First International Symposium on Adverse Health Effects from Wind Turbines
The Global Wind Industry and Adverse Health Effects: Loss of Social Justice?
Picton, Prince Edward County, Ontario, Canada
October 29-31, 2010

very good overview; could use some more interpretation on some slides, but generally can make sense of it pretty well

sick buildings are brought in. PedersonWaye and Leventhall paper.

also line rather than point source: 3dB rather than 6dB decay

Session I

No Rules, No Caution, No Accountability

Abstract and bio on slide 2 is reproduced from the Symposium Program

First International Symposium on Adverse Health Effects from Wind Turbines
The Global Wind Industry and Adverse Health Effects: Loss of Social Justice?
Picton, Prince Edward County, Ontario, Canada

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Rick James, INCE –

HOW WE GOT HERE

Abstract: What was learned in the 1980's was forgotten in the 1990's and set the stage for the Wind Turbine Boom of the 2000's. But the pillars of the position, that wind turbines are safe for use near people's homes, are falling. An overview of the key arguments presented by the wind industry's trade associations and their representatives who support their position will be discussed.

Bio: Richard James has been actively involved in the field of noise control since 1969, participating in and supervising research and engineering projects related to control of occupational and community noise. Since 2006, he has been involved with noise and health issues related to industrial wind turbines. His work includes developing siting criteria for local governments, conducting acoustical tests at wind turbine sites, providing presentations and testimony.

HOW WE GOT HERE

An Overview Of The Key Arguments
Presented By
The Wind Industry That
Industrial Scale Wind Turbines
Are Safe For Use Near People's Homes

By:
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How we Got Here

What was:

- **Learned in the 1980's and**
- **Forgotten in the 1990's**

And,
How that set the stage for the Wind Turbine Boom of the 2000's. But the pillars of the position that wind turbines are safe for use near people's homes, are falling.

What We Knew About ILFN and WT

What we knew about ILFN

- 1970's-early 1990's
  - Work on turboprop jet engines and other sources of infra and low frequency sounds (ILFN) established that inaudible levels of infra sound caused physical responses
  - "Sick Building" syndrome found that poorly or incorrectly designed HVAC systems in large office buildings resulted in inaudible modulated low frequency sounds in work areas. Workers reported symptoms similar to those for Wind Turbine Syndrome

Presented at the First International Symposium on Adverse Health Effects from Wind Turbines - October 29-31, 2010

What We Knew about ILFN

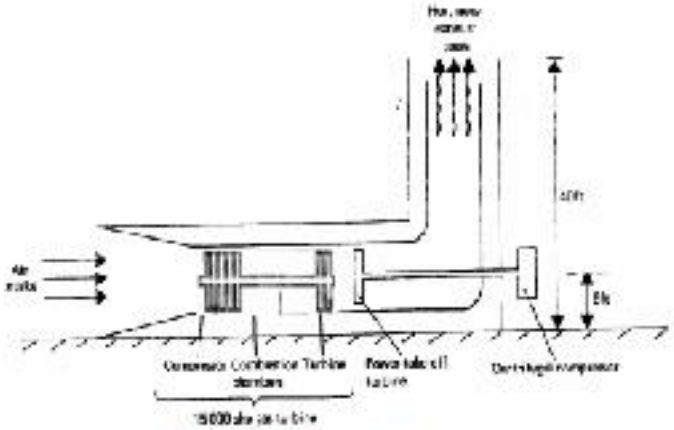
- **From Presentation by: Dr. Malcolm Swinbanks[1]**

Wind Turbines: Low-Frequency Noise & Infrasound Revisited

M.A.Swinbanks

I first became interested in Low-Frequency Sound when tackling theoretical & practical research problems relating to the Active Control of Sound, in the 1970's

Following successful laboratory experiments, in 1979 I was asked to tackle the specific problem of excess low-frequency noise from an industrial gas turbine located in a rural area.



The noise was generated by the gas turbine exhausting into a vertical silencer 40 ft high and 10 ft diameter. The exhaust turbulence induced resonances in the air column of the silencer, giving rise to unacceptable very low-frequency sound levels around 20-30Hz.

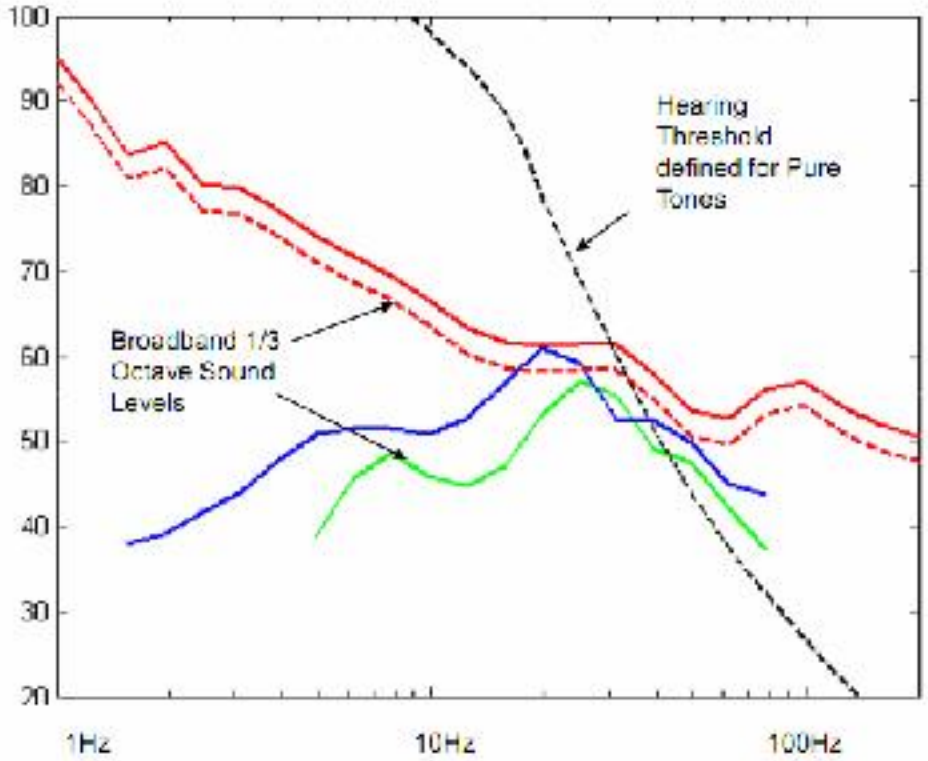
As a result of spending long hours working on the site, in the presence of significant levels of very low-frequency noise, I acquired considerable familiarity with its effects and consequences.

[1] MAS Research Ltd. (Mathematical & Scientific Research), and Chief Scientist, Vibration and Sound Solutions, Ltd. Workshop by: Environmental Protection UK, "Where now with Wind Turbine Assessment ?" 9th September 2010 , The Thistle Hotel, Birmingham

What We Knew about ILFN

- **From Presentation by: Dr. Malcolm Swinbanks[1]**

Comparison of Noise Levels with Threshold of Hearing.

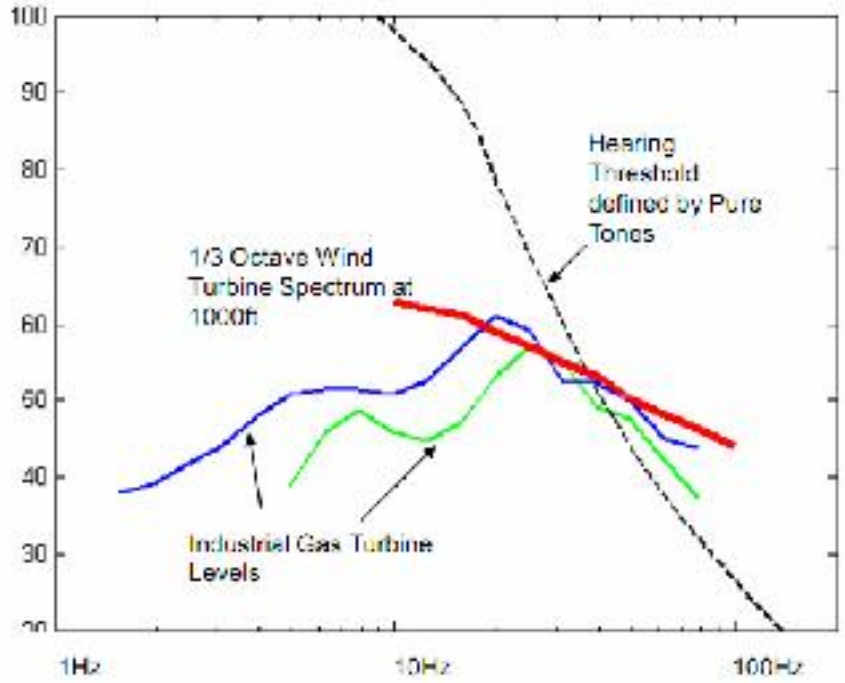


Subsequent Active Reduction of Gas Turbine Noise Levels over 20-40Hz successfully resolved Complaints. So the 20-40Hz Sound Level had been Perceptible, despite being Below the Nominal Threshold of Hearing

What We Knew about ILFN

- **From Presentation by: Dr. Malcolm Swinbanks[1]**

Example of LF Wind Turbine Spectrum, Considered to be not Audible to the Average Person up to about 31.5Hz – 40Hz. (Dr Geoff Leventhall to Public Service Commission of Wisconsin)



Present Author's Opinion: Wind Turbine LF Spectra compare directly to (projected) Industrial Gas Turbine Levels that gave rise to complaints, 25-30 years ago.

Care must be taken when comparing broad-band measurements, having noise simultaneously present at all frequencies, against a threshold defined by individual, stand-alone pure tones.

What We Knew about ILFN

- **Sick Buildings**

Journal of Sound and Vibration (1997) **205**(4), 467–474

EFFECTS ON PERFORMANCE AND WORK QUALITY DUE TO LOW FREQUENCY VENTILATION NOISE

K. PERSSON WAYE, R. RYLANDER

Department of Environmental Medicine, Göteborg University, Sweden

S. BENTON

Division of Psychology, University of Westminster, London, England

AND

H. G. LEVENTHALL

What We Knew About Modulated ILFN

- **Sick Buildings**

1. BACKGROUND

In occupational environments such as control rooms and office-like areas, there is growing concern as to the effects of low frequency noise (20–200 Hz). Low frequency noise may be emitted from ventilation, heating and air-conditioning (HVAC) systems or may occur as a result of the selective attenuation of walls, floor etc. A few previous studies indicate that low frequency noise may reduce performance at levels that can occur in such occupational environments [1, 2]. Some of the symptoms that are related to exposure to low frequency noise such as mental tiredness, lack of concentration and headache related symptoms, could be associated with a reduced performance and work satisfaction.

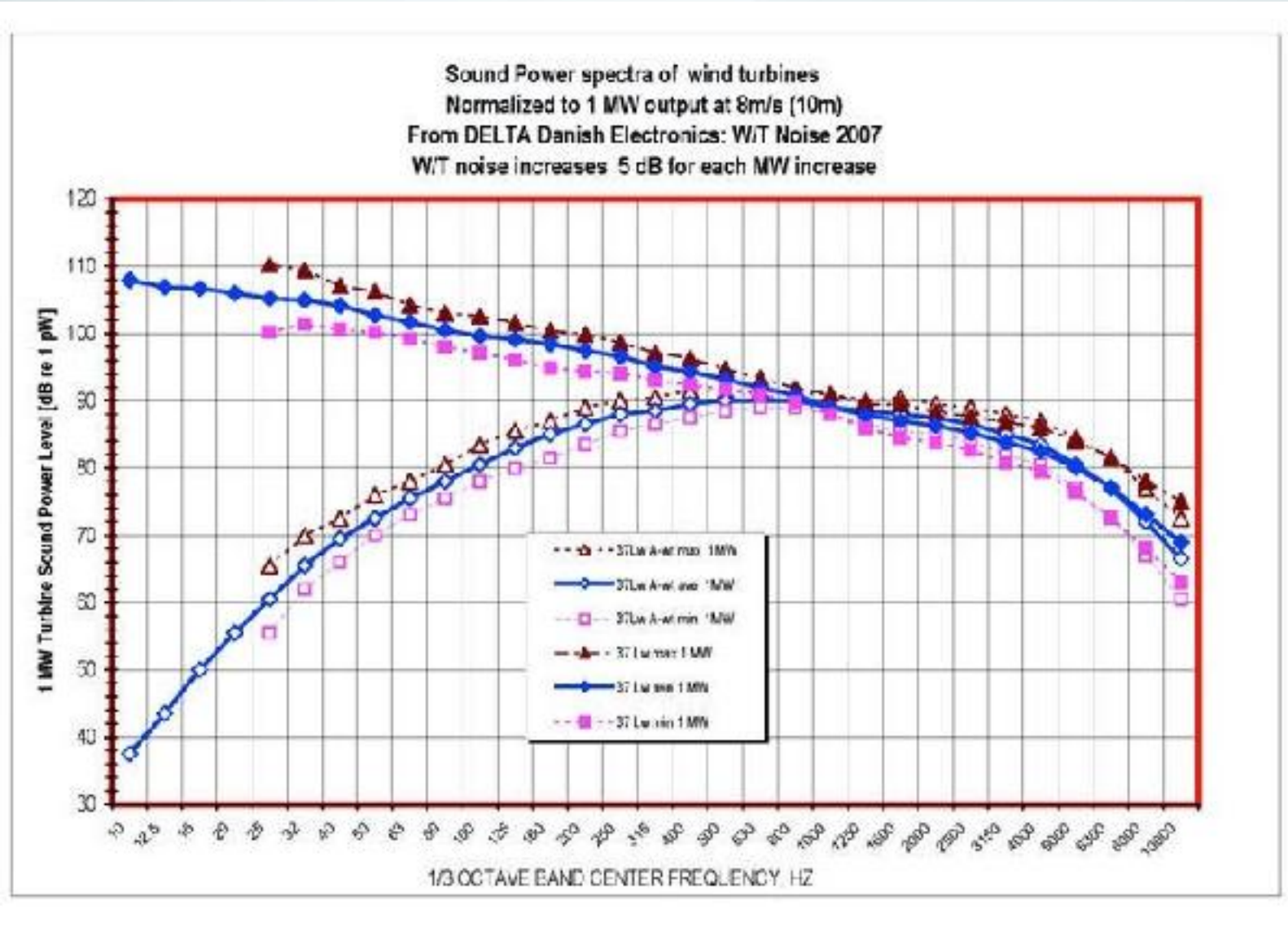
5. CONCLUSION

The results showed that the low frequency noise was estimated to interfere more strongly with performance. The results also gave some indications that cognitive demands were less well coped with under the low frequency noise condition. This effect was especially pronounced in the last parts of the tests, which indicates that the effects appear over time. If this effect can be verified in further studies, it could be hypothesized that the low frequency exposure was more difficult to habituate to. The relation between the reduced activity and response time, which was especially pronounced in the low frequency noise condition, may also indicate that increased fatigue was of importance for the results. The underlying mechanisms responsible for reduced performance caused by low frequency

What We Knew About ILFN and WT

- 1980 to 1991 NASA funded a series of research projects on wind turbine noise. The primary researchers, Hubbard and Shepherd reported:
  - Wind turbines produced primarily infra and low frequency sound
  - Determined that sound propagated from wind turbines at a decay rate half that of common 'point' sources. Wind turbine noise travels farther than other sounds.
  - Would be significant indoor noise problem due to room resonance

What We Knew About ILFN and WT



What We Knew About ILFN and WT

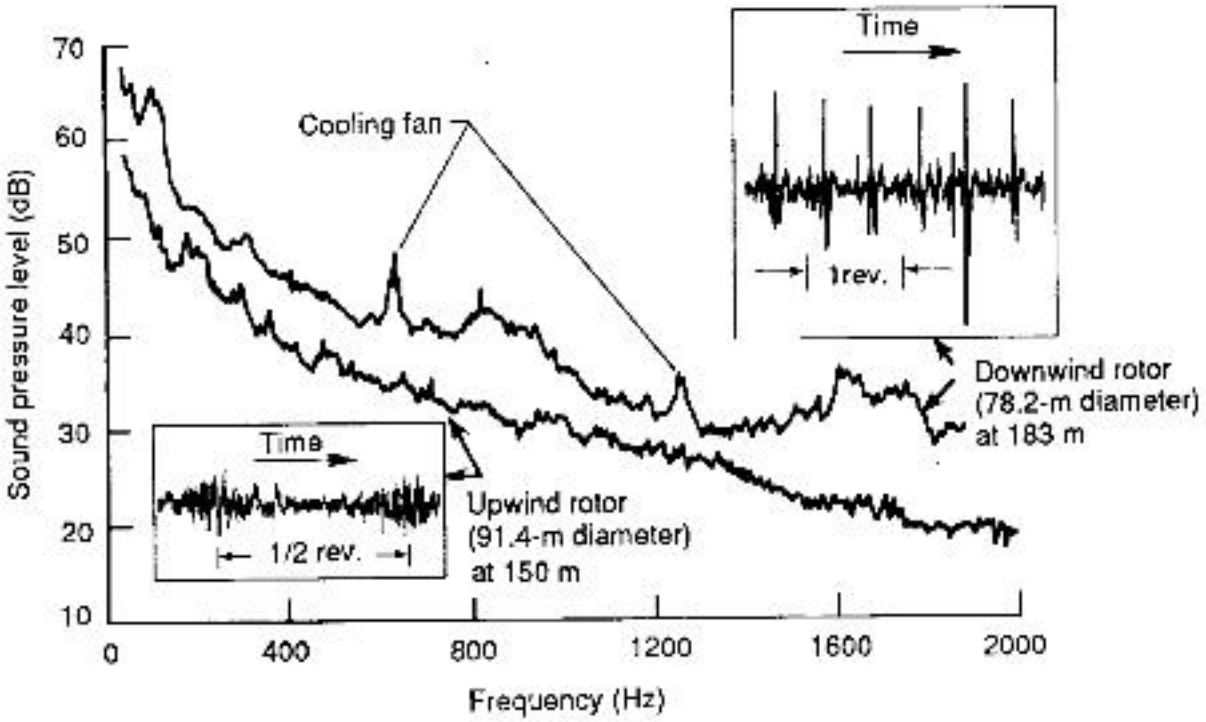


Figure 7-4. Narrow-band noise spectra from large-scale HAWTS with upwind and downwind rotors (bandwidth = 2.5 Hz)

Sound Levels will be much higher than predicted

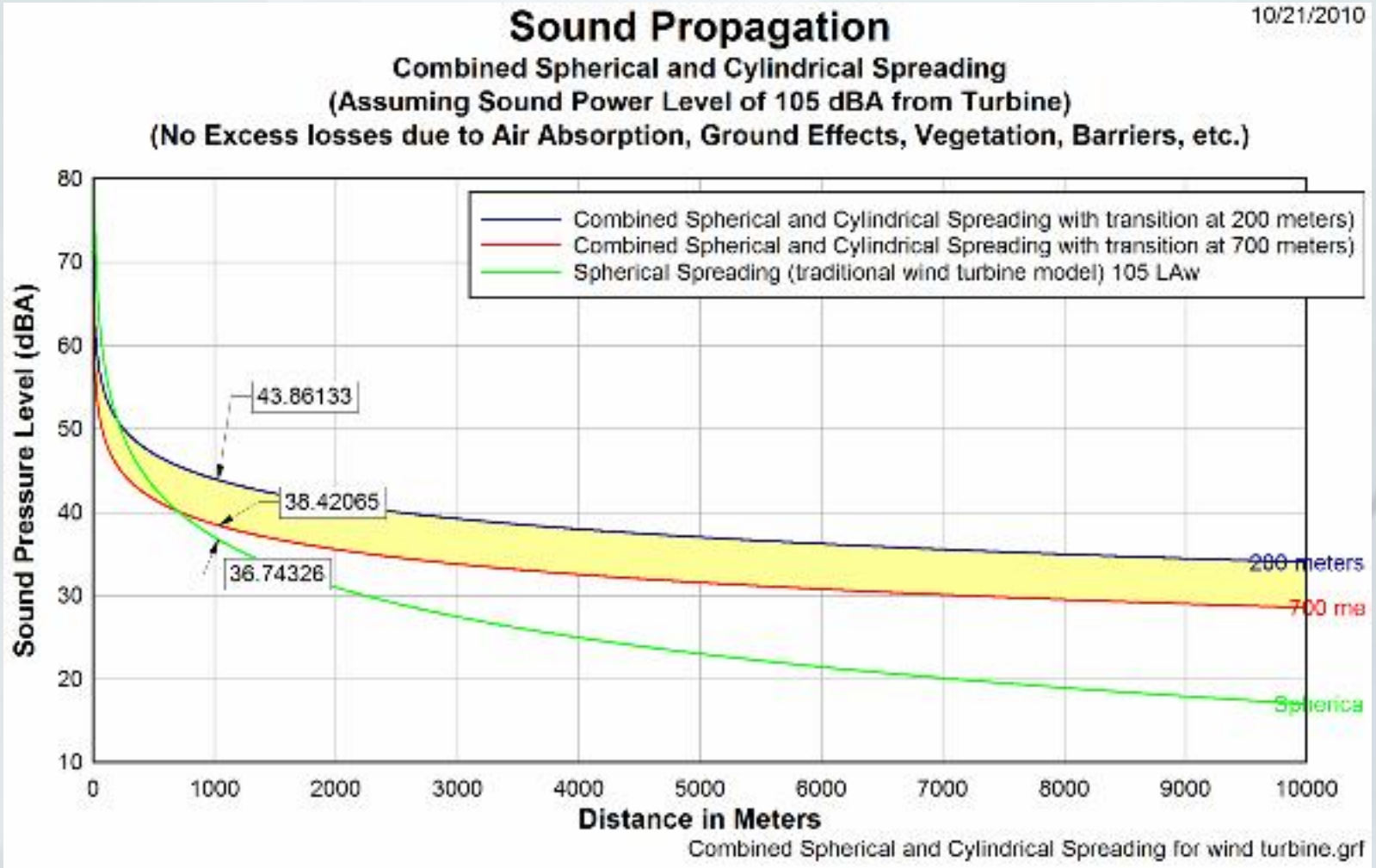
"Multiple wind turbines complicate matters further. From relatively long distances, an assembly of machines appears as a point source….

Closer to the turbines, they begin to act as a line source. The decay rate for line sources is **3-dB**, **not 6 dB** for true spherical propagation."

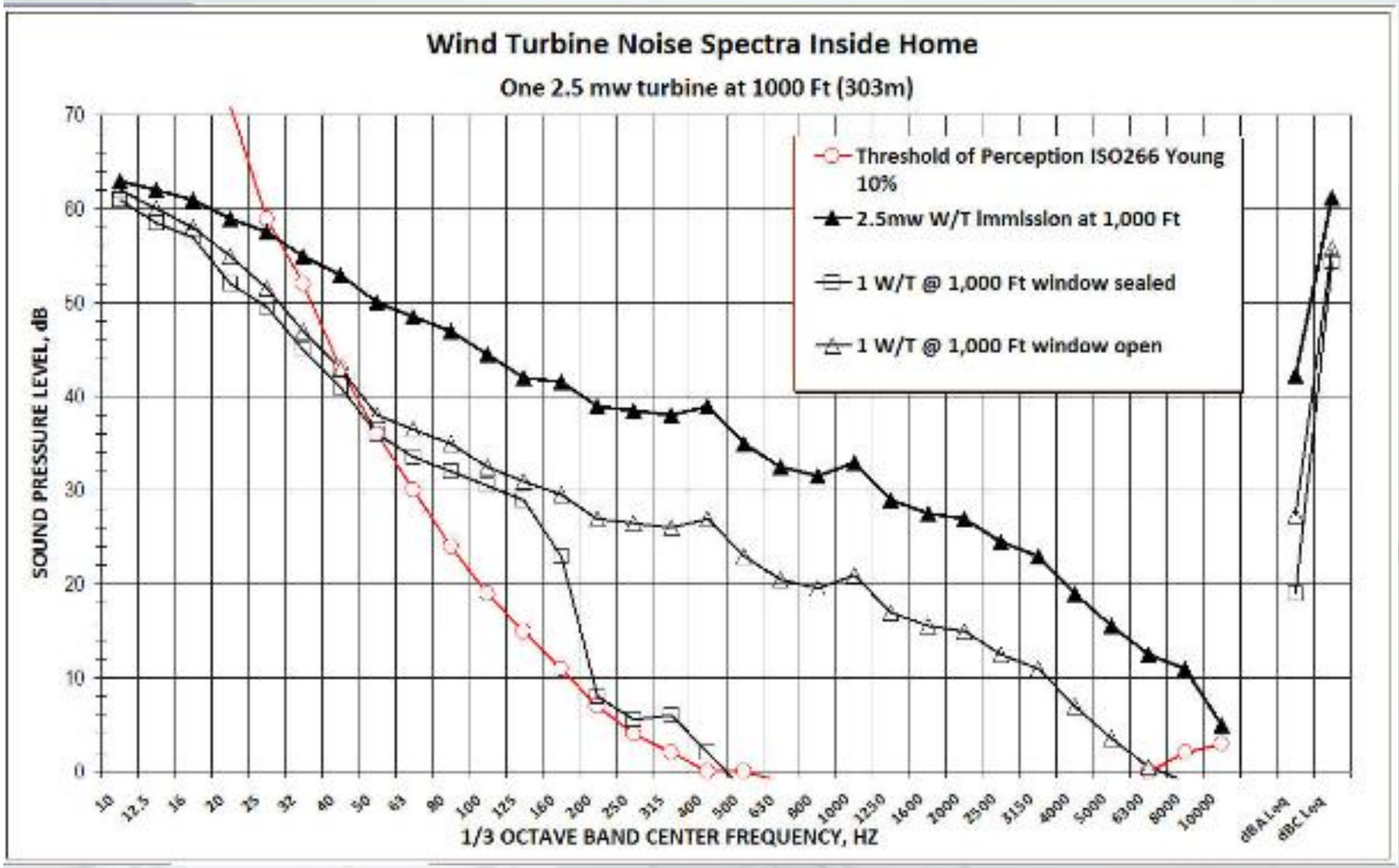
Paul Gipe, Wind Turbines Coming of Age, ©1995 (page 379)
Mr. Gipe was awarded the **World Wind Energy Award** in 2008 by the World Wind Energy Association

The standard wind turbine computer model used to estimate sound levels for Wind Project assumes 'Spherical Propagation" not "Line Propagation" even though turbines are arranged in rows. **This error means that the tables of sound levels and the contour maps grossly underestimate the true impact of the sounds on adjacent properties located along the rows.**

What We Knew About ILFN and WT



What We Knew About ILFN and WT



What NASA Knew

- **Malcolm Swinbanks**

NASA Also Identified and Investigated Important Low Frequency Effects that are not Cured by Modern Upstream Rotors

(1) Atmospheric Wind Gradients lead to Low Frequency Impulsive Noise, even from Modern Upwind Designs [1] (1989)

(2) The Threshold of Hearing can be up to 10 Times more Sensitive to the Dominant Components of Low-Frequency Impulsive Noise [2] (1982)

(3) The Threshold of Detection was found to be lower in level (7-10dB) for Coherent Phase (Repetitive) rather than for Random Phase Low Frequency Components [3] (1982).

Some Parties Dismiss this NASA Research as Out-of-Date, 1980's, and No Longer Relevant

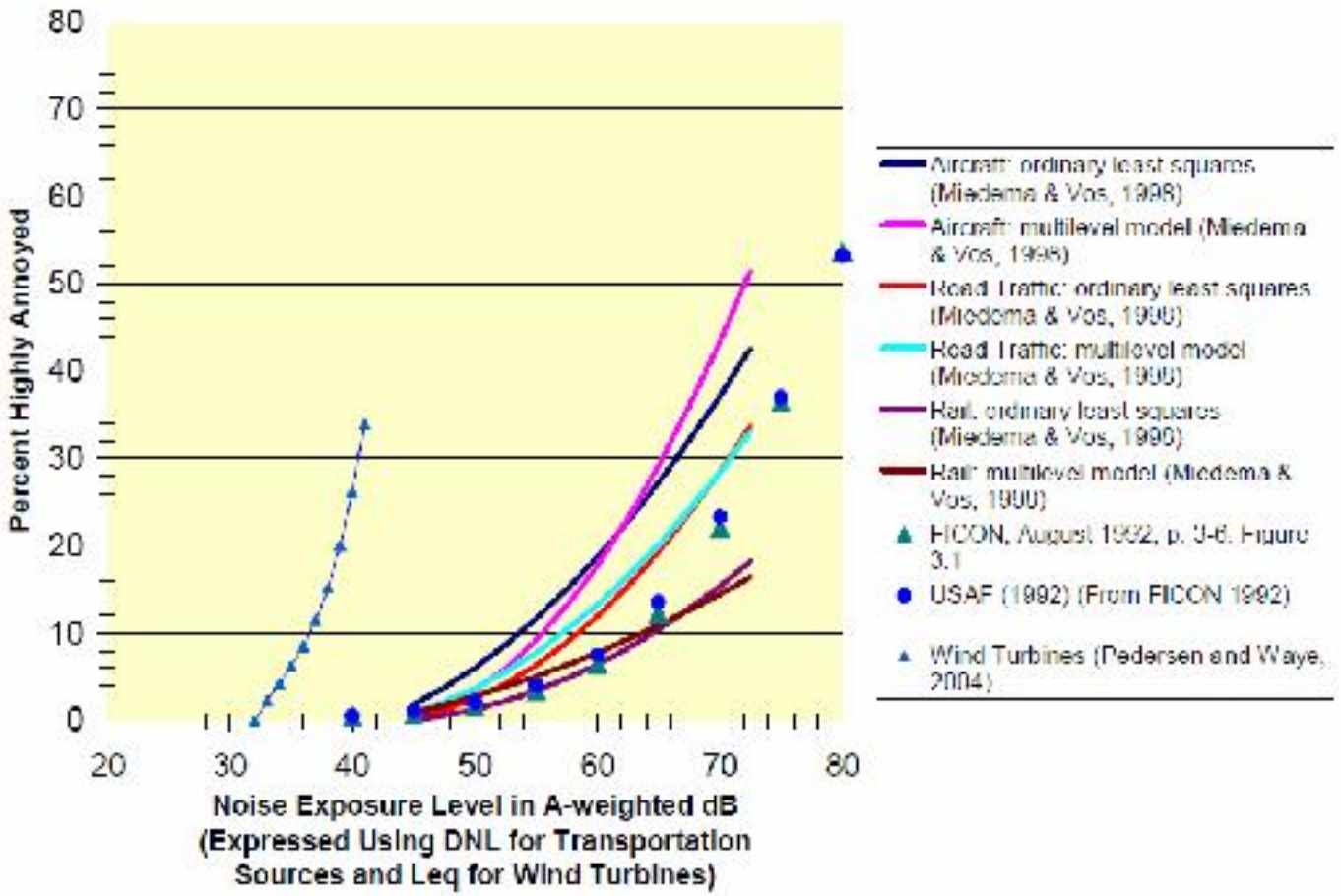
The Author believes it is Incorrect to do so – It is Directly Relevant

The properties of the winds, and the characteristics of human hearing, have not changed.

[1] Low Frequency Acoustic Emissions from Large Horizontal Wind Turbines, H.H.Hubbard & K.P.Shepherd* Inter-Noise 89, 4-6 December 1989
[2] Acoustical Criteria Applicable to Large Wind Turbine Generators K.P.Shepherd* & D.G.Stevens Inter-Noise 82, 17-19 May 1982
[3] Guide to the Evaluation of Human Exposure to Noise from Large Wind Turbines D.G.Stephens, K.P.Shepherd, H.H.Hubbard,F.W.Grosveld NASA Technical Memorandum 83288 March 1982

Annoyance of Common Noises vs Wind Turbines

more familiar dose-response relationships for transportation sources, which were developed by various researchers as noted in the legend of the graph.



5

World Health Org. on LFN

The World Health Organization is one of the bodies which recognizes the special place of low frequency noise as an environmental problem. Its publication on Community Noise (Berglund et al., 2000) makes a number of references to low frequency noise, some of which are as follows:

- *" It should be noted that low frequency noise, for example, from ventilation systems can disturb rest and sleep even at low sound levels"*
- ***"For noise with a large proportion of low frequency sounds a still lower guideline* (than 30dBA) *is recommended"***
- *" When prominent low frequency components are present, noise*
- *measures based on A-weighting are inappropriate"*
- *"Since A-weighting underestimates the sound pressure level of noise with low frequency components, a better assessment of health effects would be to use C-weighting"*
- *"It should be noted that a large proportion of low frequency components in a noise may increase considerably the adverse effects on health"*

"The evidence on low frequency noise is sufficiently strong to warrant immediate concern"

4

Wind Industry Position

Leventhal talks to BWEA

- "I can state quite categorically that there is no significant infrasound from current designs of wind turbines. To say that there is an infrasound problem is one of the hares which objectors to wind farms like to run. There will not be any effects from infrasound from the turbines.
- The turbines produce a modulated higher frequency - the swish, swish - which people may not like, but this is not infrasound. There is no low frequency in it.
- There is negligible infrasound and very little low frequency noise from wind turbines - a few low level tones from the gearbox. Whatever might be making people ill it is not low frequency noise - there just isn't enough of it from modern wind turbines. [22]"

[22] Personal communication, September 2004.

Wind Industry Position

AWEA AMERICAN WIND ENERGY ASSOCIATION

Utility Scale Wind Energy and Sound

Advisory Panel Findings

The scientific advisory panel that addressed wind turbine human health concerns, came to the following conclusions:

- Subaudible, low frequency sound and infrasound from wind turbines do not present a risk to human health.
- Sound from wind turbines does not pose a risk of hearing loss or any other adverse health effect in humans.
- Some people may be annoyed at the presence of sound from wind turbines. Annoyance is not a pathological entity.
- A major cause of concern about wind turbine sound is its fluctuating nature. Some may find this sound annoying, a reaction that depends primarily on personal characteristics as opposed to the intensity of the sound level.[2]

Wind Industry Position

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Utility Scale Wind Energy and Sound

Wind Energy, Sound, and Science

In 2009, the American Wind Energy Association (AWEA) and the Canadian Wind Energy Association (CanWEA) established a multidisciplinary scientific advisory panel comprising medical doctors, audiologists, and acoustical professionals to review current literature available on the perceived health effects of wind turbines. The panel, whose findings were published at the end of 2009, concluded that wind turbine sounds are not unique. Based on the levels and frequencies of the sounds, the panel found no reason to believe that turbines could plausibly have direct adverse physiological effects. An executive summary of the report is at http://www.awea.org/newsroom/releases/AWEA_CanWEA_SoundWhitePaper_ExecSumm.pdf.

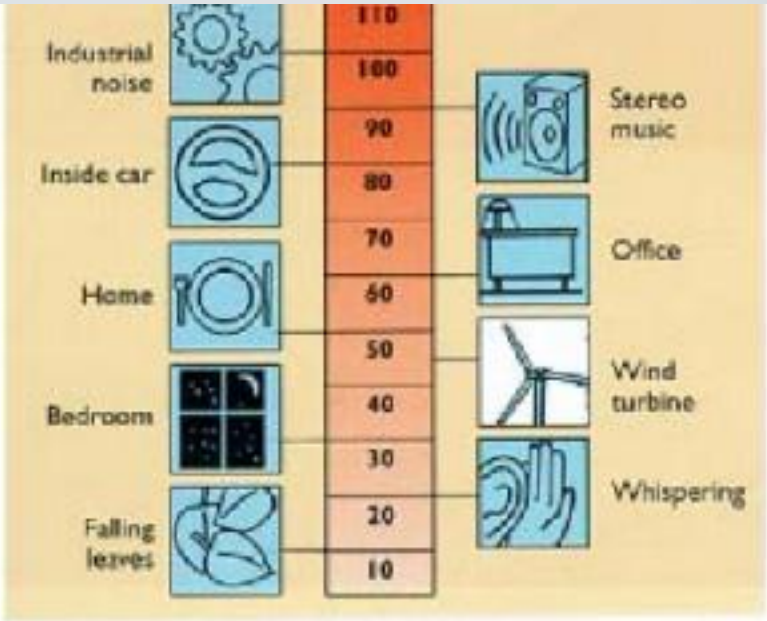
Wind Industry Position

AWEA AMERICAN WIND ENERGY ASSOCIATION

Utility Scale Wind Energy and Sound

Hertz. Sound pressure measurements that are weighted to how humans perceive them are called A-weighted and are denoted by the unit dB (A).

The graph shows the decibel level of common sounds, including wind turbines. In the range of 35 to 45 dB (A), at a distance of 350 meters, sound produced by wind turbines is similar to the background sound found in a typical home.



Wind Industry Position

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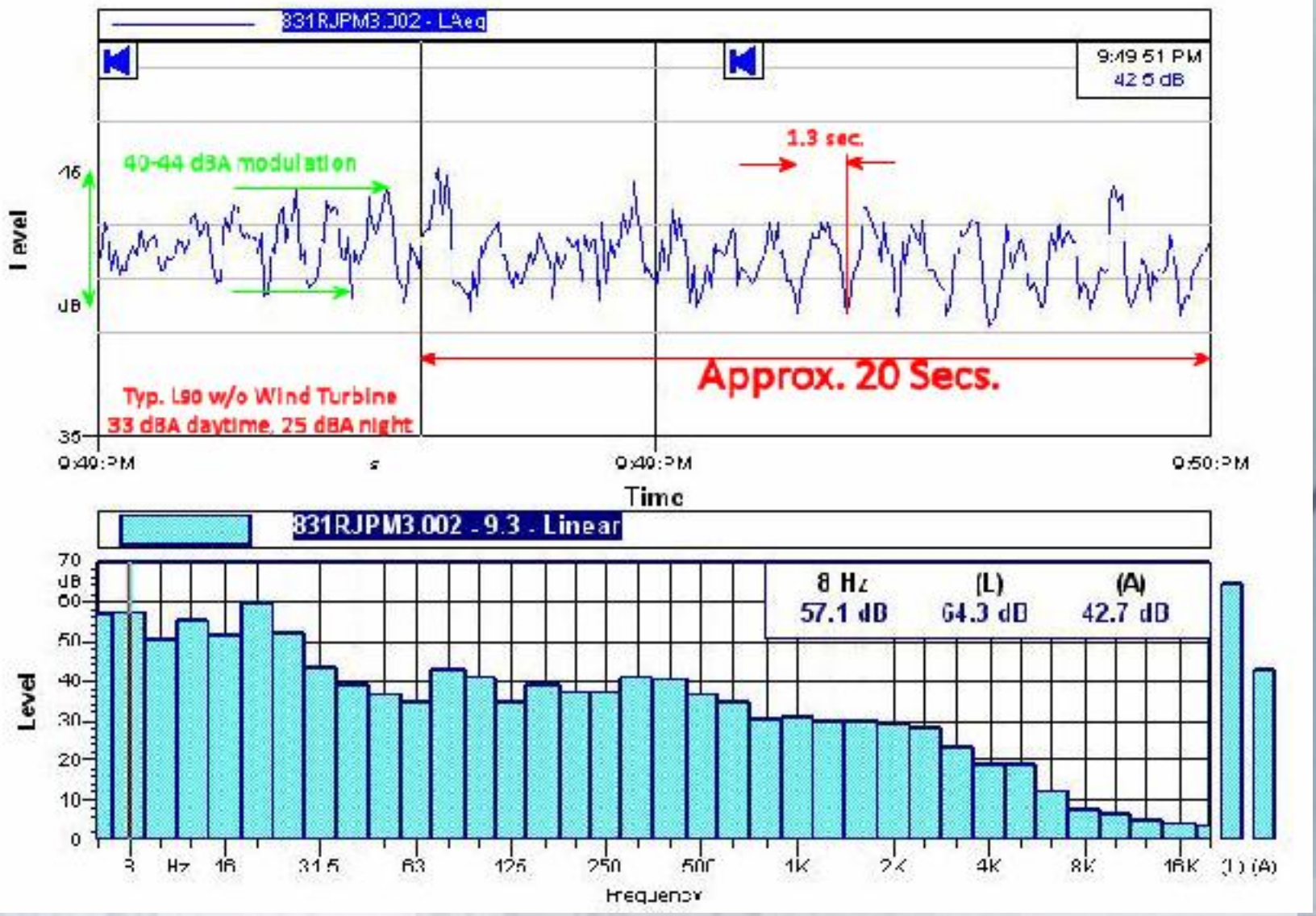
Utility Scale Wind Energy and Sound

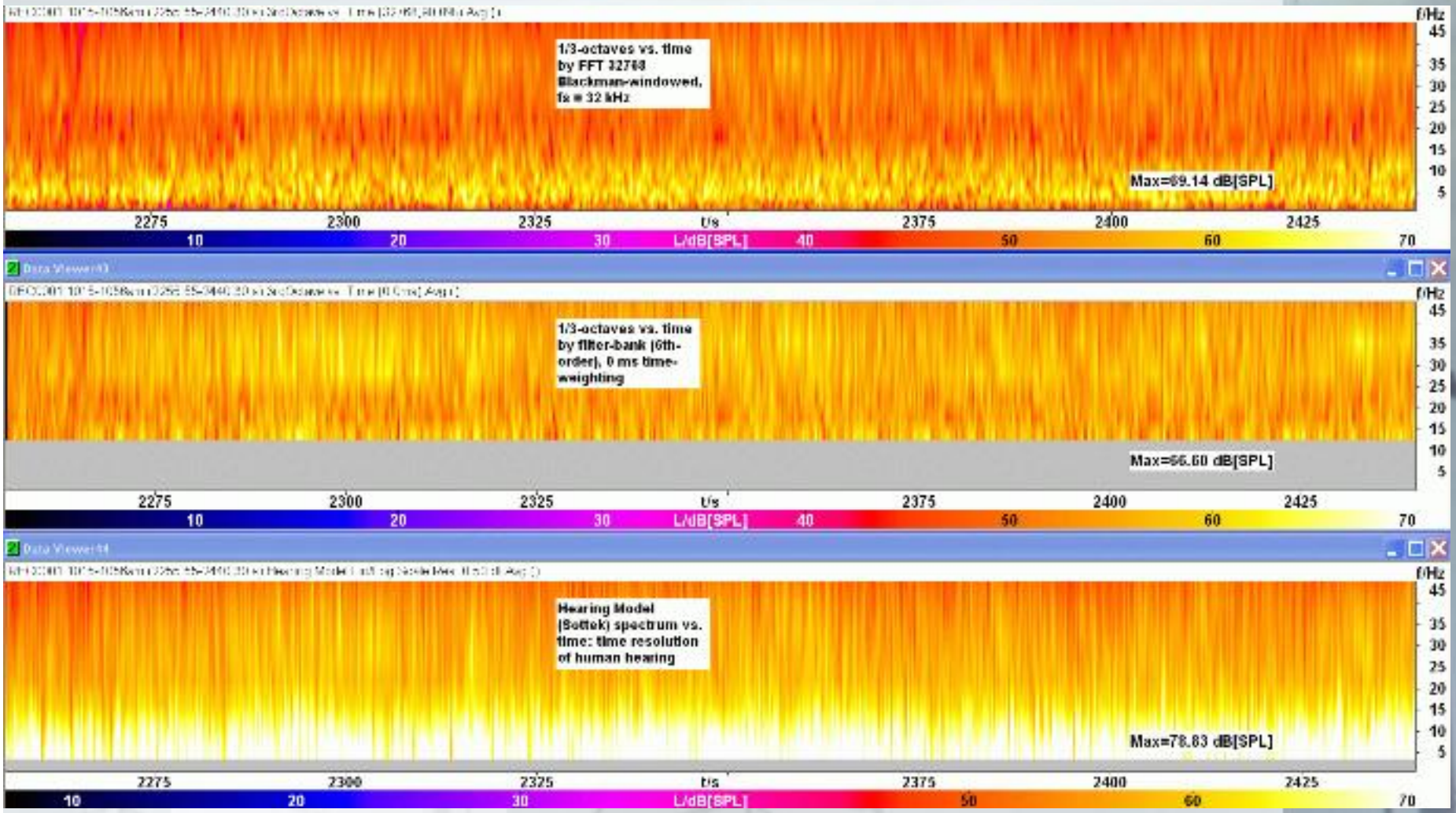
Wind plants are generally quiet

Wind plants are always located where the wind speed is higher than average, and the background sound of the wind itself will often "mask" any sounds that might be produced by operating wind turbines - especially because the turbines only run when the wind is blowing.

What We Knew about WT ILFN



New Insights Into Modulated WT ILFN



What The Public Needs to Know