Community reactions and Criteria
Wind turbine noise

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Community reactions and Criteria
Wind turbine noise

EPA Case Studies

Annoyance

Health Effects
## Community Response

<table>
<thead>
<tr>
<th>Increase in Noise</th>
<th>Estimated Community Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 dB</td>
<td>Sporadic Complaints</td>
</tr>
<tr>
<td>10 dB</td>
<td>Widespread Complaints</td>
</tr>
<tr>
<td>15 dB</td>
<td>Threats of Community Action</td>
</tr>
<tr>
<td>20 dB</td>
<td>Vigorous Community Action</td>
</tr>
</tbody>
</table>
COMMUNITY REACTION

VIGOROUS ACTION

SEVERAL THREATS
OF LEGAL ACTION
OR STRONG APPEALS
TO LOCAL OFFICIALS
TO STOP NOISE

WIDESPREAD COMPLAINTS
OR SINGLE THREAT
OF LEGAL ACTION

SPORADIC
COMPLAINTS

NO REACTION
ALTHOUGH NOISE IS
GENERALLY NOTICEABLE

DATA NORMALIZED TO:
RESIDENTIAL URBAN RESIDUAL NOISE
SOME PRIOR EXPOSURE
WINDOWS PARTIALLY OPEN
NO PURE TONE OR IMPULSES

Figure D-7. Community Reaction to Intensive Noises of Many Types as a Function of the Normalized Outdoor Day/Night Sound Level of the Intruding Noise D-3
<table>
<thead>
<tr>
<th>Type of Correction</th>
<th>Description</th>
<th>Amount of Correction to be Added to Measured L_{dn} in dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seasonal Correction</td>
<td>Summer (or year-round operation)</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Winter only (or windows always closed)</td>
<td>-5</td>
</tr>
<tr>
<td>Correction for Outdoor Noise Level Measured in Absence of Intruding Noise</td>
<td>Quiet suburban or rural community (remote from large cities and from industrial activity and trucking)</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Normal suburban community (not located near industrial activity)</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Urban residential community (not immediately adjacent to heavily traveled roads and industrial areas)</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Noisy urban residential community (near relatively busy roads or industrial areas)</td>
<td>-5</td>
</tr>
<tr>
<td></td>
<td>Very noisy urban residential community</td>
<td>-10</td>
</tr>
<tr>
<td>Correction for Previous Exposure &amp; Community Attitudes</td>
<td>No prior experience with the intruding noise</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Community has had some previous exposure to intruding noise but little effort is being made to control the noise. This correction may also be applied in a situation where the community has not been exposed to the noise previously, but the people are aware that bona fide efforts are being made to control the noise.</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Community has had considerable previous exposure to the intruding noise and the noise maker's relations with the community are good</td>
<td>-5</td>
</tr>
<tr>
<td></td>
<td>Community aware that operation causing noise is very necessary and it will not continue indefinitely. This correction can be applied for an operation of limited duration and under emergency circumstances.</td>
<td>-10</td>
</tr>
<tr>
<td>Pure Tone or Impulse</td>
<td>No pure tone or impulsive character</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Pure tone or impulsive character present</td>
<td>5</td>
</tr>
</tbody>
</table>
COMMUNITY REACTION TO WIND TURBINE NOISE IN RURAL AREAS
As a Function of NORMALIZED Day-Night Sound Level (Ldn)

- Vigorous community action
- Strong appeals to stop noise
- Widespread complaints
- Sporadic complaints
- No reaction

Similar method in ANSI S1.9 Part 4.

COMMUNITY REACTION TO WIND TURBINE NOISE IN RURAL AREAS
As a Function of NORMALIZED Day-Night Sound Level (Ldn)

- Vigorous community action
- Strong appeals to stop noise
- Widespread complaints
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- No reaction

Leq normalized to:
- Ldn (+6)
- Year-round operation (0)
- Quiet rural community (+10)
- No prior exposure to intruding noise (+5)
- Pure tone or impulsive noise character (+5)

Leq measured by sound meter


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COMMUNITY REACTION TO WIND TURBINE NOISE IN RURAL AREAS
EPA Case studies normalized to Leq in rural areas.

- Vigorous community action
- Strong appeals to stop noise
- Widespread complaints
- Sporadic complaints
- No reaction


Ldn normalized to:
- Leq (-6)
- Year-round operation (0)
- Quiet rural community (-10)
- No prior exposure to intruding noise (-5)
- Pure tone or impulsive noise character (-5)

Leq measured by sound meter

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COMMUNITY REACTION TO WIND TURBINE NOISE IN RURAL AREAS
at Wind Facilities in Maine

Vigorous community action
Strong appeals to stop noise
Widespread complaints
Sporadic complaints
No reaction

MARS HILL
FREEDOM 52
VINALHAVEN 47

45 dBA: MAINE NIGHT LIMIT


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CRITERIA TO PREVENT ADVERSE COMMUNITY REACTION

Design to widespread complaints? No.
Design to no more than sporadic complaints: 33 dBA.

33 dBA:
Hayes McKenzie Group 2006
Dan Driscoll (formerly of NYDEC) 2009
Rand & Ambrose 2010

Leq measured by sound meter
Wind power development works in other locales with 35 dBA limit. Surely wind power can work in Maine with 35 dBA limit.

Vigorous community action
Strong appeals to stop noise
Widespread complaints
Sporadic complaints
No reaction

35 dBA: GERMANY
OREGON

45 dBA: MAINE

35 dBA limit:
John Harrison, Queen’s University 2010
Moller & Pedersen, "Low-frequency noise from large wind turbines",
J. Acoust. Soc. Am. 129 (6), June 2011

Community reaction to wind turbine noise

Annoyance

Community reaction to wind turbines and Percent of community highly annoyed

Vigorous community action
Strong appeals to stop noise
Widespread complaints
Sporadic complaints
No reaction

% HIGHLY ANNOYED 150-650 kw

MARS HILL
FREEDOM 52
VINALHAVEN

47

45 dBA: MAINE NIGHT LIMIT

20 30 40 50 60 70
Leq, dBA

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# Community reaction to wind turbine noise

## Health Effects (WHO 2009)

<table>
<thead>
<tr>
<th>Average night noise level over a year ( \text{L}_{\text{night, outside}} )</th>
<th>Health effects observed in the population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 30 dB</td>
<td>Although individual sensitivities and circumstances may differ, it appears that up to this level no substantial biological effects are observed. ( \text{L}_{\text{night, outside}} ) of 30 dB is equivalent to the no observed effect level (NOEL) for night noise.</td>
</tr>
<tr>
<td>30 to 40 dB</td>
<td>A number of effects on sleep are observed from this range: body movements, awakening, self-reported sleep disturbance, arousals. The intensity of the effect depends on the nature of the source and the number of events. Vulnerable groups (for example children, the chronically ill and the elderly) are more susceptible. However, even in the worst cases the effects seem modest. ( \text{L}_{\text{night, outside}} ) of 40 dB is equivalent to the lowest observed adverse effect level (LOAEL) for night noise.</td>
</tr>
<tr>
<td>40 to 55 dB</td>
<td>Adverse health effects are observed among the exposed population. Many people have to adapt their lives to cope with the noise at night. Vulnerable groups are more severely affected.</td>
</tr>
<tr>
<td>Above 55 dB</td>
<td>The situation is considered increasingly dangerous for public health. Adverse health effects occur frequently, a sizeable proportion of the population is highly annoyed and sleep-disturbed. There is evidence that the risk of cardiovascular disease increases.</td>
</tr>
</tbody>
</table>
WHO 2009 HEALTH EFFECTS GUIDELINES
and Maine DEP Night Noise Limit

Vigorous community action
Strong appeals to stop noise
Widespread complaints
Sporadic complaints
No reaction

EPA reaction data normalized for wind turbines in quiet rural areas


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WHO 2009 Health Effects Guidelines and Mars Hill Highest Hourly Leq

- Increasingly Dangerous for Public Health
- Increasing Adverse Health Impacts
- Risk Groups More Severely Affected
- Risk Groups Susceptible to Adverse Impacts from Noise
- Sleep Disturbance
- No Observed Biological Effects

Trend, Mars Hill Measured Highest Hourly Leq
Multiple Turbine Contributions Emergent Beyond 2000 Feet

Distance from nearest turbine, feet

dBA

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