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IMMISSION AUDIT REPORT – **Project: 13228.02**

South Kent Wind Project
R3167 – Turbine T038
Chatham-Kent, Ontario

Prepared for:

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Revision History

Version	Description	Author	Reviewed	Date
1	Initial Report	AED	MAD	February 28, 2020
2	Table 3: Correction to the distances from the monitors to the test turbine.	AED	AM	May 29, 2020

Important Notice and Disclaimer

Executive Summary

Aercoustics Engineering Limited ("Aercoustics") was retained by South Kent Wind LP to complete the acoustic audit requirements outlined in the Renewable Energy Approval ("REA") for South Kent Wind Project ("SKWP"). SKWP operates under REA #2871-8UKGPC, issued on June 15, 2012.

In response to Section G of the REA, emission audit ("E-Audit") tests were conducted at six (6) SKWP turbines and test reports were submitted to the Ministry of the Environment, Conservation and Parks ("MECP"). Based on these reports, the MECP requested that additional supporting immission audit ("I-Audit") tests be conducted at receptor locations close to each test turbine in order to support the completion of the E-Audit requirement.

This report presents the results of the I-Audit assessment for receptor R3167 near turbine T038. The E-Audit results for T038 indicated that the measured sound power level of the test turbine was within the level specified in the REA plus 0.5 dB, in accordance with Section E3.1 of the Protocol. However, the E-Audit results did not meet the 3 dB signal-to-noise requirements of the IEC 61400-11 Standard and as a result, the assessment of the sound power level was inconclusive. In addition, the results indicated that the turbine had a tonal audibility greater than 3 dB and thus would need to be assessed in the far field. As such, the audit at R3167 was conducted to assess compliance of the sound pressure level and tonal audibility in the far field.

The monitoring near receptor R3167 was conducted over the following period:

Audit Receptor	Audit Start Date	Audit End Date	Monitoring Duration (weeks)
R3167	September 18, 2019	January 2, 2020	15

The audit has been completed as per the methodology outlined in Parts D and E5.5 RAM-I (Revised Assessment Methodology) of the "*MECP Compliance Protocol for Wind Turbine Noise*" (updated April 21, 2017).

Based on the results presented in this report, the assessment requirements outlined in the Compliance Protocol have been met and the cumulative sound impact calculated at R3167 complies with the MECP sound level limits at all wind bins with sufficient data for assessment.

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1 Introduction

Aercoustics Engineering Limited ("Aercoustics") was retained by South Kent Wind LP to complete the acoustic audit requirements outlined in the Renewable Energy Approval ("REA") for South Kent Wind Project ("SKWP"). SKWP operates under REA #2871-8UKGPC, issued on June 15, 2012.

In response to Section G of the REA, emission audit ("E-Audit") tests were conducted at six (6) SKWP turbines and test reports were submitted to the Ministry of the Environment, Conservation and Parks ("MECP"). Based on these reports, the MECP requested that additional supporting immission audit ("I-Audit") tests be conducted at receptor locations close to each test turbine in order to support the completion of the E-Audit requirement.

This report presents the results of the I-Audit assessment for receptor R3167 near turbine T038.

The audit was completed per the methodology outlined in Part D and Part E of the Compliance Protocol for Wind Turbine Noise ("Compliance Protocol" or "Protocol"), April 2017 revision. The Compliance Protocol is an Ontario MECP document used to evaluate noise from a wind turbine at nearby receptors.

2 Background

The most up-to-date E-Audit report submitted and reviewed by the MECP for turbine T038 is as follows:

> Acoustic Measurement Report, project number: 13228.00, South Kent Wind Farm, Turbine T038 - IEC 61400-11 measurement dated November 21, 2014 Revision 2.

The results of the E-Audit test are summarized in Table 1 below.

Table 1: E-Audit Results Summary

Sound Power			Maximum Tonal Audibility	
REA (dBA)	Audit (dBA)	Exceeds REA plus 0.5 dB* (Y/N)	Audit (dBA)	Exceeds 3 dB** (Y/N)
101	101.0	N	3.0	Y

* REA sound power levels plus 0.5 dB threshold specified in accordance with Section E3.1 of the Protocol.
** 3 dB threshold specified in accordance with Section D3.8.3 of the Protocol.

The E-Audit results did not meet the 3 dB signal-to-noise requirements of the IEC 61400-11 Standard and as a result, the assessment of the sound power level was inconclusive. In addition, the results indicated that the turbine had a tonal audibility greater than 3 dB and thus would need to be assessed in the far field.

In review of the report, the MECP requested that additional supporting measurements be conducted at the receptor location closest to the test turbine, in accordance with Section E.3.1.2 of the Protocol. This feedback was delivered in an email dated January 4, 2019 and further clarified in a call on January 14, 2019.

For reference, a detailed summary of the sound power and tonal audibility assessment results from the T038 E-Audit is provided in Appendix F.

3 Facility Description

South Kent Wind Project is a wind facility comprising 124 Siemens SWT-101 wind turbines with name plate capacities of 2.221 MW, 2.126 MW, 1.903 MW, and 1.824 MW. The total name plate capacity of the facility is 270 megawatts. Each turbine has a hub height of 99.5 metres. The facility is located in the Chatham-Kent Municipality.

The facility has two large substation transformers rated at 148 and 129 MVA. The facility is designed to operate 24 hours per day, 7 days per week.

4 Audit Location

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

4.1 Receptor Selection

Measurement equipment was erected at receptor R3167 near the test turbine T038. The measurement location was selected as per Section E3.1.2 of the Compliance Protocol, wherein measurements are to be conducted at the point of reception with the greatest predicted noise impact from the specified test turbine (“worst-case receptor”). The frequent downwind conditions were also considered for receptors with similar predicted partial sound levels from the test turbine. The prevailing wind direction for the site is discussed in the following section. The receptor location was selected in consultation with the MECP and confirmed in a letter from the MECP dated March 29, 2019.

The receptor selection table for T038 is shown in Table 2 below. Predicted sound impacts at the receptor were obtained from the Noise Assessment Report for SKWP prepared by Hatch and dated May 7, 2013. A sound model using the original assessment report parameters was created by Aercoustics to calculate predicted sound levels at monitor locations.

Table 2: Receptor Selection Table

SPL Rank	Point of Reception ID	Nearest Turbine	Distance to Test Turbine (m)	Predicted Overall Sound Level (dBA)	Predicted Partial Sound Level from **test turbine** only* (dBA)	Wind Direction from Test Turbine	Notes
1	R3179	T038	551	40.0	33.6	Crosswind	Not downwind, shielded by greenhouses
2	**R3167**	**T038**	**724**	**38.2**	**30.8**	**Downwind**	**Measured location**

* These values are predicted based on the manufacturer specified sound power level for each turbine, not the measured sound power levels. They are included to be indicative of the relative contribution of the turbine of interest at each location.

The Ontario 401 Highway (ON-401), located approximately 1 km to the north of the receptor and test turbine locations, was determined to be a dominant source of noise contamination during the E-Audit test. Due to the noise contamination from the ON-401 and given that the T038 E-Audit test did not fulfill the signal-to-noise requirements, poor quality of data was anticipated for the far field measurements at the receptor.

In order to conclusively assess the impact of the test turbine at the receptor location, an additional monitor was erected approximately half the distance from the turbine to the receptor. The additional monitor was selected with the rationale that a monitor closer to the turbine would have better signal-to-noise between the turbine operational data and the ambient data. Therefore, the results of the second monitor could be used to provide additional information on the impact of the test turbine in order to assess the sound levels at the receptor location.

The monitor in the far field of T038, adjacent to the receptor location, is referred to in this report as the “far field monitor”. The closer monitor to T038, approximately half the distance from the turbine as the far field monitor, is referred to as the “intermediate monitor”.

4.1.1 Historical Wind Direction

Historical wind direction information was provided by SKWP and used to support selection of suitable audit receptors. This wind direction information is provided in Figure 1, and the prevailing downwind direction for the facility was determined to be 210°.

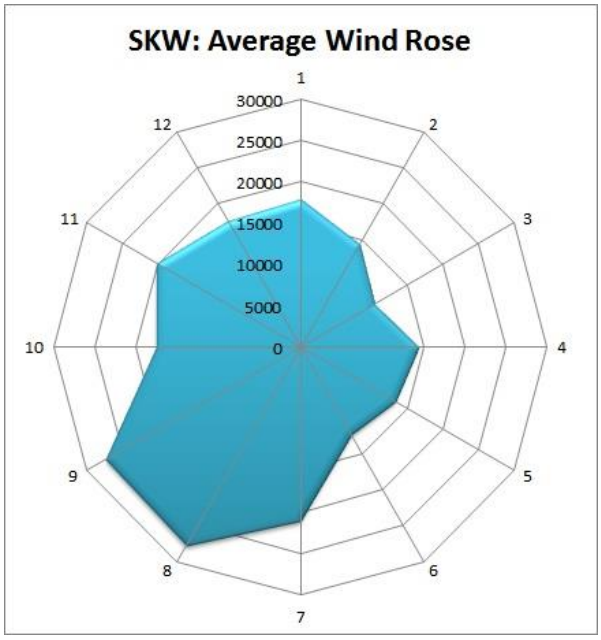

Figure 1: Historical Wind Rose used for Receptor Selection

4.2 Monitoring Location

The far field monitor, closest to the receptor, was erected approximately 60 metres from the coordinates of R3167, 41 metres closer to the test turbine (turbine T038). The intermediate monitor, approximately half the distance between the receptor and the test turbine, was erected 384 metres closer to the test turbine than the receptor. Both monitors were erected at the receptor height of 4.5 metres. The ground cover between the measurement locations and the nearest turbines was open field, predominantly covered with short crops and shrubs.

Table 3 provides a summary of the receptor and monitor locations. Site photographs and plans are provided in Appendix A.

Table 3: Coordinates and Turbines to Receptor and Measurement Locations

Audit Receptor	Measurement Duration	Location	Coordinates (UTM x,y, Zone 17T)	Distance to Test Turbine (metres)	Predicted Overall Sound Level (dBA)
R3167	Sep 18, 2019 – Jan 2, 2020	Receptor	412676 mE / 4692592 mN	724	38.2
		Monitor (Far Field)	412671 mE / 4692531 mN	667	38.6
		Monitor (Intermediate)	412467 mE / 4692238 mN	316	43.4

4.3 Existing Ambient Environment

The ambient acoustic environment for the SKWP site is comprised of a mixture of many different ambient sources. The contribution of noise from flora, fauna, traffic, and industry near the monitor location were considered throughout the measurement campaign.

Existing ambient noise sources were categorized as either extraneous—such as short-term events, or frequency-specific noise—or constant noise sources as part of the existing ambient sound environment. In the case of extraneous noise sources, filtering was employed to reduce or remove it, as further discussed in Section 5.3.2. For constant noise sources identified as being a part of the existing ambient sound environment, efforts were made to ensure that the noise was equally present in both *Total Noise* and *Background* periods, as further discussed in Section 5.3.3.

4.3.1 Flora Noise

Ambient noise from flora refers to the noise generated by wind blowing over vegetation and foliage and is typically proportional to wind speed, with higher wind speeds generating increased amounts of noise. Due to its ever-present and broadband nature, noise from flora is considered a constant noise source as part of the existing ambient environment.

The far field monitor, near the receptor coordinates, was located at the edge of a field with short crop cover, directly adjacent to the dwelling driveway. The crop cover had negligible noise impact on the measurements. The intermediate monitor, approximately halfway between the receptor and the test turbine, was surrounded by fields with short crop cover, also which had a negligible noise impact on the measurements. An area of approximately 40x40 ft was cleared around both monitors prior to installation. The far field monitor was also located approximately 25 metres from a tree line to the north-west. There were no large shrubs or trees in the vicinity of the intermediate monitor.

4.3.2 Fauna Noise

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

Cricket noise was present at the monitor location and was especially prominent in the early fall months from September to November. There were no other significant sources of fauna noise identified at the monitor location.

4.3.3 Traffic Noise

Traffic noise may include short-term events such as individual car passbys (considered extraneous noise) or constant noise (i.e. “traffic hum”) from high-volume or frequently travelled roads and highways.

The monitor was located approximately 110 metres from Huffman Road to the north-east. Due to the distance from the nearest road, the effect of individual car passbys was minimal throughout the measurement campaign.

The audit receptor is approximately 1 km from the Ontario Highway 401 to the north. As a result, traffic noise was found to be a constant presence during the measurement campaign. However, the traffic noise varied significantly based on time and weather conditions. Further discussion on the ON-401 impact and turbine sound level assessment is discussed in Section 5.6, with detailed analysis of the ON-401 impact on the ambient environment included in Appendix G.

4.3.4 Industry Noise

No significant sources of industry noise were identified in the vicinity of the monitor.

4.3.5 Self-Generated Noise

Self-generated noise is noise which results from wind blowing over the monitoring equipment and is a factor at high wind speeds at the measurement position. This noise was minimized by a secondary wind screen installed around the microphone in accordance with Section D2.1.4 of the Protocol. The insertion loss of the wind screen has been tested and was accounted for in the analysis.

4.3.6 Other Sources

No other notable ambient noise sources were identified in the vicinity of the monitor.

5 Audit Methodology

For the duration of the measurement campaign, acoustic and weather data were logged simultaneously at the measurement location. Due to data quality issues resulting from ON-401 noise contamination, measurement data was logged in 10 second intervals (i.e. sound level measurements were based on a 10 second averaging time) as permitted by Section E5.5(7) of the Protocol and as determined in consultation with the MECP.

Analysis and filtering were conducted in accordance with Sections D5.2 and E5.5 of the Protocol, with additional filters applied as needed—following the guidance in the Protocol—to remove or reduce extraneous ambient noise (see Section 5.3.2 below) and ensure representative ambient conditions (see Section 5.3.3 below). Deviations from the Protocol are discussed in Section 5.5.

Intervals that passed the filtering criteria were sorted into integer wind bins[1] depending on the measured wind speed at 10 metres above ground level (“10m-AGL”) and classified as

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

either *Total Noise* or *Background* depending on the operation of the nearby SKWP turbines. The *Turbine-Only* sound level for each wind bin was determined by logarithmically subtracting the average *Background* levels from the *Total Noise* level in wind bins with sufficient data for assessment.

The calculation of the average measured tonal audibility was determined in accordance with IEC 61400-11 Edition 3.0, as per Section D3.8.3 of the Protocol, with modifications to adapt the method to immission measurements. Calculations were conducted based on the narrowband spectra of the intervals within the tonality assessment dataset from 20 Hz to 3000 Hz with a frequency resolution of 2 Hz. As per IEC 61400-11, a tone would have to be present in at least 20% of the samples in order to be deemed relevant and evaluated under the penalty scheme (discussed in Section 5.4.3). This reduces the possibility of intermittent tones related to either the unsteady operation of the turbines, or from other contaminating sources, being attributed to the steady state operation of the turbines.

The tonal assessment dataset was determined based on the minimum power output of the test turbine corresponding to a tonal audibility greater than 0 dB in the T038 E-Audit test results. Table 3 presents a summary of the relevant tones for this assessment as determined from the E-Audit, and includes the frequency range, tonal audibility range, and corresponding turbine operational parameters during which elevated tonal audibility levels were observed. A centre frequency of 420 Hz was selected for the tonality assessment.

Table 4: Summary of Relevant Tones from T038 E-Audit

Turbine ID	Frequency Range (Hz)	Tonal Audibility (dB)	Hub Height Wind Speed Range (m/s)	Electrical Power Output Range (kW)
T038	405 – 435	1.2 – 3.0	7.0 – 15.5	1141 – 1824

5.1 Measurement Equipment

The following acoustic and non-acoustic measurement equipment was installed at the monitor location:

- One (1) Type 1 sound level meter with microphone and pre-amplifier, installed at receptor height;
- One (1) primary and one (1) secondary[2] windscreen for the microphone; and
- One (1) anemometer, installed at 10m-AGL

The measurement equipment was configured to log ten-second equivalent sound levels (L_{eq}) in A-weighted broadband and 1/3rd octave band frequencies. The microphone

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

was installed at least 5 metres away from any large reflecting surfaces, as far away as practically possible from trees and other foliage, and in direct line of sight to the nearest SKWP turbines.

Table 5 lists the specific make, model, and serial numbers for the measurement equipment.

Table 5: Equipment Details

Audit Receptor	Equipment	Make/Model	Serial Number	Date of Last Calibration
R3167 (Far Field Monitor)	Data Acquisition Card	NI 9234	1854438	July 22, 2019
	Signal Conditioner	PCB 480E09	33657	October 23, 2018
	Microphone	PCB 377B02	164139	January 14, 2019
	Pre-Amplifier	PCB 426E01	43997	January 14, 2019
	Weather Anemometer	Vaisala WXT536	R1020384	March 5, 2019
R3167 (Inter-mediate)	Data Acquisition Card	NI 9234	1C00A6B	July 22, 2019
	Signal Conditioner	PCB 480E09	34593	June 28, 2019
	Microphone	PCB 377B02	177358	June 28, 2019
	Pre-Amplifier	PCB 426E01	51458	June 28, 2019
	Weather Anemometer	Vaisala WXT536	R1151162	March 15, 2019

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

5.2 Measurement Parameters

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

Table 6: Measurement Parameters Used in the Study

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

SKWP wind turbine operational information was collected during the measurement campaign using the facility SCADA system and provided to Aercoustics by South Kent Wind LP.

5.3 Filtering Criteria

Intervals were included or excluded from analysis depending on several filtering criteria. Some of these criteria apply to all intervals and some apply only for *Total Noise* or *Background* intervals. Measurement intervals were first passed through the *All Intervals* filters, after which they were sorted into either *Total Noise* or *Background* categories based on the operation of the nearby turbines. Intervals were included in the assessment dataset if they met all the following criteria:

All Intervals

- Occurred between 10pm – 5am
- Had no precipitation within one hour before or after
- Had an ambient temperature above -20˚C
- Had minimal influence from extraneous ambient noise sources

Total Noise Intervals

- All nearby turbines were operating
- Test turbine was generating sufficient power:
    - *For sound pressure level analysis:* Test turbine was generating at least 85% of the maximum rated power output
    - *For tonality analysis:* Test turbine was generating at least the minimum power output corresponding to the conditions where the measured tonal audibility was greater than 0 dB during the E-Audit test
- Monitor was located downwind of the test turbine

Background Intervals

- All nearby turbines were parked (i.e. not rotating)
- Monitor was located downwind of the test turbine

5.3.1 Turbines in Study Area

As noted above, several filtering criteria were applied based on the operation of the test turbine and the turbines in the surrounding area. To verify the operation of these turbines, information from the facility SCADA was processed along with the acoustic and weather data.

The minimum number of turbines included in the study area for the receptor and verified for *Total Noise* measurements was selected based on the guidance of Section D3.8.1 of the Protocol:

> ***D3.8.1 Overall equivalent sound level – wind turbines operational***
>
> *"[…] At a minimum, all relevant turbines of the subject and adjacent wind facilities, typically within 3 km of the measurement location should be operational. In the event that an adjacent wind facility dominates the background sound levels, subsequent to approval by the Ministry, an alternative measurement location may be selected."*

The minimum number of turbines included in the study area of the receptor and verified for *Background* measurements was selected based on the guidance of Section D3.5.2 of the Protocol:

> ***D3.5.2 Acoustic measurements with wind turbines parked***
>
> *"Ambient noise measurements shall be carried out at a point of reception with all turbines in the vicinity of the point of reception parked. The prediction model will be used to determine the number of turbines that require parking in order for the predicted noise contribution of the wind facility to fall to 30 dBA or 10 dB less than the applicable criterion."*

The turbines in the study area of the receptor are listed in Table 7 below.

Table 7: Turbines Included in the Study Area

Audit Receptor	Turbines verified for *Total Noise* Measurements	Turbines verified for *Background* Measurements
R3167	T032, T033, T034, T037, T038, T039, T040, T041, T044, T045, T046	T032, T033, T037, T038, T039, T040, T045, T046

Parked turbines do not rotate or generate power. There is some idling of the blades (~2 RPM or less), but the acoustic impact of the turbines in this condition is negligible at the receptor. The turbines were confirmed to be running in their normal operating mode for the duration of the monitoring campaign. See Appendix B for a statement from the operator.

5.3.2 Removal of Extraneous Noise

'Extraneous noise' is defined as ambient sound sources unrelated to the operation of the wind facility. The removal or reduction of extraneous noise sources in the measurement data is important to ensure the assessment of turbine-only sound levels is as accurate and free of contamination as possible. The Protocol provides the following guidance regarding extraneous noise:

> ***C2.4.7 Extraneous noise sources[3]***
>
> *"Measurements are to be inhibited when the sound level is affected by noise from extraneous sources such as vehicle noise, dogs barking and wind gusts (i.e. other than wind turbine sound).*
>
> *"The same result can also be achieved by digitally recording the sound level time history and later editing out the extraneous events and recalculating the descriptors such as Leq. This should address measurement situations where extraneous sounds were not inhibited."*
>
> ***D3.5 Acoustic measurements***
>
> *"[…] In addition, if the background sound levels are greater than the applicable exclusion limits then the applicable limits are the background sound levels without extraneous noise sources."*
>
> ***D5.3 Effects of insects and fauna***
>
> *"The analysis shall identify the influence of any insects, fauna, or other extraneous but constant sources of noise and verify them through sound recordings. Noise from insects*

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

> *can be removed from the 1/3rd octave spectra of each measurement. It has to be shown, however, that the contribution of the wind turbine noise in those frequencies is minimal."*
>
> ***D6 Assessment of compliance***
>
> *"[…] However, if the background sound levels are greater than the applicable exclusion limits then the applicable limits are now the background sound levels without extraneous noise sources."*

Extraneous noise can be steady or transient. Steady noise can be removed via filtering or removal of specific 1/3rd octave bands affected by the contamination (as per Protocol section D5.3). Transient noise can be removed or reduced from the dataset by automatic and manual filtering techniques.

Steady noise from crickets, identified at a frequency of 3150 Hz and above and verified through listening tests, was removed from the 1/3rd octave spectra for all measurements. The contribution from the wind turbine noise in those frequencies was evaluated as further discussed in Section 6.3.2.

Extraneous noise from car passbys and other short-term events was removed by manually removing intervals that had been verified through listening tests to have audible contamination.

5.3.3 Representative Ambient Conditions

The conditions present during the *Total Noise* and *Background* periods must be from similar weather and wind shear conditions, per Protocol section D3.8.2:

> ***D3.8.2 Overall equivalent sound level – wind turbines parked***
>
> *"Ambient noise measurements should be performed with the turbines parked and conducted within the same general measurement period and with the same weather and wind shear conditions. Measurements of ambient noise obtained during other periods are not recommended and should only be used with great caution to ensure that they represent the "current" ambient noise."*

Background measurements were collected periodically throughout the measurement campaign to ensure the *Background* and *Total Noise* measurements were collected during similar conditions in the same seasons.

Due to the varying noise contribution of the ON-401 at different wind directions, the *Background* periods were filtered to only include intervals where the monitor was downwind of the test turbine location to represent the same conditions as the *Total Noise* measurements.

5.3.4 Adjacent Wind Facilities

No additional wind facilities were present in the area adjacent the receptor location.

5.4 Compliance Criteria

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

5.4.1 Sample Size Requirements

Requirements per the RAM-I methodology of the Compliance Protocol (Section E5.5) are used for this audit. Per Section E5.5 of the Protocol, an assessment dataset is considered complete if at least three wind bins from 1 – 7 m/s (inclusive) or two wind bins from 1 – 4 m/s (inclusive) are complete. A wind bin is considered complete if there are at least 60 valid *Total Noise* and 30 valid *Background* intervals.

For the purposes of the tonal audibility analysis of these far field measurements, per Section D3.8.3 of the protocol, a wind bin is considered complete if there are at least five (5) intervals for *Total Noise* and *Background.*

Application of the sample size requirements to 10 second measurement intervals is further discussed in Section 5.5.2.

5.4.2 Sound Level Limits

Sound level limits vary with 10m-AGL wind speed and by class designation. The area surrounding the South Kent Wind Project site has previously been designated as Class 3. Exclusion limits for a Class 3 area are summarized in Table 8 below.

Table 8: MECP Exclusion Limits (Class 3)

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

These sound level limits apply to points of reception. Given that the predicted impact at the monitoring location is greater than the predicted impact at the receptor (see Table 3, Section 4.2), results at the monitor are conservative and can be used to show compliance at the receptor.

Sections D3.5 and D6 of the Protocol also note that where the measured *Background* sound level exceeds the exclusion limits, the sound level limit for that wind bin is the *Background* sound level without extraneous noise sources. Wind bins where the measured *Background* sound level exceed the exclusion limits are noted in Table 15.

5.4.3 Tonal Penalty

Any applicable tonal penalties are based on the mean tonal audibility for each wind bin and are calculated according to Annex C of ISO 1996-2-2007, per Section E5.5.2 of the Protocol. The penalty scheme is summarized in Table 9 below.

Table 9: Calculation of Applicable Tonal Penalty

Mean Audibility, ΔL	Tonal Adjustment, K_T
ΔL ≤ 4 dB	0 dB
4 dB < ΔL ≤ 10 dB	ΔL-4 dB
10 dB < ΔL	6 dB

5.5 Deviations

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

5.5.1 Measurement Bandwidth

As noted in Table 6, the measurement bandwidth used is 20 – 10,000 Hz. This is a deviation from the Protocol Section D2.1.1 requirement of a 20 – 20,000 Hz frequency response. Due to the high attenuation of noise levels at high frequencies, noise at the receptor from the wind facility above 10,000 Hz will be insignificant[4].

5.5.2 Measurement Intervals

Sound levels were measured in 10 second intervals (i.e. sound level measurements were based on a 10 second averaging time) as permitted by Section E5.5(7) of the Protocol. The RAM-I Audit data count requirements of 60 valid *Total Noise* and 30 valid *Background* intervals are applicable for 10 second data intervals as determined in consultation with the MECP (initially discussed in a conference call dated January 14, 2019 and further confirmed in a meeting dated January 16, 2020).

5.6 Additional Filtering of the Assessment Dataset due to ON-401 Impact

As discussed previously, the *Background* data was filtered for the downwind direction to represent the same conditions as the *Total Noise* measurements. However, significant variation in noise impact from the ON-401 was still observed in the background measurements from different nights. For reference, detailed analysis summarizing the predicted impact of the ON-401 compared to the measured ambient levels at the receptor location is included in Appendix G.

The background measurements at the far field monitor for the full campaign period are shown in Table 10. Sound levels presented in the table are rounded to the nearest integer; all calculations and analysis are conducted using the un-rounded sound levels.

[4] From Table 2 of ISO 9613-2, acoustic frequencies above 8 kHz experience attenuation from atmospheric absorption alone of more than 80 dB/km.

Table 10: Average Measured Background Sound Levels (Full Dataset)

Audit Receptor	Period	Measurement Parameter	Wind Bin (m/s)						
			1	2	3	4	5	6	7
R3167 (Far Field Monitor)	Background	Number of Samples	427	209	8	33	99	118	43
		Average L_{Aeq} (dBA)	49†	49†	44†	44†	44†	46†	48†
		Standard Deviation (dB)	3.1	3.1	4.9	3.0	3.1	3.2	2.3

† Measured *Background* sound level is higher than the MECP exclusion limit in the wind bin.

Measurement data points from Table 10 are also plotted in Figure 2 below with the *Total Noise* data points for the same period.

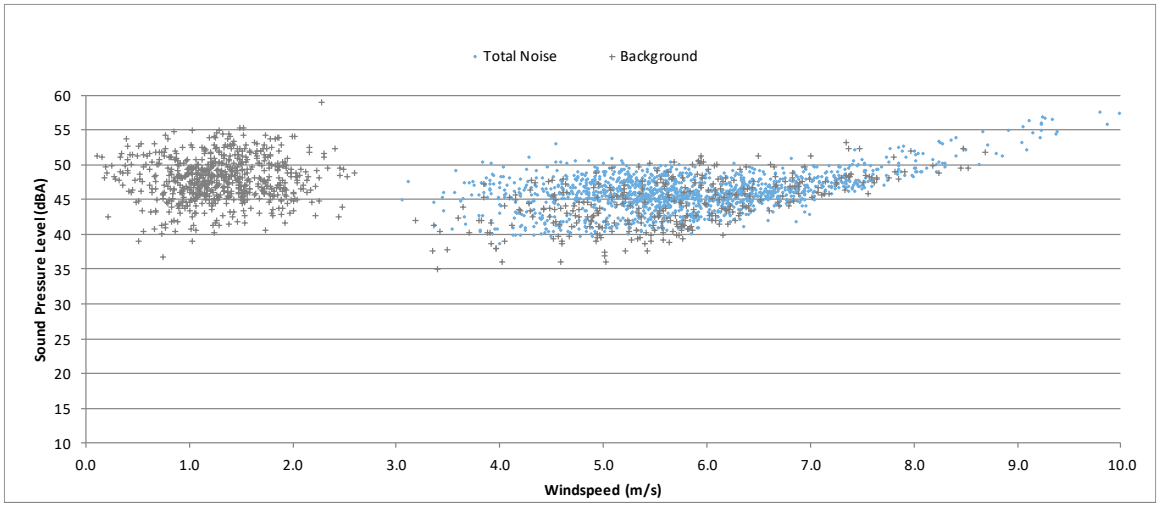

Figure 2: Average Measured Total Noise and Background Sound Levels (Full Dataset)
Far Field Monitor at R3167

As shown in Table 10 and further demonstrated in the scatter plot, the standard deviation was over 2 dB in all wind bins and there was significant overlap between the measured *Total Noise* and *Background* levels. Based on these results, calculation of the Turbine-Only sound levels would be inconclusive based on the poor quality of the data.

In order to improve the standard deviation and overall quality of the assessment dataset, individual nights were identified which met the following criteria at the intermediate monitor location:

- Includes both valid turbine operational and background data;
- Standard deviation of the background levels close to or below 2 dB;
- Signal-to-noise between the turbine operational and background levels close to or greater than 3 dB.

Based on these criteria, the following three periods were identified from the full dataset ("3 Identified Periods"):

1. November 9 – 10, 2019 10:00pm – 5:00am
2. December 8 – 9, 2019 10:00pm – 5:00am
3. January 2, 2020 12:00am – 5:00am

The measurement data at the intermediate monitor during these periods was combined into a single dataset, the average measured background sound levels for which are shown in Table 11 and measurement data for which is plotted in Figure 3.

Table 11: Average Measured Background Sound Levels (3 Identified Periods)

Audit Receptor	Period	Measurement Parameter	Wind Bin (m/s)						
			1	2	3	4	5	6	7
R3167 (Intermediate Monitor)	Background	Number of Samples	0	0	7	77	176	147	81
		Average L_{Aeq} (dBA)	-	-	-	41†	42†	43†	47†
		Standard Deviation (dB)	-	-	-	1.3	2.0	2.1	1.9

\- Sound level not reported in wind bin if minimum sample size not met for *Background* (30).

† Measured *Background* sound level is higher than the MECP exclusion limit in the wind bin.

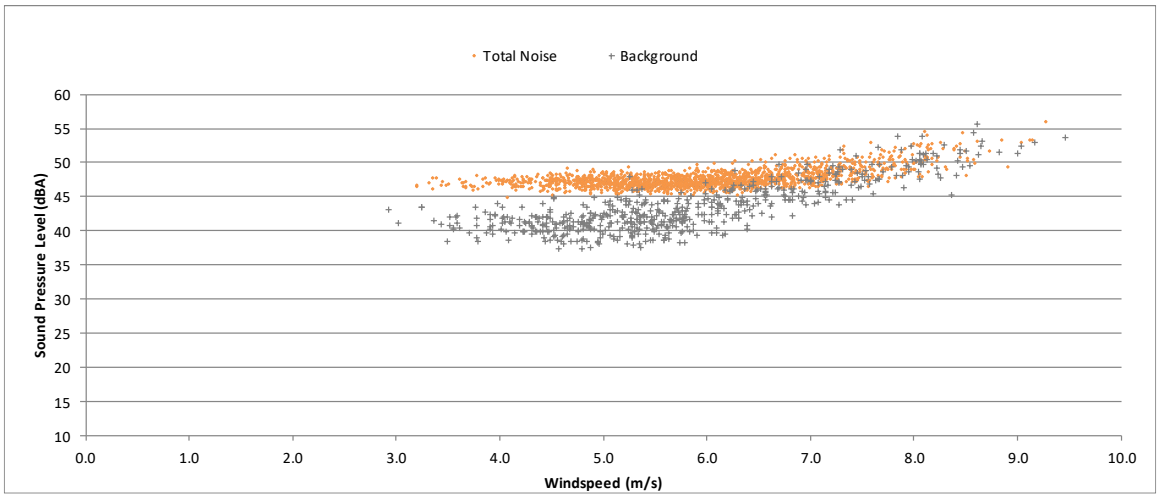

Figure 3: Average Measured Total Noise and Background Sound Levels, 3 Identified Periods Intermediate Monitor at R3167

Given the monitors were measuring simultaneously, the ambient conditions during these periods would also be present at the far field monitor. As a result, the assessment dataset used to evaluate the impact of the test turbine at the receptor was limited to the valid *Total Noise* and *Background* data from the three identified periods with the best available quality data at the far field monitor location. The results for the sound pressure level and tonal audibility assessments using these periods are outlined in the following section.

6 Audit Results

Sound levels and weather conditions during the assessed measurement periods of the I-Audit campaign are summarized in the following sections.

6.1 Audit Duration

The length of the monitoring campaign is summarized in Table 12 below.

Table 12: Length of Monitoring Campaign

Audit Receptor	Audit Start Date	Audit End Date	Monitoring Duration (weeks)
R3167	September 18, 2019	January 2, 2020	15

As discussed in Section 5.6, three specific periods including valid *Total Noise* and *Background* data were identified as the final assessment dataset for the R3167 monitor. These dates are provided in Table 13 below.

Table 13: Assessment Dataset Periods

Period Start	Period End
November 9, 2019 10:00pm	November 10, 2019 5:00am
December 8, 2019 10:00pm	December 9, 2019 5:00am
January 2, 2020 12:00am	January 2, 2020 5:00am

6.2 Weather Conditions

Throughout the measurement campaign, a variety of weather conditions were encountered. The range of weather conditions measured in the assessment dataset are summarized in Table 14. Note that the assessment dataset includes the *Total Noise* and *Background* data that remains after filtering.

Table 14: Range of Weather Conditions in Assessment Dataset

Audit Receptor	Atmospheric Pressure (hPa)	10m-AGL Wind Speed (m/s)	Relative Humidity (%)	Temperature (°C)	Hub-Height Wind Speed (m/s)
R3167	983 – 991	3.7 – 10.0	61 – 75	3 – 9	5.4 – 15.6

During the audit period, the predominant wind direction was measured to be from the south-west. A wind rose detailing the measured wind directions observed during the entire measurement campaign is provided in Figure 4. Note that wind directions shown on the wind rose indicate the direction the wind is coming from. The purple shaded region represents the downwind condition from the test turbine at the monitor location.

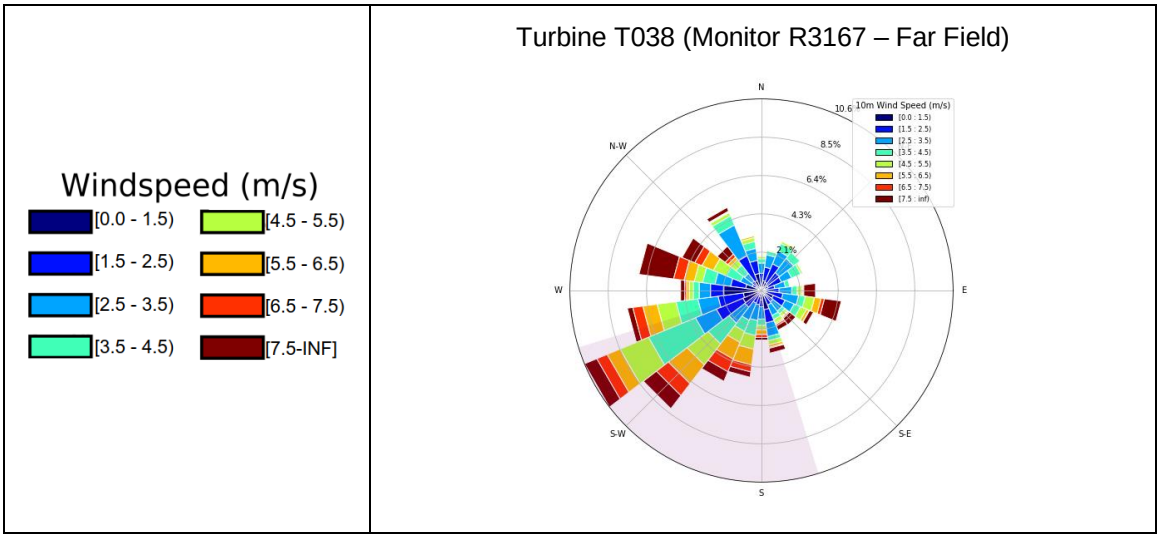

Figure 4: Wind Rose (All Measured Data)

From Figure 4, the distribution of wind directions observed during the measurement campaign is similar to those expected based on the historical wind rose provided in Section 4.1.1. Wind roses for the assessment dataset are included in Appendix C.

6.3 Measured Sound Levels

Average measured sound levels by wind bin for *Total Noise* and *Background* periods are presented in Table 15 below. As noted in Section 5.3, the sound pressure level assessment dataset was filtered based on a minimum power threshold of 85% of the maximum turbine power output and was limited to the subset of data described in Section 5.6.

Table 15: Average Measured Sound Levels (3 Identified Periods), RAM-I Analysis

Audit Receptor	Period	Measurement Parameter	Wind Bin (m/s)						
			1	2	3	4	5	6	7
R3167	Total Noise	Number of Samples	0	0	0	26	338	728	479
		Average L_{Aeq} (dBA)	-	-	-	-	44	44	46
		Standard Deviation (dB)	-	-	-	-	1.3	1.4	1.6
	Background	Number of Samples	0	0	0	39	168	148	96
		Average L_{Aeq} (dBA)	-	-	-	41†	41†	43†	46†
		Standard Deviation (dB)	-	-	-	1.8	1.7	1.9	1.8

- Sound level not reported in wind bin if minimum sample size not met for *Total Noise* (60) or *Background* (30).

† Measured *Background* sound level is higher than the MECP exclusion limit in the wind bin.

It should be noted that the sound levels presented here are rounded to the nearest integer; all calculations and analysis are conducted using the un-rounded sound levels.

Measurement data points from Table 15 are also plotted in Figure 5 below.

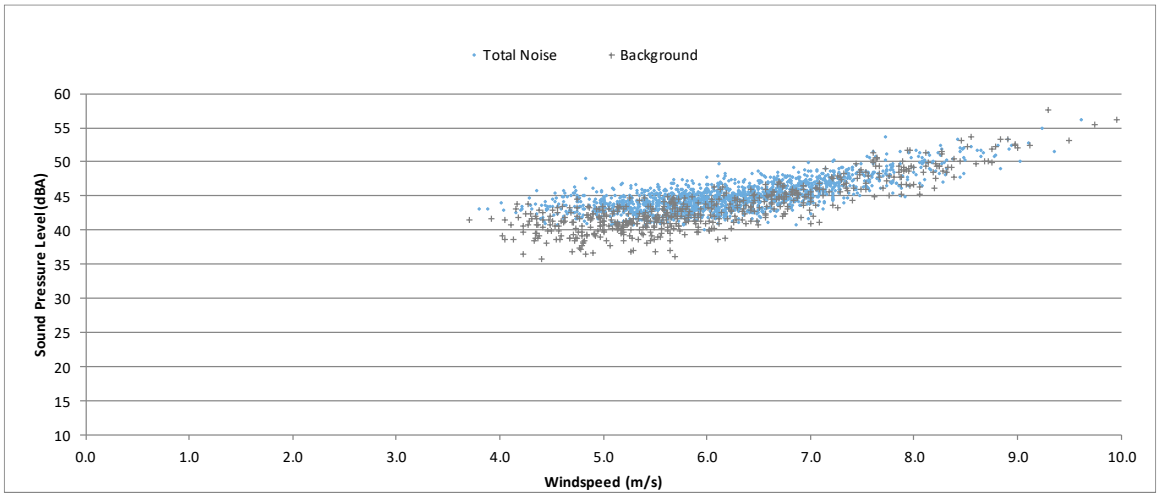

Figure 5: Average Measured Total Noise and Background Sound Levels (3 Identified Periods)
Far Field Monitor at R3167

6.3.1 Tonal Adjustment

Tonal audibility results for R3167 in the far field of T038 are presented in Table 16 below. As noted in Section 5.3, the tonal assessment dataset was filtered based on a minimum power threshold of 1141 kW.

Table 16: Tonality Assessment Table (3 Identified Periods)

Centre Frequency	Tonality Parameter	Wind Bin (m/s)						
		1	2	3	4	5	6	7
420 Hz	Data Points in Wind Bin	0	3	10	55	445	871	531
	Data Points with Detected Tone	-	-	3	5	50	83	57
	Tonal Presence	-	-	30%	9%	11%	10%	11%
	Mean Tonal Audibility, ΔL (dB)	-	-	-4.7	-4.1	-4.4	-3.8	-3.7
	Tonal Adjustment, K_T (dB)	0	0	0	0	0	0	0

- Sound level not reported in wind bin if minimum sample size (5) not met.

From the results in Table 16, no tones were detected that exceeded the 4 dB threshold for tonal penalties. As a result, no tonal penalty is applicable.

6.3.2 Other Adjustments

As noted in Section 5.3.2, the 1/3rd octave band frequencies of 3150 Hz and above were removed from the assessment dataset due to contamination from cricket noise. The contribution from the wind facility at these excluded frequencies was determined at the monitor location by calculating the partial noise impact from the facility in the excluded frequency range. The impact from the facility at 3150 Hz and above was determined to be 5.2 dBA at the monitor. Although the excluded impact is negligible, it has been added logarithmically to the final calculated Turbine-Only sound level at the monitor location shown in Table 18.

6.4 Turbine-Only Sound Levels

The average measured sound levels by wind bin for *Total Noise* and *Background* periods are presented in Table 17.

Table 17: Calculated Turbine-Only Sound Levels (3 Identified Periods), RAM-I Analysis

Audit Receptor	Measurement Period	Wind Bin (m/s) 1	2	3	4	5	6	7
R3167	Total Noise (dBA)	-	-	-	-	44	44	46
	Background (dBA)	-	-	-	41†	41†	43†	46†
	Signal to Noise (dBA)	-	-	-	-	2.5	1.8	0.8
	Turbine-Only (dBA) [monitor location]	-	-	-	-	40*	40*	39*
	Tonal Adjustment	0	0	0	0	0	0	0

- Sound level not reported in wind bin if minimum sample size not met for *Total Noise* (60) or *Background* (30).

† Measured background sound level is higher than the MECP exclusion limit in the wind bin.

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

Due to the impact of the ON-401, the measured *Background* levels were greater than the MECP exclusion limits and there was a low signal-to-noise ratio between the measured *Total Noise* and the *Background* levels at 5 – 7 m/s. As shown in Table 17 above, the signal-to-noise ratio was below 3 dB in the 5 – 7 m/s wind bins. As a result, there is an increased uncertainty in the determination of the Turbine-Only sound impact at the monitor. However, the standard deviations of the *Total Noise* data at all wind bins is below 2 dB, which indicates that the signal has low variation in the measured level.

7 Assessment of Compliance

This section provides the results of the measurements and calculations as they pertain to the determination of compliance of the facility in accordance with the criteria listed in Section 5.4 of this report.

7.1 Assessment Table

Table 18 compares the final Turbine-Only sound levels for each wind bin at the Receptor location to the applicable exclusion limits and background sound levels. Final Turbine-Only sound levels at the Point of Reception are calculated by taking the Turbine-Only sound level at the measurement location and applying any applicable adjustments as indicated in Table 17.

Table 18: Assessment Table (3 Identified Periods)

Audit Receptor	Wind speed at 10m-AGL (m/s)	1	2	3	4	5	6	7
R3167	Turbine-Only Sound Level (dBA)	-	-	-	-	44*	44*	46*
	Background Sound Level (dBA)	-	-	-	*41*†	*41*†	*43*†	*46*†
MECP Exclusion Limit (dBA)		40	40	40	40	40	40	43
Compliance? (Y/N)		-	-	-	-	Yes	Yes	Yes

- Sound level not reported in wind bin if minimum sample size not met for *Total Noise* (60) or *Background* (30).

† Measured background sound level is higher than the MECP exclusion limit in the wind bin.

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

7.2 Statement of Compliance

Based on the Receptor Turbine-Only sound levels presented in Table 18, sound immission levels at the audited receptor are in compliance with the applicable sound level limits.

8 Conclusion

Aercoustics was retained by South Kent Wind LP to complete an additional supporting I-Audit at the worst-case receptor of turbine T038, in response to the E-Audit test submitted November 21, 2014 and reviewed by the MECP.

The additional I-Audit measurements were conducted in accordance with the MECP Compliance Protocol for Wind Turbine Noise from September 18, 2019 to January 2, 2020 at receptor R3167 near T038. Based on the low quality of data due to noise contamination from the ON-401, specific periods with sufficient quality data were identified and used in the assessment.

Based on the results presented in this report, the assessment requirements outlined in the Compliance Protocol have been met and the cumulative sound impact calculated at R3167 complies with the MECP sound level limits at all wind bins with sufficient data for assessment.

Appendix A
Site Details

Appendix B
Statement from the Operator

Appendix C
Wind Roses

Appendix D
Calibration Certificates

Appendix E
MECP I-Audit Checklist

Appendix F
E-Audit Report Summary

Appendix G
Additional Justification

End of Report

Appendix A
Site Details

Legend

- Ontario HWY 401
- Campaign Monitor
- Spring 2015 Campaign Monitor
- Receptor Locations
- South Kent Turbines

Third Party Turbines

- Talbot
- Chatam
- Front Line
- Port Alma
- Bisnett Line
- Raleigh
- Erieau Blenheim

N

Project ID:	13228.02
Drawn by:	AA
Reveiwed by:	AD
Date:	February 12, 2020
Revision:	1
Scale:	As Indicated

South Kent Wind Project
Immission Audit Report
R3167 - T038

Appendix A.1

Site Plan Overview

aercoustics

Legend

- Campaign Receptor
- Campaign Monitor
- South Kent Turbines
- Ontario HWY 401

N

Project ID:	13228.02
Drawn by:	AA
Reveiwed by:	AD
Date:	November 29, 2019
Revision:	1
Scale:	As Indicated

South Kent Wind Project
Immission Audit Report
R3167 - T038

Appendix A.2

Monitor and Receptor Location

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Project ID:	13228.02
Drawn by:	AA
Reveiwed by:	AD
Date:	February 11, 2020
Revision:	1
Scale:	As Indicated

South Kent Wind Project
Immission Audit Report
R3167 - T038

Appendix A.3

Monitor to T038

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Project ID:	13228.02
Drawn by:	AA
Reveiwed by:	AD
Date:	February 11, 2020
Revision:	1
Scale:	As Indicated

South Kent Wind Project
Immission Audit Report
R3167 - T038

Appendix A.4

Monitor to Receptor

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Appendix B
Statement from the Operator

SP South Kent Wind LP
2050 Derry Road West
2nd Floor
Mississauga, ON L5N 0B9
www.southkentwind.com

February 12, 2020

Director, Environmental Approvals Access and Service
Integration Branch Ministry of Environment
2 St. St Clair Avenue West, Floor 12A
Toronto ON M4V 1L5

Subject: South Kent Wind Project (REA #2871-8UKGPC) Receptor Imission Audit 2019-2020

Dear Director

Please accept this letter as confirmation that all turbines tested during the acoustics measurement campaign conducted by Aercoustics Engineering Limited from September 18, 2019 to January 22, 2020 were operating normally for the duration of the campaign, with the exception of specific time periods during which the turbines were placed in remote owner stop to facilitate ambient noise measurements.

The turbines placed in remote owner stop for ambient measurements were different depending on the receptor targeted, and were as follows:

- R4368: T001, T002, T003, T004, T006, T106, T118, T138, T166
- R3287: T031, T032, T033, T034, T035, T036, T039, T040, T041, T108, T135, T156
- R3344: T026, T028, T029, T030, T035, T036, T042, T108, T109, T120, T135
- R3167: T032, T033, T037, T038, T039, T040, T045, T046
- R2794: T055, T056, T057, T060, T100, T111, T164
- R4248: T001, T002, T003, T004, T006, T093, T102, T138, T152, T166, T167

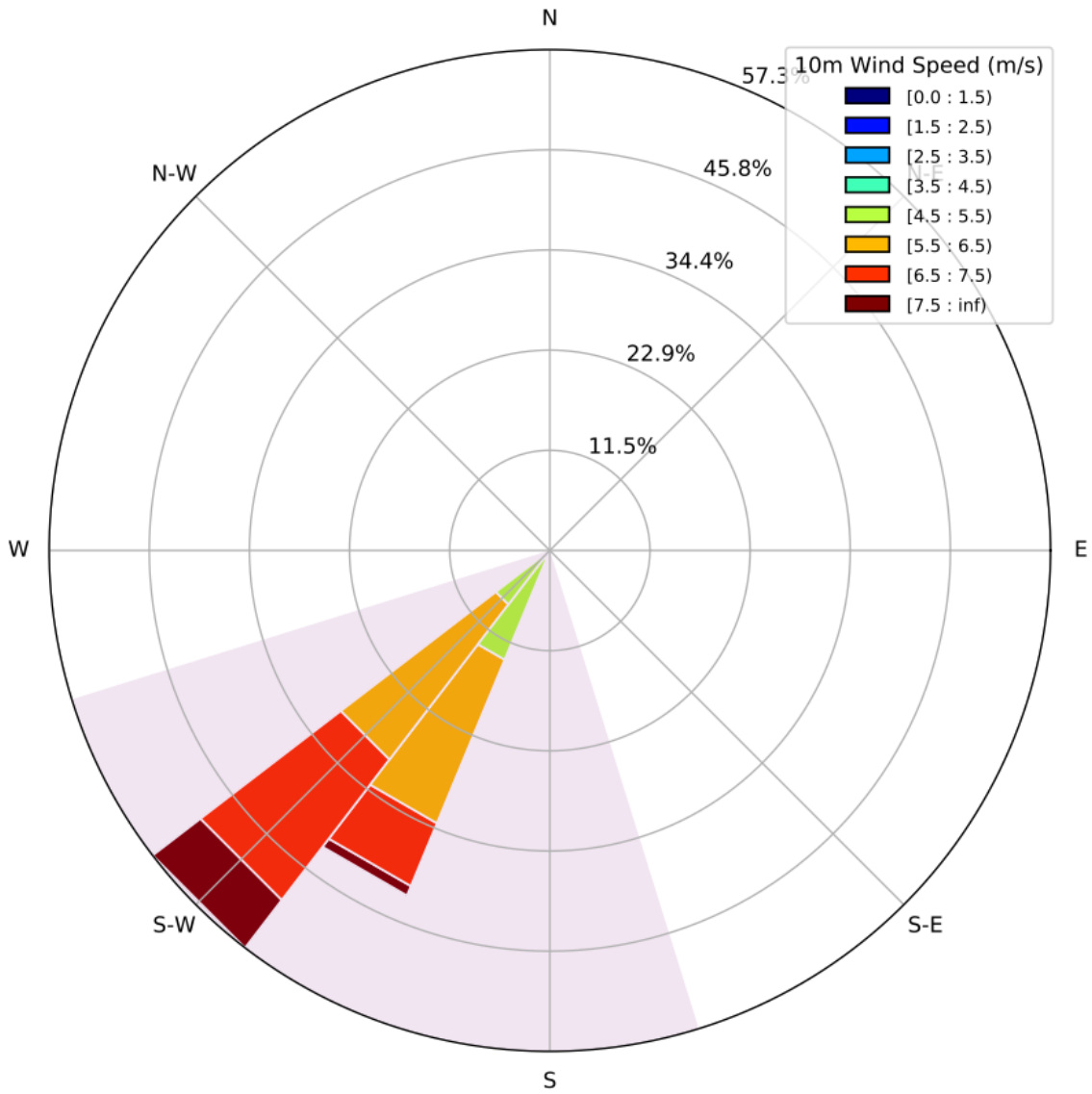
The turbines verified for operational measurements were different depending on the receptor targeted, and were as follows:

- R4368: T001, T002, T003, T004, T006, T007, T008, T093, T106, T107, T118, T138, T166, T167
- R3287: T024, T029, T030, T031, T032, T033, T034, T035, T036, T039, T040, T041, T042, T108, T120, T135, T155, T156
- R3344: T026, T028, T029, T030, T031, T034, T035, T036, T041, T042, T108, T109, T120, T135, T155
- R3167: T032, T033, T034, T037, T038, T039, T040, T041, T044, T045, T046
- R2794: T054, T055, T056, T057, T058, T060, T097, T100, T111, T163, T164
- R4248: T001, T002, T003, T004, T006, T093, T102, T138, T152, T166, T167

Sincerely,

Kevin Aikenhead
Facility Manager
South Kent Wind
C: 519-350-9373

Appendix C
Wind Roses



Legend

Turbine Downwind Direction

Project ID:	13228.02
Drawn by:	AA
Reveiwed by:	AD
Date:	February 21, 2020
Revision:	1
Scale:	As Indicated

South Kent Wind Project
Immission Audit Report
R3167 - T038

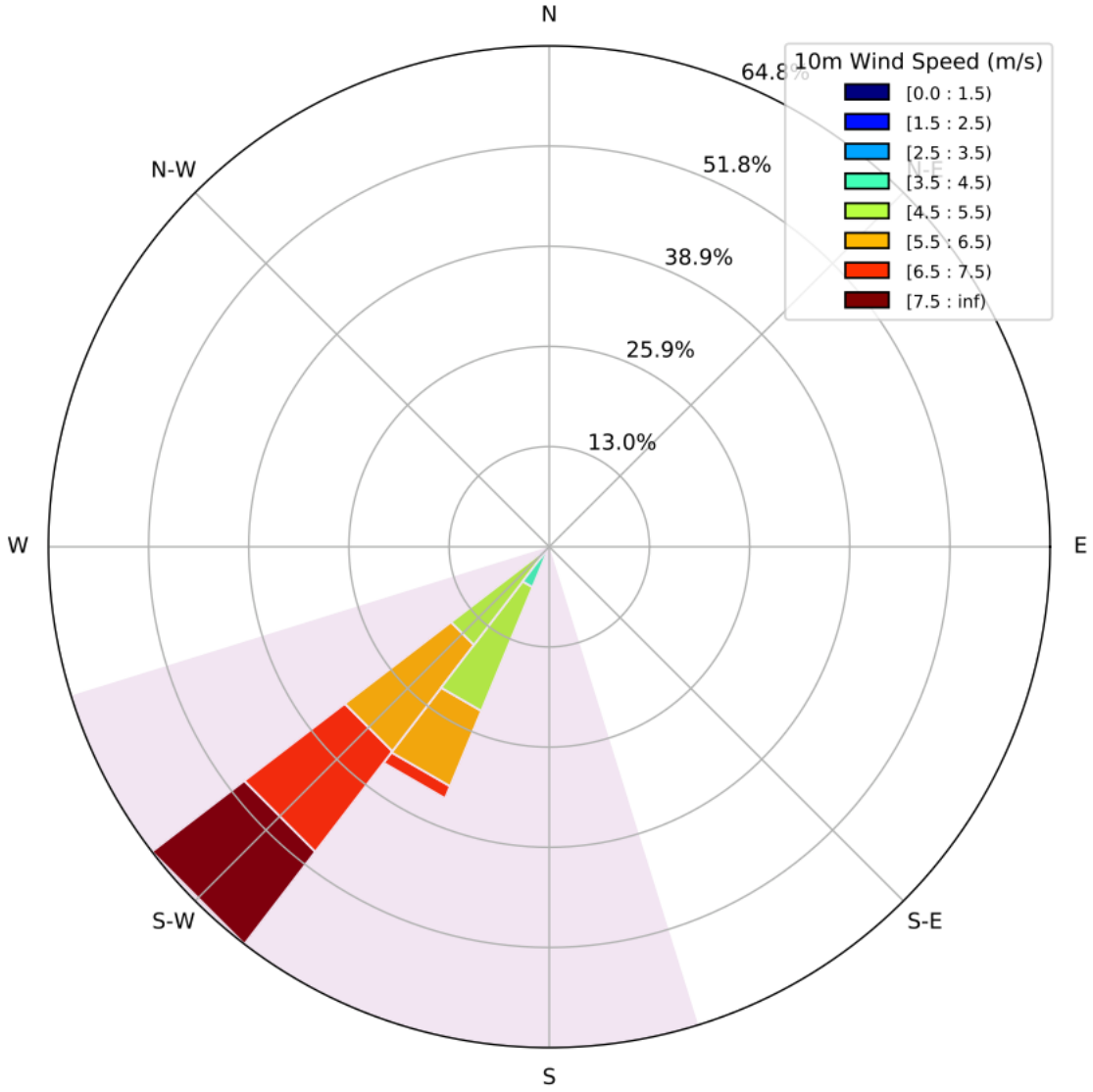
Appendix C.1

Supplementary Wind Rose based on Assessment Data Total Noise

aercoustics

Legend

Turbine Downwind Direction



Project ID:	13228.02
Drawn by:	AA
Reveiwed by:	AD
Date:	February 21, 2020
Revision:	1
Scale:	As Indicated

South Kent Wind Project
Immission Audit Report
R3167 - T038

Appendix C.2

Supplementary Wind Rose based on Assessment Data Background Noise

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Appendix D
Calibration Certificates

CALIBRATION CERTIFICATES

Details are disclosed in the table below regarding the calibration of the equipment used for the Immission Audit at the two monitor locations for R3167. The associated calibration certificates are provided in this appendix.

Audit Receptor	Equipment	Make/Model	Serial Number	Date of Last Calibration
R3167 (Far Field Monitor)	Data Acquisition Card	NI 9234	1854438	July 22, 2019
	Signal Conditioner	PCB 480E09	33657	October 23, 2018
	Microphone	PCB 377B02	164139	January 14, 2019
	Pre-Amplifier	PCB 426E01	43997	January 14, 2019
	Weather Anemometer	Vaisala WXT536	R1020384	March 5, 2019
R3167 (Inter-mediate)	Data Acquisition Card	NI 9234	1C00A6B	July 22, 2019
	Signal Conditioner	PCB 480E09	34593	June 28, 2019
	Microphone	PCB 377B02	177358	June 28, 2019
	Pre-Amplifier	PCB 426E01	51458	June 28, 2019
	Weather Anemometer	Vaisala WXT536	R1151162	March 15, 2019

CERTIFICATE of CALIBRATION

Make :	PCB Piezotronics	Reference # :	154525
Model :	480E09	Customer :	Aercoustics Engineering Ltd Mississauga, ON
Descr. :	Conditioning Amplifier		
Serial # :	00033657	P. Order :	2018.10.15C
Asset # :	00196		

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

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

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

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

Calibrated : Oct 23, 2018 By : Petro Onasko

Cal. Due : Oct 23, 2020

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

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

Navair Technologies

REPAIR AND CALIBRATION TRACEABLE TO NRC AND NIST

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

NT NAVAIR TECHNOLOGIES

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

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

Calibration Report for Certificate : **154525**

Make	Model	Serial	Asset
PCB Piezotronics	480E09	00033657	00196

Test	Input		Min	Reading	Max		In/Out

Gain accuracy at 1kHz

Gain Set				V			
• 1	1.000 V		0.9800	1.0001	1.0200		In
• 10	0.100 V		0.9800	1.0002	1.0200		In
• 100	0.010 V		0.9800	0.9987	1.0200		In

Gain Flatness

Gain • 1

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

Gain • 10

10 Hz	0.100 V		-5.0	0.0%	5.0		In
10 kHz	0.100 V		-5.0	0.0%	5.0		In
50 kHz	0.100 V		-5.0	-0.2%	5.0		In
100 kHz	0.100 V		-5.0	-0.9%	5.0		In

Gain • 100

10 Hz	0.010 V		-5.0	0.0%	5.0		In
10 kHz	0.010 V		-5.0	-0.1%	5.0		In
50 kHz	0.010 V		-5.0	-3.8%	5.0		In

CERTIFICATE of CALIBRATION

Make :	PCB Piezotronics	Reference # :	155056
Model :	378B02	Customer :	Aercoustics Engineering Ltd Mississauga, ON
Descr. :	Microphone System 1/2" Free Field		
Serial # :	125633	P. Order :	2019.01.10C
Asset # :	00957		

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 : Jan 14, 2019 By : Petro Onasko

Cal. Due : Jan 14, 2021

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

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

Navair Technologies

REPAIR AND CALIBRATION TRACEABLE TO NRC AND NIST

6375 Dixie Rd. Mississauga, ON, L5T 2E7 http: // www.navair.com

Phone : 905 565 1584 Fax: 905 565 8325 e-Mail: service @ navair.com

NT NAVAIR TECHNOLOGIES

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

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

Calibration Report for Certificate : **155056**

Make			Model	Serial		Asset
PCB Piezotronics			378B02	125633		00957
PCB Piezotronics			377B02	164139		

Sensitivity at 250Hz

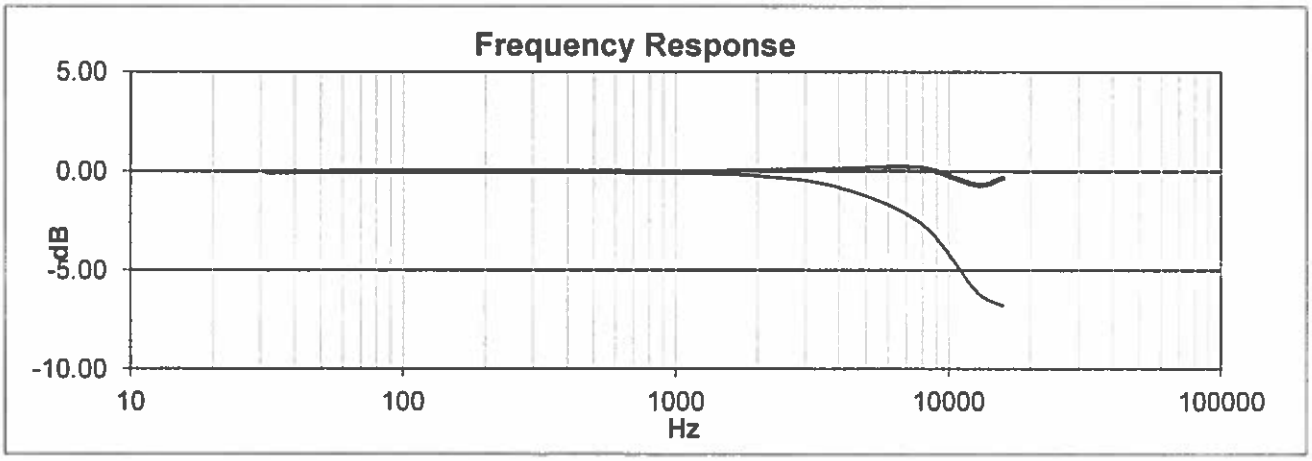
Specs Nom	Unit	Min	Reading	Max	In/Out
50	mV/Pa	39.72	49.96	62.94	In
-26.02	dB re 1V/Pa	-28.02	-26.03	-24.02	In
0	dB re 50mV/Pa	-2	-0.01	2	In

Ambient Conditions:

Static Pressure	100.4 kPa
Temperature	22.6°C
Rel.Humidity	30.5%

Frequency response

	Lower	Upper	
Freq	Pressure	Free Field	
Hz	dB	dB	
31.5	-0.04	-0.05	
63.1	-0.02	-0.02	
125.9	0.00	0.00	
251.3	0.00	0.00	ref
502.5	-0.01	-0.01	
1005.1	-0.08	-0.06	
1978.7	-0.22	0.02	
3957.5	-0.80	0.10	
7914.9	-2.62	0.16	
12663	-6.09	-0.68	
15830	-6.82	-0.33	



Compliant Calibration Certificate

Template Revision: Feb2018

Certificate Number:	6095064.1	**OE Number:**	21719015
Date Printed:	22-JUL-2019	**Page:**	1 of 14
Customer:	Aercoustics Engineering LTD (CA) 1004 Middlegate Rd No 1100 ONTARIO MISSISSAUGA, L4Y 1M4 CANADA		
Manufacturer:	National Instruments	**Model:**	NI 9234
Serial Number:	1854438		
Part Number:	195551B-01L	**Description:**	MODULE ASSY,NI 9234, 4 AI CONFIGURABLE
Calibration Date:	22-JUL-2019	**Recommended Calibration Due:**	22-JUL-2020
Procedure Name:	NI 9234	**Verification Results:**	As Found: Passed As Left: Passed
Procedure Version:	3.6.1.0	**Calibration Executive Version:**	4.6.2.0
Lab Technician:	Rachel McKinnon	**Driver Info:**	NI-DAQmx:17.6.0
Temperature:	23.0° C	**Humidity:**	44.8% RH

NATIONAL INSTRUMENTS
CALIBRATED
SN/ID 1854438
DATE 22-JUL-2019
DUE 22-JUL-2020
ni.com/calibration

The data found in this certificate must be interpreted as:

As Found The calibration data of the unit as received by National Instruments.

As Left The calibration data of the unit when returned from National Instruments.

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

This calibration conforms to ANSI/NCSL Z540.1-1994 (R2002) requirements.

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

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

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

Ted Talley
Technical Manager

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

NATIONAL INSTRUMENTS™

Calibration Notes

Type	Note
Asset	Verification and adjustment were performed.

Standards Used

Manufacturer	Model	Type	Tracking Number	Calibration Due	Notes
Fluke	5720A	Calibrator	8253	18-AUG-2019	
National Instruments	PXI-4461	Function generator	9520	20-AUG-2019	
National Instruments	PXI-4071	Digital multimeter	8241	17-DEC-2019	
National Instruments	PXI-4132	SMU	9845	21-JUN-2020	

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

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USA

Calibration Results

As Found

Verify Accuracy

Lower Range	Upper Range	Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
-5 V	5 V	0	4.00000 V	3.99520 V	3.99999 V	4.00480 V	Passed	
-5 V	5 V	0	0.00000 V	-0.00120 V	-0.00000 V	0.00120 V	Passed	
-5 V	5 V	0	-4.00000 V	-4.00480 V	-3.99997 V	-3.99520 V	Passed	
-5 V	5 V	1	4.00000 V	3.99520 V	3.99986 V	4.00480 V	Passed	
-5 V	5 V	1	0.00000 V	-0.00120 V	-0.00004 V	0.00120 V	Passed	
-5 V	5 V	1	-4.00000 V	-4.00480 V	-3.99991 V	-3.99520 V	Passed	
-5 V	5 V	2	4.00000 V	3.99520 V	3.99994 V	4.00480 V	Passed	
-5 V	5 V	2	0.00000 V	-0.00120 V	0.00000 V	0.00120 V	Passed	
-5 V	5 V	2	-4.00000 V	-4.00480 V	-3.99993 V	-3.99520 V	Passed	
-5 V	5 V	3	4.00000 V	3.99520 V	3.99996 V	4.00480 V	Passed	
-5 V	5 V	3	0.00000 V	-0.00120 V	0.00001 V	0.00120 V	Passed	
-5 V	5 V	3	-4.00000 V	-4.00480 V	-3.99993 V	-3.99520 V	Passed	

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NATIONAL INSTRUMENTS™

As Found

Verify Gain Matching

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

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As Found

Verify Phase Matching

Max Phase Difference for Channel	Rate	Samples per Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	16384	1000 Hz	-0.085 Degrees	-0.009 Degrees	0.085 Degrees	Passed	
1	51200	16384	1000 Hz	-0.085 Degrees	0.009 Degrees	0.085 Degrees	Passed	
2	51200	16384	1000 Hz	-0.085 Degrees	0.005 Degrees	0.085 Degrees	Passed	
3	51200	16384	1000 Hz	-0.085 Degrees	-0.007 Degrees	0.085 Degrees	Passed	
0	51200	16384	10000 Hz	-0.490 Degrees	-0.083 Degrees	0.490 Degrees	Passed	
1	51200	16384	10000 Hz	-0.490 Degrees	0.083 Degrees	0.490 Degrees	Passed	
2	51200	16384	10000 Hz	-0.490 Degrees	0.051 Degrees	0.490 Degrees	Passed	
3	51200	16384	10000 Hz	-0.490 Degrees	-0.063 Degrees	0.490 Degrees	Passed	

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As Found

Verify Common Mode Rejection Ratio

Channel	Rate	Samples per Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	16384	1000 Hz	40.000 dB	99.102 dB	100.000 dB	Passed	
1	51200	16384	1000 Hz	40.000 dB	97.866 dB	100.000 dB	Passed	
2	51200	16384	1000 Hz	40.000 dB	52.468 dB	100.000 dB	Passed	
3	51200	16384	1000 Hz	40.000 dB	51.554 dB	100.000 dB	Passed	

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As Found

Verify IEPE Current

Channel	Rate	DMM Range	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	0.01 A	2.000 mA	2.000 mA	2.091 mA	2.200 mA	Passed	
1	51200	0.01 A	2.000 mA	2.000 mA	2.068 mA	2.200 mA	Passed	
2	51200	0.01 A	2.000 mA	2.000 mA	2.074 mA	2.200 mA	Passed	
3	51200	0.01 A	2.000 mA	2.000 mA	2.073 mA	2.200 mA	Passed	

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NATIONAL INSTRUMENTS™

As Found

Verify IEPE Compliance Voltage

Channel	Rate	SMU Voltage Limit	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	24 V	2 mA	19.000 V	20.799 V	24.000 V	Passed	
1	51200	24 V	2 mA	19.000 V	20.806 V	24.000 V	Passed	
2	51200	24 V	2 mA	19.000 V	20.808 V	24.000 V	Passed	
3	51200	24 V	2 mA	19.000 V	20.803 V	24.000 V	Passed	

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As Left

Verify Accuracy

Lower Range	Upper Range	Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
-5 V	5 V	0	4.00000 V	3.99520 V	4.00001 V	4.00480 V	Passed	
-5 V	5 V	0	0.00000 V	-0.00120 V	0.00000 V	0.00120 V	Passed	
-5 V	5 V	0	-4.00000 V	-4.00480 V	-3.99998 V	-3.99520 V	Passed	
-5 V	5 V	1	4.00000 V	3.99520 V	4.00000 V	4.00480 V	Passed	
-5 V	5 V	1	0.00000 V	-0.00120 V	-0.00000 V	0.00120 V	Passed	
-5 V	5 V	1	-4.00000 V	-4.00480 V	-3.99998 V	-3.99520 V	Passed	
-5 V	5 V	2	4.00000 V	3.99520 V	4.00002 V	4.00480 V	Passed	
-5 V	5 V	2	0.00000 V	-0.00120 V	0.00000 V	0.00120 V	Passed	
-5 V	5 V	2	-4.00000 V	-4.00480 V	-3.99999 V	-3.99520 V	Passed	
-5 V	5 V	3	4.00000 V	3.99520 V	4.00000 V	4.00480 V	Passed	
-5 V	5 V	3	0.00000 V	-0.00120 V	0.00000 V	0.00120 V	Passed	
-5 V	5 V	3	-4.00000 V	-4.00480 V	-3.99998 V	-3.99520 V	Passed	

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As Left

Verify Gain Matching

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

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As Left

Verify Phase Matching

Max Phase Difference for Channel	Rate	Samples per Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	16384	1000 Hz	-0.085 Degrees	-0.009 Degrees	0.085 Degrees	Passed	
1	51200	16384	1000 Hz	-0.085 Degrees	0.009 Degrees	0.085 Degrees	Passed	
2	51200	16384	1000 Hz	-0.085 Degrees	0.005 Degrees	0.085 Degrees	Passed	
3	51200	16384	1000 Hz	-0.085 Degrees	-0.007 Degrees	0.085 Degrees	Passed	
0	51200	16384	10000 Hz	-0.490 Degrees	-0.083 Degrees	0.490 Degrees	Passed	
1	51200	16384	10000 Hz	-0.490 Degrees	0.083 Degrees	0.490 Degrees	Passed	
2	51200	16384	10000 Hz	-0.490 Degrees	0.051 Degrees	0.490 Degrees	Passed	
3	51200	16384	10000 Hz	-0.490 Degrees	-0.063 Degrees	0.490 Degrees	Passed	

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As Left

Verify Common Mode Rejection Ratio

Channel	Rate	Samples per Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	16384	1000 Hz	40.000 dB	52.587 dB	100.000 dB	Passed	
1	51200	16384	1000 Hz	40.000 dB	51.585 dB	100.000 dB	Passed	
2	51200	16384	1000 Hz	40.000 dB	52.449 dB	100.000 dB	Passed	
3	51200	16384	1000 Hz	40.000 dB	51.276 dB	100.000 dB	Passed	

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As Left

Verify IEPE Current

Channel	Rate	DMM Range	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	0.01 A	2.000 mA	2.000 mA	2.082 mA	2.200 mA	Passed	
1	51200	0.01 A	2.000 mA	2.000 mA	2.068 mA	2.200 mA	Passed	
2	51200	0.01 A	2.000 mA	2.000 mA	2.074 mA	2.200 mA	Passed	
3	51200	0.01 A	2.000 mA	2.000 mA	2.073 mA	2.200 mA	Passed	

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As Left

Verify IEPE Compliance Voltage

Channel	Rate	SMU Voltage Limit	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	24 V	2 mA	19.000 V	20.797 V	24.000 V	Passed	
1	51200	24 V	2 mA	19.000 V	20.806 V	24.000 V	Passed	
2	51200	24 V	2 mA	19.000 V	20.809 V	24.000 V	Passed	
3	51200	24 V	2 mA	19.000 V	20.801 V	24.000 V	Passed	

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VAISALA

#1450

Test report no. H31-19100076

TEST REPORT

Product family WXT530 series
Product type WXT536
Order code 6B1B2A4B1A1B
Serial number R1020384
Manufacturer Vaisala Oyj, Finland
Test date 5 March 2019

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	402	345	575	mV
Zero wind speed	0	0	0.4	m/s
Pressure difference	-0.19	-1	1	hPa
Temperature difference	-0.26	-2	2	°C
Humidity difference	-0.76	-10	10	%RH
Heating current	0.73	0.6	0.8	A
Current (service port)	1.03	0.5	2	mA
Communication (service port)	pass	PASS	PASS	-
Current (main port)	0.66	0.5	2	mA
Communication (main port)	pass	PASS	PASS	-

Ambient conditions / Humidity 13.08 ±5 %RH, Temperature 23.01 ±1 °C, Pressure 979.72 ±1 hPa.

Signature

Technician

Vaisala Oyj | PO Box 26, FI-00421 Helsinki, Finland
Phone +358 9 894 91 | Fax +358 9 8949 2227
Email firstname.lastname@vaisala.com | www.vaisala.com
Domicile Vantaa, Finland | VAT FI01244162 | Business ID 0124416-2

VAISALA

Calibration sheet no. H31-19100077

CALIBRATION SHEET

Instrument	WXTPTU
Serial number	R0410041
Manufacturer	Vaisala Oyj, Finland
Test date	22 January 2019

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

Calibration results

Test phase of calibration process	Reference value	Observed value	Difference*	Uncertainty**
Pressure	1083.5	1083.5	0	± 0.4 hPa
Pressure	896.8	896.8	0	± 0.4 hPa
Pressure	796.7	796.7	0	± 0.4 hPa
Pressure	599.2	599.2	0	± 0.4 hPa
Temperature	59.7	59.7	0	± 0.2 °C
Temperature	-5.7	-5.7	0	± 0.2 °C
Temperature	-32.6	-32.6	0	± 0.2 °C
Temperature	24.7	24.7	0	± 0.2 °C
Temperature	-52.1	-52.1	0	± 0.2 °C
Relative humidity	29.6	29.6	0	± 2 %RH
Relative humidity	57.6	57.6	0	± 2 %RH
Relative humidity	91.3	91.3	0	± 3 %RH

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

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

Signature

Technician

Vaisala Oyj | PO Box 26, FI-00421 Helsinki, Finland
Phone +358 9 894 91 | Fax +358 9 8949 2227
Email firstname.lastname@vaisala.com | www.vaisala.com
Domicile Vantaa, Finland | VAT FI01244162 | Business ID 0124416-2

CERTIFICATE of CALIBRATION

Make :	PCB Piezotronics	Reference # :	157708
Model :	378B02	Customer :	Aercoustics Engineering Ltd Mississauga, ON
Descr. :	Microphone System 1/2" Free Field		
Serial # :	132189	P. Order :	2019.06.26C
Asset # :	01158		

Cal. status : Received in spec's, no adjustment made.
Preamp System with Mic 377B02 s/n 177358

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

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

Our Quality System system complies with the requirements of ISO-9001-2015 and is registered under certificate CA96/269, working standards used for calibration are certified by or traceable to the National Research Council of Canada or the National Institute of Standards and Technology.

Calibrated : Jun 28, 2019 By : Petro Onasko

Cal. Due : Jun 28, 2021

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

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

Navair Technologies

REPAIR AND CALIBRATION TRACEABLE TO NRC AND NIST

6375 Dixie Rd. Mississauga, ON, L5T 2E7
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: 378B02	Approved by: JR	Feb-16	Ver 1.0

Calibration Report for Certificate : 157708

Make			Model	Serial	Asset		
PCB Piezotronics			378B02	132189	01158		
PCB Piezotronics			426E01	051458	01158		
PCB Piezotronics			377B02	177358	01158		

Sensitivity at 250 Hz

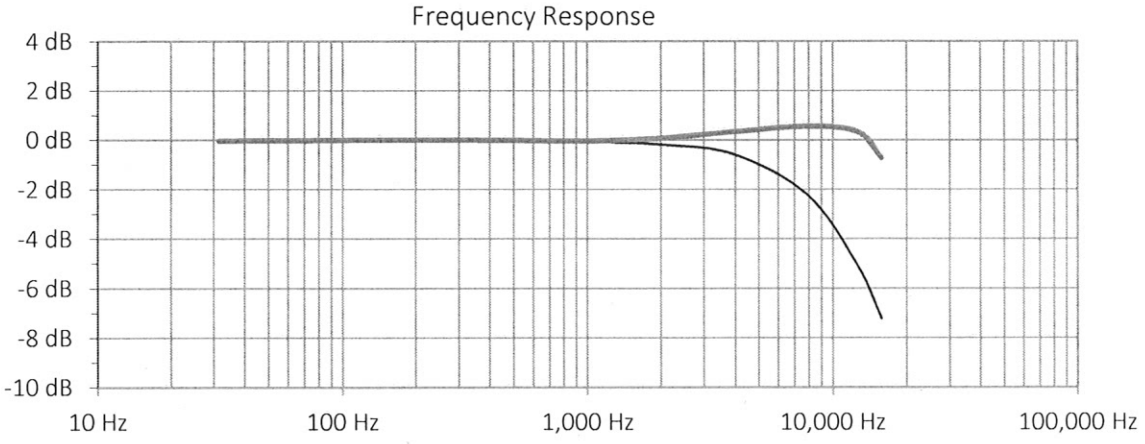
Specs Nom	Unit		Min	Reading	Max		In/Out
50	mV/Pa		39.72	49.64	62.94		In
-26.02	dB re 1V/Pa		-28.02	-26.08	-24.02		In
0	dB re 50mV/Pa		-2	-0.06	2		In

Ambient Conditions:

Static Pressure	100.2 kPa
Temperature	24.9°C
Rel.Humidity	47.0%

Frequency response

	Lower	Upper	
Freq	Pressure	Free Field	
Hz	dB	dB	
31.5	-0.04	-0.04	
63.1	-0.02	-0.02	
125.9	0.00	0.00	
251.3	**0.00**	**0.00**	ref
502.5	-0.01	-0.01	
1005.1	-0.07	-0.04	
1978.7	-0.18	0.07	
3957.5	-0.58	0.33	
7914.9	-2.23	0.56	
12663	-5.08	0.33	
15830	-7.21	-0.74	



CERTIFICATE of CALIBRATION

Make :	PCB Piezotronics	Reference # :	157717
Model :	480E09	Customer :	Aercoustics Engineering Ltd Mississauga, ON
Descr. :	Conditioning Amplifier		
Serial # :	00034593	P. Order :	2019.06.26C
Asset # :	01054		

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

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

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

Our Quality System system complies with the requirements of ISO-9001-2015 and is registered under certificate CA96/269, working standards used for calibration are certified by or traceable to the National Research Council of Canada or the National Institute of Standards and Technology.

Calibrated : Jun 28, 2019 By : Petro Onasko

Cal. Due : Jun 28, 2021

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

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

Navair Technologies

REPAIR AND CALIBRATION TRACEABLE TO NRC AND NIST

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

NT NAVAIR TECHNOLOGIES

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

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

Calibration Report for Certificate : 157717

Make	Model	Serial №	Asset	Cal by
PCB Piezotronics	480E09	00034593	01054	PO

Test	Setting	Input	Min	Reading	Max		In/Out

Excitation Voltage

• 1			25 Vdc	25.9 Vdc	29 Vdc		In

Constant Current Excitation

• 1			2.0 mA	2.98 mA	3.2 mA		In

Voltage Gain Accuracy at 1 kHz

• 1	1.000 V		0.98	1.00	1.02		In
• 10	0.100 V		9.80	10.00	10.20		In
• 100	0.010 V		98.0	99.9	102.0		In

Compliant Calibration Certificate

Template Revision: Feb2018

Certificate Number:	6095074.1	**OE Number:**	21719015
Date Printed:	22-JUL-2019	**Page:**	1 of 14
Customer:	Aercoustics Engineering LTD (CA) 1004 Middlegate Rd No 1100 ONTARIO MISSISSAUGA, L4Y 1M4 CANADA		

NATIONAL INSTRUMENTS
CALIBRATED
S/N/ID 1C00A6B
DATE 22-JUL-2019
DUE 22-JUL-2020
ni.com/calibration

Manufacturer:	National Instruments	**Model:**	NI 9234
Serial Number:	1C00A6B		
Part Number:	195551C-01L	**Description:**	MODULE ASSY,NI 9234, 4 AI CONFIGURABLE
Calibration Date:	22-JUL-2019	**Recommended Calibration Due:**	22-JUL-2020
Procedure Name:	NI 9234	**Verification Results:**	As Found: Passed As Left: Passed
Procedure Version:	3.6.1.0	**Calibration Executive Version:**	4.6.2.0
Lab Technician:	Rachel McKinnon	**Driver Info:**	NI-DAQmx:17.6.0
Temperature:	23.0° C	**Humidity:**	44.9% RH

The data found in this certificate must be interpreted as:

As Found The calibration data of the unit as received by National Instruments.

As Left The calibration data of the unit when returned from National Instruments.

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

This calibration conforms to ANSI/NCSL Z540.1-1994 (R2002) requirements.

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

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

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

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

Ted Talley
Technical Manager

National Instruments Calibration Services Austin
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USA
Tel: (800) 531-5066

NATIONAL INSTRUMENTS

Calibration Notes

Type	Note
Asset	Verification and adjustment were performed.

Standards Used

Manufacturer	Model	Type	Tracking Number	Calibration Due	Notes
Fluke	5720A	Calibrator	8253	18-AUG-2019	
National Instruments	PXI-4461	Function generator	9520	20-AUG-2019	
National Instruments	PXI-4071	Digital multimeter	8241	17-DEC-2019	
National Instruments	PXI-4132	SMU	9845	21-JUN-2020	

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

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USA

Calibration Results

As Found

Verify Accuracy

Lower Range	Upper Range	Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
-5 V	5 V	0	4.00000 V	3.99520 V	3.99990 V	4.00480 V	Passed	
-5 V	5 V	0	0.00000 V	-0.00120 V	-0.00001 V	0.00120 V	Passed	
-5 V	5 V	0	-4.00000 V	-4.00480 V	-3.99989 V	-3.99520 V	Passed	
-5 V	5 V	1	4.00000 V	3.99520 V	3.99986 V	4.00480 V	Passed	
-5 V	5 V	1	0.00000 V	-0.00120 V	-0.00005 V	0.00120 V	Passed	
-5 V	5 V	1	-4.00000 V	-4.00480 V	-3.99992 V	-3.99520 V	Passed	
-5 V	5 V	2	4.00000 V	3.99520 V	3.99988 V	4.00480 V	Passed	
-5 V	5 V	2	0.00000 V	-0.00120 V	-0.00005 V	0.00120 V	Passed	
-5 V	5 V	2	-4.00000 V	-4.00480 V	-3.99997 V	-3.99520 V	Passed	
-5 V	5 V	3	4.00000 V	3.99520 V	3.99998 V	4.00480 V	Passed	
-5 V	5 V	3	0.00000 V	-0.00120 V	-0.00001 V	0.00120 V	Passed	
-5 V	5 V	3	-4.00000 V	-4.00480 V	-3.99998 V	-3.99520 V	Passed	

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As Found

Verify Gain Matching

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

As Found

Verify Phase Matching

Max Phase Difference for Channel	Rate	Samples per Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	16384	1000 Hz	-0.085 Degrees	-0.011 Degrees	0.085 Degrees	Passed	
1	51200	16384	1000 Hz	-0.085 Degrees	0.013 Degrees	0.085 Degrees	Passed	
2	51200	16384	1000 Hz	-0.085 Degrees	-0.013 Degrees	0.085 Degrees	Passed	
3	51200	16384	1000 Hz	-0.085 Degrees	0.007 Degrees	0.085 Degrees	Passed	
0	51200	16384	10000 Hz	-0.490 Degrees	-0.103 Degrees	0.490 Degrees	Passed	
1	51200	16384	10000 Hz	-0.490 Degrees	0.136 Degrees	0.490 Degrees	Passed	
2	51200	16384	10000 Hz	-0.490 Degrees	-0.136 Degrees	0.490 Degrees	Passed	
3	51200	16384	10000 Hz	-0.490 Degrees	0.079 Degrees	0.490 Degrees	Passed	

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Verify Common Mode Rejection Ratio

Channel	Rate	Samples per Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	16384	1000 Hz	40.000 dB	51.206 dB	100.000 dB	Passed	
1	51200	16384	1000 Hz	40.000 dB	50.104 dB	100.000 dB	Passed	
2	51200	16384	1000 Hz	40.000 dB	50.768 dB	100.000 dB	Passed	
3	51200	16384	1000 Hz	40.000 dB	50.830 dB	100.000 dB	Passed	

As Found

Verify IEPE Current

Channel	Rate	DMM Range	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	0.01 A	2.000 mA	2.000 mA	2.074 mA	2.200 mA	Passed	
1	51200	0.01 A	2.000 mA	2.000 mA	2.075 mA	2.200 mA	Passed	
2	51200	0.01 A	2.000 mA	2.000 mA	2.066 mA	2.200 mA	Passed	
3	51200	0.01 A	2.000 mA	2.000 mA	2.064 mA	2.200 mA	Passed	

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As Found

Verify IEPE Compliance Voltage

Channel	Rate	SMU Voltage Limit	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	24 V	2 mA	19.000 V	20.865 V	24.000 V	Passed	
1	51200	24 V	2 mA	19.000 V	20.866 V	24.000 V	Passed	
2	51200	24 V	2 mA	19.000 V	20.869 V	24.000 V	Passed	
3	51200	24 V	2 mA	19.000 V	20.872 V	24.000 V	Passed	

As Left

Verify Accuracy

Lower Range	Upper Range	Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
-5 V	5 V	0	4.00000 V	3.99520 V	4.00001 V	4.00480 V	Passed	
-5 V	5 V	0	0.00000 V	-0.00120 V	0.00000 V	0.00120 V	Passed	
-5 V	5 V	0	-4.00000 V	-4.00480 V	-3.99999 V	-3.99520 V	Passed	
-5 V	5 V	1	4.00000 V	3.99520 V	4.00001 V	4.00480 V	Passed	
-5 V	5 V	1	0.00000 V	-0.00120 V	-0.00001 V	0.00120 V	Passed	
-5 V	5 V	1	-4.00000 V	-4.00480 V	-3.99999 V	-3.99520 V	Passed	
-5 V	5 V	2	4.00000 V	3.99520 V	4.00005 V	4.00480 V	Passed	
-5 V	5 V	2	0.00000 V	-0.00120 V	0.00004 V	0.00120 V	Passed	
-5 V	5 V	2	-4.00000 V	-4.00480 V	-3.99995 V	-3.99520 V	Passed	
-5 V	5 V	3	4.00000 V	3.99520 V	4.00000 V	4.00480 V	Passed	
-5 V	5 V	3	0.00000 V	-0.00120 V	0.00000 V	0.00120 V	Passed	
-5 V	5 V	3	-4.00000 V	-4.00480 V	-3.99998 V	-3.99520 V	Passed	

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Verify Gain Matching

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

As Left

Verify Phase Matching

Max Phase Difference for Channel	Rate	Samples per Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	16384	1000 Hz	-0.085 Degrees	-0.011 Degrees	0.085 Degrees	Passed	
1	51200	16384	1000 Hz	-0.085 Degrees	0.013 Degrees	0.085 Degrees	Passed	
2	51200	16384	1000 Hz	-0.085 Degrees	-0.013 Degrees	0.085 Degrees	Passed	
3	51200	16384	1000 Hz	-0.085 Degrees	0.008 Degrees	0.085 Degrees	Passed	
0	51200	16384	10000 Hz	-0.490 Degrees	-0.103 Degrees	0.490 Degrees	Passed	
1	51200	16384	10000 Hz	-0.490 Degrees	0.136 Degrees	0.490 Degrees	Passed	
2	51200	16384	10000 Hz	-0.490 Degrees	-0.136 Degrees	0.490 Degrees	Passed	
3	51200	16384	10000 Hz	-0.490 Degrees	0.078 Degrees	0.490 Degrees	Passed	

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Verify Common Mode Rejection Ratio

Channel	Rate	Samples per Channel	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	16384	1000 Hz	40.000 dB	53.311 dB	100.000 dB	Passed	
1	51200	16384	1000 Hz	40.000 dB	50.225 dB	100.000 dB	Passed	
2	51200	16384	1000 Hz	40.000 dB	97.922 dB	100.000 dB	Passed	
3	51200	16384	1000 Hz	40.000 dB	51.658 dB	100.000 dB	Passed	

As Left

Verify IEPE Current

Channel	Rate	DMM Range	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	0.01 A	2.000 mA	2.000 mA	2.064 mA	2.200 mA	Passed	
1	51200	0.01 A	2.000 mA	2.000 mA	2.075 mA	2.200 mA	Passed	
2	51200	0.01 A	2.000 mA	2.000 mA	2.066 mA	2.200 mA	Passed	
3	51200	0.01 A	2.000 mA	2.000 mA	2.064 mA	2.200 mA	Passed	

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Verify IEPE Compliance Voltage

Channel	Rate	SMU Voltage Limit	Test Value	Low Limit	Reading	High Limit	Status	Notes
0	51200	24 V	2 mA	19.000 V	20.862 V	24.000 V	Passed	
1	51200	24 V	2 mA	19.000 V	20.862 V	24.000 V	Passed	
2	51200	24 V	2 mA	19.000 V	20.867 V	24.000 V	Passed	
3	51200	24 V	2 mA	19.000 V	20.868 V	24.000 V	Passed	

VAISALA

Test report no. H31-19110191

TEST REPORT

Product family	WXT530 series
Product type	WXT536
Order code	6B1B2A4B1A1B
Serial number	R1151162
Manufacturer	Vaisala Oyj, Finland
Test date	15 March 2019

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	392	345	575	mV
Zero wind speed	0	0	0.4	m/s
Pressure difference	-0.11	-1	1	hPa
Temperature difference	0.37	-2	2	°C
Humidity difference	-0.7	-10	10	%RH
Heating current	0.74	0.6	0.8	A
Current (service port)	1.19	0.5	2	mA
Communication (service port)	pass	PASS	PASS	-
Current (main port)	0.85	0.5	2	mA
Communication (main port)	pass	PASS	PASS	-

Ambient conditions / Humidity 23.47 ±5 %RH, Temperature 23.16 ±1 °C, Pressure 991.07 ±1 hPa.

Signature

Technician

 DOC233154-A.doc

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Domicile Vantaa, Finland | VAT FI01244162 | Business ID 0124416-2

VAISALA

Calibration sheet no. H31-19110192

CALIBRATION SHEET

Instrument	WXTPTU
Serial number	R0620001
Manufacturer	Vaisala Oyj, Finland
Test date	11 February 2019

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

Calibration results

Test phase of calibration process	Reference value	Observed value	Difference*	Uncertainty**
Pressure	1083.6	1083.6	0	± 0.4 hPa
Pressure	898.5	898.4	-0.1	± 0.4 hPa
Pressure	797.5	797.5	0	± 0.4 hPa
Pressure	598.8	598.8	0	± 0.4 hPa
Temperature	59.7	59.7	0	± 0.2 °C
Temperature	-6	-6	0	± 0.2 °C
Temperature	-32.8	-32.8	0	± 0.2 °C
Temperature	24.9	24.9	0	± 0.2 °C
Temperature	-52.2	-52.2	0	± 0.2 °C
Relative humidity	29.3	29.3	0	± 2 %RH
Relative humidity	58	58	0	± 2 %RH
Relative humidity	92.2	92.2	0	± 3 %RH

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

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

Signature

Technician

Doc218938-A

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Appendix E
MECP I-Audit Checklist

MECP I-Audit Checklist

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

Information Required in the Acoustic Audit Report – Immission

Item #	Description	Complete?	Comment
1	Did the Sound level Meter meet the Type 1 Sound level meter requirements according to the IEC standard 61672-1 Sound level Meters, Part 1: Specifications? Section D2.1.1	✓	
2	Was the complete sound measurement system, including any recording, data logging or computing systems calibrated immediately before and after the measurement session at one or more frequencies using an acoustic calibrator on the microphone (must not exceed ±0.5dB)? Section D2.1.3	✓	
3	Are valid calibration certificate(s) of the noise monitoring equipment and calibration traceable to a qualified laboratory? Is the validity duration of the calibration stated for each item of equipment? Section D2.3	✓	
4	Was the predictable worst case parameters such as high wind shear and wind direction toward the Receptor considered? Section D3.2	✓	
5	Is there a Wind Rose showing the wind directions at the site? Section D7 (1e)	✓	
6	Did the results cover a wind speed range of at least 4-7 m/s as outlined in section D 3.8.?	✓	
7	Was the weather report during the measurement campaign included in the report? Section D7 (1c)	✓	
8	Did the audit state there was compliance with the limits at each wind speed category? Section D6	✓	
9	Are pictures of the noise measurement setup near Point of reception provided? Section D3.3.2 & D3.4	✓	
10	Was there justification of the Receptor location choice(s) prior to commencement of the I-Audit? Section D4.1	✓	
11	Was there sufficient valid data for different wind speeds? Section D5.2 # 3	✓	
12	Was the turbine (operational) specific information during the measurement campaign in tabular form (i.e. wind speed at hub height, anemometer wind speed at 10 m height, air temperature and pressure and relative humidity) Section D3.7	✓	
13	Were all the calculated standard deviations at all relevant integer wind speeds provided? Section D7 (2d)	✓	
14	Compliance statement	✓	
15	All data included in an Excel spreadsheet	✓	
16	If deviations from standard; was justification of the deviations provided	✓	

Appendix F
E-Audit Report Summary

E-AUDIT REPORT SUMMARY

This section provides a summary of the results from the following E-Audit report:

> Acoustic Measurement Report, project number: 13228.00, South Kent Wind Farm, Turbine T038 - IEC 61400-11 measurement dated November 21, 2014 Revision 2.

Sound Power Level of Turbine

The calculated apparent sound power level at hub height is summarized in Table 1.

Table 1 – $L_{WA,K}$ at each integer wind speed

Wind Speed (m/s)	Apparent L_{WA}, (dBA)	Uncertainty (dB)
6*	101.0	2.5
7**	-	-
8**	-	-
9**	-	-
10**	-	-

* Difference between Background level and Total Noise level was between 3 to 6 dB.
** Difference between Background level and Total Noise level was less than 3 dB. As such the values are not reportable (as defined by IEC 61400-11).

Tonality Analysis

The tonality analysis for the turbine is summarized in Table 2. All ΔL_{tn} and ΔL_a values reported represent the energy average of all data points with an identified tone that fall within the same frequency of origin.

Table 2 – Tonality Assessment Summary

Wind Speed (m/s)	Frequency (Hz)	Tonality, ΔL_{tn} (dB)	Tonal audibility, ΔL_a (dB)	FFT's with tones	Total # of FFT's	Presence (%)
6	76	-3.4	-1.4*	76	-3.4	-1.4*
	178	-4.3	-2.3*	178	-4.3	-2.3*
	405	-0.9	1.3*	405	-0.9	1.3*
7	58	-2.8	-0.8*	58	-2.8	-0.8*
	430	0.4	2.6*	430	0.4	2.6*
8	58	-1.4	0.6*	58	-1.4	0.6*
	254	-3.4	-1.4*	254	-3.4	-1.4*
	433	0.8	3.0*	433	0.8	3.0*
9	58	-2.7	-0.7*	58	-2.7	-0.7*
	435	-2.7	-0.5*	435	-2.7	-0.5*
10	58	-2.4	-0.4*	58	-2.4	-0.4*
	427	-1.0	1.2*	427	-1.0	1.2*

* Masking noise was influenced by background (i.e. less than 6 dB difference between masking level and background).

Closure

Measurements and analyses per IEC 61400-11:2006-05 (Edition 2.1) were performed on turbine T038 of the South Kent Wind Farm, located in the municipality of Chatham-Kent. The test turbine was found to have a maximum apparent sound power level of 101.0 dBA and a maximum tonal audibility of 3.0 dB.

Appendix G
Additional Justification

Ontario Highway 401 Noise Impact Prediction at R3167

The ambient noise at Receptor R3167 is dominated by traffic noise from the Ontario Highway 401 (ON-401), which is located approximately 1 km north of receptor R3167. The MECP requested noise level calculations be done to predict the impact of Highway 401 at the monitor location to verify whether the background levels measured at the receptor are reasonable.

Ontario Highway 401 Road Traffic Data

Road traffic noise predictions were taken from the "2006 Commercial Vehicle Survey: traffic volumes at survey stations"[1]. The traffic counts contain hourly truck and auto volumes moving in the eastbound direction from Windsor to London, collected over a two-week period. The minimum hourly count for weekend nights was taken as the most conservative option (presented in the following sections as "minimum"), while the average of all nighttime hours for the week was taken as the average case. Both conditions were escalated at a rate of 2% per year to the year 2019 and doubled to account for westbound traffic. Copies of the raw data are included in Appendix G.1, and the counts used for the noise level prediction can be found in Table 1.

Table 1: 2019 Hourly Road Traffic Counts

Type	Minimum	Average
Auto	160	264
Heavy Truck	97	243
Medium Truck	9	16
Total	266	523

Transportation Noise Calculation Procedure

Calculating ON-401 Sound Power with STAMSON

Noise level calculations were performed in accordance with MECP guidelines, including the Ontario Road Noise Analysis Method for Environment and Transportation (ORNAMENT). Calculations were done using the MECP's Road Traffic Noise Prediction Model STAMSON (version 5). A sample calculation is provided in Appendix G.2.

STAMSON was used to determine the sound power of Highway 401 based on traffic counts collected in 2006 by the Ministry of Transportation, as described above. Since STAMSON cannot model receptors at a distance greater than 500 metres and only

[1] *2006 Commercial Vehicle Survey: traffic volumes at survey stations*, Ontario Ministry of Transportation, 2015, URL: https://data.ontario.ca/dataset/2006-commercial-vehicle-survey-traffic-volumes-at-survey-stations

provides sound levels in the 500 Hz frequency band, the road noise impact calculations were extended using DataKustik's CadnaA environmental noise prediction software. Highway 401 spectral data from the Aercoustics library was adjusted to match the predicted sound power level calculated using STAMSON. This spectrum is shown in Table 2 below.

Table 2: Highway 401 (ON-401) Sound Power Spectrum

Source Description	Sound Power Spectrum (dB)							
	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
ON-401 (Aercoustics library)	80.6	71.5	63.9	71.8	75.1	68.2	57.0	0.0
ON-401 (average)	93.5	84.4	76.8	84.7	88.0	81.1	69.9	5.8
ON-401 (minimum)	89.7	80.6	73.0	80.9	84.2	77.3	66.1	2.0

H401 Noise Propagation to Monitor Location with CadnaA

The calculations were based on established prediction methods, including the standard ISO 9613-2: "Attenuation of Sound During Propagation Outdoors – Part 2: General Method of Calculation".

Noise levels were predicted using partially soft (semi-absorptive) ground modelled in all areas. The CadnaA parameters utilized in the model are provided in Table 3 below. Sample source calculations and Point of Reception (POR) tables can be found in Appendix G.3.

Table 3: CadnaA Parameters

Parameter	Value
Ground Absorption Coefficient	0.7
Search Radius (m)	5000
Temperature (ºC)	10
Humidity (%)	70

Transportation Noise Predictions

Figures G.1 and G.2 show the minimum and average noise contours respectively. Table 4 shows the lowest hourly predicted L_{Aeq} sound levels due to road traffic from Highway 401 at each measurement location along with the measured ambient levels at the same locations.

Table 4: CadnaA Predicted Levels from Highway 401 vs. Measured Levels

Receptor	Ambient Sound Level, L_{Aeq} (dBA)		
	Average Measured by Aercoustics	CadnaA Prediction based on STAMSON Minimum Counts	CadnaA Prediction based on STAMSON Average Counts
R3167 (Intermediate Monitor)	41.3	42.3	46.1
R3167 (Far Field Monitor)	41.0	43.8	47.6

The average ambient measurements were based on three nights with high signal-to-noise ratios. These three days were weekends or holidays, so it is expected that the measured ambient would more closely match the minimum prediction.

Legend

- Campaign Monitor
- Campaign Receptor
- South Kent Turbines

Minimum Noise Contours

- 35 dBA
- 40 dBA
- 45 dBA
- 50 dBA
- 55 dBA
- 60 dBA
- 65 dBA
- 70 dBA
- 75 dBA

N

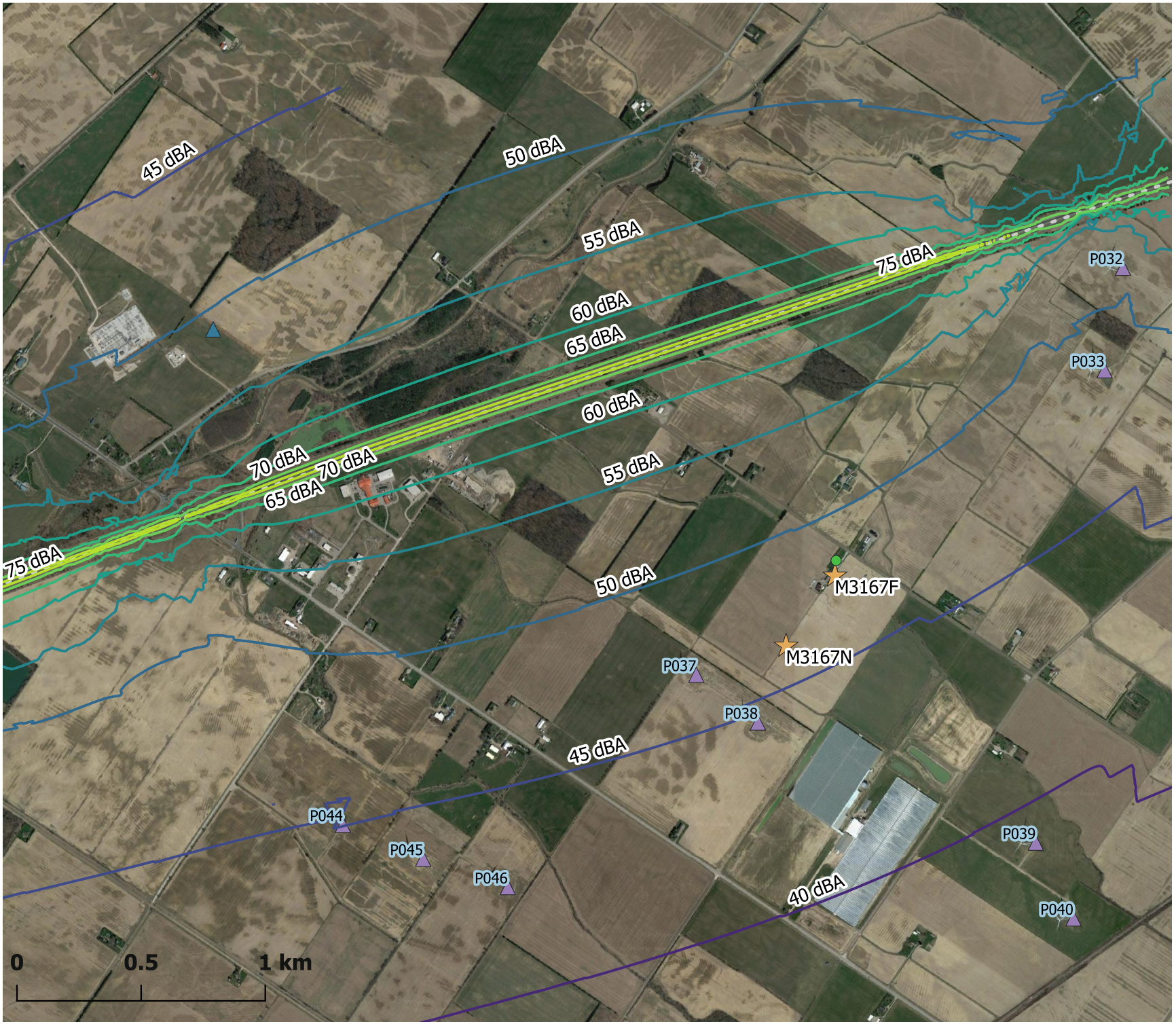
Project ID:	13228.02
Drawn by:	AA
Reveiwed by:	AD
Date:	February 12, 2020
Revision:	1
Scale:	As Indicated

South Kent Wind Project
Immission Audit Report
R3167 - T038

Figure G.1

ON-401 Minimum Noise Contours

aercoustics



Legend

- Campaign Monitor
- Campaign Receptor
- South Kent Turbines

Average Noise Contours

- 35 dBA
- 40 dBA
- 45 dBA
- 50 dBA
- 55 dBA
- 60 dBA
- 65 dBA
- 70 dBA
- 75 dBA

N

Project ID:	13228.02
Drawn by:	AA
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Revision:	1
Scale:	As Indicated

South Kent Wind Project
Immission Audit Report
R3167 - T038

Figure G.2

ON-401 Average Noise Contours

aercoustics

Traffic Data

Traffic Data pulled from the Ontario Transportation Data Catalogue: “2006 Commercial Vehicle Survey: traffic volumes at survey stations”.

Website: https://data.ontario.ca/dataset/2006-commercial-vehicle-survey-traffic-volumes-at-survey-stations

Table G.1: Background Information on Traffic Data

Parameter	Constant for Traffic Dataset
Station ID	ON0036
Station Name	Windsor (East/Est: Windsor - London)
Direction	East
MTO Region	Southwestern
Highway or Road	Hwy 401
Location	On Highway 401, between Manning Rd (Essex Rd 16 - Exit 21) & Puce Rd (Essex Rd 25 - Exit 28)

Table G.2: Explanation of Values in Traffic Data Table

Column Title	Explanation
Day of the Week Number	A number between 1 and 7 representing day of week. 1=Sunday, 7= Saturday
Hour	Hour of day, 0 to 23 represents starting hour of the day (e.g. 12 represents 12 P.M. - 1 P.M.).
Single	Number of single unit trucks
Multi	Number of multi-unit trucks
Auto	Number of cars and other passenger vehicles
Total Trucks	Sum of single and multi-unit vehicles
Total Vehicles	Number of total vehicles

Day of Week Number	Hour	Single	Multi	Auto	Total Trucks	Total vehicles
1	0	3	32	140	35	176
1	1	2	28	90	30	120
1	2	2	27	68	28	97
1	3	2	20	61	23	83
1	4	1	21	58	22	80
1	5	1	17	74	19	93
1	6	3	25	155	28	183
1	7	2	23	259	25	284
1	8	4	33	348	37	385
1	9	8	42	475	50	525
1	10	6	43	628	49	676
1	11	7	51	676	58	734
1	12	7	55	705	62	767
1	13	9	47	706	56	762
1	14	7	61	733	68	802
1	15	7	59	750	65	816
1	16	7	61	686	68	754
1	17	5	56	627	61	687
1	18	4	50	601	53	654
1	19	4	62	464	66	530
1	20	3	56	394	60	453
1	21	4	68	301	72	373
1	22	5	51	212	56	268
1	23	6	46	136	52	188
2	0	3	43	90	46	136
2	1	5	48	56	53	110
2	2	4	56	46	60	105
2	3	4	60	50	64	113
2	4	7	65	79	72	151
2	5	9	66	161	75	236
2	6	10	91	324	101	426
2	7	20	93	467	113	580
2	8	18	120	460	139	598
2	9	16	127	429	143	572
2	10	18	124	480	141	620
2	11	19	156	468	174	642
2	12	22	154	465	176	641
2	13	21	162	474	183	658
2	14	17	188	511	206	717
2	15	18	191	651	208	860
2	16	12	196	682	208	890
2	17	16	207	661	224	885
2	18	10	201	412	212	623
2	19	15	186	291	200	491
2	20	12	190	244	203	446
2	21	8	182	217	190	408

Day of Week Number	Hour	Single	Multi	Auto	Total Trucks	Total vehicles
2	22	8	167	154	175	329
2	23	9	140	130	149	280
3	0	6	122	78	128	206
3	1	4	108	56	112	168
3	2	6	106	38	112	150
3	3	5	103	30	108	138
3	4	6	95	45	101	146
3	5	14	94	124	108	231
3	6	12	110	262	122	384
3	7	20	140	469	160	629
3	8	24	159	440	183	623
3	9	19	190	412	209	621
3	10	25	205	424	230	654
3	11	17	221	438	238	676
3	12	20	196	444	217	661
3	13	22	229	457	251	708
3	14	25	217	524	242	766
3	15	19	222	661	241	902
3	16	17	212	716	228	945
3	17	16	233	699	249	948
3	18	15	213	441	228	669
3	19	12	232	322	244	567
3	20	11	200	262	212	473
3	21	9	201	241	210	451
3	22	10	169	172	180	352
3	23	9	146	144	155	299
4	0	4	104	90	108	198
4	1	7	106	54	113	167
4	2	4	108	38	111	149
4	3	6	104	34	109	142
4	4	6	89	44	95	138
4	5	12	96	125	108	232
4	6	14	123	288	137	425
4	7	20	124	488	144	632
4	8	27	165	487	192	680
4	9	20	196	445	217	662
4	10	22	214	454	237	690
4	11	22	214	449	236	685
4	12	17	219	460	236	696
4	13	17	200	501	218	718
4	14	22	222	587	243	830
4	15	21	242	704	262	966
4	16	18	236	730	254	984
4	17	17	245	745	262	1007
4	18	15	217	434	232	666
4	19	12	224	321	235	556

Day of Week Number	Hour	Single	Multi	Auto	Total Trucks	Total vehicles
4	20	11	226	270	237	506
4	21	10	204	251	215	466
4	22	11	191	173	202	375
4	23	10	158	139	167	306
5	0	7	128	91	136	227
5	1	6	126	60	132	192
5	2	7	112	45	119	164
5	3	8	112	38	120	158
5	4	7	97	51	104	155
5	5	10	96	119	106	225
5	6	16	132	290	148	438
5	7	20	142	494	162	655
5	8	26	172	477	197	674
5	9	19	209	482	228	710
5	10	22	199	481	221	702
5	11	26	228	511	253	764
5	12	23	201	517	224	741
5	13	18	240	562	259	820
5	14	22	220	626	243	869
5	15	21	239	775	260	1036
5	16	18	216	788	234	1022
5	17	16	240	802	256	1058
5	18	17	225	530	242	772
5	19	14	236	398	250	648
5	20	13	215	335	228	563
5	21	9	210	266	220	486
5	22	8	184	191	192	383
5	23	8	156	154	164	318
6	0	9	124	104	133	237
6	1	9	103	58	112	170
6	2	7	112	52	119	171
6	3	6	91	49	97	146
6	4	5	99	50	104	155
6	5	12	97	121	110	231
6	6	11	112	288	123	411
6	7	23	135	482	158	640
6	8	23	175	514	199	713
6	9	19	200	579	219	798
6	10	22	196	617	218	836
6	11	22	205	627	227	854
6	12	22	211	668	233	901
6	13	21	215	726	236	962
6	14	26	220	809	246	1055
6	15	18	217	935	235	1170
6	16	20	208	986	228	1214
6	17	21	239	1033	260	1293

Day of Week Number	Hour	Single	Multi	Auto	Total Trucks	Total vehicles
6	18	13	153	525	166	690
6	19	14	188	522	201	724
6	20	14	190	384	204	588
6	21	11	173	341	184	525
6	22	8	158	258	166	424
6	23	8	142	210	150	359
7	0	6	114	169	120	289
7	1	8	104	100	112	212
7	2	7	80	94	87	181
7	3	5	55	63	60	123
7	4	6	66	77	72	149
7	5	5	47	134	52	186
7	6	8	55	253	64	317
7	7	7	72	437	78	516
7	8	13	104	557	117	675
7	9	9	103	651	112	763
7	10	14	89	746	104	850
7	11	11	108	689	119	808
7	12	13	104	705	117	822
7	13	12	101	635	113	747
7	14	9	104	616	113	728
7	15	9	86	616	95	711
7	16	9	90	583	98	681
7	17	7	75	489	82	571
7	18	7	67	404	74	479
7	19	3	60	327	62	390
7	20	7	66	283	73	356
7	21	3	55	266	57	323
7	22	3	54	229	57	286
7	23	2	44	191	46	237

Average Level Calculation

```
STAMSON 5.0        NORMAL REPORT        Date: 23-01-2020 11:29:03
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: avgX2.te             Time Period: 1 hours
Description:


Road data, segment # 1: H401
----------------------------
Car traffic volume  :   264 veh/TimePeriod
Medium truck volume :    16 veh/TimePeriod
Heavy truck volume  :   243 veh/TimePeriod
Posted speed limit  :   100 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

Data for Segment # 1: H401
--------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  : 200.00 m
Receiver height           :   4.50 m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

↑
Results segment # 1: H401
-------------------------

Source height = 2.40 m

ROAD (0.00 + 60.01 + 0.00) = 60.01 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     90   0.54  78.63   0.00 -17.36  -1.25   0.00   0.00   0.00  60.01
-------------------------------------------------------------------------------

Segment Leq : 60.01 dBA

Total Leq All Segments: 60.01 dBA

↑


TOTAL Leq FROM ALL SOURCES:       60.01
```

Minimum Level Calculation

```
STAMSON 5.0        NORMAL REPORT        Date: 23-01-2020 11:30:21
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: min2.te              Time Period: 1 hours
Description:


Road data, segment # 1: H401
----------------------------
Car traffic volume  :   160 veh/TimePeriod
Medium truck volume :     9 veh/TimePeriod
Heavy truck volume  :    97 veh/TimePeriod
Posted speed limit  :   100 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

Data for Segment # 1: H401
--------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  : 200.00 m
Receiver height           :   4.50 m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

Results segment # 1: H401
-------------------------

Source height = 2.40 m

ROAD (0.00 + 56.16 + 0.00) = 56.16 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------------
   -90     90   0.54  74.78   0.00 -17.36  -1.25   0.00   0.00   0.00  56.16
-------------------------------------------------------------------------------

Segment Leq : 56.16 dBA

Total Leq All Segments: 56.16 dBA


TOTAL Leq FROM ALL SOURCES:       56.16
```

Receiver: R3167N
Project: South Kent Wind Farm - Immission Audit
Report Minimum Noise Impact
R3167 - T002
Project Number: 13228.02

Time Period	Total (dBA)
Night	42

Receiver Name	Receiver ID	X	Y	Z
R3167N	R3167N	412467.00 m	4692238.00 m	190.68 m

Source ID	Source Name	X	Y	Z	Refl.	Lw	L/A	Freq	Adiv	K0	Agr	Abar	Aatm	Afol	Ahous	Cmet	Dc	RL	Lr
HWY401	HWY401	412683.8	4693670.2	186.1	0	86	26.7	A	74.2	0.0	-1.5	0.0	5.4	0.0	0.0	0.0	0.0	0.0	35
HWY401	HWY401	413123.6	4693816.8	183.4	0	86	26.7	A	75.7	0.0	-1.5	7.3	6.2	0.0	0.0	0.0	0.0	0.0	25
HWY401	HWY401	411496.3	4693276.2	185.0	0	86	28.3	A	74.1	0.0	-1.5	0.0	5.3	0.0	0.0	0.0	0.0	0.0	37
HWY401	HWY401	411980.1	4693436.5	186.3	0	86	25.3	A	73.2	0.0	-1.5	0.0	4.9	0.0	0.0	0.0	0.0	0.0	35
HWY401	HWY401	412302.7	4693543.4	187.1	0	86	25.3	A	73.4	0.0	-1.5	0.0	4.9	0.0	0.0	0.0	0.0	0.0	35
HWY401	HWY401	408369.4	4692143.1	184.5	0	86	29.4	A	83.3	0.0	-1.7	4.6	12.5	0.0	0.0	0.0	0.0	0.0	17
HWY401	HWY401	409180.7	4692443.7	184.1	0	86	29.4	A	81.4	0.0	-1.6	4.6	10.6	0.0	0.0	0.0	0.0	0.0	21
HWY401	HWY401	409992.0	4692744.3	183.7	0	86	29.4	A	79.0	0.0	-1.6	4.7	8.6	0.0	0.0	0.0	0.0	0.0	25
HWY401	HWY401	410967.0	4693099.3	183.9	0	86	26.4	A	75.8	0.0	-1.5	0.0	6.2	0.0	0.0	0.0	0.0	0.0	32
HWY401	HWY401	410579.0	4692961.9	183.5	0	86	25.9	A	77.1	0.0	-1.6	0.0	7.1	0.0	0.0	0.0	0.0	0.0	29
HWY401	HWY401	415314.4	4694813.0	131.5	0	86	28.5	A	82.7	0.0	-1.7	4.6	11.9	0.0	0.0	0.0	0.0	0.0	17
HWY401	HWY401	414377.7	4694233.7	170.4	0	86	25.1	A	79.8	0.0	-1.6	4.7	9.2	0.0	0.0	0.0	0.0	0.0	19
HWY401	HWY401	414638.1	4694329.4	159.8	0	86	23.6	A	80.6	0.0	-1.6	4.6	9.9	0.0	0.0	0.0	0.0	0.0	16

Receiver: R3167F
Project: South Kent Wind Farm - Immission Audit
Report Minimum Noise Impact
R3167 - T002
Project Number: 13228.02

Time Period	Total (dBA)
Night	44

Receiver Name	Receiver ID	X	Y	Z
R3167F	R3167F	412671.00 m	4692531.00 m	190.39 m

Source ID	Source Name	X	Y	Z	Refl.	Lw	L/A	Freq	Adiv	K0	Agr	Abar	Aatm	Afol	Ahous	Cmet	Dc	RL	Lr
HWY401	HWY401	412683.8	4693670.2	186.1	0	86	26.7	A	72.1	0.0	-1.5	0.0	4.4	0.0	0.0	0.0	0.0	0.0	38
HWY401	HWY401	413123.6	4693816.8	183.4	0	86	26.7	A	73.7	0.0	-1.5	8.0	5.1	0.0	0.0	0.0	0.0	0.0	28
HWY401	HWY401	413783.3	4694036.7	179.4	0	86	29.7	A	76.4	0.0	-1.5	18.0	6.7	0.0	0.0	0.0	0.0	0.0	16
HWY401	HWY401	411496.3	4693276.2	185.0	0	86	28.3	A	73.9	0.0	-1.5	0.0	5.2	0.0	0.0	0.0	0.0	0.0	37
HWY401	HWY401	411980.1	4693436.5	186.3	0	86	25.3	A	72.1	0.0	-1.5	0.0	4.4	0.0	0.0	0.0	0.0	0.0	36
HWY401	HWY401	412302.7	4693543.4	187.1	0	86	25.3	A	71.6	0.0	-1.5	0.0	4.1	0.0	0.0	0.0	0.0	0.0	37
HWY401	HWY401	408369.4	4692143.1	184.5	0	86	29.4	A	83.7	0.0	-1.8	4.6	13.0	0.0	0.0	0.0	0.0	0.0	16
HWY401	HWY401	409180.7	4692443.7	184.1	0	86	29.4	A	81.9	0.0	-1.7	4.6	11.1	0.0	0.0	0.0	0.0	0.0	20
HWY401	HWY401	409992.0	4692744.3	183.7	0	86	29.4	A	79.6	0.0	-1.6	4.7	9.0	0.0	0.0	0.0	0.0	0.0	24
HWY401	HWY401	410967.0	4693099.3	183.9	0	86	26.4	A	76.1	0.0	-1.5	0.0	6.4	0.0	0.0	0.0	0.0	0.0	32
HWY401	HWY401	410579.0	4692961.9	183.5	0	86	25.9	A	77.6	0.0	-1.6	0.0	7.4	0.0	0.0	0.0	0.0	0.0	29
HWY401	HWY401	415314.4	4694813.0	131.5	0	86	28.5	A	81.9	0.0	-1.7	4.6	11.1	0.0	0.0	0.0	0.0	0.0	19
HWY401	HWY401	414377.7	4694233.7	170.4	0	86	25.1	A	78.6	0.0	-1.6	4.7	8.2	0.0	0.0	0.0	0.0	0.0	21
HWY401	HWY401	414638.1	4694329.4	159.8	0	86	23.6	A	79.5	0.0	-1.6	4.7	8.9	0.0	0.0	0.0	0.0	0.0	18
HWY401	HWY401	414828.6	4694424.5	152.1	0	86	22.9	A	80.2	0.0	-1.6	4.6	9.5	0.0	0.0	0.0	0.0	0.0	16

Project: South Kent Wind Farm - Immission Audit Report Minimum Noise Impact R3167 - T002

Project Number: 13228.02

Source ID	Source Name	Point of Reception R3167N		Point of Reception R3167F	
		Distance to POR (m)	Sound Level at POR (dBA) Night	Distance to POR (m)	Sound Level at POR (dBA) Night
HWY401	HWY401	1743	42	1412	44
Total Level [dBA]			**42**		**44**

Receiver: R3167N
Project: South Kent Wind Farm - Immission Audit
Report Average Noise Impact
R3167 - T002
Project Number: 13228.02

Time Period	Total (dBA)
Night	46

Receiver Name	Receiver ID	X	Y	Z
R3167N	R3167N	412467.00 m	4692238.00 m	190.68 m

Source ID	Source Name	X	Y	Z	Refl.	Lw	L/A	Freq	Adiv	K0	Agr	Abar	Aatm	Afol	Ahous	Cmet	Dc	RL	Lr
HWY401	HWY401	412683.8	4693670.2	186.1	0	90	26.7	A	74.2	0.0	-1.5	0.0	5.4	0.0	0.0	0.0	0.0	0.0	39
HWY401	HWY401	413123.6	4693816.8	183.4	0	90	26.7	A	75.7	0.0	-1.5	7.3	6.2	0.0	0.0	0.0	0.0	0.0	29
HWY401	HWY401	413783.3	4694036.7	179.4	0	90	29.7	A	78.0	0.0	-1.6	17.3	7.7	0.0	0.0	0.0	0.0	0.0	18
HWY401	HWY401	411496.3	4693276.2	185.0	0	90	28.3	A	74.1	0.0	-1.5	0.0	5.3	0.0	0.0	0.0	0.0	0.0	40
HWY401	HWY401	411980.1	4693436.5	186.3	0	90	25.3	A	73.2	0.0	-1.5	0.0	4.9	0.0	0.0	0.0	0.0	0.0	39
HWY401	HWY401	412302.7	4693543.4	187.1	0	90	25.3	A	73.4	0.0	-1.5	0.0	4.9	0.0	0.0	0.0	0.0	0.0	38
HWY401	HWY401	407558.1	4691842.5	184.9	0	90	29.4	A	84.8	0.0	-1.9	4.5	14.2	0.0	0.0	0.0	0.0	0.0	18
HWY401	HWY401	408369.4	4692143.1	184.5	0	90	29.4	A	83.3	0.0	-1.7	4.6	12.5	0.0	0.0	0.0	0.0	0.0	21
HWY401	HWY401	409180.7	4692443.7	184.1	0	90	29.4	A	81.4	0.0	-1.6	4.6	10.6	0.0	0.0	0.0	0.0	0.0	24
HWY401	HWY401	409992.0	4692744.3	183.7	0	90	29.4	A	79.0	0.0	-1.6	4.7	8.6	0.0	0.0	0.0	0.0	0.0	29
HWY401	HWY401	410967.0	4693099.3	183.9	0	90	26.4	A	75.8	0.0	-1.5	0.0	6.2	0.0	0.0	0.0	0.0	0.0	36
HWY401	HWY401	415765.3	4695220.6	112.1	0	90	27.1	A	84.0	0.0	-1.8	4.5	13.3	0.0	0.0	0.0	0.0	0.0	17
HWY401	HWY401	416140.0	4695565.9	95.9	0	90	27.1	A	84.9	0.0	-1.9	4.5	14.3	0.0	0.0	0.0	0.0	0.0	15
HWY401	HWY401	410579.0	4692961.9	183.5	0	90	25.9	A	77.1	0.0	-1.6	0.0	7.1	0.0	0.0	0.0	0.0	0.0	33
HWY401	HWY401	415314.4	4694813.0	131.5	0	90	28.5	A	82.7	0.0	-1.7	4.6	11.9	0.0	0.0	0.0	0.0	0.0	21
HWY401	HWY401	414377.7	4694233.7	170.4	0	90	25.1	A	79.8	0.0	-1.6	4.7	9.2	0.0	0.0	0.0	0.0	0.0	23
HWY401	HWY401	414638.1	4694329.4	159.8	0	90	23.6	A	80.6	0.0	-1.6	4.6	9.9	0.0	0.0	0.0	0.0	0.0	20
HWY401	HWY401	414828.6	4694424.5	152.1	0	90	22.9	A	81.2	0.0	-1.6	4.6	10.4	0.0	0.0	0.0	0.0	0.0	18
HWY401	HWY401	414982.1	4694526.2	145.7	0	90	22.4	A	81.6	0.0	-1.6	4.6	10.8	0.0	0.0	0.0	0.0	0.0	17

Receiver: R3167F
Project: South Kent Wind Farm - Immission Audit
Report Average Noise Impact
R3167 - T002
Project Number: 13228.02

Time Period	Total (dBA)
Night	48

Receiver Name	Receiver ID	X	Y	Z
R3167F	R3167F	412671.00 m	4692531.00 m	190.39 m

Source ID	Source Name	X	Y	Z	Refl.	Lw	L/A	Freq	Adiv	K0	Agr	Abar	Aatm	Afol	Ahous	Cmet	Dc	RL	Lr
HWY401	HWY401	412683.8	4693670.2	186.1	0	90	26.7	A	72.1	0.0	-1.5	0.0	4.4	0.0	0.0	0.0	0.0	0.0	42
HWY401	HWY401	413123.6	4693816.8	183.4	0	90	26.7	A	73.7	0.0	-1.5	8.0	5.1	0.0	0.0	0.0	0.0	0.0	31
HWY401	HWY401	413783.3	4694036.7	179.4	0	90	29.7	A	76.4	0.0	-1.5	18.0	6.7	0.0	0.0	0.0	0.0	0.0	20
HWY401	HWY401	411496.3	4693276.2	185.0	0	90	28.3	A	73.9	0.0	-1.5	0.0	5.2	0.0	0.0	0.0	0.0	0.0	41
HWY401	HWY401	411980.1	4693436.5	186.3	0	90	25.3	A	72.1	0.0	-1.5	0.0	4.4	0.0	0.0	0.0	0.0	0.0	40
HWY401	HWY401	412302.7	4693543.4	187.1	0	90	25.3	A	71.6	0.0	-1.5	0.0	4.1	0.0	0.0	0.0	0.0	0.0	41
HWY401	HWY401	407558.1	4691842.5	184.9	0	90	29.4	A	85.3	0.0	-1.9	4.5	14.7	0.0	0.0	0.0	0.0	0.0	17
HWY401	HWY401	408369.4	4692143.1	184.5	0	90	29.4	A	83.7	0.0	-1.8	4.6	13.0	0.0	0.0	0.0	0.0	0.0	20
HWY401	HWY401	409180.7	4692443.7	184.1	0	90	29.4	A	81.9	0.0	-1.7	4.6	11.1	0.0	0.0	0.0	0.0	0.0	23
HWY401	HWY401	409992.0	4692744.3	183.7	0	90	29.4	A	79.6	0.0	-1.6	4.7	9.0	0.0	0.0	0.0	0.0	0.0	28
HWY401	HWY401	410967.0	4693099.3	183.9	0	90	26.4	A	76.1	0.0	-1.5	0.0	6.4	0.0	0.0	0.0	0.0	0.0	35
HWY401	HWY401	415765.3	4695220.6	112.1	0	90	27.1	A	83.3	0.0	-1.7	4.6	12.5	0.0	0.0	0.0	0.0	0.0	18
HWY401	HWY401	416140.0	4695565.9	95.9	0	90	27.1	A	84.3	0.0	-1.8	4.5	13.6	0.0	0.0	0.0	0.0	0.0	16
HWY401	HWY401	410579.0	4692961.9	183.5	0	90	25.9	A	77.6	0.0	-1.6	0.0	7.4	0.0	0.0	0.0	0.0	0.0	32
HWY401	HWY401	415314.4	4694813.0	131.5	0	90	28.5	A	81.9	0.0	-1.7	4.6	11.1	0.0	0.0	0.0	0.0	0.0	23
HWY401	HWY401	414377.7	4694233.7	170.4	0	90	25.1	A	78.6	0.0	-1.6	4.7	8.2	0.0	0.0	0.0	0.0	0.0	25
HWY401	HWY401	414638.1	4694329.4	159.8	0	90	23.6	A	79.5	0.0	-1.6	4.7	8.9	0.0	0.0	0.0	0.0	0.0	22
HWY401	HWY401	414828.6	4694424.5	152.1	0	90	22.9	A	80.2	0.0	-1.6	4.6	9.5	0.0	0.0	0.0	0.0	0.0	20
HWY401	HWY401	414982.1	4694526.2	145.7	0	90	22.4	A	80.7	0.0	-1.6	4.6	10.0	0.0	0.0	0.0	0.0	0.0	19

Project: South Kent Wind Farm - Immission Audit Report Average Noise Impact R3167 - T002

Project Number: 13228.02

Source ID	Source Name	Point of Reception R3167N		Point of Reception R3167F	
		Distance to POR (m)	Sound Level at POR (dBA) Night	Distance to POR (m)	Sound Level at POR (dBA) Night
HWY		1743	46	1412	48
Total Level [dBA]			**46**		**48**

End of Report