THE STATE OF NEW HAMPSHIRE
SITE EVALUATION COMMITTEE

In the matter of the Application for Certification Pursuant to RSA 162-H of ANTRIM WIND ENERGY, LLC	)	**Docket No. 2012-01**

Pre-Filed Testimony
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1. I, Gregory C. Tocci, am a Senior Principal Consultant with and President of Cavanaugh Tocci Associates, Inc., Sudbury, Massachusetts. In 1975, Mr. William J. Cavanaugh and I founded Cavanaugh Tocci Associates—an acoustical consulting firm currently employing 16 staff members. The firm has operated continuously since it's founding and provides acoustical consulting services in architectural, environmental, and industrial acoustics, vibration, and sound system design. I am an Institute of Noise Control Engineering Board Certified Member and a Fellow of that organization. I am also a Fellow of the Acoustical Society of America, and a registered professional engineer (mechanical) in Massachusetts and Rhode Island.

2. I have been retained pursuant to RSA 162-H:10, V to assist Counsel for the Public and the Committee with the review of acoustics-related information pertaining to the proposed Antrim Wind Energy, LLC project.

3. I have reviewed the following documents:

- Sound Level Assessment Report, Antrim Wind Energy Project, Antrim, NH dated November 17, 2011 (Epsilon Associates, Inc., Maynard, MA);

- Pre-filed Direct Testimony of Robert D. O'Neal on behalf of Antrim Wind Energy, LLC dated January 30, 2012;
- Docket No. 2006-01, Application of Lempster Wind, LLC, Decision Issuing Certificate of Site and Facility with Conditions, dated June 28, 2007 (pp. 121-142).
- Docket No. 2010-01, Application of Groton Wind, LLC, Decision Granting Certificate of Site and Facility with Conditions, dated May 6, 2011 (pp. 80-89).
- Other documents footnoted in this pre-filed testimony.

Not included here are the Applicant's data underlying the Epsilon November 2011 report and described below, which I have not received for my analysis as yet.

4. In Tables 6-1 and 6-2 of the Epsilon November 2011 report, median and average equivalent and 90th percentile sound levels are provided for conditions when wind speeds at the met tower were 9.3 m/s or higher. Figure 6-2 presents measured wind speed data at 2 meters and 57 meters for the monitoring period Friday, September 16 to October 4, 2011. I would like to examine these and all other equivalent and 90th percentile sound level data, and the corresponding wind speeds, to evaluate the correlation between wind speed measured at the met tower and background sound levels measured at receptor locations. I would also wish to examine octave band sound levels if measured by any of the sound level meters used for the September 16 to October 4 survey. These data are required to ascertain

the appropriateness of wind farm sound criteria at receptor locations indicated in Section 8 of the Epsilon November 2011 report.

5. The second paragraph of Section 7.1 of the Epsilon November 2011 report explains the derivation of sound power levels provided in Table 7-1 of the report and states:

> *The sound power levels for the Acciona AW116/ClassII/3000 were estimated based on the empirical engineering models at blade level and subject to an uncertain value of 2 dB according to IEC TS 61400-14.*

A detailed explanation of the methods used showing how sound power levels were determined and reported in Table 7-1 is required to ascertain reasonableness of the sound power level estimates provided.

6. Section 8.2 discusses World Health Organization Guidelines and specifically cites "*Guideline for Community Noise*" dated 1999. It indicates that "*At night, sound levels at the outside facades of the living spaces should not exceed an L_{eq} of 45 dBA, so that people may sleep with bedroom windows open.*"

Over the intervening years between 1999 and 2006, the WHO Regional Office for Europe reviewed available scientific evidence on the health effects of night noise, and derived health-based guideline values. These guidelines values are contained in *Night Noise Guidelines for Europe* (World Health Organization, 2009). In this publication, they established a Night Noise Guideline (NNG) expressed as an $L_{night,\ outside}$ of 40 dB and a corresponding Interim Target (IT) of 55 dB. The document explains:

> *The LOAEL* [Lowest Observed Adverse Effect Level] *of night noise, 40 dB* $L_{night,outside}$*, can be considered a health-based limit value of the night noise guidelines (NNG) necessary to protect the public, including most of the vulnerable groups such as children, the chronically ill and the elderly, from the adverse health effects of night noise.*
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> *An interim target (IT) of 55 dB* $L_{night,outside}$ *is recommended in the situations where the achievement of NNG is not feasible in the short run for various reasons. It should be emphasized that IT is not a health-based limit value by itself. Vulnerable groups cannot be protected at this level. Therefore, IT should be considered only as a feasibility-based intermediate target which can be temporarily considered by policy-makers for exceptional local situations*.

The WHO NNG is provided for consideration as an additional guideline to be cited in evaluating sound produced by the proposed Antrim Wind Energy facility.

7. In a presentation to the Maine Medical Association on March 20, 2009, Dr. Michael Nissenbaum presented survey data of 20 homes within 3400 feet of the Mars Hill Wind Project, comprised of 28 1.5MW wind turbines, in Aroostook County, Maine where he interviewed 15 adults. Among the data he presented were that: "93% of those interviewed experience sleep disturbance, 60% 5-7 times per week, 87% to a degree that they have consulted a doctor. 53% have increased headaches, 40% newly onset. 20% experience dizziness, and 20% unusual body sensations (2 subjects reported chest pulsations, 1 pulsatile

ear pressure)."[1] It is noted that at least one residence, L1 Keene Road is located within 3400 feet of the Antrim Wind Energy project having 10 larger, 3.0 MW wind turbines.

8. A letter from the Falmouth Board of Health to Ms. Suzanne Condon, Associate Commissioner, Massachusetts Department of Health, Boston, MA, dated June 11, 2012, *"…requests that Mass DPH immediately initiate a health assessment of the impacts of the operation of wind turbines in Falmouth.*" Further, it cites that *"Due to the increasing intensity of the reported health impacts, the Board is considering emergency actions."* This letter culminates from a Falmouth Board of Health Hearing on the Health Effects of Wind Turbines on May 24, 2012.

A document was prepared by the Falmouth Board of Health summarizing the testimony representing 63 persons. Of the 63 persons represented: 15 indicated no health effects, 1 testimony was rejected, and the remaining 47 indicated health effects cited as being connected to or produced by the Falmouth wind turbines. The report summarizes the impacts as follows: *"The major health effect reported was sleep deprivation (85%) with attendant stress (53%), mental health problems (45%), hearing problems (32%), cognitive difficulties (25%), and other effects…"* Residents and commercial building occupants noted as "adversely effected" reside in homes and buildings ranging between 450 feet and 4900 feet from three wind turbines, two known by me to be Vestas V82 1.5 MW wind turbines.

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[1] National Wind Watch website posted March 31, 2009 http://www.wind-watch.org/documents/mars-hill-wind-turbine-project-health-effects-preliminary-symptoms-survey-results/

9. In part, health complaints observed in Falmouth may be the result of low-frequency sound that is more "felt" than "heard." Work summarized by Ambrose and Rand for a Falmouth, MA resident[2] describes hearing thresholds determined by Salt, but also describes impacts more similar to motion sickness. Much of this perceived sound appears to be below the audible frequency range, well into the infrasound range below 20 Hz. Sound levels measured inside and outside the residence studied exhibited tonality at frequencies at what appears to be wind turbine blade passage and its harmonics and/or blade bending harmonics. Both the home owners and the investigators who spent many hours in the residence during windy conditions experienced health impacts similar to what they associated with motion sickness.

10. It must be recognized that the Antrim Wind Energy facility turbines are rated to produce 3.0 MW of power as compared to those producing 1.5 MW at Falmouth. Hence, the health and annoyance impacts documented in Falmouth will extend about 40% further from the Antrim Wind Energy facility than they do from the Falmouth wind turbines.

11. Figures 2 and 3 of the 2009 paper by Pedersen *et al*[3] suggests that approximately 20% of the general population is "annoyed" and about 5-10% are "highly annoyed." by wind turbine sound.

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[2] Ambrose, S.E., Rand, R.W.; " The Bruce McPherson Infrasound and Low Frequency Noise Study," December 14, 2011 (Unpublished).

[3] Pedersen, E., van den Berg, F., Bakker, R., Bouma, J.; "Response to noise from modern wind farms in The Netherlands", J. Acoust. Soc. Am., 126(2), August 2009.

12. Section 8.3 of the Epsilon November 2011 report notes octave band sound power levels for the Acciona wind turbine were not available at the time of the report preparation. The report also notes four references reporting that utility-scale wind turbines do not produce prominent discrete tones. ISO 9613.2 permits the modeling of facility noise using A-weighed sound power levels if the sound power level is treated as energy at 500 Hz. It is our opinion that a project of this magnitude and subject to scrutiny merits the detail of octave band computer modeling in accordance with ISO 9613-2. Before rendering an opinion on the reasonableness of the sound levels produced by the proposed turbines, it would be important to assess any new information regarding the acoustic emissions of the proposed wind turbine that may have become available subsequent to the Epsilon November 2011 report. Presently, I am unaware of any published sound power levels for the Acciona 3 MW wind turbine tested in accordance with IEC Standard 61400. Given the lack of experience with these machines, installing them in close proximity to Antrim residences as this applicant proposes could prove to be very problematic.

13. Potential modulated broadband sound, often described as a "swooshing" or a "swishing" sound, has not been addressed in the Epsilon November 2011 report and has been a source of complaints at other wind farms. Pedersen and Waye (2008)[4] have determined that the "swishing" characteristic of wind turbine sound is the most identifiable aspect.

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[4] Pedersen, E., and Way, K.P.; Wind turbines—low level noise sources interfering with restoration?; Environmental Research Letters, 3 (2008)

Pedersen and Halmstad (2003)[5], quoting a paper by Waye and Olrstrom in 2002, indicate that *"The most annoying noise were predominantly described as 'swishing', 'lapping' and 'whistling.' These adjectives could all be seen as related to the aerodynamic noise and as description of a time varying (modulated) noise with high frequency content."* The only method for controlling broadband modulated sound, of which I am aware, is by modifying wind turbine blade pitch to reduce lift resulting in a loss of power generation. However, I would expect that the obtainable reduction in broadband modulated sound using this method would be modest at best. Wind turbine design continues to advance, but by itself alone currently does not eliminate modulated broadband sound. At a minimum the Committee ought to include a condition requiring such blade pitch adjustments when meteorological conditions indicate a likelihood that the turbines will produce unacceptable levels of noise.

14. The only way that broadband sound is controlled is through masking by environmental noise, implying that broadband sound only becomes acceptable at distances far enough from wind farms that broadband sound is masked, i.e. covered-up, by normal environmental background sound. Currently, there are no uniformly recognized design goals for minimizing the impact of wind turbine broadband modulated sound by environmental sound. I would suggest that broadband modulation is satisfactorily masked when peak broadband sound level does not exceed the average lowest daily $L_{90,10min}$ of environmental sound as measured in the absence of wind turbine sound by more than 5 dBA. In part, my

[5] Pedersen, E.; Halmstad, H.I.; "Noise annoyance from wind turbines – a review"; Natur vards verket Report 5308, August 2003.

request for the Epsilon sound data mentioned earlier is required to evaluate broadband sound impacts on existing receptor locations.

15. In summary, impacts of the project identified here and subject to further review are as follows:

- To determine the distance over which potential wind turbine broadband modulated sound impact might extend, I would require examining the measured wind speed and background sound data summarized in Tables 6-1 and 6-2. In addition, I would like to examine any octave band sound data collected by monitors during the September 16 to October 4 period.
- I would wish to have the opportunity to monitor A-weighted sound levels over a two-week period in 10-minute intervals in the residential area west of Gregg Lake, and at the Audubon facility as it is an outdoor nature preserve where wind turbine sound may have an unreasonable impact on visitor use and enjoyment of that pristine and quiet location.
- I would like to receive for my review one-third octave band sound power levels produced by the Acciona AW116/ClassII/3000 wind turbine proposed for use at the Antrim Wind Energy facility. I would also like an explanation of how the A-weighted sound power data for these turbines were determined and how they were used in computer modeling which is normally completed using octave band sound power levels.

- I also require sound levels at frequencies down to blade passage for purposes of evaluating the potential for complaints of infrasound.
- The experience at Mars Hill and the Falmouth, MA Board of Health inquiry into health and annoyance complaints of noise produced by 1.5 MW turbines cannot be dismissed. Accordingly, the Committee should prescribe the steps that Antrim Wind Energy, LLC must take to avoid complaints similar to those in Falmouth from its larger 3.0 MW turbines, especially as impacts similar to those experienced in Falmouth might extend well over one mile from its proposed facility.

16. This completes this pre-filed testimony for now.

Gregory C. Tocci