



MEMORANDUM

To: Lake Township Planning Board
From: Kenneth Kaliski, P.E., INCE Bd. Cert.
Subject: Comments on the Proposed Lake Township Wind Ordinance addressing noise
Date: 9 June 2009

Resource Systems Group Inc. (RSG) was retained by DTE Energy to review the proposed changes to the Lake Township Wind Ordinance with regards to noise. This memorandum summarizes our comments.

WHO WE ARE

RSG has been involved in noise assessment for wind farms and other power projects since 1993. At the time, we were asked by the Maine Land Use Regulatory Commission to review a proposal for a large wind development in the western part of the state. Subsequently, we conducted many other reviews and noise impact studies for both communities and developers, including Green Mountain Power's wind farm in Searsburg, Vermont, enXco's Hoosac project, and CPV's Brodie Mountain project. We are currently involved in wind projects in Kansas, Pennsylvania, West Virginia, Ohio, Illinois, Maine, Vermont, and Michigan. We have also done extensive work involving noise analyses at power plants and substations, including transformers, reactive devices, synchronous condensers, and high voltage power lines.

I am the director of RSG's acoustics team, which specializes in characterizing sound attenuation and propagation in outdoor environments. I am a licensed Professional Engineer and am Board Certified through the Institute of Noise Control Engineering. I have managed projects and testified as an expert witness in dozens of permitting cases. I am a member of the Institute of Noise Control Engineering and serve as its Vice President for Board Certification. My colleague, Eddie Duncan, co-chaired a session on "Noise from Wind Power Projects" at the joint meeting of the European Acoustical Association and the Acoustical Society of America, Acoustics 08, in Paris. He and I also presented a paper there, "Improving Sound Propagation Modeling for Wind Power Projects." He is Board Certified, as well, and a member of the Acoustical Society of America. Our resumes are attached.

GENERAL COMMENTS

Preparing a noise ordinance to regulate wind turbines is a difficult task, and we appreciate the time and effort the township has put in over the past year to create this first draft. We are also thankful to have the opportunity to review this first draft and would urge the township to consider the following items as it continues to develop its ordinance:

- 1) What is the goal of the ordinance? Is it to protect the health and well-being of citizens? Is it to protect against annoyance? Is it to severely limit or prohibit development of wind farms within the township?
- 2) Does the ordinance have a scientific basis or is it arbitrary? If protection of health and protection against annoyance are goals, what do scientific studies say regarding these topics? Since engineering methodologies are used to test compliance with the ordinance—and engineering by definition involves application of science and mathematics—it follows that the ordinance criterion should be based on scientific studies.
- 3) Is the ordinance reasonably understandable by those it serves to protect, by those it regulates, and by those involved with implementing the ordinance?
- 4) Is the ordinance consistent with applicable international and federal regulations and standards?

The science involved in acoustics and noise can be daunting to lay boards that have little experience with the topic. It is often difficult to distinguish good science from conjecture, bias, and conclusions that have little factual basis. That is why boards often rely on experts and expert opinion.

We have a great deal of experience with both the reviews of wind farm noise permit applications and preparing the technical noise analyses for wind farm developers. We have seen many different types of regulations related to wind turbine noise and have reviewed the extensive literature on health effects and annoyance. It is clear from our experience that wind farms have been successfully operating in the vicinity of residences in the United States and abroad with little adverse reaction from the public. However, there is evidence of excessive annoyance and health effects with wind turbines placed too close to residences, that have high sound emissions, or have abnormal issues like low-frequency modulation. The ordinance should rightly protect the public against such occurrences.

From our review, we find that as a whole, the draft ordinance's restrictions with respect to noise go well beyond what is necessary to protect public health and welfare. So much so, that it will be difficult—if not impossible—to site turbines in the township. That is, even if there is no scientific evidence that the level of noise that a turbine generates will create significant annoyance or health impacts, the wind farm could not meet the proposed standards.



In particular, the most important issues with the draft ordinance are that:

- 1) The absolute standard of no greater than 35 dBA has little basis as health effects are demonstrated only above 45 dBA.
- 2) The relative standard of no greater than 5 dB above the lowest background LA₉₀ and LC₉₀ has no basis in science.
- 3) The relative standard of an LC₉₀-LA₉₀ being no greater than 20 dB has no basis for wind turbines and does not protect against low-frequency amplitude modulation, which appears to be its intent.
- 4) The sound monitoring provisions are impractical, are not consistent with state-of-the-practice methods, and can lead to significant bias.

If the community wishes to allow wind turbines in the township, but at the same time, protect its neighbors from excessive impacts, this ordinance would not meet that goal.

SPECIFIC COMMENTS

Wind Turbine Noise Limits Table

The emission limits shown in “Table of Not-to-Exceed Property Line Sound Immission Limits” are not based on the health effects from wind turbine noise nor do they have any basis on what is currently known about the impacts of wind turbine noise.

Criterion A of the proposed standard limits the sound from a wind turbine to no more than 5 dB above the existing A- and C-weighted L90. There is no evidence from literature that validates such a standard, especially as it is applied here (to the lowest recorded L90 over the course of the night under only calm wind conditions). No lower limit or upper limit to the standard applies. This means that, in very low noise environments, the standard is very low. For example, if the lowest 10-minute background sound level is 20 dB, the standard is 25 dB. This is much lower than any recognized human health or annoyance effect.

When questioned about this at the Lake Township hearing on April 23, 2008, Mr. Rick James, who authored most of the noise section of the proposed standard, acknowledges this fact: “I think that if we were talking about 35 dBA at non-participating property, people wouldn’t even complain.” He said that in another case he worked on, they set a lower limit of 35 dBA as the standard. However, this is not what is in the draft standard. There is no lower limit to the standard.

Even at 35 dBA, which is a not-to-exceed level proposed in Criterion B, the standard sets an extremely high bar that is not supported by the current science. In a comprehensive study on the perception of wind farms on residents, the University of Gothenburg conducted a survey of



725 residences within 2.5 km from a modern wind farm in rural countryside or villages.¹ Statistical correlations were calculated between the level of wind turbine sound that these residences were being exposed to and the impacts that occurred. Their conclusion was, “There is no indication that the sound from wind turbines had an effect on respondents’ health, except for the interruption of sleep. At high levels of wind turbine sound (more than 45 dBA) interruption of sleep was more likely than at low levels.”

The World Health Organization also supports a 45 dB LAeq(8) standard to protect against sleep disturbance. In Table 4-2 of their “Guidelines for Community Noise,” they recommend a guideline value of 45 dBA averaged over the night and measured outside the bedroom window to protect against sleep disturbance.² They also recommend an interior guideline of 30 dB inside averaged during sleeping times and 60 dB LAfmax for instantaneous noises.

This recommendation is further supported by the U.S. EPA’s “Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety.”³ In this document, the U.S. EPA recommends a day-night level of 55 dB averaged over the year. Given a nighttime penalty of 10 dB, this is roughly equivalent to a nighttime level of 45 dBA and a daytime level of 55 dBA, averaged over the year.

While the WHO and EPA studies were not particular to wind turbines, the University of Gothenburg study was. Each came to a similar conclusion—that is, a 45 dBA nighttime level is sufficient to protect human health, albeit with different averaging times.

We can find no scientific evidence for Criterion B’s 55 dB L_{Ceq} for quiet rural environments and 60 dB L_{Ceq} for rural-suburban environments. If the concern of the author is to project against low-frequency health impacts, the criterion should be based on levels of low-frequency sound that creates those impacts. As an example, one could create a standard to protect against annoyance from window rattling and vibration and infrasound health impacts which are well established. This is not done here.

¹ “Project WINDFARM perception: Visual and acoustic impact of wind turbine farms on residents,” University of Gothenburg, Science Shop for Medicine and Public Health Applied Health Research, Financed by the European Union, FP6-2005-Science-and-Society-20 Specific Support Action, Project no 044628, June 3, 2008.

² “Guidelines on Community Noise,” World Health Organization, 1999.

³ “Information of Levels of Environmental Noise Requisite to Protect Public Health and Welfare with and Adequate Margin of Safety,” U.S. EPA 550/9-74-004, March 1974.



Returning to Criterion A, the proposed ordinance sets a limit of $LC90 + 5$ dB. Again, there is no evidence in the literature that increases in the $LC90$ of only 5 dB cause annoyance or sleep disturbance. A typical wind turbine has a C-weighted sound power level that is about 12 dB higher than its A-weighted level. The typical C-weighted background sound level in a rural community ranges between 8 and 25 dB higher than the A-weighted background sound level. Given the wide range in the difference between the C-weighted and the A-weighted background sound levels, implementation and testing of this criterion would be difficult to conduct with any certainty. In addition, since the dBC can contain inaudible sound, this proposed standard does nothing more than make it more difficult for a wind turbine to be sited, and does not address either annoyance or health impacts.

Criterion C of the proposed standard addresses "Immission spectra imbalance." That is, it would be a violation for the $L_{Ceq} - (LA_{90} + 5$ dBA) measured at the property line to exceed 20 dB. This section of the proposed standard is not based on scientific studies of annoyance or health effects. While a 20 dB difference in the C- and A-weighted sound levels does give an indication of the presence of lower frequency noise, it does not, in and of itself, connote annoyance. As an example, the C- to A-weighted difference in a quiet car with windows closed can typically exceed 20 dB, but one would not characterize that sound as excessively annoying. However, if there is significant amplitude modulation, it could be annoying. If the standard is trying to protect against disturbance from low-frequency amplitude modulation, it should address it directly rather than through an unproven proxy.

Finally, it is important to note that the proposed noise standards, as written, are to be applied at the property line. In Lake Township, which contains a significant number of large farms, homes can be thousands of feet from the property line closest to the wind farm. If the intent of the ordinance is to protect against sleep disturbance, which is the primary health impact of wind turbines, the ordinance should address impacts at the home. If the home and property line are near each other, it makes no difference. However, where the home and property line are very far apart, the difference can be considerable.

OTHER CRITIQUE

With respect to noise, the draft ordinance is broken out into five parts: Definitions, General Provisions, Performance and Regulatory Standards, Application Requirements, and Noise Measurement Protocols. The document can be significantly improved by removing repetitive statements and requirements, and by doing so, eliminate the possibility of conflicting requirements in different sections.

Definitions

In general, the definitions section of the draft ordinance is copied directly from Kamperman and James. They are not so much definitions, as explanations, and in some cases directions or methodologies. There are several instances where definitions are confusing or inconsistent



with the actual procedures given in the body of the ordinance. There is no need for methodology in a Definitions section.

Particular examples of this are cited below for various definitions in the draft ordinance:

1. Ambient Sound – The last sentence should be removed as it is part of the background sound definition.
2. ANSI – This is not a definition, it is a set of requirements and does not belong in this section of the ordinance. IEC 61400-11 is not an ANSI standard.
3. Anemometer – This definition is incorrect. An anemometer does not measure the direction of the wind.
4. A-Weighted Sound Level – This definition contains procedures which are redundant to the requirements in other sections. In addition, parts are incorrect or confusing.
5. Background Sound (L90) – The definition of Background Sound and L90 are not the same and should not be lumped into the same definition. The definition for background sound is not consistent with ANSI S1.1. This definition contains procedures that are repeated several times in the remainder of the ordinance.
6. C-weighted Sound Level (dBC) – This contains a poorly worded statement that dBC means LCeq.
7. Immission – This word is not used much in the U.S. and is generally confusing.
8. Immission Spectra Imbalance – This contains procedures repeated elsewhere.
9. Infra-sound – This is not so much a definition but an explanation why infrasound is not included. There is no need to include an infrasound definition since there is no reference to infrasound in the document.
10. Low Frequency Noise (LFN) – This is not a definition but a performance standard.
11. Measurement Point – This is not a definition but a measurement procedure repeated elsewhere in the document.
12. Measurement Wind Speed – This is not a definition but a measurement procedure repeated elsewhere in the document.
13. Qualified Independent Acoustical Consultant – This requires that the consultant have “no financial or other connection to a WES developer or related company.” This requirement is inconsistent with the rules and practice of the engineering profession. This implies that an acoustical consultant, who is a member of INCE or Board Certified, and that works for any wind developer (not just the applicant), is apt to modify his/her findings to benefit the applicant. Professional engineers, members of INCE, and Board Certified members are bound by a strict code of ethics (<http://www.inceusa.org/links/ETHICS.pdf>). There is no evidence to suggest that any INCE member has ever been nothing less than objective in work performed for the wind industry and related companies. Finally, this requirement allows the work to only be



performed by an acoustical firm that only works for opponents to wind farms or that has never worked on a wind farm project and thus has no financial or other connection to a developer or related company. This should not be the goal of the township as it may affect the quality of work that it receives. As with other engineering contracts, the township or developer should have the freedom to choose the best qualified acoustical consultant without regard to his/her current or past clients.

14. Sound Power – This definition contains procedures and requirements repeated elsewhere in the draft ordinance.
15. Sound Pressure Level (SPL) – This definition is not entirely consistent with ANSI S1.1. It should be 10 times the logarithm to the base ten of the ratio of the *time-mean-square* pressure of a sound to the square of the reference sound pressure.
16. Spectrum – This contains requirements repeated elsewhere.

Performance and regulatory standards: Noise regulatory standards

1. Instrumentation – This portion of the proposed ordinance requires only ANSI/IEC Type 1 sound level meters be used to monitor sound, plus meteorological instruments to measure wind velocity, temperature, and humidity. Measurement procedures must meet ANSI S12.9 Part 3. First, there is no reason to restrict measurements to Type 1 equipment only. Type 1 sound level meters are accurate to ± 0.7 dB while Type 2 sound level meters are accurate to ± 1 dB. This small difference is not noticeable given the variations in environmental sound monitoring. The result, however, is to drive up the cost of the monitoring, as Type 1 sound level meters are much more expensive (\$1,000–\$2,000 typically). Both types of sound level meters are allowed under ANSI S12.9 Part 3.
2. Measurement Locations – This requires that measurements be made at locations that are “representative” of all non-participating residential property owners within 2 miles. We comment on this issue further in other parts of this memorandum.
3. Time of Measurements – This section describes the prevailing weather conditions that are required and not the time of measurements. More detail is given in the monitoring methodology section.
4. Long-term Background Sound Measurements – This title is somewhat of a misnomer as “long-term” represents from one to several 10-minute periods, intended to capture the lowest nighttime sound level. First, this is not the prevailing and most accurate way to address background noise in the environment. Background sound in this type of environment is a function of both anthropogenic, biogenic, and meteorological influences. There is a significant correlation of background sound with wind speed. At the same time, wind turbine sound emissions is a function of wind speed. There is no one background sound level during the course of a wind farm operation. That is, when



the wind farm is operating under higher wind speeds, the background sound level will be higher. Most noise ordinances for wind turbines, such as the New Zealand standard, take this fact into account. If the township is proposing a standard that is relative to the background level, the lowest background sound level measured over the course of a night with winds under 2 m/s is not relevant. Instead, a much longer monitoring period should be used to take into account the variation in sound pressure level with wind speed. In that case, a curve of background levels versus wind speed is used as the basis for the relative standard.

Noise report

1. Sound Power Levels – Sound power levels are required to be submitted for each 1/3 octave band from 6.3 to 10,000 Hz. IEC 61400-11 does not have a standard for measuring sound power down to frequencies as low as 6.3 Hz, nor do turbine manufacturers typically test down to this level. Specialized equipment must be used. Infrasond in this range is not measured because there is no identifiable impact at frequencies this low from wind turbines. In addition, there is no proposed standard for infrasond in the township draft, and therefore modeling down to 6.3 Hz is purposeless. The Kamperman and James paper used as a template for the proposed standard shows the levels of a turbine that they tested well below audibility levels at very low frequencies.
2. Modeling – The draft standard requires the modeling of octave band sound pressure levels down to 6 Hz. There is no need to model infrasond. Sound levels at this frequency from wind turbines are well below audibility levels in the infrasond range, and there is no evidence to suggest that infrasond created by wind turbines has any impact on human health or welfare. Commercial software used for sound propagation modeling do not go down to 6 Hz. What is being proposed is completely outside the realm of the state of the practice for modeling wind turbine impacts.

Preconstruction background noise survey

In this section, the township hires the noise consultant without the opportunity for review by the applicant. It is not clear what is gained by this section. So long as the consultant is a member of INCE, he/she is bound by a code of ethics, whether the consultant is being paid by the township or the developer.



Noise measurement protocol appendix

1. This section needs to be re-written. It appears to repeat much of what is described above, in some cases is inconsistent, and in some cases presents new requirements that should be discussed in the requirements section of the ordinance.
2. The principal stated reference is ANSI 12.9 Part 3. However, this draft ordinance makes modifications to the standard. We recommend eliminating all of these modifications and limiting the test protocol to ANSI standards. There is no reason why Lake Township should vary from internationally accepted standards and methodologies.
3. The graphic on page 25, describing test procedures, is not legible.
4. Two to 10 measurement points per square mile must be tested. For the Lake Township overlay district, this represents some 10–50 monitoring positions. Given that monitoring is to be conducted from 10 PM to 4 AM on private property, there is a significant safety risk for monitoring staff being mistaken for trespassers or worse. As mentioned above, this method of monitoring is not the standard in the industry. Monitoring is typically done with fewer points over longer periods. The monitors would be set up during the day with the cooperation of the landowner and left out for 7–14 days.
5. The wind speeds must be less than 4.5 mph. This is more stringent (for no apparent reason) than the requirements in ANSI S12.9 Part 3.
6. This section includes reporting requirements, some of which are mentioned in the main body of the ordinance and some of which are not. For example, this section requires reporting of the changes in 1/1 or 1/3 octave bands from 8 Hz to 10,000 Hz. Why is this necessary if there is no octave band standard? Why 8 Hz here and 6.3 Hz in other places?
7. The appendix concludes with required amendments to ANSI S12.9. Any modification to change ANSI S12.9 is inappropriate as ANSI represents a national standard. For example, the draft ordinance requires that a calibrator cover the microphone to test for self-noise at the end of each test. This method is not approved by ANSI, is not a commonly accepted practice, and does not result in the required result, which is the noise floor of the measurement instrument. If it is important to measure the noise floor, the ANSI practice of using a “dummy mic” should be used.

CONCLUSIONS

Preparing an ordinance to protect the health and welfare of the community from the impacts of noise from wind farms can be a daunting task. It is our goal to help the Planning Board improve the ordinance so that it is founded on good science without providing excessive and



unnecessary restrictions to wind turbine operations. In its present form, the draft ordinance prevents even well-designed wind farms from being developed in the township.

In this case, we are recommending major changes to the ordinance that specifically address the causes of serious annoyance and health effects. In addition, we would recommend significant revisions to the monitoring guidelines to be consistent with current practices in the industry.

