

To: Subcommittee of the Site Evaluation Committee in Docket No. 2021-02

From: Joe Wilkas, Bridgewater, NH

Date: June 17, 2021

Subject: Appropriate methodologies for measurement and analysis of sound, and procedure for validating noise complaints based on noise problems at the Antrim Wind Project

Focus on Regulations, Information Location, and Sound Level Sampling and Averaging

Sound regulations are found at:

[http://www.gencourt.state.nh.us/rules/state\\_agencies/site100-300.html](http://www.gencourt.state.nh.us/rules/state_agencies/site100-300.html)

Site 301.14 Criteria Relative to Findings of Unreasonable Adverse Effects.

(f) In determining whether a proposed energy facility will have an unreasonable adverse effect on public health and safety, the committee shall:

(1) For all energy facilities, consider the information submitted pursuant to Site 301.08 and other relevant evidence submitted pursuant to Site 202.24, the potential adverse effects of construction and operation of the proposed facility on public health and safety, the effectiveness of measures undertaken or planned to avoid, minimize, or mitigate such potential adverse effects, and the extent to which such measures represent best practical measures;

(2) For wind energy systems, apply the following standards:

a. With respect to sound standards, the A-weighted equivalent sound levels produced by the applicant's energy facility during operations shall not exceed the greater of 45 dBA or 5 dBA above background levels, measured at the L-90 sound level, between the hours of 8:00 a.m. and 8:00 p.m. each day, and the greater of 40 dBA or 5 dBA above background levels, measured at the L-90 sound level, at all other times during each day, as measured using microphone placement at least 7.5 meters from any surface where reflections may influence measured sound pressure levels, on property that is used in whole or in part for permanent or temporary residential purposes, at a location between the nearest building on the property used for such purposes and the closest wind turbine; and

b. With respect to shadow flicker, the shadow flicker created by the applicant's energy facility during operations shall not occur more than 8 hours per year at or within any residence, learning space, workplace, health care setting, outdoor or indoor public gathering area, or other occupied building;

Site 301.18 Sound Study Methodology.

(a) The methodology for conducting a preconstruction sound background study for a wind energy system shall include:

(1) Adherence to the standard of ANSI/ASA S12.9-2013 Part 3, available as noted in Appendix B, a standard that requires short-term attended measurements;

(2) Long-term unattended monitoring shall be conducted in accordance with the standard of ANSI S12.9-1992 2013 Part 2, available as noted in Appendix B, provided that audio recordings are taken in order to clearly identify and remove transient noises from the data, with frequencies above 1250 hertz 1/3 octave band to be filtered out of the data;

(3) Measurements shall be conducted at the nearest properties from the proposed wind turbines that are representative of all residential properties within 2 miles of any turbine; and

- (4) Sound measurements shall be omitted when the wind velocity is greater than 4 meters per second at the microphone position, when there is rain, or with temperatures below instrumentation minima; following the protocol of ANSI S12.9-2013 Part 3, available as noted in Appendix B:
  - a. Microphones shall be placed 1 to 2 meters above ground level, and at least 7.5 meters from any reflective surface;
  - b. A windscreen of the type recommended by the monitoring instrument's manufacturer must be used for all data collection;
  - c. Microphones should be field-calibrated before and after measurements; and
  - d. An anemometer shall be located within close proximity to each microphone.
- (b) Pre-construction sound reports shall include a map or diagram clearly showing the following:
  - (1) Layout of the project area, including topography, project boundary lines, and property lines;
  - (2) Locations of the sound measurement points;
  - (3) Distance between any sound measurement point and the nearest wind turbine;
  - (4) Location of significant local non-turbine sound and vibration sources;
  - (5) Distance between all sound measurement points and significant local sound sources;
  - (6) Location of all sensitive receptors including schools, day-care centers, health care facilities, residences, residential neighborhoods, places of worship, and elderly care facilities;
  - (7) Indication of temperature, weather conditions, sources of ambient sound, and prevailing wind direction and speed for the monitoring period; and
  - (8) Final report shall provide A-weighted and C-weighted sound levels for L-10, Leq, and L-90.
- (c) The predictive sound modeling study shall:
  - (1) Be conducted in accordance with the standards and specifications of ISO 9613-2 1996-12-15, available as noted in Appendix B;
  - (2) Include an adjustment to the Leq sound level produced by the model applied in order to adjust for turbine manufacturer uncertainty, such adjustment to be determined in accordance with the most recent release of the IEC 61400 Part 11 standard (Edition 3.0 2012-11), available as noted in Appendix B;
  - (3) Include predictions to be made at all properties within 2 miles from the project wind turbines for the wind speed and operating mode that would result in the worst case wind turbine sound emissions during the hours before 8:00 a.m. and after 8:00 p.m. each day; and
  - (4) Incorporate other corrections for model algorithm error to be disclosed and accounted for in the model.
- (d) The predictive sound modeling study report shall:
  - (1) Include the results of the modeling described in (c)(3) above as well as a map with sound contour lines showing dBA sound emitted from the proposed wind energy system at 5 dBA intervals;
  - (2) Include locations out to 2 miles from any wind turbine included in the proposed facility; and
  - (3) Show proposed wind turbine locations and the location of all sensitive receptors, including schools, day-care centers, health care facilities, residences, residential neighborhoods, places of worship, and elderly care facilities.
- (e) Post-construction noise compliance monitoring shall include:
  - (1) Adherence to the standard of ANSI/ASA S12.9-2013 Part 3, available as noted in Appendix B, that requires short-term attended measurements to ensure transient noises are removed from the data, and measurements shall include at least one nighttime hour where turbines are operating at full sound power with winds less than 3 meters per second at the microphone;
  - (2) Unattended long-term monitoring shall also be conducted;

- (3) Sound measurements shall be omitted when there is rain, or when temperatures are below instrumentation minima, and shall comply with the following additional specification:
- a. Microphones shall be placed 1 to 2 meters above ground level and at least 7.5 meters from any reflective surface, following the protocols of ANSI/ASA S12.9-2013 Part 3, available as noted in Appendix B;
  - b. Proper microphone screens shall be required;
  - c. Microphones shall be field-calibrated before and after measurements; and
  - d. An anemometer shall be located within close proximity to each microphone;
- (4) Monitoring shall involve measurements being made with the turbines in both operating and non-operating modes, and supervisory control and data acquisition system data shall be used to record hub height wind speed and turbine power output;
- (5) Locations shall be pre-selected where noise measurements will be taken that shall be the same locations at which predictive sound modeling study measurements were taken pursuant to subsection (c) above, and the measurements shall be performed at night with winds above 4.5 meters per second at hub height and less than 3 meters per second at ground level;

**(6) All sound measurements during post-construction monitoring shall be taken at 0.125-second intervals measuring both fast response and Leq metrics; and**

- (7) Post-construction monitoring surveys shall be conducted once within 3 months of commissioning and once during each season thereafter for the first year, provided that:
- a. Additional surveys shall be conducted at the request of the committee or the administrator; and
  - b. Adjustments to this schedule shall be permitted, subject to review by the committee or the administrator.

(f) Post-construction sound monitoring reports shall include a map or diagram clearly showing the following:

- (1) Layout of the project area, including topography, project boundary lines, and property lines;
- (2) Locations of the sound measurement points; and
- (3) Distance between any sound measurement point and the nearest wind turbine.

(g) For each sound measurement period during post-construction monitoring, reports shall include each of the following measurements:

- (1) LAeq, LA-10, and LA-90; and
- (2) LCeq, LC-10, and LC-90.

(h) Noise emissions shall be free of audible tones, and if the presence of a pure tone frequency is detected, a 5 dB penalty shall be added to the measured dBA sound level.

(i) Validation of noise complaints submitted to the committee shall require field sound surveys, except as determined by the administrator to be unwarranted, which field studies shall be conducted under the same meteorological conditions as occurred at the time of the alleged exceedance that is the subject of the complaint.

SEC site (many) links to Antrim Sound info documents:

[https://www.nhsec.nh.gov/projects/2015-02/2015-02\\_post\\_certificate\\_filings.html#Current](https://www.nhsec.nh.gov/projects/2015-02/2015-02_post_certificate_filings.html#Current)

[https://www.nhsec.nh.gov/projects/2015-02/2015-02\\_post\\_certificate\\_filings.html](https://www.nhsec.nh.gov/projects/2015-02/2015-02_post_certificate_filings.html)

<https://www.nhsec.nh.gov/projects/2021-02/2021-02.htm>

Rand Sound Report May 11, 2021:

[https://www.nhsec.nh.gov/projects/2021-02/public\\_comments/2021-02\\_2021-05-11\\_comment\\_rand.pdf](https://www.nhsec.nh.gov/projects/2021-02/public_comments/2021-02_2021-05-11_comment_rand.pdf)

COMPLAINT 3/24/21 12:16 AM: "Quite loud", "Modulating" Sound data and audio occurring at the time of the Berwick noise complaint were reviewed from the NM meter records. The Antrim Wind turbines dominated the acoustic environment with pronounced low frequency whooshing-thumping fluctuations. No other significant intrusive noises were heard. For the hour from Midnight to 1AM, there was little to no wind at the NM microphone level, and no wind-induced noise in the microphone recording. The local temperature was 35-40F and humidity 71-89% [5].

Figure 5 below shows the entire hour from 12 to 1 AM. At the complaint time 12:16 AM, turbine noise levels exceeded 40 dBA (red marker). Numerous wind turbine noise fluctuations exceeded 40 dBA. Wind turbine fluctuating noise levels measured up to 50 dBA (blue marker), 14 dBA louder than the "Worst Case Sound Level" of 35.7 dBA predicted by Epsilon Associates in 2016, and up to 10 dBA over the NH SEC noise limit of 40 dBA. Figure 5. Noise levels 3/24/21 12-1 AM, Leq-0.1second. Turbines dominated the acoustical environment. The NH shall-not-exceed 40-dBA night noise limit is shown in red. The green band shows the time portion of the 1-hour record displayed (full hour).

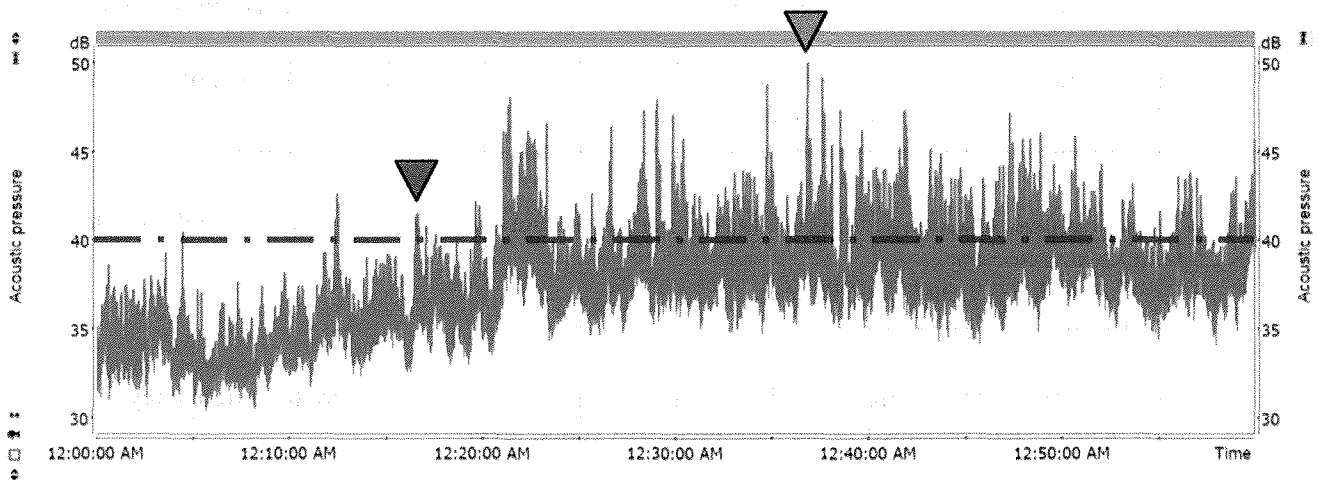


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## Tocci Sound Report September 2, 2020

[https://www.nhsec.nh.gov/projects/2015-02/post-certificate-filings/2015-02\\_2020-09-02\\_rev\\_ltr\\_town\\_antrim.pdf](https://www.nhsec.nh.gov/projects/2015-02/post-certificate-filings/2015-02_2020-09-02_rev_ltr_town_antrim.pdf)

From Page 3:

**Columns 7 and 8 are the measured 5-minute 10th and 90th percentile A-weighted sound levels.** Wind turbine sound is nominally steady, i.e. varies only a small amount during measurement intervals. The ANSI S12.9 Part 3 §6.5(b)(1) definition of “steady sound” was used to identify those 5-minute intervals when non-steady sound, mostly wind-driven foliage sound, was a significant contributor to measured levels. This test was used to identify when intrusive sound was presumed to mask steady AWE sound. The test was used by Acentech in its winter 2020 measurements and described in its May 12, 2020 report<sup>1</sup>. The method is not cited in the NH SEC Rules, but is a recognized ANSI standard<sup>2</sup> means for identifying circumstances when otherwise steady sound may be masked by non-steady intrusive sound. In Appendix A tables, all measurement intervals are noted as “void” in column 9, i.e. the arithmetic difference between 10th and 90th percentile sound levels exceed 3 dB resulting from the presence of wind-driven foliage sound and other transient sounds, for example, vehicles on Route 9.

From Page 5:

**However, many 5-minute samples were noted to be below 40 dBA after winds subsided.** Hence, it is likely that AWE wind turbine sound during conditions when complaints occurred are less than 40 dBA. Accordingly, it is our opinion that AWE wind turbine sound likely conforms to limits of NH Code Admin. R. Site 301.14(f)(2a).

Acentech Post Construction Sound Report, Fall of 2020, March 10, 2021:

[https://www.nhsec.nh.gov/projects/2015-02/post-certificate-filings/2015-02\\_2021-03-10\\_awe\\_post\\_construction\\_sound\\_monitoring\\_rpt\\_fall\\_2020.pdf](https://www.nhsec.nh.gov/projects/2015-02/post-certificate-filings/2015-02_2021-03-10_awe_post_construction_sound_monitoring_rpt_fall_2020.pdf)

From Page 15/87:

### 3.3 COMPLIANCE ASSESSMENT WITH THE SOUND LIMITS

**3.4 To assess compliance in this study the 1 hour LEQ metric is compared to the appropriate daytime and nighttime limits**

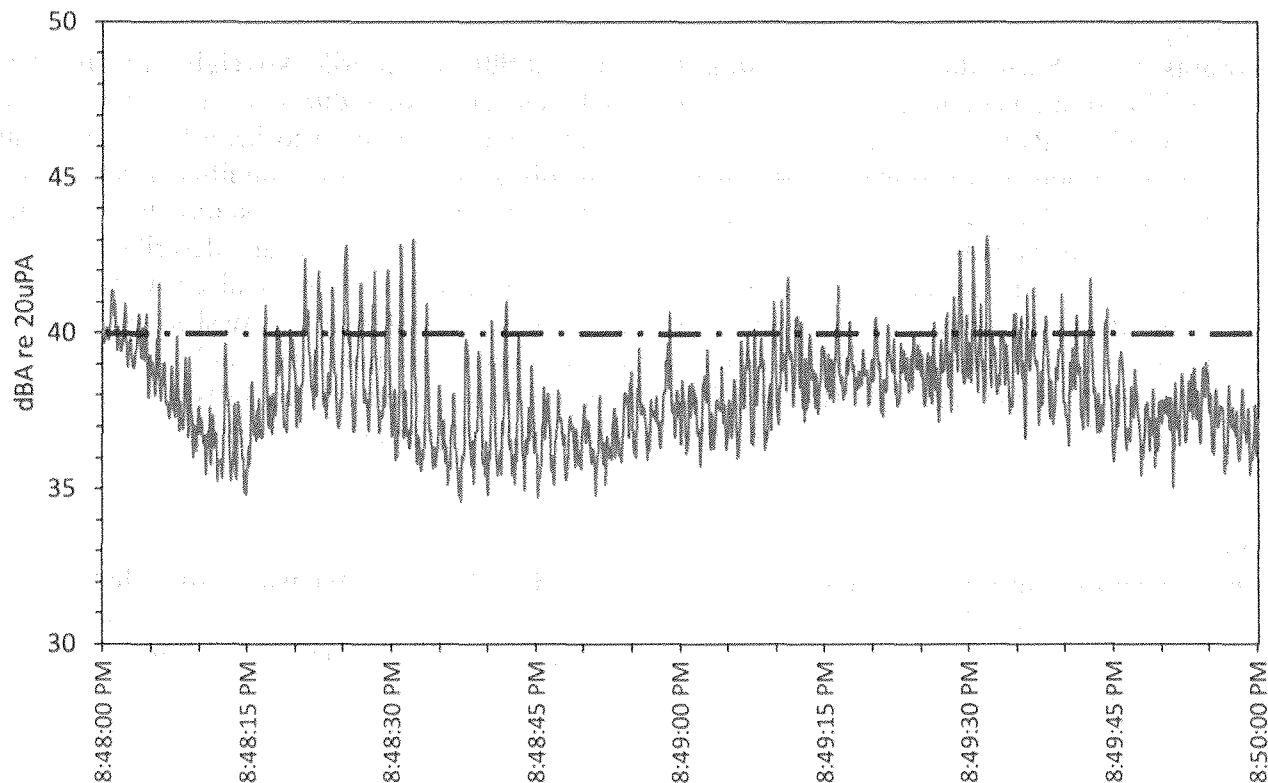
Lisa Linowes March 24, 2021 response to Antrim Wind's submitted sound reports, and several more:

[https://www.nhsec.nh.gov/projects/2015-02/post-certificate-filings/2015-02\\_2021-03-24\\_linowes\\_comment\\_technical\\_memoranda.pdf](https://www.nhsec.nh.gov/projects/2015-02/post-certificate-filings/2015-02_2021-03-24_linowes_comment_technical_memoranda.pdf)

## 2. Effect of Leq Time Interval on Noise Reporting

The purpose of the SEC sound standard is to ensure that a permitted facility does not produce an unreasonable adverse effect on public health and safety. The Committee's Leq 1/8-second standard is functionally equivalent to the Lmax noise standard applied in the Lempster, Groton, and Antrim Wind (2012) dockets. This standard is designed to capture the peaks and troughs of

amplitude modulation found in turbine noise emissions. The deficiencies of increasing the Leq time interval to 1-hour is best illustrated in the below plot of actual turbine noise measured at the Antrim Wind facility during a 2-minute period when a complaint was made. The turbines were dominating the acoustic environment at the time of the complaint.



The red dashed line denotes the Committee's 40 dBA limit; the blue lines represent 1/8-second Leq measurements. For this example, the not-to-exceed 40 dBA Lfast limit (measured as a 0.125 exponential equivalent sound level Leq) is exceeded when the blue line is above the red line. Yet, if we accept Antrim Wind's opinion that the rule is a one-hour Leq there would be no exceedances

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One-hour or even 10-minute averaging removes the amplitude modulation characteristic leaving the incorrect impression that the noise is acceptable. Doing so enables Antrim Wind to report to the SEC that its facility is operating in compliance with the standard while the Berwicks, Longgoods, Morrisons, Bucos and others suffer repeated adverse conditions. Individuals residing near the turbines still experience these sound exceedances even if an acoustician averages them away on paper.