CHAMPAIGN COUNTY ZONING BOARD OF APPEALS
NOTICE OF REGULAR MEETING

Date: **January 14, 2010**
Time: **6:30 P.M.**
Place: **Lyle Shields Meeting Room**
Brookens Administrative Center
1776 E. Washington Street
Urbana, IL 61802

Note: NO ENTRANCE TO BUILDING FROM WASHINGTON STREET PARKING LOT AFTER 4:30 PM.
Use Northeast parking lot via Lierman Ave.. and enter building through Northeast door.

If you require special accommodations please notify the Department of Planning & Zoning at (217) 384-3708

EVERYONE MUST SIGN THE ATTENDANCE SHEET – ANYONE GIVING TESTIMONY MUST SIGN THE WITNESS FORM

AGENDA

1. Call to Order
2. Roll Call and Declaration of Quorum
3. Correspondence
4. Approval of Minutes (December 17, 2009)
5. Continued Public Hearings

Case 634-AT-08 Part B. Petitioner: **Zoning Administrator**

Request: **Amend the Champaign County Zoning Ordinance as follows:**

1. **Add definitions for "SMALL WIND TURBINE TOWER" and "BIGWIND TURBINE TOWER," and revise the definition for "WIND FARM."**

2. **Amend subsection 4.2.1. to allow BIG WIND TURBINE TOWER as a second principal use on lots in the AG-1 and AG-2 Zoning Districts.**

3. **Amend paragraph 4.3.1E. to add new height regulations that apply to "SMALL WIND TURBINE TOWER" and "BIG WIND TURBINE TOWER."**

4. **In Section 5.2 replace "wind turbine" with "BIG WIND TURBINE TOWER", and indicate BIG WIND TURBINE TOWER is only authorized as a second principle use on lots in certain Zoning Districts.**

5. **In Section 6.1.3 add new standard conditions for "BIG WIND TURBINE TOWER" that are similar to the standard conditions for a WIND FARM.**

6. **Add new subsection 7.7 making "SMALL WIND TURBINE TOWER" an authorized accessory use by-right in all zoning districts and add requirements <u>including but not limited to:</u>**
   a. **the turbine must be located more than one and one half miles from the nearest municipal zoning jurisdiction; and**
   b. **minimum required yards that are the same as for other accessory structures in the district provided that the overall height is not more than 100 feet; and**
   c. **an overall height limit of 200 feet provided that the separation from the nearest property line is at least the same as the overall height and authorize private waivers of the separation by adjacent neighbors; and**

Case 634-AT-08, Part B Cont:

d. **a limit of no more than two turbine towers per lot; and**
e. **allowable noise limits; and**
f. **a requirement for engineer certification; and**
g. **a requirement to notify the electrical power provider if interconnected to the electrical grid; and**
h. **a requirement that no interference with neighboring TV, radio, or cell phone reception; and**
i. **a requirement for the removal of inoperable wind turbines.**

7. **In Section 9.3.1 add fees for SMALL WIND TURBINE TOWER and BIG WIND TURBINE TOWER.**

8. **In Section 9.3.3 add application fees for BIG WIND TURBINE TOWER Special Use Permit.**

***Case 645-S-09** Petitioner: **Robert and Barbara Gerdes**

Request: **Authorize the construction and use of a "Restricted Landing Area" as a Special Use in the AG-1 Agriculture Zoning District.**

Location: **An approximately 83 acre tract that is approximately the West Half of the Southwest Quarter of Section 33 of Ayers Township and commonly known as the farm at 52 CR 2700E, Broadlands.**

Case 658-AT-09 Petitioner: **Champaign County Zoning Administrator**

Request: **Amend the Champaign County Zoning Ordinance as follows:**
Part A:
1. **Delete subparagraph 6.1.4 A.1.c. to make consistent with paragraph 6.1.4 M.**
2. **Amend paragraph 6.1.4C.11. to require the wind farm separation from restricted landing areas or residential airports only for restricted landing areas and residential airports that existed on the effective date of County Board adoption of Case 658-AT-09.**

Part B:
1. **Amend paragraph 6.1.1 A.5. to reference the requirements of paragraph 6.1.4 P.5.**
2. **Amend paragraph 9.1.11 D.1. to include reference to subsection 6.1 instead of subsection 6.1.3.**

6. New Public Hearings

7. Staff Report

8. Other Business
   A. Cancellation of January 28, 2010, ZBA meeting

9. Audience Participation with respect to matters other than cases pending before the Board

10. Adjournment

*** Administrative Hearing. Cross Examination allowed.**

CASE NO. 634-AT-08 Part B

SUPPLEMENTAL MEMORANDUM

January 7, 2010

Champaign County Department of
PLANNING & ZONING

Brookens Administrative Center
1776 E. Washington Street
Urbana, Illinois 61802

(217) 384-3708

Petitioner: **Zoning Administrator**

Prepared by: **John Hall** Zoning Administrator — **JR Knight** Associate Planner

Request: **Amend the Champaign County Zoning Ordinance as follows:**

1. **Add definitions for "SMALL WIND TURBINE TOWER" and "BIG WIND TURBINE TOWER", and revise the definition for "WIND FARM."**
2. **Amend subsection 4.2.1. to allow BIG WIND TURBINE TOWER as a second principal use on lots in the AG-1 and AG-2 Zoning Districts.**
3. **Amend paragraph 4.3.1E. to add new height regulations that apply to "SMALL WIND TURBINE TOWER" and "BIG WIND TURBINE TOWER".**
4. **In Section 5.2 replace "wind turbine" with "BIG WIND TURBINE TOWER".**
5. **In Section 6.1.3 add new standard conditions for "BIG WIND TURBINE TOWER" that are similar to the standard conditions for WIND FARM.**
6. **Add new subsection 7.7 making "SMALL WIND TURBINE TOWER"an authorized accessory use by-right in all zoning districts and add requirements including but not limited to:**
   a. **the turbine must be located more than one and one half miles from the nearest municipal zoning jurisdiction; and**
   b. **minimum required yards that are the same as for other accessory structures in the district provided that the overall height is not more than 100 feet; and**
   c. **an overall height limit of 200 feet provided that the separation from the nearest property line is at least the same as the overall height and authorize private waivers of the separation by adjacent neighbors; and**
   d. **a limit of no more than two turbine towers per lot; and**
   e. **allowable noise limits; and**
   f. **a requirement for engineer certification; and**
   g. **a requirement to notify the electrical power provider if interconnected to the electrical grid; and**
   h. **a requirement for no interference with neighboring TV, radio, or cell phone reception; and**
   i. **a requirement for the removal of inoperable wind turbines.**
7. **In Section 9.3.1 add fees for SMALL WIND TURBINE TOWER and BIG WIND TURBINE TOWER.**
8. **In Section 9.3.3 add application fees for BIG WIND TURBINE TOWER Special Use Permit.**

STATUS

This case was continued from the November 12, 2009, ZBA meeting. Due to weather conditions there was a shortened mail deadline this week and staff was not able to prepare all necessary supplemental information in time. Additional information will be sent out before the meeting.

ATTACHMENTS

A *Wind Turbine Noise Issues* by Anthony L Rogers, and James Manwell (attached separately)
B Draft *AWEA Small Wind Turbine Performance and Safety Standard* (attached separately)
C Packet of information from Steve Burdin, received on December 31, 2009 (attached separately)

Wind Turbine Noise Issues

A white paper
prepared by the

Renewable Energy Research Laboratory
Center for Energy Efficiency and Renewable Energy
Department of Mechanical and Industrial Engineering
University of Massachusetts at Amherst
Amherst, MA 01003

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June 2002
Amended March 2004

Table of Contents

Introduction

Wind turbines generate noise from multiple mechanical and aerodynamic sources. As the technology has advanced, wind turbines have gotten much quieter, but noise from wind turbines is still a public concern. The problems associated with wind turbine noise have been one of the more studied environmental impact areas in wind energy engineering. Noise levels can be measured, but, similar to other environmental concerns, the public's perception of the noise impact of wind turbines is in part a subjective determination.

Noise is defined as any unwanted sound. Concerns about noise depend on 1) the level of intensity, frequency, frequency distribution and patterns of the noise source; 2) background noise levels; 3) the terrain between the emitter and receptor; and 4) the nature of the noise receptor. The effects of noise on people can be classified into three general categories (National Wind Coordinating Committee, 1998):

1) Subjective effects including annoyance, nuisance, dissatisfaction

2) Interference with activities such as speech, sleep, and learning

3) Physiological effects such as anxiety, tinnitus, or hearing loss.

In almost all cases, the sound levels associated with wind turbines produce effects only in the first two categories. Workers in industrial plants, and those who work around aircraft can experience noise effects in the third category. Whether a noise is objectionable will depend on the type of noise (tonal, broadband, low frequency, or impulsive) and the circumstances and sensitivity of the person (or receptor) who hears it. Because of the wide variation in the levels of individual tolerance for noise, there is no completely satisfactory way to measure the subjective effects of noise or of the corresponding reactions of annoyance and dissatisfaction.

Operating noise produced from wind turbines is considerably different in level and nature than most large scale power plants, which can be classified as industrial sources. Wind turbines are often sited in rural or remote areas that have a corresponding ambient noise character. Furthermore, while noise may be a concern to the public living near wind turbines, much of the noise emitted from the turbines is masked by ambient or the background noise of the wind itself.

At the present time, the noise produced by wind turbines has diminished as the technology has improved. As blade airfoils have become more efficient, more of the wind energy is converted into rotational energy, and less into acoustic noise. Vibration damping and improved mechanical design have also significantly reduced noise from mechanical sources.

The significant factors relevant to the potential environmental impact of wind turbine noise are shown in Figure 1 (Hubbard and Shepherd, 1990). Note that all acoustic technology is based on the following primary elements: Noise sources, propagation paths, and receivers. In the following sections, after a short summary of the basic principles of sound and its measurement, a review of noise generation from wind turbines, noise propagation, as well as noise prediction methods are given.

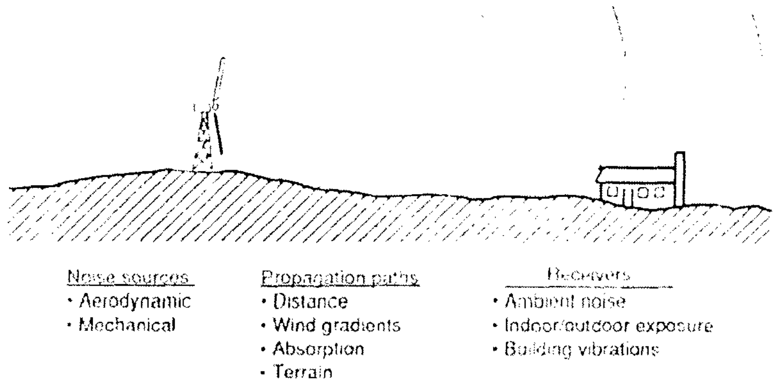

Figure 1. Sound Pressure Level (SPL) Examples

Noise and Sound Fundamentals

Sound and Noise

Sounds are characterized by their magnitude (loudness) and frequency. There can be loud low frequency sounds, soft high frequency sounds and loud sounds that include a range of frequencies. The human ear can detect a very wide range of both sound levels and frequencies, but it is more sensitive to some frequencies than others.

Sound is generated by numerous mechanisms and is always associated with rapid small scale pressure fluctuations, which produce sensations in the human ear. Sound waves are characterized in terms of their amplitude or magnitude (see below), wavelength, λ, frequency, f, and velocity v, where v is found from:

$$v = f\lambda$$

The velocity of sound is a function of the medium through which it travels, and it generally travels faster in more dense mediums. The velocity of sound is about 340 m/s (1115 ft.s) in air at standard pressures. Sound frequency (or pitch) determines the 'note' at which it sounds, and, in many cases, corresponds to notes on the musical scale (Middle C is 262 Hz). An octave is a frequency range between a sound with one frequency and one with twice that frequency, a concept often used to define ranges of sound frequency values. The frequency range of human hearing is quite wide, generally ranging from about 20 to 20 kHz (about 10 octaves). Finally, sounds experienced in daily life are usually not a single frequency, but are formed from a mixture of numerous frequencies, from numerous sources.

Sound turns into noise when it is unwanted. Whether sound is perceived as a noise depends on subjective factors such as the amplitude and duration of the sound. There are numerous physical quantities that have been defined which enable sounds to be compared and classified, and which also give indications for the human perception of sound. They are discussed in numerous texts on the subject (e.g., for wind turbine noise see Wagner, et al., 1996) and are reviewed in the following sections.

Sound Power and Pressure Measurement Scales

It is important to distinguish between the two measures of the magnitude of sounds: sound power level and sound pressure level. Sound power level is property of the source of the sound and it gives the total acoustic power emitted by the source. Sound pressure is a property of sound at a given observer location and can be measured there by a single microphone.

Because of the wide range of sound pressures to which the ear responds (a ratio of 10^5 or more for a normal person), sound pressure is an inconvenient quantity to use in graphs and tables. In addition, the human ear does not respond linearly to the amplitude of sound pressure, and, to approximate it, the scale used to characterize the sound power or pressure amplitude of sound is logarithmic (see Beranek and Ver, 1992). Whenever the magnitude of an acoustical quantity is given in a logarithmic form, it is said to be a level in decibels (dB) above or below a zero reference level.

The sound power level of a source, L_W, in units of decibels (dB), is given by:

$$L_W = 10 \log_{10}(P/P_0)$$

with P equal to the sound power of the source and P_0 a reference sound power (usually 10^{-12} Watts).

The sound pressure level (SPL) of a noise, L_p, in units of decibels (dB), is given by:

$$L_p = 20 \log_{10}(p/p_0)$$

with p equal to the effective (or root mean square, rms) sound pressure and p_0 a reference rms sound pressure (usually $20\ 10^{-5}$ Pa).

Figure 2 gives some examples for various sound pressure levels on the decibel scale. The threshold of pain for the human ear is about 200 Pa, which has an SPL value of 140 dB.

Measurement of Sound or Noise

Sound pressure levels are measured via the use of sound level meters. These devices make use of a microphone that converts pressure variations into a voltage signal which is then recorded on a meter (calibrated in decibels). As described above, the decibel scale is logarithmic. A sound level measurement that combines all frequencies into a single weighted reading is defined as a broadband sound level. For the determination of the human ear's response to changes in noise, sound level meters are generally equipped with filters that give less weight to the lower frequencies. As shown in Figure 3, there are a number of filters (such as A, B, and C) that accomplish this. The most common scale used for environmental noise assessment is the A scale, and measurements made using this filter network are expressed in units of dB(A). Details of these scales are discussed by Beranek and Ver (1992).

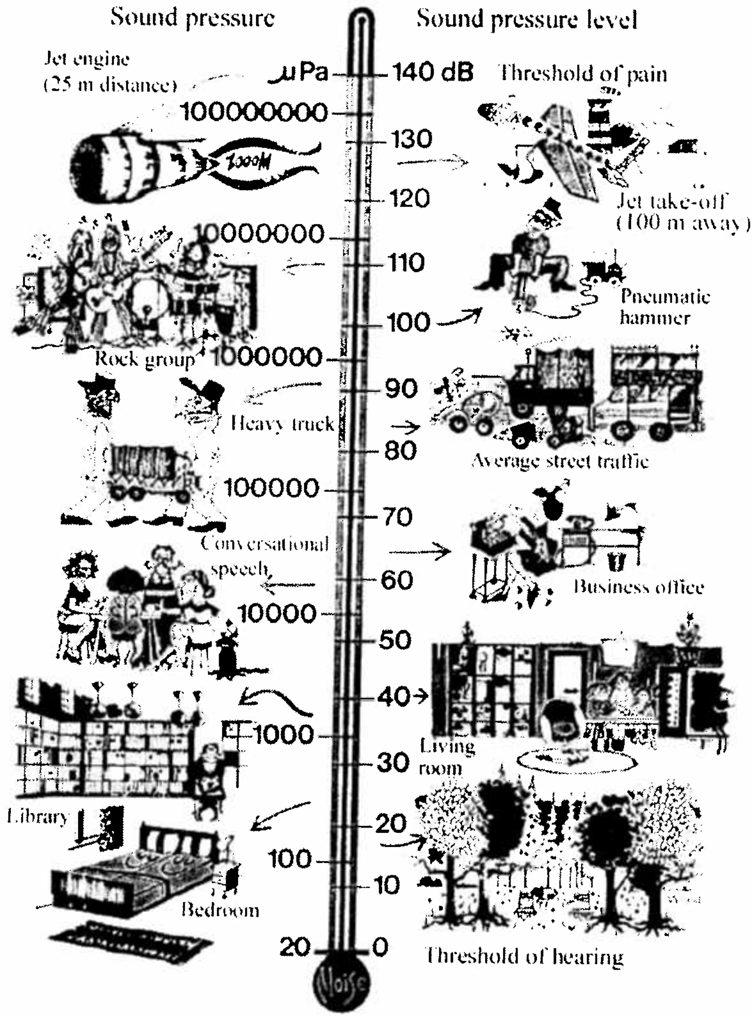

Figure 2. Sound Pressure Level (SPL) Examples (Bruel and Kjaer Instruments)

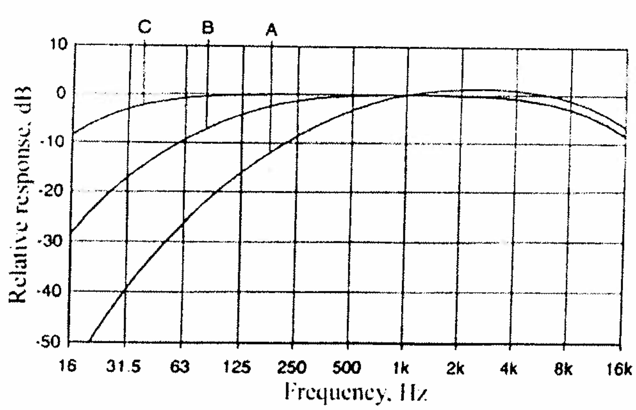

Figure 3. Definition of A, B, and C Frequency Weighing Scales (Beranek and Ver, 1992)

The human response to sounds measured in decibels has the following characteristics:

- Except under laboratory conditions, a change in sound level of 1 dB cannot be perceived.
- Doubling the energy of a sound source corresponds to a 3 dB(A) increase
- Outside of the laboratory, a 3 dB change in sound level is considered a barely discernible difference.
- A change in sound level of 5 dB will typically result in a noticeable community response.
- A 6 dB(A) increase is equivalent to moving half the distance towards a sound source
- A 10 dB increase is subjectively heard as an approximate doubling in loudness, and almost always causes an adverse community response.
- The threshold of pain is an SPL of 140 dB(A)

Once the A weighted sound pressure is measured over a period of time, it is possible to determine a number of statistical descriptions of time-varying sound and to account for the greater community sensitivity to nighttime noise levels. Common descriptors include:

1) L_{10}, L_{50}, L_{90}. The A-weighted noise levels that are exceeded 10%, 50%, and 90% of the time, respectively. During the measurement period L_{90} is generally taken as the background noise level.

2) L_{eq}. Equivalent Sound Level. The average A-weighted sound pressure level which gives the same total energy as the varying sound level during the measurement period of time.

3) L_{dn}. Day-Night Level. The average A-weighted noise level during a 24 hour day, obtained after addition of 10 dB to levels measured in the night between 10 p.m. and 7 a.m.

dB Math

From the comments above it can be seen that decibels do not add numerically as linear measures of other physical things do. Figure 4 shows how to add the decibels of two noise sources that are within 12 dB(A) of each other.

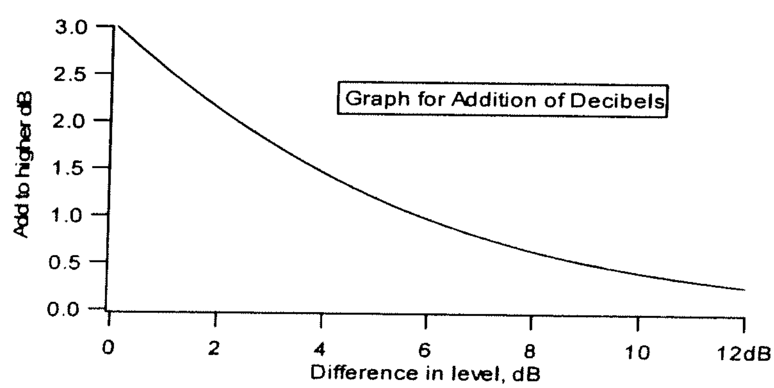

Figure 4. Addition of two sound levels.

For example, when adding two sound sources together, one being 9.5 dB(A) louder than the second, the resultant is approximately 10 dB(A) louder than the second source. It can be seen that when the sound from two sources more than 10 dB apart are combined, the total sound pressure level in decibels is very close to the louder one, with little or no contribution from the softer sound.

Sources of Wind Turbine Noise

Sources of Wind Turbine Noise

There are four types of noise that can be generated by wind turbine operation: tonal, broadband, low frequency, and impulsive:

1) Tonal. Tonal noise is defined as noise at discrete frequencies. It is caused by wind turbine components such as meshing gears, non aerodynamic instabilities interacting with a rotor blade surface or unstable flows over holes or slits or a blunt trailing edge.

2) Broadband. This is noise characterized by a continuous distribution of sound pressure with frequencies greater than 100 Hz. It is often caused by the interaction of wind turbine blades with atmospheric turbulence, and also described as a characteristic "swishing" or "whoosing" sound.

3) Low frequency. Noise with frequencies in the range of 20 to 100 Hz is mostly associated with downwind turbines (turbines with the rotor on the downwind side of the tower). It is caused when the turbine blade encounters localized flow deficiencies due to the flow around a tower.

4) Impulsive. This noise is described by short acoustic impulses or thumping sounds that vary in amplitude with time. It is caused by the interaction of wind turbine blades with disturbed air flow around the tower of a downwind machine.

The sources of noise emitted from operating wind turbines can be divided into two categories: 1) Mechanical, and 2) Aerodynamic. The primary sources of mechanical noise are the gearbox and the generator. Mechanical noise is transmitted along the structure of the turbine and is radiated from its surfaces. Aerodynamic noise is produced by the flow of air over the blades. A summary of each of these noise mechanisms follows. A more detailed review is included in the text of Wagner, et al. (1996).

Mechanical Noise

Mechanical noise originates from the relative motion of mechanical components and the dynamic response among them. Sources of such noise includes:

- Gearbox
- Generator
- Yaw Drives
- Cooling Fans
- Auxiliary Equipment (e.g., hydraulics)

Since the emitted noise is associated with the rotation of mechanical and electrical equipment, it tends to be tonal (of a common frequency), although it may have a broadband component. For example, pure tones can be emitted At the rotational frequencies of shafts and generators, and the meshing frequencies of the gears.

In addition, the hub, rotor, and tower may act as loudspeakers, transmitting the mechanical noise and radiating it. The transmission path of the noise can be air-borne or structure-borne. Air-borne means that the noise is directly propagated from the component surface or interior into the air. Structure-borne noise is transmitted along other structural components before it is radiated into the air. For example, Figure 5 shows the type of transmission path and the sound power levels for the individual components for a 2 MW wind turbine (Wagner, et al., 1996). Note that the main source of mechanical noise in this example is the gearbox, which radiates noise from the nacelle surfaces and the machinery enclosure.

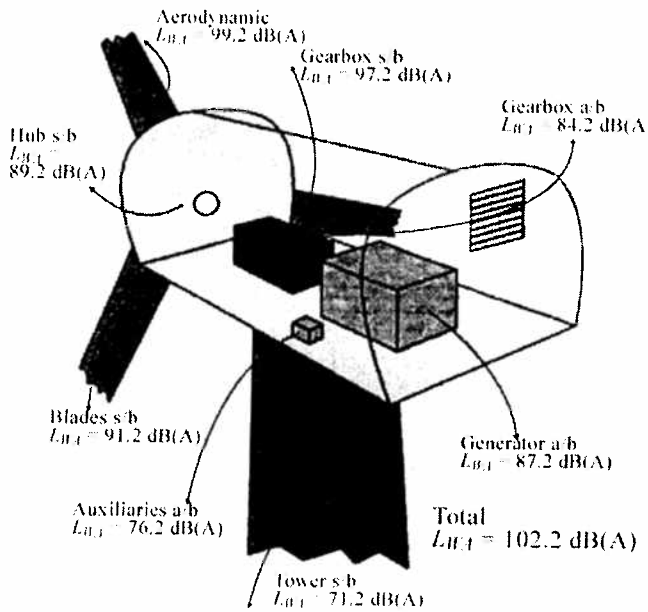

Figure 5. Components and Total Sound Power Level of a Wind Turbine

Aerodynamic Noise

Aerodynamic noise originates from the flow of air around the blades. As shown in Figure 6, a large number of complex flow phenomena occur, each of which might generate some noise. Aerodynamic noise generally increases with rotor speed. Aerodynamic broadband noise is typically the largest source of wind turbine noise. The various aerodynamic noise mechanisms that have to be considered are shown in Table 1 (Wagner, et al., 1996). They are divided into three groups:

1) Low Frequency Noise. This group is related to the low frequency part of the sound spectrum. This type of noise is generated when the rotating blade encounters localized flow deficiencies due to the flow around a tower, wind speed changes, or wakes shed from other blades.

2) Inflow Turbulence Noise. Depends on the amount of atmospheric turbulence. The atmospheric turbulence results in local force or local pressure fluctuations around the blade.

3) Airfoil Self Noise. This group includes the noise generated by the air flow right along the surface of the airfoil. This type of noise is typically of a broadband nature, but tonal components may occur due to blunt trailing edges, or flow over slits and holes.

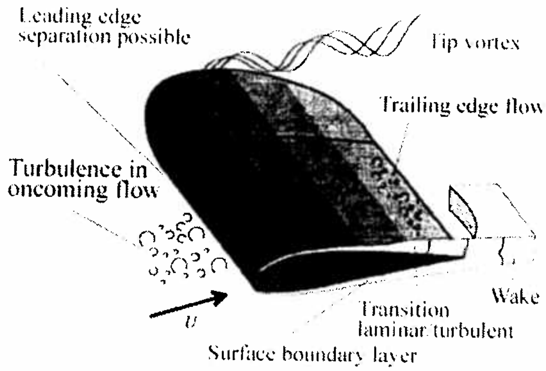

Figure 6. Schematic of Flow Around a Rotor Blade

Type or indication	Mechanism	Main characteristics and importance
Low-frequency noise		
Steady thickness noise; steady loading noise	Rotation of blades or rotation of lifting surfaces	Frequency is related to blade passing frequency, not important at current rotational speeds
Unsteady loading noise	Passage of blades through tower velocity deficit or wakes	Frequency is related to blade passing frequency, small in cases of upwind turbines/ possibly contributing in case of wind farms
Inflow turbulence noise	Interaction of blades with atmospheric turbulence	Contributing to broadband noise; not yet fully quantified
Airfoil self-noise		
Trailing-edge noise	Interaction of boundary layer turbulence with blade trailing edge	Broadband, main source of high frequency noise (770 Hz < f < 2 kHz)
Tip noise	Interaction of tip turbulence with blade tip surface	Broadband; not fully understood
Stall, separation noise	Interaction of turbulence with blade surface	Broadband
Laminar boundary layer noise	Non-linear boundary layer instabilities interacting with the blade surface	Tonal, can be avoided
Blunt trailing edge noise	Vortex shedding at blunt trailing edge	Tonal, can be avoided
Noise from flow over holes, slits and intrusions	Unstable shear flows over holes and slits, vortex shedding from intrusions	Tonal, can be avoided

Table 1 Wind Turbine Aerodynamic Noise Mechanisms

Noise Reduction Methods for Wind Turbines

Turbines can be designed or retrofitted to minimize mechanical noise. This can include special finishing of gear teeth, using low speed cooling fans and mounting components in the nacelle instead of at ground level, adding baffles and acoustic insulation to the nacelle, using vibration isolators and soft mounts for major components, and designing the turbine to prevent noises from being transmitted into the overall structure. Efforts to reduce aerodynamic noise have included (Wagner, et al. (1996) the use of lower tip speed ratios, lower blade angles of attack, upwind turbine designs, variable speed operation and most recently, the use of specially modified blade trailing edges.

Recent improvements in mechanical design of large wind turbines have resulted in significantly reduced mechanical noise from both broadband and pure tones. Thus the noise emission from modern wind turbines is dominated by broadband aerodynamic noise [Fégeant, 1999].

Noise and Wind Turbine Operation

Wind turbine generated noise is a function of wind speed and of other aspects of the design of the wind turbine. Wind turbines may have blades which are rigidly attached to the rotor shaft and that always operate at a constant speed. Other designs may have blades that can be pitched (rotated around their long axis). Other designs might change the rotor speed as the wind changes. Wind turbine rotors may be upwind or downwind of the tower. Other things being equal, each of these designs might have different noise emissions because of the way in which they operate. In general, upwind rotors as opposed to downwind rotors, lower rotational speeds and pitch control result in lower noise generation.

Aerodynamic noise generation is very sensitive to speed of translation at the very tip of the blade. To limit the generation of aerodynamic noise, large modern wind turbines limit the rotor rotation speeds to keep the tip speeds under about 65 m/s. Large variable speed wind turbines often rotate at slower speeds in low winds, increasing in higher winds until the limiting rotor speed is reached. This results in much quieter operation in low winds than a comparable constant speed wind turbine.

Small wind turbines (with ratings less than 30 kW) are also often variable speed wind turbines. These smaller wind turbine designs do not always limited the rotor tip speed in high winds to about 65 m/s. This can result in greater noise generation than would be expected, compared to larger machines. This is also perhaps due to the lower investment in noise reduction technologies in these designs. Some smaller wind turbines regulate power in high winds by turning out of the wind. This type of operation may affect the nature of the sound generation from the wind turbine.

Noise Propagation

In order to predict the sound pressure level at a distance from a known power level, one must determine how the sound waves propagate. In general, as noise propagates without obstruction from a point source, the sound pressure level decreases. The initial energy in the noise is distributed over a larger and larger area as the distance from the source increases. Thus, assuming spherical propagation, the same energy that is distributed over a square meter at a distance of one meter from a source is distributed over 10,000 m^2 at a distance of 100 meters away from the source. With spherical propagation, the sound pressure level is reduced by 6 dB per doubling of distance. This simple model of spherical propagation must be modified in the presence of reflective surfaces and other effects. For example, if the source is on a perfectly flat and reflecting surface, then hemispherical spreading has to be assumed, which also leads to a 6 dB reduction per doubling of distance, but the sound level would be 3 dB higher at a given distance than with spherical spreading. Details of sound propagation in general are discussed in Beranek and Vers (1992). The development of an accurate noise propagation model generally must include the following factors:

- Source characteristics (e.g., directivity, height, etc.)
- Distance of the source from the observer
- Air absorption, which depends on frequency
- Ground effects (i.e., reflection and absorption of sound on the ground, dependent on source height, terrain cover, ground properties, frequency, etc.)
- Blocking of sound by obstructions and uneven terrain
- Weather effects (i.e., wind speed, change of wind speed or temperature with height). The prevailing wind direction can cause considerable differences in sound pressure levels between upwind and downwind positions.

A discussion of complex propagation models that include all these factors is beyond the scope of this paper. More information can be found in Wagner, et al. (1996). For estimation purposes, a simple model based on the more conservative assumption of hemispherical noise propagation over a reflective surface, including air absorption is often used (International Energy Agency, 1994):

$$L_p = L_w - 10\,\log_{10}\left(2\pi R^2\right) - \alpha R$$

Here L_p is the sound pressure level (dB) a distance R from a noise source radiating at a power level , L_w , (dB) and α is the frequency-dependent sound absorption coefficient. This equation can be used with either broadband sound power levels and a broadband estimate of the sound absorption coefficient (α = 0.005 dB(A) per meter) or more preferably in octave bands using octave band power and sound absorption data. The total noise produced by multiple wind turbines would be calculated by summing up the noise levels due to each turbine at a specific location using the dB math mentioned above.

An example of the noise that might be produced by a singe large modern wind turbine is shown in Figure 7. This example assumes hemispherical noise propagation and uses the formula presented above. In this case the wind turbine is assumed to be on a 50 m tower, the source sound power level is 102 dB(A), and the sound pressure levels are at estimated at ground level.

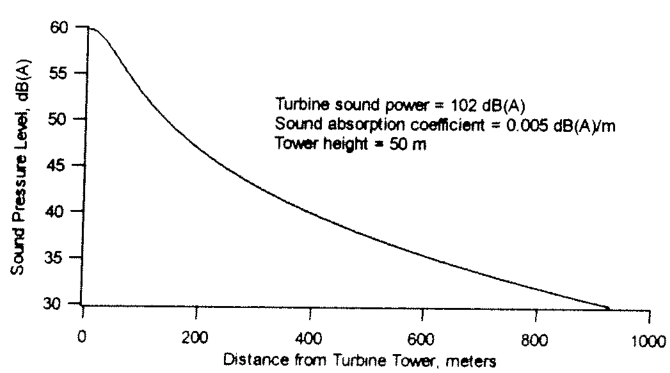

Figure 7. Sample wind turbine noise from a wind turbine

Ambient Noise

The ability to hear wind turbine noise depends on the ambient noise level. When the background noise and wind turbine noise are of the same magnitude, the wind turbine noise gets lost in the background.

Ambient baseline sound levels will be a function of such things as local traffic, industrial noises, farm machinery, barking dogs, lawnmowers, children playing and the interaction of the wind with ground cover, buildings, trees, power lines, etc. It will vary with time of day, wind speed and direction and the level of human activity. As one example, background noise levels measured in the neighborhood of the Hull High School in Hull Massachusetts on March 10, 1992 ranged from 42-48 dB(A) during conditions in which the wind speed varied from 5-9 mph (2-4 m/s).

Both the wind turbine sound power level and the ambient sound pressure level will be functions of wind speed. Thus whether a wind turbine exceeds the background sound level will depend on how each of these varies with wind speed.

The most likely sources of wind-generated noise are interactions between wind and vegetation. A number of factors affect the noise generated by wind flowing over vegetation. For example, the total magnitude of wind-generated noise depends more on the size of the windward surface off the vegetation than the foliage density or volume (Fégeant, 1999). The noise level and frequency content of wind generated noise also depends on the type of vegetation. For example, noise from deciduous trees tends to be slightly lower and more broadband than that from conifers, which generate more noise at specific frequencies.

The equivalent A-weighted broadband sound generated by wind in foliage has been shown to be approximately proportional to the base 10 logarithm of wind speed (Fégeant, 1999):

$$L_{A,eq} \propto \log_{10}(U)$$

The wind-generated contribution to background noise tends to increase fairly rapidly with wind speed. For example, during a noise assessment for the Madison Windpower Project, a project in a quiet rural setting, the background noise was found to be 25 dBA during calm wind conditions and 42 dBA when the wind was 12 mph (5.4 m/s). Background noise generated during noise measurements on a small wind turbine are shown in the Figure 8 (Huskey and Meadors, 2001). The graph includes a logarithmic fit to that data based on the model mentioned above.

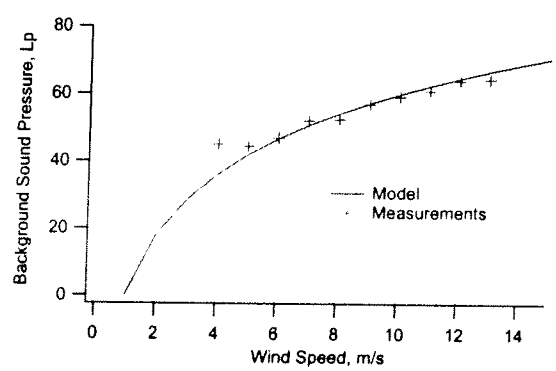

Figure 8. Sample background noise measurements as a function of wind speed

Wind turbine noise from large modern wind turbines during constant speed operation tends to increase more slowly with increasing wind speed than ambient wind generated noise. As a result, noise issues are more commonly a concern at lower wind speeds (Fégeant, 1999) and it is often difficult to measure sound from modern wind turbines above wind speeds of 8 m/s because the background wind-generated noise masks the wind turbine noise above 8 m/s (Danish Wind turbine Manufacturers Association, 2002).

It should be remembered that just using sound pressure measurements might not always indicate when a noise is detectable by a listener. Just as a dog's barking can be heard through other noise, sounds with particular frequencies or in an identifiable pattern may be heard through background noise that is otherwise loud enough to mask those noises. Noise from wind turbines will also vary as the turbulence in the wind through the rotor changes. Turbulence in the ground level winds will also affect a listener's ability to hear other noises. Because fluctuations in ground level wind speeds will not exactly correlate with those at the height of the turbine, a listener might find moments when the wind turbine could be heard over the ambient noise.

Noise Standards and Regulations

There are both standards for measuring sound power levels from wind turbines and local or national standards for acceptable noise power levels. There are also accepted practices for modeling sound propagation. Each of these is reviewed here.

Turbine Sound Power Measurement Standards

A few standards exist to ensure consistent and comparable measurements of wind turbine sound power levels. These include:

- American Wind Energy Association Standard: Procedure for Measurement of Acoustic Emissions From Wind Turbine Generator Systems, Tier I - 2.1 (AWEA, 1989)
- International Electrotechnical Commission IEC 61400-11 Standard: Wind turbine generator systems – Part 11: Acoustic noise measurement techniques (IEC, 2001)

The IEC 61400-11 standard is used in Europe and often in the US. It defines:

- The quality, type and calibration of instrumentation to be used for sound and wind speed measurements.
- Locations and types of measurements to be made.
- Data reduction and reporting requirements.

The standard requires measurements of broad band sound, sound levels in one-third octave bands and in narrow-bands. These measurements are all used to determine the sound power level of the wind turbine and the existence of any specific dominant sound frequencies. Measurements of noise directivity, infrasound (frequencies below 20 Hz which cannot be heard, but can cause problems such as building vibration), low-frequency noise between 20 and 100 Hz and impulsivity (a measure of the magnitude of thumping sounds) are optional. Measurements are to be made when the wind speeds at a height of 10 m (30 ft) are 6, 7, 8, 9 and 10 m/s (13-22 mph).

Wind turbine manufacturers should be able to provide sound power level measurements at a variety of wind speeds. These data have usually been determined by certified testing agencies using the standards mentioned here.

Sample sound power levels for a small variety of wind turbines are presented in Figure 9 as a function of rated electrical power. The data were selected from manufacturer's literature or from discussions with manufacturers. Most of these data are for operation with wind speeds of 8 m/s at a height of 10 m. The data illustrate that as wind turbines have increased in size, noise emissions have remained moderately constant. This is a result of the efforts of designers to address noise issues.

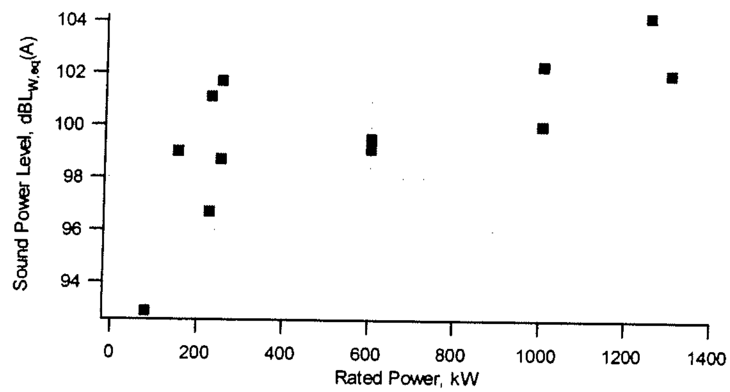

Figure 9. Sample measured wind turbine sound power levels

Community Standards for Determining Acceptable Sound Pressure Levels

At the present time, there are no common international noise standards or regulations. In most countries, however, noise regulations define upper bounds for the noise to which people may be exposed. These limits depend on the country and are often different for daytime and nighttime.

For example, in Europe, as shown in Table 2, fixed noise limits are the standard (Gipe, 1995).

Country	Commercial	Mixed	Residential	Rural
Denmark			40	45
Germany				
(day)	65	60	55	50
(night)	50	45	40	35
Netherlands				
(day)		50	45	40
(night)		40	35	30

Table 2 Noise Limits of Sound Pressure Levels, L_{eq} (dB(A)) in Different European Countries

In the U.S., although no federal noise regulations exist, the U.S. Environmental Protection Agency (EPA) has established noise guidelines. Most states do not have noise regulations, but many local governments have enacted noise ordinances to manage community noise levels.

Examples of such ordinances for wind turbines are given in the latest Permitting of Wind Energy Facilities Handbook (NWCC, 1998).

The Massachusetts Department of Environmental Protection (DEP) regulates noise emissions as a form of air pollution under 310 CMR 7.00, "Air Pollution Control." These can be found at www.state.ma.us/dep/bwp/daqc/files/regs/7a.htm. The application of these regulations to noise is detailed in the DPE's DAQC Policy Statement 90-001 (February 1, 1990). The regulation includes two requirements. First, any new broadband sound source is limited to raising noise levels no more than 10 dB(A) over the ambient baseline sound level. The ambient baseline is defined as the sound level that is exceed 90% of the time, the L_{90} level. Second, "pure tones", defined here as an octave band, may be no greater than 3 dB(A) over the two adjacent octave bands. All these readings are measured at the property line or at any inhabited buildings located within the property.

It should be pointed out that imposing a fixed noise level standard may not prevent noise complaints. This is due to the changing of the relative level of broadband background turbine noise with changes in background noise levels (NWCC, 1998). That is, if tonal noises are present, higher levels of broadband background noise are needed to effectively mask the tone(s). In this respect, it is common for community noise standards to incorporate a penalty for pure tones, typically 5 dB(A). Therefore, if a wind turbine meets a sound power level standard of 45 dB(A), but produces a strong whistling, 5 dB(A) are subtracted from the standard. This forces the wind turbine to meet a real standard of 40 dB(A).

A discussion of noise measurement techniques that are specific to wind turbine standards or regulations is beyond the scope of this paper. A review of such techniques is given in Hubbard and Shepherd (1990), Germanisher Lloyd (1994), and Wagner, et al. (1996).

Sample Noise Assessment for a Wind Turbine Project

Much of the interest in wind turbine noise is focused on the noise anticipated from proposed wind turbine installations. An appropriate noise assessment study in this situation should contain the following four major parts of information.

1. A survey of the existing ambient background noise levels.
2. Prediction (or measurement) of noise levels from the turbine(s) at and near the site.
3. Identifying a model for sound propagation.
4. Comparing calculated sound pressure levels from the wind turbines with background sound pressure levels at the locations of concern.

An example of the steps in assessing the noise anticipated from the installation of a wind turbine according to the Massachusetts regulations follows.

Ambient Background Levels. It is very important to measure the background sound pressure levels for the wind conditions in which the wind turbine will be operating. In this example it will be assumed that measurements indicate that the L_{90} sound pressure levels are 45 dB(A).

Source Sound Levels. In order to calculate noise levels heard at different distances, the reference sound levels need to be determined. The reference sound level is the acoustic power being radiated, and is not the actual sound level heard. Reference sound levels can be obtained from manufacturers and independent testing agencies. Measurements should be based on the standards mentioned above. In this example it will be assumed that the turbine will be on a 50 m tower and has a sound power level of 102 dB(A), as in the previous example of sound propagation from a wind turbine.

Noise Propagation Model. Sound propagation is a function of the source sound characteristics (directivity, height), distance, air absorption, reflection and absorption by the ground and nearby objects and weather effects such as changes of wind speed and temperature with height. One could assume a conservative hemispherical spreading model or spherical propagation in which any absorption and reflection are assumed to cancel each other out. More detailed models could be used that include the effects of wind speed and direction. Often upwind of a wind turbine there are locations where no sound is heard. On the other hand sound may be propagated more easily downwind. If the hemispherical propagation model is used, then the data in Figure 7 shows the noise levels in the vicinity of the turbine.

Comparison of Calculated Sound Levels with Baseline Sound Levels. Calculated wind turbine sound levels do not include the additional background ambient sound levels. The mathematical relationship governing the addition of dB(A) levels require that if the turbine sound level is no more than 9.5 dB(A) above the ambient noise level, then the total noise levels will be within 10 dB(A) of the ambient sound level. If the ambient sound level is 45 dB(A), then, under Massachusetts regulations, the turbine can generate no more than 54.5 dB(A) at locations of concern. It can be seen from Figure 7 that the sound from the wind turbine would not exceed that limit at all locations more than 75 m (250 ft) from the wind turbine.

Noise from Small Wind Turbines

Small wind turbines (those under 30 kW capacity) are more often used for residential power or for other dedicated loads. These systems may be grid-connected or stand-alone systems. These applications result in potential noise complaints due to the proximity of human activity. As mentioned above, small wind turbines may also operate at higher tip speeds or turned partially out of the wind. These operating conditions may aggravate noise generation. It is also not always easy to obtain reliable sound measurements from the manufacturers of smaller wind turbines, especially at the wind speeds that might be a concern. For all of these reasons it is important to carefully consider noise from small wind turbines.

For example, noise measurements have been made by the National Renewable energy Laboratory on a 900 Watt wind turbine, the Whisper 40 (Huskey and Meadors, 2001). This wind turbine has a rotor diameter of 2.1 m (7 ft) and was mounted on a 30 ft tower. The rotor rotates at 300 rpm at low power. The rotation speed increases to 1200 rpm as the rotor rotates out of the wind ("furls") to limit power in high winds. This operation results in a blade tip speeds between 33 and 132 m/s. Figure 9 illustrates the sound pressure level (with the background noise removed) and the background noise levels at a distance of 10 meters (33 ft) from the wind turbine base. Between 6 and 13 m/s the wind turbine sound pressure increases over 13 dB. This is a very large increase in sound level and would be experienced as more than a doubling of the sound level. Moreover, it increased enough that the background sound level, which also increased with wind speed, was not enough to mask the wind turbine noise until the wind speed increased to over 13 m/s (30 mph).

A study of sound produced by a 10 kW Bergey wind turbine at Halibut Point State Park in Rockport, MA, includes measured sound pressure levels under a variety of wind conditions and at a variety of distances from the wind turbine base (Tech Environmental, 1998). The study showed that under some conditions the wind turbine noise at 600 ft (182 m) from the wind turbine base increased noise levels by 13 dB(A). The study estimated that a buffer zone of 1600 ft be required to meet Massachusetts noise regulations! Finally, the study also mentioned that under high wind conditions in which the wind turbine noise was masked by the wind-induced background noise, as determined by the broadband sound pressure levels, the wind turbine could still be heard due to the presence of helicopter-like thumping sounds. Similar sounds have been described coming from other small wind turbines (Gipe, 2001). These low frequency sounds are missed by the standard A-weighted sound pressure measurements prescribed in the DEP regulations.

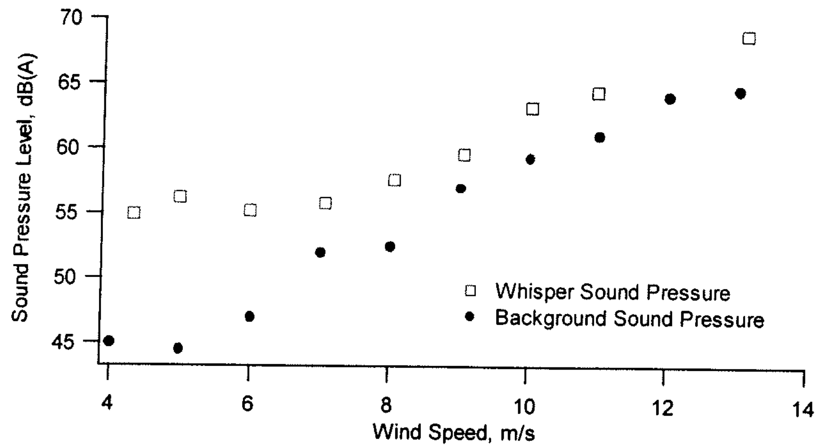

Figure 9. Sample measured wind turbine sound power levels

It can be seen that measurements prescribed in the often-used IEC 61400-11 standard that only include measurements between 6 and 10 m/s (13-22 mph) may not be adequate for estimating wind turbine noise from small wind turbines. In addition, measurement standards no not require the measurement of thumping sounds and other irregular sounds that can be found objectionable.

Conclusions and Recommendations

A number of improvements in standards and regulations are needed to ensure that communities can reliably anticipate noise from wind turbines and to ensure that the data are available to make those sound estimations:

- Guidelines for defining acceptable noise from wind turbines in Massachusetts should be expanded. These should include not only the present DEP criteria for broadband noise and pure tones, but also criteria for impulsive and other sounds and guidelines for the appropriate consideration of background noise levels at different wind speeds.
- Any incentives to promote wind energy should be provided only to turbines for which the manufacturer can provide noise data based on IEC standards or for turbines which are to be located at sites where there will clearly be no problem.
- Setbacks should be defined for turbines for which no data is available.
- Clearer state standards are needed for the measurement of background noise and the estimation of wind turbine noise in assessments of wind turbine projects. These should include standards for measuring background noise as a function of both time of day and wind speed and standards for appropriate propagation models that include the effects of

reflection and absorption of sounds in grasslands, woodlands, and pavement or urban areas and appropriate values for air absorption.

- Standards are also needed for the measurement of noise from small wind turbines. These standards should include measurements to higher wind speeds and measurements that include all the variety of operating modes that might be encountered and that include unusual noise conditions, including time dependent and frequency dependent components such as thumping and whistles. These standards need to provide sound measures that provide an accurate representation of issues of interest to potential listeners.

- Further study of small wind turbine noise is needed to adequately define the types of noise generated by small wind turbines. An understanding of the character of the noise generated by small wind turbines needs to be included in any new measurement and reporting standard and in community noise regulations.

- Finally, manufacturers of small wind turbines need to make comprehensive sound power level measurements, based on new standards, available to the public.

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DRAFT DOCUMENT
AWEA Small Wind Turbine Performance and Safety Standard

Approved by the
AWEA Standards Coordinating Committee
as a Draft Document
for review by Materially Affected Parties
2009 January 08

American Wind Energy Association
1501 M Street NW, Suite 1000
Washington, DC 20005

AMERICAN WIND ENERGY ASSOCIATION STANDARDS

Standards promulgated by the American Wind Energy Association (AWEA) conform to the AWEA Standards Development Procedures adopted by the AWEA Board of Directors. The procedures are intended to ensure that AWES standards reflect a consensus to persons substantially affected by the standard. The AWEA Standards Development Procedures are intended to be in compliance with the American National Standards Institute (ANSI) Essential Requirements. Standards developed under the AWEA Standards Development Procedures are intended to be eligible for adoption as American National Standards.

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American Wind Energy Association
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FOREWORD and BACKGROUND

The Foreword and Background sections are included with this document for information purposes only, and are not part of the AWEA Small Wind Turbine Performance and Safety Standard.

Foreword

The goal of this standard is to provide meaningful criteria upon which to assess the quality of the engineering that has gone into a small wind turbine meeting this standard, and to provide consumers with performance data that will help them make informed purchasing decisions. The standard is intended to be written to ensure the quality of the product can be assessed while imposing only reasonable costs and difficulty on the manufacturer to comply with the standard.

Background

The proposed AWEA Small Wind Turbine Performance and Safety Standard that follows is in the final stages of approval by the AWEA Standards Coordinating Committee. AWEA is recognized by the American National Standards Institute (ANSI) as an accredited standards writing body and the final standard will be an American National Standard. This standard has been developed in a regimented ANSI process for "voluntary consensus standards" which requires participation from a range of representatives for manufacturers, technical experts, public sector agencies, and consumers.

The draft that follows has been developed over the last five years in a process that involved over 60 participants, three meetings, 22 hours of conference calls, countless e-mails, a list serve, and five intermediate drafts. It represents hundreds of hours of detailed discussion, debate, compromise, revision, and formal response. The Canadian Wind Energy Association has been actively involved since the beginning and the British Wind Energy Association has now adopted and approved this standard almost word for word.

The proposed standard was developed by the AWEA Small Wind Turbine Standard Subcommittee, which is chaired by Mike Bergey of Bergey Windpower Co. Members of the subcommittee have included the following people. Please note that there has been some turnover in the subcommittee, some positions have changed, and not all members were active (though they did receive the drafts and correspondence).

Name	Affiliation	Stakeholder Category
Bill Colavecchio	Underwriters Laboratory	Certifying Agency
Lex Bartlett	Aeromag	Manufacturer
David Blittersdorf	Vermont	Manufacturer / Consumer
David Calley	Southwest Windpower	Manufacturer
Jito Coleman	Northern Power	Manufacturer
David Laino	Endurance	Manufacturer
Robert Preus	Abundant Ren. Energy	Manufacturer
Steve Turek	Wind Turbine Industries	Manufacturer
Dr. Craig Hansen	Windward Engineering	Technical Expert
Robert Poore	Global Energy Concepts	Technical Expert
Ken Starcher	Alternate Energy Institute	Technical Expert
Trudy Forsyth	National Renewable Energy Laboratory	Researcher / Technical Expert
Jim Green	National Renewable Energy Laboratory	Researcher / Technical Expert
Hal Link	National Renewable Energy Laboratory	Researcher / Technical Expert
Brian Vick	USDA/Bushland	Technical Expert
Brent Summerville	Appalachian State Univ.	Technical Expert
Alex DePillis	Wisconsin Energy Office	State Energy Office / Consumer
Jennifer Harvey	NYSERDA	State Energy Office
Cassandra Kling	New Jersey BPU	State Energy Office
Dora Yen	California Energy Comm.	State Energy Office
Paul Gipe	California	Consumer
Mike Klemen	North Dakota	Consumer
Heather Rhoads Weaver	Washington	Consumer / AWEA
Mick Sagrillo	Wisconsin	Consumer
Brad Cochran	Colorado	Interested Party
Samit Sharma	Canada	CanWEA
Svend de Bruyn	Detronics	Canadian Industry

Other participants in the development of this proposed standard have included (as they were affiliated at the time of their involvement):

Mark Bastasch
Ralph Belden, Synergy Power
Michael Blair
David Blecker, Seventh Generation
Sandy Butterfield, NREL
Bob Clarke, Ventera Energy
Dean Davis, Windward Engineering
John Dunlop, AWEA

Henry DuPont, Lorax
Mike Gray, Gray Engineering
Jeffrey Haase, State of Minnesota
Tod Hanley, Bergey Windpower
Robert Hornung, CanWEA
Arlinda Huskey, NREL
Dale Jones, Geocorp
Dan Juhl, DanMar
Steve Kalland, NCSU
Peter Konesky, State of Nevada
Andy Kruse, Southwest Windpower
Jean-Daniel Langlios
Amy Legere, Southwest Windpower
Malcomb Lodge, Entegrity Wind
Charles Newcomb, Entegrity Wind
Chuck Maas
Dennis Makeperce, E.R.D.
Tom Maves, State of Ohio
Michael Mayhew
Richard Michaud, US-DOE
Jacques Michel, E.R.D.
Paul Migliore, NREL
Lawrence Mott, Earth Turbines
Jennifer Oliver, Southwest Windpower
Philippe Quinet
Doug Selsam, Selsam Engineering
David Sharman, Ampair / BWEA
Robert Sherwin, Vermont Wind Power Int'l
Larry Sherwood, IREC
P.V. Slooten
Eric Stephens
Brian Smith, NREL
Jeroen van Dam, NREL / UL
David VanLuvanee
Jane Weismann, IREC
Kyle Wetzel, Consultant
Sean Whittaker, CanWEA

AWEA Small Wind Turbine Performance and Safety Standard

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AWEA Small Wind Turbine Performance and Safety Standard

Draft Standard Version 6.1 for adoption by the SCC (Version: 2008 October 13)

1 General Information

1.1 Purpose

This standard was created by the small wind turbine industry, scientists, state officials, and consumers to provide consumers with realistic and comparable performance ratings and an assurance the small wind turbine products certified to this standard have been engineered to meet carefully considered standards for safety and operation. The goal of the standard is to provide consumers with a measure of confidence in the quality of small wind turbine products meeting this standard and an improved basis for comparing the performance of competing products.

1.2 Overview

1.2.1 This performance and safety standard provides a method for evaluation of wind turbine systems in terms of safety, reliability, power performance, and acoustic characteristics. This standard for small wind turbines is derived largely from existing international wind turbine standards developed under the auspices of the International Electrotechnical Commission (IEC). Specific departures from the IEC standards are provided to account for technical differences between large and small wind turbines, to streamline their use, and to present their results in a more consumer-friendly manner.

1.2.2 No indirect or secondary standards references are intended. Only standards directly referenced in this standard are embodied.

1.3 Scope

1.3.1 This standard generally applies to small wind turbines for both on-grid and off-grid applications.

1.3.2 This standard applies to wind turbines having a rotor swept area of 200 m2 or less. In a horizontal-axis wind turbine this equates to a rotor diameter of ~ 16 m (~ 52 ft)

1.3.3 A turbine system includes the wind turbine itself, the turbine controller, the inverter, if required, wiring and disconnects, and the installation and operation manual(s).

1.3.4 In cases where several variations of a turbine system are available, it is expected that a full evaluation would be performed on one of the most representative arrangements. Other variations, such as different power output forms, need only be evaluated or tested in the ways in which they are different from the base configuration. For example, a wind turbine available in both grid-intertie and battery charging versions would need separate performance tests if both versions were to be certified, but would not need a separate safety evaluation in most cases.

1.3.5 Except as noted in Sections 2.1.1, 4.2, 5.2.5, 5.2.6, and 6.1.7.1, towers and foundations are not part of the scope of this standard because it is assumed that conformance of the tower structure to the International Building Code, Uniform Building Code or their local equivalent will be required for a building permit.

1.4 Compliance

1.4.1 Certification to this standard shall be done by an independent certifying agency. Self-certification is not allowed.

1.4.2 It is the intent of this standard to allow test data from manufacturers, subject to review by the certifying agency.

1.4.3 Compliance with this standard for the purposes of advertising or program qualification, or any other purpose, is the responsibility of the manufacturer.

1.5 Definitions

1.5.1 Definitions contained in IEC 61400-121, ed.1 (Performance); IEC 61400-11 (Acoustic Noise); and IEC 61400-2, Ed. 2 (Design Requirements) are hereby incorporated by reference.

1.5.2 Additional Definitions

1.5.2.1 AWEA Rated Power: The wind turbine's power output at 11 m/s (24.6 mph) per the power curve from IEC 16400-121.

1.5.2.2 AWEA Rated Annual Energy: The calculated total energy that would be produced during a one-year period at an average wind speed of 5 m/s (11.2 mph), assuming a Rayleigh wind speed distribution, 100% availability, and the power curve derived from IEC 16400-121 (sea level normalized).

1.5.2.3 AWEA Rated Sound Level: The sound level that will not be exceeded 95% of the time, assuming an average wind speed of 5 m/s (11.2 mph), a Rayleigh wind speed distribution, 100% availability, and an observer location 60 m (~ 200 ft.) from the rotor center[1], calculated from IEC 61400-11 test results, except as modified in Section III of this Standard.

1.5.2.4 Cut-in Wind Speed: The lowest wind speed at which a wind

[1] Appendix A contains guidance on obtaining sound levels for different observer locations and background sound levels.

turbine will begin to have power output[2].

1.5.2.5 Cut-out Wind Speed: The wind speed above which, due to control function, the wind turbine will have no power output.

1.5.2.6 Maximum Power: The maximum one-minute average power output a wind turbine in normal steady-state operation will produce (peak instantaneous power output can be higher).

1.5.2.7 Maximum Voltage: The maximum voltage the wind turbine will produce in operation including open circuit conditions.

1.5.2.8 Maximum Current(s): The maximum current(s) the wind turbine will produce on each side of the systems control or power conversion electronics.

1.5.2.9 Overspeed Control: The action of a control system, or part of such system, which prevents excessive rotor speed.

1.5.2.10 Power Form: Physical characteristics which describe the form in which power produced by the turbine is made deliverable to the load.

1.5.2.11 Rotor Swept Area: Projected area perpendicular to the wind direction swept by the wind turbine rotor in normal operation (un-furled position). If the rotor is ducted, the area inscribed by the ducting shall be included.

1.5.2.12 Turbulence Intensity: The standard deviation of 1-second wind speed data divided by the mean of 1-second wind speed data averaged over a period of 1-minute.

1.6 Units

1.6.1 The primary units shall be SI (metric). The inclusion of secondary units in the English system is recommended [e.g., 10 m/s (22.4 mph)].

1.7 Test Turbine and Electronics

1.7.1 Tested wind turbines and their associated electronics shall conform to the specific requirements of the governing IEC wind generator standard for each test, but incorporating any amendments contained in this standard.

2 Performance Testing

2.1 Wind turbine performance shall be tested and documented in a test report per the latest edition of IEC 61400-121, but incorporating the additional guidance provided in this section.

2.1.1 In Section 2.1, Wind Turbine Generator System: When characterizing performance, the wind turbine generator system shall include the following components, as appropriate: the turbine; turbine tower; turbine controller,

[2] As determined per Section 2.1.6

regulator, or inverter; wiring between the turbine and the load; transformer; and dump load. Power shall be measured at the connection to the load such that the losses in the complete wind turbine system are included.

2.1.2 Battery banks are not considered to be part of the wind turbine system for battery-charging wind turbines, but they are considered to be part of the system for grid-connected wind turbines that incorporate a battery bank.

2.1.3 Also in Section 2.1, Wind Turbine Generator System: The wind turbine shall be connected to an electrical load that is representative of the load for which the turbine is designed.

2.1.4 Also in Section 2.1, Wind Turbine Generator System: The wind turbine shall be installed using the manufacturer's specified mounting system. If a wind turbine is not supplied with a specific mounting system, the generator should be mounted at a hub height of at least 10 meters.

2.1.5 The total wire run length, measured from the base of the tower, must be at least 8 rotor diameters and the wiring is to be sized per the manufacturer's installation instructions.

2.1.6 The cut-in wind speed is the first wind speed bin in the averaged power curve that is positive.

2.1.7 Also in Section 2.1, Wind Turbine Generator System: The voltage regulator in a battery-charging system shall be capable of maintaining voltage at the connection of the turbine to the batteries within 10% of 2.1 volts per cell for lead acid batteries over the full range of power output of the turbine. The 1-minute average of the load voltage must be within 5% of 2.1 volts per cell for lead acid batteries to be included in the usable data set.

2.1.8 In Section 2.2.1, Distance of meteorological mast: If it is more practical to mount the anemometer on a long boom that is connected to the turbine tower, a separate meteorological mast is not required. To minimize the potential for the wake from the anemometer, the wind vane and their mounting hardware to influence flow into a small rotor, all such components shall be located at least 3 meters away from any part of the rotor. In addition, the anemometer mounting should be configured to minimize its cross-sectional area above the level that is 1.5 rotor diameters below hub height.

2.1.9 In Section 3.1, Electric power: Turbine output power shall be measured at the connection to the load.

2.1.10 In Section 3: In addition to electric power, voltage at the connection to the load shall be measured to ensure compliance with the requirements listed below.

2.1.11 In Section 3.4, Air density: The air temperature sensor and the air pressure sensor shall be mounted such that they are at least 1.5 rotor diameters below hub height even if such mounting results in a location less than 10 m above ground level.

2.1.12 In Section 3.6, Wind turbine generator status: Monitoring of small wind turbine status is required only when the turbine controller provides an indication of turbine faults.

2.1.13 In Section 4.3, Data collection: Preprocessed data shall be of 1-minute duration. In Section 4.4, Data reduction: Select data sets shall be based on 1-minute periods.

2.1.14 In Section 4.6, Database: The database shall be considered complete when it has met the following criteria:

2.1.14.1 Each wind speed bin between 1 m/s below cut-in and 14 m/s shall contain a minimum of 10 minutes of sampled data.

2.1.14.2 The total database contains at least 60 hours of data with the small wind turbine operating within the wind speed range.

2.1.14.3 The database shall include 10 minutes of data for all wind speeds at least 5 m/s beyond the lowest wind speed at which power is within 95% of Maximum Power (or when sustained output is attained).

2.1.15 In Section 5.1, Data normalization: For turbines with passive power control such as furling or blade fluttering, the power curve shall be normalized using Equation 5 (wind speed adjustment), Equation 6 (power adjustment), or an alternate method. Documentation must be provided to justify the use of an alternate method.

2.1.16 In Section 5.3, Annual energy production (AEP): In cases where the small wind turbine does not shut down in high winds, AEP measured and AEP projected shall be calculated as though cut-out wind speed were the highest, filled wind speed bin or 25 m/s, whichever is greater.

2.1.17 In Section 6, Reporting format: In addition to the information listed in clause 6, the description of the wind turbine and the test set-up shall include:

2.1.17.1 wiring sizes, conductor material, types, lengths and connectors used to connect the wind turbine to the load;

2.1.17.2 measured resistance of wiring between the inverter and the load or between the turbine and the load if no inverter is used;

2.1.17.3 voltage setting(s) for any over or under-voltage protection devices that are part of the small wind turbine generator system;

2.1.17.4 nominal battery bank voltage (e.g., 12, 24, 48 volts);

2.1.17.5 battery bank size (i.e., amp-hour capacity), battery type and age; and

2.1.17.6 description including make, model, and specifications of the voltage regulation device used to maintain the battery bank voltage within specified limits.

2.2 The Performance Test Report shall include the turbulence intensity for each data set (sequential, unbroken, time series) so that the reviewers can pass judgment on the appropriateness of the test site.

3 Acoustic Sound Testing

3.1 Wind turbine sound levels shall be measured and reported in accordance with the latest edition of IEC 61400-11 2002-12, but incorporating the additional guidance provided in this section.

3.1.1 The averaging period shall be 10 second instead of 1 minute.

3.1.2 Measuring wind speed directly instead of deriving wind speed through power is the preferred method.

3.1.3 The method of bins shall be used to determine the sound pressure levels at integer wind speeds.

3.1.4 It shall be attempted to cover an as wide a wind speed range as possible, as long as the wind screen remains effective.

3.1.5 A description shall be provided of any obvious changes in sound at high wind speeds where overspeed protection becomes active (like furling, pitching or fluttering).

3.1.6 A tonality analysis is not required, but the presence of prominent tones shall be observed and reported.

4 Strength and Safety

4.1 Except as noted below, mechanical strength of the turbine system shall be assessed using either the simple equations in Section 7.4 of IEC61400-2 ed2 in combination with the safety factors in Section 7.8, or the aeroelastic modeling methods in the IEC standard. Evaluation of, as a minimum, the blade root, main shaft and the yaw axis (for horizontal axis wind turbines) shall be performed using the outcome of these equations. A quick check of the rest of the structure for obvious flaws or hazards shall be done and if judged needed, additional analysis may be required.

4.2 Variable speed wind turbines are generally known to avoid harmful dynamic interactions with towers. Single/dual speed wind turbines are generally known to have potentially harmful dynamic interactions with their towers. Therefore, in the case of single/dual speed wind turbines, such as those using either one or two induction generators, the wind turbine and tower(s) must be shown to avoid potentially harmful dynamic interactions. A variable speed wind turbine with dynamic interactions, arising for example from control functions, must also show that potentially harmful interactions are likewise avoided.

4.3 Other safety aspects of the turbine system shall be evaluated including:

4.3.1 procedures to be used to operate the turbine;

4.3.2 provisions to prevent dangerous operation in high wind;

4.3.3 methods available to slow or stop the turbine in an emergency or for maintenance;

4.3.4 adequacy of maintenance and component replacement provisions; and

4.3.5 susceptibility to harmful reduction of control function at the lowest claimed operating ambient temperature.

4.4 A Safety and Function Test shall be performed in accordance with Section 9.6 of IEC61400-2 ed2.

5 Duration Test

5.1 To establish a minimum threshold of reliability, a duration test shall be performed in accordance with the IEC 61400-2 ed.2 Section 9.4.

5.2 Changes and additional clarifications to this standard include:

5.2.1 The test shall continue for 2500 hours of power production.

5.2.2 The test must include at least 25 hours in wind speeds of 15 m/s (33.6 mph) and above.

5.2.3 Downtime and availability shall be reported and an availability of 90% is required.

5.2.4 Minor repairs are allowed, but must be reported.

5.2.5 If any major component such as blades, main shaft, generator, tower, controller, or inverter is replaced during the test, the test must be restarted.

5.2.6 The turbine and tower shall be observed for any tower dynamics problems during the duration test and the test report shall include a statement of the presence or absence of any observable problems

6 Reporting and Certification

6.1 The test report shall include the following information:

6.1.1 Summary Report, containing a power curve, an Annual Energy Production curve, and the measured sound pressure levels (Section 9.4 of IEC 61400-11 ed.2). The report is intended to be publicly available once approved by the certifying agency.

6.1.2 Performance Test Report

6.1.3 Acoustic Test Report

6.1.4 The AWEA Rated Annual Energy

6.1.5 The AWEA Rated Sound Level

6.1.6 The AWEA Rated Power, at 11 m/s (24.6 mph)

6.1.7 Wind Turbine Strength and Safety Report

6.1.8 The tower top design loads shall be reported

6.1.9 Duration Test Report

6.2 The manufacturers of certified wind turbines must abide by the labeling requirements of the certifying agency.

7 Labeling

7.1 The AWEA Rated Annual Energy (AWEA RAE) shall be stated in any label, product literature or advertising in which product specifications are provided.

7.1.1 The AWEA RAE shall be rounded to no more than 3 significant figures.

7.2 The manufacturer shall state the AWEA Rated Power if a rated power is specified.

7.3 The manufacturer shall state the AWEA Estimated Sound Level if a sound level is specified.

7.4 Other performance data recommended to be stated in specifications about the turbine are:

7.4.1 Cut-in Wind Speed

7.4.2 Cut-out Wind Speed

7.4.3 Maximum Power

7.4.4 Maximum Voltage

7.4.5 Maximum Current(s)

7.4.6 Overspeed Control

7.4.7 Power Form

8 Changes to Certified Products

8.1 It is anticipated that certified wind turbines will occasionally be changed to provide one form of improvement or another. In some cases such changes will require review by the certifying agency and possible changes to the certified product parameters. The following guidance is provided concerning when product changes will require certifying agency review:

8.1.1 Any changes to a certified wind turbine that will have the cumulative effect of reducing AWEA Rated Power or AWEA Rated Annual Energy by more than 10%, or that will raise the AWEA Rated Sound Level by more than 1 dBA will require retesting and recertification by the certifying agency. Only those characteristics of the wind turbine affected by the design change(s) would be reviewed again.

8.1.2 Any changes to a certified wind turbine that could reduce the strength and safety margins by 10%, or increase operating voltages or currents by 10%, will require resubmission of the Wind Turbine Strength and Safety Report and recertification by the certifying agency.

8.1.3 Any changes to a certified wind turbine that could materially affect the results of the Duration Test will require retesting, submission of a new Duration Test Report, and recertification by the certifying agency.

8.2 For the first two years after turbine certification the manufacturer is required to notify the certifying agency of all changes to the product, including hardware and software. The certifying agency will determine whether the need for retesting and additional review under the guidelines provided in Section 8.1.

8.3 The use of Engineering Change Orders or their equivalent is recommended.

9 References and Appendices

9.1 References

9.1.1 Evaluation Protocol for Small Wind Systems, Rev. 3. NREL internal document.

9.1.2 IEC 61400-121 Ed. 1, Wind Turbines – Part 121: Power performance measurement of grid connected wind turbines.

9.1.3 IEC 61400-11, Second Edition 2002-12, Wind turbine generator systems - Part 11: Acoustic noise measurement techniques.

9.1.4 IEC 61400-2, Ed. 2, Wind turbine generator systems – Part 2: Design requirements of small wind systems.

Appendix A

Sound Levels for Different Observer Locations and Background Sound Levels

The AWEA Rated Sound Level is calculated at a distance of 60 meters from the rotor hub and excludes any contribution of background sound. As the distance from the turbine increases, the background sound becomes more dominant in determining the overall sound level (turbine plus background).

Background sound levels depend greatly on the location and presence of roads, trees, and other sound sources. Typical background sound levels range from 35dBA (quiet) to 50dB(A) (urban setting)

Equation 1 can be used to calculate the contribution of the turbine to the overall sound level using the AWEA Rated Sound Level. Equation 2 can be used to add the turbine sound level to the background sound level to obtain the overall sound level.

$$turbine\ \ sound\ \ level = L_{SWCC} + 10\log(4\pi 60^2) - 10\log\left(4\pi R^2\right) \qquad (1)$$

Where:
L_{AWEA} is the SWW Rated Sound Level [dBA].
R is the observer distance from the turbine rotor center [m]

$$overall\ sound\ level = 10\log(10^{\frac{turbine\ level}{10}} + 10^{\frac{background\ level}{10}}) \qquad (2)$$

Table 1 Overall Sound Levels at Different Locations for a AWEA Rated Sound Level of 40 dBA

Distance from rotor center [m]	L_{AWEA}: 40dBA				
	background noise level (dBA):				
	30	35	40	45	50
10	55.6	55.6	55.7	55.9	56.6
20	49.6	49.7	50.0	50.9	52.8
30	46.1	46.4	47.0	48.6	51.5
40	43.7	44.1	45.1	47.3	50.9
50	41.9	42.4	43.9	46.6	50.6
60	40.4	41.2	43.0	46.2	50.4
70	39.2	40.2	42.4	45.9	50.3
80	38.2	39.4	41.9	45.7	50.2
100	36.6	38.3	41.3	45.5	50.2
150	34.1	36.8	40.6	45.2	50.1
200	32.8	36.1	40.4	45.1	50.0

Table 2 Overall Sound Levels at Different Locations for a AWEA Rated Sound Level of 45 dBA

Distance from rotor center [m]	L_{AWEA}: 45dBA				
	background noise level (dBA):				
	30	35	40	45	50
10	60.6	60.6	60.6	60.7	60.9
20	54.6	54.6	54.7	55.0	55.9
30	51.1	51.1	51.4	52.0	53.6
40	48.6	48.7	49.1	50.1	52.3
50	46.7	46.9	47.4	48.9	51.6
60	45.1	45.4	46.2	48.0	51.2
70	43.8	44.2	45.2	47.4	50.9

80	42.7	43.2	44.4	46.9	50.7
100	40.9	41.6	43.3	46.3	50.5
150	37.8	39.1	41.8	45.6	50.2
200	35.9	37.8	41.1	45.4	50.1

Table 3 Overall Sound Levels at Different Locations for a AWEA Rated Sound Level of 50 dBA

Distance from rotor center [m]	L_{AWEA}: 50dBA				
	background noise level (dBA):				
	30	35	40	45	50
10	65.6	65.6	65.6	65.6	65.7
20	59.5	59.6	59.6	59.7	60.0
30	56.0	56.1	56.1	56.4	57.0
40	53.5	53.6	53.7	54.1	55.1
50	51.6	51.7	51.9	52.4	53.9
60	50.0	50.1	50.4	51.2	53.0
70	48.7	48.8	49.2	50.2	52.4
80	47.6	47.7	48.2	49.4	51.9
100	45.7	45.9	46.6	48.3	51.3
150	42.3	42.8	44.1	46.8	50.6
200	40.0	40.9	42.8	46.1	50.4

Table 4 Overall Sound Levels at Different Locations for a AWEA Rated Sound Level of 55 dBA

Distance from rotor center [m]	L_{AWEA}: 55dBA				
	background noise level (dBA):				
	30	35	40	45	50
10	70.6	70.6	70.6	70.6	70.6
20	64.5	64.5	64.6	64.6	64.7
30	61.0	61.0	61.1	61.1	61.4
40	58.5	58.5	58.6	58.7	59.1
50	56.6	56.6	56.7	56.9	57.4
60	55.0	55.0	55.1	55.4	56.2
70	53.7	53.7	53.8	54.2	55.2
80	52.5	52.6	52.7	53.2	54.4
100	50.6	50.7	50.9	51.6	53.3
150	47.1	47.3	47.8	49.1	51.8
200	44.7	45.0	45.9	47.8	51.1

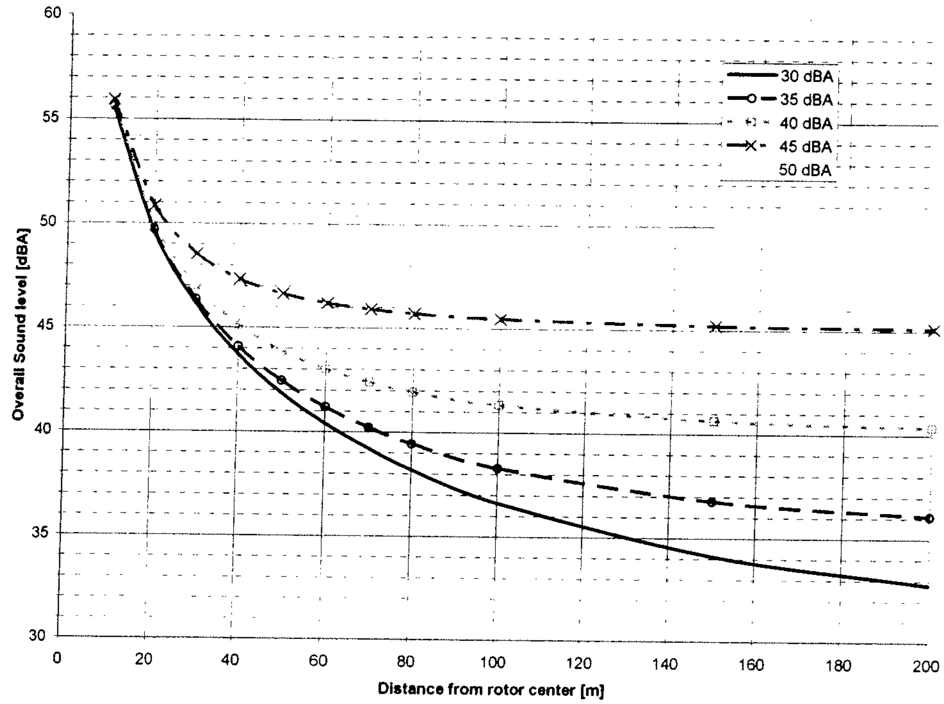

Figure 1. Sound levels as a function of distance and background noise levels for AWEA rated sound level of 40dB(A)

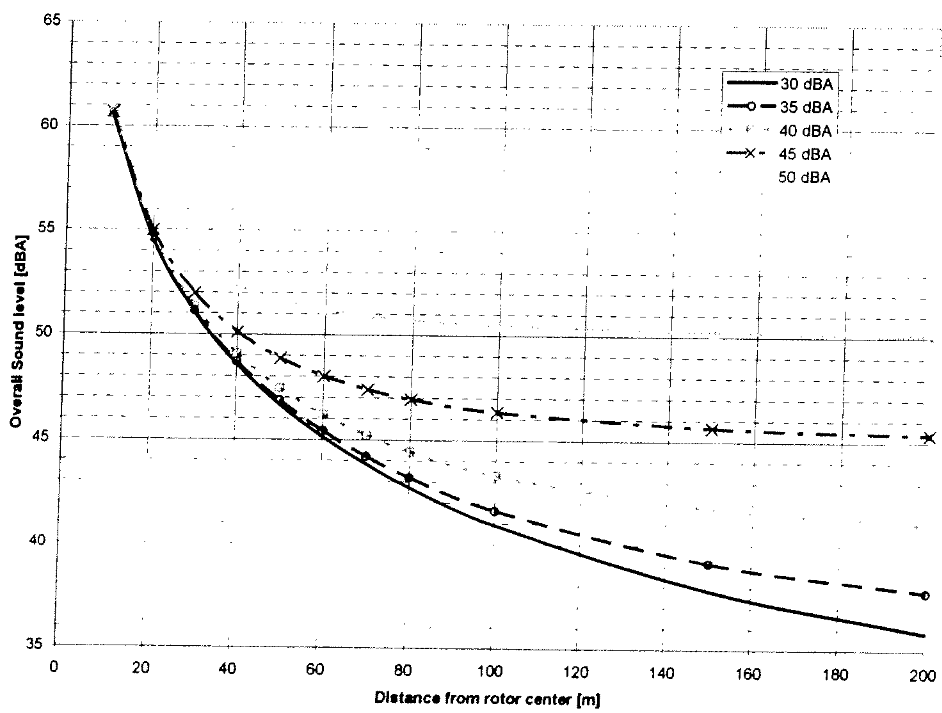

Figure 2 Sound levels as a function of distance and background noise levels for AWEA rated sound level of 45dB(A)

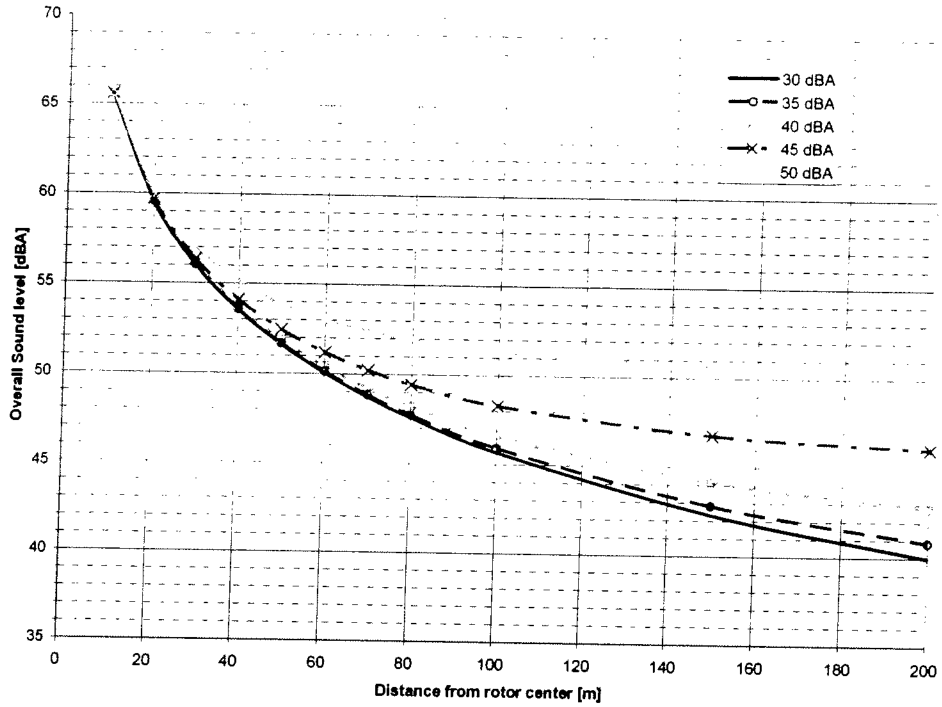

Figure 3 Sound levels as a function of distance and background noise levels for AWEA rated sound level of 50dB(A)

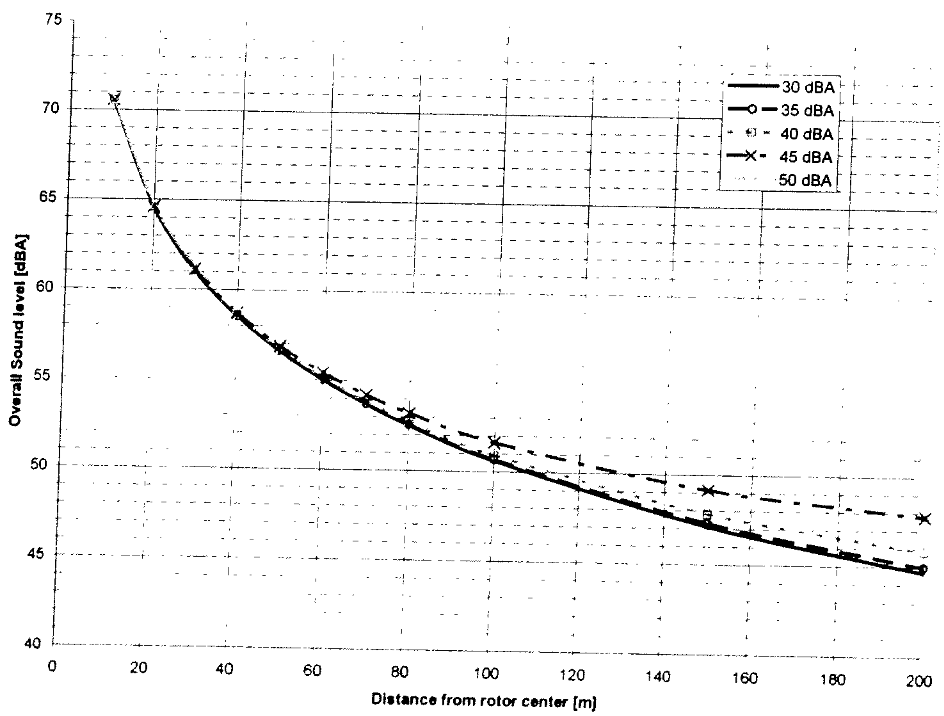

Figure 4 Sound levels as a function of distance and background noise levels for AWEA rated sound level of 55dB(A)

Much of this document is based upon the noise concerns that came up during the November 12, 2009 ZBA meeting. A paper published by the National Renewable Energy Laboratory (NREL) [a] was distributed at that time. This paper shows test results for eight turbines, and discusses testing methods. The NREL has since followed up with two more papers [b, c], announcing a program for wind turbine testing and a possible certification mechanism, sharing some results - albeit incomplete - of those tests, and promising a second round of tests on more turbines.

In the abstract of the first paper[a], progress toward quieter turbines is mentioned. While I don't doubt this observation, it's unfortunate that only the authors benefit from this observation. They don't tell us what data was used to make this comparison, so we receive no information telling us what the rate of progress may be. The paper is already a few years old; does the rate of progress mean that we're in a different regime by now? Beyond these unknowns, the paper discusses some important principles that merit attention to see how they may apply here in Champaign County.

<u>A discussion of units</u>
Sound Pressure Level (SPL) and Sound Power are both used quite a bit (not just in this paper), so it's useful to know what these are, and perhaps to decide which unit of measure is preferred.
Just what is meant when someone says "Sound Pressure" or "Sound Power?" Sound pressure is just that - pressure. Sound energy travels through the air as a wave. As the wave moves through the air, it causes local pressure fluctuations. A more intense sound produces a larger fluctuation as the wave passes by. Power - on the other hand - describes the rate at which energy is converted or used. When we use 'power' to describe electricity use, for example, it tells us how quickly we consume it. When used with acoustics (as applied to wind energy), it's the rate of conversion of mechanical energy (rotation of the turbine) to acoustic (or sound) energy.

Why mention this? Because it's important to realize that we can't sense or "hear" power. The human ear senses pressure fluctuations, not power. To some extent this means that we can use SPL (sound pressure level) as a more recognizable unit. We can't tell - with any precision - how loud a sound is, but we can recognize the difference between 50dB and 90dB (SPL).[d] Because power is the conversion rate of energy, we can't directly relate sound power to what we hear. We know that a larger number is more intense, and a lower one less so. Beyond this, it's not an intuitive unit that helps us relate how loud some sound may be. Sound pressure level is the intensity sensed by the observer – wherever that may be in relation to the source (the distance). This is <u>immission</u>. Sound Power is a measure of the intensity at the source.

Sound power is a calculated value, generally derived from a SPL measurement. The calculation is based upon the concept that sound is a point source, with emissions radiating outward in all directions. Because of this, the measured intensity is a function of distance and the sampling area. Referring to the paper [a] again, this is why the sound power calculation (equation 3, on page 3) contains a $4\pi r^2$ term. This defines the surface area of a sphere. The distance from the point source determines the radius of the sphere (r). The paper assumes an area of one square meter, hence the normalization term, S_0.

Noise and setbacks

The papers discuss a variety of turbines with a wide range of numbers. Quite obviously, they are not a complete or representative survey of products (then or now). It should be noted that there exist products with far lower noise levels (in the neighborhood of 30 or 35dB), and that this isn't insignificant. Considering this, it seems to me that setbacks shouldn't be arbitrarily set by ordinance. A fixed setback could under-protect adjacent landowners of course, but it could also require a larger setback than necessary, limiting the ability of some to erect a wind power system. As turbine noise levels improve, the setback due to height - rather than noise - may dominate. Indeed, systems may become quiet enough to allow placement in areas of higher population density. As their costs also decline, this will make installation of mixed-mode renewable energy systems (solar and wind, for example) attractive. It looks like we're already on the way down this road - see '*Lower noise products*' below. The wide range of noise levels produced by different wind energy products means that setbacks could more effectively be determined on a case-by-case basis, either considering the equipment to be installed in cases where a permit is required, or by including guidance in the ordinance [e] for by-right installations. Since we know the relationship between sound and distance [f], it's rather simple to calculate a setback to achieve a certain SPL at a given location, like a property line. The distance of a turbine from a given point is also quite simple to calculate, knowing the installation height of the unit.[g] This should be a more effective way to determine appropriate setbacks, without incurring difficult or unreasonable amounts of work on the part of the County.

More tests

The later tandem of papers [b, c] reports a testing program and some initial results. It's unfortunate that a rather esoteric set of products were chosen for the tests.[h] Testing and publication of results for the four units has begun but is yet to be completed. This is due to a variety of reasons, including site delays as well as product-related delays. Although it is mentioned that a RFP was to appear in fall 2009 (for the second set of products to be tested), there's no indication that this has happened.[i] This may seem disappointing, but any project in its infancy is bound to experience delays.

Lower noise products

There are products on the market that are far quieter than the ones seen in these publications. In particular I did some research on two such products: the Falcon series vertical axis wind turbines (VAWTs) manufactured by WePower, and the WT6500 blade tip power system (BTPS) wind turbine (a horizontal-axis unit), manufactured by Windtronics (a.k.a. 'the Honeywell turbine').[j, k]

I was interested in the acoustic specs for these products because they both advertise noise ratings below 35 decibels. The VAWTs are rated from 600 watts to 12KW and 32dB of noise, with the measurements being taken in a 15mph wind at a distance of 9 feet from the turbine.[l] The Honeywell turbine is rated 2.2KW and 'less than 35dB' noise. No other details of their measurements are shown.[m] Neither manufacturer specifies what sensor was used or what weighting may have been applied. While these numbers are impressive, there's clearly information missing that's necessary to make thorough comparisons with any other measurements. After looking over the available specifications, I contacted the manufacturers attempting to get technical details about their acoustic measurements.

I received a response from the Technical Sales Director at Windtronics. Although it was somewhat non-technical, I learned that measurements were made at about ten feet from the product. She did not know about other parameters like wind speed, weighting, and measurement device. The company is apparently in the process of arranging more authoritative testing and certification. This e-mail response is attached.[n]
Unfortunately I didn't receive a response from WePower.

Measurement equipment
The authors of the NREL papers use a microphone as the sensor to collect data. I have included the specifications for the device they used.[o] I won't include discussion of the benefits and limitations of these devices in their common applications here. It should be realized though that these devices do have shortcomings. In addition to the B&K device, a microphone is available from Radio Shack.[p] It isn't as sensitive, but other specs are similar to the B&K device.

Steve Burdin
December 30, 2009

Notes and References

a.) *Acoustic Tests of Small Wind Turbines: Preprint*, P. Migliore et al, 2003; NREL #34662; handed out at the Nov 2009 ZBA meeting, also available here: http://www.nrel.gov/docs/fy04osti/34662.pdf

b.) Attachment #1: *Testing Small Wind Turbines at the National Renewable Energy Laboratory*, K. Sinclair and A. Bowen, June, 2008 (for presentation at *Windpower 2008* - a conference); NREL # 43452

c.) Attachment #2: *Small Wind Turbine Testing Results From the National Renewable Energy Lab*, A. Bowen et al, July, 2009 (for presentation at *Windpower 2009* – a conference); NREL # 45632

d.) I'll presume white noise here. It's not trivial to sense whether different tones are the same "loudness" because human hearing response isn't flat (the same) across the frequency range that we can sense.

e.) Instead of including this language in the ordinance, this could be some accompanying document(s) that could be made available to landowners who express an interest in the installation of a wind energy system, if that were preferable. For by-right installations, this would serve to inform landowners about what is expected of their installations. It should help landowners "do it right" and could help prevent disappointments and surprises on everyone's part.

f.) It's important to be very careful with terms and units here. Sound pressure falls as the inverse of distance, or (1/d). Sound intensity (that is, sound power per unit area), falls as the square of distance so it has a ($1/d^2$) relationship. This means that at twice the distance, a given sound is ¼ as intense.

g.) The distance from a point of interest (a property line, for example), to a turbine on top of a tower forms a right triangle. Many of us know that the distance can be calculated using the Pythagorean theorem (square-root of the sum of the squares). One necessary figure is the horizontal distance from the point of interest to the base of the tower; we can call this 'd.' The other necessary figure is the height of the turbine from the base of the tower; we can call this 'h.' The distance from the observer is then evaluated in two steps; first by calculating the sum of the squares: (h x h) + (d x d), then by taking the square root of that number. In combination with the sound/distance relationship,[f] we can easily evaluate the required distance given a known noise level.

$(h^2 + d^2)$ h

d

h.) This is a personal opinion, based upon my view of the likelihood that these units would be chosen for installation - especially on a residential basis in this area. Among other reasons, I feel that these are rather large units, both physically and in power rating.

i.) http://www.nrel.gov/wind/smallwind/independent_testing.html

j.) www.WePower.us

k.) www.windtronics.com or www.earthtronics.com

l.) Attachment #3: WePower Falcon VAWTs - full series data.pdf; also available on their web site: http://www.wepower.us/products/

m.) Attachment #4: Honeywell 6500 Product Sheet.pdf; also available on their web site, in the "downloads" section: http://www.earthtronics.com/honeywell.aspx

n.) Attachment #5: Windtronics email.pdf

o.) Attachment #6: Bruel & Kjaer model 2232 microphone data sheet.pdf

p.) Attachment #7: Radio Shack 33-2055 sound level meter data sheet.pdf

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Small Wind Turbine Testing Results from the National Renewable Energy Lab

Conference Paper
NREL/CP-500-45632
July 2009

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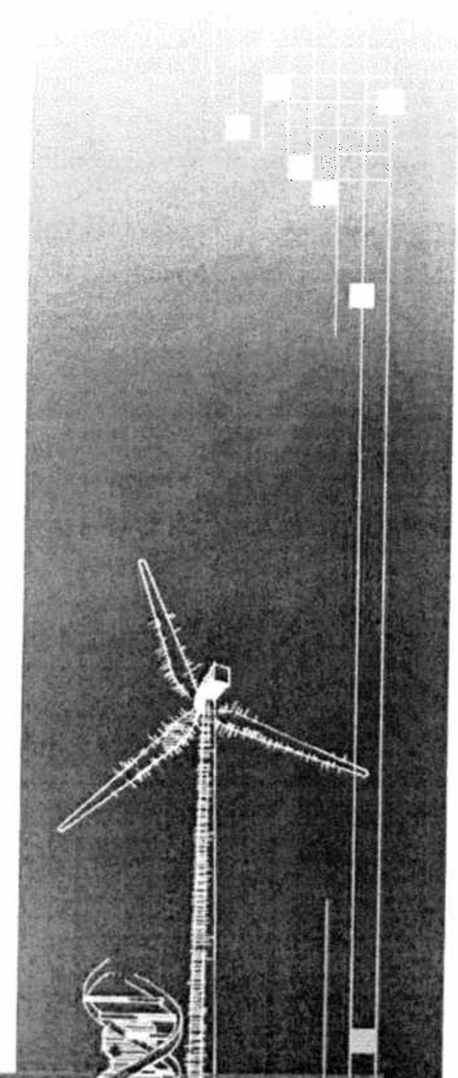
National Renewable Energy Laboratory

J. van Dam and J. Smith
Windward Engineering

Presented at the American Wind Energy Association WINDPOWER 2009 Conference and Exhibition
Chicago, Illinois
May 4–7, 2009



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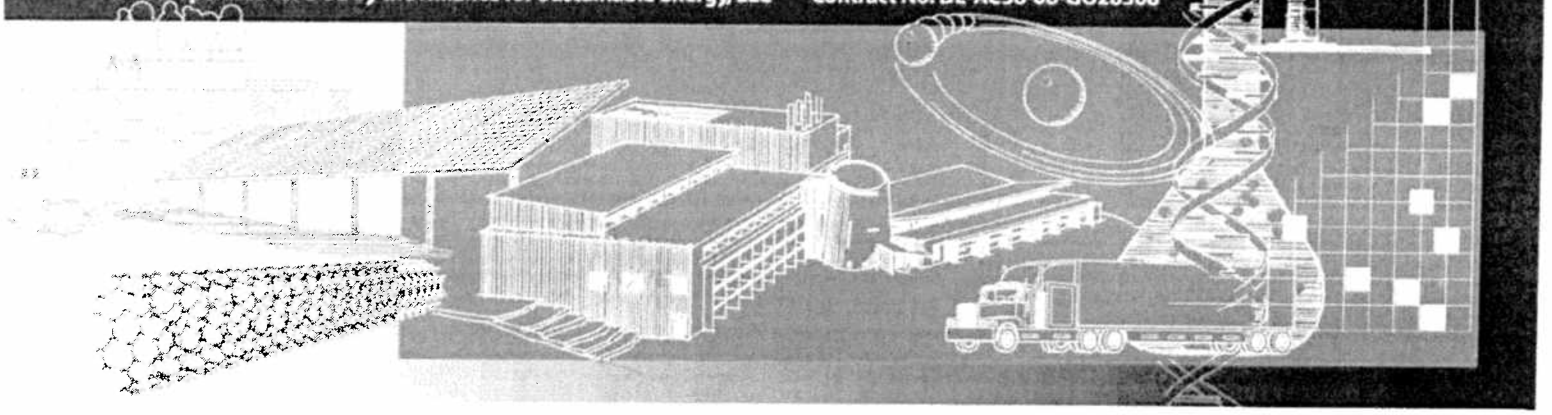

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Small Wind Turbine Testing Results from the National Renewable Energy Lab

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Abstract

In 2008, the U.S. Department of Energy's (DOE) National Renewable Energy Laboratory (NREL) began testing small wind turbines (SWTs) through the independent testing project. Using competitive solicitation, four SWTs were selected for testing at the National Wind Technology Center (NWTC). NREL's NWTC is accredited by the American Association of Laboratory Accreditation (A2LA) to conduct power performance, power quality, noise, safety and function, and duration tests to International Electrotechnical Commission (IEC) standards. Results of the tests conducted on each of the SWTs will be publicly available and likely will be used by the Small Wind Certification Council (SWCC) to certify SWTs. The results also could be used by states to decide which turbines are eligible for state incentives.

Reducing barriers for SWTs to enter the market will provide consumers in a range of sectors—including residential, ranchers/farmers, business, and community applications (e.g., schools, tribes, municipal utilities, rural electric cooperatives)—the opportunity to invest in indigenous energy, and to contribute to the shift towards energy independence. The paper reports results of testing to date, and puts the test results in perspective for the average consumer. Other topics addressed include a description of DOE's second solicitation for independent testing, and a discussion of the DOE's support for developing additional testing centers to conduct preliminary screening of SWTs to identify those turbines that are not ready for the commercial market.

Introduction

The independent testing project was established at the National Renewable Energy Laboratory to help reduce the barriers of wind energy expansion. Among these barriers is a lack of independent testing results for small turbines. Independent testing results will provide turbine manufacturers with a portion of the requirements for turbine certification. Certified turbines will give consumers confidence in small turbine technology and will separate reliable turbines from those that do not perform as advertised.

The turbines selected in the first round of the independent testing project were the Mariah Power Windspire, the Gaia-Wind 11 kW, the Abundant Renewable Energy ARE 442, and the Entegrity EW50. Figure 1 shows the selected turbines installed at the NWTC. Power performance, duration, noise, and safety and function tests are performed on all turbines. Power quality testing is performed only on three-phase turbines, as the IEC Standard 61400-21 only applies to turbines with a three-phase grid connection. The available preliminary results of those tests to date are presented below and are subject to change.

Turbines Selected

The Mariah Power Windspire was installed on May 5, 2008. It is a 120 VAC, single-phase, grid-connected, permanent-magnet generator wind turbine rated at 1 kW. The Windspire is a vertical-axis Giromill turbine mounted on a monopole tower, and has a rotor height of 6.1 m and a rotor area of 1.2 m by 6.1 m. Testing on the Windspire was terminated on January 14, 2009 after repeated turbine problems. Partial power performance and safety and function test data was collected on the Windspire.

The Gaia-Wind 11 kW turbine was installed on May 13, 2008. It is a downwind, two-bladed, horizontal-axis turbine. Its three-phase 11-kW induction generator delivers 480 VAC to the grid. The Gaia-Wind 11 kW has a 133 m^2 swept area and is mounted on an 18.2-m monopole tower. At the time of this writing, data collection for duration, safety and function, and power performance testing was complete and power quality and acoustic noise testing were in progress.

The Abundant Renewable Energy ARE 442 was installed on June 11, 2008. It is a horizontal-axis, three-bladed turbine with a swept area of 41 m^2. It operates upwind from the prevailing wind direction and uses a furling mechanism for power control. The ARE 442 is mounted on a 30.5-m lattice tower. The turbine is a single-phase, grid-connected, permanent-magnet machine that is rated at 10 kW at 240 VAC. At the time of this writing, data collection for power performance testing was complete and duration, safety and function, and acoustic noise testing were in progress.

The Entegrity EW50 was installed on March 3, 2009. The Entegrity's three-phase induction generator produces 50 kW at 480 VAC. Its rotor-swept area is 176.7 m^2 and it operates downwind. It is a horizontal-axis machine mounted on a 30.5-m monopole tower. At the time of this writing, data collection had begun for power performance, acoustic noise, safety and function, and duration testing of the Entegrity.

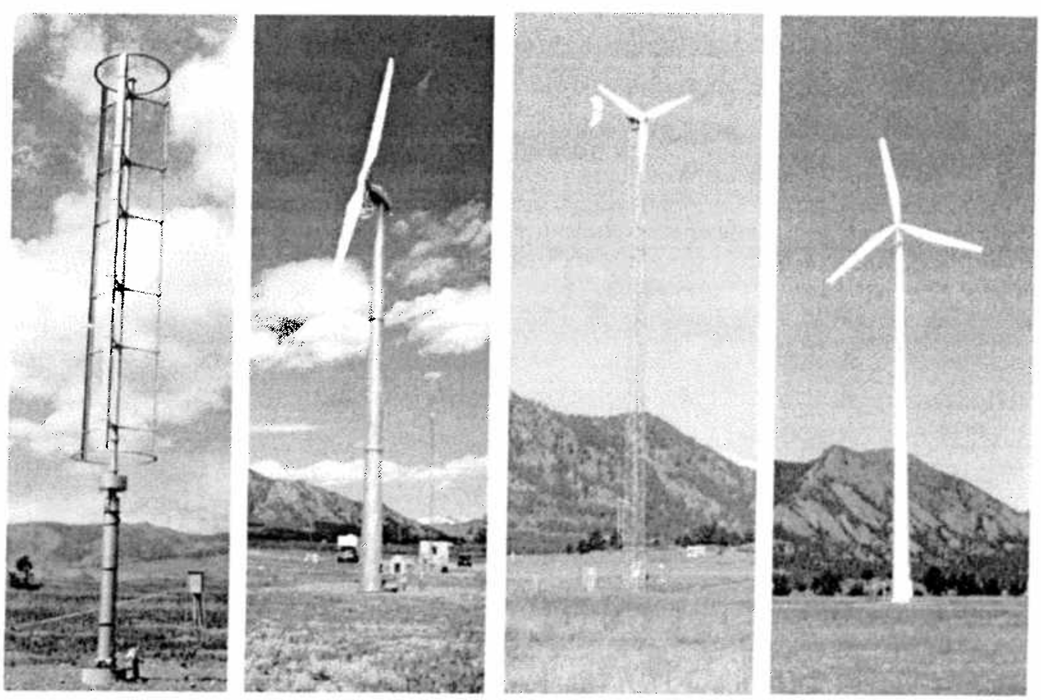

Figure 1. From left to right: the Windspire, the Gaia-Wind 11 kW, the ARE 442, the EW50

Duration Testing

The duration test is conducted according to section 9.4 of the IEC Standard 61400-2: Design Requirements for Small Wind Turbines. Duration testing provides information about the turbine's structural integrity, quality of environmental protection, and dynamic behavior. The test requires a minimum of 6 months of operation, 2,500 hours of power production in winds of any velocity, 250 hours of power production in winds of 1.2 V_{ave} and greater, and 25 hours of power production in wind of 1.8 V_{ave} and greater. Section 6.2 of IEC Standard 61400-2 defines V_{ave}, which depends on the small wind turbine class as identified by the manufacturer and based on the wind speeds in which the turbine was designed to operate. The turbine must not experience any major failures during the test period and must achieve an operational time fraction of 90% or greater. The operational time fraction is defined by the following.

$$O = \frac{T_T - T_N - T_U - T_E}{T_T - T_U - T_E} \times 100\%$$

Where T_T is the total test time, T_N is the time attributed to turbine faults and manufacturer-mandated inspections and maintenance, T_U is the time during which the turbine status is unknown due to lost data or data-acquisition failure and maintenance, and T_E is the time that is excluded from analysis due to grid faults and laboratory-mandated inspections or stops.

Part of the reliable-operation requirement for the duration test includes no significant wear, corrosion, or damage to turbine components. The structural integrity and material degradation are investigated through inspections of the turbine before, during, and after the testing period. Blades, welds, and other turbine components were visually inspected and photographed before the test and any apparent abnormalities documented. After the required test data is collected, the turbine is lowered and disassembled for inspection of all individual components. Routine inspections of both the ARE 442 and the Gaia-Wind 11 kW before and during the tests have not revealed any abnormalities. Post-test inspections for the Gaia-Wind 11 kW or the ARE 442 have not occurred.

Duration testing on the Windspire was terminated on October 14, 2008. The turbine had experienced repeated problems which resulted in a low operational time fraction. These problems included repeated loose nuts at the base of the turbine, a broken washer at the base of the turbine, broken welds at the top of the turbine, airfoil displacement in the struts, and an inverter failure.

Table 1. Preliminary Duration Results for the Gaia-Wind 11 kW

	Hours of Power Production Above:			*Max Gust*	*TI @ 15*	*# Data*	T_T	T_U	T_E	T_N	O
Month	*0 m/s*	*9 m/s*	*13.5 m/s*	*(m/s)*	*m/s (%)*	*Points*	*(hours)*	*(hours)*	*(hours)*	*(hours)*	*(%)*
Overall	2704.9	710.6	215.0	41.9	19.0	255	7094	172.5	152.0	624.6	90.8
Jun 2008	238.2	36.2	3.8	28.6	18.5	5	518	11.3	7.8	3.3	99.3
Jul	256.0	8.5	0.3	23.9	-	0	744	78.2	2.2	38.8	94.1
Aug	115.8	4.5	0.0	19.2	-	0	744	6.3	20.0	323.0	55.0
Sep	120.5	11.7	1.8	22.4	-	0	720	36.2	30.3	174.7	73.3
Oct	236.0	45.0	12.2	32.8	17.3	10	744	0.7	1.3	0.0	100.0
Nov	348.0	98.7	22.5	37.0	20.9	40	720	22.1	0.0	0.0	100.0
Dec	339.7	160.5	54.8	41.4	17.4	68	744	7.9	27.2	32.8	95.4
Jan 2009	385.0	155.5	56.0	38.8	19.9	76	744	4.9	32.0	36.5	94.8
Feb	333.2	107.3	36.8	41.9	20.0	23	672	3.2	27.0	0.0	100.0
Mar	332.5	82.7	26.8	36.7	18.0	33	744	1.7	4.2	15.5	97.9

Table 1 shows the preliminary duration results for the Gaia-Wind 11 kW. The turbine accumulated 2,704.9 hours of total run time with an operational time fraction of 90.8%.

The low operational time fraction for August and September of 2008 was caused by the failure of two contactors in the controller. Investigations suggest that the 2-pin flat connectors used to wire the contactors were poorly connected when installed at Gaia-Wind's electrical supplier. Additionally, the Gaia-Wind 11 kW turbine controller originally was designed for a 50-Hz grid, and it is possible that the contactors that originally were installed in the controller were underrated for the 60-Hz grid at the NWTC. It now is standard for all contactors in the controller to be installed with tube connectors for a more secure connection, and all turbine controllers on a 60-Hz grid are installed with the higher-rated contactors. Since the replacement of the contactor and pin connectors, the turbine has run with a high operational time fraction.

The majority of the other time classified as T_N during the test is attributed to braking-time faults, vibration errors, and maintenance. The braking-time faults occurred when the turbine took longer to brake than designed; this usually occurred during high winds. The vibration errors are expected to have occurred from birds nesting the nacelle. With guidance from Gaia-Wind, NREL installed a screen over the opening in the nacelle to prevent birds from entering. Since the installation of the screen, the turbine has run without vibration errors.

Table 2 shows the preliminary duration results to date for the ARE 442. The ARE 442 has accumulated 2,888.8 hours of total run time with an operational time fraction of 91.3%.

The low operational time fraction that occurred in November 2008 was caused by failure of the turbine's insulated-gate bipolar transistors (IGBTs) during a simulated grid fault for safety and function testing. The majority of the remaining time classified as T_N during the test is attributed to the over-temperature and overvoltage faults that the turbine experiences in high winds. The diversion loads for the turbine were located inside the data shed and did not dissipate heat properly, resulting in temperature faults at high power production. The diversion loads were moved outside of the data shed in February 2009. Since then, the over-temperature faults have been eliminated, however the turbine now is experiencing overvoltage faults.

Table 2. Preliminary Duration Results for the ARE 442

	Hours of Power Production Above:			*Max Gust*	*TI @ 15*	*# Data*	T_T	T_U	T_E	T_N	*O*
Month	*0 m/s*	*10.2 m/s*	*15.3 m/s*	*(m/s)*	*m/s (%)*	*Points*	*(hours)*	*(hours)*	*(hours)*	*(hours)*	*(%)*
Overall	2888.8	520.7	153.0	42.9	18.9	311	6576	102.5	212.0	541.9	91.3%
Jul 2008	296.0	7.5	0.0	27.8	15.8	3	744	12.5	152.2	0.0	100.0%
Aug	286.8	9.5	0.0	26.5	16.9	1	744	30.5	4.0	0.0	100.0%
Sep	217.5	8.8	0.7	23.2	13.8	8	720	49.2	5.3	0.3	100.0%
Oct	280.5	35.7	6.7	34.0	16.9	13	744	0.8	5.0	9.1	98.8%
Nov	156.0	8.2	0.0	34.3	19.5	44	720	-0.2	0.3	279.4	61.2%
Dec	379.2	131.8	41.8	42.9	18.2	72	744	1.2	10.2	120.4	83.6%
Jan 2009	466.5	146.3	44.3	42.9	20.0	93	744	0.7	1.8	76.8	89.6%
Feb	389.3	104.5	46.3	39.5	19.7	33	672	4.0	31.7	36.7	94.2%
Mar	417.0	68.3	13.2	34.9	18.4	44	744	3.8	1.5	19.1	97.4%

Turbulence intensity (TI) is the ratio of the wind-speed standard deviation to the average wind speed. Turbulence intensity is computed for each 10-minute data set and averaged to produce the monthly values provided in Table 1 and Table 2. The average turbulence intensity at 15 m/s for the entire test period was 19.0% for the Gaia-Wind 11 kW and 18.9% for the ARE 442.

Another factor of reliable operation is that the turbine should experience no significant power degradation. Each month the average power is plotted for each wind-speed bin and analyzed for any obvious trends in power production. Examination of power degradation plots indicated no apparent power degradation for the Gaia-Wind 11 kW or the ARE 442.

The dynamic behavior of the turbine is assessed by observing the turbine in a range of operating conditions. The turbine is observed at wind-speed intervals from cut-in wind speed to 20 m/s for at least one hour in total. Tower vibrations, noise, yaw behavior, and tail movement all are documented in the logbook and included in the duration-test report. For the ARE 442 the following dynamic observations were made. During high winds, the rotor operates at yaw errors of between approximately 30 degrees and 60 degrees and the furl movements excite the tower slightly. Overall, it appears that no excessive vibrations are occurring. In winds of between 8 m/s and 12 m/s the turbine tracks the wind well. For the Gaia-Wind 11 kW, the following dynamic behavior observations were made. The turbine tracks winds well in all observed wind speeds. No excessive vibration was observed. There is a slight audible thumping noise as blades pass behind the tower.

Power Performance Testing

Power performance testing is conducted per IEC standard 61400-12-1, Power Performance Measurements of Electricity Producing Wind Turbines, referencing Annex H for small wind turbines when appropriate. Products of the test include a measured power curve, a power coefficient (C_P) curve, and an estimation of annual energy production (AEP).

For small turbines, statistical data is collected in 1-minute sets and sorted into 0.5-m/s-wide wind speed bins. Data collection is complete when the wind speed bins between 1 m/s and 14 m/s contain 10 minutes of data each, and the total database consists of at least 60 relevant hours. Wind speed bins are plotted against the corresponding bin power to produce a power curve. Power curves are normalized to sea-level air density; the site-specific air density at the NWTC is relatively low, 1.0 kg/m^3. The power coefficient is the ratio of power generated by the turbine to the power available in the wind.

Preliminary power and C_P curves for the Gaia-Wind 11 kW are displayed in Figure 2. The power curve for the Gaia-Wind 11 kW shows power measurements that are greater than rated power. Preliminary power and C_P curves for the ARE 442 are displayed in Figure 3; this turbine performed as expected.

The original inverter on the Windspire was optimized for power performance and failed after several months of operation. After the failure, a production model inverter was installed and operated until testing on the Windspire was suspended. The required amount of data was not collected on either inverter due to failures, however the incomplete preliminary power and C_P curves for both configurations are shown in Figure 4.

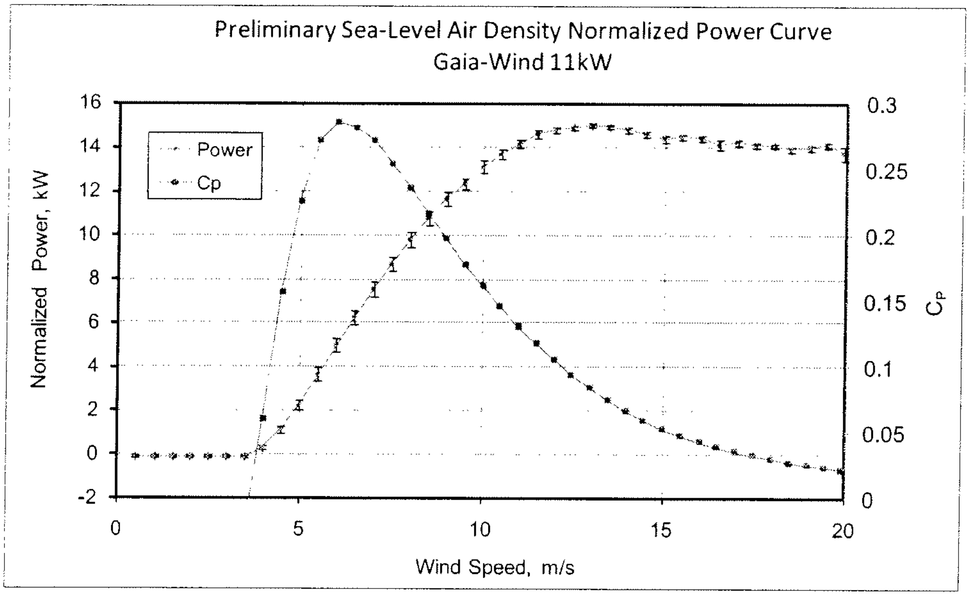

Figure 2. Preliminary power and C_P curves for the Gaia-Wind 11 kW

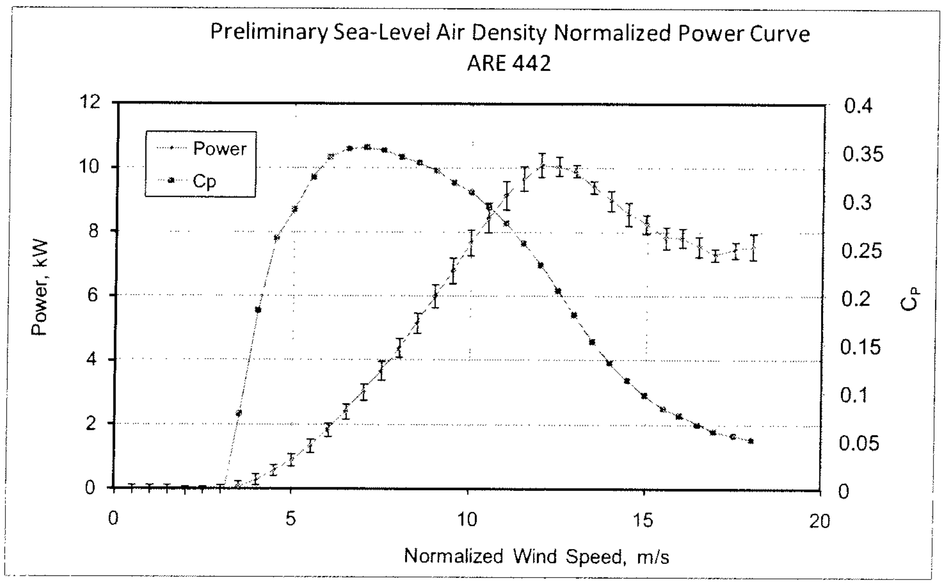

Figure 3. Preliminary power and C_P curves for the ARE 442

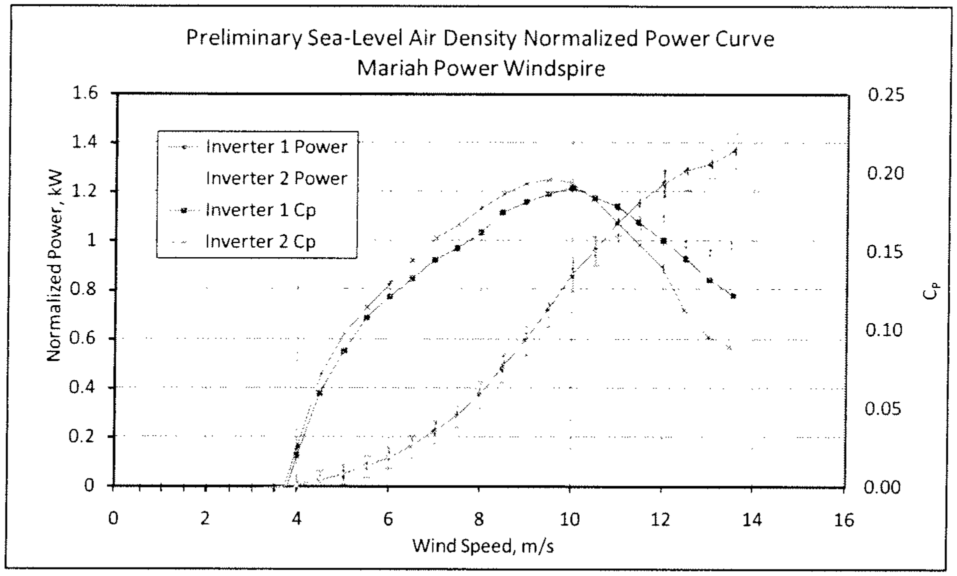

Figure 4. Mariah Power Windspire preliminary power and Cp curves for the power optimized inverter (Inverter 1) and the production inverter (Inverter 2)

Annual energy production is estimated by applying the power curve generated from power performance testing to a Rayleigh distribution. The AEP is given for annual average wind speeds at hub height for 4 m/s to 11 m/s. The measurements reported below assume no energy production beyond the highest filled bin in the power performance test. Table 3 shows the preliminary AEP as measured based on power performance data for the Gaia-Wind 11 kW and ARE 442. The AEP is not reported for the Windspire because the required amount of data was not collected.

Table 3. Preliminary Measured AEP for the Gaia-Wind 11 kW and the ARE 442

Hub Height Annual Average Wind Speed (Rayleigh) m/s	Gaia-Wind 11kW			ARE 442		
	AEP-Measured	Standard Uncertainty		AEP-Measured	Standard Uncertainty	
	kWh	kWh	%	kWh	kWh	%
4	17,716	1,692	9.6%	7,884	1,717	21.8%
5	32,122	2,093	6.5%	15,327	1,948	12.7%
6	46,292	2,284	4.9%	23,516	2,144	9.1%
7	58,690	2,327	4.0%	30,967	2,271	7.3%
8	68,525	2,285	3.3%	36,718	2,325	6.3%
9	75,474	2,197	2.9%	40,459	2,314	5.7%
10	79,617	2,087	2.6%	42,350	2,254	5.3%
11	81,326	1,966	2.4%	42,770	2,160	5.1%

Safety and Function Testing

Safety and function testing is conducted per IEC Standard 61400-2, section 9.6, and seeks to test the essential functions of the turbine system. However, NREL does not limit testing to the scope of the standard; other features that are not required by the standard also are inspected and tested. For each turbine, NREL collects data to characterize the turbine's power control, rotor-speed control, behavior upon loss of load, normal start-up, normal shutdown, and emergency shutdown. Additionally, NREL performs turbine specific tests to verify the turbine controller's function and predicted behavior. Although safety and function testing examines the essential functions of the turbine, it does not certify whether a turbine is safe to operate. Table 4 shows the preliminary safety and function data summary for the Gaia-Wind 11 kW. The turbine performed as designed with one exception. When the turbine was shut down manually using the disconnect switch and then was restarted, an over-speed error was present on the controller. The error had to be reset before the turbine could be started again.

Table 4. Preliminary Safety and Function Test Summary for the Gaia-Wind 11 kW

Test Method	Comment	Complies with Design
Power control	Turbine controls power output per design	Yes
Rotor speed control	Turbine controls rpm to 61, per design	Yes
Normal start-up	Turbine starts after several motor pulses in design wind speed and above, and below cut-out; over-speed error on start-up after manual shutdown	Partially
Normal shutdown	Turbine shuts down normally in winds less than cut-in and greater than cut-out	Yes
Emergency stop	Turbine stops within 2 to 3 seconds of pressing emergency stop button	Yes
Loss of grid	Turbine brakes immediately and stops within 2 to 3 seconds of load loss	Yes
Undervoltage / overvoltage	In an overvoltage simulation the turbine brakes immediately	Yes
High wind speed shutdown	Turbine stops in winds greater than 25 m/s and waits for start-up per the design	Yes
Rotor overspeed	Turbine brakes immediately in simulated 10% overspeed and deploys tip brakes at 15% simulated overspeed	Yes
Generator overcharge	Turbine brakes immediately in simulated generator overcharge	Yes
Excessive vibration	Vibration error registers on turbine controller after activating vibration sensor	Yes
Cable twist	Cable-twist error registers on turbine controller after lifting cable-twist arm	Yes

Table 5 shows the preliminary safety and function results for the ARE 442. The turbine's two diversion loads originally were installed inside of the data shed per the manufacturer's design. They later were moved to an enclosure outside of the data shed, after it was determined that their placement was causing repeated over-temperature faults. When the diversion loads were installed in the data shed, the over-temperature faults would occur in high-wind conditions as heat built up inside the data shed. Temperatures measured near the turbine's sensors indicated that the turbine shut down near or below its set point.

Table 5. Preliminary Safety and Function Test Summary for the ARE 442

Test Method	Comment	Complies with Design
Power control	Power is limited by the capacity of the inverters, these max out at 12 kW; after that, power is diverted to the diversion loads	Yes
Rotor speed control	Test pending	—
Yaw control	The turbine tracks the wind under all conditions; due to the furl mechanism, the rotor almost always has a yaw error	Yes
Normal start-up	Turbine starts in any winds ranging from cut-in to 25 m/s	Yes
Emergency stop	Turbine stops when stop button is pushed on the voltage clamp; this has been tested for a wide range of wind speeds	Yes

Loss of grid	Disconnecting the grid causes an immediate shutdown; in two events where a grid outage occurred in high-wind conditions, the IGBT's in the voltage clamp failed, although the turbine still shut down	Partially
Overvoltage fault	In high winds the turbine currently experiences the overvoltage fault, demonstrating that this feature works	Yes
Over-temperature fault	Temperatures measured near the turbines sensors indicate that the turbine shuts down near or below its set points	Yes

Table 6 shows the partial preliminary safety and function test summary for the Windspire. Complete safety and function test data was not collected for the Windspire before testing was terminated due to turbine problems.

Table 6. Preliminary Safety and Function Test Summary for the Windspire

Test Method	Comment	Complies with Design
Power control	Turbine controls power output per design	Yes
Rotor speed control	Turbine controls rpm per design	Yes
Normal start-up	The turbine starts normally; it experiences two resonance modes at approximately 60 rpm and 300 rpm	Yes
Normal shutdown	The turbine shuts down normally as winds drop below cut-out, however it maintain a low rpm (3–10) when braked; the turbine was not designed to shut down in high winds	Yes
Emergency stop	Turbine stops within 2 to 3 seconds of opening the disconnect switch	Yes
Loss of grid	Turbine stops within 2 to 3 seconds of load loss	Yes
Rotor over speed	Data was not collected for this test	Unknown
Overvoltage/undervoltage	Data was not collected for this test	Unknown

Power Quality

IEC standard 61400-21 for power quality is defined for three-phase turbines and only is required for medium- or high-voltage systems. Power quality testing only will be performed for the Gaia-Wind 11 kW and the Entegrity EW50 because they both are three-phase systems. Measurements include reactive power, flicker, voltage fluctuations, and harmonics. At the time of this writing, there was no data available for either turbine.

Noise Testing

IEC standard 61400-11 does not contain information specific to small wind turbines, however, they will be addressed specifically in the revision. The noise test characterizes emissions from a turbine in terms of sound power level, one-third octave levels, and tonality. For small wind turbines the IEC standard is followed with some modifications. Ten-second averages are used instead of 1-minute averages to better characterize the more-dynamic nature of small wind turbines. Also, to determine the sound pressure levels at the integer wind speeds, binning data is used instead of regression analysis. At the time of this writing, there were no results available for noise testing.

Consumer Perspective

The T_N value from the duration test gives the consumer an idea of how much downtime to expect from a turbine per year based on maintenance and faults. The operational time fraction for the Gaia-Wind 11 kW was 90.8% for the entire test period. Based on this number, the typical consumer could expect the turbine to be available to produce power 90.8% of the time. Although the actual time that the turbine is faulted can vary, NREL suspects that it might be less than reported here because the primary contributor to downtime—the failed contactors—appears to have been neutralized.

Because the downtime for the ARE occurs mostly in high winds, the operational time fraction of a particular turbine depends on the wind-speed distribution. Additionally, the furl mechanism could function differently in greater air densities, which also could affect the operational time fraction.

The average annual energy usage per household is approximately 11,000 kWh and the average energy usage per commercial establishment is approximately 77,000 kWh (Energy Information Administration 2009). Figure 5 shows the average annual energy used by consumers compared with the AEP estimated at an average hub-height wind speed of 6 m/s for the ARE 442 and Gaia-Wind 11 kW.

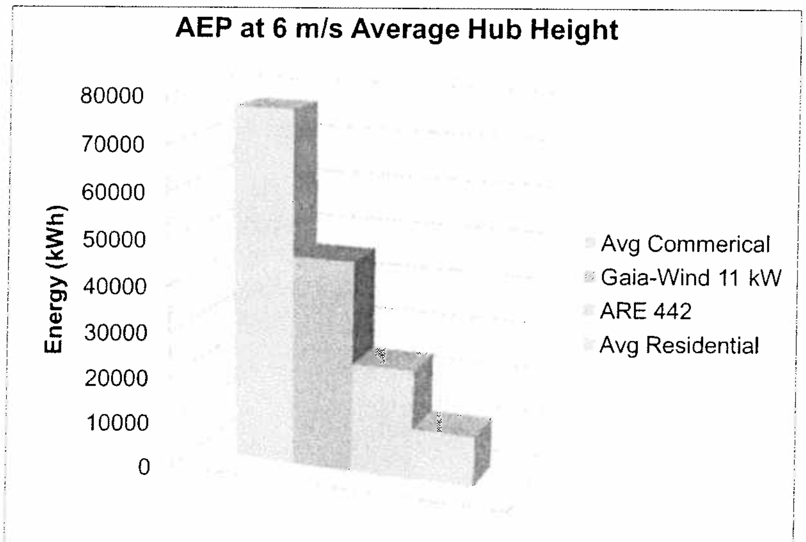

Figure 5. Average annual energy used by consumers compared with annual energy production at a hub-height wind speed of 6 m/s

Regional Test Centers

In the fall of 2008, the NWTC held a small wind testing workshop for perspective test sites. Based on the response generated at the meeting, the NWTC began developing the concept of regional test centers. NREL plans to conduct a competitive solicitation to select test centers that want to develop small turbine testing capabilities. NREL will partially fund the test centers and will provide technical support.

The Future of Independent Testing

At the time of this writing, proposals had been received and reviewed for the second solicitation of independent testing. It is expected that installation will begin on these turbines during the fall of 2009. Testing on the ARE 442 and the Gaia-Wind 11 kW is expected to continue through the spring of 2009 and possibly beyond. Testing on the Entegrity EW50 is expected to continue through the spring of 2010.

References

Energy Information Administration (January 2009). "Table 5. U.S. Average Monthly Bill by Sector, Census Division, and State 2007." Official energy statistics. U.S. Department of Energy, http://www.eia.doe.gov/cneaf/electricity/esr/table5.html. Accessed April 9, 2009.

REPORT DOCUMENTATION PAGE	*Form Approved* *OMB No. 0704-0188*

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From - To)*
July 2009	Conference Paper	4-7 May 2009

4. TITLE AND SUBTITLE
Small Wind Turbine Testing Results from the National Renewable Energy Lab

5a. CONTRACT NUMBER
DE-AC36-08-GO28308

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
A. Bowen, A. Huskey, H. Link, K. Sinclair, T. Forsyth, D. Jager, J. van Dam, and J. Smith

5d. PROJECT NUMBER
NREL/CP-500-45632

5e. TASK NUMBER
WER93010

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
National Renewable Energy Laboratory
1617 Cole Blvd.
Golden, CO 80401-3393

8. PERFORMING ORGANIZATION REPORT NUMBER
NREL/CP-500-45632

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)
NREL

11. SPONSORING/MONITORING AGENCY REPORT NUMBER

12. DISTRIBUTION AVAILABILITY STATEMENT
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

13. SUPPLEMENTARY NOTES

14. ABSTRACT *(Maximum 200 Words)*
In 2008, the U.S. Department of Energy's (DOE) National Renewable Energy Laboratory began testing small wind turbines (SWTs) through the independent testing project. Four SWTs were selected for testing at NREL's National Wind Technology Center, accredited by the American Association of Laboratory Accreditation to conduct power performance, power quality, noise, safety and function, and duration tests to IEC standards. Results of tests conducted will be publicly available and likely used by the Small Wind Certification Council to certify SWTs. Results also could be used by states to decide which turbines are eligible for state incentives. Reducing market barriers for SWTs will provide a range of consumer sectors—including residential, ranchers/farmers, business, and community applications (e.g., schools, tribes, municipal utilities, rural electric cooperatives)—the opportunity to invest in indigenous energy and contribute to energy independence. The paper reports results of testing to date, and puts the results in perspective for the average consumer. Other topics addressed include a description of DOE's second solicitation for independent testing, and a discussion of the DOE's support for developing additional testing centers to conduct preliminary screening of SWTs to identify turbines not ready for the commercial market.

15. SUBJECT TERMS
Wind; small wind turbines; power performance; power quality; manufacturer; safety and function; three-phase grid connection; noise testing

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			
Unclassified	Unclassified	Unclassified	UL		**19b. TELEPHONE NUMBER** *(Include area code)*

Setting the Meter

Setting the Weighting

Press **WEIGHTING** to select **A** or **C**.

Weighting determines the meter's frequency response curve.

A-weighting has A-curve frequency characteristics and causes the meter to respond mainly to frequencies ranging from 500 to 10,000 Hz. This is the human ear's most sensitive range. Select **A** to determine the noise level of an area.

C-weighting has C-curve (flat) frequency characteristics and causes the meter to respond mainly to frequencies ranging from 32 to 10,000 Hz. Select **C** to measure sound levels of musical material.

Note: *You can change the weighting setting only during a continuous average or maximum measurement.*

Setting the Response Time

Press **RESPONSE** to select **FAST** or **SLOW**.

When set to **FAST**, the meter updates the bar graph every 0.2 seconds. When set to **SLOW**, the meter updates the bar graph every 0.5 seconds.

Note: *You can change the response setting only during a continuous average or maximum measurement.*

Understanding Indications

Level Indicator

The meter displays sound level using a number and a bar graph. The number shows the sound level in dB within ±10 dB of the selected range and is updated once a second.

The bar graph's center point represents the midpoint of the selected range (for example, for Range 70, the center point represents 70 dB). The bar graph updates every 0.2 seconds or 0.5 seconds.

Overrange Indicator

When the sound level is higher than the highest number in the selected range, the bar graph goes to + 10 dB and both the bar graph and the number that represents the next range flash.

For example, if the meter measures 91 dB in Range 80, then the number 90 and the bar graph flash. If the meter measures more than 126 dB in Range 120, the number 126 and the bar graph flash.

If you get the overrange indicator, try a higher range setting until you get a reading in the upper half of the range (0 to + 10 dB).

Underrange Indicator

When the measured sound level is lower than the lowest sound level of the selected range, *LO* appears and the bar graph disappears. If this happens, try the next lower range.

Notes:

- *The overrange or underrange indicator can also appear when you recall a reading using the measurement holding function and the measurement is under or over the selected range.*
- *The meter can measure sound levels only from 50 to 126 dB.*

Taking Measurements

Continuous Average Measurements

Follow these steps to measure the average sound level.

1. Set **RANGE** to the desired range setting. If the sound level is very high, start at the highest range setting (120) and reduce the setting until you get a reading.

   There are seven ranges. Each covers 20 dB. The number of a range represents the center of the range. When the measured value is lower or higher than the set range, an underrange or overrange indicator appears. See "**Underrange Indicator**" and "**Overrange Indicator**" on this page. Take measurements at several different points in the area to get a good average.

   Notes:

   - *If you set* **RANGE** *to 120, the meter measures sound levels from 110 to 126 dB.*
   - *If you change the range setting during a measurement, you clear all the current data and a continuous average measurement resumes.*

2. Set the weighting and response (see "**Setting the Weighting**" and "**Setting the Response Time**" on this page).
3. Point the meter's microphone at the sound source. The meter displays the continuous average sound level during a one-second sampling period and updates the number on the display once a second.
4. After the measurement, set **RANGE** to **OFF**.

Taking Maximum Measurements

1. Follow Steps 1-3 in "**Continuous Average Measurements**".
2. Press **MAX**; the word **MAX** appears.

   The meter displays only the loudest measured sound level during the one-second sampling period. The bar graph shows the maximum level of every 0.2 or 0.5 seconds.

   The bar graph segment that corresponds to the peak reading stays on the display for 2 seconds or until the meter measures a higher maximum level.

3. Press **MAX** again to cancel the continuous maximum measurement. A continuous average measurement resumes.

Integrated Average Measurements

Follow these steps to monitor the sound level and average the measurement over a period of 1 to 199 seconds. The meter stores the average, maximum, and minimum sound levels during the set time.

1. Press and hold **DH** for about 2 seconds during a continuous average or maximum measurement. The digit **1** appears.
2. Press (or press and hold) **MAX** or **MIN** to set a period from 1 to 199 seconds; position the meter for the measurement.
3. Press **RESET** to start the monitoring.

The meter updates the current integrated average display once a second. **MIN** and **MAX** flash until the set time is up. When the set time is up, **DH** appears, and **MIN** and **MAX** go on flashing. The meter displays the total integrated average sound level.

4. Press **MAX** to display the maximum sound level for the set time, press again to return to the total integrated average sound level.

   Press **MIN** to display the minimum sound level for the set time, press again to return to the total integrated average sound level.

5. Press **RESET** after you check the average, maximum, and minimum sound levels. A continuous average or maximum measurement resumes.

Notes:

- *If you change the* **RANGE** *setting during an integrated average measurement, you clear any stored data and a continuous average or maximum measurement resumes.*
- *You must repeat the procedure for taking an integrated average measurement.*

Taking Maximum and Minimum Measurements during an Undetermined Time Period

1. Press **RESET** during a continuous average or maximum measurement. At the end of the desired time period, press **DH**. **DH** displays.
2. Press **MAX** and **MIN** respectively to check the average, maximum (**MAX** stops flashing), and minimum (**MIN** stops flashing) sound levels during the time period.
3. Press **RESET** to resume a continuous average or maximum measurement.

Checking Stereo System Acoustics

To check the sound of a stereo system, use an audio sample that produces pure tones, one at a time, at intervals that span the entire audio spectrum. Use C-weighting with either slow or fast response.

Make a graph or table to show the sound level each tone produces. This gives you a clear idea of the frequency response of the total audio system, including the room. To smooth out the response, adjust the tone control, change speaker placements, and use a frequency equalizer.

Holding Measurements

You can store the current measurements in memory and freeze measurements on the display. The meter stores the average, maximum, and minimum sound levels for the last one second.

1. Press **DH** during a continuous average or maximum measurement. **DH** displays and the last average or maximum measurement is frozen.
2. For an average measurement, what is frozen is the last average reading. Press **MAX** to check the last maximum measurement. **MAX** displays. Press **MAX** again to return to the average measurement.

   For a maximum measurement, what is frozen is the last maximum reading.

3. Press **MIN** to check the last minimum measurement. **MIN** displays. Press **MIN** again to return to the average or maximum measurement.
4. Press **RESET** to return to the continuous average or maximum measurement.

Note: *When you set* **RANGE** *to a different range during measurement holding, you disable the holding function and return to a continuous measurement.*

Care and Service

- Keep your meter dry and clean. If it gets wet or dirty, wipe it dry or clean immediately. Do not use harsh chemicals, cleaning solvents, or strong detergents to clean the meter.
- Use and store the meter in normal temperature environments only. Temperature extremes can shorten the life of electronic devices and distort or melt plastic parts.
- Handle the meter gently and carefully. Dropping it can damage the circuit boards and cause the meter to work improperly.
- Modifying or tampering the meter's internal components can cause malfunction and might invalidate its warranty. If your meter is not performing as it should, take it to your local *RadioShack* store for assistance.

Specifications

Battery	9V Alkaline
Microphone	Electret Condenser
Range	50 to 126 dB
Accuracy	±2 dB at 114 dB SPL
Reference	0dB = 0.0002 Micro Bar
Weighting	A and C
Display Response	Fast and Slow
Signal Output:	
Voltage	1 Volt Peak-Peak Min. (Open Circuit, Full Scale at 1 kHz)
Impedance	10 Kohm Min. Load
Distortion	Less than 2% at 1 kHz, 0.5 V p-p Output (Input: Mic Out, Output: 10 Kohm)
Operating Temperature	32 to 122 °F (0 to 50 °C)
Storage Temperature	-40 to 149 °F (-40 to 65 °C)
Dimensions (HWD)	6¼ × 2½ × 1¾ Inch (159 × 64 × 44 mm)
Weight (including battery)	6.7 oz (190 g)

Specifications are subject to change and improvement without notice. Actual product may vary from the images found in this document.

Protect the environment.
Go to www.E-CyclingCentral.com to find a recycling location near you.

Limited Warranty

RadioShack warrants this product against defects in materials and workmanship under normal use by the original purchaser for **ninety (90) days** after the date of purchase from a *RadioShack*-owned store or an authorized *RadioShack* franchisee or dealer. *RADIOSHACK* MAKES NO OTHER EXPRESS WARRANTIES.

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Should a problem occur that is covered by this warranty, take the product and the *RadioShack* sales receipt as proof of purchase date to any *RadioShack* store in the U.S. *RadioShack* will, at its option, unless otherwise provided by law: (a) repair the product without charge for parts and labor; (b) replace the product with the same or a comparable product; or (c) refund the purchase price. All replaced parts and products, and products on which a refund is made, become the property of *RadioShack*. New or reconditioned parts and products may be used in the performance of warranty service. Repaired or replaced parts and products are warranted for the remainder of the original warranty period. You will be charged for repair or replacement of the product made after the expiration of the warranty period.

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RadioShack Customer Relations
300 RadioShack Circle, Fort Worth, TX 76102 04/08

33-2055 RC_En 111208.indd 2

RadioShack.

Digital Sound Level Meter

User's Guide 33-2055

Thank you for purchasing your Digital Sound Level Meter from *RadioShack*. Please read this user's guide before installing, setting up and using your new meter.

Use an audio patch cord (not included) to connect to your stereo system or test equipment.

① Install the battery

1. Set **RANGE** to **OFF**.
2. Remove the battery compartment cover by pressing both side in and lifting the cover.
3. Install one 9V battery (not included) as indicated by the polarity symbols (+ and –).
4. Replace the cover.

② Set the sound range

Set **RANGE** to the desired sound range.

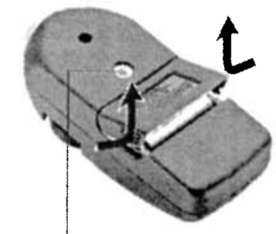
If you cannot get a reading, try other ranges until you get a reading (refer to "**Continuous Average Measurements**" on Page 2).

③ Set the weighting

Press **WEIGHTING** to select **A** (on the display) to determine the noise level of an area, or **C** to measure sound levels of musical material. Refer to "**Setting the Weighting**" on Page 2.

④ Set the response time

Press **RESPONSE** to set the response to **FAST** (on the display) or **SLOW**. Refer to "**Setting the Response Time**" on Page 2.



Tripod Adapter

Mount the meter on a (¼-inch) tripod to eliminate hand noise and minimize the effects of sound reflected from your body.

This makes it easy to use the meter with auxiliary recording or test equipment.

⑤ Read the measurement

Hold the meter and point its microphone at the sound source. The meter displays the continuous average sound level.

After the measurement, set **RANGE** to **OFF**.

What's Included

Digital Sound Level Meter
Carrying Case
User's Guide

Features

- For home/hobbyist use: fine tune your stereo, PA system, or home theater
- Attaches to a tripod with ¼ inch connector
- Selectable weighting for noise level or musical sound
- Displays average or maximum sound level
- Integrated averaging from 1 to 199 seconds

Battery Notes:

- When **BATT** displays or the meter stops operating properly, replace the battery.
- Use only a fresh battery of the required size and type.
- Dispose of old batteries promptly and properly. Do not burn or bury them.
- After using the meter, set **RANGE** to **OFF** to save power.
- If you do not plan to use your meter for a long period, remove the battery. Batteries can leak chemicals that may damage electronic parts.

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A national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy

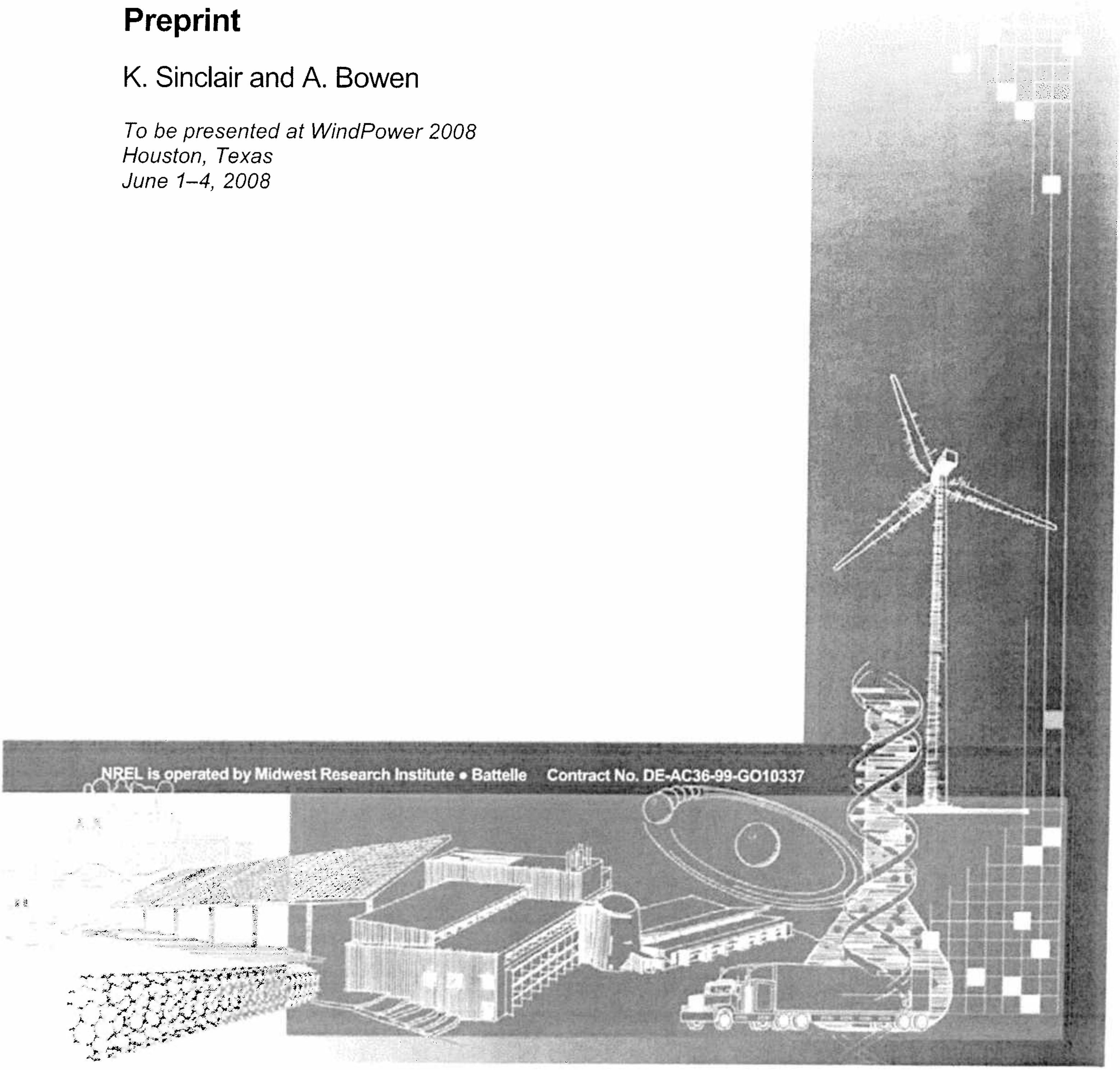
Testing Small Wind Turbines at the National Renewable Energy Laboratory

Preprint

K. Sinclair and A. Bowen

To be presented at WindPower 2008
Houston, Texas
June 1–4, 2008

Conference Paper
NREL/CP-500-43452
June 2008



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Testing Small Wind Turbines at the National Renewable Energy Laboratory

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Introduction

Reducing barriers to wind energy expansion, stabilizing the market, and expanding the number of small wind turbine (SWT) systems installed in the United States are important goals for the Department of Energy's (DOE) Wind and Hydropower Technologies Program. One of the barriers for the distributed wind market is the lack of SWT systems that are independently tested and certified.

The National Renewable Energy Laboratory (NREL) has testing capabilities that are accredited by the American Association of Laboratory Accreditation (A2LA). Currently, NREL is one of only two facilities in the United States that are A2LA accredited. To help industry provide consumers with more certified SWT systems, DOE/NREL launched a project in 2007 called Independent Testing. Through a competitive solicitation, NREL selected four commercially available SWT systems to test in 2008/2009. The turbines will be tested to standards adopted by the International Electrotechnical Commission (IEC) and in compliance with the draft American Wind Energy Association (AWEA) standards for small wind turbine systems.

The resultant test data may be used by the Small Wind Certification Council (SWCC), a nonprofit organization formed with support from DOE, AWEA, state energy offices, and turbine manufacturers to certify SWT systems. Certification by the SWCC is expected to commence in 2009. Test data could also be submitted to a certifying body as partial input for international certification.

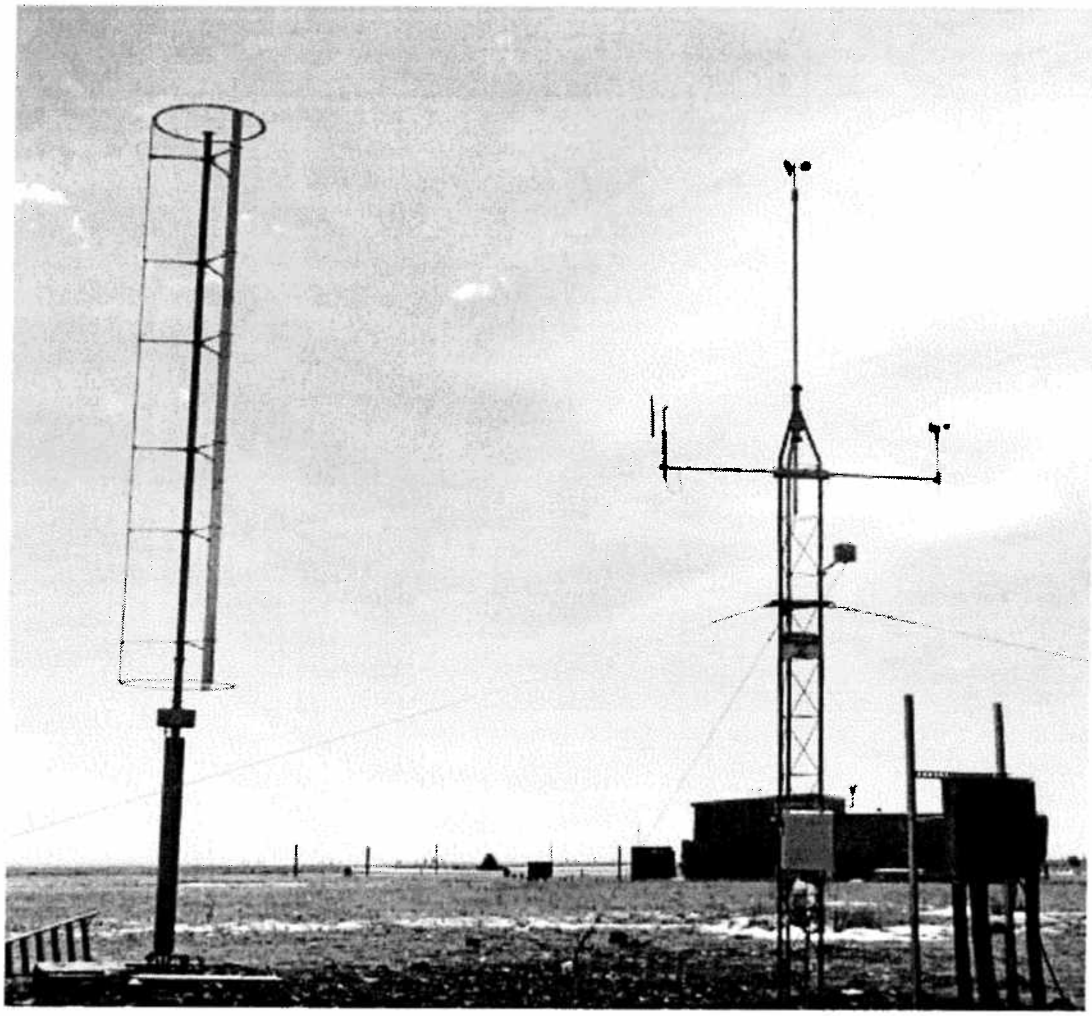
SWTs that are tested and certified will give consumers greater confidence that the systems they install will perform within specified wind regimes as advertised by the manufacturer.

Turbines Selected

Of the four turbines selected from NREL's competitive solicitation, subcontracts have been executed with three of the turbine manufacturers (Mariah Power, Abundant Renewable Energy, and Gaia Wind). The fourth subcontract (Entegrity Wind Systems) is awaiting subcontracting approval, which is anticipated to be completed in the summer of 2008. Each of the turbines in the current test cycle is described in the following section.

Mariah Power

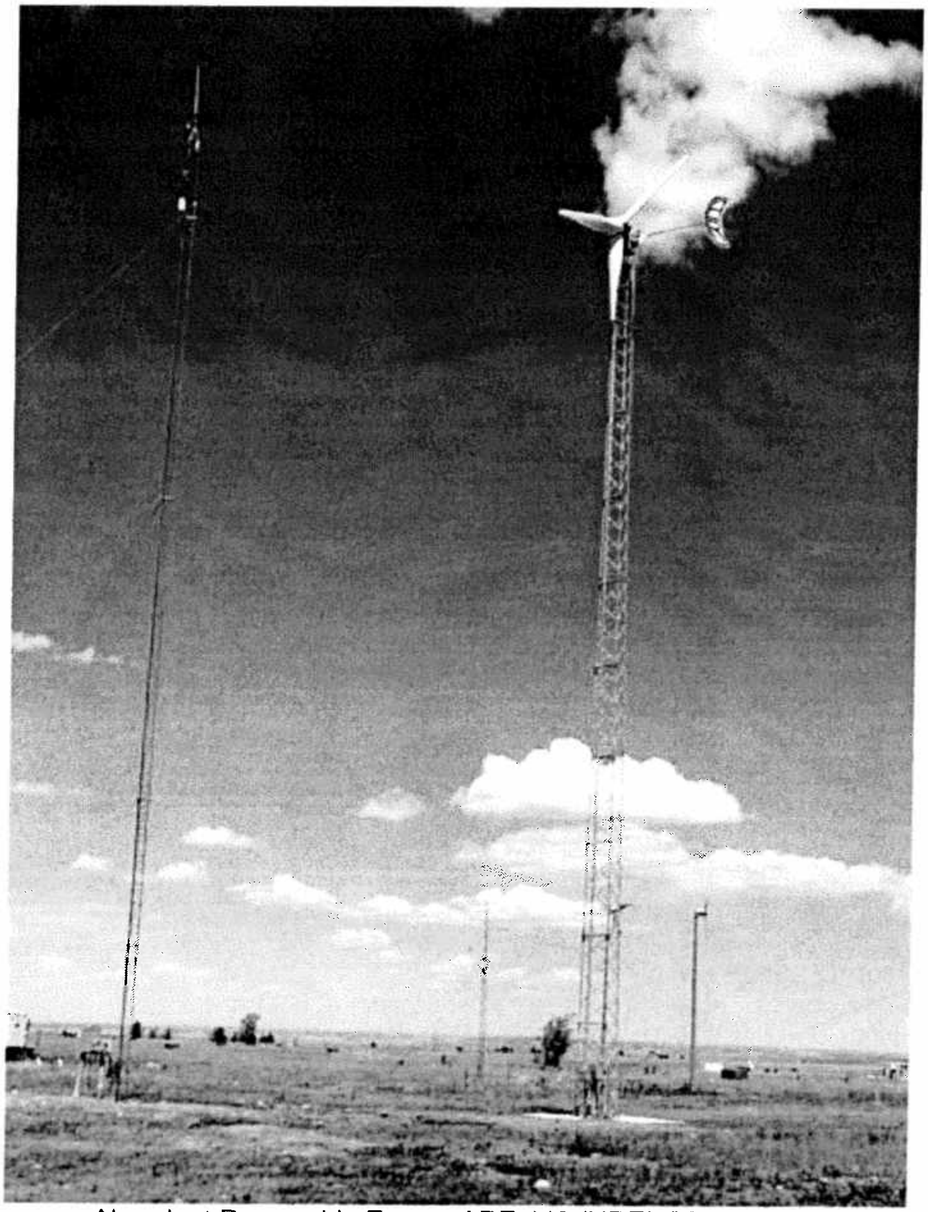
Mariah Power's Windspire is a 1.2-kW vertical-axis Giromill wind turbine. The turbine's tower is 9.1-meters tall and its rotor area is 1.2 x 6.1 meters. The turbine has a permanent-magnet generator that has a single-phase output at 120 volts AC.



Mariah Power's Windspire Giromill wind turbine (NREL PIX 15704).

Abundant Renewable Energy

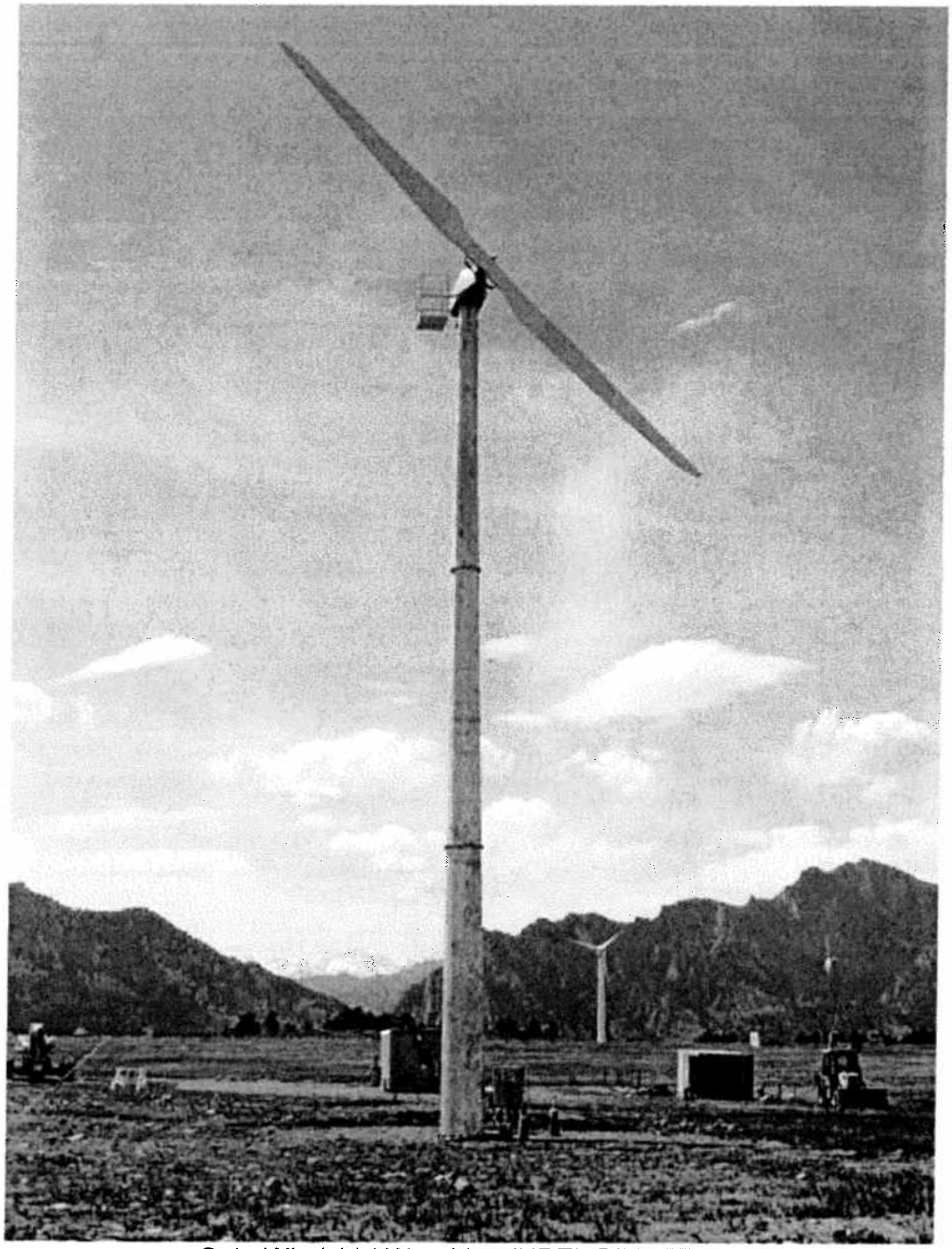
The Abundant Renewable Energy ARE 442 is a 10-kW 3-bladed horizontal-axis upwind turbine. It has a hub height of 30.9 meters and a rotor diameter of 7.2 meters. The turbine has a three-phase permanent-magnet generator that operates at variable voltages up to 410 volts AC.



Abundant Renewable Energy ARE 442 (NREL PIX 15734).

Gaia-Wind

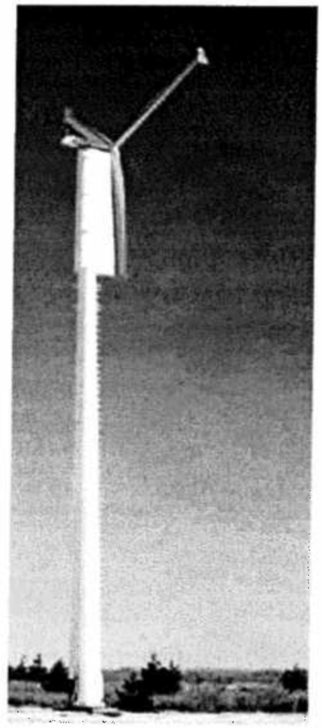
The Gaia-Wind 11-kW turbine is a three-phase induction generator that operates at 480 volts. The turbine's downwind rotor has a 13 meter diameter and its tower is 18 meters tall. The two-bladed, oversized rotor is designed for low to moderate wind speeds.



Gaia-Wind 11-kW turbine (NREL PIX 15705).

Entegrity Wind Systems

The Entegrity Wind Systems EW50 is a 50-kW 3-bladed horizontal-axis downwind turbine. The turbine's rotor diameter is 15 meters and its hub height is 30.5 meters. It has a three-phase induction generator that operates at 480 volts AC.



Entegrity Wind Systems EW50 (NREL PIX 15568).

Tests and Testing Approach

The suite of tests that will be conducted on each of the SWTs will include duration, power performance, acoustic noise emissions, safety and function, and power quality. Each is briefly described below. Tests are performed to IEC standards and in compliance with NREL's A2LA accredited Quality Assurance (QA) system. Duration, power performance, and safety and function test data will be collected using a National Instruments-based data acquisition system and compiled through custom LabVIEW software.

Duration testing is performed to summarize the turbine's performance over long periods of time. Test data will be sorted monthly into time classes specified by the standard and submitted to the client in an informal report. Duration testing will be performed according to IEC Standard 61400-2.

Power performance testing produces a power vs. wind speed graph to summarize the turbine's power generation performance at different wind speeds. This test will be performed according to IEC Standard 61400-12-1, referencing Appendix H for small turbines. Data are analyzed for rejections based on wind direction, turbine status, and instrument readings, and then compiled through an Excel-based program to produce a power curve.

Acoustic Noise Emissions testing summarizes typical noise levels emitted from the turbine at different wind speeds. Sound data are recorded (one tower height plus half a rotor diameter down wind from the tower base) and processed using Noiselab software. Noise testing will be performed according to IEC Standard 61400-11.

Safety and Function testing is performed to verify the turbine displays the behavior it is designed to have as represented by the manufacturer. Features to be tested will be drawn from the wind turbine documentation and may possibly include additional NREL specified features. The testing will be conducted in accordance with IEC Standard 61400-2.

Power Quality testing will be performed on the Gaia-Wind 11-kW and Entegrity EW50 turbines according to IEC Standard 61400-21. This testing includes assessment of power, flicker, and harmonics levels for compliance with the standard. Turbines with a UL 1741 compliant inverter will not undergo power quality testing.

Accomplishments of the Project to Date

After the four turbines were selected, two data-shed sites were developed, one existing and the other a new installation. With a possible second solicitation on the horizon, the data sheds, turbine sites, and data acquisition software were all designed to be non-turbine specific. The data sheds were outfitted with wire ways to allow easy installation and removal of data and power cables. Conduit was laid and buried from the data shed to the individual metrology tower sites to allow for future removal and new installation of power and data cables. In the case of future turbine installations, metrology tower locations will remain constant while turbine locations will vary depending on turbine sizing.

Custom data-acquisition software was developed in LabVIEW for duration, power performance, and safety and function tests. The software has built-in flexibility to allow for a varying number of data channels and signal types. This allows for minimal code-user interaction while setting up the software for new turbines.

Foundation kits for the four turbines were received ahead of the turbine system itself to allow time for foundation pouring and curing. NREL used a subcontractor for the foundation installations for the Gaia-Wind 11-kW turbine, ARE 442, and Entegrity EW50. The Windspire foundation was installed by NREL site operations crew.

The installation and commissioning of the Mariah Windspire was completed during the week of May 5, 2008; this was the first installation in the Independent Testing Project. The Gaia-Wind 11-kW turbine was installed and commissioned during the week of May

12, 2008. Installation and commissioning of the ARE 442 was completed the week of June 9, 2008.

Instrument calibration and laboratory check out (a process of validating that all systems are working as designed) to A2LA requirements and IEC recommendations have been completed for three of the turbine sites. NREL staff have completed the safety review and documentation that permit operation of the three installed turbines in an "unattended" mode. This permits the turbines to operate continuously as required for some of the test protocols. Data have been collected for several items in the safety and function test for the Gaia-Wind 11-kW turbine. Data are currently being collected for the duration and power performance tests for both the Windspire and the Gaia-Wind 11-kW turbines.

Plans to Expand with Second Solicitation

DOE is planning a second competitive solicitation to test additional SWTs in the FY 2010 timeframe. It is anticipated that the second round RFP will be released in fall 2009. In addition, DOE/NREL may consider expanding this project to support testing additional SWT systems at the NREL site with funding from non-DOE sources.

For More Information

For progress on DOE/NREL's Independent Testing Project, go to NREL's web page under a section titled Small Wind Turbine Independent Testing at: http://nrel.gov/wind/technical_support.html Test reports will be posted as they become available.

REPORT DOCUMENTATION PAGE	*Form Approved* *OMB No. 0704-0188*

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
June 2008	Conference Paper	June 2008

4. TITLE AND SUBTITLE Testing Small Wind Turbines at the National Renewable Energy Laboratory	**5a. CONTRACT NUMBER** DE-AC36-99-GO10337
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S) K. Sinclair and A. Bowen	**5d. PROJECT NUMBER** NREL/CP-500-43452
	5e. TASK NUMBER WER8.3001
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) National Renewable Energy Laboratory 1617 Cole Blvd. Golden, CO 80401-3393	**8. PERFORMING ORGANIZATION REPORT NUMBER** NREL/CP-500-43452
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	**10. SPONSOR/MONITOR'S ACRONYM(S)** NREL
	11. SPONSORING/MONITORING AGENCY REPORT NUMBER

12. DISTRIBUTION AVAILABILITY STATEMENT
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

13. SUPPLEMENTARY NOTES

14. ABSTRACT *(Maximum 200 Words)*
To describe the small wind turbine testing and certification program at NREL (NWTC).

15. SUBJECT TERMS
Wind; wind energy; small turbines; small turbine testing; Small Wind Certification Council; IEC; NWTC

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
Unclassified	Unclassified	Unclassified	UL		19b. TELEPHONE NUMBER *(Include area code)*

Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39.18

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Vertical Axis Wind Turbines (VAWT)

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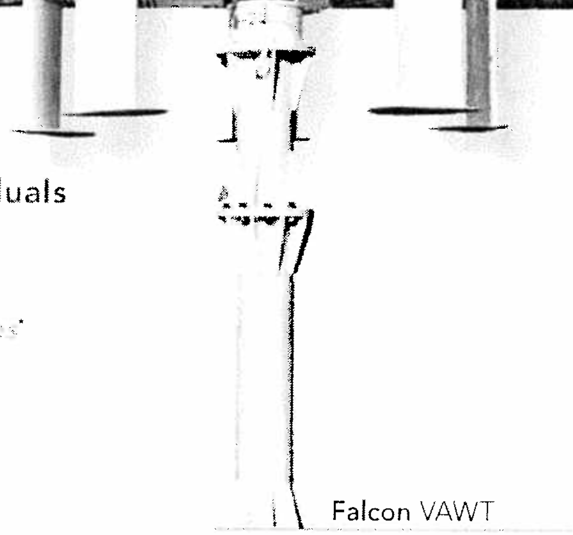

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- Extremely Quiet (Nearly Silent and Vibration Free)
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Falcon Series

Vertical Axis Wind Turbine (VAWT)

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TECHNICAL SPECIFICATIONS	FALCON MODELS 600W	1.2kW	3.4kW	5.5kW	12kW
Assuming Wind Capture 20-40% of the Time at Rated Speed	1,130 kWh - 2,270 kWh Annually*	2,100 kWh - 4,200 kWh Annually*	5,950 kWh - 11,900 kWh Annually*	9,630 kWh - 19,270 kWh Annually*	21,000 kWh - 42,000 kWh Annually*
Instantaneous Rated Power	600W*	1.2kW*	3.4kW*	5.5kW*	12kW*
Rated Wind Speed	29 mph (13 m/s)	29 mph (13 m/s)	29 mph (13 m/s)	29 mph (13 m/s)	29 mph (13 m/s)
Cut-In Speed	6 mph (2.7 m/s)	6 mph (2.7 m/s)	6 mph (2.7 m/s)	6 mph (2.7 m/s)	6 mph (2.7 m/s)
Maximum Wind Speed	111 mph (49.6 m/s)	111 mph (49.6 m/s)	111 mph (49.6 m/s)	111 mph (49.6 m/s)	111 mph (49.6 m/s)
Size Rotor Diameter X Blade Length	5'5" (1.3m) X 3'3" (1m)	5'10" (1.78m) X 6'7" (2m)	9'10" (3m) X 11'10" (3.6m)	13'1" (4m) X 15'1" (4.6m)	19'8" (6m) X 20'4" (6.2 m)
Tower Height	18' (5.5m)	18' (5.5m)	18' (5.5m)	18' (5.5m)	18' (5.5m)
Gross Weight Excluding Tower	194 lbs (88 kg)	350 lbs (160 kg)	1,393 lbs (633 kg)	2,167 lbs (985 kg)	4,190 lbs (1905 kg)
15 mph (6.7 m/s) @ 9' distance (3m)	32 dB	32 dB	32 dB	32 dB	32 dB
Output Voltage (Off Grid)	24V DC	48V DC	48V DC	48V DC	48V DC
Output Voltage (Grid Connected)	200~400V AC	200~400V AC	200~400V AC	250~500V AC	250~500V AC
Type	Permanent Magnet Direct Drive	Permanent Magnet Direct Drive	Permanent Magnet Direct Drive	Permanent Magnet Direct Drive	Permanent Magnet Direct Drive
Rated Temperature	-40°F to 239°F (-40°C to 115°C)	-40°F to 239°F (-40°C to 115°C)	-40°F to 239°F (-40°C to 115°C)	-40°F to 239°F (-40°C to 115°C)	-40°F to 239°F (-40°C to 115°C)
Input (DC) The grid connected inverter is supplied to meet local grid specifications	200~400V DC	200~400V DC	200~400V DC	250~500V DC	250~500V DC
Governed Speed Style	Electronic Dump Load	Automatic Aerodynamic Variable Pitch	Automatic Aerodynamic Variable Pitch	Automatic Aerodynamic Variable Pitch	Automatic Aerodynamic Variable Pitch
Secondary Brake	Automatic Electromagnetic	Automatic Electromagnetic	Automatic Electromagnetic	Automatic Electromagnetic	Automatic Electromagnetic

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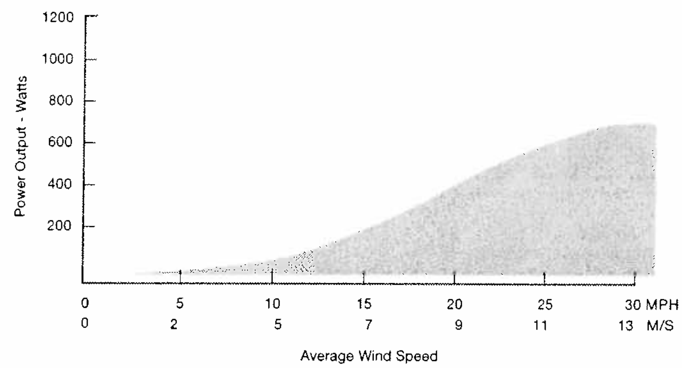
Suitable for any Application: Urban to Rural, Residential to Commercial, Industrial to Institutional

Instantaneous Rated Power	600W*
Rated Wind Speed	29 mph (13 m/s)
Cut-In Speed	6 mph (2.7 m/s)
Maximum Wind Speed	111 mph (49.6 m/s)

Assuming Wind Capture 20-40% of the Time at Rated Speed	1,130 kWh - 2,270 kWh Annually*

Size	5'5" (1.3m) Rotor Diameter X 3'3" (1m) Blade Length
Tower Height	18' (5.5m)
Gross Weight	194 lbs (88 kg) Excluding Tower

600W Power Curve



15 mph (6.7 m/s) @ 9' distance (3m)	32 dB

Output Voltage	24V DC (Off Grid)
Output Voltage	200~400V AC (Grid Connected)

Type	Permanent Magnet Direct Drive
Rated Temperature	-40°F to 239°F (-40°C to 115°C)

Input (DC)	200~400V DC

The grid connected inverter is supplied to meet local grid specifications.

Governed Speed Style	Electronic Dump Load
Secondary Brake	Mechanical Drum

Fully Equipped for Grid Connection

Fully Eligible for 30% Federal + State and Utility Incentives/Rebates**

Details at Department of Energy: www.dsireusa.org

Fully Eligible for Utility Company Net Metering

$4,990 (+ shipping and installation)

www.WEPOWER.us
sales@wepower.us
866 385-WIND (9463)

California Energy Commission

CE

ENERGY UL LISTED

32 JOURNEY SUITE 250
ALISO VIEJO, CA 92656

The information contained herein may change without notice. *Individual performance results may vary. **Subject to applicable regulations, restrictions and requirements.

Falcon 1.2 kW

Vertical Axis Wind Turbine (VAWT)

WEPOWER

Suitable for any Application; Urban to Rural, Residential to Commercial, Industrial to Institutional

Instantaneous Rated Power	1.2kW*
Rated Wind Speed	29 mph (13 m/s)
Cut-In Speed	6 mph (2.7 m/s)
Maximum Wind Speed	111 mph (49.6 m/s)

Assuming Wind Capture 20-40% of the Time at Rated Speed	2,100 kWh - 4,200 kWh Annually*

Size	5'10" (1.78m) Rotor Diameter X 6'7" (2m) Blade Length
Tower Height	18' (5.5m)
Gross Weight	350 lbs (160 kg) Excluding Tower

15 mph (6.7 m/s) @ 9' distance (3m)	32 dB

Output Voltage	48V DC (Off Grid)
Output Voltage	200~400V AC (Grid Connected)

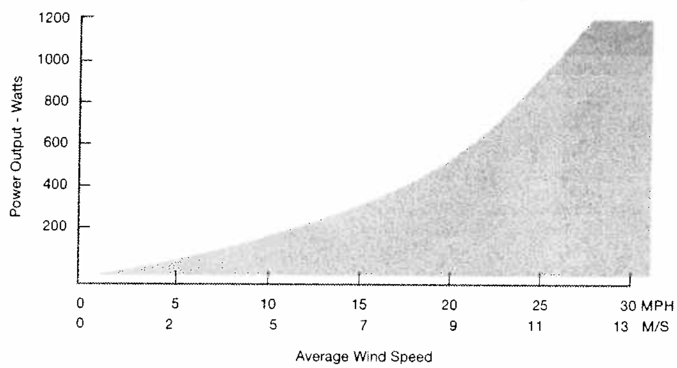
Type	Permanent Magnet Direct Drive
Rated Temperature	-40°F to 239°F (-40°C to 115°C)

Input (DC)	200~400V DC

The grid connected inverter is supplied to meet local grid specifications

Governed Speed Style	Automatic Aerodynamic Variable Pitch
Secondary Brake	Mechanical Drum

1.2kW Power Curve



Fully Equipped for Grid Connection

Fully Eligible for 30% Federal + State and Utility Incentives/Rebates**

Details at Department of Energy: www.dsireusa.org

Fully Eligible for Utility Company Net Metering

$6,890 (+ shipping and installation)

www.WEPOWER.us
sales@wepower.us
866 385-WIND (9463)

California Energy Commission

CE ENERGY UL LISTED

32 JOURNEY SUITE 250
ALISO VIEJO, CA 92656

Falcon 3.4kW

Vertical Axis Wind Turbine (VAWT)

WEPOWER



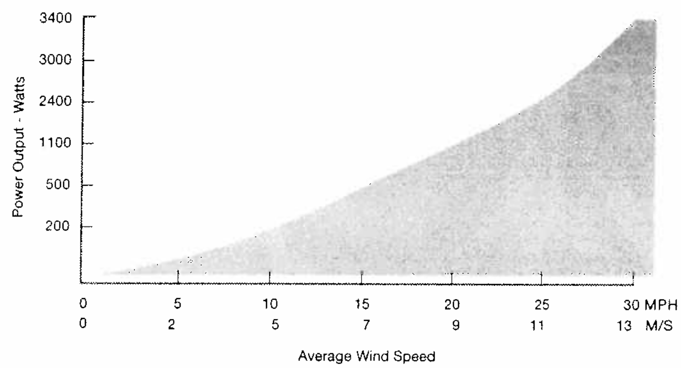
Suitable for any Application: Urban to Rural, Residential to Commercial, Industrial to Institutional

Instantaneous Rated Power	3.4kW*
Rated Wind Speed	29 mph (13 m/s)
Cut-In Speed	6 mph (2.7 m/s)
Maximum Wind Speed	111 mph (49.6 m/s)

Assuming Wind Capture 20-40% of the Time at Rated Speed	5,950 kWh - 11,900 kWh Annually*

Size	9'10" (3m) Rotor Diameter X 11'10" (3.6m) Blade Length
Tower Height	18' (5.5m)
Gross Weight	1,393 lbs (633 kg) Excluding Tower

3.4kW Power Curve



15 mph (6.7 m/s) @ 9' distance (3m)	32 dB

Output Voltage	48V DC (Off Grid)
Output Voltage	200~400V AC (Grid Connected)

Type	Permanent Magnet Direct Drive
Rated Temperature	-40°F to 239°F (-40°C to 115°C)

Input (DC)	200~400V DC

The grid connected inverter is supplied to meet local grid specifications.

Governed Speed Style	Automatic Aerodynamic Variable Pitch
Secondary Brake	Automatic Electromagnetic

Fully Equipped for Grid Connection

Fully Eligible for 30% Federal + State and Utility Incentives/Rebates**

Details at Department of Energy: www.dsireusa.org

Fully Eligible for Utility Company Net Metering

$15,390 (+ shipping and installation)

www.WEPOWER.us
sales@wepower.us
866 385-WIND (9463)

California Energy Commission

CE

ENERGY UL LISTED

32 JOURNEY SUITE 250
ALISO VIEJO, CA 92656

The information contained herein may change without notice. *Individual performance results may vary. **Subject to applicable regulations, restrictions and requirements

Falcon 5.5kW
Vertical Axis Wind Turbine (VAWT)

WEPOWER



Suitable for any Application; Urban to Rural, Residential to Commercial, Industrial to Institutional

Instantaneous Rated Power	5.5kW*
Rated Wind Speed	29 mph (13 m/s)
Cut-In Speed	6 mph (2.7 m/s)
Maximum Wind Speed	111 mph (49.6 m/s)

Assuming Wind Capture 20-40% of the Time at Rated Speed: 9,630 kWh - 19,270 kWh Annually*

Size	13'1" (4m) Rotor Diameter X 15'1" (4.6m) Blade Length
Tower Height	18' (5.5m)
Gross Weight	2,167 lbs (985 kg) Excluding Tower

15 mph (6.7 m/s) @ 9' distance (3m)	32 dB

Output Voltage	48V DC (Off Grid)
Output Voltage	250~500 AC (Grid Connected)

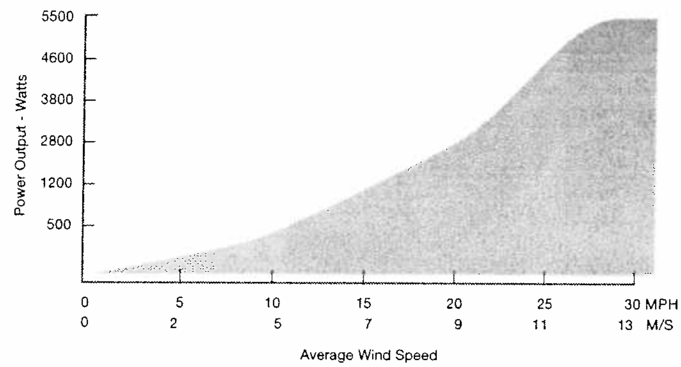
Type	Permanent Magnet Direct Drive
Rated Temperature	-40°F to 239°F (-40°C to 115°C)

Input (DC)	250~500 DC

The grid connected inverter is supplied to meet local grid specifications

Governed Speed Style	Automatic Aerodynamic Variable Pitch
Secondary Brake	Automatic Electromagnetic

5.5kW Power Curve



Fully Equipped for Grid Connection

Fully Eligible for 30% Federal + State and Utility Incentives/Rebates**
Details at Department of Energy: www.dsireusa.org

Fully Eligible for Utility Company Net Metering

$24,290 (+ shipping and installation)

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sales@wepower.us
866 385-WIND (9463)

California Energy Commission

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32 JOURNEY SUITE 250
ALISO VIEJO, CA 92656

The information contained herein may change without notice. *Individual performance results may vary. **Subject to applicable regulations, restrictions and requirements.

Falcon 12kW

Vertical Axis Wind Turbine (VAWT)

WEPOWER

Suitable for any Application: Urban to Rural, Residential to Commercial, Industrial to Institutional

Instantaneous Rated Power	12kW*
Rated Wind Speed	29 mph (13 m/s)
Cut-In Speed	6 mph (2.7 m/s)
Maximum Wind Speed	111 mph (49.6 m/s)

Assuming Wind Capture 20-40% of the Time at Rated Speed	21,000 kWh - 42,000 kWh Annually*

Size	19'8" (6m) Rotor Diameter X 20'4" (6.2 m) Blade Length
Tower Height	18' (5.5m)
Gross Weight	4,190 lbs (1905 kg) Excluding Tower

15 mph (6.7 m/s) @ 9' distance (3m)	32 dB

Output Voltage	48V DC (Off Grid)
Output Voltage	250~500 AC (Grid Connected)

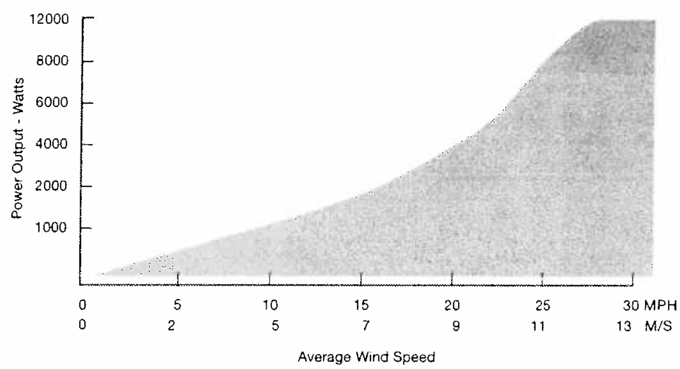
Type	Permanent Magnet Direct Drive
Rated Temperature	-40°F to 239°F (-40°C to 115°C)

Input (DC)	250~500 DC

The grid connected inverter is supplied to meet local grid specifications.

Governed Speed Style	Automatic Aerodynamic Variable Pitch
Secondary Brake	Automatic Electromagnetic

12kW Power Curve



Fully Equipped for Grid Connection

Fully Eligible for 30% Federal + State and Utility Incentives/Rebates**

Details at Department of Energy: www.dsireusa.org

Fully Eligible for Utility Company Net Metering

$41,190 (+ shipping and installation)

www.WEPOWER.us
sales@wepower.us
866 385-WIND (9463)

California Energy Commission

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ENERGY UL LISTED

32 JOURNEY SUITE 250
ALISO VIEJO, CA 92656

The information contained herein may change without notice. *Individual performance results may vary. **Subject to applicable regulations, restrictions and requirements.

From: Sarah Jenan
To: Steve Burdin
Cc: Jennifer Luttrull
Sent: Sunday, December 13, 2009 10:02 AM
Subject: RE: technical info regarding acoustics

Hello,

Thank you for your interest in our product and also for working to make sure that our technology fits into your local ordinance requirements.

We are currently working with third party labs for UL and IEC certification; these labs will also be measuring the db of our product at various wind speeds. Once we have this data we will update our spec sheet to incorporate the third party findings. In the meantime, the result of <35 db that is on our spec sheet is the measurement that was taken from our own testing. We sampled this data with a decibel meter from approximately 10 feet away; the resulting data is the difference between the turbine running and the background noise level determined at that location. At much higher wind speeds it has been determined that the wind is far louder than the turbine itself; we will certainly publish this data once it is confirmed by our third party lab testing.

Best regards,

Sarah

Sarah Jenan
Technical Sales Director
WindTronics

PRODUCT DATA

Precision Sound Level Meter — Type 2232

USES

- Community and industrial noise measurements
- Checking compliance with noise rating recommendations
- Traffic noise measurements
- Front-end for other equipment

FEATURES

- Ease of operation
- Small and lightweight, fits in a pocket
- Measuring range from 34 to 130 dB
- Type 1 precision
- Equipped with a robust, high sensitivity prepolarized condenser microphone
- Large easily-read digital display
- DC output

Introduction

Precision Sound Level Meter Type 2232 is an inexpensive instrument for primarily making community noise surveys and less demanding acoustic measurements, but nevertheless offers the accuracy and quality associated with a precision-grade sound level meter. Its excellent ergonomic design and ease of operation enable even the inexperienced user to carry out reliable measurements quickly and effectively. The handy convenience of a Type 1 precision sound level meter which can be carried around in a pocket will be appreciated by all users. A large, easily read digital display gives a single value indication of the maximum A-weighted sound level measured during the previous second, thereby eliminating meter reading errors. Type 2232 is robust, compact and lightweight (460 g), and is the ideal tool for environmental health inspectors and other personnel concerned with maintaining acceptable noise levels in industrial and residential locations, for instance police officers checking vehicle noise.

Sound Level Meter Type 2232 satisfies the requirements of IEC 60651 Type 1 and ANSI S1.4 1983 Type S1A.

Description

The Sound Level Meter consists basically of a microphone, an amplifier and a detector with associated frequency and time weighting circuits, an analogue DC output, and a digital display. Overload, underrange and low battery indicators are also provided. Type 2232 is equipped with a high sensitivity Brüel & Kjær Prepolarized Condenser Microphone Type 4176 which was developed especially for use with it. The non-removable protection grid is internally fitted with a fine gauze filter which provides excellent immunity from dust and particle penetration to the diaphragm. Measurements from 34 to 130 dB are carried out in two 60 dB measuring ranges: 34 to 94 dB and 70 to 130 dB. "F" or "S" time-weighting may be selected in accordance with IEC 60651. Two display-reset modes allow either a "max. hold" reading to be displayed or automatic resetting every second. In the automatic mode the max. time-weighted sound level measured during the preceding 1 s is displayed. When the manual displayreset mode is selected, the display shows the max. time-weighted level measured since the last manual re-set. A continuous analogue DC output, which is proportional to the A-weighted "F" or "S" time-weighted sound level, is provided for connection to other equipment. Type 2232 is powered from two 9 V, preferably alkaline, batteries (IEC Type 6LF22) which will provide approximately 30 hours continuous operation. Calibration of Type 2232 is easily carried out using an external reference source such as Sound Level Calibrator Type 4231.

Specifications – Precision Sound Level Meter Type 2232

MEASURING RANGE
34 dB to 130 dB in two 60 dB ranges: 34 to 94 dB and 70 to 130 dB

PRIMARY INDICATOR RANGE
Identical to actual display range

FREQUENCY RESPONSE
In accordance with IEC 60651 Type 1
A-weighting

DETECTOR
Characteristics: RMS indication in accordance with IEC 60651, Type 1
Dynamic Range: 70 dB (60 dB on scale plus 10 dB over)
Time Weighting: "F" and "S" to IEC/EN 60 651, Type 1
Crest Factor: 10 dB (c.f. 3) at upper limit of display range, rising linearly with decreasing signal level to a maximum of 26 dB (c.f. 20)

DISPLAY
$3^1/_3$ digit liquid crystal display with 0.1 dB display resolution. Overload, underrange and low battery warning
Read Out Interval: Updated once per second
Display Reset: "Auto" resets once per second and displays max. time-weighted value measured during the previous 1 s. "Man." resets when the reset button is pressed and displays max. time-weighted value measured since last reset

DC OUTPUT
Proportional to continuous A-weighted "F" or "S" sound level
Output Impedance: <10Ω
Nominal Output Voltage: 50 mV/dB 3% (0 to 3 V in both measuring ranges)
Offset: 7 mV ±15 mV
Minimum Load Impedance: 10 kΩ

MICROPHONE
Type: Half-inch Prepolarized Condenser Microphone Type 4176
Sensitivity: 50 mV/Pa (–26 dB re 1 V/Pa)
Cartridge Capacitance: 13 pF

EFFECT OF WINDSCREEN
<0.5 dB up to 10 kHz

CALIBRATION
Trimmer adjustment using Sound Level Calibrator Type 4231 or Multifunction Calibrator Type 4226

CALIBRATION REFERENCE CONDITIONS
Sound Field: Free Field Condition
Reference Incidence Direction: Perpendicular to microphone diaphragm (0° incidence)
Reference Sound Pressure Level: 94 dB re 20 µPa
Reference Frequency: 1000 Hz
Reference Temperature: 20°C
Reference Measuring Range: 70 to 130 dB

WARM-UP TIME
4 s

EFFECT OF AMBIENT TEMPERATURE (AT 1 KHZ)
Operating Temperature Range: –15 to +50°C
(+5 to 122°F) Sensitivity variation of complete sound level meter <0.5 dB (re 20°C)
Microphone Temperature Coefficient: –0.004 dB/°C
Storage Temperature Range: –20 to +70°C (–4 to +158°F) without batteries

EFFECT OF MAGNETIC FIELD
<22 dB for 80 A/m at 50 Hz

EFFECT OF HUMIDITY (AT 40°C, 1 KHZ)
<0.5 dB sensitivity variation for 0 to 90% R.H.

VIBRATION SENSITIVITY (10 HZ TO 2 KHZ)
Typically <76 dB equivalent sound pressure level for vibration level of 1 m/s² applied perpendicularly to microphone diaphragm (Typically <71 dB equivalent SPL for 1 m/s² parallel to diaphragm)

POWER SUPPLY
Two 9 V alkaline batteries (IEC Type 6LF22) or other 9 V batteries
Battery Life: Approx. 30 hours continuous operation with alkaline batteries.

DIMENSIONS
Overall Length: 267 mm (9.9 in)
Overall Width: 72 mm (2.8 in)
Depth: 23 mm (0.9 in)

WEIGHT
460 g (1 lb.) with batteries

Compliance with Standards

CE ✓	CE-mark indicates compliance with: EMC Directive and Low Voltage Directive. C-Tick mark indicates compliance with the EMC requirements of Australia and New Zealand
Safety	EN 61010–1 and IEC 61010–1: Safety requirements for electrical equipment for measurement, control and laboratory use. UL 3111–1: Standard for Safety – Electrical measuring and test equipment
EMC Emission	EN 50081–1: Generic emission standard. Part 1: Residential, commercial and light industry. EN 50081–2: Generic emission standard. Part 2: Industrial environment. CISPR22: Radio disturbance characteristics of information technology equipment. Class B Limits. FCC Rules, Part 15: Complies with the limits for a Class B digital device.
EMC Immunity	EN 50082-1: Generic immunity standard. Part 1: Residential, commercial and light industry. RF immunity implies that sound level indications of 45 dB or greater will be affected by no more than 0.5 dB. EN 50082-2: Generic immunity standard. Part 2: Industrial environment. RF immunity implies that sound level indications of 60 dB or greater will be affected by no more than 0.5 dB
Note: The EMC specifications are given for use with one AO 0481 AC output cable. EMC standards are not guaranteed to be fulfilled with cables other than the one mentioned above	

Ordering Information

Type 2232 Precision Sound Level Meter

ACCESSORIES INCLUDED
Type 4176 Half-inch Prepolarized Condenser Microphone
UA 0459 Windscreen
DZ 9566 Random Incidence Corrector
KE 0205 Leather Carrying Case
QB 0016 9 V Alkaline Battery (2 pieces)

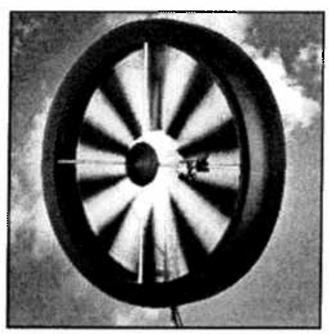
JP 0213 2.5 mm Mini-jack Plug

ACCESSORIES AVAILABLE
Type 4231 Sound Level Calibrator
AO 0481 Output Cable
UA 0587 Tripod
Type 4226 Multifunction Acoustic Calibrator

BP 0187–17 02/04 Rosendahls Bogtrykkeri

WT6500 Wind Turbine

Gearless Blade Tip Power System



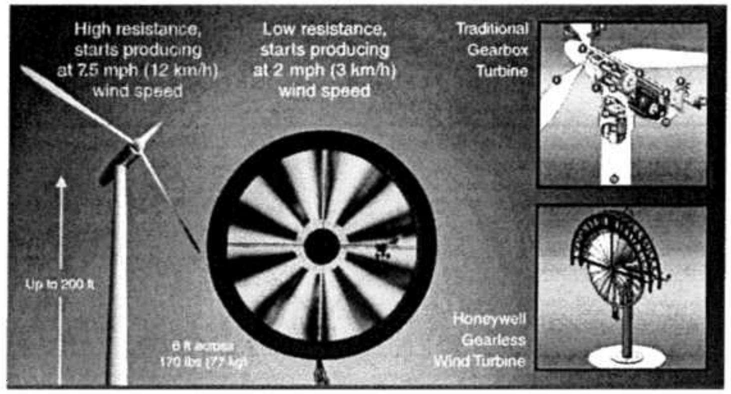
Introducing a breakthrough wind energy system for home and business featuring a revolutionary gearless Blade Tip Power System (BTPS).

The Honeywell Wind Turbine is a gearless wind turbine that measures just 6 feet in diameter, weighs 170 lbs (77 kgs) and is able to produce 2000 kWh/yr in class 3 winds representing 18% percent of an average household's annual electricity needs. The Honeywell Wind Turbine creates power at the blade tips, rather than the complicated gearing of traditional turbines, drastically reducing mechanical resistance, resulting in far greater energy production even at low wind speeds. Traditional gearbox turbines require minimum wind speeds of 7.5 mph (12 km/h) to cut in and start generating power. The Honeywell Wind Turbine begins generating energy with winds as low as 2 mph (3 km/h).

Honeywell

Bringing wind technology to life.

We've turned wind turbines inside out.
According to the National Wind Technology Center, more than 80 percent of the U.S. residential market experience winds of less than 10 mph (16 km/h) over 90 percent of the time. Standard gear box turbines require a minimum of 7.5 mph (12 km/h) to begin producing energy. The Honeywell Wind Turbine's breakthrough technology can produce energy in as little wind as 2 mph (3 km/h) and can perform in winds up to 42 mph (67.5 km/h), enabling consumers who live in areas with low wind speeds to leverage wind as an energy source.



Dealer Support

The Honeywell Wind Turbine Service Network will handle installation and services for all customers. Honeywell Wind Turbine Dealers will benefit from the following marketing and support programs.

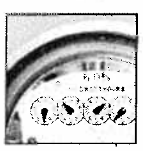

State incentives of 30-100% for wind systems


Dealer Demo Rebate Program

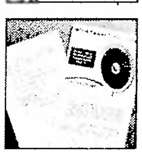

One Source Certified Installation


Technical Support

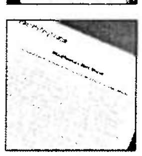

Web Resource Center


Verifiable Power Output


In Store Merchandising


Training


Consumer DVD


Marketing & Public Relations

Honeywell Model WT 6500 Star Gate Specifications

Honeywell Gearless Wind Turbine

Blade Tip Power System (BTPS)

BTPS Permanent Magnet Electric Generator, Patents Pending

UL Certified (Dec 2009)

Installs on Pole or Roof Mount

Lowest Cost kWh Installed Technology in Class

Enclosed Blade Tip Power System

Wide Wind Acceptance Angle

Acoustic Noise Emissions < 35dB

Tip to Tip Blade Dimension 5.7' (170 cm)

170 lbs (77.2 kg)

120 AC 60 Hz

220 AC 50 Hz (May 2010)

2.2 KW Plate Power

< 2mph (3 km/h) Cut in Speed, Shut down 42 mph (67.5 km/h)

Renewable Electric Generation 2000 kWh/yr - Class 3 Winds
Renewable Electric Generation 2500 kWh/yr - Class 4 Winds
(D.O.E. average US household electric 11,000 kWh/yr)

Smart Box Control System (includes)
- *Optimal Power Transfer Controller*
- *True Sine Wave Inverter*
- *Battery Power Management System*
- *Wind Direction & Speed Measurement Control System*
- *Standard RS485 Communication Port*

5 Year Limited Warranty

Annual CO2 Displacement 2.2 Tons

Product Design Life 20 Years

WindTronics
380 W. Western Suite 301, Muskegon, MI 49440
toll free 866.6.EARTH.0 (866-632-7840)
local 231.332.1188
fax 231.726.5029
www.windtronics.com
info@windtronics.com

Honeywell

CASE NO. 634-AT-08 Part B

SUPPLEMENTAL MEMORANDUM
January 8, 2010

Champaign County Department of

PLANNING & ZONING

Brookens Administrative Center
1776 E. Washington Street
Urbana, Illinois 61802

(217) 384-3708

Petitioner: **Zoning Administrator**

Prepared by: **John Hall** — Zoning Administrator; **JR Knight** — Associate Planner

Request: **Amend the Champaign County Zoning Ordinance as follows:**

1. **Add definitions for "SMALL WIND TURBINE TOWER" and "BIG WIND TURBINE TOWER", and revise the definition for "WIND FARM."**
2. **Amend subsection 4.2.1. to allow BIG WIND TURBINE TOWER as a second principal use on lots in the AG-1 and AG-2 Zoning Districts.**
3. **Amend paragraph 4.3.1E. to add new height regulations that apply to "SMALL WIND TURBINE TOWER" and "BIG WIND TURBINE TOWER".**
4. **In Section 5.2 replace "wind turbine" with "BIG WIND TURBINE TOWER".**
5. **In Section 6.1.3 add new standard conditions for "BIG WIND TURBINE TOWER" that are similar to the standard conditions for WIND FARM.**
6. **Add new subsection 7.7 making "SMALL WIND TURBINE TOWER"an authorized accessory use by-right in all zoning districts and add requirements including but not limited to:**
   a. **the turbine must be located more than one and one half miles from the nearest municipal zoning jurisdiction; and**
   b. **minimum required yards that are the same as for other accessory structures in the district provided that the overall height is not more than 100 feet; and**
   c. **an overall height limit of 200 feet provided that the separation from the nearest property line is at least the same as the overall height and authorize private waivers of the separation by adjacent neighbors; and**
   d. **a limit of no more than two turbine towers per lot; and**
   e. **allowable noise limits; and**
   f. **a requirement for engineer certification; and**
   g. **a requirement to notify the electrical power provider if interconnected to the electrical grid; and**
   h. **a requirement for no interference with neighboring TV, radio, or cell phone reception; and**
   i. **a requirement for the removal of inoperable wind turbines.**
7. **In Section 9.3.1 add fees for SMALL WIND TURBINE TOWER and BIG WIND TURBINE TOWER.**
8. **In Section 9.3.3 add application fees for BIG WIND TURBINE TOWER Special Use Permit.**

STATUS

This case was continued from the November 12, 2009, meeting. Revisions have been made to the proposed amendment based on concerns voiced at that meeting. Perhaps the most important changes have been to increase the minimum side and rear yard requirements (now proposed to be 1/3 the total height) and a more robust implementation of the Illinois Pollution Control Board noise regulations that results in no maximum noise limit if there is no Class A or Class B land use within 900 feet. See the discussion below.

All parts of the proposed amendment (including those with no revisions) are attached. The case may be ready for a final determination. A Revised Draft Finding of Fact will be available at the meeting.

FYI, the City of Champaign's recently adopted Wind Energy Conversion Systems ordinance is also included.

REVIEW OF MISCELLANEOUS DOCUMENTS IN PREVIOUS MAILING

The following documents were included in an earlier mailing:

- *Wind Turbine Noise Issues* by Anthony L Rogers, and James Manwell. This white paper provides a good discussion regarding the noise problems associated with small wind turbines and the trouble with manufacturer claims regarding noise performance.

- Draft *AWEA Small Wind Turbine Performance and Safety Standard.* This Draft is evidence that the small wind turbine industry is trying to provide better information regarding the acoustical performance of small wind turbines.

- Packet of information from Steve Burdin, received on December 31, 2009. In the cover letter to this packet of information Mr. Burdin seems to argue for determining a noise based separation on a case by case basis rather than fixed setbacks in an ordinance. Information is also provided on two small wind turbines that comply with IPCB noise limits. The Honeywell turbine is rated at 2.2 kW. The line of vertical axis WePower turbines comes in ratings from 600 watts to 12kW which is an extraordinary range of power ratings to comply with the IPCB noise ratings.

HUMMER WIND TURBINE PRODUCT INFO

A relatively new line of wind turbines are available in the US from Hummer Wind Power. This line of turbines from 500 watts to 20 kilowatts is advertised to have a noise rating of no more than 34 decibels. This is the second full line of wind turbines (see the WePower turbines submitted by Steve Burdin) claimed to meet the IPCB noise standards.

REVISIONS TO THE PROPOSED AMENDMENT

- **Revised Change to Subsection 5.2.** The proposed footnote 17 has been revised so as to be more consistent with the definition of "BIG WIND TURBINE TOWER".

- **Revised side and rear yard requirements in paragraph 7.7.D.** At the November 12 meeting the Board was concerned about the proposed side and rear yard requirements for small wind turbines. Paragraph 7.7 D. has been revised to increase the minimum side and rear yard requirements for small wind turbine towers to make them more similar to the side and rear yard requirements for principal buildings. See Sec. 5.3 (included as an attachment). The change increases the minimum from the previous requirements that varied by district (10 feet for AG-1, AG-2, CR, B Districts, and I-1; 5 feet in the R Districts; and 20 feet in I-2) to a uniform dimension for all districts that is equal to 1/3 of the total height of the wind turbine except that the rear yard can be reduced by the amount of any alleyway that is present. Thus, a 150 feet tall wind turbine will require a 50 feet side and rear yard. This requirement may act as a height limit on lots with less than a 100 feet of width but wind turbine towers on such lots are probably already limited in height due to proximity of adjacent dwellings.

- **Revised maximum noise level in paragraph 7.7.F.** Paragraph 7.7 F. has been revised to more accurately reflect the Illinois Pollution Control Board noise regulations in the following ways:
  - The maximum noise standard only applies when the noise from the turbine (a Class C land use) is discernable at a Class A land use that is either (1) a residential property (assumed here as "the property line of a LOT that is 10 acres or less in area and on which a DWELLING is the PRINCIPAL USE" or (2) a farm residence (assumed to be a "DWELLING on a LOT that is 10 acres or larger"). Noise limits have also been added for Class C to Class B (business).

    Note copies of noise ratings are attached. The Class C to Class A nighttime limit is 46dB; the Class A to Class A nighttime is 38dB; and the Class C to Class B daytime is 49dB.

  - Because the IPCB does not have a Class C to Class C noise limit, if there is no Class A or Class B land use within 900 feet there is no maximum noise standard. Thus, a wind turbine that is bordered by farmland for a distance of 900 feet has no maximum noise level. Class A and B land uses that are developed after the turbine has been authorized do not trigger the maximum noise standard unless the wind turbine is being replaced.

  - As drafted, the Board could decide whether or not to eliminate the maximum noise requirement at a certain noise threshold such as 5kW, 10kW, or 40kW. See the shaded and italicized text. On the basis of manufacturer's data for the WePower and Hummer lines of turbines there may not be a need for this kind of approach to the noise requirement.

- **Revised requirements for replacement of turbines in Subsection 7.7 and fees for replacement in Subparagraph 9.3.1.** As reviewed above, Class A or B land uses that are developed after the turbine has been authorized do not trigger the maximum noise standard unless the wind turbine is being replaced. Thus, a permit must be required for replacement. A special fee has been included for "replacement of turbine on existing tower" in subparagraph 9.3.1.

ATTACHMENTS

A Proposed Changes to Section 3 (no changes this version)
B Proposed Changes to Par. 4.2.1 C. (no changes this version)
C Proposed Changes to Subpar. 4.3.1 E (no changes this version)
D REVISED Changes to Subsection 5.2
E Proposed Addition to Subsection 6.1.3 (no changes this version)
F REVISED New Subsection 7.7
G Proposed Changes to Par. 9.1.9 B. (no changes this version)
H REVISED Changes to Par. 9.3.1 D.
I Proposed Changes to Par. 9.3.3 B. (no changes this version)
J Section 5.3 from the Champaign County Zoning Ordinance (without footnotes)
K Excerpt from the Illinois Pollution Control Board Sound Emission Standards
L Noise Rating for Class C to Class A, nighttime
M Noise Rating for Class C to Class B, daytime
N Noise Rating for Class A to Class A, nighttime
O Hummer wind turbine product information (included separately)
P Exhibit A City of Champaign Wind Energy Conversion Systems ordinance (included separately)

Attachment A. Case 634-AT-08 Part B REVISED Draft Proposed Changes To Section 3
JANUARY 7, 2010

1. Revise the following in Section 3.0 Definitions:
(Note: strike out and underlining indicate changes from the current Ordinance)

WIND FARM: A unified development of WIND FARM TOWERS and all other necessary components including cabling, transformers, a common switching station, and maintenance and management facilities which are intended to produce electricity by conversion of wind energy and to deliver the electricity to the power grid ~~and having a name plat capacity of more than 10 megawatts (MW)~~. A WIND FARM is under a common ownership and operating control even though the individual WIND FARM TOWERS may be located on land that is leased from many different landowners. A WIND TURBINE TOWER or WIND TURBINE TOWERS that do not conform to the definitions of either a SMALL WIND TURBINE TOWER or a BIG WIND TURBINE TOWER shall by definition be considered a WIND FARM and may only be authorized as a WIND FARM.

WIND FARM TOWER: A wind turbine nacelle and rotor and the supporting tower structure that are part of a WIND FARM development and intended to produce electricity for the power grid or any WIND TURBINE TOWER that does not conform to the definitions of either a SMALL WIND TURBINE TOWER or a BIG WIND TURBINE TOWER.

2. Add the following in Section 3.0 Definitions (revisions from last memo are indicated):
(Note: strike out and underlining indicate changes from the previous version)

WIND TURBINE TOWER, BIG: A wind turbine nacelle and rotor and the supporting tower structure and associated control or conversion electronics that is owned (or leased to be owned) by the owner of land on which it is located for the purpose of producing electrical energy to be used onsite by another principal use on the same property provided that any energy not used onsite may be sold to the electric power provider and which is not more than 500 feet in overall height measured to the tip of the highest blade and that is not connected to or part of a system of more than two other BIG WIND TURBINE TOWERS.

WIND TURBINE TOWER, SMALL: A wind turbine nacelle and rotor and the supporting tower structure and associated control or conversion electronics that is owned (or leased to be owned) by the owner of land on which it is located and which produces electrical energy to be used onsite by the principal use on the same property provided that any energy not used onsite may be sold to the electric power provider and which is not more than 150 feet in overall height measured to the tip of the highest blade and with a rotor diameter of not more than 75 feet.

Attachment B. Case 634-AT-08 Part B Draft Proposed Changes To Subpar. 4.2.1 C.
JANUARY 7, 2010

1. Add new subparagraph 4.2.1 C.2. as follows:

2. Up to three BIG WIND TURBINE TOWERS may be authorized as a second PRINCIPAL USE on a LOT as a Special Use Permit in the AG-1 Agriculture and AG-2 Agriculture DISTRICTS.

Attachment C. Case 634-AT-08 Part B Draft Proposed Changes To Subpar. 4.3.1 E
JANUARY 7, 2010

1. Revise subparagraph 4.3.1 E. as follows:
(Note: strike out and underlining indicate changes from the current Ordinance)

E. Any tower (including antenna) over 100 feet in HEIGHT shall be subject to the SPECIAL USE requirements in the DISTRICT in which it is located except for the following:

(1) any tower that meets the requirements of Section 4.3.1 C.; or

(2) any TEST WIND TOWER that does not exceed 200 feet in HEIGHT; or

(3) any WIND FARM TOWER except as HEIGHT regulations are required as a standard condition in Section 6.1.4. ; <u>or</u>

<u>(4) any SMALL WIND TURBINE TOWER .</u>

Attachment D. Case 634-AT-08 Part B REVISED Draft Proposed Changes To Section 5.2
JANUARY 7, 2010

1. **In Section 5.2 replace "Wind Turbine (1-3 wind turbines)" with "BIG WIND TURBINE TOWER[X] (1-3 BIG WIND TURBINE TOWERS)**

2. **Add footnote 17 to the indication for special use permit in all Districts where BIG WIND TURBINE TOWER (1-3 BIG WIND TURBINE TOWERS) is authorized (AG-1, AG-2, I-1, and I-2).**

3. **Add the following footnote 17 in Section 5.2:**

   17. A BIG WIND TURBINE TOWER must be located on the same property as another principal use for the purpose of producing electrical energy that shall ~~primarily~~ be used onsite by that other principal use provided that any energy not used onsite may be sold to the electric power provider.

Attachment E. REVISED Draft Proposed Addition to Subsection 6.1.3
JANUARY 7, 2010

1. Add "BIG WIND TURBINE TOWER" to Subsection 6.1.3 and indicate the following standard conditions:
(Note: strike out and underlining indicate changes from the previous version)

1. No minimum fencing is required.

2. The Minimum lot size is the same as applicable in the zoning DISTRICT.

3. The Maximum HEIGHT is the same as par. 6.1.4 D. 6.

4. The minimum required YARDS are the following:

   (a) The front setback is the same as par. 6.1.4 C.5.

   (b) The SIDE and REAR YARDS are the same as par. 6.1.4 C.6.

5. Add the following explanatory provisions:
   (a) No BIG WIND TURBINE shall be located in the following areas:

      (1) Less than one-and-one-half miles from an incorporated municipality that has a zoning ordinance.

      (2) In any area leased for underground gas storage or under easement for same, unless the lease or easement requires that gas injection wells and other above-ground appurtenances be located in conformance with paragraph 6.1.4 C.9.

      (3) Less than one mile from the CR Conservation Recreation Zoning District.

   (b) The special use permit for a BIG WIND TURBINE TOWER shall include all land area within 1,320 feet of a public STREET right of way that is also within 1,000 feet from the base of each BIG WIND TURBINE TOWER except that in the case of BIG WIND TURBINE TOWER in compliance with the minimum STREET separation required by paragraph 6.1.4 C. 5. in which case land on the other side of the public STREET right of way does not have to be included in the SPECIAL USE Permit.

   (c) The requirements of paragraphs 6.1.4 C. through 6.1.4 S. with the exception of paragraphs 6.1.4 E., L., and Q. shall apply.

   (d) For purposes of applying paragraphs 6.1.4 C. through 6.1.4 S. to a BIG WIND TURBINE TOWER, PARTICIPATING DWELLING or PARTICPATING PRINCIPAL USE shall mean a DWELLING or PRINCIPAL USE that is on the same land and under the same ownership as the BIG WIND TURBINE TOWER and NON- PARTICIPATING DWELLING or NON- PARTICPATING PRINCIPAL USE shall mean a DWELLING or PRINCIPAL USE that is not on the same land as the BIG WIND TURBINE TOWER and is under different ownership than the BIG WIND TURBINE TOWER.

1. Add the following new subsection 7.7:

7.7 SMALL WIND TURBINE TOWER

A SMALL WIND TURBINE TOWER shall be allowed as an ACCESSORY USE by Zoning Use Permit in all DISTRICTS as follows:

A. No SMALL WIND TURBINE TOWER shall be located less than one-and-one-half miles from an incorporated municipality that has a zoning ordinance.

B. The maximum allowable HEIGHT of a SMALL WIND TURBINE TOWER (measured to the tip of the highest rotor blade) shall be the smaller of the following dimensions:

1. A dimension equal to 90% of the minimum distance from the base of the proposed SMALL WIND TURBINE TOWER to the nearest DWELLING, PRINCIPAL STRUCTURE, or PRINCIPAL BUILDING under different ownership; or

2. A dimension equal to 90% of the minimum distance from the base of the proposed SMALL WIND TURBINE TOWER to the nearest third party above-ground electrical transmission lines, communication towers, railroad right of way, or public street right of way. This limit on height may be reduced upon submission of a PRIVATE WAIVER signed by the owner of said electrical transmission line or communication tower or the relevant railroad or public street maintenance jurisdiction. The PRIVATE WAIVER must specify the agreed minimum separation and maximum height; or

3. A dimension that for any SMALL WIND TURBINE TOWER that must be assembled on the ground and tilted vertically into final position, is no greater than the maximum length that can fit within the LOT LINES prior to being tilted into final position, as measured from the actual point of tilt up; or

4. 150 feet; provided that

(Note: At the October 15, 2009, meeting the Board decided that any small wind turbine tower between 150 feet and 200 feet tall should be a variance.)

5. The above limits on maximum allowable height notwithstanding, the maximum HEIGHT of a SMALL WIND TURBINE TOWER on a LOT in a subdivision shall not exceed 75% of the minimum required AVERAGE LOT WIDTH when any adjacent and bordering subdivision LOT is vacant; and also provided that

6. A SMALL WIND TURBINE TOWER taller than 150 feet must be authorized by VARIANCE.

(Note: Discussion by the Board at the October 15, 2009, meeting indicated that the Board was inclined to allow the 150 feet maximum height for any turbine. Note that the minimum required separation to power lines and other third-party facilities has been relocated to this section to reduce the risk of error in height determinations. Paragraph 5 minimizes conflict between wind turbines and home construction in new subdivisions. Paragraph 6 has been added to clarify that a small wind turbine tower taller than 150 feet must be authorized by variance.)

C. The maximum allowable rotor diameter for a SMALL WIND TURBINE TOWER shall be as follows:

1. 15 feet on a LOT with less than one acre LOT AREA.

2. 24 feet on a LOT with one acre or more of LOT AREA.

(Note: These heights are the same height limits that apply to residential accessory structures that are found in Footnote 4 of Section 5.3 of the Zoning Ordinance)

3. Rotor diameter greater than 24 feet may be authorized as follows:

(a) when the separation distance from the SMALL WIND TURBINE TOWER to the nearest DWELLING under other ownership is a minimum of 8.3 times the rotor diameter, up to a maximum diameter of 75 feet; and

(b) when the LOT AREA is three acres or larger.

4. VARIANCES for a maximum SMALL WIND TURBINE TOWER rotor diameter larger than 75 feet shall be prohibited.

(Note: The height limits for non-residential accessory structures are the same as for principal structures and varies by district between 35 feet and 150 feet and is 75 feet for the Light Industrial District. This revision no longer distinguishes between residential and non-residential turbines and requires a greater separation distance for any rotor larger than 24 feet in diameter and requires at least three acres of lot area. The requirement that rotors larger than 24 feet require a separation distance to the nearest dwelling (under other ownership) that is 8.3 times the rotor diameter is intended to minimize nuisance effects (including shadow flicker) from the larger rotors. A 200 feet separation is 8.3 times as long as a 24 feet diameter rotor. The American Wind Energy Association asserts that smaller rotors spin much faster than wind farm rotors and thus the flicker effect is less noticeable. However, even with no shadow flicker there is reason enough to require a greater separation from neighboring dwellings for larger rotors. With this revision even a residential turbine could have a rotor diameter of 75 feet if there is no other dwelling closer than 622.5 feet. Wind farm turbines generally have rotors that are not over 330 feet in diameter. The 1,200 feet separation required by the Zoning Ordinance is only about 3.6 times the diameter of 330 feet rotor but wind farms also have to mitigate shadow flicker if there will be more than

30 hours annually. The prohibition on variances for rotor diameter is to make sure there is no loophole in the regulations that would allow what is essentially a big wind turbine tower from being authorized either by variance rather than by special use permit or in a district where it could not be authorized by special use permit.)

D. A SMALL WIND TURBINE TOWER ~~(including any guy cables and anchors)~~ shall be allowed within any YARD in all DISTRICTS subject to the following:

1. ~~The provisions of Section 7.2 that establish the minimum YARD requirements for ACCESSORY STRUCTURES~~ The minimum SIDE YARD as measured to the base of the SMALL WIND TURBINE TOWER shall be one-third of the total HEIGHT and the minimum REAR YARD shall be same as the minimum SIDE YARD less the width of any ALLEY that may exist; and provided there is

(Note: The minimum required side yard is approximately one third the maximum allowable height for principal structures in most (but not all) zoning districts. This requirement results in a much greater side and rear yard requirement than for other accessory structures but a wind turbine tower is allowed to be much taller than other kinds of accessory towers.

Thus, a 150 feet tall wind turbine will require a 50 feet side and rear yard. This requirement may act as a height limit on lots with less than a 100 feet of width but wind turbine towers on such lots are probably already limited in height due to proximity of adjacent dwellings.)

2. A required separation distance to the nearest PRINCIPAL STRUCTURE or PRINCIPAL BUILDING under different ownership that is equal to at least a distance of 1.11 times the overall HEIGHT (measured to the tip of the highest rotor blade) of the SMALL WIND TURBINE TOWER; and provided that

3. The blades of the SMALL WIND TURBINE TOWER shall not cross the property line.

E. The number of SMALL WIND TURBINE TOWERS that shall be allowed per LOT is as follows:

1. Only one SMALL WIND TURBINE TOWER shall be authorized on a lot with less than three acres of LOT AREA.

2. No more than two SMALL WIND TURBINE TOWERS shall be authorized on a lot with three acres or more LOT AREA provided however that no more than one non-residential ACCESSORY SMALL WIND TURBINE TOWER shall be authorized less than 1,200 feet from the nearest DWELLING that is under different ownership and conforming to USE.

3. One roof-mounted or wall-mounted wind turbine shall be authorized in addition to the above limits. The roof-mounted or wall-mounted wind turbine shall not be more than 15 feet higher than any other portion of the STRUCTURE on which it is mounted. ~~Roof and wall-mounted wind turbines are not required to meet the requirements of paragraphs 7.7 A. through F. but shall meet the requirements of paragraphs 7.7 P. through 7.7 Q.~~

~~F. The noise level from the SMALL WIND TURBINE TOWER shall not exceed the regulatory standards set by the Illinois Pollution Control Board. The SMALL WIND TURBINE TOWER shall be considered a Class C land use for the purposes of the Illinois Pollution Control Board regulations. This maximum noise level shall apply at the property line regardless of the number of SMALL WIND TURBINE TOWERS.~~

F. Maximum allowable noise level.

1. A SMALL WIND TURBINE TOWER shall always be operated as recommended by the manufacturer to minimize noise.

2. The maximum allowable noise level of a SMALL WIND TURBINE TOWER *{with a manufacturer's nameplate rating of more than {5 /10 /40} kilowatts}* at the time of Zoning Use Permit approval shall generally not exceed the regulatory standards set by the Illinois Pollution Control Board (IPCB) except during short term periods due to high winds or power outages as follows:

(Note: The shaded and italicized text is optional text if the Board desires to limit the maximum noise rating to only more powerful small wind turbines. That approach would also require the shaded and italicized text in option subparagraph 3 below.)

(a) For the purposes of implementing the IPCB noise regulatory standards by this Ordinance, land use shall be considered as follows:

(1) A SMALL WIND TURBINE TOWER shall be considered a Class C land use as defined in the IPCB noise regulations.

(2) Both DWELLINGS and LOTS that are 10 acres or less in area and on which a DWELLING is the PRINCIPAL USE shall be considered as Class A land uses as defined in the IPCB noise regulations.

(3) A LOT on which a business USE is established shall be considered as Class B land use as defined in the IPCB noise regulations.

(Note: The IPCB noise regulations also identify noise limits for Class C to Class B (business. The County is not obligated to include noise limits for business turbines).

(4) In accordance with the IPCB noise regulatory standards the maximum noise level shall apply at the property line.

(b) There shall be no maximum noise level at the time of construction provided that at the time of application for the Zoning Use Permit to authorize construction or replacement the SMALL WIND TURBINE TOWER is located 900 feet or more from either of the following:

(1) the nearest property line of a LOT that is 10 acres or less in area and on which a DWELLING is the PRINCIPAL USE; or

(2) a DWELLING on a LOT that is 10 acres or larger.

(3) The nearest property line of a LOT on which a business USE is established; or

(c) If at the time of application for the Zoning Use Permit to authorize construction or replacement the SMALL WIND TURBINE TOWER is located less than 900 feet from any LOT or BUILDING as described in subparagraph 7.7, the maximum noise level from the SMALL WIND TURBINE TOWER shall comply with the noise regulatory standards set by the Illinois Pollution Control Board and shall be documented by manufacturer's data that shall be submitted with the application.

(Note: The 900 feet distance is an arbitrary standard and is 90% of the minimum 1,000 feet separation for wind farms from non-participating dwellings. A wind turbine that is bordered by farmland for a distance of 900 feet has no maximum noise level. Some small wind turbines can make as much noise as wind farm turbines.

The relevant noise standard for Class C to Class A is the nighttime standard and for Class C to Class B it is probably the daytime standard. The IPCB noise regulations specify maximum allowable noise level at eight different sound frequencies but small turbine manufacturers generally provide only a singe noise rating if any at all. Attachments to the Supplemental Memorandum dated January 8, 2010, indicate that the Class C to Class A nighttime standard equates to a 46 decibel noise rating and the Class C to Class B daytime standard equates to a 49 decibel rating.)

{3. For the purposes of this Ordinance, there is no maximum allowable noise level of a SMALL WIND TURBINE TOWER with a manufacturer's nameplate rating of {5 /10/ 40} kilowatts or less}.

(Note: See the discussion regarding limiting the maximum noise limit under subparagraph 2 above.)

G. The SMALL WIND TURBINE TOWER shall have an automatic over speed control to render the system inoperable when winds are blowing in excess of the speeds for which the system is designed and a manually operable method to render the system inoperable in the event of a structural or mechanical failure of any part of the system.

H. SMALL WIND TURBINE TOWERS shall comply with all applicable regulations of the FAA.

I. No illumination of the SMALL WIND TURBINE TOWER shall be allowed unless required by the Federal Aviation Administration.

J. The SMALL WIND TURBINE TOWER shall either be the color supplied by the manufacturer or else painted white or gray or another non-reflective, unobtrusive color that shall be specified in the Zoning Use Permit application.

K. There shall be a minimum clearance of 15 feet between the ground and the lowest arc of the rotor blades for a SMALL WIND TURBINE TOWER.

L. Any SMALL WIND TURBINE TOWER in a Residential Zoning District must be protected from unauthorized climbing by any of the following means:

1. removal of climbing rungs, if possible, to a height of 12 feet, provided that the SMALL WIND TURBINE TOWER is unclimbable without the rungs; or

2. Devices such as fences at least six feet high with locking portals or anti-climbing devices 12 feet vertically from the base of the SMALL WIND TURBINE TOWER.

M. The SMALL WIND TURBINE TOWER shall not cause any significant electromagnetic interference with any radio, television, microwave communication, or satellite navigation on other properties and compliance with the following shall be deemed to be full compliance for the purposes of this Ordinance:

1. All wind turbines shall comply with the Federal Communication Commission (FCC) requirements for electromagnetic interference including FCC Part 15. The applicant shall provide a copy of the wind turbine manufacturer's certification of compliance with FCC requirements with the Zoning Use Permit Application.

2. Metal blades shall not be used.

(Note: Non-FCC compliant wind turbines will require a variance.)

N. In the event of destruction by any means or the need for replacement, wind turbine towers and wind turbines located more than one-and-one-half miles from an incorporated municipality that has a zoning ordinance~~ and that were duly authorized by an approved Zoning Use Permit prior to *{effective date}* shall be allowed to be reconstructed to the original dimensions and in the original location pursuant to a new Zoning Use Permit provided that the reconstruction complies with all manufacturer's safety recommendations and requirements.~~may be replaced as follows:

1. The wind turbine may be replaced on the original tower pursuant to a new Zoning Use Permit provided that the replacement complies with all manufacturer's safety recommendations and requirements.

2. If a replacement wind turbine cannot be installed on an existing wind turbine tower in compliance with all manufacturer's safety recommendations and requirements and a new SMALL WIND TURBINE TOWER is required, the new SMALL WIND TURBINE TOWER shall be in full compliance with these regulations.

(Note: This change is intended to ensure that before a new turbine is mounted to an existing pole, the applicant must be able to prove that the pole is adequate for the turbine just as would be necessary for any wholly new assembly. The second subparagraph ensures that any replacement of both tower and turbine shall be in full compliance and the permitting process should identify if the maximum noise limit applies.)

O. If a wind turbine is derelict for six consecutive months the owner shall be notified that they must, within six months of receiving the notice, restore their system to operating condition. If the owner(s) fails to restore their system to operating condition within the six-month time frame, then the owner shall be required, at his expense, to remove the wind turbine from the tower and also remove the tower if it has guy cables, for safety reasons. If the owner fails to remove the wind turbine within one month the Zoning Administrator shall send a notice that the wind turbine is in violation of the Zoning Ordinance and subject to a daily fine as provided for in Section 10.

P. The Zoning Use Permit application for the SMALL WIND TURBINE TOWER shall include the following:

1. A copy of the manufacturers standard drawings of the wind turbine structure and stamped engineering drawings of the tower, base, footings, and/ or foundations as provided by the manufacturer sufficient to prove that the wind turbine tower is safe for the use intended. Wet stamps shall not be required.

2. Evidence must be given that the utility company has been informed of the customer's intent to install an interconnected customer-owned generator. Off-grid systems shall be exempt from this requirement.

3. Such evidence and documentation as required to verify that the SMALL WIND TURBINE TOWER meets all other Zoning Ordinance requirements.

Attachment G. Case 634-AT-08 Part B Draft Proposed Changes To Par. 9.1.9 B.
JANUARY 7, 2010

1. Revise paragraph 9.1.9 B. as follows:

B. Prohibited VARIANCES

At no time shall the BOARD or the Hearing Officer grant a VARIANCE in the following instances:

1. To grant a VARIANCE to allow a USE not permissible under the terms of this ordinance in the DISTRICT involved, or any USE expressly or by implication prohibited by the terms of this ordinance in said DISTRICT.

2. To waive compliance with any municipal, state, or federal regulation incorporated into this ordinance.

3. To waive compliance with any procedural requirement contained in this ordinance.

4. To waive compliance with regulations pertaining to NONCONFORMING LOTS, STRUCTURES, or USES, except as specifically authorized in Section 8.

5. To authorize any USE or CONSTRUCTION prohibited by Section 14.2.1.

6. <u>To authorize a SMALL WIND TURBINE TOWER rotor diameter larger than 75 feet.</u>

(Note: Without this prohibition or at least some limit on the amount of variance for a small wind turbine tower rotor diameter, it would be possible to propose what would in fact be a big wind turbine tower in zoning districts where it is not authorized simply by requesting variances to height and rotor diameter for a small wind turbine tower.)

Attachment H. Case 634-AT-08 Part B Draft Proposed Changes To Subpar. 9.3.1 D.
JANUARY 7, 2010

1. Revise subparagraph 9.3.1 D. H.as follows:

H. WIND FARM TOWER or BIG WIND TURBINE TOWER $4500

2. Add new subparagraph 9.3.1 D. I. as follows:

I. SMALL WIND TURBINE TOWER

1. Not over 50 feet in HEIGHT..$100
2. greater than 50 feet in HEIGHT..$100 plus $80 for each 20 feet in excess of 50 feet in height (round to next highest 20 feet increment)
3. Replacement of turbine on existing tower...$100

(Note: The proposed fees are essentially a doubling of the current fees for towers. Under the current fee structure, tower fees begin at $33 for up to 50 feet in height and $40 is added per each 20 feet in excess of 50 feet in height so that the following heights would require the following fees (the fees in parentheses are the proposed fees for small wind turbine towers of the same height; does not include $33 compliance certificate and reflects current practice in rounding to next highest 20 feet increment):

Not over 50 feet in HEIGHT.....................existing fee $ 33 (to be increased to $100)
100 feet in HEIGHT.................................existing fee $153 (to be increased to $340)
150 feet in HEIGHT.................................existing fee $233 (to be increased to $500)

The U.S. Department of Energy handout Small Wind Electric Systems (undated) that was included with the July 10, 1999, Supplemental Memorandum stated that small turbines cost anywhere from $3,000 to $50,000 installed depending upon size and other considerations and that a typical 10kW home wind system costs approximately $32,000. Thus, the erected cost of a wind turbine and tower will generally far exceed the cost of a two-car garage and, in terms of the work required for the Department in permitting a turbine, will take much more time than a simple garage. Fees that are double the current fees for towers are clearly justified.)

1. Revise subparagraph 9.3.3 as follows:

9.3.3 Zoning Case Filing Fees

A. General Provisions

1. No zoning case filing shall be accepted until the filing fee has been paid.

2. No zoning case filing fee shall be waived unless the Zoning Administrator determines that the petition is the only means reasonably available to bring a property into compliance with the provisions of this ordinance and the non-compliance is due solely to staff error.

3. No zoning case filing fee shall be refunded after required legal notice has been made by mail or publication unless the Zoning Administrator determines such filing to have been based solely upon staff error.

4. No amendment to any petition which requires new legal notice shall be considered until an amended petition fee has been received unless the Zoning Administrator determines such amendment to be required due solely to staff error.

5. The fee for SPECIAL USE permits shall be determined based on the larger of the following (except for County Board WIND FARM Special Use Permits):

   a. the area of farmland taken out of production as a result of the SPECIAL USE; or

   b. when farmland will not be taken out of production as a result of the SPECIAL USE, the land area taken up by the existing STRUCTURES and all proposed CONSTRUCTION proposed in the SPECIAL USE application.

6. When some combination of VARIANCE, SPECIAL USE and Map Amendment cases is required simultaneously for the same property, the total filing fee shall include the following (except for County Board WIND FARM Special Use Permits):

   a. The standard fee for the most expensive individual zoning case; and

   b. one-half of the standard fee for any other required VARIANCE, SPECIAL USE, or Map Amendment provided that

   c. no additional fees shall be included for multiple zoning cases of the same type that can be advertised in the same legal advertisement.

B. Fees

1. VARIANCES.

   a. ADMINISTRATIVE VARIANCES $100

   b. Minor or Major VARIANCES $200

2 SPECIAL USE permits and Map Amendments (except for County Board WIND FARM Special Use Permit and a map amendment to the WIND FARM Overlay Zoning District)

   a. Two acres or less and Base Fee for larger areas $400

   b. More than two acres but no more than 12 acres .... add $40 per acre to Base Fee for each acre over two acres

   c. More than 12 acres add $10 per acre for each acre over 12 acres and add to fees in a. and b. above

3. Appeals and Interpretations $200

4. Change of Nonconforming Use $100

5. Amendment to Petitions (requiring new legal notice) $100

6. County Board WIND FARM Special Use Permit..........
   $20,000 or $440 per WIND FARM TURBINE TOWER, whichever is greater.

7. BIG WIND TURBINE TOWER Special Use Permit..........
   $3,300 per BIG WIND TURBINE TOWER

Section 5.3 Schedule of Area, Height and Placement Regulations by District

Zoning DISTRICTS	Minimum LOT Size[12]		Maximum HEIGHT[4,11]		Required YARDS (feet) Front Setback from STREET Centerline[3] STREET Classification					Maximum LOT COVERAGE	Special Provisions
	Area (square feet)	Average Width (feet)	Feet	Stories	MAJOR	COLLECTOR	MINOR	SIDE[7]	REAR[6]		
AG-1 AGRICULTURE	1 Acre	200	50	NR[10]	85	75	55	15	25	20%	(5), (13)
AG-2 AGRICULTURE	20,000	100	50	NR[10]	85	75	55	10	20	25%	(5), (13)
CR Conservation-Recreation	1 Acre	200	35	2 1/2	85	75	55	15	25	20%	(5), (13)
R-1 Single FAMILY Residence	9,000	80	35	2 1/2	85	75	55	10	20	30%	(5), (8)
R-2 Single FAMILY Residence	6,500	65	35	2 1/2	85	75	55	10	20	30%	(5), (8)
R-3 Two FAMILY Residence	6,500 for 1st d.u.[1] 2,500 per additional d.u.	65	35	2 1/2	85	75	55	5	20	30%	(5)
R-4 Multiple FAMILY Residence	6,500 for 1st d.u.[1] 2,000 per additional d.u.	65	50	NR[10]	85	75	55	5	15	40%	(5), (9)
R-5 MANUFACTURED HOME PARK	SEE SPECIAL STANDARDS SECTION 6.2										
B-1 Rural Trade Center	6,500	65	NR[10]	NR[10]	85	75	55	10	20	50%	
B-2 Neighborhood Business	6,500	65	35	2 1/2	85	75	55	10	20	35%	(2)
B-3 Highway Business	6,500	65	40	3	85	75	55	5	20	40%	(2)
B-4 General Business	6,500	65	35	2 1/2	85	75	55	10	20	40%	(2)
B-5 Central Business	NR[10]	NR[10]	35	2 1/2	0	0	0	0	0	100%	(2)
I-1 Light Industry	10,000	100	75	NR[10]	85	75	55	10	20	50%	(2)
I-2 Heavy Industry	20,000	150	150	NR[10]	85	75	55	20	30	65%	(2)

TITLE 35: ENVIRONMENTAL PROTECTION
SUBTITLE H: NOISE
CHAPTER I: POLLUTION CONTROL BOARD

PART 901
SOUND EMISSION STANDARDS AND LIMITATIONS FOR PROPERTY LINE-NOISE-SOURCES

AUTHORITY: Implementing Section 25 and authorized by Section 27 of the Environmental Protection Act [415 ILCS 5/25 and 27].

SOURCE: Originally filed as Part 2 of Chapter 8: Noise Pollution, effective August 10, 1973; amended at 2 Ill. Reg. 27, p. 223, effective June 26, 1978; amended at 5 Ill. Reg. 6371, effective June 1, 1981; amended at 5 Ill. Reg. 8533, effective August 10, 1981; amended at 6 Ill. Reg. 10960, effective September 1, 1982; codified at 7 Ill. Reg. 13646; amended at 7 Ill. Reg. 14519, effective October 17, 1983; amended in R83-35 at 8 Ill. Reg. 18893, effective September 25, 1984; amended in R83-33, 26, 29, 30 and R83-34 at 9 Ill. Reg. 1405, effective January 17, 1985; Section 901.105(f)(1), (2) and (3) recodified to Sections 901.110, 901.111 and 901.112 at 9 Ill. Reg. 7147; amended in R83-25, 31 and 32 at 9 Ill. Reg. 7149, effective May 7, 1985; amended in R83-7 at 11 Ill. Reg. 3136, effective January

28, 1987; amended in R04-11, at 28 Ill. Reg. 11910, effective July 30, 2004; amended in R03-9 at 30 Ill. Reg.5533, effective March 10, 2006; amended in R06-11 at 31 Ill. Reg. 1984, effective January 12, 2007.

Section 901.101 Classification of Land According to Use

a) The land use classification system used for the purposes of applying numeric sound standards for this Part is based on the Land-Based Classification Standards (LBCS) (Jeer, Sanjay. 2001. Land-Based Classification Standards . Online, http://www.planning.org/LBCS. American Planning Association: Chicago, Illinois). The LBCS applicable to this Part is set forth in Appendix B.

b) Class A land includes all land used as specified by LBCS Codes 1000 through 1340, 2410 through 2455, 5200 through 5230, 5500, 6100 through 6145, 6222, 6510 through 6530, 6568 through 6600.

c) Class B land includes all land used as specified by LBCS Codes 2100 through 2336, 2500 through 2720, 3500 through 3600, 4220 through 4243, 5100 through 5160, 5300 through 5390, 5400, 6147, 6210 through 6221, 6300 through 6320, 6400 through 6430, 6560 through 6567, 6700 through 6830, 7100 through 7380.

d) Class C land includes all land used as specified by LBCS Codes 3100 through 3440, 4120 through 4180, 4210 through 4212, 4300 through 4347, 7400 through 7450, 8000 through 8500, and 9100 through 9520.

e) A parcel or tract of land used as specified by LBCS Code 9100, 9400, or 5500 when adjacent to Class B or C land may be classified similarly by action of a municipal government having zoning jurisdiction over such land. Notwithstanding any subsequent changes in actual land use, land so classified retains such B or C classification until the municipal government removes the classification adopted by it.

(Source: Amended at 30 Ill. Reg.5533, effective March 10, 2006)

Section 901.102 Sound Emitted to Class A Land

a) Except as elsewhere provided in this Part, no person shall cause or allow the emission of sound during daytime hours from any property-line-noise-source located on any Class A, B or C land to any receiving Class A land which exceeds any allowable octave band sound pressure level specified in the following table, when measured at any point within such receiving Class A land, provided, however, that no measurement of sound pressure levels shall be made less than 25 feet from such property-line-noise-source.

Octave Band Center Frequency (Hertz)	Allowable Octave Band Sound Pressure Levels (dB) of Sound Emitted to any Receiving Class A Land from		
	Class C Land	Class B Land	Class A Land

	C		A
31.5	75	72	72
63	74	71	71
125	69	65	65
250	64	57	57
500	58	51	51
1000	52	45	45
2000	47	39	39
4000	43	34	34
8000	40	32	32

b) Except as provided elsewhere in this Part, no person shall cause or allow the emission of sound during nighttime hours from any property-line-noise-source located on any Class A, B or C land to any receiving Class A land which exceeds any allowable octave band sound pressure level specified in the following table, when measured at any point within such receiving Class A land, provided, however, that no measurement of sound pressure levels shall be made less than 25 feet from such property-line-noise-source.

Octave Band Center Frequency (Hertz)	Allowable Octave Band Sound Pressure Levels (dB) of Sound Emitted to any Receiving Class A Land from		
	Class C Land	Class B Land	Class A Land
31.5	69	63	63
63	67	61	61
125	62	55	55
250	54	47	47
500	47	40	40
1000	41	35	35
2000	36	30	30
4000	32	25	25
8000	32	25	25

(Source: Amended at 30 Ill. Reg.5533, effective March 10, 2006)

Section 901.103 Sound Emitted to Class B Land

Except as provided elsewhere in this Part, no person shall cause or allow the emission of sound from any property-line-noise-source located on any Class A, B or C land to any receiving Class B land which exceeds any allowable octave band sound pressure level specified in the following table, when measured at any point within such receiving Class B land, provided, however, that no measurement of sound pressure levels shall be made less than 25 feet from such property-line-noise-source.

Octave Band Center Frequency (Hertz)	Allowable Octave Band Sound Pressure Levels (dB) of Sound Emitted to any Receiving Class B Land from		
	Class C Land	Class B Land	Class A Land

31.5	80	79	72
63	79	78	71
125	74	72	65
250	69	64	57
500	63	58	51
1000	57	52	45
2000	52	46	39
4000	48	41	34
8000	45	39	32

(Source: Amended at 30 Ill. Reg.5533, effective March 10, 2006)

Section 901.104 Highly-Impulsive Sound

Except as provided elsewhere in this Part, no person shall cause or allow the emission of highly-impulsive sound from any property-line-noise-source located on any Class A, B, or C land to any receiving Class A or B land which exceeds the allowable A-weighted sound levels, measured with fast dynamic characteristic, specified in the following table when measured in accordance with the procedure of 35 Ill. Adm. Code 900.103 at any point within such receiving Class A or B land, provided, however, that no measurement of sound levels shall be made less than 25 feet from such property-line-noise-source.

Classification of Land on which Property-Line Noise-Source: is Located	Allowable A-weighted Sound Levels in Decibels of Highly-Impulsive Sound Emitted to Receiving Class A or B Land		
	Class B Land	Class A Land	
		Daytime	Nighttime
Class A Land	47	47	37
Class B Land	54	47	37
Class C Land	58	53	43

(Source: Amended at 30 Ill. Reg.5533, effective March 10, 2006)

Section 901.105 Impact Forging Operations

a) For purposes of this Section, only the following are applicable:

1) Daytime hours means any continuous 16-hour period between 6:00 a.m. and 11:00 p.m. local time; and

2) Nighttime hours means those 8 hours between 10:00 p.m. and 7:00 a.m. which are not part of the 16 continuous daytime hours.

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Online Noise Rating - NR - Calculator

An online Noise Rating - NR - Calculator

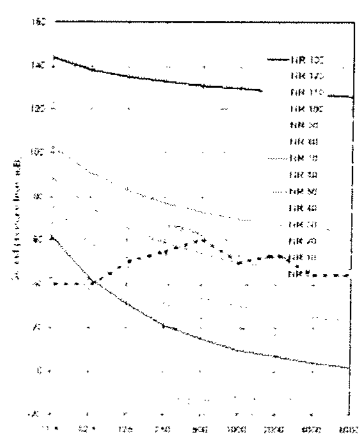
The calculator below can used to calculate the NR - Noise Rating:

Sound Pressure Level (dB) - Octave band mid-frequency (Hz)

63	*31.5 Hz*
61	*62.5 Hz*
55	*125 Hz*
47	*250 Hz*
40	*500 Hz*
35	*1000 Hz*
30	*2000 Hz*
25	*4000 Hz*
25	*8000 Hz*

Calculate NR - Noise Rating! NR=38 (CLASS A TO CLASS A, NIGHTTIME)

The NR-diagram with the default values above are indicated below:



Related Topics

- Acoustics Room acoustics, acoustic properties - decibel A, B and C - Noise Rating (NR) curves, sound transmission, sound pressure, sound intensity, attenuation and more ..

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Online Noise Rating - NR - Calculator

An online Noise Rating - NR - Calculator

The calculator below can used to calculate the NR - Noise Rating:

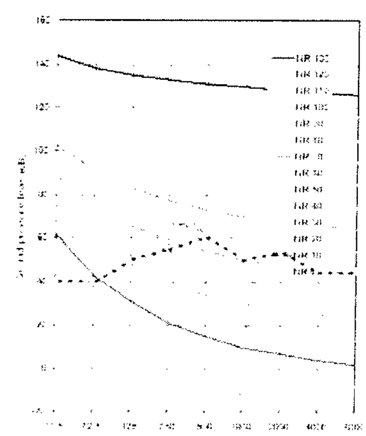
Sound Pressure Level (dB) - Octave band mid-frequency (Hz)

69	*31.5 Hz*
67	*62.5 Hz*
62	*125 Hz*
54	*250 Hz*
47	*500 Hz*
41	*1000 Hz*
36	*2000 Hz*
32	*4000 Hz*
32	*8000 Hz*

Calculate NR - Noise Rating!

NR= 46 (CLASS C TO CLASS A, NIGHTTIME)

The NR-diagram with the default values above are indicated below:



Related Topics

- Acoustics Room acoustics, acoustic properties - decibel A, B and C - Noise Rating (NR) curves, sound transmission, sound pressure, sound intensity, attenuation and more ...
- Noise and Attenuation Noise is usually defined as unwanted sound - noise, noise generation

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Online Noise Rating - NR - Calculator

An online Noise Rating - NR - Calculator

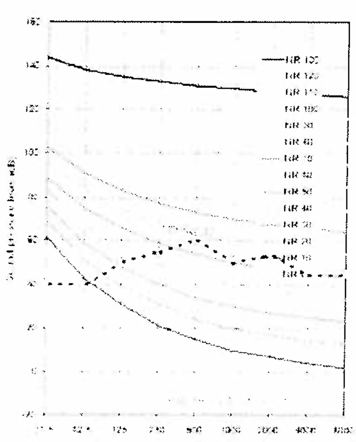
The calculator below can used to calculate the NR - Noise Rating:

Sound Pressure Level (dB) - Octave band mid-frequency (Hz)

72	*31.5 Hz*
71	*62.5 Hz*
65	*125 Hz*
57	*250 Hz*
51	*500 Hz*
45	*1000 Hz*
39	*2000 Hz*
34	*4000 Hz*
32	*8000 Hz*

Calculate NR - Noise Rating! NR=49 (CLASS C TO CLASS B, DAYTIME)

The NR-diagram with the default values above are indicated below:



Related Topics

- Acoustics Room acoustics, acoustic properties - decibel A, B and C - Noise Rating (NR) curves, sound transmission, sound pressure, sound intensity, attenuation and more ..
- Noise and Attenuation Noise is usually defined as unwanted sound - noise, noise generation

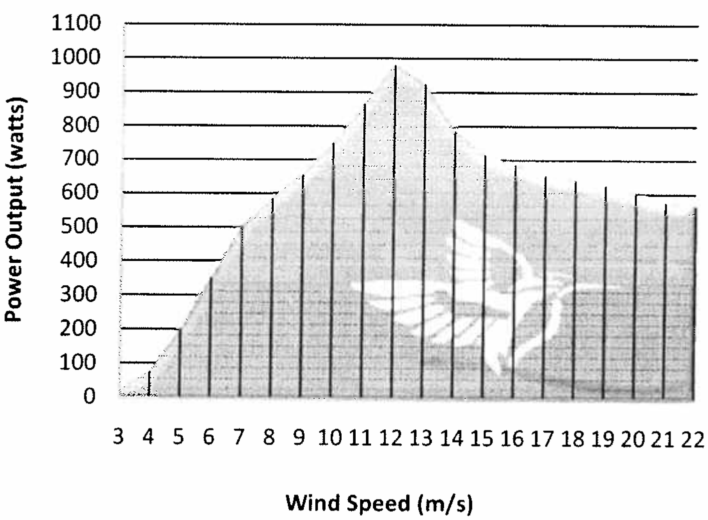
500W

HUMMER WIND POWER

Turbine Technical Parameters

Rated Power (W):	500 Watts
Maximum Output (W):	1,000 Watts
Charging Voltage (V):	DC 24V
Output Voltage (V):	110V to 240V
Number of Blades:	3
Blade Material:	GRP (Glass Fiber Reinforced Plastic)
Blade Diameter:	2.7m (8.9 ft.)
Start-up Wind Speed:	3m/s (6.7 mph)
Rated Wind Speed:	7m/s (15.7 mph)
RPM:	600
Speed Regulation (Protection):	Yawing (Mechanical) + Manual
Wind Energy Utilizing Ratio (Cp):	48%
Generator Output:	Single-phase Frequency Conversion AC
Output AC Frequency (Hz):	0-300
Rate Charging Current (A):	15
Maximum Charging Current (in a short time) (A):	25
Noise (5m behind turbine @ 5m/s gusting):	29 dB
Generator Efficiency:	>78%
Generator Weight:	6.5kg (15 lbs.)
Turbine Weight:	45kg (99 lbs.)
Off Grid Battery (12V):	2 pcs.
Warranty:	5 Year Limited

Power Curve Data Chart



Annual Electrical Output

Average Wind Speed (m/s)	3	4	5	6	7	8	9	10
Average Wind Speed (mph)	7	9	11	13	16	18	20	22
Annual Power Output (kWh)	131	729	1804	3444	4510	5274	6231	6924

Available Towers	Size
Guyed-Wire	18m (59.4')
Wireless	18m (59.4')

Standard Equipment	
Grid-Tie	Not Available.
Off Grid	Wind-Solar controller, charger & unloader.

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Hummer Turbines

500 Watt

1kW

2kW

3kW

5kW

10kW

20kW

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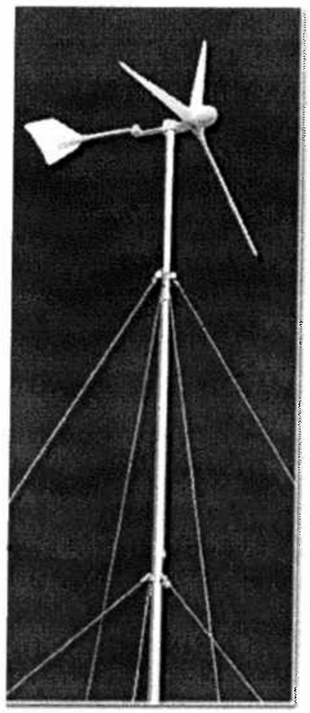
June 4, 2009.

Hummer Wind Power teams up with a National Home Improvement Lender to provide turbine financing for home owner's via the Hummer Certified Dealer Network. Read more...

Hummer 500 Watt Wind Turbine ....



The Hummer 500 Watt wind turbine is a low wind speed, direct drive generator.

It has a low starting torque, and high generating efficiency.

The patented "in-the-hub" generator emits low noise and heat.

Lightweight, easy to install and low maintenance.

It's slip ring yaw shaft means no cable un-twisting.

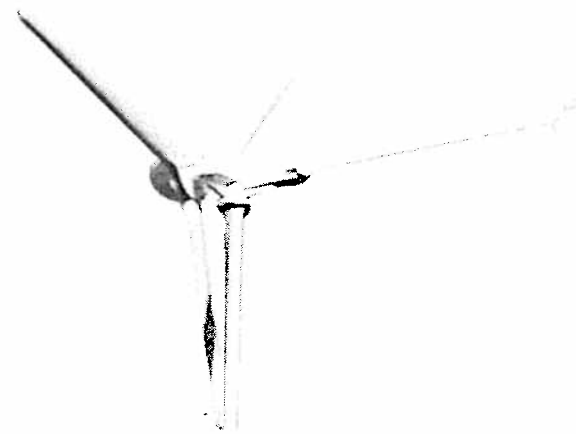
An LCD display is included for monitoring all system information and auto control protection from overcharging, over discharging, short circuit and overheating.

Off Grid components include Wind-Solar Hybrid Control System, Charger and Unloading System.

Hummer Wind Power, LLC.

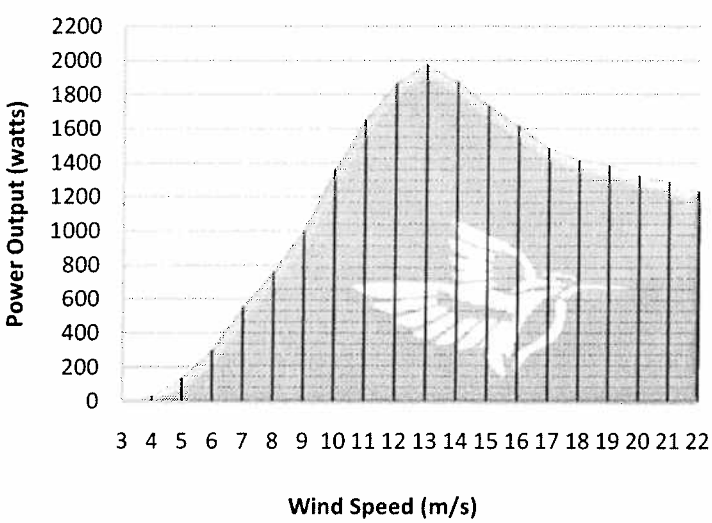
1KW

HUMMER



Turbine Technical Parameters	
Rated Power (W):	1,000 Watts
Maximum Output (W):	2,000 Watts
Charging Voltage (V):	DC 60V
Output Voltage (V):	110V to 240V
Number of Blades:	3
Blade Material:	GRP (Glass Fiber Reinforced Plastic)
Blade Diameter:	3.1m (10 ft.)
Start-up Wind Speed:	3m/s (6.7 mph)
Rated Wind Speed:	9m/s (20 mph)
RPM:	500
Speed Regulation (Protection):	Yawing (Mechanical) + Manual
Wind Energy Utilizing Ratio (Cp):	45%
Generator Output:	Single-phase Frequency Conversion AC
Output AC Frequency (Hz):	0-400
Rate Charging Current (A):	15
Maximum Charging Current (in a short time) (A):	30
Noise (5m behind turbine @ 5m/s gusting):	30 dB
Generator Efficiency:	80%
Generator Weight:	15kg (33 lbs.)
Turbine Weight:	65kg (143 lbs.)
Off Grid Battery (12V):	5 pcs.
Warranty:	5 Year Limited

Power Curve Data Chart



Annual Electrical Output								
Average Wind Speed (m/s)	3	4	5	6	7	8	9	10
Average Wind Speed (mph)	7	9	11	13	16	18	20	22
Annual Power Output (kWh)	364	1093	2369	3644	5010	9215	9566	11843

Available Towers	Size
Guyed-Wire	18m (59.4')
Wireless	18m (59.4')

Standard Equipment	
Grid-Tie	Not Available.
Off Grid	Wind-Solar controller, charger & unloader.

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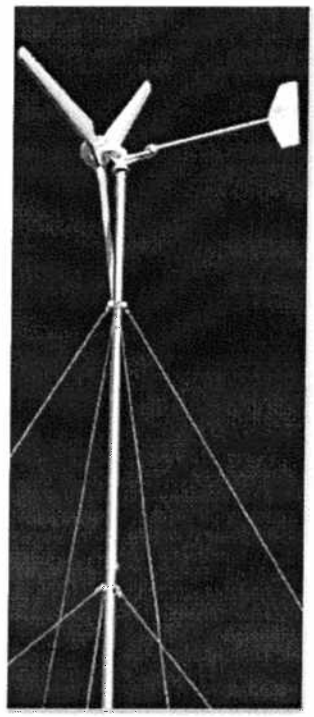
Hummer News

June 4, 2009.

Hummer Wind Power teams up with a National Home Improvement Lender to provide turbine financing for home owner's via the Hummer Certified Dealer Network. Read more...

Hummer 1kW Wind Turbine ....



The Hummer 1kW wind turbine is a low wind speed, direct drive generator.

It has a low starting torque, and high generating efficiency.

The patented "in-the-hub" generator emits low noise and heat.

Lightweight, easy to install and low maintenance.

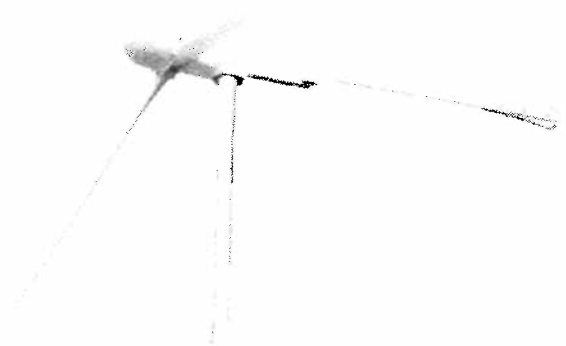
It's slip ring yaw shaft means no cable un-twisting.

An LCD display is included for monitoring all system information and auto control protection from overcharging, over discharging, short circuit and overheating.

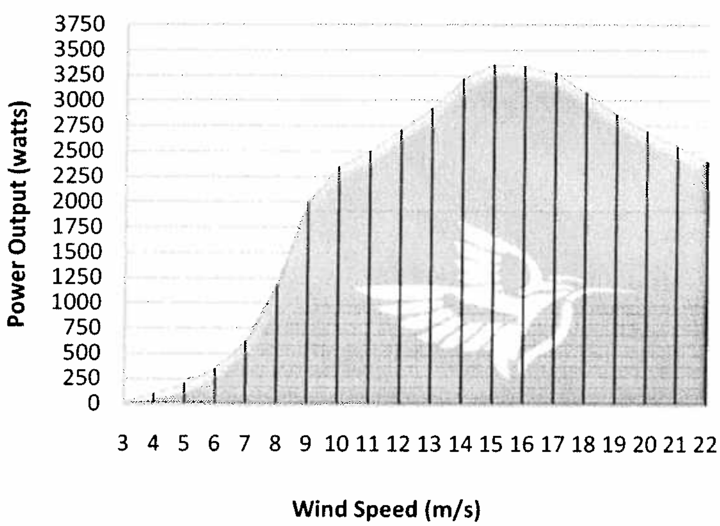
Off Grid components include Wind-Solar Hybrid Control System, Charger and Unloading System.

2KW

HUMMER



Power Curve Data Chart



Turbine Technical Parameters	
Rated Power (W):	2,000 Watts
Maximum Output (W):	3,200 Watts
Charging Voltage (V):	DC 120V
Output Voltage (V):	110V to 240V
Number of Blades:	3
Blade Material:	GRP (Glass Fiber Reinforced Plastic)
Blade Diameter:	3.8m (12.5 ft.)
Start-up Wind Speed:	3m/s (6.7 mph)
Rated Wind Speed:	9m/s (20 mph)
RPM:	450
Speed Regulation (Protection):	Yawing (Mechanical) + Manual
Wind Energy Utilizing Ratio (Cp):	45%
Generator Output:	Single-phase Frequency Conversion AC
Output AC Frequency (Hz):	0-370
Rate Charging Current (A):	15
Maximum Charging Current (in a short time) (A):	28
Noise (5m behind turbine @ 5m/s gusting):	32 dB
Generator Efficiency:	80%
Generator Weight:	25kg (55 lbs.)
Turbine Weight:	75kg (165 lbs.)
Off Grid Battery (12V):	10 pcs.
Warranty:	5 Year Limited

Annual Electrical Output								
Average Wind Speed (m/s)	3	4	5	6	7	8	9	10
Average Wind Speed (mph)	7	9	11	13	16	18	20	22
Annual Power Output (kWh)	1230	1640	3644	6559	10021	15032	19131	23332

Available Towers	Size
Guyed-Wire	18m (59.4')
Wireless	18m (59.4')

Standard Equipment	
Grid-Tie	Inverter, Controller & PC software.
Off Grid	Wind-Solar controller, charger & unloader.

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500 Watt

1kW

2kW

3kW

5kW

10kW

20kW

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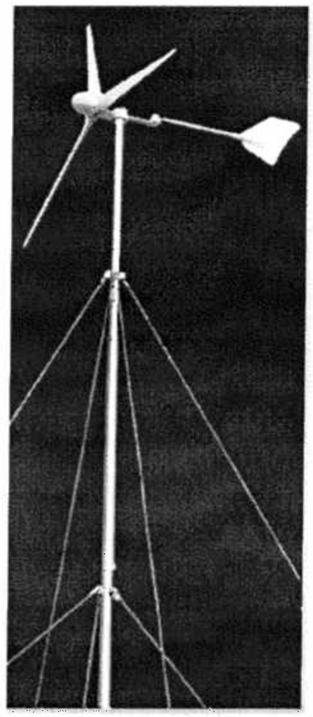
Hummer 2kW Wind Turbine ....



The Hummer 2kW wind turbine is a low wind speed, direct drive generator.

It has a low starting torque, and high generating efficiency.

The patented "in-the-hub" generator emits low noise and heat.

Lightweight, easy to install and low maintenance.

It's slip ring yaw shaft means no cable un-twisting.

An LCD display is included for monitoring all system information and auto control protection from overcharging, over discharging, short circuit and overheating.

Grid Tied components include Inverter and PC Software.

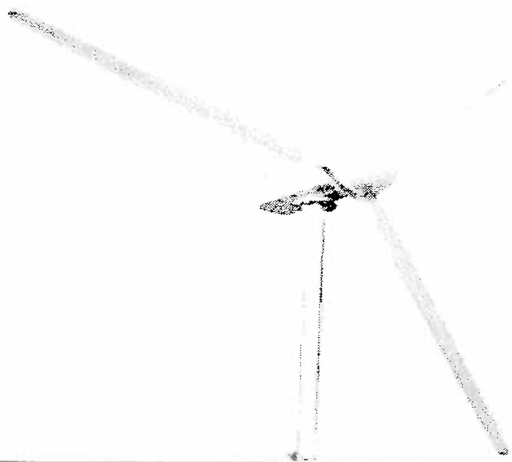
Off Grid components include Wind-Solar Hybrid Control System, Charger and Unloading System.

Hummer Wind Power, LLC.

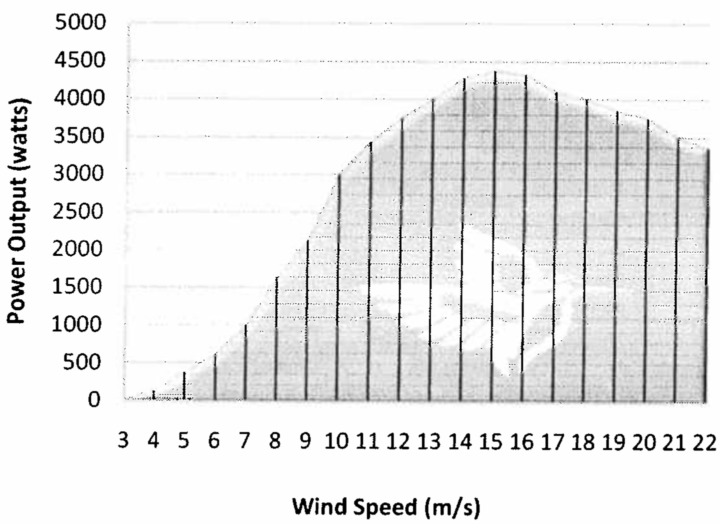
3KW

HUMMER

Turbine Technical Parameters	
Rated Power (W):	3,000 Watts
Maximum Output (W):	4,500 Watts
Charging Voltage (V):	DC 180V
Output Voltage (V):	110V to 240V
Number of Blades:	3
Blade Material:	GRP (Glass Fiber Reinforced Plastic)
Blade Diameter:	4.8m (15.7 ft.)
Start-up Wind Speed:	2.5m/s (5.6 mph)
Rated Wind Speed:	10m/s (22 mph)
RPM:	400
Speed Regulation (Protection):	Yawing (Mechanical) + Manual
Wind Energy Utilizing Ratio (Cp):	40%
Generator Output:	Single-phase Frequency Conversion AC
Output AC Frequency (Hz):	0-360
Rate Charging Current (A):	16
Maximum Charging Current (in a short time) (A):	28
Noise (5m behind turbine @ 5m/s gusting):	32 dB
Generator Efficiency:	80%
Generator Weight:	60kg (132 lbs.)
Turbine Weight:	192kg (422.4 lbs.)
Off Grid Battery (12V):	15 pcs.
Warranty:	5 Year Limited



Power Curve Data Chart



Annual Electrical Output								
Average Wind Speed (m/s)	3	4	5	6	7	8	9	10
Average Wind Speed (mph)	7	9	11	13	16	18	20	22
Annual Power Output (kWh)	875	2324	5102	7288	10841	16398	23504	27786

Available Towers	Size
Guyed-Wire or Wireless	18m (59.4')
Freestanding Lattice	80'-100'-120'-140'

Standard Equipment	
Grid-Tie	Inverter, Controller & PC software.
Off Grid	Wind-Solar controller, charger & unloader.

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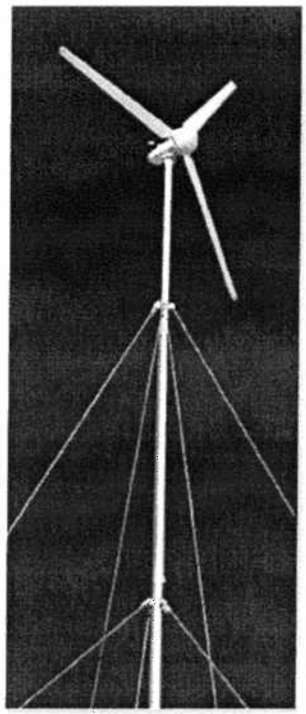
Hummer 3kW Wind Turbine ....



The Hummer 3kW wind turbine is a low wind speed, direct drive generator.

It has a low starting torque, and high generating efficiency.

The patented "in-the-hub" generator emits low noise and heat.

Lightweight, easy to install and low maintenance.

Pass through gear drive means no cable un-twisting.

An LCD display is included for monitoring all system information and auto control protection from overcharging, over discharging, short circuit and overheating.

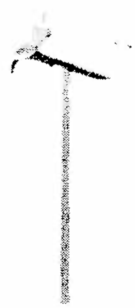
Grid Tied components include Inverter and PC Software.

Off Grid components include Wind-Solar Hybrid Control System, Charger and Unloading System.

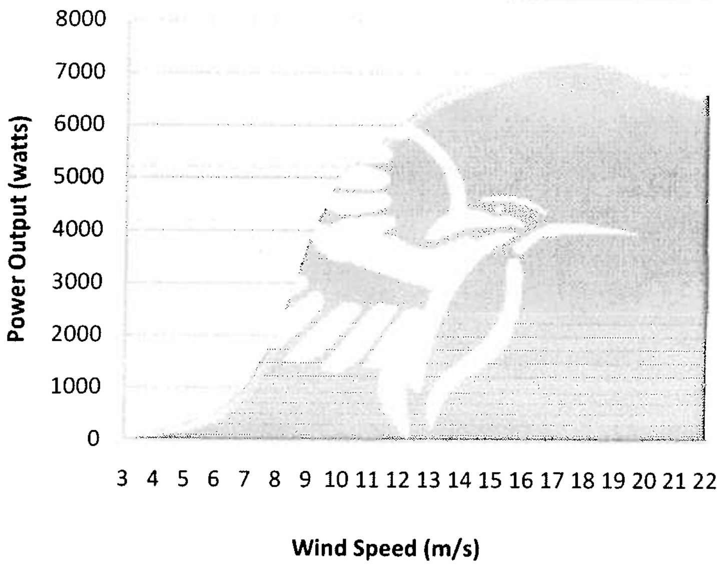
5kW

HUMMER

Turbine Technical Parameters	
Rated Power (W):	5,000 Watts
Maximum Output (W):	7,500 Watts
Charging Voltage (V):	DC 240V
Output Voltage (V):	110V to 380 V
Number of Blades:	3
Blade Material:	GRP (Glass Fiber Reinforced Plastic)
Blade Diameter:	6.4m (21 ft.)
Start-up Wind Speed:	2.5m/s (5.6 mph)
Rated Wind Speed:	10m/s (22 mph)
RPM:	240
Speed Regulation (Protection):	Yawing (Mechanical) + Manual
Wind Energy Utilizing Ratio (Cp):	40%
Generator Output:	Single-phase Frequency Conversion AC
Output AC Frequency (Hz):	0-360
Rate Charging Current (A):	20
Maximum Charging Current (in a short time) (A):	32
Noise (5m behind turbine @ 5m/s gusting):	34 dB
Generator Efficiency:	80%
Generator Weight:	147kg (323.4 lbs.)
Turbine Weight:	405kg (891 lbs.)
Off Grid Battery (12V):	20 pcs.
Warranty:	5 Year Limited



Power Curve Data Chart



Annual Electrical Output								
Average Wind Speed (m/s)	3	4	5	6	7	8	9	10
Average Wind Speed (mph)	7	9	11	13	16	18	20	22
Annual Power Output (kWh)	1549	4191	8472	13328	18220	27330	39355	46935

Available Towers	Size
Monopole	98.4' & 132'
Freestanding Lattice	80'-100'-120'-140'

Standard Equipment	
Grid-Tie	Inverter, Controller & PC software.
Off Grid	Wind-Solar controller, charger & unloader.

P.O. Box 10599, Fort Wayne, IN 46853

Office: 800-980-5440

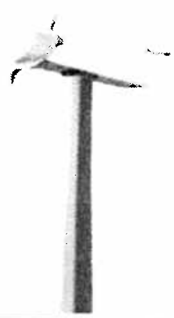
www.hummerwind.com

Fax: 260-414-1565

10KW

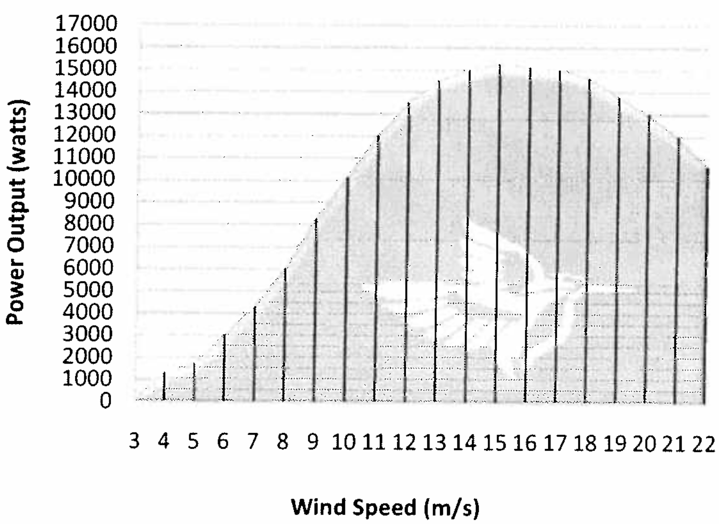
HUMMER

Turbine Technical Parameters



Rated Power (W):	10,000 Watts
Maximum Output (W):	15,000 Watts
Charging Voltage (V):	DC 240V
Output Voltage (V):	110V to 380V
Number of Blades:	3
Blade Material:	GRP (Glass Fiber Reinforced Plastic)
Blade Diameter:	8m (26.5 ft.)
Start-up Wind Speed:	3m/s (6.7 mph)
Rated Wind Speed:	10m/s (22 mph)
RPM:	200
Speed Regulation (Protection):	Yawing (Mechanical) + Manual
Wind Energy Utilizing Ratio (Cp):	40%
Generator Output:	Single-phase Frequency Conversion AC
Output AC Frequency (Hz):	0-360
Rate Charging Current (A):	41.7
Maximum Charging Current (in a short time) (A):	65
Noise (5m behind turbine @ 5m/s gusting):	34 dB
Generator Efficiency:	85%
Generator Weight:	287kg (631.4 lbs.)
Turbine Weight:	690kg (1,518 lbs.)
Off Grid Battery (12V):	20 pcs.
Warranty:	5 Year Limited

Power Curve Data Chart



Annual Electrical Output

Average Wind Speed (m/s)	3	4	5	6	7	8	9	10
Average Wind Speed (mph)	7	9	11	13	16	18	20	22
Annual Power Output (kWh)	3116	8381	16945	26656	36440	54660	78710	91829

Available Towers	Size
Monopole	98.4' & 132'
Freestanding Lattice	80'-100'-120'-140'

Standard Equipment	
Grid-Tie	Inverter, Controller & PC software.
Off Grid	Wind-Solar controller, charger & unloader.

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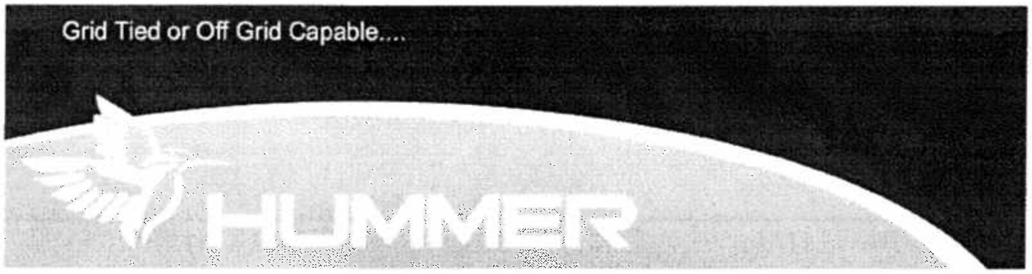


Hummer Turbines

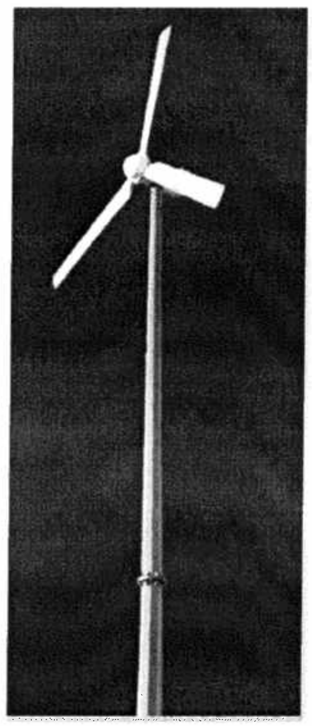
Information

Hummer News

June 4, 2009.

Hummer Wind Power teams up with a National Home Improvement Lender to provide turbine financing for home owner's via the Hummer Certified Dealer Network. Read more...

Hummer 10kW Wind Turbine ....



The Hummer 10kW wind turbine is a low wind speed, direct drive generator.

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An LCD display is included for monitoring all system information and auto control protection from overcharging, over discharging, short circuit and overheating.

Grid Tied components include Inverter and PC Software.

Off Grid components include Wind-Solar Hybrid Control System, Charger and Unloading system.

Hummer 10kW Technical Parameters

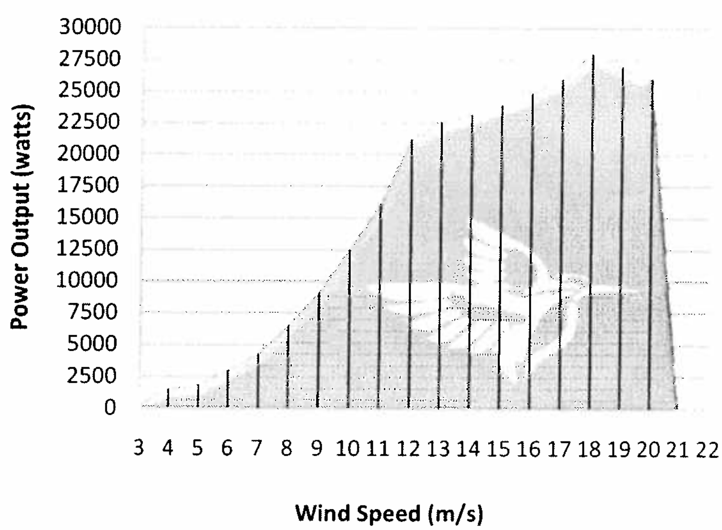
Rated power (W)	10,000 Watts
Maximum output (W)	15,000 Watts
Charging voltage (V)	DC 240V
Output voltage (V)	AC 110V, 120V, 220V, 230V, 240V, 380V
Number of blades	3
Blade material	Glass Fiber Reinforced Plastic
Blade diameter	8m (26.5 ft.)
Start up wind speed	3m/s (6.7 mph)

Rated wind speed	10m/s (22 mph)
RPM	200
[illegible]	Yawing (Mechanical) + Manual
[illegible]	40%
Generator output	Single-phase frequency conversion AC
Output AC frequency (Hz)	0-360
Rated charging current (A)	41.7
Maximum charging current (in a short time) (A)	65
Noise (5m behind turbine @ 5m/s gusting)	34dB
Generator efficiency	85%
Generator weight	287kg (631.4 lbs.)
Turbine weight	690kg (1,518 lbs.)
Off Grid battery (12V)	20 pcs.
[illegible]	5 Year Limited Warranty

20kW

HUMMER
WIND POWER

Power Curve Data Chart



Turbine Technical Parameters	
Rated Power (W):	20,000 Watts
Maximum Output (W):	30,000 Watts
Charging Voltage (V):	DC 240V
Output Voltage (V):	110V to 380V
Number of Blades:	3
Blade Material:	GRP (Glass Fiber Reinforced Plastic)
Blade Diameter:	9m (29.5 ft.)
Start-up Wind Speed:	3m/s (6.7 mph)
Rated Wind Speed:	10m/s (22 mph)
RPM:	120
Speed Regulation (Protection):	Yawing (Mechanical) + Manual
Wind Energy Utilizing Ratio (Cp):	40%
Generator Output:	Single-phase Frequency Conversion AC
Output AC Frequency (Hz):	0-360
Rate Charging Current (A):	83.4
Maximum Charging Current (in a short time) (A):	120
Noise (5m behind turbine @ 5m/s gusting):	34 dB
Generator Efficiency:	85%
Generator Weight:	310kg (682 lbs.)
Turbine Weight:	1,500kg (3,300 lbs.)
Off Grid Battery (12V):	20 pcs.
Warranty:	5 Year Limited

Annual Electrical Output								
Average Wind Speed (m/s)	3	4	5	6	7	8	9	10
Average Wind Speed (mph)	7	9	11	13	16	18	20	22
Annual Power Output (kWh)	3388	14950	18130	29473	42204	64594	89559	123838

Available Towers	Size
Monopole	98.4' & 132'
Freestanding Lattice	80'-100'-120'-140'

Standard Equipment	
Grid-Tie	Inverter, Controller & PC software.
Off Grid	Wind-Solar controller, charger & unloader.

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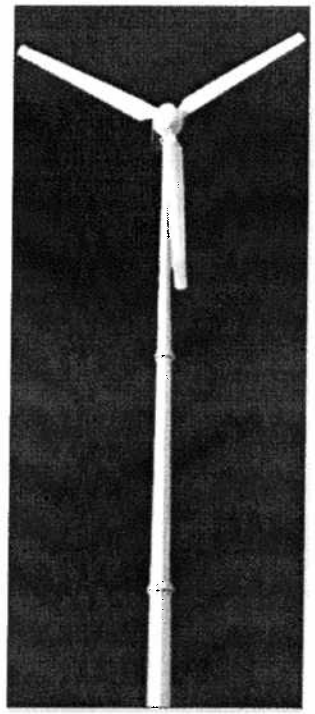

The Hummer 20kW wind turbine is a low wind speed, direct drive generator.

It has a low starting torque, and high generating efficiency.

The patented "in-the-hub" generator emits low noise and heat.

Lightweight, easy to install and low maintenance.

Pass through gear drive means no cable un-twisting.

An LCD display is included for monitoring all system information and auto control protection from overcharging, over discharging, short circuit and overheating.

Grid Tied components include Inverter and PC Software.

Off Grid components include Wind-Solar Hybrid Control System, Charger and Unloading System.

EXHIBIT A

Division VI. Wind Energy Conversion Systems

Section 37-616. Intent

The intent of this division regarding wind energy conversion systems is to:

(a) Provide regulations for the construction and operation of wind energy conversion systems in the City of Champaign and within the one and one-half (1.5) mile radius surrounding the zoning jurisdiction of the City of Champaign.
(b) Provide regulations to facilitate the development of wind energy conversion systems, while protecting adjacent land uses from adverse noise, visual, and other negative impacts that may be associated with a wind energy conversion system.
(c) Facilitate the development of low impact, sustainable energy sources within the City of Champaign and its jurisdiction.

Section 37-617. Definitions

The following terms when used in this Division shall have the meaning specified herein except where the context clearly indicates or requires a different meaning.

Diameter, Rotor shall mean the length of any rotor, or blade, as measured from the tip of the rotor to the center of the turbine multiplied by two (2).

Extraterritorial wind energy conversion system or *Extraterritorial WECS* shall mean any WECS which is or may be located within the extraterritorial jurisdiction.

Extraterritorial jurisdiction shall mean any area which is:

(1) Located outside, but within one and one-half (1.5) miles of the corporate limits of the City; and

(2) Is not located within the subdivision jurisdiction of another city or village.

Facility owner shall mean any person or entity having an equity interest in a WECS.

Institutional use shall mean an educational facility, golf course, sports arena, religious institution, athletic field or publicly owned property, provided that, said term shall exclude parks and cemeteries whether publicly or privately owned.

Operator shall mean any person or entity responsible for the day-to-day operation and maintenance of a WECS.

Publicly owned property shall mean land, buildings or structures owned by any governmental body or public agency including city, county, state or federally owned properties, other than public rights-of-way.

Shadow flicker shall mean the moving shadows or shaded areas which are cast by rotating turbine blades.

Wind Energy Conversion System Height shall mean the height of a freestanding wind energy conversion system must be measured as the distance from the ground level to the highest point on the tower, including the vertical length of any extensions such as the rotor blade. The height of a building mounted wind energy conversion system shall be measured as the distance from the point where the base of the system is attached to the building or to the lowest point on the wind energy conversion system, whichever is closer to the ground, to the highest point on the wind energy conversion system, including the vertical length of any extensions such as the rotor blade.

Small wind energy conversion system or *small WECS* shall mean any wind energy conversion system consisting of a single wind turbine having a maximum generating capacity of one hundred (100) kw, which is intended to generate energy for any contiguous property primarily for the use or consumption on that property.

Tower, monopole shall mean a wind energy conversion system tower consisting of a single pole, constructed without guy wires and anchors.

Wind energy conversion system or *WECS* shall mean an electric generating facility, whose main purpose is to supply wind-generated electricity, consisting of one (1) or more wind turbines and other accessory structures and buildings, including substations, meteorological towers, electrical infrastructure, transmission lines and other appurtenant structures and facilities.

Wind Energy Conversion Structure or wind turbine shall mean a device that converts wind energy into electricity through the use of either a horizontal or vertical axis wind turbine generator, and includes the nacelle, rotor, tower and pad transformer, if any.

Wind energy conversion system, building mounted. Shall mean a wind energy conversion system located on a building.

Wind farm means any wind energy conversion system other than a small wind energy conversion system as defined in this Division.

Section 37-618. Site Requirements

In addition, to meeting any other applicable requirements in this Code, wind energy conversion systems shall be constructed in accordance with the restrictions set forth in this Section:

a. Wind Energy Conversion Structure Height and Rotor Blade Diameter Restrictions. The height of a wind energy conversion structure and the diameter of the motor blade shall not exceed the following restrictions for various uses and zoning districts. The height of a wind energy conversion structure shall be measured from ground level to the top of the highest blade at the highest point extended.
   1. For Single and Two-Family dwellings, Multi-Family dwellings, and Non-Residential uses within the SF1, SF2, MF1, MF2, MF3, MHS, MHP, IT-SF1, IT-SF2, MF1, MF2, MF3, and IT-MF Zoning Districts the maximum height of a wind energy conversion structure, shall be may not exceed one hundred (100) feet. The maximum diameter, as measured from the tip of the rotor or blade to the center of the turbine multiplied by two (2), shall not exceed fifty (50) feet.
   2. For any use that is located in a non-residential district and located within 1,000 feet of the boundary of a lot zoned or planned for residential land use, the maximum height of a wind energy conversion structure shall be one hundred (100) feet and the maximum diameter of the rotors, or the blades, shall be fifty (50) feet. For any use that is located in a non-residential district and more than 1,000 feet away from any boundary of a lot zoned or planned for residential use the maximum height of a wind energy conversion structure shall be one hundred and seventy five (175) feet. The maximum diameter of the rotors, or the blades, for wind energy conversion systems shall not exceed one hundred (100) feet.
   3. Building mounted Wind Energy Conversion Systems in residential zoning districts shall not exceed ten (10) feet higher than the highest point on the roof of the structure it is mounted to.

b. Setbacks
   1. Setback requirements for wind energy conversion structures. The minimum setback from the property line for any wind energy conversion structure shall be the total height of said structure measured from ground level.

c. Noise
   1. No wind energy conversion system or combination of wind energy conversion systems on a single parcel shall create noise that exceeds the regulatory standards set by the Illinois EPA Pollution Control Board at any property line where the property on which the wind energy conversion system is located. Measurement of sound levels shall not be adjusted for, or averaged with, non-operating periods. Any wind energy conversion system exceeding this level shall immediately cease operation upon notification by the City of Champaign Zoning Administrator and may not resume operation until the noise levels have been reduced in compliance with the required standards and verified by an independent third party inspector, approved by the City of Champaign, at the property owner's expense. Upon review and acceptance of the third party noise level report,

the City of Champaign will allow operation of the wind energy conversion system.

d. Multiple Wind Systems.
   1. Multiple wind systems may be allowed if they meet all regulations as required herein.
   2. The number of wind turbines on any given parcel of land shall be limited to:
      i. three (3) wind energy conversion structures for parcels of land having an area of five (5) acres or less.
      ii. five (5) wind energy conversion structures for parcels of land having an area, greater than five (5) acres and not exceeding ten (10) acres.
      iii. There shall be no limit to the number of wind energy conversion structures for parcels of land having an area greater than ten (10) acres.
   3. There shall be no limit to the number of roof mounted wind energy conversion systems on any given parcel of land.

e. Force Wind Standards
   1. Wind Energy Conversion Systems must be engineered to withstand wind forces of up to 110 miles per hour.

f. Removal of nuisance wind systems or turbines.
   1. The Wind Energy Conversion System or individual turbine is hereby declared to be a public nuisance if it has been inoperable or has not been operated to generate any electricity for 180 or more consecutive days.
   2. Upon receipt of written notice from the Zoning Administrator or Administrator's designee that a Wind Energy Conversion System or individual wind turbine has become a public nuisance as defined in paragraph (1) above, the Owner of a wind energy conversion system and associated facilities shall have 180 days to restore the wind energy conversion system or individual turbine to operating condition and operation for the generation of electricity or remove it from the property, provided that in the event the Zoning Administrator or Administrator's designee determines that, because of its condition, the WECS or individual turbine poses a great and immediate threat to the public health, safety, or welfare, then the City may remove the structure(s) that specifically pose such a great and immediate threat without any prior notice to said owner, assess the owner for all costs incurred for said removal and file a lien for said costs in the manner provided herein..
   3. A written notice of pubic nuisance described herein may be personally delivered to the owner or authorized agent of the WECS in question, or delivered by First Class U.S. Mail. A written notice delivered by First Class U.S. Mail shall be deemed received by said owner three business days after its deposit in the U.S. Mail system.

4. The failure of any owner to comply with the requirements to either restore to operation or remove a public nuisance WECS or individual turbine as provided herein shall be deemed a violation of this Zoning Ordinance and shall be deemed implied consent by said owner to the City to allow the City to remove, or hire someone else to remove said wind system or individual turbine, as the case may be, and to charge said owner for the entire cost of said removal. Said cost of removal incurred by the City shall be deemed a lien against the property, and the City shall be authorized to file a notice of said lien in the Office of the Champaign County Recorder of Deeds for the cost of removing the wind energy conversion system. Removal of a wind energy conversion system that constitutes a public nuisance shall include removal of: the turbines, tower, and any above ground improvements, including fencing.
5. The City may foreclose upon any lien for removal costs as provided herein in accordance with the procedures provided for foreclosure of a mortgage in the Illinois Mortgage Foreclosure Law, 735 ILCS 5/15-1101 et seq.

g. Signage.
   1. Commercial marking, messages, banners, or signs of any kind on the wind energy conversion system or tower shall be prohibited.

h. Tower Access.
   1. The tower shall not be accessible for climbing. No rungs shall be provided for the first twelve (12) feet of the tower, the climbing apparatus shall be covered, and any other approved preventative measures, which may be applicable.

i. Color.
   1. The exterior color of the wind energy conversion system shall be limited to black, white, off-white, and grey, and the surface shall be non-reflective.

j. Lighting.
   1. No lights shall be installed on the tower, unless required to meet FAA regulations.

k. Permit for Extra-territorial Wind Energy Conversion Systems.
   1. An application to site and construct an extraterritorial WECS shall be considered by the City in the same manner as if the applicant had submitted an application for the placement of a WECS within the corporate limits of the city. The applicant, facility owner, operator and any participating landowner with respect to any approved application for an extraterritorial WECS shall be subject to the terms and conditions of this Code and any approving ordinance or resolution in the same fashion and to the same extent as if the WECS were located within the corporate limits of the City.

l. Shadow Flicker
   1. Wind Conversion Energy Systems shall be designed and located to minimize shadow flicker. Shadow flicker expected to fall on a roadway or a residential structure shall be acceptable under the following circumstances:
      i. The flicker, assuming sunlight will not be obscured by cloud cover during the entire course of the year, will not fall on the location of concern for more than 30 hours per year; and
      ii. With regards to flicker falling on roadways, the traffic volumes are less than 500 vehicles per day on the roadway.
   2. The applicant shall provide a shadow flicker model for any wind energy conversion system over 150 feet tall. The shadow flicker model shall demonstrate that the wind energy conversion system meets the stated provisions.

m. Vibrations
   1. The Wind Energy Conversion Structure shall not cause any vibrations detectible by persons without the aid of scientific instruments on any adjacent property.

n. Tower Type
   1. In residential districts, the type of tower a wind turbine may be mounted on shall be restricted to a monopole tower.

o. Minimum Ground Clearance
   1. The blade tip of a Wind Energy Conversion System, at its lowest point, shall have a ground clearance of no less than twenty (20) feet.

p. Electromagnetic Interference
   1. The Wind Energy Conversion System shall not cause any electromagnetic interference with any radio, television, microwave communication, or satellite navigation on other properties.
   2. If the Wind Energy Conversion System is found to cause electromagnetic interference on other properties, the owner shall make any necessary and reasonable changes to the Wind Energy Conversion System within 90 days of notice from the Zoning Administrator, including removal or relocation of the Wind Energy Conversion System to eliminate any electromagnetic interference.

q. Energy Efficient Subdivision.
   1. Any subdivision which is developed with the specific intention of providing wind energy to the property owners within the subdivision shall be allowed to construct a Wind Energy Conversion System on a commons lot to be maintained by the home owners association.

a. A wind energy conversion system within an energy efficient subdivision shall not be required to meet any setbacks.
b. A wind energy conversion system within an energy efficient subdivision shall be required to be constructed prior to the issuance of any building permits for any structures within the subdivision.
c. A wind energy conversion system within an energy efficient subdivision shall not exceed a maximum height of a wind energy conversion structure shall be one hundred and seventy five (175) feet. The maximum diameter of the rotors, or the blades, for wind energy conversion systems more than one hundred (100) feet.
d. A wind energy conversion system within an energy efficient subdivision shall meet all other requirements of this chapter.

r. Proposed Wind Energy Conversion Systems exceeding the Height regulations of this ordinance.
   1. Proposed Wind Energy Conversion Systems which exceed the height limitation of this ordinance shall be required to submit a Special Use Permit application in compliance with Article V of this Chapter.
   2. The proposed Special Use Permit shall meet the following findings of fact:
      i. That the proposed wind energy conversion system is designed, located, and proposed to be operated so that it will not be unreasonably injurious or unreasonably detrimental to the district in which it may be located or otherwise injurious to the public welfare. It shall be the applicant's burden to submit evidence to demonstrate the anticipated impacts of the proposed wind energy conversion system.
      ii. Other than height regulations in this Division, the proposed use conforms to all the applicable regulations and standards of the district in which it shall be located.
      iii. That the proposed use is consistent with the City of Champaign Comprehensive Plan.
   3. The issuance of a Special Use Permit for a Wind Energy Conversion System to exceed the height limitations of this chapter shall only be allowed in the CI, IOP, IBP, I1, and I2 Zoning Districts. A special use permit for a Wind Energy Conversion System to exceed the height limitations shall be allowed in the City of Champaign's Extra-territorial Jurisdiction in areas that are one thousand five hundred (1500) feet away from any residential land use or areas planned for residential land uses by the City of Champaign Future Land Use Map in the Comprehensive Plan and its subsequent amendments and updates.
   4. The applicant shall submit the following documentation as part of the Special Use Permit application:

i. A noise study, prepared by a qualified professional, demonstrates that except for intermittent episodes, the wind energy conversion system shall not emit noise in excess of the limits established by the State of Illinois Pollution Control Board. The noise study shall include:
    a. A description and map of the projects noise producing features, including the range of noise levels expected, and the basis of the expectation.
    b. A description and map of the noise sensitive environment, including any sensitive noise receptors e.g. residences, hospitals, libraries, schools, places of worship, parks, area with outdoor workers and other facilities where quiet is important or where noise could be a nuisance within one thousand feet (1,000').
    c. A description and map of the cumulative noise impacts of any problem area identified.
    d. A description of the project's proposed noise control features and specific measures proposed to mitigate noise impacts for sensitive receptors as identified above to a level of insignificance.

ii. A shadow flicker model that demonstrates that shadow flicker shall not fall on, or in, any existing residential structure and that establishes that shadow flicker expected to fall on a roadway or a portion of a residentially zoned parcel may be acceptable if the flicker does not exceed thirty (30) hours per year at the location of concern; and the flicker will fall more than one hundred feet (100') from an existing residence; or the traffic volumes are less than five hundred (500) vehicles on the roadway that is impacted by the flicker. The shadow flicker model shall:
    a. Map and describe within a one thousand foot (1,000') radius of the proposed dispersed wind energy system the topography, existing residences and location of their windows, locations of other structures, wind speeds and directions, existing vegetation and roadways. The model shall represent the most probable scenarios of wind constancy, sunshine constancy, and wind directions and speed;
    b. Calculate the locations of shadow flicker caused by the proposed project and the expected durations of the flicker at these locations, calculate the total number of houses per year of flicker at all locations;
    c. Identify problem areas where shadow flicker will interfere with existing of future residences and roadways and describe proposed mitigation measures, including, but not limited to, a change in siting of the wind energy conversion system, a

change in the operation of the wind energy conversion system, or grading or landscaping mitigation measures.

Section 37-619 through 37-630.

Reserved

CASE NO. 645-S-09

SUPPLEMENTAL MEMORANDUM
January 7, 2010

Champaign County Department of

PLANNING & ZONING

Brookens Administrative Center
1776 E. Washington Street
Urbana, Illinois 61802

(217) 384-3708

Petitioners: **Robert and Barbara Gerdes**

Request: **Authorize the construction and use of a "Restricted Landing Area" as a Special Use in the AG-1 Agriculture Zoning District**

Site Area: **approx. 83 acres**

Location: **An approximately 83 acre tract that is approximately the West Half of the Southwest Quarter of Section 33 of Ayers Township and commonly known as the farm at 52 CR 2700E, Broadlands.**

Time Schedule for Development: **Immediate**

Prepared by: **J.R. Knight**
Associate Planner
John Hall
Zoning Administrator

STATUS

This is the fourth meeting for this case, it was continued from the December 3, 2009, ZBA meeting. At that time the petitioners were considering withdrawing their case on the advice of their attorney, but staff has not received any information to date regarding the petitioners' decision.

CASE NO. 658-AT-09

PRELIMINARY MEMORANDUM

Champaign County Department of

PLANNING & ZONING

Brookens Administrative Center
1776 E. Washington Street
Urbana, Illinois 61802

(217) 384-3708

January 7, 2010

Petitioner: **Zoning Administrator**

Prepared by: **John Hall**
Zoning Administrator
J.R. Knight
Associate Planner

Request:

Amend the Champaign County Zoning Ordinance as follows:

PART A:

1. **Delete subparagraph 6.1.4 A.1.c. to make consistent with paragraph 6.1.4 M.**

2. **Amend paragraph 6.1.4 C.11. to require the wind farm separation from restricted landing areas or residential airports only for restricted landing areas and residential airports that existed on the effective date of County Board adoption of Case 658-AT-09.**

PART B:

1. **Amend paragraph 6.1.1 A.5. to reference the requirements of paragraph 6.1.4 P.5.**

2. **Amend paragraph 9.1.11 D.1. to include reference to subsection 6.1 instead of subsection 6.1.3.**

BACKGROUND

New requirements for wind farm development were added to the Zoning Ordinance by the adoption of Ordinance No. 848 (Case 634-AT-08 Part A) by the County Board on May 21, 2009. Those requirements included a minimum separation of 3,500 feet from the base of any wind farm tower to any restricted landing area (RLA) or residential airport. Case 645-S-09 for a proposed restricted landing area within the area of an anticipated wind farm has revealed what appears to be a weakness in the wind farm amendment.

The weakness in the wind farm regulations is that an agricultural RLA can be established with no approval necessary from the County and once established it will create an area of approximately 1,100 acres where no wind farm tower may be established. Wind farm towers are generally at a density of one tower per 70 acres so one RLA could easily eliminate as many as 15 wind farm towers. Wind farm towers provide tremendous economic benefit to the landowner and more importantly the local school system and eliminating so much possible income would be injurious to the district.

RLAs are also quite rare. The requirements for RLAs were added to the Zoning Ordinance by the adoption of Ordinance No. 320 (Case 642-AT-88) by the County Board on August 23, 1988. In the 21 years since the adoption of Ordinance No. 320 there had only been three applications for RLAs prior to Case 645-S-09. Thus, not only can the establishment of a so-called "spite" RLA result in injury to the district there does not appear to be much demand for bona fide RLAs.

Residential airports are even more rare. There has only been one residential airport ever proposed in Champaign County and it is not clear that this type of use is even recognized anymore by the Illinois Department of Transportation.

Clearly, existing RLA's and residential airports do merit the protection offered by the 3,500 feet separation and the proposed in the amendment continues to provide that protection.

There were also several minor errors or oversights in the final wording of Ordinance No. 848 that if not corrected could cause unnecessary complications for any wind farm review and so those oversights have also been included in this case.

Because of the imperative to get the text amendment adopted so as to prevent spite RLAs and the complications of the meeting schedule at this time of year, this text amendment has not been reviewed by the Environment and Land Use Committee (ELUC). However, the Zoning Administrator did review the text amendment with the ELUC Chair.

PROPOSED AMENDMENT

The proposed amendment addresses the following three items:

- **Clarification of standard condition for shadow flicker**. In Case 634-AT-08 Part A ELUC revised the shadow flicker requirement in paragraph 6.1.4 M by simply requiring mitigation of shadow flicker that exceeds 30 hours per year. Staff forgot to advise ELUC to coordinate that change with subparagraph 6.1.4 A.1.c. which requires the area of the wind farm to include all areas that receive in excess of 30 hours of shadow flicker per year. At this time subparagraph 6.1.4 A.1.c. is nonsensical and should be eliminated.

- **Eliminate the loophole of wind farm separation from RLAs and residential airports by requiring the separation only for <u>existing</u> RLAs and residential airports.** See the discussion in the Background.

- **Clarify paragraph 9.1.11 D.1. to make it clear that all of the requirements in subsection 6.1 are standard conditions.** Case 634-AT-08 Part A was very clear that all of the requirements for wind farms in subsection 6.1.4 are standard conditions and the Ordinance is very clear that standard conditions may be waived in any special use permit. Case 634-AT-08 Part A also reorganized subsections 6.1.1, 6.1.2, and 6.1.3 in addition to introducing subsection 6.1.4. However, the existing reference to standard conditions in paragraph 9.1.11 D.1. only mentions subsection 6.1.3. and it should now refer to subsection 6.1. A mock-up of Section 6 is also provided as Attachment E to illustrate the revised Section 6

The legal advertisement for this case also included a change to improve the cross referencing between the basic reclamation agreement requirements in paragraph 6.1.1 A. 5 and the wind farm reclamation agreement in paragraph 6.1.4 P. This change does not appear necessary and will not be included in this text amendment.

ATTACHMENTS

A Draft Proposed Change to Subparagraph 6.1.4 A. 1.(c)
B Draft Proposed Change to Subparagraph 6.1.4 C. 11.
C Draft Proposed Change to Subparagraph 9.1.11 D.1.
E Excerpts from Section 6 of the *Zoning Ordinance* (with revisions from recent text amendments)
F Draft Finding of Fact for Case 658-AT-09 (attached separately)

Attachment A. Draft Proposed Change to Subparagraph 6.1.4 A. 1.(c)
JANUARY 7, 2010

1. Delete subparagraph 6.1.4 A. 1.(c) and renumber as required:

A. General Standard Conditions

1. The area of the WIND FARM County Board SPECIAL USE Permit must include the following minimum areas:

(a) All land that is a distance equal to 1.10 times the total WIND FARM TOWER height (measured to the tip of the highest rotor blade) from the base of that WIND FARM TOWER.

(b) All land that will be exposed to a noise level greater than that authorized to Class A land under paragraph 6.1.4 I.

~~(c) All land that will be exposed to shadow flicker in excess of that authorized under paragraph 6.1.4M. and for which other mitigation is not proposed.~~

(~~d~~c) All necessary access lanes or driveways and any required new PRIVATE ACCESSWAYS. For purposes of determining the minimum area of the special use permit, access lanes or driveways shall be provided a minimum 40 feet wide area.

(~~e~~d) All necessary WIND FARM ACCESSORY STRUCTURES including electrical distribution lines, transformers, common switching stations, and substations not under the ownership of a PUBLICLY REGULATED UTILITY. For purposes of determining the minimum area of the special use permit, underground cable installations shall be provided a minimum 40 feet wide area.

(~~f~~e) All land that is within 1.50 times the total WIND FARM TOWER height (measured to the tip of the highest rotor blade) from the base of each WIND FARM TOWER except any such land that is more than 1,320 feet from any existing public STREET right of way.

(~~g~~f) All land area within 1,320 feet of a public STREET right of way that is also within 1,000 feet from the base of each WIND FARM TOWER except that in the case of WIND FARM TOWERS in compliance with the minimum STREET separation required by paragraph 6.1.4 C. 5. in which case land on the other side of the public STREET right of way does not have to be included in the SPECIAL USE Permit.

Attachment B. Draft Proposed Change to Subparagraph 6.1.4 C. 11.
JANUARY 7, 2010

1. Delete subparagraph 6.1.4 C. 11. and renumber as required:

11. At least 3,500 feet separation from the exterior above-ground base of a WIND FARM TOWER to any conforming RESTRICTED LANDING AREA or conforming RESIDENTIAL AIRPORT that existed on *{the date of adoption}*.

Attachment C. Case 658-AT-09 Draft Proposed Change To Subpar. 9.1.11 D.1.
JANUARY 7, 2010

1. Revise subparagraph 9.1.11 D.1. as follows:

D. Conditions

1. Any other provision of this ordinance not withstanding, the BOARD or GOVERNING BODY, in granting any SPECIAL USE, may waive upon application any standard or requirement for the specific SPECIAL USE enumerated in Section 6.1~~.3 Schedule of Requirements and Standard Conditions~~ Standards for Special Uses, to the extent that they exceed the minimum standards of the DISTRICT, except for any state or federal regulation incorporated by reference, upon finding that such waiver is in accordance with the general purpose and intent of this ordinance, and will not be injurious to the neighborhood or to the public health, safety and welfare.

SECTION 6 STANDARDS FOR SPECIAL USES

6.1 Standards for SPECIAL USES

The standards listed for specific SPECIAL USES which exceed the applicable DISTRICT standards in Section 5.3 and which are not specificaly required under another COUNTY ordinance, state regulation, federal regulation, or other authoritative body having jurisdiction, to the extent that they exceed the standards of the DISTRICT, shall be considered standard conditions which the BOARD is authorized to waive upon application as provided in Section 9.1.11 on an individual basis.

6.1.1 Standard Conditions that May Apply to Specific SPECIAL USES

A. Site Reclamation

1. In the course of BOARD review of a SPECIAL USE request, the BOARD may find that a proposed STRUCTURE is a NON-ADAPTABLE STRUCTURE. In such a case the developer shall enter into a reclamation agreement with the COUNTY for the subject site. The reclamation agreement shall be binding upon all successors of title to the land.

2. Prior to the issuance of a SPECIAL USE permit for such NON-ADAPTABLE STRUCTURES, the landowner shall also record a covenant incorporating the provisions of the reclamation agreement on the deed subject to the lot.

3. Separate cost estimates for Sections 6.1.1C4a and 6.1.1C4b shall be provided by an Illinois licensed Professional Engineer. Cost estimates provided shall be subject to approval of the BOARD.

4. The reclamation agreement shall provide for:

    a. removal of above-ground portion of any STRUCTURE on the subject site; site grading; and, interim soil erosion control;

    b. below-ground restoration, including final grading and surface treatment; and

    c. provision and maintenance of a letter of credit, as set forth in Section 6.1.C5.

6.1.1 Standard Conditions that May Apply to Specific SPECIAL USES – continued

5. No Zoning Use Permit for such SPECIAL USE will be issued until the developer provides the COUNTY with an irrevocable letter of credit to be drawn upon a federally insured financial institution within 200 miles of Urbana or reasonable and anticipated travel costs shall be added to the amount of the letter of credit. The irrevocable letter of credit shall be in the amount of one hundred fifty percent (150%) of an independent engineer's cost estimate to complete the work described in Section 6.1.1C4a. This letter of credit, or a successor letter of credit pursuant to Section 6.1.1C6 or 6.1.1C12 shall remain in effect and shall be made available to the COUNTY for an indefinite term.

6. One hundred twenty (120) days prior to the expiration date of an irrevocable letter of credit submitted pursuant to this Section, the Zoning Administrator shall notify the landowner in writing and request information about the landowner's intent to renew the letter of credit, or remove the NON-ADAPTABLE STRUCTURE. The landowner shall have thirty (30) days to respond in writing to this request. If the landowner's intention is to remove the NON-ADAPTABLE STRUCTURE, the landowner will have a total of ninety (90) days from the date of the COUNTY's initial notification to remove it in accordance with Section 6.1.C4a. At the end of ninety (90) days, the Zoning Administrator shall have a period of thirty (30) days to either:

   a. confirm that the bank has renewed the letter of credit; or

   b. inspect the subject property for compliance with Section 6.1C4a;

   c. draw on the letter of credit and commence the bid process to have a contractor remove the NON-ADAPTABLE STRUCTURE pursuant to Section 6.1C4a.

7. The Zoning Administrator may find a NON-ADAPTABLE STRUCTURE abandoned in place. Factors to be considered in making this finding include, but are not limited to:

   a. the nature and frequency of use as set forth in the application for SPECIAL USE;

   b. the current nature and frequency of use;

   c. whether the NON-ADAPTABLE STRUCTURE has become a public nuisance, or otherwise poses a risk of harm to public health or safety;

6.1.1 Standard Conditions that May Apply to Specific SPECIAL USES – continued

d. whether the NON-ADAPTABLE STRUCTURE has been maintained in a manner which allows it to be used for its intended purpose, with no greater effects on surrounding properties and the public as a whole than was originally intended.

8. Once the Zoning Administrator has made a finding that a NON-ADAPTABLE STRUCTURE is abandoned in place, the Zoning Administrator shall issue noted to the land owner at the owner's last known address that the COUNTY will draw on the performance guarantee within thirty (30) days unless the owner appeals the Zoning Administrator's finding, pursuant to Section 9.1.8 or enters into a written agreement with the COUNTY to remove such NON-ADAPTABLE STRUCTURE in accordance with Section 6.1.C4a within ninety (90) days and removes the NON-ADAPTABLE STRUCTURE accordingly.

9. The Zoning Administrator may draw on the funds to have said NON-ADAPTABLE STRUCTURE as per Section 6.1C4a of the reclamation agreement when any of the following occur:

   a. no response is received from the land owner within thirty (30) days from initial notification by the Zoning Administrator;

   b. the land owner does not enter, or breaches any term of a written agreement with the COUNTY to remove said NON-ADAPTABLE structure as provided in Section 6.1C8;

   c. any breach or performance failure of any provision of the reclamation agreement;

   d. the owner of record has filed a bankruptcy petition, or compromised the COUNTY's interest in the letter of credit in any way to specifically allowed by the reclamation agreement;

   e. a court of law has made a finding that a NON-ADAPTABLE STRUCTURE constitutes a public nuisance;

   f. the owner of record has failed to replace an expiring letter of credit within the deadlines set forth in Section 6.1.C6; or

   g. any other conditions to which the COUNTY and the land owner mutually agree, as set forth in the reclamation agreement.

6.1.1 Standard Conditions that May Apply to Specific SPECIAL USES – continued

10. Once the letter of credit has been drawn upon, and the site has been restored to its original condition, as certified by the Zoning Administrator, the covenant entered pursuant to Section 6.1C2 shall expire, and the COUNTY shall act to remove said covenant from the record of the property at the Recorder of Deeds within forty-five (45) days.

11. The proceeds of the letter of credit may only be used by the COUNTY to:

    a. remove the NON-ADAPTABLE STRUCTURE and return the site to its condition prior to the placement of the NON-ADAPTABLE STRUCTURE, in accordance with the most recent reclamation agreement submitted and accepted in relation to the NON-ADAPTIVE STRUCTURE;

    b. pay ancillary costs related to this process; and

    c. remove any covenants placed on the title in conjunction with Section 6.1C.

    The balance of any proceeds remaining after the site has been reclaimed shall be returned to the issuer of the letter of credit.

12. Upon transfer of any property subject to a letter of credit pursuant to this Section, the new owner of record shall submit a new irrevocable letter of credit of same or greater vale to the Zoning Administrator, prior to legal transfer of title, and shall sign a new reclamation agreement, pursuant to Section 6.1C4a. Once the new owner of record has done so, the letter of credit posted by the previous owner shall be released, and the previous owner shall be released from any further obligations under the reclamation agreement.

6.1.2 Standard Conditions for All SPECIAL USES

A. All Special Use Permits with exterior lighting shall be required to minimize glare on adjacent properties and roadways by the following means:

1. All exterior light fixtures shall be full-cutoff type lighting fixtures and shall be located and installed so as to minimize glare and light trespass. Full cutoff means that the lighting fixture emits no light above the horizontal plane.

2. No lamp shall be greater than 250 watts and the Board may require smaller lamps when necessary.

3. Locations and numbers of fixtures shall be indicated on the site plan (including floor plans and building elevations) approved by the Board.

4. The Board may also require conditions regarding the hours of operation and other conditions for outdoor recreational uses and other large outdoor lighting installations.

5. The Zoning Administrator shall not approve a Zoning Use Permit without the manufacturer's documentation of the full-cutoff feature for all exterior light fixtures.

6.1.3 Schedule of Standard Conditions for Specific Types of Special Uses

The number in parentheses within Table 6.1.3 indicate Footnotes at the conclusion of Table 6.1.3. The abbreviation NR indicates there is no requirement or standard unless required due to unique circumstances on an individual basis.

SPECIAL USES or USE Categories	Minimum Fencing Required[6]	Minimum LOT Size: AREA (Acres)	Minimum LOT Size: Width (Feet)	Maximum HEIGHT: Feet	Maximum HEIGHT: Stories	Required YARDS (feet) – Front Setback from STREET Centerline[2] – STREET Classification: MAJOR	COLLECTOR	MINOR	SIDE	REAR	Explanatory or Special Provisions
Adaptive reuse of GOVERNMENT BUILDINGS	NR	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	*See below.
	*Outdoor storage of materials, machinery, or heavy equipment is prohibited. The outdoor overnight storage of vehicles in the R-1, Single Family Residence; R-2, Single Family Residence; R-3, Two Family Residence; and R-4, Multiple Family Residence Zoning Districts is prohibited.										
AIRPORTS	NR	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	*See below.
	*Must meet the requirements of the Fedeal Aviation Administration and Illinois Department of Transportation, Division of Aeronautics. The runway safety areas as established in Figure 7-1 of the Federal Aviation Administration Advisory Circular number 150/53004B, shall be entirely located on the LOT covered by the Special Use. The runway shall be situated so that no building designed for human occupancy which is located in an R or B District, nor any PUBLIC ASSEMBLY or INSTITUTIONAL USE shall encroach in the primary surface or Runway Clear zone as described in Appendix 6 of the Federal Aviation Administration Advisory Circular number 150/5300 4B.										
All SPECIAL USES in the "Industrial Uses Chemical and Allied Products" Category	6' wire mesh	10	(1)	(1)	350	350	350	350	300	300	*See below.
	*Not permitted closer than 2,000' from any R or B DISTRICT or any residential, INSTITUTIONAL or PUBLIC ASSEMBLY USE.										
All SPECIAL USES in the "Industrial Uses Food and Kindred Products" Category	6' wire mesh	(1)	(1)	(1)	(1)	100	100	100	50	50	*See below.

6.1.3 SCHEDULE OF REQUIREMENTS AND STANDARD CONDITIONS - CONTINUED

Footnotes

1. Standard same as applicable zoning DISTRICT.

2. In no case, however, shall the FRONT YARD, measured from the nearest RIGHT-OF-WAY line, be less than 35' from a MAJOR STREET, 30' from a COLLECTOR STREET, or 25' from a MINOR STREET. Where 25% or more of the LOTS within a BLOCK, such LOTS abutting STREETS other than federal of state highways, were occupied by MAIN or PRINCIPAL STRUCTURES prior to the effective date of this ordinance, the average of the SETBACK LINES of such STRUCTURES shall be the minimum SETBACK LINE of the remaining vacant LOTS within such BLOCK except where the public health, safety, comfort, morals, or welfare are endangered.

3. Other standards shall be in accordance with the "State of Illinois Environmental Protection Agency Solid Waste Rules and Regulations," effective July 27, 1973.

4. Applications for sewage disposal facilities shall include plans for such facilities prepared by a registered professional engineer. All plans shall include assurance that the proposed facilities will not be subject to flooding, will not contaminate ground water resources, and any other assurances that may be required by the BOARD. All sewage disposal facilities shall be constructed in accordance with the rules and regulations of the State of Illinois and this ordinance.

5. Industrial Pre-existing USES must make application to obtain SPECIAL USE status.

6. The specific location and area to be enclosed by required fencing shall be determined by the Zoning Board of Appeals.

6.1.4 WIND FARM County Board SPECIAL USE Permit

A WIND FARM County Board SPECIAL USE Permit may only beauthorized in the AG-1 Zoning District subject to the following standard conditions.

A. General Standard Conditions

1. The area of the WIND FARM County Board SPECIAL USE Permit must include the following minimum areas:

   (a) All land that is a distance equal to 1.10 times the total WIND FARM TOWER height (measured to the tip of the highest rotor blade) from the base of that WIND FARM TOWER.

   (b) All land that will be exposed to a noise level greater than that authorized to Class A land under paragraph 6.1.4 I.

   (c) All necessary access lanes or driveways and any required new PRIVATE ACCESSWAYS. For purposes of determining the minimum area of the special use permit, access lanes or driveways shall be provided a minimum 40 feet wide area.

   (d) All necessary WIND FARM ACCESSORY STRUCTURES including electrical distribution lines, transformers, common

PRELIMINARY DRAFT

658-AT-09

FINDING OF FACT
AND FINAL DETERMINATION
of
Champaign County Zoning Board of Appeals

Final Determination: **RECOMMEND ENACTMENT**

Date: January 7, 2010

Petitioner: Zoning Administrator

Request: Amend the Champaign County Zoning Ordinance as follows:

PART A:

1. Delete subparagraph 6.1.4 A.1.c. to make consistent with paragraph 6.1.4 M.

2. Amend paragraph 6.1.4 C.11. to require the wind farm separation from restricted landing areas or residential airports only for restricted landing areas and residential airports that existed on the effective date of County Board adoption of Case 658-AT-09.

PART B:

Amend paragraph 9.1.11 D.1. to include reference to subsection 6.1 instead of subsection 6.1.3.

FINDING OF FACT

From the documents of record and the testimony and exhibits received at the public hearing conducted on **January 14, 2010**, the Zoning Board of Appeals of Champaign County finds that:

1. The petitioner is the Zoning Administrator.

2. The need for the amendment came about as follows:
   A. New requirements for wind farm development were added to the Zoning Ordinance by the adoption of Ordinance No. 848 (Case 634-AT-08 Part A) by the County Board on May 21, 2009.

   B. Case 645-S-09 for a proposed restricted landing area within the area of an anticipated wind farm has revealed what appears to be a weakness in the wind farm amendment.

C. The weakness in the wind farm regulations is that an agricultural RLA can be established with no approval necessary from the County and once established it will create an area of approximately 1,100 acres where no wind farm tower may be established.

D. Wind farm towers provide tremendous economic benefit to the landowner and more importantly the local school system and eliminating so much possible income would be injurious to the district.

E. There were also several minor errors or oversights in the final wording of Ordinance No. 848 that if not corrected could cause unnecessary complications for any wind farm review and so those oversights have also been included in this case.

3. Municipalities with zoning and townships with planning commissions have protest rights on all text amendments and they are notified of such cases. No comments have been received to date.

GENERALLY REGARDING THE EXISTING ZONING REGULATIONS

4. Existing Zoning regulations regarding the separate parts of the proposed amendment are as follows:
   A. Requirements for the development of wind farms were added to the *Zoning Ordinance* in Ordinance No. 848 (Case 634-AT-09 Part A) on May 21, 2009. These requirements included a 3,500 feet separation from any restricted landing area or residential airport to the base of any wind farm tower.

   B. Ordinance No. 848 also reorganized Section 6 of the *Zoning Ordinance* to make it more clear that all the requirements in Section 6.1 are standard conditions and are waiveable as part of a Special Use Permit. However, some references to standard conditions and Section 6 in other parts of the *Zoning Ordinance* were not updated.

   C. The following definitions from the *Zoning Ordinance* are especially relevant to this amendment (capitalized words are defined in the Ordinance):
      (1) "BUILDING, MAIN or PRINCIPAL" is the BUILDING in which is conducted the main or principal USE of the LOT on which it is located.

      (2) "NON-ADAPTABLE STRUCTURE" is any STRUCTURE or physical alteration to the land which requires a SPECIAL USE permit, and which is likely to become economically unfeasible to remove or put to an alternate USE allowable in the DISTRIC (by-right or by SPECIAL USE).

      (3) "RESIDENTIAL AIRPORT" is any area described or defined as an AIRPORT under the *Illinois Aviation Safety Rules* (92 *Ill. Admin. Code* Part 14) and which is classified as a Residential Airport by the Illinois Department of Transportation, Division of Aeronautics.

      (4) "RESTRICTED LANDING AREA" is any area described or defined as a Restricted Landing Area under the *Illinois Aviation Safety Rules* (92 *Ill. Admin. Code* Part 14) and

as further regulated by the Illinois Department of Transportation, Division of Aeronautics.

(5) "SPECIAL CONDITION" is a condition for the establishment of the SPECIAL USE.

(6) "SPECIAL USE" is a USE which may be permitted in a DISTRICT pursuant to, and in compliance with, procedures specified herein.

SUMMARY OF THE PROPOSED AMENDMENT

5. The proposed amendment revises portions of the recently adopted Ordinance No. 848 (Zoning Case 634-AT-09 Part A). The revisions make the ordinance more consistent and clarify references to different parts of the ordinance, as well as scaling back the separation requirement for wind farm towers near residential airports or restricted landing areas. See Attachments A-C of the Preliminary Memorandum for the proposed amendment. Attachment E to the Preliminary Memorandum includes excerpts of Section 6 as it was reorganized by Ordinance No. 848 and may be helpful when reviewing the proposed amendment.

GENERALLY REGARDING RELEVANT LAND USE GOALS AND POLICIES

6. The *Land Use Goals and Policies* (LUGP) were adopted on November 29, 1977, and were the only guidance for amendments to the *Champaign County Zoning Ordinance* until the *Land Use Regulatory Policies- Rural Districts* were adopted on November 20, 2001, as part of the Rural Districts Phase of the Comprehensive Zoning Review (CZR) and subsequently revised on September 22, 2005. The relationship of the Land Use Goals and Policies to the Land Use Regulatory Policies is as follows:
   A. Land Use Regulatory Policy 0.1.1 gives the Land Use Regulatory Policies dominance over the earlier Land Use Goals and Policies.

   B. The Land Use Goals and Policies cannot be directly compared to the Land Use Regulatory Policies because the two sets of policies are so different. Some of the Land Use Regulatory Policies relate to specific types of land uses and relate to a particular chapter in the land use goals and policies and some of the Land Use Regulatory Policies relate to overall considerations and are similar to general land use goals and policies.

REGARDING SPECIFICALLY RELEVANT LAND USE GOALS AND POLICIES

7. There are goals and policies for agricultural, commercial, industrial, and residential land uses, as well as conservation, transportation, and utilities goals and policies in the Land Use Goals and Policies, but due to the nature of the changes being proposed none of these specific goals and policies are relevant to the proposed amendment.

REGARDING THE GENERAL LAND USE GOALS AND POLICIES

8. Regarding the General Land Use Goals and Policies:
   A. The first, third, fourth, and fifth General Land Use Goals appear to be relevant to the proposed amendment, as follows:

(1) In regards to the proposed change to paragraph 6.1.4. C.11. to require the wind farm separation from restricted landing areas or residential airports only for restricted landing areas and residential airports that existed on the effective date of County Board adoption of Case 658-AT-09, the following General Land Use Goals are relevant:

(a) The first General Land Use Goal is promotion and protection of the health, safety, economy, convenience, appearance, and general welfare of the County by guiding the overall environmental development of the County through the continuous comprehensive planning process.

(b) The third General Land Use Goal is land uses appropriately located in terms of utilities, public facilities, site characteristics, and public services.

(c) The fourth General Land Use Goal is arrangement of land use patterns designed to promote mutual compatibility.

The proposed amendment ***{ACHIEVES}*** the first, third, and fourth General Land Use Goals because of the following:

(a) Based on evidence that there will be significant positive effects on Equalized Assessed Valuation that will benefit local taxing bodies from the establishment of wind farms in the County.

(b) The need for bona fide Restricted Landing Areas and Residential Airports appears to be very limited because in the 21 years since the requirements for those uses were added to the *Zoning Ordinance* only four applications for RLA's have been received and only one residential airport has been established in the county.

(2) The fifth General Land Use Goal is:

Establishment of processes of development to encourage the development of the types and uses of land that are in agreement with the Goals and Policies of this Land Use Plan

The proposed amendment appears to ***{ACHIEVE}*** the fifth General Land Use Goal because it will make the *Zoning Ordinance* more consistent and clear, as follows:

(a) Clarifying that the Site Reclamation requirements in Subparagraph 6.1.1 A. are standard conditions, which are therefore able to be waived, matches the intent of the original legal advertisement for Case 273-AT-00, which added those requirements to the *Zoning Ordinance.*

(b) Based on the requirement in subparagraph 6.1.4 M. there should not be any land that is subject to more shadow flicker than allowed by that paragraph because all land subject to greater shadow flicker will receive mitigation and so the requirements of paragraph 6.1.4 M. make the requirement of paragraph 6.1.4 A.1.c. obsolete.

B. None of the General Land Use Policies appear to be relevant to the proposed amendment.

DOCUMENTS OF RECORD

1. Application for Text Amendment from Zoning Administrator, dated December 4, 2009

2. Preliminary Memorandum for Case 658-AT-09, dated January 7, 2010, with attachments:
   - A Draft Proposed Change to Subparagraph 6.1.4 A. 1.(c)
   - B Draft Proposed Change to Subparagraph 6.1.4 C. 11.
   - C Draft Proposed Change to Subparagraph 9.1.11 D.1.
   - E Excerpts from Section 6 of the *Zoning Ordinance* (with revisions from recent text amendments)
   - F Draft Finding of Fact for Case 658-AT-09 (attached separately)

FINAL DETERMINATION

Pursuant to the authority granted by Section 9.2 of the Champaign County Zoning Ordinance, the Zoning Board of Appeals of Champaign County determines that:

> The Zoning Ordinance Amendment requested in **Case 658-AT-09** should ***{BE ENACTED / NOT BE ENACTED}*** by the County Board in the form attached hereto.

The foregoing is an accurate and complete record of the Findings and Determination of the Zoning Board of Appeals of Champaign County.

SIGNED:

Doug Bluhm, Chair
Champaign County Zoning Board of Appeals

ATTEST:

Secretary to the Zoning Board of Appeals

Date