000 Hz	-0.085 Degrees	-0.016 Degrees	0.085 Degrees	Passed	
1	51200	16384	1000 Hz	-0.085 Degrees	0.014 Degrees	0.085 Degrees	Passed	
2	51200	16384	1000 Hz	-0.085 Degrees	-0.018 Degrees	0.085 Degrees	Passed	
3	51200	16384	1000 Hz	-0.085 Degrees	0.018 Degrees	0.085 Degrees	Passed	
0	51200	16384	10000 Hz	-0.490 Degrees	-0.153 Degrees	0.490 Degrees	Passed	
1	51200	16384	10000 Hz	-0.490 Degrees	0.130 Degrees	0.490 Degrees	Passed	
2	51200	16384	10000 Hz	-0.490 Degrees	-0.179 Degrees	0.490 Degrees	Passed	
3	51200	16384	10000 Hz	-0.490 Degrees	0.179 Degrees	0.490 Degrees	Passed	

As Found

Verify Common Mode Rejection Ratio

Channel	Rate	Samples per Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	16384	1000 Hz	40.000 dB	53.402 dB	100.000 dB	Passed	
1	51200	16384	1000 Hz	40.000 dB	51.051 dB	100.000 dB	Passed	
2	51200	16384	1000 Hz	40.000 dB	54.028 dB	100.000 dB	Passed	
3	51200	16384	1000 Hz	40.000 dB	51.624 dB	100.000 dB	Passed	



As Found

Verify IEPE Current

Channel	Rate	DMM Range	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	0.01 A	2.000 mA	2.000 mA	2.082 mA	2.200 mA	Passed	
1	51200	0.01 A	2.000 mA	2.000 mA	2.072 mA	2.200 mA	Passed	
2	51200	0.01 A	2.000 mA	2.000 mA	2.082 mA	2.200 mA	Passed	
3	51200	0.01 A	2.000 mA	2.000 mA	2.063 mA	2.200 mA	Passed	



As Found

Verify IEPE Compliance Voltage

Channel	Rate	SMU Voltage Limit	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	24 V	2 mA	19.000 V	20.919 V	24.000 V	Passed	
1	51200	24 V	2 mA	19.000 V	20.924 V	24.000 V	Passed	
2	51200	24 V	2 mA	19.000 V	20.920 V	24.000 V	Passed	
3	51200	24 V	2 mA	19.000 V	20.927 V	24.000 V	Passed	



As Left

Verify Accuracy

Lower Range	Upper Range	Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
-5 V	5 V	0	4.00000 V	3.99520 V	4.00001 V	4.00480 V	Passed	
-5 V	5 V	0	0.00000 V	-0.00120 V	-0.00000 V	0.00120 V	Passed	
-5 V	5 V	0	-4.00000 V	-4.00480 V	-3.99998 V	-3.99520 V	Passed	
-5 V	5 V	1	4.00000 V	3.99520 V	4.00000 V	4.00480 V	Passed	
-5 V	5 V	1	0.00000 V	-0.00120 V	-0.00000 V	0.00120 V	Passed	
-5 V	5 V	1	-4.00000 V	-4.00480 V	-4.00000 V	-3.99520 V	Passed	
-5 V	5 V	2	4.00000 V	3.99520 V	4.00000 V	4.00480 V	Passed	
-5 V	5 V	2	0.00000 V	-0.00120 V	-0.00000 V	0.00120 V	Passed	
-5 V	5 V	2	-4.00000 V	-4.00480 V	-4.00001 V	-3.99520 V	Passed	
-5 V	5 V	3	4.00000 V	3.99520 V	4.00000 V	4.00480 V	Passed	
-5 V	5 V	3	0.00000 V	-0.00120 V	0.00000 V	0.00120 V	Passed	
-5 V	5 V	3	-4.00000 V	-4.00480 V	-3.99998 V	-3.99520 V	Passed	

As Left

Verify Gain Matching

Max Gain Difference for Channel	Rate	Samples per Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	10240	10240	4 V	-0.040 dB	0.000 dB	0.040 dB	Passed	
1	10240	10240	4 V	-0.040 dB	-0.000 dB	0.040 dB	Passed	
2	10240	10240	4 V	-0.040 dB	0.000 dB	0.040 dB	Passed	
3	10240	10240	4 V	-0.040 dB	-0.000 dB	0.040 dB	Passed	



As Left

Verify Phase Matching

Max Phase Difference for Channel	Rate	Samples per Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	16384	1000 Hz	-0.085 Degrees	-0.016 Degrees	0.085 Degrees	Passed	
1	51200	16384	1000 Hz	-0.085 Degrees	0.014 Degrees	0.085 Degrees	Passed	
2	51200	16384	1000 Hz	-0.085 Degrees	-0.018 Degrees	0.085 Degrees	Passed	
3	51200	16384	1000 Hz	-0.085 Degrees	0.018 Degrees	0.085 Degrees	Passed	
0	51200	16384	10000 Hz	-0.490 Degrees	-0.153 Degrees	0.490 Degrees	Passed	
1	51200	16384	10000 Hz	-0.490 Degrees	0.130 Degrees	0.490 Degrees	Passed	
2	51200	16384	10000 Hz	-0.490 Degrees	-0.179 Degrees	0.490 Degrees	Passed	
3	51200	16384	10000 Hz	-0.490 Degrees	0.179 Degrees	0.490 Degrees	Passed	



As Left

Verify Common Mode Rejection Ratio

Channel	Rate	Samples per Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	16384	1000 Hz	40.000 dB	53.317 dB	100.000 dB	Passed	
1	51200	16384	1000 Hz	40.000 dB	52.570 dB	100.000 dB	Passed	
2	51200	16384	1000 Hz	40.000 dB	53.176 dB	100.000 dB	Passed	
3	51200	16384	1000 Hz	40.000 dB	50.810 dB	100.000 dB	Passed	



As Left

Verify IEPE Current

Channel	Rate	DMM Range	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	0.01 A	2.000 mA	2.000 mA	2.072 mA	2.200 mA	Passed	
1	51200	0.01 A	2.000 mA	2.000 mA	2.072 mA	2.200 mA	Passed	
2	51200	0.01 A	2.000 mA	2.000 mA	2.082 mA	2.200 mA	Passed	
3	51200	0.01 A	2.000 mA	2.000 mA	2.063 mA	2.200 mA	Passed	



As Left

Verify IEPE Compliance Voltage

Channel	Rate	SMU Voltage Limit	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	24 V	2 mA	19.000 V	20.919 V	24.000 V	Passed	
1	51200	24 V	2 mA	19.000 V	20.924 V	24.000 V	Passed	
2	51200	24 V	2 mA	19.000 V	20.919 V	24.000 V	Passed	
3	51200	24 V	2 mA	19.000 V	20.928 V	24.000 V	Passed	



CERTIFICATE of CALIBRATION

Make : PCB Piezotronics

Reference # : 162443

Model : 378B02

Customer : Aeroustics Engineering Ltd
Mississauga, ON

Descr. : Microphone System 1/2" Free Field

Serial # : 120587

P. Order : 2020.08.10C

Asset # : 01026

Cal. status : Received in spec's, no adjustment made.
Preamp System with Mic 377B02 s/n 155526

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 Quality System system complies with the requirements of ISO-9001-2015 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 17, 2020

By :



Cal. Due : Aug 17, 2022

Petro Onasko

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

Standards used : J-216 J-324 J-333 J-420 J-512

Navair Technologies

REPAIR AND CALIBRATION TRACEABLE TO NRC AND NIST

6375 Dixie Rd. Mississauga, ON, L5T 2E7

Phone : 800-668-7440

Fax: 905 565 8325

<http://www.navair.com>

e-Mail: service@navair.com

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Form: 378B02 Approved by: J.R. Feb-16 Ver 1.0

Calibration Report for Certificate :

162443

Make			Model	Serial	Asset		
PCB Piezotronics			378B02	120587	01026		
PCB Piezotronics			426E01	039194	01026		
PCB Piezotronics			377B02	155526	01026		

Sensitivity at 250 Hz

Specs Nom	Unit		Min	Reading	Max		In/Out
50.0 mV/Pa			39.72	52.22	62.94		In
-26.02 dB	re 1 V/Pa		-28.02	-25.64	-24.02		In
0 dB	re 50 mV/Pa		-2	0.38	2		In

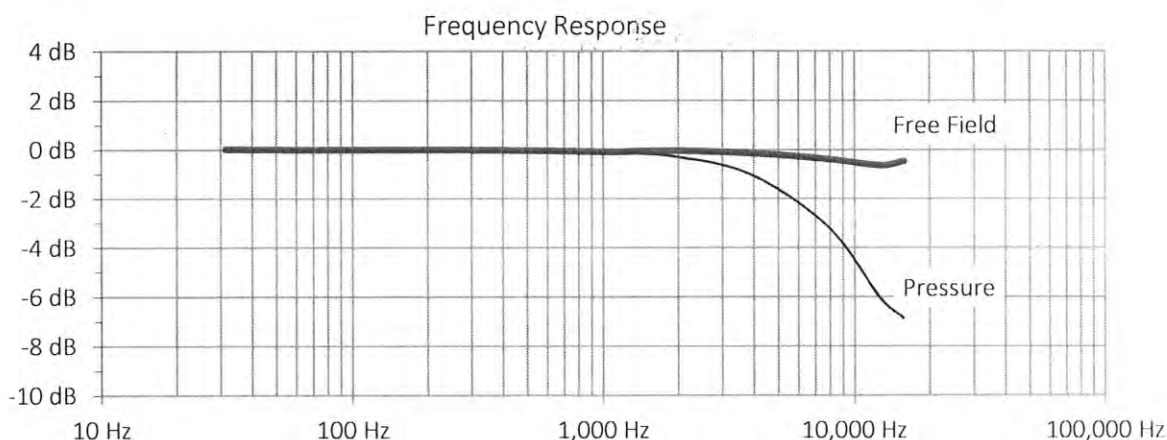
Ambient Conditions: Static Pressure
Temperature
Rel.Humidity

99.1 kPa
24.7°C
43%

Frequency response

	Lower	Upper
Freq	Pressure	Free Field
Hz	dB	dB
31.5	+0.03	+0.03
63.1	0.00	0.00
125.9	0.00	0.00
251.3	0.00	0.00
502.5	-0.02	-0.02
1005.1	-0.10	-0.08
1978.7	-0.30	-0.04
3957.5	-1.05	-0.14
7914.9	-3.19	-0.39
12663	-6.04	-0.64
15830	-6.88	-0.47

ref



CERTIFICATE of CALIBRATION

Make : PCB Piezotronics

Reference # : 162350

Model : 480E09

Customer : Aeroustics Engineering Ltd
Mississauga, ON

Descr. : Conditioning Amplifier

Serial # : 00037184

P. Order : 2020.07.29C

Asset # : 01386

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 Quality System system complies with the requirements of ISO-9001-2015 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 06, 2020

By :



Cal. Due : Aug 06, 2022

Petro Onasko

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

Standards used : J-255 J-367 J-512

Navair Technologies

REPAIR AND CALIBRATION TRACEABLE TO NRC AND NIST

6375 Dixie Rd. Mississauga, ON, L5T 2E7

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Fax: 905 565 8325

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e-Mail: service@navair.com

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Form: 480E09	Approved by: J. Raposo	Jun-19	Ver 2.0
--------------	------------------------	--------	---------

Calibration Report for Certificate : 162350

Make PCB Piezotronics	Model 480E09	Serial No 00037184	Asset 01386	Cal by P.O.
--------------------------	-----------------	-----------------------	----------------	----------------

Test	Setting	Input	Min	Reading	Max	In/Out
------	---------	-------	-----	---------	-----	--------

Excitation Voltage

• 1			25 Vdc	26.7 Vdc	29 Vdc	In
-----	--	--	--------	----------	--------	----

Constant Current Excitation

• 1			2.0 mA	2.95 mA	3.2 mA	In
-----	--	--	--------	---------	--------	----

Voltage Gain Accuracy at 1 kHz

• 1	1.000 V		0.98	1.000	1.02	In
• 10	0.100 V		9.80	10.00	10.20	In
• 100	0.010 V		98.0	99.9	102.0	In



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.US2.07596

Date of issue: August 29, 2019

Type: Vaisala Weather Transmitter, WXT520

Serial number: J3040014

Manufacturer: Vaisala, Oyj, PL 26, FIN-00421 Helsinki, Finland

Client: Aeroustics Engineering Ltd., 1004 Middlegate RD, Suite 1100, S.Tower, Mississauga, ON L4Y 1M4, Canada

Anemometer received: August 26, 2019

Anemometer calibrated: August 28, 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: $v \text{ [m/s]} = 1.01133 \cdot U \text{ [m/s]} + 0.06250$

Standard uncertainty, slope: 0.00308

Standard uncertainty, offset: 0.52440

Covariance: -0.0000956 (m/s)²/m/s

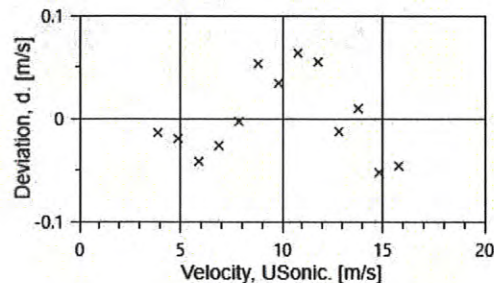
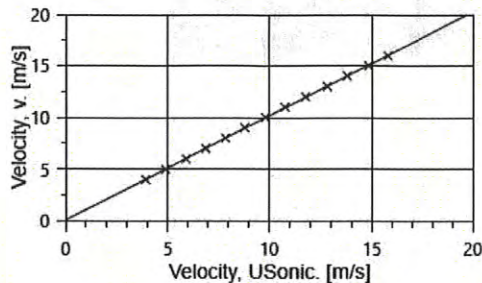
Coefficient of correlation: $\rho = 0.999948$

Absolute maximum deviation: 0.063 m/s at 11.023 m/s

Barometric pressure: 999.3 hPa

Relative humidity: 42.6%

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	9.20	25.8	31.3	3.985	3.8917	-0.014	0.023
4	14.39	25.8	31.3	4.985	4.8862	-0.019	0.026
6	20.82	25.8	31.3	5.995	5.9069	-0.042	0.030
8	28.39	25.8	31.3	7.001	6.8867	-0.026	0.034
10	37.21	25.8	31.3	8.015	7.8667	-0.003	0.038
12	47.11	25.8	31.3	9.019	8.8033	0.053	0.043
13-last	58.17	25.8	31.3	10.022	9.8138	0.034	0.047
11	70.37	25.8	31.3	11.023	10.7750	0.063	0.051
9	83.73	25.8	31.3	12.024	11.7733	0.055	0.056
7	98.20	25.8	31.3	13.022	12.8267	-0.013	0.060
5	113.85	25.8	31.3	14.022	13.7933	0.010	0.064
3	130.55	25.8	31.3	15.015	14.8367	-0.052	0.068
1-first	148.25	25.7	31.3	15.999	15.8033	-0.046	0.073



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
BP003	Setra M278, 0-5VDC Output, barometer
PL3	Pitot tube
XB001	Computer Board. 16 bit A/D data acquisition board
Njord2-PC	PC dedicated to data acquisition

The accuracies of all measurements were traceable to the SI through NIST or CIPM recognized NMI's.

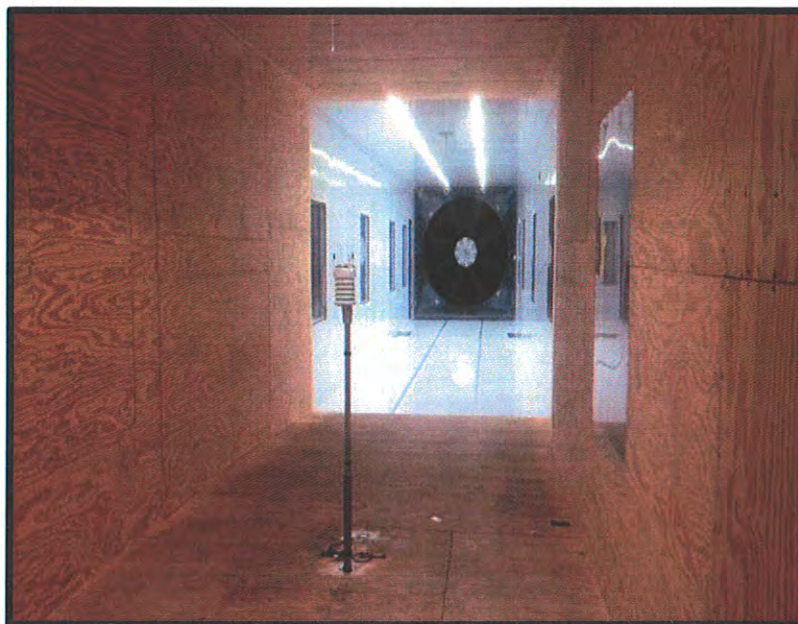


Photo of the wind tunnel setup. The cross-sectional area is 2.5m x 2.5m.

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 positioned at 90° during the calibration.

Certificate number: 19.US2.07596

The results on this certificate relate only to the serial number listed.

All calibrations are done in the "As Left" condition unless otherwise noted.

This certificate must not be reproduced, except in full, without the approval of SOG Wind Engineering LLC



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.US2.07595

Date of issue: August 29, 2019

Type: Vaisala Weather Transmitter, WXT520

Serial number: J3040014

Manufacturer: Vaisala, Oyj, PL 26, FIN-00421 Helsinki, Finland

Client: Aercooustics Engineering Ltd., 1004 Middlegate RD, Suite 1100, S.Tower, Mississauga, ON L4Y 1M4, Canada

Anemometer received: August 26, 2019

Anemometer calibrated: August 28, 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: $v \text{ [m/s]} = 1.00744 \cdot U \text{ [m/s]} + -0.03046$

Standard uncertainty, slope: 0.00216

Standard uncertainty, offset: -0.76023

Covariance: -0.0000472 (m/s)²/m/s

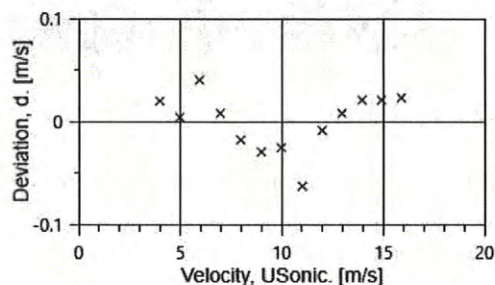
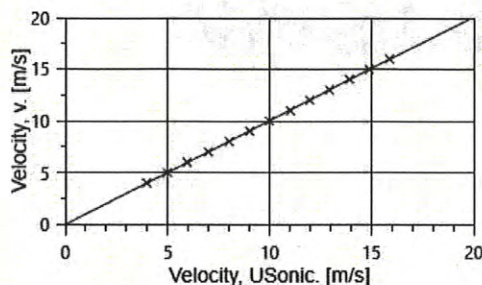
Coefficient of correlation: $\rho = 0.999974$

Absolute maximum deviation: -0.063 m/s at 11.015 m/s

Barometric pressure: 999.1 hPa

Relative humidity: 42.6%

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	9.25	25.9	31.3	3.995	3.9767	0.020	0.023
4	14.40	25.9	31.3	4.986	4.9759	0.004	0.026
6	20.80	25.9	31.3	5.994	5.9400	0.040	0.030
8	28.44	25.9	31.3	7.009	6.9800	0.008	0.034
10	37.15	25.9	31.3	8.011	8.0000	-0.018	0.038
12	47.10	25.9	31.3	9.020	9.0133	-0.030	0.043
13-last	58.02	25.9	31.3	10.012	9.9931	-0.025	0.047
11	70.23	25.9	31.3	11.015	11.0267	-0.063	0.051
9	83.81	25.9	31.3	12.033	11.9833	-0.009	0.056
7	98.22	25.9	31.3	13.027	12.9533	0.008	0.060
5	113.99	25.9	31.3	14.034	13.9400	0.021	0.064
3	130.25	25.9	31.3	15.001	14.9000	0.021	0.068
1-first	148.17	25.8	31.3	15.999	15.8879	0.023	0.073



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
BP003	Setra M278, 0-5VDC Output, barometer
PL3	Pitot tube
XB001	Computer Board. 16 bit A/D data acquisition board
Njord2-PC	PC dedicated to data acquisition

The accuracies of all measurements were traceable to the SI through NIST or CIPM recognized NMI's.

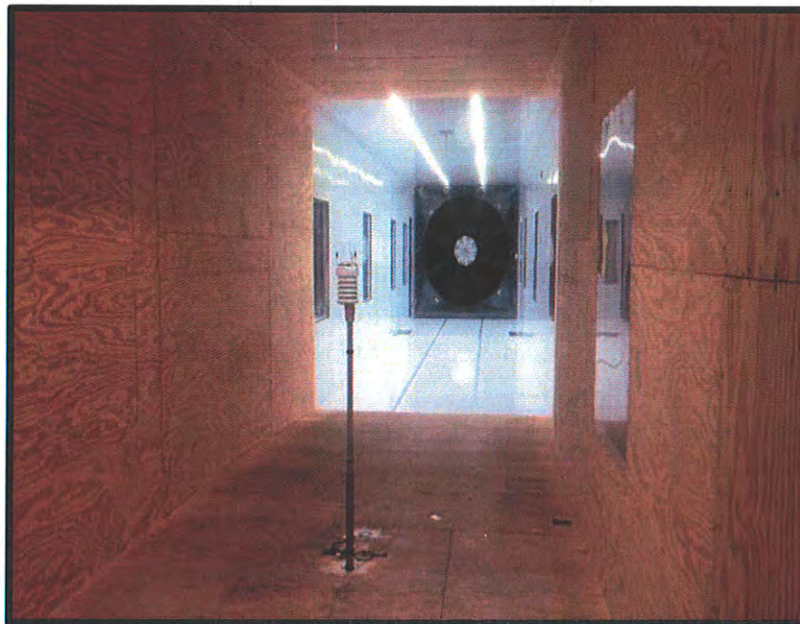


Photo of the wind tunnel setup. The cross-sectional area is 2.5m x 2.5m.

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 positioned at 0° during the calibration.

Certificate number: 19.US2.07595

The results on this certificate relate only to the serial number listed.

All calibrations are done in the "As Left" condition unless otherwise noted.

This certificate must not be reproduced, except in full, without the approval of SOG Wind Engineering LLC

Appendix C

Statement from the Operator

Niagara Region Wind Farm

2659 Industrial park road
Smithville, Ontario L0R 2A0
Canada

T. 1.844.363.6491
boralex.com

BORALEX



August 26, 2021

Mr. Denton Miller, Senior Review Engineer
Environmental Assessment and Permissions Branch
Ministry of Environment, Conservation and Parks
Floor 1, 135 St. Clair Ave W
Toronto (Ontario) M4V 1P5

Dear Sir,

Re: Operator Letter for Immission Audit at the Niagara Region Wind Farm – Receptor O_0085

Please accept this letter as confirmation that all turbines surrounding receptor O_0085 at the Niagara Region Wind Farm were operating as per specifications during the Daytime acoustic Immission Audit, Phase 4 conducted by Aercoustics Engineering Ltd, except during ambient noise measurements.

During ambient noise measurements, all turbines in the vicinity of receptor O_0085 were parked (the turbine rotors were not rotating).

There were no modifications to the blades of the wind turbines surrounding receptor O_0085 during the Audit.

The Immission Audit was specifically conducted from May 25, 2021 to June 18, 2021.

Your sincerely,

Jason Weir,
Wind Site Manager,
Niagara Region Wind Farm

Marie-Pier Bédard
Environmental Manager
Boralex inc.

Appendix D
Supplemental Information

Appendix D.01 Noise Abatement Action Plan and Mitigation Details

Boralex Inc.
36 Lajeunesse Street
Kingsey Falls, Québec J0A 1B0
Canada

T. 819.363.6363
F. 819.363.6399
boralex.com



June 4, 2019

BY EMAIL

MINISTER OF THE ENVIRONMENT, CONSERVATION AND PARKS
Niagara District Office
301 St. Paul Street, 9th Floor, Suite 15
St. Catharines, ON L2R 7R4

Attention: Christopher Medland, Environmental Officer

**Re: Niagara Region Wind Farm – REA No. 4353-9HMP2R -Acoustic Audit – Immission – Phase 2
– Action Plan and Interim Noise Abatement Measures**

Mr. Medland,

On May 24, 2019, 1021702 B.C. Ltd., as general partner for and behalf of FRWN LP submitted to the Ministry of Environment Conservation and Parks ("MECP") an Acoustic Immission Audit- Phase 2 prepared by Aercoustics Engineering Ltd., dated May 24, 2019 ("Phase 2 I-Audit").

The Phase 2 I-Audit was completed as required by the REA No. 4353-9HMP2R issued for the Niagara Region Wind Farm ("REA"). Aercoustics Engineering Ltd. ("Aercoustics") carried out the I-Audit in accordance with the MECP Compliance Protocol for Wind Turbine Noise (updated April 21, 2017). The Phase 2 I-Audit Report concluded that based on the levels measured, the facility was determined to be in compliance at receptors O1153, V2705, O1602 and O0616 and non-compliant at receptor O0085 when compared to the MECP limits described in the REA.

In response to the findings of the Phase 2 I-Audit, we have prepared an Action Plan that includes Interim Noise Abatement Measures. Before detailing our Action Plan, we believe it is important to describe the acoustic audit work that has been completed to date.

The REA for the Niagara Region Wind Farm ("NRWF") was issued on November 6, 2014. Acoustic Audits - Emission ("E-Audits") were completed at 2 turbines of the NRWF and reports prepared by Aercoustics

indicated that sound levels meet the requirements of the REA. As a result, in a letter dated September 12, 2018, the MECP confirmed that conditions F1, F2, F3 and F4 of the REA have been fulfilled.

The Phase 1 I-Audit Report dated July 19, 2018 concluded that sound levels at 4 of the 5 points of reception tested (O1153, V2705, M1602 and M0085) met the sound level requirements of the REA. Data at the fifth point of reception (O0616) had incomplete data based on the MECP Compliance Protocol despite an extended monitoring campaign. MECP confirmed compliance of the sound levels at receptors O1153, V2705, M1602 and M0085 in a letter dated September 12, 2018.

As indicated above, the Phase 2 I-Audit report submitted to the MECP on May 24, 2019 concluded that results at 4 out of 5 receptors complied with MECP sound level limits that are described in the report. Only one point of reception (O0085), that is surrounded by 3 turbines, indicated sound levels above the MECP sound level limits. It is important to note that sound levels at this same point of reception complied with the MECP limits when testing was conducted as part of the Phase 1 I-Audit.

We have been working diligently to address the issues raised by the Phase 2 I-Audit.

There are 3 turbines surrounding receptor O0085 that are located 550 meters away (T08), 1.02 km away (T53) and 1.23 km away (T52). Field verifications of each of the 3 turbines have already been performed by Enercon technicians (the turbine manufacturer) as well as by Boralex wind technicians. Enercon has confirmed that all turbines are operating according to the proper operational mode. Based on these verifications, no technical adjustments of the turbines were required as the turbines were operating according to specifications.

We have also been attempting to perform an E-Test on turbine T08 since March 7, 2019 to verify the sound power emitted by this turbine. Unfortunately, we have been unsuccessful so far because of issues related to wind speed and wind direction and field constraints (trees).

It is important to note that no complaints have been received from residents in the area surrounding receptor O0085. From the start of operations, our records indicate that we have received complaints from only 19 complainants about sound from the wind farm. Most complaints were received in 2016 and 2017. Only one complainant (repeat complainant) has complained about noise in 2019. The residence of the repeat complainant is located approximately 14 km from receptor O0085. Please note that a Part-C noise audit was performed at the residence of the repeat complainant and sound levels were found to be compliant with the REA.

Based on the testing and actions taken to date, in order to address the findings of the Phase 2- I-Audit we will implement the following Action Plan.

Under the Action Plan, we will perform a full Emission Audit at T08, T52 and T53 to verify if the sound level of these turbines meets specifications. We have already mandated Aercoustics to test the 3 turbines.

They are awaiting proper wind speed and direction to perform the tests. We note that the timing of the E-test is weather dependent and that testing at T08 is difficult because of the presence of trees nearby (depending on wind direction, the equipment required to perform the E-test will be located in the adjacent forest for most wind directions).

Once the E-tests are completed, Boralex will be able to prepare a Noise Abatement Action Plan if it is determined to be required.

If the turbines require technical adjustments/curtailment, they will be implemented shortly after the E-tests.

Moreover, given that sound levels at O0085 complied with the MECP limits when testing was conducted as part of the Phase 1 I-Audit, an additional Imissions Acoustic Audit will be performed at receptor O0085 to demonstrate that the sound level at this location is compliant. We expect that this I-Audit will be performed in the Fall of 2019 and the early Winter of 2020, once the wind allows the turbines to operate at more than 85% of their installed capacity.

During the period in which the Action Plan set out above is carried out, we also intend to implement the following Interim Noise Abatement Measures:

1. Curtailment of turbine T08, (which is the closest to receptor O0085, and located upwind from the receptor and in the general direction of the prevailing winds) at the following times and in the following conditions:
 - i. At night, between 22:00 and 05:00
 - ii. When the wind is coming from a direction between 150o and 240o which represents ± 45 degrees from the line of sight between the turbine and the measurement location (M0085);

Curtailment will be based on results of the Phase 2 Audits at M0085 and will be achieved using Enercon's pre-determined curtailment modes, where sound power at receptor M0085 will be reduced to comply with the Noise Performance Limits of the site:

- At 3 m/s, 5 m/s and 7 m/s, the sound power will be decreased by 2 dBA
- At 4 m/s, the sound power will be decreased by 1 dBA
- At 6 m/s, the sound power will be decreased by 3 dBA

2. Since both T52 and T53 are located to the north-west of receptor O0085 and the prevailing winds are from south-west, we are not currently proposing curtailment of these 2 turbines. The distance from T52 and T53 to receptor O0085 is respectively 1.3 km and 1.1 km.
3. The Interim Noise Abatement Measures will remain in place until an I-audit shows compliance at O0085 in accordance with work proposed under the Action Plan.

As we have done from the start of the NRW operations, we intend to continue to work with the MECP and keep the MECP informed of any significant developments related to the project. We are available to discuss the above Action Plan with you.

Yours truly,



Alain Pouliot

General Manager, Operations

Manufacturer's declaration on sound emissions of wind energy converters

Reference number.: SM-06795-008-A

Hereby we declare that the following wind energy converter:

Type:	ENERCON E-101 with a hub height of 124 m
Serial number:	1011169
Source ID in Approval:	T08
Wind farm operator:	FWRN LP
	36, rue Lajeunesse J0A 1B0 Kingsey Falls, Québec Canada
Location:	L0S 1E0 Pelham, Ontario, Canada
Approval authority:	Ministry of the Environment Ontario, Canada
Number of Approval:	4353-9HMP2R
Date of Approval:	November 06, 2014 - and Amendment from April 8, 2016

has a maximum power production capacity of 3.0 MW and operates continuously in *Operating Mode I* with a maximum rotational speed of 14.3 rpm when the below listed restrictions do not apply.

According to the customer's request from June 14, 2019, a noise curtailment has been set up with the following mitigation plan:

	From	To	From	To	From	To	From	To	From	To
Hub height wind speed [m/s]	7.5	10.9	11	13.9	14	16.9	17	19.9	20	22.9
Operating Mode	Mode 1500kW		Mode II (3.0 MW)		Mode 1500kW		Mode 1000kW		Mode 1500kW	

This curtailment applies during the night time from 10pm - 5am and to the wind direction range of 150° - 240° only, referencing North with 0°.

The described restrictions have been active since June 17, 2019.



Author

Aurich, June 28, 2019

Place / Date

This document was created by the author on behalf of ENERCON GmbH. The handwritten signature confirms the accuracy of the above-mentioned data. If you have any questions, please get in touch stating the above reference number.

Created/Date: A. Dörge / June 26, 2019	Department: Engineering Support - Manufacturer Declaration
Checked/Date: D. Eschen / June 28, 2019	Note: Original document
Document-ID: MD-SM_06795-008-B_20190628	1 of 1

To: Jason Weir, jason.weir@boralex.com

From: Allan Munro, AllanM@aercoustics.com

Copies: Marie-Pier Bédard, Boralex
Payam Ashtiani, Aercoustics

Subject: Niagara Region Wind Farm
Daytime Immission Audit Measurement Plan
Aercoustics Project #: 16227.07

Date: May 21, 2021

Aercoustics Engineering Limited (Aercoustics) has been retained by Niagara Region Wind Farm to complete acoustic immission audit (I-audit) measurements proposed for the Niagara Region Wind Farm (NRWF). NRWF operates under REA #4353-9MP2R, issued on November 06, 2014.

A Noise Abatement Action Plan (NAAP) was implemented at NRWF which reduces the sound impact at receptor O0085 during nighttime hours by operating turbines T08 at a reduced noise operating mode. Although compliance with the sound level limits has been demonstrated during nighttime hours through an I-audit at O0085, the Ministry of the Environment, Conservation and Parks (MECP) has indicated concern that the daytime sound impact at receptor O0085 may not be compliant.

To evaluate whether the sound impact is compliant during daytime hours, NRWF has proposed an additional I-audit campaign at O0085 to assess the daytime turbine sound impact. The proposed daytime I-Audit methodology is based on unattended measurements and generally conforms with Part D of the Compliance Protocol for Wind Turbine Noise; NPC 350, April 2017.

It is important to note that the I-Audit methodology will vary from Section D5.2 of the Compliance protocol in order to collect and analyse daytime measurement intervals. Intervals will be measured between 05:00 and 22:00.

The measurement methodology is as follows:

- A single measurement campaign will be carried out at the designated receptor with the aim to collect sufficient datapoints per MECP requirements;

- To quantify the noise contribution from factors other than the subject turbine(s), nearby turbines will need to be parked or turned on, according to site conditions;
- Meteorological data will be collected using an anemometer at a height of 10 m.

It is important to note that the campaign duration depends heavily on weather conditions and cannot be exactly predicted. Based on previous campaigns at this location, a minimum of 9 weeks is likely required to capture downwind data, however past measurement campaigns at this location have extended up to 22 weeks.

Data analysis, processing, and reporting can be completed within approximately 6 weeks of full measurement collection.

Table 1 provides a summary of the preceding information along with an approximate timeline for I-Audit measurements at O0085.

Table 1 – Approximate Daytime I-Audit Timeline at NRWF Receptor O0085

Milestone	Approximate Duration	Anticipated Period of Completion
Monitor deployment	-	May 2021
Data collection	10+ weeks	June 2021 to July 2021
Data analysis, processing, reporting	6 weeks	August 2021 to September 2021

An interim I-audit report (and statement of completeness) or final I-audit report (and statement of compliance) will be submitted no later than August 31, 2021. Obtaining sufficient data for a final I-audit report is heavily dependent on weather conditions and cannot be guaranteed. If sufficient data is not collected during the given time, alterations to the proposed filters may be considered, in consultation with the MECP.

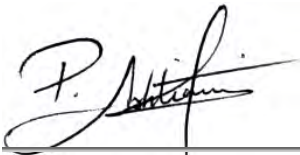
We hope this test plan provides a clear indication of our approach and methodology for daytime I-audit testing proposed for NRWF.

Sincerely,

AERCOUSTICS ENGINEERING LIMITED

A. Munro

Allan Munro, B.A.Sc., P.Eng.



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

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 $\pm 0.5\text{dB}$)? 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.?	✓	RAM-I Audit sample size utilized
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	✓	RAM-I Audit sample size utilized
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	✓	RAM-I Audit sample size utilized
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	✓	Daytime Measurement 5am-10pm

End of Report
