STATE OF NEW YORK
DEPARTMENT OF STATE
OFFICE OF RENEWABLE ENERGY SITING

COMMENTS ON
Draft Regulations
Chapter XVIII, Title 19 of NYCRR Part 900
Subparts 900-1 – 900-14

On Behalf of Save Ontario Shores, Inc.
and named signatories across upstate, western and
the Southern Tier of New York

Appendix A

- Review and comments regarding noise from Gary A. Abraham, attorney
- Review and comments regarding noise from Rob Rand of Rand Acoustics, LLC

LAW OFFICE OF GARY A. ABRAHAM

4939 Conlan Rd.
Great Valley, New York 14741
716-790-6141

gabraham44@eznet.net
www.garyabraham.com

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Draft ORES regulations, to implement Section 94-c of the New York State Executive Law
Comments on behalf of Save Ontario Shores, Inc.

NOISE[1]

The Draft regulations and standards would permit new projects to expose people to intolerable noise levels.

The purpose of specifying noise design goals and limits is to provide assurance that "the local residents are completely protected from unwanted noise that may . . . cause annoyance without the adoption of the design goal as a regulatory limit."[2] This purpose is conventionally assessed as the project noise level that causes more than 10 percent of the people living on adjacent property to become "highly annoyed". This threshold is known to result in predictable indirect adverse health effects.[3] Wind turbine noise exceeds this threshold at lower sound levels than railroad or airport noise. Solar farms may emit lower sound levels than wind turbines, but their electrical connection substations (especially transformers and inverters) generate tonal noise that is annoying at levels at or below local background, and they are often sited much closer to homes.

The Draft regulations at §900-2.8(b)(i) allow wind projects to be designed to expose people to 45 decibels (dBA), or even 55 dBA for "participants".[4] But these people live in rural communities where the background level is about 25 dBA, particularly at night when wind turbines operate the most. That is a 20 or 30 decibel change.

A design goal of 35 dBA is the maximum that should be considered. A detailed discussion of acoustic standards and field experience at wind farms is provided with the comments by Rand Acoustics. Together with the Rand Acoustics comments, the

1 These comments were prepared in consultation with Richard R. James, E-Coustic Solutions LLC, (Okemos, MI), <http://www.e-coustic.com/>, and Robert Rand, Rand Acoustics (Brunswick, ME), <https://randacoustics.com/>.

2 Case 14-F-0490, *Matter of Cassadaga Wind*, Order Granting Certificate, 70.

3 Frits van den Berg (Public Health Service, Amsterdam) and Irene van Kamp (National Institute for Public Health and the Environment, the Netherlands), Health effects related to wind turbine sound, including low-frequency sound and infrasound, 46 *Acoustics Australia* 31 (2018) (reviewing literature), available at <https://link.springer.com/article/10.1007/s40857-017-0115-6>.

4 We show in separate comments provided here that varying protections for those with land use contracts with a project sponsor—the choice embodied in ORES's proposed "participants" concept—is probably illegal and certainly inappropriate. There is no authority for allowing more lax health and safety protections for "participants" in a project.

comments below show why 35 dBA would still risk some "high annoyance" (less than 10%) in communities exposed to wind turbine noise, and why a 45 dBA design goal is unacceptable.

The Draft regulations rely on post-construction complaints and mitigation rather than on the use of best available technology for noise control. The proposed 45 dBA design goal is not best available technology.

Health impacts of large-scale renewables

There is little evidence that wind turbine noise is a direct cause of adverse health effects. However, wind turbine noise causes indirect health effects. Complaints about wind turbine noise are common among those living close to a wind project area, and "stress effects of exposure to noise" are "well-known".[5]

Draft regulation §900-2.8 (Exhibit 7: Noise and Vibration) should require consideration of health and safety risks presented by exposure to excessive renewable project noise. Potential health and safety impacts listed in Draft regulation §900-2.7 (Exhibit 6: Public Health, Safety and Security) do not include noise impacts.

Proposed subsection 900-2.7(a)(6) would limit the scope of an application's information on health and safety impacts to waste releases, waste management, and emergency services to protect against conventional hazards. However, wind turbines as tall as 700 feet are an unconventional technology, emitting modulating (pulsating) low-frequency noise over 100 decibels at a distance of 30 meters.[6] NYSDEC's noise policy states that this is equivalent to the sound of a jet plane taking off 2,000 feet away.[7] Independent research around the world has found that potential public health impacts result when wind turbine noise causes "high annoyance".[8]

Noise design goals should avoid high levels of community annoyance

Significant community annoyance is defined conventionally as noise that results in 10% or more of the community becoming "highly annoyed" (i.e., "10%HA").[9] The 10%HA standard is a qualitative assessment based on what survey data would demonstrate. Decades of community surveys support predictions of community response to noise using this standard.[10]

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5 Colby WD, Dobie R, Leventhall G, et al., *Wind turbine sound and health effects: an expert panel review,* American Wind Energy Association and Canadian Wind Energy Association (2009). *See also* van den Berg and van Kamp, Health effects related to wind turbine sound, *supra*, note 3.

6 *See* IEC 61400-11 (2012) and IEC 61400-14 (2005) (specifying the methods for standardized reporting of wind turbine sound emissions). *See also* Draft ORES regulations, §900-15.1(b)(1) (referencing these two standards).

7 New York State Department of Environmental Conservation ("NYSDEC"), Program Policy DEP-00-1, *Assessing and Mitigating Noise Impacts* (rev. February 2, 2001), , Table E, available at <https://www.dec.ny.gov/docs/permits_ej_operations_pdf/noise2000.pdf>.

8 *See* World Health Organization, *Environmental Noise Guidelines for the European Region*, 18, Table 3 (the "percentage of the population highly annoyed (%HA), assessed with standardized scale" is a "critical health outcome"). *See also* van den Berg and van Kamp, Health effects related to wind turbine sound, *supra*, note 3.

9 ANSI S12.9, Part 4 (2005).

NYSERDA has recognized that wind turbine noise results in more community annoyance than other noise sources that emit the same average sound level:

> Unpredictable and uneven sound may increase annoyance levels. Because [wind] turbine noise is amplitude modulated, and therefore more noticeable, people may be more annoyed by turbine-related noise than they would by other sources. In fact, one study (Pedersen et al., 2009) found that people were more annoyed by wind turbine noise than by transportation and industrial noise at similar levels, and suggested that this may be due in part to its rhythmic [amplitude modulated] and uneven quality.[11]

It is incumbent on ORES to act in accordance with generally accepted consensus standards, such as published acoustic standards, rather than rely on industry standards which have not been qualified by independent experts, and that conflict with generally accepted standards. We see no basis for concluding that ANSI/ASA acoustic standards are inadequate for assessing the impacts of wind turbine noise.

A qualitative screening assessment of noise impacts should be added to numerical noise design goals

The Draft regulations §900-2.8(b)(1)(vi) and §900-2.8(b)(2)(iv) would allow residents hosting a wind or solar project to be exposed to fifty-five (55) dBA. This would be the equivalent of relocating these residents' properties adjacent to a busy highway or airport. As previously discussed, because this would be a clearly intolerable impact, these two provisions should be removed from the Draft regulations. They should be replaced with a procedure for determining whether a project's noise impacts are tolerable, defined as 10% or more of the exposed community becoming highly annoyed. Published acoustic standards are available that establish reliable methods for such qualitative assessment.[12]

Another method to qualitatively assess community reaction to noise is to compare the preexisting background sound level in a community to the sound level that would result by introducing a new noise source. NYSDEC and other state jurisdictions adopt this approach, recommending that the new noise source not elevate the pre-existing background sound level in a community by more than a given number of decibels. Thus, an increase of 5-10 decibels by a new project is "intrusive" under NYSDEC's Noise Policy; an increase of 10-15 dB is "very noticeable"; an increase of 15-20 dB is "objectionable"; and an increase greater than 20 dB is "very objectionable to intolerable."[13]

Referring to NYSDEC's Noise Policy, NYSERDA notes that New York, Massachusetts and

10 *Id.*, 38. *See also* ANSI S12.9, Part 4, Annex F (citing and discussing Schultz, T.J., "Synthesis of social surveys on noise annoyance," 64 *J. Acoust. Soc. Am.* 337 (1978), and Miedema, H.M.E. Vos, H., "Exposure-response relationships for transportation noise", 104 *J. Acoust. Soc. Am.* 3432 (1998)).

11 NYSERDA Report 13-03b, "Wind Turbine-Related Noise and Community Response" (April 2013), 9.

12 The comments of Rand Acoustics that accompany this submission identify the relevant standards and how they are employed by jurisdictions elsewhere.

13 NYSDEC, *Assessing and Mitigating Noise Impacts*, 15.

California also recommend that noise limits be based on the predicted change to pre-existing ambient sound levels. This approach uses existing background sound levels to calculate acceptable noise limits, a better approach than setting absolute numerical limits because it takes into account different geographies and environments. A typical rural environment, for example, has lower ambient sound levels than an urban environment. Using a generic background level of 33 dBA for rural areas, Hessler and Hessler (2011) estimate that the design level for a new wind project should range from 38 to 40 dBA in rural areas where wind projects are typically sited.[14]

NYSERDA states that noise limits based on ambient sound levels are particularly appropriate for assessing noise impacts in rural areas:

> Most experts also recommend regulating based on existing ambient noise levels in order to account for differences in how people experience sound in urban versus rural environments. . . . Ideally, turbines should be sited at adequate distances from residences so that day and nighttime noise levels stay within the general limits recommended by the WHO, New York State, and other regulatory bodies.[15]

"Significant" impacts are determined qualitatively

NYSDEC's noise policy provides guidelines for determining "significant" impacts under the State Environmental Quality Review Act (SEQRA).[16] Part JJJ requires ORES to consider "[a]ll significant impacts on the environment, public health, and safety".[17] The noise policy should be considered applicable guidance for determining a noise design goal that avoids and minimizes significant noise impacts.

Under the noise policy, "[i]n non-industrial settings the SPL [sound pressure level, in decibels] should probably not exceed ambient noise by more than 6 dB(A) at the receptor. An increase of 6 dB(A) may cause complaints."[18] Thus, for large-scale wind energy projects and for most large-scale solar projects, expected to be sited in rural communities, a change of six dB or more compared to the pre-existing acoustic environment is significant.

"Ambient noise [levels] in industrial or commercial areas may exceed 65 dB(A) with a high end of approximately 79 dB(A)."[19] However, measurements of ambient or background sound levels in upstate rural communities using the applicable ANSI standard[20] show much lower

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14 *Id.*, 12 (discussing NYSDEC, *Assessing and Mitigating Noise Impacts*).

15 *Id.*, 17.

16 *See* 6 NYCRR § 617.7(c).

17 Draft ORES regulations, §900-2.7(6). SEQRA's significance analysis has also been applied to the siting of renewable power plants. See 16 NYCRR § 1000.2(ak)(i) (revision of an application or certificate under PSL Article 10). The use of "significant" to describe potential impacts should be confused with the "substantive and significant" standard for adjudicable issues. *Cf.* Draft ORES regulations, §900-8.3(c).

18 NYSDEC, *Assessing and Mitigating Noise Impacts*, 14.

19 *Id.*

20 ANSI S12.100, "Methods to Define and Measure the Residual Sound in Protected Natural and Quiet Residential

levels. In the Cassadaga Wind case under PSL Article 10, the applicant measured background sound levels between 21 and 32 dBA during the day (with an average across six sites of 28 dBA), and between 19 and 32 dBA at night (with an average of 26 dBA).[21] Background sound level measurements for five rural locations in western New York conducted using measurement and analysis methods prescribed by ANSI S12.9 Part 3 and ANSI S12.100 found levels between 22 and 33 dBA, except for one location away from any traffic sound, and there the background level was between 21 and 24 dBA.[22]

In the Alle-Catt Wind Energy case, using the L90 metric, "[n]ighttime ambient noise level - taken between about 10pm and 3am, ranged from 19 to 29 dBA (Leq) and 16 to 21 dBA (L90)."[23] The L90 metric reports the sound level exceeded 90% of the time measured. "L(90) is often used to designate the background noise level."[24]

ANSI S12.100 should be added to the list of standards incorporated by reference into the draft regulations, and to confirm these reported very low levels of background sound, the regulations should require a background sound study in compliance with the standard. The ORES regulations should also require a qualitative assessment of the change in the acoustic environment that would result from project noise.

Numerical sound level limits must be adjusted for wind turbine noise

Unadjusted mean sound levels (*e.g.*, using the 8-hour L_{eq} metric) are insufficiently conservative to assess a noise source that operates at night, has substantial low frequency components, or generates amplitude modulating (pulsating) noise. Wind turbine noise possesses all three characteristics. Accordingly, ANSI/ASA acoustic standards prescribe adjustments for each of these characteristics to normalize the results. When incorporated into project design goals, the adjustments, where appropriate, allow more accurate prediction of the community response.[25] However, developers routinely argue against application of such adjustments.

The low-frequency component of wind turbine noise, including inaudible vibrations (termed infrasound), have been identified as one source of annoyance. A report on the results of field measurements of wind turbine-related sound and experimental studies in which people were

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Areas" (2014). This standard requires that seasonal sounds of nature be removed by means of an A-weighted, high frequency-compensated metric, colloquially called an "insect filter."

21 Case 14-F-0490, Cassadaga Applic., Ex. 19, Figs. 19-2, 19-3 (using insect filter).

22 Case 17-F-0282, *Application of Alle-Catt Wind Energy LLC for a Certificate of Environmental Compatibility and Public Need Pursuant to Article 10 to Construct a 340 MW Wind Energy Project*, Direct Testimony of Richard R. James (October 4, 2019), Exs. 2 through 6.

23 Case 17-F-0282, Direct Testimony of Rosa Mendez and Dr. David Witt (October 4, 2019), Ex. MW-4, at 6 (applicant's response to discovery request).

24 NYSDEC, *Assessing and Mitigating Noise Impacts*, 12. ANSI S12.100 supercedes this recommendation for typical wind farm host communities.

25 *Cf.* Draft regulation §900-15.1(c)(1) (referencing "A method for Rating Amplitude Modulation in Wind Turbine Noise"). *Cf. also* NYSDEC, *Assessing and Mitigating Noise Impacts*, at 3 ("The *amplitude* (loudness), *frequency* (pitch), *impulse patterns* and duration of sound all affect the potential for a sound to be a noise.") (italics added).

purposely exposed to infrasound, found that no scientific evidence that supports the conclusion that wind turbine infrasound and low-frequency sound causes adverse health effects.[26] However, in testimony in the Cassadaga Wind case under PSL Article 10, the report's lead author "acknowledged that studies have recognized the potential for a 'cascade of annoyance leading to stress and stress leading to sleep disturbance and sleep disturbance leading to health effects' as a 'reasonable pathway.'"[27] This is important because in the literature review he co-authored, this author promotes the idea that wind turbine noise annoyance is "produced by negative expectations", a "nocebo effect" that regulators should disregard. However, "[t]his is not unique to wind turbines, but is - to some degree - also true for other sound sources" that are assessed using the percent highly annoyed approach.[28]

Wind shear elevates wind turbine noise

Under PSL Article 10, wind energy project applicants must evaluate noise impacts under stable atmospheric conditions, caused by high wind shear, because stable atmosphere makes the acoustic environment very quiet, and occurs frequently at night when there is a heightened expectation for quiet.[29] This requirement has been abandoned in the Draft regulations. *See* Draft regulation at §900-2.8(d).

Wind shear occurs when the ground-level atmosphere stabilizes (or calms) after sunset and into the night, while winds prevail in the elevated atmosphere where wind turbine blades are spinning, at speeds sufficient to allow wind turbines to operate at nominal full power. "A high wind shear at night is very common and must be regarded as a standard feature of the night-time atmosphere in the temperate zone and over land."[30] This has two effects.

First, since it is very quiet when the air is calm, noise is more noticeable. Calm ground-level air allows the continuous background sound level to be in the low 20s (dBA), making noise levels in the 30s very noticeable. No significant background noise is present to mask wind turbine noise.

Second, wind shear causes wind turbines to emit increased sound power because it creates a mismatch between the angles of attack for the blades within the blade-swept area. Wind speeds at the bottom of the rotation are much lower than at the top. Rotating wind turbine blades "thump" as they pass across the boundary between calm air near ground level and higher turbulent air. van den Berg shows that increases of 10 dB can be expected for angle mismatches of 9° or more. Even slight mismatches of 4 to 7° can increase sound power by 3 to 8 dBA.[31] Calm or stable

26 McCunney, R.J., Mundt, K.A., Colby, W.D., Dobie, R., Kaliski, K., Blais, M., Wind turbines and health: a critical review of the scientific literature, 56 *J. Occup. Environ. Med.* 108 (2014).

27 Case 14-F-0490, Recommended Decision (November 8, 2017), 109.

28 Irene van Kamp and Frits van den Berg, *Health Effects Related to Wind Turbine Sound, Including Low-Frequency Sound and Infrasound*, *supra*, note 3, at 40.

29 *See* 16 NYCRR § 1001.19(d).

30 G. P. van den Berg, "Wind Turbine Power and Sound in Relation to Atmospheric Stability", 11 Wind Energ. 151, 168 (2008).

31 G. P. van den Berg, The sound of high winds: the effect of atmospheric stability on wind turbine sound and

atmosphere at near-ground altitude with wind shear near turbine hub height occurred in the van den Berg measurements 47% of the time over the course a year on average, and most often at night.[32]

"Every meteorologist knows about atmospheric stability", but "for a long time wind turbines were not big enough for the effects of atmospheric stability to be clearly noticeable. Since wind turbines have grown taller the effect manifests itself more clearly."[33]

As previously noted, acoustic standards provide adjustments for certain noise qualities by requiring that decibels be added to sound levels predicted by noise modeling. For example, ANSI S12.9 Parts 4 & 5 recommend that 10 dB be added to predictive sound modeling "[f]or residences in quiet rural areas".[34] Since, as indicated above, wind shear should be assumed to a common condition in New York, causing the project area to be very quiet during the times wind projects are most likely to operate, the 10 dB penalty is appropriate. Applying the penalty to ORES's proposed design goal of 45 dBA results in a derived design goal of 35 dBA.[35]

Noise design goals should be applied at the property line

The Draft regulations at §900-2.8(b) provide various noise design goals for wind and solar projects, each applied at the outside of a residence. However, because residential property is used and enjoyed across its full area, noise design goals should be applied at the property line.

The Article 10 regulations require applicants to provide "noise design goals . . . at representative external property boundary lines of the facility."[36]

In its Certificate Order for the Cassadaga Wind project, the Siting Board adopted certificate conditions that apply short-term and long-term noise limits to all "portion[s] of a real property plot",[37] up to the properly line.[38] The Draft regulations should adopt this approach.

microphone noise, diss. Univ. Groningen (2006), 62-65, available at <http://www.aph.gov.au/DocumentStore.ashx?id=12de591b-804c-47c1-894b-e6156f9f5078>.

32 *Id.*, 96.

33 *Id.*, 3.

34 *See* accompanying comments by Rand Acoustics, Attachment E.

35 A 35 dBA design goal should, for the same reasons, replace the Draft regulation at §900-2.8(b)(1)(v), proposing "[a] maximum noise limit of forty (40) dBA Leq (1-hour) at the outside of any existing non-participating residence from the collector substation equipment".

36 16 NYCRR § 1001.19(g).

37 Case 14-F-0490, Order Granting Certificate of Environmental Compatibility and Public Need, with Conditions (January 17, 2018), 71.

38 *Id.*, 73.

Tonal electrical connection noise requires a 5 dB adjustment to noise design goals

Electrical connections, including electric substations and points of interconnection to transmission lines, generally emit tonal noise, which is recognized as particularly annoying. Electrical connection noise may be a particular issue for solar farms because those projects are often sited much closer to residential property than large-scale wind projects. The Draft regulations at §900-2.8(b)(1)(ii) and (2)(iii) state that there is "[a] prohibition on producing any audible prominent tones", but inconsistently also states that "[s]hould a prominent tone occur", the noise design goal "shall be *increased* by 5 dBA". The design goal should be decreased by 5 dBA for tonal noise.

The 5 dBA adjustment should be incorporated into design because the regulation addresses predictive noise modeling conducted during the design phase. Otherwise, confirmation that a prominent tone occurs must wait for operations to commence. A literal reading of the draft regulation would require a remodeling of project noise whenever audible prominent tones are reported, for example, by the lodging of a complaint. A more defensible and consistent approach is to require the 5 dB penalty be applied to the noise design goal for electrical connection facilities.

As discussed in the comments by Rand Acoustics, the 5 dB penalty is conventionally added to the 10 dB penalty for night noise.

# # #

Robert W. Rand, ASA, INCE (Member Emeritus)
RAND ACOUSTICS, LLC
65 Mere Point Road
Brunswick, ME 04011
E-mail: rrand@randacoustics.com
Telephone: 207-632-1215

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To: New York Office for Renewable Energy Siting (ORES) Staff

Re: Technical Report
Review of Draft Regulations and Draft Uniform Standards and Conditions
New York Office for Renewable Energy Siting (ORES)

I respectfully submit this review of Draft Regulations and Draft Uniform Standards and Conditions for the New York Office for Renewable Energy Siting (ORES). This review focuses on noise pollution control (protection of communities from unwanted sound). Please note that the review is necessarily highly technical. Supporting information is provided through inserts and footnotes.

Review basis

1. INCE Rules of Practice require approving only noise control engineering studies, reports, or work which, to the best of the reviewer's knowledge and belief, is safe for public health, property, and welfare and in conformance with accepted practice. From years of work in power generation noise control including ten years at Stone & Webster Engineering Corporation, accepted practice includes planning to protect communities from unwanted sound and assuring facilities comply with regulatory requirements with an adequate margin of safety.

2. The draft regulations are understood to be intended for generic permitting of wind and solar facilities with the predicate to protect people from unwanted sound and potential adverse health effects. Noise complaints occur when developers, regulators, and consultants fail to protect people from unwanted sound during the design and site selection phase.

Predicate: Protection from Unwanted Sound

1. Noise is unwanted sound; sound that is annoying or causes adverse health effects (AHE), interfering with activities such as sleep, and degrading of amenity. Noise is prevented through good siting and noise control during the design phase.

2. It is understood that: New York State has established the noise control predicate for facility permitting- that being to protect people from effects of unwanted sound.

3. It is understood that: A community response of 10 percent highly annoyed (%HA) is firmly established as an impact threshold in New York State environmental review, and provides a community-based approach to evaluating intrusive noise. Highly Annoyed is defined as an Adverse Health Effect.

4. "Qualitative Screening" is recommended to help the State during initial review by determining early if facility noise levels are appropriate through comparison with

rational ANSI noise criteria. Qualitative screening is intended to promote proper site selection and noise control considerations during the design phase. See Attachment A.

5. Wind turbines can be considered as very large fans with no housing, with pulsations of acoustic energy radiated at the blade pass frequency (around 0.5-0.9 Hz for turbines currently marketed) and with noise emissions ranging from the blade pass frequency up through to 1000 Hz and higher. The majority of the acoustic energy exists in the frequency range of 0.5 to 200 Hz. Per ISO 1996-1:2003, investigations have shown that the perception and the effects of sounds differ considerably at low frequencies (5 to 200 Hz) as compared to mid or high frequencies. The main reasons for these differences are as follows:
— perception of sounds as pulsations and fluctuations in amplitude and/or frequency;
— a much more rapid increase in loudness and annoyance with increasing sound pressure levels at low frequencies than at mid or high frequencies;
— complaints about feelings of ear and body sensed pressure, dizziness, migraines and tinnitus;
— annoyance caused by secondary effects like rattling of buildings elements, windows, and doors or the vibration of mirrors, wall hangings and bric-a-brac on tables and shelves;
—low frequencies are less attenuated by building sound transmission loss, resulting in being perceived as louder indoors at low frequencies than at mid or high frequencies.

   Sound with strong low-frequency content engenders greater annoyance than is predicted by the A-weighted sound pressure level. It is critical that the State ensure facility applicants prove their facilities will not subject people to unwanted sound by demonstrating compliance with the sound pressure level limits for low frequency sound specified in ANSI S12.2 Criteria for Evaluating Room Noise, Table 6 for the 16 Hz, 31.5 Hz, and 63 Hz octave bands.

6. Dan Driscoll of the New York State Department of Environmental Conservation (NYDEC), with whom Stone & Webster worked extensively on power generation noise control for PASNY years ago, provided input to NYSERDA in 2009 in an Environmental Stakeholder Roundtable on Wind Power; (outdoor) criteria of 39 Ldn / 33 dB Leq at night for no more than sporadic complaints (limit %HA to less than 10 percent). See this letter's Attachment B.

7. Night noise levels at 35 dBA in quiet rural areas are consistent with at most "Sporadic Complaints", and highly annoyed below 10 %HA. Night noise levels at 45 dBA in quiet rural areas are consistent with "Widespread Complaints" and "Strong Appeals to Stop the Noise", and highly annoyed exceeding 10 %HA. (See Driscoll letter in Attachment B for explanation of complaints response levels.)

   The US EPA Levels Document of 1974 determined normalized community response referenced to 55 case studies of noise complaints from a variety of intrusive noise sources, and found very strong correlation between complaints and %HA. The data are consistent with Pedersen's 2009 analysis. See this letter's Attachment C.

8. Health Canada reported high annoyance exceeding 10 %HA above 35 dBA. See this letter's Attachment D.

9. ANSI Standards establish thresholds for land use compatibility of intrusive noise. Unfamiliar intrusive noise levels at night in quiet rural residential land use are compatible below 30 dBA, marginally compatible from 30 to 35 dBA, and incompatible above 35 dBA. See this letter's Attachment E.

10. Germany, one of the world's largest producers of wind power, limits average (Leq) noise levels to 35 dBA at night in rural areas.

11. Paul Schomer, Ph.D, P.E., Schomer and Associates, Standards Director, Emeritus of the Acoustical Society of America, in 2015 recommended for wind turbines in rural areas, designing for 34 dBA and requiring that no more than 5 percent of facility noise levels exceed 39 dBA, with an upper limit of approximately 40 dBA. He wrote, "*For very low-frequency sound and infrasound, public officials should require industry to prove that their new designs will not create adverse effects on people, notably, on sleep or those of the type listed on earlier charts [pressure on the ear, headache, fatigue, nausea, dizziness]. This proof from industry must be provided before any new windfarms are approved*."

    Mr. Schomer later published "A possible criterion for wind farms" (Acoustics '17 Boston, Noise: Paper 4aNSb3), recommending "the use of A-weighting and a 24-hour Leq as the metric. 36-38 dB is recommended for the criterion." Schomer found, "four sets of independent data result in criteria recommendations that are remarkably close to one another, lending support to a 24-hour A-weighted Leq wind turbine noise criterion in or around the range of 36-38 dB(A)."

<u>Review Summary</u>

1. If New York State is going to use a generic permitting process to protect people from unwanted sound, it should focus on elements that direct proper siting selection and noise control design to preclude the need for post-installation mitigation which will be more expensive and have fewer options for the project operator. The noise standard should reflect the current acoustic science as codified in ANSI and ISO standards. Design criteria should be set at levels which will protect people from unwanted sound and adverse health effects. See Driscoll and Schomer recommendations.

2. The proposed numerical standard in §900-6.5(A)(1)(i) at 45 Leq-1hour as the project design goal will not protect people from adverse health effects of unwanted sound. A 45-dBA limit is appropriate for louder residential urban areas. However, it is unreasonably high for quiet rural areas and breaches ANSI and ISO standards for rural land use compatibility.

3. ANSI standards inform appropriate design criteria that harmonize facility planning with land use compatibility and prevent unwanted sound impacts on people. Appropriate design criteria via ANSI standards are supported in findings and limits from Dan Driscoll, EPA, Health Canada, Schomer, Germany and wind turbine noise annoyance research. Criteria to protect people from unwanted, harmful and intrusive industrial sound in quiet rural areas should fall between 33 and 38 dBA (Leq-1hour). The 35 Leq,night criterion is the highest long-term average noise limit that can be recommended for wind turbines in quiet rural areas.

4. The WHO Leq,night portion of its "conditional" Lden 45 issued in 2018 for wind turbines is by EU Directive definition in 2002, 10 dB less than the Lden, or Leq 35 dBA, which is consistent with ANSI Compatibility guidelines for intrusive, unfamiliar noise impacts on rural residential land use. The equivalent 24-hour Leq for wind turbine noise at 45 Lden is approximately 5.8 dB +/- 2 dB lower, or 39 dBA+/- 2 dB (Fritz van den Berg, DOI: 10.1121/1.2934504, 2008). See Attachment F.

5. However, the A-weighted Leq does not take into consideration noise impacts on sleep and adverse health effects from wind turbine impulsive low frequency noise fluctuations which routinely exceed the average noise level at night and during high wind shear. Low frequency crest factors of 8-12 dB were reported in the Shirley Cooperative Study. A design safety margin of up to 10 dB is therefore warranted for low frequency octave bands to prevent unwanted adverse health impacts on people. See Attachment F.

6. "Qualitative Screening" helps State work during initial review by determining early if facility noise levels are appropriate through comparison with current science and health-based noise criteria.

7. Germany now produces over 100,000 GWh per year with wind turbines with a 35-dBA night noise limit in quiet areas. This criterion has proven feasible in rural Germany. If Germany can be successful using this criterion, then so can New York.

Thank you for your consideration of this letter. If you have any questions, please contact me.

Respectfully Submitted,

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Robert W. Rand, ASA, INCE (Member Emeritus)

Attachments:

- Attachment A: Qualitative Screening
- Attachment B: Dan Driscoll 2009 Noise Impact Assessment (NYSERDA)
- Attachment C: US EPA and High Annoyance Noise Impact Assessment
- Attachment D: Health Canada High Annoyance
- Attachment E: ANSI Siting Criteria for Land Use Compatibility
- Attachment F: ORES Draft Regulations Review and Recommendations
- Attachment G: Professional Ethics
- Attachment H: Qualifications

Abbreviations:
For purposes of this report the following definitions are provided:

ANSI	American National Standards Institute
ASA	Acoustical Society of America
EPA	Environmental Protection Agency
INCE	Institute of Noise Control Engineering
NYDEC	New York State Department of Environmental Conservation
NYSERDA	New York State Energy Research and Development Authority
ORES	Office of Renewable Energy Siting (New York)
WHO	World Health Organization

AHE	Adverse Health Effects
Leq	Energy equivalent sound level over a period of time
L,night	Per EU Directive 2002/49/EC of 25 June 2002, 'Lden' (day-evening-night noise indicator), the noise indicator for overall annoyance. Also, the long-term energy equivalent sound level during night hours 11pm to 7 am.
Lden	Per EU Directive 2002/49/EC of 25 June 2002, 'Lden' (day-evening-night noise indicator), the noise indicator for overall annoyance. Also, the long-term energy equivalent sound level for 24 hours, where the evening (7 pm to 11pm) and night periods (11pm to 7 am) are weighted by 5 and 10 dB respectively.
%HA	Percent Highly Annoyed

Attachment A: Qualitative Screening

The draft regulations show consideration for detail and harmonization with ANSI standards. There is clear intent to simplify the permitting process.

With that intent in mind, it is recommended that Qualitative Screening be incorporated at the start of permitting review to reduce cost and optimize site design for land use compatibility.

Effective Qualitative Screening is seen to rest on three components,

1) protect people from unwanted sound by limiting long term intrusive facility noise (as predicted by applicants) to no more than 6 dB over the pre-existing background L90, and limiting highest short-term sound levels (e.g. Fast response A-weighted sound pressure level modulations during periods of high wind shear at night or operation with high blade angles) no more than 10 dB over the pre-existing background L90, measured per ANSI S12.100 for quiet rural areas,

2) Compliance with ANSI-ASA S12.2 Criteria for Evaluating Room Noise, Table 6 for Sound Pressure Levels in the 16 Hz, 31.5 Hz and 63 Hz octave bands with an adequate margin of safety to prevent perception and resulting high annoyance from fluctuating low frequency sound (a safety margin of at least 5-10 dB in each octave band), and

3) Requiring use of Best Available Technology to ensure the lowest practical noise emissions as designed, not as mitigation.

Longstanding research on background sound levels and studies in wind turbine facility applications in New York have found repeatedly that background L90 sound levels in quiet rural areas are below 30 dBA at night. This acoustic knowledge is codified in ANSI S12.100:

> ANSI S12.100 Section 3.12 Quiet residential areas [are defined as] "*locations where the 90th percentile for ANS-weighted sound levels that are defined in this Standard are less than 30 dB for at least two hours per day, and the A-weighted sound levels for those same two hours are less than 45 dB. These criteria apply to days with winds below 2 m/s*."

Qualitative Screening should perform a qualitative evaluation at initial permit review stages comparing the existing background to facility design noise levels with the goal to screen out significant impacts.

For Qualitative Screening, the existing quiet rural background sound level at night is assumed to be less than 30 dBA. The facility applicant may conduct at their discretion a pre-screening background sound level survey in accordance with ANSI S12.100 and report the results as a basis for a background sound level. Background, L90 sound levels higher than 30 dBA in quiet rural areas shall be flagged and require precise documentation for survey methods, locations, sounds heard and removed or retained in numeric computations, and rationale for assuming the higher background levels as a year-round design basis. Background levels shall be considered in a location by location basis, not "averaged" into a "site-wide" value.

NEPA defines 6 dB over background is a significant impact, objectionable impact at +10 dB, intrusive at +10 to +15 dB, and 20+dB is an intolerable noise impact.

Qualitative screening criteria shall be based on background and predicted sound levels:

a) night background ANS-weighted sound levels are assumed below 30 dBA (highest assumed, 29 dBA), or provided by applicant's discretionary survey report, and

b) via NEPA, a 6-dB increase over background is considered a significant impact. For facility applications predicting long-term average noise levels above 35 dBA for quiet residential land use (a significant impact threshold), screening review should generate a caution and require project re-design to protect people from unwanted sound at night. This night criteria level is established in ANSI S12.9 (see this letter's Attachment E).

Attachment B: Dan Driscoll 2009 Noise Impact Assessment (NYSERDA) (page 1)

Environmental Stakeholder Roundtable on Wind Power

June 16, 2009

Empire State Plaza

Meeting Room 1

Environmental Discussion – Daniel A. Driscoll's response to the questions about noise:

Question 1. What research has justified the choice of 50 dBA as an appropriate noise criterion, particularly for rural areas of the state?

Question 2. Have studies been done in New York that identify the low frequency sounds (infra sound) from wind turbines, and their effects on humans and animals?

Before responding to the questions, it will help to give a brief explanation about how noise can be regulated.

1. Most town zoning ordinances prohibit "excessive" noise. While suitable for neighbor to neighbor disputes, the prohibition is vague and may not be enforceable in court.

2. Control how the noise source is operated, for example, distance (setback) from residences or property lines, hours of operation, wind speed, etc. This method is very effective and easy for towns to enforce, but it does not account for possible changes in wind turbine technology. Developers have proposed 500 and 1000 foot setbacks; towns are beginning to discover that setbacks on the order of 3000 feet or more are needed for industrial-scale wind turbines.

3. Specify a numerical noise limit. This allows for changes in wind turbine technology, but towns must hire qualified noise control engineers to help with creation and enforcement of the limit. Characterizing the sound produced by the wind turbine in a way that adequately protects the community is complex and also requires the assistance of a qualified professional to verify the applicant's data.

4. Limiting the permissible increase in sound level above the background sound level is the most accurate way to control community noise and is the method recommended in DEC's noise policy. But in addition to the complexities related to setting and enforcing a noise limit, the background sound level must be measured in a way that adequately protects the community. To characterize the background sound level in quiet suburban and rural communities, the commonly used Leq can be misleading; the L90, or residual sound level more accurately reflects the community's baseline for judging the intrusiveness of a new noise source. The Noise-Con 2008 paper by Kamperman and James (Simple Guidelines for Siting Wind Turbines to Prevent Health Risks) describes this method of noise control and includes guidelines for measuring the background sound level.

Attachment B: Dan Driscoll 2009 Noise Impact Assessment (NYSERDA) (page 2)

Table D-7 shows the normalization process. If the noise source having an Ldn of 55 dBA were operated in a quiet suburban or rural community having no prior experience with the noise source, and if the noise source has a pure tone or impulsive character (an appropriate correction for the modulated low-frequency sound of industrial-scale wind turbines), the Normalized Ldn would be 75 dBA. From Figure D-7, the expected community response under those circumstances would be "several threats of legal action or strong appeals to local officials to stop [the] noise."

Table D-7

CORRECTIONS TO BE ADDED
TO THE MEASURED DAY-NIGHT SOUND LEVEL (L_{dn})
OF INTRUDING NOISE
TO OBTAIN NORMALIZED L_{dn} D-3

Type of Correction	Description	Amount of Correction to be Added to Measured L_{dn} in dB
Seasonal Correction	Summer (or year-round operation)	0
	Winter only (or windows always closed)	−5
Correction for Outdoor Noise Level Measured in Absence of Intruding Noise	Quiet suburban or rural community (remote from large cities and from industrial activity and trucking)	+10
	Normal suburban community (not located near industrial activity)	+5
	Urban residential community (not immediately adjacent to heavily traveled roads and industrial areas)	0
	Noisy urban residential community (near relatively busy roads or industrial areas)	−5
	Very noisy urban residential community	−10
Correction for Previous Exposure & Community Attitudes	No prior experience with the intruding noise	+5
	Community has had some previous exposure to intruding noise but little effort is being made to control the noise. This correction may also be applied in a situation where the community has not been exposed to the noise previously, but the people are aware that bona fide efforts are being made to control the noise.	0
	Community has had considerable previous exposure to the intruding noise and the noise maker's relations with the community are good	−5
	Community aware that operation causing noise is very necessary and it will not continue indefinitely. This correction can be applied for an operation of limited duration and under emergency circumstances.	−10
Pure Tone or Impulse	No pure tone or impulsive character	0
	Pure tone or impulsive character present	+5

This discussion is intended to illustrate the expected community response to noise; it is not a recommendation that Ldn or Normalized Ldn be used to regulate wind turbine noise. For noise sources that may change throughout the day, a long-term average sound level (such as Ldn) can be misleading by averaging periods of relative quiet with periods of maximum noise.

What should be done? In the noise control profession it is generally considered adequate to reduce expected community response to "sporadic complaints" assuming that most of those complainants are using noise as a surrogate for visual impact or general dislike of the noise source. So, if the Normalized Ldn could be reduced to about 59 dBA (see Figure D-7) the community reaction would be acceptable. Working back through the normalization process gives an Ldn of 39 dBA. Therefore, the Leq of the hypothetical wind turbine should be 33 dBA; a setback of about 3000 feet or 1 kilometer would achieve that. It should be noted that this result is consistent with the Kamperman/James paper.

Response to Question 2. I am not aware of any research in New York State dealing with the effects of low-frequency sound (20 – 200 Hz) or infrasound (below 20 Hz) on humans or animals. However there are extensive interviews and first-person reports, available on the internet and elsewhere, from people living near industrial-scale wind turbines in New York describing their experiences with the wind turbine noise. The reports I have read are generally consistent with the known effects of low-frequency sound and infrasound. For example, the sound is often more noticeable indoors; the sound is occasionally felt in the chest rather than heard; and the effects can be a mixture of sleep interference, headache, dizziness, nausea, etc. A similar situation is found in some urban apartment buildings where low frequency traffic noise resonates in stairwells and hallways.

What should be done? When low-frequency noise or infrasound is a concern it is advisable to control both A-weighted sound levels (which emphasize speech frequencies) and C-weighted sound levels (which include more low frequencies). The C-weighted measurement should not exceed the A-weighted measurement by more than 20 dB.

Attachment B: Dan Driscoll 2009 Noise Impact Assessment (NYSERDA) (page 3)

Response to Question 1. One basis for a 50 dBA noise limit is the EPA's well-known publication, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, commonly known as the Levels Document, www.nonoise.org/epa.htm. In the Levels Document, the EPA uses the day/night sound level (Ldn) as a measure of noise; the Ldn is the sound level energy-averaged over 24-hours with a 10 dB penalty added to nighttime sound levels (10 pm to 7 am). Hypothetically, if a 2.5 MW wind turbine produced a constant energy-equivalent sound level (Leq) of 49 dBA at 500 feet (complying with a 50 dBA noise limit), its Ldn would be 55 dBA. (The Ldn for a constant sound source is about 6 dB greater than the Leq for that source.)

Based on extensive research, the EPA chose a day/night sound level (Ldn) of 55 dBA to protect people from "outdoor activity interference and annoyance." The limit applies to "residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis for use."

Figure D-7 from the Levels Document shows expected community reaction to noise; the dots represent different studies of various noise sources. It shows that there would be no community reaction to a noise with an Ldn of 55 dBA, although the noise would be generally noticeable. However, notice that horizontal axis in the Figure uses Normalized Ldn. Assuming an urban residential location, some prior exposure to the noise source, windows partially open, and no pure tone or impulsive character to the noise, the Normalized Ldn and the Ldn are the same.

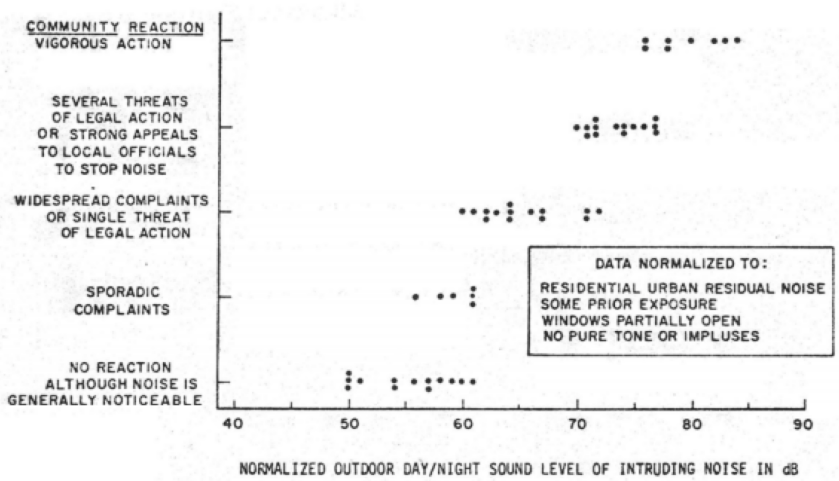

Figure D-7. Community Reaction to Intensive Noises of Many Types as a Function of the Normalized Outdoor Day Night Sound Level of the Intruding Noise D-3

Attachment C: United States EPA Noise Impact Assessment

In 1974 the United States Environmental Protection Agency (EPA) issued the "Levels Document" [1] with criteria on noise. Appendix D, Figure D-14 showed the relationship between the number of people who indicate in a social survey that they are Highly Annoyed and the number of people who indicate that they have ever Complained about the noise to anyone in authority.

The data in Figure D-14 (original figure inset) were transcribed into the log-log figure below. Log-log display reveals the very strong relationship between complaints (C) and annoyance (%HA) with R^2= 0.9694.

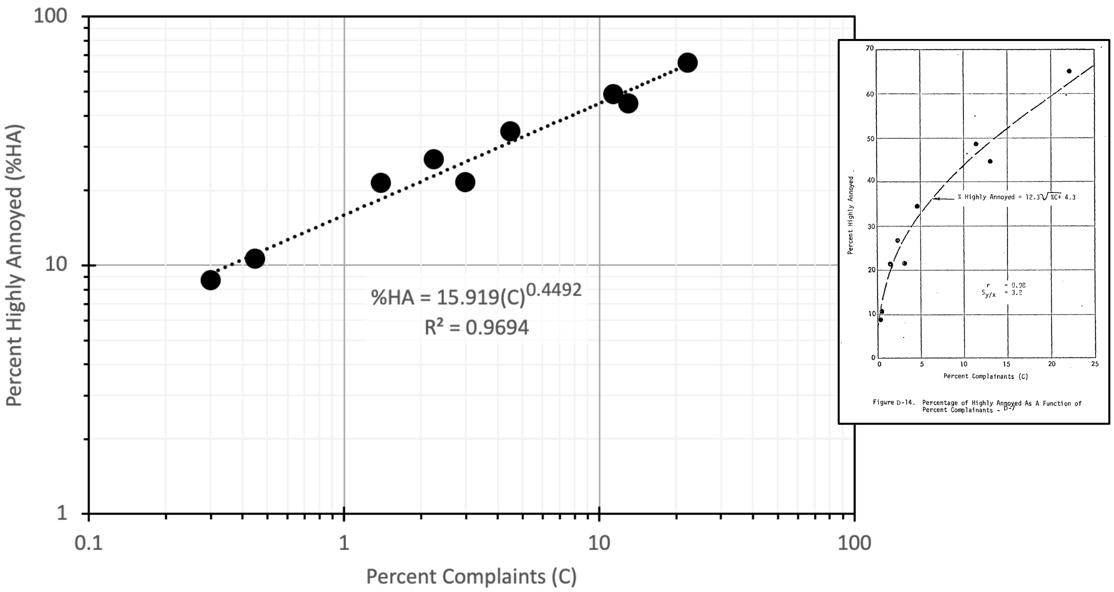

Figure C-1. EPA Figure D-14 transcribed to log-log format, relationship between the number of people who indicate in a social survey that they are Highly Annoyed (%HA) and the number of people who indicate that they have ever Complained (C) about the noise to anyone in authority.

The EPA Figure D-14 data show that for noise emissions from an operating facility achieving less than 10% highly annoyed in the neighboring area, facility noise control planning should design for a low percentage of complaints. From experience designing power generation, good noise control planning equates to designing for no more than "sporadic complaints".

The EPA case studies data in Appendix D, Figure D-7 were normalized to quiet rural areas using the method in Appendix D, Table D-7, and compared to Pedersen et al 2009 annoyance findings, shown below.

1 "Information On Levels Of Environmental Noise Requisite To Protect Public Health And Welfare With An Adequate Margin Of Safety", US EPA, 550/9-74-004, March 1974.

The community reaction level of "Sporadic complaints", analogous to a low percentage of complaints, were associated with long-term Leq sound levels between 30 and 35 dBA, and Percent Very Annoyed under 10 percent (Schomer's estimate agrees with data inspection, about 5 percent). Whereas the draft regulation's 45-dBA Leq-1hour design level is associated to "Strong appeals to stop the noise" and Percent Very Annoyed over 10 percent.

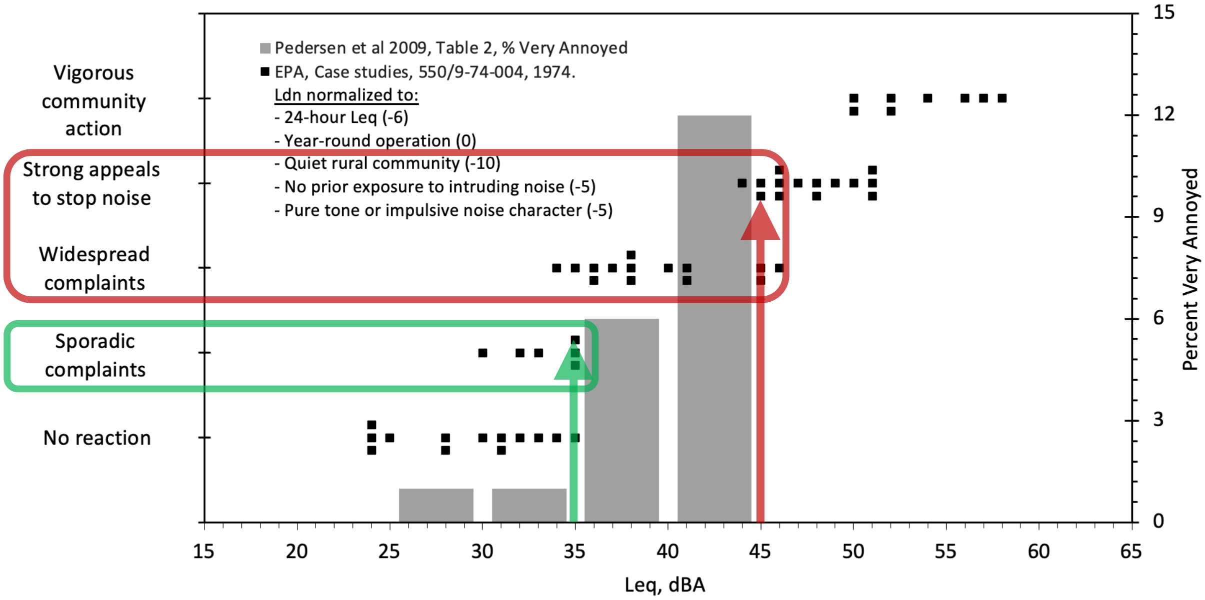

Figure C-2. Criteria guidelines using comparison of EPA complaints and Pederson Waye 2009 annoyance data. Both data sets show that a facility's long-term noise level of 45 dBA do not protect people from unwanted sound (complaints, appeals, %HA over 10 percent), whereas a facility's long-term noise level of 35 dBA is protective (at most sporadic complaints, %HA under 10 percent).

Attachment D: Health Canada High Annoyance

In 2008, Health Canada Study director David Michaud identified high annoyance due to intrusive noise as a measure of health impact [2].

In 2016, Health Canada published data from its large wind turbine study of 2014 that confirmed strong annoyance due to noise ramping up quickly in the mid-30s dBA [3]. Annoyance increased a full order of magnitude from 30-35 dBA to 35-40 dBA. See Figure D-1 below.

Health Canada's noise annoyance finding is consistent with the WHO 2018 45 Lden guideline for the Leq,night portion. By EU Directive 2002, the Leq,night nighttime portion of the Lden is 10 dB lower. For Lden 45, Leq,night is 35 dBA. The WHO L,night portion of its "conditional" Lden 45 is consistent with ANSI Compatibility guidelines for intrusive, unfamiliar noise impacts on rural residential land use.

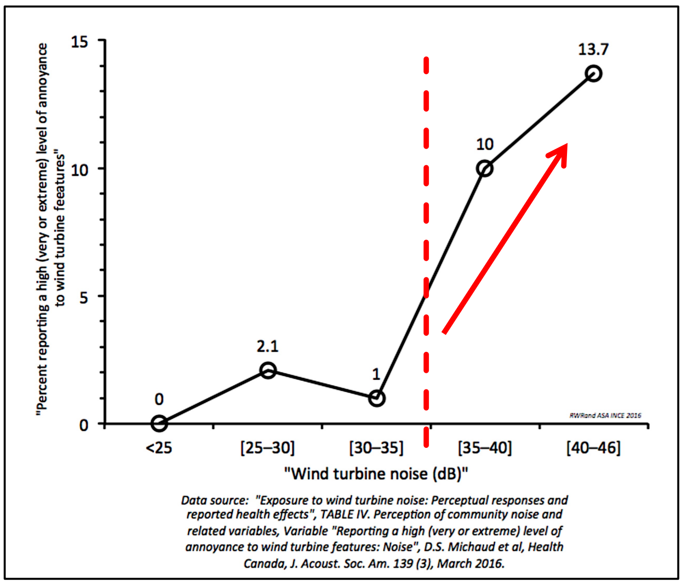

Figure D-1. Health Canada findings of high annoyance, a measure of health impact, ramping up above 35 dBA with 10-14 percent highly annoyed from 35 to 46 dBA.

The Australian Administrative Appeals Tribunal, referencing WHO research, ruled 4 December 2017 that "noise annoyance is a plausible pathway to disease", and, "There is an established association between WTN annoyance and adverse health effects".

2 Michaud et al. Canadian Acoustics, 36(2): 13-28 (2008). "Defining high noise annoyance as an adverse health effect is certainly consistent with Health Canada's definition of what constitutes "health". ... "a change in %HAn can be used in environmental assessments as one of the measures of the magnitude of an adverse health effect caused by project related noise.".
3 Michaud, D.S. et al Health Canada, J. Acoust. Soc. Am. 139 (3), March 2016.

The ORES draft regulation's 45, Leq-1hour noise limit could impose a Percent Highly Annoyed (%HA) far above 10 %HA in nearby residential land uses. From this unintended impact in the draft regulations, the standard if promulgated without responsible revision would produce adverse impacts antithetical to the State's established predicate to protect people from unwanted sound and adverse health effects.

Attachment E: ANSI Siting Criteria for Land Use Compatibility

ANSI S12.9 Parts 4 & 5 provides methods for determining noise level thresholds for compatibility with land use. Part 5 Annex A provides that "compatibility of a land use with the outdoor noise environment is assessed by comparing the predicted or measured annual average of the total day-night adjusted sound exposure or the annual average of the adjusted day-night average sound level at a site with the guidance criteria given in Figure A.1." The figure below shows ANSI S12.9 Part 5 Figure A.1. marked up for rural residential land use.

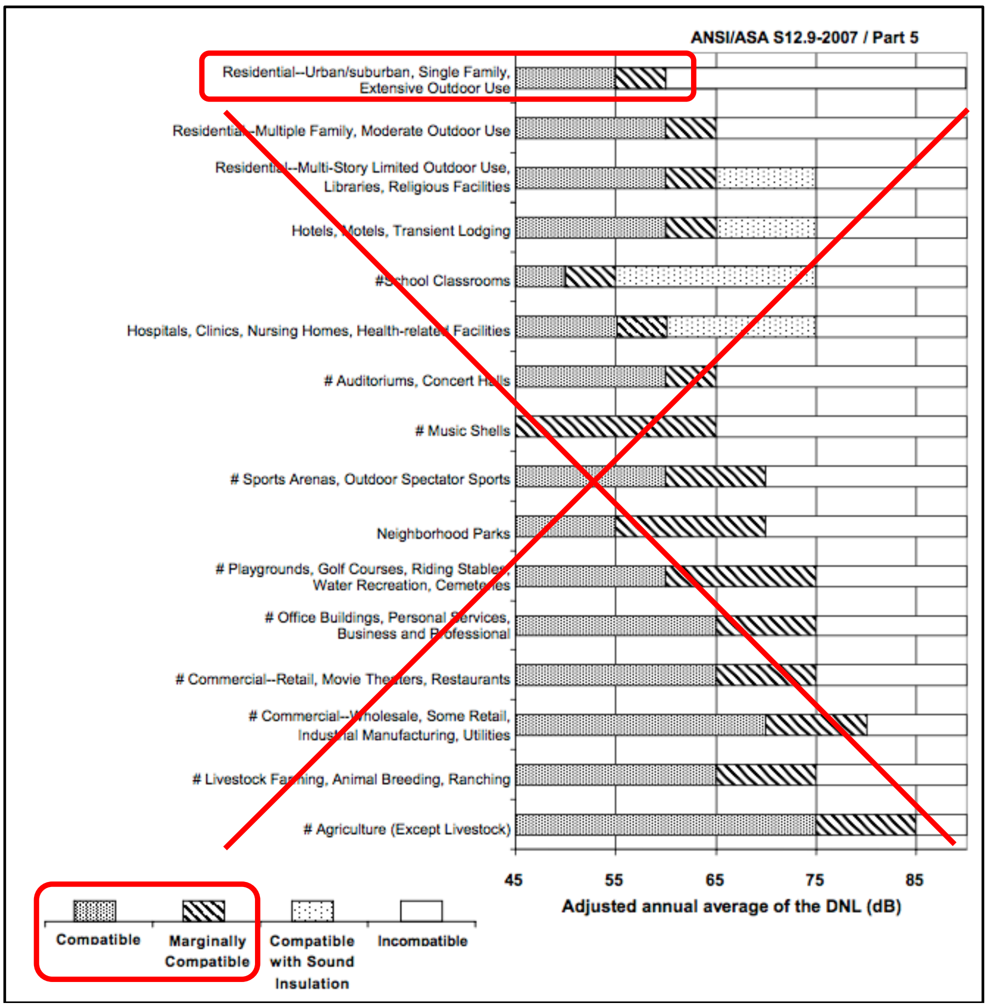

Figure E-1. ANSI S12.9 Part 5 Figure A.1, with markups. Lists a range of land uses, including at the top, "Residential-Urban/suburban, Single Family, Extensive Outdoor Use". This category was selected as a basis for evaluation of compatibility for rural residential land use.

This analysis evaluates compatibility for rural residential land use (homes), similar to the top category in Figure A.1, and does not evaluate for compatibility in farm fields proper (agricultural use). Part 5 Annex A Figure A.1 includes a footnote, "For residences in quiet rural areas (e.g., not near busy roads, busy railroads, grain elevators, etc.), the +10-dB adjustment in ANSI S12.9 Part 4 clause F.3.4.2 should be used." This adjustment was applied in this analysis to be conservative for homes away from busy roads and rail.

For each category a range of acceptable annual average day-night sound levels are listed for Compatible, Marginally Compatible, Compatible with Sound Insulation, and Incompatible. For the Residential-Urban/suburban, Single Family category, "Compatible" ranges up to 55 Ldn, and "Marginally Compatible" extends to 60 Ldn. Intrusive noise levels above 60 Ldn are "Incompatible".

Compatible land use is defined in ANSI S12.9 Part 5:

> ***3.1 compatible land use***. *Land use consistent with the outdoor noise environment such that the annual average of the total day-night adjusted sound exposure or the annual average of the adjusted day-night average sound level at a site is not greater than the compatibility limit designated for that land use.*
> ***3.2 land use***. *Existing or intended use of a specifically delineated land area or parcel.*
> ***3.3 land use category***. *A logical grouping of a set of related land uses.*

The ANSI S12.9 Part 4 adjustment from urban to quiet rural local conditions is a reduction of 15 dBA, including 10 dB for "quiet rural settings" (ANSI S12.9 Part 4 Section F.3.4.2) and 5 dB for unfamiliar intrusive noise (ANSI S12.9 Part 4 Section F.3.4.1). These two factors are additive (ANSI S12.9 Part 4 Section F.3.4.3). In practice, these factors may be used to either 1) adjust measured or predicted levels upward to assess against ANSI land use compatibility ratings, or 2) adjust ANSI land use compatibility ratings downward to assess measured or predicted sound levels. The comparative result is the same. For this calculation, the compatibility noise ratings were adjusted downward *for direct comparison to facility long term average (Leq) noise predictions*.

The tables below summarize the calculation utilized to determine land use compatibility noise criteria for rural residential land us using ANSI S12.9 Parts 4&5 assuming a quiet rural area. "Criteria" means the level that should not be exceeded- the highest allowable long-term average (Leq) noise level. The more stringent "Night" criteria are highlighted.

Criteria for "Compatibility" per ANSI S12.9:

Factor	**Day-Night Sound Level (DNL)**	***Day Sound Level:***	***Night Sound Level:***	***Average Level (Leq*):***
Part 5 Figure A.1 Residential Urban/suburban, Single Family Compatible, at the edge of Marginal Compatibility:	55	*55*	*45*	*49*
Adjust: 10 dB for quiet rural settings (Part 4 F.3.4.1):	-10	*-10*	*-10*	*-10*
Adjust: 5 dB for unfamiliar intrusive noise (Part 4 F.3.4.3):	-5	*-5*	*-5*	*-5*
Criteria for "Compatibility", dBA:	**40**	***40***	***30***	***34***

(continued)

Criteria for "Marginal Compatibility" per ANSI S12.9:

Factor	**Day-Night Sound Level (DNL)**	***Day Sound Level:***	***Night Sound Level:***	***Average Level (Leq*):***
Part 5 Figure A.1 Residential Urban/suburban, Single Family Marginal Compatibility, at edge of Incompatible:	60	*60*	*50*	*54*
Adjust: 10 dB for quiet rural settings (Part 4 F.3.4.1):	-10	*-10*	*-10*	*-10*
Adjust: 5 dB for unfamiliar intrusive noise (Part 4 F.3.4.3):	-5	*-5*	*-5*	*-5*
Criteria for "Marginal Compatibility", dBA:	**45**	***45***	***35***	***39***

* The energy-equivalent average level (Leq) equivalent to a 24-hour day-night level (DNL) is computed as 6.4 dB less than the day-night level due to level weighting of -10 dB from 10 pm to 7 am.

The ANSI S12.9 calculation concludes that for unfamiliar intrusive noise in quiet rural areas, long-term average (Leq) noise levels lower than 30 dBA are "*compatible*"; long-term Leq noise levels between 30 and 35 dBA are "*marginally compatible*"; long-term Leq noise levels exceeding 35 dBA at night are "*incompatible*".

Attachment F: ORES Draft Regulations Review and Recommendations

1. Documents Reviewed

1) Chapter XVIII, Title 19 of NYCRR Part 900, Office of Renewable Energy Siting, Subparts 900-1 – 900-5; 900-7 – 900-14
2) Chapter XVIII, Title 19 of NYCRR Part 900, Office of Renewable Energy Siting, Subpart 900-6 Uniform Standards and Conditions

2. Document Review

2.1 §900-6.4 Facility Construction and Maintenance

2.1.1 *(k) Construction Noise. To minimize noise impacts during construction, the permittee shall:*

(1) Maintain functioning mufflers on all transportation and construction machinery;

(2) Respond to noise and vibration complaints according to the complaint resolution protocol approved by the Office; and

(3) Comply with all substantive provisions of all local laws regulating construction noise unless they are waived.

The draft lacks regulatory prohibitions or standards (limits) for noise annoyance, and there are no prohibitions on vibration damage or vibration limits for most construction activities. (Bureau of Mines blast limits are listed in Section (m)(2) Blasting.) There are no vibration damage protections for historic buildings (e.g. listed on the National Historic Register) which can be more vulnerable to intrusive vibration than most structures.

> *When noise complaints are lodged, it is usually because the permitted hours of operation are breached. Daytime construction hours should be specified. Construction start time includes (shall be prior to) noise generated by warm-up and maintenance.*
>
> *Neighbors should not be asked to bear vibration annoyance during construction. Vibration capable of producing damage can occur from non-blasting equipment and should be controlled and monitored to prevent damage to nearby homes and structures.*
>
> *Human detect or sense vibrations at levels well below those which associated with structural damage. In a study performed by the United States Bureau of Mines (USBM), vibrations were classified as being "barely perceptible" to humans at levels as low as 0.011 in/sec; and vibration levels were categorized as "severe" at levels as low as 0.301 in/sec. The same USBM study evaluated the response of*

residential structures to vibrations and found that the minimum vibration level to damage older homes with plaster-on-lath construction is 0.50 in/sec; and 0.75 in/sec for newer drywall construction homes. These vibration damage levels are consistent with the Bureau of Mines blast limits listed further on in Section (m)(2) Blasting.

<u>Recommendations, Section §900-6.4(k)</u>

1. Provide protections against vibration annoyance during construction. Adherence to the vibration magnitudes corresponding to the perceptibility threshold will insure minimum discomfort and annoyance. As provided for operations in §900-6.5(a)(1)(iv), example wording is listed below in brackets:

   [Not produce human perceptible vibrations inside any non-participating residence existing as of the issuance date of the siting permit that exceed the limits for residential use recommended in ANSI/ASA Standard S2.71-1983 (R August 6, 2012) "Guide to the evaluation of human exposure to vibration in buildings" (see section 900-15.1(a)(1)(i) of this Part)".]

2. Provide protections against noise annoyance and adverse noise impacts during construction. Example noise limits below:

   [The sound from construction activities between 8:00 p.m. and 7:00 a.m. is subject to the following limits: At and within the property line of any property for which the zoning, or, if un-zoned, the existing use or use contemplated under a comprehensive plan, is not predominantly commercial, transportation, or industrial, the maximum sound level shall not exceed:

   65 dBA between 7:00 a.m. and 7:00 p.m., and
   55 dBA between 7:00 p.m. and 7:00 a.m.

   The maximum sound level shall be measured using the fast response (LAFmax).

   For noise immissions at school locations, the limits in American National Standards Institute/Acoustical Society of America [ANSI/ASA] S-12.60 "Classroom Acoustics" shall be met.]

   To be placed in the Definitions section:

   [MAXIMUM SOUND LEVEL: Ten times the common logarithm of the square of the ratio of the maximum sound to the reference sound of 20 microPascals (uPa). Symbol: LAFmax.]

3. Provide protections against vibration damage during all construction operations for

nearby structures and historic buildings, using the NCHRP report [4] as framework. Example requirements below:

[An initial screening process shall be conducted for buildings surrounding a construction site. All structures should be evaluated on their own physical condition. For the screening process, a conservative threshold for potential damage should be assumed, and simple vibration-prediction methods used to estimate levels of vibration that could occur at each building located within some assumed screening distance. A conservative screening distance of 500 feet shall be used for all but blasting activity. Conservative thresholds for potential damage of 0.2 in/sec for transient and 0.1 in/sec for continuous vibrations shall be met.

2.2 §900-6.5 Facility Operation

2.2.1 (a) Noise Limits for Wind Facilities

2.2.1.1 This section requires *"(i) Comply with a maximum noise limit of forty-five (45) dBA Leq (8-hour) at the outside of any non-participating residence, and fifty-five (55) dBA Leq (8-hour) at the outside of any participating residence existing as of the issuance date of the siting permit;*".

The noise limits and compliance location are permissive and the time frame too long, favoring the developer at the expense of the neighbors and ignoring zoning precedent,

1) An 8-hour noise limit is unreasonable due to practical inability to parse out contamination from other noise sources over such a long time period, making compliance testing unworkable,
2) An 8-hour noise limit ignores the primary complaint for wind turbine intrusive noise, sleep disturbance, which is assessed more effectively by documenting the maximum noise level and presence of deep or excessive amplitude modulations,
3) A 45-dBA noise limit assures complaints in quiet rural areas,
a) 45 dBA is some 20 dBA above typical background L90 levels, an intrusive noise increase associated with strong appeals to stop the noise and/or legal action,
b) 45 dBA is associated to annoyance, an Adverse health Effect, above 10 %HA,
c) 45 dBA is some 10 dBA above the highest threshold for intrusive noise compatibility with rural residential land use (ANSI S12.9 Parts 4 & 5), assuring unwanted sound, noise annoyance, noise complaints and amenity degradation,
d) 45 dBA outside with windows partially open assures indoors intrusive noise levels exceeding known sleep disturbance thresholds published by WHO 2009,
e) 45 dBA, night (8 hours) is 10 dB louder than the 8-hour L,night portion of the WHO's 2018 cautionary 45 Lden noise limit for wind turbines, where the evening and night portions of the Lden are 5 and 10 dB lower than the Lden, respectively,

4 "Current Practices to Address Construction Vibrations and Potential Effects to Historic Buildings Adjacent to Transportation Projects," National Cooperative Highway Research Program Report 25-25/Task 72 (Washington, D.C.: National Academy of Sciences, 2012).

4) Regulatory limits at the house are incompatible with standard zoning practice and principle which use the property line for regulatory limits on environmental intrusions. Indeed, Article 10 regulations [5] require facility applicants to provide "noise design goals … at representative external property boundary lines of the facility."

5) The design goal should be 35 dBA Leq, consistent with ANSI standards and the equivalent of most jurisdictions' requirements who have enacted protections for public health and welfare from excessive noise in quiet rural areas.

<u>Recommendations, Section §900-6.5(a)</u>

2.2.1.2 This section requires "*(ii) Not produce any audible prominent tones, as defined by using the constant level differences listed under ANSI S12.9 2005/Part 4 Annex C (sounds with tonal content) (see section 900-15.1(a)(1)(iii) of this Part) at the outside of any non-participating residence existing as of the issuance date of the siting permit. Should a prominent tone occur, the broadband overall (dBA) noise level at the evaluated non-participating position shall be increased by five (5) dBA for evaluation of compliance with subparagraphs (i) and (v) of this paragraph;*".

These requirements are consistent with ANSI S12.9 Part 4. However, from a noise control planning perspective, tonal noise notably from transformers is known and can be anticipated and prevented with noise controls during the design review phase. Noise controls should be incorporated in facility designs to prevent excessive tonal noise, rather than allowing tonal noise through and then penalizing the facility during operations and requiring noise controls to be installed after construction, which are usually much more expensive. Typically, a 5-dB penalty is added for tonal noise and should be factored into the overall facility design goal.

2.2.1.3 This section also requires *"(iii) Comply with a maximum noise limit of sixty-five (65) dB Leq (1-hour) at the full octave frequency bands of sixteen (16), thirty-one and a half (31.5), and sixty-three (63) Hertz outside of any non-participating residence existing as of the issuance date of the siting permit, in accordance with Annex D of ANSI standard S12.9-2005/Part 4 Section D.2.(1) (Analysis of sounds with strong low-frequency content) (see section 900-15.1(a)(1)(iii) of this Part);*"

These requirements are faulty suggesting there was a misinterpretation of the ANSI standard. The ANSI standard states, "*Generally, annoyance is minimal when octave-band* ***sound pressure levels*** *are less than 65 dB at 16, 31.5, and 63-Hz midband frequencies. However, low-frequency sound sources characterized by rapidly fluctuating amplitude, such as rhythm instruments for popular music, may cause annoyance when these octave-band sound pressure levels are less than 65 dB*."

The term "sound pressure level" is defined in ANSI S1.13-2005, Section 5.9 as "*Ten times the common logarithm of the square of the ratio of the sound pressure to the*

5 16 NYCRR § 1001.19(g).

reference sound pressure of 20 micropascals. Unit: decibel (dB); symbol: Lp." The ANSI standard S12.9-2005/Part 4 Section D.2.(1) uses the octave band *sound pressure level*, Lp, not the long-term average octave band Leq (1-hour).

INFORMATIVE: The Leq (1-hour) metric is not part of ANSI S12.9 Annex D Section D.2. The human ear has a short response time, on the order of milliseconds, and does not average incoming low frequency intrusive noise over an hour and then decide if the noise is annoying. It is generally accepted in the acoustics profession that a sound pressure level acquired with Fast response (0.125s time weighting) corresponds to how the ear hears. A 1-hour average sound level obscures fluctuating maximum sound pressure levels and is not informative for regulators assessing complaints of rhythmic (amplitude modulating) sound such as low frequency wind turbine noise.

ANSI goes on to say, "However, low-frequency sound sources characterized by rapidly fluctuating amplitude, such as rhythm instruments for popular music, may cause annoyance when these octave-band sound pressure levels are less than 65 dB." It is general practice in acoustics including in New York to apply a 5-dB penalty for tonal or intrusive low frequency noises due to annoyance. Wind turbine noise is fluctuating in the low frequencies with pronounced peaks at blade pass rates, especially during high wind shear conditions. "A high wind shear at night is very common and must be regarded as a standard feature of the night-time atmosphere in the temperate zone and over land."[6] Wind shear exponents routinely exceed manufacturer specifications especially at night [7] when resulting increased immitted fluctuating and pulsatile low frequency noise are most likely to disturb sleep and amenity resulting in high annoyance. ISO 9613-2 (the algorithm used in noise modeling software) accounts for moderate shear, but is not designed for high levels of shear. Regulators should recognize and factor for night noise modulation during application review, rather than rely on (unproven) assurances from developers that they can control night noise modulations with firmware. Once operating, experience confirms that wind facilities have no <u>reliable</u> means to prevent excessive night noise save facility shutdown. Accordingly, design review should factor octave bands limits in residential property to be less than 65 - 5 or 60 dB measured using Fast response.

ANSI S12.2: Provides thresholds for audible noise and for sensed vibrations in its Annex D which provides RC Mark II criteria [8]. The figure below summarizes the problem of using 65 dB as thresholds in the 16, 31.5 and 63 Hertz octave bands. A 65-dB octave-band sound pressure level is associated to "Moderately perceptible vibration and rattle likely".

6 G. P. van den Berg, "Wind Turbine Power and Sound in Relation to Atmospheric Stability", Wind Energ. 2008; II:151-169, (www.interscience.wiley.com) DOI: 10.1002/we.240.
7 Kelley, N., Smith, B., Smith, K., Randall, G., Malcolm, D., "Evaluation of Wind Shear Patterns at Midwest Wind Energy Facilities", NREL/CP-500-32492, May 2002.
8 Criteria for Evaluating Room Noise, publication date 2019 (ANSI/ASA S12.2-2019).

INFORMATIVE (continued):

A minimum 5-dB design margin of safety is needed to prevent annoyance associated with perceptible vibration and rattles.

6 Acoustically induced vibrations and rattles

Limiting levels at low frequencies are listed in Table 6 for assessing (a) the probability of clearly perceptible acoustically induced vibration and rattles in lightweight wall and ceiling constructions, and (b) the probability of moderately perceptible acoustically induced vibration in similar constructions.

Note that at 65 dB SPL (Not Leq) Moderately Perceptible Vibration and Rattle is LIKELY.

Table 6 — Measured sound pressure levels for perceptible vibration and rattles in lightweight wall and ceiling structures

Octave-band center frequency (Hz)	**16**	**31.5**	**63**
Clearly perceptible vibration and rattles likely	75	75	80
Moderately perceptible vibration and rattle likely	65	65	70
NOTE Values are sound pressure levels in decibels 20 μPa. (See [12].)			

Figure F-1. ANSI S12.2 thresholds for sensed vibrations, Annex D, RC Mark II.

SHIRLEY: During the 2012 Cooperative Study in Shirley Wisconsin, the Shirley 2.5MW wind turbine emissions were perceptible by neighbors and observable by instrumentation during noise and pressure microbarometer surveys at distances of 1300 to 7000 feet [9]. Residents reported "being intensely affected despite inaudibility and to be aware of turbine operation when the turbines are not visible". Vibration perception included perception of airborne vibrations (noise) and sensations of pressure.

It is well known from basic field research that noise can produce vibrations in homes that are humanly perceptible, as outlined by Hubbard [10].

Hubbard's Figure 8 provides a composite guideline for whole body vibration perception.

9 Channel Islands Acoustics, Camarillo, CA, Principal: Dr. Bruce Walker; Hessler Associates, Inc., Haymarket, VA Principals: George F. and David M. Hessler; Rand Acoustics, Brunswick, ME, Principal: Robert Rand; Schomer and Associates, Inc., Champaign, IL, Principal: Dr. Paul Schomer, "A Cooperative Measurement Survey and Analysis of Low Frequency and Infrasound at the Shirley Wind Farm in Brown County, Wisconsin", Wisconsin PSC REF#:178263, December 24, 2012.
10 Hubbard, H., "Noise Induced House Vibration and Human Perception", Noise Control Engineering Journal, Volume 9 No.2, pp. 49-55, September-October 1982.

INFORMATIVE (continued):

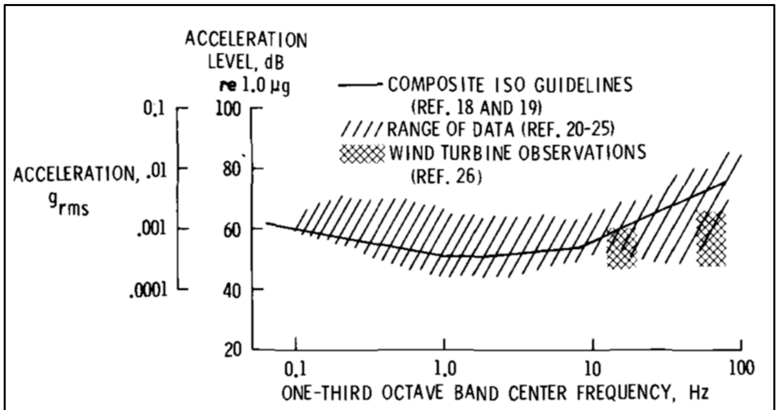

Figure 8—Most sensitive threshold of perception of vibratory motion by humans

Figure F-2. Hubbard 1982, Figure 8; curve represents the combined responses of a person in either the up and down, fore and aft, or sideways directions whichever is the most sensitive. The composite guidelines curve of Fig. 8 is judged to be the best representation of the available whole body (most sensitive axis) vibration perception data.

Hubbard's Figure 9 outlined "perceptible vibrations" thresholds spanning the low-frequency range from 0.1 to 100 Hz in one-third octave bands.

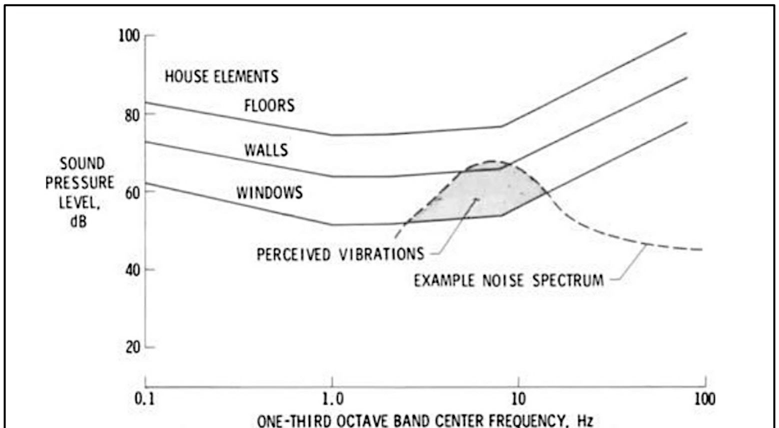

Figure 9—Sound pressure levels sufficient to cause perceptible vibrations of house structure elements over a range of frequencies

Figure F-3. Hubbard 1982, Figure 9; indicates the outside sound pressure levels in given one-third octave bands causing perceptible vibration inside a house structure.

One-third-octave band sound levels acquired outdoors during partial power operation, for the widely spaced wind facility comprised of eight, Nordex 2.5MW turbines at Shirley, were superimposed on the Hubbard data in the figure below.

INFORMATIVE (continued):

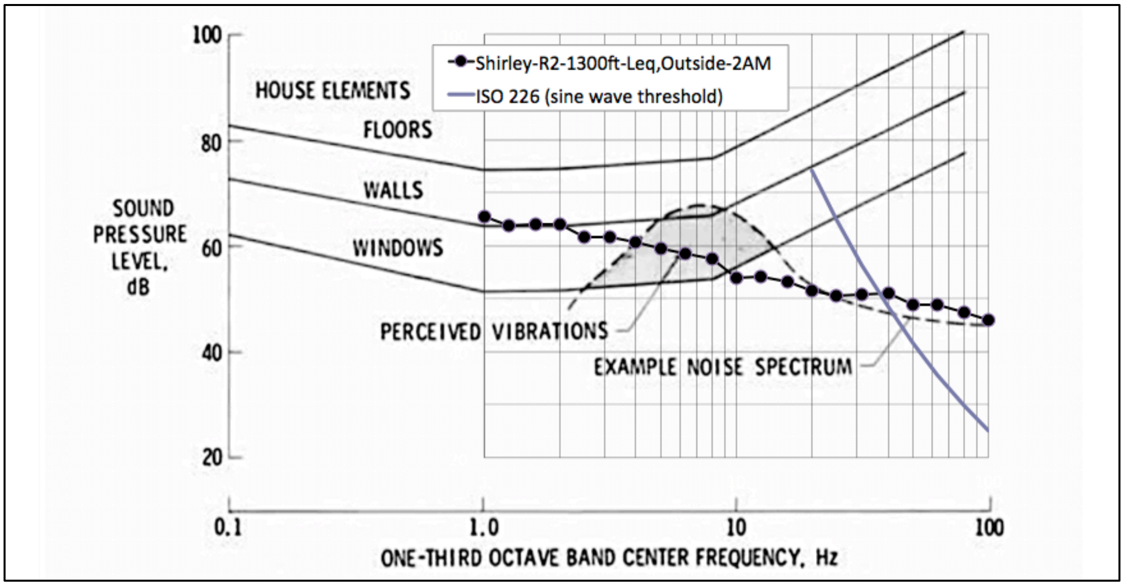

Figure F-4. Perceptible Vibration. Outdoors noise levels acquired for 2.5MW turbines at 1300 feet, compared to Hubbard 1982 Figure 9. Note: Hubbard's Figure 9 indicates the outside sound pressure levels in given one-third octave bands that will cause perceptible vibration inside a house structure. To this, outdoors 1/3 octave band Leq (average) sound levels acquired at Shirley, WI 2012 during partial power operation were superimposed, along with the median audibility threshold in ISO 226 (range +/- 12dB).

The Hubbard and Shirley data comparisons confirm that vibration sensation from wind turbine impulsive fluctuating noise is likely, and can be perceivable indoors as noise or <u>sensation</u> below the audible threshold under 40 Hz and under 60 dB.

Crest factors (ratios of peak to average levels) at Shirley location R2 reached 8-12 dB above average levels (L1 – Leq, L_0.5-100Hz, Shirley Report Table 4). Accordingly, a 10-dB safety design margin for impulsive fluctuations is warranted.

<u>Recommendations, Section §900-6.5(a) (continued)</u>

Section §900-6.5(a) can be properly adjusted to be consistent with ANSI standard S12.9-2005/Part 4 Section D.2.(1) and ANSI S12.2, and a safety margin for impulsive fluctuations, establishing conservative design criteria per octave band at 55 dB, by restating as follows:

"(iii) Comply with a maximum noise limit of fifty-five (55) dB sound pressure level (defined in ANSI S1.13-2005, Section 5.9) using meter Fast response (defined in ANSI S1.4-1983) at the full octave frequency bands of sixteen (16), thirty-one and a half (31.5), and sixty-three (63) Hertz outside of any non-participating residence existing as of the issuance date of the siting permit, octave bands as listed in Annex D of ANSI standard S12.9-2005/Part 4 Section D.2.(1) (Analysis of sounds with strong low-frequency content) (see section 900-15.1(a)(1)(iii) of this Part);".

2.3 §900-2.8 Exhibit 7 Noise and Vibration

2.3.1 (i) An evaluation of ambient pre-construction baseline noise conditions …

The draft regulations §900-2.8 Exhibit 7(i) require measurement of the existing L90 background for wind and solar facilities, "*An evaluation of ambient pre-construction baseline noise conditions by using the L90 statistical and the Leq energy based noise descriptors, and by following the recommendations included in ANSI/ASA S3/SC 1.100 -2014-ANSI/ASA S12.100-2014 American National Standard entitled Methods to Define and Measure the Residual Sound in Protected Natural and Quiet Residential Areas (see section 900-15.1(a)(1)(iv) of this Part). Sound surveys shall be conducted for, at a minimum, a seven (7) day-long period for wind facilities and a four (4) day-long period for solar facilities*."

ANSI S12.100 states, "*This standard provides basic quantities and procedures for the description of residual sound levels in protected natural areas and quiet residential areas. This information Attachments the basic information contained in the American National Standards listed as references. This standard specifies a method to measure residual sound in protected natural areas and quiet residential areas. This standard sets minimum requirements for the instruments used and for the sensitivity checks performed in conjunction with measurements in parks, wilderness areas, and quiet residential areas. This standard defines the A-weighted, noise-compensated (ANS-weighted metric), which is the standard A-weighting filtered to exclude sounds above the 1 kHz octave band. … The resulting data can be used to characterize residual sound levels with respect to anthropogenic noise. Data obtained in quiet residential areas can be used to assess the residual sound in relation to manmade noise sources* ***such as wind turbine generators****, compressor stations for pipelines, highways, and airports*." [emphasis added].

The draft section §900-2.8 Exhibit 7(i) is unconnected to other requirements in the draft regulations.

Recommendations, Section §900-2.8 Exhibit 7(i):

The generic design basis for background sound levels in quiet rural New York shall assume that the existing L90 background sound levels are below 30 dBA at night as stated in ANSI S12.100.

As an alternative to assuming existing L90 background levels are under 30 dBA as stated in ANSI S12.100 for quiet rural areas, the applicant may be granted use of ANSI S12.100 to conduct discretionary background surveys in preliminary permitting to 1) confirm existing land use including earmarking "quiet residential land use" and 2) prevent potentially fraudulent elevated (contaminated) L90 background estimates by unscrupulous parties.

Applicant-reported measured L90 background sound levels shall be acquired using the methods in ANSI S12.100 and shall free of intermittent and contaminating noise, as required in ANSI S12.100.

It is further recommended that if the applicant conducts discretionary background surveys, that L90 background measurements taken in different locations over a large project area are not to be “averaged” into a “site-wide” L90 but considered on a location by location basis. Wind and solar facility micro-siting methods are equipped to respond to local conditions (sound level, topography, setbacks, and other design considerations) and adjust equipment locations to prevent unwanted sound. Data acquired at measurement locations judged as “representative” of other locations shall be free of intermittent and contaminating noise as required in ANSI S12.100.

Recommendations, Section §900-15.1(a)

The following references should be added:

() Criteria for Evaluating Room Noise, publication date 2019 (ANSI/ASA S12.2-2019).

Attachment G: Professional Ethics

As a neutral party, my background is in power generation noise control, community noise impact assessment, designing to meet regulations and protect health and welfare. I worked for Stone & Webster for ten years in the Noise and Vibration Group and have designed or reviewed noise controls for most utility-scale power technologies and a number of commercial technologies. If someone levels the charge "anti-wind", they also don't know that by the same logic they'd have to apply labels such as "anti-coal", "anti-oil", "anti-nuclear", "anti-transformer", "anti-backup-generator", and perhaps "anti-restaurant" and "anti-concert-hall".

In my firm's independent professional capacity, there is no particular "bias" or interest in the brand of noise-producing equipment being investigated. Rand Acoustics provides consultation for the best possible facility design ensuring that regulations are met, public safety, health and welfare is protected and complaints are prevented with an adequate margin of safety. The same requirements should be applied to any acoustician who conducts studies or makes recommendations for future wind and solar energy projects.

Recommendations and professional cautions are carefully developed from years of power generation experience and professional investigations. Services and opinions have proved useful for utilities, commercial clients, the military, regulators and communities alike.

Due to materials and design challenges, at this time sufficient distance is the only reliable noise control option for large three-bladed wind turbines.

Attachment H: Qualifications

Mr. Rand is owner of Rand Acoustics, LLC, a Member Emeritus of the Institute of Noise Control Engineers (INCE) and a Member of the Acoustical Society of America (ASA) with over forty years of experience providing environmental and technical consulting services to power generation, military, medical, commercial, industrial, and community projects.

Mr. Rand's experience in general acoustics includes industrial noise control, environmental impact assessment, interior acoustics, and electroacoustics, with ten years in the Noise Control Group at Stone & Webster Engineering Corporation, and five years of consulting projects for DARPA and the U.S. Army. He has conducted environmental acoustic analyses, project engineering and budget management, permitting reviews, acoustic testing, noise control design and costing, and operations monitoring activities for power generation and commercial projects. Rand Acoustics was founded in 1996 as an independent consulting firm.

Mr. Rand's wind turbine experience spans the last eleven years from 2009 to present day 2020 with investigations and testing of acoustic and infrasonic pressure pulsations, community noise impact assessment, and expert testimony for industrial wind turbines at multiple facilities. Significant testing reported in the literature includes independent peer-reviewed investigations in Falmouth, Massachusetts in April 2011, and the Cooperative Measurement Study in Shirley, Wisconsin in December 2012.

Mr. Rand is qualified on the relationship of wind turbine acoustical emissions to health effects having unexpectedly experienced severe adverse health impacts during investigations in Falmouth, Massachusetts in April 2011, including nausea, dizziness hyperacusis and monocular vision with weeks for recovery. Unusual acoustic characteristics identified during the Falmouth survey included recurring barometric pressure oscillations occurring at the blade pass frequency of the nearby turbine, which were stronger inside the home under investigation. Impacts were mitigated with distance. Barometric oscillations at blade pass rate were confirmed at Shirley in 2012. Susceptible to motion sickness, Mr. Rand experienced adverse health impacts during investigations at four other industrial wind turbine facilities: Hardscrabble Wind Facility, NY, 2012; Vader Piet Wind Facility, Aruba, 2012; Shirley Wind Facility, Shirley, WI, 2012, and the Golden West Facility, Calhan, CO, 2016.

A copy of his biography with papers published and cases where he has been accepted as an expert witness in the field of acoustics, is available separately.