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IMMISSION AUDIT REPORT – **Project: 13228.02**

South Kent Wind Project
R3306 – Turbine T108

Chatham-Kent, Ontario

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Revision History

Version	Description	Author	Reviewed	Date
1	Initial Report	AED	MAD	February 28, 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 R3306 near turbine T108. The E-Audit results 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 also indicated that the test turbine had a tonal audibility greater than 3 dB and thus would need to be assessed in the far field.

An I-Audit had previously been conducted in Spring 2015 at R3306 near T108. As such, the audit at R3306 was conducted to assess compliance of the sound pressure level and tonal audibility in the far field. As a result, the existing I-Audit results at R3306 were used to fulfil the far field tonal audibility assessment requirements in accordance with Section E3.1.2 of the Protocol.

The monitoring near receptor R3306 was conducted over the following period:

Audit Receptor	Audit Start Date	Audit End Date	Monitoring Duration (weeks)
R3306	April 17, 2015	October 4, 2015	12

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 for the tonality assessment. The results indicated that a tonal adjustment is not applicable to the sound levels at the far field location.

Table of Contents

1 Introduction 1

2 Background 1

3 Facility Description 2

4 Audit Location 2

4.1 **Receptor Selection** 2
4.1.1 Historical Wind Direction 3

4.2 **Monitoring Location** 4

4.3 **Existing Ambient Environment** 4
4.3.1 Flora Noise 4
4.3.2 Fauna Noise 5
4.3.3 Traffic Noise 5
4.3.4 Industry Noise 5
4.3.5 Self-Generated Noise 5
4.3.6 Other Sources 5

5 Audit Methodology 5

5.1 **Measurement Equipment** 6

5.2 **Measurement Parameters** 7

5.3 **Filtering Criteria** 8
5.3.1 Turbines in Study Area 9
5.3.2 Removal of Extraneous Noise 10
5.3.3 Representative Ambient Conditions 11
5.3.4 Adjacent Wind Facilities 12

5.4 **Compliance Criteria** 12
5.4.1 Sample Size Requirements 12
5.4.2 Tonal Penalty 12

5.5 **Deviations** 12

6 Audit Results 12

6.1 **Audit Duration** 12

6.2 **Weather Conditions** 13

6.3 **Measured Sound Levels** 14

6.4 **Tonal Audibility** 15

7 **Assessment of Compliance** 15

7.1 **Statement of Compliance** 16

8 **Conclusion** 16

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

List of Tables

Table 1: E-Audit Results Summary....1
Table 2: Receptor Details....3
Table 3: Coordinates and Turbines to Receptor and Measurement Locations....4
Table 4: Summary of Relevant Tones from T108 E-Audit....6
Table 5: Equipment Details....7
Table 6: Measurement Parameters Used in the Study....8
Table 7: Turbines Included in the Study Area....10
Table 8: Calculation of Applicable Tonal Penalty....12
Table 9: Length of Monitoring Campaign....12
Table 10: Range of Weather Conditions in Tonal Assessment Dataset....13
Table 11: Average Measured Sound Levels, RAM-I Analysis....14
Table 12: Tonality Assessment Table....15

List of Figures

Figure 1: Historical Wind Rose used for Receptor Selection....3
Figure 2: Wind Rose (All Measured Data)....13
Figure 3: Average Measured Total Noise and Background Sound Levels....15

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 R3306 near turbine T108.

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 T108 is as follows:

> REPORT ID: 13228.00.T108.RP5, South Kent Wind Farm – Turbine T108, IEC 61400-11 Edition 3.0 Measurement Report dated 21 December 2018 – Revision 5.

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)
104	104.5	N	5.3	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 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 also indicated that the test 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.

In further discussion with the MECP, South Kent Wind LP elected to use the existing I-Audit results from the Phase 2 I-Audit campaign conducted in the Spring of 2015 at R3306 (near T108) to fulfil the far field tonal audibility assessment requirements in accordance with Section E3.1.2 of the Protocol. The results of this assessment are presented in this report.

For reference, a detailed summary of the sound power and tonal audibility assessment results from the T108 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

Measurements were previously conducted at R3306 as part of the second immission audit campaign in Spring 2015 at South Kent Wind Project. The original I-Audit locations were selected using the guidance provided in the REA for SKWP, with priority given to locations having high predicted sound impacts and frequent downwind conditions from SKWP turbines. The prevailing wind direction for the site is discussed in the following section.

The receptor 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”). Measurements were previously conducted at R3306 as part of the second immission audit campaign in Spring 2015 at South Kent Wind Project. The original I-Audit locations were selected using the guidance provided in the REA for SKWP, with priority given to locations having high predicted sound impacts and frequent downwind conditions from SKWP turbines. The prevailing wind direction for the site is discussed in the following section.

The receptor details for T108 are 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 Details

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	R3306	T108	618	39.4	35.5	Downwind	Measurements were already conducted at this 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.

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°.

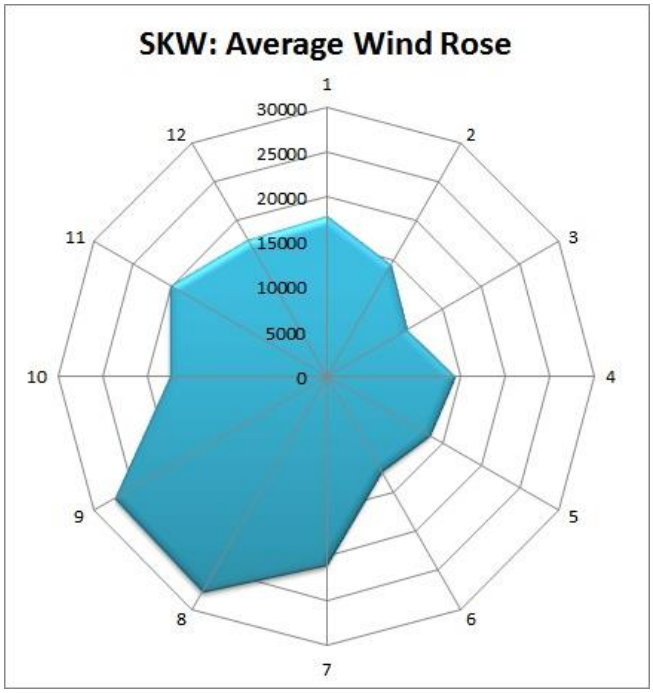

Figure 1: Historical Wind Rose used for Receptor Selection

4.2 Monitoring Location

The monitor was located approximately 70 metres from the coordinates of R3306, 25 metres closer to the nearest wind turbine (turbine T108). The monitor was at the receptor height of 4.5 metres. The ground cover between the measurement location and the nearest turbines was an open field, predominantly covered with short crops.

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)
R3306	Apr 17, 2015 – Oct 4, 2015	Receptor	416061 mE / 4691837 mN	618	39.4
		Monitor	416115 mE / 4691783 mN	593	39.7

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 monitor was located in an empty field with no crop cover. An area of approximately 40x40 ft was cleared around the monitor prior to installation. The monitor was also located approximately 20 metres from a tree line to the north-west.

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. 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 125 metres from Harwich Road to the north-east. Due to the distance from the nearest road, individual car passbys were not a significant source of noise contamination throughout the measurement campaign.

The monitor was not located near any major highways and therefore constant traffic noise was not a concern during the measurements.

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 in one-minute intervals at the measurement location. 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).

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 either *Total Noise* or *Background* depending on the operation of the nearby SKWP turbines.

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 5.4.2). 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 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 T108 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 480 Hz was selected for the tonality assessment.

Table 4: Summary of Relevant Tones from T108 E-Audit

Turbine ID	Frequency Range (Hz)	Tonal Audibility (dB)	Hub Height Wind Speed Range (m/s)	Electrical Power Output Range (kW)
T108	473 – 492	1.0 – 5.3	9 – 12.5	1540 – 2126

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

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

The measurement equipment was configured to log one-minute equivalent sound levels (L_{eq}) in A-weighted broadband and 1/3rd octave band frequencies. The microphone was installed at least 5 metres away from any large reflecting surfaces, as far away as practically possible from trees and other foliage, and in direct line of sight to the nearest 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
R3306	Sound Level Meter	B&K 2250	3004461
	Microphone	B&K 4189	2888697
	Pre-Amplifier	B&K ZC 0032	20327
	Weather Anemometer	Vaisala WXT520	K0630017

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 – 20 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 -10˚C
- Had minimal influence from extraneous ambient noise sources

Total Noise Intervals

- All nearby turbines were operating
- 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)

5.3.1 Turbines in Study Area

As noted above, several filtering criteria were applied based on the operation of the nearest 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
R3306	T029, T030, T031, T034, T035, T036, T041, T042, T108, T109, T120, T135, T155	T029, T030, T031, T034, T035, T036, T041, T042, T108, T109, T120, T135, T155

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 frequencies above 1250 Hz and verified through listening tests, was removed from the 1/3rd octave spectra for all measurements. 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 above 1250 Hz was determined to be 24.3 dBA at the monitor and is considered negligible.

A combination of automatic filtering and manual removal of the data was used to exclude intervals that were contaminated with extraneous noise from car passbys and other short-term events.

Extraneous noise was also minimized by removing intervals that contain a significant amount of wind gusting; this is determined by comparing the average and maximum measured wind speeds for a given interval.

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.

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

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) one-minute intervals for *Total Noise* and *Background.*

5.4.2 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 8 below.

Table 8: 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

There were no deviations from the methods prescribed in the Protocol.

6 Audit Results

Sound levels and weather conditions measured throughout the course of the I-Audit campaign are summarized in the following sections. The results presented are based on the tonal assessment dataset, which was filtered based on a minimum power threshold of 1540 kW, as described in Section 5.3.

6.1 Audit Duration

The length of the monitoring campaign is summarized in Table 9 below.

Table 9: Length of Monitoring Campaign

Audit Receptor	Audit Start Date	Audit End Date	Monitoring Duration (weeks)
R3306	April 17, 2015	October 4, 2015	12

6.2 Weather Conditions

Throughout the measurement campaign, a variety of weather conditions were encountered. The range of weather conditions measured in the tonal assessment dataset are summarized in Table 10. Note that the tonal assessment dataset includes the *Total Noise* and *Background* data that remains after filtering.

Table 10: Range of Weather Conditions in Tonal Assessment Dataset

Audit Receptor	Atmospheric Pressure (hPa)	10m-AGL Wind Speed (m/s)	Relative Humidity (%)	Temperature (°C)	Hub-Height Wind Speed (m/s)
R3306	977 – 1006	0 – 11	41 – 93	2 – 25	0 – 13.7

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 2. 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.

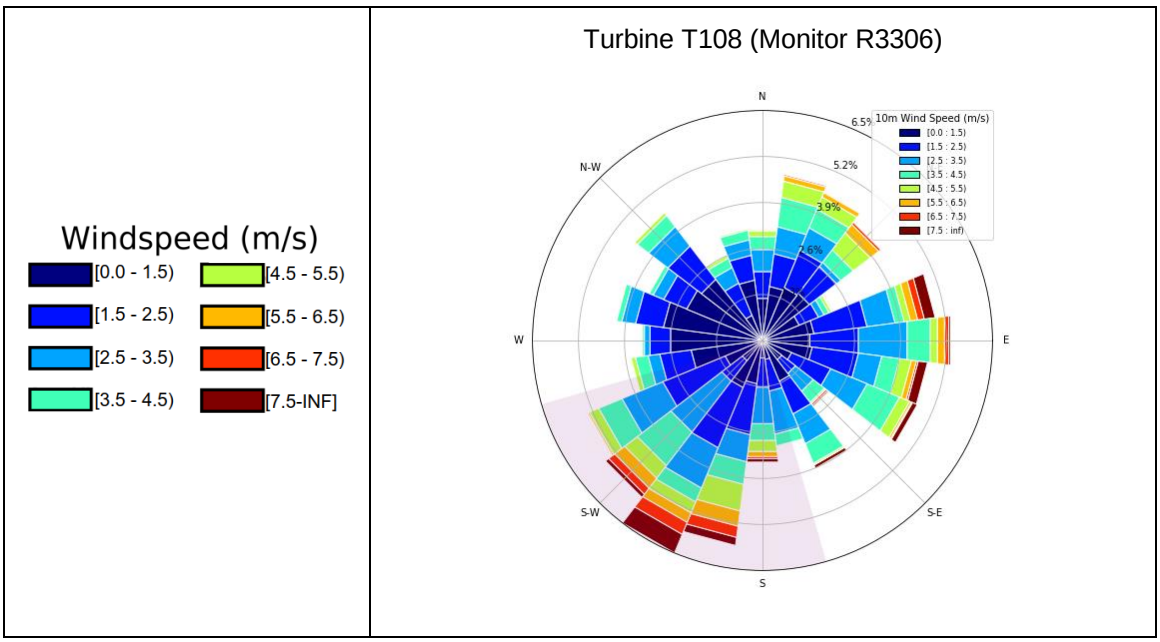

Figure 2: Wind Rose (All Measured Data)

From Figure 2, 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 tonal 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 11 below. These results are based on the tonal assessment dataset which was filtered based on a minimum power threshold of 1540 kW.

Table 11: Average Measured Sound Levels, RAM-I Analysis

Audit Receptor	Period	Measurement Parameter	Wind Bin (m/s)						
			1	2	3	4	5	6	7
R3306	Total Noise	Number of Samples	4	21	53	175	193	157	142
		Average L_{Aeq} (dBA)	-	41	40	40	41	42	44
		Standard Deviation (dB)	-	0.9	1.1	0.9	1.3	1.0	1.1
	Background	Number of Samples	558	171	55	193	134	125	51
		Average L_{Aeq} (dBA)	34	33	34	35	39	43†	44†
		Standard Deviation (dB)	3.0	3.0	2.4	2.1	1.6	1.9	1.9

\- Sound level not reported in wind bin if minimum sample size not met for tonal audibility analysis (5).

† 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 11 are also plotted in Figure 3 below.

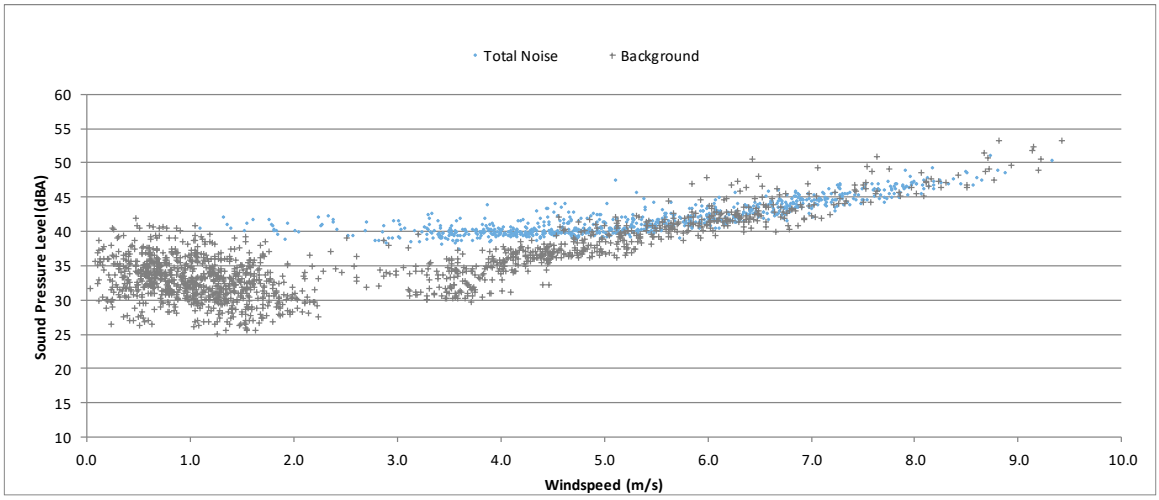

Figure 3: Average Measured Total Noise and Background Sound Levels
Monitor Near R3306 (Tonal Assessment Dataset)

6.4 Tonal Audibility

Tonal audibility results for R3306 in the far field of T108 are presented in Table 12 below. As noted in Section 5.3, the tonal assessment dataset was filtered based on a minimum power threshold of 1540 kW.

Table 12: Tonality Assessment Table

Centre Frequency	Tonality Parameter	Wind Bin (m/s)						
		1	2	3	4	5	6	7
480 Hz	Data Points in Wind Bin	4	21	53	175	193	157	142
	Data Points with Detected Tone	-	5	25	76	73	23	11
	Tonal Presence	-	24%	47%	43%	38%	15%	8%
	Mean Tonal Audibility, ΔL (dB)	-	-2.9	-3.7	-3.4	-3.5	-4.4	-6.5
	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 12, no tones were detected that exceeded the 4 dB threshold for tonal penalties. As a result, no tonal penalty is applicable.

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 Statement of Compliance

Based on the results of the tonal assessment measurements at R3306, a tonal penalty is not applicable for T108 in the far field. These results, in addition to the E-Audit results which indicated that the measured sound power level of the test turbine was within the level specified in the REA plus 0.5 dB, show that T108 is in compliance with the MECP requirements.

8 Conclusion

Aercoustics was retained by South Kent Wind LP to complete an assessment for the worst-case receptor of turbine T108, in response to the E-Audit test submitted December 21, 2018 and reviewed by the MECP.

The I-Audit measurements were previously conducted during the Spring 2015 I-Audit campaign from April 17, 2015 to October 4, 2015 at receptor R3306 near T108, in accordance with the MECP Compliance Protocol for Wind Turbine Noise. The results were reassessed for tonal audibility in the far field in accordance with Section E3.1.2 of the Protocol.

Based on the results presented in this report, the assessment requirements outlined in the Compliance Protocol have been met for the tonality assessment. The results indicated that a tonal adjustment is not applicable to the sound levels at the far field location.

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
R3306 - T108

Appendix A.1

Site Plan Overview

aercoustics

Legend

Campaign Receptor

- **Spring 2015 Campaign Monitor**
- **Spring 2015 Campaign Receptor**
- **South Kent Turbines**

N

Project ID:	13228.02
Drawn by:	AA
Reveiwed by:	AD
Date:	February 10, 2020
Revision:	1
Scale:	As Indicated

South Kent Wind Project
Immission Audit Report
R3306 - T108

Appendix A.2

Monitor and Receptor Location

aercoustics

Project ID:	13228.02
Drawn by:	AA
Reveiwed by:	AD
Date:	February 10, 2020
Revision:	1
Scale:	As Indicated

South Kent Wind Project
Immission Audit Report
R3306 - T108

Appendix A.3

Monitor to T108

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Appendix B
Statement from the Operator

South Kent Wind LP
2050 Derry Rd. West 2nd Floor
Mississauga, Ontario L5N 0B9
www.southkentwind.ca

November 6th, 2015

Ministry of the Environment and Climate Change
620-4510 Rhodes Dr.
Windsor, ON
N8W 5K5

Subject:
South Kent Wind **Renewable Energy Approval Number 2871-8UKGPC; Condition – Receptor audit immission part 2 of 2**

To whom it may concern

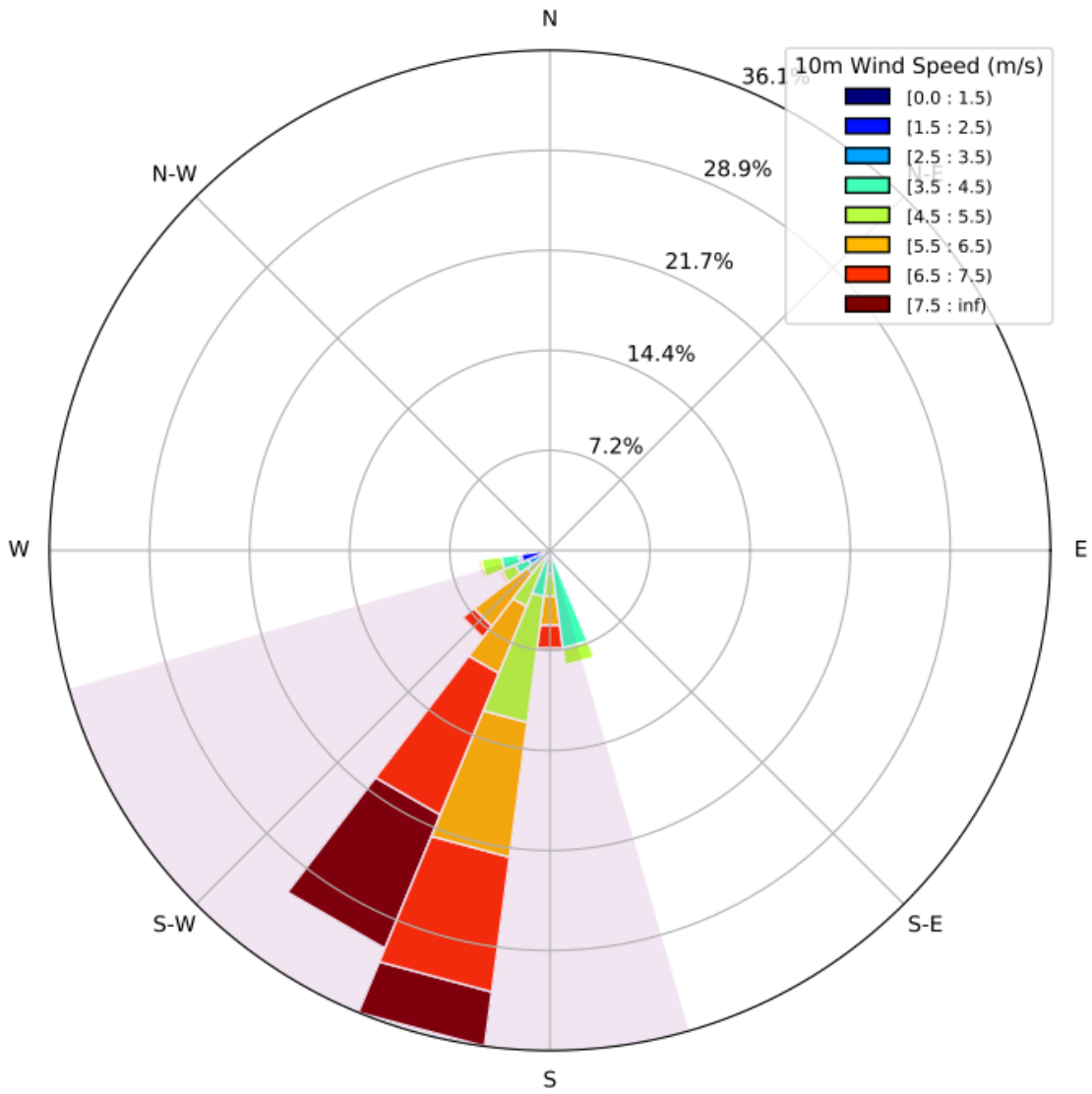
Please accept this letter as confirmation that all turbines tested during the summer 2015 acoustic measurement campaign conducted by Aercoustics Engineering Ltd. from March 10th through October 4th, 2015 were operating as normal for the duration of the campaign.

Sincerely,

Paul Dawson
Facility Manager

South Kent Wind
5873 Seventh Line
Merlin, ON N0P 1W0
C 289-380-3854
F 519-689-7956
paul.dawson@patternenergy.com
www.patternenergy.com

Appendix C
Wind Roses



Legend

Turbine Downwind Direction

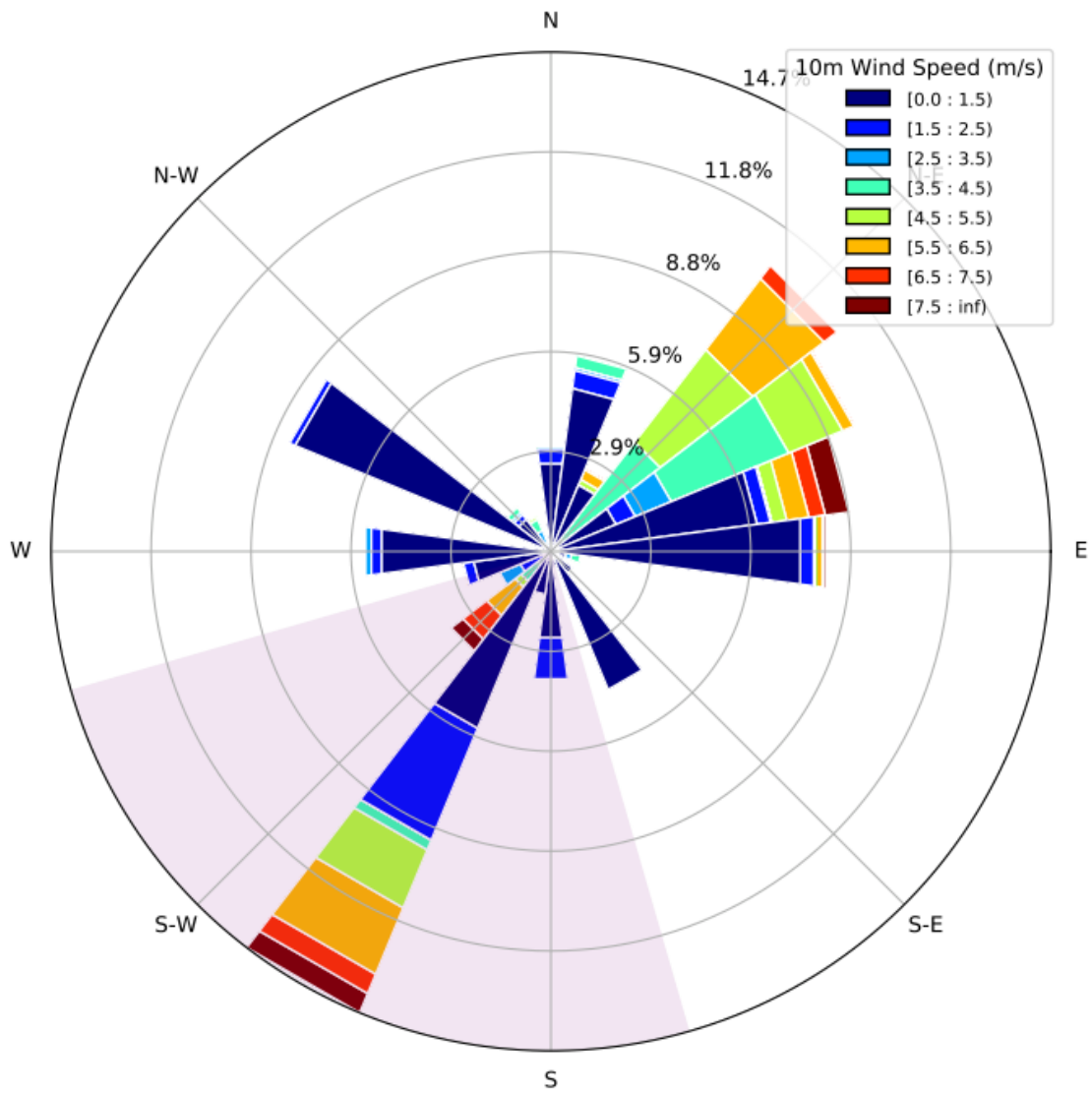
Project ID:	13228.02
Drawn by:	AA
Reveiwed by:	AD
Date:	February 14, 2020
Revision:	1
Scale:	As Indicated

South Kent Wind Project
Immission Audit Report
R3306 - T108

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 14, 2020
Revision:	1
Scale:	As Indicated

South Kent Wind Project
Immission Audit Report
R3306 - T108

Appendix C.2

Supplementary Wind Rose based on Assessment Data Background Noise

aercoustics

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 monitor location R3306. The associated calibration certificates are provided in this appendix.

Audit Receptor	Equipment	Make/Model	Serial Number
R3306	Sound Level Meter	B&K 2250	3004461
	Microphone	B&K 4189	2888697
	Pre-Amplifier	B&K ZC 0032	20327
	Weather Anemometer	Vaisala WXT520	K0630017

MANUFACTURER'S CERTIFICATE OF CONFORMANCE

We certify that Brüel & Kjær **-2250--D00-** Serial No. **3004461** has been tested and passed all production tests, confirming compliance with the manufacturer's published specification at the date of the test.

The final test has been performed using calibrated equipment, traceable to National or International Standards or by ratio measurements.

Brüel & Kjær is certified under ISO 9001:2008 assuring that all test data is retained on file and is available for inspection upon request.

Nærum 29-jan-2014

Torben Bjørn
Vice President, Operations

Please note that this document is not a calibration certificate.
For information on our calibration services please contact your nearest Brüel & Kjær office.

BA 0238 - 18

HEADQUARTERS: Brüel & Kjær Sound & Vibration Measurement A/S · DK-2850 Nærum · Denmark
Telephone: +45 7741 2000 · Fax: +45 4580 1405 · www.bksv.com · info@bksv.com
Local representatives and service organisations worldwide

Brüel & Kjær

2250/2270 SOFTWARE LICENSE

	BZ7222 ver. 4.x
License/Lizenz/Licence/Licencia/Licenza	0EF9 0DBC 9A0E C135
Serial No./Seriennummer/Numéro de série Nº de Serie/Nr. di serie	3004461

BR 1625 - 12

HEADQUARTERS: Brüel & Kjær Sound & Vibration Measurement A/S · DK-2850 Nærum · Denmark
Telephone: +45 7741 2000 · Fax: +45 4580 1405 · www.bksv.com · info@bksv.com
Local representatives and service organisations worldwide

Brüel & Kjær

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BZ7223 ver. 4.x

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65E2 D0C3 33DE D717

Serial No./Seriennummer/Numéro de série
Nº de Serie/Nr. di serie

3004461

BR 1623 - 12

HEADQUARTERS: Brüel & Kjær Sound & Vibration Measurement A/S · DK-2850 Nærum · Denmark
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License/Lizenz/Licence/Licencia/Licenza	2160 B236 C7A1 DF94
Serial No./Seriennummer/Numéro de série Nº de Serie/Nr. di serie	3004461

BR 1625 - 12

HEADQUARTERS: Brüel & Kjær Sound & Vibration Measurement A/S · DK-2850 Nærum · Denmark
Telephone: +45 7741 2000 · Fax: +45 4580 1405 · www.bksv.com · info@bksv.com
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License/Lizenz/Licence/Licencia/Licenza	96C5 D497 0A36 24D1
Serial No./Seriennummer/Numéro de série Nº de Serie/Nr. di serie	3004461

BR 1625 - 12

HEADQUARTERS: Brüel & Kjær Sound & Vibration Measurement A/S · DK-2850 Nærum · Denmark
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Local representatives and service organisations worldwide

Brüel & Kjær

Brüel & Kjær

Packing Note

Item	Description
-2250--D00-	2250-G4 Handheld Analyzer 2250-G4 Handheld Analyzer 2250-G4 Handheld Analyzer

Item	Qty	Description
-4189---	1	1/2" Free-field Microphone, 6 Hz to 20 kHz, Prepolarized 1/2"-Freifeld-Mikrofon FALCON-Serie Klasse 1 vorpolarisiert 50 mV/Pa Microphone à condensateur 1/2" Falcon, prépolarisé (0 V), champ libre, 6Hz à 20KHz
BZ-5298---	1	Software, Environmental Software Software, Environmental Software Software, Environmental Software
KE-0441---	1	Protective Cover for Hand-held Analyzer Protective Cover for Hand-held Analyzer Protective Cover for Hand-held Analyzer
ZC-0032---	1	Microphone Pre-amplifier for Hand-held Analyzer Microphone Pre-amplifier for Hand-held Analyzer Microphone Pre-amplifier for Hand-held Analyzer

QI
Performed by:

If the accessories included specified in the Product Data Sheet or Manual differ from the items supplied, the items mentioned on the Packing Note are valid.

VAISALA

Test report no. H31-14060140

TEST REPORT

Instrument	WXT520 AAB0BA10B0
Serial number	K0630017
Manufacturer	Vaisala Oyj, Finland
Test date	5th February 2014

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

Test results

Test	Result	Limit	Passed
Rain response	415.0 mV	(345...575) mV	OK
Zero wind speed	0.00 m/s	(0...0.4) m/s	OK
Pressure	1011.2 hPa	PASS/FAIL	OK
Temperature	22.4 °C	PASS/FAIL	OK
Humidity	20.9 %RH	PASS/FAIL	OK
Heating	Not tested	N/A	Not tested
Current (service port)	0.57	(0.2...0.7) mA	OK
Communication (service port)	PASS	PASS/FAIL	OK
Current (main port)	0.33	(0.1...0.4) mA	OK
Communication (main port)	PASS	PASS/FAIL	OK

Signature

Technician

 DOC216638.doc

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. H31-14060139

CALIBRATION SHEET

Instrument	WXTPTU
Serial number	K0330050
Manufacturer	Vaisala Oyj, Finland
Test date	5th February 2014

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	Error*	Uncertainty**
Pressure	1079.8 hPa	1079.8 hPa	0.0 hPa	± 0.4 hPa
Pressure	898.4 hPa	898.5 hPa	0.1 hPa	± 0.4 hPa
Pressure	797.3 hPa	797.3 hPa	0.0 hPa	± 0.4 hPa
Pressure	595.7 hPa	595.7 hPa	0.0 hPa	± 0.4 hPa
Temperature	59.8 °C	59.8 °C	0.0 °C	± 0.2 °C
Temperature	24.7 °C	24.7 °C	0.0 °C	± 0.2 °C
Temperature	-5.8 °C	-5.8 °C	0.0 °C	± 0.2 °C
Temperature	-32.9 °C	-32.8 °C	0.1 °C	± 0.2 °C
Temperature	-51.9 °C	-51.9 °C	0.0 °C	± 0.2 °C
Relative humidity	30.7 %RH	30.7 %RH	0.0 %RH	± 2 %RH
Relative humidity	57.8 %RH	57.8 %RH	0.0 %RH	± 2 %RH
Relative humidity	92.0 %RH	92.0 %RH	0.0 %RH	± 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

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:

> REPORT ID: 13228.00.T108.RP5, South Kent Wind Farm – Turbine T108, IEC 61400-11 Edition 3.0 Measurement Report dated 21 December 2018 – Revision 5.

Sound Power **Level of Turbine**

The calculated apparent sound power level at hub height is summarized in Table 1. Corresponding sound power levels for 10 m height wind speeds are provided in Table 2.

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

Wind Speed (m/s)	Apparent L_{WA}, (dBA)	Uncertainty (dB)
7.5	102.3	0.9
8	103.7	0.9
8.5	104.1	0.8
9	104.2	0.8
9.5	104.2	0.8
10	104.3	0.8
10.5	104.4	0.8
11	104.2	0.9
11.5	104.4	0.9
12	104.3	0.9
12.5	104.5	0.9

Table 2 – $L_{WA\ 10m,\,K}$ at each integer wind speed

Wind Speed (m/s)	Apparent L_{WA}, (dBA)	Uncertainty (dB)
5	102.1	1.3
6	104.0	0.8
7	104.3	0.8
8	104.3	0.9
9	104.5	0.9

Tonality Analysis

The tonality analysis for the turbine is summarized in Table 3. 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 3 – 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 (%)
7.5	536	-3.9	-1.5	18	31	58%
8	475	-4.7	-2.4	57	62	92%
	536	-4.7	-2.4	31	62	50%
8.5	474	-2.7	-0.4	69	77	90%
	596	-4.3	-1.9	21	77	27%
9	473	-1.3	1.0	125	129	97%
	596	-3.6	-1.2	32	129	25%
9.5	476	0.1	2.4	137	141	97%
	596	-3.5	-1.1	52	141	37%
10	478	0.6	2.9	90	93	97%
	596	-3.6	-1.2	29	93	31%
10.5	487	2.0	4.2	21	28	75%
	596	-3.9	-1.5	8	28	29%
11	485	1.7	4.0	47	53	89%
	596	-3.4	-1.0	16	53	30%
11.5	488	2.7	5.0	47	60	78%
	596	-3.6	-1.2	24	60	40%
12	491	1.7	4.0	34	52	65%
	596	-3.5	-1.1	14	52	27%
12.5	492	3.0	5.3	31	39	79%
	596	-3.5	-1.1	8	39	21%

Closure

Measurements and analyses per IEC 61400-11:2012 (Edition 3.0) were performed on turbine T108 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 104.5 dBA and a maximum tonal audibility of 5.3 dB.

End of Report