THE STATE OF NEW HAMPSHIRE

BEFORE THE

SITE EVALUATION COMMITTEE

DOCKET NO. 2012-01

**APPLICATION OF ANTRIM WIND ENERGY, LLC
FOR A CERTIFICATE OF SITE AND FACILITY**

FIRST SUPPLEMENTAL PREFILED TESTIMONY OF

ROBERT D. O'NEAL

ON BEHALF OF

ANTRIM WIND ENERGY, LLC

October 11, 2012

Background and Qualifications

Q. Please state your name, business address and qualifications.

A. My name is Robert O'Neal. I am a Principal at Epsilon Associates, Inc. ("Epsilon"). My business address is 3 Clock Tower Place, Maynard, Massachusetts. My qualifications remain the same as those presented in my prefiled direct testimony submitted on January 31, 2012.

Q. Who is your current employer and what position do you hold?

A. I am employed by Epsilon Associates, Inc., Maynard, Massachusetts. I am a Principal of the firm.

Purpose of Testimony

Q. What is the purpose of this testimony?

A. The purpose of my testimony is to supplement my prefiled direct testimony by addressing the potential noise-related comments or claims on the Antrim Wind Project as raised in the Pre-filed testimony of Ms. Janice Longgood, Ms. Annie Law, Ms. Susan Morse, Ms. Mary Allen, Mr. Greg Tocci, and Mr. Richard James.

Q. Are you familiar with the Project that is the subject of this proceeding?

A. Yes, as explained in more detail in my prefiled direct testimony, I am a consultant to the Antrim Wind Project and as such I am very familiar with the Project.

<u>Prefiled Testimony of Janice Longgood (dated July 31, 2012)</u>

Q. Item #4 of Ms. Longgood's testimony has some observations on sound. Are these accurate?

A. In general, no. The worst-case predicted sound level due to all the wind turbines operating will be approximately 41 dBA as she notes. However, this is not above ambient. This is an absolute sound level due to the wind turbines. The ambient sound levels vary as shown by the measurements at the nearby Location L3 in Epsilon's Sound Level Assessment Report (Appendix 13A to Antrim Wind's SEC Application.) The ambient sound levels will sometimes be higher than 41 dBA and sometimes lower than 41 dBA. The sound assessment was NOT modeled using a hub height of 30 feet. It was modeled at the wind turbine hub height of 92 meters (302 feet) above the ground (see section 7 of Appendix 13A).

<u>Prefiled Testimony of Annie Law and Robert Cleland (dated July 31, 2012)</u>

Q. Ms. Law states that sound from the wind turbines will greatly affect the recordings she makes in her home recording studio. Is this likely?

A. No. Ms. Law lives 1.5 miles (~7,900 feet) away from the closest wind turbine. As pointed out in the Applicant's response to Data Request No. Block 1-10 (June 20, 2012), Attachment RDO-A to this testimony, expected sound levels from maximum operation of the wind farm are expected to be 31 dBA at the outside of her home. Even with windows open, sound levels inside the home will be reduced even further, typically at least 10 dBA. Thus at 21 dBA, sound from the wind farm will not be an issue. In fact, the intervenors own acoustical consultant states that residences 1.25 miles or farther from a wind turbine would be compatible with wind energy facilities. Richard James' response to Applicant's Data Request #1-41 (August 14, 2012), Attachment RDO-B to this testimony).

<u>Prefiled Testimony of Susan Morse (dated July 31, 2012)</u>

Q. In the pre-filed testimony of Susan Morse, she claims that there are concerns about the ill-effects of wind turbine noise on wildlife due to chronic noise exposure. What are your thoughts on this?

A. Sound level limits and regulations with respect to wind turbines are limited to minimizing impacts to humans either at their homes or on their property. There are no applicable regulations or guidelines regarding noise and wildlife for the Antrim Wind Project. According to the paper, "The Effects of Noise on Wildlife" which is referenced by Ms. Morse, "…noise standards do not generally exist for wildlife, except in a few instances where federally listed species may be impacted." I am not aware of the Project being located in an area which would be considered as habitat for such species. According to the paper, "Avian Hearing

and the Avoidance of Wind Turbines." by R. Dooling which is referenced in a paper provided by Susan Morse, "As a general rule of thumb, noise produced by wind turbine blades is probably less audible to birds than humans." Page 13. There are no studies on the sounds generated by wind turbines and how they have impacted foraging success, anti-predation strategies, and communication success in wildlife. Therefore, there is a general lack of guidance related to acceptable sound levels from wind turbines for wildlife. The sound levels associated with this Project are similar to the sound levels found at existing wind energy facilities located along forested ridgelines such as the Lempster Wind site.

<u>Prefiled Testimony of Mary Allen (dated July 31, 2012)</u>

Q. In the pre-filed testimony of Mary Allen, she is wondering whether sound levels from the wind farm may be above the limits set in the "Agreement" at the former Hawthorne College. What are your thoughts on this?

A. I assume the former Hawthorne College property is the same as the "Flint Estate" on Old North Branch Road, Antrim, viewed during the NH SEC site tour on April 30, 2012. That property is approximately 9,000 feet (1.7 miles) northeast of the closest wind turbine. Reviewing Figure 7-1 in Epsilon's Sound Level Assessment Report (Appendix 13A to Antrim Wind's SEC Application), one can see that the former Hawthorne College is outside the 30 dBA sound level contour. In other words, sound levels at this location will be less than 30 dBA which is well below the 45 dBA sound level limit set in the "Agreement."

<u>Prefiled Testimony of Gregory C. Tocci (dated July 31, 2012)</u>

Q. Item #5 of Mr. Tocci's testimony requests more detail on how the manufacturer's sound power level data were determined. Can you shed any light on this?

A. Yes. At the moment, there are no Acciona 3 MW wind turbines with 116 meter rotor diameter blades operational in the world. Construction is under way on units in both Europe and the U.S. Therefore, it is not currently possible to conduct the IEC 61400-11 sound power level measurement tests. However, the manufacturer has performed aero-acoustics prediction modeling using empirical engineering models at aerofoil/blade level. From this they derived a maximum sound power level of 107.4 dBA with an uncertainty value of +/- 2 dBA. Epsilon modeled sound level impacts using 109.4 dBA (107.4 + 2) in the sound study (Appendix 13A in NH SEC Application) which is on the high side of anything measured in the wind industry to-date. Therefore, this is a reasonable sound level to use for these purposes.

In addition, as discussed in the Applicant's response #42 from Technical Session #1 (June 29, 2012), Attachment RDO-C to this testimony, Acciona recently produced a newer sound level document on the AW3000 116 meter wind turbine. This document kept the same sound power level (107.4 dBA) but decreased the uncertainty from 2 dBA to 1 dBA for a total worst-case sound power level of 108.4 dBA. Therefore, the sound level modeling results have a 1 dBA margin of conservatism built in (i.e., they are 1 dBA higher than expected.).

Q. Items #7, #8, #9 of Mr. Tocci's testimony discuss complaint and health information from other wind turbine Projects installed in Mars Hill, ME and Falmouth, MA. Are these claims/impacts directly applicable to Antrim Wind?

A. No. Each wind energy facility must be evaluated on its own layout, design, turbines, topography, and distances to residences. The wind turbines at Mars Hill are GE 1.5sle machines, the ones at Falmouth are Vestas V82 1.65 MW machines, and the Antrim turbines are Acciona AW3000 3 MW units. Each machine has a different sound profile. The GE and Acciona turbines are pitch-controlled and the Vestas turbines are stall-controlled (older technology). The major difference is that pitch-controlled machines reach their maximum sound level at a certain wind speed, and above this wind speed the sound levels remain constant. Sound levels from a stall-controlled machine increase approximately linearly with wind speed but do not level off as wind speed increases. The nearest residence to a wind turbine in Mars Hill is less than 1,000 feet, in Falmouth the nearest residence is approximately 1,300 feet to a wind turbine, and in Antrim the nearest residence is over 2,600 feet away from a wind turbine. It is inappropriate to take claims made in Mars Hill and Falmouth, and imply the same results will apply to the Antrim site.

Q. Item #10 of Mr. Tocci's testimony claims health and annoyance impacts in Antrim will extend 40% further than in Falmouth based on the electrical

(MW) ratings of the wind turbines at the two wind farms Is this a reasonable claim?

A. No. See the answer above regarding assessing each individual wind farm on its own wind turbines, layout, and specific sound levels.

Q. Item #11 of Mr. Tocci's testimony discusses a European study that notes people are "annoyed" by wind turbine sound. Are people "annoyed" solely from the sound of wind turbines?

A. No. The paper clearly points out that the visual aspect of wind turbines enhances a negative response in some people, and having wind turbines visible from a house significantly increases the risk of annoyance in some people. In other words, annoyance was strongly correlated with a negative attitude toward the visual impact of wind turbines on the landscape.

<u>Prefiled Testimony of Richard James (dated July 31, 2012)</u>

Q. In the pre-filed testimony of Richard James and his response to Applicant's Data Request #1-29 (dated August 14, 2012), Attachment RDO-D to this testimony, he suggests that the IEC-calculated sound power levels should be increased by up to 15 decibels above that provided by the manufacturer based on the research done by van den Berg. What are your thoughts on this?

A. The testimony of Richard James refers to a peer-reviewed article in the *Journal of Sound and Vibration* (2003) "Effects of the wind profile at night on wind turbine sound" by van den Berg. In this paper, van den Berg asserts that at one German

wind park, nighttime sound pressure levels measured under lower ground-level wind speeds (3 and 4 m/s at 10m) were higher than predicted at one location by up to 15 dBA. It should be noted that van den Berg's predictions used sound power levels based on wind speeds at 10 meters and not on maximum sound power levels. However, the data shown in Figure 5.b. of that article illustrate that maximum predicted sound pressure levels were in close agreement with the maximum measured sound pressure levels to within 2 dBA. Since predicted sound pressure levels modeled at Antrim were calculated using the maximum turbine sound power level, and not the sound power level produced at lower wind speeds, the claim that this level should be increased by 15 dBA is not supported by this research.

Additionally, Mr. James' argument assumes that IEC-calculated sound power levels are correlated to wind speeds that have been extrapolated from a reference height using an equation that does not adequately account for wind shear. However, according to the method for determining wind speed described in IEC 61400-11 §7.3.1, operational turbine sound levels are matched with wind speeds using a curve of "electrical power output" versus "hub-height wind speed," not using extrapolated ground-level wind speeds. In other words, the amount of wind shear has no bearing on the reported maximum turbine sound level emissions measured at 95% of the rated maximum electrical power, per the IEC standard, which was used in the Antrim noise study. While wind shear does affect the difference between ground-level and hub height wind speeds, compliance with the

45 dBA limit in New Hampshire, based solely on maximum turbine-only emissions, is accurately evaluated using the maximum sound power level. As an added note, there are no peer-reviewed publications indicating that the sound power level determined by IEC 61400-11 underestimates actual sound power levels.

Q. Related to the above comments of Mr. James is a criticism that the modeled sound levels from the Antrim Wind turbines are understated. In other words, Mr. James claims sound levels will be up to 15 decibels higher than those shown in the Epsilon report (Appendix 13A in the SEC Application). What are your thoughts on this?

A. The Cadna/A software using the ISO 9613-2 propagation standards does a good job of calculating the worst-case (highest) expected sound levels at the nearest residences. This has been demonstrated by actual post-construction compliance measurements at the Lempster Mountain Wind Farm that were required by the NH SEC as part of the approval process for that Project.[1] The Lempster site is a ridgeline array similar to Antrim. The wind turbine installed in Lempster is the Gamesa G87 2 MW unit mounted on a 78 meter hub height and 87 meter rotor diameter. Maximum sound power level was 105.3 dBA. It is unclear what the uncertainty factor was for this machine. Both summer and winter periods were tested in Lempster. Since sound levels were higher in winter, only those results

[1] "Lempster Mountain Wind Farm – Post Construction Sound Survey," prepared for Iberdrola Renewables by Resource Systems Group, Inc., October 29, 2009.

will be discussed here. At the closest non-participating residence (Position 1) on Guilford Road, sound levels from the wind turbines were measured at 45 dBA (L90) at a distance of 1,530 feet to the closest turbine. At Position 6 (Nichols Rd/School St), sound levels from the wind turbines were measured at less than 30 dBA (L90) at a distance of 5,200 feet to the closest turbine. By way of comparison in Antrim, the nearest non-participating residence is 2,800 feet from the closest turbine (Rowland residence at 362 Keene Road) with a predicted sound level of 41 dBA. The Janice Longgood residence at 156 Salmon Brook Road is also predicted to be 41 dBA at 3,800 feet from the closest wind turbine. Finally, the Annie Law residence at 43 Farmstead Road is predicted to be 31 dBA at a distance of 7,500 feet from the closest wind turbine. The proposed wind turbines in Antrim have a sound power level of 107.4 dBA (+/- 1 dBA) while the Lempster wind turbines have a sound power level of 105.3 dBA with no uncertainty stated. Typical uncertainty is +/- 2 dBA which would put the Lempster turbines as high as 107.3 dBA, including uncertainty. This puts the Antrim wind turbines 1 dBA to 3 dBA higher than Lempster, and thus would be expected to be a few decibels higher than Lempster at similar distances. A worst-case predicted sound level of 41 dBA at 2,800 feet in Antrim compared to a worst-case measured sound level of 45 dBA at 1,530 feet in Lempster certainly appears reasonable. Under no circumstances would we expect the measured sound levels from the wind turbines in Antrim to be an additional 15 dBA higher

than the modeled values (for a worst-case total of 56 dBA at 2,800 and 3,800 feet) as suggested by Mr. James.

Q. In the pre-filed testimony of Richard James and his reponse to Applicant's Data Request #1-30 (dated August 14, 2012), Attachment RDO-E to this testimony, he comments on the Epsilon methodology of measuring background sound levels in the Project area. What are your thoughts on this?

A. The sound level measurement program for the Antrim Wind Project was conducted in accordance with ANSI S12.9-1998, "Quantities and Procedures for Description and Measurement of Environmental Sound. Part 1". The application of this standard as stated in the standard is as follows, "This standard is applicable to the description and measurement of community sound for purposes of land use planning, environmental assessment, and noise control." The measurement locations were selected to give a spatial variation around the proposed wind energy site giving priority to those areas most sensitive to noise (residences). In addition, background locations were chosen both near and far from the busiest road in the area (NH Route 9) to understand how traffic influences community sound levels.

Q. In the pre-filed testimony of Richard James, he suggests that infrasound and low frequency sound from this Project will cause serious health risks. What are your thoughts on this?

A. The suggestion by Mr. James that infrasound and low frequency sound from the Project will cause serious health risks is conjecture and is not based on evidence. There are no peer-reviewed studies linking infrasound and low-frequency sounds at 2,600 feet (or beyond) from wind turbines to adverse health effects. Mr. James presents no evidence that the level of infrasound is above the threshold of perception at these distances even in the most sensitive people. We anticipate that there will be some low frequency sound (at frequencies above about 50 Hz) that will be perceptible[2]; however, the levels will be just barely perceptible and not significant enough to cause health risks.

Figure 16 in the paper by Moeller (cited by Mr. James) shows that on average larger powered wind turbines (greater that 2 MW) have low frequency sound power levels approximately 2 – 3 dB higher than lower powered wind turbines (less than 2 MW); however, this is not a "dramatic increase" as asserted by Mr. James. The Moeller paper shows that the average indoor one-third octave band sound pressure level at 20 Hz [the lowest one-third octave band presented] when the outdoor level is 35 dBA is approximately 40 dB lower than the threshold of audibility according to ISO 389-7 [Moeller Figure 11]. When the outdoor level is 44 dBA, the average indoor 20 Hz one-third octave band sound pressure level is 35 – 38 dB lower than the threshold of audibility [Moeller Figure 12]. As documented in the Epsilon NCEJ paper, the difference between wind turbine

[2] O'Neal, R.D., R.D. Hellweg, Jr., and R.M. Lampeter, "Low frequency noise and infrasound from wind turbines," *Noise Control Engineering Journal*, Volume 59, No. 2, 135-157.

sound pressure level and the threshold of audibility is even greater at lower frequencies. Epsilon measured differences between measured indoor infrasound levels and the threshold of hearing in the range of 30 – 40 dB at 16 Hz and lower frequencies.

We agree with Mr. James that for sounds with varying types of amplitude and frequency modulation, the threshold of perception will be lower than the threshold of audibility for steady pure tones; however, the difference would be at most on the order of 10 dB and not 30 – 40 dB. Moeller and Pederson[3] indicate that at the low frequency and infrasound region, sounds are "felt" at levels above threshold of audibility not at levels below audibility as asserted by Mr. James. ISO 226 and the Moeller and Pedersen papers suggest that the hearing threshold of one-third octave band sounds are approximately the same as pure tone thresholds.

Papers by Salt that were cited by Mr. James give "estimated" sensitivity of outer hair cells in the infrasound region based on measurements of guinea pigs. There is no evidence that humans respond at the same OHC levels, and even if humans did, there is no evidence that this has or would cause adverse effects in humans. Salt presents dBG levels that he alleges could cause response of the outer hair cells; however, the G-weighting scale amplifies some frequencies, and thus one cannot make a blanket statement about G-levels since the OHC estimated sensitivity curve varies with frequency. Salt concludes that "it is scientifically *possible* that infrasound from wind turbines *could* affect people living nearby"

[3] Moeller and Pederson, *Noise & Health*, 2004, v6, p 37 – 57.

[emphasis added]; however, no data is presented by Salt to indicate that it actually does cause adverse effects and he does not define "nearby".

In his response to Applicant's Data Request #1-29 dated August 14, 2012, Attachment RDO-D to this testimony, Mr. James mischaracterized the results presented in his own paper (Bray and James). Mr. James states in part that "the purpose [of the paper] was to demonstrate that under these conditions that cause higher sound emissions, wind turbine infrasound can exceed the threshold of perception established for steady pure tones…" However, the Bray and James paper does not demonstrate that wind turbine infrasound can exceed the threshold of perception. In the last two pages on the paper they state that the attributes of wind turbine signals at frequencies below 100 Hz "may affect the likelihood of audibility or other physiological response from low-frequency and even infrasonic wind turbine noise…" and they "encourage others to engage in further research" aided by their results.

The Epsilon NCEJ paper compared low frequency wind turbine sounds to the ANSI S12.2:2008 low frequency criteria using the methods described in ANSI S12.2. The ANSI S12.2 method includes the RNC curves (based on the earlier RC curves cited by Mr. James), when applicable. The Epsilon report found that the indoor measurements at 1,000 feet from the nearest wind turbine in an operating wind farm met the relevant ANSI S12.2 low frequency criteria. The wind turbines included 2.3 MW turbines.

With regard to claims of potential health effects from wind turbines by Mr. James, two independent studies are worth mentioning. The "Expert Panel Review" study commissioned by the American Wind Energy Association (AWEA) and Canadian Wind Energy Association (CanWEA)[4] concluded that the sounds emitted by wind turbines are not unique. Furthermore, this study concluded there is no reason to believe that the sounds from wind turbines could plausibly have direct adverse health consequences. A copy of the executive summary from this study is included as Attachment RDO-F to this testimony. Here is the link to the full study: http://www.awea.org/learnabout/publications/upload/AWEA_and_CanWEA_Sound_White_Paper.pdf. Another study using independent experts was commissioned by the Massachusetts Department of Environmental Protection (MA DEP) and the Massachusetts Department of Public Health (MA DPH).[5] This study consisted of a literature review on noise, shadow flicker, and ice throw. Among its findings, the panel concluded that there is insufficient evidence that the noise from wind turbines is directly causing health problems or disease. In addition, this study concluded that claims that infrasound from wind turbines directly impacts the vestibular system have not been demonstrated scientifically. A copy of the executive summary from this study is included as Attachment

[4] W. David Colby et al, "Wind Turbine Sound and Health Effects – An Expert Panel Review", Prepared for AWEA and CanWEA, December 2009.
[5] "Wind Turbine Health Impact Study: Review of Independent Expert Panel," January 2012, Prepared for MA DEP and MA DPH.

RDO-G to this testimony. Here is the link to the full study: http://www.mass.gov/dep/energy/wind/turbine_impact_study.pdf. The 2011 WHO[6] study "Burden of disease from environmental noise" states that for nighttime exposures Leq(night) between 30 – 40 dBA, the 2011 WHO document states that "even in the worst cases, the [health] effects seem modest." The highest Leq sound pressure level predicted at a home near the Project is 41 dBA. The equation in the 2011 WHO document estimates that for a nighttime Leq(night) of 41 dBA only 2.7 % of the population would be classified as "highly sleep disturbed", which is only 0.1% greater than the percentage at 40 dBA".

Q. Do you have anything further to add to this testimony?

A. No, not at this time.

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[6] "Burden of disease from environmental noise", World Health Organization Regional Office for Europe, Copenhagen, Denmark.

THE STATE OF NEW HAMPSHIRE
SITE EVALUATION COMMITTEE

Docket No. 2012-01

Application of Antrim Wind Energy LLC
For a Certificate of Site and Facility
For Antrim Wind Energy in Antrim, New Hampshire

Received June 1, 2012
Request No. Block 1-10

Date of Response: June 20, 2012
Witness: Rob O'Neil

REQUEST:
Please provide turbine sound data as projected for the residence of Annie Law and Robert Cleland, Parcel # 208-015-000 at 43 Farmstead Road. Please include both audible and subsonic projections for night time, day time, and four seasonal variations.

RESPONSE: This location is east of Liberty Farm Road and north of Stacy Hill Road approximately 7,500 feet from the nearest turbine (#1). Worst-case (loudest) sound levels from all wind turbines operating, day or night, is expected to be 31 dBA. This can occur in any season. With regard to "subsonic" projections, we would classify that as data in the low frequency octave bands (31.5, 63, 125 Hz). Expected sound levels at these octave bands 7,500 feet away will be way below any thresholds for perceptible vibration or annoyance according to ANSI standards S12.2 or S12.9 Part 4.[2]

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[2] O'Neal, R.D., Hellweg, Jr., R.D. and R. M. Lampeter, 2011. Low frequency sound and infrasound from wind turbines. Noise Control Engineering Journal, 59 (2), 135-157.

THE STATE OF NEW HAMPSHIRE
SITE EVALUATION COMMITTEE

Docket No. 2012-01

Application of Antrim Wind Energy, LLC
For A Certificate of Site and Facility

ANSWERS TO APPLICANT'S FIRST SET OF CONSOLIDATED DATA REQUESTS PROPOUNDED ON THE BLOCK INTERVENOR GROUP AND THEIR EXPERT WITNESSES

August 14, 2012

DATA REQUEST # 1-41:

Witness: Richard James

Reference Mr. James' statement (page 13 of his July 30, 2012 Report): "Given the analysis above it is reasonable to conclude that this project will join the ranks of wind utilities that cause adverse health conditions and noise pollution if approved." Please provide the sound level limits you feel are necessary to ensure a compatible project in the community, the metrics, measurement duration, etc. that would be needed to evaluate compliance, and include any models and techniques needed to evaluate future compliance with this limit prior to construction.

A: Mr. James and Mr. Kamperman published a set of criteria in 2008 that they believed were necessary to ensure a compatible project in the community. These criteria have been updated since that time to address wind turbine sound emission and propagation characteristics not addressed in the original report. The new criteria are provided in Appendix C of the paper "Noise: Windfarms" by Drs. Shepherd, Thorne and Hanning which is provided.

The specific criteria calling for a setback distance of 1.25 miles has been adopted by the State of Victoria in Australia and is in the process of being adopted in New South Wales, Australia.

THE STATE OF NEW HAMPSHIRE
SITE EVALUATION COMMITTEE

Docket No. 2012-01

Application of Antrim Wind Energy LLC
For a Certificate of Site and Facility
For Antrim Wind Energy in Antrim, New Hampshire

Received July 3, 2012
Request No. TS 1-42

Date of Response: July 12, 2012
Witness: Rob O'Neal

REQUEST:

Please provide all data from the manufacturer that you used in determining the sound modeling.

RESPONSE:
The Applicant respectfully objects to this request on the ground that this information is Acciona's confidential information. Notwithstanding this objection, the Applicant does not object to providing this information if a Protective Order is issued in accordance with AWE's Motion for Protective Order and Confidential Treatment Regarding Acciona Sound Data filed on July 12, 2012.

Notwithstanding this objection, the Applicant states as follows: The wind turbine data used in the sound modeling is contained in Confidential Attachment TS 1-42(a) (Acciona document DG200266 Rev. A, dated 20/05/11). This had the highest sound power level data at 107.4 dBA +/- 2 dBA uncertainty. Therefore, the wind turbines were modeled as emitting 109.4 dBA. The latest Acciona sound data (Acciona document DG200266 Rev. B, dated 28/05/12) has the same sound power level of 107.4 dBA but an uncertainty of 1 dBA, see Confidential Attachment TS 1-42(b). This would put each wind turbine as emitting no more than 108.4 dBA. In light of this information, our original sound level modeling is conservative (i.e., it is overstated by 1 dBA at all locations). Pad-mounted transformers will be rated at 3400 kVA. Sound levels will be set by NEMA standard TR1-1993 and will be approximately 63-64 dBA.

THE STATE OF NEW HAMPSHIRE
SITE EVALUATION COMMITTEE

Docket No. 2012-01

Application of Antrim Wind Energy, LLC
For A Certificate of Site and Facility

ANSWERS TO APPLICANT'S FIRST SET OF CONSOLIDATED DATA REQUESTS PROPOUNDED ON THE BLOCK INTERVENOR GROUP AND THEIR EXPERT WITNESSES

August 14, 2012

DATA REQUEST # 1-29:

Witness: Richard James

Reference Mr. James' statement (page 3 of his July 30, 2012 Report). The claim is made that the Epsilon modeling uses IEC test data under low wind shear conditions. Have you measured sound pressure levels under "high wind shear", calculated the sound power, and compared it to the manufacturer's guaranteed sound power specified in the IEC test standards ? If so, please provide references to the reports in which this was done detailing the results and measurement procedures, including the wind shear, and how these results compared to the Epsilon model.

A: IEC 61400-11 Edition 2.1 (2006) states in 7.2 Acoustic Measurements that the apparent sound power levels be determined for "integer wind speeds 6, 7, 8, 9, and 10 m/s (wind speed at 10 m. height and roughness length of 0.05 m)..." A roughness length of 0.05 meters is equivalent to a wind shear of 0.19. Thus, the apparent sound power reported by the IEC test represents the sound emissions of the wind turbine for that set of weather and topographical conditions. Studies of wind turbine acoustic emissions dating back to the 1990 NASA study of Hubbard and Shepherd (Wind Turbine Acoustics) demonstrated that sound emissions increase with increasing wind shear. This was confirmed and elaborated on by the papers of G.P. van den Berg in a series or papers and presentations beginning in 2003 to 2007 and his Thesis in 2006:

Wind turbines at night: acoustical practice and sound research, Frits G.P. van den Berg, EuroNoise 2003

Effects of the wind profile at night on wind turbine sound, G.P. van den Berg Journal of Sound and Vibration, Sept. 2003

Wind Profiles over Complex Terrain, G.P. van den Berg, 2007 Second International Meeting on Wind Turbine Noise, Lyons, France.

The sound of high winds: the effect of atmospheric stability on wind turbine sound and microphone noise, G.P. van den Berg, 12 May 2006

In reference number 1 van den Berg states that under high wind shear conditions wind turbine sound emissions were observed to be "*...sound levels are up to 15 dB (!) higher than expected at 400 m from the wind park. At a distance of 1500 m actual sound levels are 18 dB higher than expected, 15 dB of this because of the higher sound emissions and 3 dB because sound attenuation is less than predicted by the sound propagation model.*"

These "higher sound emissions" are over and above the sound emissions considered in the IEC test data used to calculate the reported sound power levels. These higher sound emissions must be accounted for in the computer model of sound propagation used to predict the wind turbine's noise impact on a community if those calculations are intended to represent commonly occurring predictable worst case conditions. Using the data for wind turbine sound power derived for the condition where wind shear is under 2.0 results in a model that reflects the sound produced by wind turbines under conditions that produce less noise at receiving locations than the turbines would produce under conditions of high wind shear. Other meteorological conditions, such as higher in-flow turbulence can also increase wind turbine sound levels.

The Cadna/A software has no method for accounting for differences in meteorological conditions (or for that matter any meteorological condition other than the mild downwind conditions upon which IS0 9613-2 is based [see email from Cadna/A software developer H. Metzen]).

One method that can be used to account for the higher sound emissions under conditions of higher wind shear (or other meteorological conditions such as higher in-flow turbulence) is to add a correction factor to the IEC based sound power levels used as input data to the computer model sufficient to increase the predicted sound pressure levels at receiving locations by an amount similar to the increases reported in van den Berg's work. Increasing the values of the IEC derived sound power levels by the 15 dB reported in the quotation provided above (for example, to represent an upper limit for the predictable worst case condition) would result in a 15 dB increase in the sound levels reported in Table 7-2 Cadna/A Modeling Sound Level Results of the Antrim Wind Energy Project. Elsewhere in Dr. van den Berg's works he reports that the range of increases is generally from 6 to 15 dB. Thus, 6 dB could be used as the correction factor for a model representing the lower bound of the predictable worst case conditions for the Antrim Wind Energy Project.

A simplier method is to directly add the correction factors to the sound levels predicted using the apparent sound power levels derived for the IEC wind shear and topography. These correction factors would increase the sound levels at receiving properties as shown below. The source table is from the Epsilon Memorandum dated Jan. 17, 2012, regarding Antrim Wind Sound

Level Assessment Report Addendum No. 1 Antrim Collector Substation, Antrim, NH (Predicted values from the Antrim Wind Energy Project report are in the third column, titled: "1-17-2012 Table 2." Applying the 6-15 dB correction factors to account for the higher sound emissions during periods when wind shear is higher than what is present during the IEC test results in the higher sound levels at each modeling location as shown below in the columns titled: "+6" and "+15".

		Wind Turbines Only		
		Broadband [dBA]		
Modeling Location	Structure Type	Calculated using apparent L_w for IEC weather	*Predictable Worst Case due to non-IEC weather conditions*	
		1-17-2012 Table 2	*+6*	*+15*
24	Hunting Camp	41.4	*47.4*	*56.4*
21	House	41.3	*47.3*	*56.3*
51	House	39.0	*45.0*	*54.0*
153	House	39.2	*45.2*	*54.2*
22	House	38.7	*44.7*	*53.7*
23	Shed	38.6	*44.6*	*53.6*
20	House	40.5	*46.5*	*55.5*
52	House	39.3	*45.3*	*54.3*
53	House	39.5	*45.5*	*54.5*
54	House	39.5	*45.5*	*54.5*
25	House	38.0	*44.0*	*53.0*

Regarding reports on wind turbine noise under conditions of a nighttime stable atmosphere, the paper co-authored with Mr. Wade Bray, V.P., Head Acoustics, titled: "*Dynamic measurement of WT noise considering time and frequency of human perception*" represents a thorough analysis of a wind turbine's sound immission characteristics using both traditional and advanced analytical methods. This paper did not back-calculate the apparent sound power level to compare to IEC test data for that particular model. Instead. the purpose was to demonstrate that under these conditions that cause higher sound emissions, wind turbine infrasound can exceed the threshold of perception established for steady pure tones and that 1/3 octave band analyzers of the type commonly used by acousticians for field measurements (such as those used by Epsilon for its study "*A Study of Low Frequency Noise and Infrasound from Wind Turbines*" are not able to make accurate measurements of infrasound when it occurs as short duration modulations of less than 100 msecs.

THE STATE OF NEW HAMPSHIRE
SITE EVALUATION COMMITTEE

Docket No. 2012-01

Application of Antrim Wind Energy, LLC
For A Certificate of Site and Facility

ANSWERS TO APPLICANT'S FIRST SET OF CONSOLIDATED DATA REQUESTS PROPOUNDED ON THE BLOCK INTERVENOR GROUP AND THEIR EXPERT WITNESSES

August 14, 2012

DATA REQUEST # 1-30:

Witness: Richard James

Reference Mr. James' statement (pages 4-5 of his July 30, 2012 Report): "the measurements used to collect this information do not meet any recognized national or international standard." Please outline what components of the measurement program do not follow each of the standards listed as references.

A: There are three standards that address measurements of sound outdoors.

First, S12.18 provides a general method (#1) which states:

- No sound level measurement shall be made when the average wind velocity exceeds 5 m/s when measured at a height of 2±0.2 m above the ground.
- No measurements shall be made during measurable precipitation or freezing rain. And,
- 8.1.3.2 General meteorological conditions:
  If the meteorological conditions such as wind speed and direction do not fall within the specifications for either METHOD H1 or METHOD H2 as specified in Section 5, measurements do not conform with the requirements of this standard. No attempt shall be made to correct measured sound

In the AWEP Sound Study it is reported that "however there were 60 to 80 dry periods (depending on location) during which elevated wind speeds correlated to maximum turbine sound emissions." The report uses data that does not meet the S12.18 requirements for many of its representations and conclusions. Thus the report demonstrates a methodology that does not meet S12.18.

There are two other standards that provide for either long term unobserved monitoring or short term observed monitoring during measurements.

ANSI-ASA_S12.9_Part_2_(R2008) Measurement of long-term, wide-area sound provides a method for long term monitoring without an observer present. Epsilon's procedures described in the AWEP report for measuring the background sound levels did not use an observer and were conducted over periods of days. The S12.9-Part 2 procedure presents three methods for using long term monitoring and all three require the use of randomly selected sampling locations, not locations determined by the person conducting the study, and statistical analysis of the results with additional requirements for more tests if the results of the first set of measurements do not meet tests provided for in the standard. The unobserved monitoring conducted for AWEP did not use randomly selected sample sites and conducted no statistical analysis of the results. Thus, the AWEP noise measurements used to derive the background noise levels reported in the study do not meet the requirements of S12.9 Part 2.

ANSI-ASA_S12.9_Part_3_(1993_R_2008) Short Term Measurements with Observer Present provide an alternative method for measuring and reporting the long term background sound which is based on short test periods (these may range from 10 minutes to an hour or longer) during which an observer is present to note the conditions that occurred during the test and removing the effects of any short term transient sounds or those that are seasonal from the test data during post measurement analysis. The Standard requires an observer to be present and that artifacts such as short term and seasonal noises be removed from the data set. The AWEP Sound Study does not report that either of these requirements were met. Further, data is retained that was measured during periods of rain and high winds which should have been removed. Thus, the AWEP noise measurements used to derive the background noise levels reported in the study do not meet the requirements of S12.9 Part 2.

A search of the AWEP Sound Study shows that the only standard referenced is the S1.4 standard for sound level meters. No standards are referenced that cover the procedures that were reported in the Sound Study.

Executive Summary

People have been harnessing the power of the wind for more than 5,000 years. Initially used widely for farm irrigation and millworks, today's modern wind turbines produce electricity in more than 70 countries. As of the end of 2008, there were approximately 120,800 megawatts of wind energy capacity installed around the world (Global Wind Energy Council, 2009).

Wind energy enjoys considerable public support, but it also has its detractors, who have publicized their concerns that the sounds emitted from wind turbines cause adverse health consequences.

In response to those concerns, the American and Canadian Wind Energy Associations (AWEA and CanWEA) established a scientific advisory panel in early 2009 to conduct a review of current literature available on the issue of perceived health effects of wind turbines. This multidisciplinary panel is comprised of medical doctors, audiologists, and acoustical professionals from the United States, Canada, Denmark, and the United Kingdom. The objective of the panel was to provide an authoritative reference document for legislators, regulators, and anyone who wants to make sense of the conflicting information about wind turbine sound.

The panel undertook extensive review, analysis, and discussion of the large body of peer-reviewed literature on sound and health effects in general, and on sound produced by wind turbines. Each panel member contributed a unique expertise in audiology, acoustics, otolaryngology, occupational/ environmental medicine, or public health. With a diversity of perspectives represented, the panel assessed the plausible biological effects of exposure to wind turbine sound.

Following review, analysis, and discussion of current knowledge, the panel reached consensus on the following conclusions:

- There is no evidence that the audible or sub-audible sounds emitted by wind turbines have any direct adverse physiological effects.
- The ground-borne vibrations from wind turbines are too weak to be detected by, or to affect, humans.
- The sounds emitted by wind turbines are not unique. There is no reason to believe, based on the levels and frequencies of the sounds and the panel's experience with sound exposures in occupational settings, that the sounds from wind turbines could plausibly have direct adverse health consequences.

Executive Summary

The Massachusetts Department of Environmental Protection (MassDEP) in collaboration with the Massachusetts Department of Public Health (MDPH) convened a panel of independent experts to identify any documented or potential health impacts of risks that may be associated with exposure to wind turbines, and, specifically, to facilitate discussion of wind turbines and public health based on scientific findings.

While the Commonwealth of Massachusetts has goals for increasing the use of wind energy from the current 40 MW to 2000 MW by the year 2020, MassDEP recognizes there are questions and concerns arising from harnessing wind energy. The scope of the Panel's effort was focused on health impacts of wind turbines *per se*. The panel was *not* charged with considering any possible benefits of avoiding adverse effects of other energy sources such as coal, oil, and natural gas as a result of switching to energy from wind turbines.

Currently, "regulation" of wind turbines is done at the local level through local boards of health and zoning boards. Some members of the public have raised concerns that wind turbines may have health impacts related to noise, infrasound, vibrations, or shadow flickering generated by the turbines. The goal of the Panel's evaluation and report is to provide a review of the science that explores these concerns and provides useful information to MassDEP and MDPH and to local agencies that are often asked to respond to such concerns. The Panel consists of seven individuals with backgrounds in public health, epidemiology, toxicology, neurology and sleep medicine, neuroscience, and mechanical engineering. All of the Panel members are considered independent experts from academic institutions.

In conducting their evaluation, the Panel conducted an extensive literature review of the scientific literature as well as other reports, popular media, and the public comments received by the MassDEP.