MEMORANDUM

Date: March 7, 2014

To: WNTAG

From: Chris Kapsambelis

Subject: Outstanding Issues

Introduction

In the course of these meetings a number of issues have arisen that need to be resolved. Wind shear plays a big role in both pre-construction acoustical studies, and post construction testing. In preconstruction studies wind speeds are measured ground level, and hub wind speeds are estimated based on the assumption of typical wind shear which yields a ratio between hub height and ground around 1.59:1. In reality at night, there are a significant number of days with extreme wind shear where the ratio exceeds 8:1. As a result these studies serve to overstate the ambient sound levels leading to installations that are later found to be out of compliance.

In post construction testing, data collection is scheduled based on forecasted ground wind speed and direction without taking extreme wind shear conditions into consideration. This leaves the worst case testing conditions up to chance leading to a small number or no violations where mitigation steps fail to resolve the issue.

What follows are issues that serve to overstate the measurement of ambient sound power levels and understate the increase in the broadband sound pressure level above ambient to establish the impact sound measurement.

Wind Shear

Present practice fails to take the effects of wind shear into full account. The National Renewable Energy Laboratory (NREL) collected large amounts of wind shear data which show that, on a significant number of days per year, the wind shear coefficient is 1 or more. For 80 meter-high wind turbines with a design wind speed rating of 8 meters per second, 10-meter-high ground wind speed will be less than 1 meter per second, in other words -- essentially calm. This will result in very low ambient sound levels in the low 20 dB(A) range at a time when wind turbines emit maximum sound power levels.

Wind Shear data, collected from the Fairhaven site from August 19, 1992 through September 23, 1993 by Second Wind, Inc, shows more than one hundred days a year when the wind shear coefficient is greater than one between midnight and 4:00 AM. The data set is made up of ten-minute wind speed averages from heights of 21.3 meters and 39.6 meters. These data files are available from the University of Massachusetts Amherst Renewable Energy Research Laboratory (RERL) website at:

http://www.ceere.org/rerl/publications/resource_data/Fairhaven/

In analyzing these data, records for the time period between midnight and 4 AM were selected. This is the time period when most widespread complaints have been filed in recent wind turbine sitings, and when the ambient sound is known to be the quietest. Further selected for analysis were the columns Date, Time, 21.3 meter speed, and 39.6 meter speed. The selected records were imported into an Excel workbook and analyzed.

Extreme wind shear conditions can be defined when hub wind speed is greater than 8 meters per second while ground wind speed at 10 meters above ground is less than 1 meter/second. In analyzing these data, the following results are found:

- Number of days/year where incidents of ground wind is less than 1 m/s and Hub wind speed is more than 8 m/s = 163
- Days/year when extreme wind shear lasts longer than one hour = 112
- Days/year when extreme wind shear lasts longer than two hours = 77
- Days/year when extreme wind shear lasts longer than three hours = 42

Given the nature of weather, these conditions can exist for many consecutive days and can result in very serious sleep deprivation.

The presence of extreme wind shear conditions for so many days throughout the year argues against the present practice of taking a small number of readings, over a short

interval of time, with the turbine off and then on to establish ambient and impact sound levels for compliance testing.

It is imperative that a methodology be developed to measure ambient sound levels at winds speeds less than 1 m/s at 10 meters above ground, and impact sound levels at hub height wind speeds greater than 8 m/s when power and sound power are at maximum levels.

Sound Power Level Discrepancy

The MassDEP measurements of impact sound in Falmouth and Fairhaven show that the specified Sound Power Levels supplied by manufacturers are understate by 10 to 15 dB(A). For example in Fairhaven on September 26, 2013, at 3 Shawmut Street, MassDEP measured an impact sound pressure level of 49.1 dB(A). Using the formulas contained in the MassDEP/DPH Health Impact Study, Appendix E :

$\mathbf{Lp = Lw - 10\log_{10}(2\pi R^2) - \alpha R}$ and $\mathbf{L_{total} = 10\,Log_{10}(10^{L1/10} + 10^{L2/10})}$

One can determine that each wind turbine was generating a sound power level of 114.3 dB(A). This is more than 10 dB(A) above the typical wind turbine sound power level specification of 103 dB(A).

Continuing to use the manufacturer’s specified sound power levels, without some adjustment factor will continue to understate the sound pressure levels predicted by modeling software employed in preconstruction sound studies leading to permits.

Existing Noise Levels

In the measurement of impact sound, there is a tendency to isolate the sound to that from the wind turbine excluding sounds from other sources. This practice distorts the meaning of the word “increase” and the preposition “above” contained in the phrase “Increases the broadband sound level by more than a dB(A) above ambient” in 310 CMR 7.10. For example, if the existing broadband sound level is 9 dB(A) above ambient, and the wind turbine sound increases the broadband sound level above 10 dB(A), in any fair understanding of the regulation, this combined broadband sound level would constitute a violation.

While it may be argued that occasional transient sounds, such as a passing airplane should be excluded, Repetitive sounds such as highway vehicle passings, air conditioning compressors and idling machinery are part of the continuous soundscape , and should not be excluded.

As to the argument that unless these exclusions are allowed, the broadband sound level already exceeds the 10 dB(A) limit, all that means is that the installation should have never been permitted, and compounding the noise level further should not be allowed to stand.

Slow vs. Fast Meter Setting

Based on the measurements with the “Fast” meter setting made by Mr. Todd Drummey during the Falmouth compliance testing, and the reports from Mr. Bahtiarian of Noise Control Engineering, it is clear that the “Fast” meter setting is necessary. The “Slow” meter setting introduces a significant error in the measurement of the impulsive and repetitive nature of Aerodynamic Amplitude Modulation.