FINAL REPORT

HAND HILLS WIND POWER PROJECT

BLUEARTH RENEWABLES INC.

NOISE IMPACT ASSESSMENT

RWDI #1702093

February 20, 2020

SUBMITTED TO

Isabelle Deguise
BluEarth Renewables Inc.
200, 4723 1 Street SW
Calgary, Alberta
T2G 4Y8

SUBMITTED BY

Teresa Drew, B.Sc., INCE.
Technical Director
teresa.drew@rwdi.com

Bryce Dawson, B.Sc., EPt
Project Manager
bryce.dawson@rwdi.com

RWDI
#1000, 736-8th Avenue S.W.
Calgary, Alberta, Canada
T2P 1H4
T: 403.232.6771
F: 519.823.1316

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Teresa Drew, B.Sc., INCE

EXECUTIVE SUMMARY

BER Hand Hills Wind LP, a wholly-owned subsidiary of BluEarth Renewables (BER) is proposing to amend approval number 22843-D02-2018 for the Hand Hills Wind Power Project (HHWPP, or "the Project") approximately 5 km southeast of Delia, AB. This Noise Impact Assessment (NIA) was prepared by RWDI to address turbine technology updates and turbine location changes from the 2018 layout for the Project (assessed in AUC Document 22843-X0054). The combined HHWPP layout now consists of a maximum of 29 wind turbine locations and has a project nameplate capacity of 130 MW.

The NIA considers the noise contributions from 32 Siemens Gamesa 4.5 MW-145 turbines, three of which are identified as spares dependent on finalized layout. The HHWPP will also develop a substation with one 130 MVA transformer.

This assessment considers noise from the proposed updated HHWPP wind turbine technology, additional turbine locations, the substation, and the effects of other energy related facilities. Other energy related facilities include the Suncor Hand Hills Wind Power Project (Suncor Project) located to the south of the HHWPP, and numerous oil and gas facilities and well pads throughout the Project area.

The results of the predictive modelling indicate the cumulative sound levels including the HHWPP are expected to comply with the Permissible Sound Levels with mitigation (low noise modes) applied at two turbine locations. The potential for low frequency sound is low.

1 INTRODUCTION

BER Hand Hills Wind LP, a wholly-owned subsidiary of BluEarth Renewables (BER) is proposing to amend approval number 22843-D02-2018 for the Hand Hills Wind Power Project (HHWPP, or "the Project") approximately 5 km southeast of Delia, AB. This Noise Impact Assessment (NIA) was prepared by RWDI to address turbine technology updates and turbine location changes from the last NIA (RWDI 2018). This NIA identifies the turbines to be constructed, estimates the noise propagation, considers the impacts of other adjacent energy related facilities, and was prepared in accordance with AUC Rule 012: Noise Control (AUC 2019).

The HHWPP layout consists of a maximum of 29 wind turbine locations and has a project nameplate capacity of 130 MW. The NIA considers the noise contributions from 32 Siemens Gamesa 4.5 MW-145 turbines, three of which are identified as spares dependent on finalized layout. The HHWPP will also develop a substation with one 130 MVA transformer.

This assessment considers noise from the proposed updated HHWPP wind turbine technology, the substation, and the effects of other energy related facilities. Other energy related facilities include the Suncor Hand Hills Wind Power Project (Suncor Project) located to the south of the HHWPP, and numerous oil and gas facilities and well pads throughout the Project area.

A noise model was generated, and compliance was determined according to AUC Rule 012. All work was completed by technical staff experienced in acoustic assessment, as detailed in Appendix A.

2 BACKGROUND AND APPROACH

Noise from the HHWPP has been estimated using predictive modelling to determine the impact at the nearest receptors. The assessment was completed by:

- Identifying receptors per Rule 012;
- Estimating sound emissions from existing and approved nearby facilities;
- Determining the PSL for receptors per Rule 012;
- Estimating sound emissions from the HHWPP;
- Modelling sound emissions to predict noise levels at receptors; and,
- Comparing cumulative results to the Rule 012 PSLs.

This report details the methods and models used in the noise assessment. While this report is an amendment to previous assessments, given the period since the site has last been assessed, the approach was taken to identify and re-verify all receptors and energy related sources independent from previous NIAs.

2.1 Environmental Noise Descriptors

As environmental noise varies over time, a single number descriptor known as the Energy Equivalent Sound Level or L_{EQ} is used to quantify noise. The L_{EQ} value, expressed in dBA, is the energy-averaged A-weighted sound level for a specified time period. It is defined as the steady continuous sound level, over a specified time period, that has the same acoustic energy as the actual varying sound levels occurring over the same time period. The L_{EQ} values are reported as A-weighted sound levels expressed in units of dBA (A-weighted decibels). The A-weightings are assigned to account for the frequency response of the human ear, which is most sensitive to mid-frequency sounds. The L_{EQ} in dBA is the primary sound level criteria addressed by AUC criteria. An additional measure used by the AUC is the L_{90}. The L_{90} is a statistical measurement for a sound level that is exceeded 90 per cent of the time.

Rule 012 has different allowable sound levels for daytime, which it defines as 07:00 to 22:00 hours, and nighttime, which it defines as 22:00 to 07:00 hours. The L_{EQ} during daytime periods is the 15-hour A-weighted energy equivalent sound level and is denoted as the $L_{EQ\ Day}$. Similarly, the L_{EQ} during nighttime periods is a 9-hour A-weighted energy equivalent sound level and is denoted as the $L_{EQ\ Night}$.

In addition to assessing A-weighted L_{EQ} sound levels, Rule 012 recommends that low frequency noise (LFN) be assessed at the NIA stage where data is available. LFN is measured using C-weighted L_{EQ} sound levels, expressed in dBC, which represent a nearly flat frequency response. The C-weighted levels are considered because A-weighted levels may not indicate the potential for disturbance caused by high levels of LFN. Rule 012 assesses the potential for LFN complaints based on the difference between the dBC and dBA levels, and whether there is tonality of the sound within the LFN frequencies.

A detailed glossary of terms is provided in Appendix B to aid the non-technical reader.

2.2 Field Survey

A field survey to conduct a visual check on dwelling receptors and, where practical or accessible, sound level measurements of energy related facilities was conducted on July 24, 2018. Measurements were conducted when the site fenceline could be safely accessed and the facility was estimated or confirmed to be in normal operation.

Measurements were conducted using a Brüel and Kjær 2250 Type 1 sound level meter. Data were analyzed and converted to sound emissions using the ANSI standard method for determination of sound power from sound pressure levels (ANSI 2011). Calibration certificates for the sound level meter and calibrator can be found in Appendix C.

2.3 Computer Modelling

Modelling for this assessment was conducted using CadnaA (Version 2019) sound level prediction software set to use the environmental sound propagation calculation methods prescribed by the ISO Standard 9613 (ISO 1993, 1996). The ISO 9613 sound propagation method predicts sound levels under moderately developed temperature inversion and downwind conditions, which enhance sound propagation to the receptor. The evaluation was based on typical summertime weather conditions, as outlined in Rule 012. Table 1 describes the configuration of the calculation parameters used to complete the noise modelling. Large structures were not included in the modelling for the HHWF, therefore the standard parameters for source directivity and reflections do not influence the analysis results.

Table 1: Model Configuration Parameters

Parameter	Model Settings	Description/Notes
Calculation Standard	ISO 9613 only	All sources and attenuators treated as required by the cited standard.
Source Directivity	Vertical sources applied to larger structures	Directivity of the source emission and the barrier effect of structures were included, if applicable.
Ground Absorption	0.7 (index value 0 to 1)	Values used for mixed, but soft ground. Applied to the entire modelling domain.
Temperature and Humidity	10°C/70% Relative Humidity	Average summer conditions for area.
Wind Conditions	Default ISO 9613	The propagation conditions in the ISO 9613 (1996) standard are valid for wind speeds between 4 and 18 km/h; all points are considered downwind.
Terrain	Terrain applied	Terrain in the area is modelled at 5 m resolution to account for any natural barriers within the study area (CDED 2009).
Reflections	1	One reflection is taken into account for reflections from on-site structures, if applicable. No structures were modelled in the considered area.
Search Radius	5000 m	Distance within which sound sources are considered for cumulative noise levels at each receptor

3 STUDY AREA AND RECEPTORS

A noise-sensitive receptor, based on Rule 012 requirements, is any permanent or seasonally occupied dwelling within 1.5 km of a facility, or with wind farms, 1.5 km of the turbine base. Therefore, a 1.5 km boundary from each turbine has been created, with overlapping boundaries merged to create a continuous 1.5 km boundary for the HHWPP. This study area defines the dwelling receptors that are considered in the noise impact assessment; specifically, any receptors that lie within this boundary are evaluated. Table 2 indicates the dwelling receptors that are within the 1.5 km boundary from the turbines, and which will be evaluated. Table 2 also indicates the evaluation height of the receptor, and the distance and direction to the nearest HHWPP turbine.

Dwellings considered at 1.5 m height are representative of 1 storey dwellings, while receptors considered at 4.5 m height are representative of 2 storey dwellings. One receptor, R33 has been updated to a 2 storey dwelling, different from the previous NIA (RWDI 2018), so is now considered at 4.5 m.

AUC Rule 012 provides guidelines for a cumulative noise assessment at the most impacted dwelling(s) within the 1.5 km project boundary. Other energy related facilities that may contribute to noise at receptors must be evaluated along with the Project sound sources, and depending on the cumulative potential, may require the inclusion of receptors farther than 1.5 km from the Project turbines.

Located to the south of the HHWPP is the approved Suncor Hand Hills Wind Power Project, which consists of 54 GE 1.6 MW turbines totaling 80 MW. Dwelling receptors for the Suncor project were compared the current field verified dwelling locations. In addition, located throughout the Project area are energy related oil and gas facilities, which include operational well pads, compressor stations and gas plants. Details of the other energy related facilities are discussed in Section 5.2. The location and contributions of all energy-related facilities did not indicate that dwelling receptors outside the Project 1.5 km boundary required inclusion in the assessment.

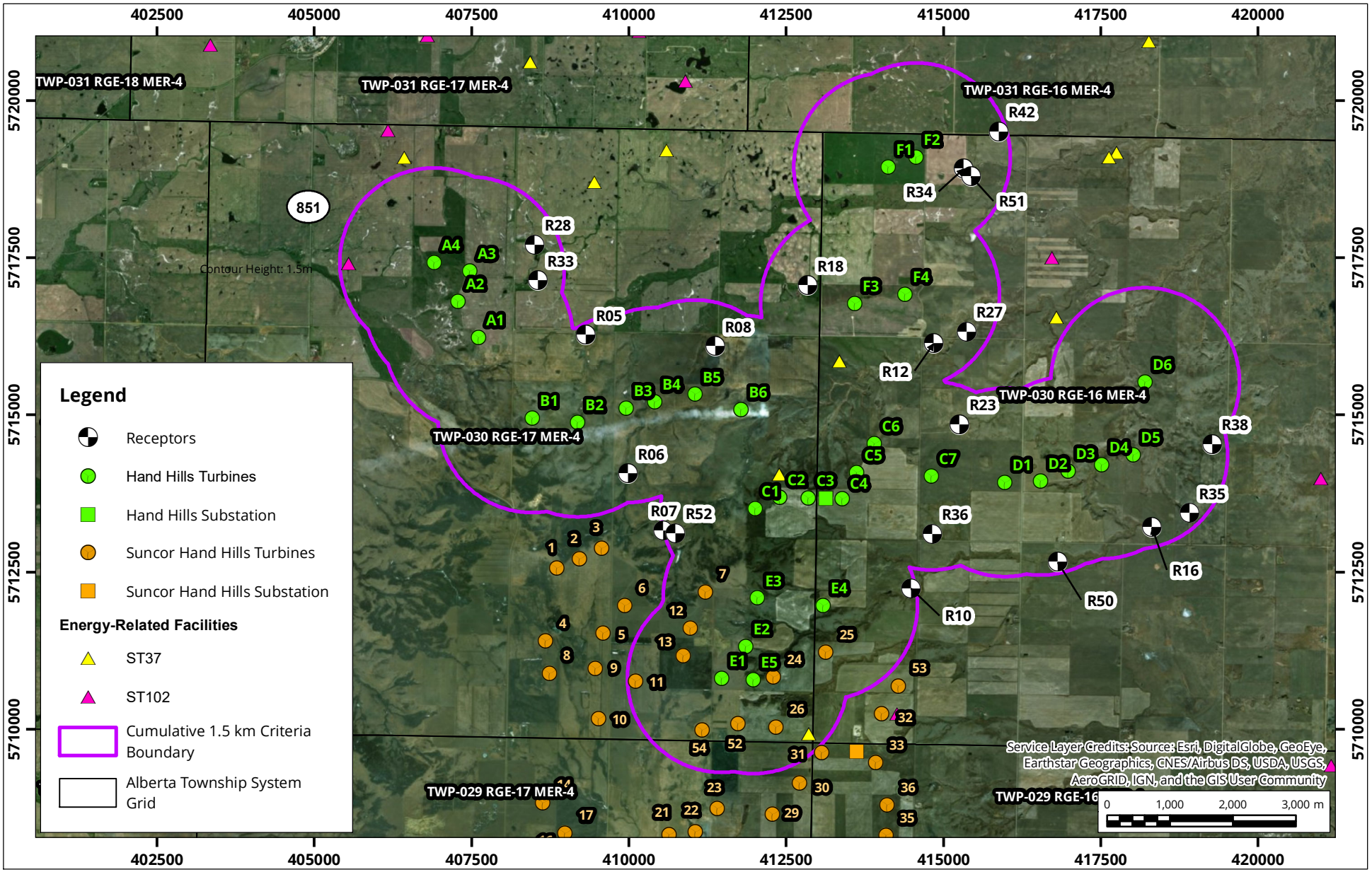
Figure 1 shows the 1.5 km Criteria Boundary, as well as the locations of the receptors.

Table 2: Location of Receptors and Spatial Locations from Nearest Turbine

Receptor ID	UTM Coordinates (NAD 83, Zone 12)		Receptor Height	Distance to Nearest Turbine (m)	Nearest Turbine ID	Angle to Nearest Turbine (0º as North)
	Easting (m)	Northing (m)	(m)			
R05[1]	409316	5716269	4.5	1328	B3	151
R06	409983	5714064	1.5	1041	B3	358
R07	410547	5713163	1.5	1499	C1	77
R08	411372	5716090	1.5	828	B5	203
R10	414484	5712240	4.5	1425	E4	259
R12	414842	5716133	4.5	907	F4	330
R16	418315	5713207	1.5	1184	D5	345
R18	412839	5717055	4.5	804	F3	110
R23[2]	415254	5714847	1.5	927	C7	209
R27	415368	5716321	1.5	1148	F4	301
R28	408502	5717703	1.5	1111	A3	248
R33	408549	5717136	4.5	1089	A3	278
R34	415320	5718909	1.5	782	F2	284
R35	418910	5713440	1.5	1286	D5	315
R36	414820	5713104	1.5	930	C7	359
R38	419268	5714528	4.5	1280	D5	262
R42	415876	5719504	1.5	1375	F2	253
R50	416814	5712658	4.5	1321	D2	348
R51	415442	5718792	4.5	932	F2	289
R52	410740	5713118	1.5	1324	C1	73

Notes: 1 – Identified as R34 in the 2017 Joss NIA, where a post-construction comprehensive noise survey is required as part of Approval 22843-D02-2018.
2 - Identified as R17 in the 2017 Joss NIA, where a post-construction comprehensive noise survey is required as part of Approval 22843-D02-2018.

Two residences were selected for post construction monitoring in Project Approval 22843-D02-2018 for the HHWPP, specifically Joss ID R17 and Joss ID R34 (Genivar 2010 – AUC Exhibit 0037.00.JOSSWIND-302). The location for Joss ID R17is identified as R23 in this NIA, and the location for Joss ID R34 is identified as receptor R05 in this NIA.



Hand Hills Wind Power Project

Detailed Project Location, Receptors, and Cumulative 1.5 km Criteria Boundary

True North

Drawn by: DJH	Figure: 1
Approx. Scale:	1:85,000
Date Revised:	Feb 7, 2020

Map Projection: NAD 1983 UTM Zone 12N

BluEarth Renewables Inc. - Hand Hills, Alberta

Project #: 1702093

Map Document: \\rwdgroup.net\calgary\Jobs\2017\1702093 - BRD - Hand Hills\4. Analysis\GIS\1702093 - Hand Hills - Figure 1 V5 200207.mxd

4 PERMISSIBLE SOUND LEVEL

4.1 Permissible Sound Level Determination

The requirements of Rule 012 limit the amount of sound contribution at a receptor location that may be generated by facilities. The sound level limits for a dwelling receptor are set by calculating permissible sound levels (PSLs) according to the procedures in Rule 012. Where dwellings or receptors are present, the PSL is determined using a Basic Sound Level (BSL) plus any allowed adjustments. Where no special conditions exist, the PSL is determined as follows:

Permissible Sound Level	=	Basic Sound Level (Table 1 in AUC Rule 012)	+	Daytime Adjustment (If applicable)	+	Class A Adjustment (If applicable)	+	Class B Adjustment (If applicable)	+	Class C Adjustment (If applicable)

The BSL is determined based on dwelling density and proximity to heavily travelled roadways. All receptors are rural residences with a dwelling density of less than 8 dwellings per quarter section, and the resulting PSL is 40 dBA for nighttime and 50 dBA for daytime. These are the PSLs previously determined for receptors affected by the Project. A summary of the PSLs is provided in Table 3. Appendix D presents a detailed calculation matrix of the applicable PSL calculation for all area receptor locations evaluated.

Where no permanent or seasonally-occupied human dwelling exists within a distance of 1.5 km from the HHWPP, Rule 012 requires that the cumulative sound level at 1.5 km from the HHWPP "fenceline" not exceed 40 dBA L_{EQ} during nighttime hours. Twenty receptors have been identified, so no Criteria Boundary receptors are identified. The boundary is still provided on the report figures for reference.

Regarding LFN, Rule 012 states that a complaint condition may exist where the difference between the HHWPP only time weighted average dBA and dBC levels is equal to or greater than 20 dB, and where a clear tonal component exists at a frequency below 250 Hz.

Table 3: PSL Determination (Rule 012 – Table 1)

Receptor ID	Proximity to Transportation Category[1]	Dwelling Density per Quarter Section of Land [2]	Dwelling Category	Nighttime BSL[3]	Permissible Sound Level	
					Night[4]	Day[5]
					(dBA)	(dBA)
R05	1	1 to 8 dwelling	1	40	40	50
R06	1	1 to 8 dwelling	1	40	40	50
R07	1	1 to 8 dwelling	1	40	40	50
R08	1	1 to 8 dwelling	1	40	40	50
R10	1	1 to 8 dwelling	1	40	40	50
R12	1	1 to 8 dwelling	1	40	40	50
R16	1	1 to 8 dwelling	1	40	40	50
R18	1	1 to 8 dwelling	1	40	40	50
R23	1	1 to 8 dwelling	1	40	40	50
R27	1	1 to 8 dwelling	1	40	40	50
R28	1	1 to 8 dwelling	1	40	40	50
R33	1	1 to 8 dwelling	1	40	40	50
R34	1	1 to 8 dwelling	1	40	40	50
R35	1	1 to 8 dwelling	1	40	40	50
R36	1	1 to 8 dwelling	1	40	40	50
R38	1	1 to 8 dwelling	1	40	40	50
R42	1	1 to 8 dwelling	1	40	40	50
R50	1	1 to 8 dwelling	1	40	40	50
R51	1	1 to 8 dwelling	1	40	40	50
R52	1	1 to 8 dwelling	1	40	40	50

Notes: 1 - Category 1 dwelling units are more than 500 m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers (AUC, 2013)
2 - Density per quarter section refers to a quarter section with affected dwellings at the centre (a 451m radius). For quarter sections with various land uses or with mixed densities, the density chosen is averaged for the area under consideration (AUC, 2013).
3 - Basic sound level as identified per Table 1 of AUC Rule 012.
4 - Nighttime PSL is equal to the BSL as there are no A, B, or C adjustments
5 - Daytime PSL is equal to the BSL plus the 10 dBA daytime adjustment, as there are no A, B, or C adjustments.

5 EXISTING CONDITIONS

5.1 Ambient Conditions

Ambient sound levels may be established using an assumed level as defined in Rule 012, or through measurement, particularly where pristine conditions or unregulated industry are present. The presence of agricultural land use and oil and gas related operations throughout the study area precludes the determination of the assessed residences as being situated within a pristine area. No significant non-noise regulated industry (such as feed lots, or saw mills) was identified thought review of the area mapping or during the field survey. Therefore, the assumed ambient noise level approach is used.

The use of the "assumed ASLs presented in AUC Rule 012 for rural residential receptors is intended to provide a reasonable, consistent and practical mechanism for predicting and assessing cumulative sound levels in NIAs, especially where, as in the case for wind developments, the project area spans many square kilometres" (AUC 24401-D01-2019). The assumed ambient sound levels are justified when the levels describe typical or representative ambient conditions for the receptors assessed where industry-related activities contribute to the existing soundscape.

According to AUC Rule 012, the Ambient Sound Level (ASL) is assumed to be five dBA less than the BSL for night, and BSL plus the daytime adjustment for day. For all receptors, the ASL is 35 dBA during the night and 45 dBA during the day.

5.2 Energy Related Facilities

AUC Rule 012 requires that a cumulative assessment be considered for the development of any energy related facilities in Alberta. The cumulative assessment must include the contributions from energy related existing and approved facilities.

5.2.1 Suncor Wind Power Project

Located to the south of the proposed Project area is the Suncor Project, approved in 2014 and yet to be constructed.

The Suncor Project NIA (RWDI, 2014), addressed contributions from the Suncor Project turbines, the Joss Wind Project (now the HHWPP), several existing oil and gas facilities, and the Suncor Project substation. The results presented in the assessment addressed eight of the receptors that are part of the HHWPP NIA. To achieve compliance during the nighttime period, the Suncor Project turbines are required to engage a noise reducing

operating mode (NRO mode). Therefore, the daytime and nighttime turbine contributions were assessed separately.

To account for contributions from the Suncor Project, a noise model was constructed in CadnaA. This current model replicated the 2014 NIA results. It includes the Suncor Project turbine locations and sound power levels in addition to the energy related facilities assessed in the 2014 NIA. The model was calibrated to the 2014 NIA results by varying modelling parameters to best match the predictions at the eight receptors in the 2014 NIA that correspond to receptors being assessed for HHWPP. To generate good modelling agreement, a maximum source to receiver search radius of 5 km was used.

Table 4 shows the comparison of the 2014 NIA results and the modelled results and considers only the receptors that are common to both. The results for the receptors are at 1.5 m elevation to match the Suncor modelling, and the results match the results reproduced in the previous HHWPP NIA (RWDI 2017). The greatest difference is 0.9 dBA.

Table 4: Comparison of the Suncor NIA contributions and the Re-Modelled Suncor Power Project and Energy Related Facility Contributions at the HHWPP receptors during the Daytime and Nighttime periods at common receptors

Receptor[1]	Daytime		Nighttime	
	Suncor Project Contributions from RWDI 2014 NIA[2] (dBA)	Modelled Suncor Project Contributions (dBA)	Suncor Project Contributions from RWDI 2014 NIA[2] (dBA)	Modelled Suncor Project Contributions (dBA)
R05	24.4	24.6	20.0	20.6
R06	32.4	32.8	29.5	30.2
R07	35.8	35.9	33.1	33.5
R08	23.5	22.8	19.1	18.9
R10	31.3	31.8	28.0	28.9
R12	0	0	0	0
R36	28.6	28.8	24.6	25.5

Notes: 1 – All receptors modelled at 1.5 m for this analysis only, to be representative of the Suncor Wind Farm NIA (RWDI 2014) results.
2 - Contributions as reported in the Suncor Wind Farm NIA (RWDI 2014).
-indicates the receptor was not considered in the Suncor NIA (RWDI 2014)

Table 4 indicates a good agreement between the contributions from the Suncor 2014 NIA and the re-modelled Suncor Project contributions at the HHWPP receptors. Differences in the results from the 2014 model and current results are likely due to updated software versions and updated terrain data. The remodeled results allowed for analyzing the contributions from the Suncor Project at the HHWPP receptors not considered in the Suncor Project 2014 NIA, as well as generating the predicted sound contours.

5.2.2 Oil and Gas

To identify facilities that may contribute to the acoustic environment, publicly available databases were reviewed to determine the locations of potential energy related contributors. The following databases were consulted to determine the locations of facilities in the HHWPP area:

- Alberta Energy Regulator ST37 – Alberta well listing (AER 2020a)
- Alberta Energy Regulator ST102 – Alberta facility list (AER 2020b)
- National Pollutant Release Inventory Reporting Facilities (NPRI 2015)

The area planned for the HHWPP is populated with oil and gas facilities, which include well pads, and compressor stations or plants.

Oil and gas facilities were ground verified where accessible from public roads and estimated as part of the original Hand Hills Wind Power Project NIA (RWDI 2017). The field survey on July 24, 2018, conducted measurements at 4 compressor sites (see table notes) and includes updated calculated sound powers, which was detailed in the previous NIA (RWDI 2018).

Some pumping wells were also dropped if they were further than 3km from a dwelling, as the contributions from these sites were found to be less than 20 dBA at all residents. No compressors or proration batteries that were identified in the original NIA (RWDI 2017) changed in this assessment. Appendix E shows the full listing of all the wells and facilities listed on the AER databases within 3 km of receptors.

Table 5 shows sound power levels and locations of the oil and gas facilities considered in this assessment.

Table 5: Oil and Gas Facilities Sound Power Levels

Item	Location UTM 12 (NAD 83)		Type[1]	Levels at Octave Band Center Frequencies (dB)									Overall Sound Power		Source
	X (m)	Y (m)		31.5	63	125	250	500	1,000	2,000	4,000	8,000	(dBA)	(dB)	
AER ST37															
OMERS MICHICHI 8-34-30-17	409451	5718704	P	98.9	100.0	96.8	83.3	74.8	69.7	66.6	61.8	60.8	83.1	103.6	(2)
POCO WATTS 16-3-31-16	418264	5720940	P	98.9	100.0	96.8	83.3	74.8	69.7	66.6	61.8	60.8	83.1	103.6	(2)
OMERS WATTS 4-9-31-16	415601	5721469	P	98.9	100.0	96.8	83.3	74.8	69.7	66.6	61.8	60.8	83.1	103.6	(2)
OMERS MICHICHI 14-35-30-17	410597	5719215	P	104.9	98.2	95.3	93.6	95.2	87.6	86.0	85.8	80.1	95.6	106.8	(2)
CNRL HZ WATTS 2-33-30-16	417749	5719172	P	98.9	100.0	96.8	83.3	74.8	69.7	66.6	61.8	60.8	83.1	103.6	(2)
OMERS MICHICHI 9-32-30-17	406426	5719089	P	98.9	100.0	96.8	83.3	74.8	69.7	66.6	61.8	60.8	83.1	103.6	(2)
MARQUEE HZ 103 WATTS 14-28-30-1	416791	5716552	P	98.9	100.0	96.8	83.3	74.8	69.7	66.6	61.8	60.8	83.1	103.6	(2)
Marquee 01-01-030-17w400 Mulit Well	412857	5709928	P	103.5	95.9	89.8	82.0	78.6	71.5	72.3	69.1	65.5	81.5	104.4	(2)
AVALANCHE ET AL WATTS 16-33-30-	417628	5719102	P	104.9	98.2	95.3	93.6	95.2	87.6	86.0	85.8	80.1	95.6	106.8	(2)
MARQUEE MICHI 5-3-31-17	407372	5720283	P	98.9	100.0	96.8	83.3	74.8	69.7	66.6	61.8	60.8	83.1	103.6	(2)
MARQUEE MICHI 13-19-30-16	413345	5715852	P	98.9	100.0	96.8	83.3	74.8	69.7	66.6	61.8	60.8	83.1	103.6	(2)
MARQUEE MICHI 10-13-30-17	412389	5714054	P	98.9	100.0	96.8	83.3	74.8	69.7	66.6	61.8	60.8	83.1	103.6	(2)
MARQUEE MICHI 9-3-31-17	408426	5720611	P	98.9	100.0	96.8	83.3	74.8	69.7	66.6	61.8	60.8	83.1	103.6	(2)
AER ST102															
Canadian Natural Resources Limited - 11-29-030-17-4	405545	5717411	P	123.7	123.2	118.9	110.0	104.6	103.1	103.1	99.5	97.8	110.6	127.3	(4)
D Energy Craigmyle Michichi 4-10	407137	5721428	P	123.7	123.2	118.9	110.0	104.6	103.1	103.1	99.5	97.8	110.6	127.3	(2)
Michichi 16-6-31-17w4	403343	5720885	P	104.9	98.2	95.3	93.6	95.2	87.6	86.0	85.8	80.1	95.6	106.8	(2)
Bankeno Bonanza Watts 14-28-30-16	416725	5717500	P	91.4	100.4	93.0	88.1	93.5	97.9	87.9	82.2	75.3	99.3	103.8	(3)

Item	Location UTM 12 (NAD 83)		Type[1]	Levels at Octave Band Center Frequencies (dB)									Overall Sound Power		Source
	X (m)	Y (m)		31.5	63	125	250	500	1,000	2,000	4,000	8,000	(dBA)	(dB)	
Centrica Canada Limited - 15-32-030-17-4	406166	5719522	P	110.0	108.6	113.4	97.6	96.7	100.9	94.3	89.9	79.4	104.1	116.2	(3)
Player Resources Ltd - 09-14-030-16-4	420999	5713990	P	123.7	123.2	118.9	110.0	104.6	103.1	103.1	99.5	97.8	110.6	127.3	(2)
Michichi 16-02	410162	5721102	P	123.7	123.2	118.9	110.0	104.6	103.1	103.1	99.5	97.8	110.6	127.3	(2)
Poco Michichi 6-1	410899	5720307	P	110.0	108.6	113.4	97.6	96.7	100.9	94.3	89.9	79.4	104.1	116.2	(3)
Watts 4-9-31-16w4	415593	5721488	P	98.6	101.2	95.4	86.6	82.4	78.8	78.0	87.4	77.6	90.6	104.0	(3)
Husky Michichi 16-4-31-17-W4	406797	5721039	P	116.7	116.2	11.9	102.9	97.6	96.1	96.0	92.5	90.8	102.8	119.6	(2)
Marathon Player 13-36 Ggs	421168	5709424	P	123.7	123.2	118.9	110.0	104.6	103.1	103.1	99.5	97.8	110.6	127.3	(2)
Regulator Station 8-6-30-16 W4M	414260	5710242	P	85.1	74.9	63.1	53.4	50.2	45.1	40.0	36.5	30.3	54.7	85.5	(2)

Notes: 1 - Represents the following source types: P - Point Source, L - Line Source, A - Area Source, and V - Vertical Area Source.
2 – Sound power has not changed since the previous HHWPP NIA (RWDI 2017)
3 – Sound power based on measurement from the 2018 field survey.
4 – Added facility from the previous NIA, sound power based from internal RWDI library reference of measurements from similar equipment.

5.2.3 Cumulative Energy Related Facility Contributions

The total cumulative contributions for each receptor can be calculated as the logarithmic sum of the Suncor wind project contributions and the area oil and gas contributions, which are presented in Table 6.

Table 6: Cumulative Contributions of Energy Related Facilities at Receptors

Receptor	Modelled Suncor Project Contributions[1] (dBA)		Contribution from Third Party Oil and Gas Facilities[2] (dBA)	Cumulative Third Party Contributions[3] (dBA)	
	Daytime	Nighttime		Daytime	Nighttime
R05	25.3	22.2	21.2	26.7	24.7
R06	32.8	30.2	1.8	32.8	30.2
R07	35.9	33.5	4.8	35.9	33.5
R08	22.8	18.9	10.7	23.1	19.5
R10	33.1	30.9	1.7	33.1	30.9
R12	0.0	0.0	11.6	11.6	11.6
R16	14.5	10.2	22.4	23.1	22.7
R18	0.0	0.0	18.3	18.3	18.3
R23	21.2	17.0	7.6	21.4	17.5
R27	0.0	0.0	13.8	13.8	13.8
R28	14.2	9.7	24.6	25.0	24.7
R33	20.5	17.1	24.5	26.0	25.2
R34	0.0	0.0	17.1	17.1	17.1
R35	0.0	0.0	24.7	24.7	24.7
R36	28.8	25.2	3.0	28.8	25.2
R38	0.0	0.0	29.7	29.7	29.7
R42	0.0	0.0	16.4	16.4	16.4
R50	25.1	22.0	17.3	25.8	23.3
R51	0.0	0.0	18.9	18.9	18.9
R52	36.0	33.5	5.0	36.0	33.5

Notes: 1- Based on modelled results of 2014 Suncor and oil & gas contributions.
2- Modelled oil &gas contribution.
3- The cumulative sound level is the logarithmic sum of adjacent wind farms and oil and gas facilities

6 PREDICTIONS

6.1 Noise Sources

The updated HHWPP consists of 32 Siemens Gamesa 4.5 MW-145 wind turbine locations, of which 29 locations will be constructed and 3 locations are included as spares.

The turbine reaches a maximum sound output of 107.8 dBA at 13 m/s hub height wind speeds. HHWPP has indicated that the proposed hub height of the turbines will be 107.5 m above grade. The turbines were modelled at 107.5 m elevation above grade and assumed continuous operation over the day and night periods. The standardized 10 m wind speed for 13 m/s wind speed at the hub height of 107.5 m is 8.98 m/s. Calculated wind speeds at the standardized height of 10 m are determined in accordance with IEC 61400-11 (IEC 2012).

Two turbines will have mitigation applied. Turbine F3 will run under the NR-1 mode, which has a maximum sound power output of 105.7 dBA at 13 m/s with a total power output of 4.0 MW. Turbine F3 will run in mode NR-1 24 hours a day in this mode, but it is not required to meet Rule 012 noise requirements. Turbine F4 will run under a AM-3 mode, which has a maximum sound power output of 106.9 dBA at 13 m/s with a total power output of 4.2 MW. Turbine F4 will run under mode AM-3 for nighttime hours only.

Acoustic specifications for the modelled turbines can be found in Appendix F. Turbine coordinates for all 32 wind turbine locations are provided in Appendix G. The Siemens Gamesa 4.5 MW-145 turbine also offers a range of different operating modes. The turbine has the flexible rating, consisting of modes AM -3 thru AM +3 options, as well as Noise Reduced System (NRS) modes N1 through N8. Each of these operating modes have different turbine capacities and noise curves.

The Project will also include a substation located at 05-18-030-16 W4M. The substation will consist of one 130 MVA ONAF transformer. Turbines and the substation transformers are modelled as all running continuously at maximum sound output.

Table 7 shows the sound power levels for the substation and the wind turbines.

Table 7: Project Sound Power Levels

Item	UTM Coordinates (NAD 83, Zone 12)		Levels at Octave Band Center Frequencies (dB)									Overall Sound Power	
	Easting (m)	Northing (m)	31.5	63	125	250	500	1,000	2,000	4,000	8,000	(dBA)	(dB)
Siemens Gamesa 4.5 MW-145[1]	(3)	(3)	117.6	116.5	112.0	108.0	103.6	102.2	100.6	94.6	83.2	107.8	121.1
Siemens Gamesa 4.5 MW-145 Mode NR-1 (Turbine F3)[1]	(3)	(3)	117.3	115.8	110.9	105.8	101.4	100.0	98.4	92.4	81.0	105.7	120.5
Siemens Gamesa 4.5 MW-145 Mode AM-3 (Turbine F4)[1]	(3)	(3)	117.5	116.2	111.5	107.1	102.7	101.3	99.7	93.7	82.3	106.9	120.8
Hand Hills Substation - 130 MVA ONAF Transformer[2]	413132	5713671	96.7	102.7	104.7	99.7	99.7	93.7	88.7	83.7	76.7	100.0	108.7

Notes: 1 - Taken from Siemens Gamesa 4.5 MW - 145 specifications (Appendix E).
2 - Derived using theoretical calculations based on power ratings, dimensions, and capacities provided by the client (Crocker 2009).
3 - Turbine locations listed in Appendix F.

6.2 Operation Results

6.2.1 Assessment of Compliance with AUC Rule 012 PSL

Table 8 and Table 9 show the compliance determination with the daytime and nighttime PSLs, respectively, according to AUC Rule 012. The results indicate that the HHWPP will comply with the PSLs.

Figures 2 and 3 show the predicted noise contours due to the HHWPP, the modeled contribution from the Suncor Project, and the contribution from oil and gas facilities. Since the Suncor Wind turbines operate in NRO mode during the nighttime period there will be a difference between daytime and nighttime cumulative energy related facility contributions. The figures show the overall predicted daytime and nighttime sound contours at 1.5 m.

Table 8: Assessment of Compliance with Daytime PSLs

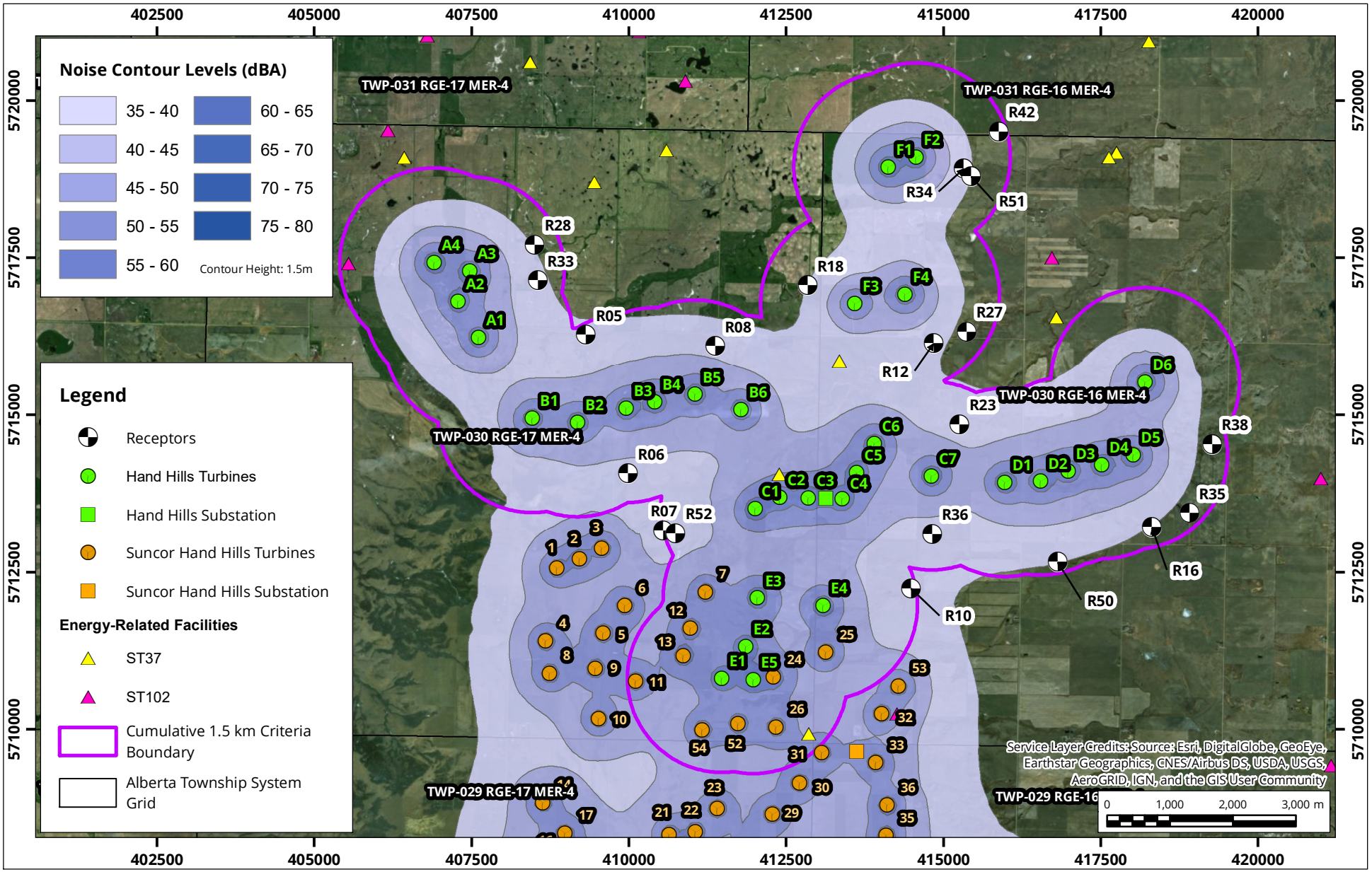
Receptor ID	Assumed Ambient Sound Level[1] (dBA)	Suncor Wind Power Project Contributions[2] (dBA)	Oil and Gas Third Party Contributions[3] (dBA)	Proposed Project Contribution (dBA)	Cumulative Sound Level[4] (dBA)	PSL[5] (dBA)	Complies with AUC Rule 012? (Y/N)
Daytime (22:00 - 07:00)							
R05	45	25.3	21.2	37.7	46	50	Y
R06	45	32.8	1.8	37.4	46	50	Y
R07	45	35.9	4.8	34.7	46	50	Y
R08	45	22.8	10.7	37.8	46	50	Y
R10	45	33.1	1.7	36.7	46	50	Y
R12	45	0	11.6	37.8	46	50	Y
R16	45	14.5	22.4	34.7	45	50	Y
R18	45	0	18.3	36.8	46	50	Y
R23	45	21.2	7.6	37.8	46	50	Y
R27	45	0	13.8	33.9	45	50	Y
R28	45	14.2	24.6	34.7	45	50	Y
R33	45	20.5	24.5	37.8	46	50	Y
R34	45	0	17.1	36.4	46	50	Y
R35	45	0	24.7	32.8	45	50	Y
R36	45	28.8	3	37.5	46	50	Y
R38	45	0	29.7	35.1	46	50	Y
R42	45	0	16.4	30.5	45	50	Y
R50	45	25.1	17.3	36.6	46	50	Y
R51	45	0	18.9	36.6	46	50	Y
R52	45	36	5	35.2	46	50	Y

Notes: 1 - Ambient sound level as outlined by AUC Rule 012, Table 1.
2 – Suncor Wind Power Project contributions as calculated in Section 5.2.3.
3 - Existing Oil and Gas Facilities contributions as calculated in Section 5.2.3.
4 - The cumulative sound level is the logarithmic sum of assumed ambient, third party contributions, and the project contribution.
5 - Permissible sound level as outlined by AUC Rule 012.

Table 9: Assessment of Compliance with Nighttime PSLs

Receptor ID	Assumed Ambient Sound Level[1] (dBA)	Suncor Wind Power Project Contributions[2] (dBA)	Oil and Gas Third Party Contributions[3] (dBA)	Proposed Project Contribution (dBA)	Cumulative Sound Level[4] (dBA)	PSL[5] (dBA)	Complies with AUC Rule 012? (Y/N)
Nighttime (07:00 - 22:00)							
R05	35	22.2	21.2	37.7	40	40	Y
R06	35	30.2	1.8	37.4	40	40	Y
R07	35	33.5	4.8	34.7	39	40	Y
R08	35	18.9	10.7	37.8	40	40	Y
R10	35	30.9	1.7	36.7	40	40	Y
R12	35	0.0	11.6	37.4	39	40	Y
R16	35	10.2	22.4	34.7	38	40	Y
R18	35	0.0	18.3	36.7	39	40	Y
R23	35	17.0	7.6	37.8	40	40	Y
R27	35	0.0	13.8	33.5	37	40	Y
R28	35	9.7	24.6	34.7	38	40	Y
R33	35	17.1	24.5	37.8	40	40	Y
R34	35	0.0	17.1	36.4	39	40	Y
R35	35	0.0	24.7	32.8	37	40	Y
R36	35	25.2	3.0	37.5	40	40	Y
R38	35	0.0	29.7	35.1	39	40	Y
R42	35	0.0	16.4	30.4	36	40	Y
R50	35	22.0	17.3	36.6	39	40	Y
R51	35	0.0	18.9	36.6	39	40	Y
R52	35	33.5	5.0	35.2	39	40	Y

Notes: 1 - Ambient sound level as outlined by AUC Rule 012, Table 1.
2 – Suncor Wind Power Project contributions as calculated in Section 5.2.3.
3 - Existing Oil and Gas Facilities contributions as calculated in Section 5.2.3.
4 - The cumulative sound level is the logarithmic sum of assumed ambient, third party contributions, and the project contribution.
5 - Permissible sound level as outlined by AUC Rule 012..



Hand Hills Wind Power Project

Daytime Predicted Noise Contours - Project and Third Party Facilities

True North

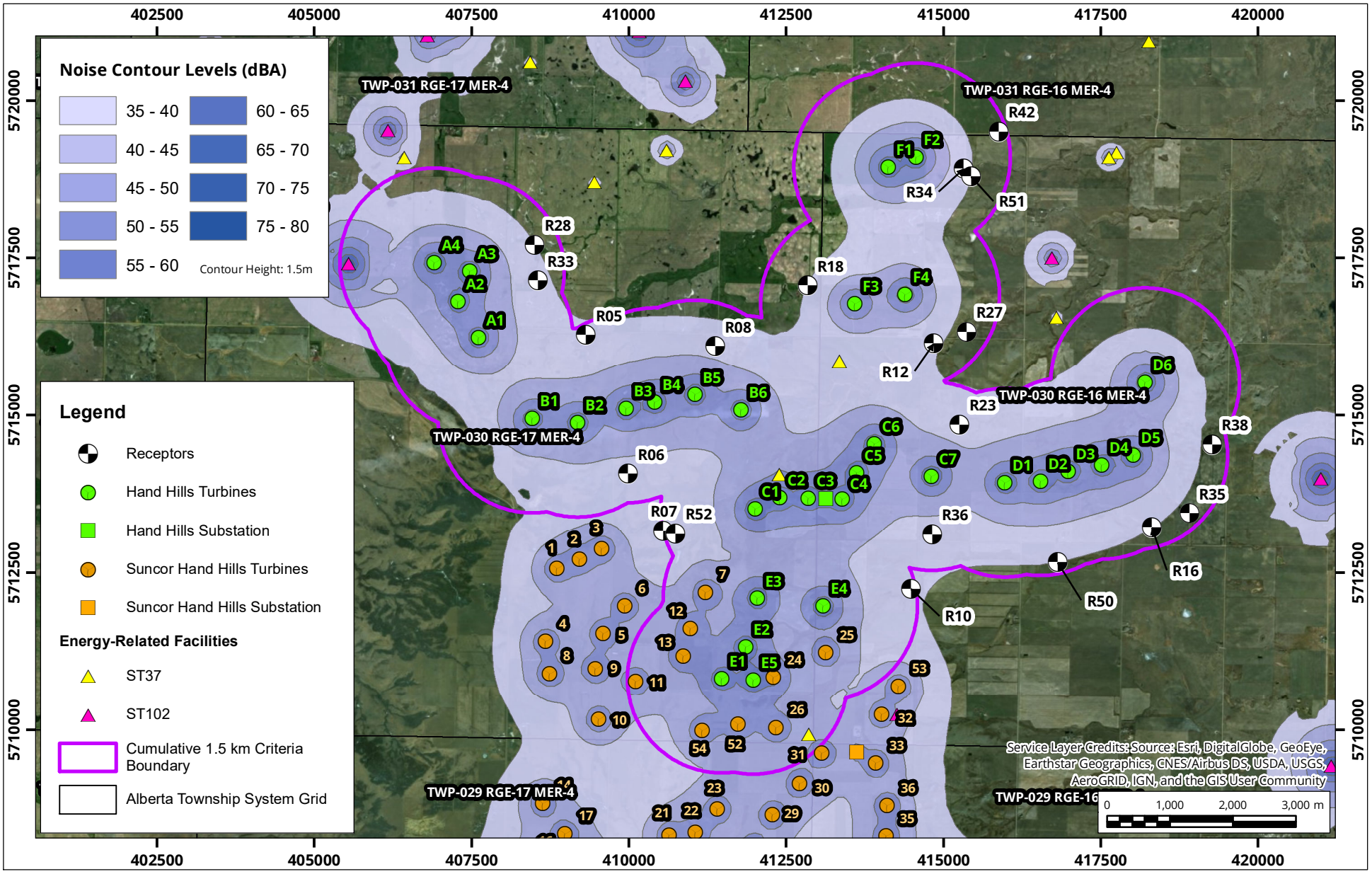
Drawn by: DJH	Figure: 2
Approx. Scale:	1:85,000
Date Revised:	Feb 7, 2020

Map Projection: NAD 1983 UTM Zone 12N

BluEarth Renewables Inc. - Hand Hills, Alberta

Project #: 1702093

Map Document: \\rwdgroup.net\calgary\Jobs\2017\1702093 - BRD - Hand Hills\4. Analysis\GIS\1702093 - Hand Hills - Figure 2 V6 200207.mxd



Hand Hills Wind Power Project

Nighttime Predicted Noise Contours - Project and Third Party Facilities

Map Projection: NAD 1983 UTM Zone 12N

BluEarth Renewables Inc. - Hand Hills, Alberta

True North

Project #: 1702093

Drawn by: DJH	Figure: 3
Approx. Scale:	1:85,000
Date Revised:	Feb 7, 2020

Map Document: \\rwdgroup.net\calgary\Jobs\2017\1702093 - BRD - Hand Hills\4. Analysis\GIS\1702093 - Hand Hills - Figure 3 V6 200207.mxd

6.3 Low Frequency Noise

The C-Weighted sound level (dBC) results generated by the HHWPP have been reviewed for the receptors to determine if there is potential for LFN due to the Project. The greatest difference between HHWPP C- and A-weighted values is 20.8 dB at receptor R27, as shown in Table 10.

Table 10: Low Frequency Noise Potential

Receptor ID	C-Weighted Sound Level	A-Weighted Sound Level	dBC-dBA
R05	56.1	37.7	18.4
R06	57.1	37.4	19.7
R07	55.4	34.7	20.7
R08	57.0	37.8	19.2
R10	55.7	36.7	19.0
R12	56.1	37.4	18.7
R16	54.4	34.7	19.7
R18	55.2	36.7	18.5
R23	57.5	37.8	19.7
R27	54.3	33.5	20.8
R28	54.4	34.7	19.7
R33	55.6	37.8	17.8
R34	54.9	36.4	18.5
R35	52.9	32.8	20.1
R36	57.3	37.5	19.8
R38	53.2	35.1	18.1
R42	50.6	30.4	20.2
R50	55.1	36.6	18.5
R51	54.2	36.6	17.6
R52	55.6	35.2	20.4

The daytime dBC-dBA values are greater than 20 for some receptor locations. However, the overall C-weighted levels are below the highest value for dBC indicated by the AUC Rule 012 method for LFN analysis. The Rule allows a 20 dB difference from the PSL of 40 dBA, indicating a threshold of 60 dBC is a useful secondary guideline for result comparison.

The second condition that defines LFN in Rule 012 is the presence of tonal sound at frequencies lower than 250 Hz. The Siemens Gamesa 4.5MW -145 1/3 octave bands provided in Appendix F were analyzed using the tonal analysis provided by the AUC in Appendix E of AUC Rule 012. The tonal analysis is comprised of two parts, a calculation of the low frequency 1/3 octave band data and a comparison of the individual octave band data. The Siemens Gamesa 4.5MW -145 1/3 octave bands for all modelled turbines were found to have no octave band that

was ≥10 dB within two octave bands less than 250 Hz. The comparison of 1/3 octave data bands also indicated no tonal component.

The Siemens Gamesa 4.5MW -145 1/3 octave band data has no tonality present according to American National Standards Institute (ANSI) and the Acoustical Society of America (ASA) standard practice for determining tones (ANSI 2005).

Due to the C-weighted values being below 60 dBC and the absence of tonal sound, the potential for an LFN issue from the Project is considered to be low.

7 CONSTRUCTION NOISE

AUC Rule 012 requires Licensees manage the impact of construction noise. Construction plans are not available for this stage of Project design; so quantitative effects are not known. BER will consider construction-generated noise in its execution plans and through the consultation program, including the following measures identified in Rule 012:

a) Conduct construction activity between the hours of 7 a.m. and 10 p.m., where practical
b) Advise nearby residents of significant noise-causing activities and schedule these events to reduce disruption to them
c) Ensure that all internal combustion engines are well maintained with muffler systems

8 CONCLUSIONS

The NIA provides a cumulative assessment that includes the neighboring Suncor Hand Hills Wind Power Project, AER regulated oil and gas facilities, ambient sound levels and the HHWPP. The results demonstrate that the HHWPP will comply with PSLs as calculated using AUC Rule 012 guidelines, with two turbines operating with mitigation applied. The potential for an LFN condition is considered low with some nighttime dBC-dBA values being greater than 20 dB, although the turbines do not have any tonal components that present in the spectra.

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APPENDIX A

APPENDIX A: PRACTITIONER BIOGRAPHIES

Teresa Drew, B.Sc., INCE. Technical Director

Teresa joined RWDI in 2011 as a Senior Consultant/Technical Director for the Noise group in the Calgary office. Teresa is an accomplished professional with over 25 years of consulting experience, focused on the acoustic environment. She has extensive experience in project management, acoustic & environmental consulting, environmental impact assessments and industrial permit applications. The skills Teresa has acquired in the acoustics field have allowed her to play a prominent role in both domestic and international projects for multiple industries.

Her experience in the wind power industry includes applications, noise predictions, and compliance monitoring and policy development. She has lead the technical studies for provincial (Alberta and British Columbia) power project approvals as well as provided expert testimony at federal, provincial and municipal level hearings.

Bryce Dawson, B.Sc., EPt. Senior Project Manager

Bryce joined RWDI in 2010 and brings nearly a decade of project management and environmental consulting experience to his work. Bryce has supported diverse projects throughout Western Canada providing senior oversight and guidance. He has focused primarily on energy development, with an emphasis in renewable power. Bryce is well versed in regulatory requirements to support permitting for matters related to noise monitoring, predictions, and stakeholder engagement.

Daniel Kremer, M.Sc., E.I.T. Intermediate Scientist/Engineer

Daniel joined RWDI in 2013 as a Noise & Vibration Scientist specializing in environmental noise. He has completed many environmental noise studies for regulatory compliance in Alberta and British Colombia. His work has focused on long-term monitoring programs, sound source measurements and predictive modelling for noise and acoustics to support regulatory requirements (AUC Rule 012, AER Directive 038).

His experience is focused on environmental noise related to energy, oil & gas, and mining applications in Western Canada and includes oil sands mining, in-situ oil sands projects, conventional oil and gas extraction, and wind turbine projects. His expertise has been to model and develop noise strategies for large scale projects for future developments at the provincial and federal levels.

Daniel has experience in the planning and post construction stages of wind power development, and in providing analysis and reporting to meet regulatory requirements (AUC Rule 012). He has provided detailed analysis on the relationships between meteorological conditions and turbine operating parameters, and the effects at receptors, including conducting comprehensive post-construction sound level surveys for wind turbines.

APPENDIX B

APPENDIX B: ENVIRONMENTAL NOISE DESCRIPTORS AND TERMINOLOGY

Abnormal noise events

Noises that are sufficiently infrequent as to be uncharacteristic of an area or that occur so close to the microphone as to dominate the measurements in an unrealistic manner. Consideration must be given to deleting occurrences of abnormal noise from the measurements to obtain a reasonably accurate representation of the sound environment. Examples of abnormal noises include a dog barking close to the microphone, a vehicle passing nearby, people talking in the vicinity of the microphone in a quiet environment, or a passing road grader.

Airborne Sound

Sound that reaches the point of interest by propagation through air.

Ambient noise or sound

All noises that exist in an area and are not related to a facility under study. Ambient noise may include sound from other existing industrial facilities, transportation sources, animals, and nature. Context for ambient noise should be defined for each project.

Attenuation

The reduction of sound intensity by various means (e.g., air, humidity, porous materials, etc.)

A-weighted sound level

The sound level as measured on a sound level meter using a setting that emphasizes the middle frequency components similar to the frequency response of the human ear.

A-weighting shows that the measured sound pressure levels have been filtered using a frequency weighting network that mimics the response of the human ear.

The resultant sound pressure level with the associated unit “dBA” is therefore a representative of the subjective response of the human ear. The weightings are assigned in a way to reflect the higher sensitivity of human ear to sound in the mid and high frequency band as shown in the curve labelled A-weighting in Figure B-1.

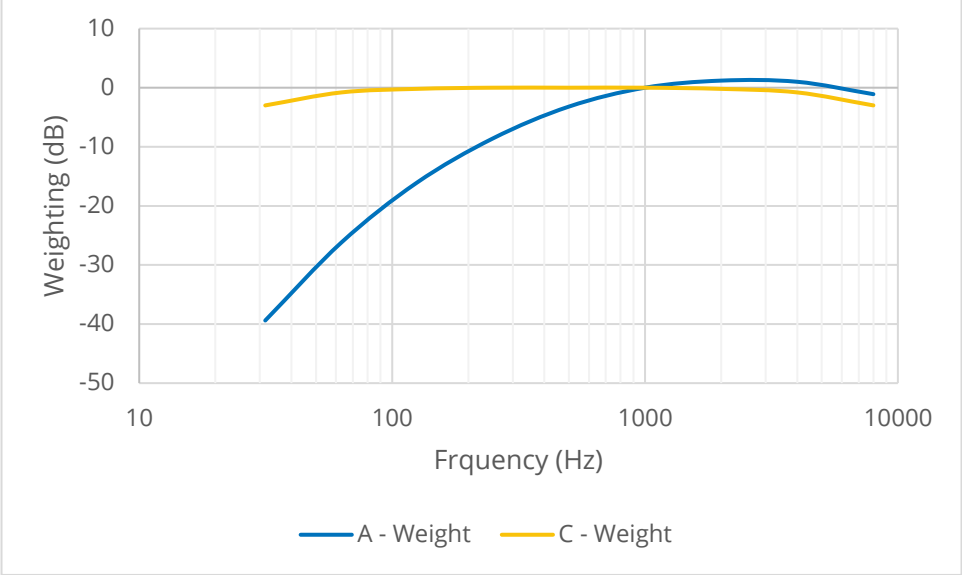


Figure B-1 Sound Weighting Network

Calibration

The procedure used for the adjustment of a sound level meter using a reference source of a known sound pressure level and frequency. Calibration must take place before and after the sound level measurements.

C-Weighted Sound Level

The sound level as measured on a sound level meter using a setting that emphasizes the low and middle frequency components. The weightings are assigned as shown in the curve labelled C-weighting in Figure B-1. The resultant sound pressure level is reported with the associated unit “dBC”

Daytime

Defined as the hours from 07:00 to 22:00.

dB (decibel)

A unit of measure of sound pressure that compresses a large range of numbers into a more meaningful scale. Hearing tests indicate that the lowest audible pressure is approximately 2 x 10-5 Pa (0 dB), while the sensation of pain is approximately 2 x 102 Pa (120 dB). Generally, an increase of 10 dB is perceived as twice as loud.

dBA

The decibel (dB) sound pressure level filtered through the A filtering network to approximate human hearing response at low frequencies.

dBC

The decibel (dB) sound pressure level filtered through the C filtering network to highlight low and middle frequencies.

Dwelling

Any permanently or seasonally occupied residence with the exception of an employee or worker residence, dormitory, or construction camp located within an industrial plant boundary. Trailer parks and campgrounds may qualify as a dwelling unit if it can be demonstrated that they are in regular and consistent use during the applicable season.

Energy equivalent sound level (Leq)

The Leq is the average A-weighted sound level over a specified period of time. It is a single-number representation of the cumulative acoustical energy measured over a time interval. If a sound level is constant over the measurement period, the Leq will equal the constant sound level where f is the fraction of time the constant level L is present.

Standardized Wind Speed at 10 m

The standardized wind speed at a height of 10 m is calculated in accordance with IEC 614000-11 (2012) and is given below. In the case of calculating the standardized wind speed for turbines in Alberta, a roughness length of 0.05 m is used, which is representative of farmland with vegetation.

$$V_H = V_{10}\left[\frac{\ln\left(\frac{H}{z_{0ref}}\right)}{\ln\left(\frac{10}{z_{0ref}}\right)}\right]$$

Where:

V_H is the wind speed at hub height z (m), determined from the power curve;

V_{10} is the standardized wind speed at 10m;

z_{0ref} is the reference roughness length of 0.05 m; and

H is the rotor centre height (m).

Far Field

Describes a region in free space where the sound pressure level from a source obeys the inverse-square law (the sound pressure level decreases 6 dB with each doubling of distance from the source). Also, in this region the sound particle velocity is in phase with the sound pressure. Closer to the source where these two conditions do not hold constitutes the “near field” region.

Frequency

The number of times per second that the sine wave of sound or of a vibrating object repeats itself. The unit is expressed in hertz (Hz), formerly in cycles per second (cps).

Human Perception of Sound

The human perception of noise impact is an important consideration in qualifying the noise effects caused by projects. The following table presents a general guideline.

Table B-1 Human Perception of Sound

Increase in Noise Level (dBA)	Perception
1 to 3	Imperceptible to possibly perceptible
4 to 5	just-noticeable difference
6 to 9	marginally significant
10 or more	significant, perceived as a doubling of sound level

Impulsive Noise

Single or multiple sound pressure peak(s) (with either a rise time less than 200 milliseconds or total duration less than 200 milliseconds) spaced at least by 500 millisecond pauses. A sharp sound pressure peak occurring in a short interval of time.

L_{EQ}

See Energy equivalent sound level.

L_{90}

The sound level that is exceeded 90 per cent of the time. The L_{90} must be measured in the setting "fast" on the sound level meter and is expressed in dBA.

Nighttime

Defined as the hours from 22:00 to 07:00.

Noise

Generally defined as the unwanted portion of sound.

Noise Level

This is the same as sound level except that it is applied to unwanted sounds, general the sound level at a point of reception.

Sound

A dynamic (fluctuating) pressure.

Sound level meter (SLM)

An instrument designed and calibrated to respond to sound and to give objective, reproducible measurements of sound pressure level. It normally has several features that would enable its frequency response and averaging times to be changed to make it suitable to simulate the response of the human ear.

Sound Pressure Level (SPL)

The logarithmic ratio of the RMS sound pressure to the sound pressure at the threshold of hearing. The sound pressure level is defined by equation (1) where P is the RMS pressure due to a sound and P0 is the reference pressure. P0 is usually taken as 2.0 × 10-5 Pascals.

(1) SPL (dB) = 20 log(PRMS/P0)

Sound Power Level (PWL)

The logarithmic ratio of the instantaneous sound power (energy) of a noise source to that of an international standard reference power. The sound power level is defined by equation (2) where W is the sound power of the source in watts, and W0 is the reference power of 10-12 watts.

(2) PWL (dB) = 10 log(W/W0)

Interrelationships between sound pressure level (SPL) and sound power level (PWL) depend on the location and type of source.

Spectrum

The description of a sound wave's resolution into its components of frequency and amplitude.

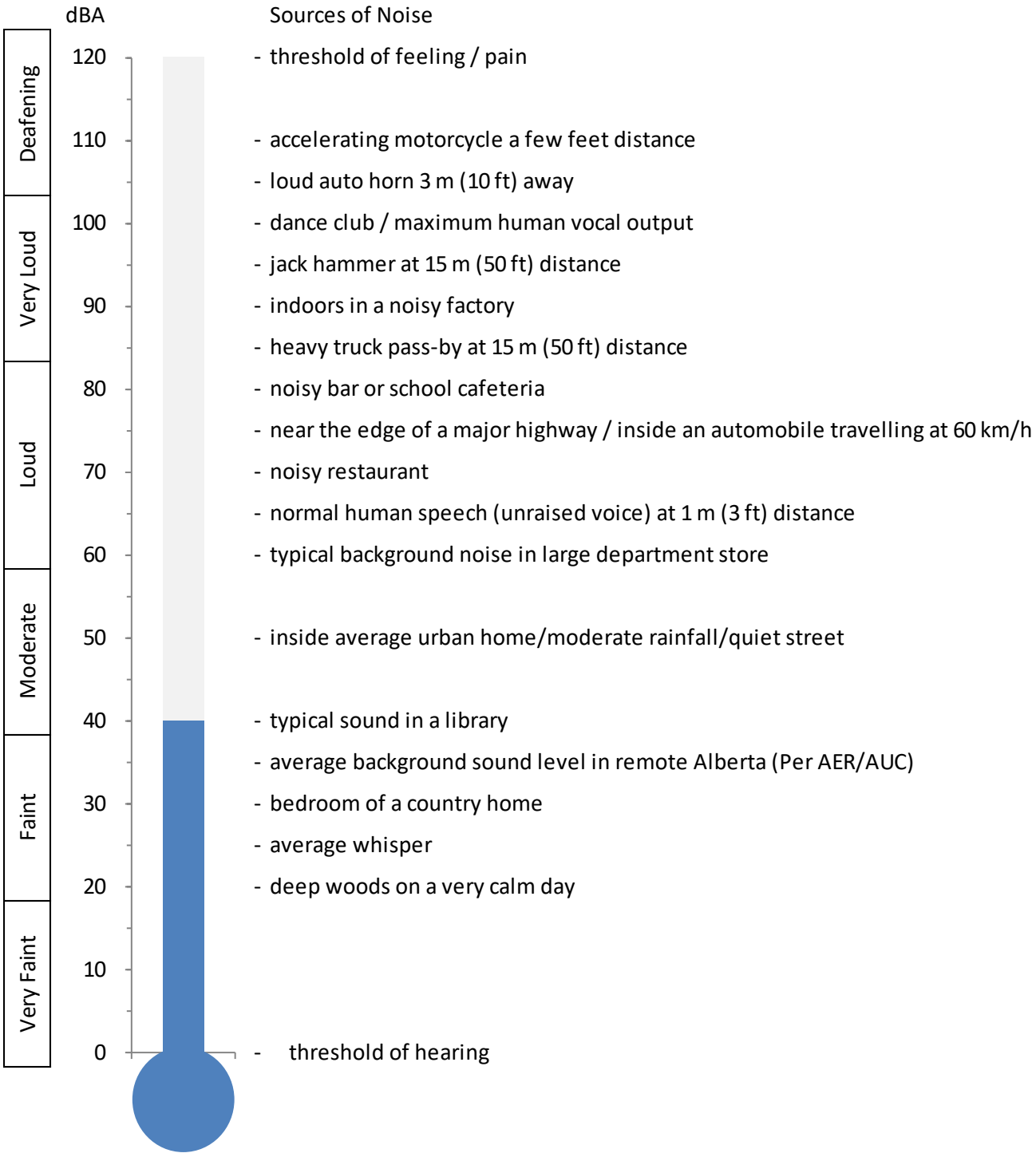
Speed of Sound in Air

344 m/s at 70°F (21°C) in air at sea level.

Tonal Components

Some industrial facilities typically exhibit a tonal component. Examples of tonal components are transformer hum, sirens, and piping noise. The test for the presence of tonal components consists of two parts. The first part must demonstrate that the sound pressure level of any one of the slow-response, A-weighted, 1/3-octave bands between 20 and 16000Hz is 10 dBA or more than the sound pressure level of at least one of the adjacent bands within two 1/3-octave bandwidths. In addition, there must be a minimum of a 5 dBA drop from the band containing the tone within 2 bandwidths on the opposite side. The second part is that the tonal component must be a pronounced peak clearly obvious within the spectrum.

RELATIONSHIPS BETWEEN EVERYDAY SOUNDS



APPENDIX C

Brüel & Kjær
North America Inc.

The Bruel and Kjaer Calibration Laboratory
3079 Premiere Parkway Suite 120
Duluth, GA 30097
Telephone: 770-209-6907
Fax: 770-447-4033
Web site address: http://www.bkhome.com

ACCREDITED

Calibration Certificate # 1568.01

CERTIFICATE OF CALIBRATION

No.: CAS-189218-V7D3N5-502

CALIBRATION OF:

Calibrator:	Brüel & Kjær	Type 4231 IEC Class: 1		Serial No.:	2730602

CUSTOMER:

RWDI Air Inc.
1000, 736 - 8th Avenue SW
Calgary, AB Canada T2P 1H4

CALIBRATION CONDITIONS:

Environment conditions:	Air temperature:	22.9	°C
	Air pressure:	97.903	kPa
	Relative Humidity:	47	%RH

SPECIFICATIONS:

This document certifies that the acoustic calibrator as listed under "Type" has been calibrated and unless otherwise indicated under "Final Data", meets acceptance criteria as prescribed by the referenced Procedure. Statements of compliance, where applicable, are based on calibration results falling within specified criteria with no reduction by the uncertainty of the measurements. The calibration of the listed transducer was accomplished using a test system which conforms to the requirements of ISO/IEC 17025, ANSI/NCSL Z540-1, and guidelines of ISO 10012-1. For "as received" and "final" data, see the attached page(s). Items marked with one asterisk (*) are not covered by the scope of the current A2LA accreditation. This Certificate and attached data pages shall not be reproduced, except in full, without written approval of the Bruel and Kjaer Calibration Laboratory-Duluth, GA. Results relate only to the items tested. The transducer has been calibrated using Measurement Standards with values traceable to the National Institute of Standards and Technology, National Measurement Institutes or derived from natural physical constants. The acoustic calibrator has been calibrated in accordance with the requirements as specified in IEC60942.

PROCEDURE:

The measurements have been performed with the assistance of Brüel & Kjær acoustic calibrator calibration application Software version 2.3.4 Type 7794 using calibration procedure 4231 Complete

RESULTS:

- [X] "As Received" Data: Within Acceptance Criteria
- [ ] "As Received" Data: Outside Acceptance Criteria
- [X] "Final" Data : Within Acceptance Criteria
- [ ] "Final" Data : Outside Acceptance Criteria

The reported expanded uncertainty is based on the standard uncertainty multiplied by a coverage factor $k = 2$, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with EA-4/02from elements originating from the standards, calibration method, effect of environmental conditions and any short time contribution from the calibrator under calibration.

Date of Calibration: 19 January, 2017

Certificate issued: 19 January, 2017

Jimmy Smith
Calibration Technician

Harold L. Williams
Quality Representative

"Final" Data:

Sound Pressure Levels

All stated values are valid at environmental reference conditions

Nominal Level [dB]	Accept Limit Lower [dB]	Accept Limit Upper [dB]	Measured Level [dB]	Measurement Uncertainty [dB]
94	93.80	94.20	94.00	0.12
114	113.80	114.20	114.03	0.12

Frequency

Nominal Frequency [Hz]	Accept Limit Lower [Hz]	Accept Limit Upper [Hz]	Measured Frequency [Hz]	Measurement Uncertainty [Hz]
1000	999.00	1001.00	1000.00	0.10

Total Distortion*

Distortion mode: [X] TD* [ ] THD*

Calibration Level [dB]*	Accept Limit [%]*	Measured Distortion [%]*	Measurement Uncertainty [%]*
94	1.00	0.42	0.13
114	1.00	0.26	0.13

Environmental Reference Conditions:

Pressure: 101.3 kPa, Temperature: 23 °C, Relative Humidity: 50%

"As Received" Data:

Sound Pressure Levels

All stated values are valid at environmental reference conditions

Nominal Level [dB]	Accept Limit Lower [dB]	Accept Limit Upper [dB]	Measured Level [dB]	Measurement Uncertainty [dB]
94	93.80	94.20	94.06	0.12
114	113.80	114.20	114.08	0.12

Frequency

Nominal Frequency [Hz]	Accept Limit Lower [Hz]	Accept Limit Upper [Hz]	Measured Frequency [Hz]	Measurement Uncertainty [Hz]
1000	999.00	1001.00	1000.00	0.10

Total Distortion*

Distortion mode: [X] TD* [ ] THD*

Calibration Level [dB]*	Accept Limit [%]*	Measured Distortion [%]*	Measurement Uncertainty [%]*
94	1.00	0.41	0.13
114	1.00	0.26	0.13

Environmental Reference Conditions:

Pressure: 101.3 kPa, Temperature: 23 °C, Relative Humidity: 50%

Instrument List

Type	Description	Serial no	Cal. date	Due date	Calibrated by	Trace number
3560	PULSE Analyzer	2610402	2016-10-31	2017-10-31	JA	CAS-172070-S6D6D2-102
9545	Transfer Microphone	3	2016-11-16	2017-11-30	WS	CAS-179633-C8F0Z6-701
4228	Reference Sound Source	2970961	2016-04-01	2017-04-30	Rich Haller	CAS-117980-J7K7C6-302

During the calibration the calibrator has been loaded by the load volume of the Transfer Microphone. The load volumes for a number of different types of Transfer Microphones are listed in the table below.
For Brüel & Kjær Pistonphones types 4220 and 4228 the result of the SPL calibration has been corrected to be valid for a load volume of 1333 mm^3 . For all other types the result is valid with the actual load volume.

Transfer Microphone Type	Fulfils standard IEC 61094-1 LS	Fulfils standard IEC 61094-4 WS	Load Volume 1" (1/2" mic including DP-0776)	Load Volume 1/2"
4180	yes	yes	1126 mm^3	43 mm^3
4192	-	yes	1273 mm^3	190 mm^3
9545	-	-	1333 mm^3	-

Condition "As Received":

Good

Comments: Adjust closer to nominal Sound Pressure Level

Brüel & Kjær
North America Inc.

The Bruel and Kjaer Calibration Laboratory
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Duluth, GA 30097
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Web site address: http://www.bkhome.com

ACCREDITED

Calibration Certificate # 1568.01

CERTIFICATE OF CALIBRATION

No.: CAS-189218-V7D3N5-902

CALIBRATION OF:

Microphone: Brüel & Kjær Type 4189 Serial No. 2741325

CUSTOMER:

RWDI Air Inc.
1000, 736 - 8th Avenue SW
Calgary, AB Canada T2P 1H4

CALIBRATION CONDITIONS:

Environment conditions:	Air temperature:	23	°C
	Air pressure:	99.267	kPa
	Relative Humidity:	42	%RH
Applied polarization voltage:	0 Vdc		

SPECIFICATIONS:

This document certifies that the instrument as listed under "Type" has been calibrated and unless otherwise indicated under "Final Data", meets acceptance criteria as prescribed by the referenced Procedure. Statements of compliance, where applicable, are based on calibration results falling within specified criteria with no reduction by the uncertainty of the measurements. The calibration of the listed transducer was accomplished using a test system which conforms to the requirements of ISO/IEC 17025, ANSI/NCSL Z540-1, and guidelines of ISO 10012-1. For "as received" and "final" data, see the attached page(s). Items marked with one asterisk (*) are not covered by the scope of the current A2LA accreditation. This Certificate and attached data pages shall not be reproduced, except in full, without written approval of the Bruel and Kjaer Calibration Laboratory-Duluth, GA. Results relate only to the items tested. The transducer has been calibrated using Measurement Standards with values traceable to the National Institute of Standards and Technology, National Measurement Institutes or derived from natural physical constants.

PROCEDURE:

The measurements have been performed with the assistance of Brüel & Kjær Microphone Calibration System B&K 9721 with application software WT9649 and WT9650 version 6.0.12 using calibration procedure: 4189-S251-FF-01

RESULTS:

- [X] "As Received" Data: Within Acceptance Criteria
- [ ] "As Received" Data: Outside Acceptance Criteria
- [X] "Final" Data : Within Acceptance Criteria
- [ ] "Final" Data : Outside Acceptance Criteria

The reported expanded uncertainty is based on the standard uncertainty multiplied by a coverage factor k =2 providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with EA-4/02 from elements originating from standards, calibration method, effect of environmental conditions and any short term contribution from the device under calibration.

Date of Calibration: 13 January, 2017

Certificate issued: 13 January, 2017

Harold Williams
Calibration Technician

Jimmy Smith
Quality Representative

Sensitivity

Nominal sensitivity:	-26	dB re. 1V/Pa	+/-	1.5 dB
Sensitivity at calibration conditions:	-25.29	dB re. 1V/Pa	or	54.36 mV/Pa
Sensitivity at reference conditions:	-25.32	dB re. 1V/Pa	or	54.23 mV/Pa
Uncertainty:	+/- 0.11	dB		
Correction factor K at reference conditions:	-0.68	dB		
Calibration Frequency:	251.19	Hz		

Reference Conditions:
Pressure: 101.3 kPa
Temperature: 23 °C
Relative Humidity: 50%

Traceable references

Type	Serial no	Cal. date	Due date	Calibrated by	Trace number
4180	2889922	2015-11-02	2017-11-30	DPLA	M2.10-1070-3.1

Condition "As Received":

GOOD

Comments:

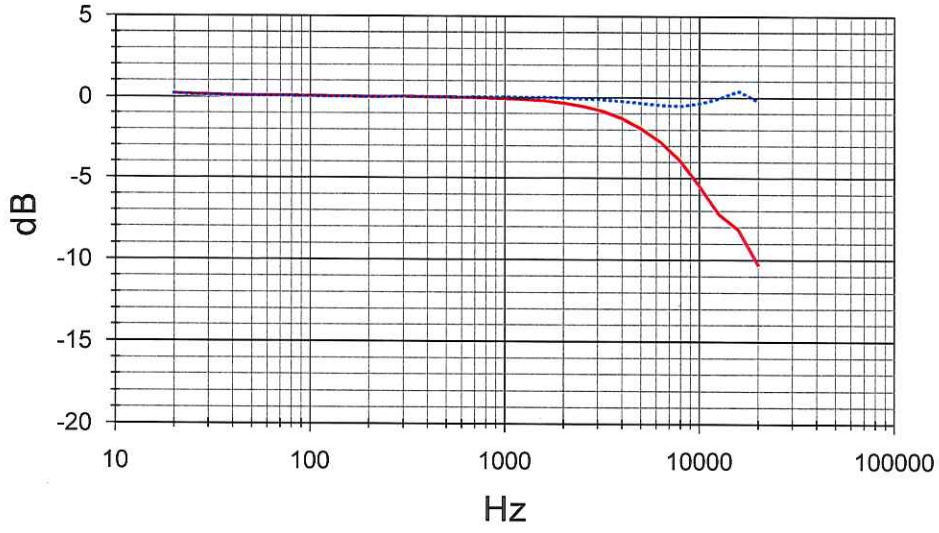
Normalized Frequency Response

Normalization Frequency: 251.19 Hz
Actuator Response is valid at Calibration Conditions
Applied Sound Field Correction: Free-field Correction with Grid, 0 deg incidence.

Frequency [Hz]	Actuator Response [dB]	Sound Field Response [dB]	Combined Uncertainty [dB]	Upper Tolerance [dB]	Lower Tolerance [dB]	Tolerance Exceeded
19.9526	0.16	0.16	0.30	1.00	-1.00	
25.1189	0.11	0.11	0.24	1.00	-1.00	
31.6228	0.09	0.09	0.19	1.00	-1.00	
39.8107	0.06	0.06	0.17	1.00	-1.00	
50.1187	0.06	0.06	0.16	1.00	-1.00	
63.0957	0.05	0.05	0.16	1.00	-1.00	
79.4328	0.04	0.04	0.16	1.00	-1.00	
100.000	0.03	0.03	0.16	1.00	-1.00	
125.893	0.02	0.02	0.16	1.00	-1.00	
158.489	0.01	0.01	0.16	1.00	-1.00	
199.526	-0.01	-0.01	0.16	1.00	-1.00	
251.189	0.00	0.00	0.00	1.00	-1.00	
316.228	0.01	0.01	0.16	1.00	-1.00	
398.107	-0.02	-0.01	0.16	1.00	-1.00	
501.187	-0.03	-0.01	0.16	1.00	-1.00	
630.957	-0.05	-0.01	0.16	1.00	-1.00	
794.328	-0.07	-0.01	0.16	1.00	-1.00	
1000.00	-0.10	-0.01	0.16	1.00	-1.00	
1258.93	-0.17	-0.02	0.16	1.00	-1.00	
1584.89	-0.23	-0.01	0.16	1.00	-1.00	
1995.26	-0.37	-0.05	0.16	1.00	-1.00	
2511.89	-0.58	-0.11	0.17	1.00	-1.00	
3162.28	-0.87	-0.15	0.18	1.00	-1.00	
3981.07	-1.31	-0.25	0.19	1.00	-1.00	
5011.87	-1.94	-0.37	0.19	1.00	-1.00	
6309.57	-2.77	-0.50	0.20	1.00	-1.00	
7943.28	-3.93	-0.55	0.20	1.00	-1.00	
10000.0	-5.50	-0.38	0.25	2.00	-2.00	
12589.3	-7.25	-0.06	0.31	2.00	-2.00	
15848.9	-8.19	0.39	0.40	2.00	-2.00	
19952.6	-10.29	-0.24	0.54	2.00	-2.00	

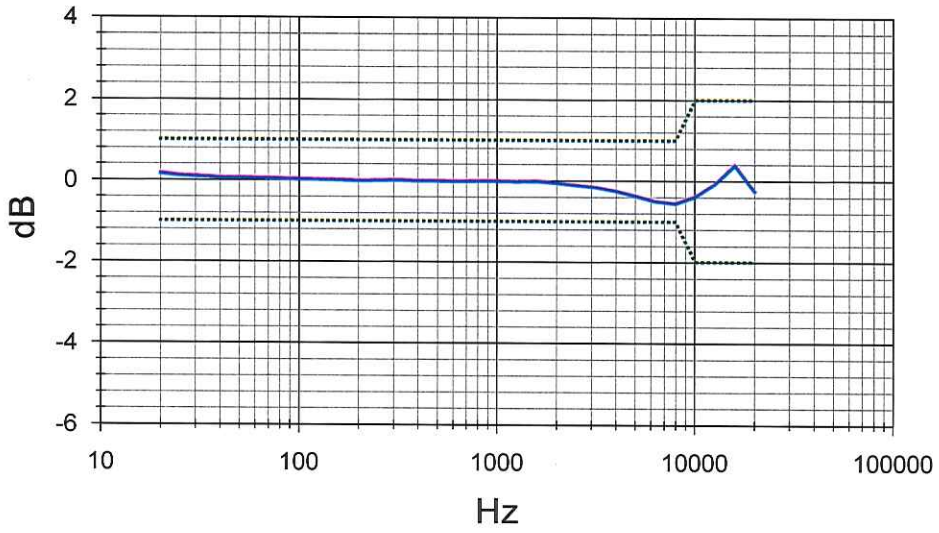
Measured Frequency Response

Solid curve: Actuator response Dotted curve: Sound field response
Applied Sound Field Correction: Free-field Correction with Grid, 0 deg incidence.



Result Response

Solid curve: Sound field response Dotted curves: Tolerance limits
Applied Sound Field Correction: Free-field Correction with Grid, 0 deg incidence.



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Web site address: http://www.bkhome.com

ACCREDITED
Calibration Certificate Number 1568.01

CERTIFICATE OF CALIBRATION

Certificate No: CAS-189218-V7D3N5-802

CALIBRATION OF:

Sound Level Meter:	Brüel & Kjær	2250	Serial No: 2749844
Microphone:	Brüel & Kjær	4189	Serial No: 2741325
Preamplifier:	Brüel & Kjær	ZC-0032	Serial No: 15132
Supplied Calibrator:	Brüel & Kjær	4231	Serial No: 2730602
Software version:	BZ7222 Version 4.7.1		

CLIENT:

RWDI Air Inc.
#1000 - 736 8th Avenue SW
Calgary, AB T2P 1H4

CALIBRATION CONDITIONS:

Preconditioning: 4 hours at 23 ± 3 °C
Environment conditions See actual values in Environmental Condition sections

SPECIFICATIONS:

This document certifies that the instrument as listed under "Model/Serial Number" has been calibrated and unless otherwise indicated under "Final Data", meets acceptance criteria as prescribed by the referenced Procedure. The reported expanded uncertainty is based on the standard uncertainty multiplied by a coverage factor $k = 2$ providing a level of confidence of approximately 95%. Statements of compliance, where applicable, are based on calibration results falling within specified criteria with no reduction by the uncertainty of the measurement. The calibration of the listed instrumentation, was accomplished using a test system which conforms with the requirements of ISO/IEC 17025, ANSI/NCSL Z540-1, and ISO 10012-1. For "as received" and/or "final" data, see the attached page(s). Items marked with one asterisk (*) are not covered by the scope of the current A2LA accreditation This Certificate and attached data pages shall not be reproduced, except in full, without the written approval of the Brüel and Kjær Calibration Laboratory-Duluth, GA. Results relate only to the items tested. This instrument has been calibrated using Measurement Standards with values traceable to the National Institute of Standards and Technology, National Measurement Institutes or derived from natural physical constants.

PROCEDURE:

Brüel and Kjær Model 3630 Sound Level Meter Calibration System Software 7763 Version 6.0 - DB: 6.01 Test Collection 2250-4189.

RESULTS:

As Received Condition
__X__ Received in good condition
___ Damaged - See attached report

As Received Data
__X__ Within acceptance criteria
___ Outside acceptance criteria
___ Inoperative
___ Data not taken

Final Data
__X__ Within acceptance criteria
___ Limited test - See attached details

Date of Calibration: 17 Jan. 2017

Certificate issued: 18 Jan. 2017

Debra Wilson

Calibration Technician

John Astle

Quality Representative

Summary

Preliminary inspection	Passed
Environmental conditions, Prior to calibration	Passed
Reference information	Passed
Indication at the calibration check frequency	Passed
Self-generated noise, Microphone installed	Passed
Acoustical signal tests of a frequency weighting, C weighting	Passed
Self-generated noise, Electrical	Passed
Electrical signal tests of frequency weightings, A weighting	Passed
Electrical signal tests of frequency weightings, C weighting	Passed
Electrical signal tests of frequency weightings, Z weighting	Passed
Frequency and time weightings at 1 kHz	Passed
Level linearity on the reference level range, Upper	Passed
Level linearity on the reference level range, Lower	Passed
Toneburst response, Time-weighting Fast	Passed
Toneburst response, Time-weighting Slow	Passed
Toneburst response, LAE	Passed
Peak C sound level, 8 kHz	Passed
Peak C sound level, 500 Hz	Passed
Overload indication	Passed
Environmental conditions, Following calibration	Passed

The sound level meter submitted for periodic testing successfully completed the class 1 tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed.
However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2002 because evidence was not publicly available, from an independent testing organization responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002 and because the periodic test of IEC 61672-3:2006 cover only a limited subset of the specifications in IEC 61672-1:2002.

Conformance to the requirements of IEC 61672-3:2006, is demonstrated when the measured deviations extended by the actual expanded uncertainties of measurement, do not exceed the applicable tolerance limits given in IEC 61672-1:2002. (as specified in IEC 61672-3:2006 § 4.1)

Instruments

Category:	Type:	Manufacturer:	Serial No.:	Next Calibration Date:	Traceable to:
Voltmeter	DMM34970A	Agilent	44002586	31 Jul. 2017	395457
Calibrator	4226	Brüel & Kjær	2433680	31 May. 2017	CAS--134036-T9Z7X5-902
Adaptor	WA0302B, 15 pF	Brüel & Kjær	2368671	30 Jun. 2017	375702
Generator	Pulse Generator	Brüel & Kjær	2604447	30 Apr. 2017	CAS-181227-M4B9R3-805
AmplifierDivider	3111 Output Module	Brüel & Kjær	2590603	30 Apr. 2017	CAS-181227-M4B9R3-805

Preliminary inspection

Visually inspect instrument, and operate all relevant controls. (section 5)

	Result
Visual inspection	OK

Environmental conditions, Prior to calibration

Actual environmental conditions prior to calibration. (section 7)

	Measured [Deg / kPa / %RH]
Air temperature	24.00
Air pressure	98.19
Relative humidity	44.30

Reference information

Information about reference range, level and channel. (section 19.h + 19.m)

	Value [dB]
Reference sound pressure level	94
Reference level range	140
Channel number	1

Indication at the calibration check frequency

Measure and adjust sound level meter using the supplied calibrator. (section 9 + 19.m)

	Measured [dB / Hz]	Uncertainty [dB / Hz]
Initial indication (supplied calibrator)	93.86	0.14
Calibration check frequency (supplied calibrator)	1000.00	1.00
Adjusted indication (supplied calibrator)	93.86	0.14

Self-generated noise, Microphone installed

Self-generated noise measured with microphone submitted for periodic testing, and with sensitivity set to nominal microphone open circuit sensitivity. Averaging time is 30 seconds. An anechoic chamber is used to isolate environmental noise. (section 10.1)

	Max [dB]	Measured [dB]	Deviation [dB]	Uncertainty [dB]		
A weighted	17.70	16.45	-1.25	0.50	Underrange	*
Monitor Level	20.70	5.82	-14.88	1.00		*

Acoustical signal tests of a frequency weighting, C weighting

Frequency weightings measured acoustically with a calibrated multi-frequency sound calibrator. Averaging time is 10 seconds, and the result is the average of 2 measurements. (section 11)

	Coupler Pressure Lc [dB]	Mic. Correction C4226 [dB]	Body Influence [dB]	Expected [dB]	Measured [dB]	Accept - Limit [dB]	Accept + Limit [dB]	Deviation [dB]	Uncertainty [dB]
1000Hz, Ref. (1st)	94.07	0.10	-0.07	94.04	93.92	-1.1	1.1	-0.12	0.20
1000Hz, Ref. (2nd)	94.07	0.10	-0.07	94.04	93.91	-1.1	1.1	-0.13	0.20
1000Hz, Ref. (Average)	94.07	0.10	-0.07	94.04	93.91	-1.1	1.1	-0.13	0.20
125.89Hz (1st)	94.05	0.00	0.00	93.79	93.83	-1.5	1.5	0.04	0.20
125.89Hz (2nd)	94.05	0.00	0.00	93.79	93.83	-1.5	1.5	0.04	0.20
125.89Hz (Average)	94.05	0.00	0.00	93.79	93.83	-1.5	1.5	0.04	0.20
3981.1Hz (1st)	93.92	0.90	-0.09	92.25	91.95	-1.6	1.6	-0.30	0.30
3981.1Hz (2nd)	93.92	0.90	-0.09	92.25	91.96	-1.6	1.6	-0.29	0.30
3981.1Hz (Average)	93.92	0.90	-0.09	92.25	91.96	-1.6	1.6	-0.29	0.30
7943.3Hz (1st)	93.51	2.80	-0.08	87.73	87.17	-3.1	2.1	-0.56	0.40
7943.3Hz (2nd)	93.51	2.80	-0.08	87.73	87.17	-3.1	2.1	-0.56	0.40
7943.3Hz (Average)	93.51	2.80	-0.08	87.73	87.17	-3.1	2.1	-0.56	0.40

Self-generated noise, Electrical

Self-generated noise measured in most sensitive range, with electrical substitution for microphone, according to manufacturer's specifications. The noise is measured with sensitivity set to nominal microphone open circuit sensitivity.
Exceedance of the measured level above the corresponding level given in the instruction manual does not, by itself, mean that the performance of the sound level meter is no longer acceptable for many practical applications. (section 10.2)

	Max [dB]	Measured [dB]	Uncertainty [dB]	
A weighted	13.60	11.85	0.30	*
C weighted	14.30	11.90	0.30	*
Z weighted	19.40	17.01	0.30	*

Electrical signal tests of frequency weightings, A weighting

Frequency response measured with electrical signal relative to level at 1 kHz in reference range. (section 12)

	Input Level	Expected	Measured	El.+Acous. Resp.	Body Influence	Corr. Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dBV]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]
1000Hz, Ref.	-23.81	95.00	95.00	0.01	-0.07	94.94	-1.1	1.1	-0.06	0.12
63.096Hz	2.39	95.00	95.00	0.00	0.00	95.00	-1.5	1.5	0.00	0.12
125.89Hz	-7.71	95.00	95.00	0.00	0.00	95.00	-1.5	1.5	0.00	0.12
251.19Hz	-15.21	95.00	94.96	0.00	0.07	95.03	-1.4	1.4	0.03	0.12
501.19Hz	-20.61	95.00	94.96	-0.01	0.22	95.17	-1.4	1.4	0.17	0.12
1995.3Hz	-25.01	95.00	95.00	0.04	-0.09	94.95	-1.6	1.6	-0.05	0.12
3981.1Hz	-24.81	95.00	94.99	0.04	-0.09	94.94	-1.6	1.6	-0.06	0.12
7943.3Hz	-22.71	95.00	95.00	-0.03	-0.08	94.89	-3.1	2.1	-0.11	0.12
15849Hz	-17.21	95.00	94.10	0.87	0.11	95.08	-17.0	3.5	0.08	0.12

Electrical signal tests of frequency weightings, C weighting

Frequency response measured with electrical signal relative to level at 1 kHz in reference range. (section 12)

	Input Level	Expected	Measured	El.+Acous. Resp.	Body Influence	Corr. Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dBV]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]
1000Hz, Ref.	-23.81	95.00	95.00	0.01	-0.07	94.94	-1.1	1.1	-0.06	0.12
63.096Hz	-23.01	95.00	94.96	0.00	0.00	94.96	-1.5	1.5	-0.04	0.12
125.89Hz	-23.61	95.00	95.02	0.00	0.00	95.02	-1.5	1.5	0.02	0.12
251.19Hz	-23.81	95.00	94.99	0.00	0.07	95.06	-1.4	1.4	0.06	0.12
501.19Hz	-23.81	95.00	95.03	-0.01	0.22	95.24	-1.4	1.4	0.24	0.12
1995.3Hz	-23.61	95.00	95.04	0.04	-0.09	94.99	-1.6	1.6	-0.01	0.12
3981.1Hz	-23.01	95.00	95.01	0.04	-0.09	94.96	-1.6	1.6	-0.04	0.12
7943.3Hz	-20.81	95.00	95.00	-0.03	-0.08	94.89	-3.1	2.1	-0.11	0.12
15849Hz	-15.31	95.00	94.07	0.87	0.11	95.05	-17.0	3.5	0.05	0.12

Electrical signal tests of frequency weightings, Z weighting

Frequency response measured with electrical signal relative to level at 1 kHz in reference range. (section 12)

Input Level	Expected	Measured	El.+Acous. Resp.	Body Influence	Corr. Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty

	[dBV]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]
1000Hz, Ref.	-23.81	95.00	95.00	0.01	-0.07	94.94	-1.1	1.1	-0.06	0.12
63.096Hz	-23.81	95.00	94.98	0.00	0.00	94.98	-1.5	1.5	-0.02	0.12
125.89Hz	-23.81	95.00	94.98	0.00	0.00	94.98	-1.5	1.5	-0.02	0.12
251.19Hz	-23.81	95.00	94.99	0.00	0.07	95.06	-1.4	1.4	0.06	0.12
501.19Hz	-23.81	95.00	94.99	-0.01	0.22	95.20	-1.4	1.4	0.20	0.12
1995.3Hz	-23.81	95.00	95.01	0.04	-0.09	94.96	-1.6	1.6	-0.04	0.12
3981.1Hz	-23.81	95.00	95.03	0.04	-0.09	94.98	-1.6	1.6	-0.02	0.12
7943.3Hz	-23.81	95.00	95.00	-0.03	-0.08	94.89	-3.1	2.1	-0.11	0.12
15849Hz	-23.81	95.00	94.13	0.87	0.11	95.11	-17.0	3.5	0.11	0.12

Frequency and time weightings at 1 kHz

Frequency and time weighting measured at 1 kHz with electrical signal in reference range. Measured relative to A-weighted and Fast response. (section 13)

	Expected	Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]
LAF, Ref.	94.00	94.00	-0.4	0.4	0.00	0.12
LCF	94.00	94.00	-0.4	0.4	0.00	0.12
LZF	94.00	94.00	-0.4	0.4	0.00	0.12
LAS	94.00	93.96	-0.3	0.3	-0.04	0.12
LAeq	94.00	94.00	-0.3	0.3	0.00	0.12

Level linearity on the reference level range, Upper

Level linearity in reference range, measured at 8 kHz until overload. (section 14)

	Expected	Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]
94 dB	94.00	94.00	-1.1	1.1	0.00	0.13
99 dB	99.00	99.00	-1.1	1.1	0.00	0.13
104 dB	104.00	104.01	-1.1	1.1	0.01	0.13
109 dB	109.00	109.01	-1.1	1.1	0.01	0.13

114 dB	114.00	114.01	-1.1	1.1	0.01	0.13
119 dB	119.00	119.02	-1.1	1.1	0.02	0.13
124 dB	124.00	124.02	-1.1	1.1	0.02	0.13
129 dB	129.00	129.02	-1.1	1.1	0.02	0.13
134 dB	134.00	134.02	-1.1	1.1	0.02	0.13
135 dB	135.00	135.02	-1.1	1.1	0.02	0.13
136 dB	136.00	136.02	-1.1	1.1	0.02	0.13
137 dB	137.00	137.02	-1.1	1.1	0.02	0.13
138 dB	138.00	138.02	-1.1	1.1	0.02	0.13
139 dB	139.00	139.02	-1.1	1.1	0.02	0.13

Level linearity on the reference level range, Lower

Level linearity in reference range, measured at 8 kHz down to lower limit, or until underrange. (section 14)

	Expected [dB]	Measured [dB]	Accept - Limit [dB]	Accept + Limit [dB]	Deviation [dB]	Uncertainty [dB]
94 dB	94.00	94.00	-1.1	1.1	0.00	0.13
89 dB	89.00	89.00	-1.1	1.1	0.00	0.13
84 dB	84.00	84.00	-1.1	1.1	0.00	0.13
79 dB	79.00	79.00	-1.1	1.1	0.00	0.13
74 dB	74.00	74.00	-1.1	1.1	0.00	0.13
69 dB	69.00	68.99	-1.1	1.1	-0.01	0.13
64 dB	64.00	63.99	-1.1	1.1	-0.01	0.13
59 dB	59.00	58.99	-1.1	1.1	-0.01	0.13
54 dB	54.00	53.99	-1.1	1.1	-0.01	0.13
49 dB	49.00	49.00	-1.1	1.1	0.00	0.13
44 dB	44.00	44.01	-1.1	1.1	0.01	0.13
39 dB	39.00	39.03	-1.1	1.1	0.03	0.24
34 dB	34.00	34.06	-1.1	1.1	0.06	0.24
29 dB	29.00	29.16	-1.1	1.1	0.16	0.24
28 dB	28.00	28.19	-1.1	1.1	0.19	0.24
27 dB	27.00	27.27	-1.1	1.1	0.27	0.24
26 dB	26.00	26.30	-1.1	1.1	0.30	0.24
25 dB	25.00	25.39	-1.1	1.1	0.39	0.24

Toneburst response, Time-weighting Fast

Response to 4 kHz toneburst measured in reference range, relative to continuous signal. (section 16)

	Expected [dB]	Measured [dB]	Accept - Limit [dB]	Accept + Limit [dB]	Deviation [dB]	Uncertainty [dB]	
Continuous, Ref.	137.00	137.00	-0.8	0.8	0.00	0.12	*
200 ms Burst	136.00	136.00	-0.8	0.8	0.00	0.12	*
2 ms Burst	119.00	118.93	-1.8	1.3	-0.07	0.12	*
0.25 ms Burst	110.00	109.83	-3.3	1.3	-0.17	0.12	*

Toneburst response, Time-weighting Slow

Response to 4 kHz toneburst measured in reference range, relative to continuous signal. (section 16)

Expected	Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty

	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	
Continuous, Ref.	137.00	137.00	-0.8	0.8	0.00	0.12	*
200 ms Burst	129.60	129.60	-0.8	0.8	0.00	0.12	*
2 ms Burst	110.00	109.99	-3.3	1.3	-0.01	0.12	*

Toneburst response, LAE

Response to 4 kHz toneburst measured in reference range, relative to continuous signal. (section 16)

	Expected	Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty	
	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]	
Continuous, Ref.	137.00	137.00	-0.8	0.8	0.00	0.11	*
200 ms Burst	130.00	129.99	-0.8	0.8	-0.01	0.11	*
2 ms Burst	110.00	109.96	-1.8	1.3	-0.04	0.11	*
0.25 ms Burst	101.00	100.85	-3.3	1.3	-0.15	0.11	*

Peak C sound level, 8 kHz

Peak-response to a 8 kHz single- cycle sine measured in least-sensitive range, relative to continuous signal. (section 17)

	Expected	Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]
Continuous, Ref.	135.00	135.00	-0.4	0.4	0.00	0.09
Single Sine	138.40	138.45	-2.4	2.4	0.05	0.12

Peak C sound level, 500 Hz

Peak-response to a 500 Hz half-cycle sine measured in least-sensitive range, relative to continuous signal. (section 17)

	Expected	Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dB]	[dB]	[dB]	[dB]	[dB]	[dB]
Continuous, Ref.	135.00	135.00	-0.4	0.4	0.00	0.09
Half-sine, Positive	137.40	137.12	-1.4	1.4	-0.28	0.12
Half-sine, Negative	137.40	137.11	-1.4	1.4	-0.29	0.12

Overload indication

Overload indication in the least sensitive range determined with a 4 kHz positive/negative half-cycle signal. (section 18)

	Measured	Accept - Limit	Accept + Limit	Deviation	Uncertainty
	[dB]	[dB]	[dB]	[dB]	[dB]
Continuous	140.00	-0.4	0.4	0.00	0.20
Half-sine, Positive	141.20	-10.0	10.0	1.20	0.20

Half-sine, Negative	141.20	-10.0	10.0	1.20	0.20
Difference	141.20	-1.8	1.8	0.00	0.30

Environmental conditions, Following calibration

Actual environmental conditions following calibration. (section 7)

	Measured [Deg / kPa / %RH]
Air temperature	24.00
Air pressure	98.08
Relative humidity	45.30

CERTIFICATE of CALIBRATION

Make : Bruel & Kjaer

Model : 4231

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

Serial # : 2730602

Asset # : 2250 KIT 3

Reference # : 151514

Customer : Rowan Williams Davies & Irwin Inc
Calgary, AB

P. Order : NOI-01-01-KAMH

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 : Feb 01, 2018

Cal. Due : Feb 01, 2020

By : J. Raposo

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

Standards used : J-163 J-261 J-282 J-508

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

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

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

Calibration Report part of Certificate #: 151514

Make	Model	Serial	Asset	Cal. By
Bruel&Kjaer	4231	2730602	2250 KIT 3	jr

Test	Reading	Spec's	In/Out
SPL at 98.7kPa Ref 20µPa			
94dB	94.0	±0.2dB	In
114dB	114.0	±0.2dB	In
Freq. Accuracy			
1000Hz	1000.0	±2Hz	In

APPENDIX D

APPENDIX D: PERMISSIBLE SOUND LEVEL

Proximity to Transportation	Dwelling Unit Density per 1/4 Section of Land[1]			Daytime (07:00 - 22:00)	Nighttime (22:00 - 07:00)
	1-8 Dwellings (dBA)	9-160 Dwellings (dBA)	>160 Dwellings (dBA)		
Basic Sound Level[2]					
No Residences within 1.5 km from the facility fence line					
Category 1[3]	40	43	46	40	40
Category 2[4]	45	48	51		
Category 3[5]	50	53	56		
Daytime Sound Level Adjustment				+10	0
Basic Sound Level				50	40
Ambient Sound Level Adjustment[6]				-5	-5
Assumed Ambient Sound Level				45	35

Class	Reason for Adjustments	Value (dBA Leq)	Daytime (07:00 - 22:00)	Nighttime (22:00 - 07:00)
Class A Adjustments[7]				
A1	Seasonal adjustment (wintertime conditions)	0 to +5	0	0
A2	Ambient monitoring adjustment	-10 to +10	0	0

Class	Duration of activity	Value (dBA Leq)	Daytime (07:00 - 22:00)	Nighttime (22:00 - 07:00)
Class B Adjustments				
B1	1 day	+15		
B2	7 days	+10		
B3	≤ 60 days	+5		
B4	> 60 days	0	0	0

Class	Reason for Adjustments	Value (dBA Leq)	Daytime (07:00 - 22:00)	Nighttime (22:00 - 07:00)
Class C Adjustments[8]				
C1	This adjustment applies to the noise level from wind turbines, only in the presence of wind speeds of 12 m/s or more near a dwelling.	+5	0	0
C2	Class C2 adjustment = measured ambient wind sound level – (basic sound level from Table 1 - five dB)	+1 to +10	0	0

Receptor Location	PSL Calculation	Daytime (07:00 - 22:00)	Nighttime (22:00 - 07:00)
Permissible Sound Level			
All Area Receptors Evaluated	PSL = BSL + Class A + Class B + Class C	50	40

Notes:

1 - Density per quarter section—refers to a quarter section with the affected dwelling at the center (a 451 m radius). For quarter sections with various land uses or with mixed densities, the density chosen is then averaged for the area under consideration.

2 - Basic Sound Level—AUC Rule 012 Table 1 BSL for nighttime

3 - Category 1—dwelling units more than 500 m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers

4 - Category 2—dwelling units more than 30 m but less than 500 m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers

5 - Category 3—dwelling units less than 30 m from heavily travelled roads and/or rail lines and/or subject to frequent aircraft flyovers

6 - The assumed nighttime ambient sound level is five dBA less than the applicable basic sound level. See document text for justification of the assumed ambient sound level for rural area.

7 - After consultation with and approval from the AUC, the PSL may be modified to reflect site specific conditions

8 - See AUC Rule 012 Table 4 for a detailed explanation of Class C Adjustments

APPENDIX E

APPENDIX E: AER ST37 WELLS WITHIN 3KM OF HHWPP TURBINES

UWI	Name	License	LicStatus	LicDate	Licensee	Operator	WellStat	StatDate	Fluid_Desc	ModeDesc	BH_Long	BH_Lat	Licence	Latitude	Longitude	GroundElev	SurfLoc
00/16-28-030-16W4/0	BANKENO BONANZA WATTS 16-28-30-16	123348	RecCertified	19860624	0HE9		2000000	19911009	N/A	ABD	-112.1881	51.6035	123348	51.6035	-112.1881	880.1	16-28-030-16W4
00/05-03-031-17W4/2	MARQUEE MICHI 5-3-31-17	307795	Issued	20040429	A5EB		500	20041119	N/A	N/A	-112.3381	51.62589	307795	51.62589	-112.3381	915.6	05-03-031-17W4
00/08-20-030-17W4/0	MARQUEE MICHI 8-20-30-17	166544	Abandoned	19940421	A5EB		2000000	20121018	N/A	ABD	-112.3541	51.58017	166544	51.58017	-112.3541	952.3	08-20-030-17W4
00/01-26-030-17W4/0	MARQUEE MICHI 1-26-30-17	234608	RecCertified	20000302	A5EB		202000000	20051028	GAS	ABD	-112.2836	51.59428	234608	51.59428	-112.2836	929.4	01-26-030-17W4
03/14-28-030-16W4/0	MARQUEE HZ 103 WATTS 14-28-30-16	444234	Issued	20120216	A5EB	A5EB	111000000	20120616	CR-OIL	PUMP	-112.1999	51.60327	444234	51.59387	-112.2012	882	03-28-030-16W4
00/16-34-030-17W4/2	OMERS MICHICHI 16-34-30-17	117341	Issued	19850829	0HE9	0HE9	210000000	20110706	GAS	FLOW	-112.3078	51.61689	117341	51.61689	-112.3078	923.5	16-34-030-17W4
00/11-32-030-16W4/0	OMERS ET AL WATTS 11-32-30-16	230037	Issued	19991209	0HE9	0HE9	210000000	20000601	GAS	FLOW	-112.2236	51.61391	230037	51.61391	-112.2236	886.2	11-32-030-16W4
00/16-34-030-17W4/0	OMERS MICHICHI 16-34-30-17	117341	Issued	19850829	0HE9		103000000	19931125	CR-OIL	ABZONE	-112.3078	51.61689	117341	51.61689	-112.3078	923.5	16-34-030-17W4
00/02-17-030-17W4/0	MARQUEE MICHI 2-17-30-17	226718	Suspension	19990924	A5EB	A5EB	201000000	20090801	GAS	SUSP	-112.3598	51.56491	226718	51.56491	-112.3598	976.7	02-17-030-17W4
00/16-33-030-16W4/0	AVALANCHE ET AL WATTS 16-33-30-16	125706	Issued	19870130	0HE9	0HE9	111000000	20170613	CR-OIL	PUMP	-112.1898	51.61691	125706	51.61691	-112.1898	862	16-33-030-16W4
00/06-33-030-16W4/0	MARQUEE WATTS 6-33-30-16	126118	Abandoned	19870309	A5EB		2000000	19910801	N/A	ABD	-112.1972	51.61014	126118	51.61014	-112.1972	872.4	06-33-030-16W4
00/13-19-030-16W4/0	MARQUEE MICHI 13-19-30-16	225356	Issued	19990813	A5EB	A5EB	210000000	20060308	GAS	FLOW	-112.2506	51.58711	225356	51.58711	-112.2506	935.9	13-19-030-16W4
00/13-19-030-16W4/2	MARQUEE MICHI 13-19-30-16	225356	Issued	19990813	A5EB		500	20060308	N/A	N/A	-112.2506	51.58711	225356	51.58711	-112.2506	935.9	13-19-030-16W4
00/07-09-030-17W4/0	NCO CANOXY HANDHILLS 7-9-30-17	67381	RecCertified	19771212	0HE9		2000000	19780217	N/A	ABD	-112.3322	51.55228	67381	51.55228	-112.3322	1080.2	07-09-030-17W4
S0/04-14-030-16W4/0	IMP 20 WATTS TH 4-14-30-16	0004492Q	RecExempt	19520409	7		2000000	19520410	N/A	ABD	-112.1611	51.56164	0004492Q	51.56164	-112.1611	932.7	04-14-030-16W4
00/08-09-030-16W4/0	BANKENO BONANZA PEARL 8-9-30-16	124390	RecCertified	19861119	0HE9		2000000	19861130	N/A	ABD	-112.1903	51.55204	124390	51.55204	-112.1903	927.7	08-09-030-16W4
00/16-09-031-16W4/0	OMERS ET AL WATTS 16-9-31-16	109978	Issued	19841017	0HE9	0HE9	210000000	19870424	GAS	FLOW	-112.2068	51.64558	109978	51.64558	-112.2068	867.8	16-09-031-16W4
00/16-21-030-17W4/0	MARQUEE MICHI 16-21-30-17	109365	Abandoned	19840919	A5EB		203000000	19991227	GAS	ABZONE	-112.3305	51.5878	109365	51.5878	-112.3305	983.6	16-21-030-17W4
00/08-31-030-16W4/0	MARQUEE WATTS 8-31-30-16	345617	Abandoned	20051215	A5EB		3000000	20060307	N/A	ABZONE	-112.2362	51.61094	345617	51.61094	-112.2362	890.4	08-31-030-16W4
00/16-21-030-17W4/3	MARQUEE MICHI 16-21-30-17	109365	Abandoned	19840919	A5EB		2000000	20000124	N/A	ABD	-112.3305	51.5878	109365	51.5878	-112.3305	983.6	16-21-030-17W4
00/16-21-030-17W4/2	MARQUEE MICHI 16-21-30-17	109365	Abandoned	19840919	A5EB		4000000	20000125	N/A	ABRENT	-112.3305	51.5878	109365	51.5878	-112.3305	983.6	16-21-030-17W4
00/08-31-030-16W4/2	MARQUEE WATTS 8-31-30-16	345617	Abandoned	20051215	A5EB		2000000	20171220	N/A	ABD	-112.2362	51.61094	345617	51.61094	-112.2362	890.4	08-31-030-16W4
00/16-16-030-16W4/0	COGI COYOTE 16-16-30-16	304369	Abandoned	20040218	A6L2		102000000	20171214	CR-OIL	ABD	-112.1874	51.57271	304369	51.57271	-112.1874	922.2	16-16-030-16W4
02/06-27-030-17W4/0	MARQUEE MICHI 6-27-30-17	226878	Suspension	19990928	A5EB	A5EB	201000000	20121001	GAS	SUSP	-112.3182	51.59766	226878	51.59766	-112.3182	956.3	06-27-030-17W4

UWI	Name	License	LicStatus	LicDate	Licensee	Operator	WellStat	StatDate	Fluid_Desc	ModeDesc	BH_Long	BH_Lat	Licence	Latitude	Longitude	GroundElev	SurfLoc
00/06-24-030-17W4/0	ECA MICHI 6-24-30-17	96392	Abandoned	19820622	26		202000000	20160815	GAS	ABD	-112.2723	51.58004	96392	51.58004	-112.2723	940.7	06-24-030-17W4
00/14-03-031-16W4/0	POCO WATTS 14-3-31-16	123328	RecCertified	19860618	A5G3		2000000	19860628	N/A	ABD	-112.1931	51.63145	123328	51.63145	-112.1931	858	14-03-031-16W4
00/10-12-030-17W4/0	MARQUEE MICHI 10-12-30-17	357203	Issued	20060512	A5EB	A5EB	210000000	20061202	GAS	FLOW	-112.2651	51.5572	357203	51.56207	-112.266	1008.4	02-13-030-17W4
00/06-09-030-16W4/0	TURBO BONANZA WATTS 6-9-30-16	60618	RecCertified	19761013	0M69		202000000	19761025	GAS	ABD	-112.1974	51.55384	60618	51.55384	-112.1974	931.8	06-09-030-16W4
00/14-30-030-16W4/0	AVALANCHE ET AL MICHICHI 14-30-30-16	125670	Abandoned	19870127	0HE9		102000000	20030613	CR-OIL	ABD	-112.249	51.60498	125670	51.60498	-112.249	900.4	14-30-030-16W4
00/07-21-030-16W4/0	COGI WATTS 7-21-30-16	293977	Issued	20030926	A6L2	A5EB	210000000	20040405	GAS	FLOW	-112.1919	51.58091	293977	51.58091	-112.1919	924.8	07-21-030-16W4
00/14-10-030-16W4/0	COGI COYOTE 14-10-30-16	255942	Re-Entered	20010607	A6L2		2000000	20150108	N/A	ABD	-112.1747	51.56103	255942	51.56103	-112.1747	922.4	14-10-030-16W4
00/11-01-030-17W4/0	MEOTA QUESTAR MICHICHI 11-1-30-17	172670	RecCertified	19941117	0XT9		2000000	19941125	N/A	ABD	-112.2686	51.54062	172670	51.54062	-112.2686	1055	11-01-030-17W4
00/07-27-030-17W4/0	SOC MICHI 7-27-30-17	393195	Abandoned	20080129	A7H2		3000000	20130310	N/A	ABZONE	-112.3115	51.59683	393195	51.59683	-112.3115	950.8	07-27-030-17W4
00/07-27-030-17W4/2	SOC MICHI 7-27-30-17	393195	Abandoned	20080129	A7H2		2000000	20130312	N/A	ABD	-112.3115	51.59683	393195	51.59683	-112.3115	950.8	07-27-030-17W4
00/07-13-030-17W4/0	SCEPTRE ET AL ABEL 7-13-30-17	90728	RecCertified	19810615	0NA6		202000000	19920129	GAS	ABD	-112.2646	51.56742	90728	51.56742	-112.2646	1005.9	07-13-030-17W4
00/16-20-030-16W4/0	COGI WATTS 16-20-30-16	298255	Issued	20031209	A6L2	A5EB	210000000	20040405	GAS	FLOW	-112.21	51.5873	298255	51.5873	-112.21	905.3	16-20-030-16W4
00/09-02-030-17W4/0	WWEC ET AL MICHI 9-2-30-17	356376	Suspension	20060501	A6RF		2000000	20060523	N/A	ABD	-112.2845	51.54218	356376	51.54218	-112.2845	1045.1	09-02-030-17W4
02/10-23-030-16W4/2	CNRL 102 WATTS 10-23-30-16	315608	Abandoned	20040929	0HE9		2000000	20161209	N/A	ABD	-112.1468	51.58523	315608	51.58523	-112.1468	882.2	10-23-030-16W4
02/10-23-030-16W4/0	CNRL 102 WATTS 10-23-30-16	315608	Abandoned	20040929	0HE9		3000000	20041021	N/A	ABZONE	-112.1468	51.58523	315608	51.58523	-112.1468	882.2	10-23-030-16W4
00/15-01-031-17W4/0	CNRL HZ MICHI 15-1-31-17	456684	Suspension	20130506	0HE9	0HE9	101000000	20160831	CR-OIL	SUSP	-112.2835	51.63336	456684	51.62283	-112.2973	915.6	01-02-031-17W4
00/14-09-031-16W4/0	OMERS WATTS 14-9-31-16	123068	Suspension	19860404	0HE9		103000000	19960711	CR-OIL	ABZONE	-112.2145	51.64566	123068	51.64566	-112.2145	872.3	14-09-031-16W4
02/13-19-030-16W4/2	MARQUEE MICHI 13-19-30-16	349494	Issued	20060119	A5EB	A5EB	210000000	20060801	GAS	FLOW	-112.2523	51.58709	349494	51.58709	-112.2523	939	13-19-030-16W4
02/06-35-030-17W4/0	OMERS MICHICHI 6-35-30-17	114948	Suspension	19850529	0HE9		103000000	19960807	CR-OIL	ABZONE	-112.2954	51.61169	114948	51.61169	-112.2954	917.6	06-35-030-17W4
02/13-19-030-16W4/0	MARQUEE MICHI 13-19-30-16	349494	Issued	20060119	A5EB	A68P	201000000	20060710	GAS	SUSP	-112.2523	51.58709	349494	51.58709	-112.2523	939	13-19-030-16W4
00/16-11-030-16W4/0	DOME PEARL 16-11-30-16	103288	RecCertified	19830927	A62D		2000000	19831008	N/A	ABD	-112.143	51.55829	103288	51.55829	-112.143	949.5	16-11-030-16W4
00/02-33-030-16W4/0	CNRL HZ WATTS 2-33-30-16	456707	Issued	20130506	0HE9	0HE9	111000000	20170613	CR-OIL	PUMP	-112.1951	51.60633	456707	51.61756	-112.188	862	16-33-030-16W4
02/06-35-030-17W4/3	OMERS MICHICHI 6-35-30-17	114948	Suspension	19850529	0HE9		3000000	20050519	N/A	ABZONE	-112.2954	51.61169	114948	51.61169	-112.2954	917.6	06-35-030-17W4
02/06-35-030-17W4/2	OMERS MICHICHI 6-35-30-17	114948	Suspension	19850529	0HE9		203000000	20050518	GAS	ABZONE	-112.2954	51.61169	114948	51.61169	-112.2954	917.6	06-35-030-17W4
00/16-01-030-17W4/0	SCEPTRE ET AL MICHICHI 16-1-30-17	129525	RecCertified	19871022	0HE9		102000000	19890515	CR-OIL	ABD	-112.2605	51.54396	129525	51.54396	-112.2605	1025.2	16-01-030-17W4
02/06-35-030-17W4/5	OMERS MICHICHI 6-35-30-17	114948	Suspension	19850529	0HE9		3000000	20050525	N/A	ABZONE	-112.2954	51.61169	114948	51.61169	-112.2954	917.6	06-35-030-17W4

UWI	Name	License	LicStatus	LicDate	Licensee	Operator	WellStat	StatDate	Fluid_Desc	ModeDesc	BH_Long	BH_Lat	Licence	Latitude	Longitude	GroundElev	SurfLoc
00/07-33-030-17W4/2	RENAISSANCE ETAL MICHICHI 7-33-30-17	88399	RecCertified	19810121	0RL9		2000000	19860910	N/A	ABD	-112.3366	51.61205	88399	51.61205	-112.3366	948.4	07-33-030-17W4
02/06-35-030-17W4/4	OMERS MICHICHI 6-35-30-17	114948	Suspension	19850529	0HE9		3000000	20050524	N/A	ABZONE	-112.2954	51.61169	114948	51.61169	-112.2954	917.6	06-35-030-17W4
00/07-33-030-17W4/0	RENAISSANCE ETAL MICHICHI 7-33-30-17	88399	RecCertified	19810121	0RL9		3000000	19860910	N/A	ABZONE	-112.3366	51.61205	88399	51.61205	-112.3366	948.4	07-33-030-17W4
00/08-36-030-17W4/0	SCEPTRE ET AL MICHICHI 8-36-30-17	129526	RecCertified	19871022	0NA6		2000000	19930226	N/A	ABD	-112.2602	51.612	129526	51.612	-112.2602	899.8	08-36-030-17W4
00/14-29-030-17W4/0	OIL CREST-MONOGRAM DELIA NO.1	3054	RecExempt	19510618	0D45		2000000	19510806	N/A	ABD	-112.3638	51.60343	3054	51.60343	-112.3638	923.8	14-29-030-17W4
02/14-28-030-16W4/0	MARQUEE WATTS 14-28-30-16	234341	Issued	20000227	A5EB	A5EB	210000000	20011001	GAS	FLOW	-112.2024	51.60249	234341	51.60249	-112.2024	886.5	14-28-030-16W4
00/07-10-031-16W4/0	DEML WATTS 7-10-31-16	87553	Suspension	19801209	A5EB		3000000	20070822	N/A	ABZONE	-112.1895	51.64125	87553	51.64125	-112.1895	852.5	07-10-031-16W4
00/02-21-030-17W4/0	MARQUEE MICHI 2-21-30-17	327955	Amended	20050311	A5EB		2000000	20050925	N/A	ABD	-112.3367	51.57795	327955	51.57708	-112.3385	998.9	03-21-030-17W4
00/08-10-031-16W4/0	OMERS WATTS 8-10-31-16	123055	Issued	19860326	0HE9	0HE9	101000000	20050531	CR-OIL	SUSP	-112.1836	51.63858	123055	51.63858	-112.1836	851	08-10-031-16W4
00/12-34-030-17W4/0	OMERS MICHICHI 12-34-30-17	106032	Issued	19840217	0HE9	0HE9	210000000	20000908	GAS	FLOW	-112.3208	51.61585	106032	51.61585	-112.3208	925.4	12-34-030-17W4
00/03-10-031-16W4/0	ATCOR ET AL WATTS 3-10-31-16	141193	RecCertified	19891006	0T82		2000000	19891018	N/A	ABD	-112.1928	51.63737	141193	51.63737	-112.1928	859.2	03-10-031-16W4
02/08-21-030-17W4/0	MARQUEE MICHI 8-21-30-17	328123	Abandoned	20050316	A5EB		202000000	20111108	GAS	ABD	-112.3312	51.58152	328123	51.58135	-112.3325	992.7	07-21-030-17W4
00/08-10-031-16W4/2	OMERS WATTS 8-10-31-16	123055	Issued	19860326	0HE9	0HE9	210000000	20030308	GAS	FLOW	-112.1836	51.63858	123055	51.63858	-112.1836	851	08-10-031-16W4
00/06-28-030-16W4/0	BONANZA WATTS 6-28-30-16	126493	RecCertified	19870515	A5G3		102000000	19910228	CR-OIL	ABD	-112.2012	51.59637	126493	51.59637	-112.2012	876.7	06-28-030-16W4
02/08-21-030-17W4/2	MARQUEE MICHI 8-21-30-17	328123	Abandoned	20050316	A5EB		3000500	20111017	N/A	ABZONE	-112.3312	51.58152	328123	51.58135	-112.3325	992.7	07-21-030-17W4
00/02-23-030-17W4/0	POCO ABEL 2-23-30-17	107941	RecCertified	19840627	A5G3		2000000	19840709	N/A	ABD	-112.2881	51.57979	107941	51.57979	-112.2881	973.4	02-23-030-17W4
00/01-27-030-16W4/0	MARQUEE WATTS 1-27-30-16	295453	Suspension	20031103	A5EB	A5EB	201000000	20120507	GAS	SUSP	-112.1654	51.59121	295453	51.59121	-112.1654	891.8	01-27-030-16W4
00/10-10-030-17W4/0	VH1 MICHI 10-10-30-17	271920	Abandoned	20020718	A6GB		2000000	20121128	N/A	ABD	-112.3108	51.55508	271920	51.55508	-112.3108	1071.9	10-10-030-17W4
00/11-12-030-17W4/0	CENTRAL-DEL RIO HANDH 11-12-30-17	20196	RecExempt	19601223	26		2000000	19610216	N/A	ABD	-112.2699	51.55613	20196	51.55613	-112.2699	1074.1	11-12-030-17W4
00/01-04-031-17W4/2	MARQUEE MICHI 1-4-31-17	354340	Abandoned	20060317	A5EB		2000000	20171220	N/A	ABD	-112.3483	51.62275	354340	51.62275	-112.3483	930.4	01-04-031-17W4
02/16-05-031-16W4/2	CNRL 102 WATTS 16-5-31-16	301231	Abandoned	20040112	0HE9		3000000	20100718	N/A	ABZONE	-112.2263	51.63252	301231	51.63252	-112.2263	867.29	16-05-031-16W4
02/16-05-031-16W4/0	CNRL 102 WATTS 16-5-31-16	301231	Abandoned	20040112	0HE9		3000000	20100717	N/A	ABZONE	-112.2263	51.63252	301231	51.63252	-112.2263	867.29	16-05-031-16W4
02/16-05-031-16W4/4	CNRL 102 WATTS 16-5-31-16	301231	Abandoned	20040112	0HE9		3000000	20100718	N/A	ABZONE	-112.2263	51.63252	301231	51.63252	-112.2263	867.29	16-05-031-16W4
02/16-05-031-16W4/3	CNRL 102 WATTS 16-5-31-16	301231	Abandoned	20040112	0HE9		3000000	20100720	N/A	ABZONE	-112.2263	51.63252	301231	51.63252	-112.2263	867.29	16-05-031-16W4
00/13-09-031-16W4/0	OMERS WATTS 13-9-31-16	268625	Issued	20020314	0HE9	0HE9	201000000	20040531	GAS	SUSP	-112.2211	51.64632	268625	51.64632	-112.2211	872.1	13-09-031-16W4
00/09-32-030-17W4/2	OMERS MICHICHI 9-32-30-17	268837	Issued	20020322	0HE9		3000000	20020611	N/A	ABZONE	-112.3515	51.61505	268837	51.61505	-112.3515	942.3	09-32-030-17W4

UWI	Name	License	LicStatus	LicDate	Licensee	Operator	WellStat	StatDate	Fluid_Desc	ModeDesc	BH_Long	BH_Lat	Licence	Latitude	Longitude	GroundElev	SurfLoc
02/16-05-031-16W4/5	CNRL 102 WATTS 16-5-31-16	301231	Abandoned	20040112	0HE9		2000000	20110806	N/A	ABD	-112.2263	51.63252	301231	51.63252	-112.2263	867.29	16-05-031-16W4
00/09-32-030-17W4/0	OMERS MICHICHI 9-32-30-17	268837	Issued	20020322	0HE9	0HE9	211000000	20170613	GAS	PUMP	-112.3515	51.61505	268837	51.61505	-112.3515	942.3	09-32-030-17W4
00/13-09-031-16W4/2	OMERS WATTS 13-9-31-16	268625	Issued	20020314	0HE9	0HE9	210000000	20020601	GAS	FLOW	-112.2211	51.64632	268625	51.64632	-112.2211	872.1	13-09-031-16W4
00/09-32-030-17W4/3	OMERS MICHICHI 9-32-30-17	268837	Issued	20020322	0HE9		7000000	20020530	N/A	DRL&C	-112.3515	51.61505	268837	51.61505	-112.3515	942.3	09-32-030-17W4
00/08-11-030-16W4/0	MARQUEE COYOTE 8-11-30-16	241366	Suspension	20000828	A5EB	0HE9	201000000	20120426	GAS	SUSP	-112.1429	51.55261	241366	51.55261	-112.1429	942.9	08-11-030-16W4
00/09-14-030-16W4/2	SOC COYOTE 9-14-30-16	228163	Abandoned	19991102	A7H2		202000000	20100521	GAS	ABD	-112.1383	51.57113	228163	51.57144	-112.1397	910.7	09-14-030-16W4
00/10-32-030-17W4/0	POCO ABEL 10-32-30-17	108152	RecCertified	19840711	A5G3		2000000	19840716	N/A	ABD	-112.3567	51.613	108152	51.613	-112.3567	937.1	10-32-030-17W4
00/09-14-030-16W4/0	SOC COYOTE 9-14-30-16	228163	Abandoned	19991102	A7H2		3000000	20100304	N/A	ABZONE	-112.1383	51.57113	228163	51.57144	-112.1397	910.7	09-14-030-16W4
00/08-12-030-17W4/0	SCEPTRE ET AL MICHICHI 8-12-30-17	130818	Abandoned	19871222	0HE9		2000000	19910712	N/A	ABD	-112.2602	51.55103	130818	51.55103	-112.2602	1017.1	08-12-030-17W4
00/02-03-031-16W4/2	CNRL HZ WATTS 2-3-31-16	434436	Amended	20110617	0HE9	0HE9	110000000	20111006	CR-OIL	FLOW	-112.1877	51.62122	434436	51.63205	-112.1773	849.9	13-02-031-16W4
02/16-36-029-17W4/2	MARQUEE HZ MICHI 16-36-29-17	459410	Suspension	20130916	A5EB		600	20131108	N/A	N/A	-112.2571	51.53106	459410	51.5339	-112.2565	1043.6	01-01-030-17W4
00/01-36-029-17W4/0	MARQUEE HZ MICHI 1-36-29-17	459410	Suspension	20130916	A5EB	A5EB	111000000	20170630	CR-OIL	PUMP	-112.2571	51.51967	459410	51.5339	-112.2565	1043.6	01-01-030-17W4
03/16-01-030-17W4/2	MARQUEE 03 HZ MICHI 16-1-30-17	459411	Issued	20130916	A5EB	A5EB	111000000	20131223	CR-OIL	PUMP	-112.2599	51.5461	459411	51.53399	-112.2565	1043.1	01-01-030-17W4
02/09-03-031-16W4/0	CNRL HZ WATTS 9-3-31-16	434436	Amended	20110617	0HE9		14000000	20110810	N/A	ABDWHP	-112.1805	51.62944	434436	51.63205	-112.1773	849.9	13-02-031-16W4
03/16-01-030-17W4/0	MARQUEE 03 HZ MICHI 16-1-30-17	459411	Issued	20130916	A5EB		600	20131005	N/A	N/A	-112.257	51.54611	459411	51.53399	-112.2565	1043.1	01-01-030-17W4
00/06-35-030-17W4/0	MARQUEE MICHI 6-35-30-17	88213	Abandoned	19810113	A5EB		202000000	19940822	GAS	ABD	-112.2913	51.61044	88213	51.61044	-112.2913	918.2	06-35-030-17W4
00/14-32-029-16W4/0	SOQUIP ET AL COYOTE 14-32-29-16	123888	RecCertified	19860912	0EB2		2000000	19860925	N/A	ABD	-112.2229	51.52958	123888	51.52958	-112.2229	988.4	14-32-029-16W4
00/06-15-030-16W4/0	OMERS ET AL PEARL 6-15-30-16	58299	Suspension	19760521	0HE9	0HE9	101000000	20091231	CR-OIL	SUSP	-112.174	51.56572	58299	51.56572	-112.174	922.6	06-15-030-16W4
02/16-01-030-17W4/0	CELTIC MICHICHI 16-1-30-17	224068	RecCertified	19990629	A6GB		2000000	19991027	N/A	ABD	-112.2587	51.54378	224068	51.54378	-112.2587	1021.9	16-01-030-17W4
00/14-10-030-16W4/2	TRAVERSE COYOTE 14-10-30-16	486581	Issued	20171128	0F9L		0	20171128	N/A	N/A	-112.1747	51.56103	486581	51.56103	-112.1747	922.2	14-10-030-16W4
00/03-16-030-16W4/2	COGI COYOTE 3-16-30-16	318372	Abandoned	20041104	A6L2		2000000	20080830	N/A	ABD	-112.2012	51.563	318372	51.563	-112.2012	934.5	03-16-030-16W4
00/03-16-030-16W4/0	COGI COYOTE 3-16-30-16	318372	Abandoned	20041104	A6L2		3000000	20050128	N/A	ABZONE	-112.2012	51.563	318372	51.563	-112.2012	934.5	03-16-030-16W4
02/16-31-030-16W4/0	MARQUEE WATTS 16-31-30-16	224047	Abandoned	19990629	A5EB		2000000	20030613	N/A	ABD	-112.2365	51.61671	224047	51.61671	-112.2365	904.7	16-31-030-16W4
W0/13-13-030-16W4/0	IMP 30 PEARL TH 13-13-30-16	K0005107J	RecExempt	19520912	7		2000000	19520913	N/A	ABD	-112.1381	51.57491	K0005107J	51.57491	-112.1381	0.9	13-13-030-16W4
S0/01-27-030-16W4/0	IMP 29 WATTS TH 1-27-30-16	K0005107I	RecExempt	19520912	7		2000000	19520913	N/A	ABD	-112.1626	51.59073	K0005107I	51.59073	-112.1626	0.9	01-27-030-16W4
S0/01-29-030-16W4/0	IMP 32 WATTS TH 1-29-30-16	K0005107L	RecExempt	19520912	7		2000000	19520913	N/A	ABD	-112.2093	51.59072	K0005107L	51.59072	-112.2093	0.9	01-29-030-16W4

UWI	Name	License	LicStatus	LicDate	Licensee	Operator	WellStat	StatDate	Fluid_Desc	ModeDesc	BH_Long	BH_Lat	Licence	Latitude	Longitude	GroundElev	SurfLoc
S0/01-17-030-16W4/0	IMP 31 PEARL TH 1-17-30-16	K0005107K	RecExempt	19520912	7		2000000	19520913	N/A	ABD	-112.2094	51.56161	K0005107K	51.56161	-112.2094	0.9	01-17-030-16W4
W0/13-29-030-16W4/0	IMP 34 WATTS TH 13-29-30-16	K0005107N	RecExempt	19520912	7		2000000	19520913	N/A	ABD	-112.2319	51.60374	K0005107N	51.60374	-112.2319	0.9	13-29-030-16W4
00/12-11-030-17W4/2	CELTIC MICHI 12-11-30-17	107478	Abandoned	19840606	A6GB		2000000	20080620	N/A	ABD	-112.2972	51.5566	107478	51.5566	-112.2972	1071.5	12-11-030-17W4
W0/13-03-030-16W4/0	IMP 33 PEARL TH 13-3-30-16	K0005107M	RecExempt	19520912	7		2000000	19520913	N/A	ABD	-112.185	51.54598	K0005107M	51.54598	-112.185	0.9	13-03-030-16W4
00/12-11-030-17W4/0	OMERS MICHICHI 12-11-30-17	107478	Abandoned	19840606	A6GB		4000000	19971127	N/A	ABRENT	-112.2972	51.5566	107478	51.5566	-112.2972	1071.5	12-11-030-17W4
00/09-16-030-17W4/0	DEML MICHI 9-16-30-17	259397	RecCertified	20010911	0RC3		2000000	20010919	N/A	ABD	-112.3309	51.5708	259397	51.5708	-112.3309	1080.4	09-16-030-17W4
00/13-15-030-16W4/0	IMP 36 PEARL TH 13-15-30-16	K0005107P	RecExempt	19520912	7		2000000	19520913	N/A	ABD	-112.1819	51.57618	K0005107P	51.57618	-112.1819	0.9	13-15-030-16W4
00/08-03-031-16W4/0	OMERS WATTS 8-3-31-16	124064	Suspension	19860929	0HE9	0HE9	101000000	20120331	CR-OIL	SUSP	-112.1796	51.62669	124064	51.62669	-112.1796	856.4	08-03-031-16W4
W0/04-20-030-16W4/0	IMP 35 WATTS TH 4-20-30-16	K0005107O	RecExempt	19520912	7		2000000	19520913	N/A	ABD	-112.2319	51.57676	K0005107O	51.57676	-112.2319	0.9	04-20-030-16W4
W0/04-34-030-16W4/0	IMP 41 WATTS TH 4-34-30-16	K0005107R	RecExempt	19520912	7		2000000	19520913	N/A	ABD	-112.1849	51.60553	K0005107R	51.60553	-112.1849	0.9	04-34-030-16W4
00/11-33-030-16W4/0	BANKENO BONANZA WATTS 11-33-30-16	124066	RecCertified	19860930	0HE9		2000000	19881022	N/A	ABD	-112.1972	51.61574	124066	51.61574	-112.1972	869.8	11-33-030-16W4
W0/04-08-030-16W4/0	IMP 37 PEARL TH 4-8-30-16	K0005107Q	RecExempt	19520912	7		2000000	19520913	N/A	ABD	-112.2318	51.54874	K0005107Q	51.54874	-112.2318	0.9	04-08-030-16W4
00/01-33-030-17W4/0	OMERS REN MICHICHI 1-33-30-17	98414	RecCertified	19821102	0HE9		202000000	19891018	GAS	ABD	-112.3308	51.60888	98414	51.60888	-112.3308	950.9	01-33-030-17W4
00/11-34-030-16W4/0	CNRL WATTS 11-34-30-16	315560	Abandoned	20040929	0HE9		3000000	20041029	N/A	ABZONE	-112.1785	51.61576	315560	51.61576	-112.1785	861.9	11-34-030-16W4
00/11-34-030-16W4/2	CNRL WATTS 11-34-30-16	315560	Abandoned	20040929	0HE9		2000000	20141019	N/A	ABD	-112.1785	51.61576	315560	51.61576	-112.1785	861.9	11-34-030-16W4
00/14-15-030-16W4/0	SHAPCO PEARL 14-15-30-16	163058	RecCertified	19931210	0GW1		2000000	19940102	N/A	ABD	-112.1746	51.5729	163058	51.5729	-112.1746	918.1	14-15-030-16W4
00/14-26-030-17W4/0	HOME DOME MICHICHI 14-26-30-17	122768	RecCertified	19860228	0K29		102000000	19870913	CR-OIL	ABD	-112.2959	51.60475	122768	51.60475	-112.2959	935.1	14-26-030-17W4
00/01-04-031-17W4/0	RENAISSANCE ET AL MICHI 1-4-31-17	110851	Re-Entered	19841120	0RL9		204000000	19890809	GAS	ABRENT	-112.3483	51.62277	110851	51.62277	-112.3483	930.1	01-04-031-17W4
00/16-03-031-16W4/0	POCO WATTS 16-3-31-16	123643	Issued	19860815	0HE9	0HE9	111000000	19870616	CR-OIL	PUMP	-112.181	51.63352	123643	51.63352	-112.181	848.5	16-03-031-16W4
00/06-30-030-16W4/2	MARQUEE MICHI 6-30-30-16	333103	Suspension	20050617	A5EB		7000000	20050713	N/A	DRL&C	-112.2456	51.59584	333103	51.59341	-112.2481	945.6	03-30-030-16W4
00/06-02-031-17W4/0	MARQUEE MICHI 6-2-31-17	403082	Suspension	20081030	A5EB	A5EB	101000000	20150301	CR-OIL	SUSP	-112.3119	51.62575	403082	51.62575	-112.3119	907	06-02-031-17W4
00/06-13-030-16W4/0	GULF PEARL 6-13-30-16	97446	RecCertified	19820916	A5G3		2000000	19981019	N/A	ABD	-112.1276	51.56561	97446	51.56561	-112.1276	925.7	06-13-030-16W4
00/14-35-030-17W4/0	OMERS MICHICHI 14-35-30-17	114209	Issued	19850411	0HE9	0HE9	111000000	19850505	CR-OIL	PUMP	-112.2913	51.61686	114209	51.61686	-112.2913	925.6	14-35-030-17W4
00/08-27-030-17W4/0	MARQUEE MICHI 8-27-30-17	227153	Suspension	19991005	A5EB	A5EB	201000000	20061201	GAS	SUSP	-112.3077	51.59772	227153	51.59772	-112.3077	955.2	08-27-030-17W4
00/14-21-030-16W4/0	BANKENO BONANZA PEARL 14-21-30-16	124472	RecCertified	19861120	0HE9		2000000	19861213	N/A	ABD	-112.2002	51.59028	124472	51.59028	-112.2002	892.7	14-21-030-16W4
00/13-12-030-16W4/0	SOC COYOTE 13-12-30-16	233054	Issued	20000202	A7H2	0HE9	201000000	20180531	GAS	SUSP	-112.1358	51.55977	233054	51.55974	-112.1339	954.7	13-12-030-16W4

UWI	Name	License	LicStatus	LicDate	Licensee	Operator	WellStat	StatDate	Fluid_Desc	ModeDesc	BH_Long	BH_Lat	Licence	Latitude	Longitude	GroundElev	SurfLoc
00/05-23-030-16W4/0	LADD CWWE WATTS 5-23-30-16	115876	RecCertified	19850705	0H92		2000000	19850718	N/A	ABD	-112.1574	51.58161	115876	51.58161	-112.1574	907.3	05-23-030-16W4
00/10-08-030-17W4/0	MARQUEE MICHI 10-8-30-17	254142	Abandoned	20010417	A5EB		202000000	20090813	GAS	ABD	-112.3574	51.55725	254142	51.56059	-112.3603	1003.2	15-08-030-17W4
00/14-04-031-16W4/0	POCO WATTS 14-4-31-16	108091	RecCertified	19840706	A5G3		2000000	19840717	N/A	ABD	-112.2177	51.63153	108091	51.63153	-112.2177	868.1	14-04-031-16W4
00/12-02-030-16W4/0	IMPERIAL GOLDEN HILL NO. 12-2-30-16	3832	RecExempt	19511123	0EX1		2000000	19520304	N/A	ABD	-112.1585	51.54168	3832	51.54168	-112.1585	925.7	12-02-030-16W4
00/14-28-030-16W4/0	BANKENO BONANZA WATTS 14-28-30-16	126203	RecCertified	19870320	0HE9		102000000	19910731	CR-OIL	ABD	-112.1992	51.60196	126203	51.60196	-112.1992	883.1	14-28-030-16W4
00/16-05-031-16W4/2	OMERS WATTS 16-5-31-16	110442	Abandoned	19841101	0HE9		602040000	20101103	WATER	ABD	-112.2265	51.63268	110442	51.63268	-112.2265	868.6	16-05-031-16W4
00/12-04-031-16W4/0	COL WATTS 12-4-31-16	252427	Issued	20010302	A60Z	0HE9	210000000	20150610	GAS	FLOW	-112.2212	51.63067	252427	51.63067	-112.2212	869.9	12-04-031-16W4
02/12-35-030-17W4/0	MARQUEE MICHI 12-35-30-17	343838	Amended	20051130	A5EB	A5EB	210000000	20060720	GAS	FLOW	-112.3016	51.61256	343838	51.61253	-112.3031	925.3	08-34-030-17W4
02/12-35-030-17W4/3	MARQUEE MICHI 12-35-30-17	343838	Amended	20051130	A5EB		500	20060720	N/A	N/A	-112.3016	51.61256	343838	51.61253	-112.3031	925.3	08-34-030-17W4
02/12-35-030-17W4/2	MARQUEE MICHI 12-35-30-17	343838	Amended	20051130	A5EB		500	20060720	N/A	N/A	-112.3016	51.61256	343838	51.61253	-112.3031	925.3	08-34-030-17W4
00/06-07-030-16W4/2	MARQUEE MICHI 6-7-30-16	188784	RecCertified	19960618	A5EB		2000000	20130708	N/A	ABD	-112.2455	51.55281	188784	51.55281	-112.2455	982	06-07-030-16W4
00/06-30-030-16W4/0	MARQUEE MICHI 6-30-30-16	333103	Suspension	20050617	A5EB	A5EB	210000000	20051218	GAS	FLOW	-112.2456	51.59584	333103	51.59341	-112.2481	945.6	03-30-030-16W4
00/06-07-030-16W4/0	MARQUEE MICHI 6-7-30-16	188784	RecCertified	19960618	A5EB		3000000	19980303	N/A	ABZONE	-112.2455	51.55281	188784	51.55281	-112.2455	982	06-07-030-16W4
00/07-16-030-16W4/0	DEKALB ET AL PEARL 7-16-30-16	139468	RecCertified	19890330	0AW4		2000000	19890407	N/A	ABD	-112.1938	51.56567	139468	51.56567	-112.1938	921.6	07-16-030-16W4
00/15-22-030-17W4/0	MARQUEE MICHI 15-22-30-17	138443	Suspension	19890125	A5EB	A5EB	201000000	20111101	GAS	SUSP	-112.3113	51.58749	138443	51.58749	-112.3113	974.9	15-22-030-17W4
00/06-17-030-16W4/0	BANKENO ET AL PEARL 6-17-30-16	125753	RecCertified	19870206	0HE9		2000000	19870913	N/A	ABD	-112.2229	51.56735	125753	51.56735	-112.2229	948.6	06-17-030-16W4
00/06-29-030-16W4/0	PAN AM A-1 HANDHILLS EV 6-29-30-16	36214	RecCertified	19690520	A5G3		2000000	19690726	N/A	ABD	-112.2252	51.59529	36214	51.59529	-112.2252	921.1	06-29-030-16W4
00/09-04-030-17W4/0	MARQUEE MICHI 9-4-30-17	386122	RecCertified	20071130	A5EB		2000000	20121116	N/A	ABD	-112.3287	51.54217	386122	51.54339	-112.3284	1046.17	09-04-030-17W4
00/07-29-030-16W4/0	POCO WATTS 7-29-30-16	131915	RecCertified	19880203	A5G3		2000000	19880210	N/A	ABD	-112.2158	51.59765	131915	51.59765	-112.2158	893.1	07-29-030-16W4
00/06-03-031-16W4/0	MARQUEE WATTS 6-3-31-16	414201	Abandoned	20091119	A5EB		8000000	20100304	N/A	J&A	-112.191	51.62568	414201	51.62568	-112.191	862.1	06-03-031-16W4
00/04-09-031-16W4/0	OMERS WATTS 4-9-31-16	107431	Issued	19840604	0HE9	0HE9	111000000	20070701	CR-OIL	PUMP	-112.2196	51.63789	107431	51.63789	-112.2196	863.8	04-09-031-16W4
00/08-34-030-17W4/0	OMERS MICHICHI 8-34-30-17	116620	Issued	19850731	0HE9	0HE9	111000000	19851012	CR-OIL	PUMP	-112.3077	51.61207	116620	51.61207	-112.3077	929.9	08-34-030-17W4
00/04-33-030-16W4/0	MARQUEE WATTS 4-33-30-16	325065	Issued	20050126	A5EB	A5EB	210000000	20050613	GAS	FLOW	-112.2032	51.60848	325065	51.6078	-112.2016	872.5	03-33-030-16W4
00/12-35-030-17W4/0	OMERS H MICHICHI 12-35-30-17	144297	Suspension	19900529	0HE9	0HE9	101000000	20061231	CR-OIL	SUSP	-112.297	51.61606	144297	51.60663	-112.301	926	04-35-030-17W4
00/06-06-030-16W4/0	LONG RUN MICHI 6-6-30-16	338733	Suspension	20050922	A517		7000000	20051004	N/A	DRL&C	-112.245	51.53683	338733	51.53596	-112.2416	1037.9	02-06-030-16W4
00/07-14-030-17W4/0	B.A. OMNITRANS HAND HILLS #1 WELL	B0001852	RecExempt	19470829	2		2000000	19480111	N/A	ABD	-112.29	51.56745	B0001852	51.56745	-112.29	1025.7	07-14-030-17W4

UWI	Name	License	LicStatus	LicDate	Licensee	Operator	WellStat	StatDate	Fluid_Desc	ModeDesc	BH_Long	BH_Lat	Licence	Latitude	Longitude	GroundElev	SurfLoc
00/06-06-030-16W4/2	LONG RUN MICHI 6-6-30-16	338733	Suspension	20050922	A517		7000000	20051004	N/A	DRL&C	-112.245	51.53683	338733	51.53596	-112.2416	1037.9	02-06-030-16W4
00/16-05-031-16W4/0	OMERS WATTS 16-5-31-16	110442	Abandoned	19841101	0HE9		203030000	19870605	GAS	ABZONE	-112.2265	51.63268	110442	51.63268	-112.2265	868.6	16-05-031-16W4
00/11-25-030-17W4/2	MARQUEE MICHI 11-25-30-17	350320	Suspension	20060127	A5EB	A5EB	201000000	20091101	GAS	SUSP	-112.2694	51.60016	350320	51.60016	-112.2694	922.8	11-25-030-17W4
00/06-14-030-16W4/0	ATCOR ET AL PEARL 6-14-30-16	126594	RecCertified	19870527	0T82		2000000	19870606	N/A	ABD	-112.1554	51.56833	126594	51.56833	-112.1554	926.7	06-14-030-16W4
02/06-10-030-16W4/0	COGI COYOTE 6-10-30-16	170858	Abandoned	19940928	A6L2		2000000	19950926	N/A	ABD	-112.1771	51.55384	170858	51.55384	-112.1771	921.3	06-10-030-16W4
00/16-35-030-17W4/0	POCO MICHICHI 16-35-30-17	130711	RecCertified	19871218	A5G3		2000000	19880108	N/A	ABD	-112.2844	51.61689	130711	51.61689	-112.2844	920.2	16-35-030-17W4
00/11-27-030-17W4/2	DEML MICHI 11-27-30-17	89824	RecCertified	19810421	0RC3		2000000	19940226	N/A	ABD	-112.3153	51.5986	89824	51.5986	-112.3153	949.6	11-27-030-17W4
00/11-27-030-17W4/0	DEML MICHI 11-27-30-17	89824	RecCertified	19810421	0RC3		203000000	19940226	GAS	ABZONE	-112.3153	51.5986	89824	51.5986	-112.3153	949.6	11-27-030-17W4
02/06-09-030-16W4/0	OMERS PEARL 6-9-30-16	125746	Abandoned	19870205	0HE9		202000000	20071030	GAS	ABD	-112.1982	51.55286	125746	51.55286	-112.1982	932.6	06-09-030-16W4
00/08-08-031-16W4/0	POCO WATTS 8-8-31-16	108665	RecCertified	19840813	A5G3		2000000	19840830	N/A	ABD	-112.2308	51.63952	108665	51.63952	-112.2308	872.5	08-08-031-16W4
00/08-25-030-17W4/0	POCO MICHICHI 8-25-30-17	118847	RecCertified	19851101	A5G3		2000000	19851121	N/A	ABD	-112.2608	51.5966	118847	51.5966	-112.2608	933.4	08-25-030-17W4
00/06-19-030-16W4/0	SCEPTRE ET AL PEARL 6-19-30-16	88650	RecCertified	19810130	0HE9		2000000	19881006	N/A	ABD	-112.2463	51.58003	88650	51.58003	-112.2463	940.7	06-19-030-16W4
00/08-21-030-16W4/0	MARQUEE WATTS 8-21-30-16	273768	RecCertified	20020913	A5EB		2000000	20021002	N/A	ABD	-112.1902	51.58069	273768	51.58069	-112.1902	920.6	08-21-030-16W4
02/14-21-030-16W4/0	COGI WATTS 14-21-30-16	376768	Issued	20070430	A6L2	A5EB	210000000	20070906	GAS	FLOW	-112.1996	51.59019	376768	51.59019	-112.1996	892.65	14-21-030-16W4
00/05-31-029-16W4/0	MARQUEE HZ MICHI 5-31-29-16	445780	Amended	20120510	A5EB	A5EB	111000000	20121101	CR-OIL	PUMP	-112.2534	51.5239	445780	51.53372	-112.2564	1043.7	01-01-030-17W4
00/06-27-030-17W4/0	POCO MICHICHI 6-27-30-17	117789	RecCertified	19850920	A5G3		2000000	19910611	N/A	ABD	-112.3184	51.59765	117789	51.59765	-112.3184	957.4	06-27-030-17W4
00/10-31-030-16W4/0	MARQUEE WATTS 10-31-30-16	294776	Suspension	20031021	A5EB		3000000	20150109	N/A	ABZONE	-112.2385	51.61572	294776	51.61572	-112.2385	910.6	10-31-030-16W4
00/08-06-030-16W4/0	LONG RUN MICHI 8-6-30-16	248069	Suspension	20001227	A517		3000000	20050831	N/A	ABZONE	-112.2362	51.53676	248069	51.53676	-112.2362	1017.1	08-06-030-16W4
00/11-23-030-16W4/0	DOBC ET AL HAND HILLS 11-23-30-16	48282	RecCertified	19731207	0K35		2000000	19731222	N/A	ABD	-112.1541	51.58619	48282	51.58619	-112.1541	890.3	11-23-030-16W4
00/11-22-030-16W4/0	MARQUEE WATTS 11-22-30-16	270697	Issued	20020607	A5EB		3000000	20020708	N/A	ABZONE	-112.1746	51.58422	270697	51.58422	-112.1746	910.5	11-22-030-16W4
00/08-02-031-17W4/0	OMERS MICHICHI 8-2-31-17	130502	Suspension	19871207	0HE9	0HE9	101000000	20140630	CR-OIL	SUSP	-112.297	51.62386	130502	51.62386	-112.297	915.1	08-02-031-17W4
00/08-06-030-16W4/2	LONG RUN MICHI 8-6-30-16	248069	Suspension	20001227	A517		7000000	20010410	N/A	DRL&C	-112.2362	51.53676	248069	51.53676	-112.2362	1017.1	08-06-030-16W4
00/11-22-030-16W4/3	MARQUEE WATTS 11-22-30-16	270697	Issued	20020607	A5EB		7000000	20020630	N/A	DRL&C	-112.1746	51.58422	270697	51.58422	-112.1746	910.5	11-22-030-16W4
00/09-06-031-16W4/0	MARQUEE WATTS 9-6-31-16	369734	Issued	20061220	A5EB	A5EB	210000000	20070820	GAS	FLOW	-112.2526	51.62845	369734	51.63039	-112.2526	886	09-06-031-16W4
00/11-22-030-16W4/2	MARQUEE WATTS 11-22-30-16	270697	Issued	20020607	A5EB	A5EB	210000000	20020830	GAS	FLOW	-112.1746	51.58422	270697	51.58422	-112.1746	910.5	11-22-030-16W4
00/16-31-030-16W4/0	MARQUEE WATTS 16-31-30-16	123163	Abandoned	19860520	A5EB		202000000	20030613	GAS	ABD	-112.2367	51.61685	123163	51.61685	-112.2367	904.1	16-31-030-16W4

UWI	Name	License	LicStatus	LicDate	Licensee	Operator	WellStat	StatDate	Fluid_Desc	ModeDesc	BH_Long	BH_Lat	Licence	Latitude	Longitude	GroundElev	SurfLoc
00/07-09-030-16W4/0	COGI COYOTE 7-9-30-16	417537	Issued	20100119	A6L2	A5EB	210000000	20100817	GAS	FLOW	-112.191	51.55204	417537	51.55204	-112.191	928.54	07-09-030-16W4
00/13-25-030-17W4/0	MARQUEE MICHI 13-25-30-17	224181	Abandoned	19990705	A5EB		202000000	20111108	GAS	ABD	-112.2736	51.60218	224181	51.60218	-112.2736	915.5	13-25-030-17W4
00/11-23-030-17W4/0	MARQUEE MICHI 11-23-30-17	224180	Abandoned	19990705	A5EB		202000000	20131025	GAS	ABD	-112.2954	51.58668	224180	51.58668	-112.2954	964.3	11-23-030-17W4
00/10-28-030-17W4/0	OMERS MICHICHI 10-28-30-17	106954	Abandoned	19840504	0HE9		202000000	20120814	GAS	ABD	-112.3327	51.60168	106954	51.60168	-112.3327	959.5	10-28-030-17W4
02/13-29-030-16W4/2	CNRL WATTS 13-29-30-16	268103	Abandoned	20020227	0HE9		203000000	20141206	GAS	ABZONE	-112.2271	51.60184	268103	51.60184	-112.2271	898.6	13-29-030-16W4
00/01-36-030-17W4/0	MARQUEE MICHI 1-36-30-17	224183	RecCertified	19990705	A5EB		202000000	20031202	GAS	ABD	-112.2601	51.6081	224183	51.6081	-112.2601	902.9	01-36-030-17W4
02/13-29-030-16W4/0	CNRL WATTS 13-29-30-16	268103	Abandoned	20020227	0HE9		3000000	20020916	N/A	ABZONE	-112.2271	51.60184	268103	51.60184	-112.2271	898.6	13-29-030-16W4
00/12-13-030-17W4/0	MARQUEE MICHI 12-13-30-17	224182	Abandoned	19990705	A5EB		202000000	20030609	GAS	ABD	-112.2734	51.57181	224182	51.57181	-112.2734	972.1	12-13-030-17W4
00/08-21-030-17W4/0	MARQUEE MICHI 8-21-30-17	224185	Abandoned	19990705	A5EB		202000000	20111108	GAS	ABD	-112.3266	51.58163	224185	51.58163	-112.3266	991.2	08-21-030-17W4
02/13-29-030-16W4/3	CNRL WATTS 13-29-30-16	268103	Abandoned	20020227	0HE9		202000000	20150121	GAS	ABD	-112.2271	51.60184	268103	51.60184	-112.2271	898.6	13-29-030-16W4
00/10-23-030-16W4/0	RWTR WESTCOAST WATTS 10-23-30-16	27514	RecCertified	19650112	A6EH		2000000	19650127	N/A	ABD	-112.147	51.58524	27514	51.58524	-112.147	881.8	10-23-030-16W4
00/10-13-030-17W4/0	MARQUEE MICHI 10-13-30-17	360952	Issued	20060728	A5EB	A5EB	210000000	20061128	GAS	FLOW	-112.2623	51.56987	360952	51.56987	-112.2623	1005.3	10-13-030-17W4
02/16-21-030-17W4/0	MARQUEE MICHI 16-21-30-17	390845	Suspension	20080104	A5EB		7000000	20080119	N/A	DRL&C	-112.3307	51.58768	390845	51.58805	-112.3297	985.1	16-21-030-17W4
02/14-15-030-16W4/0	COGI COYOTE 14-15-30-16	408941	Issued	20090204	A6L2		7000000	20090219	N/A	DRL&C	-112.1749	51.57309	408941	51.57309	-112.1749	917.2	14-15-030-16W4
00/11-25-030-17W4/0	MARQUEE MICHI 11-25-30-17	350320	Suspension	20060127	A5EB		7000000	20060203	N/A	DRL&C	-112.2694	51.60016	350320	51.60016	-112.2694	922.8	11-25-030-17W4
00/14-31-030-16W4/0	MARQUEE WATTS 14-31-30-16	338347	Suspension	20050916	A5EB	A68P	201000000	20150101	GAS	SUSP	-112.2486	51.61649	338347	51.61649	-112.2486	909.1	14-31-030-16W4
00/12-16-030-17W4/0	POCO ABEL 12-16-30-17	107792	RecCertified	19840621	A5G3		2000000	19840703	N/A	ABD	-112.3437	51.5698	107792	51.5698	-112.3437	1017.8	12-16-030-17W4
00/05-13-030-16W4/0	NEC COYOTE 5-13-30-16	252602	Abandoned	20010307	A5R5		202000000	20180315	GAS	ABD	-112.1363	51.5675	252602	51.56491	-112.1389	932.2	01-14-030-16W4
00/08-05-031-16W4/2	OMERS WATTS 8-5-31-16	109595	Issued	19841001	0HE9		103000000	20080203	CR-OIL	ABZONE	-112.231	51.62599	109595	51.62599	-112.231	876.4	08-05-031-16W4
00/08-05-031-16W4/0	OMERS WATTS 8-5-31-16	109595	Issued	19841001	0HE9		103000000	20080203	CR-OIL	ABZONE	-112.231	51.62599	109595	51.62599	-112.231	876.4	08-05-031-16W4
00/05-03-031-17W4/0	MARQUEE MICHI 5-3-31-17	307795	Issued	20040429	A5EB	A5EB	210000000	20041119	GAS	FLOW	-112.3381	51.62589	307795	51.62589	-112.3381	915.6	05-03-031-17W4
00/08-05-031-16W4/3	OMERS WATTS 8-5-31-16	109595	Issued	19841001	0HE9	0HE9	601040000	20170731	WATER	SUSP	-112.231	51.62599	109595	51.62599	-112.231	876.4	08-05-031-16W4
00/06-10-030-16W4/0	MAYNARD ET AL PEARL 6-10-30-16	105871	RecCertified	19840210	274		2000000	19861230	N/A	ABD	-112.1786	51.55386	105871	51.55386	-112.1786	921.7	06-10-030-16W4

APPENDIX E: AER ST102 FACILTIES WITHIN 3KM OF HHWPP TURBINES

X	Y	Facility I	Facility N	Operator C	Operator N	Sub Type C	Sub Type	LSD	Licence Nu	EDCT Code	EDCT Descr	Licensee C	Operationa	pid
405544.7754	5717410.641	ABCS0028265	Canadian Natural Resources Limited	0HE9	Canadian Natural Resources Limited	601	Compressor Station	11-29-030-17-4	F28265	40	Compressor Stn <0.01	0HE9	Active	2147483647
415399.9987	5721296.276	ABBT9330005	Watts 4-9-31-16w4	0HE9	Canadian Natural Resources Limited	322	Crude Oil Multiwell Proration Battery	04-09-031-16-4	F4198	30	Oil Multi Bty <0.01	0HE9	Active	2147483647
412389.1732	5714054.475	ABBT0092354	D Energy Michi 10-13-30-17w4	A5EB	Marquee Energy Ltd.	351	Gas Single-Well Battery	10-13-030-17-4	W 0360952	140	Single Well 0.00	A5EB	Active	2147483647
413331.8313	5720527.018	ABBT0095339	D Energy 9-6-31-16w4	A5EB	Marquee Energy Ltd.	351	Gas Single-Well Battery	09-06-031-16-4	W 0369734	140	Single Well 0.00	A5EB	Active	2147483647
412376.5898	5713250.736	ABBT0092355	D Energy Michi 10-12-30-17w4	A5EB	Marquee Energy Ltd.	351	Gas Single-Well Battery	02-13-030-17-4	W 0357203	280	Single Well <0.01	A5EB	Active	2147483647
410048.7596	5719773.042	ABBT0130364	Michichi 15-1-31-17w4	0HE9	Canadian Natural Resources Limited	311	Crude Oil Single-Well Battery	01-02-031-17-4	W 0456684	280	Single Well <0.01	0HE9	Active	2147483647
416903.0747	5716412.244	ABBT0122365	Marquee 103/14-28-30-16w4(surf 3-28)	A5EB	Marquee Energy Ltd.	311	Crude Oil Single-Well Battery	03-28-030-16-4	F44662	320	Oil Single Bty <1t/d	A5EB	Active	2147483647
406381.7154	5719409.521	ABBT6210012	Renaissance Michichi 16-32	A5EB	Marquee Energy Ltd.	361	Gas Multiwell Group Battery	16-32-030-17-4					Active	2147483647
413245.2898	5716047.971	ABBT0090284	13-19-30-16/02	A6RF	Trident Exploration (wx) Corp.	351	Gas Single-Well Battery	13-19-030-16-4	W 0349494	280	Single Well <0.01	A5EB	New	2147483647
408426.4544	5720610.887	ABBT0086926	Wwec 9-3-31-17w4 Single Well Gas	A6RF	Trident Exploration (wx) Corp.	351	Gas Single-Well Battery	09-03-031-17-4	W 0327768	140	Single Well 0.00	A5EB	New	2147483647
409629.0544	5719354.897	ABBT0144345	Michichi 16-34-30-17w4	0HE9	Canadian Natural Resources Limited	351	Gas Single-Well Battery	16-34-030-17-4	W 0117341			0HE9	Active	2147483647
413653.6831	5716464.664	ABBT0087599	Wrangler West 6-30-30-16w4	A5EB	Marquee Energy Ltd.	351	Gas Single-Well Battery	03-30-030-16-4	W 0333103	140	Single Well 0.00	A5EB	Active	2147483647
420915.0766	5713917.231	ABCS0004087	Player Resources Ltd	0TM9	NAL Resources Limited	601	Compressor Station	09-14-030-16-4	F4087	40	Compressor Stn <0.01	A5R5	Active	2147483647
412722.4284	5710010.139	ABBT0130409	Marquee 01-01-030-17w400 Mulit Well	A5EB	Marquee Energy Ltd.	321	Crude Oil Multiwell Group Battery	01-01-030-17-4	F44900	321	Oil Multi Bty <1t/d	A5EB	Active	2147483647
416921.9153	5717618.72	ABCS0033365	Centrica Canada Limited	A68P	Canlin Resources Partnership	601	Compressor Station	14-28-030-16-4	F33365	40	Compressor Stn <0.01	A5EB	Active	2147483647
407207.3915	5720226.581	ABBT0083073	D Energy Wrangler West 100/5-3-31-17	A5EB	Marquee Energy Ltd.	351	Gas Single-Well Battery	05-03-031-17-4	W 0307795	280	Single Well <0.01	A5EB	Active	2147483647
417749.201	5719217.843	ABBT0129325	Watts 16-33-30-16w4	0HE9	Canadian Natural Resources Limited	311	Crude Oil Single-Well Battery	16-33-030-16-4	W 0125706			0HE9	Active	2147483647
417749.201	5719217.843	ABBT0129202	Watts 02/16-33-30-16w4	0HE9	Canadian Natural Resources Limited	311	Crude Oil Single-Well Battery	16-33-030-16-4	W 0456707	280	Single Well <0.01	0HE9	Active	2147483647

APPENDIX F

SIEMENS Gamesa RENEWABLE ENERGY	**GENERAL CHARACTERISTICS MANUAL**	*Code:* **GD381009-en** *Rev:* **1**
		Date: **13/07/2018** *Pg.* **1** *of* **11**
Approval process: **STD - Support**	*Title:* **SG 4.5-145 NOISE EMISSION ANALYSIS**	*Approval process:* **Electronic: PDM Flow**
		Prepared: **SNOVO**
Deliverable: **S12**		*Verified:* **JEJGUERRERO**
		Approved: **RRS**

INDEX

RECORD OF CHANGES

Rev.	Date	Author	Description
0	29/06/2018	SNOVO	Initial Version
1	13/07/2018	SNOVO	Added noise spectra for more wind speed values

1 AIM

This document aims to give an estimation of the noise spectra for the SG 4.5-145 wind turbine.

2 SCOPE

The values in the present document are applicable to all the existing configurations for SG 4.5-145 wind turbine, for standard and low noise operation modes.

3 ABBREVIATIONS, DEFINITIONS

- **WT**: Wind turbine.
- **Wind speed (W_S.):** Expressed in m/s, it is the horizontal wind component value at the height of the hub averaged every 10 minutes.
- **Frequency (f):** Central frequency of a given band spectra, expressed in Hz.
- **L_{WA}:** A-weighted sound power level, expressed in dB(A).
- **Noise level:** The expected sound power level values, expressed in dB(A), represent the sound power that the WT emits at the height of the hub for a given wind speed.
  The noise levels shown in this document are average expected values, called Lw in IEC-61400-14. To obtain the Lwd value, as defined in IEC-61400-14, an increase of 2 dB(A) shall be considered over said Lw values.
- **dB(A):** An A type frequency filter is applied, in accordance with the IEC standard.

4 DESCRIPTION

When not specified otherwise, data in following sections is calculated using the parameters from **Table 1**. All tip speed ratio curves in this document are subject to the validity ranges presented in **Table 2**.

Rated power	OptimaFlex 4.2MW to 4.8 MW
Frequency	50 Hz/60 Hz
Rotor Diameter	145m
Angle of blade tip	Pitch control regulation
Air density reference	1.225 kg/m^3

Table 1 Calculation parameter values for the SG 4.5-145 noise spectra.

Wind Shear (10min average)	≤ 0.3
Turbulence intensity TI [%] for bin i	$5\%\frac{(0.75v_i+5.6)}{v_i} < TI_i < 12\%\frac{(0.75v_i+5.6)}{v_i}$
Terrain	Not complex according to IEC 61400-12-1
Upflow β [º]	$-2^o \leq \beta \leq +2^o$
Grid frequency [Hz]	± 0.5 Hz

Table 2 Validity ranges of the noise spectra for the SG 4.5-145.

Noise values included in the present document correspond to the wind turbine configuration with noise reduction add-ons attached to the blade.

5 NOISE SPECTRA

Table 3 shows the noise curves for the SG 4.5-145 MW expressed as A-weighted sound power level in function of wind speed at hub height, for the standard, Flexible Rating and Noise Reduction System operation and application modes.

Wind Speed [m/s]	6	7	8	9	10	11	12	13	Up to cut-out
SG 4.5-145 Baseline AM0 @ 4.5MW	99.7	103.2	106.2	107.8	107.8	107.8	107.8	107.8	107.8
SG 4.5-145 AM-3 @ 4.2MW	99.7	103.2	106.2	106.9	106.9	106.9	106.9	106.9	106.9
SG 4.5-145 AM-2 @ 4.3MW	99.7	103.2	106.2	107.2	107.2	107.2	107.2	107.2	107.2
SG 4.5-145 AM-1 @ 4.4MW	99.7	103.2	106.2	107.5	107.5	107.5	107.5	107.5	107.5
SG 4.5-145 AM+1 @ 4.6MW	99.7	103.2	106.2	108.1	108.1	108.1	108.1	108.1	108.1
SG 4.5-145 AM+2 @ 4.7MW	99.7	103.2	106.2	108.4	108.4	108.4	108.4	108.4	108.4
SG 4.5-145 AM+3 @ 4.8MW	99.7	103.2	106.2	108.7	108.7	108.7	108.7	108.7	108.7
SG 4.5-145 NRS Mode N1	99.7	103.2	105.7	105.7	105.7	105.7	105.7	105.7	105.7
SG 4.5-145 NRS Mode N2	99.7	103.2	105.2	105.2	105.2	105.2	105.2	105.2	105.2
SG 4.5-145 NRS Mode N3	99.7	103.2	103.7	103.7	103.7	103.7	103.7	103.7	103.7
SG 4.5-145 NRS Mode N4	99.7	102.7	102.7	102.7	102.7	102.7	102.7	102.7	102.7
SG 4.5-145 NRS Mode N5	99.7	101.7	101.7	101.7	101.7	101.7	101.7	101.7	101.7
SG 4.5-145 NRS Mode N6	99.7	99.9	99.9	99.9	99.9	99.9	99.9	99.9	99.9
SG 4.5-145 NRS Mode N7	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0
SG 4.5-145 NRS Mode N8	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0	98.0

Table 3 Noise curves for the SG 4.5-145 MW for the standard, Flexible Rating and Noise Reduction System operation and application modes (ref: *SG145spectra_4X00KW_R01_13072018*).

Tables 4 to 13 show the 1/3 octave band noise spectra for the SG 4.5-145 MW expressed as A-weighted sound power level for a given frequency band, for the standard, Flexible Rating and Noise Reduction System operation and application modes, at 6 m/s wind speed at hub height.

Central Frequency [Hz]	**10**	**12.5**	**16**	**20**	**25**	**31.5**	**40**	**50**	**63**	**80**	**100**
SG 4.5-145 Baseline AM0 @ 4.5MW	38	43.7	49.4	54.8	59.4	64.1	68.3	72.9	77.2	79.7	81.6
SG 4.5-145 AM-3 @ 4.2MW	38	43.7	49.4	54.8	59.4	64.1	68.3	72.9	77.2	79.7	81.6
SG 4.5-145 AM-2 @ 4.3MW	38	43.7	49.4	54.8	59.4	64.1	68.3	72.9	77.2	79.7	81.6
SG 4.5-145 AM-1 @ 4.4MW	38	43.7	49.4	54.8	59.4	64.1	68.3	72.9	77.2	79.7	81.6
SG 4.5-145 AM+1 @ 4.6MW	38	43.7	49.4	54.8	59.4	64.1	68.3	72.9	77.2	79.7	81.6
SG 4.5-145 AM+2 @ 4.7MW	38	43.7	49.4	54.8	59.4	64.1	68.3	72.9	77.2	79.7	81.6
SG 4.5-145 AM+3 @ 4.8MW	38	43.7	49.4	54.8	59.4	64.1	68.3	72.9	77.2	79.7	81.6
SG 4.5-145 NRS Mode N1	38	43.7	49.4	54.8	59.4	64.1	68.3	72.9	77.2	79.7	81.6
SG 4.5-145 NRS Mode N2	38	43.7	49.4	54.8	59.4	64.1	68.3	72.9	77.2	79.7	81.6
SG 4.5-145 NRS Mode N3	38	43.7	49.4	54.8	59.4	64.1	68.3	72.9	77.2	79.7	81.6
SG 4.5-145 NRS Mode N4	38	43.7	49.4	54.8	59.4	64.1	68.3	72.9	77.2	79.7	81.6
SG 4.5-145 NRS Mode N5	38	43.7	49.4	54.8	59.4	64.1	68.3	72.9	77.2	79.7	81.6
SG 4.5-145 NRS Mode N6	38	43.7	49.4	54.8	59.4	64.1	68.3	72.9	77.2	79.7	81.6
SG 4.5-145 NRS Mode N7	38	43.7	49.4	54.8	59.3	64	68.2	72.7	76.9	79.4	81.2
SG 4.5-145 NRS Mode N8	38	43.7	49.4	54.7	59.2	63.8	67.9	72.4	76.6	78.9	80.6
Central Frequency [Hz]	**125**	**160**	**200**	**250**	**315**	**400**	**500**	**630**	**800**	**1000**	**1250**
SG 4.5-145 Baseline AM0 @ 4.5MW	83.1	84.1	85.3	86.8	87.2	86.9	87	88.6	88.4	89.4	90.1
SG 4.5-145 AM-3 @ 4.2MW	83.1	84.1	85.3	86.8	87.2	86.9	87	88.6	88.4	89.4	90.1
SG 4.5-145 AM-2 @ 4.3MW	83.1	84.1	85.3	86.8	87.2	86.9	87	88.6	88.4	89.4	90.1
SG 4.5-145 AM-1 @ 4.4MW	83.1	84.1	85.3	86.8	87.2	86.9	87	88.6	88.4	89.4	90.1
SG 4.5-145 AM+1 @ 4.6MW	83.1	84.1	85.3	86.8	87.2	86.9	87	88.6	88.4	89.4	90.1
SG 4.5-145 AM+2 @ 4.7MW	83.1	84.1	85.3	86.8	87.2	86.9	87	88.6	88.4	89.4	90.1
SG 4.5-145 AM+3 @ 4.8MW	83.1	84.1	85.3	86.8	87.2	86.9	87	88.6	88.4	89.4	90.1
SG 4.5-145 NRS Mode N1	83.1	84.1	85.3	86.8	87.2	86.9	87	88.6	88.4	89.4	90.1
SG 4.5-145 NRS Mode N2	83.1	84.1	85.3	86.8	87.2	86.9	87	88.6	88.4	89.4	90.1
SG 4.5-145 NRS Mode N3	83.1	84.1	85.3	86.8	87.2	86.9	87	88.6	88.4	89.4	90.1
SG 4.5-145 NRS Mode N4	83.1	84.1	85.3	86.8	87.2	86.9	87	88.6	88.4	89.4	90.1
SG 4.5-145 NRS Mode N5	83.1	84.1	85.3	86.8	87.2	86.9	87	88.6	88.4	89.4	90.1
SG 4.5-145 NRS Mode N6	83.1	84.1	85.3	86.8	87.2	86.9	87	88.6	88.4	89.4	90.1
SG 4.5-145 NRS Mode N7	82.6	83.5	84.6	86.1	86.5	86.2	86.3	87.9	87.7	88.7	89.4
SG 4.5-145 NRS Mode N8	81.9	82.6	83.5	85	85.4	85.1	85.2	86.8	86.6	87.6	88.3
Central Frequency [Hz]	**1600**	**2000**	**2500**	**3150**	**4000**	**5000**	**6300**	**8000**	**10000**		
SG 4.5-145 Baseline AM0 @ 4.5MW	90	88.9	87.5	85.3	82.2	77.9	72.7	66.9	62.3		
SG 4.5-145 AM-3 @ 4.2MW	90	88.9	87.5	85.3	82.2	77.9	72.7	66.9	62.3		
SG 4.5-145 AM-2 @ 4.3MW	90	88.9	87.5	85.3	82.2	77.9	72.7	66.9	62.3		
SG 4.5-145 AM-1 @ 4.4MW	90	88.9	87.5	85.3	82.2	77.9	72.7	66.9	62.3		
SG 4.5-145 AM+1 @ 4.6MW	90	88.9	87.5	85.3	82.2	77.9	72.7	66.9	62.3		
SG 4.5-145 AM+2 @ 4.7MW	90	88.9	87.5	85.3	82.2	77.9	72.7	66.9	62.3		
SG 4.5-145 AM+3 @ 4.8MW	90	88.9	87.5	85.3	82.2	77.9	72.7	66.9	62.3		
SG 4.5-145 NRS Mode N1	90	88.9	87.5	85.3	82.2	77.9	72.7	66.9	62.3		
SG 4.5-145 NRS Mode N2	90	88.9	87.5	85.3	82.2	77.9	72.7	66.9	62.3		
SG 4.5-145 NRS Mode N3	90	88.9	87.5	85.3	82.2	77.9	72.7	66.9	62.3		
SG 4.5-145 NRS Mode N4	90	88.9	87.5	85.3	82.2	77.9	72.7	66.9	62.3		
SG 4.5-145 NRS Mode N5	90	88.9	87.5	85.3	82.2	77.9	72.7	66.9	62.3		
SG 4.5-145 NRS Mode N6	90	88.9	87.5	85.3	82.2	77.9	72.7	66.9	62.3		
SG 4.5-145 NRS Mode N7	89.3	88.2	86.8	84.6	81.5	77.2	72	66.2	61.6		
SG 4.5-145 NRS Mode N8	88.2	87.1	85.7	83.5	80.4	76.1	70.9	65.1	60.5		

Table 4 One-third octave band noise spectra of SG 4.5-145 @ 6 m/s
(*ref: SG145spectra_4X00KW_R01_13072018*)

Central Frequency [Hz]	**10**	**12.5**	**16**	**20**	**25**	**31.5**	**40**	**50**	**63**	**80**	**100**
SG 4.5-145 Baseline AM0 @ 4.5MW	41.5	47.2	52.9	58.3	62.9	67.6	71.8	76.4	80.7	83.2	85.1
SG 4.5-145 AM-3 @ 4.2MW	41.5	47.2	52.9	58.3	62.9	67.6	71.8	76.4	80.7	83.2	85.1
SG 4.5-145 AM-2 @ 4.3MW	41.5	47.2	52.9	58.3	62.9	67.6	71.8	76.4	80.7	83.2	85.1
SG 4.5-145 AM-1 @ 4.4MW	41.5	47.2	52.9	58.3	62.9	67.6	71.8	76.4	80.7	83.2	85.1
SG 4.5-145 AM+1 @ 4.6MW	41.5	47.2	52.9	58.3	62.9	67.6	71.8	76.4	80.7	83.2	85.1
SG 4.5-145 AM+2 @ 4.7MW	41.5	47.2	52.9	58.3	62.9	67.6	71.8	76.4	80.7	83.2	85.1
SG 4.5-145 AM+3 @ 4.8MW	41.5	47.2	52.9	58.3	62.9	67.6	71.8	76.4	80.7	83.2	85.1
SG 4.5-145 NRS Mode N1	41.5	47.2	52.9	58.3	62.9	67.6	71.8	76.4	80.7	83.2	85.1
SG 4.5-145 NRS Mode N2	41.5	47.2	52.9	58.3	62.9	67.6	71.8	76.4	80.7	83.2	85.1
SG 4.5-145 NRS Mode N3	41.5	47.2	52.9	58.3	62.9	67.6	71.8	76.4	80.7	83.2	85.1
SG 4.5-145 NRS Mode N4	41.5	47.2	52.9	58.3	62.9	67.5	71.7	76.3	80.5	83	84.8
SG 4.5-145 NRS Mode N5	41.5	47.2	52.9	58.2	62.8	67.4	71.5	76	80.1	82.5	84.2
SG 4.5-145 NRS Mode N6	41.5	47.2	52.8	58.1	62.6	67.1	71.1	75.4	79.4	81.6	83.1
SG 4.5-145 NRS Mode N7	41.5	47.2	52.8	58.1	62.5	67	70.9	75.2	79.1	81.1	82.6
SG 4.5-145 NRS Mode N8	41.5	47.2	52.8	58	62.4	66.8	70.7	74.9	78.7	80.6	81.9
Central Frequency [Hz]	**125**	**160**	**200**	**250**	**315**	**400**	**500**	**630**	**800**	**1000**	**1250**
SG 4.5-145 Baseline AM0 @ 4.5MW	86.6	87.6	88.8	90.3	90.7	90.4	90.5	92.1	91.9	92.9	93.6
SG 4.5-145 AM-3 @ 4.2MW	86.6	87.6	88.8	90.3	90.7	90.4	90.5	92.1	91.9	92.9	93.6
SG 4.5-145 AM-2 @ 4.3MW	86.6	87.6	88.8	90.3	90.7	90.4	90.5	92.1	91.9	92.9	93.6
SG 4.5-145 AM-1 @ 4.4MW	86.6	87.6	88.8	90.3	90.7	90.4	90.5	92.1	91.9	92.9	93.6
SG 4.5-145 AM+1 @ 4.6MW	86.6	87.6	88.8	90.3	90.7	90.4	90.5	92.1	91.9	92.9	93.6
SG 4.5-145 AM+2 @ 4.7MW	86.6	87.6	88.8	90.3	90.7	90.4	90.5	92.1	91.9	92.9	93.6
SG 4.5-145 AM+3 @ 4.8MW	86.6	87.6	88.8	90.3	90.7	90.4	90.5	92.1	91.9	92.9	93.6
SG 4.5-145 NRS Mode N1	86.6	87.6	88.8	90.3	90.7	90.4	90.5	92.1	91.9	92.9	93.6
SG 4.5-145 NRS Mode N2	86.6	87.6	88.8	90.3	90.7	90.4	90.5	92.1	91.9	92.9	93.6
SG 4.5-145 NRS Mode N3	86.6	87.6	88.8	90.3	90.7	90.4	90.5	92.1	91.9	92.9	93.6
SG 4.5-145 NRS Mode N4	86.2	87.2	88.3	89.8	90.2	89.9	90	91.6	91.4	92.4	93.1
SG 4.5-145 NRS Mode N5	85.5	86.3	87.3	88.8	89.2	88.9	89	90.6	90.4	91.4	92.1
SG 4.5-145 NRS Mode N6	84.2	84.7	85.4	86.9	87.3	87	87.1	88.7	88.5	89.5	90.2
SG 4.5-145 NRS Mode N7	83.5	84	84.5	86	86.4	86.1	86.2	87.8	87.6	88.6	89.3
SG 4.5-145 NRS Mode N8	82.8	83.1	83.4	84.9	85.3	85	85.1	86.7	86.5	87.5	88.2
Central Frequency [Hz]	**1600**	**2000**	**2500**	**3150**	**4000**	**5000**	**6300**	**8000**	**10000**		
SG 4.5-145 Baseline AM0 @ 4.5MW	93.5	92.4	91	88.8	85.7	81.4	76.2	70.4	65.8		
SG 4.5-145 AM-3 @ 4.2MW	93.5	92.4	91	88.8	85.7	81.4	76.2	70.4	65.8		
SG 4.5-145 AM-2 @ 4.3MW	93.5	92.4	91	88.8	85.7	81.4	76.2	70.4	65.8		
SG 4.5-145 AM-1 @ 4.4MW	93.5	92.4	91	88.8	85.7	81.4	76.2	70.4	65.8		
SG 4.5-145 AM+1 @ 4.6MW	93.5	92.4	91	88.8	85.7	81.4	76.2	70.4	65.8		
SG 4.5-145 AM+2 @ 4.7MW	93.5	92.4	91	88.8	85.7	81.4	76.2	70.4	65.8		
SG 4.5-145 AM+3 @ 4.8MW	93.5	92.4	91	88.8	85.7	81.4	76.2	70.4	65.8		
SG 4.5-145 NRS Mode N1	93.5	92.4	91	88.8	85.7	81.4	76.2	70.4	65.8		
SG 4.5-145 NRS Mode N2	93.5	92.4	91	88.8	85.7	81.4	76.2	70.4	65.8		
SG 4.5-145 NRS Mode N3	93.5	92.4	91	88.8	85.7	81.4	76.2	70.4	65.8		
SG 4.5-145 NRS Mode N4	93	91.9	90.5	88.3	85.2	80.9	75.7	69.9	65.3		
SG 4.5-145 NRS Mode N5	92	90.9	89.5	87.3	84.2	79.9	74.7	68.9	64.3		
SG 4.5-145 NRS Mode N6	90.1	89	87.6	85.4	82.3	78	72.8	67	62.4		
SG 4.5-145 NRS Mode N7	89.2	88.1	86.7	84.5	81.4	77.1	71.9	66.1	61.5		
SG 4.5-145 NRS Mode N8	88.1	87	85.6	83.4	80.3	76	70.8	65	60.4		

Table 5 One-third octave band noise spectra of SG 4.5-145 @ 7 m/s
(*ref: SG145spectra_4X00KW_R01_13072018*)

Central Frequency [Hz]	**10**	**12.5**	**16**	**20**	**25**	**31.5**	**40**	**50**	**63**	**80**	**100**
SG 4.5-145 Baseline AM0 @ 4.5MW	44.5	50.2	55.9	61.3	65.9	70.6	74.8	79.4	83.7	86.2	88.1
SG 4.5-145 AM-3 @ 4.2MW	44.5	50.2	55.9	61.3	65.9	70.6	74.8	79.4	83.7	86.2	88.1
SG 4.5-145 AM-2 @ 4.3MW	44.5	50.2	55.9	61.3	65.9	70.6	74.8	79.4	83.7	86.2	88.1
SG 4.5-145 AM-1 @ 4.4MW	44.5	50.2	55.9	61.3	65.9	70.6	74.8	79.4	83.7	86.2	88.1
SG 4.5-145 AM+1 @ 4.6MW	44.5	50.2	55.9	61.3	65.9	70.6	74.8	79.4	83.7	86.2	88.1
SG 4.5-145 AM+2 @ 4.7MW	44.5	50.2	55.9	61.3	65.9	70.6	74.8	79.4	83.7	86.2	88.1
SG 4.5-145 AM+3 @ 4.8MW	44.5	50.2	55.9	61.3	65.9	70.6	74.8	79.4	83.7	86.2	88.1
SG 4.5-145 NRS Mode N1	44.5	50.2	55.9	61.3	65.9	70.5	74.7	79.3	83.6	86	87.9
SG 4.5-145 NRS Mode N2	44.5	50.2	55.9	61.3	65.8	70.5	74.6	79.2	83.4	85.8	87.7
SG 4.5-145 NRS Mode N3	44.5	50.2	55.9	61.2	65.7	70.3	74.4	78.9	83	85.3	87
SG 4.5-145 NRS Mode N4	44.5	50.2	55.8	61.1	65.6	70.1	74	78.4	82.4	84.5	86
SG 4.5-145 NRS Mode N5	44.5	50.2	55.8	61.1	65.5	69.9	73.8	78.1	82	84	85.4
SG 4.5-145 NRS Mode N6	44.5	50.2	55.7	61	65.3	69.6	73.4	77.5	81.2	83.1	84.3
SG 4.5-145 NRS Mode N7	44.5	50.2	55.7	60.9	65.2	69.5	73.2	77.2	80.9	82.6	83.7
SG 4.5-145 NRS Mode N8	44.5	50.1	55.7	60.8	65.1	69.3	73	76.9	80.5	82.1	83
Central Frequency [Hz]	**125**	**160**	**200**	**250**	**315**	**400**	**500**	**630**	**800**	**1000**	**1250**
SG 4.5-145 Baseline AM0 @ 4.5MW	89.6	90.6	91.8	93.3	93.7	93.4	93.5	95.1	94.9	95.9	96.6
SG 4.5-145 AM-3 @ 4.2MW	89.6	90.6	91.8	93.3	93.7	93.4	93.5	95.1	94.9	95.9	96.6
SG 4.5-145 AM-2 @ 4.3MW	89.6	90.6	91.8	93.3	93.7	93.4	93.5	95.1	94.9	95.9	96.6
SG 4.5-145 AM-1 @ 4.4MW	89.6	90.6	91.8	93.3	93.7	93.4	93.5	95.1	94.9	95.9	96.6
SG 4.5-145 AM+1 @ 4.6MW	89.6	90.6	91.8	93.3	93.7	93.4	93.5	95.1	94.9	95.9	96.6
SG 4.5-145 AM+2 @ 4.7MW	89.6	90.6	91.8	93.3	93.7	93.4	93.5	95.1	94.9	95.9	96.6
SG 4.5-145 AM+3 @ 4.8MW	89.6	90.6	91.8	93.3	93.7	93.4	93.5	95.1	94.9	95.9	96.6
SG 4.5-145 NRS Mode N1	89.3	90.3	91.3	92.8	93.2	92.9	93	94.6	94.4	95.4	96.1
SG 4.5-145 NRS Mode N2	89.1	90	90.7	92.2	92.6	92.3	92.4	94	93.8	94.8	95.5
SG 4.5-145 NRS Mode N3	88.2	89	89.2	90.7	91.1	90.8	90.9	92.5	92.3	93.3	94
SG 4.5-145 NRS Mode N4	87.1	87.6	88.2	89.7	90.1	89.8	89.9	91.5	91.3	92.3	93
SG 4.5-145 NRS Mode N5	86.3	86.7	87.1	88.6	89	88.7	88.8	90.4	90.2	91.2	91.9
SG 4.5-145 NRS Mode N6	84.9	85.1	85.3	86.8	87.2	86.9	87	88.6	88.4	89.4	90.1
SG 4.5-145 NRS Mode N7	84.2	84.2	84.3	85.8	86.2	85.9	86	87.6	87.4	88.4	89.1
SG 4.5-145 NRS Mode N8	83.5	83.3	83.3	84.8	85.2	84.9	85	86.6	86.4	87.4	88.1
Central Frequency [Hz]	**1600**	**2000**	**2500**	**3150**	**4000**	**5000**	**6300**	**8000**	**10000**		
SG 4.5-145 Baseline AM0 @ 4.5MW	96.5	95.4	94	91.8	88.7	84.4	79.2	73.4	68.8		
SG 4.5-145 AM-3 @ 4.2MW	96.5	95.4	94	91.8	88.7	84.4	79.2	73.4	68.8		
SG 4.5-145 AM-2 @ 4.3MW	96.5	95.4	94	91.8	88.7	84.4	79.2	73.4	68.8		
SG 4.5-145 AM-1 @ 4.4MW	96.5	95.4	94	91.8	88.7	84.4	79.2	73.4	68.8		
SG 4.5-145 AM+1 @ 4.6MW	96.5	95.4	94	91.8	88.7	84.4	79.2	73.4	68.8		
SG 4.5-145 AM+2 @ 4.7MW	96.5	95.4	94	91.8	88.7	84.4	79.2	73.4	68.8		
SG 4.5-145 AM+3 @ 4.8MW	96.5	95.4	94	91.8	88.7	84.4	79.2	73.4	68.8		
SG 4.5-145 NRS Mode N1	96	94.9	93.5	91.3	88.2	83.9	78.7	72.9	68.3		
SG 4.5-145 NRS Mode N2	95.4	94.3	92.9	90.7	87.6	83.3	78.1	72.3	67.7		
SG 4.5-145 NRS Mode N3	93.9	92.8	91.4	89.2	86.1	81.8	76.6	70.8	66.2		
SG 4.5-145 NRS Mode N4	92.9	91.8	90.4	88.2	85.1	80.8	75.6	69.8	65.2		
SG 4.5-145 NRS Mode N5	91.8	90.7	89.3	87.1	84	79.7	74.5	68.7	64.1		
SG 4.5-145 NRS Mode N6	90	88.9	87.5	85.3	82.2	77.9	72.7	66.9	62.3		
SG 4.5-145 NRS Mode N7	89	87.9	86.5	84.3	81.2	76.9	71.7	65.9	61.3		
SG 4.5-145 NRS Mode N8	88	86.9	85.5	83.3	80.2	75.9	70.7	64.9	60.3		

Table 6 One-third octave band noise spectra of SG 4.5-145 @ 8 m/s
(*ref: SG145spectra_4X00KW_R01_13072018*)

Central Frequency [Hz]	**10**	**12.5**	**16**	**20**	**25**	**31.5**	**40**	**50**	**63**	**80**	**100**
SG 4.5-145 Baseline AM0 @ 4.5MW	46.1	51.8	57.5	62.9	67.5	72.2	76.4	81	85.3	87.8	89.7
SG 4.5-145 AM-3 @ 4.2MW	46.1	51.8	57.5	62.9	67.4	72.1	76.3	80.8	85	87.5	89.3
SG 4.5-145 AM-2 @ 4.3MW	46.1	51.8	57.5	62.9	67.5	72.1	76.3	80.9	85.1	87.6	89.4
SG 4.5-145 AM-1 @ 4.4MW	46.1	51.8	57.5	62.9	67.5	72.2	76.4	80.9	85.2	87.7	89.6
SG 4.5-145 AM+1 @ 4.6MW	46.1	51.8	57.5	62.9	67.5	72.2	76.4	81.1	85.4	87.9	89.8
SG 4.5-145 AM+2 @ 4.7MW	46.1	51.8	57.5	62.9	67.5	72.3	76.5	81.1	85.5	88	90
SG 4.5-145 AM+3 @ 4.8MW	46.1	51.8	57.5	62.9	67.6	72.3	76.5	81.2	85.6	88.1	90.1
SG 4.5-145 NRS Mode N1	46.1	51.8	57.5	62.8	67.4	72	76.1	80.5	84.7	87	88.8
SG 4.5-145 NRS Mode N2	46.1	51.8	57.5	62.8	67.3	71.9	76	80.4	84.6	86.9	88.5
SG 4.5-145 NRS Mode N3	46.1	51.8	57.4	62.7	67.2	71.7	75.7	80.1	84.1	86.3	87.9
SG 4.5-145 NRS Mode N4	46.1	51.8	57.4	62.6	67	71.4	75.3	79.5	83.3	85.3	86.6
SG 4.5-145 NRS Mode N5	46.1	51.8	57.4	62.6	66.9	71.3	75.1	79.2	82.9	84.8	86
SG 4.5-145 NRS Mode N6	46.1	51.8	57.3	62.5	66.7	71	74.6	78.6	82.2	83.8	84.8
SG 4.5-145 NRS Mode N7	46.1	51.7	57.3	62.4	66.6	70.8	74.4	78.3	81.8	83.4	84.2
SG 4.5-145 NRS Mode N8	46.1	51.7	57.3	62.3	66.5	70.7	74.2	78	81.4	82.8	83.6
Central Frequency [Hz]	**125**	**160**	**200**	**250**	**315**	**400**	**500**	**630**	**800**	**1000**	**1250**
SG 4.5-145 Baseline AM0 @ 4.5MW	91.2	92.2	93.4	94.9	95.3	95	95.1	96.7	96.5	97.5	98.2
SG 4.5-145 AM-3 @ 4.2MW	90.7	91.6	92.5	94	94.4	94.1	94.2	95.8	95.6	96.6	97.3
SG 4.5-145 AM-2 @ 4.3MW	90.9	91.8	92.8	94.3	94.7	94.4	94.5	96.1	95.9	96.9	97.6
SG 4.5-145 AM-1 @ 4.4MW	91	92	93.1	94.6	95	94.7	94.8	96.4	96.2	97.2	97.9
SG 4.5-145 AM+1 @ 4.6MW	91.4	92.4	93.7	95.2	95.6	95.3	95.4	97	96.8	97.8	98.5
SG 4.5-145 AM+2 @ 4.7MW	91.5	92.6	94	95.5	95.9	95.6	95.7	97.3	97.1	98.1	98.8
SG 4.5-145 AM+3 @ 4.8MW	91.7	92.8	94.3	95.8	96.2	95.9	96	97.6	97.4	98.4	99.1
SG 4.5-145 NRS Mode N1	90.1	90.9	91.2	92.7	93.1	92.8	92.9	94.5	94.3	95.3	96
SG 4.5-145 NRS Mode N2	89.8	90.5	90.7	92.2	92.6	92.3	92.4	94	93.8	94.8	95.5
SG 4.5-145 NRS Mode N3	89	89.5	89.1	90.6	91	90.7	90.8	92.4	92.2	93.2	93.9
SG 4.5-145 NRS Mode N4	87.5	87.7	88.1	89.6	90	89.7	89.8	91.4	91.2	92.2	92.9
SG 4.5-145 NRS Mode N5	86.7	86.8	87.1	88.6	89	88.7	88.8	90.4	90.2	91.2	91.9
SG 4.5-145 NRS Mode N6	85.3	85.2	85.2	86.7	87.1	86.8	86.9	88.5	88.3	89.3	90
SG 4.5-145 NRS Mode N7	84.6	84.3	84.2	85.7	86.1	85.8	85.9	87.5	87.3	88.3	89
SG 4.5-145 NRS Mode N8	83.8	83.4	83.2	84.7	85.1	84.8	84.9	86.5	86.3	87.3	88
Central Frequency [Hz]	**1600**	**2000**	**2500**	**3150**	**4000**	**5000**	**6300**	**8000**	**10000**		
SG 4.5-145 Baseline AM0 @ 4.5MW	98.1	97	95.6	93.4	90.3	86	80.8	75	70.4		
SG 4.5-145 AM-3 @ 4.2MW	97.2	96.1	94.7	92.5	89.4	85.1	79.9	74.1	69.5		
SG 4.5-145 AM-2 @ 4.3MW	97.5	96.4	95	92.8	89.7	85.4	80.2	74.4	69.8		
SG 4.5-145 AM-1 @ 4.4MW	97.8	96.7	95.3	93.1	90	85.7	80.5	74.7	70.1		
SG 4.5-145 AM+1 @ 4.6MW	98.4	97.3	95.9	93.7	90.6	86.3	81.1	75.3	70.7		
SG 4.5-145 AM+2 @ 4.7MW	98.7	97.6	96.2	94	90.9	86.6	81.4	75.6	71		
SG 4.5-145 AM+3 @ 4.8MW	99	97.9	96.5	94.3	91.2	86.9	81.7	75.9	71.3		
SG 4.5-145 NRS Mode N1	95.9	94.8	93.4	91.2	88.1	83.8	78.6	72.8	68.2		
SG 4.5-145 NRS Mode N2	95.4	94.3	92.9	90.7	87.6	83.3	78.1	72.3	67.7		
SG 4.5-145 NRS Mode N3	93.8	92.7	91.3	89.1	86	81.7	76.5	70.7	66.1		
SG 4.5-145 NRS Mode N4	92.8	91.7	90.3	88.1	85	80.7	75.5	69.7	65.1		
SG 4.5-145 NRS Mode N5	91.8	90.7	89.3	87.1	84	79.7	74.5	68.7	64.1		
SG 4.5-145 NRS Mode N6	89.9	88.8	87.4	85.2	82.1	77.8	72.6	66.8	62.2		
SG 4.5-145 NRS Mode N7	88.9	87.8	86.4	84.2	81.1	76.8	71.6	65.8	61.2		
SG 4.5-145 NRS Mode N8	87.9	86.8	85.4	83.2	80.1	75.8	70.6	64.8	60.2		

Table 7 One-third octave band noise spectra of SG 4.5-145 @ 9 m/s
(*ref: SG145spectra_4X00KW_R01_13072018*)

Central Frequency [Hz]	**10**	**12.5**	**16**	**20**	**25**	**31.5**	**40**	**50**	**63**	**80**	**100**
SG 4.5-145 Baseline AM0 @ 4.5MW	46.1	51.8	57.5	62.9	67.5	72.2	76.4	81	85.3	87.8	89.7
SG 4.5-145 AM-3 @ 4.2MW	46.1	51.8	57.5	62.9	67.4	72.1	76.3	80.8	85	87.5	89.3
SG 4.5-145 AM-2 @ 4.3MW	46.1	51.8	57.5	62.9	67.5	72.1	76.3	80.9	85.1	87.6	89.4
SG 4.5-145 AM-1 @ 4.4MW	46.1	51.8	57.5	62.9	67.5	72.2	76.4	80.9	85.2	87.7	89.6
SG 4.5-145 AM+1 @ 4.6MW	46.1	51.8	57.5	62.9	67.5	72.2	76.4	81.1	85.4	87.9	89.8
SG 4.5-145 AM+2 @ 4.7MW	46.1	51.8	57.5	62.9	67.5	72.3	76.5	81.1	85.5	88	90
SG 4.5-145 AM+3 @ 4.8MW	46.1	51.8	57.5	62.9	67.6	72.3	76.5	81.2	85.6	88.1	90.1
SG 4.5-145 NRS Mode N1	46.1	51.8	57.5	62.8	67.4	72	76.1	80.5	84.7	87	88.8
SG 4.5-145 NRS Mode N2	46.1	51.8	57.5	62.8	67.3	71.9	76	80.4	84.6	86.9	88.5
SG 4.5-145 NRS Mode N3	46.1	51.8	57.4	62.7	67.2	71.7	75.7	80.1	84.1	86.3	87.9
SG 4.5-145 NRS Mode N4	46.1	51.8	57.4	62.6	67	71.4	75.3	79.5	83.3	85.3	86.6
SG 4.5-145 NRS Mode N5	46.1	51.8	57.4	62.6	66.9	71.3	75.1	79.2	82.9	84.8	86
SG 4.5-145 NRS Mode N6	46.1	51.8	57.3	62.5	66.7	71	74.6	78.6	82.2	83.8	84.8
SG 4.5-145 NRS Mode N7	46.1	51.7	57.3	62.4	66.6	70.8	74.4	78.3	81.8	83.4	84.2
SG 4.5-145 NRS Mode N8	46.1	51.7	57.3	62.3	66.5	70.7	74.2	78	81.4	82.8	83.6
Central Frequency [Hz]	**125**	**160**	**200**	**250**	**315**	**400**	**500**	**630**	**800**	**1000**	**1250**
SG 4.5-145 Baseline AM0 @ 4.5MW	91.2	92.2	93.4	94.9	95.3	95	95.1	96.7	96.5	97.5	98.2
SG 4.5-145 AM-3 @ 4.2MW	90.7	91.6	92.5	94	94.4	94.1	94.2	95.8	95.6	96.6	97.3
SG 4.5-145 AM-2 @ 4.3MW	90.9	91.8	92.8	94.3	94.7	94.4	94.5	96.1	95.9	96.9	97.6
SG 4.5-145 AM-1 @ 4.4MW	91	92	93.1	94.6	95	94.7	94.8	96.4	96.2	97.2	97.9
SG 4.5-145 AM+1 @ 4.6MW	91.4	92.4	93.7	95.2	95.6	95.3	95.4	97	96.8	97.8	98.5
SG 4.5-145 AM+2 @ 4.7MW	91.5	92.6	94	95.5	95.9	95.6	95.7	97.3	97.1	98.1	98.8
SG 4.5-145 AM+3 @ 4.8MW	91.7	92.8	94.3	95.8	96.2	95.9	96	97.6	97.4	98.4	99.1
SG 4.5-145 NRS Mode N1	90.1	90.9	91.2	92.7	93.1	92.8	92.9	94.5	94.3	95.3	96
SG 4.5-145 NRS Mode N2	89.8	90.5	90.7	92.2	92.6	92.3	92.4	94	93.8	94.8	95.5
SG 4.5-145 NRS Mode N3	89	89.5	89.1	90.6	91	90.7	90.8	92.4	92.2	93.2	93.9
SG 4.5-145 NRS Mode N4	87.5	87.7	88.1	89.6	90	89.7	89.8	91.4	91.2	92.2	92.9
SG 4.5-145 NRS Mode N5	86.7	86.8	87.1	88.6	89	88.7	88.8	90.4	90.2	91.2	91.9
SG 4.5-145 NRS Mode N6	85.3	85.2	85.2	86.7	87.1	86.8	86.9	88.5	88.3	89.3	90
SG 4.5-145 NRS Mode N7	84.6	84.3	84.2	85.7	86.1	85.8	85.9	87.5	87.3	88.3	89
SG 4.5-145 NRS Mode N8	83.8	83.4	83.2	84.7	85.1	84.8	84.9	86.5	86.3	87.3	88

Central Frequency [Hz]	**1600**	**2000**	**2500**	**3150**	**4000**	**5000**	**6300**	**8000**	**10000**
SG 4.5-145 Baseline AM0 @ 4.5MW	98.1	97	95.6	93.4	90.3	86	80.8	75	70.4
SG 4.5-145 AM-3 @ 4.2MW	97.2	96.1	94.7	92.5	89.4	85.1	79.9	74.1	69.5
SG 4.5-145 AM-2 @ 4.3MW	97.5	96.4	95	92.8	89.7	85.4	80.2	74.4	69.8
SG 4.5-145 AM-1 @ 4.4MW	97.8	96.7	95.3	93.1	90	85.7	80.5	74.7	70.1
SG 4.5-145 AM+1 @ 4.6MW	98.4	97.3	95.9	93.7	90.6	86.3	81.1	75.3	70.7
SG 4.5-145 AM+2 @ 4.7MW	98.7	97.6	96.2	94	90.9	86.6	81.4	75.6	71
SG 4.5-145 AM+3 @ 4.8MW	99	97.9	96.5	94.3	91.2	86.9	81.7	75.9	71.3
SG 4.5-145 NRS Mode N1	95.9	94.8	93.4	91.2	88.1	83.8	78.6	72.8	68.2
SG 4.5-145 NRS Mode N2	95.4	94.3	92.9	90.7	87.6	83.3	78.1	72.3	67.7
SG 4.5-145 NRS Mode N3	93.8	92.7	91.3	89.1	86	81.7	76.5	70.7	66.1
SG 4.5-145 NRS Mode N4	92.8	91.7	90.3	88.1	85	80.7	75.5	69.7	65.1
SG 4.5-145 NRS Mode N5	91.8	90.7	89.3	87.1	84	79.7	74.5	68.7	64.1
SG 4.5-145 NRS Mode N6	89.9	88.8	87.4	85.2	82.1	77.8	72.6	66.8	62.2
SG 4.5-145 NRS Mode N7	88.9	87.8	86.4	84.2	81.1	76.8	71.6	65.8	61.2
SG 4.5-145 NRS Mode N8	87.9	86.8	85.4	83.2	80.1	75.8	70.6	64.8	60.2

Table 8 One-third octave band noise spectra of SG 4.5-145 @ 10 m/s
(*ref: SG145spectra_4X00KW_R01_13072018*)

Central Frequency [Hz]	**10**	**12.5**	**16**	**20**	**25**	**31.5**	**40**	**50**	**63**	**80**	**100**
SG 4.5-145 Baseline AM0 @ 4.5MW	46.1	51.8	57.5	62.9	67.5	72.2	76.4	81	85.3	87.8	89.7
SG 4.5-145 AM-3 @ 4.2MW	46.1	51.8	57.5	62.9	67.4	72.1	76.3	80.8	85	87.5	89.3
SG 4.5-145 AM-2 @ 4.3MW	46.1	51.8	57.5	62.9	67.5	72.1	76.3	80.9	85.1	87.6	89.4
SG 4.5-145 AM-1 @ 4.4MW	46.1	51.8	57.5	62.9	67.5	72.2	76.4	80.9	85.2	87.7	89.6
SG 4.5-145 AM+1 @ 4.6MW	46.1	51.8	57.5	62.9	67.5	72.2	76.4	81.1	85.4	87.9	89.8
SG 4.5-145 AM+2 @ 4.7MW	46.1	51.8	57.5	62.9	67.5	72.3	76.5	81.1	85.5	88	90
SG 4.5-145 AM+3 @ 4.8MW	46.1	51.8	57.5	62.9	67.6	72.3	76.5	81.2	85.6	88.1	90.1
SG 4.5-145 NRS Mode N1	46.1	51.8	57.5	62.8	67.4	72	76.1	80.5	84.7	87	88.8
SG 4.5-145 NRS Mode N2	46.1	51.8	57.5	62.8	67.3	71.9	76	80.4	84.6	86.9	88.5
SG 4.5-145 NRS Mode N3	46.1	51.8	57.4	62.7	67.2	71.7	75.7	80.1	84.1	86.3	87.9
SG 4.5-145 NRS Mode N4	46.1	51.8	57.4	62.6	67	71.4	75.3	79.5	83.3	85.3	86.6
SG 4.5-145 NRS Mode N5	46.1	51.8	57.4	62.6	66.9	71.3	75.1	79.2	82.9	84.8	86
SG 4.5-145 NRS Mode N6	46.1	51.8	57.3	62.5	66.7	71	74.6	78.6	82.2	83.8	84.8
SG 4.5-145 NRS Mode N7	46.1	51.7	57.3	62.4	66.6	70.8	74.4	78.3	81.8	83.4	84.2
SG 4.5-145 NRS Mode N8	46.1	51.7	57.3	62.3	66.5	70.7	74.2	78	81.4	82.8	83.6
Central Frequency [Hz]	**125**	**160**	**200**	**250**	**315**	**400**	**500**	**630**	**800**	**1000**	**1250**
SG 4.5-145 Baseline AM0 @ 4.5MW	91.2	92.2	93.4	94.9	95.3	95	95.1	96.7	96.5	97.5	98.2
SG 4.5-145 AM-3 @ 4.2MW	90.7	91.6	92.5	94	94.4	94.1	94.2	95.8	95.6	96.6	97.3
SG 4.5-145 AM-2 @ 4.3MW	90.9	91.8	92.8	94.3	94.7	94.4	94.5	96.1	95.9	96.9	97.6
SG 4.5-145 AM-1 @ 4.4MW	91	92	93.1	94.6	95	94.7	94.8	96.4	96.2	97.2	97.9
SG 4.5-145 AM+1 @ 4.6MW	91.4	92.4	93.7	95.2	95.6	95.3	95.4	97	96.8	97.8	98.5
SG 4.5-145 AM+2 @ 4.7MW	91.5	92.6	94	95.5	95.9	95.6	95.7	97.3	97.1	98.1	98.8
SG 4.5-145 AM+3 @ 4.8MW	91.7	92.8	94.3	95.8	96.2	95.9	96	97.6	97.4	98.4	99.1
SG 4.5-145 NRS Mode N1	90.1	90.9	91.2	92.7	93.1	92.8	92.9	94.5	94.3	95.3	96
SG 4.5-145 NRS Mode N2	89.8	90.5	90.7	92.2	92.6	92.3	92.4	94	93.8	94.8	95.5
SG 4.5-145 NRS Mode N3	89	89.5	89.1	90.6	91	90.7	90.8	92.4	92.2	93.2	93.9
SG 4.5-145 NRS Mode N4	87.5	87.7	88.1	89.6	90	89.7	89.8	91.4	91.2	92.2	92.9
SG 4.5-145 NRS Mode N5	86.7	86.8	87.1	88.6	89	88.7	88.8	90.4	90.2	91.2	91.9
SG 4.5-145 NRS Mode N6	85.3	85.2	85.2	86.7	87.1	86.8	86.9	88.5	88.3	89.3	90
SG 4.5-145 NRS Mode N7	84.6	84.3	84.2	85.7	86.1	85.8	85.9	87.5	87.3	88.3	89
SG 4.5-145 NRS Mode N8	83.8	83.4	83.2	84.7	85.1	84.8	84.9	86.5	86.3	87.3	88
Central Frequency [Hz]	**1600**	**2000**	**2500**	**3150**	**4000**	**5000**	**6300**	**8000**	**10000**		
SG 4.5-145 Baseline AM0 @ 4.5MW	98.1	97	95.6	93.4	90.3	86	80.8	75	70.4		
SG 4.5-145 AM-3 @ 4.2MW	97.2	96.1	94.7	92.5	89.4	85.1	79.9	74.1	69.5		
SG 4.5-145 AM-2 @ 4.3MW	97.5	96.4	95	92.8	89.7	85.4	80.2	74.4	69.8		
SG 4.5-145 AM-1 @ 4.4MW	97.8	96.7	95.3	93.1	90	85.7	80.5	74.7	70.1		
SG 4.5-145 AM+1 @ 4.6MW	98.4	97.3	95.9	93.7	90.6	86.3	81.1	75.3	70.7		
SG 4.5-145 AM+2 @ 4.7MW	98.7	97.6	96.2	94	90.9	86.6	81.4	75.6	71		
SG 4.5-145 AM+3 @ 4.8MW	99	97.9	96.5	94.3	91.2	86.9	81.7	75.9	71.3		
SG 4.5-145 NRS Mode N1	95.9	94.8	93.4	91.2	88.1	83.8	78.6	72.8	68.2		
SG 4.5-145 NRS Mode N2	95.4	94.3	92.9	90.7	87.6	83.3	78.1	72.3	67.7		
SG 4.5-145 NRS Mode N3	93.8	92.7	91.3	89.1	86	81.7	76.5	70.7	66.1		
SG 4.5-145 NRS Mode N4	92.8	91.7	90.3	88.1	85	80.7	75.5	69.7	65.1		
SG 4.5-145 NRS Mode N5	91.8	90.7	89.3	87.1	84	79.7	74.5	68.7	64.1		
SG 4.5-145 NRS Mode N6	89.9	88.8	87.4	85.2	82.1	77.8	72.6	66.8	62.2		
SG 4.5-145 NRS Mode N7	88.9	87.8	86.4	84.2	81.1	76.8	71.6	65.8	61.2		
SG 4.5-145 NRS Mode N8	87.9	86.8	85.4	83.2	80.1	75.8	70.6	64.8	60.2		

Table 9 One-third octave band noise spectra of SG 4.5-145 @ 11 m/s
(*ref: SG145spectra_4X00KW_R01_13072018*)

Central Frequency [Hz]	**10**	**12.5**	**16**	**20**	**25**	**31.5**	**40**	**50**	**63**	**80**	**100**
SG 4.5-145 Baseline AM0 @ 4.5MW	46.1	51.8	57.5	62.9	67.5	72.2	76.4	81	85.3	87.8	89.7
SG 4.5-145 AM-3 @ 4.2MW	46.1	51.8	57.5	62.9	67.4	72.1	76.3	80.8	85	87.5	89.3
SG 4.5-145 AM-2 @ 4.3MW	46.1	51.8	57.5	62.9	67.5	72.1	76.3	80.9	85.1	87.6	89.4
SG 4.5-145 AM-1 @ 4.4MW	46.1	51.8	57.5	62.9	67.5	72.2	76.4	80.9	85.2	87.7	89.6
SG 4.5-145 AM+1 @ 4.6MW	46.1	51.8	57.5	62.9	67.5	72.2	76.4	81.1	85.4	87.9	89.8
SG 4.5-145 AM+2 @ 4.7MW	46.1	51.8	57.5	62.9	67.5	72.3	76.5	81.1	85.5	88	90
SG 4.5-145 AM+3 @ 4.8MW	46.1	51.8	57.5	62.9	67.6	72.3	76.5	81.2	85.6	88.1	90.1
SG 4.5-145 NRS Mode N1	46.1	51.8	57.5	62.8	67.4	72	76.1	80.5	84.7	87	88.8
SG 4.5-145 NRS Mode N2	46.1	51.8	57.5	62.8	67.3	71.9	76	80.4	84.6	86.9	88.5
SG 4.5-145 NRS Mode N3	46.1	51.8	57.4	62.7	67.2	71.7	75.7	80.1	84.1	86.3	87.9
SG 4.5-145 NRS Mode N4	46.1	51.8	57.4	62.6	67	71.4	75.3	79.5	83.3	85.3	86.6
SG 4.5-145 NRS Mode N5	46.1	51.8	57.4	62.6	66.9	71.3	75.1	79.2	82.9	84.8	86
SG 4.5-145 NRS Mode N6	46.1	51.8	57.3	62.5	66.7	71	74.6	78.6	82.2	83.8	84.8
SG 4.5-145 NRS Mode N7	46.1	51.7	57.3	62.4	66.6	70.8	74.4	78.3	81.8	83.4	84.2
SG 4.5-145 NRS Mode N8	46.1	51.7	57.3	62.3	66.5	70.7	74.2	78	81.4	82.8	83.6
Central Frequency [Hz]	**125**	**160**	**200**	**250**	**315**	**400**	**500**	**630**	**800**	**1000**	**1250**
SG 4.5-145 Baseline AM0 @ 4.5MW	91.2	92.2	93.4	94.9	95.3	95	95.1	96.7	96.5	97.5	98.2
SG 4.5-145 AM-3 @ 4.2MW	90.7	91.6	92.5	94	94.4	94.1	94.2	95.8	95.6	96.6	97.3
SG 4.5-145 AM-2 @ 4.3MW	90.9	91.8	92.8	94.3	94.7	94.4	94.5	96.1	95.9	96.9	97.6
SG 4.5-145 AM-1 @ 4.4MW	91	92	93.1	94.6	95	94.7	94.8	96.4	96.2	97.2	97.9
SG 4.5-145 AM+1 @ 4.6MW	91.4	92.4	93.7	95.2	95.6	95.3	95.4	97	96.8	97.8	98.5
SG 4.5-145 AM+2 @ 4.7MW	91.5	92.6	94	95.5	95.9	95.6	95.7	97.3	97.1	98.1	98.8
SG 4.5-145 AM+3 @ 4.8MW	91.7	92.8	94.3	95.8	96.2	95.9	96	97.6	97.4	98.4	99.1
SG 4.5-145 NRS Mode N1	90.1	90.9	91.2	92.7	93.1	92.8	92.9	94.5	94.3	95.3	96
SG 4.5-145 NRS Mode N2	89.8	90.5	90.7	92.2	92.6	92.3	92.4	94	93.8	94.8	95.5
SG 4.5-145 NRS Mode N3	89	89.5	89.1	90.6	91	90.7	90.8	92.4	92.2	93.2	93.9
SG 4.5-145 NRS Mode N4	87.5	87.7	88.1	89.6	90	89.7	89.8	91.4	91.2	92.2	92.9
SG 4.5-145 NRS Mode N5	86.7	86.8	87.1	88.6	89	88.7	88.8	90.4	90.2	91.2	91.9
SG 4.5-145 NRS Mode N6	85.3	85.2	85.2	86.7	87.1	86.8	86.9	88.5	88.3	89.3	90
SG 4.5-145 NRS Mode N7	84.6	84.3	84.2	85.7	86.1	85.8	85.9	87.5	87.3	88.3	89
SG 4.5-145 NRS Mode N8	83.8	83.4	83.2	84.7	85.1	84.8	84.9	86.5	86.3	87.3	88

Central Frequency [Hz]	**1600**	**2000**	**2500**	**3150**	**4000**	**5000**	**6300**	**8000**	**10000**
SG 4.5-145 Baseline AM0 @ 4.5MW	98.1	97	95.6	93.4	90.3	86	80.8	75	70.4
SG 4.5-145 AM-3 @ 4.2MW	97.2	96.1	94.7	92.5	89.4	85.1	79.9	74.1	69.5
SG 4.5-145 AM-2 @ 4.3MW	97.5	96.4	95	92.8	89.7	85.4	80.2	74.4	69.8
SG 4.5-145 AM-1 @ 4.4MW	97.8	96.7	95.3	93.1	90	85.7	80.5	74.7	70.1
SG 4.5-145 AM+1 @ 4.6MW	98.4	97.3	95.9	93.7	90.6	86.3	81.1	75.3	70.7
SG 4.5-145 AM+2 @ 4.7MW	98.7	97.6	96.2	94	90.9	86.6	81.4	75.6	71
SG 4.5-145 AM+3 @ 4.8MW	99	97.9	96.5	94.3	91.2	86.9	81.7	75.9	71.3
SG 4.5-145 NRS Mode N1	95.9	94.8	93.4	91.2	88.1	83.8	78.6	72.8	68.2
SG 4.5-145 NRS Mode N2	95.4	94.3	92.9	90.7	87.6	83.3	78.1	72.3	67.7
SG 4.5-145 NRS Mode N3	93.8	92.7	91.3	89.1	86	81.7	76.5	70.7	66.1
SG 4.5-145 NRS Mode N4	92.8	91.7	90.3	88.1	85	80.7	75.5	69.7	65.1
SG 4.5-145 NRS Mode N5	91.8	90.7	89.3	87.1	84	79.7	74.5	68.7	64.1
SG 4.5-145 NRS Mode N6	89.9	88.8	87.4	85.2	82.1	77.8	72.6	66.8	62.2
SG 4.5-145 NRS Mode N7	88.9	87.8	86.4	84.2	81.1	76.8	71.6	65.8	61.2
SG 4.5-145 NRS Mode N8	87.9	86.8	85.4	83.2	80.1	75.8	70.6	64.8	60.2

Table 10 One-third octave band noise spectra of SG 4.5-145 @ 12 m/s
(*ref: SG145spectra_4X00KW_R01_13072018*)

Central Frequency [Hz]	**10**	**12.5**	**16**	**20**	**25**	**31.5**	**40**	**50**	**63**	**80**	**100**
SG 4.5-145 Baseline AM0 @ 4.5MW	46.1	51.8	57.5	62.9	67.5	72.2	76.4	81	85.3	87.8	89.7
SG 4.5-145 AM-3 @ 4.2MW	46.1	51.8	57.5	62.9	67.4	72.1	76.3	80.8	85	87.5	89.3
SG 4.5-145 AM-2 @ 4.3MW	46.1	51.8	57.5	62.9	67.5	72.1	76.3	80.9	85.1	87.6	89.4
SG 4.5-145 AM-1 @ 4.4MW	46.1	51.8	57.5	62.9	67.5	72.2	76.4	80.9	85.2	87.7	89.6
SG 4.5-145 AM+1 @ 4.6MW	46.1	51.8	57.5	62.9	67.5	72.2	76.4	81.1	85.4	87.9	89.8
SG 4.5-145 AM+2 @ 4.7MW	46.1	51.8	57.5	62.9	67.5	72.3	76.5	81.1	85.5	88	90
SG 4.5-145 AM+3 @ 4.8MW	46.1	51.8	57.5	62.9	67.6	72.3	76.5	81.2	85.6	88.1	90.1
SG 4.5-145 NRS Mode N1	46.1	51.8	57.5	62.8	67.4	72	76.1	80.5	84.7	87	88.8
SG 4.5-145 NRS Mode N2	46.1	51.8	57.5	62.8	67.3	71.9	76	80.4	84.6	86.9	88.5
SG 4.5-145 NRS Mode N3	46.1	51.8	57.4	62.7	67.2	71.7	75.7	80.1	84.1	86.3	87.9
SG 4.5-145 NRS Mode N4	46.1	51.8	57.4	62.6	67	71.4	75.3	79.5	83.3	85.3	86.6
SG 4.5-145 NRS Mode N5	46.1	51.8	57.4	62.6	66.9	71.3	75.1	79.2	82.9	84.8	86
SG 4.5-145 NRS Mode N6	46.1	51.8	57.3	62.5	66.7	71	74.6	78.6	82.2	83.8	84.8
SG 4.5-145 NRS Mode N7	46.1	51.7	57.3	62.4	66.6	70.8	74.4	78.3	81.8	83.4	84.2
SG 4.5-145 NRS Mode N8	46.1	51.7	57.3	62.3	66.5	70.7	74.2	78	81.4	82.8	83.6
Central Frequency [Hz]	**125**	**160**	**200**	**250**	**315**	**400**	**500**	**630**	**800**	**1000**	**1250**
SG 4.5-145 Baseline AM0 @ 4.5MW	91.2	92.2	93.4	94.9	95.3	95	95.1	96.7	96.5	97.5	98.2
SG 4.5-145 AM-3 @ 4.2MW	90.7	91.6	92.5	94	94.4	94.1	94.2	95.8	95.6	96.6	97.3
SG 4.5-145 AM-2 @ 4.3MW	90.9	91.8	92.8	94.3	94.7	94.4	94.5	96.1	95.9	96.9	97.6
SG 4.5-145 AM-1 @ 4.4MW	91	92	93.1	94.6	95	94.7	94.8	96.4	96.2	97.2	97.9
SG 4.5-145 AM+1 @ 4.6MW	91.4	92.4	93.7	95.2	95.6	95.3	95.4	97	96.8	97.8	98.5
SG 4.5-145 AM+2 @ 4.7MW	91.5	92.6	94	95.5	95.9	95.6	95.7	97.3	97.1	98.1	98.8
SG 4.5-145 AM+3 @ 4.8MW	91.7	92.8	94.3	95.8	96.2	95.9	96	97.6	97.4	98.4	99.1
SG 4.5-145 NRS Mode N1	90.1	90.9	91.2	92.7	93.1	92.8	92.9	94.5	94.3	95.3	96
SG 4.5-145 NRS Mode N2	89.8	90.5	90.7	92.2	92.6	92.3	92.4	94	93.8	94.8	95.5
SG 4.5-145 NRS Mode N3	89	89.5	89.1	90.6	91	90.7	90.8	92.4	92.2	93.2	93.9
SG 4.5-145 NRS Mode N4	87.5	87.7	88.1	89.6	90	89.7	89.8	91.4	91.2	92.2	92.9
SG 4.5-145 NRS Mode N5	86.7	86.8	87.1	88.6	89	88.7	88.8	90.4	90.2	91.2	91.9
SG 4.5-145 NRS Mode N6	85.3	85.2	85.2	86.7	87.1	86.8	86.9	88.5	88.3	89.3	90
SG 4.5-145 NRS Mode N7	84.6	84.3	84.2	85.7	86.1	85.8	85.9	87.5	87.3	88.3	89
SG 4.5-145 NRS Mode N8	83.8	83.4	83.2	84.7	85.1	84.8	84.9	86.5	86.3	87.3	88
Central Frequency [Hz]	**1600**	**2000**	**2500**	**3150**	**4000**	**5000**	**6300**	**8000**	**10000**		
SG 4.5-145 Baseline AM0 @ 4.5MW	98.1	97	95.6	93.4	90.3	86	80.8	75	70.4		
SG 4.5-145 AM-3 @ 4.2MW	97.2	96.1	94.7	92.5	89.4	85.1	79.9	74.1	69.5		
SG 4.5-145 AM-2 @ 4.3MW	97.5	96.4	95	92.8	89.7	85.4	80.2	74.4	69.8		
SG 4.5-145 AM-1 @ 4.4MW	97.8	96.7	95.3	93.1	90	85.7	80.5	74.7	70.1		
SG 4.5-145 AM+1 @ 4.6MW	98.4	97.3	95.9	93.7	90.6	86.3	81.1	75.3	70.7		
SG 4.5-145 AM+2 @ 4.7MW	98.7	97.6	96.2	94	90.9	86.6	81.4	75.6	71		
SG 4.5-145 AM+3 @ 4.8MW	99	97.9	96.5	94.3	91.2	86.9	81.7	75.9	71.3		
SG 4.5-145 NRS Mode N1	95.9	94.8	93.4	91.2	88.1	83.8	78.6	72.8	68.2		
SG 4.5-145 NRS Mode N2	95.4	94.3	92.9	90.7	87.6	83.3	78.1	72.3	67.7		
SG 4.5-145 NRS Mode N3	93.8	92.7	91.3	89.1	86	81.7	76.5	70.7	66.1		
SG 4.5-145 NRS Mode N4	92.8	91.7	90.3	88.1	85	80.7	75.5	69.7	65.1		
SG 4.5-145 NRS Mode N5	91.8	90.7	89.3	87.1	84	79.7	74.5	68.7	64.1		
SG 4.5-145 NRS Mode N6	89.9	88.8	87.4	85.2	82.1	77.8	72.6	66.8	62.2		
SG 4.5-145 NRS Mode N7	88.9	87.8	86.4	84.2	81.1	76.8	71.6	65.8	61.2		
SG 4.5-145 NRS Mode N8	87.9	86.8	85.4	83.2	80.1	75.8	70.6	64.8	60.2		

Table 11 One-third octave band noise spectra of SG 4.5-145 @ 13 m/s and up to cut out wind speed (*ref: SG145spectra_4X00KW_R01_13072018*)

APPENDIX G

APPENDIX G: TURBINE LOCATIONS

Turbine	Location - UTM 12 (NAD 83)		Spare	Daytime Hours (07:00 - 22:00)		Nighttime Hours (22:00 - 07:00)	
	Easting (m)	Northing (m)		Noise Mode	Overall Sound Power (dBA)	Noise Mode	Overall Sound Power (dBA
A1	407609	5716237		Normal	107.8	Normal	107.8
A2	407282	5716813	Y	Normal	107.8	Normal	107.8
A3	407471	5717288		Normal	107.8	Normal	107.8
A4	406901	5717428		Normal	107.8	Normal	107.8
B1	408464	5714946		Normal	107.8	Normal	107.8
B2	409183	5714879		Normal	107.8	Normal	107.8
B3	409954	5715104		Normal	107.8	Normal	107.8
B4	410411	5715206		Normal	107.8	Normal	107.8
B5	411048	5715328		Normal	107.8	Normal	107.8
B6	411783	5715085		Normal	107.8	Normal	107.8
C1	412005	5713510		Normal	107.8	Normal	107.8
C2	412394	5713683		Normal	107.8	Normal	107.8
C3	412852	5713677		Normal	107.8	Normal	107.8
C4	413386	5713663		Normal	107.8	Normal	107.8
C5	413621	5714082		Normal	107.8	Normal	107.8
C6	413900	5714540		Normal	107.8	Normal	107.8
C7	414809	5714034		Normal	107.8	Normal	107.8
D1	415975	5713928		Normal	107.8	Normal	107.8
D2	416540	5713951		Normal	107.8	Normal	107.8
D3	416980	5714109		Normal	107.8	Normal	107.8
D4	417515	5714212		Normal	107.8	Normal	107.8
D5	418001	5714349		Normal	107.8	Normal	107.8
D6	418204	5715523		Normal	107.8	Normal	107.8
E1	411475	5710814		Normal	107.8	Normal	107.8
E2	411857	5711318		Normal	107.8	Normal	107.8
E3	412043	5712089		Normal	107.8	Normal	107.8
E4	413085	5711966		Normal	107.8	Normal	107.8
E5	411974	5710794	Y	Normal	107.8	Normal	107.8
F1	414120	5718947		Normal	107.8	Normal	107.8
F2	414562	5719100		Normal	107.8	Normal	107.8
F3	413592	5716774		NR-1	105.7	NR-1	105.7
F4	414388	5716918	Y	Normal	107.8	AM-3	106.9