November 22, 2013

A Brief Review Of The Hoosac Wind Turbine Noise Studies

Stephen E. Ambrose
Principal Consultant, INCE Board Certified

&

Robert W. Rand
Principal Consultant, INCE

Acoustics, Environmental Sound & Industrial Noise Control
Themes considered for this presentation:
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1. Another study to mislead neighbors
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2. History of Hoosac wind turbine studies
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4. Evidence that demands a verdict
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1. Another study to mislead neighbors,
2. History of Hoosac wind turbine studies,
3. Blind eyes and deaf ears,
4. Evidence that demands a verdict,

Winner: “Back to the Future II”

Acknowledgements: Steven Spielberg, Robert Zemeckis, Michael J Fox, Christopher Lloyd
This is a true story, depicted by Marty and Doc.
Their mission: identify the ignored warnings in the Hoosac wind turbine studies
Only then can Marty and Doc correct significant *warnings* in history.
That opened rifts into an alternate universe, where noisy wind turbines were permitted to invade homes.
The wayback clock is set

OCT 06 2003 0800
First study

SPECIAL PERMIT APPLICATION
FOR
enXco INCORPORATED
HOOSAC WIND PROJECT
FLORIDA / MONROE, MASS.

Compiled By:
Hill Engineers, Architects, Planners, Inc.
50 Depot Street
Dalton, MA 01226

October 6, 2003
SRV-755
October 3, 2003

Ms. Marcella Stafford-Gore  
Town Clerk  
Monroe Town Hall  
3 School Street  
Monroe, MA 01350

Subject: Hoosac Wind Project: Application for Special Permit

Todd Presson, Project Manager  
enXco East Coast, Inc.

In accordance with section 2.2c of the zoning bylaws of the Town of Monroe, we believe that the proposed use is not detrimental to the established or future character of the neighborhood and/or district and town. The region would benefit from the local generation of clean, renewable power that reduces our dependence on imported energy; and the town would benefit directly from increased tax and rental revenues without a corresponding increase in demands on town services and infrastructure.

Sincerely,

Todd Presson, Project Manager  
enXco East Coast, Inc.
Doc, this is good news, … Project Manager says this will benefit neighbors …

Wait Marty, … how can this be?

We need to assess the existing noise environment.
Florida and Monroe are rural, so how quiet?

Let’s ask an expert for help.
There are no busy roads or commercial activity. This chart shows a “Quiet Rural Nighttime” at 25 dBA and even less.
Doc, does Massachusetts have noise limits for large wind turbines.

Yes, let’s look at the MassDEP noise policy.
Noise is a public health concern that falls within the scope of Massachusetts Department of Environmental Protection (MassDEP) authority as a form of regulated air pollution (M.G.L. Chapter 111, Sections 142A-M provide statutory authority for MassDEP’s Air Pollution Control Regulations, 310 CMR 7.00).
Noise

Background
Noise is a type of air pollution that results from sounds that cause a nuisance, are or could injure public health, or unreasonably interfere with the comfortable enjoyment of life, property, or the conduct of business. Types of sounds that may cause noise include:

- “Loud” continuous sounds from industrial or commercial activity, demolition, or highly amplified music;
- Sounds in narrow frequency ranges such as “squealing” fans or other rotary equipment; and
- Intermittent or “impact” sounds such as those from pile drivers, jackhammers, slamming truck tailgates, public address systems, etc.

Policy
A noise source will be considered to be violating the Department’s noise regulation (310 CMR 7.10) if the source:

1. Increases the broadband sound level by more than 10 dB(A) above ambient, or
2. Produce a “pure tone” condition – when any octave band center frequency sound pressure level exceeds the two adjacent center frequency sound pressure levels by 3 decibels or more.

These criteria are measured both at the property line and at the nearest inhabited residence. “Ambient” is defined as the background A-weighted sound level that is exceeded 50% of the time, measured during equipment operating hours. “Ambient” may also be established by other means with consent of the Department.

For more information:
For complaints about specific noise sources, call the Board of Health for the municipality in which the noise source is located.

To learn more about responding to noise, odor and dust complaints or to request state assistance or support, please contact the service center in the nearest DEP regional office.

- Central Region, Worcester: (508) 792-7683
- Northeast Region, Wilmington: (978) 661-7677
- Southeast Region, Lakeville: (508) 946-2714
- Western Region, Springfield: (413) 755-2214

This Policy was originally adopted by the MA Department of Public Health in the early 1970’s. It was reaffirmed by DEP’s Division of Air Quality Control on February 1, 1990, and has remained in effect.
Noise

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Will neighbors complain?

Marty, ISO has a simple table.
## Noise Complaint Response Levels

### International Standards Organization
ISO 1996-1:2003

<table>
<thead>
<tr>
<th>dBA above noise level criterion</th>
<th>Estimated Community Response</th>
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<tr>
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<td>Category</td>
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<tr>
<td>5</td>
<td>Little</td>
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<td>10</td>
<td>Medium</td>
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<td>15</td>
<td>Strong</td>
</tr>
<tr>
<td>20</td>
<td>Very Strong</td>
</tr>
</tbody>
</table>
Doc, this is easy. No noise louder than “sporadic complaints”.

We need to read the report to find the Acoustical Study.
6. Acoustical Study

To estimate noise impacts from sound generated by the 1.5 MW GE Wind turbines, enXco commissioned a study of noise levels at eight homes located near the project. The study evaluated noise levels at various homes located near the project.

Results of the study indicate that the highest average noise level at an occupied residence will be 42.6 dBA. The lowest level of the eight homes in the study was 36.6 dBA. The study was conducted in accordance with the international norm "ISO 9613-2 Acoustics - Attenuation of sound during propagation outdoors." The study assumes a typical wind speed of approximately 18 mph. See Appendix E.
Doc, they wrote this without knowing how quiet the area is…?

Marty, they failed to design to be good acoustic neighbors.

Let’s look at the noise data they used in Appendix E.
Wind speed; 10 m height at 8 m/s
Maximum noise level required for each receptor location … 55 dBA.

### Calculation Results

<table>
<thead>
<tr>
<th>No</th>
<th>Name</th>
<th>East</th>
<th>North</th>
<th>Z  [m]</th>
<th>Demands Noise [dB(A)]</th>
<th>Calculated Noise [dB(A)]</th>
<th>Demands fulfilled?</th>
</tr>
</thead>
<tbody>
<tr>
<td>NR01</td>
<td>NR01</td>
<td>661,629</td>
<td>4,732,645</td>
<td>687</td>
<td>55.0</td>
<td>36.6</td>
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<td>NR02</td>
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<td>Yes</td>
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<tr>
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<td>NR03</td>
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<td>55.0</td>
<td>40.4</td>
<td>Yes</td>
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<tr>
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<td>NR04</td>
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<td>764</td>
<td>55.0</td>
<td>40.5</td>
<td>Yes</td>
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<tr>
<td>NR05</td>
<td>NR05</td>
<td>661,285</td>
<td>4,730,731</td>
<td>748</td>
<td>55.0</td>
<td>42.6</td>
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<tr>
<td>NR06</td>
<td>NR06</td>
<td>661,296</td>
<td>4,729,792</td>
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<tr>
<td>NR07</td>
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<td>662,534</td>
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<td>697</td>
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</table>
The existing ambient noise level is 55 dBA?

Marty, this is a BIG Mistake! “Quiet Rural Nighttime” is less than 30 dBA, … 55 dBA is TOO LOUD.
## Appendix E: Noise Study Data

### Maximum noise level required for each receptor location.

### Predicted wind turbine noise level

### Calculation Results

<table>
<thead>
<tr>
<th>Sound Level</th>
<th>Noise sensitive area</th>
<th>NAD27 Zone: 18</th>
<th>Demands Noise Level [dB(A)]</th>
<th>Calculated Sound Level [dB(A)]</th>
<th>Demands fulfilled?</th>
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</thead>
<tbody>
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Maximum noise level required for each receptor location.

Predicted wind turbine noise level

Complies less than 55 dBA

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This is crazy! 55 dBA makes it look like the turbine noise is quieter than ambient.

GREAT SCOTT!!
You’re right Marty, they failed to apply the MassDEP regulations.
Second study
Findings:

After review under Section 4.1.7 and subject to the conditions set forth below, the Board makes the following findings:

1. Because the Hoosac Wind Project, subject to the special conditions set forth below, is consistent with the protection authorized by Chapter 40A of the General Laws of Massachusetts, will have significant environmental benefits by providing virtually emissions-free energy, will promote the general and economic welfare of Florida’s inhabitants, and will preserve the natural beauty and environmental resources of the Town, the Board determines that the Hoosac Wind Project will be in harmony with the general purpose and intent of the By-Law.

2. The Board finds that, subject to the special conditions set forth below, the Hoosac Wind Project will promote sustainable sources of energy, will be located and constructed to minimize environmental and visual impacts, will preserve local recreational opportunities, and will not be offensive or detrimental to the neighborhood.
Special Permit Conditions:

14. The turbines shall be operated so that sounds generated by the turbines shall not exceed 65 dBA at any property line that is not a part of the Hoosac Wind Project by more than 20 dB.

Lawn Tiller at 50-ft?
Special Permit Conditions:

14. The turbines shall be operated so that sounds generated by the turbines shall not exceed 65 dBA at any property line that is not a part of the Hoosac Wind Project by more than 20 dB.
Special Permit Conditions:

14. The turbines shall be operated so that sounds generated by the turbines shall not exceed 65 dBA at any property line that is not a part of the Hoosac Wind Project by more than 20 dBA at any time, or by more than 10 dBA for more than ten minutes in any hour, or at all for more than thirty minutes in any hour.
Special Permit Conditions:

14. The turbines shall be operated so that sounds generated by the turbines shall not exceed 65 dBA at any property line that is not a part of the Hoosac Wind Project by more than 20 dBA at any time, or by more than 10 dBA for more than ten minutes in any hour, or at all for more than thirty minutes in any hour.
Doc, this Florida Board decision makes no sense.

A peer-review by a community noise expert would have predicted “Very Strong” reaction.
Widespread Complaints!!

MassDEP recognizes this, turbine max noise no more than 10 dB above ambient (L90).
+ 20 dB is the HIGHEST REACTION !!!

Marty!! This is INCREDIBLE! It is OFF THE CHART.
Third study

Hoosac Wind Sound Level Monitoring
2. Project Description

The Hoosac Wind facility is located in northwestern Massachusetts, in the Berkshire Mountains. There are 19 1.5 MW GE 1.5 sle turbines located on two different ridges. The turbines have 63 meter (207 feet) hub heights with rotor diameters of 77 meters (253 feet).

The northwestern group of 10 turbines is located on Bakke Mountain, with all turbines having base elevations between 845 and 902 meters (2,770 and 2,960 feet respectively). The closest public roads to these turbines are Bliss Road, located approximately 975 meters (3,200 feet) to the east and East Road, located approximately 1,600 meters (1 mile) to the west. The southeastern group of nine turbines is located on Crum Hill, with turbine base elevations between 843 and 926 meters (2,775 and 3,040 feet respectively). The closest public roads are Tilda Hill Road, located approximately 650 meters (2,130 feet) to the west; Moores Road, located approximately 580 meters (1,900 feet) to the southeast; and Massachusetts Route 2, located approximately 1,200 meters (3,940 feet) to the south.
2. **PROJECT DESCRIPTION**

**No nearby residence identified!!**

The northwestern group of 10 turbines is located on Bakke Mountain, with all turbines having base elevations between 845 and 902 meters (2,770 and 2,960 feet respectively). The closest public roads to these turbines are Bliss Road, located approximately 975 meters (3,200 feet) to the east and East Road, located approximately 1,600 meters (1 mile) to the west. The southeastern group of nine turbines is located on Crum Hill, with turbine base elevations between 843 and 926 meters (2,775 and 3,040 feet respectively). The closest public roads are Tilda Hill Road, located approximately 650 meters (2,130 feet) to the west; Moores Road, located approximately 580 meters (1,900 feet) to the southeast; and Massachusetts Route 2, located approximately 1,200 meters (3,940 feet) to the south.
Comparison Chart of Noise Levels

Figure 2: Common Sounds in A-weighted Decibels
Quiet Rural Area; 30 dBA >>>
no Insects, traffic or wind in trees

Quiet Winter Night; 20 dBA >>>
Wilderness; no Insects, traffic or wind in trees

Figure 2: Common Sounds in A-weighted Decibels
RSG shows “Quiet Rural Area”

Marty, it’s INCREDIBLE!! They do not use their own chart.
How can a “Quiet Rural Area” be ignored?

Increase background ambient with wind?

S E. Ambrose & R W Rand, INCE Members
Measure wind noise?

Look at the Hoosac measurement pictures, sound level meters are too close to trees.
Hoosac Wind Sound Level Monitoring

Microphones

Figure 13: Moores North Monitoring Setup

Figure 14: Moores South Monitoring Setup
How loud is a 1.5 MW turbine?

We need to ask Rob Rand. He MEASURES wind turbine noise by DISTANCE.
1.5 MW turbine, 42 dBA at 1200-ft and 2000-ft
Caution! Trend line shows potential for 47 dBA at 1200-ft
Marty, … measurements cannot be ignored, more reliable than predictions, must be used to validate predictions.

Doc, 42, 47 dBA at 1200-ft !!
Can wind turbine noise measurements mislead?

Yes, when the turbine is not operating properly.
GE 1.5 MW turbines produce an “acoustic fingerprint”, a tone at 160 Hz band.

Really?
125 Hz, Slowed RPM

Figure 28: Arithmetic Average Spectrum – WT+Background for Moores North 4/4/2013 10:00 After Startup
Figure 30: Arithmetic Average Spectrum – WT+Background for East Road South 4/18/2013 2:00 After Startup

100 Hz, Slower RPM

160 Hz
A graph by Chris Kapsambelis’ was in Rob’s peer-review. Chris plotted the turbine power output vs. wind speed given in the Hoosac Sound Study with the published GE 1.5sle data.
In comparing the recorded power output to the published power curve data, it is clear that the wind turbines were not operating normally. The power output was as much as 33% less than normal which would mean that the sound power level was also substantially reduced.
Wow, a double whammy!

These graphs raise questions about their noise measurements?
7. Attended monitoring results showed $L_{\text{max}}$ (WT+Background) minus $L_{A_{90}}$ (Background) differentials between not-discernible and 9.7 dB depending on location and curtailment period. Over the same testing periods, the unattended monitoring showed differentials between not-discernible and 10.7 dB.

10. The maximum monitored sound levels from the wind turbines, with background subtracted, ranged from 29 dBA at Tilda Hill North to 43 dBA at Moores Road North.

**No nearby residence identified !!**
### Turbines Not at Rated Power Output

#### Table 11: Sound Levels – Monitoring Period 3, Unattended Method – 4/4/2013 10:30

<table>
<thead>
<tr>
<th>Location</th>
<th>Scenario</th>
<th>Unfiltered Overall L90</th>
<th>Unfiltered Overall Leq</th>
<th>Filtered Lmax 3rd 5 minutes</th>
<th>Avg Filtered Lmax</th>
<th>Lmax minus Ambient L90</th>
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<tr>
<td>Tilda Hill N</td>
<td>Ambient</td>
<td>21.1</td>
<td>26.2</td>
<td>33.1</td>
<td>33.8</td>
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<td>27.8</td>
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<td>WT+Background Before Shutdown</td>
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</tbody>
</table>

*nd = wind turbines not discernible*
Incredible!! Again, measurements show, … Hoosac too loud!
And at too low power output!

Hoosac too low noise levels are above the MassDEP noise limit.
Marty! ... This is proof! ... They do not know how to be GOOD ACOUSTIC NEIGHBORS!
Doc! are neighbors protected by “blind eyes and deaf ears”?

Marty, you’re right, … these reports present “evidence that demands a verdict”.

S E. Ambrose & R W Rand, INCE Members
Community Response Prediction

Pederson & Waye 2004
No Observed Effect Level
Lowest Observed Adverse Effect Level
Community Response Prediction

WHO 2009 Health Effects Guidelines

- Vigorous community action
- Strong appeals to stop noise
- Widespread complaints
- Sporadic complaints
- No reaction

Hoosac L90 Nite
Existing 20-30
Community Response Prediction

[Graph showing WHO 2009 Health Effects Guidelines with data points for existing and predicted scenarios.]

Existing

Predicted
Community Response Prediction

WHO 2009 HEALTH EFFECTS GUIDELINES

Vigorous community action
Strong appeals to stop noise

Widespread complaints
Sporadic complaints
No reaction

WHO 2009 HEALTH EFFECTS GUIDELINES

Existing

Widespread complaints
Low Power
Predicted

EXTENDED CONCIBLITY RESPONSE

NOEL
LOAEL

20
30
40
50
60
70
dBA


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Community Response Prediction

WHO 2009 HEALTH EFFECTS GUIDELINES

Vigorous community action
Strong appeals to stop noise
Widespread complaints
Sporadic complaints
No reaction

Hoosac Response
Measured Low Power
Predicted

Existing

"NOEL" "LOAEL"


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S E. Ambrose & R W Rand, INCE Members 76
Measured Louder Than Predicted

**type-mw, qty**

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<thead>
<tr>
<th>Location</th>
<th>Model</th>
<th>Type</th>
<th>Quantity</th>
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</table>

**Prediction Model Ref.**
Thank You

Stephen E. Ambrose
Principal Consultant, INCE Board Certified
&
Robert W. Rand
Principal Consultant, INCE

Acoustics, Environmental Sound & Industrial Noise Control