aercoustics

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ASSESSMENT REPORT - **Project: 14215.04**

Suncor Adelaide Wind Power Project
Additional Acoustic Immission Audit- Phase 1

Township of Adelaide-Metcalfe, Country of Middlesex

Prepared for:

Suncor Energy Services Inc.
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September 17, 2019

Table of Contents

1 Introduction

Aercoustics Engineering Limited has been retained by Suncor Energy Services Incorporated ("Suncor") to conduct an additional acoustic immission audit to support the completion of the requirements outlined in Section E of the Renewable Energy Approval ("REA") for the Suncor Adelaide Wind Power Project ("SAWPP"). SAWPP operates under REA #8279-9AUP2B [1], issued on December 11, 2013 and amended on August 5, 2014 [2].

As per Section E1(2) of the SAWPP REA, I-audits are to be conducted at three (3) Points of Reception for two (2) separate occasions. Acoustic immission audits have been previously conducted at receptors R331, R347 and R393 for SAWPP. The results of these measurements have been submitted to the Ontario Ministry of Environment, Conservation and Parks (MECP) in the following reports; completing the measurement requirements per Section E of the REA:

- Suncor Adelaide Wind Power Project – 1st Acoustic Immission Audit (Revision 3) dated October 10, 2017, and

- Suncor Adelaide Wind Power Project – 2nd Acoustic Immission Audit dated May 27, 2016.

In a letter dated October 16, 2018, the MECP confirmed that the measurements at two of the required three receptors (M331 and M393) have adequately fulfilled the requirements of condition "E" in the approval. However, the letter directed that one audit location (R347) required additional measurements to support the determination of compliance due to high ambient sound levels.

Per further discussion with the MECP, it was mutually agreed that an alternate Point of Reception would be chosen in place of R347. The Points of Reception chosen for the additional audits is R754.

Monitoring equipment was erected near the receptor R754 and measurements were conducted nightly from March 2019 to June 2019.

The audit has been conducted as per the methodology outlined in Part D and E5.5 RAM-I (Revised Assessment Methodology) of the "MECP Compliance Protocol for Wind Turbine Noise" (Updated: April 21, 2017). This report outlines the measurement methodology, results, and a comparison of the turbine-only sound contribution to the MECP sound level limits of the I-audit measurements conducted in the Spring of 2019.

2 Facility Description

SAWPP is a class 4 wind facility consisting of eighteen (18) Siemens 2.3-113 wind turbines, each turbine with a nameplate capacity of 2.221 MW. The turbines have a hub height of 99.5 m with a rotor diameter of 113 m. The facility operates 24 hours per day, 7 days per week.

There are four adjacent wind facilities within 10 km of SAWPP: Bornish Wind Energy Centre approximately 6 km to the north, NextEra Adelaide Wind Energy Centre approximately 1 km to the south, Jericho Wind Energy Centre approximately 2.5 km to the west, and Napier Wind Farm approximately 6 km to the southwest. These facilities are located at a distance greater than 5 km from the audit location and do not have a significant impact for the current measurement campaign.

For Total Noise measurement periods, the current audit considers the operations of any wind turbines within 3.0 km of the monitor location. For Background measurement periods, all relevant turbines in the vicinity of the monitor location were parked such that the cumulative predicted level was 30 dBA or less.

A Site Plan of the facility and the surrounding area are provided in Appendix A.

2.1 Measurement Locations

The following section describes the measurement location at receptor R754. Table 1 provides specific details of the receptor and monitoring equipment locations. Photos of the measurement setup and surrounding area are included in Appendix A.

2.1.1 Receptor R754

Monitoring equipment for receptor R754 was located roughly 30 m west of Hansford Road, approximately 630 m to the northeast of turbine WTG06. Highway 402 is located approximately 3 km away and was noted to be audible during periods of the audit. The ground cover between the measurement location and turbine WTG06 was predominantly open farmland with mix woodlots in the surrounding area.

Table 1: Receptor and Sound Monitor Locations

Receptor	Measurement Duration	Location	UTM Coordinates [m] (Zone 17T)	Distance to Nearest Turbine [m]	Predicted Level (dBA)
R754	*Mar 26, 2019 to Jun 2, 2019*	*Receptor*	452,347 E 4,763,086 N	602	37.5*
		Monitor	452,264 E 4,763,140 N	602	37.7*

* Based on CadnaA prediction model created by Aercoustics

3 Measurement Methodology

Measurements and data analyses were conducted per the Ministry of the Environment, Conservation and Parks ("MECP") Compliance Protocol for Wind Turbine Noise ("Protocol") of 2017. Specific details regarding the measurement methodology are presented in this section.

3.1 Test Equipment

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

- One (1) Type 1 sound level meter, with microphone and pre-amplifier installed 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 measurement analysis.
- One (1) anemometer, installed 10 metres above ground level ("10-m AGL").

Table 2 provides the specific make, model, and serial number of each piece of measurement equipment used during the I-audit campaign.

Table 2: Equipment Details

Location	Equipment	Make/Model	Serial Number
R754	Sound Level Meter	NI 9234	1AA831C
	Microphone/Pre-amp pair (Microphone)	PCB 378B02 (PCB 377B02)	132192 (174130)
	Pre-amplifier	PCB 426E01	051461
	Signal Conditioner	PCB 480E09	35342
	Weather Anemometer	Vaisala WXT520	M0410642

The measurement chain was calibrated during the measurement campaign using a Type 4231 Brüel & Kjær acoustic calibrator.

Calibration certificates have been included in Appendix B.

3.2 Measurement Parameters

During the measurement campaign, acoustic and weather data were logged simultaneously in one-minute intervals.

Measured acoustic data includes A-weighted overall equivalent sound levels ("LA_{eq}"), 90th percentile statistical levels ("L_{90}")[1], and 1/3rd octave band levels between 20 Hz and 10,000 Hz (inclusive). Raw signal recordings were also stored for listening and post-processing. Measured weather data includes average wind direction, wind speed, temperature, relative humidity, and atmospheric pressure. The maximum and minimum wind speed for each one-minute interval was also stored.

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

3.3 Data Reduction and Filtering

Data reduction procedures have been employed according to the Protocol to remove invalid and extraneous data points from the assessment datasets. Specific filters are summarized below.

3.3.1 General Filters

General filters are applied to all measurement intervals and are designed to maximize data quality by minimizing ambient contamination and removing periods when the environmental conditions are outside of the specification of the acoustic equipment.

A measurement interval is excluded if any of the following criteria are <u>not</u> satisfied:

- The interval occurred between 10pm – 5am
- No precipitation was detected within 60 minutes before or after the interval
- The ambient temperature was above -20˚C

The following filters are also applied to all intervals:

[1] L_{90} refers to the sound level that is exceeded for 90% of samples in the measurement interval.

Transient Contamination Filter

Listening tests have been conducted to identify contaminated intervals from transient events such as car passbys.

Flora and Fauna

Ambient contamination from flora and fauna was present to varying degrees at the measurement location. Transient contamination (dogs barking etc.) is removed primarily by the automatic transient contamination filter described above.

Insects, birds, and noise from leaves and crops rustling were present to varying degrees in the environment surrounding all receptors; this noise is present to greater degrees at high frequencies, see Section 6.1 for more details.

Wind Facility Operation

Intervals that pass the filtering criteria listed above are sorted into Total Noise or Background periods according to the conditions listed below. If neither Total Noise or Background conditions are met, the data point is excluded from further analysis.

- Total Noise: All facility turbines within 3 km must be rotating and generating power
- Background: All facility turbines with predicted impact of greater than 30 dBA must be parked and not generating power

Note that the study area only includes wind turbines from SAWPP. No wind turbines from another wind facility are located within 3.0 km of the monitoring location.

Table 3 identifies the wind turbines that are considered during Total Noise and Background measurements periods.

Table 3: Turbines considered for Total Noise and Background Periods

Measurement Period	SAWPP Turbines Considered
Total Noise	WTG05, WTG06, WTG07, WTG08, WTG09
Background	WTG06, WTG08

Wind facility SCADA information was provided for the duration of the measurement campaign by SAWPP. This data was used to verify that the SAWPP wind turbines were operational for Total Noise periods and parked for Background periods. The turbine operating conditions were verified by SAWPP for the duration of the campaign, see Appendix C.

Once an interval is sorted based on facility operation, additional filters are applied as described in Sections 3.3.2 for Total Noise Intervals.

3.3.2 Total Noise Filters

Total Noise filters are applied per Protocol guidance and designed such that the noise output from the wind facility is maximized. Filtering is based on the power output and wind direction measured from the nearest turbine. 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.* {Section D5.2(5)}

Downwind angle from WTG06 to R754 is 208 ±45 degrees. This corresponds to a range of 163 to 253 degrees.

3.4 Revised Assessment Methodology – "RAM-I"

RAM-I analysis, described in Section E5.5 of the Protocol, is employed in cases where insufficient data is collected after an extended monitoring campaign lasting 6-weeks or more. The SAWPP monitoring campaign lasted for almost 10-weeks and therefore RAM-I analysis is employed for all receptors. RAM-I methodologies used in this assessment, in addition to those already mentioned in Section 3.3, are detailed below.

3.4.1 Allowable Wind Speed Range

Per Protocol Section E5.5(1), the range of wind bins which may be used to assess compliance is expanded to include a minimum of one of the following conditions:

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)"*

3.4.2 Minimum Sample Size

Per Protocol Section E5.5(5), the sample size requirements are relaxed:

> "*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)"*

The threshold of 60 data points for Total Noise measurements and 30 data points for Background measurements is used in this assessment.

3.5 Sample Size Requirements

Section D3.8 of the Protocol requires at least 120 Total Noise intervals and 60 Background intervals in a wind bin for that bin to be deemed complete. However, as noted in Section 3.4.2, a reduced threshold for completeness has been applied to this dataset based on the allowances for RAM-I analysis given in Protocol Section E5.5.

The RAM-I sample size requirement of 60 data points for Turbine ON and 30 data points for the ambient measurements for 3 wind speed bins between 1 and 7 m/s has been satisfied for receptor R754.

3.6 Contribution from Adjacent Wind Facilities

The operations of any wind turbines within in a 3 km of the monitoring location are considered this assessment. All neighbouring wind facilities are located further than 3 km from the monitoring location.

There are four wind facilities within a 10 km distance from the SAWPP: NextEra Adelaide Wind Energy Centre to the southwest, Bornish Wind Energy Centre to the North, Napier Wind Farm to the west and Jericho Wind Energy Centre to the northwest. Distances to the nearest turbines of each adjacent wind facility from the monitoring location are shown in Table 4.

Table 4: Approximate Distances to Nearest Turbines from Adjacent Wind Facilities

Nearby Wind Facilities	Approximate Distance of Closest Turbine to the Monitoring Location
NextEra Adelaide	6 km (NextEra Adelaide T11)
Bornish	10 km (Bornish T45)
Napier	13 km (Napier WTG2)
Jericho	19 km (Jericho WTG103)

The closest turbine from an adjacent facility is greater than 5 km and no appreciable noise impact is expected at the monitoring location.

4 Sound Level Limits

Sound level limits are set by the MECP and vary based on the classification of the surrounding acoustic environment as well as the measured background sound level (if available). The area surrounding the facility has been deemed Class III, having exclusion limits based on 10-m AGL wind speed as noted in Table 5.

Table 5: MECP Exclusion Limits

Wind speed at 10-m AGL [m/s]	MECP Sound level limit [dBA]
≤ 6	40
7	43

Per Sections D3.5 and D6 of the Protocol, wind bins where the measured background sound levels are greater than the applicable exclusion limits have a sound level limit equal to the background sound level without extraneous noise sources. In effect, the exclusion limits outline the minimum sound level limit by wind bin, with increases in sound level limit permissible if it can be shown through measurements that the existing background sound level is higher than the exclusion limit.

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 measurement are summarized in Table 6. These values represent the range of weather conditions present in the data used for assessment.

Table 6: General Weather Conditions – Range of Measured Values (Assessment Dataset)

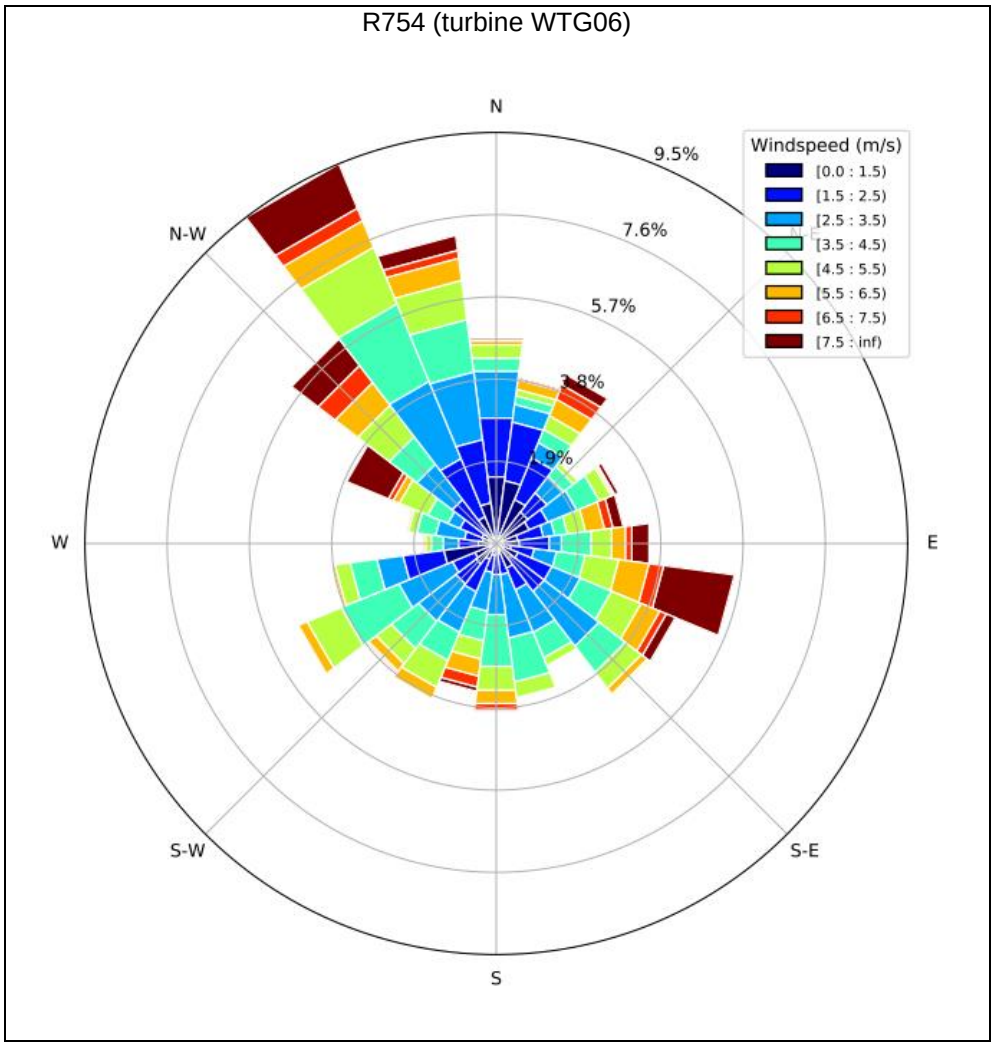
		10-m AGL				*Hub height*
		Atmospheric Pressure [hPa]	Wind Speed [m/s]	Relative Humidity [%]	Temperature [°C]	Wind speed [m/s]
R754	Minimum	963.80	0.2	44.1	-0.4	0.3
	Maximum	994.30	8.3	91.7	19.4	12.1

5.2 Wind Direction

A Wind rose was created for monitor R754 using the yaw angle from the nearest wind turbine and the wind speeds from the 10m-AGL anemometer. As noted in Section 3.4 of this report, RAM-I methodology is being used, and thus all wind speeds from 1-7 m/s 10-m AGL can be used in the assessment.

Wind roses for receptor R754 are provided in Figure 1. Additional wind roses for the Turbine ON and Turbine OFF condition are provided in Appendix E.

Figure 1: Measured wind roses of all collected data for I-audit campaign. Turbine from which the yaw angle information was taken is indicated in brackets.



5.3 Sound Levels

Table 7 presents the average measured sound levels at the monitoring location. Results are separated by wind bin into Total Noise and Background periods.

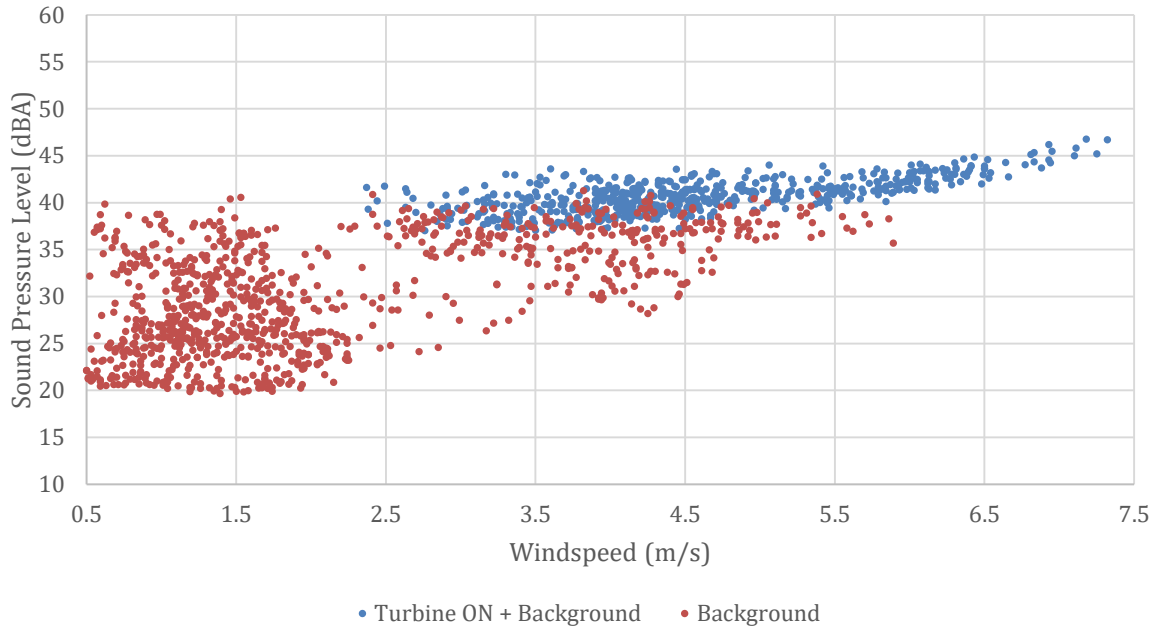
Table 7: Average Measured Sound Levels at Points of Reception, RAM-I Analysis

Receptor	Period	Measurement Parameter	I-audit Wind Bins (m/s)						
			1	2	3	4	5	6	7
R754	*Total Noise*	Number of Samples	0	4	80	247	139	98	22
		Average LAeq [dBA]	-	-	39.5	40.3	41.2	42.5	-
		Standard Deviation	-	-	1.4	1.4	1.2	1.0	-
	Background	Number of Samples	405	236	105	129	51	7*	0
		Average LAeq [dBA]	31.0	30.6	36.1	36.3	37.7	-	-
		Standard Deviation	5.1	4.8	3.6	3.2	1.9	-	-

- *indicates insufficient data counts were collected for the wind speed bin*

Visualizations of the assessment datasets for all receptors are presented in Figure 2.

Figure 2: Measurement Dataset – R754



6 Discussion

Additional discussion of the measured sound levels and analysis methodology are provided in this section.

6.1 Impact of Excluded Frequencies

Analysis of the measured sound levels for R754 were limited to 1/3rd octave band frequencies below 1600 Hz and frequencies above 5000 Hz. This frequency band was excluded to minimize contamination of the acoustic measurements from steady ambient sources such as insects and birds. The predicted impact at these frequencies is presented in Table 8.

Table 8: Impact from Facility of Excluded Frequencies

Measurement Location	Predicted Facility Immission, 2000 Hz – 4000 Hz octave bands[2]
R754	24.5 dBA

The contribution from the wind facility at these frequencies is small because high frequency sound is more efficiently absorbed by the atmosphere. The predicted facility sound impact at from frequencies excluded from the measurement data have been added back to the Turbine-Only sound level.

6.2 Effect of Filtering

The measurement data was assessed according to Part D of the Protocol with the incorporation of the RAM-I data reduction methodology per Section E5.5 of the Protocol. The effect of each filter on the measurement datasets, as well as the total portion of measurement data excluded for each period, are summarized in Table 9.

[2] Contribution by octave band frequency determined using CadnaA model

Table 9: Effect of Data Filtering on Measurement Dataset

Data Filter	*% Data Excluded* R754
Turbine Power below threshold	84%
Wind Direction not downwind	80%
Rain	14%
Gusting	0%
Low Temperature	0%
Transient Contamination	0%
Excluded from Total Noise	98%

Table 9 illustrates the proportion of measurement time that during the campaign did not meet the criteria for worst-case noise impact at the receptor. Data not excluded by filters are used in the assessment of compliance.

It is important to note that the data that remains after filtering represents the conditions when the turbines were generating high power output in a downwind condition without transient contamination or inclement environmental conditions (such as precipitation or low temperature). In other words, this remaining data represents the portion of time during the monitor's I-audit campaign during which the immission impact from the facility was at its highest.

7 Assessment of Compliance

7.1 Tonality Assessment

The emission test results for SAWPP turbines WTG05 [3] and WTG26 [4] indicate a maximum tonal audibility from the wind turbines below 3 dB. Accordingly, as per Section D3.8.3 of the Protocol, no further assessment of tonality was carried out for the current I-audit.

7.2 Assessment Tables

Cumulative turbine-only sound levels at receptor R754 is presented in the table below. The cumulative noise impact is calculated using the data presented in Table 7 and adding any relevant adjustments discussed in Section 6. Wind bins having insufficient data with which to determine the cumulative sound impact are marked with a "-". The signal-to-noise for each complete wind bin is also presented. This is the difference between the average Total Noise and Background sound levels from Table 7, unless otherwise noted.

Table 10: R754 Assessment Table – Cumulative Turbine-only Sound Impact

Audited Receptor	Wind speed at 10m height [m/s]	1	2	3	4	5	6	7
R754	Cumulative Sound Impact - Receptor Location	-	-	37	38	39	-	-
	Signal-to-noise	-	-	*3.4*	*4.0*	*3.4*	-	-
MECP Exclusion Limit		40	40	40	40	40	40	43
Measured Background		-	-	36.1	36.3	37.7	-	-
Predicted Sound Level (Monitor Location)		37.7						
Compliance? (Y/N)		-	-	Yes	Yes	Yes	-	-

Note: Cumulative Sound Impacts presented in Table 10 is calculated at the *monitor location*. Predicted sound impacts at the monitoring location are presented in the assessment tables and in Table 1.

7.3 Assessment of Compliance

Based on the results presented in Section 7.2, the cumulative sound impact complies with the MECP sound level limits at all wind bins having sufficient data for assessment.

8 Conclusion

Aercoustics Engineering Limited has conducted an additional Immission audit outlined in Condition E the Renewable Energy Approval #8279-9AUO2B for the Suncor Adelaide Wind Power Project ("SAWPP"). Testing was conducted in accordance with the methodology outlined in Part D and Part E of the MECP Compliance Protocol for Wind Turbine Noise. The sound levels at the surrounding receptors to the Suncor Adelaide Wind Power Project facility are deemed to be in compliance with the applicable sound level limits.

9 REFERENCES

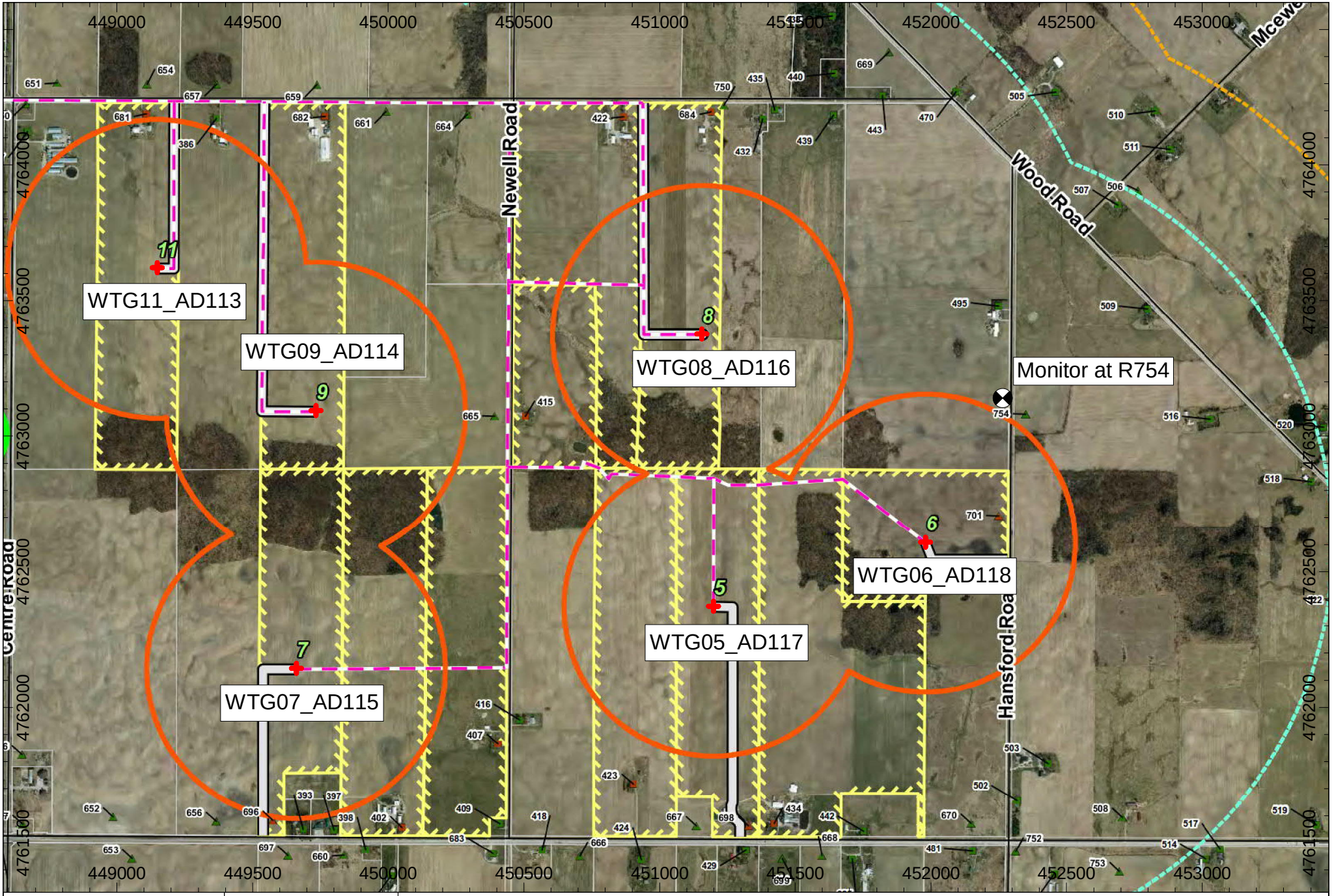
[1] Ministry of Environment Conservation and Parks, “Renewable Energy Approval #8279-9AUP2B,” Government of Ontario, Toronto, 2013.

[2] Ministry of the Environment Conservation and Pakrs, “Amendment to Renewable Energy Approval #8279-9AUP2B,” Government of Ontario, Toronto, 2014.

[3] A. Munro and P. Ashtiani, “Adelaide Wind Power Project- Tubrine T05 (AD117) IEC 61400-11 Edition 3.0 Measurement Report, ID: 14215.01.T05.RP6,” Aercoustics Engineering Limited, Missisauga, 2018.

[4] A. Munro and P. Ashtiani, “Adelaide Wind Power Project - Turbine T026 (AD102) IEC 61400-11 Edition 3.0 Measurement Report, ID: 14215.01.T26.RP6,” Aercoustics Engineering Limited, Missisauga, 2018.

APPENDIX A – LOCATION DETAILS



aercoustics	Project ID: 14215.04 Scale: As Shown Drawn by: NT Reviewed by: AM Date: Jun 2019 Revision: 1	**Project Name** Suncor Adelaide Wind Power Project Additional Acoustic Immission Audit - Phase 1 **Figure Title** Site Plan

Figure A.01

aercoustics	Project ID: 14215.04	**Project Name**
	Scale: NA Drawn by: NT Reviewed by: AM Date: Jun 2019 Revision: 1	Suncor Adelaide Wind Power Project Additional Acoustic Immission Audit - Phase 1
		Figure Title Monitoring Location- R754
		Figure A.02

APPENDIX B – CALIBRATION CERTIFICATES

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

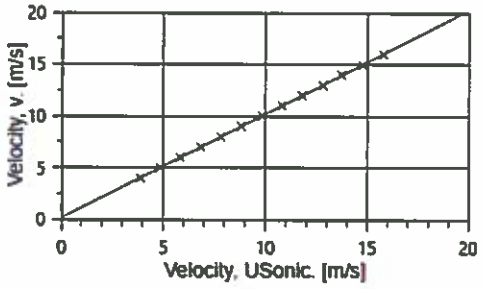
Certificate number: 17.US1.11150 **Date of issue:** December 18, 2017
Type: Vaisala Weather Transmitter, WXT520 **Serial number:** M0410642
Manufacturer: Vaisala, Oyj, Pl 26, FIN-00421 Helsinki, Finland
Client: Aercoustics Engineering Ltd., 1004 Middlegate RD, Suite 1100, S.Tower, Mississauga, ON L4Y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

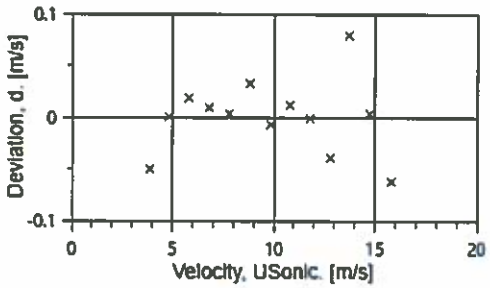
Anemometer received: December 14, 2017 **Anemometer calibrated:** December 15, 2017
Calibrated by: MEJ **Procedure:** MEASNET, IEC 61400-12-1:2017 Annex F
Certificate prepared by: EJF **Approved by:** Calibration engineer, EJF

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

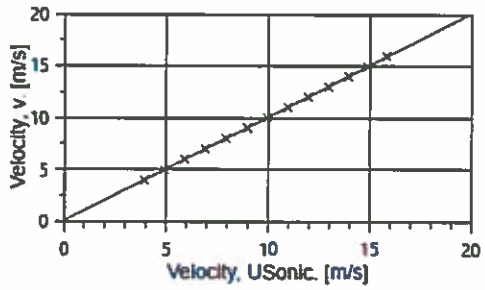
Certificate number: 17.US1.11157 **Date of issue:** December 18, 2017
Type: Vaisala Weather Transmitter, WXT520 **Serial number:** M0410642
Manufacturer: Vaisala, Oyj, Pl 26, FIN-00421 Helsinki, Finland
Client: Aercoustics Engineering Ltd., 1004 Middlegate RD, Suite 1100, S.Tower, Mississauga, ON L4Y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

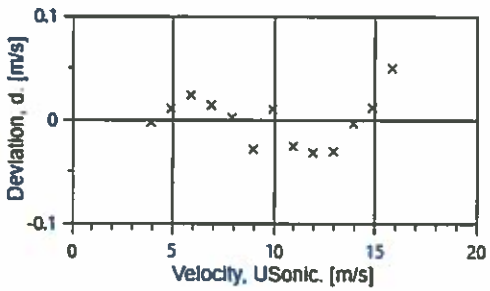
Anemometer received: December 14, 2017 **Anemometer calibrated:** December 15, 2017
Calibrated by: MEJ **Procedure:** MEASNET, IEC 61400-12-1:2017 Annex F
Certificate prepared by: EJF **Approved by:** Calibration engineer, EJF

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

CERTIFICATE of CALIBRATION

Make :	PCB Piezotronics	Reference # :	153591
Model :	378B02	Customer :	Aercoustics Engineering Ltd Mississauga, ON
Descr. :	Microphone System 1/2" Free Field		
Serial # :	132192	P. Order :	2018.08.03C
Asset # :	01161		

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

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

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

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

Calibrated : Aug 08, 2018 By : Petro Onasko

Cal. Due : Aug 08, 2020

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

Standards used : J-216 J-325 J-333 J-420 J-512

Navair Technologies

REPAIR AND CALIBRATION TRACEABLE TO NRC AND NIST

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

NT NAVAIR TECHNOLOGIES

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

Form:378B02	Approved by: JR	Feb-16	Ver 1.0

Calibration Report for Certificate : **153591**

Make			Model	Serial		Asset
PCB Piezotronics			378B02	132192		01161
PCB Piezotronics			377B02	174130		

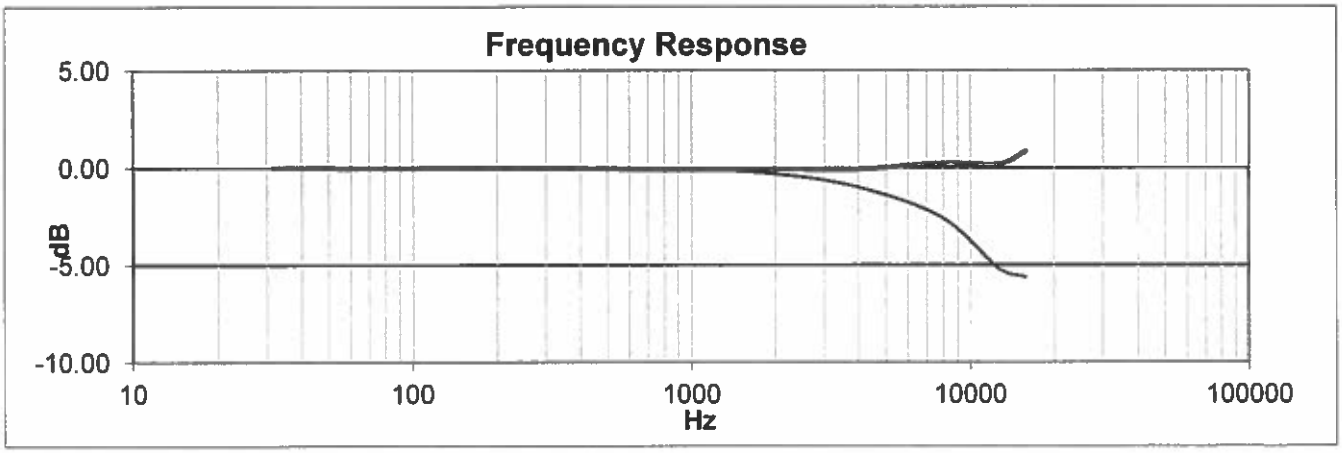
Sensitivity at 250Hz

Specs Nom	Unit	Min	Reading	Max	In/Out
50	mV/Pa	39.72	45.04	62.94	In
-26.02	dB re 1V/Pa	-28.02	-26.93	-24.02	In
0	dB re 50mV/Pa	-2	-0.91	2	In

Ambient Conditions: Static Pressure 99.0 kPa
Temperature 23.5°C
Rel.Humidity 55.0%

Frequency response

	Lower	Upper	
Freq	Pressure	Free Field	
Hz	dB	dB	
31.5	0.02	0.02	
63.1	0.00	0.00	
125.9	0.00	0.00	
251.3	0.00	0.00	ref
502.5	-0.02	-0.02	
1005.1	-0.10	-0.08	
1978.7	-0.31	-0.05	
3957.5	-0.99	-0.07	
7914.9	-2.55	0.24	
12663	-5.19	0.20	
15830	-5.63	0.86	



CERTIFICATE of CALIBRATION

Make :	PCB Piezotronics	Reference # :	154368
Model :	480E09	Customer :	Aercoustics Engineering Ltd Mississauga, ON
Descr. :	Conditioning Amplifier		
Serial # :	35342	P. Order :	2018.10.09C
Asset # :	01229		

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

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

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

Our calibration system complies with the requirements of ISO-17025 standard, 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 : Oct 10, 2018 By : Petro Onasko

Cal. Due : Oct 10, 2020

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

Standards used : J-255 J-301 J-512

Navair Technologies

REPAIR AND CALIBRATION TRACEABLE TO NRC AND NIST

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

NT NAVAIR TECHNOLOGIES

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

Form:480E09	Approved by: JR	Jun-18	ver 1.2

Calibration Report for Certificate : **154368**

Make	Model	Serial	Asset
PCB Piezotronics	480E09	00035342	01229

Test	Min	Reading	Max	In/Out

Gain accuracy at 1kHz

Gain Set	Input			V			
x1	1.000 V		0.9800	1.0000	1.0200		In
x10	0.100 V		0.9800	1.0002	1.0200		In
x100	0.010 V		0.9800	0.9987	1.0200		In

Gain Flatness

X1

I/P				%			
10 Hz	1.000 V		-5.0	-0.1	5.0		In
10 kHz	1.000 V		-5.0	0.0	5.0		In
50 kHz	1.000 V		-5.0	0.0	5.0		In
100 kHz	1.000 V		-5.0	0.2	5.0		In

X10

I/P				%			
10 Hz	0.100 V		-5.0	0.1	5.0		In
10 kHz	0.100 V		-5.0	0.0	5.0		In
50 kHz	0.100 V		-5.0	-0.2	5.0		In
100 kHz	0.100 V		-5.0	-0.7	5.0		In

X100

I/P				%			
10 Hz	0.010 V		-5.0	0.0	5.0		In
10 kHz	0.010 V		-5.0	-0.2	5.0		In
50 kHz	0.010 V		-5.0	-3.7	5.0		In

Compliant Calibration Certificate

Template Revision: Feb2018

Certificate Number:	5800426.1	**OE Number:**	21521268
Date Printed:	25-OCT-2018	**Page:**	1 of 14
Customer:	Aercoustics Engineering LTD (CA) 1004 Middlegate Road Suite 1100 MISSISSAUGA, L4Y 0G1 CANADA		
Manufacturer:	National Instruments	**Model:**	NI 9234
Serial Number:	1AA831C		
Part Number:	195551B-01L	**Description:**	MODULE ASSY,NI 9234, 4 AI CONFIGURABLE
Calibration Date:	25-OCT-2018	**Recommended Calibration Due:**	25-OCT-2019
Procedure Name:	NI 9234	**Verification Results:**	As Found: Passed As Left: Passed
Procedure Version:	3.6.1.0	**Calibration Executive Version:**	4.5.1.0
Lab Technician:	Rodolfo Maldonado	**Driver Info:**	NI-DAQmx:17.1.0
Temperature:	23.1° C	**Humidity:**	45.6% RH

NATIONAL INSTRUMENTS
CALIBRATED
SN/ID 1AA831C
DATE 25-OCT-2018
DUE 25-OCT-2019
ni.com/calibration

The data found in this certificate must be interpreted as:

As Found	The calibration data of the unit as received by National Instruments.
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/NCSL Z540.1-1994 (R2002) requirements.

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%. The uncertainty is calculated at time of calibration and does not include the object long-term stability and different environmental and operational conditions.

Results are reviewed to establish where any measurement results exceeded the manufacturer's specifications. Measured values greater than the Manufacturer's specification limits are marked as 'Failed', measured values within the Manufacturer's specifications are marked as 'Passed'.

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 E-mail customer.service@NI.com

Victor Peña
Technical Manager

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

NATIONAL INSTRUMENTS

APPENDIX C – STATEMENT FROM THE OPERATOR

PO 2844
150 -6th Ave SW
Calgary Alberta, T2P 3E3
Tel 403 296 8929
www.suncor.com

July 26th, 2019

To: Whom it may concern

Subject: Additional Acoustic Immission Audit – Phase 1

Please accept this letter as confirmation that all turbines at the Suncor Adelaide Wind Power Project were operating normally during the measurement campaign conducted by Aercoustics Engineering Ltd. from March 26, 2019 to June 2, 2019 at receptor R754. Turbines WTG 6 and WTG 8 were not operational during background sound level measurements.

Sincerely,

Joseph P. Starcok
Adelaide Site Supervisor
Suncor Energy Inc.
(519) 801-8633.

APPENDIX D – I-AUDIT CHECKLIST

Appendix D: I-Audit checklist

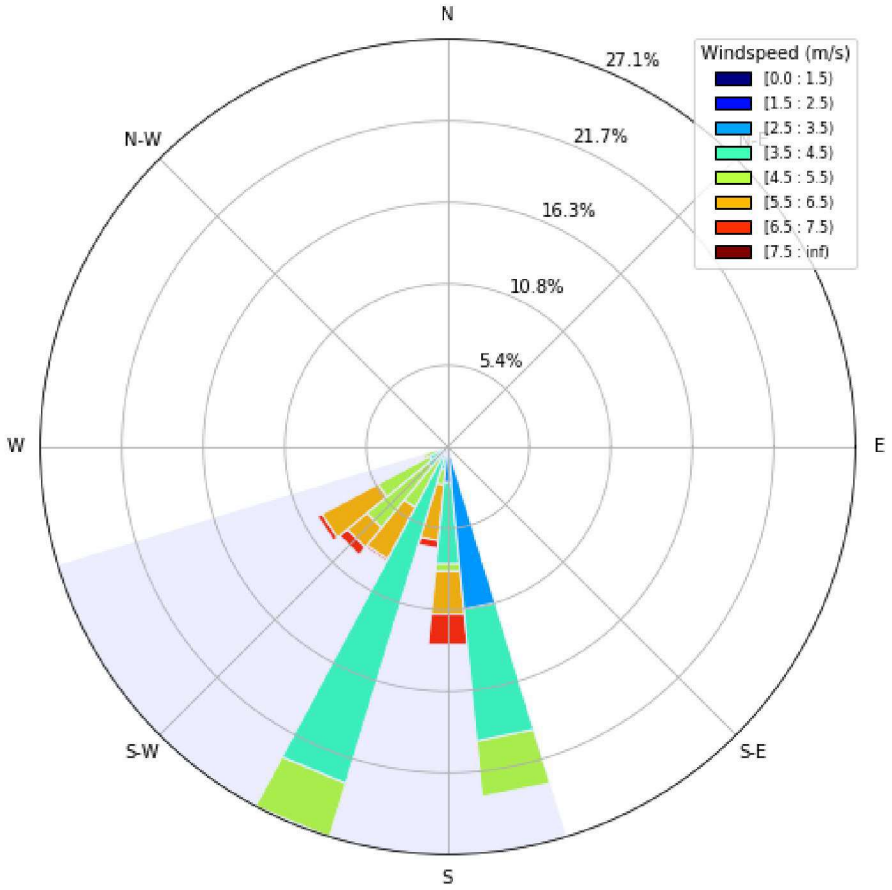
Wind Energy Project – Screening Document – Acoustic Audit Report – Immission

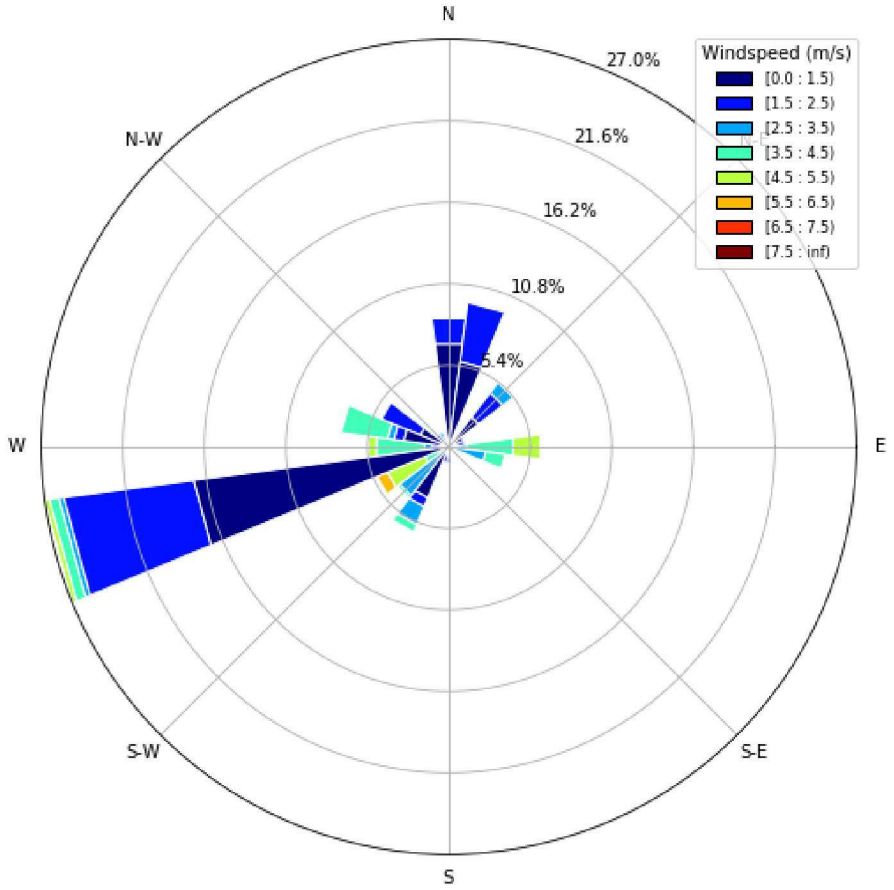
Information Required in the Acoustic Audit Report – Immission

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

APPENDIX E – DETAILED WIND ROSES

M754 TON	M754 TOFF





Note: Shaded area indicates downwind

aercoustics

14215.04	**Project Name**
Scale: NTS Drawn by: AM Reviewed by: PA Date: Sep 17, 2019 Revision: 1	Suncor Adelaide Wind Power Project Additional Acoustic Immission Audit - Phase 1
	Figure Title Wind Roses - M754 Turbine ON and Turbine OFF

Figure E.01

END OF REPORT