

Saddleback Ridge Wind, LLC // Natural Resource Protection Act (NRPA) and Site Location of Development Act applications

- *Exhibit 4: Post-Hearing Comments by Petitioners and Friends of Maine's Mountains (re: BEP Chapter 375 rulemaking)*

- FMM Exhibit 4

STATE OF MAINE
BOARD OF ENVIRONMENTAL PROTECTION

In Re:

PROPOSAL TO AMEND DEPARTMENT OF)	POST-HEARING COMMENTS
ENVIRONMENTAL PROTECTION RULE 375.10)	BY PETITIONERS AND
ON CITIZEN PETITION PURSUANT TO)	FRIENDS OF MAINE'S
5 M.R.S.A. §8055.3)	MOUNTAINS

Petitioners and Friends of Maine's Mountains ("FMM") request the Board of Environmental Protection (the "Board") to adopt the Proposed Rule as revised through July 18, 2011, attached hereto as *Exhibit A*, for the following reasons:

I. Proposed Sound Level Limits.

Petitioners and FMM propose that the Board adopt the following Sound Limits for wind turbine noise:

(3) *Sound Limitations:*

Sound from Wind Turbine Projects during routine operations during the nighttime, as measured at protected locations in an area where the nighttime pre-development ambient hourly sound level at a protected location is equal to or less than 35 dBA shall not exceed 35 dBA and 55 dBC (Leq) at the protected location.

[Alternative: Sound from Wind Turbine Projects during routine operations during the nighttime, as measured at protected locations in an area where the nighttime pre-development ambient hourly sound level at a protected location is equal to or less than 35 dBA shall not exceed 10 dB above the A-weighted pre-operation nighttime background LA90.] Sound from wind turbine projects as described above shall not produce noise that exceeds the pre-operational background (residual) LCEq by more than 20 dB.[new]

The testimony at the hearing supports either version of this health based sound limit. The testimony of Richard James confirmed that the two alternatives will result in approximately the same limits as a practical matter and that these limits are reasonable and practical. He also testified that the 55 dBC levels are at this time roughly equivalent to 35 dBA but the dBC limit would protect against low frequency noise in the future from larger turbines than currently used

in Maine. The 10 dB over background is a standard used in many jurisdictions, including Oregon, New York, Massachusetts, New Zealand and others as referenced in Petitioners' original Statement of Position. France applies a limit of background (30 minute L99) plus 3 dB for wind turbine noise limits at night. A 35 dBA limit is used in Sweden, Germany, South Australia, U.K., and New Zealand. Moller and Pedersen, two highly respected independent acousticians from Aalborg University in Denmark, in their peer reviewed article, *Low Frequency Noise From Large Wind Farms*, 129 J. Acoust. Soc. Am. 3727 (2010) at 3734 comment that a "limit of 35 dB is used for wind turbines, e.g., in Sweden for quiet areas. Thus 35 dB seems as a very reasonable limit for wind turbine noise." They also report that low frequency sound is becoming more of a problem as turbines increase in size.

The proposed sound limits in the revised proposed rule amendment is also supported by the testimony of Robert Rand who demonstrated, based on a United States Environmental Protection Agency matrix, that strong appeals to stop noise and threats of legal action should be expected for wind turbine noise of 45 dBA, which has happened at Mars Hill, Vinalhaven and Freedom. He recommended maximum sound levels at night in a quiet area at 33 dBA to avoid widespread complaints. The EPA matrix is now an ANSI Standard (S12.9 Pt 4) for assessing land use compatibility with a new noise source. See *Exhibit B*, attached hereto. Both the early 1973 EPA method and current ANSI method support rural nighttime noise limits of 35 dBA or lower for rural communities with no prior noise experience to the new noise source.

Michael Nissenbaum recommended 35 dBA at the façade of a residence or the property line, whichever is more protective in his testimony. He based his testimony on a structured epidemiological study of health effects from residents living near the Mars Hill and Vinalhaven wind projects and basic medical principles that annoyance is itself an adverse health effect and is

one of the root causes of sleep disturbance and secondary adverse health effects. His studies revealed that those living within 1.4 km of turbines had significantly worse sleep than the control group living much further away and those living within 375 to 1400 meters had a significant increase in psychotropic medications compared to those living 3.3 km to 6 km from the wind project. The Board requested a copy of the questionnaires he used in his studies and they have been submitted today.

The wind industry was critical of the absence of sound levels in his study. Because several complete studies of sound levels had previously been conducted for Mars Hill it is possible to provide this information to the Board. These calculations were made by Richard James and are attached hereto in graphic form as *Exhibit C*. They show that sound levels for homes within a 1500 foot radius of the closest wind turbine is 45 dBA or higher when turbines are at 50% full power or higher. For homes 1500 to 2500 feet from the turbines this range is 40 to 45 dBA. Homes at this distance would meet the current nighttime limit of 45 dBA set by Chapter 375 for sensitive properties. Yet, Dr. Nissenbaum's study shows that people at this distance show adverse health impacts. Although it may be claimed that Mars Hill (and Vinalhaven) represent failed projects that do not represent how projects are now designed the Nissenbaum study shows that for people living with sound levels that would comply there are adverse health effects. This region of concern for public health extends beyond 2500 feet out to 5900 feet, the end of the data collected by RSE in its 2007 study. People living at these distances (1/2 to about 1 mile) reported adverse health effects yet the wind turbine sound levels were mainly between 35 and 40 dBA. The Table below presents the data from the 2007 RSE sound study and Exhibit ----- provides a graph showing the level versus distance relationships.

Mars Hill Wind Turbine Sound Levels at Selected Distances

Measurement Point	Distance (ft) to nearest Turbine	Lower Levels (1Hr. LAeq)	Modeled Levels	Higher Levels (1Hr. LAeq)
1	800	47	51	51
8	1200	46	47.5	50
6	2050	39	43	45
6A	2100	38	42	44
7	2500	39	40	44
4A	3250	34	37	37
3	3400	33	36	37
5	3400	39	39	40
2	5900	30	35	36

Modeled at 95% full power

Data taken from RSE Report to MDEP, June 21, 2007

"Ambient and Operations Sound Level Monitoring" esp. pages 40 to 42 and Table 7-1.

"Lower Levels" means the lowest reported measurement when turbines were operating at 50% capacity or higher. "Higher Levels" meant the highest reported measurement when turbines were operating at 50% capacity or higher. "Modeled Levels" means the predicted sound level with turbines at 95% full power.

The wind industry also questioned whether there was "recall bias" in the study results. However, this was addressed in the questionnaires Dr. Nissenbaum using Pittsburgh Sleep Quality Index and the Epworth Sleepiness Scale. Further discussion of the literature on the health effects of excess noise is found at the Statement of Position of Petitioners and FMM.

The Board heard from the wind industry's health witness, Robert McCunney, MD in opposition to the proposed rule change. Dr. McCunney questioned the use of the World Health Organization's definition of health cited by many others in support of the proposition that annoyance is itself an adverse health effect because he "couldn't find" it. This concession is remarkable for someone who held himself out as an expert on publications on health issues. The

definition and its source were quoted in Petitioners' Statement of Position at 27 as follows:

The 1948 WHO definition of health is a "state of complete physical, mental and social well-being and not merely the absence of disease or infirmity." Preamble of the Constitution of the World Health Organization as adopted by the International Health Conference, 19-22 June 1948, WHO New York (1948).

A copy of the document that Dr. McCunney could not find – the Preamble to the 1948 WHO Constitution containing this definition -- is attached hereto as *Exhibit D.*

Dr. McCunney verified at the hearing what he had earlier testified in Vermont proceedings on the health implications of wind turbine. In the Vermont proceedings, see *Exhibit E*, Dr. McCunney acknowledged that annoyance from wind turbine noise "may cause recognized medical disorders such as sleep deprivation" and that "health impacts associated with sleep disturbance may be experienced at noise levels below 45 dBA." *Id.* at 42. At the Board hearings he testified that he agreed with Dr. Nissenbaum that "there is no question" that annoyance leads to stress which over time leads to sleep disturbances that can have adverse health effects. He said again, "there is no question that annoyance leads to sleep disturbance", that "sleep disturbance starts at 40 dB." Dr. McCunney also did not question his Vermont testimony that if it were his home, he would want "the noise level [to] be kept below 35 decibels, maybe 40." *Id.* at 103. Consistent with this testimony at the Board hearing he did not claim the absence of adverse health effects for noise in excess of 40 dBA; he limited his comments about health effects for levels below 40dBA.

Dr. McCunney, along with other industry witnesses, argued that the Board should be content with the existing 45 dBA sound levels in the Noise Rule because these limits are more conservative (by about 3 decibels) than the 40 dB guideline limits of the 2009 WHO *Night Noise Guidelines for Europe* because the WHO Guidelines limits of 40 dB are measured at the façade

of a residence and use yearlong averages, whereas the current 45 dB limit in the Noise Rule is measured at a "protected location" (500 feet from the residence or at the property line if less than 500 feet) as an hourly average. This argument is specious for several reasons. First, the *WHO Guidelines* explain "[c]loser examination of the precise impact will be necessary in the range between 30 dB and 55 dB as much will depend on the detailed circumstances of each case." *Id.* at XVI (Executive Summary). The "circumstances" under review in the Board hearing is wind turbine noise that is not addressed at all by the *WHO Guidelines*. Dr. McCunney acknowledged in his testimony what the literature clearly demonstrates: wind turbine noise is more annoying and thus has a greater potential for adverse health effects than the type of industrial/transportation noises that the *WHO Guidelines* addresses. In addition, the *WHO Guidelines* do not address amplitude modulation, the unique characteristic of wind turbine noise that Dr. McCunney recognized at the hearing as the "aspect of wind turbine noise that people find annoying." Perhaps most importantly, the *WHO Guidelines* explain that its use of year long average was imposed on the *Guidelines* from EU directives, whereas from a scientific point of view, sleep disturbance is best measured by instantaneous measurements, not long term averages. *Id.* at X (Executive Summary). This is why Petitioners urge the Board to look at the science behind the *WHO Guidelines*, not the politics of enforcement.

Dr. McCunney devoted most of his testimony to the need to rely on peer reviewed literature, mentioning time and again the peer reviewed articles of the Swedish wind turbine noise expert, Dr. Eja Pedersen. He overlooks the fact that it was Petitioners who posted all the relevant articles of Dr. Pedersen and liberally quoted from these articles in their Statement of Position. Dr. McCunney cherry picked quotes from Dr. Pedersen, not mentioning her deep concern about wind turbine noise or her call for action by regulators to lower noise level limits to

avoid annoyance and secondary health effects. We urge the Board to review these studies in their entirety. Dr. McCunney also placed great weight on the article by Lee, et al, *Annoyance Caused by Amplitude Modulation of Wind Turbine Noise*, also placed in the record by Petitioners. This article reports on listening tests, concluding that "amplitude modulation of wind turbine noise has a statistically significant effect on noise annoyance." *Id.* at 45. Dr. McCunney agrees with this conclusion and so do we.

In addition to Dr. McCunney, the wind industry presented testimony and arguments challenging the need for low frequency limits as set forth in the proposed, revised rule change for sound limits and explained in the Statement of Position of Petitioners and FMM at 6-8 and 19. Robert O'Neal, a wind industry witness, testified at the Board hearing that low frequency sound levels must exceed 100 dB before it is considered a problem, which does not occur in wind turbines. However, Mr. O'Neal applies standards that are not suitable for the dynamically modulated infra and low frequency sounds observed inside homes located near operating wind turbines. His assertion is based on studies using steady pure tones. Wind turbine infra and low frequency sound is a complex mix of dynamically modulated tones and tone fragments. The human auditory system is more sensitive to these complex sounds than to steady pure tones. As discussed by Dr. Malcolm Swinbanks, in his article, *The Audibility of Low Frequency Wind Turbine Noise, Exhibit F*, there have been a number of real world situations where inaudible infra and low frequency sounds result in adverse health effects. Dr. Swinbanks also cautions against judging health risks of complex sounds using studies of steady pure tones. Mr. O'Neal's criticisms are based on an incomplete understanding of these risks.

Further, those testifying for the wind industry at the hearing did not offer any evidence to contradict the findings of independent, academic acousticians, Henrik Moller & C. Pederson in

their 2010 peer reviewed article, *supra* at 3742 reporting that “it is beyond doubt that the low frequency part of the spectrum plays an important role in the noise at the neighbors.” Moller and Pedersen explain that as wind turbines increase in size and power production, the sound spectrum of wind turbines noise moves down in frequency. *Id.* Based on their work, these authors conclude that “[p]roblems are much reduced with an outdoor limit of 35 dB,” which is what Petitioners propose. As explained by Richard James in his testimony, this 35 dBA limit is roughly equivalent to the 55 dBC not-to-exceed limit the Petitioner's are proposing to establish a cap on low frequency from future larger wind turbines.

Kenneth Kaliski testified for the wind industry that requiring a 35 dBA sound limit would require setbacks of 3.1 miles. This testimony cannot be credited as the Mars Hill measurements show 35 dBA at just over a mile.

In addition to the experts, the Board heard the heartfelt testimony of residents living near all three of the operating wind turbine facilities built near residents (Mars Hill, Freedom and Vinalhaven), all regarded as “failed projects.” These individuals shared their agony from living near projects that were too loud, some even at levels over 50 dBA. They testified that even at 45 dBA the noise was unbearable.

Finally the Board heard testimony that it should adopt the “precautionary principle” when considering the proper sound limits for wind turbine noise and we agree. The precautionary principle is an approach to risk management that has been developed in circumstances of scientific uncertainty, reflecting the need to take prudent action in the face of potentially serious risk without having to await the completion of further scientific research. See, en.wikipedia.org/wiki/Precautionary_principle The precautionary principle was adopted as Principle #15 of the June 1992 Declaration of the Rio Conference on Environment and

Development and is currently enshrined in the 1999 Canadian Environmental Protection Act (CEPA 1999), which states:

Whereas the Government of Canada is committed to implementing the precautionary principle that, where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

The Board should be guided by this principle and discount the wind industry's attempt to raise doubts about the levels of harm from wind turbine noise at levels below 40 dB.

II. Proposed Changes for Amplitude Modulation.

Petitioners and FMM propose that the Board adopt the following amendments on the treatment of Short Duration Repetitive Sound:

(4) SDRS; Tonality Measurements.

(a) In determining whether a sequence of repetitive sounds constitutes Short Term Duration Repetitive Sounds, the lowest sound level in a sequence will be compared to the highest sound level in the sequence.

(b) If there are more than 2 sequences where peak to valley is 3 dBA or more in an hour, or any one sequence that lasts five minutes or more, a 5 dB penalty shall be applied against the sound level limitations as set forth in subsection 3 above.

(e) If there is substantial uncertainty as to whether SDRS or tonal sounds will occur in the routine operations of the wind turbine project, the Department will apply the 5 dbA penalties as described above, subject to removal if post-construction compliance testing shows the absence of SDRS or tonal sounds.

In the Board hearing there seemed to be consensus that amplitude modulation is a feature of wind turbine noise that distinguishes it and makes it more annoying than other forms of industrial noise. Warren Brown is also on record for recommending that "sound level limits should be conservatively applied by the department given their periodic, low frequency modulating annoyance factor." *Mars Hill Wind-Farm Post-Development Sound Level Study Peer*

Review" (2007) at 9, attached hereto as *Exhibit G*. There was also consensus, or at least lack of dispute, that the current Noise Rule definition of SDRS fails to adequately regulate wind turbine amplitude modulation because it averages measurements over an hour and that the threshold for measurement is too high.

There was one voice of dissent and that came from Scott Bodwell, who argued that his measurements at Stetson II show that SDRS was not a significant issue. He based his findings on the *existing definition* of SDRS, which is not appropriate for amplitude modulation from wind turbine noise. To the extent that Mr. Bodwell argues that a 5 dBA is too large a penalty for an appropriately defined standard for wind turbine amplitude modulation, he does so against the advice of the EPA Levels Document and ANSI S12.9 Part IV which assign a 5 dBA penalty for amplitude modulation.

III. Proposed Changes for Measurements.

Petitioners and FMM propose that the Board adopt the following measurements for wind turbine noise:

(2) *Modeling:*

(a) *The computer model shall be designed to represent the "predictable worst case" noise impact on properties. The "predictable worst case" noise assessment shall represent the maximum rated output of the wind utility operating during nighttime stable atmospheric conditions with high wind shear above the boundary layer and all other conditions that affect the in-flow airstream that can exceed the design limits for normal operation of the turbines. The sound propagation rate shall reflect a point or line source (6 dB vs. 3 dB decay rates), or combination thereof, as is most appropriate for the proposed arrangement of wind turbines.*

(b) *Long-Term Background Sound Measurements:*

(i) *All data recordings shall be a series of contiguous ten (10) minute measurements. The measurement objective is to determine the quietest ten minute period at each location of interest. Nighttime test periods are preferred unless daytime conditions are quieter. The following data shall be recorded simultaneously for each ten (10) minute measurement period: dBA data includes*

LA90, LA10, LAeq and dBC data includes LC90, LC10, and LCeq. Record the maximum wind speed at the microphone during the ten minutes, a single measurement of temperature and humidity at the microphone for each new location or each hour whichever is oftener shall also be recorded. A ten (10) minute measurement contains valid data provided: Both LA10 minus LA90 and LC10 minus LC90 are not greater than 10dB and the maximum wind speed at the microphone is less than 2 m/s during the same ten (10) minute period as the acoustic data.

(ii) *Site selection, weather/wind conditions during tests, instrumentation use, calibration, etc. shall comply with ANSI S12.9 Part 3 "Short Term Measurements with and Observer Present;" S12.9 Part 1 "Quantities and Procedures for Description and Measurement of Environmental sound." Long Term Background sound is defined here-in as residual sound (5.1.14; and S12.18 Procedures for Outdoor Measurement of Sound Pressure Level" Method 1 to the extent practicable. If Long term un-observed monitoring is substituted for Short term observed measurements the protocol shall comply with one of the three sampling protocols and account for spatial and temporal uncertainty in the manner required by S12.9 Part 2, Measurement of long term wide area sound.*

(c) *Coherence and turbine wake:*

Predictive modeling shall include the effect of combining sounds of multiple turbines with similar spectral and temporal content and turbulence caused by the wake of other nearby turbines.

(d) *Atmospheric stability:*

Modeling shall include predictive sound levels at night under conditions of atmospheric stability.

(e) *Uncertainty factors:*

Sound level estimates for predictive monitoring shall add a (i) a 2 dBA uncertainty factor to the manufacture's rated operating sound level at full turbine power (IEC 61400-11) and (ii) a 3 dBA uncertainty factor for sound propagation predictions using ISO 9613-2. The modeling shall also exclude attenuation factors except for atmospheric absorption. Ground absorption shall be 0 and there should be no attenuation due to ground cover or vegetation.

There seemed to be consensus that the Board should adopt into the Noise Rule the "uncertainty factors" currently being applied informally as set forth in Section 2(e) of the proposed rule amendment, with one exception. That exception came from the testimony of Kenneth Kaliski, who argued that if the uncertainty factors requires that ground absorption is

equal to 0 and if coherence must be accounted for (adding 3 dBA according to Kaliski) the proposed rule change would add 6 dB to sound predications and this would result in over-predictions of noise. We disagree.

ANSI S12.18 (Annex A.3.2) addresses ground absorption by noting that when the grazing angle between the noise source (top of a ridge) and the receiver (valley below) exceeds 20 degrees the "... soft ground becomes a good reflector of sound and can be considered *hard ground*." Further, most ridge mounted turbines are on ridges with either hard rock exposed below them or a thin layer of vegetation. During cold weather seasons the ground freeze and this is also considered to be *hard ground*. Conservative modeling should set the ground absorption to hard ground to represent these understandings. This adjustment is separate from the need to add 3 dBA for modeling uncertainties. Ground absorption is a different issue than uncertainty in algorithms.

Petitioners ask that the effects of coherence be considered in modeling in addition to the uncertainty factors because coherence is a real aspect of wind turbine sound propagation. It is being studied by several independent acousticians. For example, recent reports from New Zealand by Dr. Robert Thorne of Noise Measurement Inc. and others show that coherence can be a significant contributor for some arrangements of wind turbines in that country. A paper on the need to consider coherence was presented at the 2011 Wind Turbine Conference in Rome, Italy by Bruce Walker of Channel Islands Acoustics (Camarillo, CA) titled: *Coherence Issues in Wind Turbine Assessment*, attached as *Exhibit H* hereto. This paper shows that coherence effects in wind turbine sound propagation have been known for over 25 years. Yet, models used for permitting still do not account for this effect. Mr. Kaliski's assertion that this is an unnecessary "penalty" on the wind developer is wrong. It is a real aspect of wind turbine noise that increases

potential for annoyance and sleep disturbance.

The wind industry presented the testimony of Scott Bodwell to argue that measurement specifications in the existing Noise Rule are adequate because he was able to demonstrate in Stetson II that the actual noise was slightly less than that predicted. The Petitioner's do not disagree with Mr. Bodwell's findings as they pertain to Stetson II. However, the tests conducted by Mr. Bodwell and reported to LURC only represent a simple validation of the model for that specific set of turbines and topography. We are pleased to see that the model reflects the conditions to a reasonable level of accuracy. But, a single test for a specific set of turbines, with a single arrangement, on a single topography does not support a claim that the "model is validated" for all turbines, arrangements, and topographies. Thus, we support Mr. Bodwell's work and hope that it represents a continuing trend in improving accuracy and applicability of wind turbine models. But, it does not represent "validation" in any independent, comprehensive manner.

The long terms measurement standards set forth in Section 2(b) of the proposed rule amendments are necessary only if the Board adopts the 10 dB over background as the sound level limit. No objection to this proposed change was voice in the hearing. Nor was there objection to the proposed modeling for wake induced turbulence or atmospheric stability other than the general objections based on the Stetson project.

IV. Proposed Changes for Compliance.

Petitioners and FMM propose that the Board adopt changes for compliance protocols based on protocols developed by the Department for use at the Vinalhaven wind project where there was significant resistance by the licensee to resolve compliance issues. No objections were raised to these revised proposals at the hearing.

V. Proposed Changes for Noise Easements.

Petitioners and FMM proposed the following rule changed for noise easements:

(5) *Noise Easements:*

Noise Easements will be given effect under Section 10.C.5(s) only if the applicant submits to the Department a written statement of the disclosures given to the resident or owner executing the noise easement which adequately discloses the public health risks associated with the noise expected to be propagated in relation to the property that is the subject of the easements.

No objections were raised to this proposed change.

VI. Other Points Raised at the Board Hearing.

Charles Wallace of RSE raised the possibility of having "real time" monitoring of noise with wind turbines automatically reducing in power (and sound levels) when noise limits are reached. There is no evidence that such technology exists or, if it exists, that it available at a reasonable cost. The experience of the Department with the Vinalhaven project indicates that no such equipment is available on the market today.

One Board member raised the question of having a "stakeholder" process between Petitioners and the wind industry with the goal of reaching agreement on noise limits. As attractive as the suggestion might sound, the reality is that it is unworkable. Most importantly, projects are currently under review and others will shortly be added to this list that has the potential to adversely affect many residents of Maine. Changes are urgently needed. A "stakeholder" process could easily delay resolution for a year or more. Further, the composition of the current Board may be substantially change after September 16, 2011 as a result of recent legislative changes to the Board's statute. If there were a stakeholder process, the matter would come back to a different Board than sat in the hearings, wasting the tremendous effort put into the hearing. From the standpoint of the Petitioners and FMM, it is important that the Board take

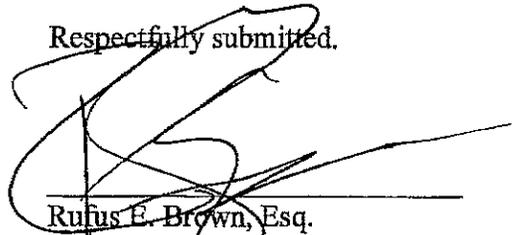
action on the proposed rule changes before the September 16, 2011 deadline, not only because of the continuity of the Board membership through that date, but also because changes are sorely needed without further delay. The stakeholder process also would be unfair to the Petitioners and FMM because we do not have the resources of the wind industry to bring to the process.

CONCLUSION

For the reasons set forth above and the hearing testimony and the Statement of Position of Petitioners and FMM previously filed with the Board, we urge the Board to approve the proposed rule amendments as revised through July 18, 2011 attached hereto as *Exhibit A*.

Dated: July 18, 2011

Respectfully submitted,



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