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June 6, 2013

Mr. Erle Townsend, Environmental Specialist
Maine Department of Environmental Protection
Division of Land Resource Regulation
17 State House Station
Augusta, ME 04333-0017

Re: Independent Peer Review of the Revised Noise Impact Study for the Canton Mountain Wind Project

Dear Erle:

Tech Environmental, Inc. (TE) has completed an independent peer review of the acoustic impacts of the 24-MW Canton Mountain Wind Project with regard to Maine Site Location of Development (SLOD) Regulations. The project is located in the Town of Canton, Oxford County.

The applicant is proposing to install either: (1) eight GE 2.85-103 2.85 MW turbines on an 85-m hub (total capacity 22.8 MW); or (2) eight Siemens SWT 3.0-113 3.0 MW turbines on a 79.5-m hub (total capacity 24 MW). The applicant has presented predicted sound levels for both wind turbine configurations. A 34.5/115 kV transformer will be installed at the substation 1.5 miles to the southwest of the project area, next to an identical transformer being built for the Saddleback Ridge Wind Project. The previous Resource Systems Group (RSG) sound studies for either GE or Siemens turbines were reviewed by TE in July 2012 and found to be technically correct according to standard engineering practices.

The documents I received for this review include:

- A revised report by Resource Systems Group, Inc., “Noise Modeling Study for Canton Wind Farm” dated May 7, 2013.

- Additional information on the Siemens wind turbine sound power levels provided under a Non-Disclosure Agreement: 1) Siemens Wind Power, “SWT-3.0-113 rev 0, Standard Acoustic Emission,” 2013; 2) Siemens Wind Power, “Exhibit T, Sound Level Test Procedure,” 2011.

Review Standard

The purpose of this peer review is to determine if the acoustic studies submitted with the Application are reasonable and technically correct according to standard engineering practices and the Department Regulations on Control of Noise (06-096 CMR 375.10), referred to herein as the “Maine Noise Regulations”. The nighttime sound limit at a Protected Location is 42 dBA (1-hour L_{eq}).

Sound Power Levels Assumed for the Turbines

The sound power level (L_w) on a decibel scale[1] is determined by the manufacturer through a series of prescribed field measurements using the International Standard IEC 61400-11 test method.[2] The IEC-reported sound power level for a given hub-height wind speed is an average value, meaning there is a scatter of values about the average and the actual sound power level emitted in the field may either be lower or higher. To quantify that variability in values of L_w, the IEC provides a method for assessing L_w measurement uncertainty and unit-to-unit turbine production uncertainty, combining both into a total uncertainty "K" factor (IEC Technical Specification 61400-14)[3]; the K factor has a value of 2.0 dBA for the GE wind turbine and 1.5 dBA for the Siemens wind turbine.

The IEC method defines the "Declared Sound Power Level" as $L_w + K$, and the sum represents an upper-bound sound power level that, under the stated wind speed conditions, will not be exceeded 95% of the time. The Declared Sound Power Level should be used in acoustic modeling to ensure the predicted sound pressure levels are conservative estimates and reasonably account for known uncertainties.

The applicant followed this procedure in modeling sound power levels that are the IEC reported maximum value for the GE 2.85-103 turbine of 105.0 dBA plus an uncertainty K factor of 2.0 dBA, and the IEC reported maximum value for the Siemens SWT 3.0-113 turbine of 105.5 dBA plus an uncertainty factor of 1.5 dBA.[4] The applicant then added a 1.0 dBA modeling uncertainty factor for the ISO 9613-2 sound propagation method[5] at an inland location, and thus a total sound power level of 108.0 dBA was modeled for both makes of turbine. The modeling uncertainty factor of 1 dBA is in the middle of the 0 to 2 dBA range for modeling uncertainty listed as a rebuttable presumption in sub-section I(7)(c)(9) of the Maine Noise Regulations.

Conservatism of the Combined Uncertainty Factor

Our review of the sound test reports for the Stetson I and II wind energy facilities, where wind turbines are located on ridge top settings similar to Canton Mountain Wind, reveal use of the IEC reported sound power level plus uncertainty K factor and adding 1 dBA for modeling uncertainty is a conservative modeling approach for assessing wind turbine acoustic impacts.[6] Thus, RSG's combined uncertainty

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[1] The sound power level is defined as $10*\log_{10}(W/W_o)$, where W is the sound power of the source in Watts and W_o is the reference power of 10^{-12} Watts. The sound power level (energy density) and sound pressure level (what we hear) are not the same, yet both are reported using a decibel levels scale. An acoustic model uses the sound power level of a wind turbine along with other assumptions to calculate the sound pressure level heard at a receiver located a certain distance from the wind turbine.

[2] International Electrotechnical Commission, International Standard IEC 61400-11 Edition 2.1, "Wind turbine generator systems – Part 11: Acoustic noise measurement techniques," Geneva, 2006.

[3] International Electrotechnical Commission, Technical Specification TS 61400-14,"Wind turbines – Part 14: Declaration of apparent sound power level and tonality values," Geneva, 2005.

[4] The IEC sound power levels L_w were independently confirmed.

[5] International Organization for Standardization, Standard ISO 9613-2, "Acoustics – Attenuation of sound during propagation outdoors, Part 2: General method of calculation," Table 5.

[6] Tech Environmental, Inc., "Independent Peer Review of the Sound Level Assessment for the Oakfield Wind Project," September 1, 2011.

factors used in the Canton Mountain Wind acoustic modeling are appropriate and should accurately predict turbine sound levels.

Acoustic Model and Assumptions

Sound levels from the wind turbines were predicted using the Cadna\A acoustic model, the International Standard ISO 9613-2 sound propagation method, and a conservative ground absorption factor of G=0.5 that represents winter frozen-ground conditions. Discrete receivers for residences were placed 4 m above grade, corresponding to the height of a second-floor window, and at 1.5 m above grade for other receivers, representing the ear height for a person standing on the ground. RSG used proper analytical tools for evaluating sound impacts. While the ISO method provides estimates of accuracy for source heights up to 30 m and the Canton Mountain Wind turbines are higher at 79.5 m to 85 m, this acoustic modeling approach has been found to be accurate for utility wind turbine sounds on several past projects with similar hub heights.

The project is located in a mountainous, forested area with residential properties to the north, east and south of the project. The two closest Protected Locations (Non-Participating residences) are approximately 4,900 feet to the northwest (Receiver 7) and approximately 5,400 feet to the south (Receiver 1). A decibel contour map was generated for Canton Mountain Wind to allow verification of predicted sound levels at other residential locations.

The acoustic modeling results are conservative due to the following assumptions:

1. All wind turbines were assumed to be operating simultaneously and at the design wind speed, corresponding to maximum sound power.

2. All wind turbine sound power levels correspond to the IEC 61400-11 maximum sound power level plus a combined uncertainty factor of 2.5 to 3.0 dBA.

3. The acoustic model assumed the most favorable conditions for sound propagation, corresponding to a ground-based temperature inversion, such as might occur on a calm, clear night, or during a downwind condition with a moderate wind speed.

4. No attenuation from trees or other vegetation was assumed.

5. Winter frozen ground conditions were assumed for minimal ground absorption (G=0.5).

6. Excess attenuation from wind shadow effects and daytime air turbulence were ignored.

Acoustic Modeling Results

With this conservative modeling approach, the applicant predicted maximum sound levels and the results are documented in the tables and figures of the May 2013 RSG report. The maximum predicted sound level at any protected location (500 feet from a non-participating residence) for either turbine configuration is 36.1 dBA at Receiver 7B, and the maximum predicted sound level at any non-participating residence is 36.4 dBA at Receiver 7.[7] These maximum levels comply with the daytime (55 dBA) and nighttime (42 dBA) limits in the Maine Noise Regulations. The maximum predicted sound level at any project boundary is 50 dBA at the boundary line east of T1, and this complies with the 75 dBA property boundary limit in the Maine Noise Regulations.

Tonal Sounds

An analysis of the sound power level spectrum for the GE 2.85-103 wind turbine reveals no potential to create a "tonal sound" as defined in the Maine Noise Regulations. While no 1/3-octave band data are available for the Siemens SWT 3.0-113 turbine, the manufacturer has guaranteed that the turbine emits no tonal sound as defined by Maine DEP. Thus, none of the turbines are expected to create a "tonal sound" as defined in the Maine Noise Regulations. Post-construction sound monitoring will confirm this fact.

The two transformers at the substation off Ludden Lane, southwest of the project area, will create a low-frequency hum (RSG report, Table 2 and Figure 6) and since low frequency sound is not quickly attenuated by atmospheric absorption like high frequency sound, the transformers will create a "tonal sound," as defined in the Maine Noise Regulations, at the nearest non-participating residence, which is Receiver 45 (RSG report, Table 3). While Table 3 does not present the total broadband sound levels from the transformers alone, or from the transformers plus turbines, I calculated those values as 24.8 dBA and 31.4 dBA, respectively, from the octave band modeling results. The total transformer sound level of 24.8 dBA is quite low and whether any hum is audible at protected locations will depend on the ambient sound level.

The tonality analysis in the RSG report (Table 3) shows that no tonality exists in the combined sound level from transformers and turbines, but will exist in the sound from the transformers alone. Under the provisions of the Maine Noise Regulations, a 5 dBA penalty is added for tonality to the maximum transformer sound level, yielding a total of 29.8 dBA, which is less than both the daytime (55 dBA) and nighttime (42 dBA) sound limits. This analysis confirms the conclusion put forth by the applicant that sound levels at the closest residence to the substation (Receiver 45) will be well below 42 dBA, even with the 5 dBA penalty (RSG report, page 10). Thus, the transformer sound complies with the Maine Noise Regulations.

Low Frequency Sound

Though there are no limits for low frequency sound in the Maine Noise Regulations, the applicant offered a comparison of the maximum predicted turbine sound level in the two low-frequency bands of 31.5 Hz and 63 Hz. The modeling results reveal that maximum low-frequency sound levels at residences will be below the noise-induced vibration thresholds of American National Standard ANSI S12.2-2008, "Criteria for evaluating room noise."

[7] The slightly higher sound level at the residence, which is farther from the nearest turbine than the protected location, is due to the different receiver heights assigned to the protected location buffer (1.5 m) and the residence (4 m).

Short Duration Repetitive Sound (SDRS)

The definition of SDRS in the section of the Maine Noise Regulations that pertains to Wind Energy Developments is an impulse sound that is 5 dBA or greater "on the fast meter response above the sound level observed immediately before and after the event." Typically this modulation of the turbine mid-frequency sound (the audible "swish-swish") has an amplitude range of 2 to 6 dBA. The 5-dBA penalty for SDRS is applied to each 10-minute period in which more than five SDRS events occur.

The RSG Report examines the likelihood for SDRS at Canton Mountain Wind. From an analysis of wind shear and turbulence data for the Canton Mountain site, and from an SDRS analysis for Spruce Mountain Wind, and considering the fact both the GE 2.85-103 and SWT-3.0-113 turbines have independent blade pitch controls, RSG concludes SDRS events will be infrequent at Canton Mountain Wind. I conclude any correction for SDRS is likely to be far less than the 5.6 dBA difference between the maximum predicted sound level at a Protected Location and the 42 dBA nighttime limit in the Maine Noise Regulations. Sound compliance testing, including SDRS effects, will be done after project completion.

Construction Noise

Construction of the Canton Mountain Wind Project will produce sound levels similar to those generated during roadway construction, and much of the heavy equipment is similar. Daytime construction activity is not subject to the limits in the Maine Noise Regulations. Any nighttime construction activity will need to comply with the nighttime limit in the Maine Noise Regulations.

Post-Construction Sound Level Testing

To ensure that the sound level predictions submitted by the applicant are accurate, and to ensure compliance with the Maine Noise Regulations, including the provisions regarding SDRS and tonal sound, the Department should require limited post-construction sound monitoring for the project, following the general test methodology used in other recent wind energy Land Use Permits.

Whereas projected maximum sound levels are very low at 36 dBA and Noise Reduced Operation (NRO) is not used to achieve compliance, a single compliance test in the first year of operation is sufficient. Testing needs only be done at one location, either Receiver 7B to the northwest or Receiver 1B to the south.

I note that the compliance testing requirements in Section I of the Maine Noise Regulations, "Sound Level Standards for Wind Energy Developments" do not specify how many 10-minute test periods must occur in the day or night, only that 12 such valid test periods must be presented in the compliance test report. I recommend that any permit the Department may issue for Canton Mountain Wind require that at least 6 of the 12 test periods used in the compliance test report represent the nighttime period (7 p.m. through 7 a.m.) during which the sound level limit is 42 dBA and during which wind shear and SDRS conditions are more likely.

Summary

A peer review was done of the report by RSG, Inc., "Noise Modeling Study for Canton Wind Farm" dated May 7, 2013. The results confirm: the turbine maximum sound power level with a conservative uncertainty factor was used in the analysis; the acoustic model and its assumptions are appropriate; the sound receiver locations are appropriate; the decibel contour maps adequately cover the potential impact area; and the Department Regulations on Control of Noise (06-096 CMR 375.10) have been properly interpreted and applied for the Canton Mountain Wind Project. RSG's model estimates are conservative and tend to overstate actual turbine sound levels. No additional studies and/or monitoring requirements are warranted.

For the reasons stated above, I conclude that the acoustic studies submitted with the SLOD Application are reasonable and technically correct according to standard engineering practices and the Department Regulations on Control of Noise (06-096 CMR 375.10).

Recommendations

I recommend that any permit the Department may issue for the Canton Mountain Wind Project require a single compliance test in the first year of operation at one of the following locations: Receiver 7B or Receiver 1B. I also recommend that at least 6 of the 12 test periods used in the compliance test report represent the nighttime period (7 p.m. through 7 a.m.) during which the sound level limit is 42 dBA, and that the compliance test report include a complete presentation of the data and calculations for the SDRS analysis.

Thank you for the opportunity to provide an independent peer review of the Canton Mountain Wind Project Noise Impact Study.

Sincerely yours,

TECH ENVIRONMENTAL, INC.

Peter H. Guldberg

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Managing Principal
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