

**House Committee on Natural Resources and Energy**  
Vermont Testimony – 14 April 2016

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My name is Stephen Ambrose. I am a Board Certified member of the Institute of Noise Control Engineering, and full-member of the Acoustical Society of America. Coauthored with Robert Rand, "The Bruce McPherson Infrasound and Low Frequency Noise Study", professional papers and articles about wind turbine noise and adverse health impacts.

I am an independent consultant near Portland, Maine, providing 40 years' experience in acoustics, environmental sound, and industrial noise control. My approach is that of an acoustic investigator; determine why, and then provide a solution. All public and private projects must be good acoustic neighbors. A noise control engineer's ability is proven when there are no noise complaints. Meeting the requirements of defective noise regulations do not provide public protections. This may be the reason why I have been asked to present. Thank you.

Everything has a beginning, or the unexpected awakening moment. The Bruce Study was about two-acousticians going to a home in Falmouth MA to measure sound from wind turbines. It turned out to be more than we anticipated. An experience that proved to us why there are so many neighbors complaining about excessive noise and adverse health impacts. Wind turbines sound awful in quiet environments; constantly fluctuating, unnatural character, thumps or roar.

With all of our industrial noise experience, we were surprised that after 30-minutes being inside the home we felt miserable with headache, nausea, loss of cognitive ability, and later sleep interference/interruption to name a few. Leaving the home and area diminished symptoms, which quickly resumed upon our return to the home. It took several months for us unravel our experiences and sound data to understand what happened. Little was learned when we first graphed wind turbine noise levels, power output, and wind speed versus time in hours; 3 days and 2 nights. However, weeks later we correlated personal experiences the graph, and found that when the wind turbine power output was above half-power, our headaches, nausea, cognitive ability, and sleep difficulties were at their worst.

Vermont has too many wind turbine noise complaints, which are directly related to the 45 dBA nighttime noise limit. This is contrary to the USEPA findings; 45 dBA was the recommendation for urban area noise assessments.

Vermont is not urban; it is 99.9% rural with nighttime noise levels 20 to 30 dB quieter than 45 dBA. A 10 dB increase causes wide spread complaints, 15 dB threats of legal action, and 20 dB appeals to stop the noise. The latter is why we are here.

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The 45 dBA hourly-averaged nighttime limit has proven to be too loud by the evidenced submitted by too many neighbors. Too many complaints about excessive noise, too many adverse public health impacts, too many ruined lives, and too many home abandonments.

- Regulatory boards are defeated in their ability to protect public health and wellbeing when they accept recommendations from wind turbine promoters and consultants [1].
- Regulatory agencies should understand that the wind industry has crafted a unique set of test procedures and protocols with the pretext for being prepared, reviewed and accepted by unbiased international committees [2,3].
- Sound level measurements are meaningless when contaminated by wind; air turbulence induced distortions [4].
- Yet, the wind industry has justified wind contamination, made this an acceptable method to increase background noise levels, in order to minimize the noise level increase caused by wind turbines.
- This practice is contrary to all other sound level measurement and assessment practices.
- Without this sleight of hand deception, regulators would recognize that wind turbines increase noise levels by more than 20 dB; resulting in “public appeals to stop the noise”.

Has Vermont experienced “Regulatory Capture”, a term that may describe why Regulators are no longer able to protect public health and wellbeing. Another example is the Health Canada Study (HCS); where there is a push to increase the 40 dBA noise limit to 46 dBA, in order to permit more wind turbines closer to neighbors. Fortunately, a recognized and respected acoustic expert, Dr. Paul Schomer has commented on Health Canada Study for the Acoustical Society of America; “Introductory remarks for special issue on wind turbine noise;

“A rather strong finding to emerge from this study is that there appears to be a sharp break point at 35 dB where the odds of reporting high annoyance with WTN increase by a factor of 10, and continue to increase further at the highest WTN level category assessed”. This means 35 dB for wind turbines has 10 times greater responses.

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<sup>1</sup> Winning Community Acceptance: Dispelling Myths and Promoting the Realities about Wind Power – Noise Impacts, AWEA Regional Wind Energy Summit – New England, Kenneth Kaliski, P.E., INCE Bd. Cert., Senior Director, RSG, Inc., September 5, 2012

<sup>2</sup> The Assessment and Rating of Noise from Wind Farms, The Working Group on Noise from Wind Turbines Final Report, ETSU-R-97, September 1996

<sup>3</sup> Wind turbines – IEC 61400: Part 11: Acoustic noise measurement techniques, International Electrotechnical Commission

<sup>4</sup> Wind-induced pseudo-noise and leaf-rattle noise, Paul Schomer, Geoffrey Beck; Schomer and Associates, Inc. Champaign, IL 61821, Inter Noise 2009, Ottawa, Canada

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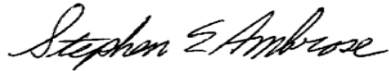
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Dr. Schomer reinforces the 2010 recommendation of 35 dBA independently proposed by Rand/Ambrose based on USEPA studies and the 2004 Pedersen/Waye research identifying 33 dBA for the onset for wind turbine noise complaints. Their findings support the earlier 2008 Kamperman/James findings.

Vermont should abandon the nighttime 45 dBA hourly-average, which has produced an urban nightmare for quiet areas. Vermont should consider a nighttime hourly-average of 35 dBA to protect public health and wellbeing.

Thank you. I look forward to questions.

Respectfully,



Stephen E. Ambrose, ASA, INCE, *Board Certified*  
Principal Consultant

Stephen E. Ambrose, ASA, INCE, Bd.Cert.  
Acoustics, Environmental Sound and Industrial Noise  
SE Ambrose & Associates      Tel/Fax: 207.892.6691  
15 Great Falls Road              Mobile: 207.653.9099  
Windham, ME 04062      Email: seaa@myfairpoint.net

**Wind Speed Not Needed**

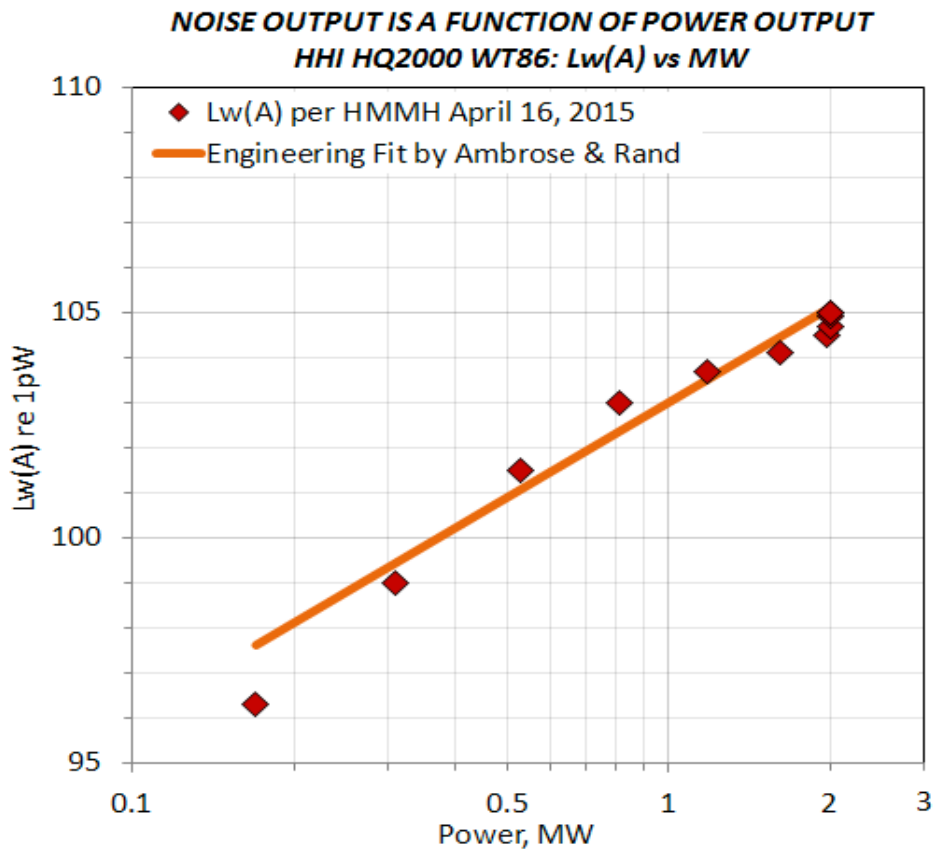
Wind turbine electric power output is sound power level, therefore wind speed not needed.

Sound power level (log y-axis), Electric power output (log x-axis), “line of best fit” good agreement.

Sound power level is determined from electric power output.

**data point  $\diamond$  versus equation**

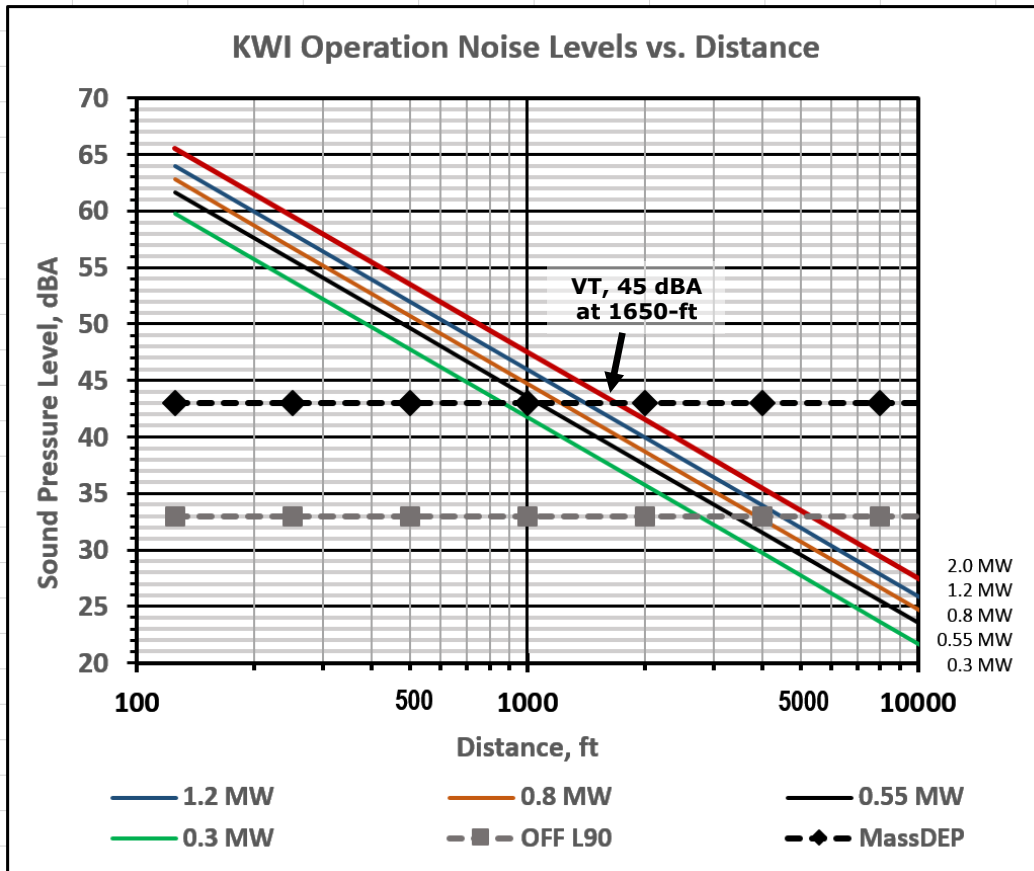
0.3 MW = 99 dBA	99.3 dBA
0.5 MW = 101 dBA	100.9 dBA
0.8 MW = 103 dBA	102.3 dBA
2.0 MW = 105 dBA	105.1 dBA



Good Engineering Fit:  $L_w(A) = 7\log(MW) + 103$ , dB(A) re 1pW  
Accuracy:  $\pm 0.6$  dB, 300 to 2000 KW

Compliance Distance Predictable

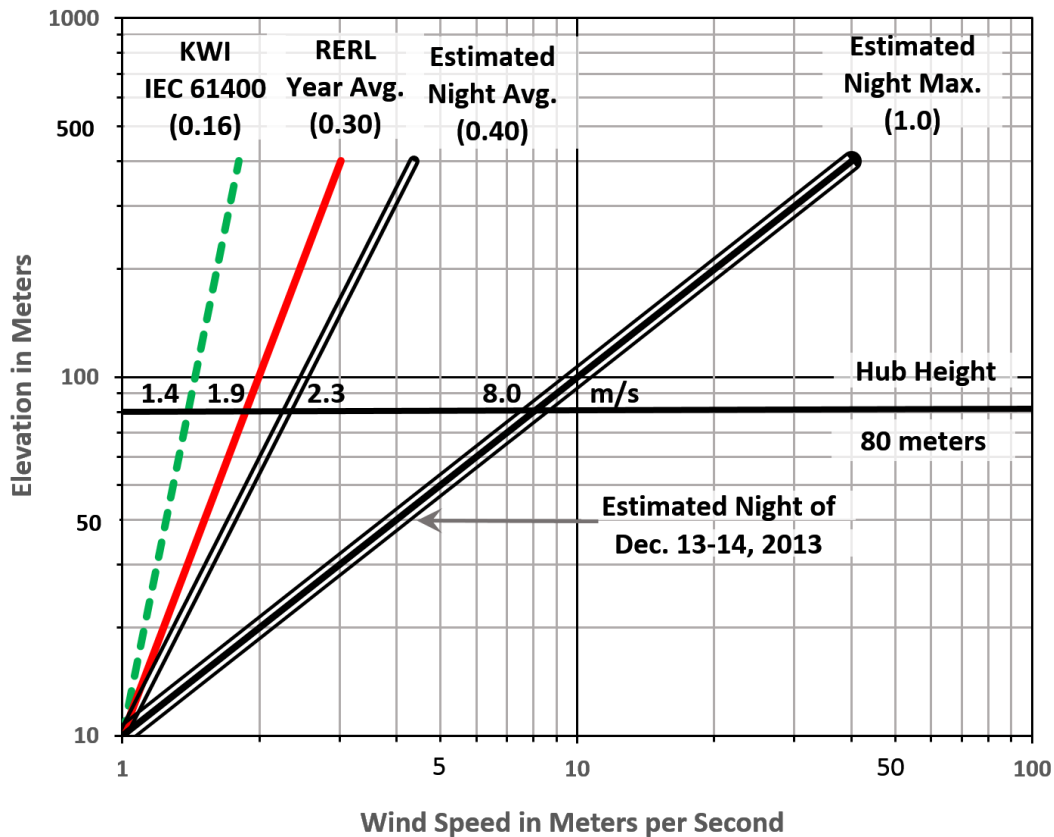
- This graph predicts operational noise levels for electric power output from 2.0 to 0.3 MW versus distance. Ref. KWI; Kingston (MA) Wind Independence, 2.0 MW wind turbine.
- The graph shows distances for compliance with the Mass DEP 10 dB noise increase.



**Wind Shear, Turbine Hub-height vs 10 Meter Anemometer**

- Wind shear values are power functions that plot as straight lines on log-scales.
- Wind shear represents wind speed increasing with higher elevation.
- Wind shear varies considerably due to differences in daytime and nighttime atmospheric conditions above ground surface roughness.
- Wind turbine test-stand sites are positioned on flat plains far away from mountains, hills, buildings and trees.
- IEC 61400 shows test-stand site wind speed rises slowly with elevation as shown by the dashed line.
- IEC 61400 under-predicts wind shear by 2, 4 or even more times.

**Kingston Wind Shear Comparison**

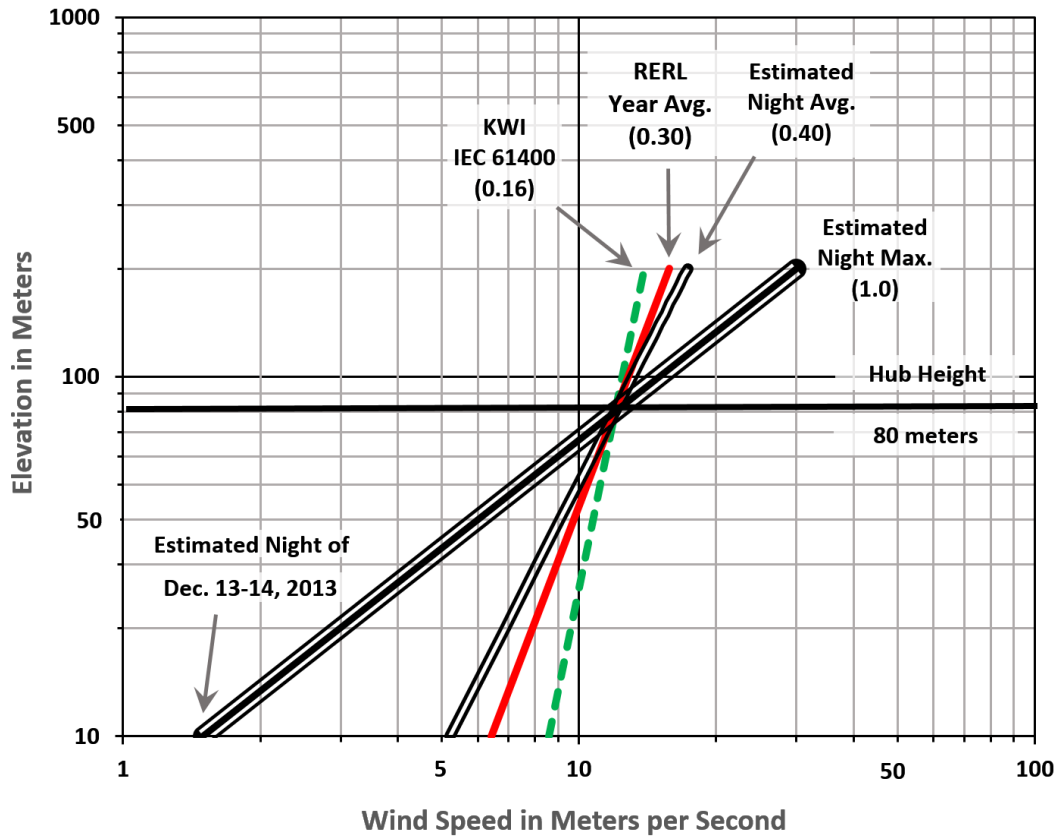


**Wind Shear at Hub Height**

- Wind shear shows the differences for ground level wind speed at hub-height.
- Ground level wind speed decreases from 6.0 to 0.2 meters per second (calm).
- High wind shear produces full electric power and maximum sound power level at low ground level wind speed.
- This indicates that the baseline nighttime ambient L90 is less than 30 dBA when shut down.
- Four wind shear values were evaluated for wind speed at 80, 10 & 1-meter elevations.

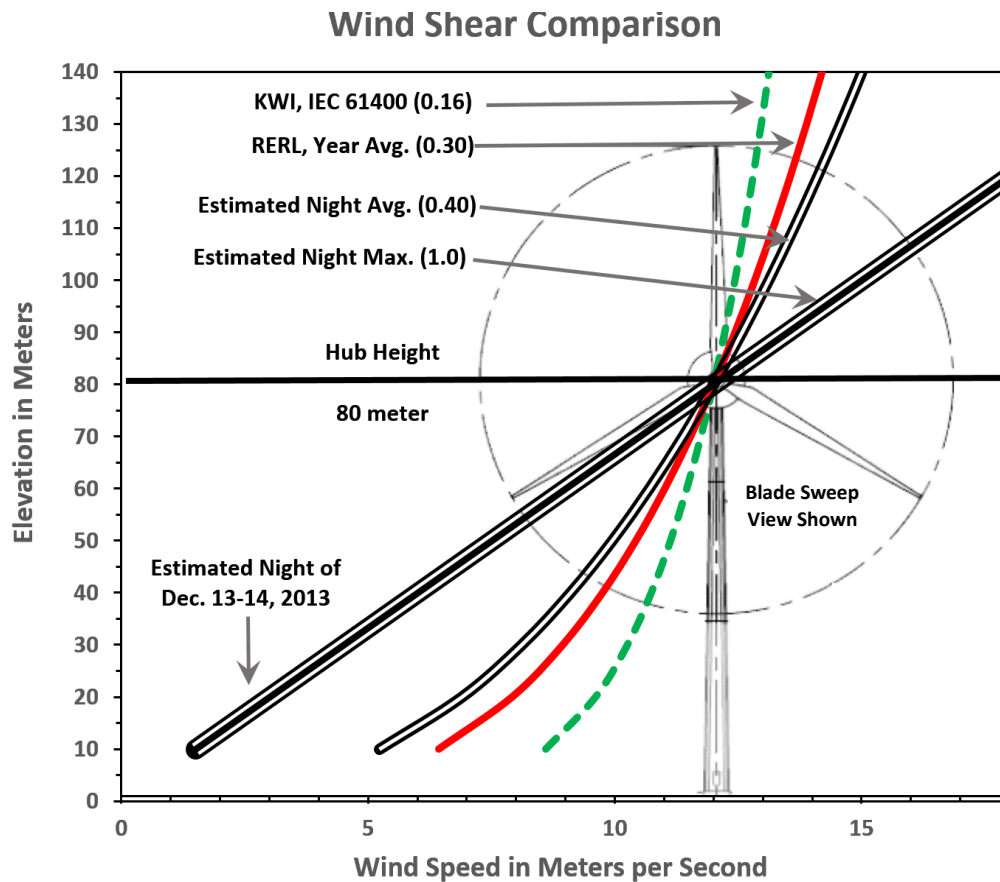
Wind Shear	0.16	0.30	0.40	1.0
80-m Hub-Height	12.0	12.0	12.0	12.0
10-m Wind Speed	8.6	6.4	5.2	1.5
1-m Wind Speed	6.0	3.2	2.1	0.2

**12 m/s Hub-Height Wind Shear Comparison**



### Wind Shear Hub-Height Comparison

- Linear scales can be used to overlay a wind turbine image with wind shear data.
- Wind shear values normalized to a hub-height wind speed of 12 meters per second (m/s).
- 1.0 wind shear follows a linear-scale straight-line.
- IEC 61400 (0.16) wind shear values that are too low as shown by the dashed line.
- Graph reveals significant wind speed variation from bottom to top of blade rotation.
- Ground level and 10-meter height wind speeds do not correlate to hub-height without knowing the true wind shear value
- Cannot accurately predict wind turbine noise from wind speed alone.
- Sound measurements and electric power output are more accurate & reliable indicators than noise models with faulty wind shear values [5].



<sup>5</sup> Wind shear values that are too low can under-predict turbine noise levels by 3, 5, 8 or more dB