EPUK Noise Update

Wind Turbine Noise Assessment
The IoA Acoustics Bulletin Agreement

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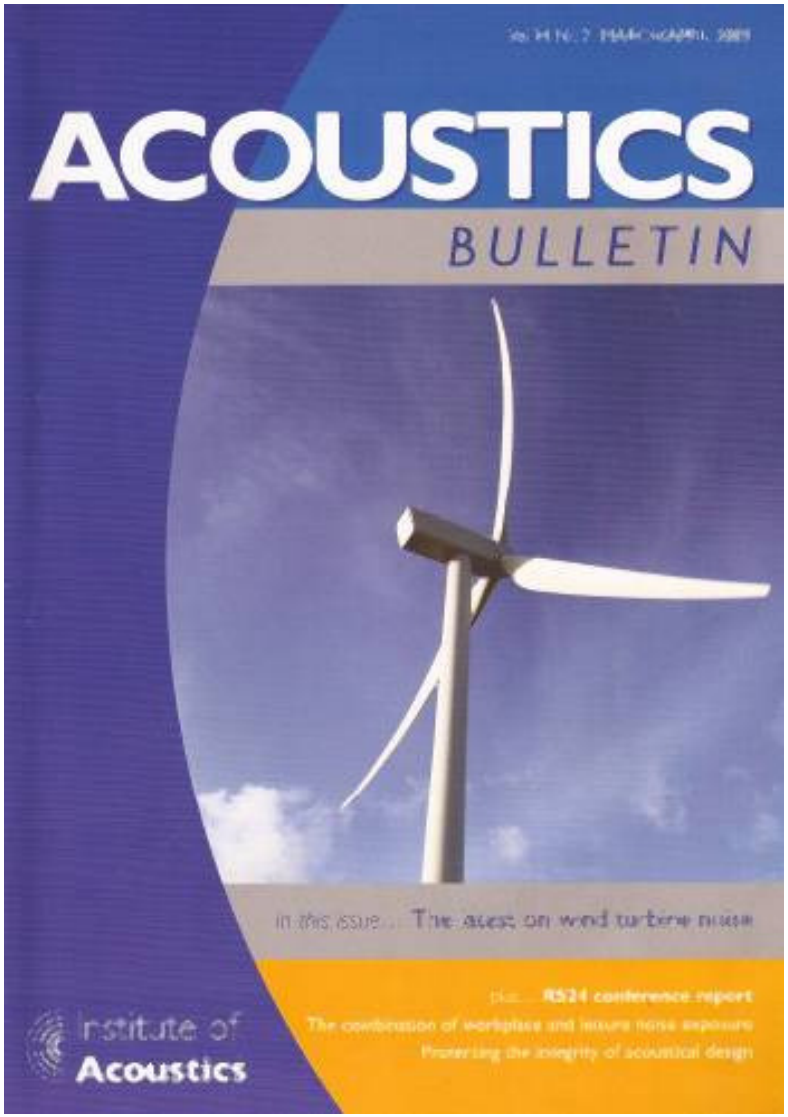
What is the IoA Bulletin Agreement?



What did it consist of?

- An agreement between an ad-hoc group members of which had faced each other many times at Inquiry covering...
  - Wind Shear
  - Noise Predictions
  - Vibration and Low Frequency Noise
- Is not official IoA Guidance and should not be regarded as such.

Who were these people?

Dick Bowdler, **Andrew Bullmore**, **Bob Davis**, **Malcolm Hayes**, **Mark Jiggins**, **Geoff Leventhall** (Section 4), **Andy McKenzie**

The authors were the independent noise consultants who sat on the DTI/BERR Noise Working Group on wind farm noise in 2006/2007

Geoff Leventhall PhD HonFIOA is a noise and vibration consultant.

Andrew Bullmore PhD BSc MIOA is with Hoare Lea Acoustics, Bristol

Mark Jiggins MSc MIOA is with Hoare Lea Acoustics, Castle Douglas

Malcolm Hayes BSc MIOA is with Hayes McKenzie, Machynlleth

Andy McKenzie PhD BSc MIOA is with Hayes McKenzie, Salisbury

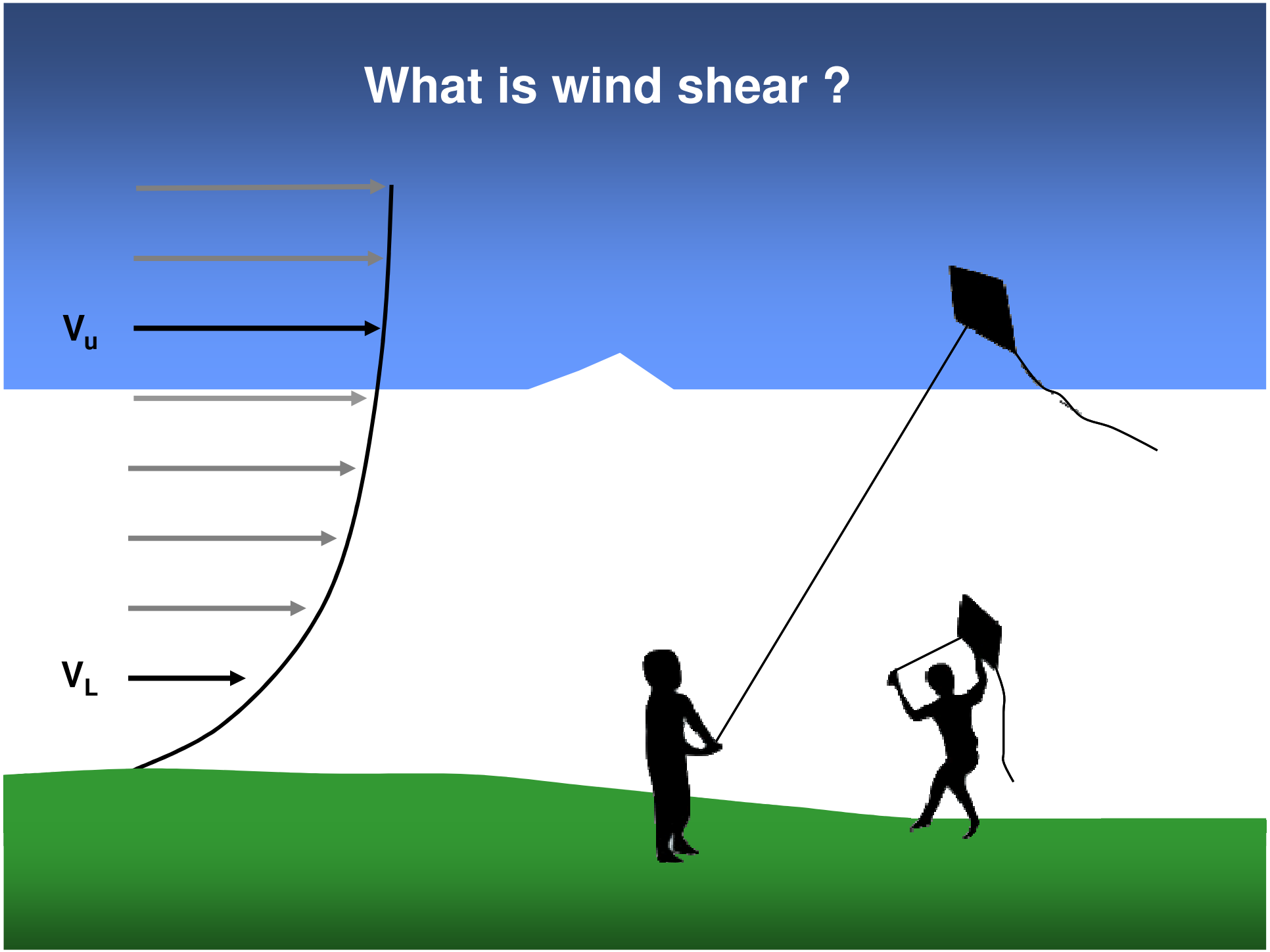
Dick Bowdler BSc FIOA is with New Acoustics, Clydebank

Bob Davis BSc(Eng) MIOA is with Robert Davis Associates, Hampshire

Wind shear …….

- What is wind shear ?
- What causes wind shear ?
- Can a single value of site specific wind shear be defined ?
- Why is wind shear an issue for wind farm noise assessment ?
- How can wind shear be dealt with ?
- How does the IoA Bulletin Agreement deal with it?

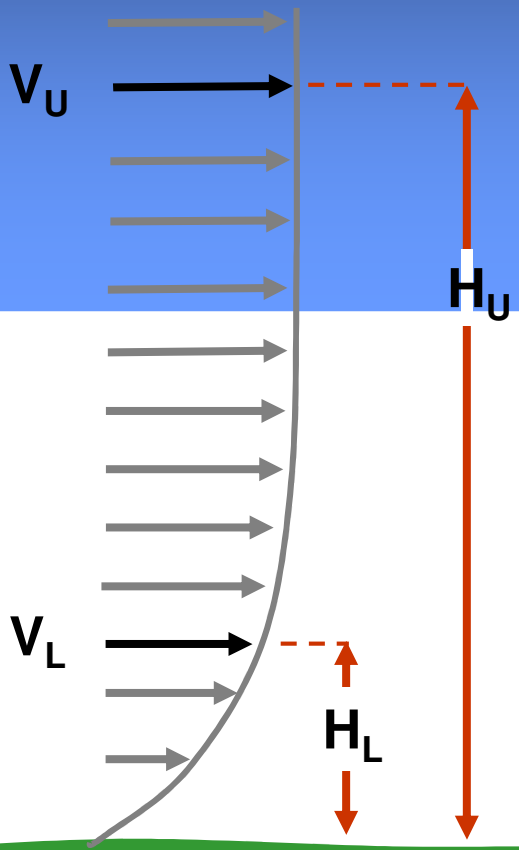
What is wind shear ?



What causes wind shear ?

- Ground Roughness
- Atmospheric Factors
  - In practice a combination of both occur

Modelling wind shear due to ground roughness



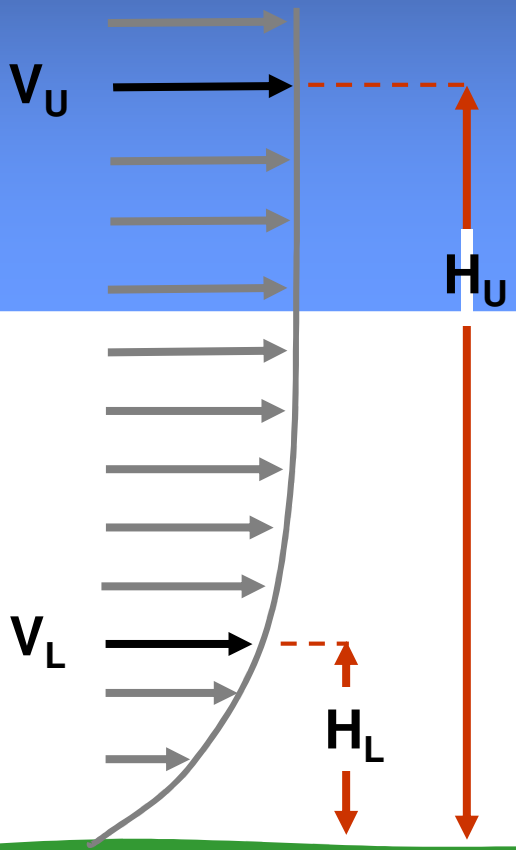
$$V_U = V_L \times \frac{\log(H_U/z_0)}{\log(H_L/z_0)}$$

z_0 = ground roughness length

Type of Terrain	Roughness length z_0
Water areas, snow or sand surfaces	0.001m
Open, flat land, mown grass, bare soil	0.01m
Farmland with some vegetation	0.05m
Suburbs, towns, forests, many trees and bushes	0.30m

Ground roughness is fixed for a given site

Modelling wind shear due to atmospheric effects



$$V_U = V_L \times \left\{ \frac{H_U}{H_L} \right\}^m$$

m = shear exponent

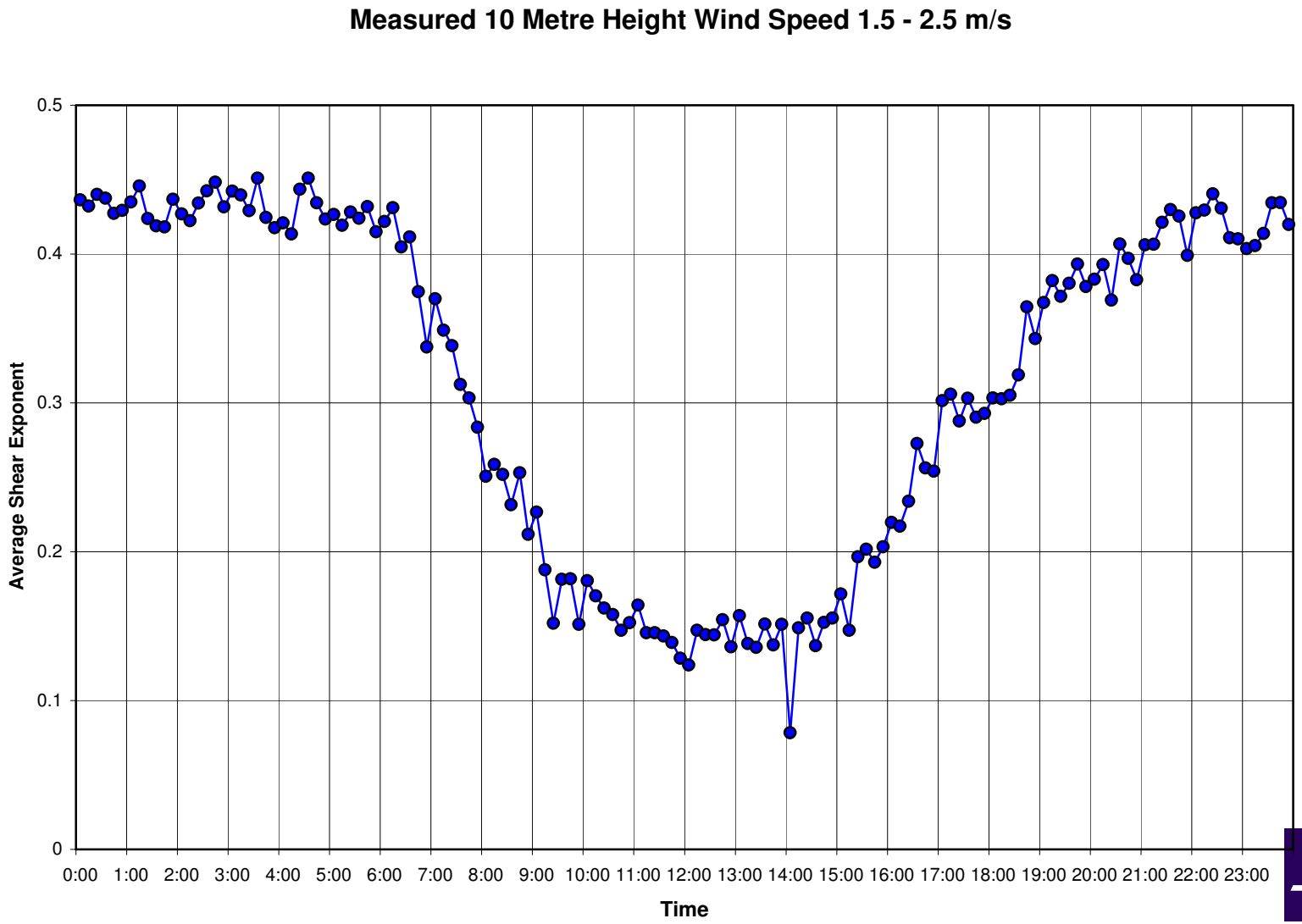
Pasquill class	name	shear exponent
A – B	(very – moderately) unstable	$m \leq 0.21$
C	near neutral	$0.21 < m \leq 0.25$
D – E	(slightly – moderately) stable	$0.25 < m \leq 0.4$
F	very stable	$0.4 < m$

Atmospheric effects are not fixed for a given site and vary, particularly by time of day

Can a single value of site specific wind shear be defined ?

- No, because…
- No fixed value of 'z_0' or 'm' can be used to define the speed up from one height to another.
- Varies with atmospheric conditions which means it varies with:
  - Weather (including wind)
  - Time of day

Wind shear as a function of time of day for increasing wind speed



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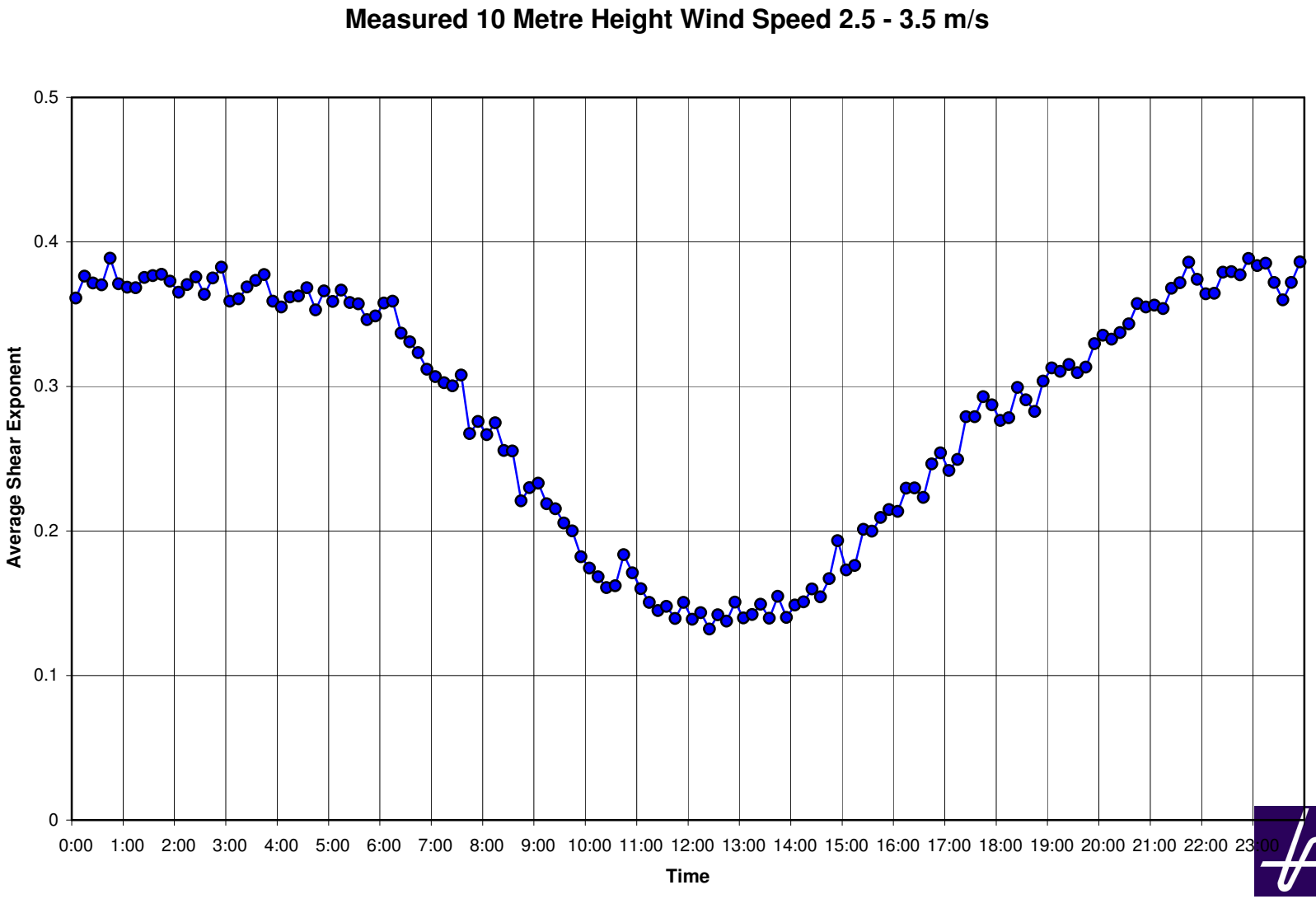

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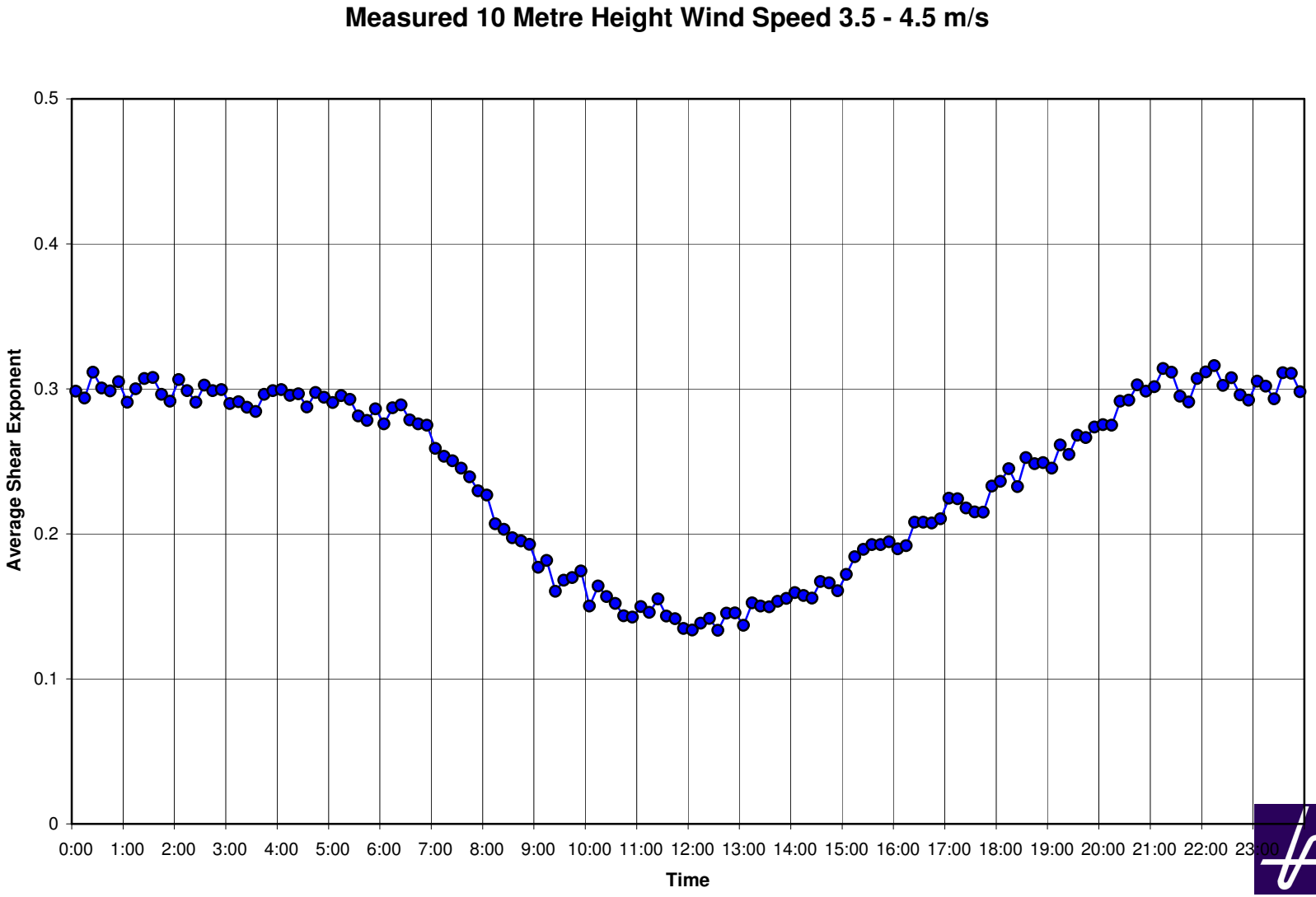

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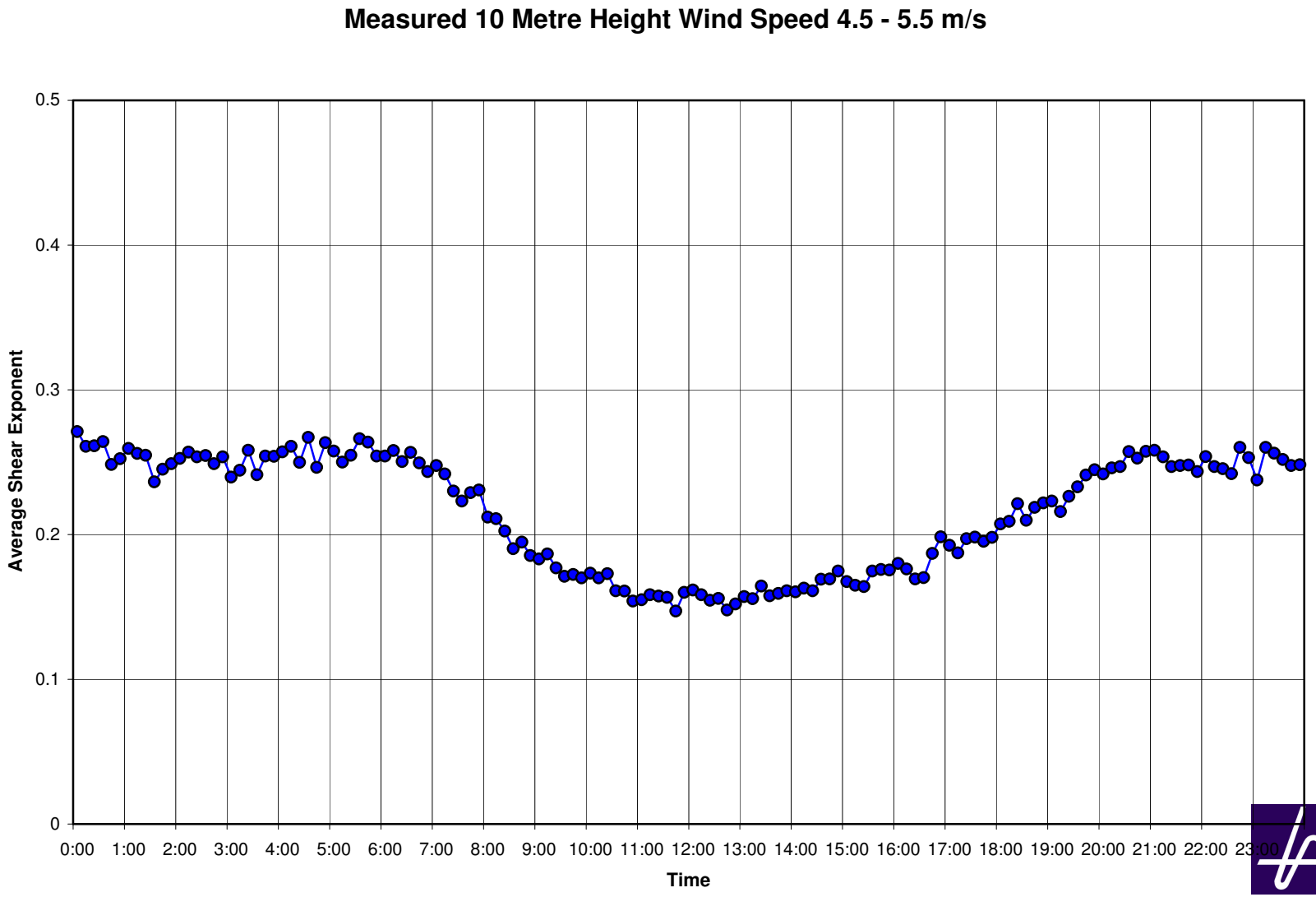

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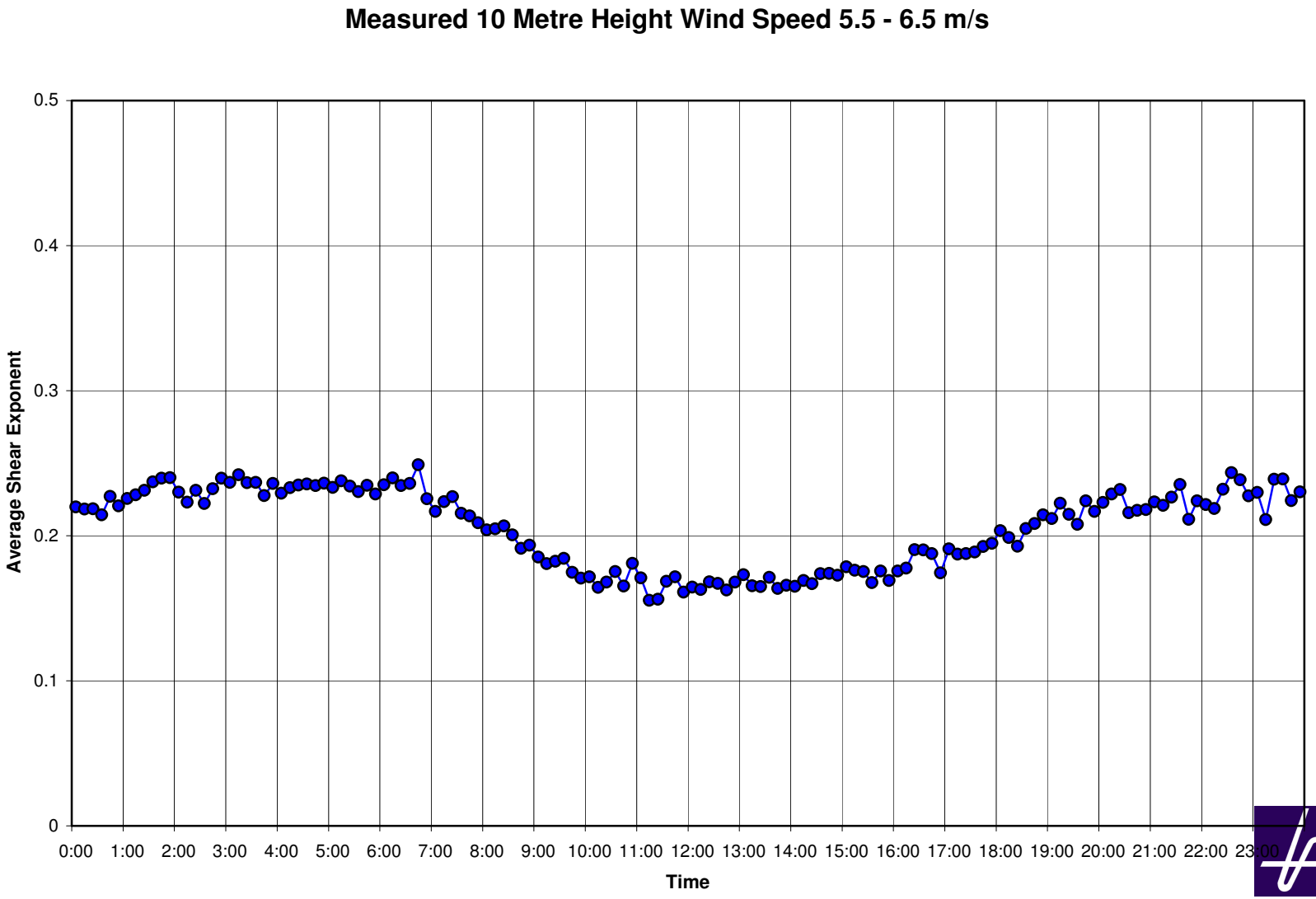

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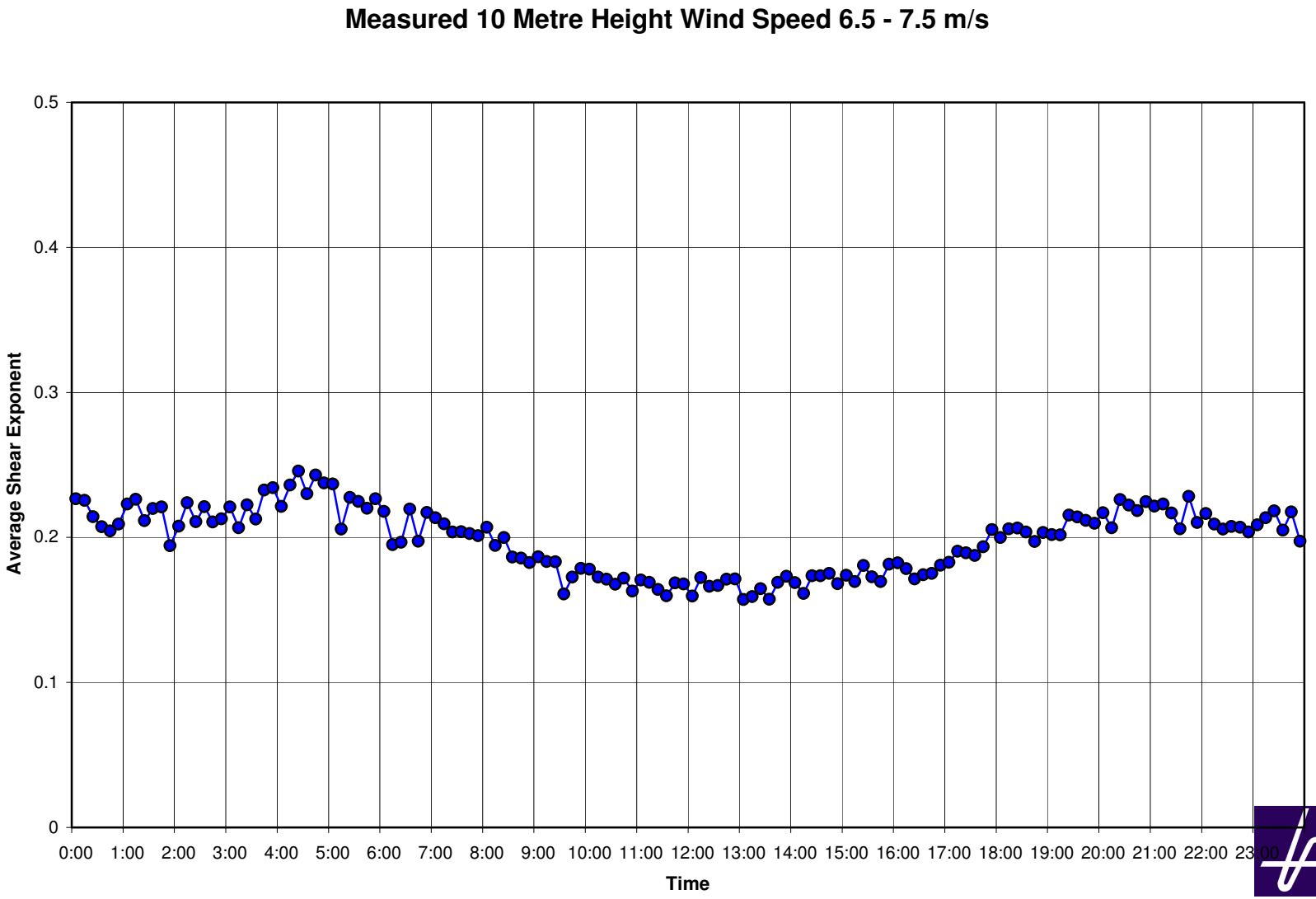

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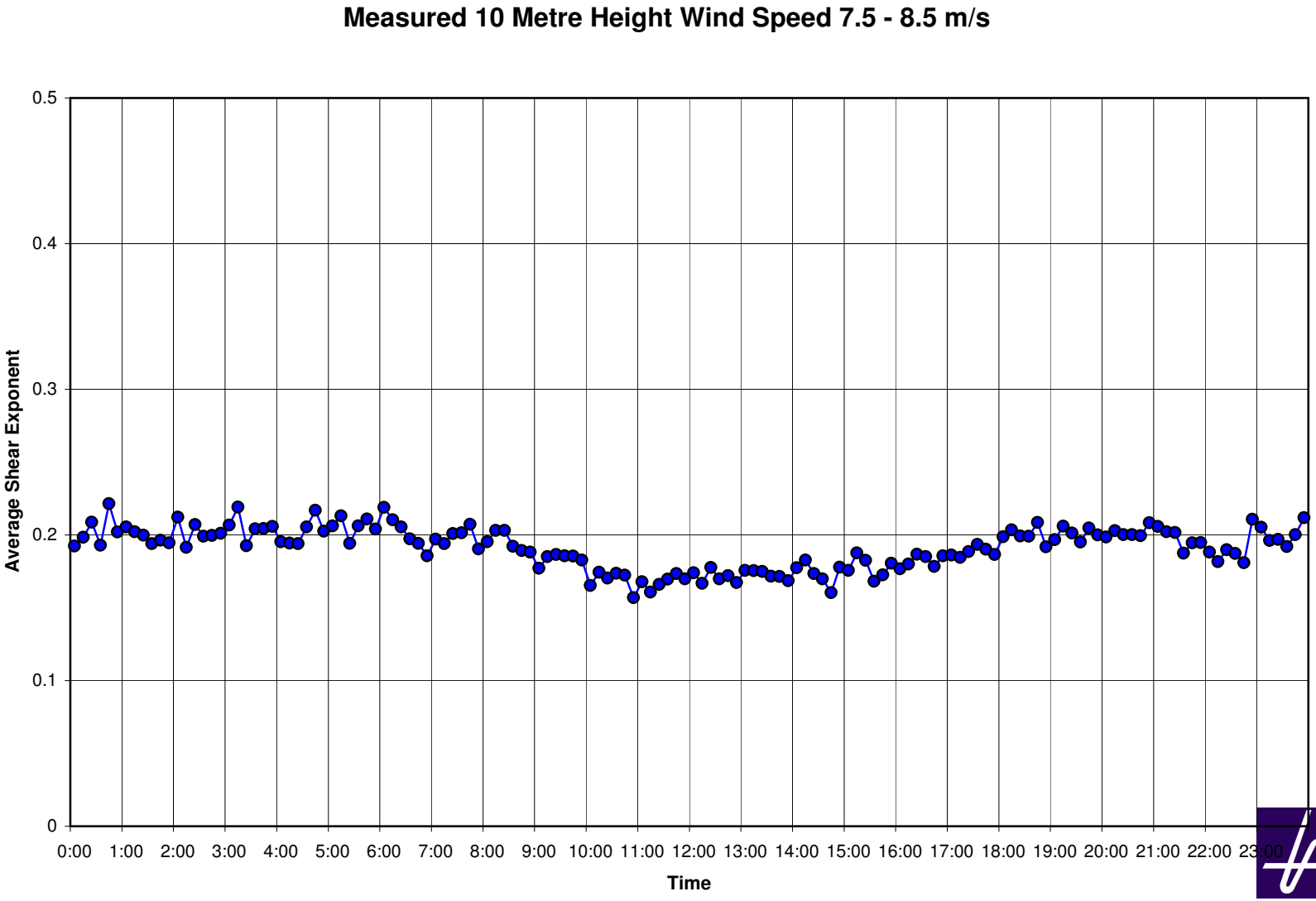


Two fundamental standards for wind farm noise assessment…

- ETSU-R-97, *The Assessment and Rating of Noise from Wind Farms*

- IEC61400-11, *Wind Turbine Generator Systems Part 11: Acoustic noise measurement techniques*

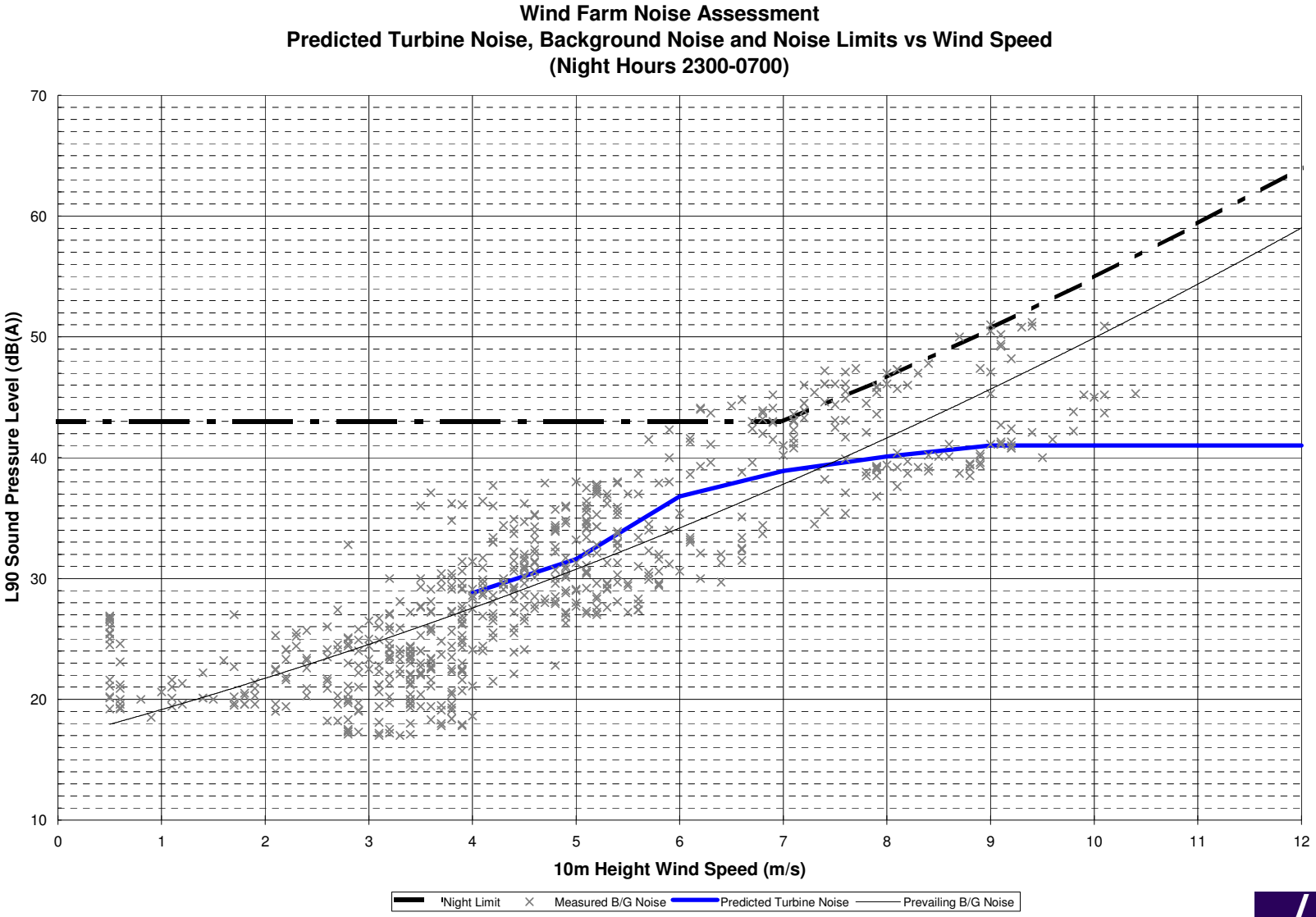
Why is wind shear an issue for wind farm noise assessment ?

- Because…
- ETSU-R-97 requires correlation of noise measurements with measurements of wind speed at 10m height to quantify baseline.
- IEC61400-11 requires correlation of noise measurements with hub height wind speed ‘standardised’ to 10m height for quantification of turbine noise (ie. based on ground roughness of 0.05 – equivalent to unstable conditions / low wind shear).

Why is wind shear an issue for wind farm noise assessment

- And…
- The inherent assumption in ETSU-R-97 that referencing everything to 10m height in this manner provides a comparison between predicted turbine and background noise under the same wind conditions (at the turbine hub).
- Or is there?

Effects of Wind Shear with 10m Height Measurements



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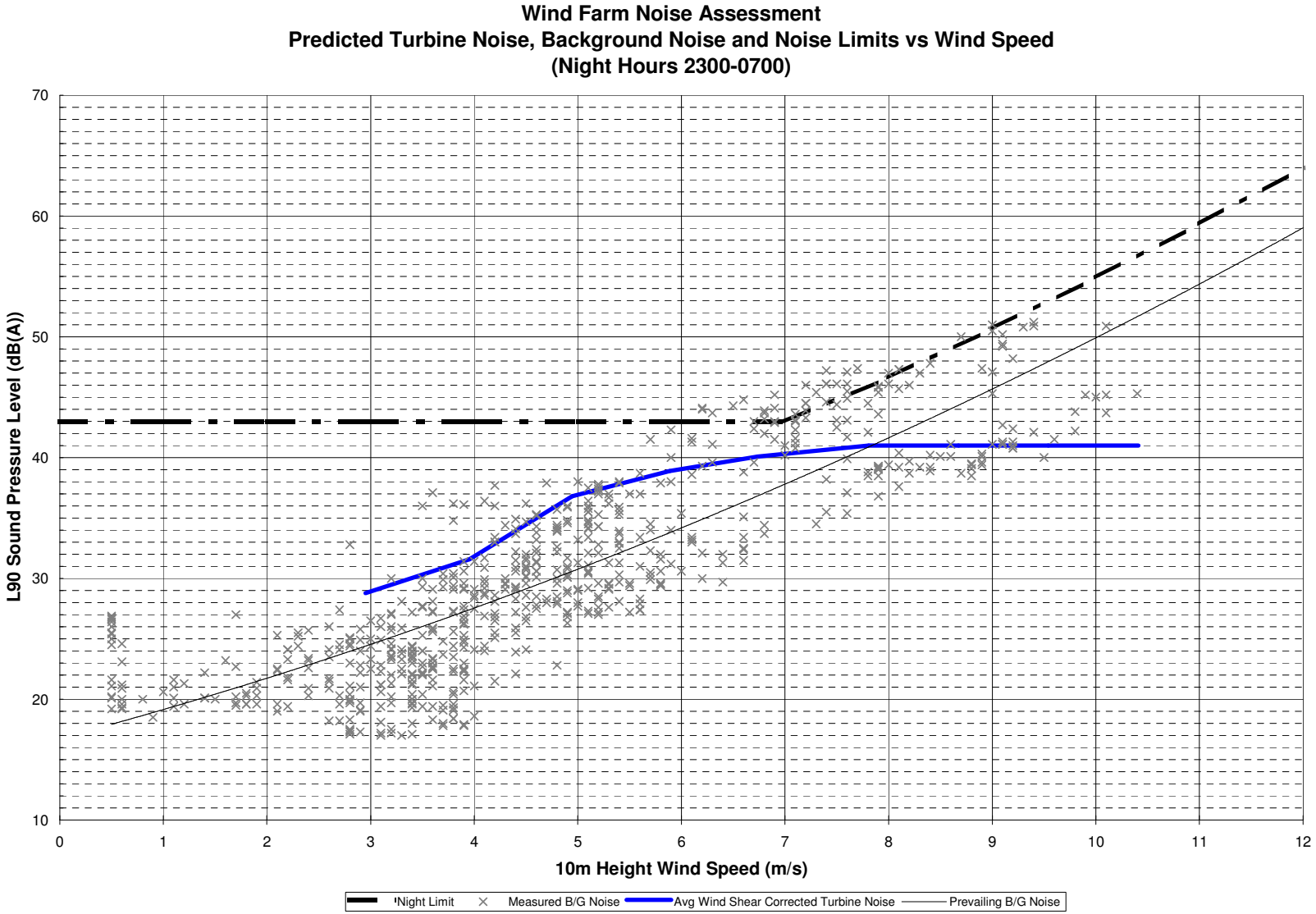

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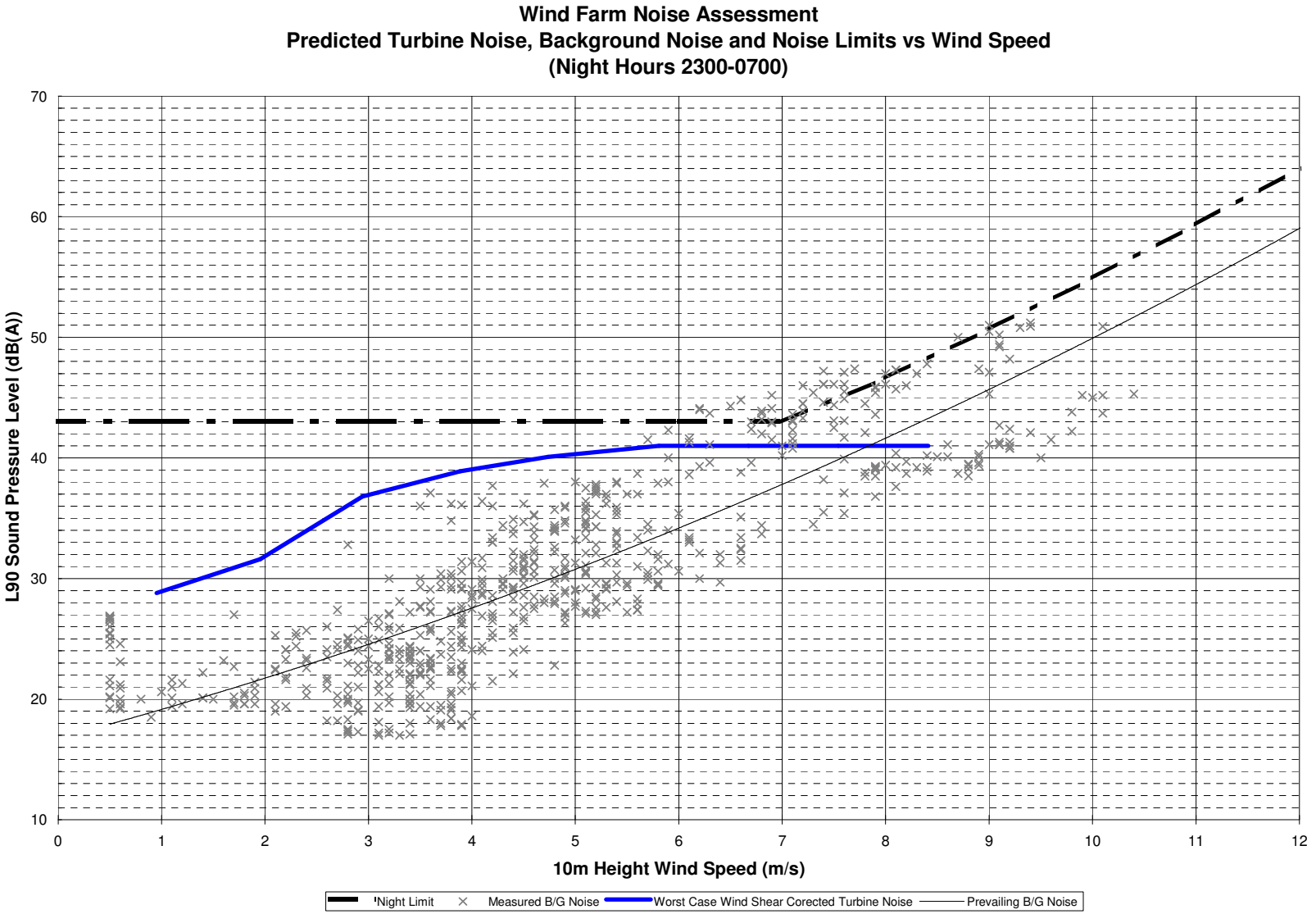

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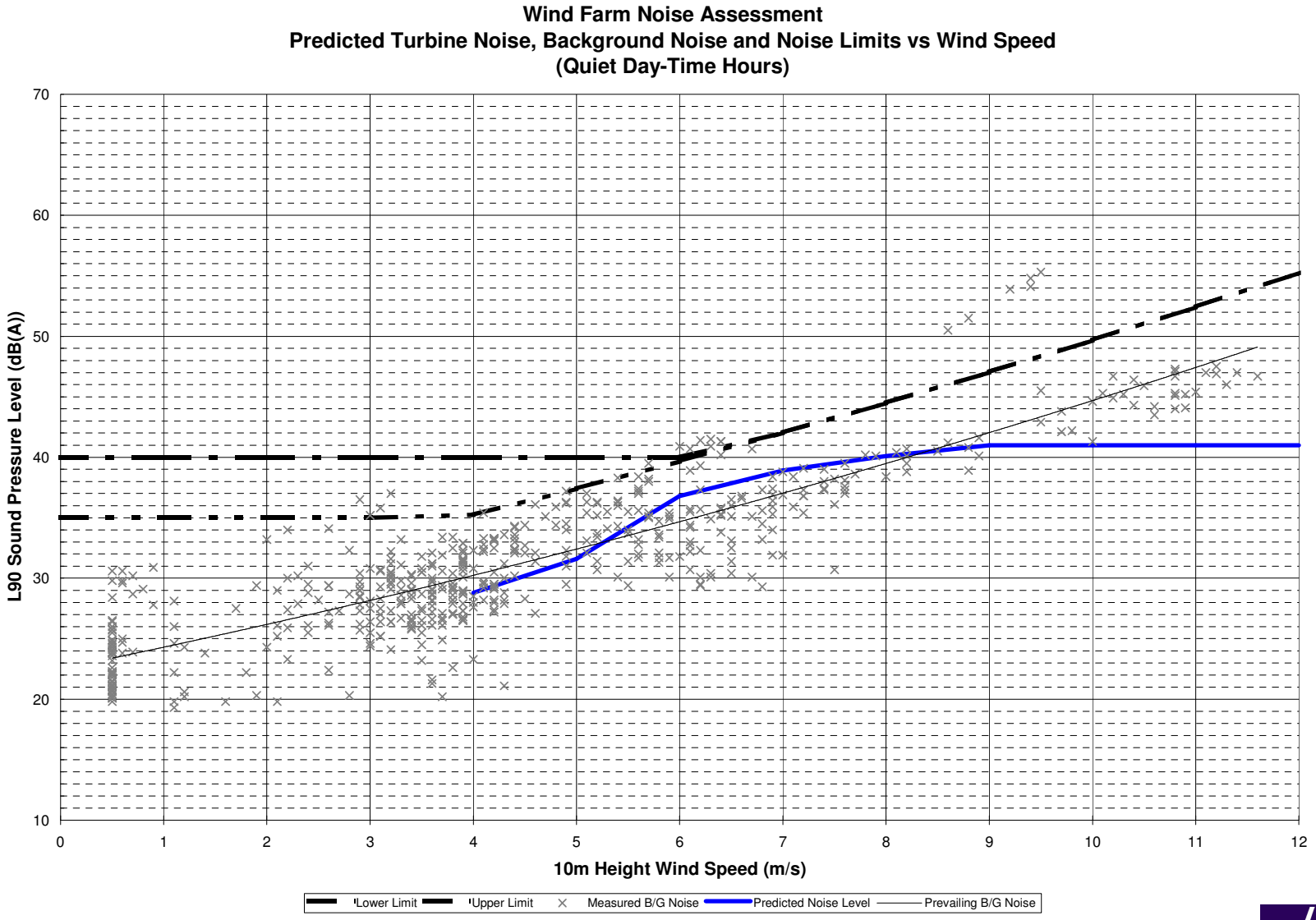

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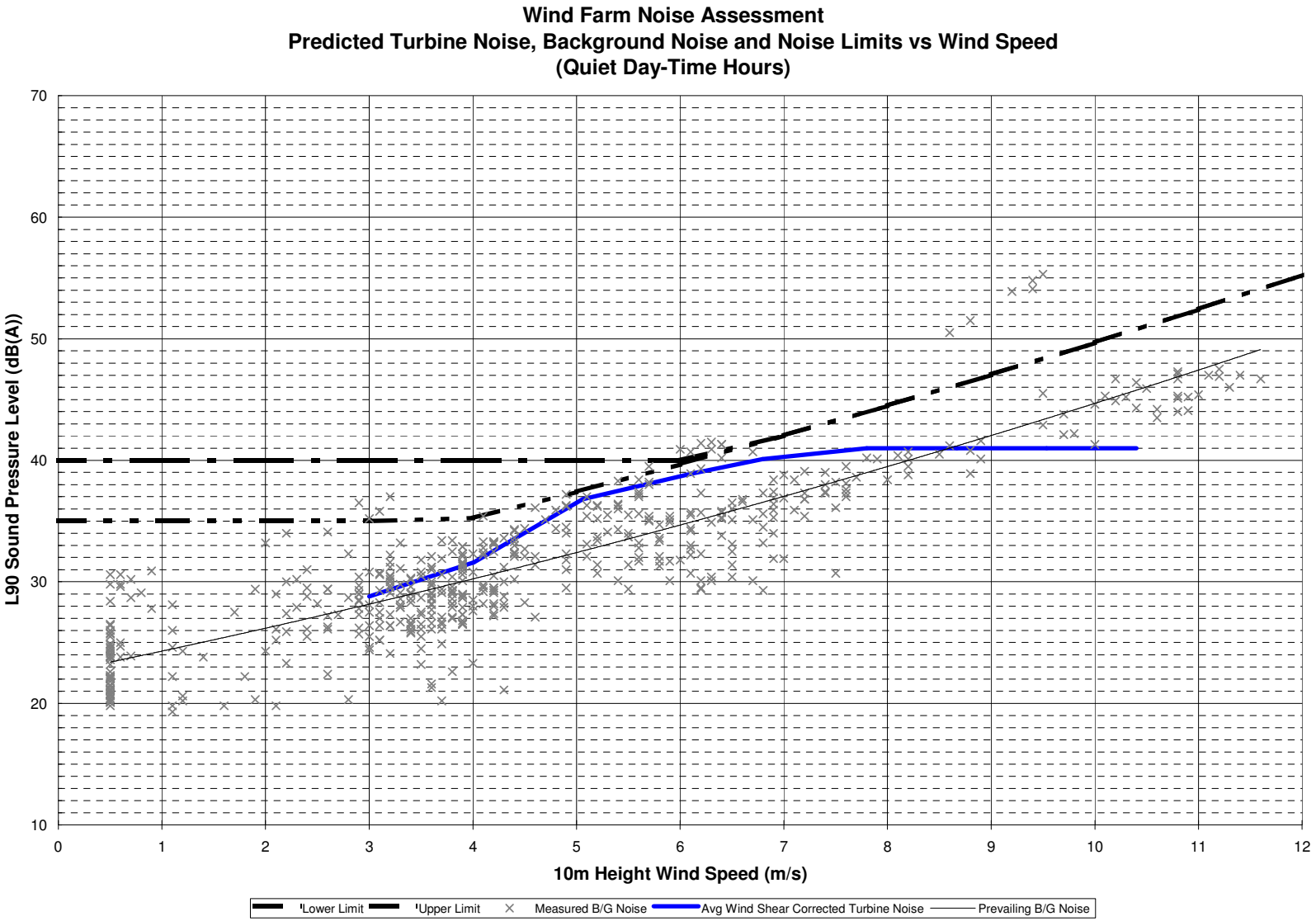

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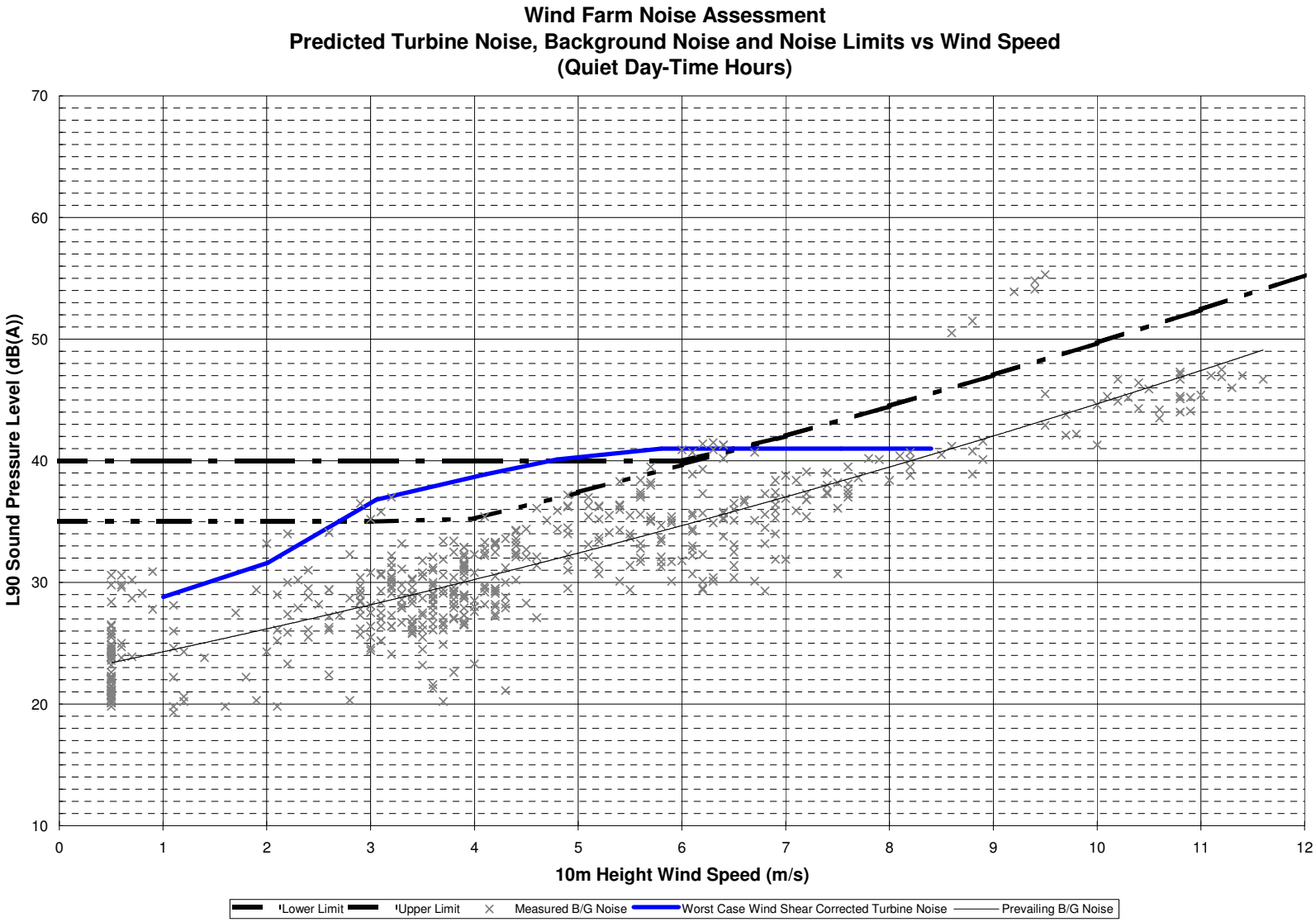
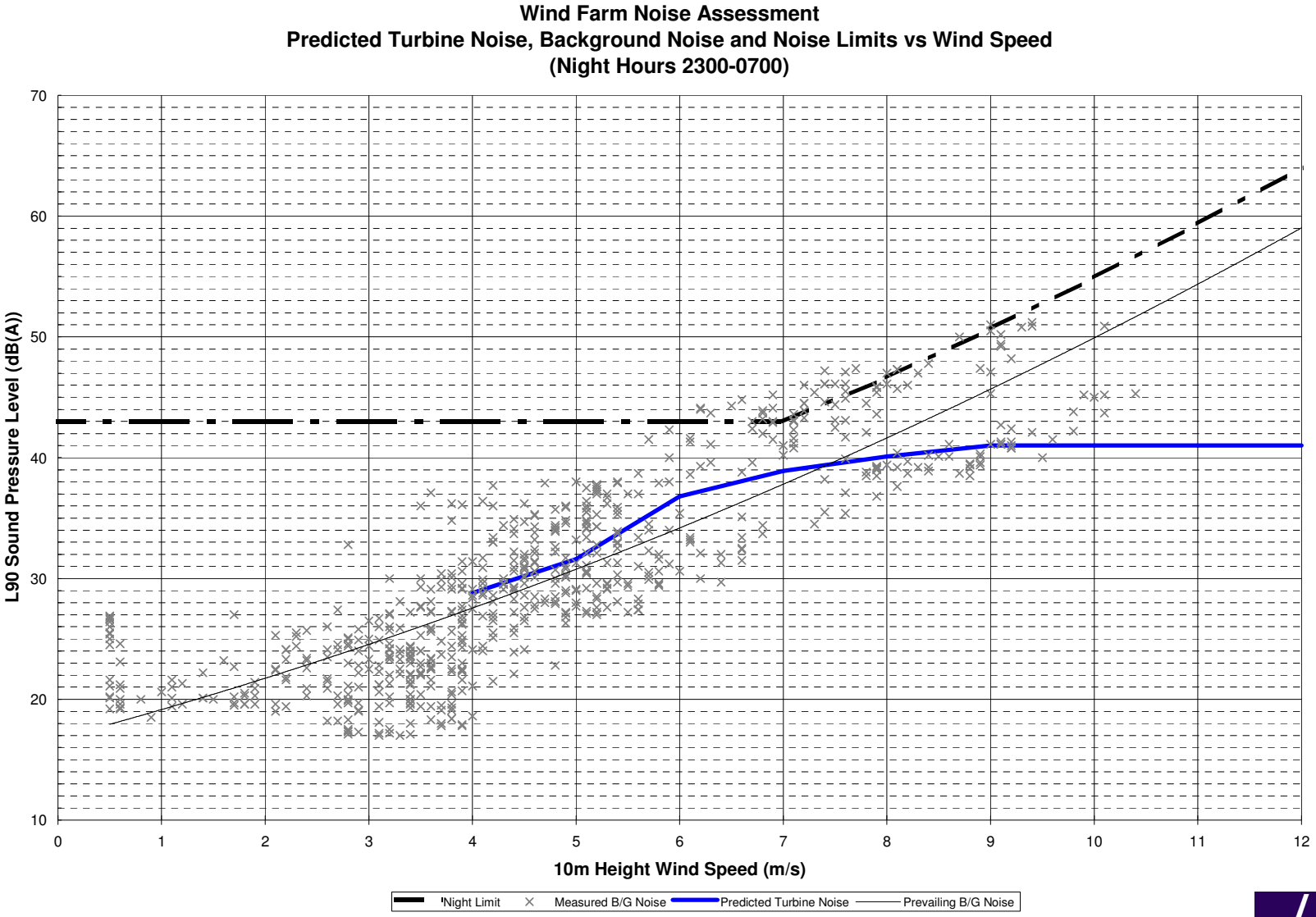


An alternative approach ?



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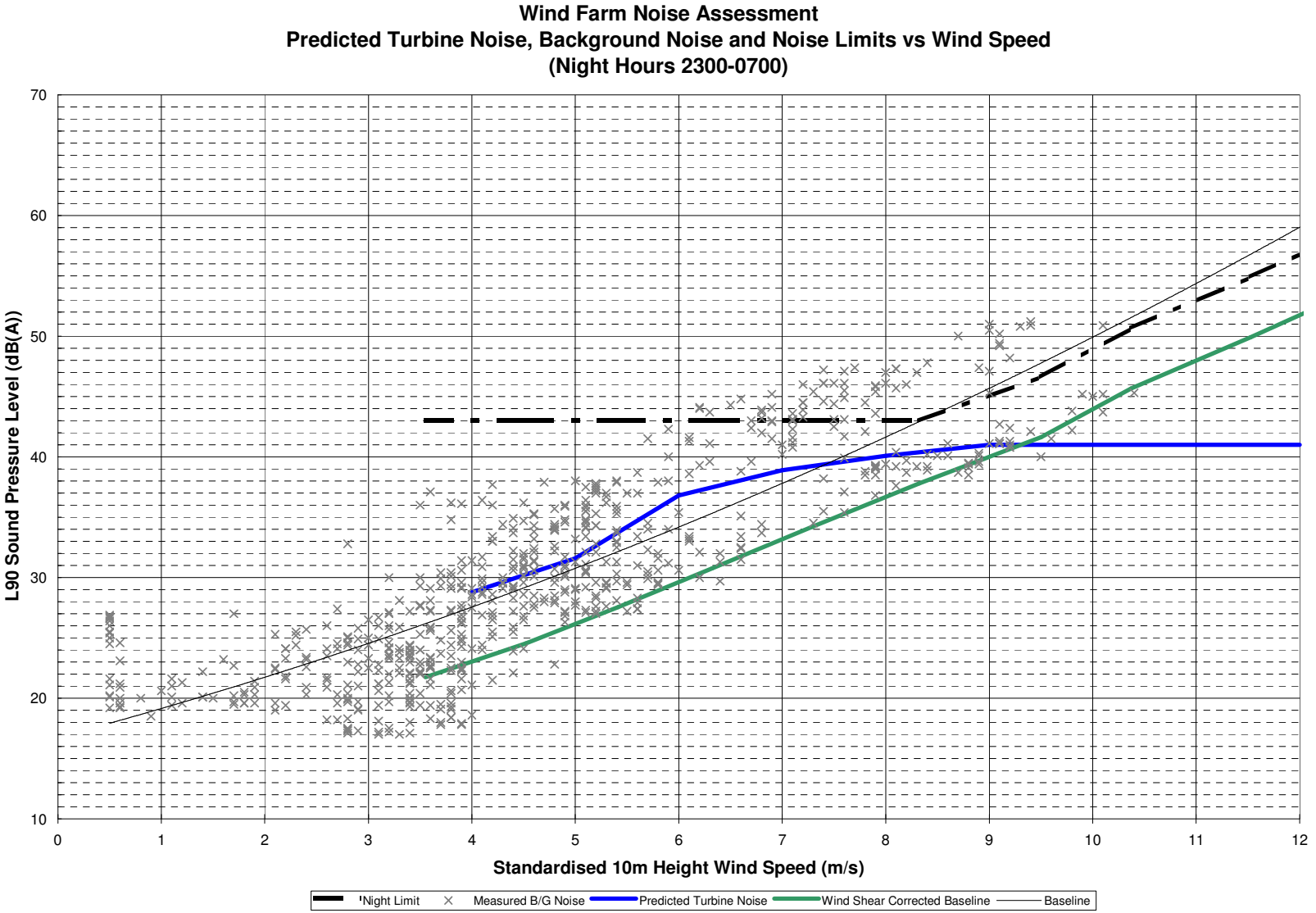

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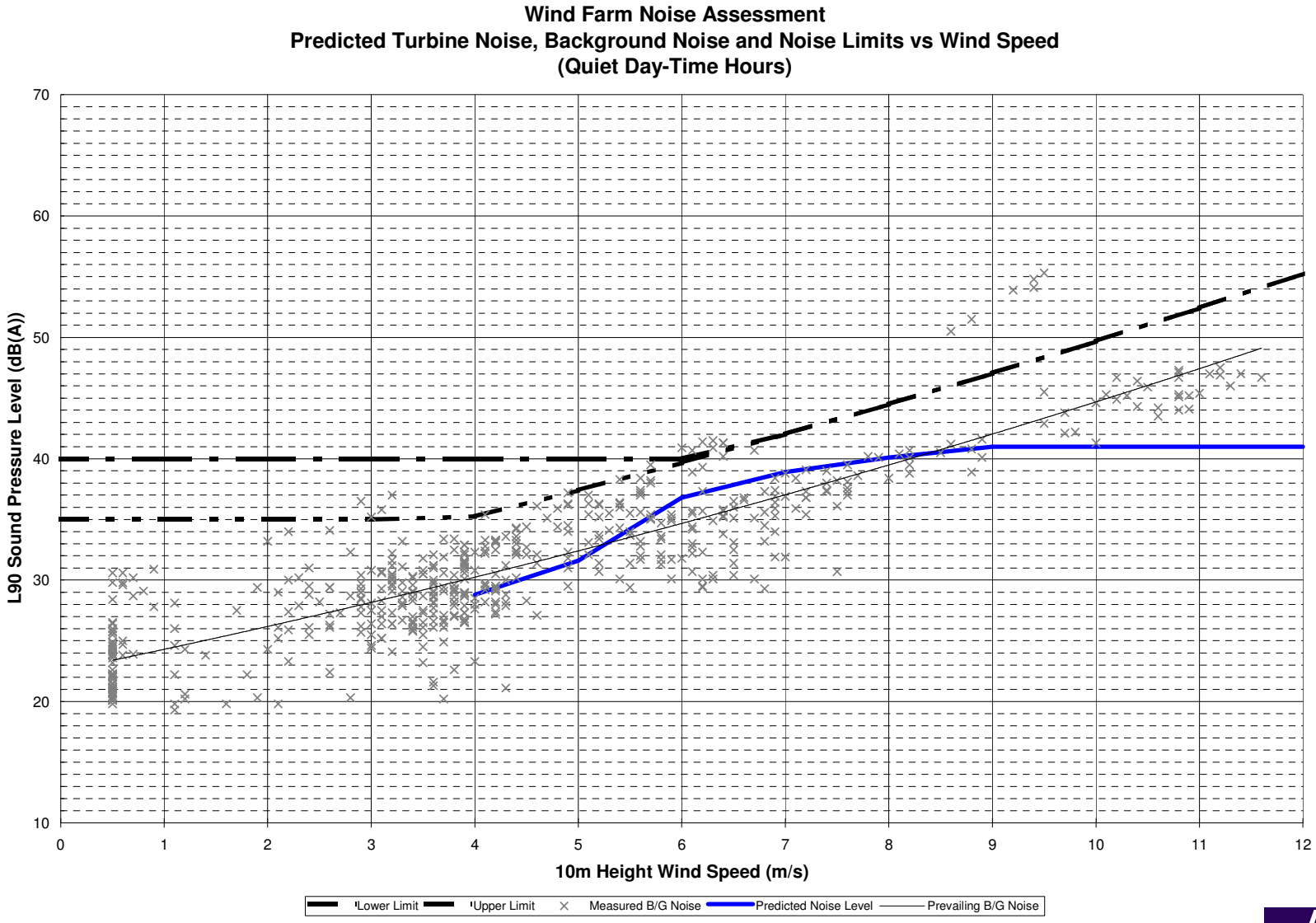

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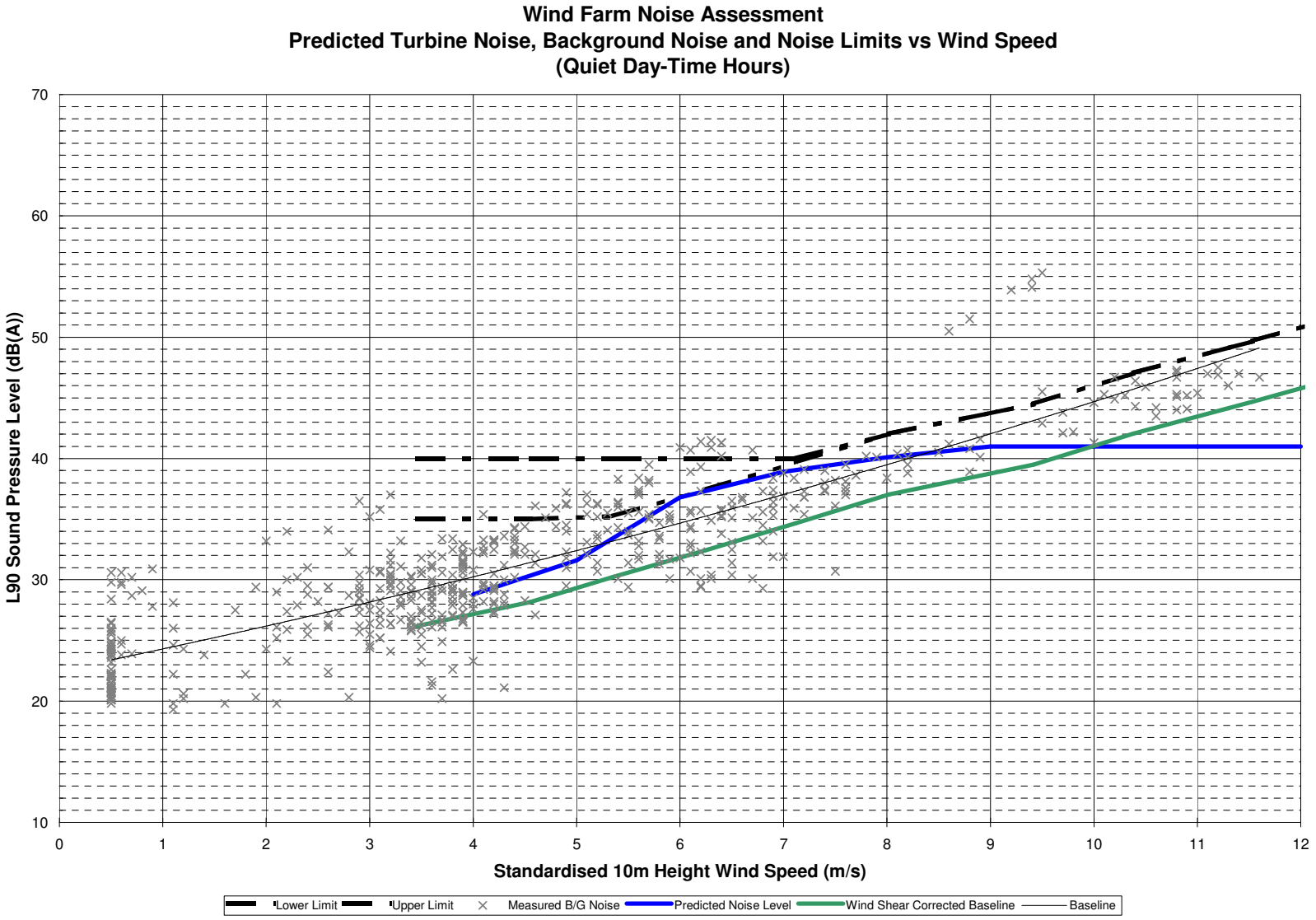
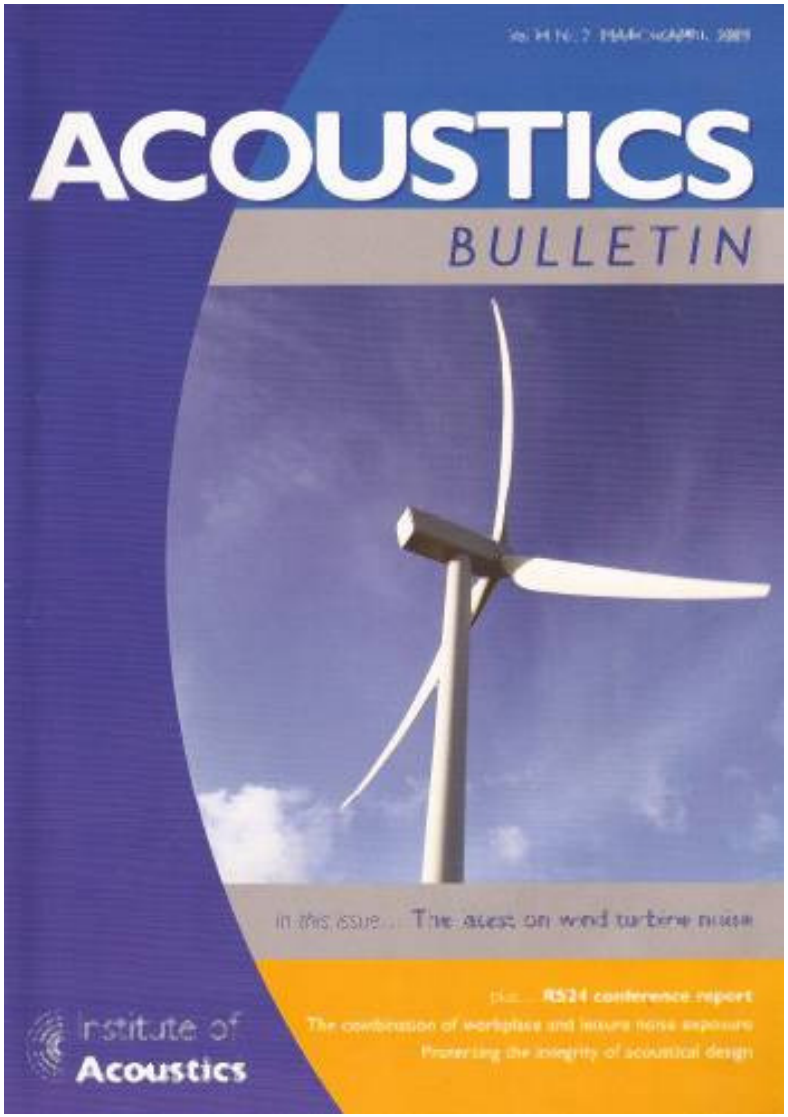


The best approach?

- Correlate background noise measurements with hub height wind speed derived from:
  - Measurements at multiple anemometry heights
  - Direct anemometry measurement
  - Remote sensing by LIDAR / SODAR
- Standardisation to 10m height adds confusion
  - Necessary for consistency with ETSU-R-97
  - Necessary for consistency with manufacturers data
  - IEC61400-11 change to quantify WT noise wrt Hub Height

Consistent with approach advocated by:



How does it tackle wind shear ?

- As for ‘best approach’, background noise measurements correlated with hub height wind speed ‘standardised’ to 10 m height.
- If HH WS not measured directly then derive shear exponent ‘m’ from measurements at heights H1 and H2 for each 10 minute period.
  - H1 >=60% of HH
  - H2 = 40–50% of HH
- Derive HH WS from measurements at H1 and derived values of ‘m’ for each 10 minute period.

What are positive implications of this approach for planning purposes ?

+ Clear methodology for taking wind shear into account without possibility of unknowns.

+ Allows meaningful evaluation of whether limits in planning conditions can be met.

What are negative implications of this approach for planning purposes ?

- Creates more ‘scatter’ around trendline through baseline data. ETSU-R-97 already criticised for ‘average’ approach to baseline data.

- Problems for small schemes where costs of deriving hub height wind speeds may be prohibitive. Will need to keep to <35 dB LA90 unless non-wind related b/g shown to be > 30 dB LA90 in the absence of hub height wind data.

Conclusions…

- Removes uncertainty
- Provides a meaningful comparison between turbine noise and existing noise under the same wind conditions.
- Adds to the complexity of deriving the ‘prevailing’ background noise level.
- Adds to question mark over meaningfulness background noise measurements in rural areas.