International Electrotechnical Commission Standard IEC 61400-11 and Other Procedures

Acoustic Noise Measurement Techniques

Arlinda Huskey
National Renewable Energy Laboratory
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Standards and Other Procedures

  – Amendment approved in 2005
• MEASNET, Version 2, January 2005
• AWEA small wind turbine performance and safety standard
IEC 61400-11 2002

• Used by
  – Manufacturers to declare acoustic emission performance
  – Purchasers to verify declared values
  – Wind turbine operators to verify declared values
  – Wind turbine planner or regulator to meet regulations or permit requirements

• Reporting
  – Sound power level at 6, 7, 8, 9, and 10 m/s
  – 1/3 octave levels at 6, 7, 8, 9, and 10 m/s
  – Tonality at 6, 7, 8, 9, and 10 m/s
  – Uncertainty for all above values
IEC 61400-11 Method
Measured wind speed @10 m

Sound pressure level [dB(A)]

<table>
<thead>
<tr>
<th>Measured sound levels</th>
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<tbody>
<tr>
<td>1/3rd octave levels</td>
</tr>
<tr>
<td>5 m/s</td>
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<tr>
<td>0</td>
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</tbody>
</table>

Sound Power Levels

1/3rd octave band [Hz]

Sound Pressure Level (dB)

<table>
<thead>
<tr>
<th>1/3rd octave band [Hz]</th>
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<tbody>
<tr>
<td>0</td>
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<td>0</td>
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Tonality

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
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<tr>
<td>0</td>
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NREL National Renewable Energy Laboratory
IEC 61400-11 Changes from 1st Edition

• Tonality
  – Improvement for pitch controlled and stall controlled turbines
  – Analysis on shorter time periods to better characterize tones
  – Improvement on procedure to identify tones
  – Optional audibility criterion added for reportable tones

• Sound power levels, 1/3 octave, and tonality reported for 6, 7, 8, 9, and 10 m/s
  – Previously reported for only 8 m/s
IEC 61400-11 Changes from 1st Edition

- Derived wind speed from power above 95% of rated power
  - No previous method but needed for turbines reaching rated power before 10 m/s
  - A ratio of measured and derived wind speed before 95% rated power used to derive wind speed from power after 95% rated power
  - “Questionable”

- More work and complicated but more information reported, better repeatability
Amendment to IEC 61400-11

- Nacelle anemometer method preferred to using ratio for wind speed determination above 95% of rated power
- Reporting of rotor speed and pitch angle recommended
- In determining the sound pressure levels, a higher order regression will be used. Another option is linear regression within bins
IEC 61400-11 Revision for 3rd Edition

- New revision started May 2006
- Methods for other wind turbines will be considered (small, low wind speed, offshore)
- Anemometer height (currently 10 meters up to hub height)
- Averaging period (currently 1-minute)
- Improvements in 1/3 octave procedure for modeling purposes
- Improvements in the uncertainty analysis
- Wind farm verification
- Possibly including infrasound, impulsive, and low frequency noise
MEASNET

• International MEASuring NETwork of wind energy institutes

• MEASNET objectives:
  – High quality measurements
  – Uniform interpretation of standards
  – Interchangeability of results (round robin comparisons)

• Expert groups for acoustic noise, power performance, power quality, and anemometer calibration

• NREL is MEASNET member approved for power quality and acoustic noise

• Procedures based on IEC with modifications
• Faster process of approval than IEC
AWEA Small Wind Turbine Performance and Safety Standard

- Procedure for evaluating the safety, reliability, performance, and acoustic characteristics of a small wind turbine
- Uses terms very close to the IEC standard but suited to help the consumer understand better
- Uses the general methodology of the IEC standard for quality measurements but has some changes to better characterize dynamic small wind turbines such as overspeed control
- Overall reporting “number” is the Small Wind Certification Corporation (SWCC) rated sound level
Conclusions

• Standards need revision:
  – “State–of–the-art” knowledge changes
  – Wind turbines change
• The best methods differ based on the type and size of wind turbine
• All standards and procedures are to ensure quality and repeatable measurements
• Terminology can be confusing, make sure you understand what number is used