Association of Noise Consultants

Wind Turbine Noise Assessment
What Constitutes Best Practice?

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Part 1 - The Issues

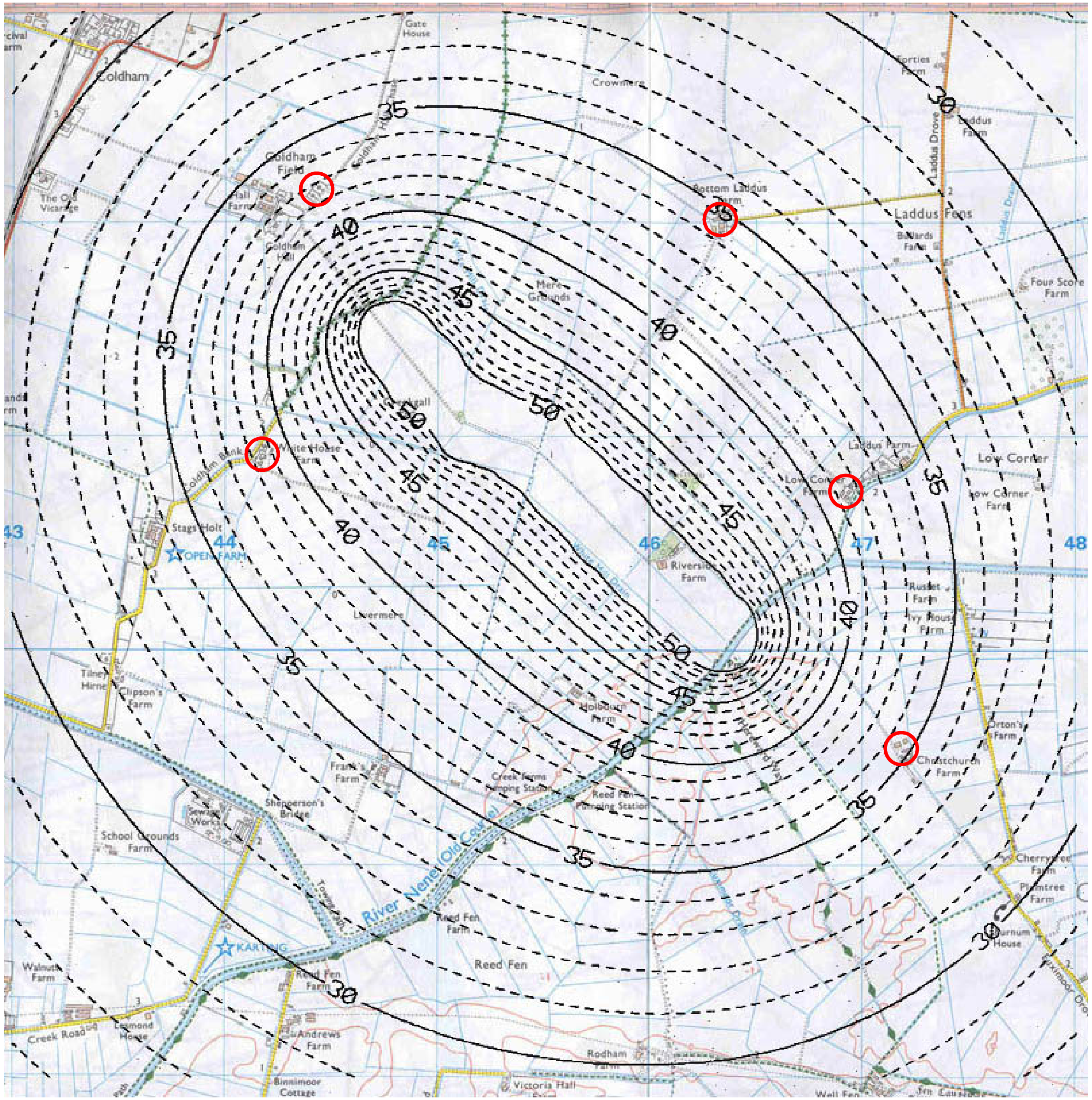
- ETSU-R-97
- B/G Noise
- ‘Wind Shear’
- Noise Prediction Methodology
- Amplitude Modulation
- Infrasound, LF Noise and Vibration
- ‘Health’ Issues
- Audibility and Complaints

ETSU-R-97

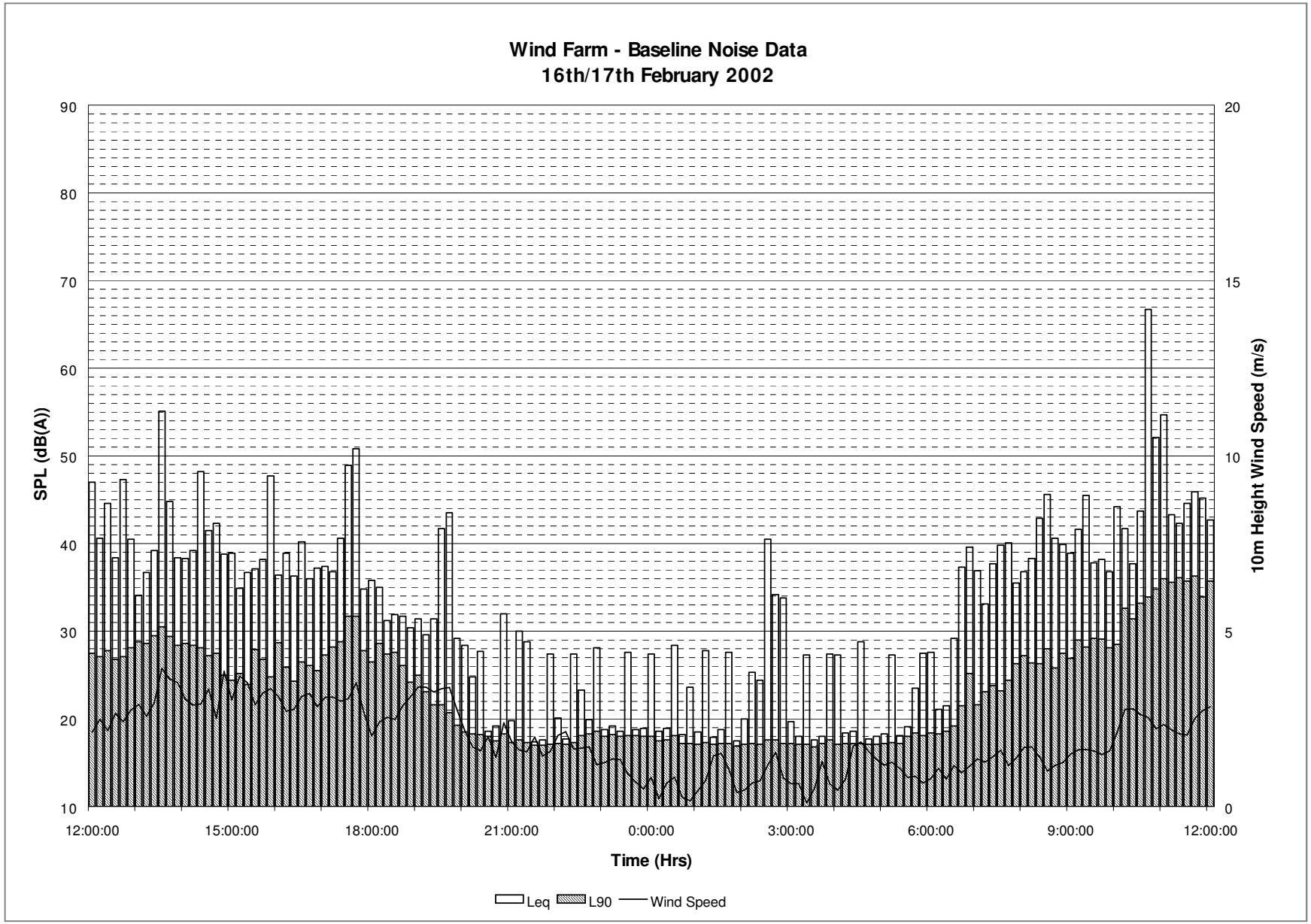

ETSU–R–97
The Assessment
& Rating of
NOISE
From Wind Farms
ETSU
for the
dti

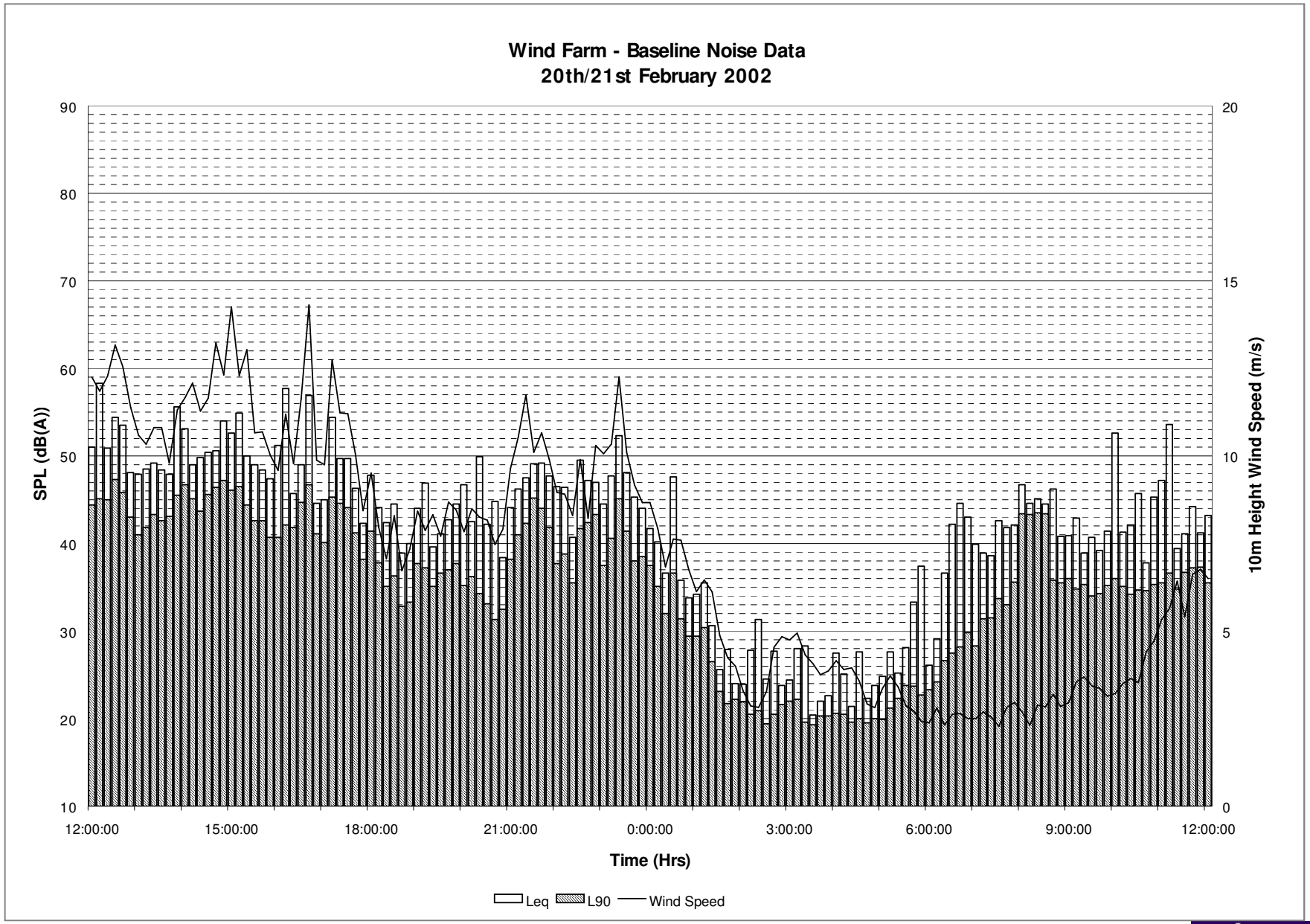
ETSU-R-97

- Correlation of b/g noise with wind speed.
- Definition of prevailing b/g noise.
- Limits to apply when b/g noise is low
  - 35-40 dB LA90 during the day
  - 43 dB LA90 at night
  - 45 dB LA90 at ‘involved’ properties

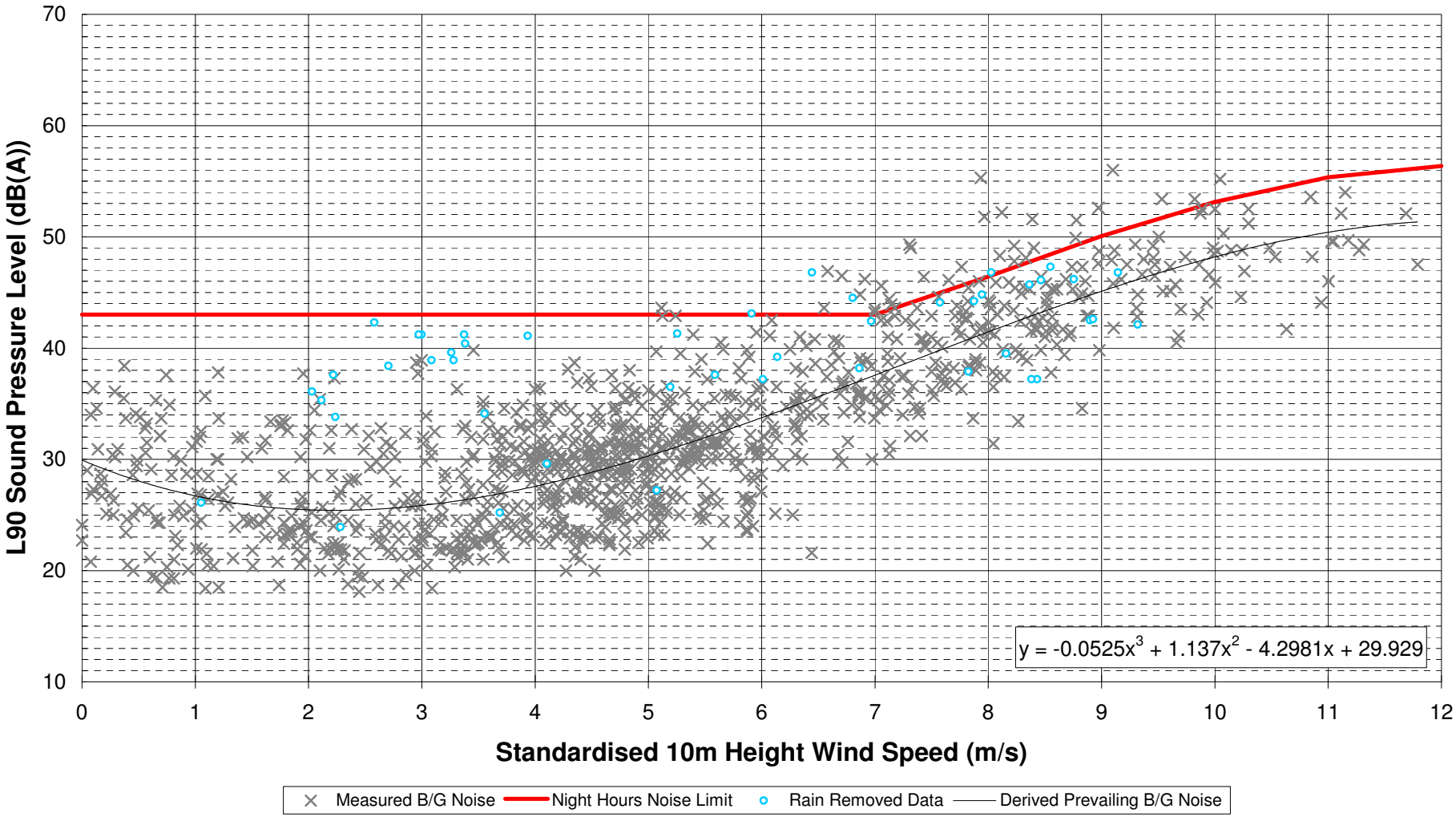


Coldham
Gate House
Crowmere
Coldham Field
Hall Farm
Coldham Hall
The Old Vicarage
Bottom Laddus Farm
Laddus Farm
Laddus Fens
Laddus Drove
Forties Farm
Bullards Farm
Four Score Farm
Mere Grounds
White House Farm
Coldham Bank
Stags Holt
OPEN FARM
Laddus Farm
Low Corner Farm
Low Corner
Riverside Farm
Russet Farm
Ivy House Farm
Livermere
Tilney Hirne
Clipson's Farm
Holbourn Farm
Orton's Farm
Christchurch Farm
Frank's Farm
Creek Farms Pumping Station
Reed Fen Pumping Station
Shepperson's Bridge
Sewage Works
School Grounds Farm
Cherrytree Farm
Plumtree Farm
Laburnum House
River Nene (Old Course)
KARTING
Reed Fen Farm
Reed Fen
Walnut Farm
Creek Road
Lesmond House
Andrews Farm
Binnimoor Cottage
Rodham Farm
Victoria Hall
Well Fen
43
44
45
46
47
48
30
35
40
45
50


Wind Farm - Baseline Noise Data
16th/17th February 2002
SPL (dB(A))
10m Height Wind Speed (m/s)
Time (Hrs)
90
80
70
60
50
40
30
20
10
20
15
10
5
0
12:00:00
15:00:00
18:00:00
21:00:00
0:00:00
3:00:00
6:00:00
9:00:00
12:00:00
Leq
L90
Wind Speed


Wind Farm - Baseline Noise Data
20th/21st February 2002
SPL (dB(A))
10m Height Wind Speed (m/s)
90
80
70
60
50
40
30
20
10
20
15
10
5
0
12:00:00
15:00:00
18:00:00
21:00:00
0:00:00
3:00:00
6:00:00
9:00:00
12:00:00
Time (Hrs)
Leq
L90
Wind Speed

W/F Noise Assessment
Prevailing Background Noise, Derived Noise Limits and Predicted Turbine Noise
Night Hours (2300-0700)



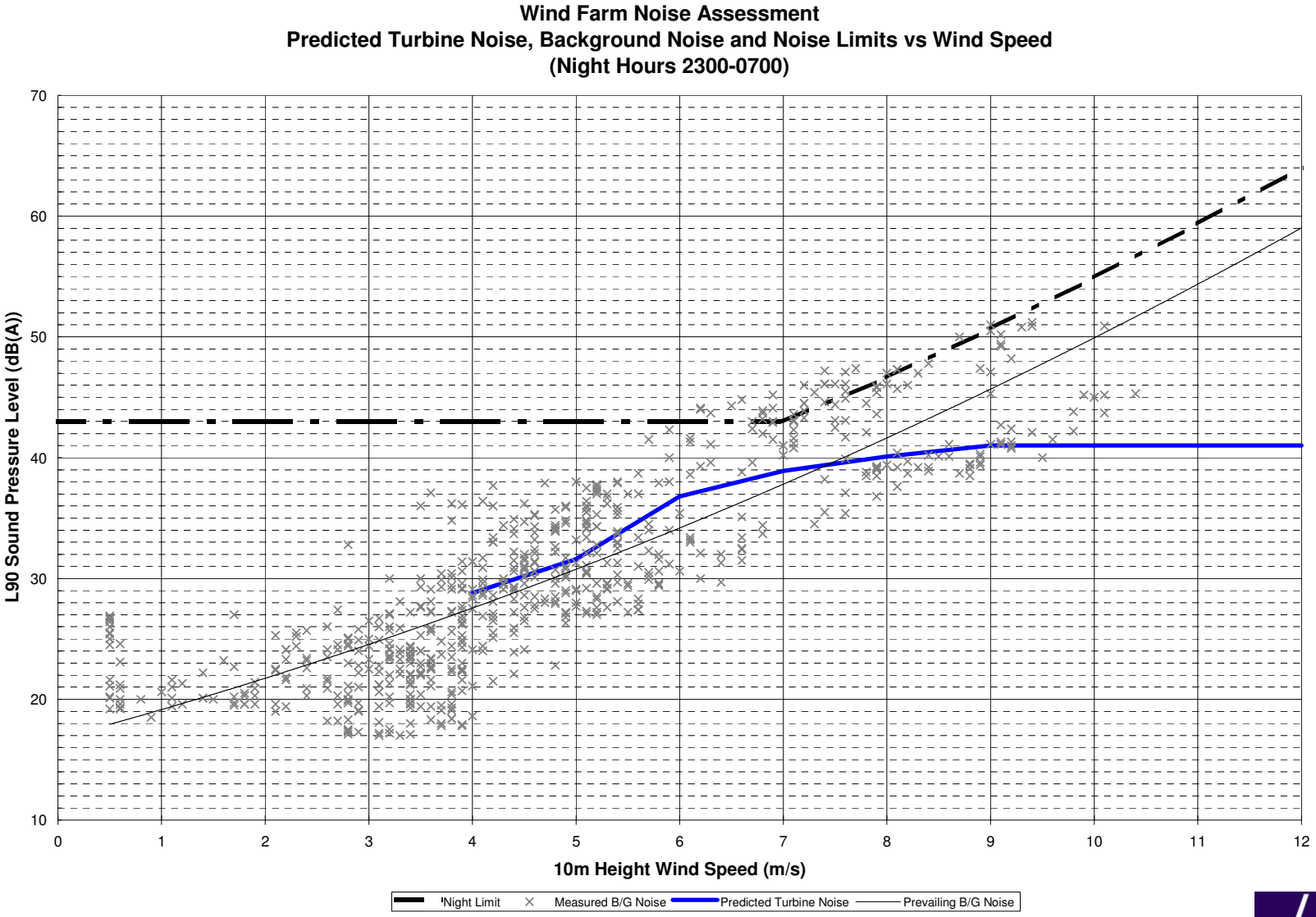
B/G Noise Measurements

- Location of instrumentation
- Effects of season
- Access / Can't measure everywhere
- Effects of wind direction
- Direct effects of wind
- Rainfall
- Other extraneous data (What is extraneous?)
- Traffic flow, birds, scatter (and effects on R^2)
- Wind shear (and more scatter)

Wind Shear

- Wind turbine noise ref. 10m height
  - but not really…!
- Problems occur if b/g ref. 10m height
  - as referred to by ETSU…!

Effects of Wind Shear with 10m Height Measurements



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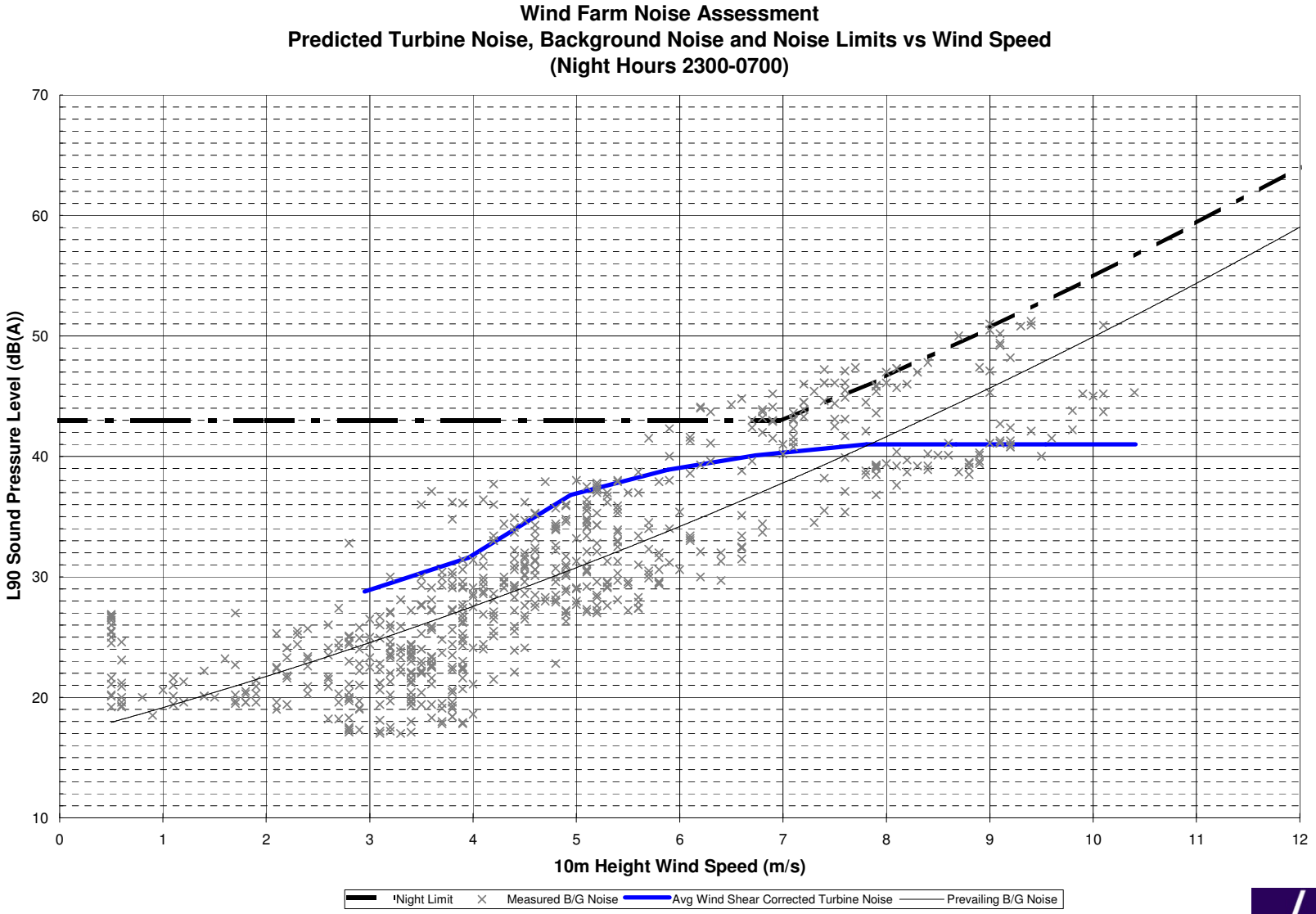

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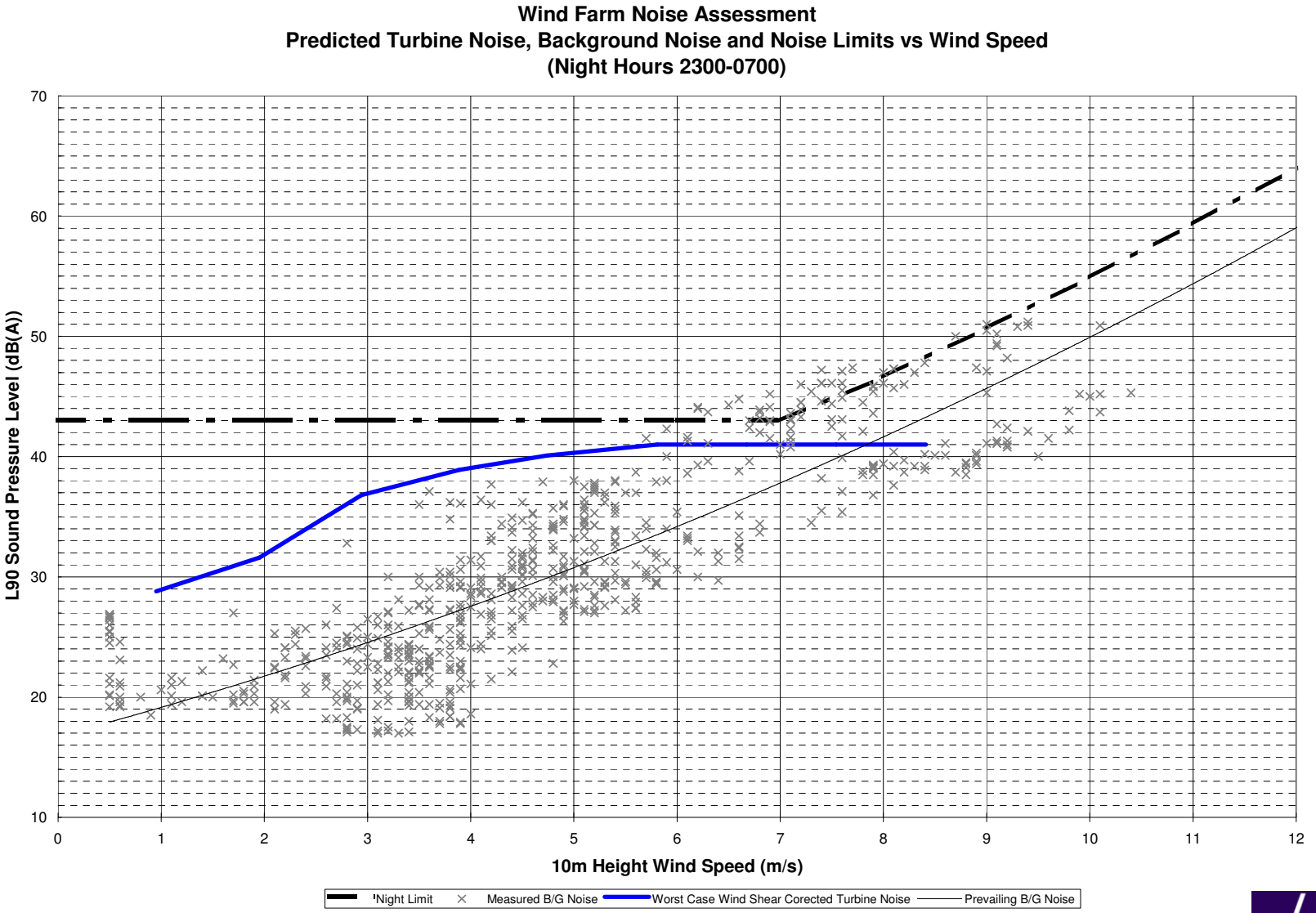

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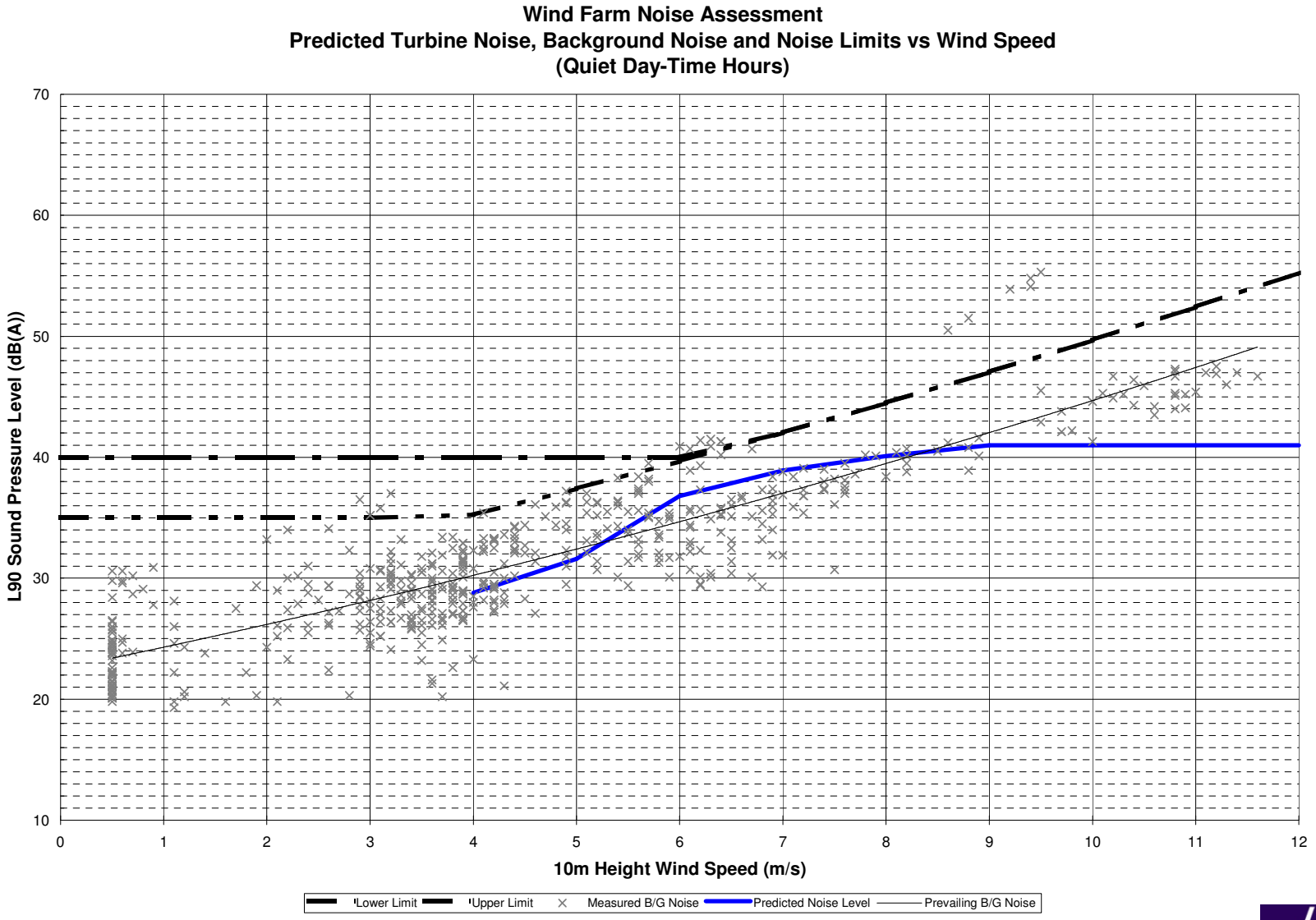

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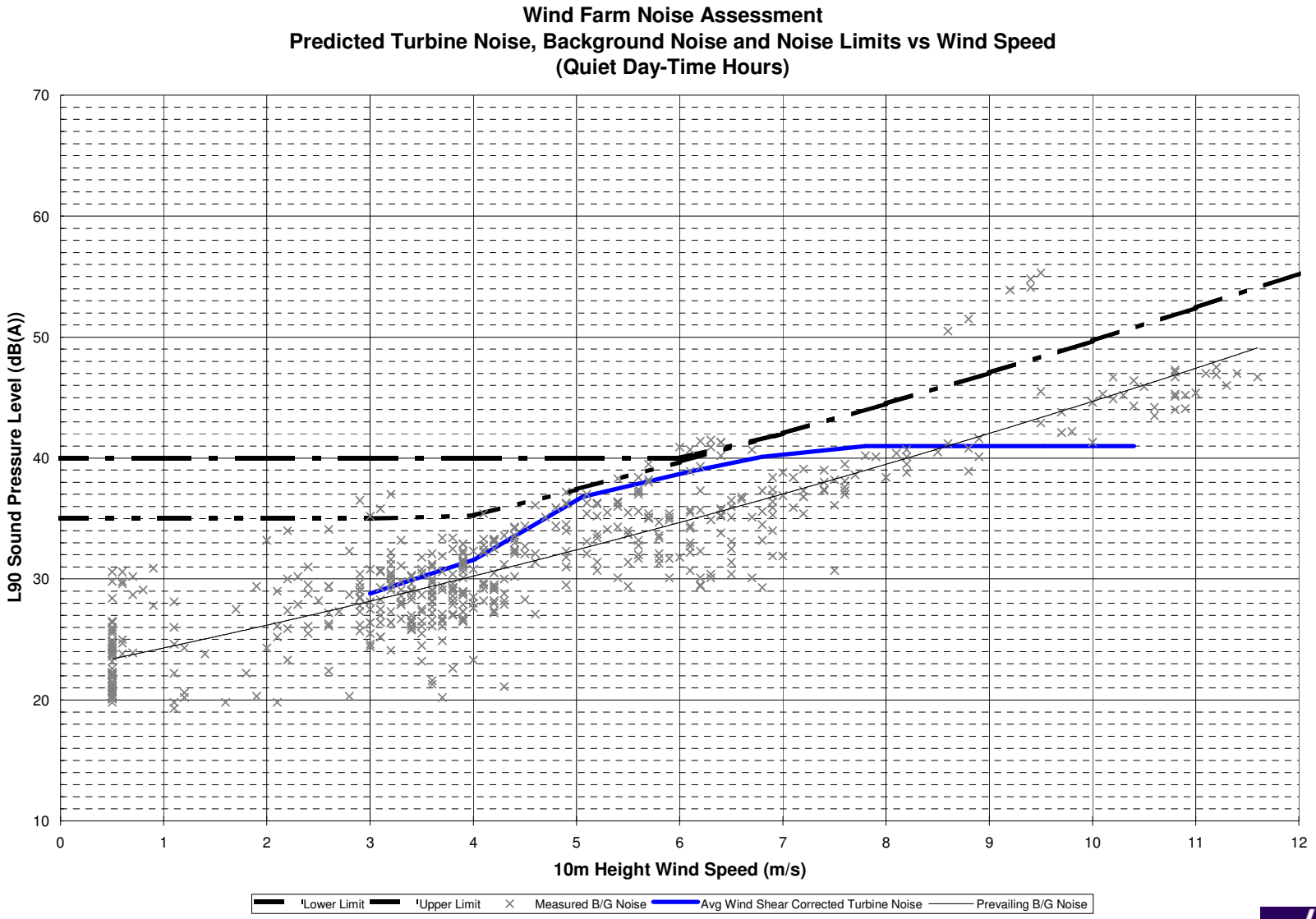

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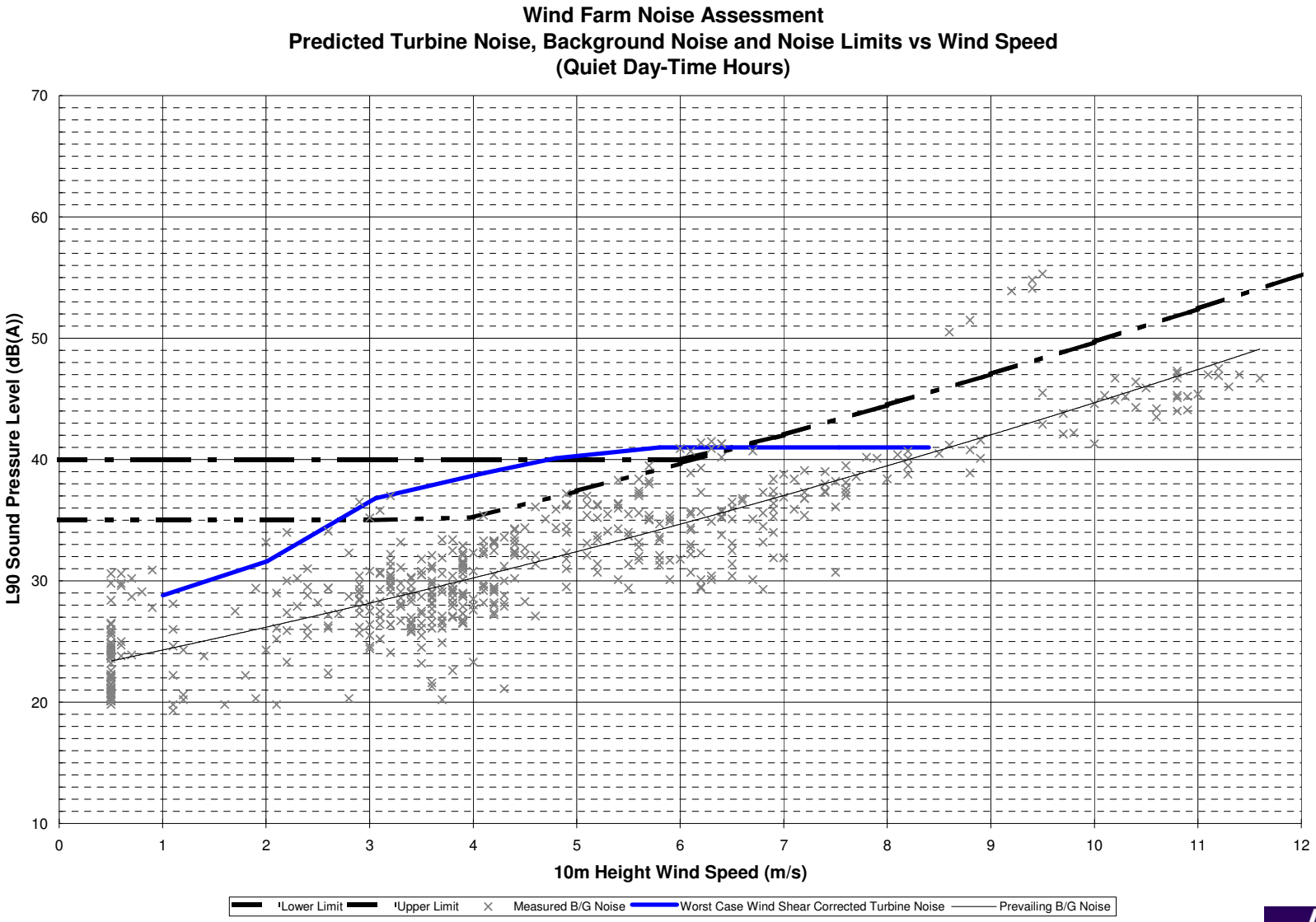


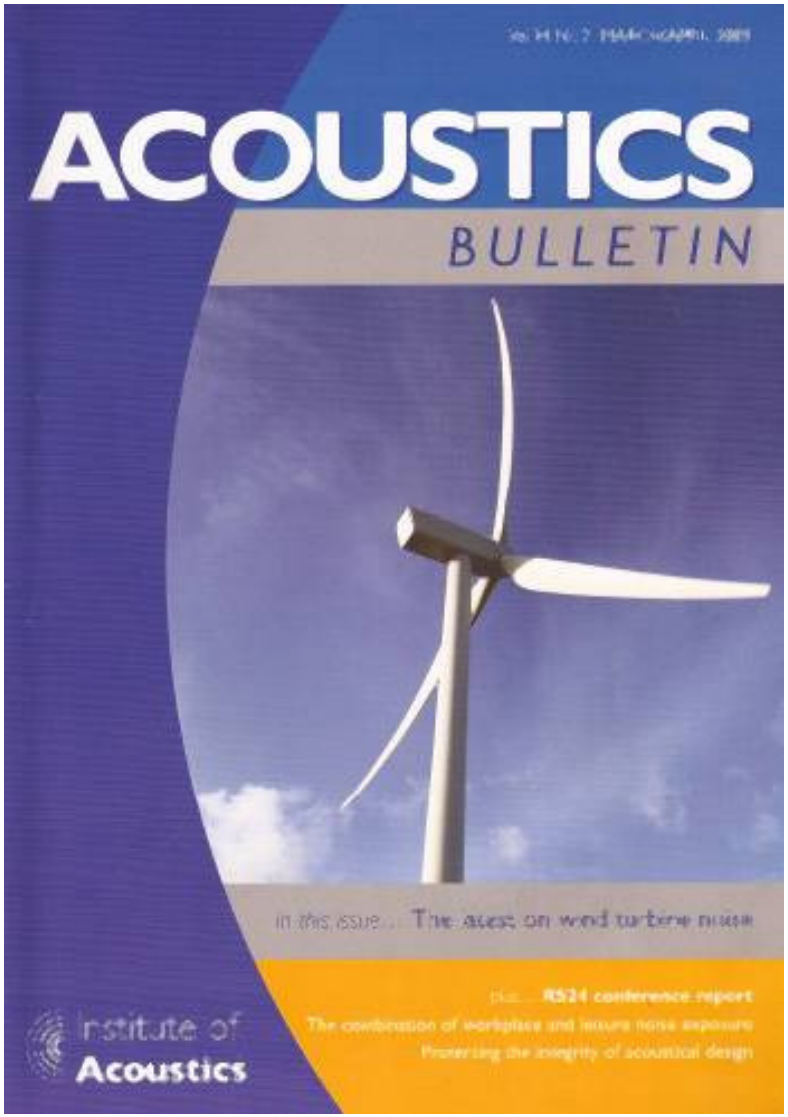
How should wind shear be dealt with?

- Reference b/g noise to 10 metre height wind speed. Predict variation in turbine noise wrt actual 10m wind speed.

  or

- Reference background noise to hub height wind speed ‘standardised’ to 10 metre height. Turbine noise stays constant wrt standardised 10m wind speed.

The IoA Bulletin Agreement…



Noise Predictions

- ISO9613-2
- Source Noise Levels
  - Test Report or Warranted Data
- Propagation
  - Ground Effects: G=0 / G = 0.5 (@4m). Not G=1!
  - Atmospheric Attenuation: 10^{o}C / 70% RH
  - Barrier Attenuation: Just 2 dB. Need to justify any more.

Amplitude Modulation

- ETSU-R-97 says '*the noise levels recommended in this report take into account the character of noise described… as blade swish. Given that all wind turbines exhibit blade swish to a certain extent we feel this is a more common-sense approach given the current level of knowledge*'

Amplitude Modulation

- The DTI/BERR report (on low frequency noise) concluded that '*it may be appropriate to re-visit the issue of aerodynamic modulation and the means by which it should be addressed. In the presence of high levels of amplitude modulation a correction for the presence of the acoustic feature should be considered'.*

Amplitude Modulation

- The Salford University report on Amplitude Modulation concluded that '*since AM cannot be fully predicted at present, and its causes are not fully understood we consider that it might be prudent to carry out further research to improve understanding in this area*'.

- Govt. Statement accompanying report stated that it '*continues to support the approach set out in PPS22*' ... '*through the use of the 1997 report by ETSU to assess and rate noise from wind energy developments*'.

Amplitude Modulation

- Renewable UK Project to establish:
  - Causes
  - Quantification
  - Penalty/Correction

Infrasound, Low Frequency Noise & Vibration

- Despite media hype, noise output from wind turbines is not particularly biased towards low frequency and there is no significant infrasound or vibration.
- As a result, infrasound, low frequency noise and vibration is not an issue for on-shore wind turbine sites.

‘Health’ Effects

- Direct health effects
  - Tendancy for a few medical professionals to make a link between this and low frequency noise and / or infrasound.
- In-direct health effects.
  - A possible effect of stress and / or sleep disturbance caused either directly or as a result of stress.

Audibility and Complaints

- Audibility is unacceptable for some (many?) and complaints may occur.

Part 2 - Areas for Debate

- Quantification of Baseline
- Noise Prediction Methodology
- Wind Shear
- Noise Limits and Assessment
- (Excess) Amplitude Modulation
- Cumulative Impact

* See also conclusions of DECC Report

http://www.decc.gov.uk/en/content/cms/meeting_energy/wind/onshore/onshore.aspx

Quantification of Baseline

- Location – Free field / and façade issues.
- Duration of Survey – Effect of season and other variability.
- Extrapolation – Is it valid to measure ‘nearby’?
- Effects of wind direction – How to take into account?
- Direct effects of wind – wind shields.
- Extraneous data - what is extraneous?
- Scatter – does scatter matter?
- Prevailing background – good approach?

Noise Prediction Methodology

- Source Noise Data – Measurement reports, warranties, uncertainties, declared apparent sound power level, octave band levels.
- Noise Propagation – IoA Bulletin Article
- Atmospheric, Ground and Barriers – Covered adequately?
- Other Factors – Forestry, sea.
- Use of LA90 – and conversion from LAeq

Wind Shear

- Baseline Noise – Reference to hub height or 10m height?
- How to Account for WS if Ref to 10m Height – ‘Correct’ baseline or turbine noise?
- How to Account for WS if correcting turbine noise – Worst case, typical worst case or average?
- Deriving Hub Height Wind Speed – IOA Bulletin method, Hub height mast, LiDAR/SoDAR

Noise Limits and Assessment

- Limits based on wind related background noise – how to make robust?
- Are ‘fixed lower limit’ values (day, night, financially involved) appropriate?
- Should assessment go beyond ETSU-R-97? ie. Lden / Ln or similar
- Or should it be made simpler – ie. using a completely fixed limit or one based on non-wind related background noise? How would this be quantified?

(Excess) Amplitude Modulation

- What is it?
- Does it need to be measured / quantified?
- If so, how to take into account?
- How should it be controlled?

Cumulative Impact

- Should baseline exclude all turbine noise? – how to manage in practice?
- Given requirement for all turbine noise to meet ETSU limits, how should cumulative impact be assessed?
- Given that planning conditions only control consented site, how should cumulative impact be controlled?
- What happens where conditions on first site ‘use up’ noise limits?