

# Simple guidelines for siting wind turbines to prevent health risks

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## Initial Review of Wind Turbine Studies and Research

- **Studies performed to address annoyance complaints**
- **Studies of health complaints**
- **Review of Project EIS documents**
- **Review of WT research and technical papers**
- **Sound Criteria in other countries**

## Wind Turbine Siting Criteria for Sound

- **Single Level not-to-exceed criteria**
  - Germany 35dBA night rural/noise sensitive
  - Most countries other than North America use 40 dBA or lower
  - U.S.: 50 dBA or higher (1000 feet or less setbacks)
- **Nighttime Background level ( $L_{90A}$ ) + 5 dBA**
- **Most do not have any criteria for low frequency sound (e.g. dBC)**

## Harvest Wind, Elkton, MI



Michigan Wind Turbine Siting Standards permit 55 dBA or  $L_{90} + 5$  dBA whichever is highest at nearest residence

## Harvest Wind-1300 feet from home



## Cedar Ridge Wind Farm, 41 WT, 204 homes



Wisconsin Guidelines permit sound levels from WT to be 50 dBA at home

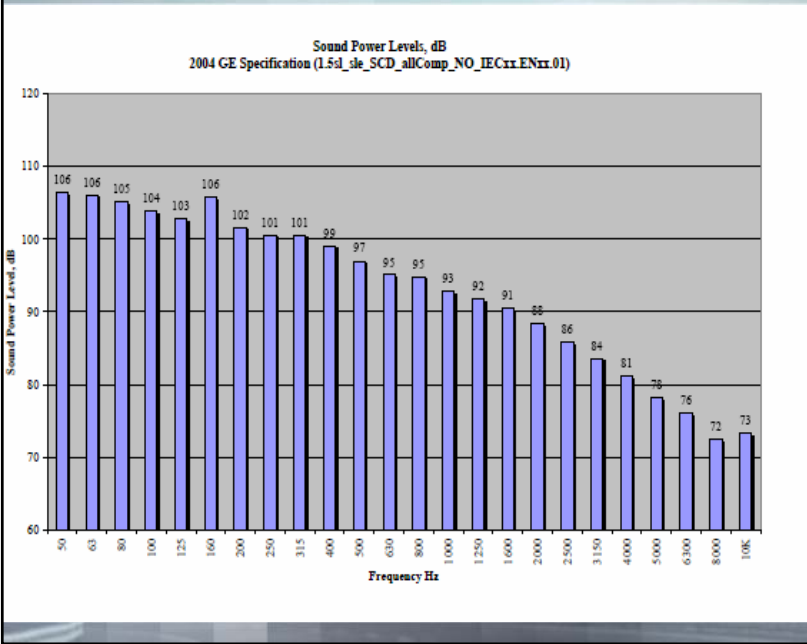
## Blue Sky, Green Fields, Johnsburg, WI



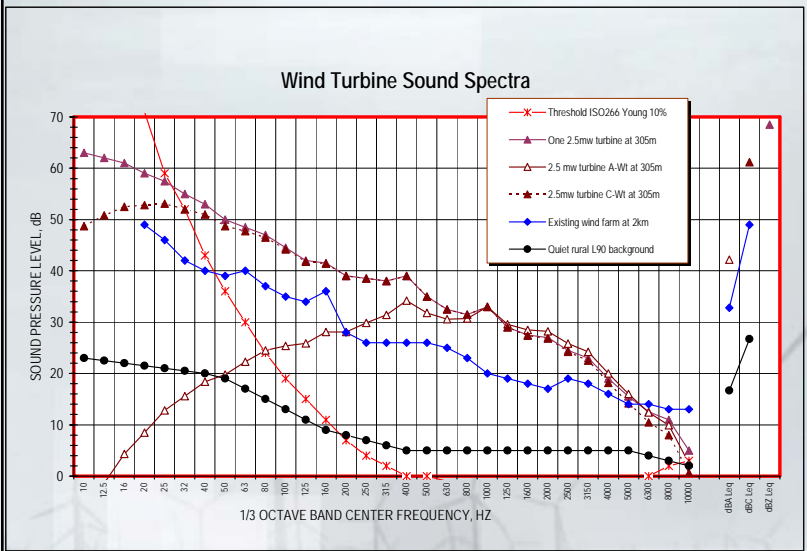
## Wind Turbine Complaints Attributed to Sound

- **Audible Sounds**
  - Reasonably steady sound of blades moving through air
  - Swishes, Thumps, etc
  - Periodic mechanical sounds
  - Rumble inside homes and other buildings
  - Higher annoyance at lower levels than other common Community Sound Sources
- **Non-auditory**
  - Body sensations
  - Building response

# GE Sound Power Level (1.5 Mwatt series)

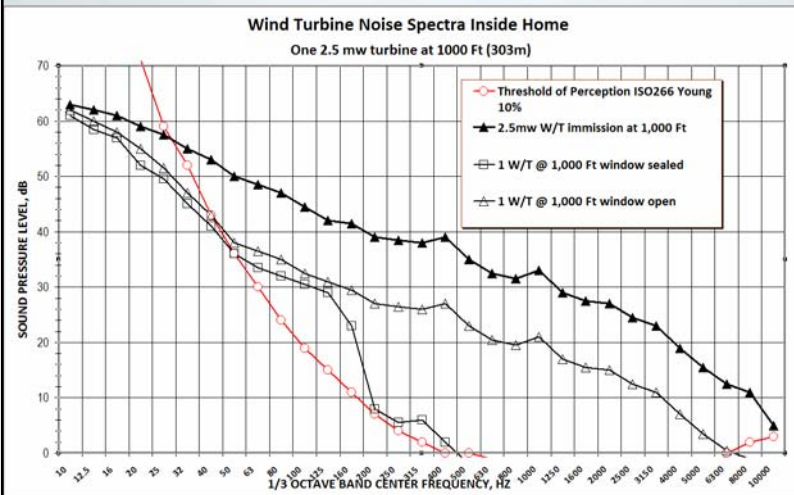


# Two Examples of Wind Turbine Sound

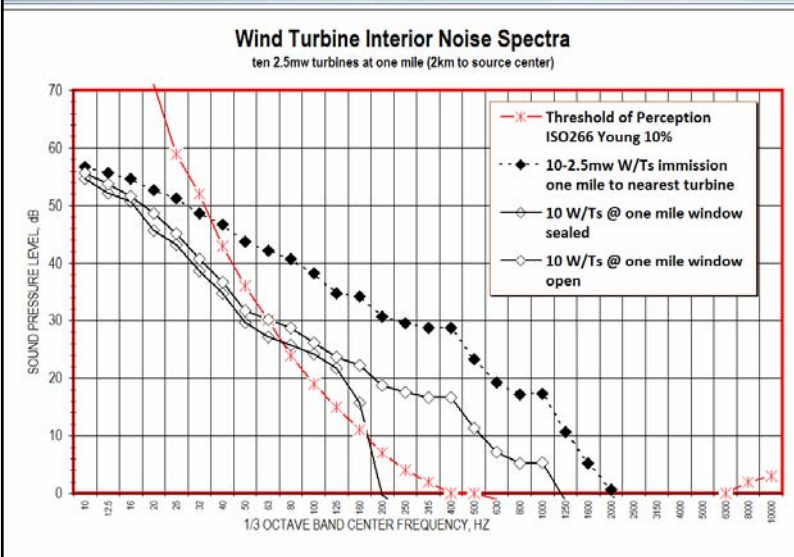




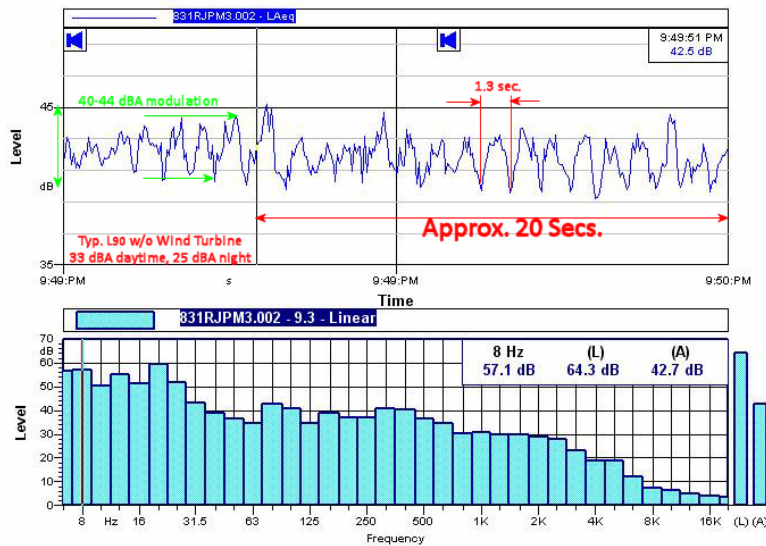
## Example of Interior Sound from WT @ 1000 ft.



## Example of Interior Sound from 10 WT @ one mile



## Wind Turbine Amplitude Modulation and Spectrum



## Wind Turbine Siting Criteria for Sound

- **Single Level not-to-exceed criteria**
  - Germany 35dBA night rural/noise sensitive
  - Most countries other than North America use 40 dBA or lower
  - U.S.: 50 dBA or higher (1000 feet setback typical)
    - Michigan permits 55 dBA or L90 + 5 dBA whichever is higher.
    - Ohio is considering 750 foot setbacks to encourage higher density turbine siting)
- **Nighttime Background level (L<sub>90A</sub>) + 5 dBA**
- **Most do not have any criteria for low frequency sound (e.g. dBC)**

## 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"**

## Recommendations for Sound Requirements

- **Audible Sound Limit**
  - Not-to-exceed the background  $L_{90A}+5$  dBA where  $L_{90A}$  is measured during a pre-construction noise study at the quietest time of night.
  - 5 dB penalty for pure tones.
  - Limits apply to Property lines, not homes
- **In-Audible (e.g. Low Frequency) Sound Limit**
  - $L_{eqC}-L_{90A}$  cannot exceed 20 dB at receiving property
  - Not to exceed 50  $L_{90C}$  from Wind Turbine (55  $L_{90C}$  for properties near major roads)



## Recommendations for Sound Requirements

- **General Clause**
  - Not to exceed 35 dBA within 100 feet of any occupied structure (or for more safety beyond the property line of the host's property.)
- **Requirements:**
  - All instruments must meet ANSI Type 1 performance specs.
  - Procedures must meet ANSI S12.9 and other applicable ANSI standards.
  - Measurements must be made when ground level winds are 10 mph or less. Background sound measurements are with winds of 2m/s (4.5 mph) or less. Wind shear in the evening and night often result in low ground level wind speed. At turbine fan heights, the wind must be at or above nominal operating wind speeds for operational test.