

Question 15

1st Survey

Original Question	Selection	# Resp	%
If you checked one or more the standards in the previous question Would you recommend that wind turbine siting guidelines specify using these standards?			
ICE 614000-11 Wind Energy Standards: Acoustic Emission Measurement Techniques	Yes	1	100%

Further Discussion

Since only one person had experience with any of the standards, we omit this question from further rounds of the survey.

Question 13c

1st Survey

This question was not included with the first survey, but participant responses suggested that we add it.

2nd Survey

Should Michigan's Wind Turbine Siting Guidelines recommend specific penalties for noise violations. Note: These would not be legally binding. It would be up to local communities to enact legally binding penalties.

Yes

No

Question 14

1st Survey

Original Question	Selection	# Resp	%
Do you have first-hand experience with the following?			
ASTM E 1240 "Standard Test Method for Performance Testing of Wind Energy Conversion Systems"	Yes	1	4%
ICE 614000-11 Wind Energy Standards: Acoustic Emission Measurement Techniques	Yes	1	4%
ISO 1996 "Description and Measurement of Environmental Noise"	Yes	1	4%
EPA Model Noise Ordinance	Yes	0	0%
SERI/TP-217-3261 "A Proposed Metric for assessing the Potential of Community Annoyance for Wind Turbine Low Frequency Noise Emissions"	Yes	0	0%

Further Discussion

Only one person had experience with any of the standards. Since most of these standards must be purchased and are not readily accessible, we will omit this question from further rounds of the survey.

However the EPA model noise ordinance can be downloaded free from <http://www.nonoise.org/epa.htm> and may be worth examining.

One respondent mentioned wrote in 30 dB and no one selected 60 dB. So we have changed the possible responses to this question. See the presentation handout page 12 for statistics on sleep interference.

2nd Survey

If you selected absolute values for Question 11, what should the siting guidelines should specify as the maximum dB during the **night** for frequencies between 20 Hz and 20 kHz? (Please circle only one)

30 dB

40 dB

45 dB

50 dB

55 dB

Question 12

1st Survey

Original Question	Selection	# Resp	%
Should wind turbine siting guidelines specify a maximum number of starts and stops during the night?	Yes	12	44%
	No	10	37%
	No Answer	5	19%

Further Discussion

See the presentation handout page 12 for statistics on sleep interference.

2nd Survey

Should wind turbine siting guidelines specify a maximum number of starts and stops during the **night**?

Yes

No

Question 13

1st Survey

Original Question	Selection	# Resp	%
Siting Guidelines should specify penalties when noise exceeds the limit for more than:	5 min	7	26%
	20 min	2	7%
	30 min	4	15%
	45 min	0	0%
	1 hr	4**	15%
	3 hrs	1	4%
	No penalty	2	7%
	No Answer	8	30%

2nd Survey

If you answered Yes to specifying a Speech Interference Level, on what distance should this be based? (Please circle only one)

1/2 ft

1 ft

3 ft

6 ft

10 ft

Question 11

1st Survey

Original Question	Selection	# Resp	%
Should sound levels at night be specified as adjustments to day values or absolute values?	Adjusted	9	33%
	Absolute values	14	52%
	No Answer	4	15%

2nd Survey

Should sound levels at **night** be specified as adjustments to day values or absolute values? (Please circle only one)

Adjustments

Absolute values

Question 11a

1st Survey

Original Question	Selection	# Resp	%
If you selected absolute values for the previous question, what should the siting guidelines should specify as the maximum dB during the night for frequencies between 20 Hz and 20 kHz?	30 dB*	2	14%
	40 dB	5	36%
	45 dB	2	14%
	50 dB	1	7%
	55 dB	1	7%
	60 dB	0	0%
	No Answer	3	21%

Further Discussion

The percentages for this question are based on the number (14) of people who answered yes to Question 11.

Question 10

1st Survey

Original Question	Selection	# Resp	%
Should the maximum turbine noise allowed during the day be based on any of the following indices?			
Speech Interference Level (SIL)	Yes	8	30%

Further Discussion

This question was originally part of Question 9. However, the SIL is not a statistical measure, and should not be grouped with those measures. The SIL is a maximum noise level that will not interfere with speech recognition between individuals a set distance apart.

2nd Survey

Should Michigan's Wind Turbine Siting Guidelines specify a maximum noise level for speech interference?

Yes

No

Question 10a

1st Survey

Original Question	Selection	# Resp	%
If you answered 'yes' to specifying a Speech Interference Level, on what distance should this be based?	1/2 ft	0	0%
	1 ft	0	0%
	3 ft	1	12%
	6 ft	2	25%
	10 ft	4	50%
	No Answer	1	12%

Further Discussion

The percentages for this question are based on the number (8) of people who answered Yes to Question 10. One respondent mentioned that 10 ft is the distance of most rooms. For more information, refer to the presentation handout page 11.

2nd Survey

Should Michigan's wind turbine siting guidelines specify that a wind turbine not increase prior existing statistical noise levels by a specified amount? (The levels would be measured at the location you specified in Question 6 and Question 6a.)

L_{10} (annoyance)	Yes	No
L_{eq} (average sound energy)	Yes	No
L_{90} (background noise)	Yes	No
L_{dn} (day-night average)	Yes	No

Question 9a

1st Survey

This question was not included in the first survey.

2nd Survey

If you answered yes for L_{10} , L_{50} or L_{90} in Question 9, over what time period should the Michigan Wind Turbine Siting guidelines specify these values be measured.

1 hour 3 hours 6 hours 12 hours Other: _____

Note: L_{dn} is a 24-hour average.

Question 9b

1st Survey

This question was not included in the first survey.

2nd Survey

If you answered yes for any statistical value in Question 9, what should the Michigan's Wind Turbine Siting guidelines specify as the maximum increase in these levels caused by wind turbine operation?

3 dB 5 dB 6 dB 10 dB 15 dB

2nd Survey

If ambient noise during the **day** (7 a.m. - 7 p.m.) from sources other than the wind turbines becomes higher than the specified limits, the limits should be adjusted by:

None 3 dB 5 dB 6 dB 10 dB

Question 9

1st Survey

Original Question	Selection	# Resp	%
Should the maximum turbine noise allowed during the day be based on any of the following indices?			
L_{\max} (Maximum volume)	Yes	11	40%
L_{10} (annoyance)	Yes	16	60%
L_{eq} (average sound energy)	Yes	10	37%
L_{90} (background noise)	Yes	12	44%
L_{dn} (day-night average)	Yes	6	22%
Speech Interference Level (SIL)	Yes	8	30%

Further Discussion

Two participants indicated that this question was confusing. When we reviewed the surveys, we discovered that the question was poorly worded and the responses don't provide useful information.

In many areas, noise levels change several times per day. So a noise source that might seem loud at some times might be barely noticeable at other times. To account for these differences, some acoustic engineers recommend specifying statistical limits.

For example, the Oregon Noise Control Regulation requires the operator of noise producing equipment determine the L_{10} and L_{50} of a community **prior** to installing the equipment. Once the equipment is operating, it must not raise the statistical levels L_{10} or L_{50} by more than 10 dB in any one hour. (Remember that L_{10} refers to a noise level exceeded 10% of the time.) You can read more about Oregon's Noise Control Regulation at <http://www.energy.state.or.us/siting/noise.htm>. This web site also discusses some of the difficulty of measuring statistical noise levels for wind turbines.

With all of this in mind, we now ask somewhat different questions.

Original Question

Selection	# Resp	%
6 dB	0	0%
10 dB	3	11%
No Answer	6	22%

Question 7

1st Survey

Original Question	Selection	# Resp	%
Siting guidelines should specify the following maximum dB during the day for frequencies between 20 Hz and 20 kHz:	30 dB	1	4%
	40 dB	5	19%
	45 dB	2	7%
	50 dB	10	37%
	55 dB	1	4%
	60 dB	3	11%
	No Answer	5	19%

Further Discussion

One participant wrote in 30 dB. A few participants stated they were uncertain where this noise was measured. Our intention was that it be measured at the location you indicated in Question 6 and Question 6a. To make this clearer we rephrased the question.

2nd Survey

Assuming the noise is measured at the location you specified in Question 6 and Question 6a, what should wind turbine siting guidelines specify as the maximum allowable noise during the day (7 a.m. - 7 p.m.)?

30 dB 40 dB 45 dB 50 dB 55 dB 60 dB

Question 8

1st Survey

Original Question	Selection	# Resp	%
If ambient noise (such as noise from the wind) during the day becomes higher than the specified limits, the limits should be adjusted by:	None	8	30%
	3 dB	2	7%
	5 dB	8	30%

2nd Survey

If turbines are placed **on a the same property** where someone resides, where should the noise impact be measured?

outside dwelling on
same property

Inside dwelling on
same property

Question 6a

1st Survey

Original Question	Selection	# Resp	%
If turbines are placed on a property adjacent to a residence, where should the noise impact be measured?	outside dwelling on same property	7	26%
	Inside dwelling on same property	4	15%
	Property line	19	70%
	Outside neighboring dwelling	5	19%
	Inside neighboring dwelling	6	22%

Further Discussion

The participants voted to add this question to the first survey to protect people living near (but not on) a wind farm. Since this question was patterned after Question 6, the same answers were possible. However, since the first two options are covered in Question 6a, we omit them from the second Survey.

The participants also voted to allow multiple answers.

One comment made during the discussion was that requiring noise measurements inside of a neighboring dwelling might be practical. He said zoning boards could not mandate that a wind farm developer have access to neighboring homes to conduct measurements inside. If a zoning ordinance required noise measurement inside of a neighboring home, and the homeowner refused to allow the developer inside, it would cause conflicts

2nd Survey

If turbines are placed **adjacent** to a residence, where should the noise impact be measured?

Property line

Outside
neighboring
dwelling

Inside
neighboring
dwelling

Question 5

1st Survey

Original Question	Selection	# Resp	%
If you answered yes to Question 4 on which scale infrasound requirements be measured?	A	0	0%
	B	0	0%
	C	3	11%
	D	0	0%
	G	14	51%
	No Answer	10	37%

2nd Survey

If you answered yes to Question 4, on which scale infrasound requirements be measured? (Please circle only one answer.)

A

B

C

D

G

Question 6

1st Survey

Original Question	Selection	# Resp	%
If turbines are placed on a farm where someone resides, where should the noise impact be measured?	outside dwelling on same property	18	67%
	Inside dwelling on same property	9	33%
	Property line	15	56%
	Outside neighboring dwelling	5	19%
	Inside neighboring dwelling	5	19%

Further Discussion

Since the participants voted to add Question 6a, the last two options are more appropriately covered in that question. So for the second survey, they are omitted from Question 6.

The participants voted to allow multiple answers to this question.

Question 3

1st Survey

Original Question	Selection	# Resp	%
If you answered yes to question 2, on which scale low-frequency requirements be measured?	A	2	7%
	B	0	0%
	C	14	52%
	D	0	0%
	G	1	4%
	No Answer	10	37%

2nd Survey

If you answered yes to Question 2, on which scale low-frequency requirements be measured? (Please circle only one answer.)

A

B

C

D

G

Question 4

1st Survey

Original Question	Selection	# Resp	%
Should infranoise (< 20 Hz) requirements be specified separately?	Yes	18	67%
	No	3	11%
	No Answer	6	22%

Further Discussion

One participant stated that it was very important that infranoise not be heard or felt past the property line of the least land of the project. For a good description of infranoise and its impacts, please read <http://www.lowertheboom.org/trice/BoomCarNoise.pdf> pages 14-19

2nd Survey

Should wind turbine siting guidelines specify a maximum loudness for infranoise (< 20 Hz) at the locations you specify in Question 6 and Question 6a?

Yes

No

including the Transportation Noise Reference Book, state that in most circumstances the B and C scales offer little advantage over the A scale. The Transportation Noise Reference Book describes the B scale as obsolete and the C scale as having no correlation to human perception of loudness.

Beranek¹ reports that the A scale is used to estimate the probability of hearing damage from noise exposure and Magrab² reports that the US Department of Labor based their noise exposure standards on the A scale. Magrab also reports that the A scale should only be used for broadband sound, never for narrow band (less than 1/3 octave) or sound with discernable tones.

Additional information can also be found at:

<http://www.lowertheboom.org/trice/decibelometers.htm>

<http://www.acoustics-noise.com/dBA-B-C-D-U-G-U-AU-tables.shtml>

<http://www.lowertheboom.org/trice/BoomCarNoise.pdf>

<http://www.dataphysics.com/support/library/downloads/articles/DP-Aweight.pdf>

2nd Survey

On what scale do you believe wind turbine noise should for frequencies between 20 Hz – 20kHz (normal hearing) be measured? (Please circle only one answer.)

A

B

C

D

G

Question 2

1st Survey

Original Question	Selection	# Resp	%
Should low frequency noise (20-250 Hz) requirements be specified separately?	Yes	17	63%
	No	5	19%
	No Answer	5	19%

2nd Survey

Should wind turbine siting guidelines specify a maximum loudness for low frequency noise (20-250 Hz) at the locations you select in Question 6 and Question 6?

Yes

No

¹ Noise and Vibration Control by Leo Beranek

² Environmental Noise Control by Edward Magrab

Participant Name: _____

Question 1

1st Survey

Original Question	Selection	# Resp	%
The siting guidelines should specify that the loudness of frequencies between 20 Hz – 20kHz (normal hearing) be measured on which scale?	A	7	27%
	B	0	0%
	C	13	48%
	D	0	0%
	G	0	0%
	No Answer	7	26%

Further Discussion

More than 30 percent of the participants indicated that they felt unqualified to answer Questions 1, 3 and 5. So we have provided additional information here and some additional references.

Noise scales are like to temperature scales. A thermometer measures the amount of heat in the air. The heat measurement is then compared to a reference scale Fahrenheit or Celsius. When we measure noise, we are actually measuring the amount of pressure that sound makes on the receiver. We then compare that pressure to one of five reference scales. Each scale is designed for specific uses. The table and paragraphs below gives more information on the scales.

Scale	Purpose
A	Designed to approximate the subjective human response to different frequencies. In different frequency ranges, a sound pressure will be given different dB levels to approximate human subjective response.
B	Designed to measure the annoyance of traffic. Sound pressures are adjusted less than on the A scale.
C	Designed to measure actual sound pressure. Sound pressures are only adjusted in the extreme frequencies ranges outside the range of human hearing.
D	Designed to determine the annoyance of airplane engines. This scale attributes more significance to sounds between 1000 and 10,000 Hz.
G	Designed to measure infrasound (below 20 Hz).

The Handbook for Sound Engineers recommends using the A scale for sounds between 20 and 55 dB; the B scale for sounds between 55 and 85 dB; and the C scale for sounds above 85 dB. However , many other sources,

Project Summary

The Energy Office of Michigan and the Michigan Wind Working Group asked Lawrence Technological University (LTU) to conduct a Delphi Inquiry into wind turbine siting issues. A Delphi Inquiry is an iterative series of open dialogs and surveys that leads to a consensus of informed opinions. Our goal is to provide a structured forum that helps state and local policy makers collect, understand and analyze the technical data that they need to consider to develop wind turbine siting guidelines.

LTU initiated our inquiry into wind turbine noise with a teleconference presentation on December 3, 2004. This introduced our participants to the basics of noise measurement community noise assessment and wind turbine noise. On that day we also conducted an initial survey to assess participants' level of understanding of the noise issue.

Participants in this process include county commissioners, zoning board members, concerned citizens, wind energy developers, university students and instructors, and utility representatives. Participants represented five regions of the state: SE MI, the thumb area, northern Lower Peninsula, Western Lower Peninsula, and the Upper Peninsula. For more information about the participants, you can download the project's Draft Report from http://www.ltu.edu/engineering/mechanical/delphi_wind.asp.

This packet is for the second survey of the noise inquiry. It presents the results of the first survey with some Further Discussion that we hope will help participants better understand the concepts and issues being considered. This packet also contains the second the survey on noise.

Survey 2

Please note that in this second survey the instructions are a little different. For each question, you are given the original question and the responses from the first survey. Where possible we provide some additional background material to help with your understanding. Thanks to your feedback, we have modified some of the questions for this second survey. Please consider all the information provided, including the results of the first survey, when responding to this second survey and answer the questions as best you can.

Remember that our goal is to reach a consensus of informed opinions.

Lawrence Technological University's Delphi Inquiry into Wind Turbine Noise

2nd Iteration

March 1, 2005

www.ltu.edu/engineering/mechanical/delphi_wind.asp
dja1701@nethere.com

To all Participants:

Thank you again for participating in Lawrence Technological University's Delphi Inquiry into Wind Turbine Noise Issues. As I explained during the presentation, a Delphi Inquiry is an iterative series of discussions and surveys.

Although we have not had the lively electronic dialog for which we'd hoped, it is still very important that we proceed with the second survey. For this reason, I've put together this information packet.

This packet contains:

- the results of the first survey
- the second survey
- some additional background information on noise measurements
- some additional reference material

If you have any questions on the material, please post them to our discussion list at mwwg@topica.com. Or contact me at my email address dja1701@nethere.com. Those of you who haven't joined the list may still do so at <http://lists.topica.com/lists/mwwg>.

Please take the time to consider this information, fill out the second survey and return the surveys to the address below by April 1, 2005.

Thank you.

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