Acoustic Immission Audit – RAM I-Audit

Napier Wind Project

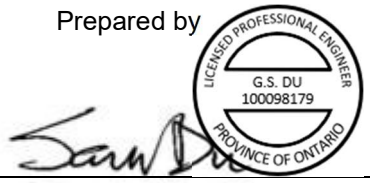
27904 Brown Road
Adelaide Metcalfe Township
County of Middlesex

January 22, 2021
Project: 118-0338-100

Prepared for

SWNS Wind LP

Prepared by



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VALCOUSTICS
Canada Ltd.

Version History

Version #	Date	Comments
1.0	December 18, 2020	Final to client and MECP
2.0	January 22, 2021	Revision to Address Review Comments

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Acoustic Immission Audit –RAM I-Audit

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EXECUTIVE SUMMARY

Valcoustics Canada Ltd. was retained by wpd Napier Wind Inc. to conduct the acoustic audit required in Section E of the Renewable Energy Approval ("REA") for the Napier Wind Project ("NAPWP") REA #8388-9B7N4J, dated December 3, 2013. Condition E1 of the REA requires the acoustic immission audits (I-Audit) to be performed on two separate occasions.

Acoustic imission audits were carried out in three sessions. We have completed the analyses for each of the three sessions of the measurement campaigns as well as combing all three sessions of the measurement data.

Valcoustics Canada Ltd. followed the appropriate recommendations contained in an email dated November 7, 2017, from Mohsen Keyvani, P.Eng., Manager of Renewable Energy at the Ministry of the Environment, Conservation and Parks (MECP), to Jonathan Clifford, Operations Manager, wpd Canada Ltd. The email describes the required steps and milestones following the implementation of the Noise Abatement Action Plan recommended by Aercoustics Engineering Ltd. and approved by the MECP.

The previous reports pertinent to the acoustic audit done by Valcoustics Canada Ltd. are:

1. MM92, Standard, 93129 / T01 Napier Wind Project, Results of Acoustic Noise Measurements According to ICE 61400-11 Edition 3.0, prepared by DNV GL, dated March 8, 2019.
2. Napier Wind Project, Phase 1 Acoustic Immission Audit, prepared by Aercoustics Engineering Ltd., dated February 28, 2017.
3. Napier Wind Project, Phase 2 Acoustic Immission Audit, prepared by Aercoustics Engineering Ltd., dated July 31, 2017.
4. Noise Abatement Action Plan – Napier Wind Project (REA #8388-9B7N4J), prepared by Aercoustics Engineering Ltd., dated October 16, 2017.
5. Acoustic Imission Audit – Phase 1, Napier Wind Project, prepared by Valcoustics Canada Ltd., dated March 20, 2019.

6. Noise Assessment Report, Napier Wind Project, prepared by Howe Gastmeier Chapnik Limited, Dated September 20, 2013.

Sound (and wind) measurements of the I-Audit were carried out in three sessions in Fall of 2018 (Phase 1A), Spring of 2019 (Phase 2A), and Spring of 2020 (Phase 2B) at a location in the vicinity of Receptor R020 in the Acoustic Assessment Report (AAR) done for the REA application. The acoustic audit was done in accordance with Parts D and E of the Compliance Protocol for Wind Turbine Noise. The combined I-Audit results indicated that noise from the Napier wind farm is in compliance with the applicable sound level limits.

1.0 INTRODUCTION

Valcoustics Canada Ltd. previously prepared an Acoustic Immission Audit – Phase 1 report dated March 20, 2019, and Acoustic Immission Audit – Phase 1 (RAM-I) report dated October 7, 2019 (herein referred to as the Phase 1A reports) as required in Section E1 of the Renewable Energy Approval ("REA") for the Napier Wind Project ("NAPWP") REA #8388-9B7N4J, dated December 3, 2013.

After submission of the Phase 1A reports, we had a meeting with the MECP Noise Approvals branch on February 27, 2020, to discuss the review comments on the Phase 1A reports and the challenges to collect sufficient valid data points/intervals for this particular wind project as per the MECP Compliance Protocol and the measurement procedures that could be used for the future measurement campaign. This was summarized in our letter dated April 6, 2020.

As a result of the February 27, 2020 meeting, a measurement campaign was done between April 27 and July 26, 2020 (herein referred to as the Phase 2B I-Audit) in accordance with the measurement procedures outlined in our April 6, 2020 letter.

As of to-date, a total of three (3) separate I-Audit measurement campaigns were conducted to satisfy condition E1 of the REA. However, multiple factors caused significant challenges to collect complete datasets at the receptor location. Contributing factors include prevailing wind direction at the subject site and electrical power filter as required by the MECP compliance protocol. In this case, the audit receptor is to the south of the closest wind turbine while the prevailing wind is in the south direction (i.e., the receptor is in the upwind direction) making it difficult to satisfy the downwind filter as required by the MECP compliance protocol. Additionally, in accordance with the MECP protocol, a data interval is considered valid only when the electrical power output from the closest wind turbine is not less than 85% of the maximum rated power of the turbine. This filter applies to all the wind speed bins. As expected, under a typical weather condition, the electrical power output from the turbine at lower wind speeds is less than the power criterion. In order to satisfy this filter, the wind shear needs to be very high at the lower wind speeds making it difficult to collect sufficient valid data intervals at the lower wind speed bins. As shown in the analysis result tables below, no valid data intervals were retained in the wind speed bins from 1 m/s to 3 m/s for the turbine on the scenario. There were only a few data points retained at the 4 m/s wind speed bin. As such, conference calls with the MECP occurred on November 18th and 25th, 2020 to discuss the challenges of getting complete datasets as well as the preliminary analysis results of the Phase 2B I-Audit. As a result of the conference calls, the analysis parameters were further refined in an effort to retain enough valid data intervals/points in order to determine the compliance status of the wind project. The analysis parameters were summarized in an email dated December 4, 2020 to the MECP and was confirmed/accepted by the MECP on December 4, 2020. Subsequently, an Acoustic Immission Audit –RAM-I Audit report

dated December 18, 2020 was submitted to the MECP outlining the measurement campaigns, data analysis details and results of the I-Audit.

This report is to address review comments from the MECP on the December 18, 2020 report and to provide additional analysis details.

2.0 FACILITY DESCRIPTION

The NAPWP is a Class 4 wind facility consisting of two (2) REpower MM92 wind turbine generators (WTG) with a total nameplate capacity of 4.1 MW. The hub height of each WTG is 100 meters above grade. The facility operates 24 hours per day, 7 days per week.

There is a wind farm – the NextEra Energy Adelaide Wind Energy Centre (herein referred to as the Adelaide Project) – adjacent to the NAPWP. The closest Adelaide Project wind turbines are approximately 800 m from the NAPWP turbines.

Figure 1 shows an overall site plan taken from the AAR.

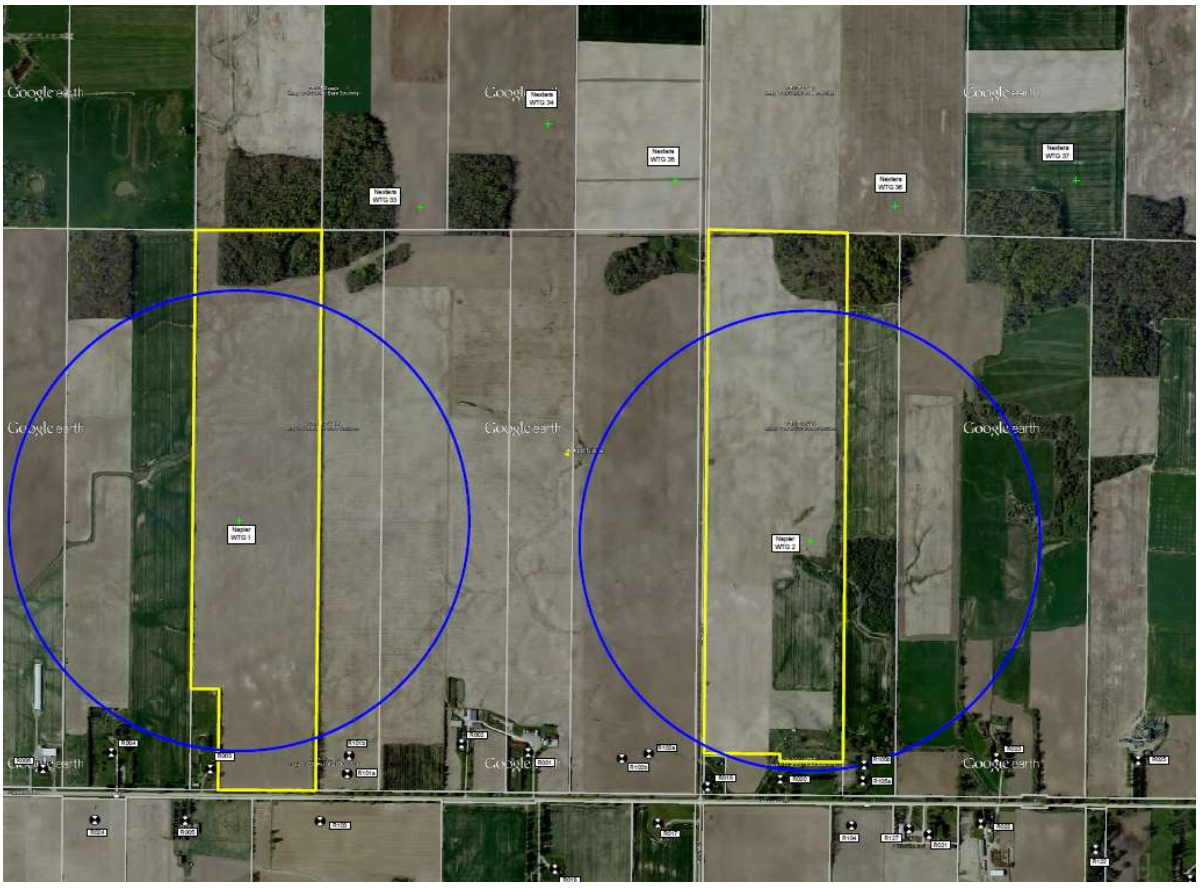

FIGURE 1: OVERALL SITE PLAN

3.0 REA REQUIREMENTS

3.1 NOISE PERFORMANCE LIMITS

Section C1 (1) of the REA requires that the sound levels from the wind turbines shall comply with the sound level limits set in the Noise Guidelines for Wind Farms, as applicable. The sound level limits are summarized in Table 1.

TABLE 1: NOISE PERFORMANCE LIMITS

Wind Speed (m/sec) at 10 m Height	≤6	7	8	9	10
Sound Level Limits (dBA)	40	43	45	49	51

3.2 ACOUSTIC IMMISSION AUDIT

Section E.1(2) of the REA requires that the acoustic audit measurements shall be performed by an Independent Acoustical Consultant at one (1) Point of Reception that has been selected using the following criteria:

a) the Point of Reception should represent the location of the greatest predicted noise impact, i.e., the highest predicted Sound Level; and

b) the Point of Reception should be located in the direction of prevailing winds from the Facility.

In addition, Section E.1(3) of the REA requires that acoustic measurements shall be performed on two (2) separate occasions. This was also requested in an email dated November 7, 2017, from Mohsen Keyvani, P.Eng., Manager of Renewable Energy at the MECP, to Jonathan Clifford, Operations Manager, wpd Canada Ltd.

4.0 COMPLIANCE PROTOCOL

The Compliance Protocol outlines several data filtering/reduction options in Parts D and E. The Compliance Protocol is summarized briefly below.

4.1 PART D OF COMPLIANCE PROTOCOL

4.1.1 Data Filtering Procedures

Section D5.2 of the Compliance Protocol outlines the data filtering/reduction procedures. These are summarized below.

1) Intervals must be measured between 2200 and 0500 hours (i.e., nighttime only);

2) Rainfall must not have occurred within at least one hour of the measurement interval;

3) The objective value for the standard deviation of the sound level in each relevant wind speed bin is 2 dB. If the standard deviation exceeds 2 dB, then an acceptable explanation/justification should be documented in the audit report.

4) The measurement location shall be downwind from the closest wind turbine, i.e., ±45 degrees from the line of sight between the wind turbine and the audit receptor. The downwind direction should be based on the yaw angle of the turbine.

5) The closest wind turbine shall produce at least 85% of its rated power output.

Note that additional filters can be considered, such as the removal of individual events where the signal-to-noise ratio is low. This additional filtering should be discussed with Ministry staff to ensure that the data would be accepted.

It should also be noted that filters 3 to 5 do not apply to the background ambient sound measurements when the wind turbines are parked.

4.1.2 Sample Size Requirement

Section D3.8 of the Compliance Protocol establishes the data set sample size requirements.

For the turbine on the scenario, no less than 120 one-minute intervals are required to be measured for each integer wind speed bin (within ±0.5 m/s) for the data set to be considered large enough to conduct the analysis. In an audit scenario, this amount of data is required between 4 – 7 m/s integer wind speeds inclusively (10 m height).

For the turbine parked scenario, no less than 60 one-minute intervals are required to be measured for each integer wind speed bin (within ±0.5 m/s) for the ambient noise level to be determined.

4.2 REVISED ASSESSMENT METHODOLOGY ANALYSIS – RAM-I

If the data reduction procedures in Part D of the Compliance Protocol make it impossible to conduct an assessment in a reasonable amount of time, the MECP has provided an alternative assessment methodology – the Revised Assessment Methodology (“RAM-I”) – intended to provide alternative assessment methods to enable an assessment of compliance to be completed. Section E5.5 Option 3 of the Compliance Protocol outlines details of the RAM-I procedure and summarized below.

- 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).
- The owner/operator of the wind facility will be required to verify that all wind turbines and transformers within the facility are operating within the manufacturer's performance parameters (i.e. there are no maintenance issues).
- Only downwind data will be considered in the analysis. With reference to the Turbine location, downwind directions are ±45 degrees from the line of sight between the Turbine and receptor/measurement location. The downwind direction should be based on the yaw angle of the Turbine. In addition, the receptor anemometer wind direction and wind speed (at a 10 m height) should also be reported.

- The analysis should only be based on data when the Turbine's sound power level is approximately equal to or greater than 85% of its rated electrical power output and at least 90% of its maximum sound power level.
- If the measurement campaign is unable to acquire the minimum number of ambient sound level data, the owner/operator of the wind facility will be permitted to use one of the provisions described below:
    a) use the ambient sound level data from a lower wind speed bin to represent a higher wind speed bin (i.e. if 6 m/s data is unavailable, the owner/operator is permitted to use 5 m/s data to represent the 6 m/s data bin), or
    b) use a value of 30 dBA.
- The Ministry will permit the data filtering criterion as noted in Section 4.1 above to be modified as noted below:

  The objective value for the standard deviation of the sound level in each relevant wind speed bin (comprised of the mean of the one (1) minute equivalent sound level measurements) is 2 dB, with the exceptions of wind speed bins 6 and 7 m/s which should not exceed 2.5 dB.

- All measurements should be taken at least 5 m from any objects (e.g., trees, cars, trailers, etc.). Where impractical, documentation must be included in the report to support the chosen measurement location.

- In unique circumstances, the Ministry will consider not only the individual turbine with the highest predicted impact at the subject receptor but a group of turbines that represent the greatest contribution at the receptor. Greatest contribution means turbines that have sound pressure levels that are up to two (2) dB lower at the receptor/measurement location than the turbine with the highest predicted impact at the receptor/measurement location.

  In addition, with reference to the measurement location (vertex), only turbine configurations that are within an angle of 90 degrees can be considered in the assessment.

- At a minimum, the analysis should be based on six (6) weeks of measurements unless the required data is obtained in less time.

  In the event that the required data is not acquired within six (6) weeks of measurements, then on a case-by-case basis, the Ministry may permit appropriate (statistical) data analysis, where necessary to derive valid conclusions (i.e., statement of compliance), in accordance with good scientific data analysis techniques.
- 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).
- The Ministry, on a case-by-case basis, may also accept sound level measurements based on a shorter averaging time, for all data points in all wind speed bins, rather than the

current one (1) minute averaging time (minimum interval 10 seconds). However, in such cases, the equivalent data set should be comprised of:

a) a minimum of 120 minutes of data per wind speed bin for the turbine operational measurements, and

b) 60 minutes of data per wind speed bin when the turbines are parked.

4.3 TONALITY ANALYSIS

Section D3.8.3 of the Compliance Protocol indicates that if there is a concern regarding the tonal nature of the turbine (or wind facility) noise, tonality analysis should be considered. Such analysis may be triggered if there is observed continuous tonal sound from the turbine or if the turbine manufacturer's noise test report shows tonal audibility ($\Delta L_{a,k}$) to be a positive value greater than 3 dB.

In the event that tonality measurements are carried out or analyzed, for each integer wind speed at least five one-minute intervals are required for wind turbine noise and background noise (wind turbines parked). The wind speed during these intervals shall be as close as possible to the integer wind speed.

The tonality assessment should be conducted in accordance with the procedures in IEC 61400-11-07, or at the Director's discretion, compliant with another equivalent standard/procedure.

Section E5.1 of the Compliance Protocol indicates that if a tonal assessment indicates a tonal audibility value that exceeds 4 dB, the Ministry will require that a tonal penalty be applied at all Receptors in accordance with the penalties described in Annex C of ISO 1996-2.

5.0 ACOUSTIC IMMISSION MEASUREMENT

5.1 MEASUREMENT PHASES

I-Audit measurements were carried out in three independent campaigns as follows:

- Phase 1A – over a period of approximately two and half months between October 14, 2018, and January 4, 2019.
- Phase 2A – over a period of approximately three and half months between April 10, 2019, and August 1, 2019.
- Phase 2B – over a period of three months between April 27, 2020, and July 26, 2020.

5.2 ACOUSTIC AUDIT LOCATION

In accordance with the REA requirements, the acoustic audit measurement campaigns were done at a location close to Receptor R020 with UTM coordinates of (17T 441366 m Easting and 4756200 m Northing). The UTM coordinates of the measurement location are (17T 441373 m Easting, 4756261 m Northing). Figure 2 shows the audit location and the WTG locations.

FIGURE 2: MEASUREMENT LOCATION

5.3 MEASUREMENT EQUIPMENT

The test equipment used in the measurement campaigns is summarized in Table 2.

TABLE 2: TESTING EQUIPMENT

Measurement Campaign	Equipment	Qty	Make & Model	Serial No.	Calibration Date	Calibration Expiry Date
Phase 1A	Sound Level Meter	1	Norsonic 140	1404671	Feb. 22, 2018	Feb. 22, 2019
	Microphone	1	Norsonic 1227	142243	Mar. 7, 2018	Mar. 7, 2019
	Microphone PreAmp	1	Norsonic 1209	13992	Mar. 7, 2018	Mar. 7, 2019
	Acoustic Calibrator	1	Brüel & Kjær 4231	2309067	Dec. 17, 2018	Dec. 17, 2019
	Anemometer	1	R.M. Young 05103-0	WM124098	Sept. 12, 2018	Sept. 12, 2019
	Leaf Wetness Sensor	1	Decagon LWS-1	161772	--	--
Phase 2A	Sound Level Meter	1	Norsonic 140	1404670	Mar. 28, 2019	Mar. 28, 2020
	Microphone	1	Norsonic 1227	142316	Mar. 28, 2019	Mar. 28, 2020
	Microphone PreAmp	1	Norsonic 1209	14464	Mar. 28, 2019	Mar. 28, 2020
	Acoustic Calibrator	1	Brüel & Kjær 4231	2309067	Dec. 17, 2018	Dec. 17, 2019
	Anemometer	1	R.M. Young 05103-0	WM124098	Sept. 12, 2018	Sept. 12, 2019
	Leaf Wetness Sensor	1	Decagon LWS-1	161772	--	--
Phase 2B	Sound Level Meter(1)	1	Norsonic 1531	15313538	Nov. 23, 2018	Nov. 23, 2020
	Microphone(1)	1	Norsonic 1227	332148	Nov. 21, 2018	Nov. 21, 2020
	Microphone PreAmp(1)	1	Norsonic 1209A	12525	Nov. 23, 2018	Nov. 23, 2020
	Acoustic Calibrator	1	Brüel & Kjær 4231	2309067	Dec. 18, 2019	Dec. 18, 2020
	Anemometer	1	R.M. Young 05103-0	WM124098	Mar. 2, 2020	Mar. 2, 2021
	Leaf Wetness Sensor	1	Decagon LWS-1	161772	--	--

Note:

1) Calibration interval of the sound measurement equipment is two years as per the manufacturer's specifications.

The sound level meter was field calibrated prior to the measurement campaign and recalibrated every 4 to 6 weeks using an acoustic calibrator. The microphone was equipped with a primary windscreen (90 mm in diameter) and a secondary windscreen with a diameter of approximately 490 mm.

The sound measurements were taken at a height of 4.5 m above grade while the wind measurements were taken at a height of 10 m above grade. The measurement setup was more than 5 m away from any reflecting surfaces.

Figure 3 shows a photo of the equipment setup. The closest wind turbine in Figure 3 is part of NAPWP. The more distant wind turbines are part of the Adelaide Project.

FIGURE 3: MEASUREMENT SETUP

5.4 MEASUREMENT PARAMETERS

Measurements were made over a period of approximately three months in each phase near Receptor R020 identified in the Noise Assessment Report (herein referred to as the NAR). Based on the manufacturers' environmental specifications, all the measurement equipment described above are appropriate for use during the measurement campaigns.

During the measurement campaigns, sound and wind data were logged simultaneously at 1-minute intervals for Phase 1A and 2A, and at 10-second intervals for Phase 2B.

Various acoustical parameters were measured: A-weighted energy equivalent sound levels (L_{Aeq}), various percentile statistical levels (L_1, L_5, L_{10}, L_{50}, L_{90}, L_{95} and L_{99}), and 1/3 octave band sound levels between 20 Hz and 20,000 Hz. Audio recordings were made for listening and post-processing.

The weather data included wind direction, wind speed, and minimum and maximum wind speeds for each time interval. In addition, the leaf wetness sensor was also used to determine if there was any precipitation/rain for each time interval.

6.0 ACOUSTIC IMMISSION DATA ANALYSIS PROCEDURES

The analysis procedures considered in order to determine compliance for the wind farm are discussed below.

6.1 DATA FILTERING/REDUCTION

The data filters discussed below are generally compliant with the MECP compliance protocol with minor revisions to the electrical power filter and the downwind filter in an effort to retain sufficient valid data intervals to assess the compliant status of the wind project. These minor revisions were approved/accepted by the MECP as indicated in Section 1.0 above.

6.1.1 Turbines-On Scenario

Based on various discussions with the MECP, the following filters were applied for turbine-on scenario:

1) Measurement time filter: Intervals between 2200 and 0500 hours. Daylight saving adjustment was applied wherever applicable.
2) Wind filter: Downwind from the closest wind turbine. The downwind directions were expanded to ±49.5 degrees from the line of sight between the turbine and the measurement location for windspeed bins from 1m/s to 5m/s in an effort to retain sufficient valid data intervals/points.

   To compensate for the increased angle, an adjustment of +0.17 dBA was applied to the turbine only sound levels based on a linear interpolation between 0 dBA adjustment at 0-degree angle increase and +3 dBA adjustment at 90-degree angle increase. For windspeed bins 6m/s and 7m/s, the downwind directions were maintained at ±45 degrees as in the MECP protocol and therefore no adjustment was applied to the turbine only sound levels.
3) Precipitation filter: No rain or snow within one hour of the interval.

4) Turbine output filter: The closest turbine at 90% of the sound emission level (i.e., 1727 kW), instead of 85% of the maximum rated power. This is based on a curve fit to the measured electrical power output and the measured sound emission (power) levels included in the DNV GL E-Audit report. The calculation details are included in Appendix D.
5) Standard deviation: No more than 2.0 for Section D method for all wind speeds.

6.1.2 Turbines-Parked Scenario

The following filters were applied for the turbines-parked scenario:

1) Measurement time filter: Intervals between 2200 and 0500 hours. Daylight saving adjustment was applied wherever applicable.
2) Precipitation filter: No rain or snow within one hour of the interval.
3) Turbine output filter: The closest turbine parked with power output less than 0.5 kW.
4) Standard deviation: No more than 2.0 for Section D method for all wind speeds.

6.2 DATA BINNING

In accordance with the Compliance Protocol, the valid measurement intervals, after the above data filtering/reduction procedures, were sorted into integer wind speed bins based on the measured wind speeds at 10 m height. Each wind speed bin includes wind speeds from 0.5 m/s below to 0.5m/s above each integer wind speed (e.g., the 4 m/s wind speed bin includes all intervals with average wind speeds between 3.5 m/s and 4.499 m/s). The binning method was applied to both turbine-on and turbine parked-scenarios.

6.3 AUDIO RECORDING REVIEW

In order to further reduce the influence from local activities such as airplanes, trains, traffic, etc., we reviewed the audio recordings for the data intervals with sound levels greater than the arithmetic mean value of each wind speed bin. The data interval was excluded if there was noticeable interference in the audio recording for that interval. This was done for all wind speed bins.

6.4 TONALITY ANALYSIS

The emission test results outlined in the "*Results of Acoustic Noise Measurements According to IEC 61400-11 Edition 3.0*" report dated March 8, 2019, prepared by GL Garrad Hassan Deutschland GmbH (herein referred to as the Emission Test Report), concluded that "*The values of measured Tonal audibility ΔLa,k [dB] shown in annex Figure 10.33 do not comply with the maximum tonal audibility values noted in the Acoustic Assessment Report. The tonal audibility also exceeds the 2017 Ontario Compliance Protocol allowable value of 3 dB.*" Thus, tonality analyses were done for all the valid data interval.

6.5 ADJUSTMENT FOR THE ADELAIDE PROJECT

The NAR indicated that the Adelaide Project is within 1500 m of the Napier Wind Project. Table A4 of the NAR indicated that the cumulative sound level (i.e., the Napier Wind Project and the Adelaide Project) at receptor R020 is 38.7 dBA. Table A5 of the NAR indicated that the sound

level from the Napier Wind Project alone at receptor R020 is 37.4 dBA. Based on this, the sound level at R020 due to the Adelaide Project is determined to be 32.8 dBA.

Since the operating status of the Adelaide Project was not known during the background ambient sound tests for the Napier Wind Project, it is assumed that the Adelaide Project was fully operational during the background ambient testing and the sound level contribution (i.e., 32.8 dBA) from the Adelaide Project was subtracted logarithmically from the measured background ambient sound levels. This is considered conservative.

6.6 DISTANCE ADJUSTMENT

The monitoring location is located approximately 60 m closer to the closest WTG than the point of reception representing the residential dwelling at R020. In order to determine the sound levels at the receptor location R20, an acoustical model was developed using CadnaA 2018 MR1 environmental noise modelling software, which follows the protocol of ISO Standard 9613 Part 2, "Acoustics – Attenuation of Sound During Propagation Outdoors".

The UTM coordinates for the WTG's and R020 as well as the sound power level and the hub height of the WTG's were taken from the NAR. A global ground attenuation factor (G) of 0.7 was used in the acoustic model.

The acoustic modelling results indicate that the predicted sound level at the monitor location is 1.0 dBA higher than at receptor R20. Thus, an adjustment of -1.0 dBA was applied to the Turbine Only sound levels at the monitor location to predict the sound level at R020.

The modelling parameters and results are included in Appendix E.

7.0 ACOUSTIC IMMISSION RESULTS

The results from the three sessions of the I-Audit measurements and the combined I-Audit measurements are summarized below.

7.1 PHASE 1A I-AUDIT MEASUREMENTS

7.1.1 Tonality Analysis – Phase 1A

Table 3-1A summarizes the tonality analysis results for Phase 1A at the measurement location. The analysis results concluded that no tones with tone audibility levels greater than 0 dB were present at the measurement location and therefore no tonal adjustment is needed in accordance with the procedure described in Section E5.1 of the MECP Compliance Protocol.

TABLE 3-1A TONALITY ANALYSIS SUMMARY – PHASE 1A

Wind Speed at 10 m Height (m/s)	1	2	3	4	5	6	7
Total of Valid Intervals	0	0	0	1	3	7	14
Average Tonality (dB)(1)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Average Tone Audibility (dB)(1)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
# of Intervals with $\Delta L_{a,k} \geq$ *-0 dB*	0	0	0	0	0	0	0
% of Intervals with $\Delta L_{a,k} \geq$ *0 dB*	N/A	N/A	N/A	N/A	N/A	N/A	N/A
% of Intervals with $\Delta L_{a,k} \geq$ *4dB*	N/A	N/A	N/A	N/A	N/A	N/A	N/A
# of Intervals with $\Delta L_{a,k} \geq$ *4 dB*	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tonal Penalty Adjustment K_t (dB)	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Note:
(1) All tones identified with an audibility level of -3 dB or higher were included in the calculation.

7.1.2 Acoustic I-Audit Results – Phase 1A

Table 4-1A summarizes the analysis results for Phase 1A, based on Parts D and E of the Compliance Protocol. The Phase 1A measurement campaign was not able to collect sufficient valid data intervals for any of the wind speed bins for the turbine-on scenario and the 6 m/s and 7 m/s wind speed bins for the turbine parked scenario to satisfy the sample size requirements of Part E of the Compliance Protocol.

TABLE 4-1A ACOUSTIC IMMISSION AUDIT RESULTS – PHASE 1A

Wind Speed at 10 m Height (m/s)		1	2	3	4	5	6	7
WTG Parked	# of Valid Intervals	52(1)	102	164	125	33(1)	3(2)	0(2)
	Measured Averaged L_{Aeq} (dBA)	30	30	34	36	38	N/A	N/A
	Standard Deviation (dBA)	2.0	2.0	2.0	2.0	2.0	N/A	N/A
	The Adelaide Project (dBA)	32.8						
	Adjusted Ambient Sound Level (dBA)(3)	30	30	26	32	37	N/A	N/A
WTG ON	# of Valid Intervals	0(2)	0(2)	0(2)	1(2)	3(2)	7(2)	14(2)
	Averaged L_{Aeq} (dBA)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Standard Deviation (dBA)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tonal Penalty (dB)		N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crosswind Adjustment (dBA)		N/A	N/A	N/A	N/A	N/A	N/A	N/A
Distance Adjustment (dBA)		-1.0						
Turbine Only L_{Aeq} (dBA)		N/A	N/A	N/A	N/A	N/A	N/A	N/A
Applicable Sound Level Limits (dBA)		40(4)	40(4)	40(4)	40(4)	40(4)	N/A	N/A
Compliance with REA (Yes/No)		N/A	N/A	N/A	N/A	N/A	N/A	N/A

Notes:

(1) Number of valid data intervals does not satisfy Part D of the Compliance Protocol but satisfies Part E of the Compliance Protocol.
(2) Number of valid data intervals does not satisfy either Part D or Part E of the Compliance Protocol.
(3) Contribution from the Adelaide Project was subtracted from the measured averaged L_{Aeq} for background ambient.
(4) Exclusion limit of the MECP guideline.

The measurement data points (i.e., the valid data intervals) from Table 4-1A were shown in Figure 4-1A for all wind speed bins between 1 m/s and 7 m/s.

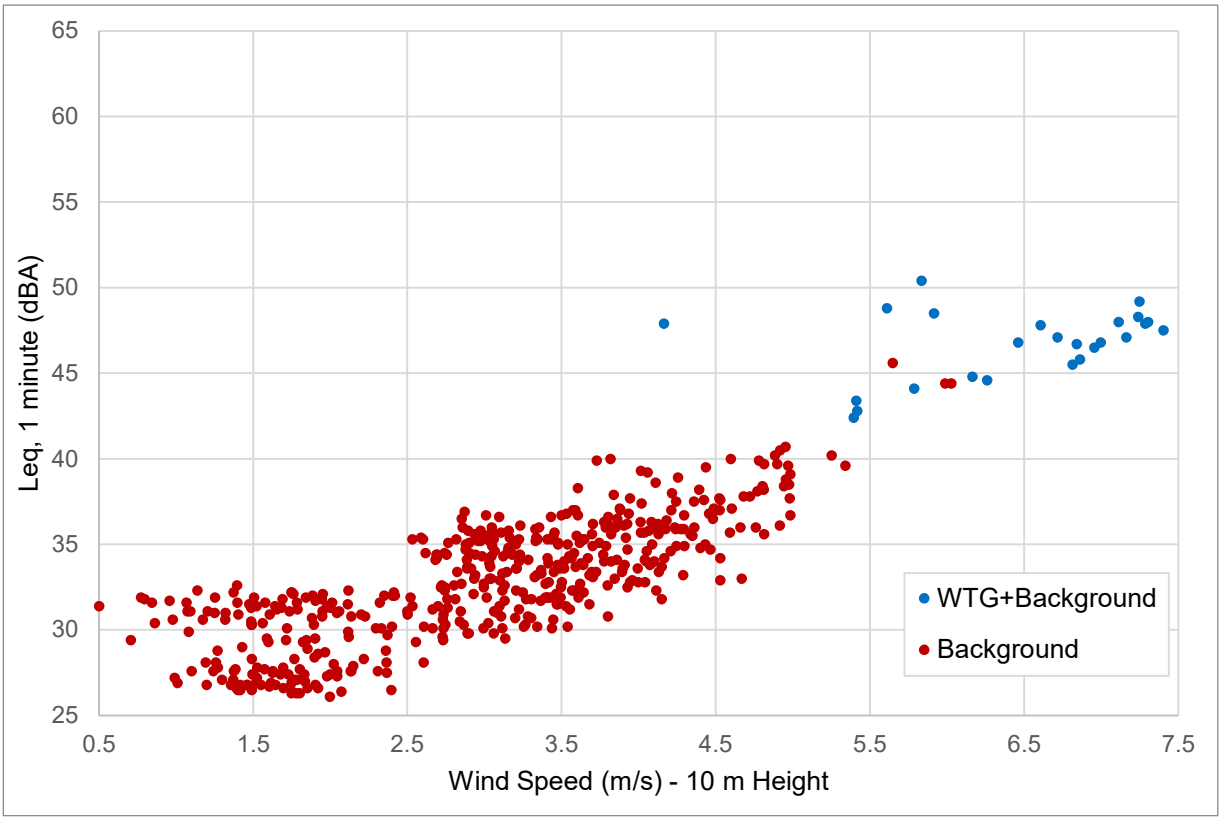

FIGURE 4-1A: MEASURED SOUND LEVELS – PHASE 1A

7.1.3 Effect of Data Reduction Filters

To demonstrate the effect of the data reduction filters discussed in Section 6.1.1 for the turbine-on scenario, the following data filtering stages were applied to the measured data intervals.

- **Stage 1**: Time range filter applied;
- **Stage 2**: Stage 1 + rain/precipitation filter applied;
- **Stage 3**: Stage 2 + downwind filter applied; and
- **Stage 4**: Stage 3 + power filter applied.

Table 5-1A shows the data intervals retained after each stage of the data filtering processes. The downwind filter and the electrical power filter have the most impact on the data. Note, the above data filtering process included all the data points prior to the audio recording review process.

TABLE 5-1A EFFECT OF DATA FILTERING ON MEASUREMENT DATA (STAGED FILTERING) – PHASE 1A

Stage	Data Reduction Filter	1mps	2mps	3mps	4mps	5mps	6mps	7mps
1	Total valid intervals (including time range filter)	4823	4859	3896	2658	1338	706	492
2	# of Intervals with Rain/precipitation filter	3013	3090	2524	1641	656	226	170
	% of Intervals with Rain/precipitation filter	62.5%	63.6%	64.8%	61.7%	49.0%	32.0%	34.6%
3	# of Intervals with Downwind filter	20	138	393	388	104	18	29
	% of Intervals with Downwind filter	0.4%	2.8%	10.1%	14.6%	7.8%	2.5%	5.9%
4	# of Intervals with Power filter	0	0	0	1	6	9	15
	% of Intervals with Power filter	0.0%	0.0%	0.0%	0.0%	0.4%	1.3%	3.0%
5	Valid data points (with manual reject)	0	0	0	1	6	7	15

In addition, in order to demonstrate the effect from each individual filter, the time range filter was applied to the raw data. Then each filter was applied to the data independently. Table 6-1A summarizes the effect from each individual filter. It can be seen that the data is greatly reduced at all windspeed bins due to the downwind filter. As expected, the data is significantly reduced at the lower windspeed bins (1-4 m/s) due to the electrical power filter.

TABLE 6-1A EFFECT OF DATA FILTERING ON MEASUREMENT DATA (INDIVIDUAL FILTERING) – PHASE 1A

Data Reduction Filter	1mps	2mps	3mps	4mps	5mps	6mps	7mps
Total valid intervals (including time range filter)	4823	4859	3896	2658	1338	706	492
# of Intervals with Rain/precipitation filter	3013	3090	2524	1641	656	226	170
% of Intervals with Rain/precipitation filter	62.5%	63.6%	64.8%	61.7%	49.0%	32.0%	34.6%
# of Intervals with Downwind filter	185	681	671	582	294	151	121
% of Intervals with Downwind filter	3.8%	14.0%	17.2%	21.9%	22.0%	21.4%	24.6%
# of Intervals with Power filter	392	585	538	670	652	565	453
% of Intervals with Power filter	8.1%	12.0%	13.8%	25.2%	48.7%	80.0%	92.1%
# of Intervals with Downwind and Power filter	0	0	1	33	65	100	95
% of Intervals with Downwind and Power filter	0.0%	0.0%	0.0%	1.2%	4.9%	14.2%	19.3%

7.1.4 Wind Rose – Phase 1A

A wind rose diagram for Phase 1A showing the wind directions and the wind speed bins is provided as Figure 5-1A. The wind rose diagram includes all the measurement data in the Phase 1A measurement campaign. The wind rose was divided up into 16 equal segments, with 22.5 degrees per segment as per the MECP protocol. As shown on Figure 5-1A, the prevailing wind was the south-east direction during the Phase 1A measurement campaign (i.e., the wind blowing from south-east to north-west).

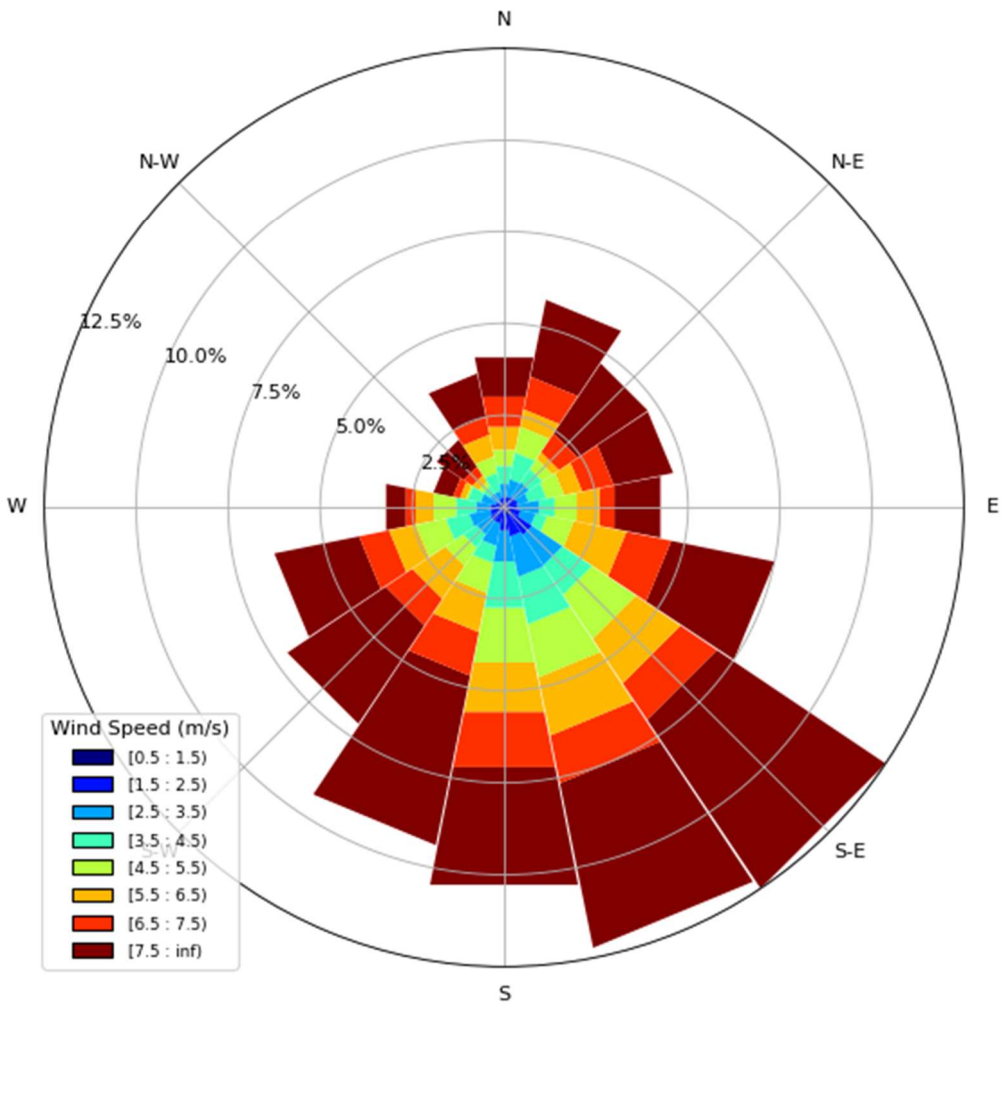

FIGURE 5-1A: WIND ROSE – PHASE 1A

7.1.5 Compliance Assessment – Phase 1A

As indicated above, the Phase 1A measurement campaign was not able to collect sufficient valid data intervals (minutes) to satisfy Part D or Part E of the Compliance Protocol and therefore was

not able to assess the compliance status for the wind farm in accordance with the Compliance Protocol.

7.2 PHASE 2A I-AUDIT MEASUREMENTS

7.2.1 Tonality Analysis – Phase 2A

Table 3-2A summarizes the tonality analysis results for Phase 2A at the measurement location. The analysis results concluded that tones were present at the measurement location at the 5 m/s, 6 m/s and 7 m/s wind speed bins. The tone audibility is less than 4 dB and therefore tonal adjustment is not required in accordance with the procedure described in Section E5.1 of the Compliance Protocol.

TABLE 3-2A TONALITY ANALYSIS SUMMARY – PHASE 2A

Wind Speed at 10 m Height (m/s)	1	2	3	4	5	6	7
Total of Valid Intervals	0	0	0	5	23	20	32
Average Tonality (dB)(1)	N/A	N/A	N/A	N/A	-0.2	-0.1	-2.1
Average Tone Audibility (dB)(1)	N/A	N/A	N/A	N/A	2.2	2.3	0.2
# of Intervals with $\Delta L_{a,k} \geq 0$ dB	N/A	N/A	N/A	0	9	5	1
% of Intervals with $\Delta L_{a,k} \geq 0$ dB	N/A	N/A	N/A	0%	39%	25%	3%
% of Intervals with $\Delta L_{a,k} \geq 4$dB	N/A	N/A	N/A	0	0	0	0
# of Intervals with $\Delta L_{a,k} \geq 4$ dB	N/A	N/A	N/A	0%	0%	0%	0%
Tonal Penalty Adjustment K_t (dB)	N/A	N/A	N/A	0	0	0	0

Note:
(1) All tones identified with an audibility level of -3 dB or higher were included in the calculation.

7.2.2 Acoustic I-Audit Results – Phase 2A

Table 4-2A summarizes the analysis results for Phase 2A, based on Parts D and E of the Compliance Protocol. The Phase 2A measurement campaign was not able to collect sufficient valid data intervals for any of the wind speed bins for the turbine-on scenario and the 5 m/s to 7 m/s wind speed bins for the turbine parked scenario to satisfy the sample size requirements of Part E of the Compliance Protocol.

TABLE 4-2A ACOUSTIC IMMISSION AUDIT RESULTS – PHASE 2A

Wind Speed at 10 m Height (m/s)		1	2	3	4	5	6	7
WTG Parked(1)	# of Valid Intervals	85	228	192	77	28(1)	9(1)	0(1)
	Measured Averaged L_{Aeq} (dBA)	34	34	38	42	N/A	N/A	N/A
	Standard Deviation (dBA)	2.0	2.0	2.0	1.8	N/A	N/A	N/A
	The Adelaide Project (dBA)	32.8						
	Adjusted Ambient Sound Level (dBA)(2)	26	29	37	42	N/A	N/A	N/A
WTG ON	# of Valid Intervals	0(1)	0(1)	0(1)	5(1)	23(1)	20(1)	32(1)
	Averaged L_{Aeq} (dBA)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Standard Deviation (dBA)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tonal Penalty (dB)		N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crosswind Adjustment (dBA)		N/A	N/A	N/A	N/A	N/A	N/A	N/A
Distance Adjustment (dBA)		-1.0						
Turbine Only L_{Aeq} (dBA)		N/A	N/A	N/A	N/A	N/A	N/A	N/A
Applicable Sound Level Limits (dBA)		40(3)	40(3)	40(3)	42(4)	N/A	N/A	N/A
Compliance with REA (Yes/No)		N/A	N/A	N/A	N/A	N/A	N/A	N/A

Notes:

(1) Number of valid data intervals does not satisfy either Part D or Part E of the Compliance Protocol.
(2) Contribution from the Adelaide Project was subtracted from the measured averaged L_{Aeq} for background ambient.
(3) Exclusion limit of the MECP guideline.
(4) Measured ambient sound level.

The data points from Table 4-2A were shown in Figure 4-2A for all wind speed bins between 1 m/s and 7 m/s.

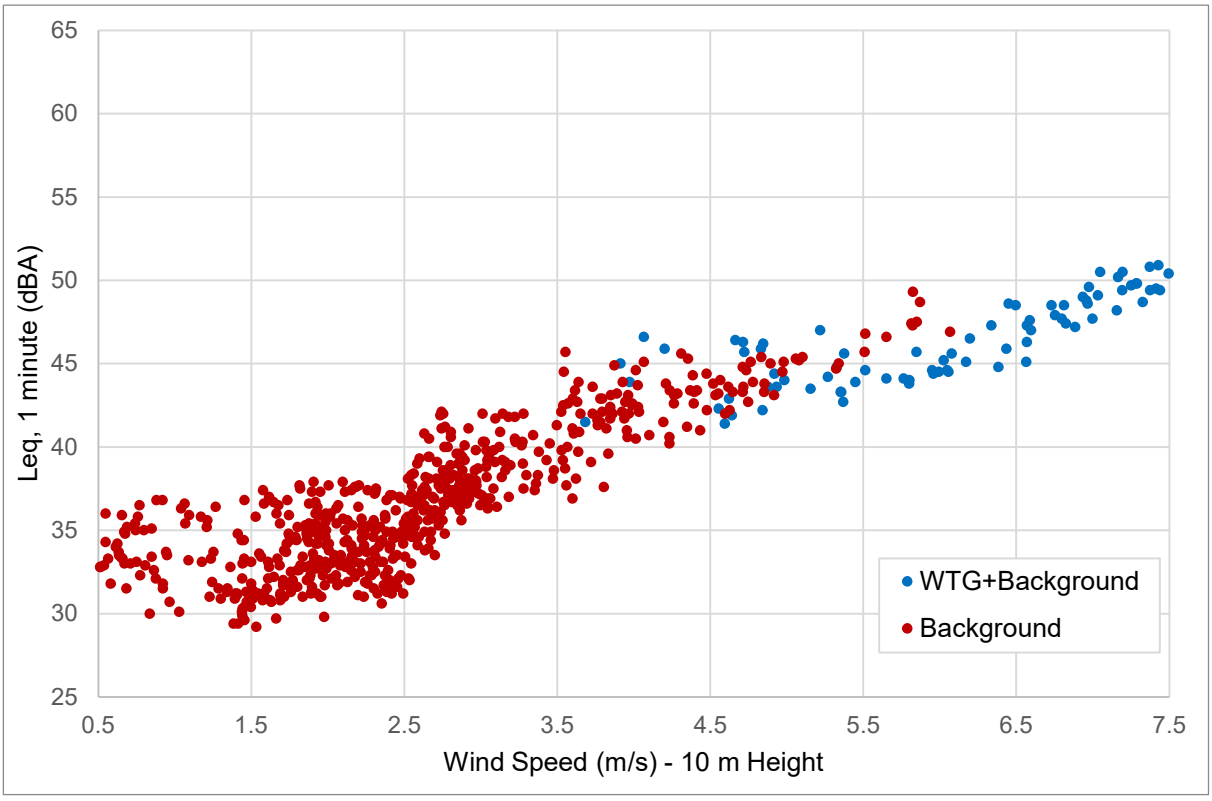

FIGURE 4-2A: MEASURED SOUND LEVELS – PHASE 2A

7.2.3 Data Filtering

To demonstrate the effect of the data reduction filters discussed in Section 6.1.1 for the turbine-on scenario, the following data filtering stages were applied to the measured data intervals.

- **Stage 1**: Time range filter applied;
- **Stage 2**: Stage 1 + rain/precipitation filter applied;
- **Stage 3**: Stage 2 + downwind filter applied; and
- **Stage 4**: Stage 3 + power filter applied

Table 5-2A shows the data intervals retained after each stage of the data filtering processes. The downwind filter and the electrical power filter have the most impact on the data. Note, the above data filtering process included all the data points prior to the audio recording review process.

TABLE 5-2A EFFECT OF DATA FILTERING ON MEASUREMENT DATA (STAGED FILTERING) – PHASE 2A

Stage	Data Reduction Filter	1mps	2mps	3mps	4mps	5mps	6mps	7mps
1	Total valid intervals (including time range filter)	7272	4666	3557	1535	1262	785	280
2	# of Intervals with Rain/precipitation filter	3361	2895	2487	940	706	451	113
	% of Intervals with Rain/precipitation filter	46.2%	62.0%	69.9%	61.2%	55.9%	57.5%	40.4%
3	# of Intervals with Downwind filter	691	1094	1361	460	334	173	67
	% of Intervals with Downwind filter	9.5%	23.4%	38.3%	30.0%	26.5%	22.0%	23.9%
4	# of Intervals with Power filter	0	0	0	6	23	20	32
	% of Intervals with Power filter	0.0%	0.0%	0.0%	0.4%	1.8%	2.5%	11.4%
5	Valid data points (with manual reject)	0	0	0	5	23	20	32

In addition, in order to demonstrate the effect from each individual filter, the time range filter was applied to the raw data. Then each filter was applied to the data independently. Table 6-2A summarizes the effect from each individual filter. It can be seen that the data is greatly reduced at all windspeed bins due to downwind filter. As expected, the data is significantly reduced at the lower windspeed bins (1-4 m/s) due to the electrical power filter.

TABLE 6-2A EFFECT OF DATA FILTERING ON MEASUREMENT DATA (INDIVIDUAL FILTERING) – PHASE 2A

Data Reduction Filter	1mps	2mps	3mps	4mps	5mps	6mps	7mps
Total valid intervals (including time range filter)	7272	4666	3557	1535	1262	785	280
# of Intervals with Rain/precipitation filter	3361	2895	2487	940	706	451	113
% of Intervals with Rain/precipitation filter	46.2%	62.0%	69.9%	61.2%	55.9%	57.5%	40.4%
# of Intervals with Downwind filter	1351	1900	2083	908	791	442	208
% of Intervals with Downwind filter	18.6%	40.7%	58.6%	59.2%	62.7%	56.3%	74.3%
# of Intervals with Power filter	378	703	344	282	448	369	176
% of Intervals with Power filter	5.2%	15.1%	9.7%	18.4%	35.5%	47.0%	62.9%
# of Intervals with Downwind and Power filter	8	1	12	35	120	145	122
% of Intervals with Downwind and Power filter	0.1%	0.0%	0.3%	2.3%	9.5%	18.5%	43.6%

7.2.4 Wind Rose – Phase 2A

A wind rose diagram for Phase 2A showing the wind directions and the wind speed class is provided as Figure 5-2A. The wind rose diagram includes all the measurement data in the Phase 2A measurement campaign. The prevailing wind was the south-west-west direction during the Phase 2A measurement campaign (spring) which is different from the Phase 1A (fall) result.

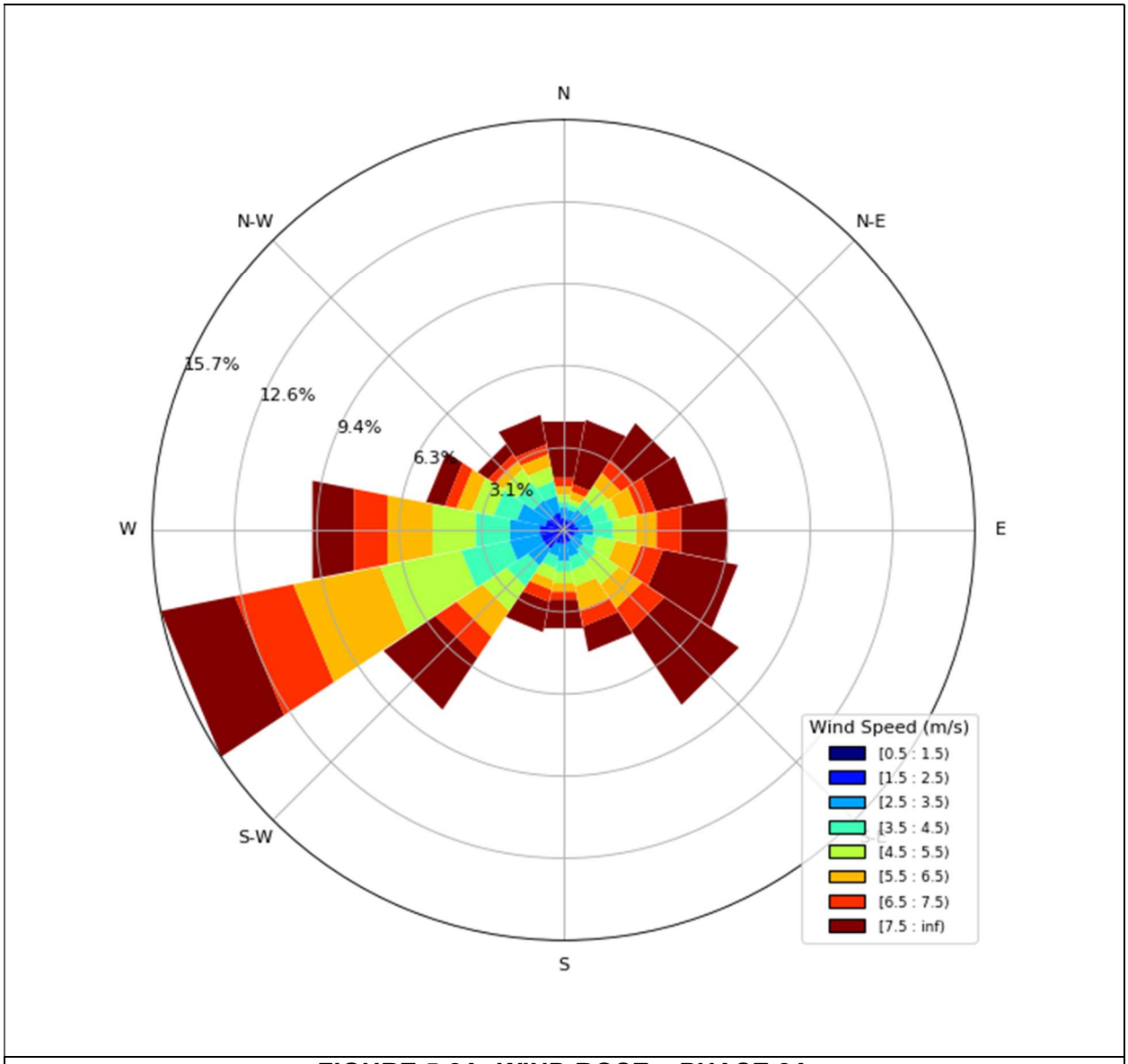

FIGURE 5-2A: WIND ROSE – PHASE 2A

7.2.5 Compliance Assessment – Phase 2A

As indicated above, the Phase 2A measurement campaign was not able to collect sufficient valid data intervals (minutes) to satisfy the Part D or Part E of the Compliance Protocol and therefore

was not able to assess the compliance status for the wind farm in accordance with the Compliance Protocol.

7.3 PHASE 2B I-AUDIT MEASUREMENTS

7.3.1 Tonality Analysis – Phase 2B

Table 3-2B summarizes the tonality analysis results for Phase 2B at the measurement location. The analysis results concluded that tones were present at the measurement location for the 5 m/s and 6 m/s wind speed bins. The tone audibility is less than 4 dB and therefore tonal adjustment is not required in accordance with the procedure described in Section E5.1 of the Compliance Protocol.

TABLE 3-2B TONALITY ANALYSIS SUMMARY – PHASE 2B

Wind Speed at 10 m Height (m/s)	1	2	3	4	5	6	7
Total of Valid Intervals	0	0	0	2	34	63	74
Average Tonality (dB)(1)	N/A	N/A	N/A	-5.3	-3.6	-4.0	-4.0
Average Tone Audibility (dB)(1)	N/A	N/A	N/A	-2.9	-1.2	-1.6	-1.6
# of Intervals with $\Delta L_{a,k} \geq 0$ dB	N/A	N/A	N/A	0	3	1	0
% of Intervals with $\Delta L_{a,k} \geq 0$ dB	N/A	N/A	N/A	0%	9%	2%	0%
# of Intervals with $\Delta L_{a,k} \geq 4$dB	N/A	N/A	N/A	0	0	0	0
% of Intervals with $\Delta L_{a,k} \geq 4$ dB	N/A	N/A	N/A	0%	0%	0%	0%
Tonal Penalty Adjustment K_t (dB)	N/A	N/A	N/A	0	0	0	0

Note:
(1) All tones identified with an audibility level of -3 dB or higher were included in the calculation.

7.3.2 Acoustic I-Audit Results – Phase 2B

Table 4-2B summarizes the analysis results for Phase 2B, based on Parts D and E of the Compliance Protocol. Note, the original sound measurements were done at a time interval of 10 seconds. The 10-second interval data were combined into 1-minute intervals in order to compare with the data collected in Phases 1A and 2A.

The Phase 2B measurement campaign was not able to collect sufficient valid data intervals at the wind speed bins from 1 m/s to 5 m/s for the turbine on scenario and the 1 m/s, 6 m/s and 7 m/s wind speed bins for the turbine parked scenario, to satisfy the sample size requirements of Part E of the Compliance Protocol.

As shown in Table 4-2B, the measured background sound levels for the turbine parked scenario in the Phase 2B measurement campaign were found to be considerably higher than those measured in Phases 1A and 2A.

TABLE 4-2B ACOUSTIC IMMISSION AUDIT RESULTS – PHASE 2B

Wind Speed at 10 m Height (m/s)		1	2	3	4	5	6	7
WTG Parked[1]	# of Valid Intervals	10[2]	38[1]	47[1]	43[1]	35[1]	21[2]	7[2]
	Measured Averaged L_{Aeq} (dBA)	N/A	42	50	53	54	N/A	N/A
	Standard Deviation (dBA)	N/A	2.0	2.0	2.0	2.0	N/A	N/A
	The Adelaide Project (dBA)	32.8						
	Adjusted Ambient Sound Level (dBA)[3]	N/A	41	50	53	53	N/A	N/A
WTG ON	# of Valid Intervals	0[2]	0[2]	0[2]	2[2]	34[2]	63[1]	74[1]
	Averaged L_{Aeq} (dBA)	N/A	N/A	N/A	N/A	N/A	46	49
	Standard Deviation (dBA)	N/A	N/A	N/A	N/A	N/A	1.5	1.1
Tonal Penalty (dB)		N/A	N/A	N/A	N/A	N/A	0.0	0.0
Crosswind Adjustment (dBA)		N/A	N/A	N/A	N/A	N/A	0	0
Distance Adjustment (dBA)		-1.0						
Turbine Only L_{Aeq} (dBA)		N/A	N/A	N/A	N/A	N/A	N/A	N/A
Applicable Sound Level Limits (dBA)		N/A	41[4]	50[4]	53[4]	53[4]	N/A	N/A
Compliance with REA (Yes/No)		N/A	N/A	N/A	N/A	N/A	N/A	N/A

Notes:

(1) Number of valid data intervals does not satisfy Part D of the Compliance Protocol but satisfies Part E of the Compliance Protocol.

(2) Number of valid data intervals does not satisfy either Part D or Part E of the Compliance Protocol.

(3) Contribution from the Adelaide Project was subtracted from the measured averaged L_{Aeq} for background ambient.

(4) Measured background sound levels.

The data points from Table 4-2B were shown in Figure 4-2B for all wind speed bins between 1 m/s and 7 m/s .

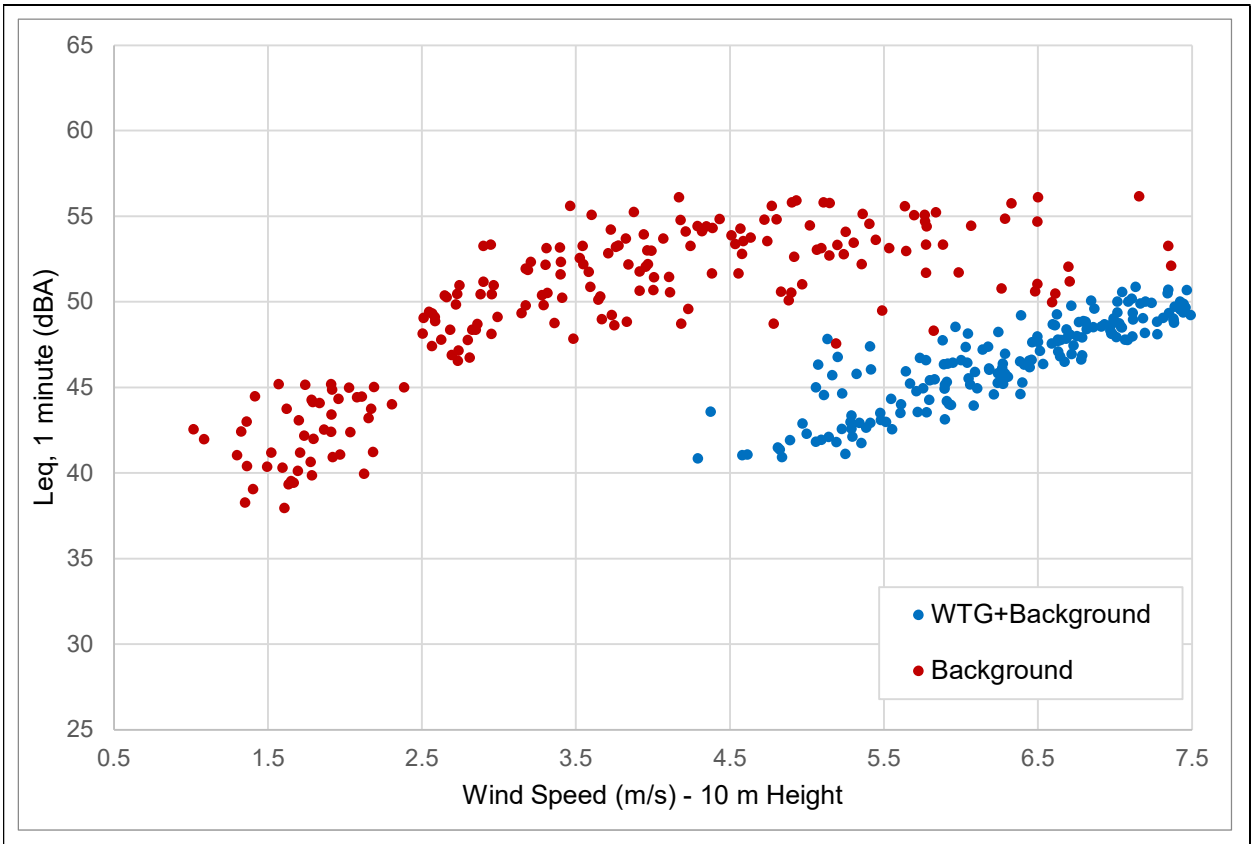

FIGURE 4-2B: MEASURED SOUND LEVELS – PHASE 2B

7.3.3 Data Filtering

To demonstrate the effect of the data reduction filters discussed in Section 6.1.1 for the turbine-on scenario, the following data filtering stages were applied to the measured data intervals.

- **Stage 1**: Time range filter applied;
- **Stage 2**: Stage 1 + rain/precipitation filter applied;
- **Stage 3**: Stage 2 + downwind filter applied; and
- **Stage 4**: Stage 3 + power filter applied

Table 5-2B shows the data intervals retained after each stage of the data filtering processes. The downwind filter and the electrical power filter have the most impact on the data. Note, the above data filtering process included all the data points prior to the audio recording review process.

TABLE 5-2B EFFECT OF DATA FILTERING ON MEASUREMENT DATA (STAGED FILTERING) – PHASE 2B

Stage	Data Reduction Filter	1mps	2mps	3mps	4mps	5mps	6mps	7mps
1	Total valid intervals (including time range filter)	7400	3998	2461	1347	787	624	363
2	# of Intervals with Rain/precipitation filter	4175	3120	2117	1134	490	329	225
	% of Intervals with Rain/precipitation filter	56.4%	78.0%	86.0%	84.2%	62.3%	52.7%	62.0%
3	# of Intervals with Downwind filter	485	711	1165	884	340	97	79
	% of Intervals with Downwind filter	6.6%	17.8%	47.3%	65.6%	43.2%	15.5%	21.8%
4	# of Intervals with Power filter	0	0	0	2	35	63	77
	% of Intervals with Power filter	0.0%	0.0%	0.0%	0.1%	4.4%	10.1%	21.2%
5	Valid data points (with manual reject)	0	0	0	2	34	63	74

In addition, in order to demonstrate the effect from each individual filter, the time range filter was applied to the raw data. Then each filter was applied to the data independently. Table Table 6-2B summarizes the effect from each individual filter. It can be seen that the data is greatly reduced at all windspeed bins due to the downwind filter. As expected, the data is significantly reduced at the lower windspeed bins (1-4 m/s) due to the electrical power filter.

TABLE 6-2B EFFECT OF DATA FILTERING ON MEASUREMENT DATA (INDIVIDUAL FILTERING) – PHASE 2B

Data Reduction Filter	1mps	2mps	3mps	4mps	5mps	6mps	7mps
Total valid intervals (including time range filter)	7400	3998	2461	1347	787	624	363
# of Intervals with Rain/precipitation filter	4175	3120	2117	1134	490	329	225
% of Intervals with Rain/precipitation filter	56.4%	78.0%	86.0%	84.2%	62.3%	52.7%	62.0%
# of Intervals with Downwind filter	1380	1321	1451	1006	513	269	134
% of Intervals with Downwind filter	18.6%	33.0%	59.0%	74.7%	65.2%	43.1%	36.9%
# of Intervals with Power filter	81	138	192	164	251	412	342
% of Intervals with Power filter	1.1%	3.5%	7.8%	12.2%	31.9%	66.0%	94.2%
# of Intervals with Downwind and Power filter	0	0	0	2	35	79	117
% of Intervals with Downwind and Power filter	0.0%	0.0%	0.0%	0.1%	4.4%	12.7%	32.2%

7.3.4 Wind Rose – Phase 2B

A wind rose diagram for Phase 2B showing the wind directions and the wind speed class is provided as Figure 5-2B. The wind rose diagram includes all the measurement data in the Phase 2B measurement campaign. The prevailing wind was in the south-west-west direction, similar to Phase 2A. Note, both Phases 2A and 2B measurement campaigns were conducted in the spring. Phase 1A had a different prevailing wind direction when the measurement campaign was conducted in the fall.

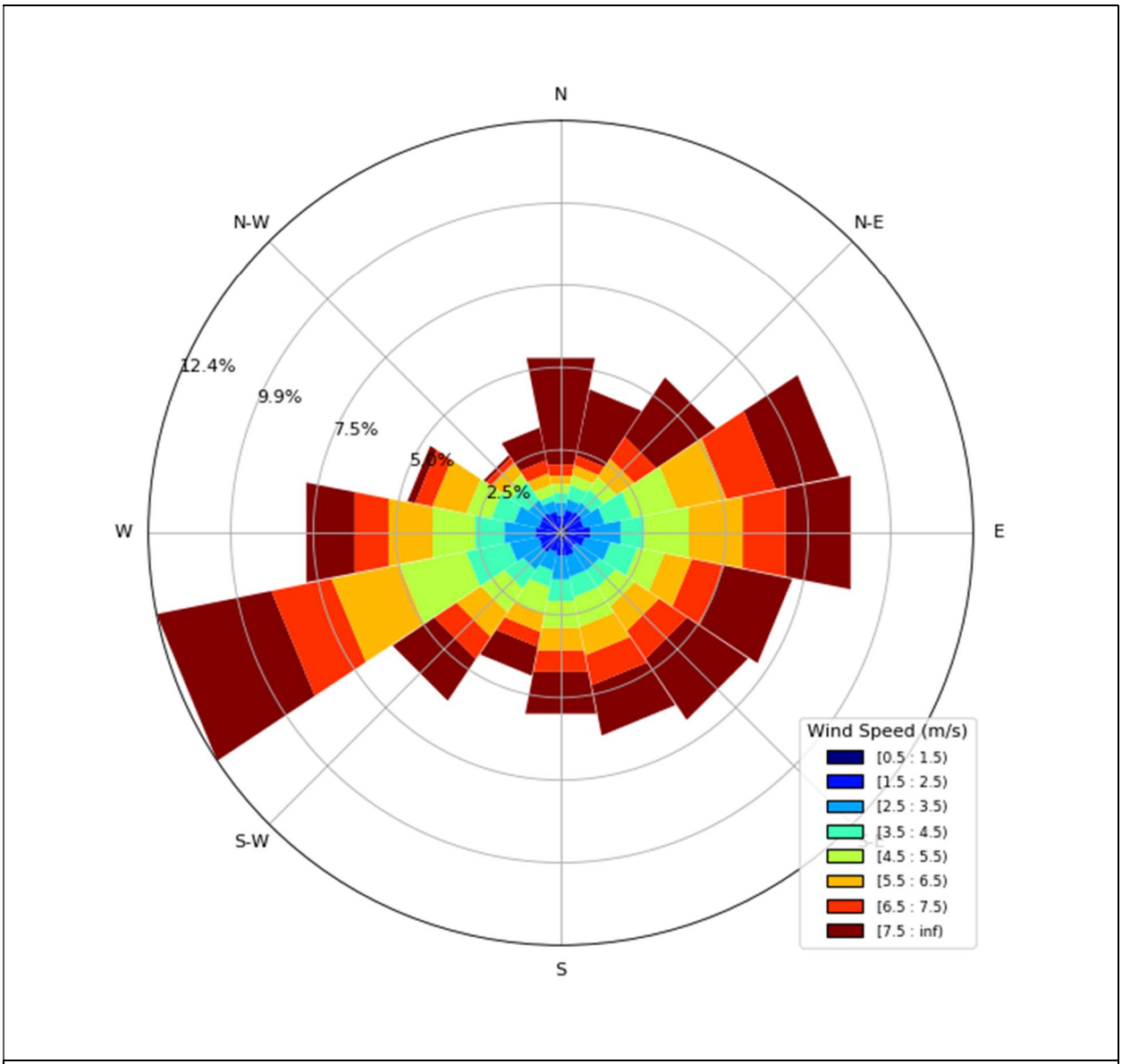

FIGURE 5-2B: WIND ROSE – PHASE 2B

7.3.5 Compliance Assessment – Phase 2B

As indicated above, the Phase 2B measurement campaign was not able to collect sufficient valid data intervals (minutes) to satisfy Part D or Part E of the Compliance Protocol and therefore was not able to assess the compliance status for the wind farm in accordance with the Compliance Protocol.

7.4 COMBINED I-AUDIT MEASUREMENTS

As per our various discussions with the MECP, there were significant challenges to collect sufficient valid data intervals/points in each of three approximate 3-month long measurement campaigns for this specific wind project to satisfy the MECP protocol and therefore a conclusion could not be drawn to assess the compliance status of the Napier Wind Project in each of these noise measurement campaigns.

As a result of the teleconference meetings with the MECP, for this specific wind project, the measurement data from Phases 1A, 2A, or 2B were combined to assess the compliance status of the Napier Wind Project. The combined data analysis results are summarized below.

7.4.1 Tonality Analysis – Phases 1A, 2A and 2B Combined

Table 7 summarizes the tonality analysis results for the combined data at the measurement location. The analysis results concluded that tones were present at the measurement location in the 5 m/s, 6 m/s and 7 m/s wind speed bins. The tone audibility is less than 4 dB and therefore tonal adjustment is not required in accordance with the procedure described in Section E5.1 of the Compliance Protocol. Appendix F shows samples of the tonality analysis details.

TABLE 7 TONALITY ANALYSIS SUMMARY – PHASES 1A, 2A & 2B COMBINED

Wind Speed at 10 m Height (m/s)	1	2	3	4	5	6	7
Total of Valid Intervals	0	0	0	7	60	90	120
Average Tonality (dB)(1)	N/A	N/A	N/A	-5.3	-2.7	-3.3	-3.2
Average Tone Audibility (dB)(1)	N/A	N/A	N/A	-2.9	-0.3	-0.9	-0.9
# of Intervals with $\Delta L_{a,k} \geq 0$ dB	0	0	0	0	12	6	1
% of Intervals with $\Delta L_{a,k} \geq 0$ dB	N/A	N/A	N/A	0%	20%	7%	1%
# of Intervals with $\Delta L_{a,k} \geq 4$dB	N/A	N/A	N/A	0	0	0	0
% of Intervals with $\Delta L_{a,k} \geq 4$ dB	N/A	N/A	N/A	0%	0%	0%	0%
Tonal Penalty Adjustment K_t (dB)	N/A	N/A	N/A	0	0	0	0

Note:

(1) All tones identified included in the calculation.

7.4.2 Acoustic I-Audit Results – Phases 1A, 2A and 2B Combined

Table 8 summarizes the analysis results for the combined data, based on Parts D and E of the Compliance Protocol.

TABLE 8 ACOUSTIC IMMISSION AUDIT RESULTS – PHASES 1A, 2A & 2B COMBINED

Wind Speed at 10 m Height (m/s)		1	2	3	4	5	6	7
WTG Parked(1)	# of Valid Intervals – original dataset(1)	147	368	403	245	96	33(2)	7(3)
	# of Valid Intervals – reduced dataset(11)	114	267	277	93	31	3	0
	Measured Averaged L_{Aeq} (dBA)	32(4)	33(4)	36(4)	38(4)	41(4)	45(5)	45(6)
	Standard Deviation (dBA)	2.0	2.0	2.0	2.0	2.0	0.6	N/A
	The Adelaide Project (dBA)	32.8						
	Adjusted Ambient Sound Level (dBA)(7)	32	21	34	37	40	45	45(6)
WTG ON	# of Valid Intervals – original dataset (1)	0(3)	0(3)	0(3)	8(3)	60(2)	90(2)	120
	# of Valid Intervals – reduced dataset(11)	0	0	0	8	56	90	115
	Averaged L_{Aeq} (dBA)	N/A	N/A	N/A	N/A	44	46	49
	Standard Deviation (dBA)	N/A	N/A	N/A	N/A	1.6	1.6	1.2
Tonal Penalty (dB)		N/A	N/A	N/A	N/A	0.0	0.0	0.0
Crosswind Adjustment (dBA)		N/A	N/A	N/A	N/A	+0.17	0	0
Distance Adjustment (dBA)		-1						
Turbine Only L_{Aeq} (dBA)(8)		N/A	N/A	N/A	N/A	40	40	45
Applicable Sound Level Limits (dBA)		40(9)	40(9)	40(9)	40(9)	40(9)	45(5,10)	45(6)
Compliance with REA (Yes/No)		N/A	N/A	N/A	N/A	Yes	Yes	Yes

Notes:

(1) The values shown are the total number of the valid intervals from Phases 1A, 2A and 2B.
(2) Number of valid data intervals does not satisfy Part D of the Compliance Protocol but satisfies Part E of the Compliance Protocol.
(3) Number of valid data intervals does not satisfy either Part D or Part E of the Compliance Protocol.
(4) Based on Phase 1A and 2A measurement data only. Background sound levels from Phase 2B were not included due to relatively higher sound levels measured in Phase 2B.
(5) Based on Phase 1A measurement data only. Background sound levels from Phases 2A and 2B were not included due to relatively higher sound levels measured in Phases 2A and 2B.
(6) Taken from the lower wind speed bin (i.e., 6 m/s wind speed bin). Phase 1A and 2A have no valid intervals for windspeed bin 7m/s. Background sound levels from Phase 2B were relatively higher.
(7) Contribution from the Adelaide Project was subtracted from the measured averaged L_{Aeq} for background ambient.
(8) Contribution from background sound levels was logarithmically subtracted from the measured averaged L_{Aeq} for turbine-on scenario. After that, the adjustments for tonal penalty, crosswind and distance were arithmetically applied to determine the turbine-only sound levels.
(9) Exclusion limits of the MECP guideline.
(10) Measured background sound level.
(11) The standard deviation filter was applied to the combined data set to improve dataset quality.

The measurement data points from Table 8 were shown in Figure 6 for all wind speed bins between 1 m/s and 7 m/s. Note, only the valid intervals after applying additional filters to improve dataset quality were included on Figure 6.

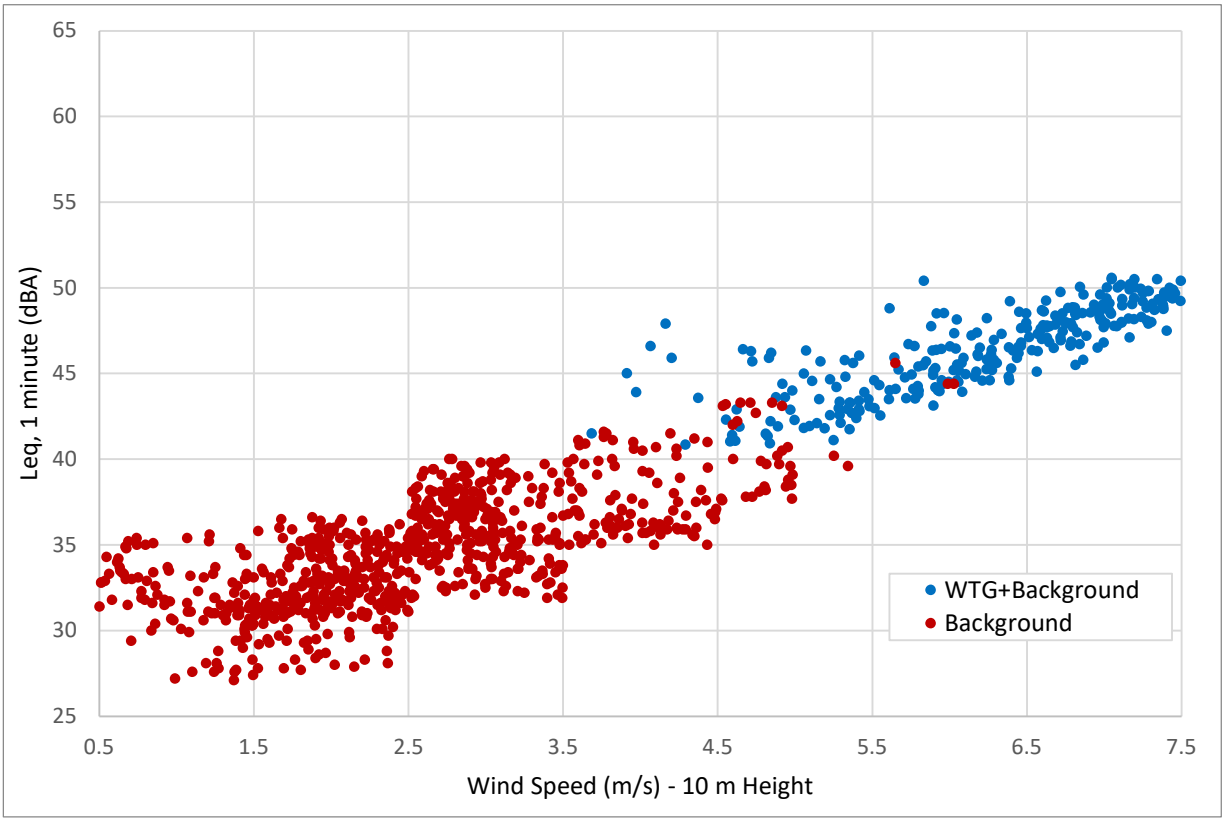

FIGURE 6 MEASURED SOUND LEVELS – PHASES 1A, 2A AND 2B

As shown in Table 8, a sufficient number of valid data points were retained at the 5 m/s, 6m/s and 7 m/s wind speed bins for the turbine on scenario. For the turbine parked scenario, a sufficient number of valid data intervals/points were retained at the wind speed bins from 1 m/s to 6 m/s in accordance with the Part E of the MECP protocol.

For the turbine parked scenario, there was an insufficient number of valid data points in the 7 m/s wind speed bin. In accordance with the MECP protocol, the sound level limit for the 7 m/s wind speed bin was taken from that measured at the 6 m/s wind speed bin.

7.4.3 Data Filtering

Tables 9 and 10 summarize the effect of the data reduction filters discussed in Section 6.1.1 for the turbine-on scenario. Note, the numbers of data intervals are the sum of the corresponding number of data intervals in each of Phases 1A, 2A and 2B. The percentage of the intervals was calculated based on the combined data intervals.

TABLE 9 EFFECT OF DATA FILTERING ON MEASUREMENT DATA (STAGED FILTERING) – PHASES 1A, 2A AND 2B

Stage	Data Reduction Filter	1mps	2mps	3mps	4mps	5mps	6mps	7mps
1	Total valid intervals (including time range filter)	19495	13523	9914	5540	3387	2115	1135
2	# of Intervals with Rain/precipitation filter	10549	9105	7128	3715	1852	1006	508
	% of Intervals with Rain/precipitation filter	54.1%	67.3%	71.9%	67.1%	54.7%	47.6%	44.8%
3	# of Intervals with Downwind filter	1196	1943	2919	1732	778	288	175
	% of Intervals with Downwind filter	6.1%	14.4%	29.4%	31.3%	23.0%	13.6%	15.4%
4	# of Intervals with Power filter	0	0	0	9	64	92	124
	% of Intervals with Power filter	0.0%	0.0%	0.0%	0.2%	1.9%	4.3%	10.9%
5	Valid data points (with manual reject)	0	0	0	7	60	90	120

TABLE 10 EFFECT OF DATA FILTERING ON MEASUREMENT DATA (OVERALL FILTERING) – PHASES 1A, 2A AND 2B

Data Reduction Filter	1mps	2mps	3mps	4mps	5mps	6mps	7mps
Total valid intervals (including time range filter)	19495	13523	9914	5540	3387	2115	1135
# of Intervals with Rain/precipitation filter	10549	9105	7128	3715	1852	1006	508
% of Intervals with Rain/precipitation filter	54.1%	67.3%	71.9%	67.1%	54.7%	47.6%	44.8%
# of Intervals with Downwind filter	2916	3902	4205	2496	1598	862	463
% of Intervals with Downwind filter	15.0%	28.9%	42.4%	45.1%	47.2%	40.8%	40.8%
# of Intervals with Power filter	851	1426	1074	1116	1351	1346	971
% of Intervals with Power filter	4.4%	10.5%	10.8%	20.1%	39.9%	63.6%	85.6%
# of Intervals with Downwind and Power filter	8	1	13	70	220	324	334
% of Intervals with Downwind and Power filter	0.0%	0.0%	0.1%	1.3%	6.5%	15.3%	29.4%

7.4.4 Wind Rose – Phases 1A, 2A and 2B

Figure 7 shows the wind rose diagram based on all the measurement data in the Phases 1A, 2A and 2B measurement campaign. The prevailing wind is generally in the south. As a result, the number of valid data points satisfying the downwind condition was reduced significantly. Note, the receptor location is to the south of the closest turbine (i.e., in an upwind direction).

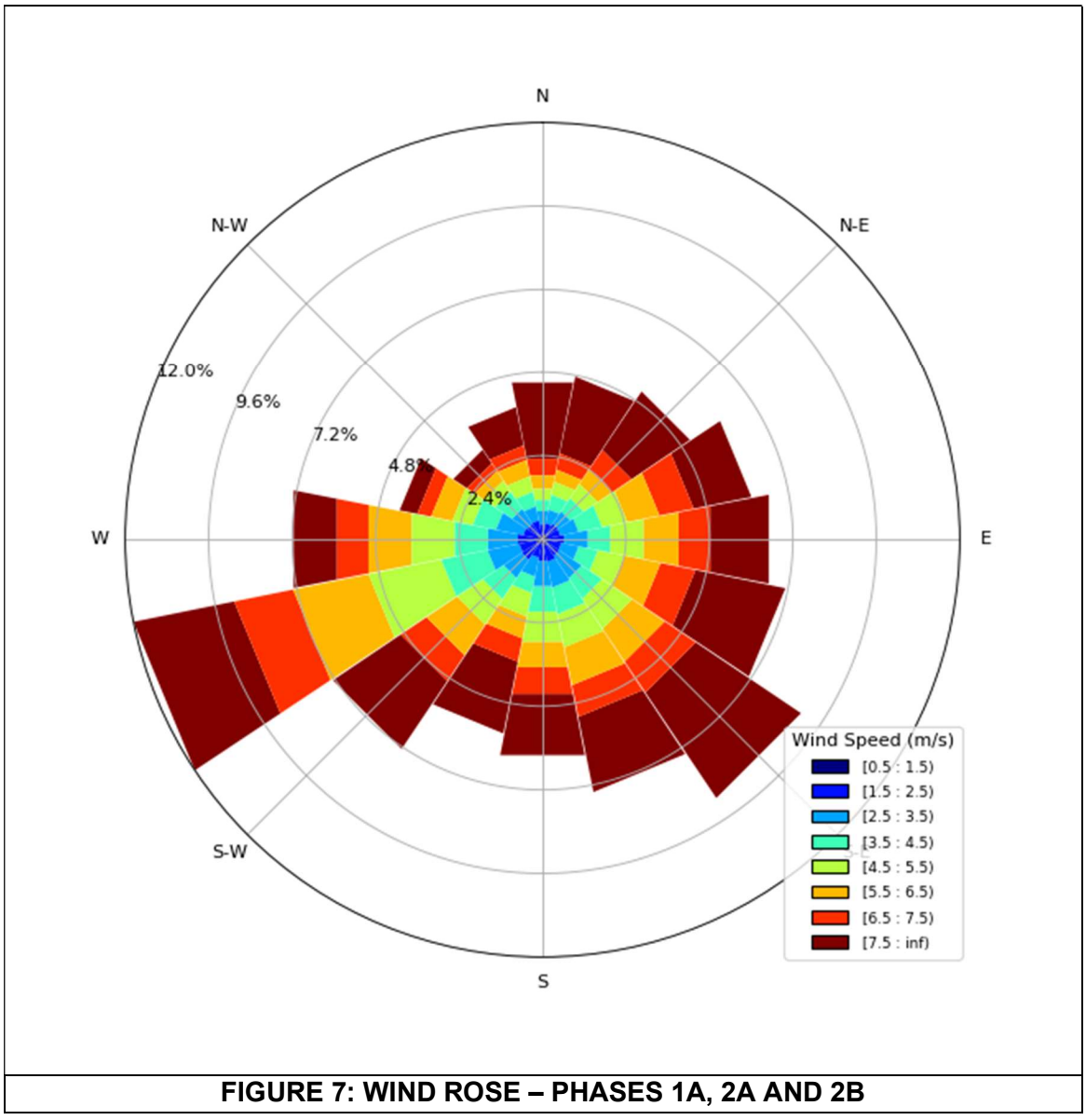

FIGURE 7: WIND ROSE – PHASES 1A, 2A AND 2B

7.4.5 Compliance Assessment – Phases 1A, 2A and 2B Combined

As indicated above, a sufficient number of valid data points were retained at the 5 m/s, 6m/s and 7 m/s wind speed bins for the turbine on scenario. For the turbine parked scenario, a sufficient number of valid data intervals/points were retained at the wind speed bins from 1 m/s to 6 m/s in accordance with the Part E of the MECP protocol.

The analysis results for the combined data from Phases 1A, 2A and 2B indicated that turbine only sound levels from the Napier Wind Project meets the applicable sound level limits in three (3) wind speed bins from 5 m/s to 7 m/s, satisfying the Part E of the MECP protocol. Thus, it can be concluded that the Napier Wind Project is in compliance with the applicable MECP sound level limits at receptor R20.

8.0 CONCLUSIONS

Three sets of I-Audit measurement campaigns were completed by Valcoustics Canada Ltd. for the Napier Wind Project. The analysis results of the combined data from all three sets of measurements concluded that noise from the Napier Wind Project is in compliance with the applicable MECP sound level limits at the audit receptor required in Section E1 of the Renewable Energy Approval ("REA") for the Napier Wind Project ("NAPWP") REA #8388-9B7N4J, dated December 3, 2013.

9.0 REFERENCES

1. "Compliance Protocol for Wind Turbine Noise", Ministry of the Environment and Climate Change, April 2017.

2. Noise Assessment Report, Napier Wind Project, prepared by Howe Gastmeier Chapnik Limited, Dated September 20, 2013.

3. "Napier Wind Project Phase 1 Acoustic Immission Audit", Aercoustics Engineering Ltd., February 28, 2017.

4. "Napier Wind Project Phase 2 Acoustic Immission Audit", Aercoustics Engineering Ltd., July 31, 2017.

5. Napier Wind Project – Turbine WTG1 IEC 61400-11 Edition 2.1 Measurement Report", Aercoustics Engineering Ltd., Revision 1, December 6, 2016.

6. Renewable Energy Approval, Number 8388-9B7N4J, "Napier Wind Project, 27904 Brown Road, Adelaide Metcalfe Township, County of Middlesex", Ministry of the Environment, Issue Date: December 3, 2013.

7. "Noise Abatement Action Plan – Napier Wind Project (REA #8388-9B7N4J)", Aercoustics Engineering Ltd., October 16, 2017, Revised August 31, 2018.

8. "Results of Acoustic Noise Measurements According to IEC 61400-11, Edition 3.0, MM92, Standard, 93129 / T01 Napier Wind Project", Senvion Canada Inc., March 8, 2019.

9. International Standard Organization (ISO). ISO 1996-2:2007: "Acoustics — Description, assessment and measurement of environmental noise — Part 2: Determination of environmental noise levels",

10. Acoustic Imission Audit – Phase 1, Napier Wind Project, Valcoustics Canada Ltd., March 20, 2019.

11. Acoustic Imission Audit – RAM-I Audit, Napier Wind Project, Valcoustics Canada Ltd., December 18, 2020.

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J:\2018\1180338\000\Reports\Phase combined 1A+2A+2B\Acoustic Audit - Napier Wind Farm Combined I-Audit V2_0.docx

APPENDIX A
OPERATOR STATEMENTS

Sam Du

To: Jonathan Clifford
Cc: Tim Hryzyk
Subject: RE: Napier - Statement from the Operator

From: Jonathan Clifford <jonathan@wpd-canada.ca>
Sent: March 15, 2019 11:38 AM
To: Sam Du <sam@valcoustics.com>
Cc: Tim Hryzyk <t.hryzyk@wpd.de>
Subject: FW: Napier - Statement from the Operator

Hello Sam,

Below is the statement from Senvion concerning the Napier turbines operation during the period. In addition to Senvion's statement, I can confirm that the turbines were non-operational during the following periods.

Turbine 1	
Start	**End**
29/10/2018 09:50	30/10/2018 10:00
04/11/2018 10:20	05/11/2018 12:30
27/11/2018 05:50	27/11/2018 14:40

Turbine 2	
Start	**End**
29/10/2018 09:50	30/10/2018 09:50
04/11/2018 10:20	05/11/2018 12:30
27/11/2018 05:50	28/11/2018 12:10

Thank you,

Jonathan Clifford
Operations Manager

wpd windmanager

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F +1 905-813-7487
jonathan@wpd-canada.ca
http://www.windmanager.de/en

wpd windmanager Canada Inc.
2233 Argentia Road Suite 102
ON L5N 2X7 Mississauga

Director: Dipl.-Oec. Nils Brümmer

From: Labbate, Antonio <antonio.labbate@senvion.com>
Sent: Friday, March 15, 2019 8:19 AM
To: Jonathan Clifford <jonathan@wpd-canada.ca>
Cc: Sam Du <sam@valcoustics.com>
Subject: RE: Napier - Statement from the Operator

Hi Jonatan,

I am writing this email as a confirmation that Napier Wind Farm was operating normally during the acoustic measurement campaign that took place between October 17^{h} 2018 to January 05th, 2019. No alteration or modifications were made to any operating parameters at any time. The turbine were not curtailed and not had any operations altered for the course of the audit.

Sumac Ridge Wind Farm was placed in "Manual Stop" during ambient sound level measurement periods specified by the client. In manual stop condition, all wind turbine generators are disconnected from grid and not generating power. "Manual Stop" is used to park the Turbine. During this period, the blades are set to 92.5^{o}, which will allow the turbine to idle at 1 rpm or less with no brake applied. Components of a wind turbine are extremely heavy and the repeated use of the holding brake for long period of time, can damage bearing. As an example, 1 turbine blade weights about 11 tons with the 3 blade set being 33 ton.

I hope that is will suffice as written confirmation to the MOE.

Please note that on Nov 5th, 6th, 9th, 13th, between 7pm to 7am (EST), Napier WEC2 has sound curtailment activated.

Best Regards,

Antonio Labbate
Site Manager Operations & Maintenance
Senvion Canada Inc.
5-545 Trillium Dr.
Kitchener, ON, N2R 1J4
C +1-905-714-4149
antonio.labbate@senvion.com
www.senvion.com/ca

Sam Du

From: Jonathan Clifford <jonathan@wpd-canada.ca>
Sent: November 30, 2018 11:04 AM
To: Sam Du
Subject: Napier Operation

Hi Sam,

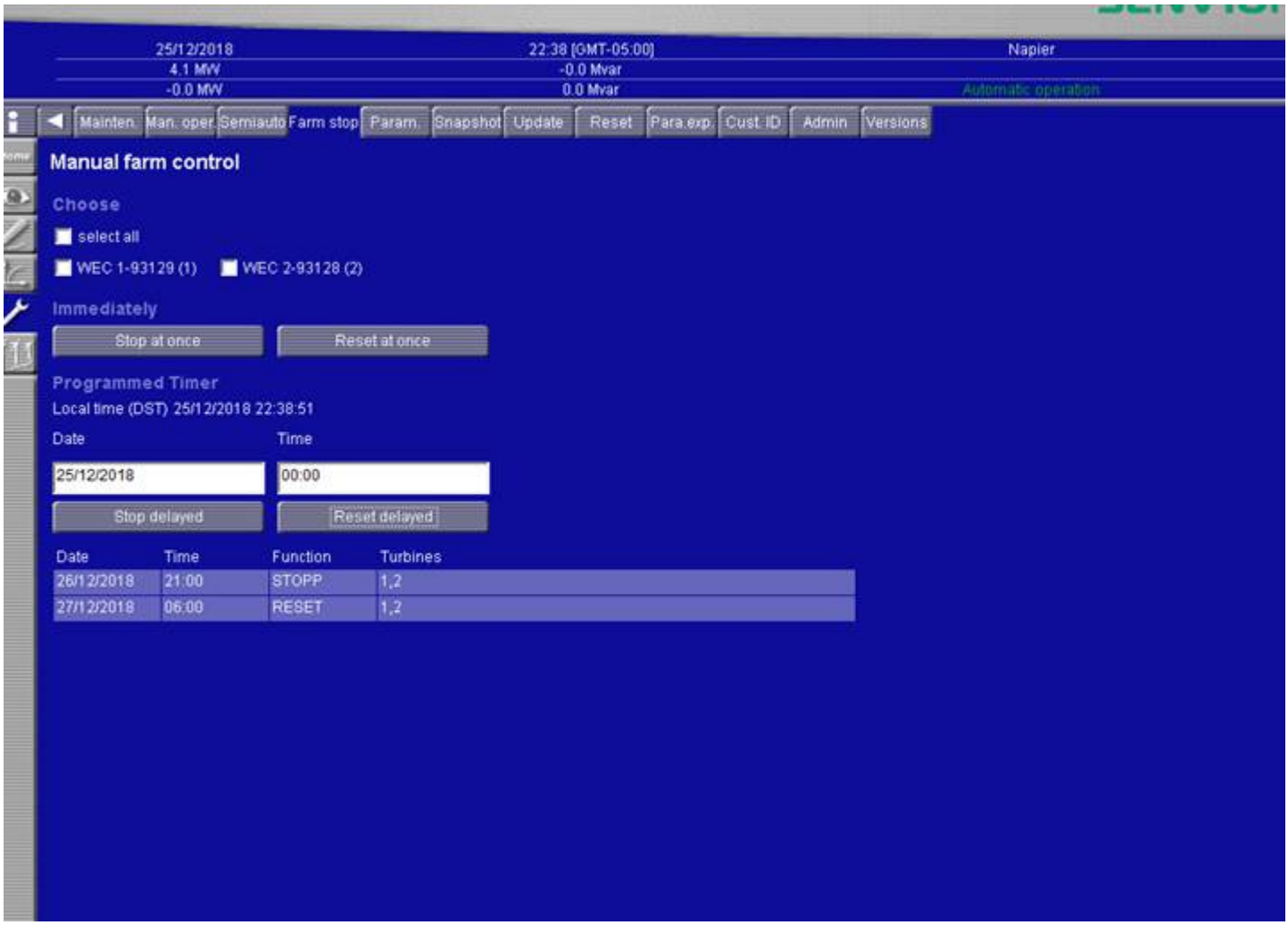
FYI the turbines at Napier have been down since Wed morning. We have a communication issue keeping us from generating. Data collected during this time, if useful, can be used for ambient data points. Hopefully the turbines will be back up today.

Jon

Sam Du

From: Labbate, Antonio <antonio.labbate@senvion.com>
Sent: December 25, 2018 10:41 PM
To: Sam Du
Cc: Jonathan Clifford; Nathan Lee; Vivek Shankar; Harbison, Ethan; Cocarla, John
Subject: RE: Napier Background Ambient noise measurements

Hi Sam,
Yes I confirm that the two turbines in Napier will be stopped from Wednesday (December 26) evening around 9:00 pm to Thursday(December 27) morning around 6:00 am.



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Vivek Shankar

From: Labbate, Antonio <antonio.labbate@senvion.com>
Sent: Tuesday, September 3, 2019 5:20 PM
To: Jonathan Clifford
Cc: Sam Du
Subject: Napier - Statement from the Operator

Hi Jonathan,

I am writing this email as a confirmation that Napier Wind Farm was operating normally during the acoustic measurement campaign that took place between April 10th 2019 to August 01st 2019. No alteration or modifications were made to any operating parameters at any time. The turbines were not curtailed and not had any operations altered for the course of the audit.

Napier Wind Farm was placed in "Manual Stop" during ambient sound level measurement periods specified by the client. These times included:

Start Time	End Time
'2019-05-21 21:00'	'2019-05-22 06:00'
'2019-06-14 21:00'	'2019-06-15 06:00'
'2019-07-11 21:00'	'2019-07-12 06:00'
'2019-07-19 21:00'	'2019-07-20 06:00'
'2019-07-22 21:00'	'2019-07-23 06:00'
'2019-07-25 21:00'	'2019-07-26 06:00'

In manual stop condition, all wind turbine generators are disconnected from grid and not generating power. "Manual Stop" is used to park the Turbine. During this period, the blades are set to 92.5^{o}, which will allow the turbine to idle at 1 rpm or less with no brake applied. Components of a wind turbine are extremely heavy and the repeated use of the holding brake for long period of time, can damage bearing. As an example, 1 turbine blade weights about 11 tons with the 3 blade set being 33 ton.

I hope that is will suffice as written confirmation to the MOE.

Best regards,

Antonio Labbate
Site Manager Operations & Maintenance
Senvion Canada Inc.
5-545 Trillium Dr.
Kitchener, ON, N2R 1J4
C +1-905-714-4149
antonio.labbate@senvion.com
www.senvion.com/ca

December 18, 2020

Hello Sam,

I am writing this letter as a confirmation that the Napier Wind Farm was operating normally during the acoustic measurement campaign that took place between April 27th, 2020 to July 26, 2020. No alteration or modifications were made to any operating parameters at any time. The turbine were not curtailed and operations were not altered for the course of the audit.

The Napier Wind Farm was placed in "Manual Stop" during ambient sound level measurement periods specified by Valcoustics. In manual stop condition, all wind turbine generators are disconnected from grid and not generating power. "Manual Stop" is used to park the Turbine. During this period, the blades are set to 92.5°, which will allow the turbine to idle at 1 rpm or less with no brake applied. Components of a wind turbine are extremely heavy and the repeated use of the holding brake for long period of time, can damage bearing. As an example, 1 turbine blade weights about 11 tons with the 3 blade set being 33 tons.

Thank you,

Jonathan Clifford
Operations Manager
wpd windmanager

APPENDIX B

EQUIPMENT SPECIFICATIONS & CALIBRATION CERTIFICATES

Technical Specifications

ANALOGUE INPUTS
Number of channels: 1
Input connector:
7 pin LEMO connector for Norsonic microphone systems.
Microphone: Nor1225, 1/2", free-field, 50 mV/Pa
Preamplifier: Nor1209 (Normal) or ICP®-type by menu selection.
Preamplifier supply voltage:
±15 volt, max 3 mA
Polarisation voltage:
0 V and 200 V, selectable.
Maximum input signal: ±11 V peak
Preamplifier ICP®:
Supply current: 4mA
Supply voltage: 24V
Input impedance:
>100 kΩ, <650 pF

Measurement range: 0,3 µV - 7Vrms (10 Vpeak) in one range corresponding to -10 dB to 137 dB (140 dB peak) with a microphone sensitivity of 50 mV/Pa. Option 18 shifts the measurement range to 147 dB (150 dB peak) by reducing the microphone sensitivity.

Highpass filter
The input section is equipped with an analogue highpass filter to reduce noise from wind or other sources with frequencies below the frequency range for measurements. The filter is switched on if the limited frequency range is selected (>6,3 Hz).
Filter type: 3rd order HP filter (-3 dB at 3,4 Hz, Butterworth response)

Analogue to digital conversion
The analogue input signal is converted to a digital signal by a multi-range sigma-delta converter with an effective sampling frequency of 48 kHz. The anti-aliasing filter is a combination of an analogue and a digital filter.

Frequency weightings
Simultaneous measurement of A- and C-weighting or A- and Z-weighting. 1/1 octave band or 1/3 octave band levels may be measured simultaneously if options providing these weightings are installed.
1/1 octave filters: 0,5 - 16000 Hz, class 1, digital IIR filters, base 10 system (IEC 61260) and ANSI S1.11-2004 Class 1.

1/3 octave filters: 0,4 - 20000 Hz, class 1, digital IIR filters, base 10 system (IEC 61260) and ANSI S1.11-2004 Class 1.
Level detector
Detector type: Digital true root-mean-square (RMS) detection, resolution 0.1 dB which may optionally be increased to 0.01 dB for indicated levels in the range –9.99 to 99.99 dB.
Crest factor capability: The crest factor is only limited by the peak-value of the signal.

Simultaneous measurement of the following functions: SPL, L_{max}; L_{min}; L_{eq}; L_E; L_{peak}; L_N ; L_{eql}; L_{EI}; L_{TMax5}.

Indication range
The calibration of the instrument allows microphones with sensitivity in the range -84 dB to +15.9 dB relative to 1V/Pa to be applied. The corresponding display range for the indicated sound level is -50 dB to +180 dB.

Self-noise levels
The self-noise is measured with the calibration set to –26.0 dB corresponding to a microphone sensitivity of 50 mV/Pa. For voltage input, the level 0 dB then corresponds to 1µV. Typical values for the self-noise are 5 dB lower than the values stated.

Noise measured with 18 pF microphone dummy and microphone preamplifier Nor1209, averaged over 30 s of measurement time:
A-weighted: 13 dB
C-weighted: 15 dB
Z-weighted: 25 dB
1/3 oct: 6.3 Hz to 250 Hz: 10 dB
1/3 oct: 315 Hz to 20 kHz: 5 dB

Noise measured with Nor1225 microphone and preamplifier Nor1209, averaged over 30 s of measurement time:
A-weighted: 18 dB
C-weighted: 22 dB
Z-weighted: 30 dB
1/3 oct: 6.3 Hz to 250 Hz: 15 dB
1/3 oct: 315 Hz to 20 kHz: 10 dB

Power supply
Batteries: 4 cells, IEC LR6, AA-sized
Typical battery life time: up to 14 hours

Overall Performance

The Nor140 fulfill the following standards set for sound level meters, 1/1-octave and 1/3 octave filters:

IEC61672-1:2002 class 1, IEC60651 class 1, IEC60804 class 1, IEC61260 class 1, ANSI S1.4-1983 (R2001) with amendment S1.4A-1985 class 1, ANSI S1.43-1997 (R2002) class 1, ANSI S1.11-2004 class 1.

External DC: 11 - 16V. Power consumption approximately 1.2W depending on selected modes of operation. The mains adapter Nor340 is recommended for use with the instrument. If the external supply falls below 9 V, the instrument will use the internal batteries if available. If the instrument switched itself off due to loss of power, it will automatically switch on and resume normal operation after reapplying the external DC supply.

Display
The display is a monochrome, transreflective LCD graphical display with 160×240 pixels (W×H) with automatic temperature compensation for contrast and viewing angle. Pressing the light key illuminates the display. The light switches off automatically two minutes after the last operation of any key. The bargraph display covers 80 dB which may be scrolled in 10 dB steps to cover the total range.

Signal generator output
Max output voltage: ±10V
Output impedance: <100Ωohm. The output is short-circuit proof to GND and output current is in excess of 3 mA.
Gain accuracy at 1 kHz: ±0.2 dB
Frequency response re. 1 kHz: ±0.5 dB for 20 Hz < f< 20 kHz

AC-out: 3,5 mm stereo jack. Both channels have identical signals driven by two separate amplifiers. Load impedance shall be 16 ohm or more. Output voltage is generated by the 48 kHz DAC based on data from DSP. Full scale on the display bargraph corresponds to 100 mV.
Output impedance: Less than 10 ohm, AC-coupled 100 µF.
Gain accuracy 1 kHz: ±0,2 dB
Frequency response re. 1 kHz: ±0,5 dB for 20 Hz < f < 20 kHz.

USB interface: USB type 2.0

USB socket: B411
Serial I/O port:
RS232 port, 9600 - 115200 baud.
Digital inputs: 3 pc
Digital outputs: 4 pc

SD Memory Card
The instrument may use SD memory card for storing of setup information, sound recordings and measurement results. SD memory card included in the delivery.

Data storage
Measured data is stored in the internal memory of the sound level meter or on the SD memory card. The internal memory is of the "flash" type retaining the information without battery supply. Approximately 25 Mbyte is available for the data storage.

Environmental condition for operation
Temperature: –10°C to +50°C
Humidity: 5% to 90% RH, dewpoint less than 40°C.
Atmospheric pressure: 85 kPa to 108 kPa.

Environmental condition for storage
Temperature: –30°C to +60°C
Humidity: 5% to 90% RH, dewpoint less than 40°C.
Atmospheric pressure: 50 kPa to 108 kPa.

Dimensions:
Depth: 30 mm, **Width:** 75 mm,
Weight incl. batteries: 410 g
Length, excl.microphone/ preamplifier: 210 mm
Length, incl. microphone/ preamplifier: 292 mm

Some of the feature listed in this leaflet may be optional in certain markets. Contact your local representative or the factory for details.

Norsonic reserve the right to amend any of the information given in this leaflet in order to take advantage of new developments.

Distributor:

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info@norsonic.com www.norsonic.com

11.2008

Cartridge Overview

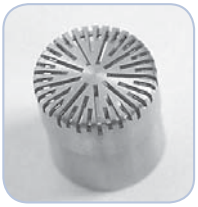
Below is a summary of our range of microphone cartridges.

Nor1220 is a ½" free-field response microphone with a high sensitivity.A general purpose microphone with an integral actuator grid to allow electrostatic calibration checks to be carried out without removing the protection grid. Conforms to IEC 61672 Class 1.

Nor1225 is a ½" free-field high sensitivity microphone. A general purpose microphone covering the frequency range from 3.15Hz to 20 kHz. Correspond to the Class 1 of the sound level meter standard IEC 61672.

Nor1227 is a ½" free-field, high sensitivity self-polarised microphone for use in applications where environmental or safety considerations do not permit the use of 200-volt polarisation supplies, or as a general IEC 61672 Class 1 microphone in sound level meters with no polarisation voltage.

Nor1228 is a ½" free-field, high sensitivity, low cost self-polarised Class 1 microphone. Ideal for use in multi channels systems or other applications that requires a self polarised IEC 61672 Class 1 microphone at low cost.



Nor1229 is a ½" free-field, high sensitivity, low cost self-polarised Class 2 microphone. Ideal for use in multi channels systems or other applications that requires a self polarised microphone at low cost with Class 2 accuracy. Unlike most other low cost Class 2 microphones it features a nickel membrane and a stainless steel housing, ensuring low sensitivity to environmental parameters such as temperature, static pressure and humidity.

Selection chart microphone cartridges

Parameter	Unit	Microphone type No.				
		Nor1220	**Nor1225**	**Nor1227**	**Nor1228**	**Nor1229**
Cartridge size	"	½"	½"	½"	½"	½"
Main standard		IEC 61672 Class 1	IEC 61672 Class 1	IEC 61672 Class 1	IEC 61672 Class 1	IEC 61672 Class 2
Polarisation voltage	V	200	200	0	0	0
IEC 61094-4 type Designation	—	WS2F Free-field	WS2F Free-field	WS2F Free-field	WS2F Free-field	WS2F Free-field
Nomial sensitivity@ 250Hz	mV/Pa	50	50	50	50	40
Frequency Respons ±1dB ±3dB	Hz Hz	12.5-10k 3.15-16k	12.5-10k 3.15-20k	10-8k 6.3-20k	20-10k 12.5-16k	– 20-10k
Maximum SPL 3%	dB	146	146	146	146	146
Self noise Based on typical thermal noise	dB(A)	14	15	15	16	24
Response		Free field	Free field	Free field	Free field	Free field
Capacitance	pF	20	18	14	16	13
Effective front volume	mm^3	40	50	50	50	45
Temperature coeff. @250Hz -10 to +50°C -40 to +150°C	dB/°C	-0.01 —	<-0.005 <-0.01	<-0.005 <-0.01	<-0.005 —	<-0.01 —
Max. temperature	°C	100	300	150	80	80
Static pressure coeff @250Hz	dB/kPa	-0.001	-0.0008	-0.0008	-0.004	±0.03
Realtive humidity NM = not measureable 0-100% RH no condensation	dB/%	NM	NM	NM	-0.003	±0.006
Vibration sensitivity SPL for 0.1g perpendicular do diaphragm	dB	62	62	62	62	65
Magnetic field effect SPL for field strength of 80A/m	dB	4	3.5	3.5	4	5
Diameter with protection grid	mm	13.2	13.2	13.2	13.2	13.2
Length with protection grid	mm	16.4	16.2	16.2	17.3	16.6
Weight with protection grid	g	9	6	6	9	7

Norsonic
P.O.Box 24, N-3421 Lierskogen, Norway
Tel.: +47 3285 8900 Fax.: +47 3285 2208
info@norsonic.com www.norsonic.com

Distributor:

CERTIFICATE of CALIBRATION

Make :	Norsonic	Reference # :	151799
Model :	NOR140	Customer :	Valcoustics Canada Ltd Richmond Hill, ON
Descr. :	Sound Level Meter Type 1		
Serial # :	1404590	P. Order :	Visa-Michael Light
Asset # :	A00282SM		

Cal. status : Received out of spec's, adjustments made.
Cal with 1227Mic sn:142243 & 1209 Preamp sn:13992

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

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

Our calibration system complies with the requirements of ISO-17025 standard, working standards used for calibration are certified by or traceable to the National Research Council of Canada or the National Institute of Standards and Technology.

Calibrated : Mar 07, 2018 By : T. Beilin

Cal. Due : Mar 07, 2019

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

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

Navair Technologies

REPAIR AND CALIBRATION TRACEABLE TO NRC AND NIST
6375 Dixie Rd. Mississauga, ON, L5T 2E7
Phone : 905 565 1584 Fax: 905 565 8325
http: // www.navair.com
e-Mail: service @ navair.com

NT NAVAIR TECHNOLOGIES

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

Form:NOR140	Approved by:JR	Date:Jan/2015	ver1.1

Calibration Report part of Certificate: 151799

Make	Model	Serial	Asset
Norsonic	NOR140	1404590	A00282SM

With mike NOR1227 s# 142243 preamp 1209 s# 13992
TYPE 1 Specs

Test	Reading	In/Out

Freq.Response
Tested with dummy mike IEC61672-1 limits
WTG Curve Check

kHz	Min	A	Max	
0.0315	72.6	74.5	76.6	In
0.063	86.3	87.7	89.3	In
0.125	96.4	97.8	99.4	In
0.25	103.9	105.3	106.8	In
0.5	109.4	110.7	112.2	In
1	112.9	114.0	115.1	In
2	113.6	115.2	116.8	In
4	113.4	114.9	116.6	In
8	109.8	112.8	115.0	In
12.5	103.7	109.8	112.7	In
		C		
0.0315	109.0	110.9	113.0	In
0.063	111.7	113.1	114.7	In
0.125	112.3	113.8	115.3	In
0.25	112.5	114.0	115.4	In
0.5	112.6	114.0	115.4	In
1	112.9	114.0	115.1	In
2	112.2	113.8	115.4	In
4	111.6	113.1	114.8	In
8	107.9	110.9	113.1	In
12.5	101.8	107.9	110.8	In

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

151799

Test	Reading			In/Out
		Z		
0.0315	112.0	114.0	116.0	In
0.063	112.5	114.0	115.5	In
0.125	112.5	114.0	115.5	In
0.25	112.5	114.0	115.4	In
0.5	112.6	114.0	115.4	In
1	112.9	114.0	115.1	In
2	112.4	114.0	115.6	In
4	112.4	114.0	115.6	In
8	110.9	114.0	116.1	In
12.5	108.0	114.0	117.0	In
Scale Test with microphone				
Scale				
dBc @1kHz				
I/P dB				
120dB Range				
114	113.5	114.0	114.5	In
104	103.5	104.0	104.5	In
94	93.5	94.0	94.5	In
130dB Range				
114	113.0	114.0	115.0	In
110dB Range				
104	103.0	104.0	105.0	In
94	93.0	94.0	95.0	In
100dB Range				
94	83.0	94.0	95.0	In
Impulse Test				Pass
Fast/Slow				Pass
AC O/P				Pass

NT NAVAIR TECHNOLOGIES

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

Before

Test	Min	Reading	Max	In/Out
Scale Test with microphone				
Scale				
dBc @1kHz				
I/P dB				
120dB Range				
114	113.5	113.2	114.5	Out
104	103.5	103.2	104.5	Out
94	93.5	93.2	94.5	Out

CERTIFICATE of CALIBRATION

Make :	Norsonic	Reference # :	151644
Model :	NOR140	Customer :	Valcoustics Canada Ltd Richmond Hill, ON
Descr. :	Sound Level Meter Type 1		
Serial # :	1404671	P. Order :	Visa-Michael Light
Asset # :	A00313SM		

Cal. status : Received out of spec's, adjustments made.
Level cal. done.

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

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

Our calibration system complies with the requirements of ISO-17025 standard, working standards used for calibration are certified by or traceable to the National Research Council of Canada or the National Institute of Standards and Technology.

Calibrated : Feb 22, 2018 By : T. Beilin

Cal. Due : Feb 22, 2019

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

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

Navair Technologies

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

Form:NOR140	Approved by:JR	Date:Jan/2015	ver1.1

Calibration Report part of Certificate: 151644

Make	Model	Serial	Asset
Norsonic	NOR140	1404671	A00313SM

With mike NOR1227 s# 142316 preamp 1209 s# 14464
TYPE 1 Specs

Test	Reading	In/Out

Freq.Response
Tested with dummy mike IEC61672-1 limits
WTG Curve Check

kHz	Min	A	Max	
0.0315	72.6	74.4	76.6	In
0.063	86.3	87.8	89.3	In
0.125	96.4	97.8	99.4	In
0.25	103.9	105.3	106.8	In
0.5	109.4	110.7	112.2	In
1	112.9	114.0	115.1	In
2	113.6	115.2	116.8	In
4	113.4	114.9	116.6	In
8	109.8	112.8	115.0	In
12.5	103.7	109.8	112.7	In
		C		
0.0315	109.0	111.0	113.0	In
0.063	111.7	113.2	114.7	In
0.125	112.3	113.8	115.3	In
0.25	112.5	114.0	115.4	In
0.5	112.6	114.0	115.4	In
1	112.9	114.0	115.1	In
2	112.2	113.8	115.4	In
4	111.6	113.1	114.8	In
8	107.9	110.9	113.1	In
12.5	101.8	107.8	110.8	In

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Fax: (905)565-8325

151644

Test	Reading			In/Out
		Z		
0.0315	112.0	113.9	116.0	In
0.063	112.5	113.9	115.5	In
0.125	112.5	114.0	115.5	In
0.25	112.5	114.0	115.4	In
0.5	112.6	114.0	115.4	In
1	112.9	114.0	115.1	In
2	112.4	114.0	115.6	In
4	112.4	114.0	115.6	In
8	110.9	113.9	116.1	In
12.5	108.0	113.9	117.0	In
Scale Test with microphone				
Scale				
dBc @1kHz				
I/P dB				
120dB Range				
114	113.5	113.9	114.5	In
104	103.5	103.9	104.5	In
94	93.5	93.9	94.5	In
130dB Range				
114	113.0	113.9	115.0	In
110dB Range				
104	103.0	103.9	105.0	In
94	93.0	93.9	95.0	In
100dB Range				
94	83.0	93.9	95.0	In
Impulse Test				Pass
Fast/Slow				Pass
AC O/P				Pass

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Fax: (905)565-8325

151644

Before

Scale Test with microphone
Scale
dBc @1kHz
I/P dB
120dB Range

114	113.5	112.2	114.5	Out
104	103.5	102.2	104.5	Out
94	93.5	92.2	94.5	Out

CERTIFICATE of CALIBRATION

Make : Bruel & Kjaer

Reference # : 154904

Model : 4231

Customer : Valcoustics Canada Ltd
Richmond Hill, ON

Descr. : Sound cal 94/114dB 1KHz Type 1

Serial # : 2309067

P. Order :

Asset # : A00089

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

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

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

Our calibration system complies with the requirements of ISO-9001-2015 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 : Dec 17, 2018

By : J. Raposo

Cal. Due : Dec 17, 2019

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

Standards used : J-163 J-261 J-282 J-512

Navair Technologies

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Fax: (905)565-8325

Form:BK4231	Approved By:JR Nov/07	ver 2.1

Calibration Report part of Certificate #: 154904

Make	Model	Serial	Asset	Cal. By
Bruel&K	4231	2309067	A00089	jr

Test	Reading	Spec's	In/Out
SPL at 98.9kPa ref 20µPa			
94dB	94.0	±.2dB	In
114dB	114.0	±.2dB	In
FREQ. ACCURACY			
1000Hz	1000.0	±1Hz	In

CAMPBELL SCIENTIFIC

Calibration Certificate

Calibration Procedure No.
PR-025-ISO

ilac-MRA A2LA ACCREDITED CERT #4227.01

Certificate Number:	ISO_W201809-001-0	**Customer:**	Valcoustics Canada Ltd.
RMA Number:	27662		25 - 30 Wertheim Court
Description:	Wind Monitor		Richmond Hill ON
Manufacturer:	RM Young		Canada L4B 1B9
Model:	05103 Series	**Lab Temperature:**	22.1°C
UUT Serial Number:	124098	**Lab Relative Humidity:**	33.3%
As Found Condition:	Out of Tolerance	**Date of Calibration:**	September 12, 2018
As Left Condition:	In Tolerance	**Calibration Due Date:**	September 12, 2019
Adjustment Made:	Yes	**Interval:**	1 Year
Comments:			

Calibration Equipment

	Manufacturer	Model	Serial No.	Certificate No.	Cal Due Date
DC Calibration Source	Krohn-Hite	523	DD50002	13134337	January 4, 2019
Digital Multimeter	Agilent	34410A	MY45002508	13117158REV1	December 27, 2018

The instrument listed above has been calibrated using policies and procedures that comply with ISO/IEC 17025:2005 and equipment traceable through NIST standards. The calculated uncertainty was scaled with a K = 2 coverage factor that results in an expanded uncertainty with a confidence level of 95%. Any statement of compliance is made without taking uncertainty into account and is based on the Unit Under Test performance against tolerance only.

The data on the certificate is accurate at the time of calibration and depending on certain factors such as environmental, duration of use, or location of installation, the accuracy of the instrument may be reduced.

CAMPBELL SCIENTIFIC

Calibration Certificate

Calibration Procedure No.
PR-025-ISO

ilac-MRA A2LA ACCREDITED CERT #4227.01

Certificate Number:	ISO_W201809-001-0	**Description:**	Wind Monitor
RMA Number:	27662	**Manufacturer:**	RM Young
Date of Calibration:	September 12, 2018	**Model:**	05103 Series
Calibration Due Date:	September 12, 2019	**UUT Serial Number:**	124098

Functional Check*

	BEFORE SERVICE	AFTER SERVICE
Propeller Shaft Alignment	GOOD	GOOD
Vane Balance	GOOD	GOOD
Flange Bearings	GOOD	GOOD
Vertical Shaft Bearings	GOOD	GOOD

*Functional Check outcomes are not taken into account when determining "As Found" and "As Left" condition.

Voltage Calibration (Wind Direction)

		AS FOUND			AS LEFT				
Test Point	**Range (Degrees)**	**UUT(V)**	**UUT(°)**	**Result**	**UUT(V)**	**UUT(°)**	**Result**	**Tolerance**	**Uncertainty**
I.A.1.a	0.0°	0.0070	0.70	PASS	0.0064	0.64	PASS	±3.0°	0.77°
I.A.1.b	20.0°	0.2057	20.57	PASS	0.2172	21.72	PASS	±3.0°	0.76°
I.A.1.c	40.0°	0.4091	40.91	PASS	0.4209	42.09	PASS	±3.0°	0.75°
I.A.1.d	60.0°	0.6065	60.65	PASS	0.6229	62.29	PASS	±3.0°	0.74°
I.A.1.e	80.0°	0.8093	80.93	PASS	0.8227	82.27	PASS	±3.0°	0.73°
I.A.1.f	100.0°	1.0097	100.97	PASS	1.0136	101.36	PASS	±3.0°	0.72°
I.A.1.g	120.0°	1.2041	120.41	PASS	1.2118	121.18	PASS	±3.0°	0.70°
I.A.1.h	140.0°	1.4030	140.30	PASS	1.4077	140.77	PASS	±3.0°	0.69°
I.A.1.i	160.0°	1.5973	159.73	PASS	1.6030	160.30	PASS	±3.0°	0.68°
I.A.1.j	180.0°	1.7964	179.64	PASS	1.8019	180.19	PASS	±3.0°	0.67°
I.A.1.k	200.0°	1.9918	199.18	PASS	1.9882	198.82	PASS	±3.0°	0.66°
I.A.1.l	220.0°	2.1916	219.16	PASS	2.1807	218.07	PASS	±3.0°	0.65°
I.A.1.m	240.0°	2.3937	239.37	PASS	2.3783	237.83	PASS	±3.0°	0.64°
I.A.1.n	260.0°	2.5914	259.14	PASS	2.5764	257.64	PASS	±3.0°	0.63°
I.A.1.o	280.0°	2.8000	280.00	PASS	2.7781	277.81	PASS	±3.0°	0.62°
I.A.1.p	300.0°	3.0038	300.38	PASS	2.9841	298.41	PASS	±3.0°	0.61°
I.A.1.q	320.0°	3.2006	320.06	PASS	3.1847	318.47	PASS	±3.0°	0.60°
I.A.1.r	340.0°	3.4088	340.88	PASS	3.3963	339.63	PASS	±3.0°	0.59°
I.A.1.s	355.0°	0.0000	0.00	FAIL	3.5438	354.38	PASS	±3.0°	0.77°

Frequency Calibration (Wind Speed)

		AS FOUND			AS LEFT				
Test Point	**Range (RPM)**	**UUT(Hz)**	**UUT(RPM)**	**Result**	**UUT(Hz)**	**UUT(RPM)**	**Result**	**Tolerance(RPM)**	**Uncertainty**
II.A.1.a	1000.0	50.00	1000.0	PASS	50.00	1000.0	PASS	±61.2 RPM	3.0 RPM
II.A.1.b	2000.0	100.00	2000.0	PASS	100.00	2000.0	PASS	±61.2 RPM	3.1 RPM
II.A.1.c	3000.0	150.00	3000.0	PASS	150.00	3000.0	PASS	±61.2 RPM	3.1 RPM
II.A.1.d	4000.0	200.01	4000.2	PASS	200.00	4000.0	PASS	±61.2 RPM	3.1 RPM
II.A.1.e	5000.0	250.00	5000.0	PASS	250.01	5000.2	PASS	±61.2 RPM	3.2 RPM
II.A.1.f	6000.0	300.00	6000.0	PASS	300.02	6000.4	PASS	±61.2 RPM	3.2 RPM
II.A.1.g	7000.0	350.01	7000.2	PASS	350.01	7000.2	PASS	±61.2 RPM	3.2 RPM
II.A.1.h	8000.0	400.01	8000.2	PASS	400.02	8000.4	PASS	±61.2 RPM	3.3 RPM
II.A.1.i	9000.0	450.01	9000.2	PASS	450.01	9000.2	PASS	±61.2 RPM	3.3 RPM
II.A.1.j	10000.0	500.00	10000.0	PASS	500.01	10000.2	PASS	±61.2 RPM	3.3 RPM

UUT=Unit Under Test

Calibrated by: Michael Dar **Reviewed by:** Jacques Bouchard

CERTIFICATE of CALIBRATION

Make : Norsonic

Model : NOR140

Descr. : Sound Level Meter Type 1

Serial # : 1404670

Asset # : A00312SM

Reference # : 156052

Customer : Valcoustics Canada Ltd
Richmond Hill, ON

P. Order :

Cal. status : Received out of spec's, adjustments made.
Cal with 1227 Mic sn:142316 & 1209 Preamp sn:14464

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

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

Our calibration system complies with the requirements of ISO-17025 standard, working standards used for calibration are certified by or traceable to the National Research Council of Canada or the National Institute of Standards and Technology.

Calibrated : Mar 28, 2019

By : T. Beilin

Cal. Due : Mar 28, 2020

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

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

Navair Technologies

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

Form:NOR140	Approved by:JR	Date:Jan/2015	ver1.1

Calibration Report part of Certificate: 156052

Make	Model	Serial	Asset
Norsonic	NOR140	1404670	A00312SM

With mike NOR1227 s# 142316 preamp 1209 s# 14464
TYPE 1 Specs

Test	Reading	In/Out

Freq.Response
Tested with dummy mike IEC61672-1 limits
WTG Curve Check

kHz	Min	A	Max	
0.0315	72.6	74.3	76.6	In
0.063	86.3	87.7	89.3	In
0.125	96.4	97.8	99.4	In
0.25	103.9	105.3	106.8	In
0.5	109.4	110.7	112.2	In
1	112.9	114.0	115.1	In
2	113.6	115.2	116.8	In
4	113.4	114.9	116.6	In
8	109.8	112.8	115.0	In
12.5	103.7	109.8	112.7	In
		C		
0.0315	109.0	1109.0	113.0	In
0.063	111.7	113.1	114.7	In
0.125	112.3	113.8	115.3	In
0.25	112.5	114.0	115.4	In
0.5	112.6	114.0	115.4	In
1	112.9	114.0	115.1	In
2	112.2	113.8	115.4	In
4	111.6	113.1	114.8	In
8	107.9	110.9	113.1	In
12.5	101.8	107.8	110.8	In

6375 Dixie Rd Unit# 7,
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Tel: (905)565-1583
Fax: (905)565-8325

156052

Test	Reading			In/Out
		Z		
0.0315	112.0	113.8	116.0	In
0.063	112.5	114.0	115.5	In
0.125	112.5	114.0	115.5	In
0.25	112.5	114.0	115.4	In
0.5	112.6	114.0	115.4	In
1	112.9	114.0	115.1	In
2	112.4	114.0	115.6	In
4	112.4	114.0	115.6	In
8	110.9	114.0	116.1	In
12.5	108.0	114.0	117.0	In
Scale Test with microphone				
Scale				
dBc @1kHz				
I/P dB				
120dB Range				
114	113.5	114.1	114.5	In
104	103.5	104.1	104.5	In
94	93.5	94.1	94.5	In
130dB Range				
114	113.0	114.1	115.0	In
110dB Range				
104	103.0	104.1	105.0	In
94	93.0	94.1	95.0	In
100dB Range				
94	83.0	94.1	95.0	In
Impulse Test				Pass
Fast/Slow				Pass
AC O/P				Pass

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

156052

Before
dBc @1kHz
I/P dB
120dB Range

114	113.5	113.2	114.5	OUT
104	103.5	103.2	104.5	OUT
94	93.5	93.2	94.5	OUT

CERTIFICATE of CALIBRATION

Make : Bruel & Kjaer

Reference # : 154904

Model : 4231

Customer : Valcoustics Canada Ltd
Richmond Hill, ON

Descr. : Sound cal 94/114dB 1KHz Type 1

Serial # : 2309067

P. Order :

Asset # : A00089

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

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

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

Our calibration system complies with the requirements of ISO-9001-2015 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 : Dec 17, 2018

By : J. Raposo

Cal. Due : Dec 17, 2019

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

Standards used : J-163 J-261 J-282 J-512

Navair Technologies

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Fax: (905)565-8325

Form:BK4231	Approved By:JR Nov/07	ver 2.1

Calibration Report part of Certificate #: 154904

Make	Model	Serial	Asset	Cal. By
Bruel&K	4231	2309067	A00089	jr

Test	Reading	Spec's	In/Out
SPL at 98.9kPa ref 20µPa			
94dB	94.0	±.2dB	In
114dB	114.0	±.2dB	In
FREQ. ACCURACY			
1000Hz	1000.0	±1Hz	In

Warranty

Norsonic products are thoroughly inspected before they leave the factory. Carefully check the shipment for any physical damage in transit. Notify the factory or the distributor and file the claim with the carrier if there is any such damage.

Product type:	Environmental cabinet incl. Nor150 HW
Serial no.:	15313538
Power:	90-264 Volt AC
Option included:	3,4,11,12
Option description:	03: 1/1 & 1/3 octave filters 0,1-20kHz with reference spectrum and QC test 04: Audio recording and markers 11: Enhanced noise assessment package with profile B and noise monitoring scheduler 12: NorCloud

Application version:	2.1.2315	
Id no.:	12153921	
Accessories:	Preamplifier 1: 1209A	Serial No.: 12525
	Microphone 1: 1227	Serial No.: 322148
Related to order:	SO1843012	

Checked and approved by: E.March **Date:** 2018-11-23

Warranty statement

Norsonic products are warranted against defects in material and workmanship. This warranty applies to 36 months from date of delivery. Rechargeable batteries and commercial available computer products and peripherals such as modems, printers etc supplied by Norsonic is covered by a 12 month warranty, unless other stated.
Norsonic AS will repair or replace equipment, which proves to be defective during the warranty period. This warranty includes labour and parts. Equipment returned to the factory, for repair must be shipped freight prepaid.
Repair due to misuse of the equipment and/or use of hardware, software or interfacing not provided by Norsonic AS are not covered by this warranty.
No other warranty is expressed or implied, included, but not limited to, the implied warranties of merchantability and fitness for a particular purpose.
Norsonic AS shall not be liable for consequential damages.

Norsonic AS, P.B 24, 3421 Lierskogen. Visitor address: Gunnersbråtan 2, Tranby, Norway.
Phone +47 32858900 Fax.: +47 32852208. email: info@norsonic.com

Certificate of Calibration

Certificate No.: 4712153921

Object:	Environmental cabinet incl. Nor150 HW
Supplier:	Norsonic AS
Type:	Nor1531/150
Serial number:	15313538
Client:	Valcoustics, Richmond Hill, Ontario, Canada.

This instrument is tested and calibrated in accordance to the Norsonic production standard set for Nor150, ensuring that the instrument conforms to the following standards;

IEC 61672-1:2002 class 1
IEC 61260-1 class 1 Ed 1.0 2014-02
ANSI S1.4-1983 (R2001) with amd. S1.4A-1985 class 1
ANSI S1.43-1997 (R2002) class 1
ANSI S1.11-2004 class 1
DIN 45 657, Applicable parts
IEC 61094 part 4

Instrumentation used for calibration traceable to:

Electrical Parameters: MT, Norway
Acoustical Parameters: PTB, Germany
Environmental Parameters: Justervesenet. Norway

Adjustments: None

Comments: None

Date of calibration:	**Calibration interval recommended**
2018-11-23	2 years

The environmental parameters applicable to this calibration are kept well within limits ensuring negligible deviation on obtained measurement results.

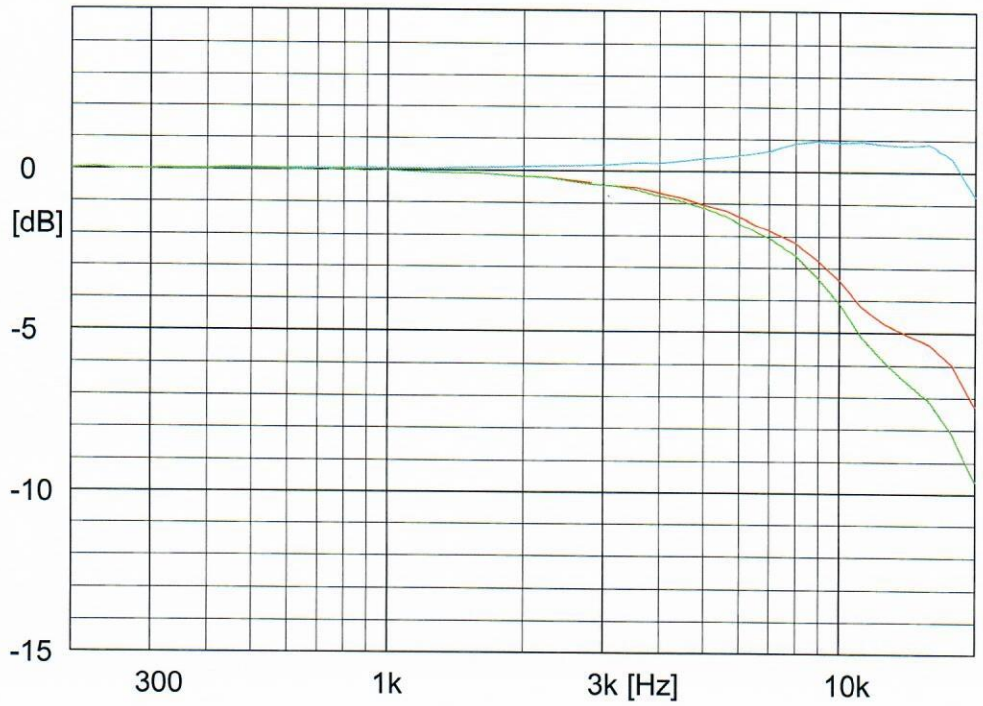
Calibrated by:

E. Mørch

Sign.

Norsonic AS, P.B 24, 3421 Lierskogen. Visitor address: Gunnersbråtan 2, Tranby, Norway.
Phone +47 32858900 Fax.: +47 32852208. email: info@norsonic.com

Microphone Calibration Certificate



Norsonic
Type: 1227

Serial no: 322148

Sensitivity: 51,6 mV/Pa
-25,7 dB re. 1 V/Pa
Capacitance: 13,1 pF
Date: 2018-11-21

Signature: E. March

Measurement conditions:

Polarisation voltage:	0,0 V
Pressure:	100,30 kPa
Temperature:	23,3 °C
Relative humidity:	37,5 %RH

Results are normalized to the reference conditions.

Free field response
Diffuse field response
Pressure (Actuator) response

Norsonic AS
www.norsonic.com

Microphone Specifications

Calibration of your microphone cartridge has been made with utmost care to meet all your needs for a high quality measurement device. The calibration is traceable to PTB in Germany.

Nominal Specifications

Ambient temperature coeffecient: 0.01 dB/°C
Ambient pressure coeffecient: -1×10^{-5} dB/Pa
Temperature range: -30 to +70°C
Diameter: 13.2 mm with protection grid on,
12.7 mm without protection grid
Thread for preamp mounting: 11.7 mm 60 UNS

Reference Values

Temperature: 23°C
Relative humidity: 50%
Ambient pressure: 101.325 kPa
Test frequency for sensitivity: 250 Hz

Norsonic Warranty Statement

The warranty period for microphones is 36 months after the time of delivery.
The warranty does not include damage due to improper handling, overload, force majeur, or normal wear and tear. The warranty is not granted if the buyer make modifications or repairs without our written consent. Norsonic can choose either to repair or replace microphones having defects due to material or workmanship. Defective goods should be returned to our factory or one of our distributors, and shipments are to be paid and insured by the buyer unless otherwise agreed.

CERTIFICATE of CALIBRATION

Make :	Bruel & Kjaer	Reference # :	159853
Model :	4231	Customer :	Valcoustics Canada Ltd Richmond Hill, ON
Descr. :	Sound cal 94/114dB 1KHz Type 1		
Serial # :	2309067	P. Order :	Michael VISA
Asset # :	A00089		

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

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

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

Our calibration system complies with the requirements of ISO-17025 standard, working standards used for calibration are certified by or traceable to the National Research Council of Canada or the National Institute of Standards and Technology.

Calibrated : Dec 18, 2019 By : J. Raposo

Cal. Due : Dec 18, 2020

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

Standards used : J-163 J-261 J-282 J-512

Navair Technologies

REPAIR AND CALIBRATION TRACEABLE TO NRC AND NIST

6375 Dixie Rd. Mississauga, ON, L5T 2E7
Phone : 800-668-7440 Fax: 905 565 8325
http: // www.navair.com
e-Mail: service @ navair.com

NT NAVAIR TECHNOLOGIES

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

Form:BK4231	Approved By:JR Nov/07	ver 2.1

Calibration Report part of Certificate #: 159553

Make	Model	Serial	Asset	Cal. By
Bruel&K	4231	2309067	A00089	jr

Test	Reading	Spec's	In/Out
SPL at 99.1kPa ref 20µPa			
94dB	94.0	±.2dB	In
114dB	114.0	±.2dB	In
FREQ. ACCURACY			
1000Hz	1000.0	±1Hz	In

Calibration Certificate

Calibration Procedure No.
PR-025-ISO

ACCREDITED
CERT #4227.01

Date of Issue:	March 4, 2020	**Customer:**	Valcoustics Canada Ltd.
Certificate Number:	ISO_W202003-001-0		
RMA Number:	28791		25 - 30 Wertheim Court
Description:	Wind Monitor		Richmond Hill ON
Manufacturer:	RM Young		Canada L4B 1B9
Model:	05103 Series	**Lab Temperature:**	22.0°C
UUT Serial Number:	111705	**Lab Relative Humidity:**	30.2%
As Found Condition:	In Tolerance	**Date of Calibration:**	March 2, 2020
As Left Condition:	In Tolerance	**Calibration Due Date:**	March 2, 2021
Adjustment Made:	Yes	**Interval:**	1 Year
Comments:			

Calibration Equipment

	Manufacturer	Model	Serial No.	Certificate No.	Cal Due Date
DC Calibration Source	Krohn-Hite	523	BG50124	14542429	April 9, 2020
Digital Multimeter	Agilent	34410A	MY47025216	14979494	September 12, 2020
Wind Drive	RM Young	18802	CA 02008	1715	September 4, 2020

The instrument listed above has been calibrated using policies and procedures that comply with ISO/IEC 17025:2017, equipment traceable through NIST standards and the International System of Units (SI). The statement of conformity is only for the instrument listed above. The calculated uncertainty was scaled with a K = 2 coverage factor that results in an expanded uncertainty with a confidence level of 95%. Any statement of compliance is made without taking uncertainty into account and is based on the Unit Under Test performance against tolerance only.

The data on the certificate is accurate at the time of calibration and depending on certain factors such as environmental, duration of use, or location of installation, the accuracy of the instrument may be reduced.

CAMPBELL SCIENTIFIC

Calibration Certificate

Calibration Procedure No.
PR-025-ISO

ilac-MRA A2LA ACCREDITED CERT #4227.01

Certificate Number:	ISO_W202003-001-0	**Description:**	Wind Monitor
RMA Number:	28791	**Manufacturer:**	RM Young
Date of Calibration:	March 2, 2020	**Model:**	05103 Series
Calibration Due Date:	March 2, 2021	**UUT Serial Number:**	111705

Functional Check[1]

	BEFORE SERVICE	AFTER SERVICE
Propeller Shaft Alignment	GOOD	GOOD
Vane Balance	GOOD	GOOD
Flange Bearings	GOOD	GOOD
Vertical Shaft Bearings	GOOD	GOOD

[1]Functional Check outcomes are not taken into account when determining "As Found" and "As Left" condition.

Voltage Calibration (Wind Direction)

		AS FOUND			AS LEFT					
Test Point	**Range(°)**[2]	**UUT (V)**	**UUT (°)**[2]	**Result**	**UUT (V)**	**UUT (°)**[2]	**Result**	**Tolerance (°)**[2]	**Tolerance (mV)**	**Uncertainty (mV)**
I.A.1.a	0.0°	0.0137	1.37	PASS	As Found	As Found	PASS	±3.0°	±30 mV	5.8 mV
I.A.1.b	20.0°	0.2112	21.12	PASS	As Found	As Found	PASS	±3.0°	±30 mV	6.0 mV
I.A.1.c	40.0°	0.4107	41.07	PASS	As Found	As Found	PASS	±3.0°	±30 mV	6.2 mV
I.A.1.d	60.0°	0.6101	61.01	PASS	As Found	As Found	PASS	±3.0°	±30 mV	6.4 mV
I.A.1.e	80.0°	0.8065	80.65	PASS	As Found	As Found	PASS	±3.0°	±30 mV	6.6 mV
I.A.1.f	100.0°	1.0076	100.76	PASS	As Found	As Found	PASS	±3.0°	±30 mV	6.3 mV
I.A.1.g	120.0°	1.2078	120.78	PASS	As Found	As Found	PASS	±3.0°	±30 mV	6.3 mV
I.A.1.h	140.0°	1.4062	140.62	PASS	As Found	As Found	PASS	±3.0°	±30 mV	6.4 mV
I.A.1.i	160.0°	1.6086	160.86	PASS	As Found	As Found	PASS	±3.0°	±30 mV	6.4 mV
I.A.1.j	180.0°	1.8094	180.94	PASS	As Found	As Found	PASS	±3.0°	±30 mV	6.5 mV
I.A.1.k	200.0°	2.0058	200.58	PASS	As Found	As Found	PASS	±3.0°	±30 mV	6.1 mV
I.A.1.l	220.0°	2.2050	220.50	PASS	As Found	As Found	PASS	±3.0°	±30 mV	6.1 mV
I.A.1.m	240.0°	2.4059	240.59	PASS	As Found	As Found	PASS	±3.0°	±30 mV	6.1 mV
I.A.1.n	260.0°	2.6036	260.36	PASS	As Found	As Found	PASS	±3.0°	±30 mV	6.2 mV
I.A.1.o	280.0°	2.8043	280.43	PASS	As Found	As Found	PASS	±3.0°	±30 mV	6.0 mV
I.A.1.p	300.0°	3.0030	300.30	PASS	As Found	As Found	PASS	±3.0°	±30 mV	6.0 mV
I.A.1.q	320.0°	3.2098	320.98	PASS	As Found	As Found	PASS	±3.0°	±30 mV	6.0 mV
I.A.1.r	340.0°	3.4098	340.98	PASS	As Found	As Found	PASS	±3.0°	±30 mV	6.1 mV
I.A.1.s	355.0°	3.5436	354.36	PASS	As Found	As Found	PASS	±3.0°	±30 mV	6.1 mV

Frequency Calibration (Wind Speed)

		AS FOUND			AS LEFT					
Test Point	**Range(RPM)**[2]	**UUT (Hz)**	**UUT (RPM)**[2]	**Result**	**UUT (Hz)**	**UUT (RPM)**[2]	**Result**	**Tolerance (RPM)**[2]	**Tolerance (Hz)**	**Uncertainty (Hz)**
II.A.1.a	1000.0	50.00	1000.0	PASS	50.00	1000.0	PASS	±61.2 RPM	±3.06 Hz	0.022 Hz
II.A.1.b	2000.0	99.99	1999.8	PASS	99.98	1999.6	PASS	±61.2 RPM	±3.06 Hz	0.031 Hz
II.A.1.c	3000.0	150.03	3000.6	PASS	149.97	2999.4	PASS	±61.2 RPM	±3.06 Hz	0.039 Hz
II.A.1.d	4000.0	200.01	4000.2	PASS	200.01	4000.2	PASS	±61.2 RPM	±3.06 Hz	0.048 Hz
II.A.1.e	5000.0	250.01	5000.2	PASS	250.03	5000.6	PASS	±61.2 RPM	±3.06 Hz	0.056 Hz
II.A.1.f	6000.0	300.00	6000.0	PASS	300.01	6000.2	PASS	±61.2 RPM	±3.06 Hz	0.065 Hz
II.A.1.g	7000.0	349.98	6999.6	PASS	350.01	7000.2	PASS	±61.2 RPM	±3.06 Hz	0.073 Hz
II.A.1.h	8000.0	400.02	8000.4	PASS	400.01	8000.2	PASS	±61.2 RPM	±3.06 Hz	0.082 Hz
II.A.1.i	9000.0	450.04	9000.8	PASS	450.01	9000.2	PASS	±61.2 RPM	±3.06 Hz	0.090 Hz
II.A.1.j	10000.0	500.01	10000.2	PASS	500.01	10000.2	PASS	±61.2 RPM	±3.06 Hz	0.099 Hz

[2] *RPM and Angle (°) are not covered by Scope of Accreditation. These measurements are calculated values based on a conversion multiplier.*
UUT = Unit Under Test

Calibrated by: Paul Duperreault **Reviewed by:** Michael Dar

APPENDIX C

NOISE ABATEMENT ACTION PLAN

aercoustics

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

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

16 October 2017, Revised August 31, 2018

Ministry of the Environment and Climate Change
2 St. Clair Avenue West, Floor 12A
Toronto, Ontario
M4V 1L5

Attn: Mohsen Keyvani

Re: Noise Abatement Action Plan – Napier Wind Project (REA #8388-9B7N4J)

1 Introduction

Aercoustics Engineering Ltd ("Aercoustics") has been retained by wpd Napier Wind to provide a Noise Abatement Action plan for the Napier Wind Project to achieve compliance with the Noise Performance Limits prescribed in Section C1(1) of REA #8388-9B7N4J.

Based on the results presented in the Acoustic Immission Audit ("I-audit") report for the Napier Wind Project ("Napier"), dated July 31, 2017, the sound levels the audited point of reception near the Napier wind turbines were found to be above the sound level limits by up to 2 dB. The reason for the exceedance has been attributed to the turbines at the Napier wind farm. Wpd Napier Wind has committed to installing mitigation measures on their turbines to address the acoustic issues and bring the facility into compliance. The plan to install and test these measures is outlined in this report.

Based on feedback with the MOECC[1], wpd Napier has agreed to curtail the Napier turbines during the night-time[2] as a temporary abatement measure while permanent fixes to the turbines are evaluated and tested.

[1] Ontario Ministry of the Environment and Climate Change
[2] 7pm – 7am

2 Napier Sound Levels

2.1 Immission Audit

Between April 12 and July 4, 2017, an I-audit measurement campaign per the 2017 Compliance Protocol for Wind Turbine Noise ("Protocol") was conducted at Napier. The results of this measurement campaign are summarized a corresponding I-audit report, dated July 31, 2017, which states that the Napier turbine sound levels exceeded the sound level limits at the audited point of reception by as much as 2 dB. Results were presented filtered for downwind conditions (I-audit Table 4), as well as all wind directions (I-audit Table 5). Due to the low wind resources available during the time of measurement, not enough data was measured in the downwind condition to make an assessment.

Based on feedback from the MOECC, the I-audit dataset has been re-evaluated to provide more downwind data. Small increases in assessable downwind data were possible by removing the filter for wind gusting, and relaxing the threshold for transient noise (Leq-L90) from 4 dB to 6 dB. The results of this re-evaluated data, including updated tonal audibilities, are summarized in Table 1.

Table 1: Wind-bin average sound levels, Turbine ON & Background, Napier Receptor R020. Downwind only

Wind Bin	Turbine ON Data Points	Turbine ON Sound Level (dBA)	Turbine ON Std Dev	Background Data Points	Background Sound Level* (dBA)	Background Std Dev	Turbine – Corrected**	Exceedance?
1	0	-	-	800	35	6.0	-	n/a
2	0	-	-	241	43	7.9	-	n/a
3	0	-	-	93	43	7.8	-	n/a
4	0	-	-	81	39	4.6	-	n/a
5	10	44	1.4	66	40	3.3	42	2 dB
6	81	46	1.5	16	43	3.3	43	0 dB
7	230	50	1.4	10	52	1.1	n/a	n/a

*Wind bins having average background sound levels higher than the MOECC sound level limit are highlighted in red. Per section D3.5 of the Protocol, if the measured background sound level is higher than the exclusion limit in that wind bin, then the measured background level shall be the sound level limit.
**includes tonal penalty from Table 2, predicted impact of adjacent 3rd party wind farm, and correction for distance between monitoring position and receptor location.

Note that the MOECC recommends a minimum of 60 Turbine ON and 30 Background data points in a wind bin. While there are not enough data points in any wind bin for a formal assessment, the exceedances above the sound level limit align with the conclusions in the original Immission Audit report (i.e. exceedances above the MOECC sound level limit of up to 2 dB).

Tonal penalties, included in Table 1, were calculated based on the re-evaluated dataset summarized above. Tonal audibility results, by wind bin, are presented in Table 2.

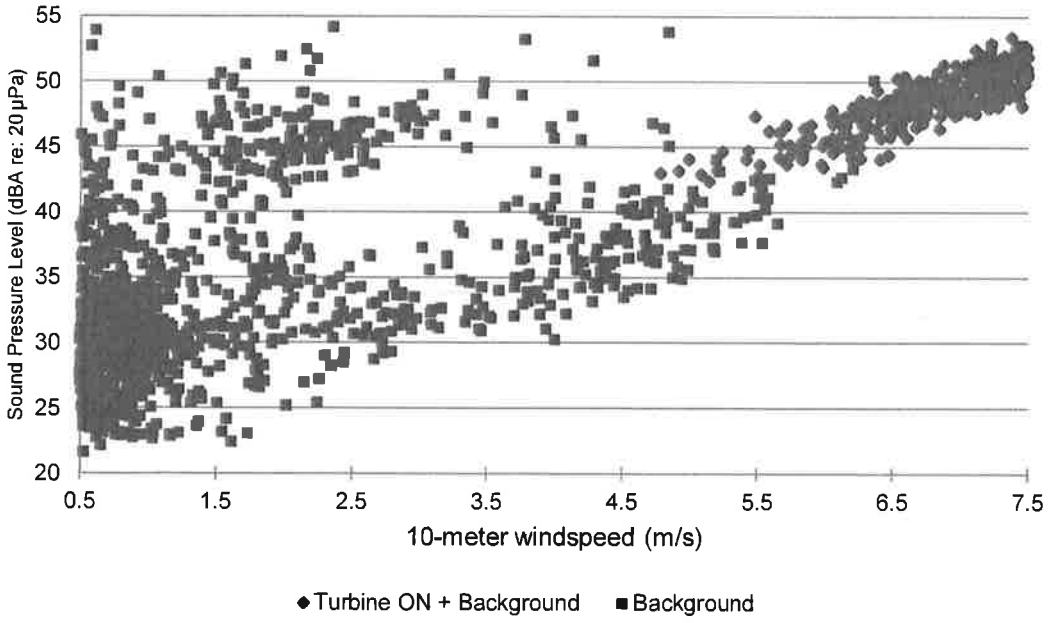
Table 2: Tonal audibility 600Hz assessment results, Napier Receptor R020. Downwind only.

Wind Bin	Turbine ON Data points	Data Points with Tone	Presence (%)	Tonal Audibility (dB)*	Applicable Penalty (dB)**
1	0	0	-	-	-
2	0	0	-	-	-
3	0	0	-	-	-
4	0	0	-	-	-
5	10	9	90%	4.7	0.7
6	81	78	96%	0.9	0.0
7	230	218	95%	-0.7	0.0

*Average tonal audibility of all intervals having a detectable tone at that frequency (per IEC 61400-11)
**tonal penalty, applied to the turbine-only sound level in the same wind bin. Penalties based on ISO 1996-2

The scatterplot of all the measurement intervals used in the assessments summarized in Table 1 and Table 2 is presented below in Figure 1. This scatterplot illustrates the high ambient sound level present at the measurement location.

Figure 1: Plot of all valid measurement intervals. Turbine ON data points filtered for 85% power output and downwind conditions

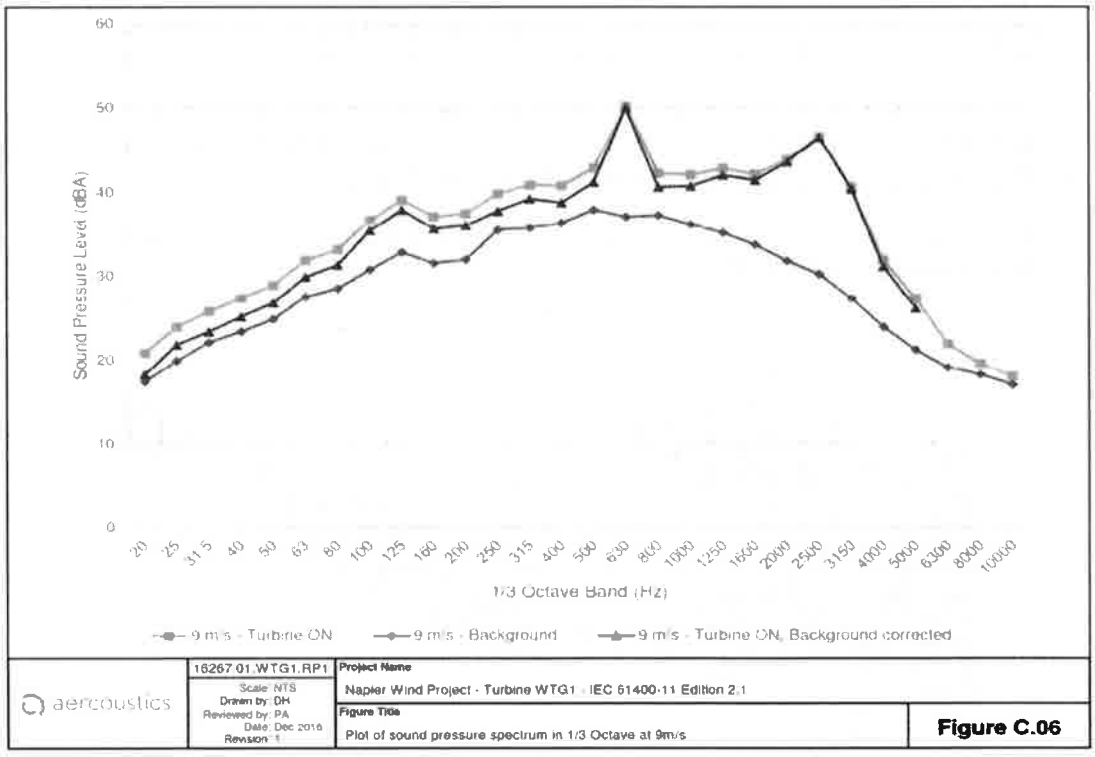


2.2 IEC 61400-11 Testing

To investigate the possible cause of the immission exceedance, the IEC 61400-11 ed2.1 test report, conducted on Napier turbine WTG1, was used to further assess the Napier wind turbine acoustic spectrum. This test report was submitted to the MOECC as part of the testing required by Napier to satisfy their REA requirements (report ID: 16267.01.WTG1.RP1, dated December 6, 2016). Some figures and tables presented in this plan are taken from this test report.

The spectrum of WTG1, presented as the A-weighted 1/3rd octave band spectrum for Turbine ON and Background noise in the 9 m/s wind bin[3], measured 150m from the turbine, is presented in Figure 2. From this figure, the biggest stand-out feature is the high energy in the 630 Hz 1/3rd octave band spectrum of WTG1.

Figure 2: Measured wind turbine spectrum, Napier WTG2, 150 meters from turbine



From Figure 2, it is apparent that the elevated sound levels at the 630Hz octave band is the single biggest contributor to the overall sound level from the turbine.

[3] Wind speed at a 10m height, based on a standardized wind shear (see IEC 61400-11 ed2.1 for details regarding the wind speed calculation)

2.3 Tonality at 600Hz

Tests at turbine WTG1 confirmed a high tonal audibility at roughly 600Hz, as measured at the IEC 61400-11 measurement location (150m from the turbine). The tonal audibility results, showing a tonal audibility of up to 9.7 dB, are presented below.

Figure 3: Tonal audibility results, Napier WTG1, 150m from turbine

Table 12 - Tonality Assessment Summary

Wind Speed (m/s)	Frequency (Hz)	Tonality, ΔL_t (dB)	Tonal audibility, ΔL_a (dB)	FFT's with tones	Total # of FFT's	Presence (%)
6	598.3	-0.4	2.0	10	12	83%
7	112.3	-4.7	-2.6	10	12	83%
7	598.8	3.7	6.1	12	12	100%
8	112.5	-0.4	1.6*	12	12	100%
8	599.5	6.6	9.0	12	12	100%
9	112.1	-1.6	0.4*	10	12	83%
9	595.8	7.1	9.5*	12	12	100%
10	112.7	-0.5	1.5*†	12	12	100%
10	599.3	7.3	9.7	12	12	100%

* Denotes tones in which the masking noise is influenced by background
† Denotes tones whose background correction was capped at 3dB

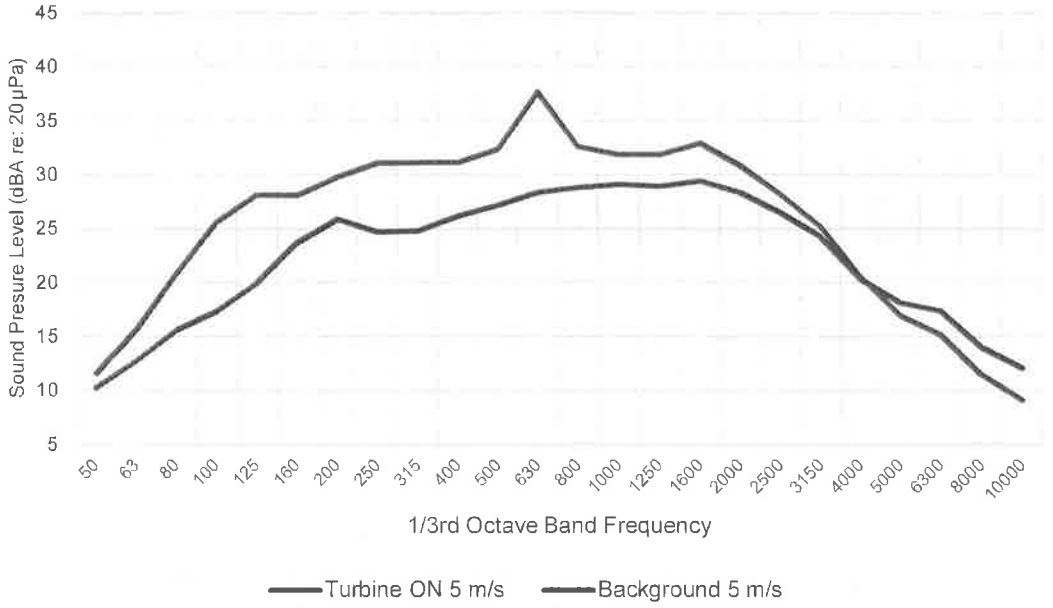
Based on the high measured tonal audibility at 600Hz, it is reasonable to assume that the elevated turbine sound levels in the 630Hz 1/3rd octave band are cause by the tonal noise at 600Hz. Based on discussions with the manufacturer, the source of this tonal noise was determined to be the turbine gearbox.

2.4 Effect at the Receptor

The sound levels measured at the IEC 61400-11 location provide a good indication of the sound emission of a specific turbine; however, compliance with respect to REA section Section C1(1) is assessed at the worst-case point of reception, rather than the IEC 61400-11 measurement location.

A 1/3rd octave spectrum of the sound levels at the receptor during the immission measurement campaign is presented in Figure 4. This spectrum is based on the average measured sound level in the 5m/s wind bin. Turbine ON sound levels are measured under downwind conditions when all Napier turbines are operational and the nearest Napier turbine is generating at least 85% of its nominal power output.

Figure 4: 1/3rd octave sound level at 5m/s wind bin[4], measured at receptor R020



Evident in Figure 4 is an elevated sound level present in the immission measurement data at the same 630Hz 1/3rd octave band observed at the turbine in the IEC 61400-11 test. The sound level in this frequency band is the highest contributor to the overall sound level, with a measured impact over 5 dB higher than the next highest frequency band. Based on the sound levels measured at the receptor, the acoustic issue of most importance is the 600Hz tone from the wind turbine gearbox.

3 Proposed Mitigation

Mitigation measures to address the acoustic issues are proposed in the following section.

3.1 Temporary Mitigation

In response to direction from the MOECC, wpd Napier implemented a night-time curtailment of all Napier turbines from 2.05MW to 1.88MW, to immediately address noise issues while a long-term solution is investigated. A comparison of the sound levels measured for each configuration of the same make/model turbine, but a different site, are attached to this report. A reduction of roughly 2 dB is apparent in both the measured overall level and tonal audibility. Based on the results in the original Immission audit as

[4] Wind speed bins for immission measurements per the MOECC Protocol are determined by the measured wind speed at 10-meter height at the sound measurement location.

well as the re-evaluated results presented in this report, 2 dB should be sufficient to reduce tonality and the overall sound level to bring the facility into compliance in the short term.

3.2 Gearbox Tone at 600Hz

To solve the issue of tonality caused by the wind turbine gearbox, the manufacturer has proposed a dampening solution to reduce the effect of the tone. The manufacturer expects this solution to result in a 5 dB reduction in tonal sound. Details regarding the dampener, provided by the manufacturer, are appended to this report.

3.3 Verification of Compliance

Upon completion of the proposed fix to the gearbox noise to the satisfaction of both the manufacturer and wpd Napier, a verification of compliance will be conducted in the form of an Immission test per the requirements of Part D of the MOECC Compliance Protocol for Wind Turbine Noise.

Wpd Napier will, based on feedback from the manufacturer after the installation of the proposed fix, communicate with the MOECC on whether they are prepared to conduct a final verification of the turbine noise levels, or whether they will need to investigate different or additional mitigation measures.

The temporary night-time curtailment will remain in place until such time that wpd Napier is confident that the mitigation measures have been successful. At that point, they will return the Napier turbines to normal operation (2.05MW) and conduct the final immission test to verify compliance.

4 Timelines for NAAP Implementation

Proposed timelines are the implementation of the Napier NAAP and communication of progress to the MOECC are provided in Table 3.

Table 3: Timeline for NAAP implementation at Napier

Milestone	Anticipated Date of Completion
Night-time curtailment of all Napier turbines to 1.88MW	August 24, 2017
Installation of gearbox dampener	December 8, 2017
Napier to provide MOECC update on gearbox mitigation installation	December 12, 2017
E-Audit completed and submitted (nighttime curtailment removed)	December 31, 2018
Fall I-Audit under NPC 350, 2017 begins Fall 2018, (nighttime curtailment removed)	March 1, 2019
Spring I-Audit under NPC 350, 2017 begins Spring 2019, (nighttime curtailment removed)	September 1, 2019

Should any changes to the schedule be required, wpd Napier will communicate the change and provide an updated NAAP to the MOECC.

5 Closure

Aercoustics has provided a Noise Abatement Action Plan to the MOECC on behalf of wpd Napier to address the wind turbine noise issues discovered during the audits of acoustic compliance conducted at the Napier Wind Project.

Upon completion of the NAAP, the Napier Wind Project will be in compliance with the sound level limits prescribed in Section C1(1) of REA #8388-9B7N4J. The NAAP is regarded as a "living" document, that will be updated an amended as necessary as wpd Napier investigate mitigation solutions with the manufacturer and work with the MOECC to achieve acoustic compliance.

The initial plan for mitigation, along with proposed timelines, is provided in this first version of the NAAP document. Should modifications or additions to the NAAP be required, these changes will be communicated as soon as possible to the MOECC.

Regards,

Aercoustics Engineering Limited

Duncan Halstead, B.A.Sc.

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

c. Jonathan Clifford, wpd-Canada; Gabriel Bloom, Senvion; Mahdi Zangeneh, MOECC; Rob Wrigley, MOECC

SENVION

VIA EMAIL

October 13, 2017
Jonathan Clifford
Operations Manager
WP Windmanager Canada Inc.
2233 Argentia Road, Suite 102
Mississauga, Ontario
L5N 2X7 Canada
Document # SEN-9999-2017-CRO-026-0003

Senvion Canada Inc.
1100 René-Lévesque Blvd. West, Suite 1910
Montreal, Quebec, H3B 4N4
Canada
Gabriel.Bloom@senvion.com
www.senvion.com

ECT
Napier ound Po er e el
en ion s next steps

Mr. Clifford,

As follow-up to Hardy's letter from last month, I write to give you further detail about the proposed installation of tuned mass dampers. The dampers will be available for installation at Napier by mid-November, calendar week 45 or 46. Our Customer Service Bulletin ("CSB") is in preparation now, to give you detailed information regarding the product and installation procedure. We will share this document at the same time as proposing which turbine and which date we will install the dampers. In the meantime, given the urgency of your NAAP submission, I am of course happy to share some info about the product with you.

We have experience with this product in comparable turbines in Europe, which is basis for our confidence in them as an option for your turbines in Ontario. We need to

SENVION

implement the product in your turbine to observe what level of benefit you might see from it. Senvion expects tonality reduction of up to -5dB thanks to the dampers. See attached document for further technical explanation of the proposed damper solution.

To the right, please find a diagram and a photo of the product.

If you have any question or need further support between now and November, do not hesitate to contact Senvion.

Yours sincerely,

en ion

Gabriel Bloom
Customer Care Manager
Senvion Canada Inc.
On behalf of Senvion GmbH

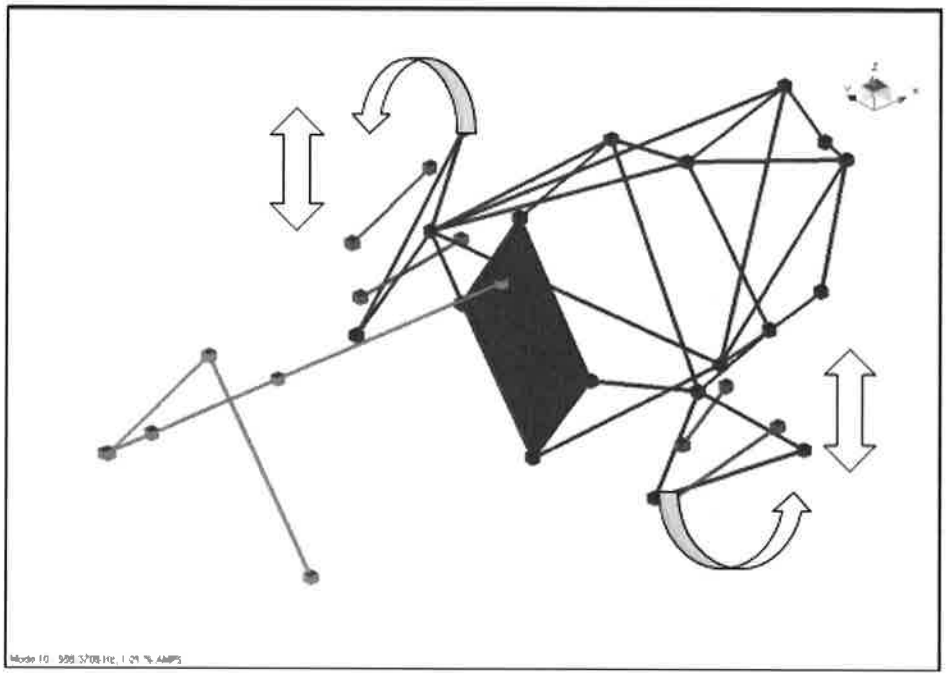
CC: Hardy Steinacker, Andy Burdeney, Guy Pinho, Chris Cyrillus

Attachment: SEN-9999-2017-ATT2-028-1032 Technical update to the Tuned Mass Damper solution

Technical update to the ***Tuned Mass Damper*** solution:

In the Rootcause analyses we find two possible Modes they are close to 570/600Hz tone Frequency. This Modes has a high amplitude and movement in the torque arm pins and therefor they are potential for the tonality because the movement is in the possible transfer path from gearbox to the tower as radiator.

1. Mode: A kind of torsion of the torque arm along the horizontal axis of the gearbox (counter phase)
2. Mode: A kind of in phase vertical flap of the torque arms caused of an ovalisation of the first hollow weel



In a First Step we checked to bring 2x TMD to both side of the torque arms at the back side of PINS. This reduce the torsional mode but not the tone in the WTG airborne noise. The flapping stays but changed a little by amplifying the front side Pin.

In the next Step we decide to mound 2 further more TMD as well at the front side. And this failed in the first trail again.

But after re-tuning the dampers at the turbine to a proper frequency from round about 530-550Hz the tonality were reduced by -5dB (in the meanwhile we does not have the original PIN in that gearbox due to tha original one the reduction has to be -7dB)
Popper frequency should be close under the mode and/or excitation frequency (in this case 570Hz).

The reduction of the mode in the structure born measurements is not complete yet (data still on turbine) but because of the good results we want to avoid lost time and go on to Test @60Hz turbines.

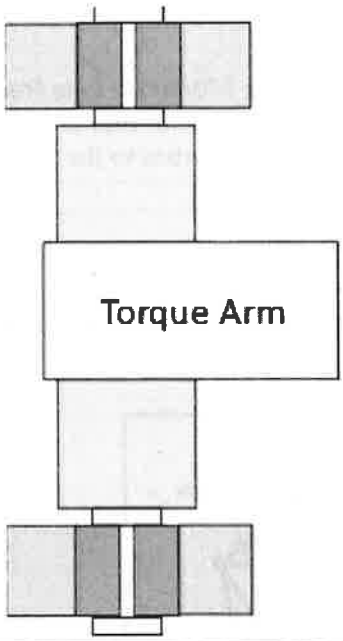


Abbildung 1 Sketch of Symmetric TMD on one TA side pins (with higher mass)

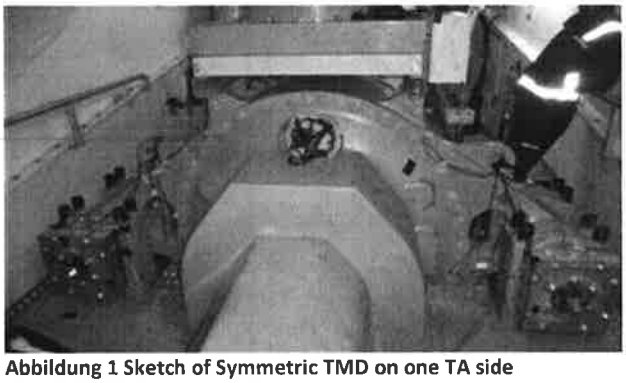
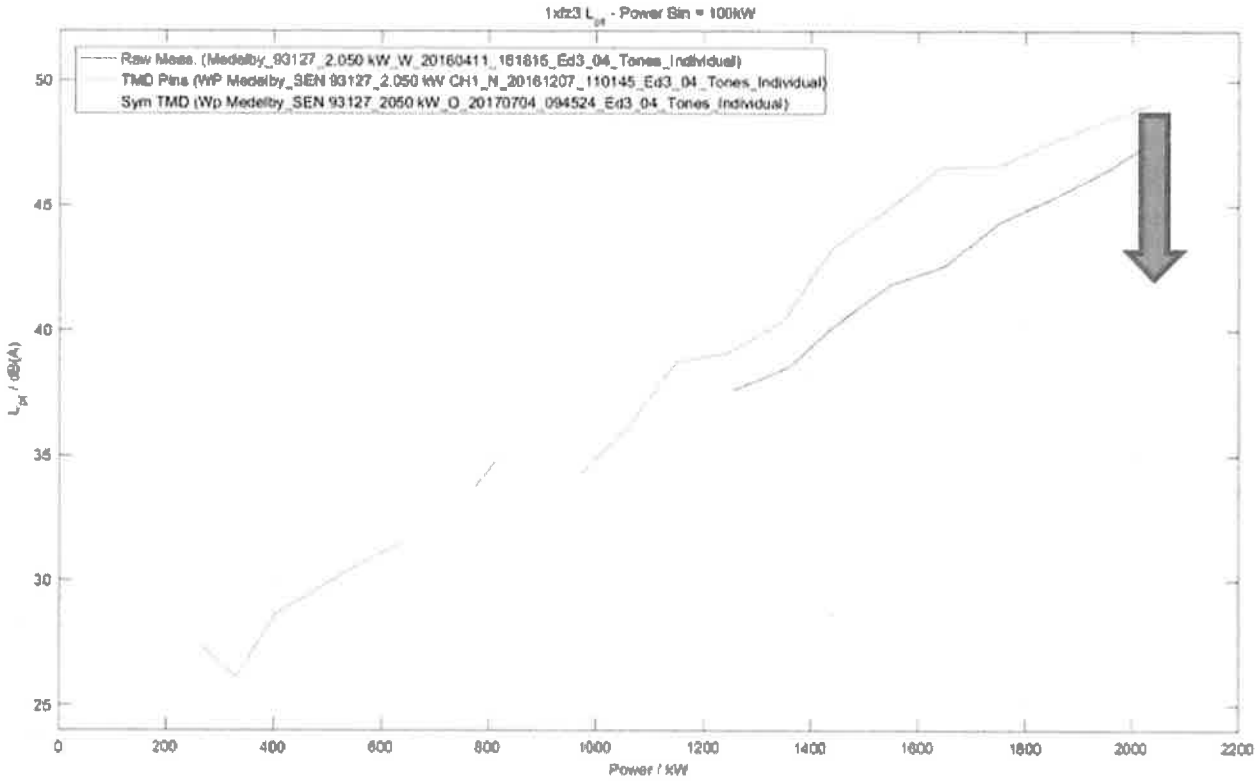


Abbildung 2 Principle mount of TMD @

Abbildung 1 Reduction of -5dB (Sorry for the hard readable yellow line)



IEC 61400-11 Edition 3.0 - Test Summary

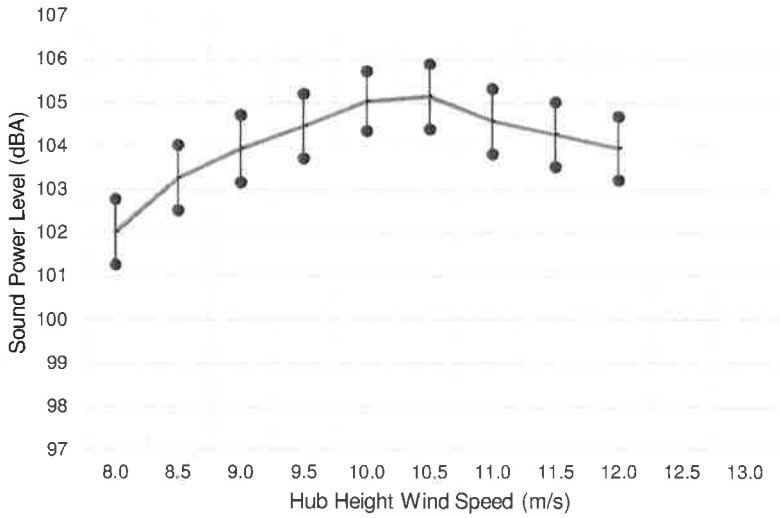
Project: Springwood Wind Farm - Turbine WEC4 - Normal Operation

Project ID: 14350.00

Created on: 8/22/2017

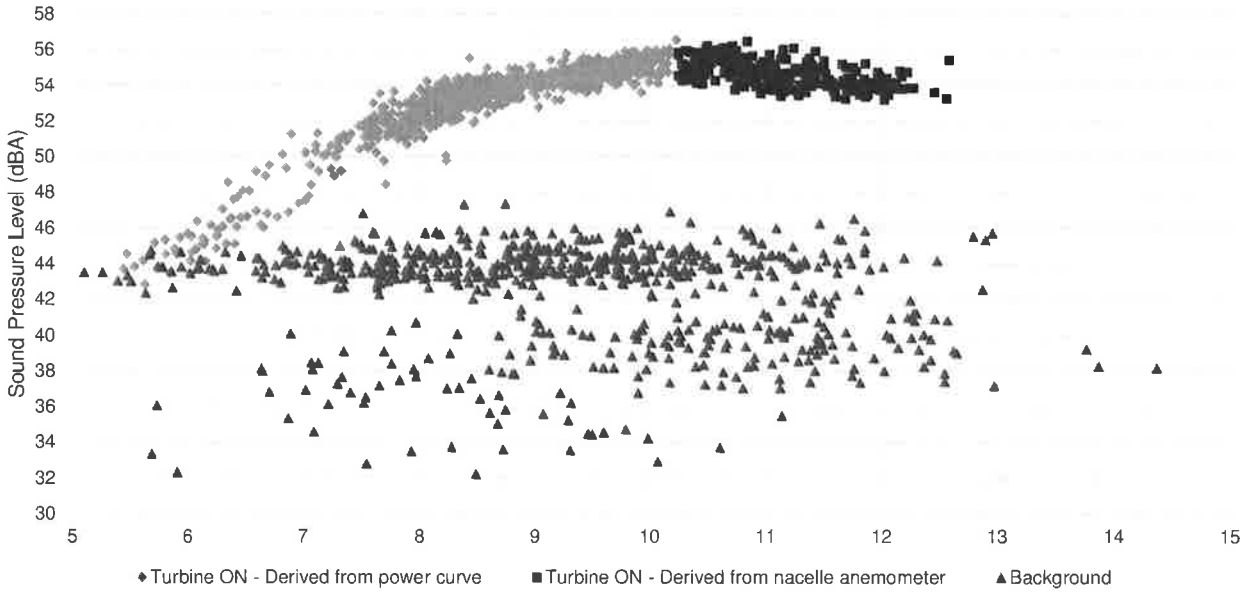
Measurement Information	
Turbine ID	WEC4
Project ID	14350.00
Project Name	Springwood
Make	Senvion
Model	MM92
Power Output	2050 kW
Hub Height	100 m
Microphone Distance	146 m
Roughness Length	0.05 m
Anemometer Height	10 m
Mic Distance to Rotor R	180.05 m

Hub Height Wind Speeds Required		
85% Power	1742.5	kW
Corresponding wind speed	9.9	m/s
Minimum bin	8.0	m/s
Maximum bin	13.0	m/s



Summary Sound Power Level Data

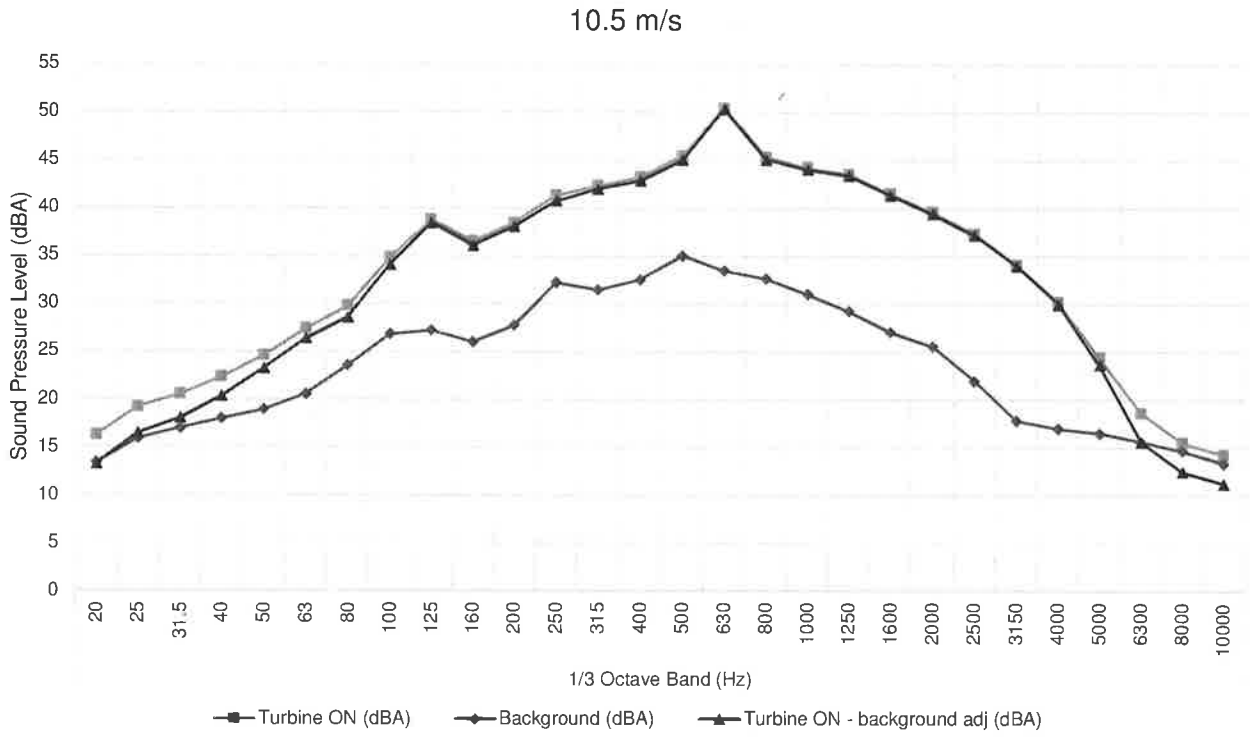
Parameter	Hub Height Wind Speed (m/s)												
	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0
Power Output (kW)			979	1177	1375	1585	1795	1898	2000	2020	2040	2045	2050
Turbine ON (dBA)			52.5	53.6	54.2	54.7	55.2	55.3	54.8	54.4	54.1		
Turbine ON - # of data points			147	208	160	180	96	76	82	52	35	5	0
Background (dBA)			43.5	43.3	43.6	43.4	43.1	42.6	42.9	42.4	42.3	40.9	
Background - # of data points			62	66	82	67	78	53	48	46	18	17	5
Turbine ON - back adj (dBA)			51.9	53.2	53.8	54.4	54.9	55.0	54.5	54.2	53.8		
Signal to noise (dB)			9.0	10.3	10.6	11.3	12.1	12.7	11.9	12.1	11.8		
Uncertainty (dB)			0.7	0.7	0.8	0.7	0.7	0.7	0.8	0.7	0.7		
PWL (dBA)			102.0	103.3	103.9	104.5	105.0	105.1	104.6	104.3	103.9		



IEC 61400-11 Edition 3.0 - Test Summary

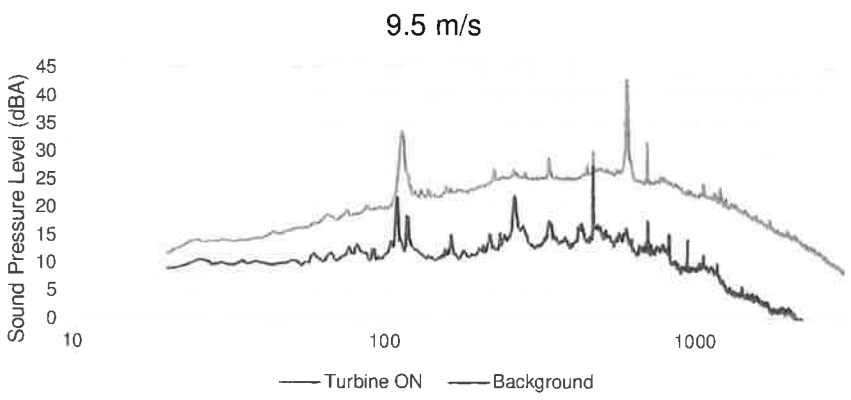
Project: Springwood Wind Farm - Turbine WEC4 - Normal Operation
Project ID: 14350.00

Created on: 8/22/2017



Summary Tonal Audibility Data

Parameter	Hub Height Wind Speed (m/s)												
	7.5	8.0	8.5	9.0	9.0	9.5	10.0	10.0	10.5	11.0	11.5	12.0	12.0
Power Output (kW)	812	979	1177	1375	1375	1585	1795	1795	1898	2000	2020	2040	2040
Frequency of max tone (Hz)	103	108	112	112	600	600	113	600	601	601	601	113	601
Tonality, ΔLtn (dB)	-1.1	-0.8	-1.1	-1.5	-1.6	0.0	-1.2	1.2	2.8	2.1	2.2	-0.8	2.3
Tonal audibility, ΔLa (dB)	0.9	1.2	0.9	0.5	0.8	2.4	0.8	3.6	5.2	4.5	4.6	1.3	4.7
FFT's with tones	57	143	204	152	159	180	95	96	76	82	52	34	35
Total # of FFT's	58	147	208	160	160	180	96	96	76	82	52	35	35
Presence (%)	98%	97%	98%	95%	99%	100%	99%	100%	100%	100%	100%	97%	100%



Special Notes & Considerations

-testing conducted March 30, 2016

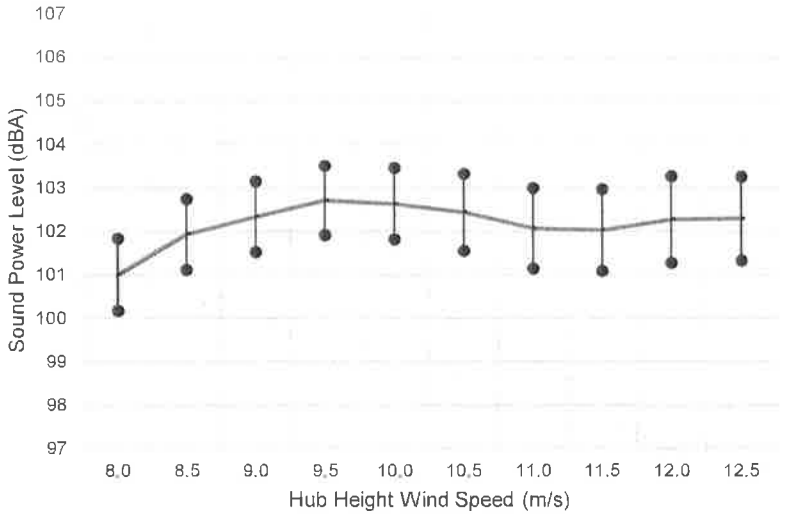
IEC 61400-11 Edition 3.0 - Test Summary

Project: Senvion Acoustic Testing - Turbine SPG WEC4 - SM1 mode
Project ID: 15248.02

Created on: 10/16/2017

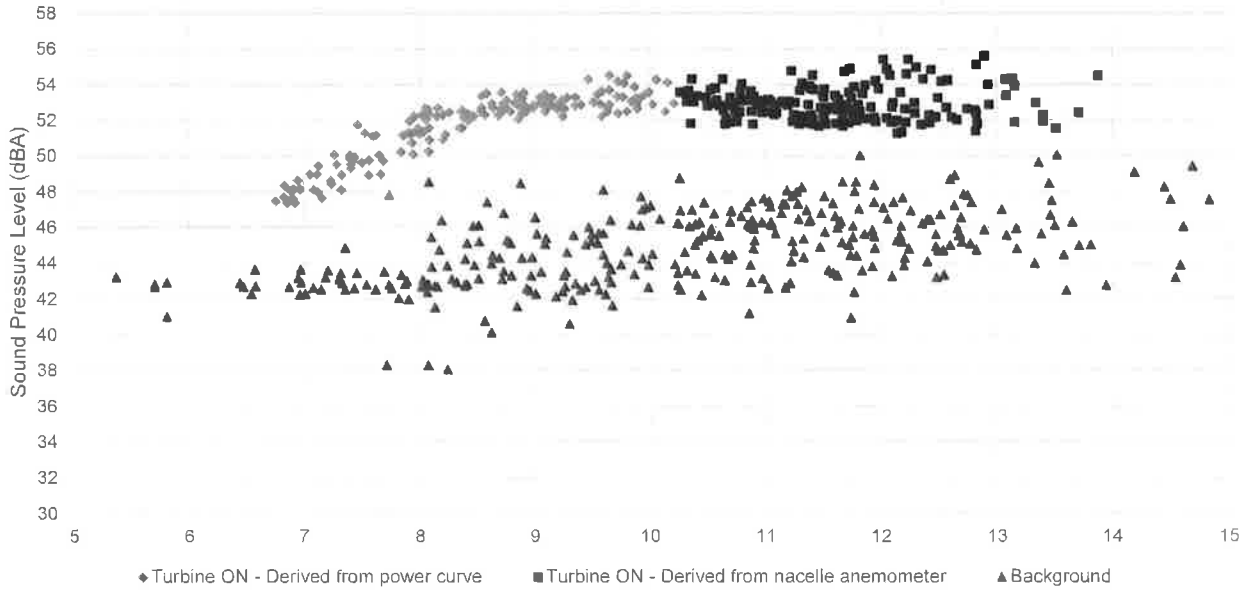
Measurement Information	
Turbine ID	WEC4
Project ID	15248.02
Wind Farm Name	Springwood
Make	Senvion
Model	MM92
Power Output	1880 kW
Hub Height	100 m
Microphone Distance	146 m
Roughness Length	0.05 m
Anemometer Height	10 m
Mic Distance to Rotor R	180.05 m

Hub Height Wind Speeds Required		
85% Power	1598	kW
Corresponding wind speed	9.7	m/s
Minimum bin	8.0	m/s
Maximum bin	12.5	m/s



Summary Sound Power Level Data

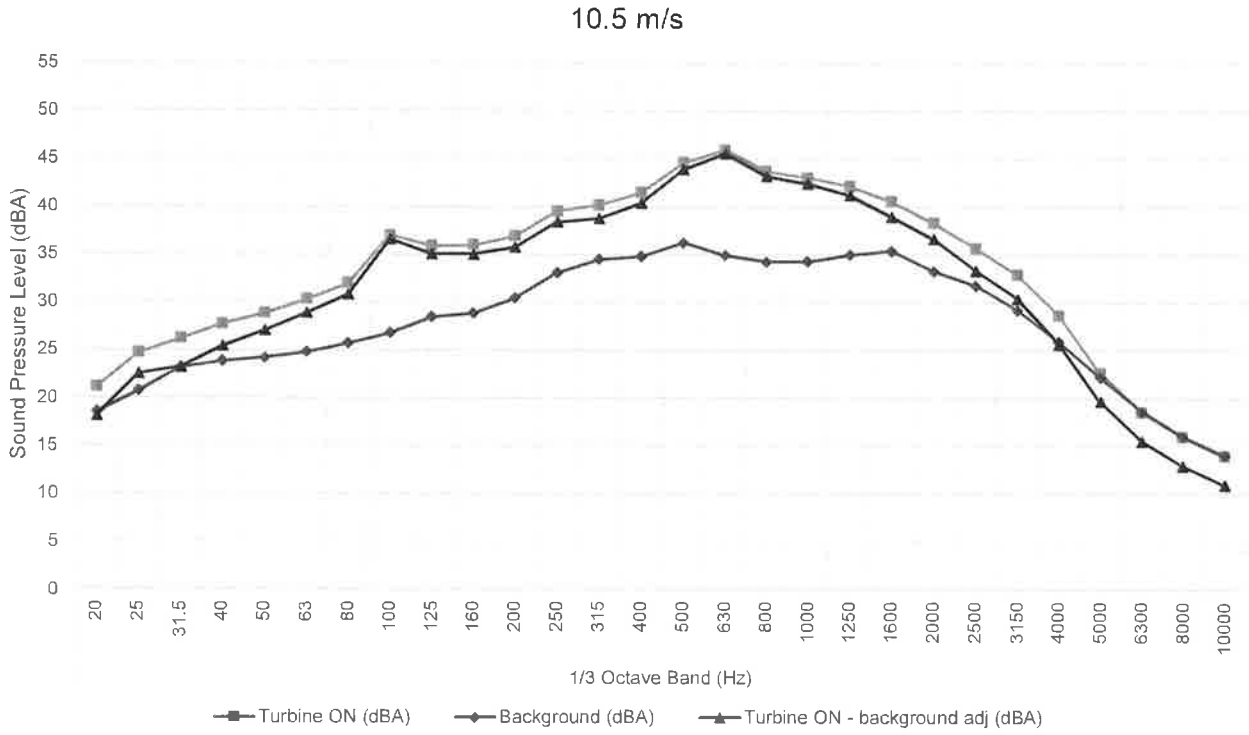
Parameter	Hub Height Wind Speed (m/s)												
	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0
Power Output (kW)			957	1145	1332	1521	1710	1795	1880	1880	1880	1880	
Turbine ON (dBA)			51.6	52.5	52.9	53.2	53.3	53.2	52.9	53.0	53.2	53.2	
Turbine ON - # of data points			30	23	31	20	24	30	31	38	33	17	
Background (dBA)			43.5	44.3	44.5	44.3	45.4	45.7	45.9	46.2	46.4	46.2	
Background - # of data points			23	21	19	29	18	30	31	27	30	22	
Turbine ON - back adj (dBA)			50.9	51.8	52.2	52.6	52.5	52.3	52.0	51.9	52.2	52.2	
Signal to noise (dB)			8.1	8.3	8.4	8.9	7.9	7.5	7.0	6.8	6.8	7.0	
Uncertainty (dB)			0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	1.0	1.0	
PWL (dBA)			101.0	101.9	102.3	102.7	102.6	102.4	102.1	102.0	102.3	102.3	



IEC 61400-11 Edition 3.0 - Test Summary

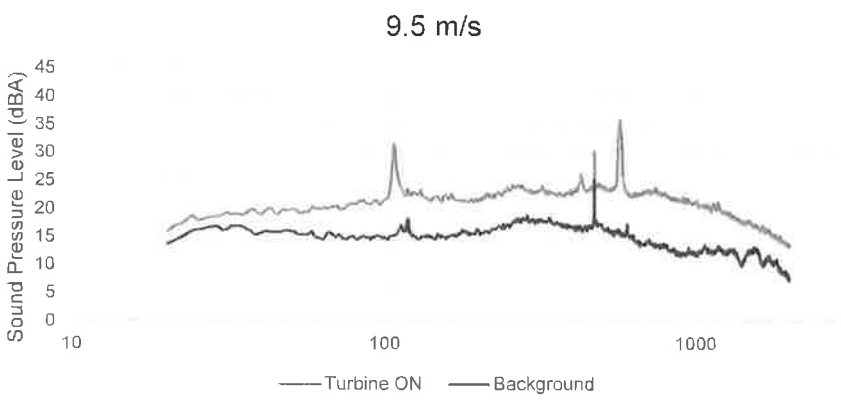
Project: Senvion Acoustic Testing - Turbine SPG WEC4 - SM1 mode
Project ID: 15248.02

Created on: 10/16/2017



Summary Tonal Audibility Data

Parameter		Hub Height Wind Speed (m/s)											
		7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	
Power Output (kW)	#N/A	796	957	1145	1332	1521	1710	1795	1880	1880	1880	1880	#N/A
Frequency of max tone (Hz)		101	106	567	566	566	567	568	566	567	568	568	
Tonality, ΔLtn (dB)		-2.0	-0.1	-1.3	-1.1	-0.5	-0.8	1.3	0.9	0.8	0.9	0.3	
Tonal audibility, ΔLa (dB)		0.0	1.9	1.0	1.3	1.9	1.6	3.6	3.3	3.2	3.2	2.7	
FFT's with tones		17	31	26	31	30	23	28	31	38	26	17	
Total # of FFT's		18	31	26	31	30	23	28	31	38	26	17	
Presence (%)		94%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	



Special Notes & Considerations

-testing conducted March 21, 2016

APPENDIX D
ELECTRICAL POWER FILTER

Based on the discussions with the MECP, the power output filter of the turbine was revised such that the noise emission from the closest turbine is not less than 90% its maximum sound power level.

Based on the DNV GL E-Audit report, the electrical power output ($\mathbf{P_k}$) of the turbine was plotted against the measured sound emission level ($\mathbf{L_{WA,k}}$), at the relevant wind speed (**k**). Regression analysis was done based on a second-degree polynomial equation. The analysis result was show on Figure D1 and the equation below.

$$\mathbf{P_k} = 0.127198220994861(\mathbf{L_{WA,k}})^2 - 25.679981337055500\ (\mathbf{L_{WA,k}}) + 1{,}297.089953803720000$$

Based on the DNV GL E-Audit report, the maximum sound power level of the turbine was determined to be 103.9 dB. Based on the above equation, the electrical power output at 90% of maximum sound emission of the turbine (i.e., a sound power level of 103.4 dB) is 1.727 MW.

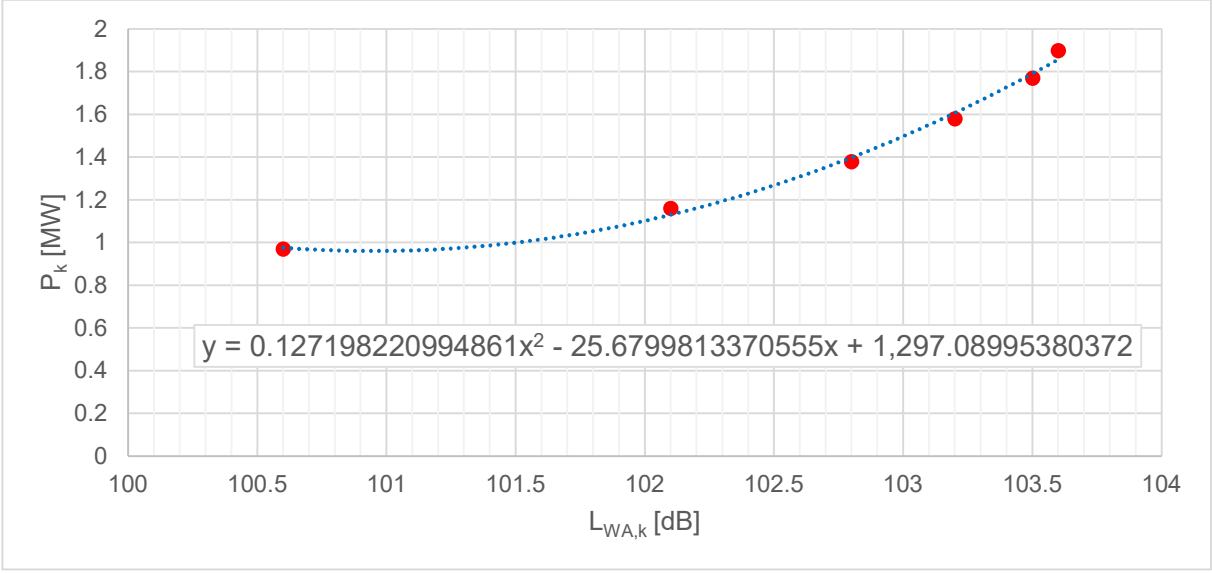
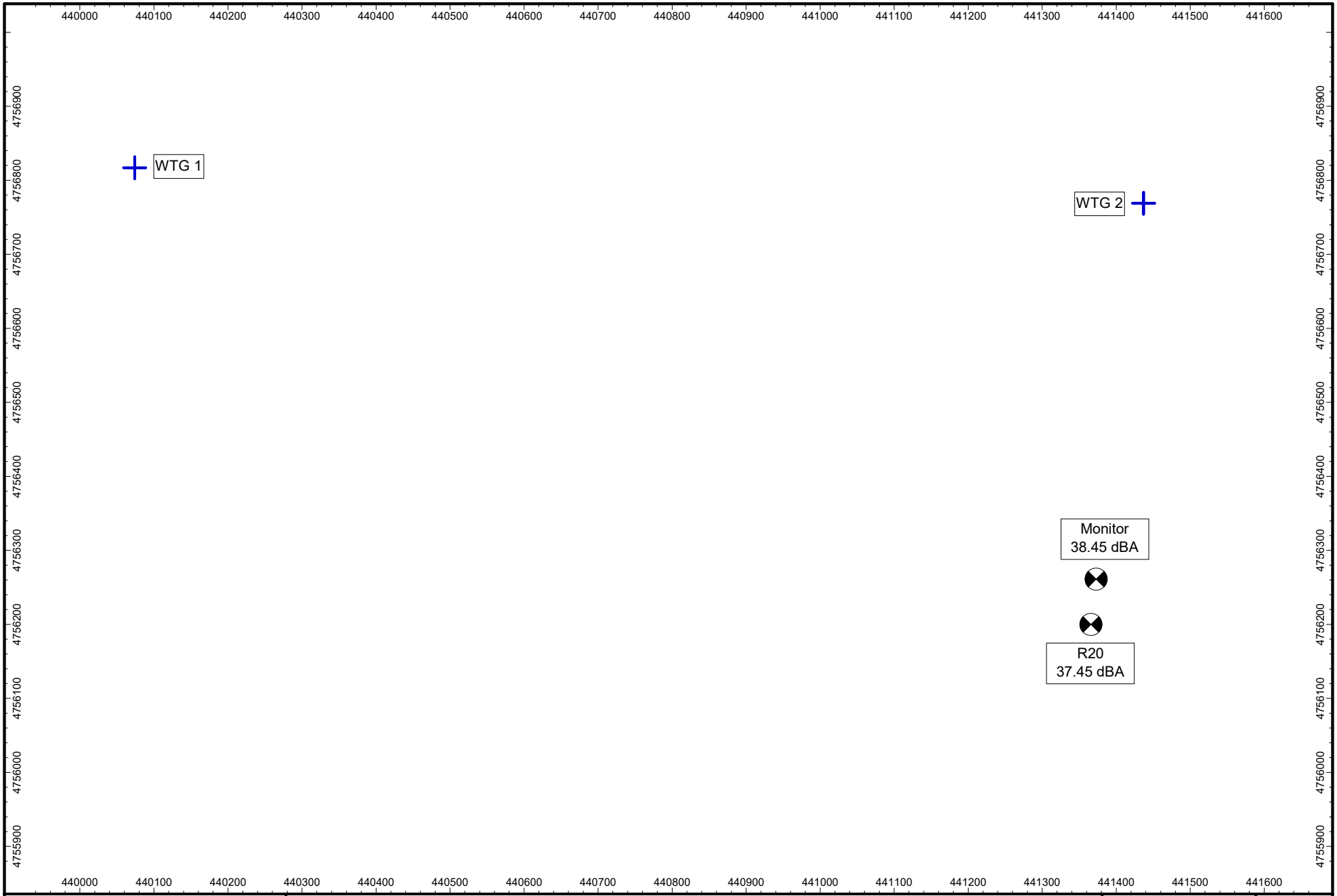


FIGURE D1: RELATIONSHIP BETWEEN MEASURED ELECTRICAL POWER OUTPUT AND MEASURED SOUND EMISSION LEVEL

APPENDIX E
DISTANCE ADJUSTMENT



VALCOUSTICS
Canada Ltd.
consulting acoustical engineers

Title: **Predicted Sound Levels (dBA)**	Date: **2019-10-07**	Figure: **E1**
Project Name: **Napier Wind Project**	Project No.: **118-0338**	

J:\2018\1180338\000\Analysis\Phase 2\Cadna\Naiper - gnd attenuation calc_2019-09-03.cna

Date Plotted: 07.10.19

APPENDIX F

TONAL AUDIBILITY SAMPLE CALCULATIONS

1. SAMPLE CALCULATION DETAILS IN WORST-CASE WIND SPEED BIN

A sample calculation for determining the audibility of tones, in accordance with the procedure specified in IEC61400-11, including interim calculations in the worst-case wind speed bin of 5 m/s (i.e., with the highest average tone audibility), is show below.

The calculations are based on the FFT spectrum determined from the recoded sound file at 2020-05-03 21:00 (see Figure F1). The FFT spectrum has a frequency resolution Δf of 1 Hz.

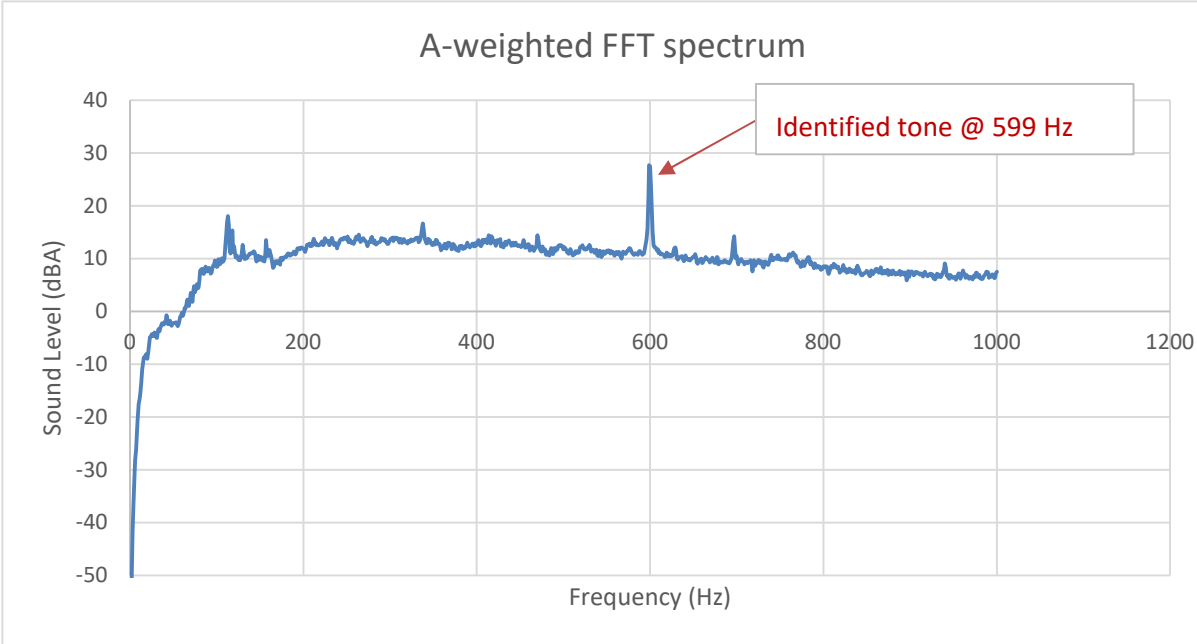


FIGURE F1: FFT PLOT WITH AN IDENTIFIED TONE (A VALID INTERVAL FROM PHASE 2B AT 2020-05-03 21:00

Possible peak being investigated - peak with centre frequency fc at 599 Hz.

The critical bandwidth is determined as,

$$\text{Critical bandwidth} = 25 + 75 \cdot \left(1 + 1.4 \left[\frac{fc}{1000}\right]^2\right)^{0.69}$$

$$= 124 \text{ Hz}$$

Critical band was calculated to be between 537 Hz and 661 Hz.

$L_{70\%}$ sound pressure level, i.e., the energy average of the 70% of spectral lines in the critical band with the lowest levels:

$L_{70\%} = 12.3$ dB (based on 87 spectral lines sorted by the lowest levels).

$$\text{Criterion Level} = L_{70\%} + 6 \text{ dB} = 18.3\ dB$$

Spectral lines in the critical band can be classified as 'masking' if sound level is less than the criterion level, i.e. < 18.3 dB

$L_{pn,avg}$ is the energy average of all the spectral lines classified as 'masking' within the critical band.

$L_{pn,avg} = 12.8$ dB

$\text{Effective noise bandwidth} = 1.5\Delta f = 1.5(1) = 1.5$

The masking noise level (L_{pn}) is determined as,

$$L_{pn} = L_{pn,avg} + 10.\log\left[\frac{\text{Critical bandwidth}}{\text{Effective noise bandwidth}}\right] = 12.8 + 10.\log\left[\frac{124}{1.5}\right] = 32.0 \text{ dB}$$

Spectral lines in the critical band can be classified as 'tones' if sound level exceeds $L_{pn,avg} + 6$ i.e., > 18.8 dB

The sound pressure level of the tone (L_{pt}) is the energy average of all the spectral lines classified as 'tones' within the critical band. If 2 or more adjacent spectral lines are identified, a correction for Hanning window is applied.

$L_{pt} = 33.8 \text{ dB} - 1.76 \text{ dB} = 32.0 \text{ dB}$. Correction for windowing was added since 5 spectral lines between 598 Hz to 602 Hz were classified as tones.

A line is classified as 'neither' if it cannot be classified as either 'tone' or 'masking'. In this case, no such spectral lines exist.

Tonality (L_{tn}) is calculated as,

$L_{tn} = L_{pt} - L_{pn} = 32.0 - 32.0 = 0.06$ dB

The tonal audibility (ΔL_a) for the spectrum is defined as,

$\Delta L_a = L_{tn} - L_a$, where L_a is the frequency dependent audibility criterion defined as,

$$L_a = -2 - \log\left[1 + \left[\frac{fc}{502}\right]^{2.5}\right] = -2.4 \text{ dB}$$

$\Delta L_a = 0.06 - (-2.4) = 2.5$ dB

The classification of spectral lines and relevant parameters are shown in Figure F2.

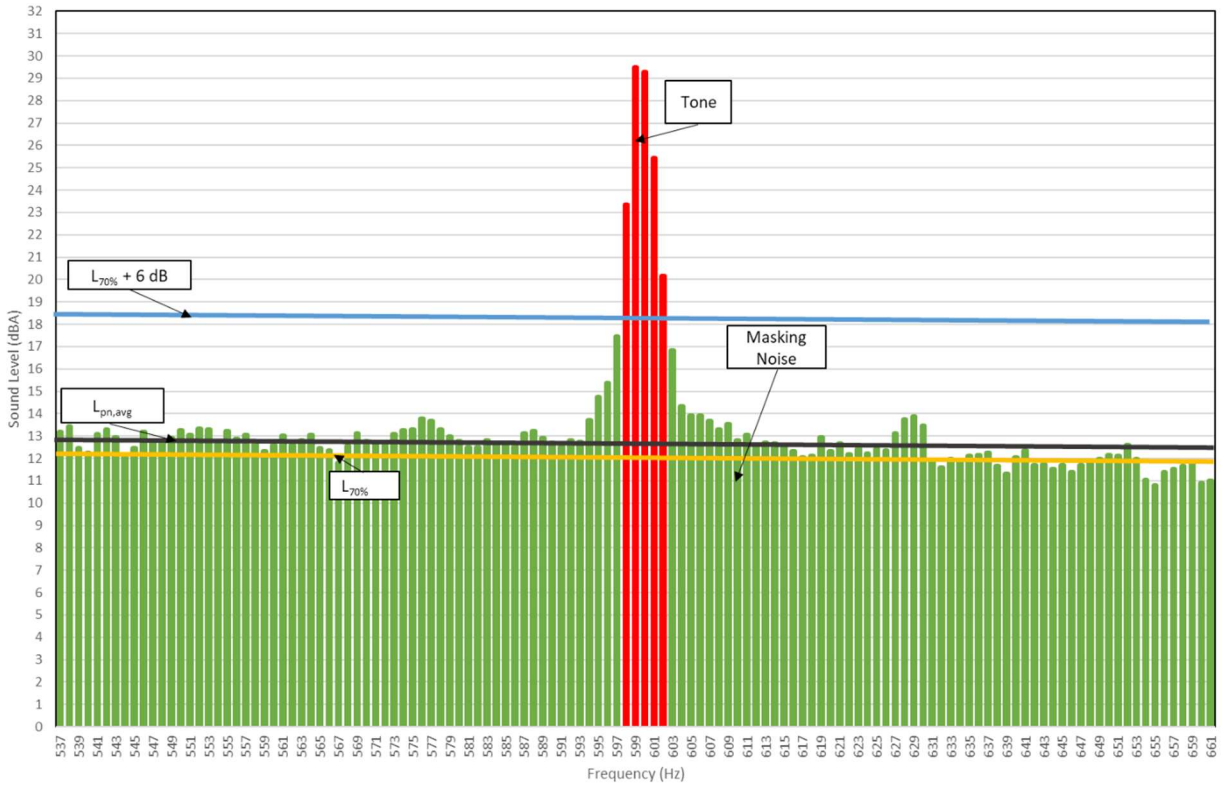


FIGURE F2: ILLUSTRATION OF CLASSIFYING SPECTRAL LINES FOR SIGNAL BOUND BY THE CRITICAL BAND

2. SAMPLE CALCULATION DETAILS IN WORST-CASE WIND SPEED BIN

In addition, a sample calculation for determining the audibility of tones was summarized below for the worst case data sample (i.e., with the highest tone audibility level).

The calculations are based on the FFT spectrum determined from the recoded sound file at 2019-04-14 02:10 (see Figure F3). The FFT spectrum has a frequency resolution Δf of 1 Hz.

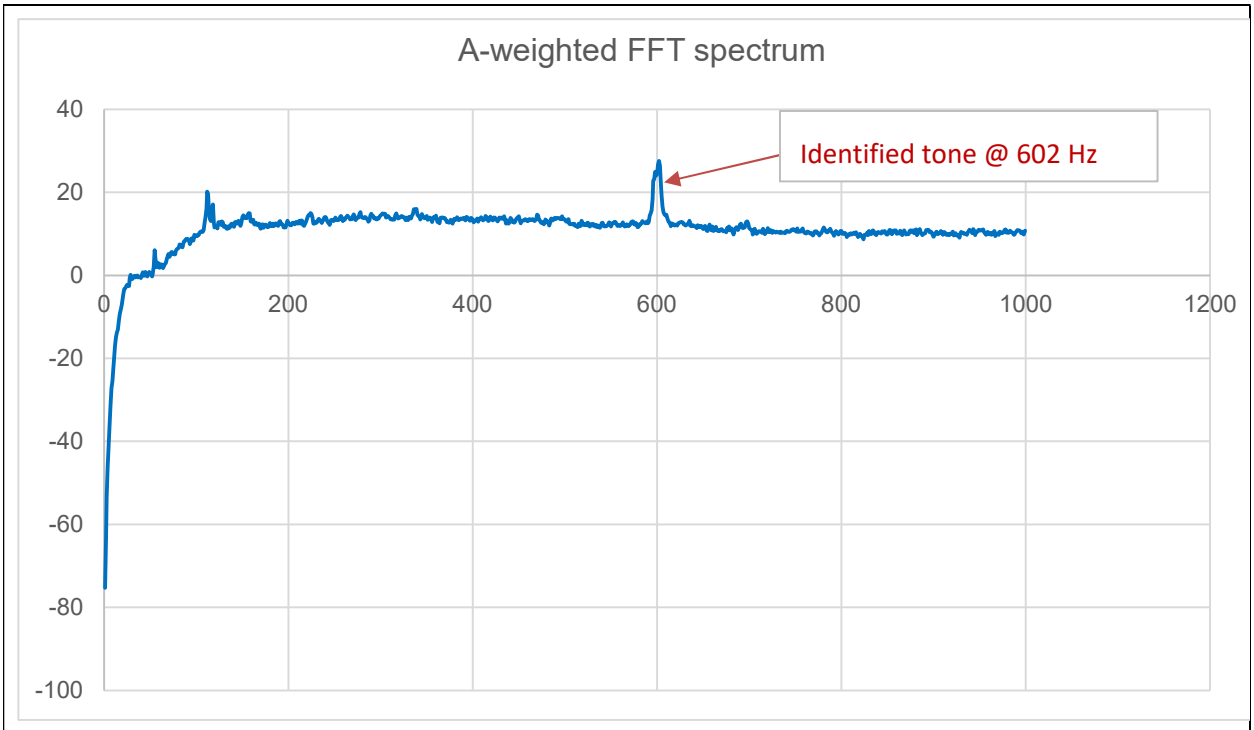


FIGURE F3: FFT PLOT WITH AN IDENTIFIED TONE (A VALID INTERVAL FROM PHASE 2B AT 2019-04-14 02:10

Possible peak being investigated - peak with centre frequency fc at 599 Hz.

The critical bandwidth is determined as,

$$\text{Critical bandwidth} = 25 + 75 \cdot \left(1 + 1.4 \left[\frac{fc}{1000}\right]^2\right)^{0.69}$$

$$= 125 \text{ Hz}$$

Critical band was calculated to be between 540 Hz and 664 Hz.

$L_{70\%}$ sound pressure level, i.e., the energy average of the 70% of spectral lines in the critical band with the lowest levels:

$L_{70\%} = 12.1$ dB (based on 125 spectral lines sorted by the lowest levels).

$\text{Criterion Level} = L_{70\%} + 6 \text{ dB} = 18.1\ dB$

Spectral lines in the critical band can be classified as 'masking' if sound level is less than the criterion level, i.e. < 18.1 dB

$L_{pn,avg}$ is the energy average of all the spectral lines classified as 'masking' within the critical band.

$L_{pn,avg} = 12.6$ dB

$$\text{Effective noise bandwidth} = 1.5\Delta f = 1.5(1) = 1.5$$

The masking noise level (L_{pn}) is determined as,

$$L_{pn} = L_{pn,avg} + 10.\log\left[\frac{\text{Critical bandwidth}}{\text{Effective noise bandwidth}}\right] = 12.6 + 10.\log\left[\frac{125}{1.5}\right] = 31.7 \text{ dB}$$

Spectral lines in the critical band can be classified as 'tones' if sound level exceeds $L_{pn,avg} + 6$ i.e., > 18.6 dB

The sound pressure level of the tone (L_{pt}) is the energy average of all the spectral lines classified as 'tones' within the critical band. If 2 or more adjacent spectral lines are identified, a correction for Hanning window is applied.

$L_{pt} = 34.9 \text{ dB} - 1.76 \text{ dB} = 33.1 \text{ dB}$. Correction for windowing was added since 5 spectral lines between 598 Hz to 602 Hz were classified as tones.

A line is classified as 'neither' if it cannot be classified as either 'tone' or 'masking'. See Figure F4.

Tonality (L_{tn}) is calculated as,

$$L_{tn} = L_{pt} - L_{pn} = 33.1 - 31.7 = 1.4 \text{ dB}$$

The tonal audibility (ΔL_a) for the spectrum is defined as,

$\Delta L_a = L_{tn} - L_a$, where L_a is the frequency dependent audibility criterion defined as,

$$L_a = -2 - \log\left[1 + \left[\frac{fc}{502}\right]^{2.5}\right] = -2.4 \text{ dB}$$

$$\Delta L_a = 1.4 - (-2.4) = 3.8 \text{ dB}$$

The classification of spectral lines and relevant parameters are shown in Figure F4.

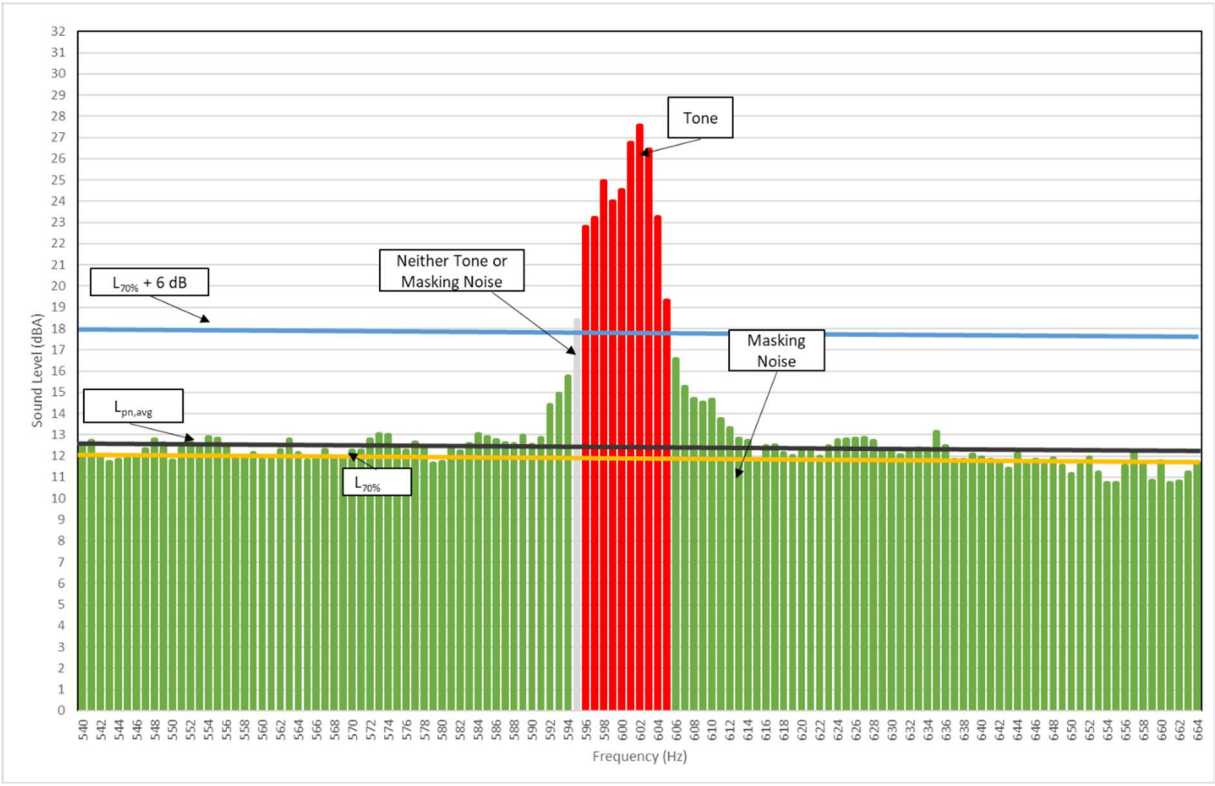


FIGURE F4: ILLUSTRATION OF CLASSIFYING SPECTRAL LINES FOR SIGNAL BOUND BY THE CRITICAL BAND