

Oakfield Wind Project Amendment Sound Level Assessment -- Peer Review

OAKFIELD, MAINE

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Review Basis

Evergreen Wind Power II, LLC proposes a wind energy facility to operate 34 utility-scale wind turbines in the Oakfield area of Aroostook County, Maine. At the request of the Maine Department of Environmental Protection (MDEP) a peer review is undertaken to determine if the noise study is reasonable and technically correct according to standard engineering practices and the Department Regulations on Control of Noise (06-096 CMR 375.10). This review includes amendment changes submitted September 15, 2009.

It is noted that this reviewer concurrently reviewed model predictions, and compliance measurements for Stetson Wind Project, a State of Maine Land Use Regulation Commission zoned development.

1.0 Introduction

The stated objective of the sound assessment was to demonstrate that the Oakfield wind project will meet applicable sound level limits. Sound levels from the construction activity, and operation of the substation and other electrical transmission facilities are briefly discussed.

The routine operation sound level estimates are compared to the Maine DEP sound level limits to demonstrate that Oakfield wind project will meet applicable sound level limits.

2.0 Sound and Decibels

Informational

3.0 Site Description

The wind turbine portion of the project consists of 34 General Electric 1.5 MW turbines located a top Oakfield North and South in Oakfield (Aroostook County). Both clusters include 17 turbine sites and one alternative. Operation of the substation and transmission lines are not expected to generate significant sound levels, which are not included in sound level estimates for the wind project facility.

The turbines will generally run southwest-northeast along various ridges with base elevations of the turbines ranging from approximately 910-1430 feet above mean sea level. The spacing between turbines within the two turbine clusters will range from a minimum of approximately 660-1700 feet. The distance between the two clusters is approximately 1.6 miles. In addition to the turbine structures, the project will include construction of an operations and maintenance facility to the northwest of Oakfield South and a substation to the west of Oakfield North.

Residential properties are located around the perimeter of Oakfield North,

northwest of Oakfield South, along South Road which bisects Oakfield South, and along Nelson Road (including an approved subdivision 1987) between the two clusters otherwise this project site is largely undeveloped forestry land.

Evergreen Wind Power II (Evergreen II) has purchased property or obtained leases with local landowners to install and operate wind turbines at the proposed locations. Evergreen II has also obtained agreements with landowners who may experience sound levels from the project that have the potential to exceed applicable sound level limits (MDEP Chap 375.10)

Parcels for which Evergreen II has a lease, easement or other arrangement are indicated in the assessment.

4.0 Noise Control Standards

The town of Oakfield enacted a land-use ordinance specifically addressing commercial wind turbine permitting (September 28, 2009). This reviewer has considered the aforementioned land-use ordinance in arriving at recommendations, based on Maine DEP Chap 375.10 regulations.

5.0 Existing Sound Levels

Evergreen II proposes to not confirm predevelopment ambient sound levels, but rather, in recognition of the rural nature of the site accept the most conservative regulation levels of 55 dBA daytime and 45 dBA nighttime. Mention is made of elevated wind effects on ambient noise during wind speeds required for turbine operation.

6.0 Sound Level Limits

Sound level limits were determined at protected locations and property lines based on land owner agreements and land uses. As previously mentioned, Evergreen II has obtained leases or agreements with many local landowners to exempt the project from sound level limits at those sites.

Nine nearby sensitive receiver points are listed respective to residences/property boundaries and estimated development impact.

7.0 Future Sound Levels

7.1 Construction

Standard discussion

7.2 Proposed Operation

Operation sound level estimates were based on an acoustic model employing CADNA/A software utilizing area topography and wind turbine locations as provided by Stantec.

Wind turbine operation and sound power output relative to wind speed are discussed and plotted. Sound level estimates are based on full turbine sound power output plus an uncertainty factor of + 5 dBA to allow for wind turbine sound power specification (IEC 61400-11) and outdoor propagation prediction (ISO 9613-2) uncertainties. Attenuation factors were intentionally omitted from the estimate model, which may have lessened resulting estimates further.

Selected sensitive receiver position sound level estimates from routine wind turbine operation range from 42-45 dBA. Actual measured sound levels will vary substantially with wind speeds/directions, subsequent to microphone interference and numerous wind generated noise sources (ambient + operation).

Wind speed generally varies with the elevation and may contain both horizontal and vertical components. Sound level measurements taken during turbine operation levels at or near maximum power will occur under a wide range of increased wind speeds. These measurement periods will be characterized by times when wind turbines are completely inaudible due to high ambient noise and times when surface level operation noise is more prominent.

Accurate, measurement-derived operation sound levels can only be made when conditions permit, a clear separation between operation and background sound. Forested receiver locations may not allow adequate separation of operation and ambient sound sources under representative operating conditions.

Tonal sounds (MDEP defined) are not expected based on manufacturer specifications, but may occur. Short duration repetitive sounds (MDEP defined) may occur as a result of amplitude modulation during intermittent conditions.

8.0 Conclusions and Recommendations

Maine DEP sound level limits based on land use and land owner agreements were set at "quiet limits -- 45 dBA nighttime/55 dBA daytime" (within 500 feet of residence).

Future sound level estimates from the proposed development indicate compliance with the Maine DEP requirements.

In addition to this proposed application, the reviewer performed a general review of the Stetson Wind Project data focusing particularly on a singular measurement location chosen for demonstration of the MDEP commercial wind turbine routine operation

compliance measurement protocol [See Conclusion-(Peer Review) Rollins Wind Project Sound Level Assessment -- Peer Review April 6, 2009 (*Rollins compliance protocol*)]. The measurement location selected was near the center of a concave array of five line-of-sight turbines, ranging from 1300-2000 feet from the microphone position and varying in elevation from each turbine hub by 250-400 feet. Meteorological data was correlated between 10 m, and the closest turbine for correlation with sound measurements to achieve desired measurement conditions (> 60% maximum wind turbine operation (maximum sound power output) during light surface winds).

The data was rigorously evaluated *using the Rollins Compliance Protocol* methodology for sound level equivalent, tonal and short duration repetitive sounds. The measurement period was characterized by prolonged stable atmospheric conditions. The Stetson Wind Project predictions were based on CADNA/A software, including numerous prediction assumptions (consistent modeling assumptions used by RSE for this proposed Oakfield site and numerous wind projects before this) and the addition of an uncertainty factor of + 5 dBA were 2-3 dBA less than predicted operating levels.

This singular ridge-top, wind turbine operating sound assessment was conducted under "worst case" array geometry, line-of-sight and meteorological conditions. The documented results support a "calibrated prediction model" which is representative of "sensitive receivers" at similar distances and elevations.

Conclusion - (Peer Review)

In my opinion the Oakfield Wind Project noise assessment is reasonable and technically correct according to standard engineering practices and the Department Regulations on Control of Noise (06-096 CMR 375.10).

The wind project prediction model based on CADNA/A software, based on the following prediction assumptions:

- individual wind turbine spherical wave fronts,
- mixed ground cover attenuation (general) and reflective water surfaces,
- atmospheric attenuation based on 10°C, 70% RH,
- no attenuation due to foliage or barriers,
- all wind turbines operating at maximum sound power output and
- all wind turbines operating under moderate downwind conditions simultaneously.

Incorporation of an uncertainty factor of + 5 dBA for maximum equipment specification potential inaccuracy under stable atmospheric conditions and measurement methodology uncertainties resulted in a reasonable prediction model that is conservative at times.

SDRS was not observed using a rigorous protocol under very favorable geometric and atmospheric conditions. A tonal sound was observed periodically at 3150 Hz, but did not result in a penalty that effectively changed findings.

I recommend required routine operation noise compliance measurements at a minimum of six protected locations designated in the application noise assessment as "Receiver Positions" R1, R4-7 and R9. These particular sites not only represent the highest predicted levels, but also both the northern and southern turbine arrays from multiple directions and elevations. Please note specific recommendations (pending landowner agreement) for some locations.

Receiver Position	Recommendation/s
R1	as a proxy for the proposed R1 location, compliance measurements should be made in a field west of the residence (same parcel of land) toward the proposed development, at a point where the predicted model indicates a level of 43.8 dBA (PURPOSE -- minimization of extraneous noise sources from the tree canopy)
R4	No additions
R5	Efforts should be made to make measurements at a proxy location on the western end of the northern array at a similar elevation (~800 ft. msl) where predicted sound levels approximate 44 dBA (PURPOSE -- minimization of extraneous noise sources from the tree canopy)
R6	No additions
R7	This forested location should be evaluated during hardwood defoliation. (PURPOSE -- this receiver position is representative of downwind, lower elevation properties along the southern array and suitable alternatives do not exist in this wooded region)
R9	No additions

Compliance should be demonstrated, based on following outlined conditions for 12, 10-minute measurement intervals per monitoring location meeting 06-096 CMR 375.10 requirements.

Background ambient monitoring may be required in the areas where extraneous sounds could potentially or do complicate routine operation compliance assessment. If required, background ambient monitoring locations and times will be determined with concurrence from the MDEP.

- a. Compliance will be demonstrated when the required operating/test conditions have been met for twelve 10-minute measurement intervals at each monitoring location.
- b. Measurements will be obtained during weather conditions when wind turbine sound is most clearly noticeable, i.e. when the measurement location is downwind of the development and maximum surface wind speeds ≤ 6 mph with concurrent turbine hub-elevation wind speeds sufficient to generate the maximum continuous rated sound power from the five nearest wind turbines to the measurement location. Measurement intervals affected by increased biological activities, leaf rustling, traffic, high water flow or other extraneous ambient noise sources that affect the ability to demonstrate compliance will be excluded from

reported data. A downwind location is defined as within 45° of the direction between a specific measurement location and the acoustic center of the five nearest wind turbines.

c. Sensitive receiver sound monitoring locations should be positioned to most closely reflect the representative protected locations for purposes of demonstrating compliance with applicable sound level limits, subject to permission from the respective property owner(s). Selection of monitoring locations should require concurrence from MDEP.

d. Meteorological measurements of wind speed and direction should be collected using anemometers at a 10-meter height above ground at the center of large unobstructed areas and generally correlated with sound level measurement locations. Results should be reported, based on 1-second integration intervals, and be reported synchronously with hub level and sound level measurements at 10 minute intervals. The wind speed average and maximum should be reported from surface stations. MDEP concurrence on meteorological site selection is required.

e. Sound level parameters reported for each 10-minute measurement period, should include A-weighted equivalent sound level, 10/90% exceedance levels and ten 1-minute 1/3 octave band linear equivalent sound levels (dB). Short duration repetitive events should be characterized by event duration and amplitude. Amplitude is defined as the peak event amplitude minus the average minima sound levels immediately before and after the event, as measured at an interval of 50 ms or less, A-weighted and fast time response, i.e. 125 ms. For each 10-minute measurement period short duration repetitive sound events should be reported by percentage of 50 ms or less intervals for each observed amplitude integer above 4 dBA. Reported measurement results should be confirmed to be free of extraneous noise in the respective measurement intervals to the extent possible and in accordance with (b).

f. Compliance data collected in accordance with the assessment methods outlined above for representative locations selected in accordance with this protocol will be submitted to the Department for review and approval prior to the end of the first year of facility operation. Compliance data for each location will be gathered and submitted to the Department at the earliest possible opportunity after the commencement of operation, with consideration for the required weather, operations, and seasonal constraints.