DNV·GL

GUNN'S HILL WIND FARM

First Acoustic Immission Audit - Spring 2018

Gunn's Hill LP

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This report presents the results of analysis conducted by DNV GL on behalf of Gunn's Hill LP

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1 INTRODUCTION

GL Garrad Hassan Canada Inc. ("DNV GL") was retained by Gunn's Hill LP (the "Proponent" or "Prowind") to conduct an acoustic immission audit at the Gunn's Hill Wind Farm (the "Project"). The requirement to complete an audit is detailed under Part E of the Renewable Energy Approval, number 6862-9RDJZX dated 9 April 2015 ("REA"). The purpose of the assessment is to determine the noise contribution of the wind turbine generators on the nearby Receptors, and to compare the levels against the permissible sound levels in Ontario.

The Project has been operational since fall 2016, and is comprised of ten Senvion MM92 1.88 MW wind turbines, for a total nameplate capacity of 18 MW. Project is located in the township of Norwich, within Oxford County, Ontario. The area consists of flat terrain with farming activities and isolated woodlots. A pre-construction Noise Impact Assessment (NIA) was prepared [1] as per the Ontario Noise Guidelines in effect at the time (Noise Guidelines) [2].

As per the REA, the audit shall follow Part D of the latest Compliance Protocol for Wind Turbine Noise ("Compliance Protocol") [3], and be completed at two Receptors. Two separate and distinct audits shall be conducted; one in Spring and one in Fall. The audit detailed in this report commenced in Spring 2018.

2 METHODLOGY

2.1 Measurement Locations

On-site monitoring was conducted at two locations, nearest to R55 and R80 in the NIA. As per Appendix F3 of the Compliance Protocol, a careful selection of audit receptors was undertaken, with the following criteria:

1. Receptors with highest modelled sound levels and higher than 37 dBA;
2. Receptors that are generally downwind from the prevailing wind direction(s) during the audit timeline (Spring and Fall);
3. Receptors that agree to host an audit; and
4. Consideration for other constraints that could impede with audit (ex. prevalent domestic sound, trees, etc.).

The list of considered Receptors, as well as the selection rationale, is shown in Appendix A of this document.

Receptor R55 is located in the central area of the Project. It is comprised of a dwelling and several sheds. The monitoring location (M55) was positioned 54 m to the southwest of the dwelling on the adjacent lot, towards the nearest turbines T4 and T5, in order to clear the trees and sheds. The ground cover was an open field between the monitoring station and the nearest turbines. The sound level at the Receptor in the NIA was modelled at 37.0 dBA. The predicted sound level at the monitoring station which was closer to the wind turbines, was 37.2 dBA when modelled by DNV GL based on the parameters of the NIA. As mentioned in Section 2.3 below, all the data in this assessment (i.e. when the turbines are operational and but also parked) were filtered for downwind conditions from the nearest turbines to the monitoring stations.

Receptor R80 is located in the eastern area of the Project. The monitoring location (M83) was positioned 160 m to the southwest of the R80 dwelling, nearest to T9 and T10, on the land owned by Participant R83. The ground cover was an open field between the monitoring station and the nearest turbines. The sound level at the Receptor was modelled at 38.4 dBA in the NIA. The predicted sound level at the monitoring station, as modelled by DNV GL based on the parameters of the NIA, was 38.8 dBA.

The recommended monitoring locations were provided to the MOECC prior to mobilization and were deemed acceptable based on the rationale presented [4].

Table 2-1 provides a summary of the Receptors and selected monitoring locations.

Table 2-1 Receptor and Measurement Locations

Location	Easting	Northing	Distance to nearest turbine	Modelled sound level
R55	525949	4769269	733 m from T5	37.0 dBA
M55	525904	4769239	702 m from T5	37.2 dBA
R80	527612	4769608	675 m from T10	38.3 dBA
M83 (for R80)	527515	4769482	549 m from T9	38.8 dBA

All coordinates in UTM NAD83 zone 17

Figure 2-1 presents a general overview map of the measurement locations in relation to the Project. Figure 2-2 provide locations for the equipment on the properties. Pictures of the monitoring locations are included in Appendix B.

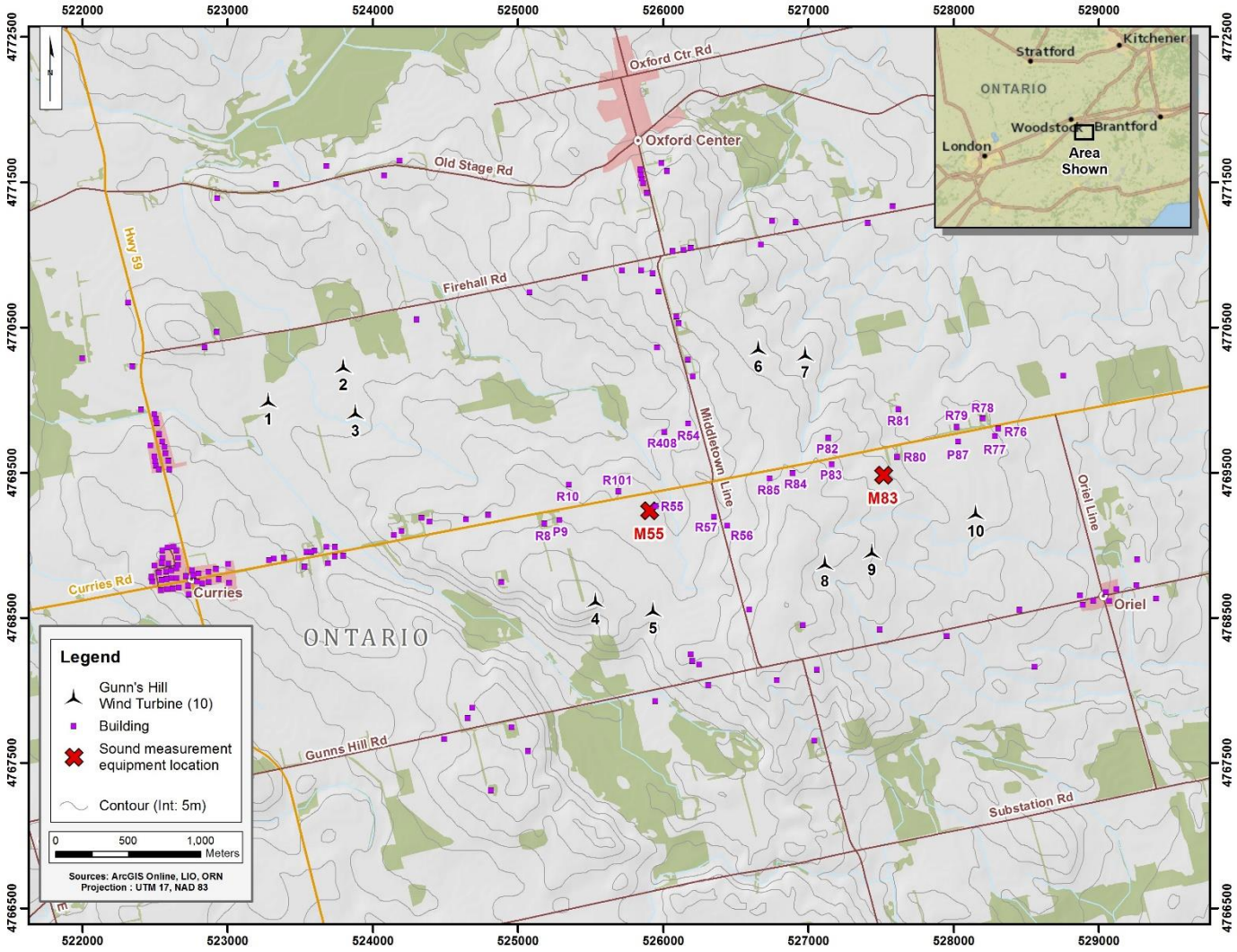

Figure 2-1 Map of Project and Monitoring Locations

Figure 2-2 Equipment Locations on Properties

2.2 Instrumentation

The instrumentation used for the post-construction noise monitoring included the following:

- Larson Davis sound meters model 831C Class 1;
- FreeField ½ inch Class 1 microphone model 377B02;
- Preamplifier model PRM831;
- Vaisala Weather Transmitter model SEN-031;
- Larson Davis Precision Acoustic on-site Calibrator model CAL200; and
- Complete kit for outside sound measurement (including 10m mast, primary and secondary wind screens, protective case, solar panels, and long range batteries).

In addition to the primary wind screens, secondary wind screens were installed over the microphones. The secondary wind screens consisted of a 600 mm (24 in) outer diameter sphere, composed of a 25 mm (1 in) layer of open cell foam fastened over a slender aluminum cage. The screens were tested in an anechoic wind tunnel prior to deployment, which showed negligible insertion loss and good performance under high winds.

The Vaisala weather sensor provided in-situ data for wind speed, wind direction, temperature, humidity and precipitation. The weather data was directly connected to the sound meter with synchronized data.

The sound meters met IEC 61672 and IEC 61260 Class 1 specifications, and were compliant with the Ministry of the Environment and Climate Change (MOECC) instrument requirements detailed under Section D2.1 of the Compliance Protocol. Pictures of the monitoring set-ups are including in Appendix B. All instruments had valid calibrations, within the year of monitoring, and calibration sheets are included in Appendix C of this document.

Table 2-2 provides the serial numbers of the equipment used at each monitoring location.

Table 2-2 Equipment Serial Numbers by Monitoring Location

Monitoring location	Sound Level Meter	Preamplifier	Microphone	Weather sensor
M55	10397	012425	304703	G38600219
M83	10143	023899	166816	P1320473

2.3 Data Collection

Data collection ran for more than 6 weeks at both locations, as stipulated in the Compliance Protocol. The start and end of both datasets were the following:

- M55: from 9 May to 1 August 2018 (12 weeks);
- M83: from 9 May to 4 August 2018 (12 weeks).

Throughout the campaign, operational data and ambient data (i.e. with the turbines parked) were collected, and subsequently binned per wind speed at a height of 10 m. Sound measurements were made continuously using a FAST response setting and statistics were derived by the sound meter and stored every second and every minute. Audio recordings were collected continuously throughout the campaign for future analysis. Sound events louder than 60 dBA were logged as events.

Only nighttime data (10pm-5am) were retained for further analysis. Extraneous events such as rain, or other atypical sounds such as an airplane flyover, dog barking or gunshots, were filtered out of the dataset.

2.3.1 Operational data

Operational data represents total noise data, i.e. the ambient data plus the wind turbine cumulative contribution. Due to the relatively small size of the wind farm, all turbines nearby the monitoring stations were required to be operational in order for the operational dataset to be considered valid.

For directional filtering, only downwind data with a yaw angle of ± 45 degrees from the nearest wind turbines to the monitoring stations, were considered valid. Furthermore, due to the proximity of two turbines to each station, both proximate turbines were considered for operational data. As per Appendix F11 of the Compliance Protocol, considering a cluster of wind turbines is acceptable with the condition that the modelled sound levels from each turbine were within 2 dB at the receptor/measurement location , and the two turbines were within a 90 degrees' window from the monitoring stations. In summary, operational data were filtered for the following direction criteria:

- M55: downwind from turbine T4 (i.e. yaw angle of 165° to 255°) or from turbine T5 (i.e. yaw angle of 135° to 225°);
- M83: downwind from turbine from turbine T9 (i.e. yaw angle of 144° to 234°) or T10 (i.e. yaw angle 68° to 158°).

As per the Compliance Protocol, operational data were finally filtered for when the nearest relevant turbines were producing at least 85% of rated power. This consisted in a power production of more than 1,598 kW at turbines T4 and T5 (for M55) or at turbines T9 and T10 (for M83). The remaining valid dataset therefore only considered periods with high shear and/or high wind speeds.

The sound and weather data at the monitoring stations were coupled with the SCADA data obtained by the Client. The data was obtained in 10 min timestamp averages, and included power production, nacelle wind speed, rotor rpm and yaw angle for all wind turbines. It was confirmed by the turbine vendor that smaller increments (i.e. 1 minute) were not possible with the current SCADA system.

2.3.2 Ambient Data

The ambient data represents data without the contribution of the wind turbines. i.e. ambient data only. For the ambient data, the wind turbines which would result in the predicted sound level to fall below 30 dBA at the monitoring stations, were required to be parked. As estimated by DNV GL's modelling, this consisted in the following turbines:

- M55: Turbines T4, T5, T6, T7, T8, T9 and T10 to be parked;
- M83: Turbines T5, T7, T8, T9 and T10 to be parked.

In addition, the same directional filtering criteria as for the operational data was applied for the ambient data, which consisted of an overall range of 135° to 255° for M55 and 68° to 234° for M83. The turbine yaw may not correlate to wind direction during ambient periods or when curtailed. Therefore, wind direction was based on each monitoring station's Vaisala weather sensor at a 10 m height. This provided comparisons of operational and ambient data from the similar directions which typically produces more conclusive results.

In order to ensure relevant wind turbines were parked during these periods, DNV GL filtered the SCADA power production *and* rotor speed to ensure wind turbines were not contributing to the ambient measurements. A wind farm operator statement can also be found under Appendix D.

2.3.3 Field Calibration

On-site maintenance visits were performed approximately every 2 weeks in order to verify the integrity of the monitoring stations, download data and field calibrate the sound meters. The field calibrations were performed with the Larson Davis CAL-200 calibrator, at the beginning of the monitoring campaign and during all subsequent visits. The differential calibrations during the subsequent visits were not greater than 0.5 dB, and are shown in Table 2-3.

Table 2-3 Site Calibration Log

Monitoring location	Date / Calibration differential						
	9 May	17 May	4-Jun	19 June	4 July	25 July	Aug 9
M55	-0.15 dB	0.10 dB	-0.04 dB	0.06 dB	-0.12 dB	0.09 dB	0.21 dB
M83	-0.15 dB	-0.05 dB	-0.40 dB	0.02 dB	-0.02 dB	-0.11 dB	-0.06 dB

2.4 Compliance Requirements

The sound level limits are outlined in the Nosie Guidelines and under Condition C1. of the REA. The sound level limits are based on the cumulative contribution of the Project, excluding ambient sound. The sound levels are shown in Table 2-4 and increase at higher wind speeds.

Table 2-4 Ontario Permissible Sound Levels

Wind speed at 10 m height	Up to 6 m/s	7 m/s	8 m/s	9 m/s	10 m/s
Sound level limit (dBA)	40	43	45	49	51

Per the Compliance Protocol, the sample size requirements for the comprehensive audit are 120 minutes of valid operational data in each of the 4, 5, 6, and 7 m/s wind speed bins and 60 minutes of valid ambient data in each of the 4, 5, 6 and 7 m/s wind speed bins. As stipulated in the Compliance Protocol, if the audit failed to collect sufficient data after 6 weeks of monitoring, statistical analysis can be used to determine compliance. It shall also be noted that ambient data from a lower wind speed bin can be conservatively used for a higher wind speed bin, in case of insufficient data, with the rationale that ambient sound increases with wind speed.

Compliance was finally determined by logarithmically subtracting valid ambient data results from operational data results, in each discrete wind speed bin relevant to the audit. Results were rounded to the nearest integer, as per the Compliance Protocol and compared against the levels in Table 2-4.

2.4.1 RAM-I Compliance Requirements

Per the compliance protocol, if the I-Audit is incomplete, the owner/operator is provided the option to use a revised assessment methodology (RAM I-Audit). The data must be acquired to include three (3) wind speed bins between 1 and 7 m/s (inclusive) or two (2) of the wind speed bins must be between 1 and 4 m/s. A

reduced number of data points for each wind speed bin (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) is considered acceptable.

To demonstrate compliance, the RAM I-Audit criteria is the most appropriate method for evaluating for this extended measurement campaign.

3 ANALYSIS AND RESULTS

3.1 Audit results

During the overall campaign, sound was measured and recorded under various meteorological conditions. The following range of conditions were encountered:

- Temperature range of -2.0 to 31.7;
- Humidity range from 23 % to 96 %;
- Wind speed range at the wind turbines from 0 to 18 m/s;
- Wind speed range at the 10 m towers from 0 to 16 m/s.

Wind rose plots for the duration of the campaign at both 10 m towers can also be found in Appendix E.

As detailed under Section 2.3, the data was filtered as per the Compliance Protocol requirements. The following provides the filtering summary;

All data:

- Nighttime only (10 pm – 5 am);
- Removal of rain events, within one hour of the measurement interval, as recorded by in-situ weather sensor;
- Removal of extraneous events (airplane fly-over, gun shots and fireworks).

Operational data:

- Power production of more than 1,598 kW at turbines T4 or T5 (for M55), or power production of more than 1,598 kW at turbines T9 or T10 (for M83);
- Neighboring turbines operational;
- Downwind from turbine T4 (yaw angle of 165° to 255°) or from turbine T5 (yaw angle of 135° to 255°) for M55;
- Downwind from turbine T9 (yaw angle of 144° to 234°) or turbine T10 (yaw angle of 68° to 158°) for M83.

Ambient data:

- Turbines T4, T5, T6, T7, T8, T9 and T10 to be parked for R55;
- Turbines T5, T7, T8, T9 and T10 to be parked for P83;
- Wind direction at the 10 m mast between 135° and 255° for R55;
- Wind direction at the 10 m mast between 68° to 234° for P83.

The remaining valid data were then grouped per wind speed bin, measured at a height of 10 m above ground. Table 3-1 and Table 3-2 below provide the number of valid samples, the logarithmically averaged sound levels, the standard deviations, and the resulting wind turbine contributions.

Table 3-1 M55 Audit Results

	Operational			Ambient			
Wind Speed at 10 m (m/s)	**Number of Valid 1 min samples**	**LAeq (dBA)**	**Standard deviation (dBA)**	**Number of Valid 1 min samples**	**LAeq (dBA)**	**Standard Deviation (dBA)**	**Turbine Contribution (dBA)**
3	245	42.0	1.9	1212	41.2	4.3	**34.4**
4	880	42.4	2.0	553	40.6	2.4	**37.6**
5	79	43.3	1.9	54	41.4	1.5	**38.9**

Table 3-2 M83 Audit Results

	Operational			Ambient			
Wind Speed at 10 m (m/s)	**Number of Valid 1 min samples**	**LAeq (dBA)**	**Standard deviation (dBA)**	**Number of Valid 1 min samples**	**LAeq (dBA)**	**Standard Deviation (dBA)**	**Turbine Contribution (dBA)**
3	73	44.1	1.0	1149	42.8	5.9	**38.1**
4	110	42.7	1.2	492	40.3	3.1	**39.1**
5	50	43.4	1.4	53	41.8	1.9	**38.4**

The extended survey period provided sufficient sample sizes to meet the RAM-I Audit criteria. Results for the 5 m/s bin are also presented, with sufficient data for M55 (Table 3-1) to meet the RAM I-Audit criteria and with a reasonable amount of data points for M83 (Table 3-2). Since the data thresholds are met and the standard deviations demonstrate data were reasonably coherent, it is DNV GL's opinion that the results can be treated as conclusive.

Furthermore, as detailed under Section 2.1, the monitoring location near Receptor R55 was situated closer to the nearest wind turbines from the receptor. DNV GL modeling showed a decrease of approximately 0.2 dB between the monitoring location and Receptor R55. This decrease has not been applied to turbine contribution audit results, but provides an additional level of confidence for the statement of compliance. Similarly, audit results at monitoring location M83 are at a Participant, and would decrease by 0.5 dB when extrapolated to Receptors R80. This decrease has not been applied to turbine contribution audit results, but also provides an additional level of confidence in results for the statement of compliance. It shall be noted that since directional filtering were applied to both operational and ambient data, there is increased accuracy in extrapolating the audit results downwind to nearby Receptors.

The Figure 3-1 and Figure 3-2 M83 Sound Level Graph provide graphs depicting the operational and ambient measured sound levels, as well as the resulting wind turbine only contributions. The standard deviations are also shown as a dashed line.

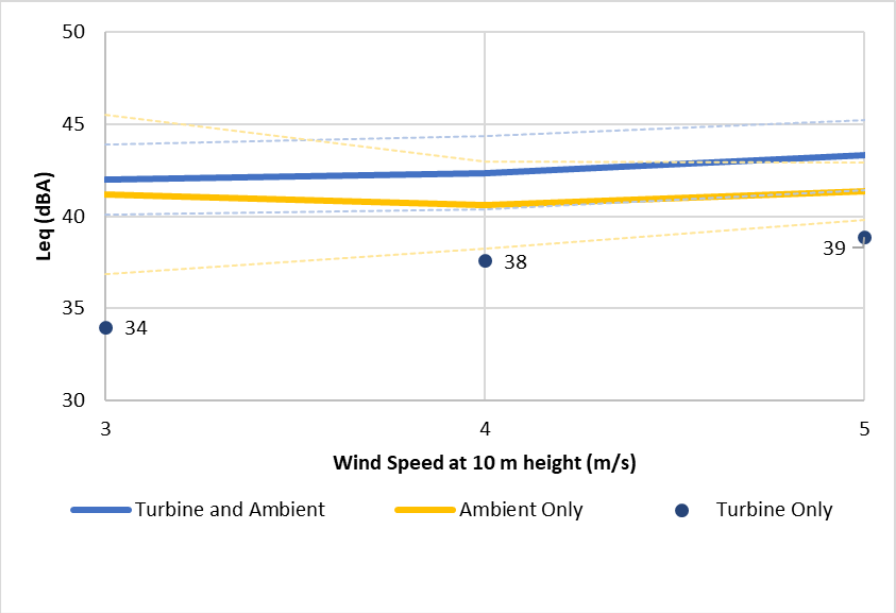

Figure 3-1 M55 Sound Level Graph

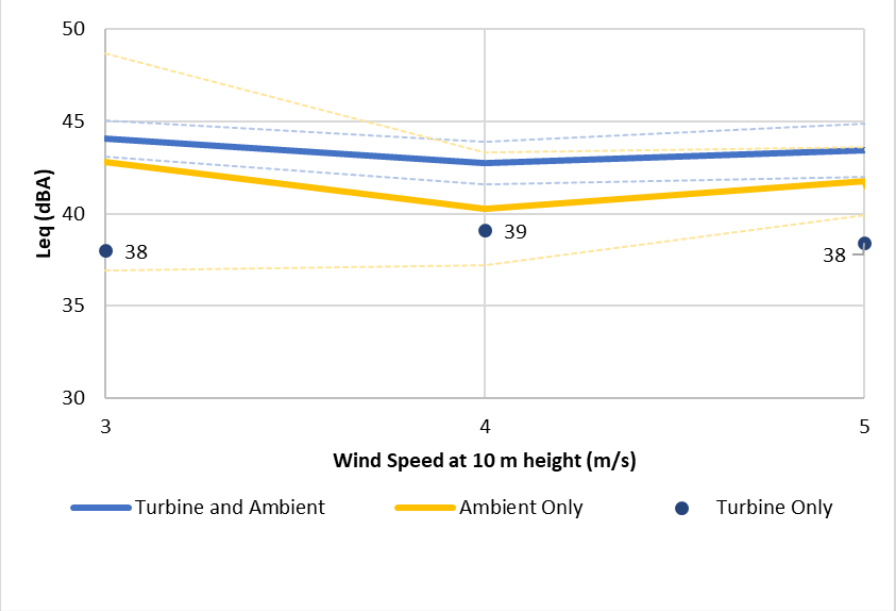

Figure 3-2 M83 Sound Level Graph

Figure 3-3 and Figure 3-4 provide scatter plots for all the valid data.

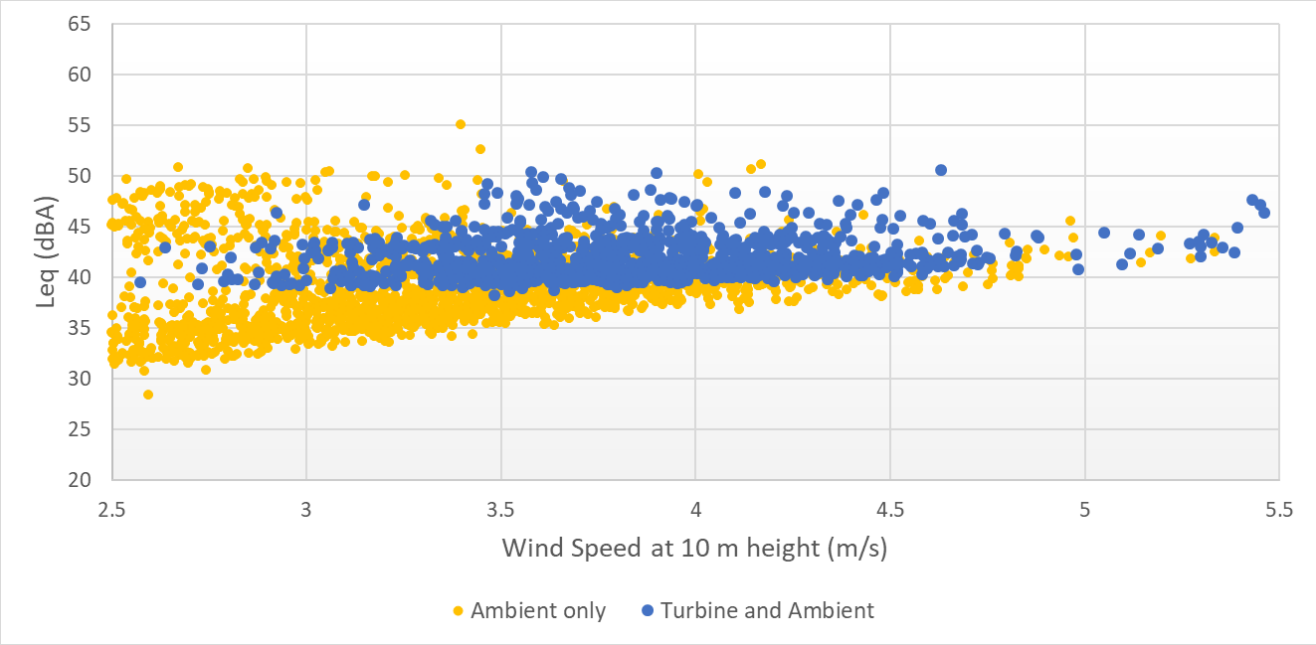

Figure 3-3 M55 Sound Pressure Level Scatter Plot

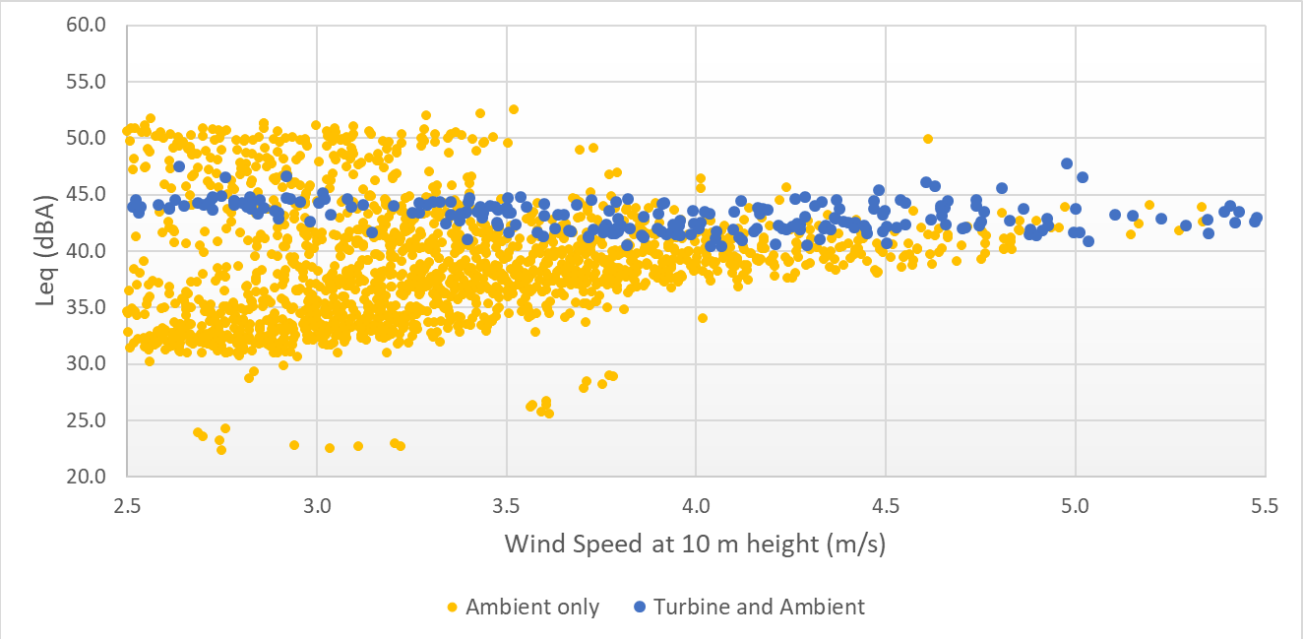

Figure 3-4 M83 Sound Pressure Level Scatter Plot

3.2 Tonality

On site observations during installations, numerous site visits and demobilizations, as well as a summary review of 1/3rd octave bands, indicated no tone from the wind turbines. As well, prior wind turbine Emission testing by DNV GL, as per IEC 61400-11 Ed 3, at the Gunn's Hill Wind Farm indicated no relevant tone from the wind turbine [5].

4 COMPLIANCE ASSESSMENT

Table 4-1 and Table 4-2 below compare the audit results to the permissible sound level limits in Ontario. As discussed under Section 3.1, the audit results presented are at the monitoring stations, and have not been extrapolated to the nearby Receptor locations. The monitor locations are closer to the turbines from the Receptors. DNV GL's modelling indicates a decrease of 0.2 dB at Receptor R55 and 0.5 dB at R80, which is expected based on the additional distance between the turbines and the Receptors. Considering the audit results at the monitoring stations are compliant, and with the additional decrease at the nearby Receptors, the Gunn's Hill Wind Farm is considered compliant with Condition C1. of the REA at the relevant Receptors.

Table 4-1 M55 Compliance Assessment

Wind Speed at 10 m (m/s)	Turbine Contribution (dBA) [1]	MOECC Limit (dBA)	Compliant (Yes/No)
3	**34.4**	40	**Yes**
4	**37.6**	40	**Yes**
5	**38.9**	40	**Yes**

Note 1: Turbine contribution at M55 in Table.
Based on modelled results, R55 would be expected to be 0.2 dB lower.

Table 4-2 M83 Compliance Assessment

Wind Speed at 10 m (m/s)	Turbine Contribution (dBA) [1]	MOECC Limit (dBA)	Compliant (Yes/No) [1]
3	**38.1**	40	**Yes**
4	**39.1**	40	**Yes**
5	**38.4**	40	**Yes**

Note 1: Turbine contribution at M83 In Table.
Based on modelled results, R80 would be expected to be 0.5 dB lower.

5 CONCLUSION

DNV GL completed an Immission audit at the Gunn's Hill Wind Farm during Spring 2018, as per REA requirements. The audit was conducted per Part D the MOECC Compliance Protocol, at two locations. The campaign ran for 12 weeks at both monitoring locations, under various meteorological conditions when the wind turbines were operational and parked.

Sufficient data were gathered to conclude results, under a RAM-I audit scenario per the Compliance Protocol. Audit results at the monitoring stations demonstrate compliance, and with the additional expected sound level decrease at the nearby Receptors, the Gunn's Hill Wind Farm is considered compliant with Condition C1. of the REA, at the relevant Receptors.

6 REFERENCES

[1] Noise Assessment Report, Gunn's Hill Wind Farm Ridge Wind Project, Zephyr North Ltd., 8 October 2014.

[2] Noise Guidelines for Wind farms – Interpretation for Applying MOE NPC Publications to Wind, Ministry of the Environment and Climate Change, October 2008.

[3] Compliance Protocol for wind turbine noise, Ministry of the Environment and Climate Change, NPC-350, April 2007.

[4] Email correspondence and verbal discussions with MOECC Senior Noise Engineer Denton Miller. 27 April 2018 and prior calls.

[5] Results of acoustic noise measurements to IEC 61400-11 Edition 3.0 – MM92, 1880 kW, 93626 / T4, Gunn's Hill LP, GLGH-4286 16 14199 293-A-0007-A, December 2017.

APPENDIX A – AUDIT RECEPTOR SELECTION RATIONALE

Receptor ID	Description	Height (m) [1]	Distance to Closest Turbine (m)	Closest Turbine ID	Modelled sound level - (dBA) [2]	Rationale
P83	**Participant**	**4.5**	**583**	**T10**	**38.9**	**Permission Granted. Monitoring location near R80 selected.**
R84	Residence	4.5	673	T8	38.6	Not in prevailing wind directions
R80	Residence	4.5	675	T10	38.4	Permission not granted
R85	Residence	4.5	709	T8	38.1	Not in prevailing wind directions
R56	Residence	4.5	729	T8	37.7	Not in prevailing wind direction
R57	Residence	4.5	788	T05	37.3	Permission not granted
V107	VLR	4.5	680	T10	37.3	Not in prevailing wind directions
R55	**Residence**	**4.5**	**733**	**T5**	**37.0**	**Permission Granted.**
R81	Residence	4.5	737	T7	37.0	Less favorable wind direction
R36	Residence	4.5	609	T2	37.0	No receptor on this location based on aerial imagery, only a farm building. (VLR)

Note 1: All receptors are modelled at 4.5 m in NIA [1]. The Compliance Protocol requires measuring at NIA modelled height regardless if an existing dwelling is 1-storey [1].

Note 2: As per [1].

APPENDIX B – MEASUREMENT POINT PHOTOS

M55 facing Southwest

M55 facing East

M83 facing Northeast

M83 facing Southwest

APPENDIX C – CALIBRATION SHEETS

Calibration Certificate

Certificate Number 2018003965
Customer:
The Modal Shop
3149 East Kemper Road
Cincinnati, OH 45241, United States

Model Number	831C	***Procedure Number***	D0001.8378		
Serial Number	10143	***Technician***	Ron Harris		
Test Results	**Pass**	***Calibration Date***	18 Apr 2018		
Initial Condition	AS RECEIVED same as shipped	***Calibration Due***			
Description	Larson Davis Model 831C Class 1 Sound Level Meter Firmware Revision: 03.0.6R0	***Temperature***	23.46	°C	± 0.25 °C
		Humidity	50	%RH	± 2.0 %RH
		Static Pressure	86.76	kPa	± 0.13 kPa

Evaluation Method Tested electrically using Larson Davis PRM831 S/N 029412 and a 12.0 pF capacitor to simulate microphone capacitance. Data reported in dB re 20 µPa assuming a microphone sensitivity of 50.0 mV/Pa.

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8384:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61260:2014 Class 1	ANSI S1.11-2014 Class 1
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005. **Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.**

The quality system is registered to ISO 9001:2008.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

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Correction data from Larson Davis SoundAdvisor Model 831C Reference Manual, I831C.01 Rev B, 2017-03-31

Calibration Check Frequency: 1000 Hz; Reference Sound Pressure Level: 114 dB re 20 µPa; Reference Range: 0 dB gain

Periodic tests were performed in accordance with precedures from IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part3.

Larson Davis, a division of PCB Piezotronics, Inc
1681 West 820 North
Provo, UT 84601, United States
716-684-0001

ilac-MRA ACCREDITED Cert. #3622.01

LARSON DAVIS
A PCB PIEZOTRONICS DIV.

2018-4-18T13:45:38

D0001.8407 Rev B

Calibration Certificate

Certificate Number 2018003332
Customer:
The Modal Shop
3149 East Kemper Road
Cincinnati, OH 45241, United States

Model Number	831C	***Procedure Number***	D0001.8378	
Serial Number	10397	***Technician***	Ron Harris	
Test Results	**Pass**	***Calibration Date***	3 Apr 2018	
Initial Condition	As Manufactured	***Calibration Due***	3 Apr 2020	
		Temperature	23.45 °C	± 0.25 °C
Description	Larson Davis Model 831C Class 1 Sound Level Meter Firmware Revision: 03.0.6R0	***Humidity***	50.2 %RH	± 2.0 %RH
		Static Pressure	86.79 kPa	± 0.13 kPa

Evaluation Method Tested electrically using Larson Davis PRM831 S/N 051237 and a 12.0 pF capacitor to simulate microphone capacitance. Data reported in dB re 20 µPa assuming a microphone sensitivity of 50.0 mV/Pa.

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8384:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61260:2014 Class 1	ANSI S1.11-2014 Class 1
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005. **Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.**

The quality system is registered to ISO 9001:2008.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

Correction data from Larson Davis SoundAdvisor Model 831C Reference Manual, I831C.01 Rev B, 2017-03-31

Calibration Check Frequency: 1000 Hz; Reference Sound Pressure Level: 114 dB re 20 µPa; Reference Range: 0 dB gain

Larson Davis, a division of PCB Piezotronics, Inc
1681 West 820 North
Provo, UT 84601, United States
716-684-0001

ilac-MRA ACCREDITED Cert. #3622.01

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A PCB PIEZOTRONICS DIV.

2018-4-3T14:06:18

D0001.8407 Rev B

THE MODAL SHOP INC.
A PCB GROUP CO.

~Certificate of Calibration~

3149 East Kemper Rd.
Cincinnati, OH 45241
Ph : 513-351-9919
Fax: 513-458-2172
www.modalshop.com

Manufacturer: PCB
Model Number: 377B02
Serial Number: 166816
Asset ID:
Description: Free-Field Microphone

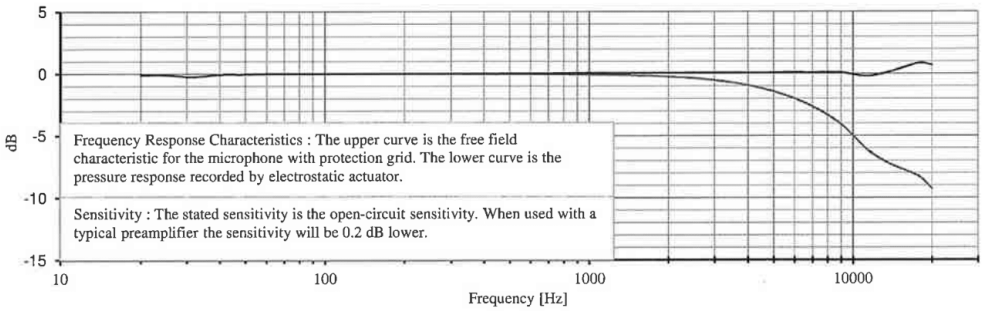
Sensitivity:	**250 Hz**	**1 kHz**	
	-25.64	-25.70	dB re. 1V/Pa
	52.27	51.85	mV/Pa

Cal. Results: In Tolerance

Customer: TMS Rental
Address:

Calibration Date: Feb 26, 2018 15:28:58
Due Date:

Temperature:	74 (23)	°F (°C)
Humidity:	23	%
Ambient Pressure:	1004.4	mbar
Polarization Voltage:	0	VDC



Traceability: The calibration is traceable through A1633.
Notes: Calibration results relate only to the items calibrated.
This certificate may not be reproduced, except in full, without written permission.
This calibration is performed in compliance with ISO 9001, ISO 17025 and ANSI Z540.
Measurement uncertainty (250 Hz sensitivity calibration) at 95% confidence level: 0.30 dB
Calibrated per procedure PRD-P204.

User Note: As Found / As Left: In Tolerance.

Frequency Response with reference to level at 250 Hz

Frequency (Hz)	Upper (dB)	Frequency (Hz)	Upper (dB)	Frequency (Hz)	Upper (dB)	Frequency (Hz)	Upper (dB)
20	-0.09	**630**	0.01	**4500**	0.07		
25	-0.10	**800**	0.05	**5000**	0.08		
31.5	-0.24	**1000**	0.06	**5600**	0.09		
40	-0.06	**1120**	0.06	**6300**	0.10		
50	-0.04	**1250**	0.06	**7100**	0.09		
63	0.00	**1400**	0.07	**8000**	0.11		
80	0.01	**1600**	0.06	**9000**	0.10		
100	0.01	**1800**	0.06	**10000**	-0.06		
125	0.01	**2000**	0.07	**11200**	-0.20		
160	0.00	**2240**	0.07	**12500**	-0.06		
200	0.00	**2500**	0.08	**14000**	0.20		
250	0.00	**2800**	0.09	**16000**	0.57		
315	0.01	**3150**	0.09	**18000**	0.86		
400	0.00	**3550**	0.08	**20000**	0.70		
500	0.02	**4000**	0.07				

Technician: Ed Devlin

Approval: Edward A. Devlin

Reference Equipment Used:

Manuf.	*Model*	*Serial*	*Cal. Date*	*Due Date*
GRAS	40AG	9542	2/22/2018	2/22/2019

ACCREDITED
Calibration Lab
CALIBRATION CERT 2649.01

Page 1 of 1

Calibration Certificate

Certificate Number 2018003341

Customer:
The Modal Shop
3149 East Kemper Road
Cincinnati, OH 45241, United States

Model Number	377B02	***Procedure Number***	D0001.8387		
Serial Number	304703	***Technician***	Abraham Ortega		
Test Results	**Pass**	***Calibration Date***	3 Apr 2018		
Initial Condition	As Manufactured	***Calibration Due***	3 Apr 2020		
Description	1/2 inch Microphone - FF - 0V	***Temperature***	24.2	°C	± 0.01 °C
		Humidity	27.4	%RH	± 0.5 %RH
		Static Pressure	101.69	kPa	± 0.03 kPa

Evaluation Method Tested electrically using an electrostatic actuator.

Compliance Standards Compliant to Manufacturer Specifications.

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the SI through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005.
Test points marked with a ‡ do not fall within this laboratory's scope of accreditation.

The quality system is registered to ISO 9001:2008.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

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Standards Used

Description	Cal Date	Cal Due	Cal Standard
Larson Davis Model 2900 Real Time Analyzer	07/17/2017	07/17/2018	001230
Microphone Calibration System	08/30/2017	08/30/2018	001233
1/2" Preamplifier	12/14/2017	12/14/2018	001274
Agilent 34401A DMM	12/07/2017	12/07/2018	001329
Larson Davis CAL250 Acoustic Calibrator	01/03/2018	01/03/2019	003030
1/2" Preamplifier	04/12/2017	04/12/2018	006506
Larson Davis 1/2" Preamplifier 7-pin LEMO	09/12/2017	09/12/2018	006507
1/2 inch Microphone - RI - 200V	04/24/2017	04/24/2018	006510
1/2 inch Microphone - RI - 200V	08/09/2017	08/09/2018	006519
Larson Davis 1/2" Preamplifier 7-pin LEMO	09/12/2017	09/12/2018	006530
Larson Davis 1/2" Preamplifier 7-pin LEMO	08/11/2017	08/11/2018	006531

Larson Davis, a division of PCB Piezotronics, Inc
1681 West 820 North
Provo, UT 84601, United States
716-684-0001

ilac-MRA A2LA ACCREDITED Cert. #3672.01

LARSON DAVIS
A PCB PIEZOTRONICS DIV.

THE MODAL SHOP INC.
A PCB GROUP CO.

~Calibration Certificate~

3149 East Kemper Rd.
Cincinnati, OH 45241
Ph : 513-351-9919
Fax: 513-458-2172
www.modalshop.com

Manufacturer:	Larson Davis	Asset ID:	59726
Model:	CAL200	Calibration Date:	Apr 26, 2018 10:03:46
Serial Number:	11336	Due Date:	
Description:	Acoustic Calibrator	Technician:	Ed Devlin
Customer:	TMS Rental	Approval:	

Calibration Results:

Measured SPL : 94.10 dB re. 20µPa

Measured Frequency : 1,000.00 Hz

Temperature: 22 °C (72 °F)

Humidity: 34.90%

Pressure: 992.5 mbar

Upon receipt for calibration, the instrument was found to be:
WITHIN the stated tolerance of the manufacturer's specification.

Note: **As-Found As-Left in tolerance**

Measurement uncertainty at 95% confidence level: 0.30 dB

The subject instrument was calibrated to the indicated specification using standards stated below or to accepted values of natural physical constants. This document certifies that the instrument met the following specification upon its return to the customer.

This calibration is traceable through : A1633

Notes:
The calibration was performed under operating procedures intended to implement the requirements of ISO 9001, ISO 17025 and ANSI Z540. Unless otherwise noted, the reported value is both "as found" and "as left" data. Calibration results relate only to the items calibrated. This certificate may not be reproduced, except in full, without written permission.

Reference Equipment Used:

Manuf.	*Model*	*Serial*	*Cal. Date*	*Due Date*
GRAS	40AG	9542	2/22/2018	2/22/2019

VAISALA

1(1)

Test report no. H31-18130045

TEST REPORT

Product family	WXT530 series
Product type	WXT536
Order code	6B1B2A1D1A1B
Serial number	P1320473
Manufacturer	Vaisala Oyj, Finland
Test date	27 March 2018

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

Test results

Test	Result	Lower limit	Upper limit	Unit
Rain response	394	345	575	mV
Zero wind speed	0	0	0.4	m/s
Pressure difference	-0.14	-1	1	hPa
Temperature difference	0.04	-2	2	°C
Humidity difference	-1	-10	10	%RH
Heating current	0.72	0.6	0.8	A
Current (service port)	0.96	0.5	2	mA
Communication (service port)	pass	PASS	PASS	-
Current (main port)	0.61	0.5	2	mA
Communication (main port)	pass	PASS	PASS	-

Ambient conditions / Humidity 15.7 ±5 %RH, Temperature 23.2 ±1 °C, Pressure 1013.07 ±1 hPa.

Signature

Technician

 DOC233154-A.doc

Vaisala Oyj | PO Box 26, FI-00421 Helsinki, Finland

Test report no. H31-11380287

TEST REPORT

Instrument WXT520 AAB1BA30B0
Serial number G3860019
Manufacturer Vaisala Oyj, Finland
Test date 25th September 2011

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

Test results

Test	Result	Limit	Passed
Rain response	1030.0 mV	(950...1600) mV	OK
Zero wind speed	0.00 m/s	(0...0.4) m/s	OK
Pressure	1011.5 hPa	PASS/FAIL	OK
Temperature	23 °C	PASS/FAIL	OK
Humidity	34 %RH	PASS/FAIL	OK
Heating	PASS	PASS/FAIL	OK
Current (service port)	0.55	(0.2...0.7) mA	OK
Communication (service port)	PASS	PASS/FAIL	OK
Current (main port)	0.31	(0.1...0.4) mA	OK
Communication (main port)	PASS	PASS/FAIL	OK

Signature

COPY

_____

Technician *(Reprinted in BOS Oct. 3, 2018)*

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APPENDIX D – OPERATOR STATEMENT

From: Burdeney, Andy
Sent: 09 October 2018 13:50
Subject: Gunn's Hill - Letter for Immission Report

To whom it may concern,

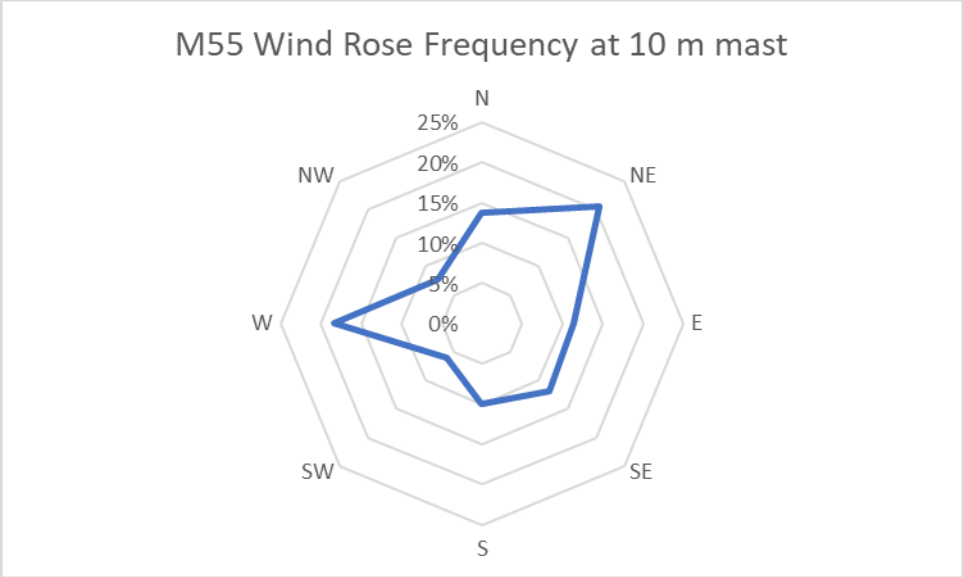
I am writing this email as a confirmation that Gunn's Hill Wind Farm WEC 4-93626, WEC 5 – 93623, WEC 9-93624 and WEC 10 – 93621 were operating normally during the acoustic measurement campaign that took place between May 9, 2018 and August 4, 2018. No alteration or modification were made to any operating parameters at any time. The turbine were not curtailed and not had any operations altered for the course of the audit.

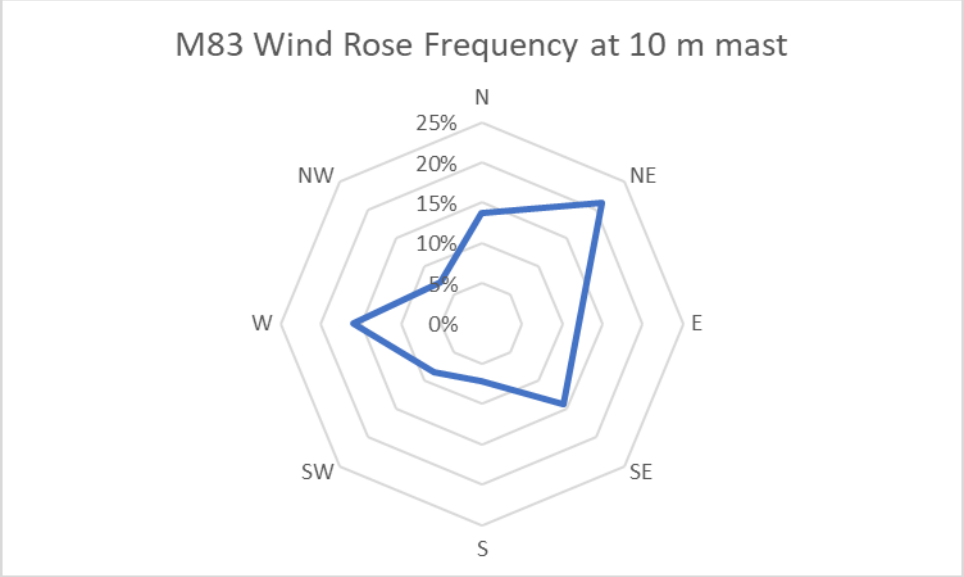
Gunn's Hill Wind Farm was placed in "Manual Stop" during ambient sound level measurement periods specified by the client. In manual stop condition, all wind turbine generators are disconnected from grid and not generating power. "Manual Stop" is used to park the Turbine. During this period, the blades are set to 92.5°, 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.

Best Regards,

Andy Burdeney
Site lead Operations & Maintenance
Senvion Canada Inc.
5-545 Trillium Dr.
Kitchener, ON, N2R 1J4
C-905 714-4149

APPENDIX E – OVERALL CAMPAIGN WIND ROSES





About DNV GL

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification, technical assurance, software and independent expert advisory services to the maritime, oil & gas and energy industries. We also provide certification services to customers across a wide range of industries. Combining leading technical and operational expertise, risk methodology and in-depth industry knowledge, we empower our customers' decisions and actions with trust and confidence. We continuously invest in research and collaborative innovation to provide customers and society with operational and technological foresight. Operating in more than 100 countries, our professionals are dedicated to helping customers make the world safer, smarter and greener.