

**Spruce Mountain Wind Project  
Woodstock, Maine -- Peer Review**

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## **Review Basis**

PATRIOT RENEWABLES Spruce Mountain Wind, LLC (Project) proposes the development of a 18-20 MW wind power generating facility in western Maine. The Project is located entirely in the town of Woodstock in Oxford County, Maine. The general project area is located along the ridge line of Spruce Mountain. Current land use in the project area consists primarily of undeveloped forests that have been subject to commercial forest harvesting operations. At the request of the Maine Department of Environmental Protection (MDEP) a peer review is undertaken to determine if the Project noise study is reasonable and technically correct according to standard engineering practices and the Site Location Development Law (38 M.R.S.A. §§ 481-490) Chapter 375.10. The review includes the original study dated January 2010 and subsequent memoranda dated March 24, 2010 and May 7, 2010.

## **Noise**

Tetra Tech has completed an acoustic assessment for predicted operational and construction noise, specifically addressing Project sound sources, site-specific sound propagation characteristics and a range of meteorological conditions. Project operational noise was determined with the use of computer modeling based on internationally accepted algorithms.

### **5.1 Acoustic Terminology and Definitions**

Informational

### **5.2 Noise Regulations and Performance Standard**

#### **5.2.1 Town Of Woodstock Noise Performance Standards**

Correctly identified based on Town of Woodstock formal waivers dated November 10, 2009 and January 5, 2010.

#### **5.2.2 Maine Department Of Environmental Protection Noise Control Regulations**

Correctly identified The study proposes to achieve MDEP sound level limit compliance at the 500 foot radius around receptors, regardless of property lines

### **5.3 Project Noise Assessment**

The Project noise assessment includes both construction and operation sounds for two configurations – 10 and 11 turbines.

#### **5.3.1 Construction**

Standard discussion – appropriate

#### **5.3.2 Operation**

Introduces modeling basis

- Manufacturer specifications
- Three-dimensional based on site-specific typography
- Acoustic software modeling program (CadnaA) and widely accepted algorithms (ISO-9613.2)
- Additional application of appropriate conservative input assumptions

### 5.3.2.1 Sound Propagation Model

Specifies modeling assumptions applied to the project comprised of up to 11 GE 1.5sle wind turbines or a combination of 9 or 10 Gamesa G87 and G90 2.0-MW wind turbines:

- Manufacturer specifications (IEC 61400-11)
- Geometric spreading wave divergence (spherical to modified-cylindrical at extended distances)
- Reflection from surfaces
- Atmospheric absorption (10° C 70% RH)
- Screening by topography and obstacles (3 dimensional analysis)
- Terrain complexity and ground effects (G=0.5)
- Source directivity factors (worst-case assumed)
- Height of both sources and receptors (source location sensitivity analysis)
- Foliage effects (not included)
- Meteorological conditions including the effects of wind and atmospheric inversions (Anomalous  $C_{met}$  calculations with  $C_0 = 3$  dB)
- Omni-directional downwind propagation

Proposed wind turbines, GE and Gamesa G87/G90 manufacturers report the following maximum sound power output  $L_{WA}$  respectively,  $104.0 \pm 2.0$  dB and 105.3 (uncertainty factor included). Wind turbine sound power specifications are based on IEC 61400-11 assumptions extrapolating turbine hub level wind speeds from 10-meter measurements assuming a standard logarithmic wind profile with a surface roughness of ( $z_{0ref}$ ) = 0.03 m (representative of average terrain conditions). Construction of the proposed facility using the GE model could potentially result in source maximum sound power levels exceeding those modeled by approximately 1 dB. Average roughness length calculations incorporating the effect of localized windshear were completed, but diurnal/nocturnal ridge/ground surface measurement data was unavailable for actual analysis of worst-case nighttime high windshear occurrence frequency and surface meteorological stability classification.

The geometric spreading algorithm (spherical to modified-cylindrical at extended distances) results in negligible increases in predicted sound levels at nearest protected locations (10-12).

Reflection from surfaces, atmospheric absorption, screening by topography and obstacles, source directivity factors and foliage effects are common methodology (ISO 9613-2) for similar sites.

Terrain complexity and ground effects factor  $G = 0.5$  in the absence of an additional correcting factor requires a marked extrapolation from the ISO 9613-2 standard that assumes approximately flat terrain from source to receiver and a maximum source height of 30 m.

TRC's source location sensitivity analysis based on the height of both sources and receptors results in no adjustments for nearest protected locations 10-12.

In the absence of area specific, long-term windshear and temperature inversion data, it is somewhat arbitrary to calculate worst-case  $C_{met}$  specifying  $C_0$  as 2, 3, 4 or 5 from ISO 9613-2 long term average methods and results in no adjustments for nearest protected locations 10-12. MDEP compliance measurements are conversely required at nearest protected locations during worst-case (nighttime, stable atmospheric) conditions.

Additionally, ISO 9613-2 Accuracy and limitations of the method (clause 9) indicates a broadband noise estimated accuracy of  $\pm 3$  dB.

The 40 m ridgeline wind rose data indicates predominant W-NW winds exceeding 8 m/s resulting in the Project's nearest protected locations (10-12) being directly downwind from turbines 9-11 during a considerable period of WT maximum or near-maximum sound power output.

The acoustic model assumes the standard methodology of all wind turbines operating continuously and concurrently at maximum manufacturer rated sound levels under omnidirectional, downwind conditions.

#### 5.3.2.2 Analysis Results

The acoustic model was completed for 10 and 11 Gamesa G 90 - 2.0 MW wind turbines under various operating conditions.

#### 5.3.2.3 Short Duration Repetitive Sound

The assessment claims not to expect SDRS based on the findings of two, studies (1996 and 2007).

Short duration repetitive sounds (SDRS) for the GE 1.5 sle are not expected based on manufacturer's specifications and the reviewer's prior experience, but Gamesa 87/90 WTs are not manufacturer specified for SDRS sounds nor has this reviewer sufficient prior experience to know otherwise. Quantified amplitude modulation (potential SDRS) during worst-case meteorological conditions are not presented by TRC.

#### 5.3.2.4 Tonal Sound

Specifies conservative predictive modeling findings are well within the MDEP standards

### 5.4 Conclusions

TRC concludes the proposed Spruce Mountain Wind Project noise will operate in compliance with the Town of Woodstock Noise Performance Standards and the State of Maine DEP noise limits for wind power projects at all residential receptor locations.

The reviewer does not concur with TRC, but finds several modeling assumptions insufficiently conservative to assure that nearest protected locations (10-12) from excessive noise levels as specified in Regulations on Control of Noise (06-096 CMR 375.10). I will expand my concerns in the following section.

TRC incorporate several factors that become conservative at distances exceeding those within the region of the nearest protected locations (10-12) where compliance must be demonstrated.

### Conclusion - (Peer Review)

In my opinion Spruce Mountain Wind Project must reevaluate, but not necessarily incorporate all the following conservative predictive assumptions:

Adjustments for the GE 1.5 sle source maximum sound power level, including uncertainties

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Adjustments for terrain complexity and ground effects to adequately address ISO algorithm limitations

Adjustments for worst-case meteorological conditions that are not addressed in TRC's location specific roughness length evaluation or ISO 9613 -2

Additionally, ISO 9613-2 Accuracy and limitations of the method (clause 9) which indicates a broadband noise estimated accuracy of  $\pm 3$  dB.

And finally Gamesa 87/90 WTs quantifiable amplitude modulation (potential SDRS) during worst-case meteorological conditions must be comprehensively addressed.