TECH environmental

FOCUSED KNOWLEDGE. REAL SOLUTIONS.

March 30, 2012

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

Re: Independent Peer Review of the Sound Level Assessment for the Canton Mountain Wind Project

Dear Erle:

Tech Environmental, Inc. (TE) has completed an independent peer review of the acoustic impacts of the 22-MW Canton Mountain Wind Project with regard to Maine Site Location of Development (SLOD) Regulations. The applicant is proposing to install either: (1) seven GE 2.75-103 2.75 MW wind turbines and one GE 2.75-100 2.75 MW wind turbine, with a total capacity 22 MW; or (2) eight Gamesa Noise Optimized G90 2.0 MW wind turbines, with a total capacity 16 MW. The applicant has presented predicted sound levels for both 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 project is located in the Town of Canton, Oxford County.

The documents I received for this review include:

- Section 5 of the SLOD Application, Canton Mountain Wind Project, which includes the original report by RSG, Inc., "Noise Modeling Study for Canton Wind Farm".
- A letter from Mr. Andy Novey of Patriot Renewables to Mr. Erle Townsend, dated March 28, 2012, containing responses to questions.
- A revised report by RSG, Inc., "Noise Modeling Study for Canton Wind Farm" dated March 27.
- Canton Mountain Property Owners Map, dated March 23.

Review Standard

The purpose of this peer review is to determine if the acoustic studies submitted with the Combined 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".

Sound Power Levels Assumed for the Turbines

Sound power level (L_w) is on a decibel scale[1], leading to possible confusion since sound power (energy density) and sound pressure (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. The sound power level (L_w) 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 and combines both into a total uncertainty "K" factor (IEC Technical Specification 61400-14)[3]; the K factor has a typical value of 2.0 dBA for a 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 values plus an uncertainty K factor of 2.0 dBA. The applicant went further and included an additional 2.0 dBA uncertainty factor for the ISO 9613-2 sound propagation method[4], and thus a total of 4.0 dBA was added to the manufacturers' IEC sound power levels.

The manufacturer reported IEC L_w values are 105.0 dBA, 106.5 dBA, and 105.0 dBA, for the GE 2.75-103 turbine, the GE 2.75-100 turbine, and the Gamesa Noise-Optimized G90 turbine, respectively[5]. The G90 turbine as originally made by Gamesa had a maximum L_w of 106.4 dBA, though now a quieter Noise Optimized G90 turbine is available with a maximum L_w of 105.0 dBA. The RSG report assumes the second configuration for the Canton Mountain Wind Project involves the Noise Optimized G90 turbine with the lower sound power level though it does not label it as such. Any decision by the Department regarding this application should identify the Gamesa configuration as consisting of eight Noise Optimized G90 wind turbines.

The 4.0 dBA uncertainty factor was added to the manufacturer-reported IEC L_w values. The resulting modeled L_w values are 109.0 dBA, 110.5 dBA, and 109.0 dBA for the GE 2.75-103 turbine, the GE 2.75-100 turbine, and the Gamesa Noise Optimized G90 turbine, respectively (RSG report, page 8).

---

[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.

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

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

Conservatism of the 4-dBA 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, concluded that a 2-dBA uncertainty factor added to the manufacturer's sound power level is adequate to accurately calculate maximum turbine sound levels with the Cadna\A model in a high-ridge environment.[6] Thus, RSG's model estimates for the Canton Mountain Wind Project, which include a 4-dBA uncertainty factor, are conservative and tend to overstate actual turbine sound levels.

Acoustic Model and Assumptions

Sound levels from the wind turbines were predicted by RSG using the Cadna\A acoustic model, the International Standard ISO 9613-2 sound propagation method, and a conservative ground absorption factor of 0.5 that represents winter frozen-ground conditions. These are the proper tools for accurately 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 75-85 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 method is judged to be accurate for the Canton Mountain Wind Project.

The applicant has voluntarily agreed that all "protected locations" within the project area are subject to the "quiet area" hourly sound level limits (L_{eqA}) of 55 dBA daytime and 45 dBA nighttime in the Maine Noise Regulations. The sound limits for protected locations apply only to land that is not owned or leased by the applicant, and the noise receivers selected for the noise study (RSG report, Receivers 1-60, 2B, 4b, and 9b on pages A1 and A2) are appropriate and represent the nearest protected locations to the turbines (non-participating land parcels with occupied structures), out to a distance of approximately two miles. A sound level limit of 75 dBA applies to the project's property line or lease line boundary. Sound levels were predicted for the discrete receiver locations as well as a fine grid of points to enable the creation of sound contour maps.

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 an uncertainty factor of 4.0 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.

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

5. Winter frozen ground conditions were assumed for minimal ground absorption. (G=0.5 in the model, representing a mixed ground surface that is midway between completely absorptive and reflective. Most of the year the vegetated ground surface in the project area is highly absorptive).

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

7. Receiver height for residences was set to 4 m (the second floor window) and the receiver height for all other locations was set to 1.5 m (the ear height for a person standing on the ground).

Acoustic Modeling Results

With this conservative modeling approach, the applicant predicted maximum sound levels and the results are documented in Tables A1 and A2, and in Figures 11 and 12, of the RSG report. The maximum predicted sound level at any protected location (500 feet from a non-participating residence) is 43 dBA at Receiver 9b for either the GE or Gamesa turbine configuration, and complies with the daytime (55 dBA) and nighttime (45 dBA) limits in the Maine Noise Regulations. The maximum predicted sound level at any non-participating residence is 43 dBA at Receiver 9 for either the GE or Gamesa turbine configuration, and complies with the daytime (55 dBA) and nighttime (45 dBA) limits in the Maine Noise Regulations.

The maximum predicted sound level at any project boundary (the lease line on the Helene Industries parcel near T8 is the closest boundary to any turbine) is 58 to 59 dBA for the two turbine configurations. These sound levels were calculated assuming the lease line is approximately 300 feet from T8, and they comply 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 2.75-103 and GE 2.75-100 turbines reveals that neither has the potential for creating a "tonal sound" as defined in the Maine Noise Regulations (RSG report, Figures 4 and 5). The sound power level spectrum for the Gamesa Noise Optimized G90 turbine, however, does reveal a tonal spike in the high frequency 1/3-octave band at 6300 Hz (RSG report, Figure 6). Applying the absorption coefficient for a standard atmosphere at this frequency (ANSI Standard S1.26-1995) over the distance to the nearest receiver, the high frequency sound at 6300 Hz will attenuate to below 0 dB, the threshold of hearing, as claimed by the applicant (RSG report, page 8). Thus, none of the turbines will create a "tonal sound" as defined in the Maine Noise Regulations.

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 7) 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, we calculated those values as 24 dBA and 33 dBA, respectively, from the octave band modeling results. The total transformer sound level of 24 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 dBA, which is less than both the daytime (55 dBA) and nighttime (45 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 45 dBA, even with the 5 dBA penalty (RSG report, page 8). Thus, the transformer sound complies with the Maine Noise Regulations.

Short Duration Repetitive Sound (SDRS)

The definition of SDRS in the Maine Noise Regulations is an impulse sound that is 6 dBA or higher "on the fast meter response above the sound level observed immediately before and after the event." Typically this modulation of the turbines mid-frequency sound (the audible "swish-swish") has an amplitude range less than 6 dBA. Since the 5-dBA penalty for SDRS is applied only to the SDR sounds and not the entire measurement interval, the infrequent occurrence of SDRS sound events are not expected to significantly affect the project's sound levels and no adjustment to the acoustic model predictions for 1-hour L_{eqA} levels is necessary. Compliance testing for SRDS will be done after project completion.

Low Frequency Sound

Though there are no limits for low frequency sound in the Maine Noise Regulations, the applicant has offered a comparison of maximum turbine sound levels in the low-frequency 31.5 Hz and 63 Hz bands to the building-vibration thresholds listed in ANSI Standard S12.2-2008 (65 dB for the 31.5 Hz band and 70 dB for the 63 Hz band). While the applicant states no data is available for sound power in the 31.5 Hz band for the Gamesa Noise Optimized G90, we have located spectrum measurements for the G90[7] that allow us to estimate that band's sound power level (and hence sound pressure level at a nearby receiver) as 5 dB above the level for the 63 Hz band, or 60 dB. The predicted maximum sound levels in the 31.5 Hz and 63 Hz bands, for both turbine configurations, when compared to the thresholds in ANSI S12.2-2008 suggest the project will not cause sound-induced vibration within any non-participating residence.

---

[7] Gamesa, "Design Calculation and Compliance Report – Noise Emission Analysis for G8X Wind Turbines," Report GD027805-en, December 2008, page 24. This report contains spectrum data for G80 through G90 turbines.

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 limits applicable to routine facility operation.

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 post-construction sound monitoring for the project, following the test methodology in the Saddleback Mountain Land Use Permit. The project is upwind of, and easterly flanked by, five protected locations (non-participating residences and surrounding lands) which will receive sound levels at or above 40 dBA. This region should be monitored both acoustically and meteorologically in no less than two locations representative of non-participating receivers and their respective elevations. Acoustic monitoring should occur, at a minimum, at the cluster of four non-participating residences to the east on Canton Mountain Road (Receivers 9, 10, 11 and 12) and at the single closest non-participating residence to the southeast on Town Farm Road (Receiver 3).Other non-participating residences to the south, southwest, northwest, and north that are approximately one mile or farther from the turbines, and which have maximum predicted sound levels at or below 35 dBA, do not require sound compliance monitoring due to their greater distance from the wind turbines.

Summary

A peer review was done of the report by RSG, Inc., “Noise Modeling Study for Canton Wind Farm”. 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 for the Canton Mountain Wind Project, which include a 4-dBA uncertainty factor, 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). Any decision by the Department regarding this application should identify the Gamesa configuration as consisting of eight Noise Optimized G90 wind turbines.

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

Sincerely yours,

TECH ENVIRONMENTAL, INC.

Peter H. Guldberg

Peter H. Guldberg, INCE, CCM
Managing Principal
3543/Letter Report March 29 2012