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ACOUSTIC AUDIT - IMMISSION REPORT

300 KW REDUCED MODE

Unifor Wind Turbine

Port Elgin, Ontario

Prepared for:

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June 29, 2018

VERSION CONTROL

Version	Date	Version Description
1	June 29, 2018	Original Report

EXECUTIVE SUMMARY

Howe Gastmeier Chapnik Limited ("HGC Engineering") was retained by Union Building Corporation of Canada to complete an acoustic immission audit of the Unifor Wind Turbine ("Wind Project"). The Wind Project includes one Enercon wind turbine generator, operating in a 300 kW reduced mode. HGC Engineering has assessed the acoustic impact against the acoustic criteria of the Ministry of the Environment and Climate Change ("MOECC") in accordance with the requirements of the MOECC's 2017 *Compliance Protocol for Wind Turbine Noise – Guidelines for Acoustic Assessment and Measurement* ("Compliance Protocol"). The immission audit was completed between March 5 and May 24, 2018. The sound level measurements and analysis, as performed in accordance with the Compliance Protocol, indicate that the Wind Project is operating in compliance of the applicable sound level criteria at all selected monitoring locations. Details of the measurements and analysis are provided herein.

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TABLE OF CONTENTS

1 INTRODUCTION

Howe Gastmeier Chapnik Limited ("HGC Engineering") was retained by Union Building Corporation of Canada to complete an Acoustic Audit – Immission of the Unifor Wind Turbine ("Wind Project"). The Wind Project is located at the Unifor Family Education Center in the Town of Port Elgin, Ontario and consists of one Enercon E-48 wind turbine generator, designated turbine T1. Turbine T1 has a hub height of 76 m.

The audit was completed as a follow-up to a previous immission audit of the turbine operating in its 500 kW reduced mode, completed by HGC Engineering and published in a report dated January 8, 2018 [1]. The previously completed immission audit of the 500 kW reduced mode indicated sound level excesses at the closest monitoring location. As a result, a Noise Abatement Action Plan ("NAAP") was prepared by Jade Acoustics dated on March 18, 2018 [2]. The noise mitigation measures in the NAAP included implementation of the 300 kW reduced mode and sectoral curtailment (0 RPM) when the closest receptors to the northwest are downwind of turbine T1. Both of these measures were in place during the immission audit described in this report.

2 MONITORING LOCATIONS

The *Environmental Noise Impact Report: Enercon E48 500 kW constrained operation, CAW Clean Wind Energy Project* ("ENIR") prepared by M.K. Ince and Associates Ltd. dated March 1, 2012 [3], provides sound level predictions for locations within 1000 m of the Wind Project wind turbine generator, using the 500 kW reduced mode.

A number of locations were considered for use as sound level monitoring locations for the audit, as shown in Table A1 and Figure A2 of Appendix A. Predicted sound levels for the receptors surrounding the Wind Project were taken from the ENIR.

The receptors were selected based on their predicted sound level and consultation with the land owners. The annual wind rose for the area is provided in Figure A1 of Appendix A. Photos of the selected receptor locations can be found in Appendix B. The selected monitoring locations are unchanged from the previously completed audit.

HGC Engineering developed an acoustic predictive model of the site to determine the sound levels at the selected monitoring locations, using manufacturer's sound power data of the 300 kW reduced mode. The predicted sound levels at the monitoring and receptor locations, along with UTM coordinates can be found in Table 1.

Table 1: Predicted Sound Levels and UTM Coordinates of Selected Locations

Location		Easting	Northing	Predicted Sound Level [dBA]
J	Receptor	467256	4919594	42.7[±]
	Monitoring Location M1	467348	4919607	40.0[*]
T	Receptor	467416	4919124	40.1[±]
	Monitoring Location M2	467474	4919119	35.2[*]
Q	Receptor	467169	4919269	42.0[±]
	Monitoring Location M3	467212	4919266	40.2[*]

[±] Sound level taken from ENIR [3] using the 500 kW reduced mode
[*] Sound level predicted by acoustic model created by HGC Engineering using the 300 kW reduced mode

Receptor location J is a single storey dwelling located at 12 Goble Place. Turbine T1 is approximately 210 m to the southeast. The sound level meter was installed on a fence at the northwest side of the Unifor property, approximately 200 m from T1, designated Monitoring Location M1. The microphone was placed at a height of 4.5 m, consistent with the ENIR and representative of potential second storey windows at other nearby receptors.

Receptor location T is a two storey home located at 77 CAW Road (Bruce County Road 25). Turbine T1 is approximately 290 m to the north. The sound level meter was installed in an agricultural field to the east of the property, approximately 315 m from turbine T1, designated Monitoring Location M2. The microphone was placed at a height of 4.5 m, consistent with the ENIR.

Receptor location Q is a two storey home located at 107 CAW Road (Bruce County Road 25). The turbine, T1 is approximately 230 m to the northeast. The sound level meter was installed in an agricultural field to the east of the property, approximately 205 m from turbine T1, designated Monitoring Location M3. The microphone was placed at a height of 4.5 m, consistent with the ENIR.

The Wind Project area is generally residential in nature. Locations M2 and M3 were located next to a frequently travelled road. Location M1 was located next to a baseball diamond.

3 INSTRUMENTATION

The MOECC document, *Compliance Protocol for Wind Turbine Noise – Guidelines for Acoustic Assessment and Measurement* [4] ("Compliance Protocol") provides instrumentation requirements for Acoustical Audits of wind energy projects. The instrumentation used for this acoustic audit satisfies the requirements of the Compliance Protocol.

Audio frequency sound levels were measured using Svantek 977 sound level meters, each connected to ½" microphones. The microphones were set at a height of approximately 4.5 m and equipped with 175 mm diameter windscreens to minimize wind-induced microphone self-noise.

The energy-equivalent average sound level, denoted L_{EQ} was recorded by the instrumentation. The audio-frequency measurements are presented as A-weighted sound levels as they are intended to represent the loudness of sounds as perceived by the human ear. The overall audio-frequency sound level monitoring results are summarized in this report.

In addition to the acoustic instrumentation, meteorological instruments were used. A Davis weather station was deployed at Monitoring Location M1 to collect ground weather conditions including temperature, humidity, and precipitation. NRG anemometers and wind vanes were used at each receptor location to collect 10 m height wind speed and direction.

The various instruments deployed by HGC Engineering are summarized in Table 2, and their respective locations are shown in Figure 1.

Table 2: Measurement Instrumentation

Location	Instrumentation Make and Model	Serial Number
M1	Svantek 977 sound level meter	36439
	NRG #40C anemometer connected to a Campbell Scientific datalogger	179500262926
M2	Svantek 977 sound level meter	36426
	NRG #40C anemometer connected to a Campbell Scientific datalogger	179500262946
M3	Svantek 977 sound level meter	36428
	NRG #40C anemometer connected to a Campbell Scientific datalogger	179500265230

The sound level meters were configured to measure and record spectral (frequency-dependent) one-minute L_{EQ} sound level measurements. For identification of dominant sources, the sound level meters also recorded audio files.

Correct calibration of the acoustic instrumentation was verified using an acoustic calibrator manufactured by Brüel & Kjær (B&K). Calibration verification was carried out on a bi-weekly basis throughout the measurement period.

Windscreens were used on the microphones, consistent with the requirements of MOECC technical publication NPC-103, *Procedures* [5]. A large wind screen, 175 mm in diameter, was used on each sound level meter to minimize wind-induced microphone self-noise at higher wind speeds. Sound level data included herein has not been adjusted for the sound insertion loss of the large wind screen.

All the equipment was within its annual or bi-annual calibration, confirmed by the calibration certificates found in Appendix C.

4 ASSESSMENT CRITERIA

The MOECC publication *Noise Guidelines for Wind Farms – Interpretation for Applying MOE NPC Publications to Wind Power Generation Facilities* [6] indicates the applicable sound level limit for wind energy projects in a Class 2 environment. Additionally, the Compliance Protocol includes the same sound level limits which are shown in Table 3.

Table 3: Wind Turbine Noise Criteria [dBA]

10 m Height Wind Speed [m/s]	4	5	6	7	8	9	10
Wind Turbine Sound Level Limits Class 2 Area [dBA]	45.0	45.0	45.0	45.0	45.0	49.0	51.0

It should be noted that the sound level limits of the MOECC apply only to the sound level contribution of the sound source under assessment, in this case the sound from the wind turbine generator. Thus, where a sound level measured at a receptor location includes significant sound due to the relevant sound source and unrelated background sound sources (i.e., road vehicles, trains, air traffic, farming machinery, wind, etc.), some form of evaluation must be made to determine the sound level contribution of the source under assessment in the absence of the background sounds. Methodology prescribed by the MOECC to complete an assessment of a wind energy project is discussed in the following section.

5 METHODOLOGY

The MOECC requested the acoustic audit be completed in accordance with Part D of the Compliance Protocol. Part D includes requirements for instrumentation, measurement parameters, and data reduction procedures to assist with determining compliance.

A series of one-minute energy-equivalent sound level measurements are collected with ("ON") and without ("OFF") the turbine operating. Simultaneously, wind speed and direction at 10 m height are measured and collected in one-minute intervals. The measured sound level data is separated into integer wind speed "bins" where the sound levels corresponding to each integer wind speed are logarithmically averaged to determine the average sound level when the wind turbine is operational and when it is parked. The ambient L_{EQ} (turbine parked) is logarithmically subtracted from the overall L_{EQ} (turbine operational) to determine the sound level contribution of the wind turbine alone. Supplementary data including wind speed at turbine hub height, wind speed at noise measurement height, turbine electrical power output, turbine yaw position, temperature, humidity, and statistical noise indices (Ln) can also be measured during the monitoring campaign to aid in the analysis.

Part D of the Compliance Protocol requires at least 120 one-minute intervals be measured for each 10 m height wind speed between 4 and 7 m/s when the turbine is operating and at least 60 one-minute intervals be measured for each 10 m height wind speed between 4 and 7 m/s when the turbine is parked. Prior to determining the number of data points measured in each wind speed bin, the data is filtered to only include night-time hours (between 22:00 and 05:00) and data outside of rainfall (no rain within one hour of the measurement interval). Data is also filtered to only include periods where the turbine is operating at greater or equal to 85% of its rated electrical power output and at least 90% of its maximum sound power, and the turbine yaw position is +/-45 degrees from the line of sight between the turbine and the measurement location (measurement location is downwind). In consultation with the MOECC, a modified wind direction filter was used for monitoring locations M1 and M2 to minimized sound interference from Lake Huron. A detailed drawing of the modified wind direction criteria can be found in Appendix D.

The ability to collect sufficient data during a measurement campaign is heavily dependent on environmental conditions. For example, data may be difficult to collect if the predominant wind direction during the measurement campaign is different than the direction predicted using the historical wind rose for the area. If the measurement campaign does not yield sufficient data to satisfy the minimum requirements of Part D of the Compliance Protocol, a Revised Assessment Methodology Immission Audit ("RAM I-Audit") can be completed. As described in Part E5.5 of the Compliance Protocol, three wind speed bins between 1 and 7 m/s or two wind speed bins between 1 and 4 m/s are required. With appropriate justification, the number of one-minute intervals required in each bin may be reduced to 60 for turbine operational measurements (ON) and 30 for ambient measurements (OFF). If there is insufficient ambient sound level data (OFF), a value of 30 dBA or data from a lower wind speed bin may be used to represent a wind speed bin.

The Compliance Protocol allows for the removal of individual events to improve the signal to noise ratio. A review of the audio recordings allows for the identification of the dominant noise source within a given one-minute interval, and the subsequent removal of data points that contain interference.

Adjustments to the measured sound levels may be required based on wind turbine tonality, if any. If during the acoustic measurement campaign the project wind turbines exhibit tonal characteristics (a whine, screech, buzz or hum) then an assessment of the tonal audibility is required according to the CAN/CSA publication *Wind Turbine Generator Systems – Part 11: Acoustical Measurement Techniques* [7]. The average tonal audibility correction must be determined for each integer wind speed and the correction added to the final noise contribution of the Wind Project at those wind speeds, in accordance with International Standards Organization *1996-2* [8].

6 TONALITY ASSESSMENT

Based on our site observations and measurements up close to the wind turbine generator there were no tones identified/observed at the turbine or the monitoring locations. Additionally, no tones were identified in the audio recordings of the valid data points used in the analysis.

7 MEASUREMENTS AND RESULTS

Sound level measurements were conducted between March 5 and May 24, 2018. The weather during the monitoring period varied, including several days with rain. Temperatures ranged from -15 to 25°C. Wind speeds at 10 m height ranged from 0 m/s up to 15 m/s. The prevailing wind direction during the measurement campaign was from the southeast and north, inconsistent with the historical wind rose, which shows wind predominantly from the southwest. Figures 2a through 4b show the wind roses for the receptor locations during the ON and OFF conditions.

The sound level summary for data collected at Monitoring Location M1 is shown in Tables 4a and 4b. Data were collected between March 5 and May 24, 2018.

Table 4a: Monitoring Location M1 - Summary of Valid Data Points

	10 m Height Wind Speed [m/s]				
Wind Project Condition	**1**	**2**	**3**	**4**	**5**
Operating (ON)	52[1]	48[1]	140	152	81
Ambient (OFF)	852	425	78	201	82

[1] Less than 60 data points for Operating (ON) Condition

Table 4b: Monitoring Location M1 - Sound Level Summary

	10 m Height Wind Speed [m/s]									
L_{EQ} Sound Level [dBA]	**1**		**2**		**3**		**4**		**5**	
Average Operating (ON) / Std Dev.	-[1]		-[1]		42	1.4	42	1.6	45	1.7
Average Ambient (OFF) / Std Dev.	34	5.7	34	4.0	37	2.4	40	1.8	41	2.0
Wind Project Only	-		-		40		38		42	
Criteria	45.0		45.0		45.0		45.0		45.0	
Excess	-		-		**0**		**0**		**0**	

[1] Less than 60 data points for Operating (ON) Condition

Based on the data presented above and in Figures 5a and 5b, the Wind Project is compliant with the MOECC sound level criteria at Monitoring Location M1.

The sound level summary for data collected at Monitoring Location M2 is shown in Tables 5a and 5b. Data were collected between March 5 and May 24, 2018.

Table 5a: Monitoring Location M2 - Summary of Valid Data Points

	10 m Height Wind Speed [m/s]				
Wind Project Condition	**1**	**2**	**3**	**4**	**5**
Operating (ON)	98	94	45[1]	10[1]	0[1]
Ambient (OFF)	83	47	13[1]	19[1]	146

[1] Less than 60 data points for Operating (ON) Condition or 30 data point for Ambient (OFF) condition

Table 5b: Monitoring Location M2 - Sound Level Summary

	10 m Height Wind Speed [m/s]									
L_{EQ} Sound Level [dBA]	**1**		**2**		**3**		**4**		**5**	
Average Operating (ON) / Std Dev.	38	2.0	37	2.0	-[1]		-[1]		-[1]	
Average Ambient (OFF) / Std Dev.	32	4.5	34	4.0	-[1]		-[1]		41	1.5
Wind Project Only	36		36		-		-		-	
Criteria	45.0		45.0		45.0		45.0		45.0	
Excess	**0**		**0**		-		-		-	

[1] Less than 60 data points for Operating (ON) Condition or 30 data point for Ambient (OFF) condition

Based on the data presented above and in Figures 6a and 6b, the Wind Project is compliant with the MOECC sound level criteria at Monitoring Location M2.

The sound level summary for data collected at Monitoring Location M3 is shown in Tables 6a and 6b. Data were collected between March 5 and May 24, 2018.

Table 6a: Monitoring Location M3 - Summary of Valid Data Points

	10 m Height Wind Speed [m/s]				
Wind Project Condition	**1**	**2**	**3**	**4**	**5**
Operating (ON)	45[1]	205	111	20[1]	2[1]
Ambient (OFF)	536	316	161	55	95

[1] Less than 60 data points for Operating (ON) Condition

Table 6b: Monitoring Location M3 - Sound Level Summary

	10 m Height Wind Speed [m/s]									
L_{EQ} Sound Level [dBA]	**1**		**2**		**3**		**4**		**5**	
Average Operating (ON) / Std Dev.	-[1]		42	1.3	43	1.6	-[1]		-[1]	
Average Ambient (OFF) / Std Dev.	32	4.5	33	4.1	34	3.6	37	3.2	42	2.7
Wind Project Only	-		41		42		-		-	
Criteria	45.0		45.0		45.0		45.0		45.0	
Excess	-		**0**		**0**		-		-	

[1] Less than 60 data points for Operating (ON) Condition

Based on the data presented above and in Figures 7a and 7b, the Wind Project is compliant with the MOECC sound level criteria at Monitoring Location M3.

Appendix E includes a statement from Union Building Corporation of Canada indicating the wind turbine generator was operating normally from March 5 to May 24, 2018.

8 CONCLUSIONS

The measurements and analysis, performed in accordance with the methods prescribed by the Ontario Ministry of the Environment and Climate Change's 2017 publication *Compliance Protocol for Wind Turbine Noise* indicates that the Wind Project is operating in compliance of the MOECC's sound level criteria at the selected monitoring locations.

REFERENCES

1. HGC Engineering, *Acoustic Audit - Immission Report - Unifor Wind Turbine,* January 8, 2018.
2. Jade Acoustics, *Unifor Wind Turbine Noise Abatement Action Plan*, March 18, 2018.
3. M.K. Ince and Associates Ltd., *Environmental Noise Impact Report: Enercon E48 500 kW constrained operation, CAW Clean Wind Energy Project*, March 1, 2012.
4. Ontario Ministry of the Environment and Climate Change, *Compliance Protocol for Wind Turbine Noise Guideline for Acoustic Assessment and Measurement,* April 2017.
5. Ontario Ministry of the Environment and Climate Change Publication, NPC-103, *Procedures.*
6. Ontario Ministry of the Environment and Climate Change Publication, *Noise Guidelines for Wind Farms, Interpretation for Applying MOE NPC Publications to Wind Power Generation Facilities*, October 2008.
7. CAN/CSA-C61400-11:07, *Wind Turbine Generator Systems – Part 11: Acoustical Measurement Techniques*, October, 2007
8. International Standards Organization 1996-2, *Acoustics – Description, assessment and measurement of environmental noise – Part 2: Determination of environmental noise levels*, 2007.
9. Government of Canada, *Canadian Wind Energy Atlas,* Retrieved from http://www.windatlas.ca/nav-en.php?no=24&field=EU&height=30&season=ANU on November 12, 2017

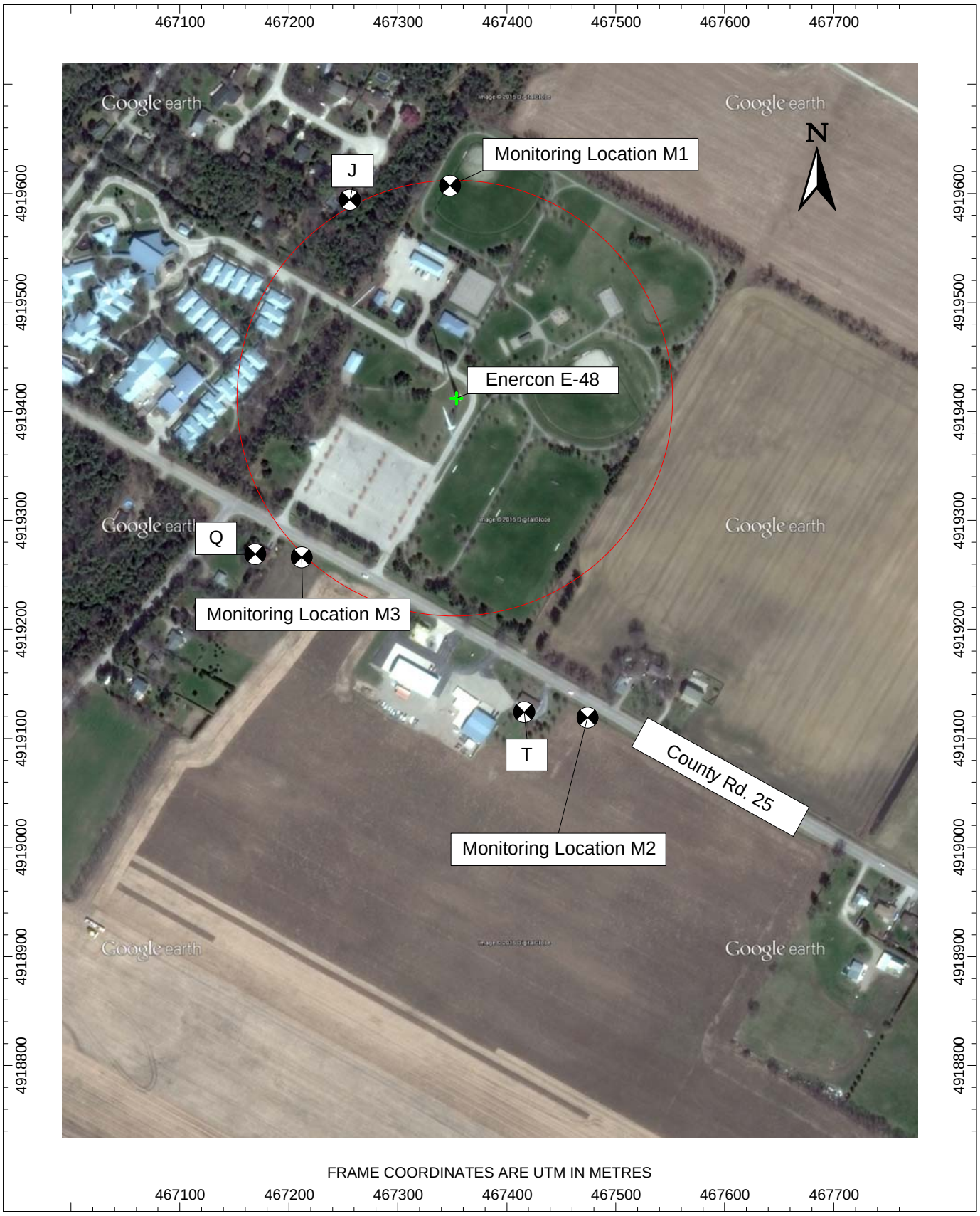


Figure 1: Receptor Monitoring Locations
Unifor Wind Energy Project

Figure 2a: Wind Direction - Unifor Wind Turbine

Monitoring Location M1, 10 m Height, ON Condition - March 5 to May 24, 2018

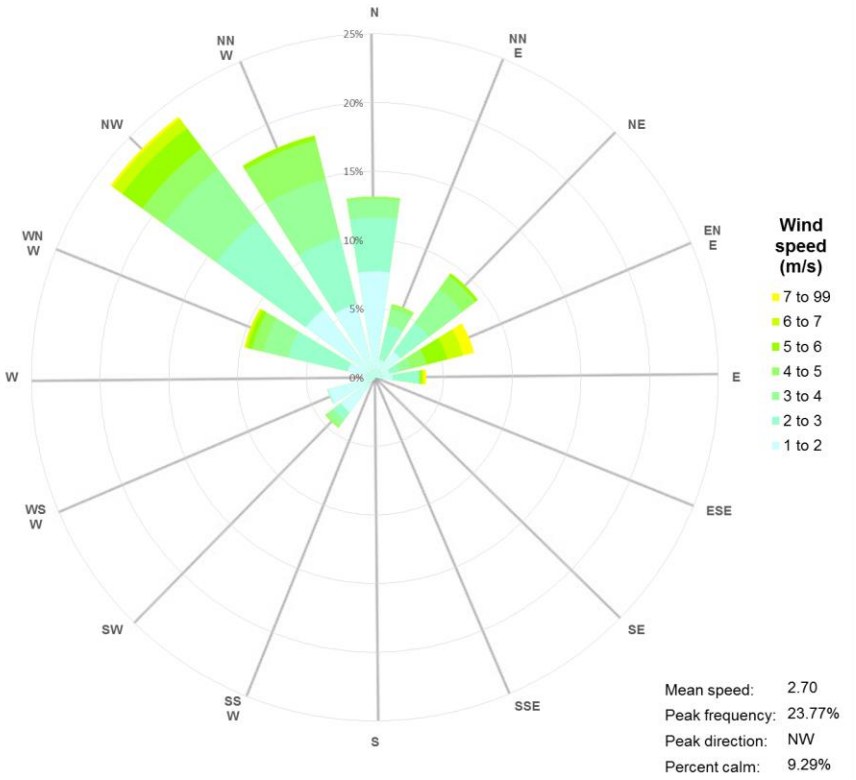


Figure 2b: Wind Direction - Unifor Wind Turbine

Monitoring Location M1, 10 m Height, OFF Condition - March 5 to May 24, 2018

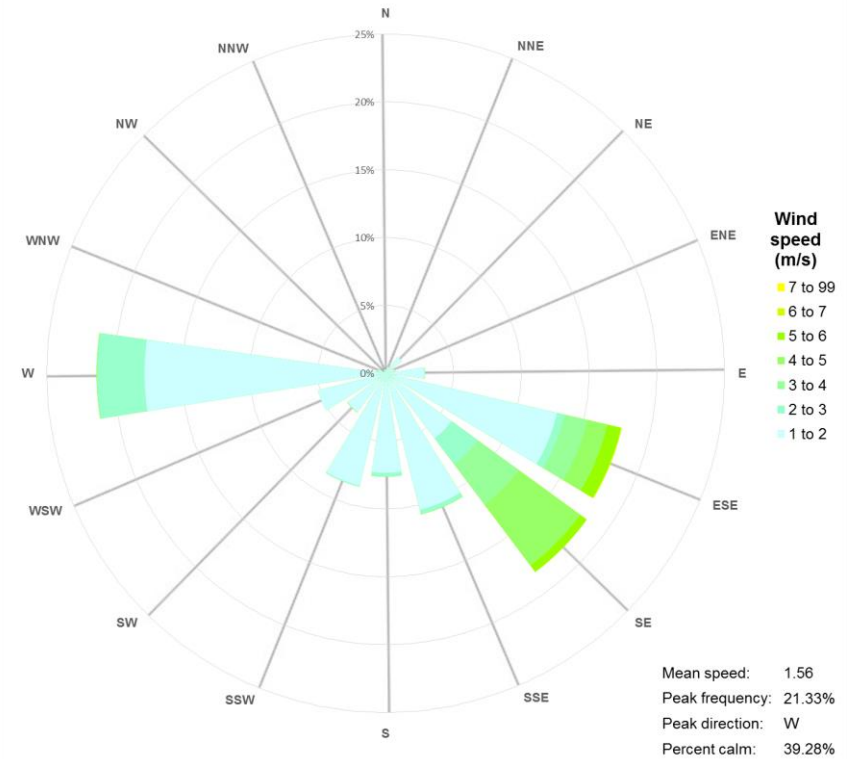


Figure 3a: Wind Direction - Unifor Wind Turbine

Monitoring Location M2, 10 m Height, ON Condition - March 5 to May 24, 2018

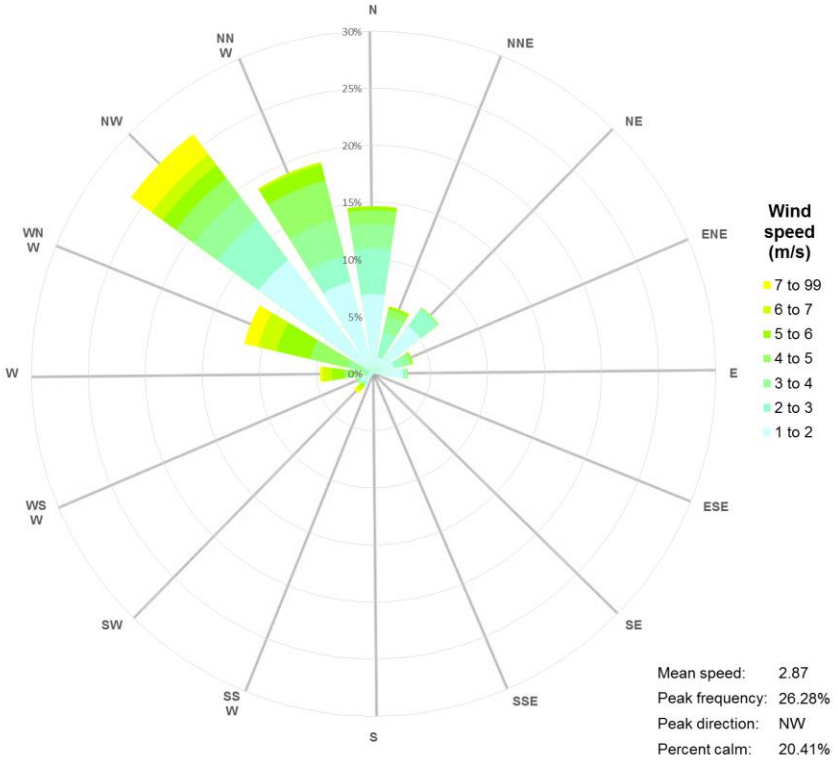


Figure 3b: Wind Direction - Unifor Wind Turbine

Monitoring Location M2, 10 m Height, OFF Condition - March 5 to May 24, 2018

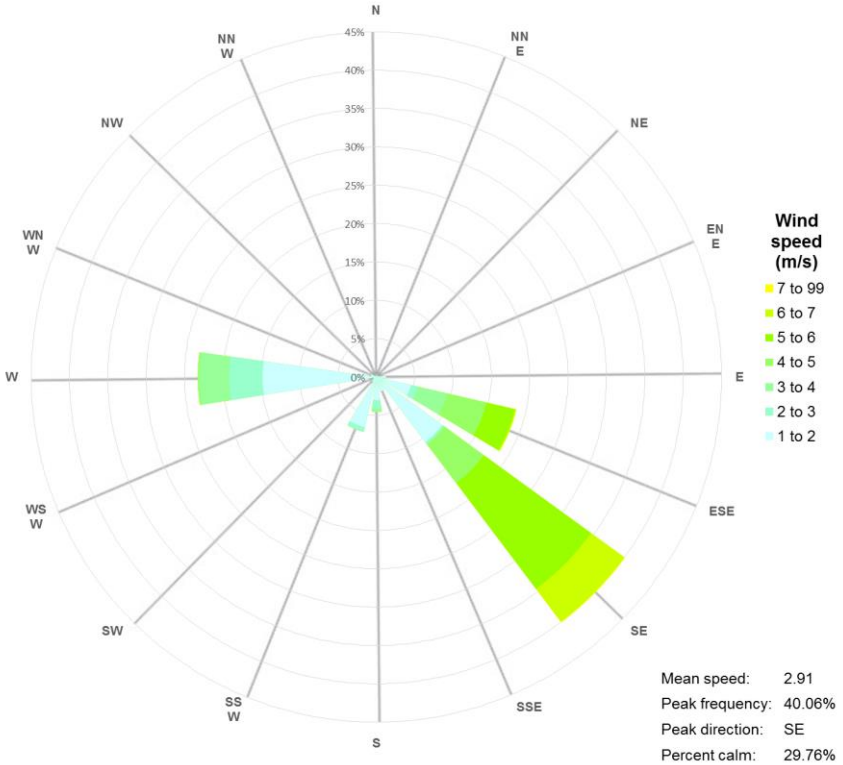


Figure 4a: Wind Direction - Unifor Wind Turbine

Monitoring Location M3, 10 m Height, ON Condition - March 5 to May 24, 2018

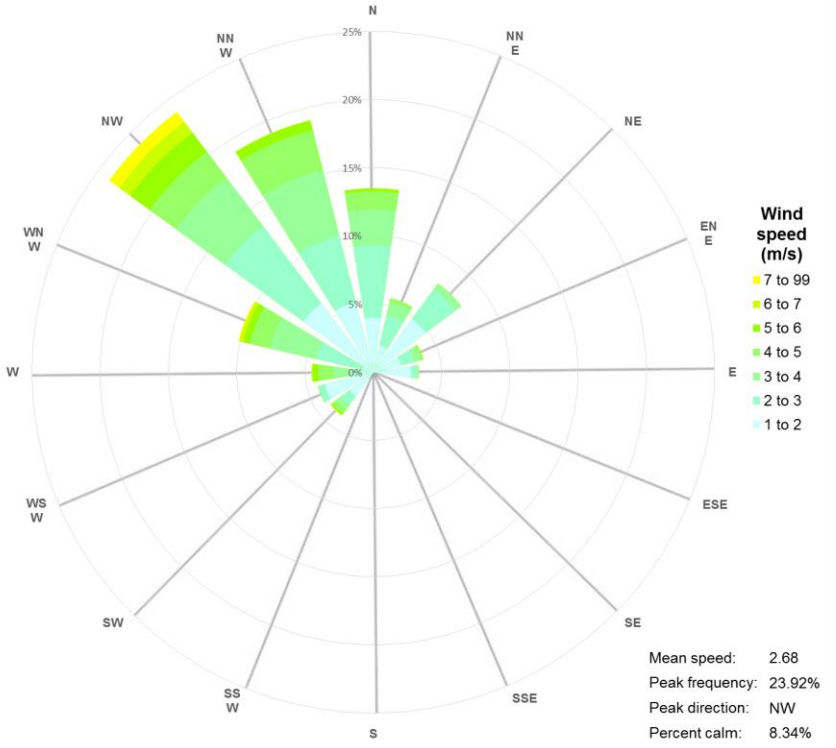


Figure 4b: Wind Direction - Unifor Wind Turbine

Monitoring Location M3, 10 m Height, OFF Condition - March 5 to May 24, 2018

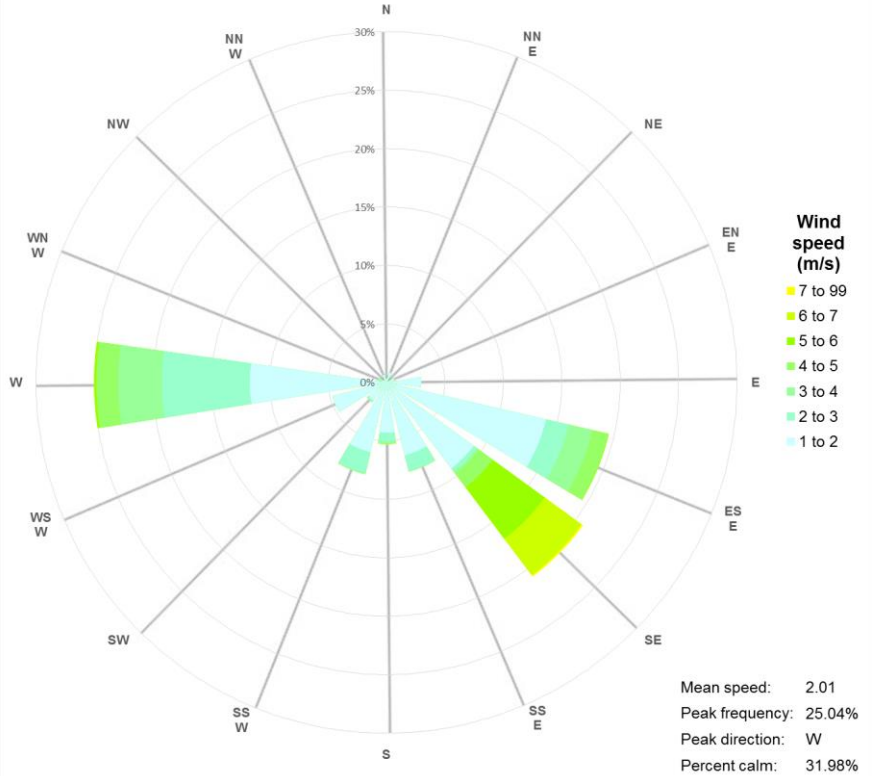


Figure 5a: Unifor Wind Turbine, Immission Results
Monitoring Location M1, March 5 to May 24, 2018

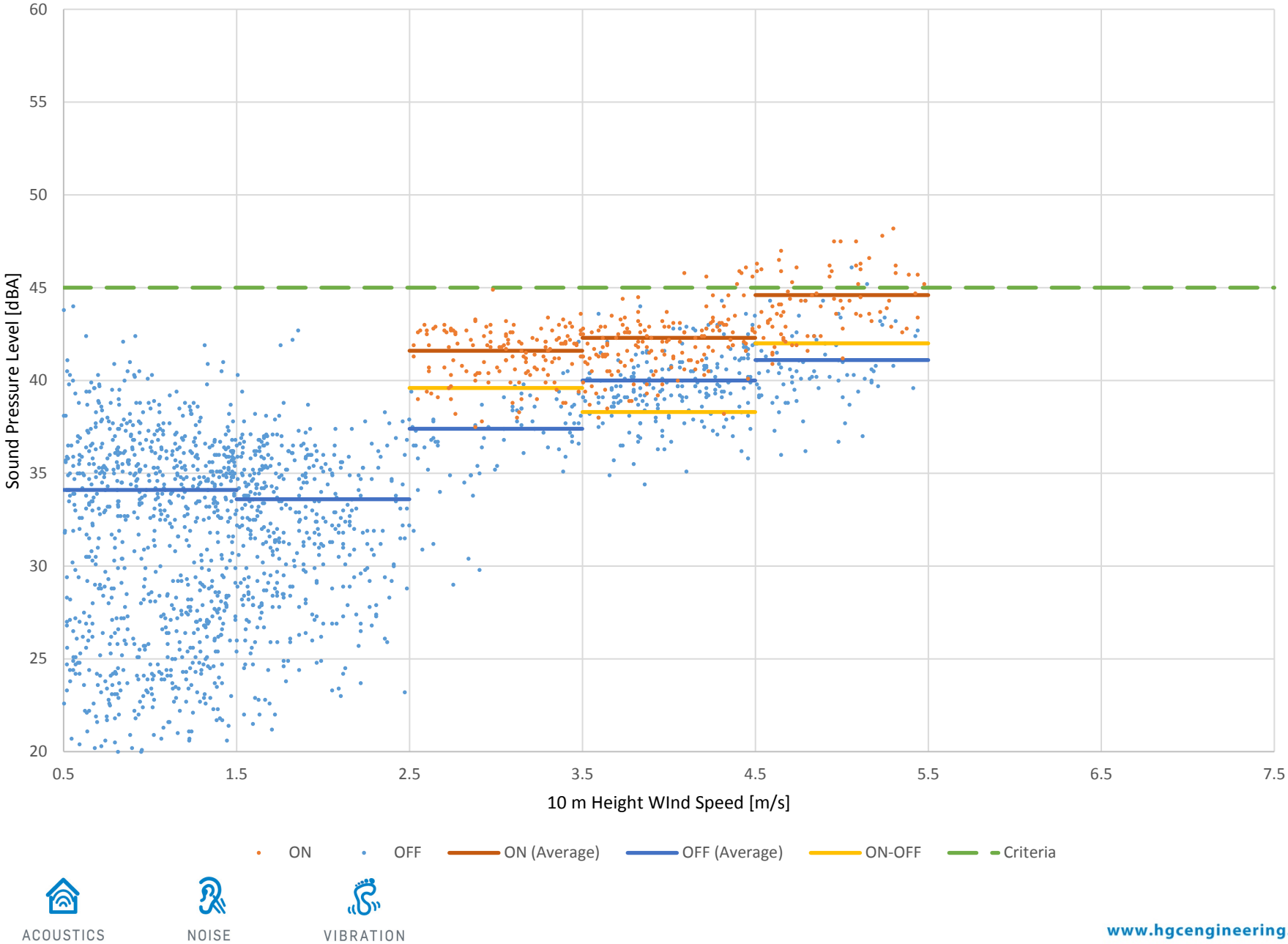


Figure 5b: Unifor Wind Turbine, Immission Results
Monitoring Location M1, March 5 to May 24, 2018

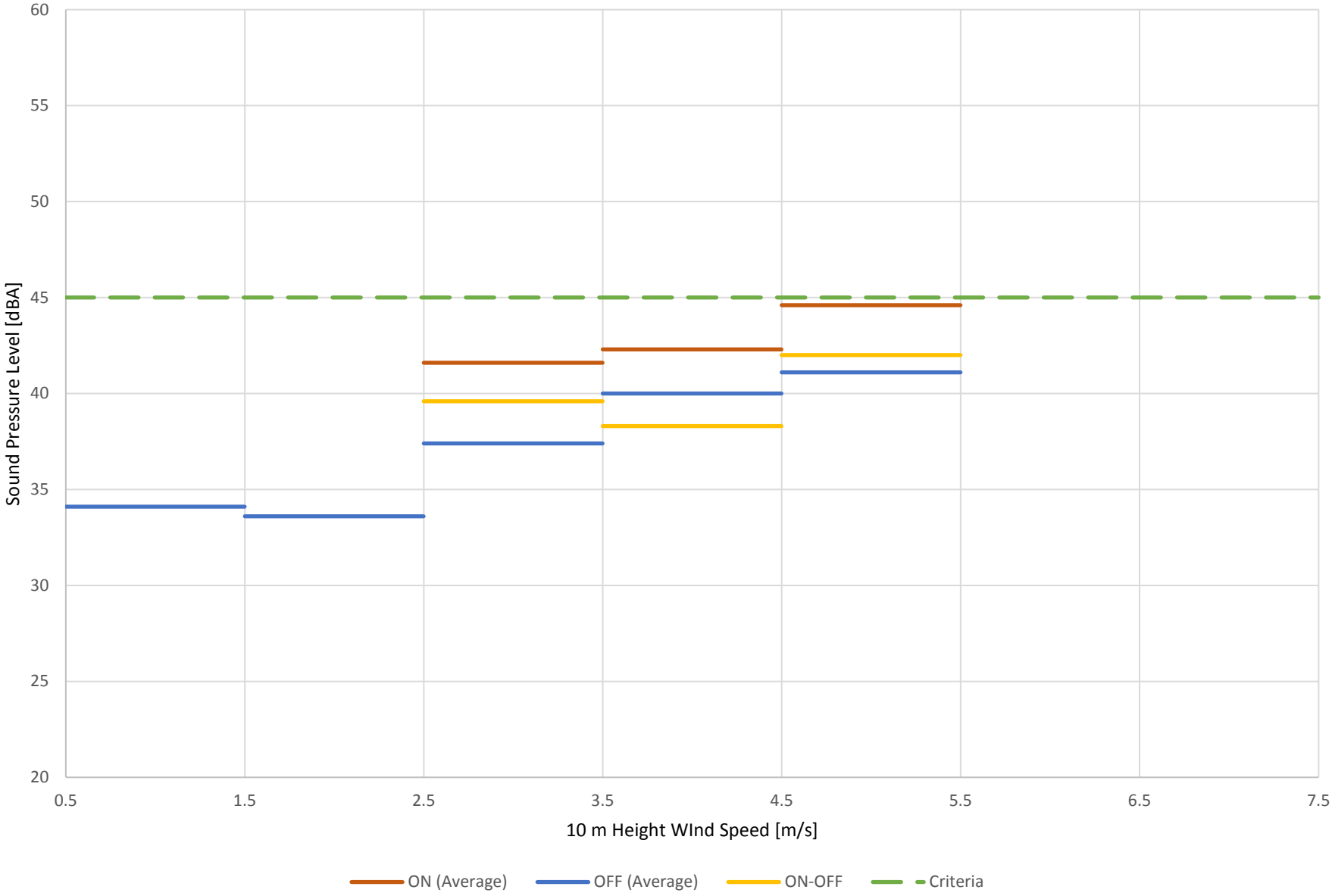


Figure 6a: Unifor Wind Turbine, Immission Results
Monitoring Location M2, March 5 to May 24, 2018

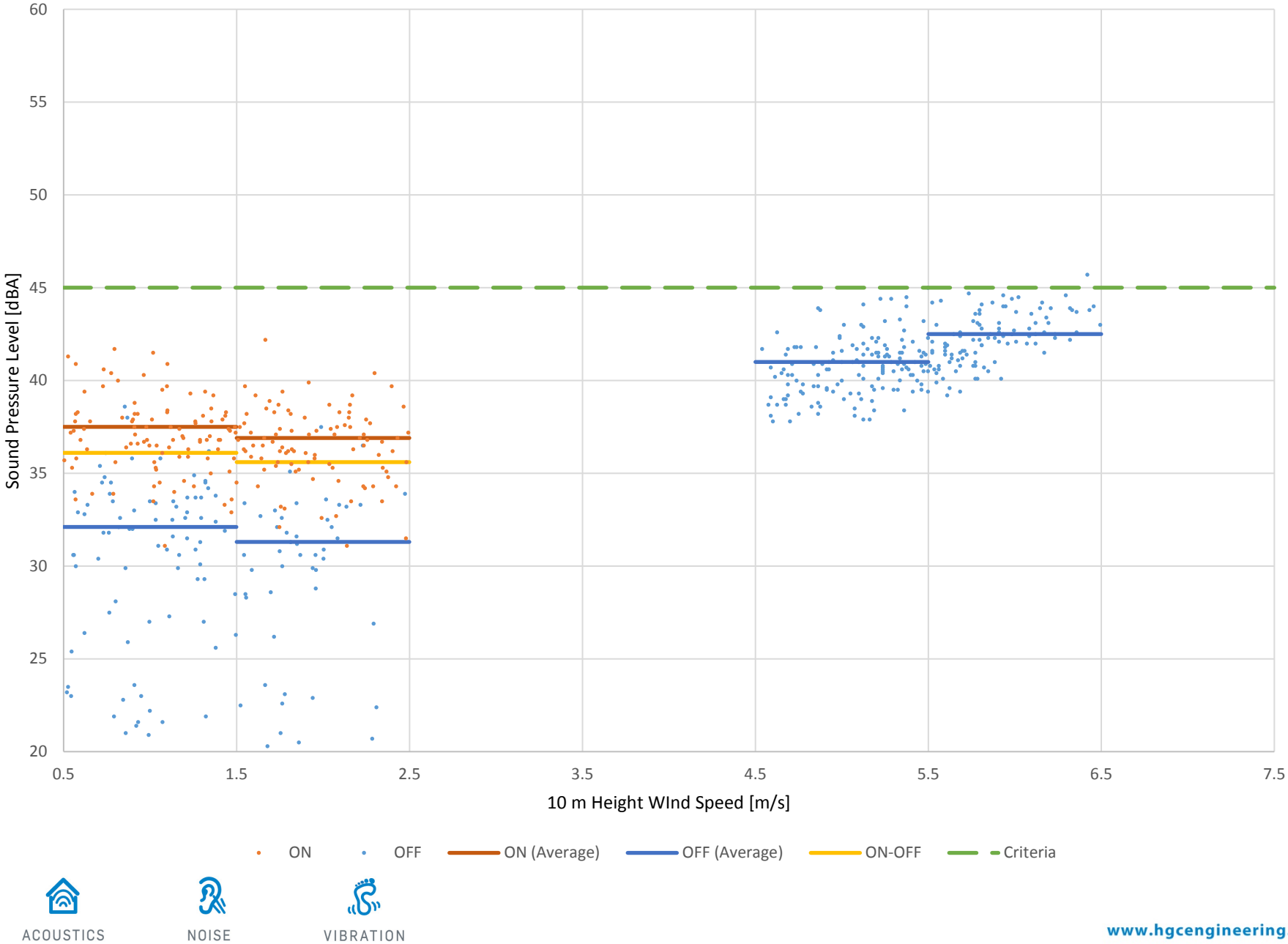


Figure 6b: Unifor Wind Turbine, Immission Results
Monitoring Location M2, March 5 to May 24, 2018

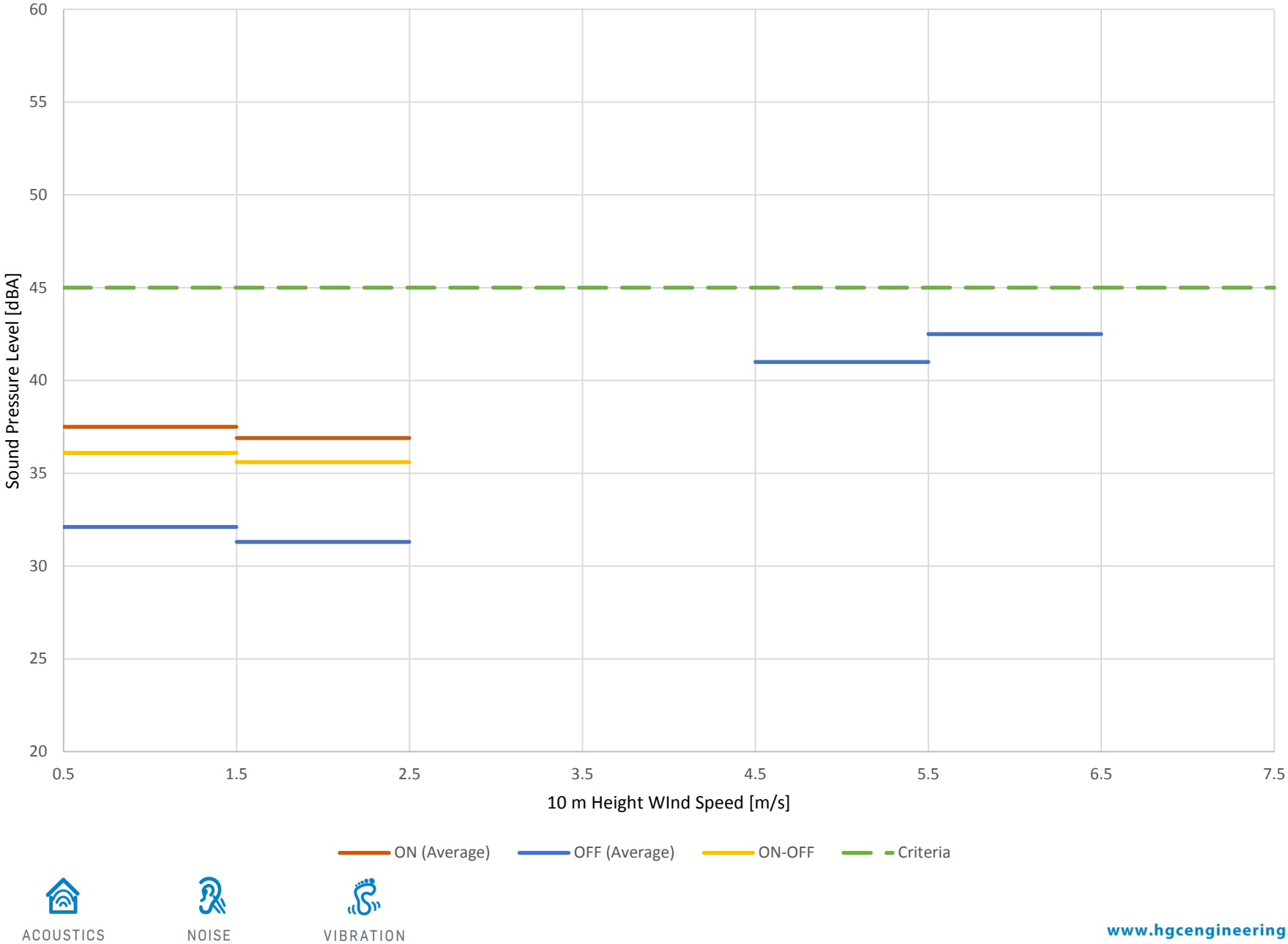


Figure 7a: Unifor Wind Turbine, Immission Results
Monitoring Location M3, March 5 to May 24, 2018

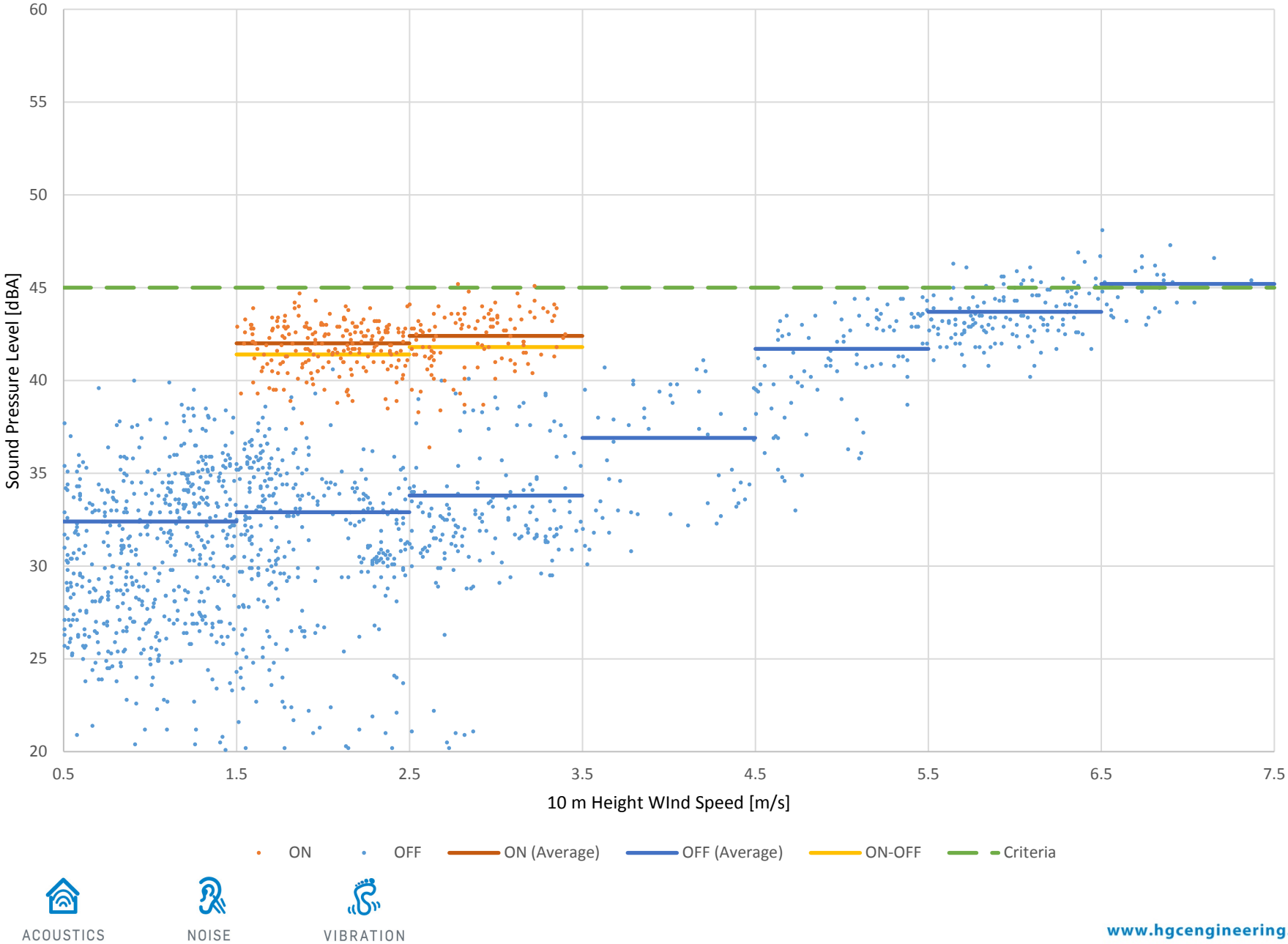
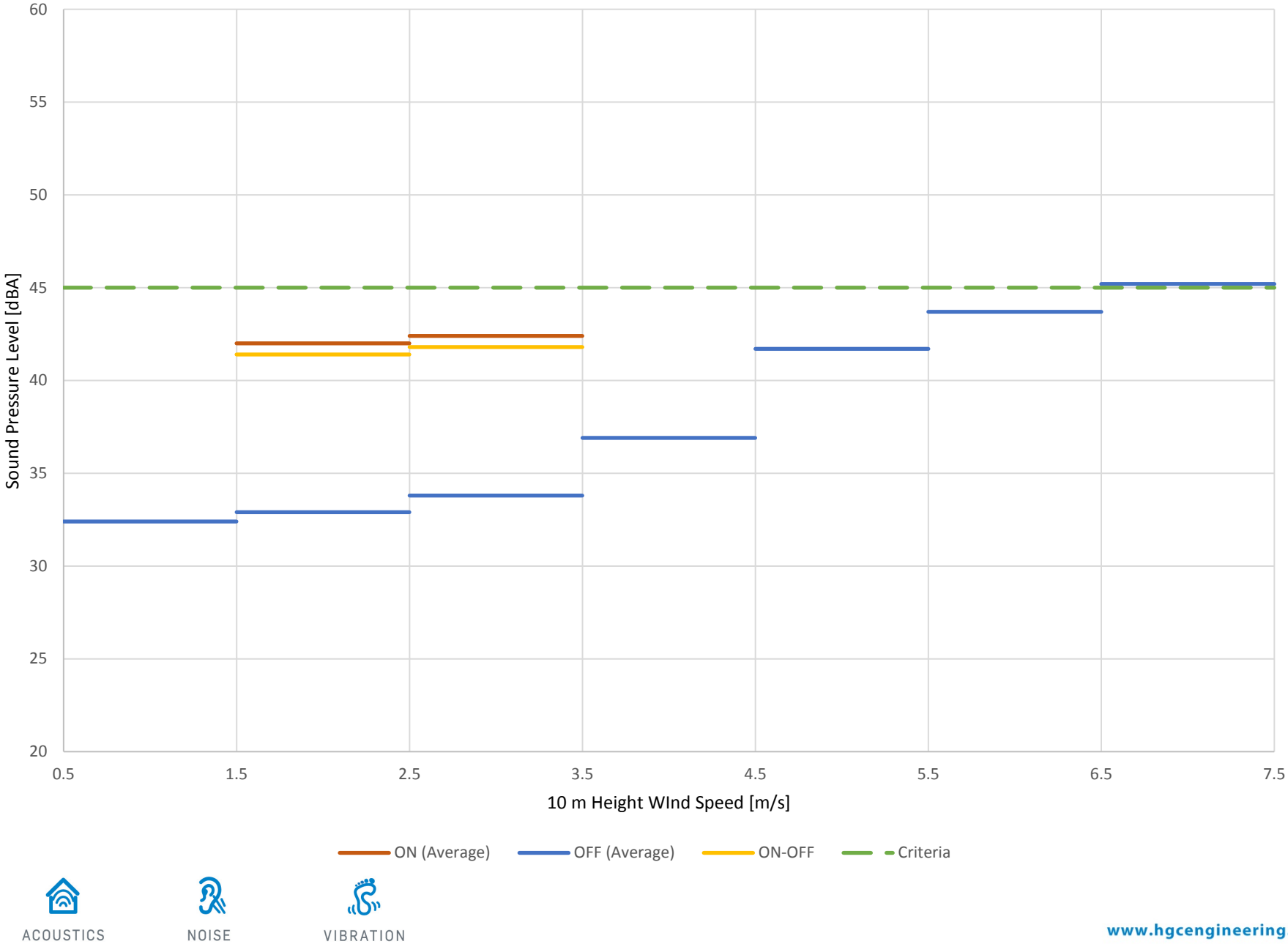


Figure 7b: Unifor Wind Turbine, Immission Results
Monitoring Location M3, March 5 to May 24, 2018



APPENDIX A:
MONITORING LOCATION SELECTION

Figure A1: Annual Wind Rose [9]

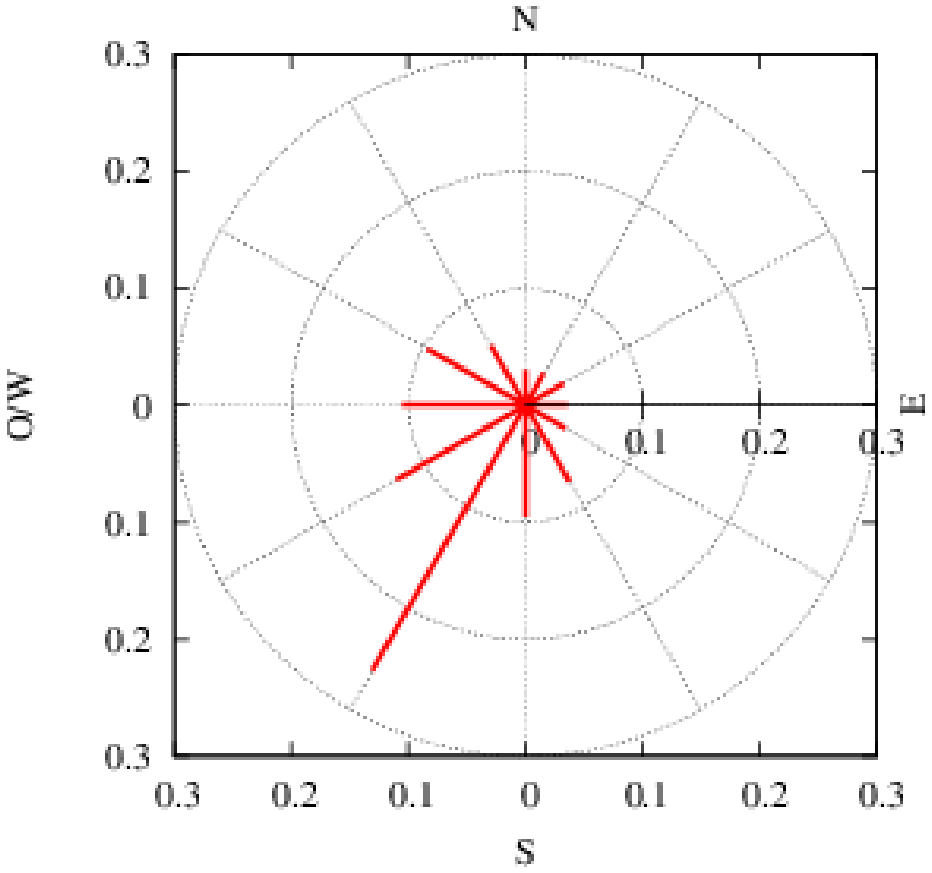


Figure A2: Map of Nearby Noise-Sensitive Receptors [3]

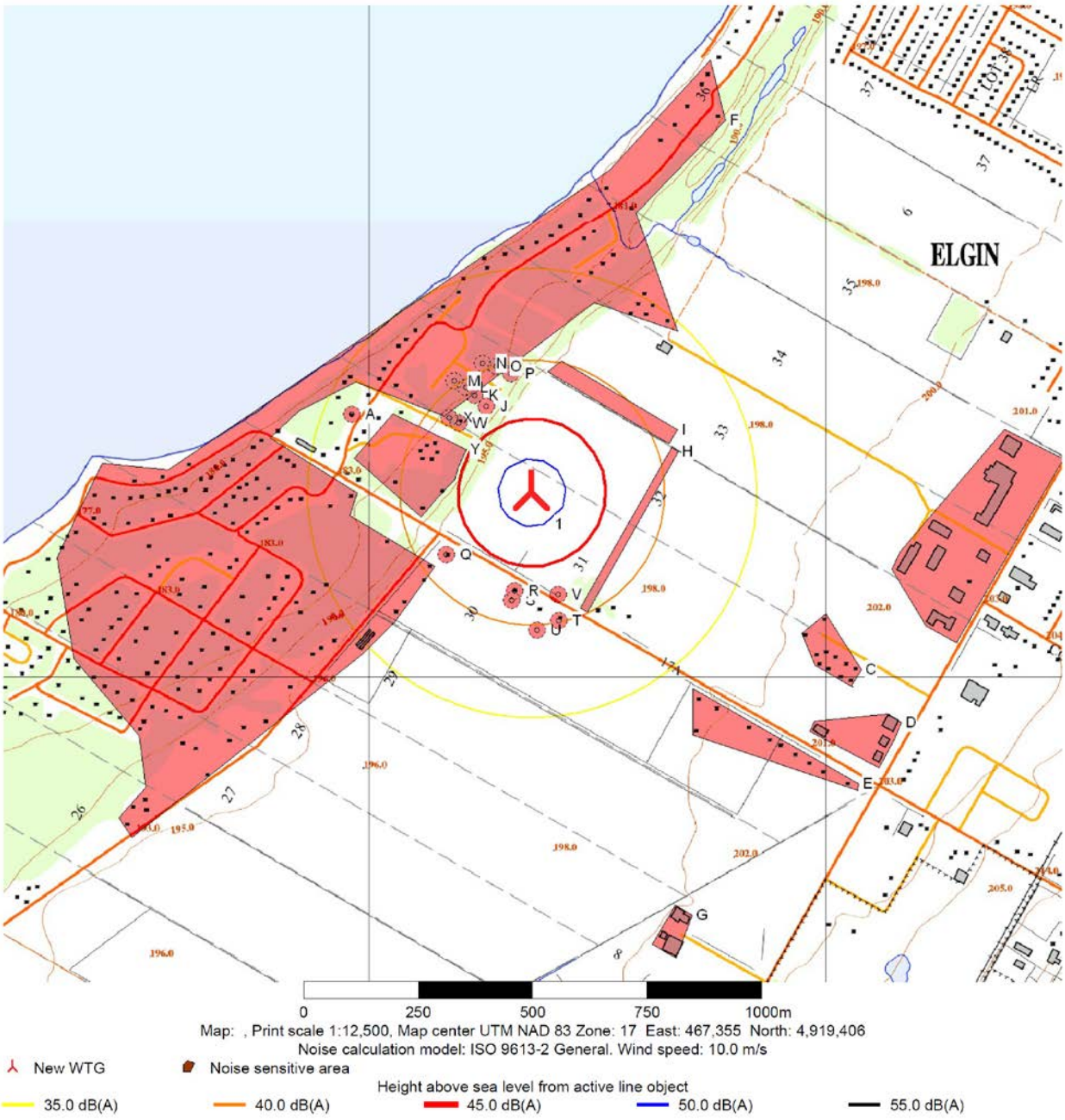


Table A1: Potential Receptor Locations

ID	Distance to Turbine T1 [m]	Predicted Sound Pressure Level [dBA] [1]	Comments
J	213	42.7	Selected Receptor
M1	194	40.0*	Monitoring Location
W	219	42.4	Monitoring Location M1 is representative
H	218	42.6	Permission Not Granted
R	219	42.5	Permission Not Granted
Q	231	42	Selected Receptor
M3	233	40.2*	Monitoring Location
V	232	42	Unsuitable Location
X	242	41.5	Monitoring Location M1 is Representative
I	246	41.5	Unsuitable Location
K	246	41.4	Monitoring Location M1 is Representative
S	242	41.7	Permission Not Granted
F	248	41.3	Monitoring Location M1 is Representative
P	263	40.8	Monitoring Location M1 is Representative
L	270	40.5	Monitoring Location M1 is Representative
O	285	40.1	Monitoring Location M1 is Representative
T	289	40.1	Selected Receptor
M2	292	35.2*	Monitoring Location

[1] Sound levels taken from ENIR [3], using 500 kW reduced mode.
* Sound level predicted by acoustic model prepared by HGC Engineering, using 300 kW reduced mode.

APPENDIX B:

MONITORING LOCATION PHOTOS

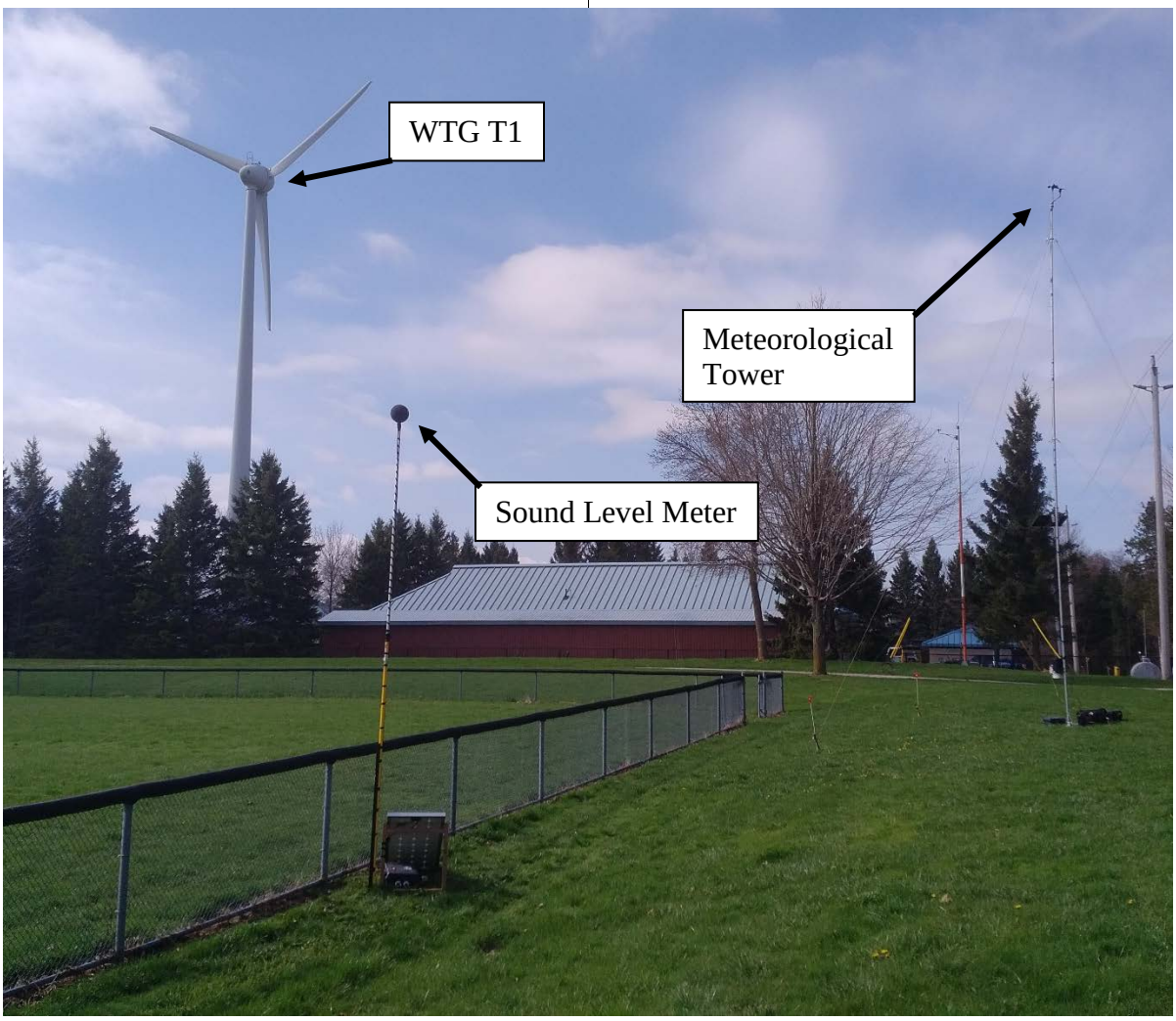


Photo of Meteorological Tower and Sound Level Meter at Location M1 (looking southwest)

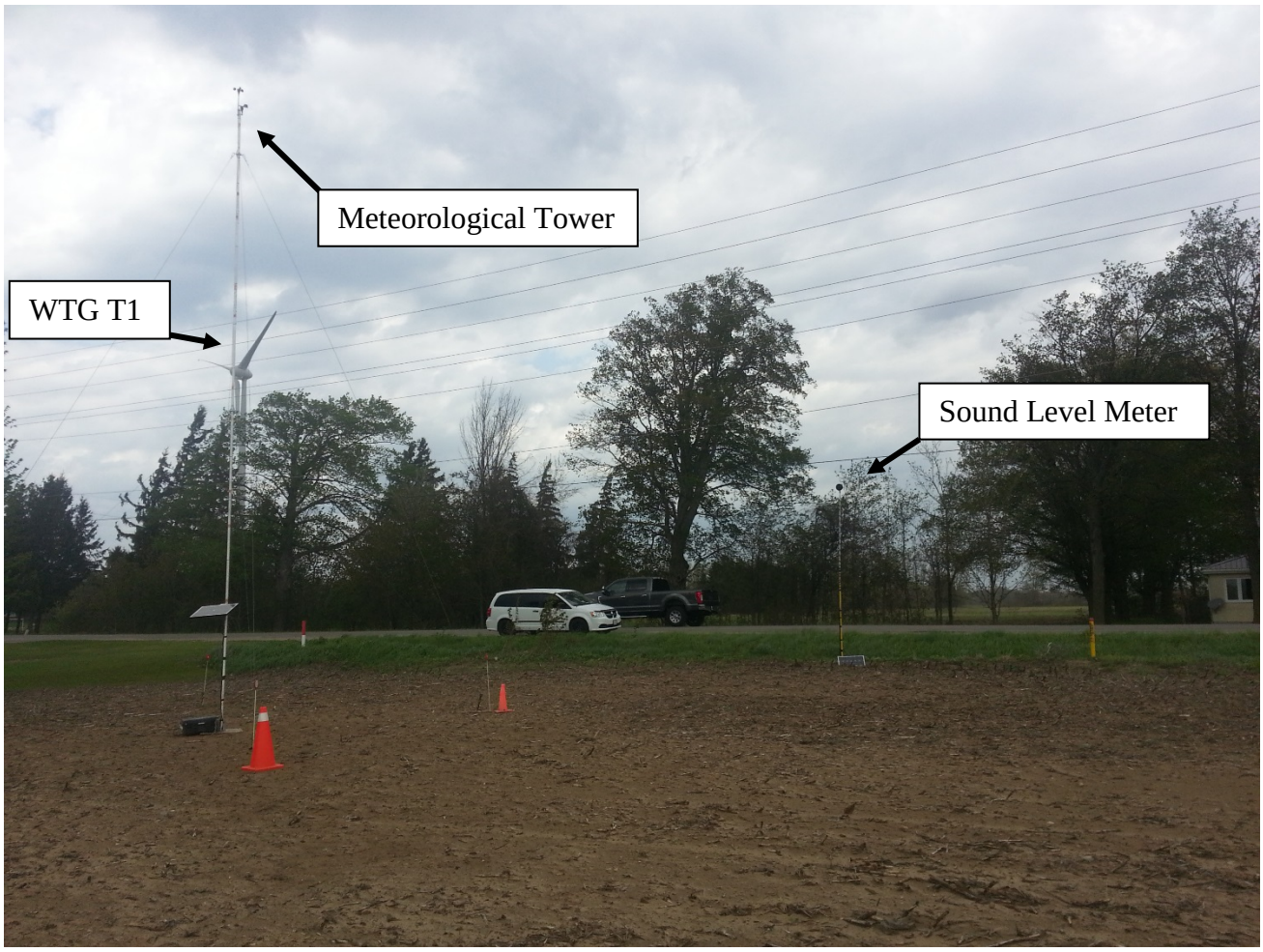


Photo of Meteorological Tower and Sound Level Meter at Location M2 (looking northeast)

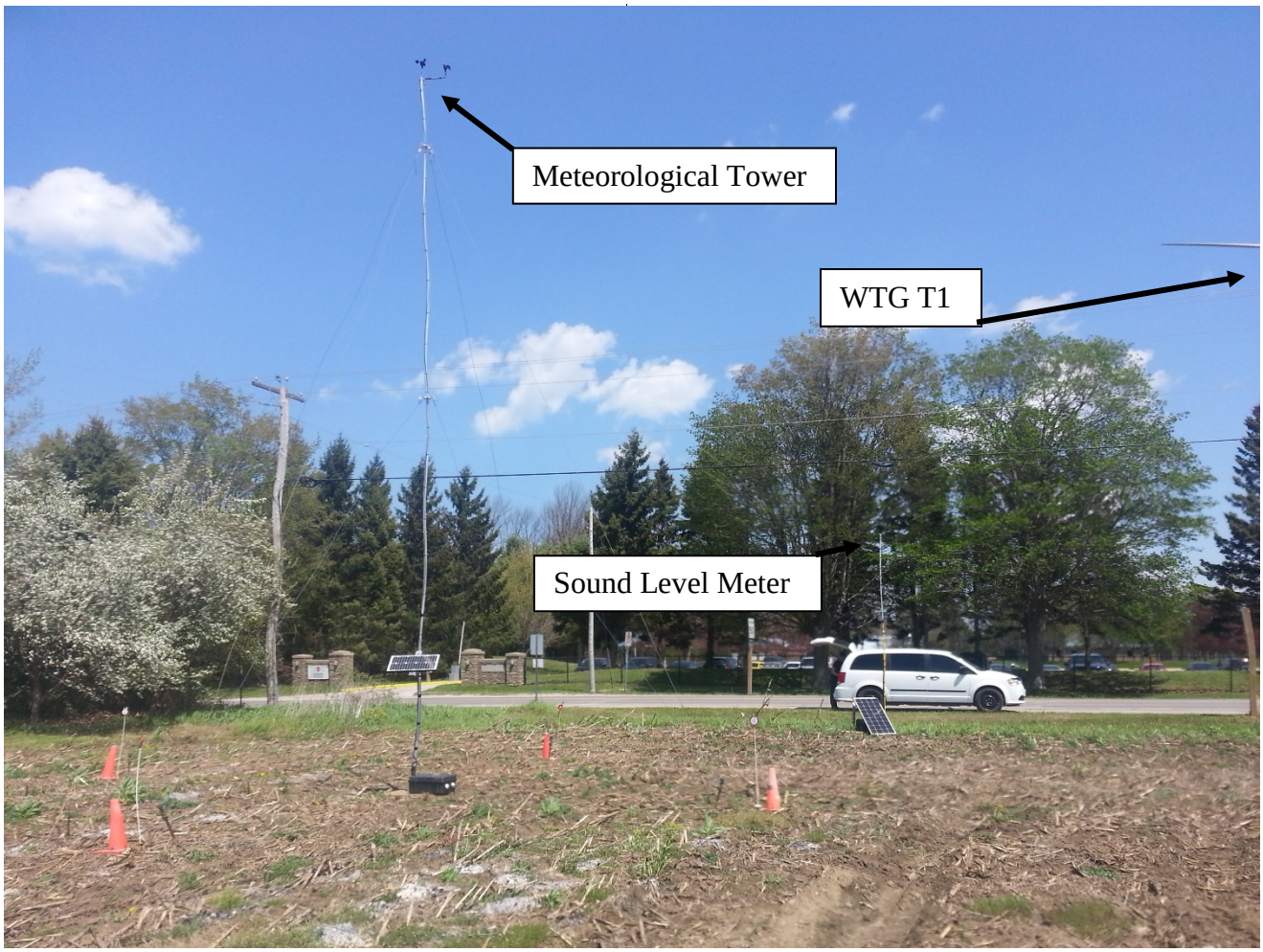


Photo of Meteorological Tower and Sound Level Meter at Location M3 (looking north)

APPENDIX C:
CALIBRATION CERTIFICATES

CERTIFICATE of CALIBRATION

Make : Svantek

Model : SVAN977

Descr. : Sound Level Meter Type 1

Serial # : 36439

Asset # : SV977-4

Reference # : 151324

Customer : HGC Engineering
Mississauga, ON

P. Order : NG

16 Jan 2018

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 15, 2018

Cal. Due : Jan 15, 2019

By : T. Beilin

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

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

Navair Technologies

REPAIR AND CALIBRATION TRACEABLE TO NRC AND NIST

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

CERTIFICATE of CALIBRATION

Make : Svantek

Model : SVAN977

Descr. : Sound Level Meter Type 1

Serial # : 36428

Asset # : SV977-3

Reference # : 151329

Customer : HGC Engineering
Mississauga, ON

P. Order : N6
16 Jan 2018

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 15, 2018

Cal. Due : Jan 15, 2019

By : T. Beilin

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

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

Navair Technologies

REPAIR AND CALIBRATION TRACEABLE TO NRC AND NIST

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

CERTIFICATE of CALIBRATION

Make : Svantek

Model : SVAN977

Descr. : Sound Level Meter Type 1

Serial # : 36426

Asset # : SV977-2

Reference # : 151326

Customer : HGC Engineering
Mississauga, ON

P. Order : 76
16 Jan 2018

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 15, 2018

By : T. Beilin

Cal. Due : Jan 15, 2019

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

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

Navair Technologies

REPAIR AND CALIBRATION TRACEABLE TO NRC AND NIST

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

SOH Wind Engineering LLC
141 Leroy Road · Williston, VT 05495 · USA
Tel 802.316.4368 · Fax 802.735.9106 · www.sohwind.com

CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

NRG 11
N6
8 Jan 2018

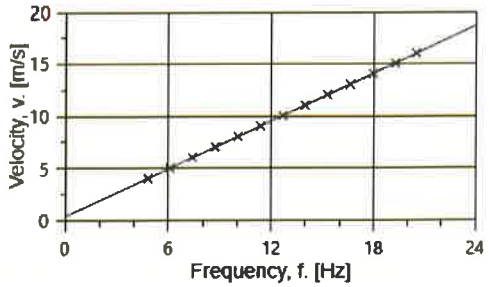
Certificate number: 18.US2.00837 **Date of issue:** January 25, 2018
Type: NRG 40C Anemometer **Serial number:** 179500262926
Manufacturer: NRG Systems Inc, 110 Riggs Road, Hinesburg, VT 05461, USA
Client: HGC Engineering, 2000 Argentia Road, Plaza One, Suite 203, Mississauga, ON L5N 1P7, Canada
Anemometer received: January 19, 2018 **Anemometer calibrated:** January 23, 2018
Calibrated by: MEJ **Procedure:** MEASNET, IEC 61400-12-1:2017 Annex F
Certificate prepared by: EJF **Approved by:** Calibration engineer, EJF

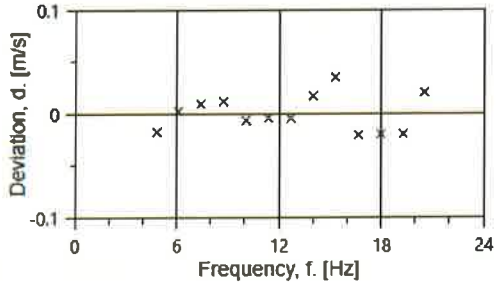
Eric Jeffcott

Calibration equation obtained: v [m/s] = 0.76360 · f [Hz] + 0.34642

Standard uncertainty, slope: 0.00137 **Standard uncertainty, offset:** 0.04097
Covariance: -0.0000138 (m/s)²/Hz **Coefficient of correlation:** ρ = 0.999990
Absolute maximum deviation: 0.035 m/s at 12.044 m/s
Barometric pressure: 992.9 hPa **Relative humidity:** 17.1%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	Temperature in d.p. box [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.38	20.7	25.7	3.994	4.8006	-0.018	0.024
4	14.69	20.7	25.7	5.000	6.0908	0.002	0.025
6	21.18	20.8	25.7	6.003	7.3958	0.009	0.027
8	28.90	20.8	25.7	7.014	8.7162	0.012	0.030
10	37.73	20.8	25.7	8.015	10.0510	-0.007	0.033
12	47.81	20.8	25.7	9.022	11.3673	-0.004	0.036
13-last	59.05	20.8	25.7	10.027	12.6836	-0.005	0.039
11	71.49	20.8	25.7	11.032	13.9724	0.017	0.042
9	85.20	20.8	25.7	12.044	15.2729	0.035	0.045
7	99.66	20.8	25.7	13.026	16.6320	-0.021	0.048
5	116.08	20.7	25.7	14.057	17.9817	-0.020	0.051
3	132.84	20.7	25.7	15.037	19.2645	-0.020	0.054
1-first	150.83	20.6	25.7	16.020	20.4996	0.020	0.057





AC-1746

SOH Wind Engineering LLC
141 Leroy Road · Williston, VT 05495 · USA
Tel 802.316.4368 · Fax 802.735.9106 · www.sohwind.com

NRG 12
NG 30 Jan 2018

CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

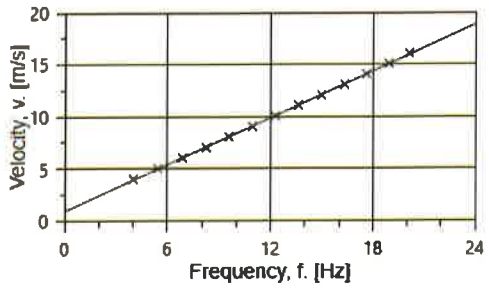
Certificate number: 18.US2.00838 **Date of issue:** January 25, 2018
Type: NRG 40C Anemometer **Serial number:** 179500262946
Manufacturer: NRG Systems Inc, 110 Riggs Road, Hinesburg, VT 05461, USA
Client: HGC Engineering, 2000 Argentia Road, Plaza One, Suite 203, Mississauga, ON L5N 1P7, Canada
Anemometer received: January 19, 2018 **Anemometer calibrated:** January 23, 2018
Calibrated by: MEJ **Procedure:** MEASNET, IEC 61400-12-1:2017 Annex F
Certificate prepared by: EJF **Approved by:** Calibration engineer, EJF

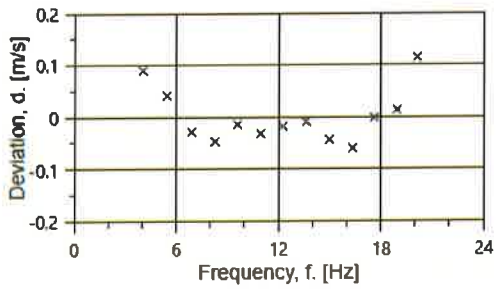
Eric Jeffrey

Calibration equation obtained: $v\,[m/s] = 0.74720 \cdot f\,[Hz] + 0.88867$

Standard uncertainty, slope: 0.00405 **Standard uncertainty, offset:** 0.04506
Covariance: -0.0001122 $(m/s)^2/Hz$ **Coefficient of correlation:** $\rho = 0.999910$
Absolute maximum deviation: 0.114 m/s at 16.027 m/s
Barometric pressure: 992.5 hPa **Relative humidity:** 17.0%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	d.p. box [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.37	21.0	25.7	3.995	4.0382	0.089	0.024
4	14.64	21.1	25.7	4.994	5.4391	0.041	0.025
6	21.11	21.1	25.7	5.997	6.8757	-0.029	0.027
8	28.78	21.1	25.7	7.004	8.2478	-0.047	0.030
10	37.78	21.1	25.7	8.025	9.5707	-0.015	0.033
12	47.78	21.1	25.7	9.026	10.9333	-0.032	0.036
13-last	59.01	21.1	25.7	10.031	12.2603	-0.018	0.039
11	71.66	21.1	25.7	11.054	13.6165	-0.009	0.042
9	84.82	21.1	25.7	12.025	14.9637	-0.044	0.045
7	99.53	21.1	25.7	13.026	16.3247	-0.061	0.048
5	115.73	21.1	25.7	14.045	17.6103	-0.002	0.051
3	132.88	21.0	25.7	15.049	18.9338	0.013	0.054
1-first	150.76	20.9	25.7	16.027	20.1077	0.114	0.057





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NRG 13
NG
30 Jan 2018

CERTIFICATE FOR CALIBRATION OF CUP ANEMOMETER

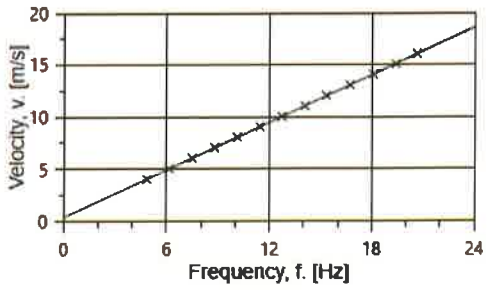
Certificate number: 18.US2.00840 **Date of issue:** January 25, 2018
Type: NRG 40C Anemometer **Serial number:** 179500265230
Manufacturer: NRG Systems Inc, 110 Riggs Road, Hinesburg, VT 05461, USA
Client: HGC Engineering, 2000 Argentia Road, Plaza One, Suite 203, Mississauga, ON L5N 1P7, Canada
Anemometer received: January 19, 2018 **Anemometer calibrated:** January 23, 2018
Calibrated by: MEJ **Procedure:** MEASNET, IEC 61400-12-1:2017 Annex F
Certificate prepared by: EJF **Approved by:** Calibration engineer, EJF

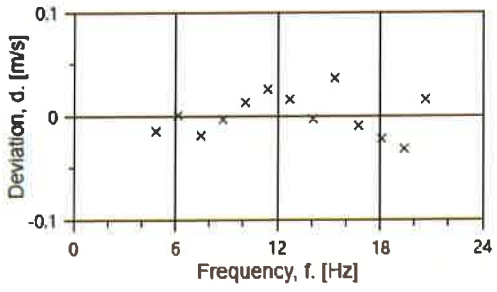
Eric Jeffcott

Calibration equation obtained: v [m/s] = 0.76049 · f [Hz] + 0.31991

Standard uncertainty, slope: 0.00155 **Standard uncertainty, offset:** 0.05025
Covariance: -0.0000176 (m/s)²/Hz **Coefficient of correlation:** ρ = 0.999987
Absolute maximum deviation: 0.036 m/s at 12.021 m/s
Barometric pressure: 991.5 hPa **Relative humidity:** 16.9%

Succession	Velocity pressure, q. [Pa]	Temperature in wind tunnel [°C]	d.p. box [°C]	Wind velocity, v. [m/s]	Frequency, f. [Hz]	Deviation, d. [m/s]	Uncertainty u_c (k=2) [m/s]
2	9.33	21.6	25.8	3.992	4.8481	-0.015	0.024
4	14.61	21.6	25.8	4.998	6.1507	0.000	0.025
6	21.06	21.6	25.8	6.000	7.4939	-0.019	0.027
8	28.72	21.7	25.8	7.007	8.7973	-0.004	0.030
10	37.63	21.7	25.8	8.021	10.1098	0.013	0.033
12	47.71	21.7	25.8	9.032	11.4232	0.025	0.036
13-last	58.59	21.7	25.8	10.009	12.7205	0.016	0.039
11	70.99	21.7	25.8	11.018	14.0710	-0.003	0.042
9	84.50	21.7	25.8	12.021	15.3385	0.036	0.045
7	99.29	21.6	25.8	13.030	16.7259	-0.010	0.048
5	115.45	21.6	25.8	14.051	18.0846	-0.022	0.051
3	132.30	21.6	25.8	15.040	19.3983	-0.032	0.054
1-first	150.21	21.5	25.8	16.024	20.6302	0.015	0.057





AC-1746

APPENDIX D:

MODIFIED WIND DIRECTION CRITERIA FOR MONITORING LOCATIONS M1 and M2

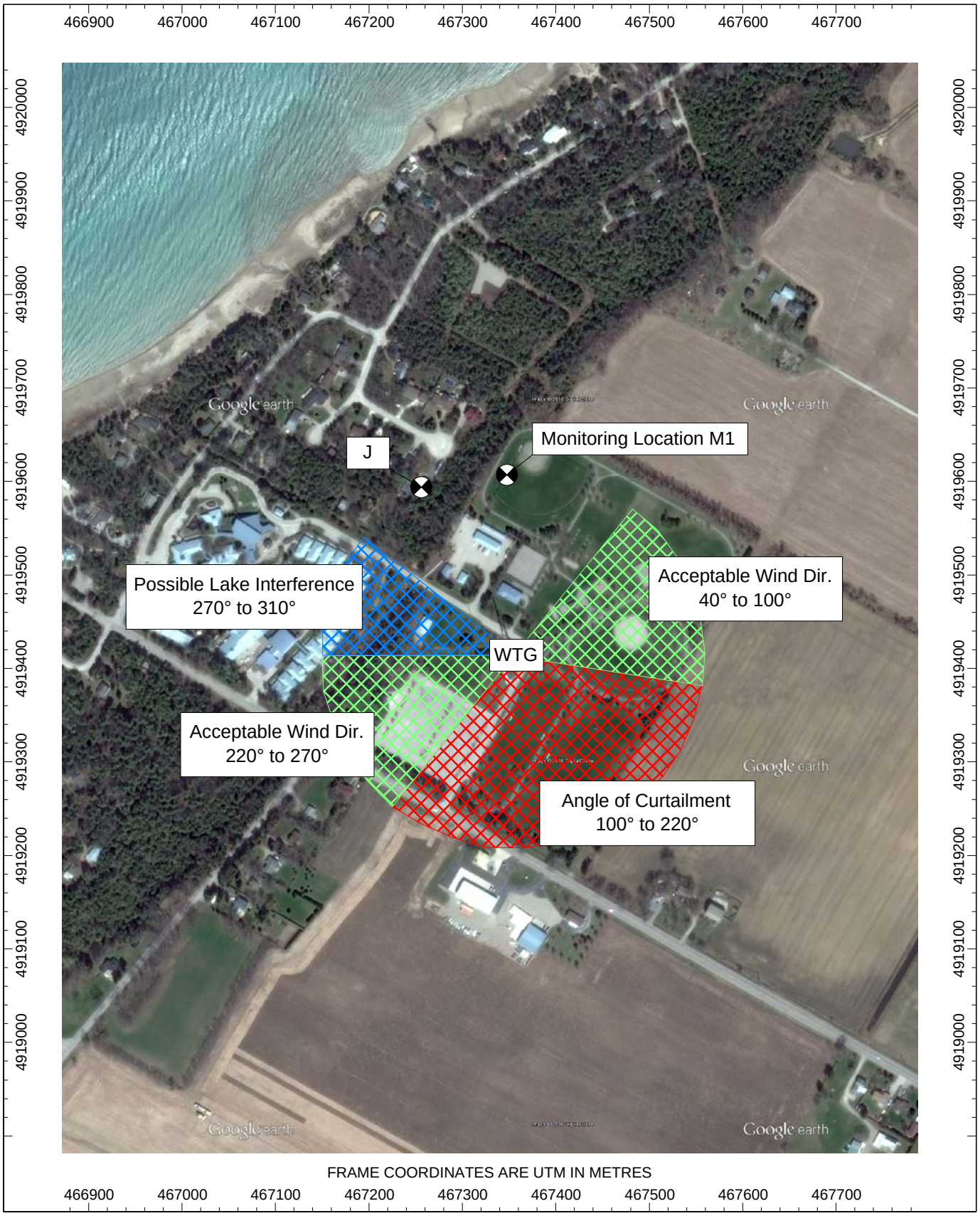


Figure D1 - Modified Wind Direction Filter - Monitoring Location M1
Unifor Wind Turbine - Spring 2018 Monitoring Campaign

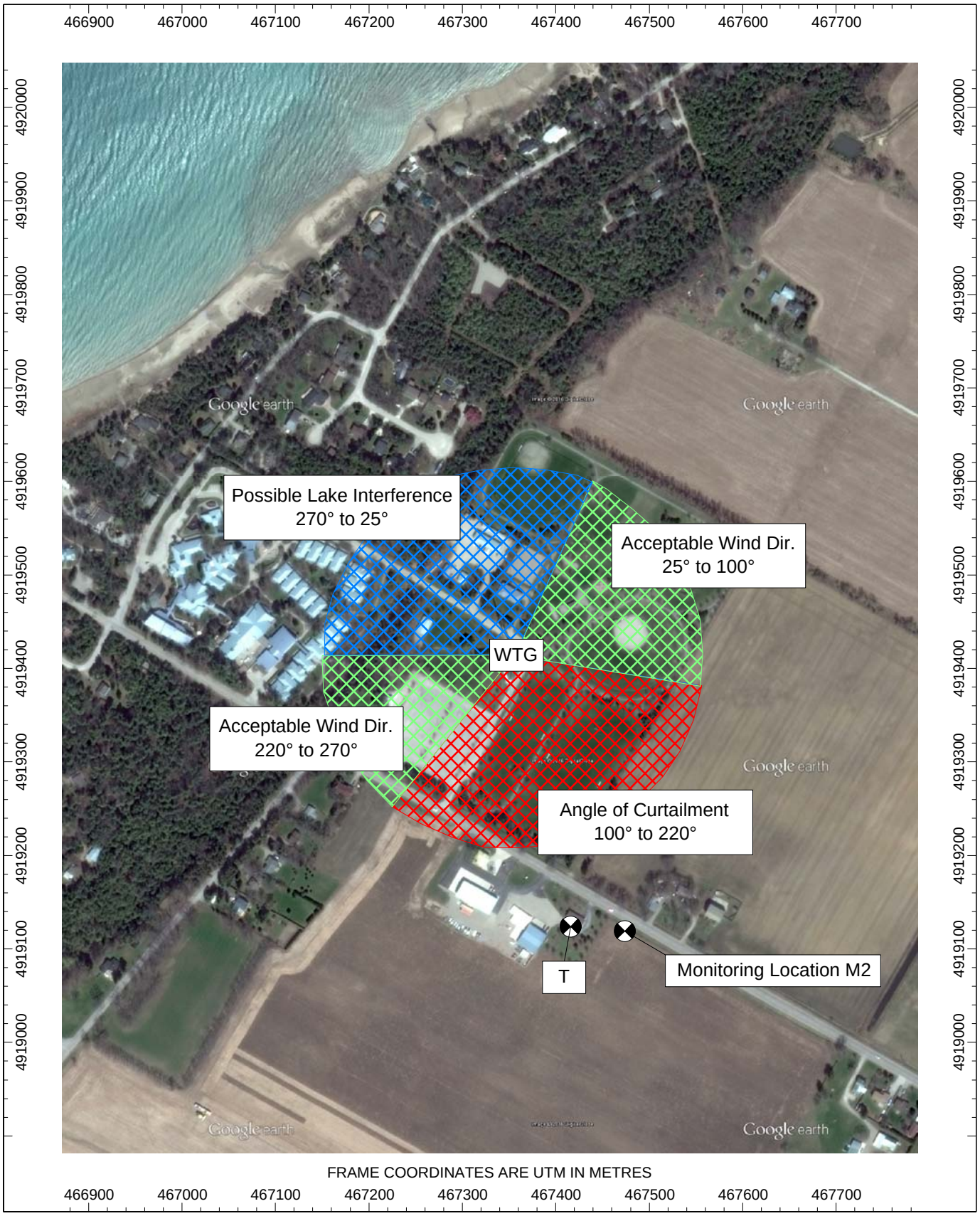


Figure D2 - Modified Wind Direction Filter - Monitoring Location M2
Unifor Wind Turbine - Spring 2018 Monitoring Campaign

APPENDIX E:

STATEMENT OF OPERATION

National Office
205 Placer Court
Toronto, Ontario M2H 3H9

UNIFOR
theUnion | lesyndicat

Bureau national
205 Placer Court
Toronto (Ontario) M2H 3H9

Jerry Dias
National President
Président national

Renaud Gagné
Quebec Director
Directeur québécois

Robert J. Orr
National Secretary-Treasurer
Secrétaire-trésorier national

June 28, 2018

SENT VIA EMAIL

Re: Statement of Operation
Union Building Corporation of Canada
Port Elgin, Ontario

To whom it may concern,

This letter is to confirm that the wind turbine generator at the Unifor Family Education Center was operating in its 300 kW Reduced Mode during nighttime hours between March 5 and May 24, 2018. Additionally, this letter confirms that the turbine was shut down for ambient (OFF) condition measurements.

Yours Truly,

Graeme Brown
Director, Operations and Facilities
GB/klcope343