

Dearborn, Michigan

## **NOISE-CON 2008**

2008 July 28-31

# **Simple guidelines for siting wind turbines to prevent health risks**

George W. Kamperman  
Kamperman Associates, Inc.  
george@kamperman.com

Richard R. James  
E-Coustic Solutions  
rickjames@e-coustic.com

Industrial scale wind turbines are a familiar part of the landscape in Europe, U.K. and other parts of the world. In the U.S. similar wind energy developments are just beginning operation. This will increase given the push by the Federal and State Governments to promote renewable energy sources through tax incentives and other forms of economic and political support. States and local governments in the U.S. are promoting very lenient rules for how industrial wind farms can be located in communities which are predominantly quiet and rural. Studies already completed and currently in progress describe significant health effects associated with living in the vicinity of industrial grade wind turbines. This paper reviews a number of sites with known health problems and the sound studies conducted by consultants for governments, the wind turbine owner, or the local residents. The purpose is determine if a set of simple guidelines using dBA and dBC sound levels can serve as the 'safe' siting guidelines. Findings of the review and recommendations for sound limits will be presented. A discussion of how the proposed limits would have affected the existing sites where people have demonstrated pathologies apparently related to wind turbine sound will also be presented.

## **BACKGROUND**

A relatively new source of community noise is spreading rapidly across the rural U.S. countryside. Industrial grade wind turbines, a common sight in many European countries, are now being promoted by Federal and State governments as the way to minimize coal powered electrical energy and its effects on global warming. But, the initial developments using the newer 1.5 to 3 MWatt wind turbines here in the U.S. has also led to numerous complaints from residents who find themselves no longer in the quiet rural communities they were living in before the wind turbine developments went on-line. Questions have been raised about whether the current siting guidelines being used in the U.S. are sufficiently protective for the people living the closest to the developments. Research being conducted into the health issues using data from established wind turbine developments is beginning to appear that leaves open the possibility that there is a basis for the health concerns. Other research into the computer modeling and other methods used for determining the layout of the industrial wind turbine developments and the distances from residents in the adjacent communities are showing that the output of the models should not be considered accurate enough to be used as the sole basis for making the siting decisions.

The authors have reviewed a number of noise studies conducted in response to community complaints for wind energy systems sited in Europe, Canada, and the U.S. to determine if additional criteria are needed for establishing safe limits for industrial wind turbine sound immissions in rural communities. In several cases, the residents who filed the complaints have been included in studies by medical researchers who are investigating the potential health risks associated with living near industrial grade wind turbines 365 days a year. These studies were also reviewed by the authors to help in identifying what factors need to be considered in setting criteria for 'safe' sound limits at receiving properties. Due to concerns about medical privacy, details of these studies are not discussed in this paper. Current standards used in the U.S. and in most other parts of the world rely on not-to-exceed dBA sound levels, such as 50 dBA, or on not-to-exceed limits based on the pre-construction background sound level plus an adder (e.g.  $L_{90A} + 5$  dBA).

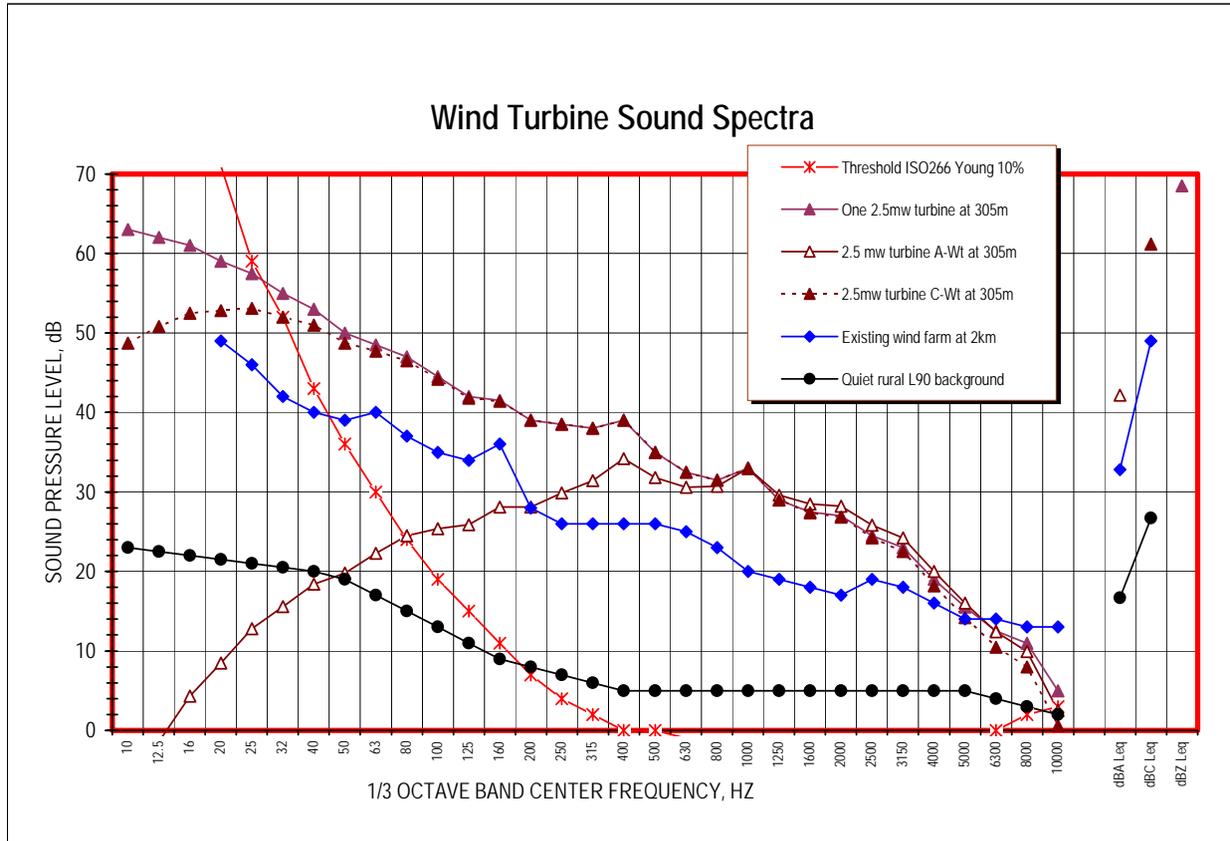


Figure 1-Generalized Sound Spectra vs. perception and rural community L<sub>90A</sub> background 1/3 octave SPL

6. Is wind turbine noise at a residence much more annoying than traffic noise? *Yes, researchers have found that “Wind turbine noise was perceived by about 85% of the respondents, even when the calculated A-weighted SPL*

## PROPOSED SOUND LIMITS

The simple fact that so many residents complain of low frequency noise from wind turbines is clear evidence the single A-weighted (dBA) noise descriptor used in most jurisdictions for siting turbines is not adequate. The only other simple audio frequency weighting that is standardized and available on all sound level meters is the C-weighting or dBC. A standard sound level meter set to measure dBA is increasingly less sensitive to low frequency below 500 Hz (one octave above middle-C). The same sound level meter set to measure dBC is equally sensitive to all frequencies above 32 Hz (lowest note on grand piano).

We are proposing to use the commonly accepted dBA criteria that is based on the pre-existing background sound levels plus a 5 dB allowance for the wind turbine's immissions (e.g.  $L_{90A} + 5$ ) for the audible sounds from wind turbines. But, to address the lower frequencies that are not considered in A-weighted measurements we are proposing to add limits based on dBC. The Proposed Sound Limits are presented in the text box at the end of this paper.

For the current industrial grade wind turbines in the 1.5 to 3 MWatt range the addition of the dBC requirement will result in an increased distance between wind turbines and the near-by residents. For the generalized graphs shown in Figure 1, the distances would need to be approximately double the current distance. This will result in setbacks in the range of 1 km or greater for the current generation of wind turbines if they are to be located in rural areas where the  $L_{90A}$  background sound levels are 30 dBA or lower. In areas with higher background sound levels, turbines could be located somewhat closer but still at a distance greater than the 305 m (1000 ft.) or less setbacks commonly seen in US based wind turbine developments.

## PROPOSED WIND TURBINE SITING SOUND LIMITS

### 1. Audible Sound Limit

- a. No Wind Turbine or group of turbines shall be located so as to cause an exceedance of the pre-construction/operation background sound levels by more than 5 dBA. The background sound levels shall be the  $L_{90A}$  sound descriptor measured during a pre-construction noise study during the quietest time of evening or night. All data recording shall be a series of contiguous ten (10) minute measurements.  $L_{90A}$  results are valid when  $L_{10A}$  results are no more than 15 dBA above  $L_{90A}$  for the same time period. Noise sensitive sites are to be selected based on wind development's predicted worst-case sound emissions (in  $L_{eqA}$  and  $L_{eqC}$ ) which are to be provided by developer.
- b. Test sites are to be located along the property line(s) of the receiving non-participating property(s).
- c. A 5 dB penalty is applied for tones or when the sound emissions fluctuate in amplitude or frequency over time in reasonable synchronicity with the blade revolution.

### 2. Low Frequency Sound Limit

- a. The  $L_{eqC}$  sound levels from the wind turbine at the receiving property shall not to exceed the lower of either:
  - 1)  $L_{eqC}-L_{90A}$  greater than 20 dB outside any occupied structure, or
  - 2) A maximum not-to-exceed sound level of 50 dBC.These limits shall be assessed using the same nighttime and wind/weather conditions required in 1.a. Turbine operating sound immissions ( $L_{eqA}$  and  $L_{eqC}$ ) shall represent worst case sound immissions for stable nighttime conditions with low winds at ground level and winds sufficient for full operating capacity at the hub.

### 3. General Clause

- a. Not to exceed 35 dBA within 30 m. (approx. 100 feet) of any occupied structure.

### 4. Requirements

- a. All instruments must meet ANSI or IEC Precision sound level meter performance specifications.
- b. Procedures must meet ANSI S12.9 and other applicable ANSI standards.
- c. Measurements must be made when ground level winds are 2m/s (4.5 mph) or less. Wind shear in the evening and night often result in low ground level wind speed and nominal operating wind speeds at wind turbine hub heights.
- d. IEC 61400 procedures are not suitable for enforcement of these requirements. ANSI standards shall be followed for testing procedures.