CROWNED RIDGE WIND II -COMPLAINT SOUND MONITORING PROTOCOL



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Crowned Ridge Wind II - Complaint Sound Monitoring Protocol

Report Prepared by:

RSG

Report Prepared for:

Xcel Energy

For additional information regarding this report, or for questions about permissions or use of findings contained therein, please contact:

RSG (Headquarters) 55 Railroad Row White River Junction, VT 05001 (802) 295-4999 www.rsginc.com

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1.0 INTRODUCTION1
1.1 OVERVIEW1
1.2 BACKGROUND1
1.3 PROTOCOL SCOPE1
2.0 NOISE COMPLIANCE ASSESSMENT
2.1 PERMIT SPECIFICATION2
3.0 MONITORING LOCATIONS
3.1 SITE SELECTION
3.2 PROPOSED MONITORING LOCATIONS
4.0 DEPLOYMENT OF MONITORING STUDY
4.1 INSTRUMENTATION5
4.2 SITING INDIVIDUAL MONITORS
5.0 DATA COLLECTION AND PROCESSING
5.1 DATA COLLECTION6
5.2 DATA EXCLUSIONS AND QUALIFICATIONS6
5.3 RESULTS7
6.0 DETERMINATION OF COMPLIANCE
6.1 SHUTDOWN SPECIFICATION
6.2 DETERMINATION OF WIND TURBINE-ONLY SOUND LEVELS
7.0 REPORTING
APPENDIX A. MONITOR LOCATION MAPS
LIST OF FIGURES
FIGURE 1: MONITOR LOCATION OVERVIEW MAP. 4 FIGURE 2: MONITORING LOCATION (LT2). 10 FIGURE 3: MONITORING LOCATION (LT3). 11 FIGURE 4: MONITORING LOCATION (LT6). 12
LIST OF TABLES

LIST OF TABLES	
TABLE 1: PROPOSED MONITORING LOCATIONS	
TABLE 2. SUGGESTED DAILY SHUTDOWNS SCHEDULE (24-HOUR TIME) 8	

1.0 INTRODUCTION

1.1 OVERVIEW

This is the second Post-Construction & Complaint Sound Monitoring Protocol ("Protocol") for additional noise compliance testing at Crowned Ridge II Wind (the "Project"). The Project is located in Codington, Deuel, and Grant Counties in South Dakota. Originally designed and permitted as a 300 MW project, only a 200 MW portion of the project commenced commercial operation in late 2020. The currently operating 200 MW Project consists of eighty-eight (88) wind turbines: nine (9) GE 2.1 and seventy-nine (79) GE 2.3 wind turbines. The GE 2.1 models are at an 80-meter hub-height above ground level, and the GE 2.3 models are 90 meters above ground level. Both wind turbine models have 116-meter rotor diameters. All wind turbines have low-noise trailing edges (LNTE) installed on the blades.

1.2 BACKGROUND

Noise complaints following the commercial operation of the Project prompted the South Dakota Public Utility Commission ("SD PUC") to initiate a post-construction sound monitoring study to determine if the sound levels attributable to the Project at surrounding residences are in compliance with the applicable noise standards. The basic methodology and conditions are stipulated in the project permit¹ (the "Permit") issued by the SD PUC and additional SD PUC guidance.

A Post-Construction Noise Study (Post-Con Study) completed in May/June 2021² concluded that the Project was in compliance with the Permit (Section 2.1). Without any prior formal action on Post-Con Study, noise complaints from the Project were discussed at the SD PUC meeting on August 30, 2022. At the meeting, Xcel agreed to the SD PUC's request to perform a second noise study in the fall because residents felt that the Project was louder during that season.

1.3 PROTOCOL SCOPE

The scope of this Protocol includes:

- The purpose and scope of the sound monitoring study;
- Proposed monitoring locations;
- Specifications for monitoring duration and instrumentation for data collection;
- Data collection and processing methodology; and
- A discussion of how data will be analyzed, presented, and reported

¹ Wind energy permit EL19-027, South Dakota Public Utility Commission ("SD PUC")

² EL19-027: 8/06/21 - Post Construction Noise Compliance Report

2.0 NOISE COMPLIANCE ASSESSMENT

2.1 PERMIT SPECIFICATION

Specification of the sound level metrics that shall be assessed for compliance are stated in Condition #26 of the Project's Permit:

The Crowned Ridge Wind II Project (CRW II), exclusive of all unrelated background noise except for that associated with the pre-existing Crowned Ridge Wind I Project (CRW I), shall not generate a sound pressure level (10-minute equivalent continuous sound level, Leq) of more than 45 dBA as measured within 25 feet of any nonparticipating residence unless the owner of the residence has signed a waiver, or more than 50 dBA (10-minute equivalent continuous sound level, Leq) within 25 feet of any participating residence unless the owner of the residence has signed a waiver.

Subparts a) through f) of Condition #26 further specify the parameters for post-construction noise compliance assessment. The outlined methodology is summarized below.

Sound levels and ground level wind speeds shall be continuously monitored at three locations for 14 days or more.

• Sound level meters shall be certified to meet the Class 1 accuracy requirements as specified in ANSI S1.4 and IEC 61672-1.

The 10-minute equivalent continuous wind turbine sound level ($L_{eq10min}$) will be assessed at monitoring locations 25 feet from residences.

- Several wind turbine shutdowns will occur each calendar day to assess the background sound levels ("Background"). Background sound levels will be determined by shutting down all wind turbines within 2.8 kilometers (1.75 miles) of a monitor location. After a background period of at least 10-minutes, the wind turbines will be restarted.
- Up to six 10-minute equivalent continuous sound levels (L_{eq10min}) will be measured before and after each shutdown with the wind turbines operating normally ("Total" sound levels). Periods more than 1 hour from a turbine shutdown will not be analyzed for compliance purposes.
- Background sound levels shall be removed from measured Total sound levels following ANSI S12.9 Part 3 Section 7.
- The noise limit for non-participating residences is 45 dBA and 50 dBA for participating residences). "Compliance shall be demonstrated if all samples are less than the limits."
- The target condition for compliance includes, at a minimum, the 5 nearest turbines operating and the closest turbine operating within 1 dB of its maximum sound emission

The specific application of this basic methodology is detailed in the following sections.

3.0 MONITORING LOCATIONS

3.1 SITE SELECTION

Three locations from the original Noise Study (LT2, LT3, and LT6) are the subjects of this study, and were selected for monitoring as a result of formal noise complaints registered at these residences. Monitoring locations are specified in the following section (Section 3.2). Monitor deployment is contingent upon landowner consent.

3.2 PROPOSED MONITORING LOCATIONS

The primary and alternate monitor locations are listed in Table 1, with modeled sound levels³ and coordinates provided. An overview of the geographic location of the monitor locations is provided in Figure 1; detailed maps of each location are provided in Appendix A.

MONITOR	ТҮРЕ	RECEPTOR ID	PROJECT PARTICIPANT?	MODELED SOUND LEVEL (dBA)	LONGITUDE	LATITUDE
LT2	Primary	CR2-C132-NP	No	42.4	-96.8829	44.99933
LT3	Primary	CR2-C79-NP	No	41.4	-96.8831	44.99555
LT6	Primary	CR2-D221-NP	No	41.7	-96.8425	44.89467

TABLE 1: PROPOSED MONITORING LOCATIONS⁴



FIGURE 1: MONITOR LOCATION OVERVIEW MAP.

4.0 DEPLOYMENT OF MONITORING STUDY

4.1 INSTRUMENTATION

Monitoring equipment at three sites will be deployed for a 14- to 21-day period in the fall of 2022. The study is currently planned to start in the second half of November 2022. ANSI/IEC Class 1 sound level meters, logging 1/3 octave band sound pressure levels once each second and coupled with audio recorders to aid in sound source identification and soundscape characterization, will be deployed. Anemometers will be located at all locations within 20 feet of the microphone at microphone height to measure wind speed. In addition, precipitation and wind direction will be measured at one location. Additional meteorological data will be obtained from a nearby National Weather Service station and project SCADA systems.

4.2 SITING INDIVIDUAL MONITORS

Sound level meter microphones shall be micro-sited in accordance with the following criteria.

- 1) The microphone shall be fitted with a 7-inch diameter hydrophobic windscreen.
- 2) The microphone shall be placed outside, approximately 1.5 meters above the ground.
- 3) The microphone shall not be placed such that any structure blocks the line of sight between the microphone and otherwise visible wind turbines.
- 4) The microphone shall be located in such a way that it is representative of the noise exposure at the monitoring location.
- 5) The microphone at each site will be placed within 7.7 meters (25 feet) of the residence.

If, at a given site, any of these criteria interfere with the others, they shall take precedence in the order listed.

Each sound level meter shall be field-calibrated immediately before and after each monitoring period. Any calibration drift will be noted.

5.0 DATA COLLECTION AND PROCESSING

5.1 DATA COLLECTION

Overall equivalent continuous A-weighted sound levels and 1/3 octave band spectra⁵ will be logged at one-second time intervals over the entire monitoring period.

Further, additional supporting data to be logged or otherwise obtained during the monitoring period shall include:

- Wind and gust speed at 1.5 meters above ground level adjacent to each monitor on at least a 1-minute basis at each monitor;
- Wind direction and temperature in at least 1-minute intervals for at least one monitor;
- ASOS meteorological data from Watertown (KATY) or Brandt (WBRA), including regional wind speed and direction, temperature, and regional rainfall data (typically one-hour intervals); and
- Wind speed, wind direction, and power output as measured at each Crowned Ridge II turbine within 2.8 kilometers (1.75 miles) of each monitoring location in 10-minute intervals.

5.2 DATA EXCLUSIONS AND QUALIFICATIONS

Data shall be excluded from the analysis for periods with precipitation and when average 10-minute ground level wind speeds exceed 5 m/s. 6

Condition 26d of the Permit indicates that "[m]easurements shall be conducted using sound level meters meeting ANSI Type 1 specifications." Sound level meters are required to be certified to Class 1 specifications⁷ from -10 °C to 50 °C (14°F to 122 °F) and from 30% to 90% relative humidity. The uncertainty guaranteed in Class 1 instruments is not defined outside of these ranges and the expanded uncertainty of the measurement for Class 1 specifications may not be met for extreme temperatures and humidities.⁸ As a result, periods outside of the specified temperature and humidity ranges will be marked with an asterisk indicating that results from outside of the specified temperature and humidity range may be less reliable.⁹

 $^{^{5}}$ At a minimum, 1/3 octave bands from 20 Hz to 10,000 Hz.

⁶ Condition 26e

⁷ ANSI S1.04. "Class 1" and "Type 1" are equivalent with respect to sound level meters

⁸ Some instruments may have been tested to operating ranges beyond Class 1 uncertainty (e.g., humidity range up to 95%). The instrument manufacturer's defined range (that meets or exceeds the Class 1 specification) will be used directly to qualify the data.

⁹ These data are typically excluded from analyses because the conditions are outside of the Class 1 specifications. In this case, to maximize the opportunity to capture winter conditions that the study is intended to measure, results outside of the range will be calculated but qualified that they may not meet Class 1 sound level meter precision.

For periods when the Total sound level is above the sound standard, the presence of contaminating sound caused by transient sources such as wind gusts or other nearby activity will be reviewed; anomalous (non-wind turbine) activity will be eliminated. Anomalous and invalid data will be determined by examining (listening to) the station's audio recordings and analyzing the spectrograms of logged 1-second 1/3 octave band sound levels.

5.3 RESULTS

Data will be aggregated into 10-minute periods and time history results will be presented as described in Section 7.0.

Further, all periods within 1-hour of a wind turbine shutdown will be evaluated for compliance using the shutdown method described in Section 6.2.¹⁰ Any of these periods with a Total sound level above the sound standard will be evaluated for the presence of non-wind turbine sound; anomalous sounds will be excluded from the dataset and sound levels will be recalculated.

¹⁰ Periods more than one hour from wind turbine shutdowns will not be assessed for compliance due to insufficient background sound level information to determine Project attribution

6.0 DETERMINATION OF COMPLIANCE

6.1 SHUTDOWN SPECIFICATION

Background sound levels shall be determined using wind turbine shutdowns. To this end, all wind turbines from CRW II within 2.8 km (1.75 mi) of each deployed monitoring station shall be shut down on several occasions each day. Wind turbines shall be completely shut down for periods of at least 10 minutes at a time. Wind turbine shutdowns do not need to occur when hub height wind speeds are below 8 m/s¹¹ or during periods with precipitation.

Generally, wind turbine shutdowns are best performed at night to limit background sound levels associated with anthropogenic activity and to allow for atmospheric conditions that are most conducive to sound propagation (i.e., a temperature inversion and higher wind shear).

The suggested shutdown schedule is provided in Table 2. To provide temporal variation in the periods assessed, three nighttime shutdowns and one daytime shutdown are specified.

	SHUTDOWN	SHUTDOWN	SHUTDOWN	SHUTDOWN					
	1	2	3	4					
Shutdown Time	01:30	04:00	13:00	23:00					
Startup Time	01:50	04:20	13:20	23:20					

TABLE 2. SUGGESTED DAILY SHUTDOWNS SCHEDULE (24-HOUR TIME)¹²

6.2 DETERMINATION OF WIND TURBINE-ONLY SOUND LEVELS

Sound levels measured during the periods up to one hour prior to and following each shutdown period shall be designated as "Total" (Turbine + Background).¹³ The sound levels measured during the shutdown period shall be designated as "Background."

The sound level attributed to turbine operations ("Turbine-only") shall be determined by subtracting, on an energy basis, the Background from the Total sound level, by 1/3 octave band, consistent with ANSI S12.9 Part 3 Section 7. If Turbine-only levels are found to exceed 45 dBA, audio recordings and other data will be examined to determine whether the Project was attributable to the apparent exceedance. If applicable, anomalous sound sources will be removed from the data and the results will be recalculated.

 ¹¹ As determined by the power output from SCADA data and the manufacturer's power curve.
¹² While the turbines are shut down completely for 10 minutes, 20-minute periods are provided in this table to allow for spin-down and spin-up.

¹³ Elevated sound levels for a few minutes may occur when wind turbines are abruptly started up after a manual shutdown. Therefore, the Total sound level period after the turbine shutdown will start three to five minutes after all turbines have restarted to allow time to return to normal operation.

7.0 REPORTING

A report will be submitted within six weeks¹⁴ of the end of the sound monitoring. It will include the following information:

- 1) Maps and descriptions of each monitoring location, including the distance from each to the nearest turbine.
- 2) A summary of all data collected presented as 10-minute time histories of overall A- and C-weighted sound levels, meteorological data at the monitoring stations, and turbine operating conditions associated with each monitor. Time periods that are more than 1hour from a turbine shutdown will not be evaluated for compliance due to a lack of background sound level data.
- 3) A summary of the results of the turbine-only sound levels resulting from the shutdown analysis periods at each monitor.
- 4) An assessment of the Project's compliance with the permit based on the results of the shutdown analysis.
- 5) Appendix figures depicting the detailed time history results for the shutdown periods corresponding to the highest calculated wind-turbine only sound level for each monitor.
- 6) Appendix tables listing the conditions and results for each shutdown period for each monitor. The tables will include sound levels during and around each shutdown, calculated turbine-only sound levels for each valid period, and wind turbine conditions such as hub height wind speed, wind direction, and power output. Data will be reported for the closest turbine to each monitor as well as the average conditions at all wind turbines within 2.8 km (1.75 mi) of the specified monitor.

Raw and processed data can be provided to SD PUC staff or their agents upon request.

APPENDIX A. MONITOR LOCATION MAPS



FIGURE 2: MONITORING LOCATION (LT2)

Docket No. EL19-027 Complaint Sound Monitoring Protocol Page 14 of 16



FIGURE 3: MONITORING LOCATION (LT3)

Docket No. EL19-027 Complaint Sound Monitoring Protocol Page 15 of 16





The proposed LT6 monitor locations are north of US Highway 212 and just west of 468th Avenue.

Docket No. EL19-027 Complaint Sound Monitoring Protocol Page 16 of 16

October 2022