A Variety of Wind Turbine Noise Regulations in the United States – 2007

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Abstract

Similar to other new large-scale projects, proposed wind turbine projects can produce varying reactions among community residents, including potential concerns about noise. Both state and local governments within the United States have developed a variety of noise regulations that specifically address wind turbine installations. These regulations have sought a balance of allowing for wind turbine development with protection of the public from excessive noise. A presentation at the First International Meeting on Wind Turbine Noise 2005 focused on regulation of wind turbine noise in the Western United States. Since that time, new regulations have been adopted in areas throughout the United States. This paper will identify several types of regulations and discuss their characteristics and impact on wind turbine projects and their associated communities.

Introduction

Well-balanced noise regulations aim to protect the interests of both the general public and the business community. To encourage this balance the United States chose decades ago that noise be regulated by state and local governments rather than on a national level. Although several federal agencies are concerned with noise associated with transportation systems (highway, air, and rail), interstate gas transmission facilities (gas compressor stations), and developments on federally-owned land, there are no federal noise limits that apply to either individual wind turbines or to entire wind turbine projects. Many states have also chosen to consider noise a local issue best addressed by local regulations that reflect the specific needs and wishes of a community. Consequently, few states have enacted noise regulations or siting procedures that pertain specifically to wind turbine developments. Many local communities, which are typically rural in nature, are now for the first time reviewing site applications for small, medium, and large-scale wind turbine projects. In an effort to support this review process and to provide appropriate protection for all interested parties, communities have adopted a variety
of local laws since 2000 that specifically address wind turbine noise. An earlier paper, which was presented at the First International Meeting on Wind Turbine Noise 2005, describes the federal noise regulations and guidelines and discusses state and local noise regulations in the Western United States for wind turbines. We expect that noise and other associated wind turbine regulations throughout the U.S. will continue to evolve as wind turbine manufacturers advance the design and capacity of their machines, and as more communities gain experience in reviewing and hosting wind turbine developments. The wind industry, host communities, and government policy-makers will benefit by collecting and sharing this knowledge. The following provides examples of wind turbine noise regulations and comments on the salient features of these regulations.

**Positions on Wind Power**

Official statements of federal, state, and local government agencies uniformly embrace the development of renewable energy sources, including wind power. However, in practice, most regulation of a wind turbine project is at the local level, and local community attitudes and regulations can range from encouraging development to actively discouraging some development. Regulations may distinguish between private and commercial wind turbine developments, and set maximum heights and electrical ratings, number of turbines, and minimum setbacks, as well as other criteria in response to community wishes. One town’s thoughts and concerns are expressed below:

**Community Benefits and Concerns about Wind Power**

The “Wind Energy Facility Law of the Town of Ellenburg, New York,” (Local Law No. 4 of 2005)\(^2\) states its purpose, and also, identifies community benefits and concerns, including potential noise, that are associated with wind turbine developments. The local law contains:

§2 Purpose. The Town Board of the Town of Ellenburg adopts this Local Law to promote the effective and efficient use of the Town’s wind energy resource through wind energy conversion systems (WECS), and to regulate the placement of such systems so that the public health, safety, and welfare will not be jeopardized.

§4. Findings. The Town Board of the Town of Ellenburg finds and declares that:

1. Wind energy is an abundant, renewable and nonpolluting energy resource of the Town and its conversion to electricity may reduce dependence on nonrenewable energy sources and decrease the air and water pollution that results from the use of conventional energy sources.
2. The generation of electricity from properly Sited wind turbines, including small systems, can be cost effective, and in many cases existing power distribution systems can be used to transmit electricity from wind-generating stations to utilities or other users, or on-Site consumption can be reduced.
3. Regulation of the siting and installation of wind turbines is necessary for the purpose of protecting the health, safety, and welfare of neighboring property owners and the general public.
4. Wind Energy Facilities represent significant potential aesthetic impacts because of their large size, lighting, and shadow flicker effects.
5. If not properly regulated, installation of Wind Energy Facilities can create drainage problems through erosion and lack of sediment control for facility and access road Sites, and harm farmlands through improper construction methods.
6. Wind Energy Facilities may present a risk to bird and bat populations if not properly Sited.
7. If not properly Sited, Wind Energy Facilities may present risks to the property values of adjoining property owners.

8. Wind Energy Facilities are significant sources of noise, which, if unregulated, can negatively impact adjoining properties.

9. Construction of Wind Energy Facilities can create traffic problems and damage local roads.

10. Wind Energy Facilities can cause electromagnetic interference issues with various types of communications.

Of note, the Town of Malone, New York shares similar words in the Findings section of its local law, but names only large-scale multi-tower wind energy facilities in most of its statements.

**Project Size and Purpose**

The following paragraphs from the Town of Malone, New York Local Law of 2006 distinguish between private and commercial wind turbine developments, allowing one small tower (Wind Conversions System, WECS, no greater than 10 kW) per private party and strongly discouraging large-scale/commercial projects.

§ 80-11 Development Standards.

All small wind energy systems shall comply with the following standards. Additionally, such systems shall also comply with all the requirements established by other sections of this Article that are not in conflict with the requirements contained in this section.

1. A system shall be located on a lot a minimum of one acre in size, however, this requirement can be met by multiple owners submitting a joint application, where the aggregate size of their lots is at least one acre.

2. Only one Small WECS (plus, where authorized, a temporary wind measurement tower) per legal lot shall be allowed. Where there are multiple applicants, their joint lots shall be treated as one lot for purposes of this limitation.

3. Small WECS shall be used primarily to reduce the on-site consumption of utility-provided electricity.

§ 80-12 Standards

A Small Wind Energy System shall comply with the following standards:

1. **Setback requirements.** A Small WECS shall not be located closer to a property line than one and a half times the Total Height of the facility.

2. **Noise.** Except during short-term events including utility outages and severe wind storms, a Small WECS shall be designed, installed, and operated so that noise generated by the system shall not exceed the 50 decibels (dBA), as measured by an unweighted meter at the closest property line.

5. The maximum turbine power output is limited to 10 kW.

§ 80-14 Variances.

A. The Zoning Board of Appeals in accordance with its normal procedures may grant variances for Small WECS, but in no event shall the Zoning Board of Appeals grant a variance
allowing a larger WECS than permitted by this Chapter, or a WECS primarily designed to generate electricity for off-site use, or any large-scale multiple-tower wind facilities.

B. If a court of competent jurisdiction (1) orders the Zoning Board of Appeals to consider a use variance for any Wind Energy Facility other than a Small WECS, and such use variance is granted, or (2) the prohibition on any Wind Energy Facility other than a Small WECS is invalidated, no Wind Energy Facility shall be allowed except upon issuance of a Special Use Permit issued by the Town Board after a public hearing, which Permit shall require a Decommissioning Plan and removal bond, a Public Improvement Bond to protect public roads, and shall comply with the following minimum setbacks:

a. The statistical sound pressure level generated by a WECS shall not exceed L_{10} = 45 dBA measured at the nearest off-Site dwelling existing at the time of application. If the ambient sound pressure level exceeds 45 dBA, the standard shall be ambient dBA plus 5 dBA. Independent certification shall be provided before and after construction demonstrating compliance with this requirement.

b. 1,500 feet from the nearest Site boundary property line.

c. 1,500 feet from the nearest public road.

d. 1,500 feet from the nearest off-Site residence existing at the time of application, measured from the exterior of such residence.

Although the Malone Local Law does include noise and setback standards for a commercial and/or large-scale WECS, it requires a court order for the town to even consider a variance application for this type of WECS. In addition, defining the maximum rating at 10 kW for a small-scale WECS maintains a relatively low ceiling for the size of the units. The setbacks between the small-scale and commercial/large-scale developments also differ, with 1500 ft (460 m) minimum setbacks from the Site property line, public roads, and off-Site residences required for the wind turbines of the latter projects. The noise limits for the project types differ as well; the small scale WECS has L_{max}=50 dBA at the nearest property line and the commercial/large-scale WECS has L_{10}=45 dBA at the nearest off-Site dwelling (and for an elevated ambient, relaxes the L_{10} limit to ambient plus 5 dBA).

Other local laws may recognize the size (small or large) or type (non-commercial or commercial) development, but still set uniform standards for all wind turbines. For example, the Town of Westfield, New York - Local Law No. 2 for the Year 2002 requires for all WECS projects:

c. Setback. The minimum required setback for any WECS tower from property lines, overhead utility lines, dwellings, agricultural buildings, or other WECS shall be equal to 1.5 times the proposed structure height, including blades.

d. Noise. WECS towers shall be properly maintained and operated at all times and shall be located with relation to property lines so that the noise produced during operation shall not exceed fifty (50) dBA, measured at the boundaries of all of the closest parcels that are owned by non-site owners.

Project Participants

Both acoustic and non-acoustic factors strongly influence a person's reaction to sound. High level sounds, tones, beats, significant low-frequency energy, and other distinctive acoustic factors will contribute to annoyance. However, a person's feeling
about the source is a major non-acoustic factor, and indeed, may control the extent of a person’s annoyance to the sound. Power plant developers have long recognized that good community relations contribute to the success of a project. Although not a standard practice for siting traditional electric power plants, proponents of several projects have developed Property Value Assurance Plans where the project itself would purchase a nearby home at a fair market assessed price, should the resident decide to sell. The plant would then resell the home to a willing buyer. These programs, which were developed during each plant’s permitting process, helped to gain the community’s support for the project. In other cases, projects have purchased a noise easement from a resident only after considering and/or implementing other noise mitigation measures.

We understand that wind power developers have also offered a Property Value Assurance Plan to neighbors as well as purchased easements from neighbors. Wind power projects are unique in that developers must typically assemble a site by negotiating land lease and easement options with many community landowners during the permitting phase. Should the project move forward, these community residents would then become economic participants, and likely, would be more accepting of any project noise or other impacts. As acknowledgement of this condition, wind turbine laws normally distinguish between participants and non-participants and allow for project noise requirements and setbacks to be waived at a participant’s property.

In at least one case though, landowners’ plans to become wind power project participants could not be fulfilled. Wabaunsee County, Kansas has chosen to prohibit large wind turbines [greater than 100 kW or taller than 120 ft (37 m) in total height] and to limit small turbines to one turbine per 20 acres. This ban is in response to the county’s fear of large-scale wind turbine developments changing the overall character of its environment.

**State Level**

A few state agencies and environmental groups have published model ordinances to help guide local communities in developing local laws. The model ordinance recommended by the State of Wisconsin for local communities includes:

**Wisconsin’s Draft Model Ordinance (22 October 2003)**

1) Audible noise due to Wind Energy Facility operations shall not exceed fifty (50) dBA for any period of time, when measured at any residence, school, hospital, church or public library existing on the date of approval of any Wind Energy Facility Siting Permit.

2) In the event audible noise due to Wind Energy Facility operations contains a steady pure tone, such as a whine, screech, or hum, the standards for audible noise set forth in subparagraph 1) of this subsection shall be reduced by five (5) dBA. A pure tone is defined to exist if the one-third (1/3) octave band sound pressure level in the band, including the tone, exceeds the arithmetic average of the sound pressure levels of the two (2) contiguous one-third (1/3) octave bands by five (5) dBA (sic) for center frequencies of five hundred (500) Hz and above, by eight (8) dBA for center frequencies between one hundred and sixty (160) Hz and four hundred (400) Hz, or by fifteen (15) dBA for center frequencies less than or equal to one hundred and twenty-five (125) Hz.

3) In the event the ambient noise level (exclusive of the development in question) exceeds the applicable standard given above, the applicable standard shall be adjusted so as to equal the ambient noise level. The ambient noise level shall be expressed in terms of the highest whole number sound...
pressure level in dBA, which is succeeded for more than five (5) minutes per hour. Ambient noise levels shall be measured at the exterior of potentially affected existing residences, schools, hospitals, churches and public libraries. Ambient noise level measurement techniques shall employ all practical means of reducing the effect of wind generated noise at the microphone. Ambient noise level measurements may be performed when wind velocities at the proposed project site are sufficient to allow Wind Turbine operation, provided that the wind velocity does not exceed thirty (30) mph at the ambient noise measurement location.

4) Any noise level falling between two whole decibels shall be the lower of the two.

5) In the event the noise levels resulting from the Wind Energy Facility exceed the criteria listed above, a waiver to said levels may be granted by the Committee provided that the following has been accomplished:
   a. Written consent from the affected property owners has been obtained stating that they are aware of the Wind Energy Facility and the noise limitations imposed by this Ordinance, and that consent is granted to allow noise levels to exceed the maximum limits otherwise allowed; and
   b. If the applicant wishes the waiver to apply to succeeding owners of the property, a permanent noise impact easement has been recorded in the [Office of the Town/County Register of Deeds] which describes the benefited and burdened properties and which advises all subsequent owners of the burdened property that noise levels in excess of those permitted by this Ordinance may exist on or at the burdened property.

This model ordinance limits the Wind Energy Facility (WEF) sound level to $L_{max}=50$ dBA at noise sensitive receptors, reduces the limit by 5 dBA for tonal sound, increases the limit to match elevated ambient sound levels, and waives the limits for landowners who participate in the project (e.g., lease or noise easement with WEF). We do not know the primary source(s) for this model ordinance and it’s quite possible that Wisconsin borrowed paragraphs from elsewhere. However, since the time that this model ordinance was first published, communities from within and outside Wisconsin have adopted similar words for their own local laws. [A few sections have unfortunately propagated without revision though, such as the tonal criterion in Paragraph 2, which refers to dBA rather than dB; and of less importance, the ambient definition of the sound level exceeded for more than five minutes per hour rather than six minutes per hour (i.e., $L_{10}$ sound level)].

In contrast to the Wisconsin Model Ordinance, the model ordinance below, which was developed by an environmental organization (PennFuture) for the State of Pennsylvania, suggests higher sound limits for the WEF, does not consider potential tonal sound of the WEF, and does not address the ambient sound environment.

PennFuture Model Wind Ordinance (21 March 2006)

13. NOISE AND SHADOW FLICKER

A. Audible sound from a Wind Energy Facility shall not exceed fifty-five (55) dBA as measured at the exterior of any Occupied Building on a Non-participating Landowner’s property. Methods for measuring and reporting acoustic emissions from Wind Turbines and the Wind Energy Facility shall be equal to or exceed the minimum standards for precision described in AWEA Standard 2.1 - 1989 titled Procedures for the Measurement and Reporting of Acoustic Emissions from Wind Turbine Generation Systems Volume I: First Tier.

New York State has not developed a model ordinance for wind turbine developments, but instead, has summarized and published for general reference a
document on local ordinances. This on-line publication\(^2\) presents a wide variety of local ordinances adopted throughout New York State.

Applying another approach, the West Virginia Public Service Commission (WVPSC) has adopted a set of guidelines for noise studies for siting certificates, which they apply to wind power projects throughout that state. The guidelines require information on the existing ambient and sound estimates for the construction and operation of the proposed projects; they do not set standards. The required information includes:

Preconstruction – identify land uses and existing ambient sound levels (Ldn) in communities within one mile of the facility.

Construction – predict construction noise associated with blasting, earthmoving, pile driving, erection, traffic, and equipment installation at the nearest property boundary and within one mile and five miles from the facility. Identify noise sensitive areas within one mile and five miles of the facility. The noise sensitive areas include hospitals, schools, residences, cemeteries, parks, and churches. Describe construction equipment, procedure, and potential noise mitigation options.

Operation – predict operation noise and identify land uses and type of structures (residential, commercial, or industrial) within one mile of the facility. Describe equipment and procedures to mitigate potential noise.

The WVPSC reviews and evaluates this information, which is supplied by the project developer, during the permitting process for a wind power project.

**Local Level**

The noise standards in local laws can range from a relatively simple sound limit to a set of complex requirements for a wind power project. This section presents examples of local laws and comments on their various features.

**Antis Township, Pennsylvania (2006)**

A. Developer/Permittee shall comply with the following noise standards:

1. Developer/Permittee shall make a good faith effort to maintain a noise level attributable to the wind turbine generators of not more than 45dB (sic) within a reasonable margin of error as measured from the property line of existing Non-Participating residences;

2. The Parties acknowledge that the Project’s construction will be the source of intermittent noise. Developer/Permittee shall require all contractors to incorporate reasonable noise reduction measures in order to mitigate the amount of noise generated during the construction phase.

   (http://antistownship.org/antis/lib/antis/2006_wind_turbine_ordinance.pdf)

One questions whether “dBC” was intended by the township rather than “dBA”, however, of more interest here are the stated requirements of “good faith effort”, “reasonable margin of error”, and “reasonable noise reduction measures.” These qualitative standards would require interpretation and agreement by the community and developer for a project.
12.7. Subdivision 7 — Setback Requirements

<table>
<thead>
<tr>
<th>Object</th>
<th>Setback Over 100 KW</th>
<th>Setback Under 100 KW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residence (Other than applicant’s residence)</td>
<td>750 ft (229 m)</td>
<td>300 ft (91 m)</td>
</tr>
<tr>
<td>Project Boundary</td>
<td>5 rotor diameters</td>
<td>5 rotor diameters</td>
</tr>
<tr>
<td>Public Roads (from right-of-way)</td>
<td>300 ft (91 m)</td>
<td>1 times height (max)</td>
</tr>
<tr>
<td>Other Structures</td>
<td>1.25 times height</td>
<td>1.25 times height (max)</td>
</tr>
</tbody>
</table>

12.8. Subdivision 8 — Noise Standards

12.8.1. Noise is regulated by the MPCA under Chapter 7030. These rules establish the maximum nighttime and daytime noise levels that effectively limit wind turbine noise to 50 db (A) at farm residences. However, these standards may not be sufficient for the “preservation of public health and welfare” in relation to impulsive noises. Additional local limits relative to impulsive and pure tone noises may be appropriate.

(http://www.co.chippewa.mn.us/Ordinance%20Section%2012%20Windpower%20Mgt.pdf)

The standards require greater setbacks for wind turbines rated greater than 100 kW than those rated less than 100 kW, but they apply the same noise criterion for each size machine. In addition, they also suggest the need for more limits on wind turbine projects. The Minnesota Pollution Control Agency, (MPCA, a state agency) adopted a set of receptor noise standards over 25 years ago. The sound level standards (dBA) at noise sensitive receptors (e.g., residences) are: $L_{10}=65$ (day)/55 (night) and $L_{50}=60$ (day)/50 (night). We understand that funding has been reduced at MPCA and that enforcement of these standards has now been left to local governments.


“Large wind system” means a wind tower and turbine that has a nameplate capacity of more than 100 kilowatts or a total height of more than 170 feet, or both.

(2) Set Backs. The wind tower in a large wind system and each wind tower in a wind farm system must be set back:
(a) at least 1.1 times the total height of the large wind system from the property line of a participating property.
(b) at least 1,000 feet from the property line of a nonparticipating property unless the owner of the nonparticipating property grants an easement for a lesser setback. The easement must be recorded with the Register of Deeds and may not provide for a setback that is less than 1.1 times the total height of the large wind system.
(c) at least 1.1 times the total height of the large wind system or 500 feet, whichever is greater, from any public road or power line right-of-way.

(14) Noise. The noise generated by the operation of a large wind energy system may not exceed the ambient noise level by more than 5 dBA as measured at any point on property adjacent to the parcel on which the large wind energy system is located. The noise level generated by the operation of a large wind energy system will be determined during the investigation of a noise complaint by comparing the sound level measured when the wind generator blades are rotating to the sound level measured when the wind generator blades are stopped.


The Manitowoc County regulations define large wind systems by rated capacity (greater than 100 kW) and by height [taller than 170 ft (52 m)]. The standards for large wind systems have setbacks of 1000 ft (305 m) from the property lines of non-participating properties and 500 ft (152.5 m) from public roads and right-of-ways.
The sound limit for a large-scale wind power project is 5 dBA above the existing ambient sound level, measured at any location within an adjacent property.

**Benton County, Indiana**

A. Noise and Vibration

1. At no point within 200 feet of a primary residence may the sound pressure levels from a wind turbine exceed the following sound levels. Sound levels shall be measured with an octave band analyzer or sound level meter and associated filter manufactured in compliance with standards prescribed by the American National Standards Institute (ANSI). This standard shall supersede any noise standard(s) set forth in Section 8-7 of the Benton County Zoning Ordinance.

<table>
<thead>
<tr>
<th>Octave Bands (Hz), per ANSI</th>
<th>Maximum Permitted Sound Level (dB) measured 200 feet from the edge of any Primary Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>63</td>
<td>75</td>
</tr>
<tr>
<td>125</td>
<td>70</td>
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<tr>
<td>250</td>
<td>65</td>
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<td>4000</td>
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<td>8000</td>
<td>41</td>
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</table>

(http://www.ces.purdue.edu/Benton/files/noise%20and%20vibration.pdf)

This standard attempts to address the spectral content of the wind turbine sound. We note that a sound that matches the maximum permitted level for each octave band would result in an overall A-weighted sound level of 62 dBA; this overall sound level is significantly greater than limits in other wind turbine laws that we have reviewed.

**Summary - Features in Wind Turbine Regulations**

The list below summarizes the numerous features that we have found in the variety of wind turbine noise regulations:

**Project Type**
- Small-scale/large-scale (10 kW, 20 kW, 100 kW)
- Single tower/multi-tower
- Private/commercial

**Overall Sound Level (dBA)**
- Absolute (Lmax, L10, L50; 45, 50, 55, 60 dBA)
- Relative to ambient (equal, +5 dBA)

**Spectral Content**
- Tone (qualitative, quantitative criterion)
- 1/3 or 1/1 octave band limits
- dBC

**Other Characteristics**
- Impulsive
- Low frequency

**Measurement Location**
- Site property line
- Non-participant's property line
- Noise-sensitive non-participant's structure (e.g., residence)

**Related Standards**
- Setback (300, 750, 1000, 1500 ft) – 90 m to 460 m
- Height (65, 80, 120, 125, 170, 350, 400, 440 ft) – 20 m to 135 m
- Participants (easement, waiver)
Conclusions
Most regulation is performed on the local level, with the noise standards and related size and setback standards reflecting the different positions of communities on wind turbine development. As wind turbine designs evolve and as communities gain more experience in reviewing and hosting wind power projects, we expect that the regulations will also evolve in a continuing effort to balance the interests of all parties.

References


3 ANP-Blackstone and Ocean State Power Combined-Cycle Power Projects.

4 NEA-Bellingham Cogeneration Power Project.