EWEA Noise Wind Turbine Noise Workshop

Pre- and Post Construction Noise Measurements

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UK Wind Turbine Noise Planning
ETSU-R-97

• X dB LA90 or 5 dB above ‘prevailing’ b/g, whichever is greater
  – X varies with time of day and other factors
    • Day-time: X=35-40
    • Night-time: X=43
    • Land-owner: X=45
  – B/G quantified as a function of wind speed
  – B/G averaged over relevant period
    • night 2300-0700
    • ‘sensitive’ day-time hours (1800-2300, Sat pm and all day Sun)
Pre-Construction Measurements

• Need to carry out measurements to set noise limits for assessment and for eventual turbine operation.

• Location, positioning and circumstances of measurements are crucial.
  – Easy target for criticism
  – Covered in depth in Consultation Draft of Institute of Acoustics Good Practice Guide

B/G Noise Measurements
for wind turbine sites

• Precise location of instrumentation
  – Proximity to facades
  – Proximity to trees
  – Boiler flues, water features, wind chimes, driveways

• Effects of season
  – Trees and foliage
  – Running water
  – Harvesting and other farm / animal activity

• Access / Can’t measure everywhere

• Effects of wind direction over survey period
B/G Noise Measurements
for wind turbine sites

• Direct effects of wind & wind shield performance
• Rainfall – how and where to measure
• Other ‘extraneous data’
  – birdsong
  – early morning traffic
  – what is ‘extraneous’?
• Wind speed measurement
  – Height
  – Mast or remote sensing
  – Calibration
W/F Noise Assessment
Background Noise vs Wind Speed
(Night Hours 2300-0700)
W/F Noise Assessment

Background Noise and Derived Limits vs Wind Speed
(Night Hours 2300-0700)

\[ y = 0.1473x^2 - 1.5258x + 36.547 \]

- Night Noise Limit
- Measured B/G Noise
- Derived Prevailing B/G Noise
Pre-Construction Measurements

• Given the number of variables and uncertainties, do we need to re-structure our approach to baseline measurements.

• One approach might be to look at non-wind dependent background noise and noise limits which are not wind speed dependent.
Post-Construction Measurements

• Need to carry out measurements to determine whether limits are being met.
• May be in response to complaints or as required by planning conditions.
• Precise positioning less crucial but other significant challenges.
• Assessment of tonal noise will require audio recordings.
W/F Noise Assessment

Background Noise vs Wind Speed
(Night Hours 2300-0700)

L90 Sound Pressure Level (dB(A))

10m Height Wind Speed (m/s)

- Measured B/G Noise
- Night Noise Limit
- Derived Prevailing B/G Noise
W/F Noise Assessment
Operational Noise & Background Noise vs Wind Speed
(Night Hours 2300-0700)
W/F Noise Assessment
Operational Noise and Background Noise vs Wind Speed
(Amenity Hours)

Lower Noise Limit
Measured B/G Noise
Including Turbine Operation
Derived Prevailing B/G Noise
W/F Noise Assessment
Operational Noise and Background Noise vs Wind Speed
(Amenity Hours)

Lower Noise Limit
Measured B/G Noise
Including Turbine Operation
Derived Prevailing B/G Noise
W/F Noise Assessment
Operational Noise and Background Noise vs Wind Speed
(Amenity Hours)

Lower Noise Limit
Measured B/G Noise
Night Hours Turbine Operation
Another Wind Farm Noise Assessment

Measured Noise vs Wind Speed
(Evening Hours 1800-2300)

Including Wind Directions of 192 to 20 degrees

\[ y = -0.0253x^3 + 0.4139x^2 + 0.0565x + 26.367 \]

\[ y = -0.0373x^3 + 0.7255x^2 - 2.0391x + 24.931 \]
Another Wind Farm Noise Assessment

Measured Noise vs Wind Speed
(Evening Hours 1800-2300)

Including Wind Directions of 192 to 20 degrees

\[
y = -0.0253x^3 + 0.4139x^2 + 0.0565x + 26.367
\]

\[
y = -0.0144x^3 + 0.4408x^2 - 1.5679x + 24.588
\]
Compliance Noise Assessment
Measured Total Noise/BG Noise (downwind)
(Night Hours 2300-0700)

\[ y = -0.2156x^2 + 5.4165x + 13.252 \]

\[ y = -0.1463x^2 + 4.9783x + 11.781 \]

- Measured Total Noise
- Planning Limit Night
- Measured BG during SD
- Planning Limit Day
- Derived Prevailing Total Noise downwind
- Derived Prevailing BG Noise during SD downwind

L90 Sound Pressure Level (dB(A))
10 m Height Wind Speed Converted from Nacelle Anemometer of Turbine T2 (m/s)
Noise Data

• Definition of downwind (worst case)?
• Biggest problem is ‘background’ or other competing noise.
  – Use of $L_{A90}$ in UK helps with this.
  – Only use results of night-time measurements if possible
• Can correct for background up to a point:
  – Requires significant shut-downs (~1hr per night/day)
  – Can only be representative of periods when shut-downs occur
  – Noise during operation may be ~ same level as b/g
• Significant amount of data may be required
Turbine vs Triton Wind Speed Velocities

- Operational Turbine
- Shutdown

Triton Interpolated Speed (m/s)

Turbine Measured Wind Speed (m/s)

Linear (Operational Turbine)
Linear (Shutdown)
Wind Data

- Noise measurements without wind data are meaningless.
- Anemometry data not always available.
- 10 metre mast data only useable where limits are referenced to actual 10m height wind speed.
- Wind speed from power output and power curve is only of use below rated power.
- Wind speed from nacelle may not be reliable especially when shut-down.
- SoDAR / LiDAR maybe best option for compliance tests. May prevent meaningful measurements by third parties however.
Questions?