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***Via Electronic Submittal***

December 17, 2020

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**Re: Port Dover & Nanticoke Wind – 2020 Immission Audit Report Results**
**Renewable Energy Approval 2869-8VDRCV**

Please find attached the 2020 immission audit report, prepared by Aercoustics for the Port Dover and Nanticoke Wind Farm.

The associated I-audit data package (4 excel files) is also included within a OneDrive link provided on the email that accompanied this submittal.

If you have any questions, please contact either Casey Chan at (780) 392-5173 or the undersigned at (780) 392-5183.

Sincerely,

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cc: Michael Durst, MECP
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IMMISSION AUDIT REPORT – **Project: 14000.07**

# Port Dover and Nanticoke Wind Farm

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Prepared for:

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December 16, 2020

## Revision History

| Version | Description | Author | Reviewed | Date |
|---|---|---|---|---|
| 1.0 | Initial Report | DAF | DH | December 16, 2020 |
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# Executive Summary

Aercoustics Engineering Limited was retained by Capital Power Ltd. to conduct a detailed acoustic immission measurement (I-Audit), as requested by the Ministry of the Environment, Conservation and Parks (MECP), to confirm that the Port Dover and Nanticoke Wind Farm is in compliance with MECP sound level limits. The Port Dover and Nanticoke Wind Farm is located in the counties of Haldimand and Norfolk, comprising fifty-eight wind turbine generators, having a total nameplate capacity of one hundred and four megawatts.

The purpose of an I-Audit is to determine the sound level produced by the operation of facility wind turbines following the methodology prescribed in the MECP publication entitled “Compliance protocol for wind turbine noise”, dated April 2017. Sound levels from the facility are then compared to the applicable sound level limits and an assessment of compliance is made in this report.

Measurements for the I-audit began in Spring 2020 at two noise sensitive points of reception having high predicted noise impacts from the facility under study; the two receptors under study are V2820 and R487. Monitoring at V2820 was completed in July, whereas monitoring at R487 was restarted in August after blade issues were discovered and subsequently repaired on the nearby turbines. Monitoring for this receptor was completed in November. The resultant turbine-only sound levels determined at both receptors were found to comply with the applicable MECP sound level limits.

# Table of Contents

# 1 Introduction

Aercoustics Engineering Limited (“Aercoustics”) has been retained by Capital Power L.P. (“Capital Power”) to complete an Immission Audit (“I-audit”) of the Port Dover and Nanticoke Wind Farm (“PDN Wind Farm”). The PDN Wind Farm operates under Renewable Energy Approval ("REA") #2869-8VDRCV [1].

This I-audit has been conducted per the methodology outlined in Part D and Part E of the Compliance Protocol for Wind Turbine Noise (“Compliance Protocol”). The Compliance Protocol is an Ontario Ministry of the Environment, Conservation and Parks (“MECP”) document used to evaluate noise from a wind facility at nearby receptors [2].

This report summarizes the results of I-audit testing conducted at two (2) points of reception to the PDN Wind Farm.

# 2 Background

I-audit compliance testing for the PDN Wind Farm was originally conducted in 2014 and 2015 in two phases, per Condition E of the PDN Wind Farm REA. The reports detailing this testing were reviewed by the MECP, and a letter of review (“MECP Letter”) was issued from the MECP to Capital Power in December 2018 recommending two (2) additional I-audits and one additional Emission Audit (“E-audit”) be conducted [3].

Following the MECP Letter and subsequent coordination between Capital Power, Aercoustics, and the MECP, I-audit testing began in the Spring of 2019 at two (2) receptors – V2310 and R203. The result of this testing was determined to be inconclusive [4], due to the elevated ambient noise measured at both receptors overshadowing the turbine sound level.

In response to these findings, Capital Power retained Aercoustics to conduct a survey of the ambient sound levels at several receptors in Summer 2019 to determine two new locations for I-audit testing. The results of this survey were used to select two new receptors – V2820 and R487 – and a summary report with the new proposed receptors was sent to the MECP in September 2019. The new locations were approved by the MECP in April 2020, and I-audit testing began at both locations shortly after.

Testing was completed at V2820 in Spring 2020 with the measurements indicating compliance with the applicable sound level limits. Over the same period, acoustic anomalies were identified during the spring I-audit at R487 which required further investigation and inspections of the turbine blades surrounding R487. After confirming that repair work was required on some of the turbine blades, the repairs were immediately conducted and completed in July 2020. The I-audit testing was restarted in August 2020 at R487 and subsequently completed in November 2020. The I-audit at V2820 was completed without issue in July.

# 3 Facility Description

The PDN Wind Farm is a wind facility located in the counties of Haldimand and Norfolk comprising of fifty-eight (58) wind turbine generators ("turbines"), having a total nameplate capacity of one hundred and four (104.4) megawatts. Each turbine has a hub height of ninety-five (95) metres. The facility has one (1) substation transformer, rated at 133 MVA.

The following wind facilities are located in the vicinity of the project: Summerhaven Wind Energy Center ("SWEC"), a one hundred and twenty-four (124) megawatt facility bordering the north and east of the PDN Wind Farm.

The facility is designed to operate 24 hours per day, 7 days per week.

# 4 Audit Location

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

## 4.1 Receptor Selection

A total of two (2) audit receptors were selected for this I-audit. The receptor selection criteria, including prevailing wind direction and predicted sound levels, used to select the audit receptors are detailed in this section.

### 4.1.1 Receptor Selection Criteria

Per the requirements of the Compliance Protocol, audit receptors were selected such that they represent the location of the greatest possible predicted noise impacts[1]. The Compliance Protocol also requires data be collected during downwind periods[2]. As such, receptors in locations that are downwind of the nearest turbines are prioritized to assist with timely completion of the I-audit data collection.

### 4.1.2 Prevailing Wind Direction

Historical wind direction information was provided to Aercoustics by Capital Power and used to support the selection of suitable I-audit receptors. This wind direction information is provided in Figure 1. The most frequently occurring wind direction is taken to be the prevailing wind direction.

From the information in Figure 1, the prevailing downwind direction for the PDN Wind Farm is determined to be 247.5° (west-southwest).

[1] "Predicted noise impact" refers to the predicted impacts outlined in the facility acoustic assessment report [5].
[2] A "Downwind" receptor indicates that the direction from receptor to turbine is within +/-45° of the direction of the prevailing winds.

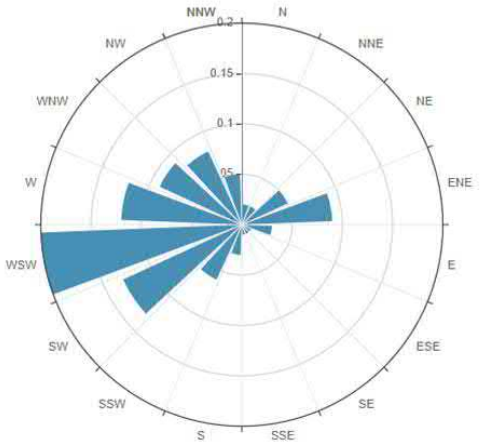


Figure 1: Historical Wind Rose used for Receptor Selection

### 4.1.3 Receptor Selection Table

Receptors to the PDN Wind Farm's greatest predicted noise impacts are shown in Table 1, sorted in descending order. Selected audit receptors are highlighted in green. Note that the receptors in Table 1 are only the locations that are in a downwind position with respect to the closest turbines. A complete list of receptors is provided in Appendix D.

Table 1: Receptor Selection Table. Locations selected for monitoring are identified in green.

| ID | Receptor Type | Height (m) | Distance to Closest Turbine (m) | Nearest Turbine | Predicted Impact (dBA) | Notes |
|---|---|---|---|---|---|---|
| P0472 | Participating Receptor | 1.5 | 234 | T551 | 45.9 | Participating |
| P1382 | Participating Receptor | 4.5 | 322 | T502 | 42.7 | Participating |
| R0203 | Receptor | 4.5 | 646 | T525 | 39.9 | Previously measured, high ambient noise* |
| P1433 | Participating Receptor | 4.5 | 421 | T511 | 39.4 | Participating |
| R0487 | Receptor | 4.5 | 615 | T552 | 39.3 | Selected Receptor |
| R0241 | Receptor | 4.5 | 560 | T533 | 39.2 | High ambient noise* |
| R0488 | Receptor | 4.5 | 686 | T552 | 39.2 | Redundant to R487 |
| R0413 | Receptor | 4.5 | 691 | T541 | 38.5 | High ambient noise* |
| R0303 | Receptor | 4.5 | 754 | T537 | 38.5 | Declined land access |

| | | | | | | |
|---|---|---|---|---|---|---|
| V2727 | Vacant Lot | 4.5 | 626 | T558 | 38.5 | Declined land access |
| R0122 | Receptor | 4.5 | 592 | T513 | 38.3 | High ambient noise* |
| R0322 | Receptor | 1.5 | 557 | T558 | 38.3 | High ambient noise* |
| R0025 | Receptor | 1.5 | 558 | SWEC T014 | 38.3 | High ambient noise* |
| V2820 | Vacant Lot | 4.5 | 754 | T540 | 38.2 | Selected Receptor |

* Measured or predicted to have significant impacts from ambient or third party noise sources.

Predicted receptor noise impacts were determined using the Acoustic Assessment Report for PDN Wind Farm, prepared by RWDI AIR Inc. and dated November 14, 2014 [5]. Sound levels at the monitoring locations were determined by Aercoustics using the same modelling parameters as the original noise report.

### 4.2 Monitoring Location

The location of the monitoring equipment for each audit receptor is described below. Coordinates for receptor and monitor locations, as well as distances to the nearest or primary[3] turbine are provided in Table 2.

**V2820**: The monitor was erected approximately 78 metres from the audit receptor, towards the nearest turbine. The ground cover between the monitoring location and the nearest turbines was open fields divided by two bush lined fences.

**R487**: The monitor was erected approximately 84 metres from the audit receptor, towards the nearest turbine. The ground cover between the monitoring location and the nearest turbines was open field planted with soybeans. The monitor was located 30 metres from the from a wooded area to the south and 30 metres from an old barn to the east. Note that this location represents a closer monitoring position to the turbines than was used in the Spring 2020 period. During the blade repair process, the monitor was moved away from the nearby barn and closer to the nearest turbines by approximately 35 metres to increase signal-to-noise and data quality.

[3] Primary turbine refers to the individual turbine having the highest predicted noise impact at the subject receptor. In certain cases, this may not correspond to the closest turbine.

Table 2: Coordinates and Primary Turbine for each Receptor and Monitor Location

| Audit Receptor | Coordinates (UTM x,y, Zone 17T) | | Primary Turbine ID | Distance to Primary Turbine | |
|---|---|---|---|---|---|
| | *Receptor* | *Monitor* | | *Receptor* | *Monitor* |
| V2820 | 584261 mE / 4744686 mN | 584195.6 mE / 4744675.2 mN | T540 | 754 m | 679 m |
| R487* | 586087 mE / 4744171 mN | 586029.3 mE / 4744235.7 mN | T552 | 615 m | 553 m |

* Monitor location for Aug – November 2020. Spring location was 586059 m E / 4744216 m N

Site plans and photographs of the monitoring equipment are provided in Appendix A. Details regarding the monitoring equipment are provided in Section 5.1.

## 4.3 Ambient Environment

PDN 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 5.3.2). 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 5.3.3).

In addition to ambient noise sources, self-generated noise from the monitoring equipment is typically 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.

### 4.3.1 Flora

Noise from flora was found to be the main driver of the ambient noise during the I-audit at high winds speeds. The noise from flora is generated by the vegetation around the two monitors and is proportional to both ground level and hub height wind speeds.

### 4.3.2 Fauna

Occasional activity from birds or dogs introduced extraneous noise in a small number of intervals, which were removed from the dataset. Extraneous noise from insects was found to be significant at frequencies above 1600 Hz, and was removed from the assessment via the 1/3$^{rd}$ octave spectra (see Section 5.3.2).

### 4.3.3 Traffic

Noise from traffic was found to be an occasional source of extraneous noise during the I-audit. Roadways near the project include Concession 2 Walpole and Concession 3

Walpole. Intervals influenced by car passbys were removed from the dataset whenever possible (see Section 5.3.2).

#### 4.3.4 Industry

There are a few heavy industrial sites in the Nanticoke area, including the Imperial Oil Refinery and the Stelco Lake Erie Works. Both sites are more than 6 km away from the nearest audit receptor and are not suspected to have had a significant impact on the measurement dataset.

#### 4.3.5 Other Sources

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

# 5 Audit Methodology

For the duration of the I-audit, acoustic and weather data are logged simultaneously in one-minute intervals at each monitoring location. Analysis and filtering are conducted per Section D5.2 of the Compliance Protocol with additional filters applied as needed – following the guidance the Compliance Protocol – to remove or reduce extraneous ambient noise (see Section 5.3.2) and ensure representative ambient conditions (see Section 5.3.3).

Intervals that pass the filtering criteria are sorted into integer wind bins[4] depending on the measured wind speed and classified as either *Total Noise* or *Background* depending on the operation of the nearby PDN Wind Farm turbines (see Section 5.3.1). 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 5.5.1.

## 5.1 Monitoring Equipment

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

- One (1) Type 1 sound level meter with microphone and pre-amplifier, installed at receptor height for V2820 and 1 metre above receptor height for R487 (see Section 5.6.2).
- One (1) primary and one (1) secondary[5] windscreen for the microphone.
- One (1) anemometer installed 10 metres above ground level (“10m-AGL”).

[4] 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.
[5] The 1/3 octave band insertion loss of the secondary windscreen has been tested and has been accounted for in the data analysis.

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 metres 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 PDN Wind Farm turbines.

Table 3 lists the specific make, model, and serial number for the monitoring equipment used at each audit receptor.

Table 3: Monitoring Equipment Details

| Audit Receptor | Equipment | Make/Model | Serial Number | Date of Last Calibration |
|---|---|---|---|---|
| V2820 | Sound Level Meter | NI 9234 | 1B3CE71 | Dec 06, 2019 |
| | Microphone | PCB 378B02 | 121695 | Nov 26, 2019 |
| | Pre-amplifier | PCB 426E01 | 156314 | Nov 26, 2019 |
| | Signal Conditioner | PCB 480E09 | 37185 | Aug 24, 2019 |
| | Weather Station | Vaisala WXT520 | P4830521 | Nov 28, 2018 |
| R487 | Sound Level Meter | NI 9234 | 1A67099 | May 14, 2020 |
| | Microphone | PCB 378B02 | 123029 | May 05, 2020 |
| | Pre-amplifier | PCB 426E01 | 158838 | May 05, 2020 |
| | Signal Conditioner | PCB 480E09 | 33804 | May 12, 2020 |
| | Weather Station | Vaisala WXT520 | L0910581 | July 11, 2019 |

Each 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.

## 5.2 Measurement Parameters

The monitoring equipment is configured to run nightly from approximately 9pm to 6am, local time. The measurement parameters acquired and used in the audit are listed in Table 4.

Table 4: Measurement parameters used for the I-audit

| Parameter Group | Measurement Parameters | Notes |
|---|---|---|
| Acoustic (microphone height) | $L_{Aeq}$ | dBA |
| | $L_{90}$ | dBA |
| | 1/3rd 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 | m/s |
| | Yaw Angle | 0-360˚ |
| | Power Output | kW |
| | Rotational Speed | RPM |

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

### 5.3 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 10pm – 5am
- 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 5.3.2)

*Total Noise Intervals*

- Have all nearby turbines operating (see Section 5.3.1)
- 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 5.3.1)
- Have ambient conditions representative of Total Noise periods (Section 5.3.3)

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

### 5.3.1 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 each receptor are 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 PDN Wind Farm turbines in the audit study area for each receptor are listed in Table 5 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.

The turbines confirmed to be operating for Total Noise periods were all those within 3 kilometres of a monitor location. The turbines required to be confirmed as parked for Background periods were those that were predicted to cause the contribution of the wind facility to exceed 30 dBA at a monitor location.

Table 5: Turbines included in the study area for each receptor

| Audit Receptor | Turbines verified for Total Noise Measurements | Turbines verified for Background Measurements |
|---|---|---|
| V2820 | T533, T534, T536, T538, T539, T540, T541, T543, T546, T547, T548, T549, T550, T551, T552, T553 | T540, T541, T547, T548, T549, T550, T551, T552 |
| R487 | T540, T541, T543, T546, T547, T548, T549, T550, T551, T552, T553, T554 | T547, T549, T550, T551, T552, T553 |

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.

### 5.3.2 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 sources[6]***
>
> *"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)."*
>
> *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."*

[6] 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.

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).

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.

Note: the identification and removal of extraneous noise in the measurement datasets presented in this report is achieved by listening tests, removing 1/3rd octave bands above 1600 Hz from the assessment, and an automatic filter that excludes any Total Noise or Background interval if the difference between average and minimum sound level for the interval (LAeq-L90) is greater than 10 dB. The impact of the PDN Wind Farm at 1/3rd octave frequency above 1600 Hz is predicted to be less than 30 dBA at the monitor and therefore are considered negligible.

### 5.3.3 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. Further the assessment dataset for R487 includes a downwind direction filter and both datasets include a minimum hub height wind speed filter.

## 5.4 Adjacent Wind Facilities

The SWEC wind facility is located on the northern and eastern edges of the PDN Wind Farm. The closest SWEC turbines to the monitoring locations are approximately 1.86 km from R487, and 2.65 km from V2820. Based on Aercoustics' sound model of the PDN Wind Farm, the predicted downwind impacts from the SWEC facility are 28.4 dBA at V2820 and 30.6 dBA at R487. The closest SWEC turbines are crosswind of V2820 and upwind of R487, compared to the nearest turbines of both receptors.

Given that the predicted impact is below 30 dBA at V2820, and marginally above 30 dBA at R487 in an upwind direction, the impacts from the SWEC facility are considered negligible and are not accounted for in the analysis. There are no other wind facilities adjacent to the PDN Wind Farm.

## 5.5 Compliance Criteria

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

### 5.5.1 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)."*

In this study, a wind bin is considered complete if there are at least 60 valid *Total Noise* and 30 valid *Background* intervals.

### 5.5.2 Sound Level Limits

The area surrounding the PDN Wind Farm has been designated as Class III (rural). Exclusion limits for a Class III area are summarized in Table 6 below.

Table 6: 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. Wind bins where the measured *Background* sound level exceed the exclusion limits are noted in Table 11.

### 5.5.3 Tonality

A tonality assessment of the measurement data has been conducted at the request of the MECP, as outlined in the MECP Letter. The calculation of the mean tonal audibility attributable to the PDN Wind Farm turbines is determined in accordance the IEC 61400-11:2012 standard [6]. Frequencies of interest were determined using the original E-audit reports for the PDN Wind Farm (Table 13 of [7] and [8]). Following the guidance of Section D3.8.3 of the Compliance Protocol, frequencies of any detected tones having a tonal audibility greater than 3 dB in the E-audit test were used in the tonality assessment. One frequency of interest was determined: ~136-186 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 [9] and Section E5.5.2 of the Compliance Protocol. Applicable tonal penalties are determined using the mean tonal audibility. The calculation method for a tonal penalty is summarized in Table 7. Tonal penalties are applied to the turbine-only sound level.

Table 7: Calculation of Applicable Tonal Penalty

| Mean Audibility, $\Delta L$ | 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 |

## 5.6 Deviations

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

### 5.6.1 Measurement Bandwidth

As noted in Table 4, the measurement bandwidth used is 20-10,000 Hz. This is a deviation from the Compliance Protocol section D2.1.1 requirement of a 20-20,000 Hz frequency response. Due to the high attenuation of noise levels at high frequencies, noise at the receptor from the wind facility above 10,000 Hz will be insignificant[7].

### 5.6.2 Microphone Height – R487 Monitor

Due to an oversight during the monitor installation process, the microphone height for the R487 monitor was installed at 5.5 metres, 1 metre higher than the height of the audit receptor. This change would result in a slightly higher measured facility sound level

[7] From Table 2 of ISO 9613-2, acoustic frequencies above 8 kHz experience attenuation from atmospheric absorption of more than 80 dB/km. This combined with the other sources of attenuation will reduce high frequency noise to negligible levels by the time it reaches the receptor.

compared to level at the 4.5 metre receptor height. This deviation is not considered to be significant.

# 6 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.

## 6.1 Audit Duration

The length of monitoring time at each location is summarized below in Table 8. The period indicated below for R487 represents the monitoring conducted after blade repairs were confirmed complete by the operator.

Table 8: Length of monitoring campaign for each audit receptor

| Audit Receptor | Audit Start Date | Audit End Date | Monitoring Duration (weeks) |
|---|---|---|---|
| V2820 | May 8, 2020 | July 28, 2020 | 12 |
| R487 | July 31, 2020 | Nov 6, 2020 | 14 |

## 6.2 Weather Conditions

The range of weather parameters measured at each monitor during the I-audit are summarized in Table 9. These values show the range in weather conditions measured in the assessment dataset.

Table 9: 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) |
|---|---|---|---|---|---|
| V2820 | 980 – 1001 | 0.6 – 7.5 | 50 – 90 | 7.7 – 25.8 | 5.0 – 15.7 |
| R487 | 981 – 998 | 1.3 – 7.5 | 57 – 90 | -0.1 – 20.0 | 8.0 – 14.4 |

Wind roses showing the measured wind directions at each audit location are provided in Figure 2. 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 red shaded area represent the downwind angle for each receptor.

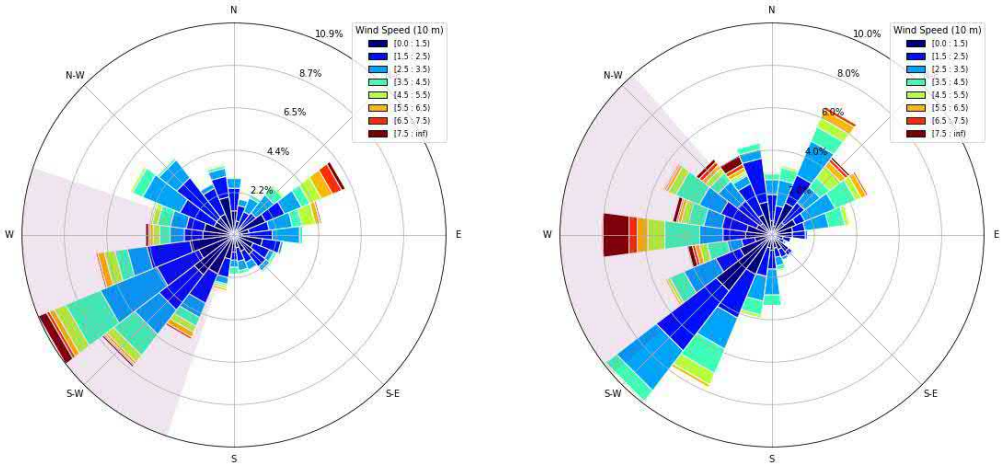


Figure 2: Wind Roses for monitors V2820 (left) and R487 (right). Data presented includes all measured data. Wind direction is taken from the yaw angle of the primary turbine and wind speed is taken from the 10m-AGL weather station.

## 6.3 Data Excluded due to Filtering Criteria

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 I-audit, the total proportion of measurement time where these two conditions were satisfied is presented in Table 10. This data shows how often during the I-audit the minimum assessment requirements in the Compliance Protocol were met at each audit receptor.

Table 10: Prevalence of Occurrence of Suitable Turbine Conditions

| Audit Receptor | Primary Turbine | Prevalence of Downwind | Prevalence of High Output, >85% power | Prevalence of Downwind and High Output |
|---|---|---|---|---|
| V2820 | T540 | 40% | 6% | 2% |
| R487 | T487 | 27% | 30% | 3% |

It is noted that the proportion of measurement data indicated above in Table 10 represents the maximum available data for assessment. Additional filters applied to remove contaminated or otherwise unsuitable measurement data (as discussed in Section 5.3) will further reduce the assessment dataset.

## 6.4 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 11. Measurement data points from Table 11 are also

plotted in Figure 3 and Figure 4. Sufficient valid measurements were acquired at both monitors to meet the minimum sample size requirements as indicated in Section E5.5(1) of the Protocol.

Table 11: Average measured sound levels at each monitoring Location

| Audit Receptor | Period | Measurement Parameter | Wind Bin (m/s) 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|
| V2820 | Total Noise | Number of Samples | 0 | 5 | 8 | 25 | 75 | 104 | 67 |
| | | Average $L_{Aeq}$ [dBA] | - | - | - | 40* | 41 | 43 | 46 |
| | | Standard Deviation [dB] | - | - | - | 0.9 | 1.4 | 1.6 | 1.6 |
| | Background | Number of Samples | 93 | 217 | 349 | 182 | 63 | 35 | 33 |
| | | Average $L_{Aeq}$ [dBA] | 31 | 32 | 33 | 34 | 37 | 42 | 45 |
| | | Standard Deviation [dB] | 1.9 | 1.9 | 1.6 | 2.0 | 2.1 | 2.3 | 1.3 |
| R487 | Total Noise | Number of Samples | 2 | 126 | 305 | 84 | 24 | 5 | 22 |
| | | Average $L_{Aeq}$ [dBA] | - | 42 | 43 | 43 | 42* | - | 44* |
| | | Standard Deviation [dB] | - | 1.0 | 0.9 | 1.2 | 1.6 | - | 1.2 |
| | Background | Number of Samples | 3 | 83 | 192 | 75 | 16 | 16 | 11 |
| | | Average $L_{Aeq}$ [dBA] | - | 38 | 39 | 40 | 38* | 38* | 41* |
| | | Standard Deviation [dB] | - | 2.0 | 1.3 | 1.3 | 2.1 | 1.6 | 1.7 |

- Sample size below reporting requirements in this wind bin, sound levels not reported except as noted by (*).
* Below minimum sample size requirements, data presented for information only.

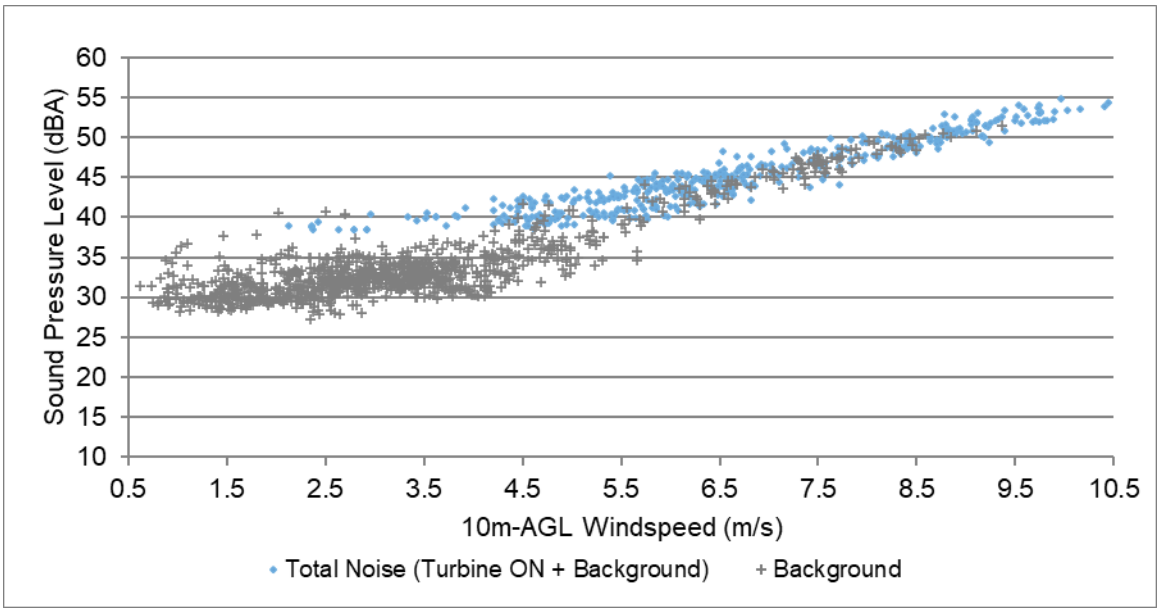


Figure 3: All valid Total Noise and Background intervals measured at V2820 Monitor

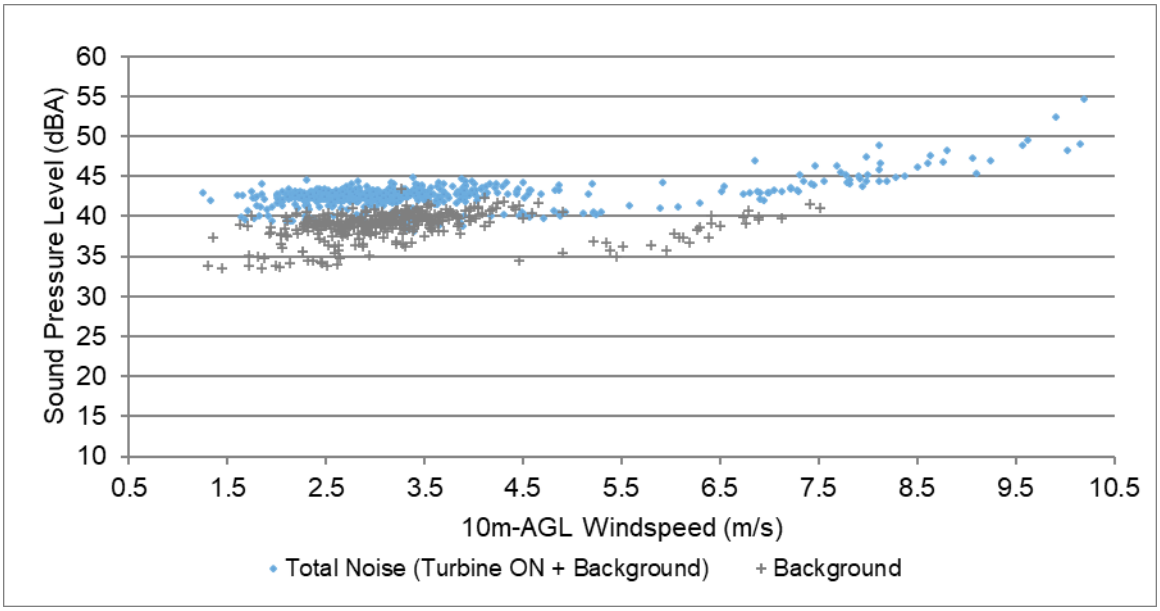


Figure 4: All valid Total Noise and Background intervals measured at R487 Monitor.

## 6.5 Sound Level Adjustments

The following sections detail any adjustments made to the sound levels presented in Section 6.4.

### 6.5.1 Tonal Adjustment

Tonal audibility results are presented below in Table 12. Tones with a Tonal Presence less than 20% or a Tonal Audibility less than -3 dB are not reported, per the IEC 61400-11 methodology.

Table 12: Tonality Assessment Table – 136-186 Hz

| Audit Receptor | Tonality Parameter | Wind Bin (m/s) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **V2820** | Data Points in Wind Bin | 0 | 5 | 8 | 25 | 75 | 104 | 67 |
| | Data Points with Tone | 0 | 5 | 3 | 1 | 3 | 4 | 1 |
| | Tonal Presence | 0% | 100% | 38% | 4% | 4% | 4% | 1% |
| | Tonal Audibility, ΔL [dB] | - | - | - | - | - | - | - |
| | Tonal Adjustment, $K_T$ [dB] | - | - | - | - | - | - | - |
| **R487** | Data Points in Wind Bin | 2 | 126 | 305 | 84 | 24 | 5 | 22 |
| | Data Points with Tone | 0 | 10 | 14 | 5 | 1 | 0 | 4 |
| | Tonal Presence | 0% | 8% | 5% | 6% | 4% | 0% | 18% |
| | Tonal Audibility, ΔL [dB] | - | - | - | - | - | - | - |
| | Tonal Adjustment, $K_T$ [dB] | - | - | - | - | - | - | - |

From the results in Table 12, no tones were detected that exceeded the threshold for tonal penalties. Further, no tones were detected that exceeded the IEC 61400-11 reporting threshold of -3 dB.

## 6.6 Turbine-Only Sound Levels

The average *Total Noise* and *Background* sound levels by wind bin at each monitoring location are presented in Table 13. Any sound level adjustments used to determine the Turbine-Only sound level at the audit receptor (Point of Reception) are also presented.

Table 13: Calculated Turbine-Only Sound Levels

| Audit Receptor | Measurement Period | Wind Bin (m/s) 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| **V2820** | Total Noise (dBA) | - | - | - | 40* | 41 | 43 | 46 |
| | Background (dBA) | 31 | 32 | 33 | 34 | 37 | 42 | 45 |
| | Signal to Noise (dBA) | - | - | - | 6.6 | 4.3 | 1.5 | 0.5 |
| | Turbine-Only (dBA) [monitor location] | - | - | - | 39* | 39 | 38 | 36 |
| | Turbine-Only (dBA) [Point of Reception] | - | - | - | 39* | 39 | 38 | 36 |
| **R487** | Total Noise (dBA) | - | 42 | 43 | 43 | 42* | 42* | 44* |
| | Background (dBA) | - | 38 | 39 | 40 | 38* | 38* | 41* |
| | Signal to Noise (dBA) | - | 4.0 | 3.3 | 2.9 | 3.7 | 3.6 | 2.7 |
| | Turbine-Only (dBA) [monitor location] | - | 40 | 40 | 40 | 40* | 40* | 40* |
| | Turbine-Only (dBA) [Point of Reception] | - | 40 | 40 | 40 | 40* | 40* | 40* |

- Sample size below reporting requirements in this wind bin, sound levels not reported except as noted by (*).

* Below minimum sample size requirements, data presented for information only.

An assessment compliance of the Turbine-Only sound levels at the Point of Reception is provided in Table 14.

# 7 Discussion

The measurement datasets at both receptors collected sufficient data for assessment without requiring any modification of the filters. For V2820, most of the assessment dataset was collected in the 5 m/s wind bin and above. Conversely, for R487 the assessment dataset was primarily collected in the 2 to 4 m/s wind bins. The difference in wind speed bins collected may be attributed to the different time of year (spring vs. fall), and it may also be attributed to the higher levels of vegetation and trees nearby R487 influencing the wind shear profile in the area.

This increased vegetation is likely be the source of higher ambient sound levels measured at R487 in the 1 to 4 m/s wind bins. The Background periods of the assessment dataset at this receptor were filtered for the same wind shear conditions as the Total Noise periods (see Section 5.3.3), and therefore the wind speed at elevation is high even at low ground level wind speed bins. Ambient sound levels in similar studies were found to be proportional to wind speed at both ground level and elevation [10], and therefore may explain the elevated ambient noise at low wind speed bins for this receptor.

Despite higher ambient sound levels at R487, a signal-to-noise above 3 dB was maintained in most of the assessment wind bins. This is due, in part, to the closer monitoring location and the higher microphone height elevating the PDN Wind Farm sound

level at the monitoring location compared to the receptor location[8]. Note that no adjustments to the sound level based on distance or measurement height were applied to either the R487 or V2820 assessment datasets. Therefore, the calculated turbine-only sound levels at these monitoring locations represent a conservative determination of compliance.

At V2820, the highest signal-to-noise levels are present at the lower wind speed bins (4 and 5 m/s). These wind bins have the lowest impact from ambient noise, and therefore the least amount of associated uncertainty in calculation of the turbine-only sound levels. The influence of ambient noise increases in the higher wind bins, and the reduction in turbine-only sound level in the 7 m/s wind bin is likely due to the increased uncertainty due to low signal-to-noise, rather than any actual decrease in the turbine sound level. The predicted sound level of the V2820 monitor is slightly higher than that of the V2820 receptor, and therefore represents a somewhat conservative determination of turbine-only sound level.

All Total Noise wind bins having sufficient data meet the MECP standard deviation targets of 2/2.5 dB (Section E5.5(8) of the Protocol).

# 8 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 5.5 details the criteria used to evaluate compliance.

## 8.1 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 14. 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 13. Compliance assessments are provided only for wind bins meeting the minimum sample size requirements.

[8] Per Aercoustics' sound model of the PDN Wind Farm, the predicted sound level is 0.9 dB higher at the monitoring location for R487 compared to the point of reception.

Table 14: Assessment Table

| Audited Receptor | Wind speed 10m-AGL [m/s] | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| **V2820** | Turbine-Only Sound Level (Point of Reception) [dBA] | - | - | - | 39* | 39 | 38[a] | 36[a] |
| | *Background Sound Level [dBA]* | 31 | 32 | 33 | 34 | 37 | 42[b] | 45[b] |
| MECP Exclusion Limit [dBA] | | 40 | 40 | 40 | 40 | 40 | 40 | 43 |
| Compliance? (Y/N) | | - | - | - | - | Y | Y | Y |
| **R487** | Turbine-Only Sound Level (Point of Reception) [dBA] | - | 40 | 40 | 40[a] | 40* | - | 40* |
| | *Background Sound Level [dBA]* | 35* | 38 | 39 | 40 | 38* | 38* | 41* |
| MECP Exclusion Limit [dBA] | | 40 | 40 | 40 | 40 | 40 | 40 | 43 |
| Compliance? (Y/N) | | - | Y | Y | Y | - | - | - |

- Sample size below minimum requirements in this wind bin, sound levels not reported except as noted by (*).

* Below minimum sample size requirements, data presented for information only.

[a] Signal-to-noise level less than 3 dB. Increased uncertainty in determination of Turbine-Only Sound Impact.

[b] Average measured Background sound level higher than MECP Exclusion Limit

### 8.2 Statement of Compliance

Based on the results presented in Table 14, the Turbine-Only sound levels at the audit receptors for PDN Wind Farm are in compliance with the applicable sound level limits.

# 9 Conclusion

An acoustic immission audit per the requirements of the MECP Compliance Protocol for Wind Turbine Noise was conducted at PDN Wind Farm receptors V2820 and R487. Per the results presented in this report and summarized in Table 14, the noise impacts at both receptors were found to be in compliance with the applicable sound level limits.

# 10 References

[1] *Renewable Energy Approval #2869-8VDRCV,* Toronto: Ontario Ministry of the Environment, 2012.

[2] Government of Ontario, *NPC 350 - Compliance protocol for wind turbine noise,* Toronto: Ministry of the Environment and Climate Change, 2017.

[3] M. Ubovic, “Acoustic Audits for REA #2869-8VDRVC, Port Dover & Nanticoke Wind Farm,” Ministry of the Environment, Conservation and Parks, Toronto, 2018.

[4] A. Denison and P. Ashtiani, “Port Dover and Nanticoke Wind Power Project - REA # 2869-8VDRCV - Additional RAM I-Audit Measurements Interim Update and Location Change Request,” Aercoustics Engineering Limited, Mississauga, 2019.

[5] S. Schajnoha, B. Coulson and G. Redman, “Port Dover and Nanticoke Wind Project Acoustic Assesment Report,” RWDI Air Inc., Guelph, 2014.

[6] “IEC 61400-11:2012 Wind Turbine - Part 11: Acoustic noise measurement techniques,” International Electrotechnical Commission, Geneva, 2012.

[7] R. Jozwiak and P. Ashtiani, “Port Dover & Natnticoke Wind Farm Turbine T538 - IEC 61400-11 measurement,” Aercoustics Engineering Limited, Toronto, 2014.

[8] R. Jozwiak and P. Ashtiani, “Port Dover & Natnticoke Wind Farm Turbine T543 - IEC 61400-11 measurement,” Aercoustics Engineering Limited, Toronto, 2014.

[9] “ISO 1996-2: Acoustics - Description, measurement and assessment of environmental noise - Part 2: Determination of Sound Pressure Levels,” International Organization for Standardization, Geneva, 2007.

[10] D. Halstead and N. Tam, “A study of background noise levels measured during far-field receptor testing of wind turbine facilities,” in *8th International Conference on Wind Turbine Noise*, Lisbon, 2019.

# Appendix A
Site Details


## Legend

- Turbine Locations
- Monitor Locations
- Receptor Locations

N

| | |
|---|---|
| **Project ID:** | 14000.07 |
| **Drawn by:** | DAF |
| **Reveiwed by:** | DH |
| **Date:** | November 2020 |
| **Revision:** | 1 |
| **Scale:** | As Indicated |

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# Appendix A.1

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## Legend

- Turbine Locations
- Monitor Locations
- Receptor Locations

N

**Project ID:** 14000.07
**Drawn by:** DAF
**Reveiwed by:** DH
**Date:** November 2020
**Revision:** 1

**Scale:** As Indicated

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# Appendix A.2a

Monitor and Receptor Location

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## Legend

- Turbine Locations
- Monitor Locations
- Receptor Locations

N

**Project ID:** 14000.07
**Drawn by:** DAF
**Reveiwed by:** DH
**Date:** November 2020
**Revision:** 1

**Scale:** As Indicated

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# Appendix A.2b

Monitor and Receptor Location

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**Project ID:** 14000.07
**Drawn by:** DAF
**Reveiwed by:** DH
**Date:** November 2020
**Revision:** 1

**Scale:** As Indicated

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# Appendix A.3a

Monitor V2820
to T540

aercoustics

**Project ID:** 14000.07
**Drawn by:** DAF
**Reveiwed by:** DH
**Date:** November 2020
**Revision:** 1

**Scale:** As Indicated

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# Appendix A.3b

Monitor R487
to T552

aercoustics

**Project ID:** 14000.07
**Drawn by:** DAF
**Reveiwed by:** DH
**Date:** November 2020
**Revision:** 1

**Scale:** As Indicated

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# Appendix A.4a

Monitor R487
to Receptor

aercoustics

**Project ID:** 14000.07
**Drawn by:** DAF
**Reveiwed by:** DH
**Date:** November 2020
**Revision:** 1

**Scale:** As Indicated

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# Appendix A.4b

Monitor R487
to Receptor

aercoustics

# Appendix B
Calibration Certificates

# Compliant Calibration Certificate

NATIONAL INSTRUMENTS
CALIBRATED
SN/ID 1A67099
DATE: 14-MAY-2020
DUE: 14-MAY-2021
ni.com/calibration

| | | | |
|---|---|---|---|
| **Certificate Number:** | 6401655.1 | **OE Number:** | 21921971 |
| **Date Printed:** | 14-MAY-2020 | **Page:** | 1 of 14 |
| **Customer:** | Aercoustics Engineering Ltd (CA)<br>5335 Lucas Court<br>ONTARIO Mississauga, L4Z 4A9<br>CANADA | | |
| **Manufacturer:** | National Instruments | **Model:** | NI 9234 |
| **Serial Number:** | 1A67099 | | |
| **Part Number:** | 195551B-01L | **Description:** | MODULE ASSY,NI 9234, 4 AI CONFIGURABLE |
| **Calibration Date:** | 14-MAY-2020 | **Issued Date:** | 14-MAY-2020 |
| **Procedure Name:** | NI 9234 | **Recommended Calibration Due:** | 14-MAY-2021 |
| **Procedure Version:** | 3.6.1.0 | **Verification Results:** | As Found: Passed<br>As Left: Passed |
| **Lab Technician:** | Pamela Rotan | **Calibration Executive Version:** | 5.1.0.0 |
| | | **Driver Info:** | NI-DAQmx:18.1.0 |
| **Temperature:** | 23.0° C | **Humidity:** | 44.2% 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/NCSL 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.

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**Ted Talley**
**Technical Manager**

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

NATIONAL INSTRUMENTS™

## Calibration Notes

| Type | Note |
|---|---|
| Asset | Verification and adjustment were performed. |

## Standards Used

| Manufacturer | Model | Type | Tracking Number | Calibration Due | Notes |
|---|---|---|---|---|---|
| Fluke | 5720A | Calibrator | 9379 | 27-JUL-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 | 9845 | 21-JUN-2020 | |

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).

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## 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 | 3.99991 V | 4.00480 V | Passed | |
| -5 V | 5 V | 0 | 0.00000 V | -0.00120 V | -0.00002 V | 0.00120 V | Passed | |
| -5 V | 5 V | 0 | -4.00000 V | -4.00480 V | -3.99990 V | -3.99520 V | Passed | |
| -5 V | 5 V | 1 | 4.00000 V | 3.99520 V | 3.99987 V | 4.00480 V | Passed | |
| -5 V | 5 V | 1 | 0.00000 V | -0.00120 V | -0.00004 V | 0.00120 V | Passed | |
| -5 V | 5 V | 1 | -4.00000 V | -4.00480 V | -3.99993 V | -3.99520 V | Passed | |
| -5 V | 5 V | 2 | 4.00000 V | 3.99520 V | 3.99968 V | 4.00480 V | Passed | |
| -5 V | 5 V | 2 | 0.00000 V | -0.00120 V | -0.00025 V | 0.00120 V | Passed | |
| -5 V | 5 V | 2 | -4.00000 V | -4.00480 V | -4.00016 V | -3.99520 V | Passed | |
| -5 V | 5 V | 3 | 4.00000 V | 3.99520 V | 3.99993 V | 4.00480 V | Passed | |
| -5 V | 5 V | 3 | 0.00000 V | -0.00120 V | -0.00001 V | 0.00120 V | Passed | |
| -5 V | 5 V | 3 | -4.00000 V | -4.00480 V | -3.99991 V | -3.99520 V | Passed | |

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Tel: (800) 531-5066

## 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 | |

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## 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 | -0.018 Degrees | 0.085 Degrees | Passed | |
| 1 | 51200 | 16384 | 1000 Hz | -0.085 Degrees | 0.012 Degrees | 0.085 Degrees | Passed | |
| 2 | 51200 | 16384 | 1000 Hz | -0.085 Degrees | -0.011 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 | -0.181 Degrees | 0.490 Degrees | Passed | |
| 1 | 51200 | 16384 | 10000 Hz | -0.490 Degrees | 0.115 Degrees | 0.490 Degrees | Passed | |
| 2 | 51200 | 16384 | 10000 Hz | -0.490 Degrees | -0.108 Degrees | 0.490 Degrees | Passed | |
| 3 | 51200 | 16384 | 10000 Hz | -0.490 Degrees | 0.181 Degrees | 0.490 Degrees | Passed | |

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Tel: (800) 531-5066

## 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 | 75.422 dB | 100.000 dB | Passed | |
| 1 | 51200 | 16384 | 1000 Hz | 40.000 dB | 74.017 dB | 100.000 dB | Passed | |
| 2 | 51200 | 16384 | 1000 Hz | 40.000 dB | 64.152 dB | 100.000 dB | Passed | |
| 3 | 51200 | 16384 | 1000 Hz | 40.000 dB | 68.947 dB | 100.000 dB | Passed | |

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## 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 | 2.091 mA | 2.200 mA | Passed | |
| 1 | 51200 | 0.01 A | 2.000 mA | 2.000 mA | 2.077 mA | 2.200 mA | Passed | |
| 2 | 51200 | 0.01 A | 2.000 mA | 2.000 mA | 2.085 mA | 2.200 mA | Passed | |
| 3 | 51200 | 0.01 A | 2.000 mA | 2.000 mA | 2.081 mA | 2.200 mA | Passed | |

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## 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 | 20.810 V | 24.000 V | Passed | |
| 1 | 51200 | 24 V | 2 mA | 19.000 V | 20.812 V | 24.000 V | Passed | |
| 2 | 51200 | 24 V | 2 mA | 19.000 V | 20.812 V | 24.000 V | Passed | |
| 3 | 51200 | 24 V | 2 mA | 19.000 V | 20.811 V | 24.000 V | Passed | |

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## 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 | -3.99994 V | -3.99520 V | Passed | |
| -5 V | 5 V | 1 | 4.00000 V | 3.99520 V | 3.99999 V | 4.00480 V | Passed | |
| -5 V | 5 V | 1 | 0.00000 V | -0.00120 V | -0.00001 V | 0.00120 V | Passed | |
| -5 V | 5 V | 1 | -4.00000 V | -4.00480 V | -3.99997 V | -3.99520 V | Passed | |
| -5 V | 5 V | 2 | 4.00000 V | 3.99520 V | 3.99977 V | 4.00480 V | Passed | |
| -5 V | 5 V | 2 | 0.00000 V | -0.00120 V | -0.00021 V | 0.00120 V | Passed | |
| -5 V | 5 V | 2 | -4.00000 V | -4.00480 V | -4.00016 V | -3.99520 V | Passed | |
| -5 V | 5 V | 3 | 4.00000 V | 3.99520 V | 3.99999 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 | -3.99996 V | -3.99520 V | Passed | |

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## 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 | |

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## 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 | -0.019 Degrees | 0.085 Degrees | Passed | |
| 1 | 51200 | 16384 | 1000 Hz | -0.085 Degrees | 0.012 Degrees | 0.085 Degrees | Passed | |
| 2 | 51200 | 16384 | 1000 Hz | -0.085 Degrees | -0.012 Degrees | 0.085 Degrees | Passed | |
| 3 | 51200 | 16384 | 1000 Hz | -0.085 Degrees | 0.019 Degrees | 0.085 Degrees | Passed | |
| 0 | 51200 | 16384 | 10000 Hz | -0.490 Degrees | -0.181 Degrees | 0.490 Degrees | Passed | |
| 1 | 51200 | 16384 | 10000 Hz | -0.490 Degrees | 0.115 Degrees | 0.490 Degrees | Passed | |
| 2 | 51200 | 16384 | 10000 Hz | -0.490 Degrees | -0.108 Degrees | 0.490 Degrees | Passed | |
| 3 | 51200 | 16384 | 10000 Hz | -0.490 Degrees | 0.181 Degrees | 0.490 Degrees | Passed | |

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## 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 | 69.463 dB | 100.000 dB | Passed | |
| 1 | 51200 | 16384 | 1000 Hz | 40.000 dB | 73.867 dB | 100.000 dB | Passed | |
| 2 | 51200 | 16384 | 1000 Hz | 40.000 dB | 82.002 dB | 100.000 dB | Passed | |
| 3 | 51200 | 16384 | 1000 Hz | 40.000 dB | 74.067 dB | 100.000 dB | Passed | |

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**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 | 2.077 mA | 2.200 mA | Passed | |
| 1 | 51200 | 0.01 A | 2.000 mA | 2.000 mA | 2.077 mA | 2.200 mA | Passed | |
| 2 | 51200 | 0.01 A | 2.000 mA | 2.000 mA | 2.077 mA | 2.200 mA | Passed | |
| 3 | 51200 | 0.01 A | 2.000 mA | 2.000 mA | 2.081 mA | 2.200 mA | Passed | |

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**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 | 20.809 V | 24.000 V | Passed | |
| 1 | 51200 | 24 V | 2 mA | 19.000 V | 20.811 V | 24.000 V | Passed | |
| 2 | 51200 | 24 V | 2 mA | 19.000 V | 20.813 V | 24.000 V | Passed | |
| 3 | 51200 | 24 V | 2 mA | 19.000 V | 20.811 V | 24.000 V | Passed | |

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USA
Tel: (800) 531-5066

# *CERTIFICATE of CALIBRATION*

| | | | |
|---|---|---|---|
| Make : | PCB Piezotronics | Reference # : | 161543 |
| Model : | 378B02 | Customer : | Aercoustics Engineering Ltd<br>Mississauga, ON |
| Descr. : | Microphone System 1/2" Free Field | | |
| Serial # : | 123029 | P. Order : | 2020.05.04C |
| Asset # : | 00813 | | |

Cal. status : Received in spec's, no adjustment made.
Preamp System with Mic 377B02 s/n 158838

*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 : May 05, 2020 By : Petro Onasko

Cal. Due : May 05, 2022

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

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


## *Navair Technologies*

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Tel: (905) 565-1583
Fax: (905) 565-8325

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

Calibration Report for Certificate : 161543

| Make | | | Model | Serial | Asset | | |
|---|---|---|---|---|---|---|---|
| PCB Piezotronics | | | 378B02 | 123029 | 00813 | | |
| PCB Piezotronics | | | 426E01 | 041180 | 00813 | | |
| PCB Piezotronics | | | 377B02 | 158838 | 00813 | | |

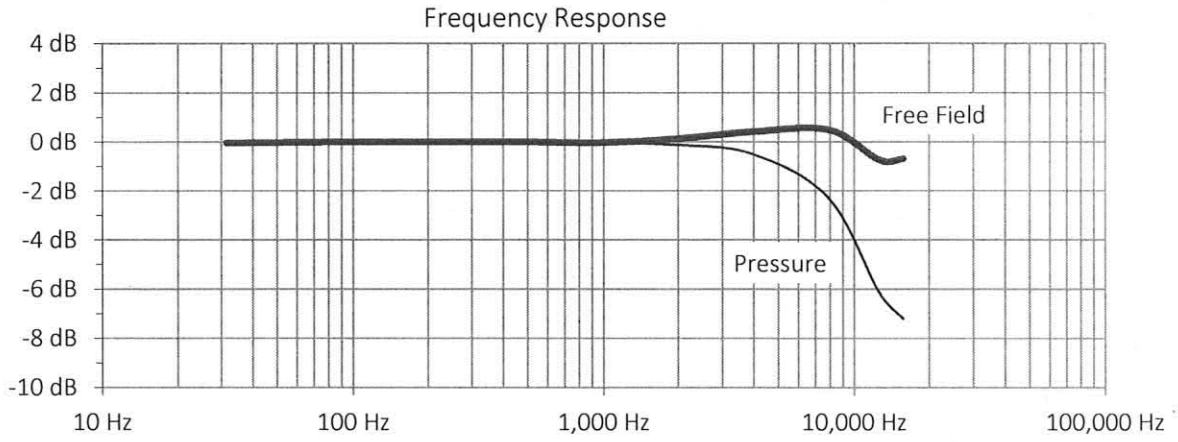
Sensitivity at 250 Hz

| Specs Nom | Unit | | Min | Reading | Max | | In/Out |
|---|---|---|---|---|---|---|---|
| 50.0 mV/Pa | | | 39.72 | 52.96 | 62.94 | | In |
| −26.02 dB | re 1 V/Pa | | -28.02 | -25.52 | -24.02 | | In |
| 0 dB | re 50 mV/Pa | | -2 | 0.50 | 2 | | In |

Ambient Conditions: Static Pressure 99.7 kPa
Temperature 23.0°C
Rel.Humidity 31.0%

Frequency response

| | Lower | Upper | |
|---|---|---|---|
| Freq | Pressure | Free Field | |
| Hz | dB | dB | |
| 31.5 | −0.04 | −0.04 | |
| 63.1 | −0.02 | −0.01 | |
| 125.9 | −0.00 | −0.00 | |
| 251.3 | 0.00 | 0.00 | ref |
| 502.5 | −0.01 | −0.01 | |
| 1005.1 | −0.06 | −0.03 | |
| 1978.7 | −0.12 | +0.12 | |
| 3957.5 | −0.50 | +0.41 | |
| 7914.9 | −2.30 | +0.49 | |
| 12663 | −6.17 | −0.75 | |
| 15830 | −7.22 | −0.69 | |



# *CERTIFICATE of CALIBRATION*

| | | | |
|---|---|---|---|
| Make : | PCB Piezotronics | Reference # : | 161619 |
| Model : | 480E09 | Customer : | Aercoustics Engineering Ltd<br>Mississauga, ON |
| Descr. : | Conditioning Amplifier | | |
| Serial # : | 00033804 | P. Order : | 2020.05.07C |
| Asset # : | 00763 | | |

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 : May 12, 2020 By : Petro Onasko

Cal. Due : May 12, 2022

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

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

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Fax: (905) 565-8325

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

Calibration Report for Certificate : 161619

| Make | Model | Serial № | Asset | Cal by |
|---|---|---|---|---|
| PCB Piezotronics | 480E09 | 00033804 | 00763 | P.O. |

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

Excitation Voltage

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| • 1 | | | 25 Vdc | 26.0 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**

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# CERTIFICATE FOR CALIBRATION OF SONIC ANEMOMETER

**Certificate number:** 19.US2.06160 **Date of issue:** July 08, 2019

**Type:** Vaisala Weather Transmitter, WXT520 **Serial number:** L0910581

**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:** July 11, 2019 **Anemometer calibrated:** July 08, 2019

**Calibrated by:** MEJ **Procedure:** MEASNET, IEC 61400-12-1:2017 Annex F

**Certificate prepared by:** EJF **Approved by:** Calibration engineer, EJF

**Calibration equation obtained:** $v$ [m/s] = 0.99859 · U [m/s] + -0.05112

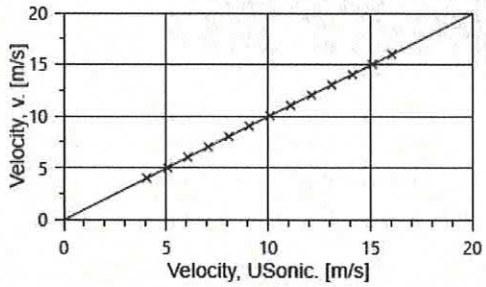
**Standard uncertainty, slope:** 0.00132 **Standard uncertainty, offset:** -0.27724

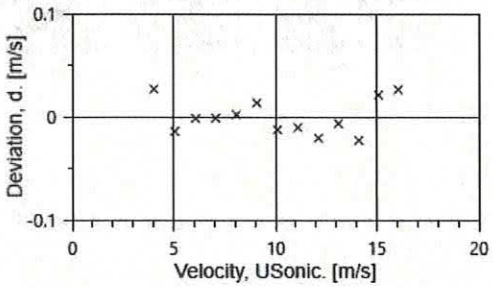
**Covariance:** -0.0000175 (m/s)²/m/s **Coefficient of correlation:** ρ = 0.999990

**Absolute maximum deviation:** 0.027 m/s at 4.010 m/s

**Barometric pressure:** 1004.1 hPa **Relative humidity:** 47.3%

| Succession | Velocity pressure, q. [Pa] | Temperature in wind tunnel [°C] | d.p. box [°C] | Wind velocity, $v$. [m/s] | Anemometer Output, U. [m/s] | Deviation, d. [m/s] | Uncertainty $u_c$ (k=2) [m/s] |
|---|---|---|---|---|---|---|---|
| 2 | 9.38 | 25.1 | 27.2 | 4.010 | 4.0400 | 0.027 | 0.023 |
| 4 | 14.58 | 25.1 | 27.2 | 5.000 | 5.0724 | -0.014 | 0.026 |
| 6 | 21.10 | 25.1 | 27.2 | 6.015 | 6.0767 | -0.002 | 0.030 |
| 8 | 28.66 | 25.1 | 27.2 | 7.011 | 7.0733 | -0.001 | 0.034 |
| 10 | 37.49 | 25.1 | 27.2 | 8.018 | 8.0783 | 0.002 | 0.038 |
| 12 | 47.61 | 25.1 | 27.2 | 9.036 | 9.0867 | 0.013 | 0.043 |
| 13-last | 58.65 | 25.1 | 27.2 | 10.029 | 10.1069 | -0.013 | 0.047 |
| 11 | 71.02 | 25.1 | 27.2 | 11.036 | 11.1133 | -0.010 | 0.051 |
| 9 | 84.53 | 25.1 | 27.2 | 12.041 | 12.1300 | -0.021 | 0.056 |
| 7 | 99.09 | 25.1 | 27.2 | 13.037 | 13.1133 | -0.007 | 0.060 |
| 5 | 114.81 | 25.1 | 27.2 | 14.033 | 14.1267 | -0.023 | 0.064 |
| 3 | 131.98 | 25.1 | 27.2 | 15.045 | 15.0967 | 0.021 | 0.069 |
| 1-first | 149.54 | 25.0 | 27.2 | 16.013 | 16.0600 | 0.026 | 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 the 0° orientation during calibration.

**Certificate number:** 19.US2.06160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# CERTIFICATE FOR CALIBRATION OF SONIC ANEMOMETER

**Certificate number:** 19.US2.06159 **Date of issue:** July 08, 2019

**Type:** Vaisala Weather Transmitter, WXT520 **Serial number:** L0910581

**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:** July 11, 2019 **Anemometer calibrated:** July 08, 2019

**Calibrated by:** MEJ **Procedure:** MEASNET, IEC 61400-12-1:2017 Annex F

**Certificate prepared by:** EJF **Approved by:** Calibration engineer, EJF

**Calibration equation obtained:** $v$ [m/s] = 1.01811 · U [m/s] + 0.04684

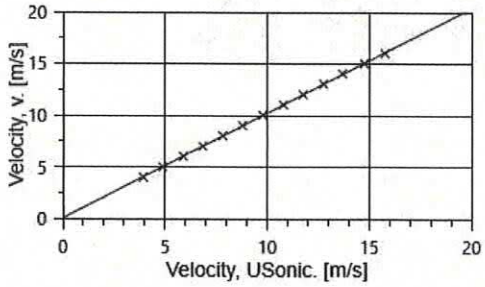
**Standard uncertainty, slope:** 0.00323 **Standard uncertainty, offset:** 0.73496

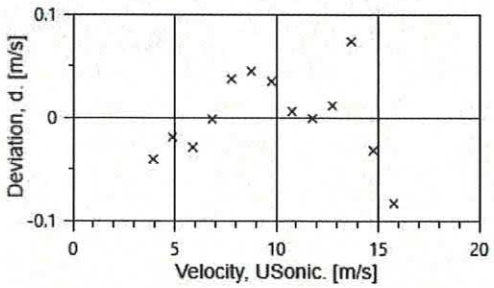
**Covariance:** -0.0001059 (m/s)²/m/s **Coefficient of correlation:** $\rho = 0.999943$

**Absolute maximum deviation:** -0.083 m/s at 16.023 m/s

**Barometric pressure:** 1004.3 hPa **Relative humidity:** 47.9%

| 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 | 9.36 | 24.9 | 27.4 | 4.004 | 3.9267 | -0.041 | 0.023 |
| 4 | 14.63 | 25.0 | 27.4 | 5.006 | 4.8897 | -0.019 | 0.026 |
| 6 | 21.13 | 25.0 | 27.4 | 6.018 | 5.8933 | -0.029 | 0.030 |
| 8 | 28.67 | 25.0 | 27.3 | 7.009 | 6.8400 | -0.002 | 0.034 |
| 10 | 37.68 | 25.0 | 27.3 | 8.035 | 7.8100 | 0.037 | 0.039 |
| 12 | 47.58 | 25.0 | 27.3 | 9.030 | 8.7800 | 0.045 | 0.043 |
| 13-last | 58.71 | 25.0 | 27.3 | 10.031 | 9.7724 | 0.035 | 0.047 |
| 11 | 71.09 | 25.0 | 27.3 | 11.038 | 10.7900 | 0.006 | 0.051 |
| 9 | 84.47 | 25.0 | 27.3 | 12.032 | 11.7733 | -0.001 | 0.056 |
| 7 | 99.40 | 25.0 | 27.3 | 13.053 | 12.7633 | 0.011 | 0.060 |
| 5 | 115.31 | 24.9 | 27.4 | 14.058 | 13.6900 | 0.074 | 0.064 |
| 3 | 131.95 | 24.9 | 27.4 | 15.039 | 14.7567 | -0.032 | 0.069 |
| 1-first | 149.80 | 24.8 | 27.5 | 16.023 | 15.7733 | -0.083 | 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.

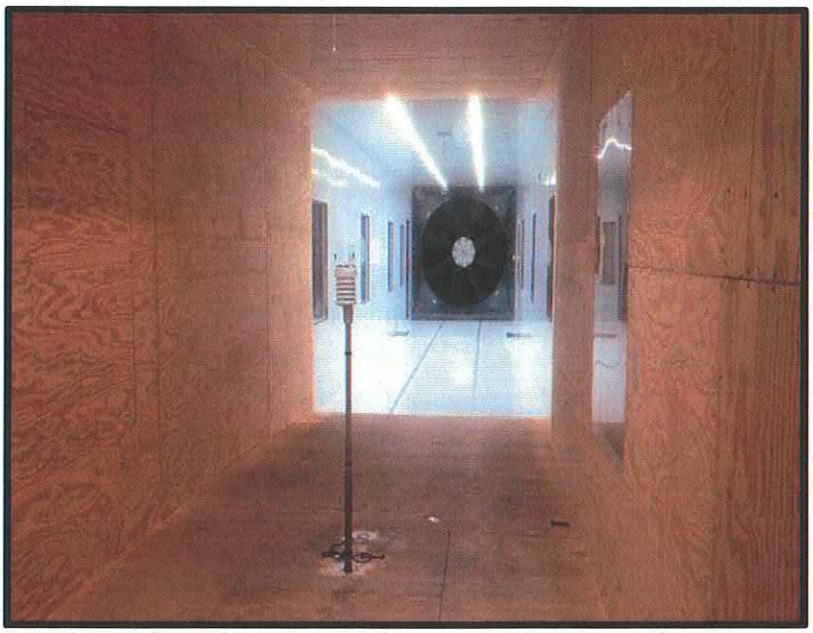


*Photo of the wind tunnel setup. The cross-sectional area is 2.5m x 2.5m.*

## 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 the 90° orientation during calibration.

**Certificate number:** 19.US2.06159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# Compliant Calibration Certificate

NATIONAL INSTRUMENTS
CALIBRATED
SN/ID 1B3CE71
DATE 06-DEC-2019
DUE 06-DEC-2020
ni.com/calibration

| | | | |
|---|---|---|---|
| **Certificate Number:** | 6241566.1 | **OE Number:** | 21815539 |
| **Date Printed:** | 06-DEC-2019 | **Page:** | 1 of 14 |
| **Customer:** | Aercoustics Engineering LTD (CA)<br>1004 Middlegate Road<br>Suite 1100<br>ONTARIO MISSISSAUGA, L4Y 0G1<br>CANADA | | |
| **Manufacturer:** | National Instruments | **Model:** | NI 9234 |
| **Serial Number:** | 1B3CE71 | | |
| **Part Number:** | 195551C-01L | **Description:** | MODULE ASSY,NI 9234, 4 AI CONFIGURABLE |
| **Calibration Date:** | 06-DEC-2019 | **Issued Date:** | 06-DEC-2019 |
| **Procedure Name:** | NI 9234 | **Recommended Calibration Due:** | 06-DEC-2020 |
| **Procedure Version:** | 3.6.1.0 | **Verification Results:** | As Found: Passed<br>As Left: Passed |
| **Lab Technician:** | Carlos Perez | **Calibration Executive Version:** | 5.0.2.0 |
| | | **Driver Info:** | NI-DAQmx:19.0.0 |
| **Temperature:** | 23.0° C | **Humidity:** | 40.7% 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/NCSL 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**

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

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## Calibration Notes

| Type | Note |
|---|---|
| Asset | Verification and adjustment were performed. |

## Standards Used

| Manufacturer | Model | Type | Tracking Number | Calibration Due | Notes |
|---|---|---|---|---|---|
| FLUKE | 5700A | Calibrator | 3020 | 10-DEC-2019 | |
| Agilent | 33250A | Function generator | 2472 | 27-AUG-2020 | |
| National Instruments | PXI-4071 | Digital multimeter | 9433 | 28-AUG-2020 | |
| National Instruments | PXI-4132 | SMU | 9170 | 06-MAY-2020 | |

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 | 3.99987 V | 4.00480 V | Passed | |
| -5 V | 5 V | 0 | 0.00000 V | -0.00120 V | -0.00023 V | 0.00120 V | Passed | |
| -5 V | 5 V | 0 | -4.00000 V | -4.00480 V | -4.00034 V | -3.99520 V | Passed | |
| -5 V | 5 V | 1 | 4.00000 V | 3.99520 V | 4.00001 V | 4.00480 V | Passed | |
| -5 V | 5 V | 1 | 0.00000 V | -0.00120 V | -0.00007 V | 0.00120 V | Passed | |
| -5 V | 5 V | 1 | -4.00000 V | -4.00480 V | -4.00016 V | -3.99520 V | Passed | |
| -5 V | 5 V | 2 | 4.00000 V | 3.99520 V | 4.00027 V | 4.00480 V | Passed | |
| -5 V | 5 V | 2 | 0.00000 V | -0.00120 V | 0.00019 V | 0.00120 V | Passed | |
| -5 V | 5 V | 2 | -4.00000 V | -4.00480 V | -3.99991 V | -3.99520 V | Passed | |
| -5 V | 5 V | 3 | 4.00000 V | 3.99520 V | 4.00010 V | 4.00480 V | Passed | |
| -5 V | 5 V | 3 | 0.00000 V | -0.00120 V | 0.00006 V | 0.00120 V | Passed | |
| -5 V | 5 V | 3 | -4.00000 V | -4.00480 V | -3.99997 V | -3.99520 V | Passed | |

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## 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 | -0.005 Degrees | 0.085 Degrees | Passed | |
| 1 | 51200 | 16384 | 1000 Hz | -0.085 Degrees | 0.003 Degrees | 0.085 Degrees | Passed | |
| 2 | 51200 | 16384 | 1000 Hz | -0.085 Degrees | 0.005 Degrees | 0.085 Degrees | Passed | |
| 3 | 51200 | 16384 | 1000 Hz | -0.085 Degrees | 0.005 Degrees | 0.085 Degrees | Passed | |
| 0 | 51200 | 16384 | 10000 Hz | -0.490 Degrees | -0.045 Degrees | 0.490 Degrees | Passed | |
| 1 | 51200 | 16384 | 10000 Hz | -0.490 Degrees | 0.031 Degrees | 0.490 Degrees | Passed | |
| 2 | 51200 | 16384 | 10000 Hz | -0.490 Degrees | 0.045 Degrees | 0.490 Degrees | Passed | |
| 3 | 51200 | 16384 | 10000 Hz | -0.490 Degrees | 0.039 Degrees | 0.490 Degrees | Passed | |

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## 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 | 74.938 dB | 100.000 dB | Passed | |
| 1 | 51200 | 16384 | 1000 Hz | 40.000 dB | 73.541 dB | 100.000 dB | Passed | |
| 2 | 51200 | 16384 | 1000 Hz | 40.000 dB | 73.747 dB | 100.000 dB | Passed | |
| 3 | 51200 | 16384 | 1000 Hz | 40.000 dB | 73.868 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 | 2.080 mA | 2.200 mA | Passed | |
| 1 | 51200 | 0.01 A | 2.000 mA | 2.000 mA | 2.076 mA | 2.200 mA | Passed | |
| 2 | 51200 | 0.01 A | 2.000 mA | 2.000 mA | 2.078 mA | 2.200 mA | Passed | |
| 3 | 51200 | 0.01 A | 2.000 mA | 2.000 mA | 2.077 mA | 2.200 mA | Passed | |

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## 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 | 20.832 V | 24.000 V | Passed | |
| 1 | 51200 | 24 V | 2 mA | 19.000 V | 20.830 V | 24.000 V | Passed | |
| 2 | 51200 | 24 V | 2 mA | 19.000 V | 20.830 V | 24.000 V | Passed | |
| 3 | 51200 | 24 V | 2 mA | 19.000 V | 20.833 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 | 0.00001 V | 0.00120 V | Passed | |
| -5 V | 5 V | 0 | -4.00000 V | -4.00480 V | -4.00000 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 | -0.00001 V | 0.00120 V | Passed | |
| -5 V | 5 V | 1 | -4.00000 V | -4.00480 V | -3.99999 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 | -3.99999 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 | |

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## 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 | -0.005 Degrees | 0.085 Degrees | Passed | |
| 1 | 51200 | 16384 | 1000 Hz | -0.085 Degrees | 0.003 Degrees | 0.085 Degrees | Passed | |
| 2 | 51200 | 16384 | 1000 Hz | -0.085 Degrees | 0.005 Degrees | 0.085 Degrees | Passed | |
| 3 | 51200 | 16384 | 1000 Hz | -0.085 Degrees | 0.005 Degrees | 0.085 Degrees | Passed | |
| 0 | 51200 | 16384 | 10000 Hz | -0.490 Degrees | -0.045 Degrees | 0.490 Degrees | Passed | |
| 1 | 51200 | 16384 | 10000 Hz | -0.490 Degrees | 0.031 Degrees | 0.490 Degrees | Passed | |
| 2 | 51200 | 16384 | 10000 Hz | -0.490 Degrees | 0.045 Degrees | 0.490 Degrees | Passed | |
| 3 | 51200 | 16384 | 10000 Hz | -0.490 Degrees | 0.039 Degrees | 0.490 Degrees | Passed | |

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**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 | 74.967 dB | 100.000 dB | Passed | |
| 1 | 51200 | 16384 | 1000 Hz | 40.000 dB | 72.726 dB | 100.000 dB | Passed | |
| 2 | 51200 | 16384 | 1000 Hz | 40.000 dB | 73.948 dB | 100.000 dB | Passed | |
| 3 | 51200 | 16384 | 1000 Hz | 40.000 dB | 73.851 dB | 100.000 dB | Passed | |

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**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 | 2.079 mA | 2.200 mA | Passed | |
| 1 | 51200 | 0.01 A | 2.000 mA | 2.000 mA | 2.077 mA | 2.200 mA | Passed | |
| 2 | 51200 | 0.01 A | 2.000 mA | 2.000 mA | 2.078 mA | 2.200 mA | Passed | |
| 3 | 51200 | 0.01 A | 2.000 mA | 2.000 mA | 2.077 mA | 2.200 mA | Passed | |

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## 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 | 20.832 V | 24.000 V | Passed | |
| 1 | 51200 | 24 V | 2 mA | 19.000 V | 20.830 V | 24.000 V | Passed | |
| 2 | 51200 | 24 V | 2 mA | 19.000 V | 20.834 V | 24.000 V | Passed | |
| 3 | 51200 | 24 V | 2 mA | 19.000 V | 20.833 V | 24.000 V | Passed | |

# *CERTIFICATE of CALIBRATION*

| | | | |
|---|---|---|---|
| Make : | PCB Piezotronics | Reference # : | 159677 |
| Model : | 378B02 | Customer : | Aercoustics Engineering Ltd<br>Mississauga, ON |
| Descr. : | Microphone System 1/2" Free Field | | |
| Serial # : | 121695 | P. Order : | 2019.11.19C |
| Asset # : | 00471 | | |

Cal. status : Received in spec's, no adjustment made.
Preamp System with Mic 377B02 s/n 156314

*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 : Nov 26, 2019 By : Petro Onasko

Cal. Due : Nov 26, 2021

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 http: // www.navair.com
Phone : 800-668-7440 Fax: 905 565 8325 e-Mail: service @ navair.com

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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 : 159677

| Make | | | Model | Serial | Asset | | |
|---|---|---|---|---|---|---|---|
| PCB Piezotronics | | | 378B02 | 121695 | 00471 | | |
| PCB Piezotronics | | | 426E01 | 039843 | 00471 | | |
| PCB Piezotronics | | | 377B02 | 156314 | 00471 | | |

Sensitivity at 250 Hz

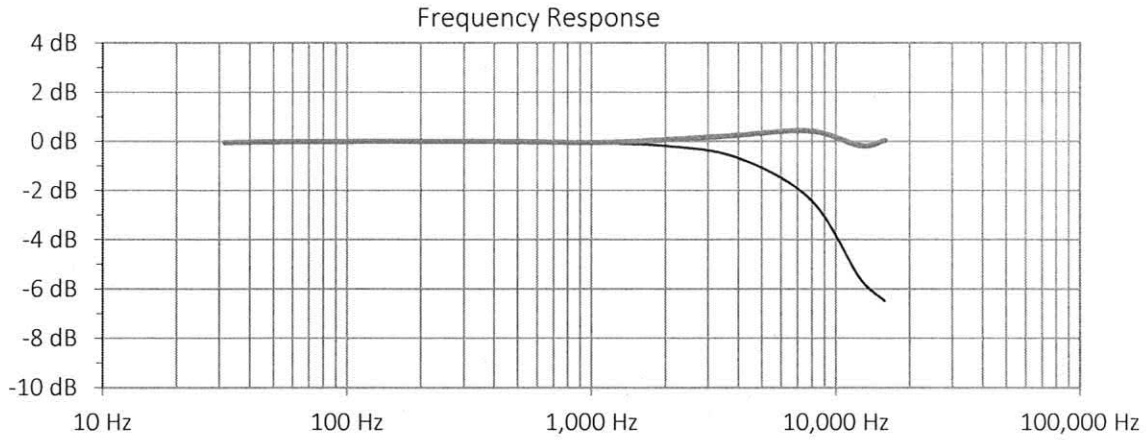
| Specs Nom | Unit | | Min | Reading | Max | | In/Out |
|---|---|---|---|---|---|---|---|
| 50 | mV/Pa | | 39.72 | 50.10 | 62.94 | | In |
| -26.02 | dB re 1V/Pa | | -28.02 | -26.00 | -24.02 | | In |
| 0 | dB re 50mV/Pa | | -2 | 0.02 | 2 | | In |

Ambient Conditions:

| | |
|---|---|
| Static Pressure | 99.0 kPa |
| Temperature | 23.2°C |
| Rel.Humidity | 33.0% |

Frequency response

| | Lower | Upper | |
|---|---|---|---|
| Freq | Pressure | Free Field | |
| Hz | dB | dB | |
| 31.5 | -0.04 | -0.04 | |
| 63.1 | -0.02 | -0.02 | |
| 125.9 | 0.00 | 0.00 | |
| **251.3** | **0.00** | **0.00** | ref |
| 502.5 | -0.02 | -0.01 | |
| 1005.1 | -0.07 | -0.05 | |
| 1978.7 | -0.18 | 0.06 | |
| 3957.5 | -0.66 | 0.25 | |
| 7914.9 | -2.38 | 0.42 | |
| 12663 | -5.61 | -0.18 | |
| 15830 | -6.48 | 0.04 | |



# ~ *Calibration Certificate* ~

Model Number: 480E09

Serial Number: 37185

Description: Signal Conditioner

Manufacturer: PCB

Customer:

P.O.:

Method : Comparison Method (AT103-3)

## *Calibration Data*

Temperature: 73 °F ( 23 °C)

Humidity: 56%

| Channel | Volts | Current (mA) | Gain X1 | Gain X10 | Gain X100 |
|---|---|---|---|---|---|
| 1 | 27.1 | 2.98 | 1.001 | 10.020 | 100.097 |

## *Condition of Unit*

As Found: n/a

As Left: New unit, in tolerance

## *Notes*

1. Calibration is N.I.S.T. traceable through PCB control number QC-726.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 10012-1, ANSI/NCSL Z540.3 and ISO 17025.
4. Measurement uncertainty (95% confidence level with a coverage factor of 2) for the sensitivity reading is +/- 0.2 %
5. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.

Technician: Darius Story DS

Date: 08/24/19

Due Date:

ilac-MRA A2LA ACCREDITED

CALIBRATION CERT #1862.02

PCB PIEZOTRONICS INC.

Headquarters: 3425 Walden Avenue, Depew, NY 14043

Calibration Performed at: 10869 Highway 903, Halifax, NC 27839

TEL: 888-684-0013 FAX: 716-685-3886 www.pcb.com



CAL29-3649494139

VAISALA

Test report no. H31-18480107

# TEST REPORT

| | |
|---|---|
| **Product family** | WXT530 series |
| **Product type** | WXT536 |
| **Order code** | 6B1B2A4B1B1B |
| **Serial number** | P4830521 |
| **Manufacturer** | Vaisala Oyj, Finland |
| **Test date** | 28 November 2018 |

This test report certifies that the product was thoroughly tested and inspected, and found to meet its published test limits when it was shipped from Vaisala.

**Test results**

| Test | Result | Lower limit | Upper limit | Unit |
|---|---|---|---|---|
| Rain response | 401 | 345 | 575 | mV |
| Zero wind speed | 0 | 0 | 0.4 | m/s |
| Pressure difference | -0.22 | -1 | 1 | hPa |
| Temperature difference | 0.06 | -2 | 2 | °C |
| Humidity difference | -0.77 | -10 | 10 | %RH |
| Heating current | 0.75 | 0.6 | 0.8 | A |
| Current (service port) | 1.07 | 0.5 | 2 | mA |
| Communication (service port) | pass | PASS | PASS | - |
| Current (main port) | 0.73 | 0.5 | 2 | mA |
| Communication (main port) | pass | PASS | PASS | - |

**Ambient conditions** / Humidity 15.39 ±5 %RH, Temperature 22.22 ±1 °C, Pressure 1028.01 ±1 hPa.

Signature

Technician

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Phone +358 9 894 91 | Fax +358 9 8949 2227
Email firstname.lastname@vaisala.com | www.vaisala.com
Domicile Vantaa, Finland | VAT FI01244162 | Business ID 0124416-2

VAISALA

Calibration sheet no. H31-18480108

# CALIBRATION SHEET

| | |
|---|---|
| **Instrument** | WXTPTU |
| **Serial number** | P4350033 |
| **Manufacturer** | Vaisala Oyj, Finland |
| **Test date** | 31 October 2018 |

This test report certifies that the instrument was thoroughly tested and inspected, and found to meet its published test limits when it was shipped from Vaisala.

**Calibration results**

| Test phase of calibration process | Reference value | Observed value | Difference* | Uncertainty** |
|---|---|---|---|---|
| Pressure | 1076.6 | 1076.5 | -0.1 | ± 0.4 hPa |
| Pressure | 900.4 | 900.4 | 0 | ± 0.4 hPa |
| Pressure | 798 | 798 | 0 | ± 0.4 hPa |
| Pressure | 599.3 | 599.3 | 0 | ± 0.4 hPa |
| Temperature | 59.7 | 59.7 | 0 | ± 0.2 °C |
| Temperature | -5.7 | -5.7 | 0 | ± 0.2 °C |
| Temperature | -32.5 | -32.5 | 0 | ± 0.2 °C |
| Temperature | 24.8 | 24.8 | 0 | ± 0.2 °C |
| Temperature | -51.9 | -51.9 | 0 | ± 0.2 °C |
| Relative humidity | 29.5 | 29.5 | 0 | ± 2 %RH |
| Relative humidity | 57.7 | 57.7 | 0 | ± 2 %RH |
| Relative humidity | 91.4 | 91.4 | 0 | ± 3 %RH |

*The test points for error values are polynomial fitting curve fitting points.
**The calibration uncertainty given at 95 % confidence level, k = 2

**Traceability**
The working standards for pressure and temperature are calibrated at Vaisala Measurement Standards Laboratory (MSL) by using MSL working standards traceable to National Institute of Standards and Technology (NIST, USA). The relative humidity values are calculated from measured temperature and dew-point temperature values. The dew-point working standards are traceable to the Finnish National Humidity Laboratory (MIKES).

Signature

Technician

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*Doc218938-A*

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Phone +358 9 894 91 | Fax +358 9 8949 2227
Email firstname.lastname@vaisala.com | www.vaisala.com
Domicile Vantaa, Finland | VAT FI01244162 | Business ID 0124416-2

# Appendix C
Statement from the Operator

Capital Power
1200-10423 101 Street NW
Edmonton, AB  T5H 0E9

November 27, 2020

To: Whom it may concern

**RE: Port Dover and Nanticoke Wind – Acoustic Audits**
**2020 Acoustic Measurement Campaign**
**Renewable Energy Approval Number 2869-8VDRCV**

This letter is to confirm that all the turbines tested at the Port Dover and Nanticoke Wind farm during the spring and fall 2020 acoustic measurement campaign conducted by Aercoustics Engineering Ltd were operating as normal for the duration of the campaign. In addition, for the ambient measurements taken, the turbines were stopped.

If you have any questions, please contact me at (780) 392-5376.

Yours truly,

Jordan Heavenor
Senior Manager, Renewables - Canada

# Appendix D
Supplemental Information

| Receptor ID | Receptor Type | Height | Distance from Receptor to Source (m) | Nearest Turbine | Predicted Impact (Assessment) | Wind Direction | Added notes |
|---|---|---|---|---|---|---|---|
| P0472 | PDN Participating Receptor | 1.5 | 234 | PDNWP T551 | 45.9 | DW | Participating |
| P0442 | PDN Participating Receptor | 4.5 | 322 | PDNWP T547 | 44.6 | CW | Participating |
| P1382 | PDN Participating Receptor | 4.5 | 322 | PDNWP T502 | 42.7 | DW | Participating |
| P0431 | PDN Participating Receptor | 4.5 | 554 | PDNWP T548 | 41.7 | CW | Participating |
| P0204 | PDN Participating Receptor | 4.5 | 611 | PDNWP T524 | 40.6 | CW | Participating |
| P0443 | PDN Participating Receptor | 4.5 | 515 | PDNWP T546 | 40.4 | CW | Participating |
| P0196 | PDN Participating Receptor | 4.5 | 592 | PDNWP T524 | 40.3 | CW | Participating |
| P1402 | PDN Participating Receptor | 4.5 | 563 | PDNWP T507 | 40.2 | CW | Participating |
| P0228 | PDN Participating Receptor | 4.5 | 587 | PDNWP T535 | 40.2 | CW | Participating |
| P0459 | PDN Participating Receptor | 4.5 | 560 | PDNWP T546 | 40.2 | CW | Participating |
| R0193 | Residence | 4.5 | 564 | PDNWP T523 | 40.0 | CW | Poor wind direction |
| R0159 | Residence | 4.5 | 586 | PDNWP T521 | 40.0 | UW | Poor wind direction |
| V2824 | Vacant Lot | 4.5 | 573 | PDNWP T546 | 40.0 | CW | Poor wind direction |
| V2823 | Vacant Lot | 4.5 | 617 | PDNWP T546 | 40.0 | CW | Poor wind direction |
| R1165 | Residence | 4.5 | 667 | PDNWP TR101 | 39.9 | CW | Poor wind direction |
| R0203 | Residence | 4.5 | 646 | PDNWP T525 | 39.9 | DW | Previously measured, high ambient noise |
| R0211 | Residence | 1.5 | 631 | PDNWP T524 | 39.9 | CW | Poor wind direction |
| R0214 | Residence | 1.5 | 650 | PDNWP T524 | 39.9 | CW | Poor wind direction |

| Receptor ID | Receptor Type | Height | Distance from Receptor to Source (m) | Nearest Turbine | Predicted Impact (Assessment) | Wind Direction | Added notes |
|---|---|---|---|---|---|---|---|
| R0088 | Residence | 4.5 | 391 | PDNWP TR101 | 39.8 | CW | Poor wind direction |
| R0191 | Residence | 4.5 | 660 | PDNWP T524 | 39.8 | CW | Poor wind direction |
| R0126 | SWEC Participating Receptor | 4.5 | 581 | SWEC T061 | 39.8 | CW | Poor wind direction, nearest turbine not PDN |
| R0218 | Residence | 4.5 | 564 | PDNWP T529 | 39.8 | CW | Poor wind direction |
| R1295 | Residence | 1.5 | 573 | PDNWP T409 | 39.8 | UW | Poor wind direction |
| R1394 | Residence | 4.5 | 616 | PDNWP T506 | 39.7 | CW | Poor wind direction |
| R3312 | Residence | 4.5 | 559 | PDNWP T524 | 39.7 | UW | Poor wind direction |
| R0217 | Residence | 4.5 | 582 | PDNWP T529 | 39.7 | CW | Poor wind direction |
| R0463 | Residence | 4.5 | 638 | PDNWP T546 | 39.7 | CW | Poor wind direction |
| R0003 | Residence | 4.5 | 601 | SWEC T020 | 39.6 | CW | Poor wind direction, nearest turbine not PDN |
| R0197 | Residence | 4.5 | 593 | PDNWP T523 | 39.6 | CW | Poor wind direction |
| R0219 | Residence | 4.5 | 661 | PDNWP T533 | 39.6 | CW | Poor wind direction |
| V2617 | Vacant Lot | 4.5 | 588 | PDNWP T506 | 39.6 | CW | Poor wind direction |
| V2683 | Vacant Lot | 4.5 | 548 | PDNWP T517 | 39.6 | CW | Poor wind direction |
| R0444 | Residence | 4.5 | 551 | SWEC T026 | 39.5 | CW | Poor wind direction, nearest turbine not PDN |
| P1405 | PDN Participating Receptor | 4.5 | 500 | PDNWP T507 | 39.5 | CW | Participating |
| V2615 | Vacant Lot | 4.5 | 412 | PDNWP TR101 | 39.5 | UW | Poor wind direction |
| P0238 | PDN Participating Receptor | 4.5 | 627 | PDNWP T535 | 39.5 | CW | Participating |
| V2825 | Vacant Lot | 4.5 | 708 | PDNWP T546 | 39.5 | CW | Poor wind direction |

| Receptor ID | Receptor Type | Height | Distance from Receptor to Source (m) | Nearest Turbine | Predicted Impact (Assessment) | Wind Direction | Added notes |
|---|---|---|---|---|---|---|---|
| R0438 | Residence | 1.5 | 564 | PDNWP T546 | 39.5 | CW | Poor wind direction |
| P1433 | PDN Participating Receptor | 4.5 | 421 | PDNWP T511 | 39.4 | DW | Participating |
| V2822 | Vacant Lot | 4.5 | 764 | PDNWP T548 | 39.4 | CW | Poor wind direction |
| R0186 | Residence | 4.5 | 683 | PDNWP T524 | 39.4 | CW | Poor wind direction |
| R1385 | Residence | 4.5 | 562 | PDNWP T505 | 39.4 | CW | Poor wind direction |
| R1272 | Residence | 4.5 | 566 | PDNWP T401 | 39.4 | CW | Poor wind direction |
| R0487 | Residence | 4.5 | 615 | PDNWP T552 | 39.3 | DW | Selected Receptor |
| R0099 | Residence | 4.5 | 812 | SWEC T059 | 39.3 | CW | Poor wind direction, nearest turbine not PDN |
| V2616 | SWEC Participating Vacant Lot | 4.5 | 761 | SWEC T004 | 39.3 | CW | Poor wind direction, nearest turbine not PDN |
| R0081 | Residence | 4.5 | 783 | SWEC T015 | 39.3 | CW | Poor wind direction, nearest turbine not PDN |
| V2685 | Vacant Lot | 4.5 | 653 | PDNWP T518 | 39.3 | CW | Poor wind direction |
| R0206 | Residence | 1.5 | 639 | PDNWP T528 | 39.3 | CW | Poor wind direction |
| R0227 | Residence | 1.5 | 572 | PDNWP T534 | 39.3 | CW | Poor wind direction |
| R0222 | Residence | 1.5 | 555 | PDNWP T533 | 39.3 | CW | Poor wind direction |
| R0067 | Residence | 4.5 | 750 | SWEC T004 | 39.2 | CW | Poor wind direction, nearest turbine not PDN |
| R0182 | SWEC Participating Receptor | 4.5 | 643 | PDNWP T523 | 39.2 | CW | Poor wind direction |
| R0241 | Residence | 4.5 | 560 | PDNWP T533 | 39.2 | DW | High ambient noise |

| Receptor ID | Receptor Type | Height | Distance from Receptor to Source (m) | Nearest Turbine | Predicted Impact (Assessment) | Wind Direction | Added notes |
|---|---|---|---|---|---|---|---|
| R0488 | Residence | 4.5 | 686 | PDNWP T552 | 39.2 | DW | Redundant to R487 |
| R0441 | Residence | 4.5 | 618 | PDNWP T550 | 39.1 | CW | Poor wind direction |
| R0002 | SWEC Participating Receptor | 4.5 | 802 | SWEC T020 | 39.1 | CW | Poor wind direction, nearest turbine not PDN |
| R0418 | Residence | 4.5 | 793 | PDNWP T548 | 39.1 | CW | Poor wind direction |
| R1308 | Residence | 4.5 | 587 | PDNWP T408 | 39.1 | CW | Poor wind direction |
| V2490 | Vacant Lot | 4.5 | 725 | SWEC T012 | 39.1 | CW | Poor wind direction, nearest turbine not PDN |
| R0125 | Residence | 4.5 | 681 | SWEC T061 | 39.0 | CW | Poor wind direction, nearest turbine not PDN |
| R0234 | Residence | 4.5 | 576 | PDNWP T536 | 39.0 | CW | Poor wind direction |
| R1168 | Residence | 4.5 | 758 | PDNWP T548 | 39.0 | CW | Poor wind direction |
| R1765 | Residence | 4.5 | 750 | SWEC T012 | 39.0 | CW | Poor wind direction, nearest turbine not PDN |
| V2491 | Vacant Lot | 4.5 | 751 | SWEC T012 | 39.0 | CW | Poor wind direction, nearest turbine not PDN |
| R0233 | Residence | 1.5 | 639 | PDNWP T533 | 39.0 | CW | Poor wind direction |
| R0401 | Residence | 4.5 | 579 | PDNWP T541 | 38.9 | CW | Poor wind direction |
| R0430 | SWEC Participating Receptor | 4.5 | 688 | SWEC T026 | 38.9 | UW | Poor wind direction, nearest turbine not PDN |
| V2744 | SWEC Participating Vacant Lot | 4.5 | 695 | PDNWP T523 | 38.9 | CW | Poor wind direction |

| Receptor ID | Receptor Type | Height | Distance from Receptor to Source (m) | Nearest Turbine | Predicted Impact (Assessment) | Wind Direction | Added notes |
|---|---|---|---|---|---|---|---|
| R0189 | Residence | 4.5 | 600 | PDNWP T523 | 38.9 | CW | Poor wind direction |
| V2403 | Vacant Lot | 4.5 | 698 | PDNWP T407 | 38.9 | CW | Poor wind direction |
| R0173 | Residence | 4.5 | 756 | PDNWP T518 | 38.9 | CW | Poor wind direction |
| V2733 | Vacant Lot | 4.5 | 555 | PDNWP T540 | 38.9 | UW | Poor wind direction |
| V2408 | Vacant Lot | 4.5 | 551 | PDNWP T414 | 38.9 | CW | Poor wind direction |
| R0469 | Residence | 1.5 | 677 | PDNWP T546 | 38.9 | CW | Poor wind direction |
| V2810 | Vacant Lot | 4.5 | 693 | PDNWP T541 | 38.8 | CW | Poor wind direction |
| R0294 | Residence | 4.5 | 602 | PDNWP T536 | 38.8 | CW | Poor wind direction |
| R0295 | Residence | 4.5 | 608 | PDNWP T536 | 38.8 | CW | Poor wind direction |
| V2808 | SWEC Participating Vacant Lot | 4.5 | 639 | SWEC T026 | 38.8 | CW | Poor wind direction, nearest turbine not PDN |
| R0403 | Residence | 4.5 | 723 | PDNWP T541 | 38.8 | CW | Poor wind direction |
| R0483 | Residence | 4.5 | 697 | PDNWP T554 | 38.8 | CW | Poor wind direction |
| R1314 | Residence | 1.5 | 572 | PDNWP T409 | 38.8 | CW | Poor wind direction |
| R0457 | Residence | 1.5 | 594 | PDNWP T546 | 38.8 | CW | Poor wind direction |
| V2811 | Vacant Lot | 4.5 | 750 | PDNWP T541 | 38.7 | CW | Poor wind direction |
| V2307 | Vacant Lot | 4.5 | 623 | PDNWP T408 | 38.7 | CW | Poor wind direction |
| V2614 | Vacant Lot | 4.5 | 483 | PDNWP TR101 | 38.7 | UW | Poor wind direction |
| V2306 | Vacant Lot | 4.5 | 636 | PDNWP T408 | 38.6 | CW | Poor wind direction |
| V2308 | Vacant Lot | 4.5 | 623 | PDNWP T408 | 38.6 | CW | Poor wind direction |
| V2309 | Vacant Lot | 4.5 | 622 | PDNWP T408 | 38.6 | CW | Poor wind direction |
| V2310 | Vacant Lot | 4.5 | 623 | PDNWP T408 | 38.6 | CW | Previously measured, high ambient noise |

| Receptor ID | Receptor Type | Height | Distance from Receptor to Source (m) | Nearest Turbine | Predicted Impact (Assessment) | Wind Direction | Added notes |
|---|---|---|---|---|---|---|---|
| R1374 | Residence | 4.5 | 561 | PDNWP T501 | 38.6 | UW | Poor wind direction |
| R0246 | Residence | 4.5 | 744 | PDNWP T535 | 38.6 | CW | Poor wind direction |
| V2311 | Vacant Lot | 4.5 | 626 | PDNWP T408 | 38.6 | CW | Poor wind direction |
| V2312 | Vacant Lot | 4.5 | 629 | PDNWP T408 | 38.6 | CW | Poor wind direction |
| R0124 | SWEC Participating Receptor | 4.5 | 592 | SWEC T061 | 38.6 | CW | Poor wind direction, nearest turbine not PDN |
| R0166 | Residence | 4.5 | 631 | PDNWP T523 | 38.5 | CW | Poor wind direction |
| P0307 | PDN Participating Receptor | 4.5 | 572 | PDNWP T538 | 38.5 | CW | Participating |
| V2313 | Vacant Lot | 4.5 | 634 | PDNWP T408 | 38.5 | CW | Poor wind direction |
| V2698 | Vacant Lot | 4.5 | 571 | PDNWP T527 | 38.5 | CW | Poor wind direction |
| R0413 | Residence | 4.5 | 691 | PDNWP T541 | 38.5 | DW | High ambient noise |
| R0409 | Residence | 4.5 | 792 | PDNWP T540 | 38.5 | CW | Poor wind direction |
| R0303 | Residence | 4.5 | 754 | PDNWP T537 | 38.5 | DW | Declined land access |
| V2727 | Vacant Lot | 4.5 | 626 | PDNWP T558 | 38.5 | DW | Declined land access |
| R0188 | Residence | 1.5 | 793 | PDNWP T524 | 38.5 | CW | Poor wind direction |
| R0471 | Residence | 1.5 | 689 | PDNWP T554 | 38.5 | CW | Poor wind direction |
| R1284 | Residence | 1.5 | 670 | PDNWP T407 | 38.5 | CW | Poor wind direction |
| R0433 | Residence | 1.5 | 570 | PDNWP T543 | 38.5 | CW | Poor wind direction |
| R1383 | Residence | 4.5 | 606 | PDNWP T503 | 38.4 | CW | Poor wind direction |
| V2314 | Vacant Lot | 4.5 | 646 | PDNWP T408 | 38.4 | CW | Poor wind direction |
| R1337 | Residence | 4.5 | 599 | PDNWP T413 | 38.4 | CW | Poor wind direction |
| P0209 | PDN Participating Receptor | 4.5 | 644 | PDNWP T527 | 38.4 | CW | Participating |

| Receptor ID | Receptor Type | Height | Distance from Receptor to Source (m) | Nearest Turbine | Predicted Impact (Assessment) | Wind Direction | Added notes |
|---|---|---|---|---|---|---|---|
| R0117 | Residence | 4.5 | 751 | SWEC T061 | 38.4 | UW | Poor wind direction, nearest turbine not PDN |
| R0033 | Residence | 4.5 | 781 | SWEC T003 | 38.3 | CW | Poor wind direction, nearest turbine not PDN |
| V2684 | Vacant Lot | 4.5 | 568 | PDNWP T519 | 38.3 | UW | Poor wind direction |
| V2814 | Vacant Lot | 4.5 | 694 | SWEC T026 | 38.3 | CW | Poor wind direction, nearest turbine not PDN |
| R0122 | Residence | 4.5 | 592 | PDNWP T513 | 38.3 | DW | High ambient noise |
| V2699 | Vacant Lot | 4.5 | 606 | PDNWP T532 | 38.3 | CW | Poor wind direction |
| V2730 | Vacant Lot | 4.5 | 670 | PDNWP T536 | 38.3 | CW | Poor wind direction |
| R0322 | Residence | 1.5 | 557 | PDNWP T558 | 38.3 | DW | High ambient noise |
| R0025 | Residence | 1.5 | 558 | SWEC T014 | 38.3 | DW | High ambient noise, nearest turbine not PDN |
| P0477 | PDN Participating Receptor | 1.5 | 575 | PDNWP T554 | 38.3 | CW | Participating |
| V2820 | Vacant Lot | 4.5 | 754 | PDNWP T540 | 38.2 | DW | Selected Receptor |

## End of Report