

Vermont Public Service Board Sound Rule Workshop



December 2, 2016

Montpelier Room at the Capitol Plaza Hotel

100 State Street, Montpelier, Vermont

Vermont Public Service Board Sound Rule Workshop

Presenter: Stephen E. Ambrose, ASA, INCE Board Certified

SE Ambrose & Assoc, Windham, Maine 04062

Acoustics, Environmental Sound & Noise Control

Experience: Started in 1976; listen first, ... then sound measurements

LG Copley & Assoc, Stone & Webster Engineering, Shaw Group

Design Goal; Require Clients to be Good Acoustic Neighbors,
Know Why Neighbors Complain, and Hold Paramount Public
Health, Safety And Wellbeing

Today; listen first, ... then sound measurements

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A Simple Conversation About Wind Turbine Noise

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**Why Are
Neighbors
Complaining ?**

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Too Loud !



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Sounds Awful !

(low frequency & infrasound)



Shirley Wind residents testified that they and their children have suffered severe adverse health effects, forcing home abandonment. They attribute their problems to arrival of the wind turbines.

During the sound survey, George Hessler, *INCE* noted that a baby started crying shortly after arriving at the abandoned home.

Ref: A Cooperative Measurement Survey and Analysis of Low Frequency and Infrasound at the Shirley Wind Farm in Brown County, Wisconsin – 24Dec2012

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Sounds Awful !

(low frequency & infrasound)



Dr. Paul Shomer, et al, Dec 21, 2012

I) Observations from discussions with residents: (page 46, item 5)

Residents of the nearest house reported that their baby son, now 2 years old, would wake up 4 times a night screaming. This totally stopped upon their leaving* the vicinity of the wind turbines, and he now sleeps 8 hours and awakens happy. * abandoned their home

Ref: A Cooperative Measurement Survey and Analysis of Low Frequency and Infrasound at the Shirley Wind Farm in Brown County, Wisconsin – 24Dec2012)

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Fix ?

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Must, ...
Protect Neighbors
Minimize Adverse
Human Responses

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How ?

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Lower dBA Limit

**use
Published Studies
& Standards**

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**Make Compliance
Easy to Assess
and Measure, ...**

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**Long-term
Average ?**

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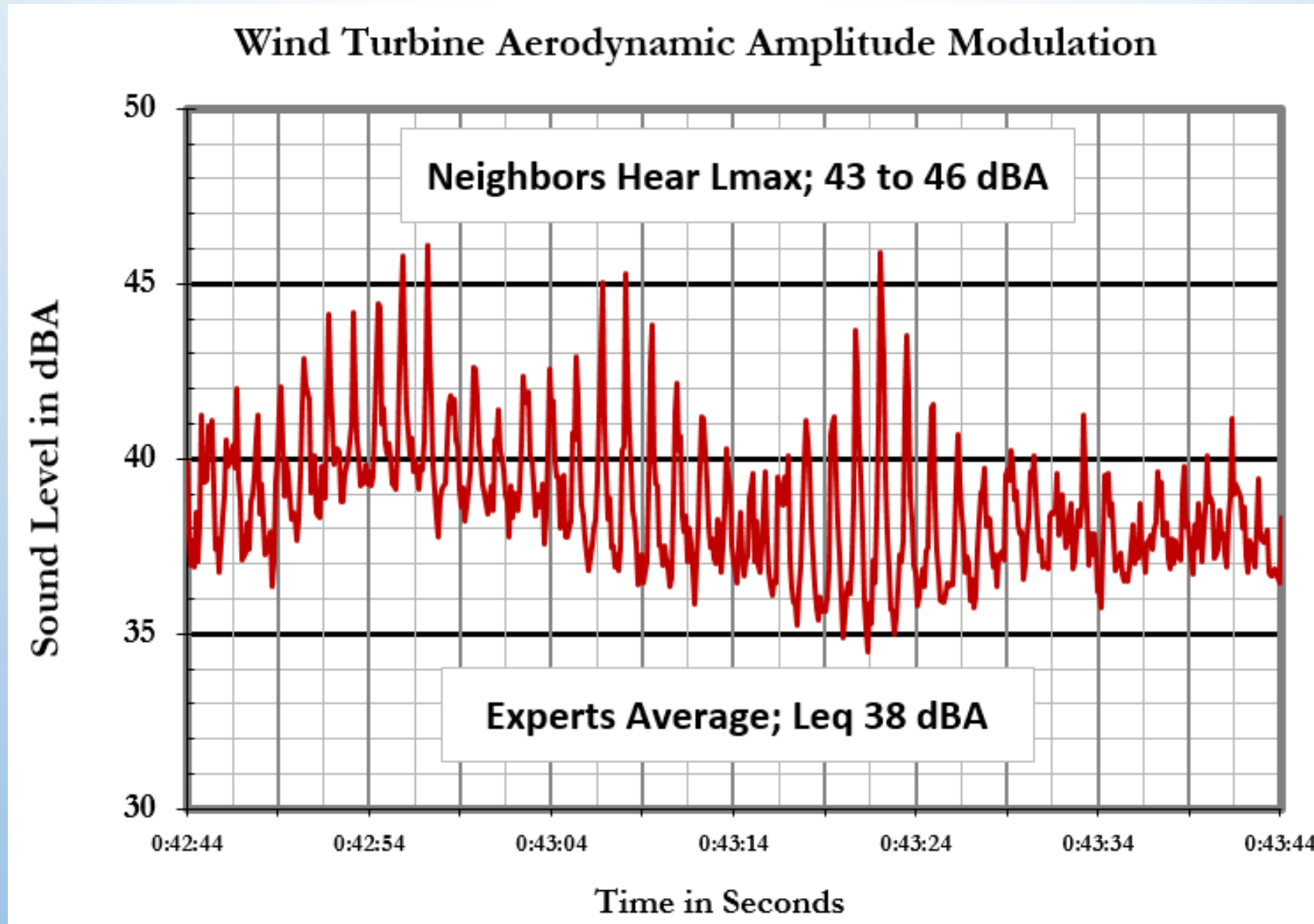


No, ...

Averages Hide !!!

(next chart)

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People React to Changes In Sound Levels, Frequency Content, Pure Tones, Infrasound, Pressure Impulses

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**As previously
shown with
Vermont's
ACT 250**

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Act 250

Environmental Board (EB) & Agency of Natural Resources (ANR)

ACT 250, Listening is Important

People hear instantaneous peak variations above background and respond accordingly

Vermont Supreme Court

Ruled: Act 250 case involving noise;

**L_{max} more
appropriate than L_{eq}**

ACT 250, Listening is Important

Findings;

When a sound source is variable, and especially when higher than the normal background,

The higher levels affect people,

Therefore, **Lmax the proper protective standard**

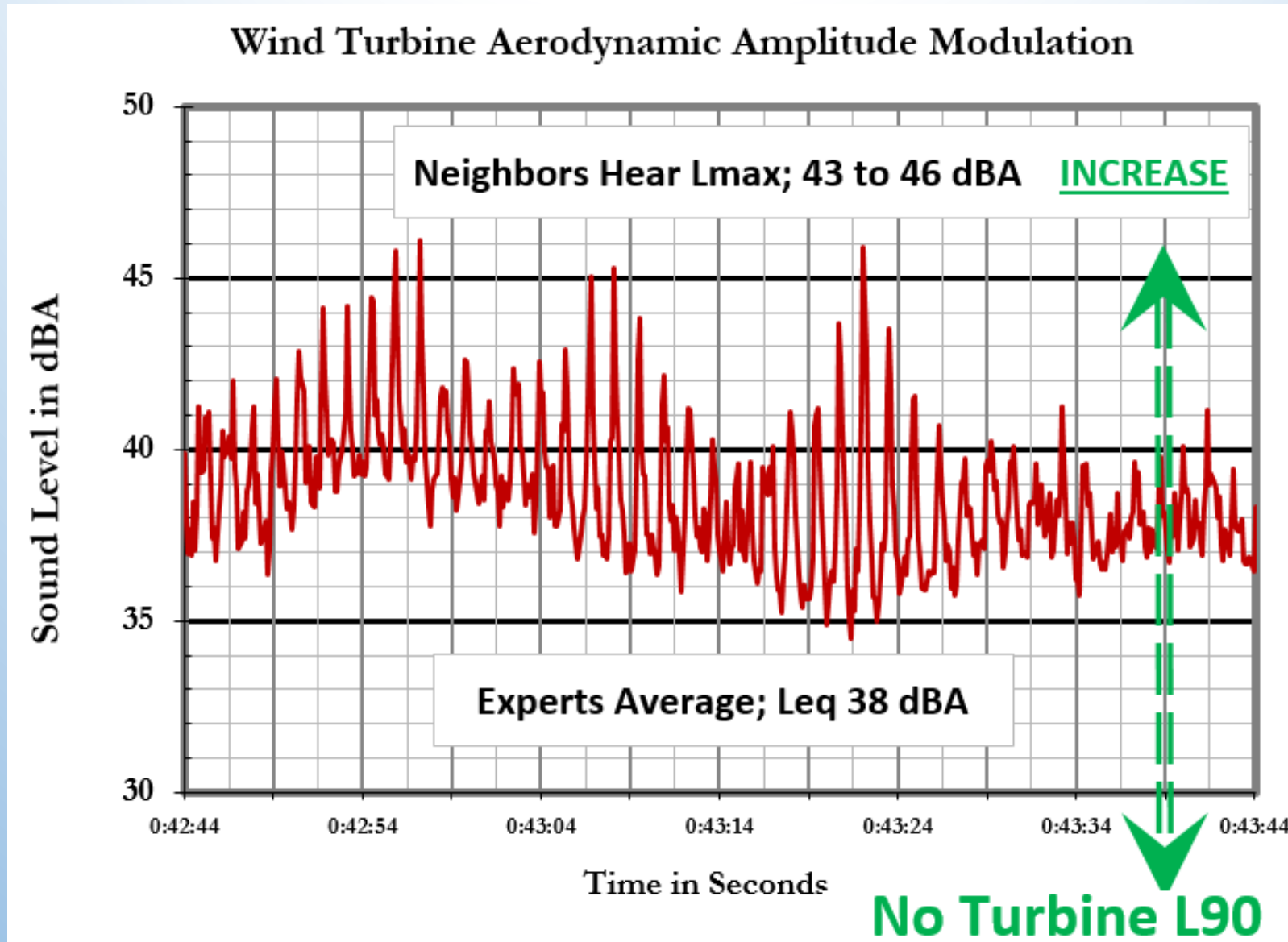
ACT 250

Instantaneous Maximum Relative to Background

$$LA_{max} - LA_{90} \leq 10 \text{ dB}$$

(**Turbines ON**) (**No Turbines**)
 (**Ambient Background**)

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Background Ambient ?

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Easy, ...

ISO 1996-1971

ANSI S12.9, Part 4

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ISO 1996-1971

Recommendations for Community Noise Limits

District Type	Daytime Limit (7 AM – 7 PM)	Evening Limit (7 -11 PM)	Night limit (11 PM – 7 AM)
<u>Rural</u>	35 dB(A)	30 dB(A)	<u>25 dB(A)</u>
Suburban	40 dB(A)	35 dB(A)	30 dB(A)
<u>Urban residential</u>	45 dB(A)	40 dB(A)	<u>35 dB(A)</u>
Urban Mixed	50 dB(A)	45 dB(A)	40 dB(A)

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ISO 1996-1971

Recommendations for Community Noise Limits

District Type	Daytime Limit (7 AM – 7 PM)	Evening Limit (7 -11 PM)	Night limit (11 PM – 7 AM)
> Vermont Ridge Line Wind Turbine Site <			<u>25 dB(A)</u>
Suburban	40 dB(A)	35 dB(A)	30 dB(A)
<u>Urban residential</u>	45 dB(A)	40 dB(A)	<u>35 dB(A)</u>
Urban Mixed	50 dB(A)	45 dB(A)	40 dB(A)

ANSI S12.9, Part 4

A quiet rural area with new unfamiliar intrusive noise source, outdoors night average should not exceed;

(F.3.4.1) **30 dBA for compatibility**

(F.3.4.2) **35 dBA for marginal compatibility**

> Vermont Ridge Line Wind Turbine Sites <

ANSI S12.9, Part 4

A new unfamiliar industrial noise source should be considered **incompatible** when sited in a **quiet rural area**

Can produce annoyance equivalent to **15 dB increase** above measured or predicted levels

> Vermont Ridge Line Wind Turbine Sites <

ANSI S12.9, Part 4

**USEPA provided this same assessment
in their 1973 *Community Noise*
and 1974 *Levels Document*.**

Can produce annoyance equivalent to **15 dB
increase above measured or predicted levels**

> Vermont Ridge Line Wind Turbine Sites <

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Wind Masking ?

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No, ...

Wind Does Not Mask !

supported by:

ANSI S12.9-2005, Part 4

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Masking; ANSI S12.9-2005, Part 4, (A.1.3)

Masking occurs when the threshold of detection of one sound is raised by another sound

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Masking; ANSI S12.9-2005, Part 4, A.1.3

Masking occurs when the threshold of detection of one sound is raised by another sound. Masking levels vary, with complete masking resulting in inaudibility.

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Masking; ANSI S12.9-2005, Part 4, A.1.3

Masking occurs when the threshold of detection of one sound is raised by another sound. Masking levels vary, with complete masking resulting in inaudibility. Time varying sounds and **spectral content** may require **up to 20 dB difference** between sound sources

How to Establish Background Ambient L90

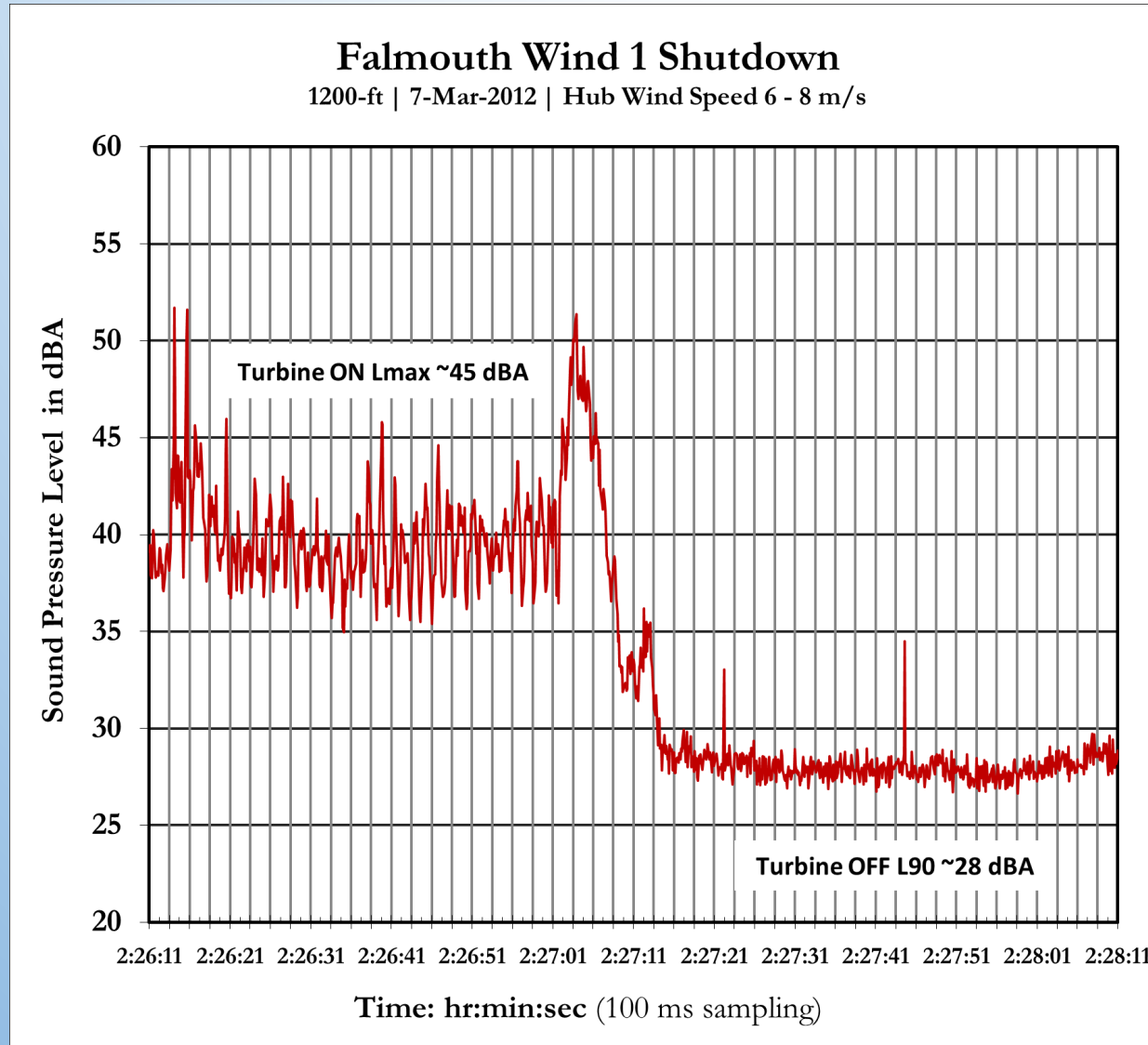
ANSI S12.9 (2013), Part 3



7.3 **On/Off** test requires the operator to fully cooperate and shut-down noise sources

(**All turbine SCADA** info at **>80%** electric-power output)

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2 AM Measurements

Lmax ON > 40 to 45 dBA

Background L90 = 28 dBA

Not at Full Elec-Pwr Out

How to Establish Background Ambient L90



ANSI S12.9 (2013), Part 3

7.4.2. (a) **“Proxy”** test at a location without noise source

(no need for shut-down)

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What About Noise and Health ?

World Health Organization (WHO)



Well researched,

Presented in

WHO 2009 Publication

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LAeq Night Outside	WHO 2009 Observed Health Effects
Up to 30 dBA <u>NOEL</u>	No substantial biological effects, <u>no observed effect level</u>
30 to 40 dBA	<u>Affects sleep, body movements, awakening, self-reported sleep disturbance, arousals, vulnerable groups; children, chronically ill & elderly are more susceptible to adverse health effects; AHEs.</u>
40 dBA <u>LOAEL</u>	Night noise guideline (NNG), <u>lowest observed adverse effect level</u> for the general population .
40 to 55 dBA	AHEs are observed and many have to adapt lives to cope with noise at night. <u>Vulnerable groups are more severely affected.</u>
Above 55 dBA	<u>Increasingly dangerous for public health.</u> AHEs occur frequently; sizeable proportion of population highly annoyed and sleep-disturbed; increased risk of cardiovascular disease.

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LAeq Night Outside	WHO 2009 Observed Health Effects
Up to 30 dBA <u>NOEL</u>	No substantial biological effects, <u>no observed effect level</u>
30 to 40 dBA	<u>Affects sleep, body movements, awakening, self-reported sleep disturbance, arousals, vulnerable groups; children, chronically ill & elderly</u> are more susceptible to <u>adverse health effects</u> ; AHEs.

WHO 2009

Night Noise Guidelines for Europe

ISBN 9789289041737

Table 1 – Summary of effects and threshold levels where sufficient evidence is available

Effect	Description	Indicator	Threshold, dB
Biological	Change in cardiovascular activity	*	*
	EEG awakening	LAm _{ax} , inside	35 (dBA)
	Motility, onset of motility	LAm _{ax} , inside	32 (dBA)
	Changes in duration of various stages of sleep, in sleep structure and fragmentation of sleep	LAm _{ax} , inside	35 (dBA)
Sleep Quality	Waking up in the night and/or too early in the morning	LAm _{ax} , inside	42 (dBA)
	Prolongation of the sleep inception period, difficulty getting to sleep	*	*
	Sleep fragmentation, reduced sleeping time	*	*
	Increased average motility when sleeping	Lnight, outside	42 (dB)
Well-being	Self-reported sleep disturbance	Lnight, outside	42 (dB)
	Use of somnifacient drugs or sedatives	Lnight, outside	40 (dB)
Medical Conditions	Environmental insomnia	Lnight, outside	42 (dB)

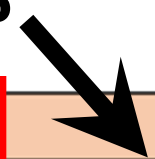
* Although the effect has been shown to occur or a plausible biological pathway could be constructed, indicators or threshold levels could not be determined.

** Note that “environmental insomnia” is the result of diagnosis by a medical professional whilst “self-reported sleep disturbance” is essentially the same, but reported in the context of a social survey. Number of questions and exact wording may differ.

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Effect	Description	Indicator	Threshold, dB
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Infrasound ?



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**Each slide is very
convincing, ...
is there an easy
way to show ?**

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Yes, ...

**USEPA “Levels Document” with
the cautionary advisory by
Dr. Ken Eldred (Appendix D, 1974),
& supported by
other researchers and investigators**

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Community Noise Reaction

- **USEPA “Levels Document”, 1974**
- **Pedersen & Waye, 2004**
- **Hayes McKenzie Group, 2006**
(Draft Report Before Wind Advocate Revisions)
- **Kemperman/James, 2008**
- **WHO Health Effects Night, 2009**
- **Dan Driscoll (Formerly w/NYDEQ), 2009**
- **Rand/Ambrose, 2010**

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**These researchers and
investigators listened, ...**

Hear as a neighbor, ...

(next chart)

Predicted Community Reaction

For Wind Turbines in a Quiet Area and Percent of Community Highly Annoyed

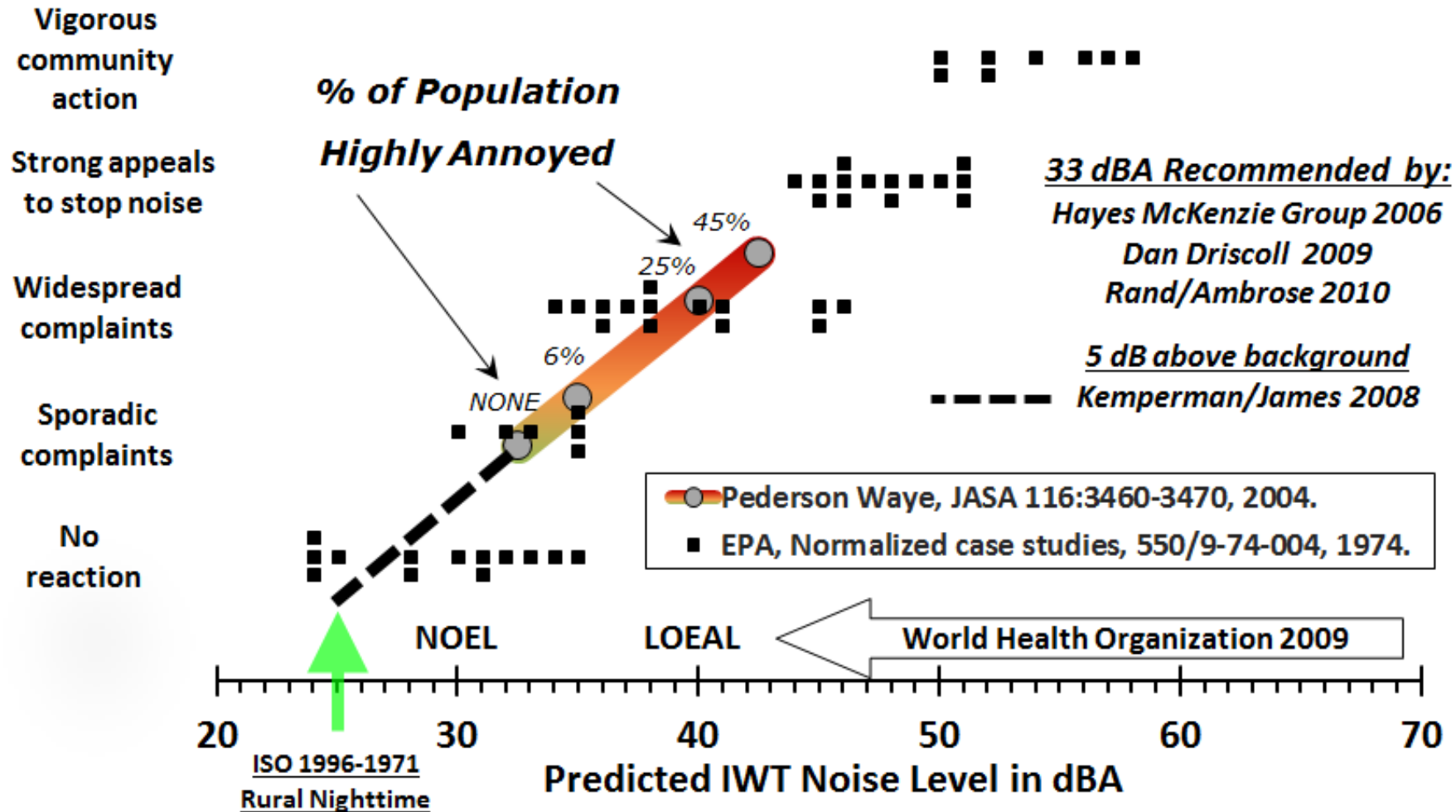


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Predicted Community Reaction

For Wind Turbines in a Quiet Area

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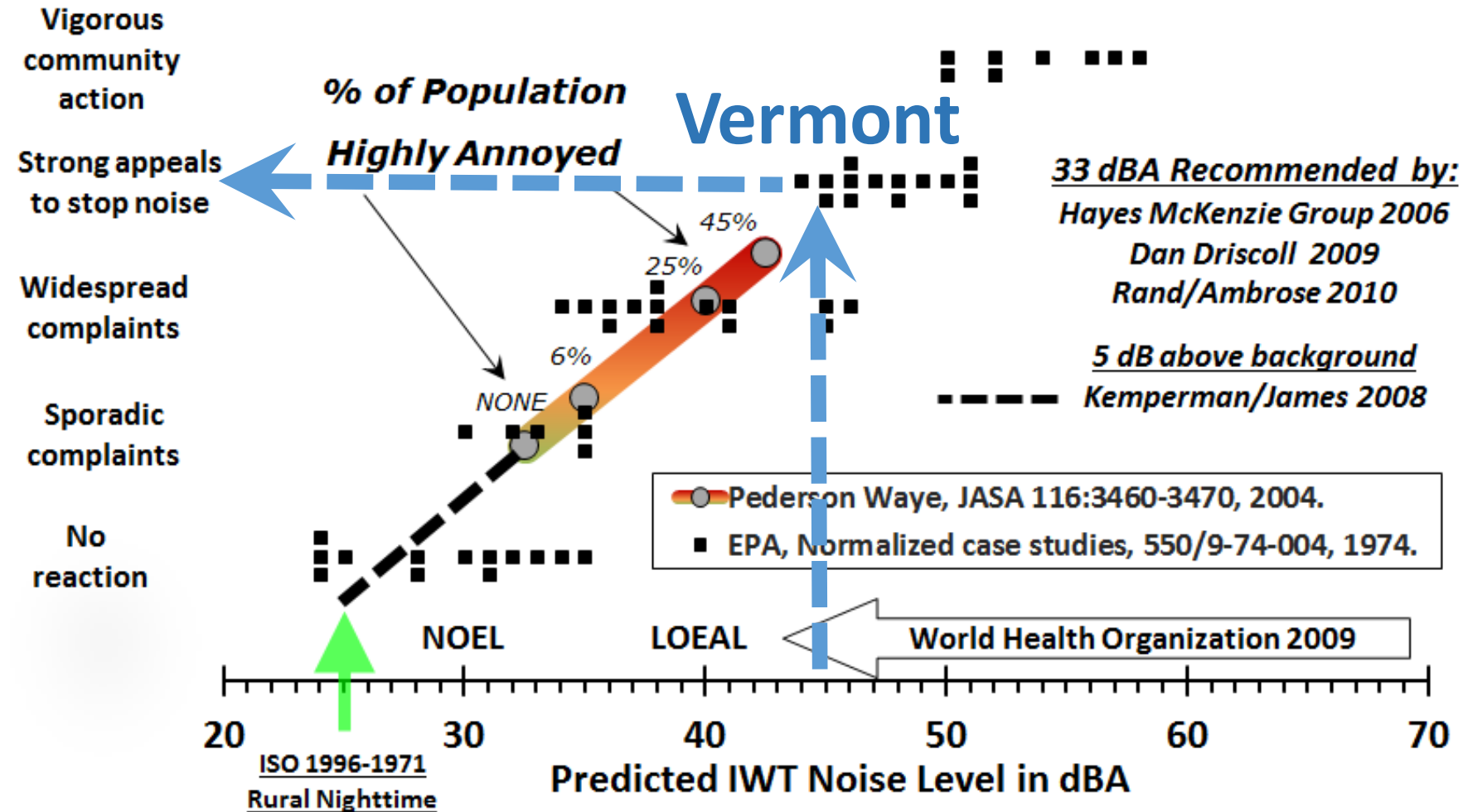


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Predicted Community Reaction For Wind Turbines in a Quiet Area and Percent of Community Highly Annoyed

Suicide ?
Abandon
Home
Vigorous
community
action
Strong appeals
to stop noise

<<< A Real Problem Exists !!!

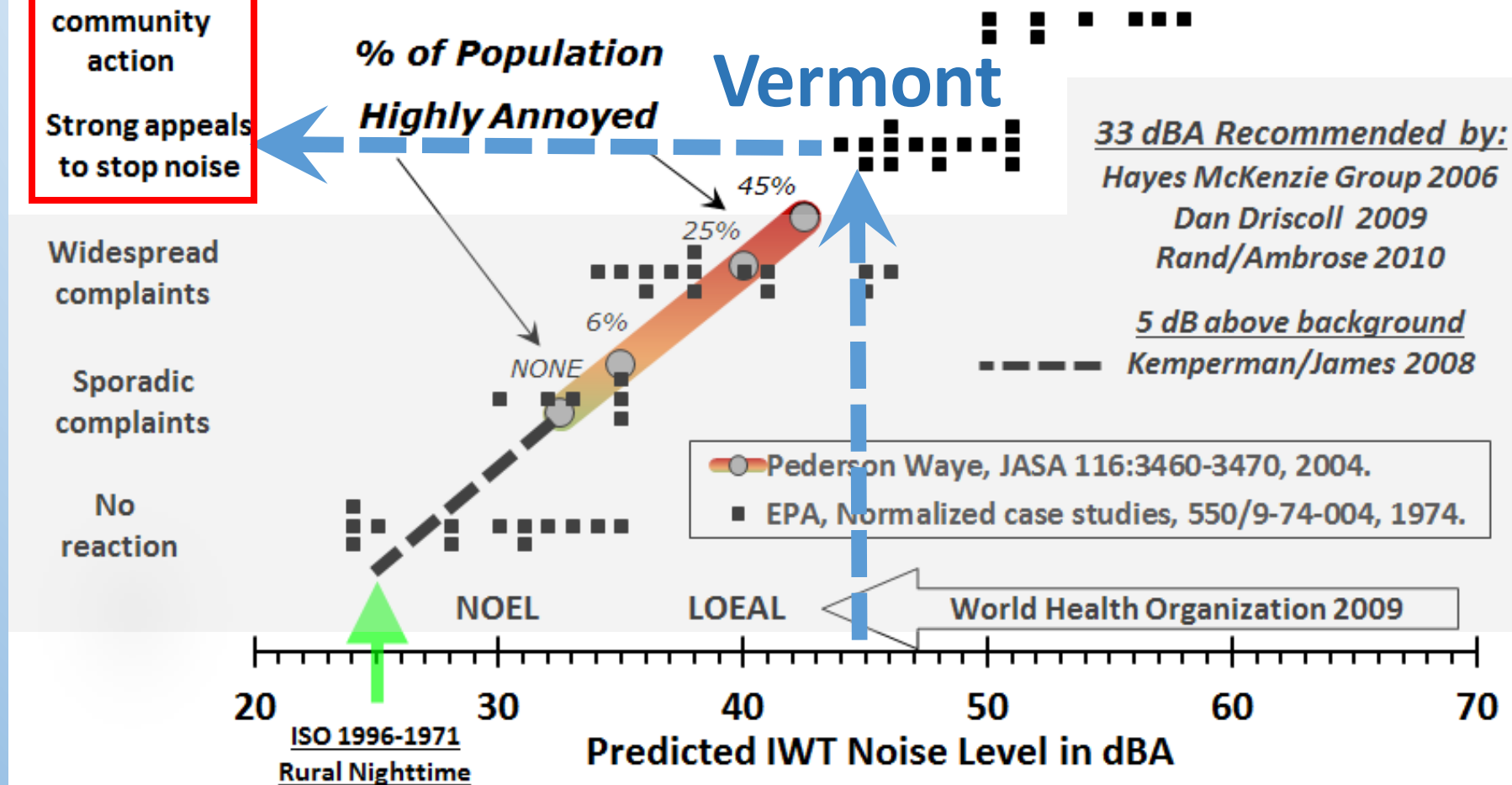


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**Why are wind turbine
prediction noise models
ineffective ?**

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In the late 1980s*, **wind began to influence professional organizations, international standards, ...**
put into practice **specific wind turbine procedures, protocols, methods, ...**



* only my opinion

Thereby, reducing the noise level requirements for protecting public health and well-being.

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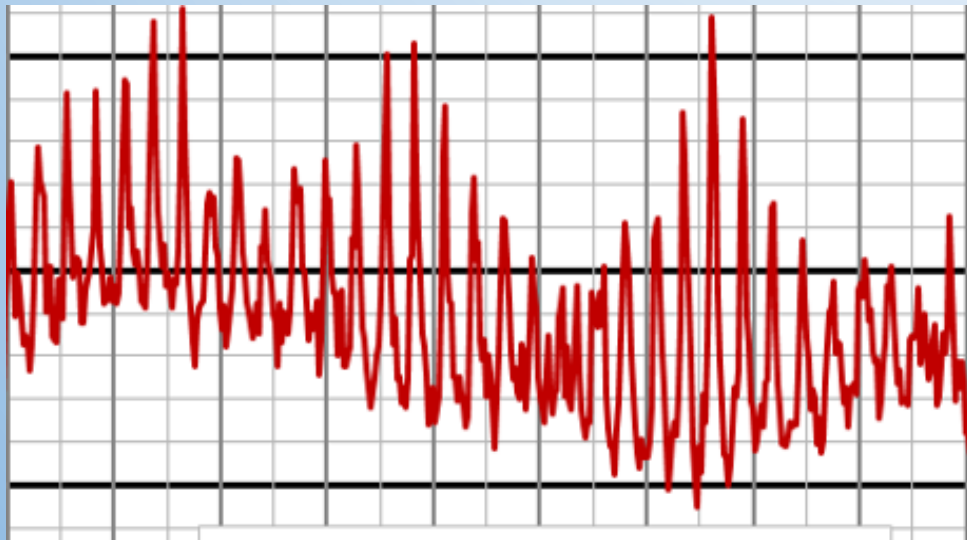


**Noise predictors use Leqs
to hide worst-case **Lmax**,
which neighbors hear**

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**Imagine this presentation, ...
a 10-min Leq straight red line,**



VS

fluctuations > 10 dB
Dramatically Different !!!

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Noise Recommendations ?



Think About
Neighbors What they hear and live with
Compatibility (ANSI 12.9, Part 5)
Trust independent noise studies that
do not favor wind turbines.
Vermont Act 250: **$L_{max} - L_{90} \leq 10$**

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Recommendations

Consistent
With
ACT 250

Critical *hours* are at night:

Establish for design purposes;

Ambient baseline: $L_{90} < 25$ dBA

No wind masking

Predictions and Measurements

Wind turbine operation compliance,

$L_{max} < 35$ dBA & $L_{eq} < 32$ dBA

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How About Setback Distance Recommendations?

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Easy, ...

Europe: Poland, Bavaria

10 times total height
(tower + blade length)

Mass: Cape Cod Commission

10 times blade diameter

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**Thank You
For
Listening**



**Time For
Your
Questions**

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Appreciation to INCE Members; Richard James & Robert Rand