

# Rheiner Windenergie-Forum 2011

Verhaelt sich Schall in Grossbritannien  
anders als in Deutschland?

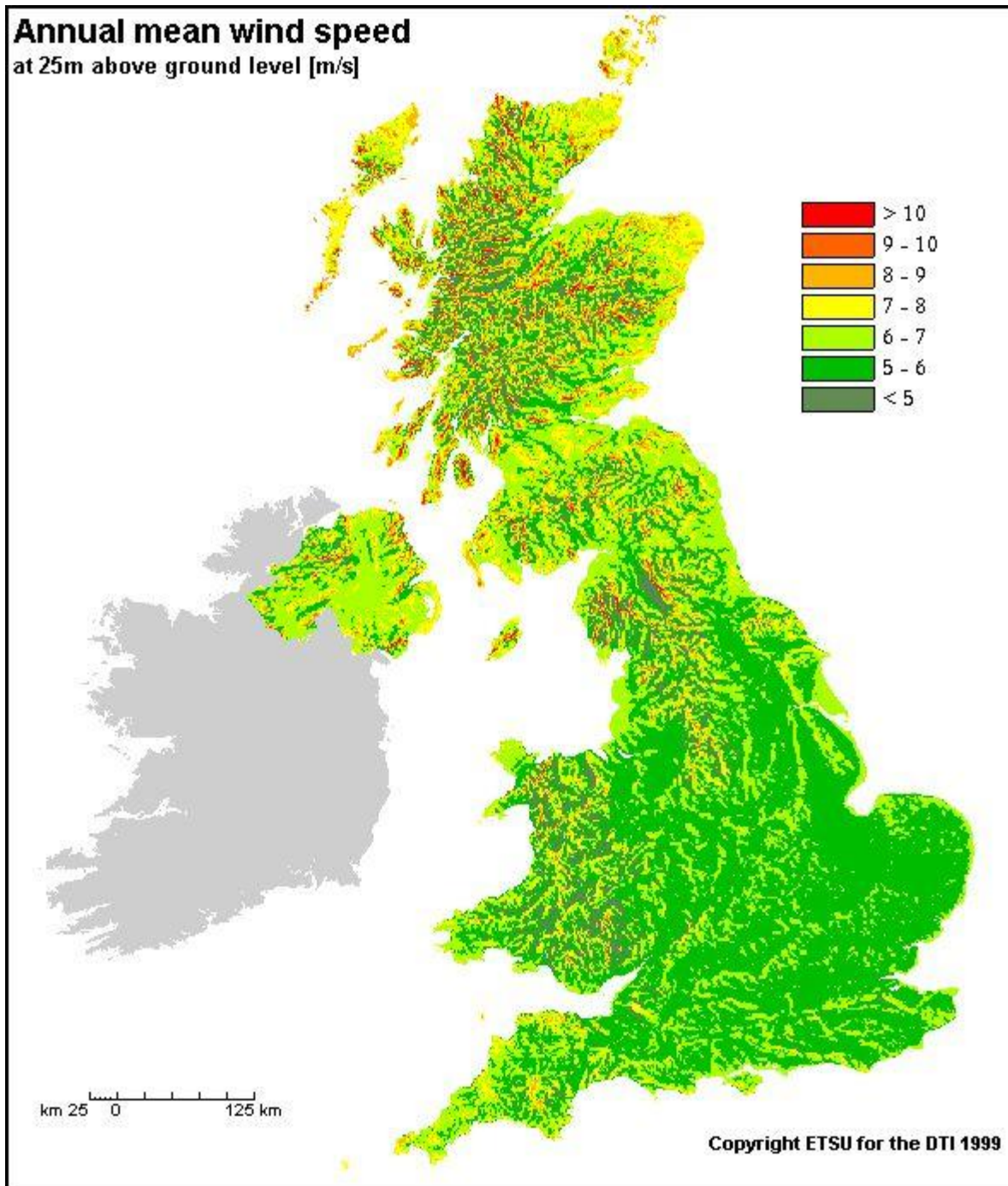
**Dipl.-Ing. Sylvia Broneske**

Hayes McKenzie Partnership Ltd

Salisbury & Machynlleth



# Annual mean wind speed at 25m above ground level [m/s]

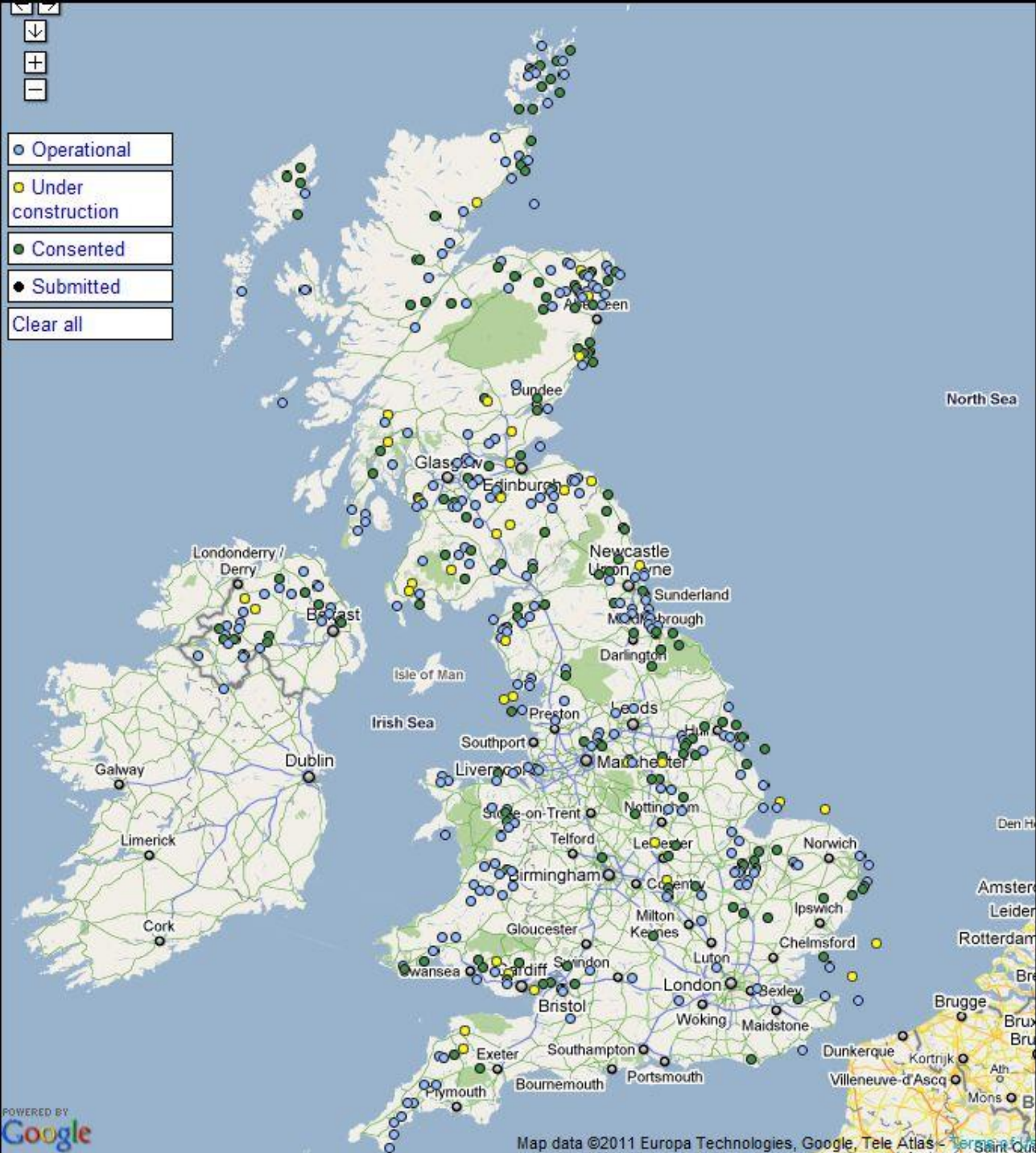


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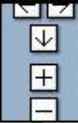
- Operational
- Under construction
- Consented
- Submitted
- Clear all



# Hayes McKenzie Partnership Ltd

- 1978 lernen sich die beiden Direktoren beim Studium am ISVR/University of Southampton kennen
- Zunaechst getrennte Wege:
  - Malcolm Hayes – Consultancy at Hann Tucker
  - Andy McKenzie – Research at ISVR + Freelance
- Hayes McKenzie Partnership gegrundet in **1991**





Map

HMPL Salisbury


North Sea

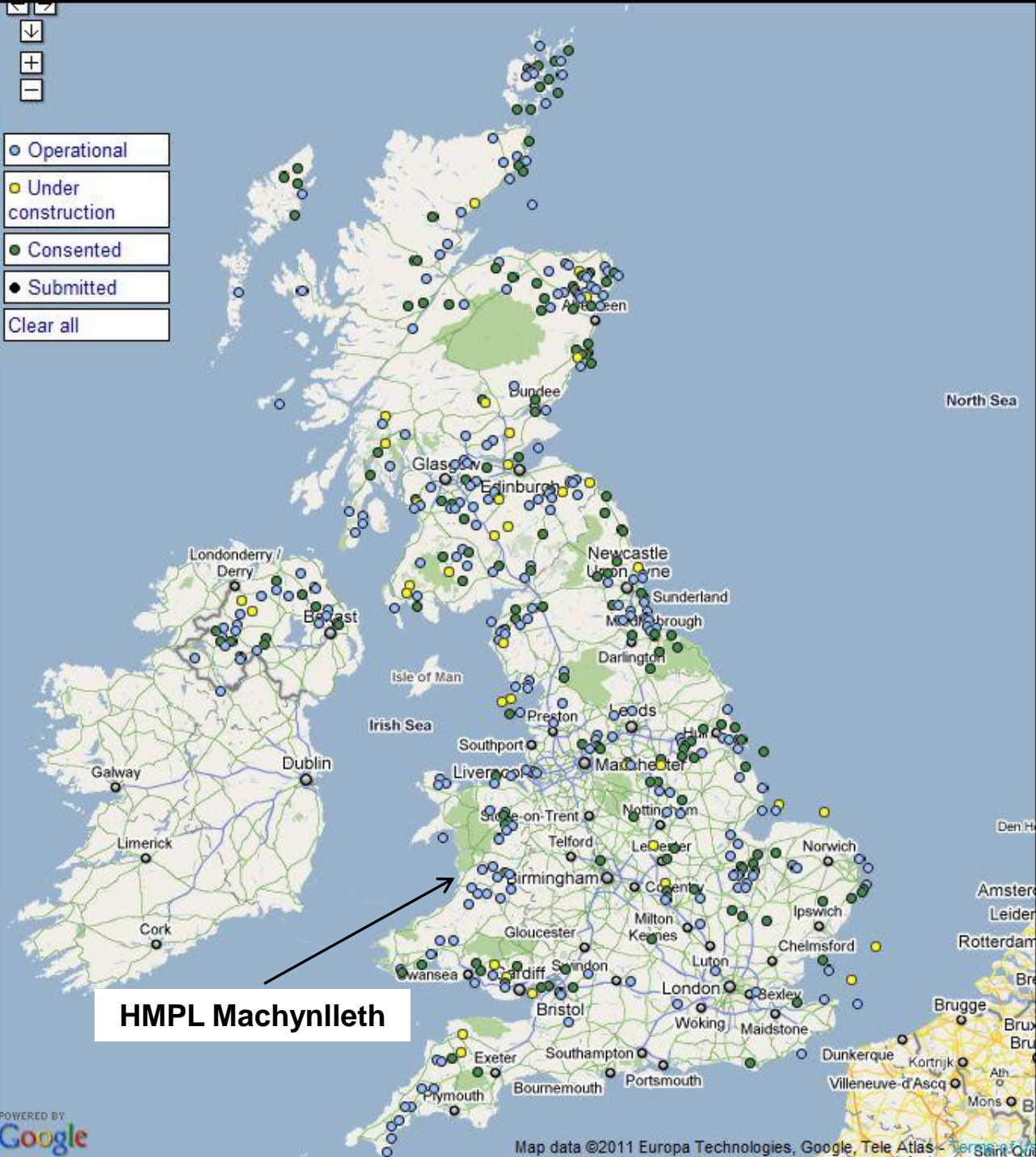


POWERED BY  
Google

Map data ©2011 Europa Technologies, Google, Tele Atlas



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**HMPL Machynlleth**



# Hayes McKenzie Partnership Ltd

- Direktoren Dr. Andy R McKenzie und Malcolm D Hayes
  - 7 Mitarbeiter (Vollzeit)
  - 3 Buerokraefte (Teilzeit) und
  - 4 Buerohunde
- Haben an ueber 600 Windparks (in Planung, genehmigt oder aufgestellt) gearbeitet
- In UK, Continental Europe, USA, Canada, Australia, New Zealand und Asia



# Hayes McKenzie Partnership Ltd

- Schallvermessungen von etwa 30 Anlagentypen
- Immissionsmessungen an ca. 30 bestehenden Windparks
- Gutachter (expert witness) in ueber 70 UK oeffentlichen Anhoerungen im Rahmen des Genehmigungsverfahrens (public inquiries)
- Vermessungen von Kleinwindkraftanlagen



# Dienstleistungen HMPL

- Umweltverträglichkeitsprüfung und Planung
  - Hintergrundgeräuschemessungen
  - Schallausbreitungsberechnungen
  - Vergleich von Berechnungen mit Schallgrenzwerten
  - Berichte in der Planungsphase oder Kapitel für die UVP Unterlagen



# Dienstleistungen HMPL

- Immissionsmessungen
- Schallvermessung fuer Bauvorhaben
  - ob Wohnhaeuser gebaut werden duerfen
  - ob eine industrielle Anlage/Handwerksbetrieb etc. in der Naehе von Wohnbebauung gebaut werden duerfen
- Vermessung von Schallisolierung in Gebaeuden
- Sodar (Triton)





# Issues

- ETSU-R-97
- Background Noise Measurements
- Wind Shear
- Noise Predictions
- Low Frequency Noise and Vibration
- Amplitude Modulation
- ‘Vibro-Acoustic Disease’
- ‘Wind Turbine Syndrome’



# ETSU-R-97



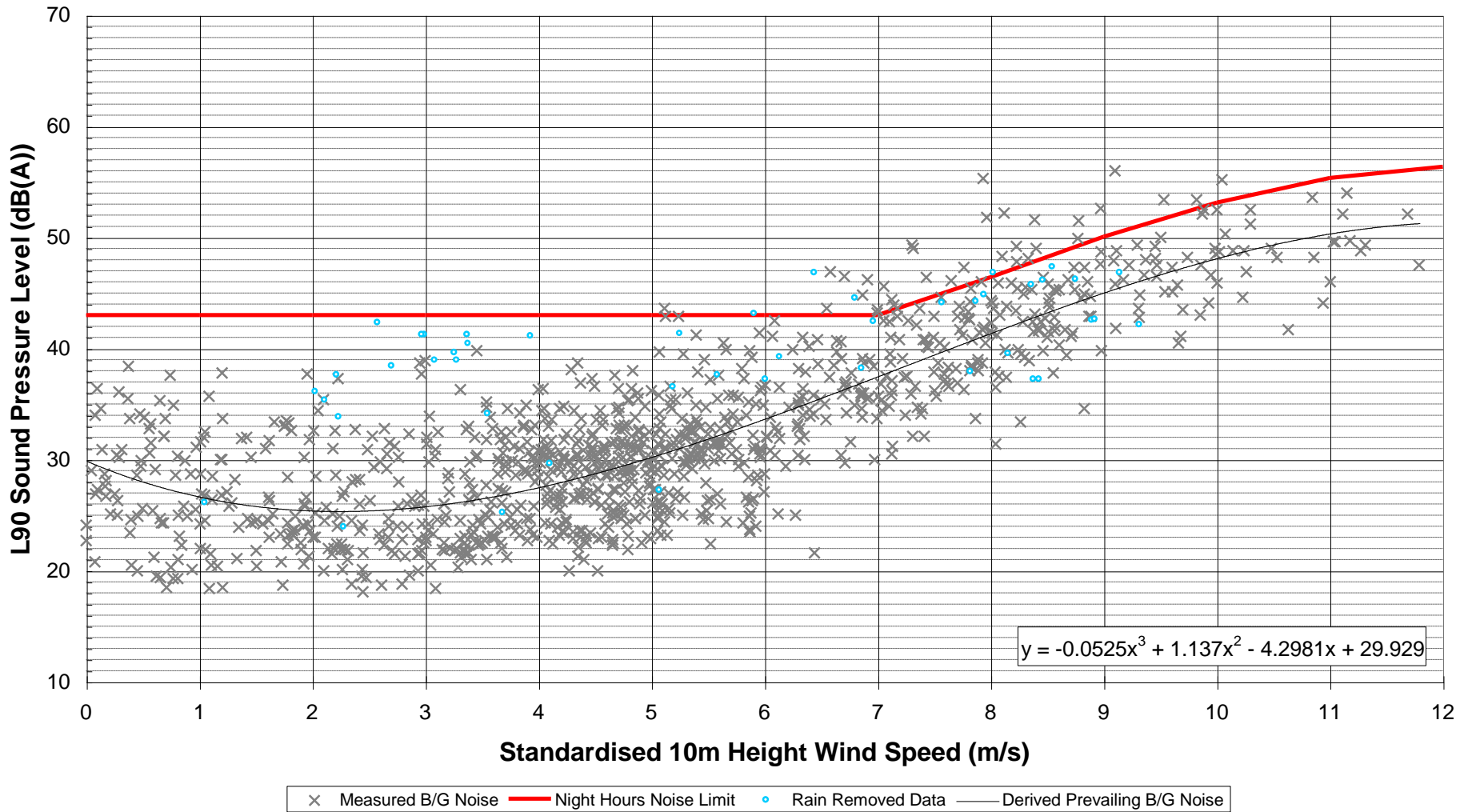
# ETSU-R-97

- Korrelation von Hintergrundgeräuschen mit Windgeschwindigkeit
- ‘Vorherrschendes’ Hintergrundgeräusch
- Grenzwerte fuer niedriges Hintergrundgeräusch
  - 35-40 dB  $L_{A90}$  waehrend des Tages
  - 43 dB  $L_{A90}$  waehrend der Nacht
  - 45 dB  $L_{A90}$  fuer ‘involvierte’ Grundstuecke
- Vereinfachtes Verfahren  $< 35$  dB  $L_{A90}$



# W/F Noise Assessment

## Prevailing Background Noise, Derived Noise Limits and Predicted Turbine Noise Night Hours (2300-0700)



# B/G Noise Measurements

## In Rural Areas

- Precise 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?)
- Scatter (and effects on  $R^2$ )
- Wind shear (and more scatter)



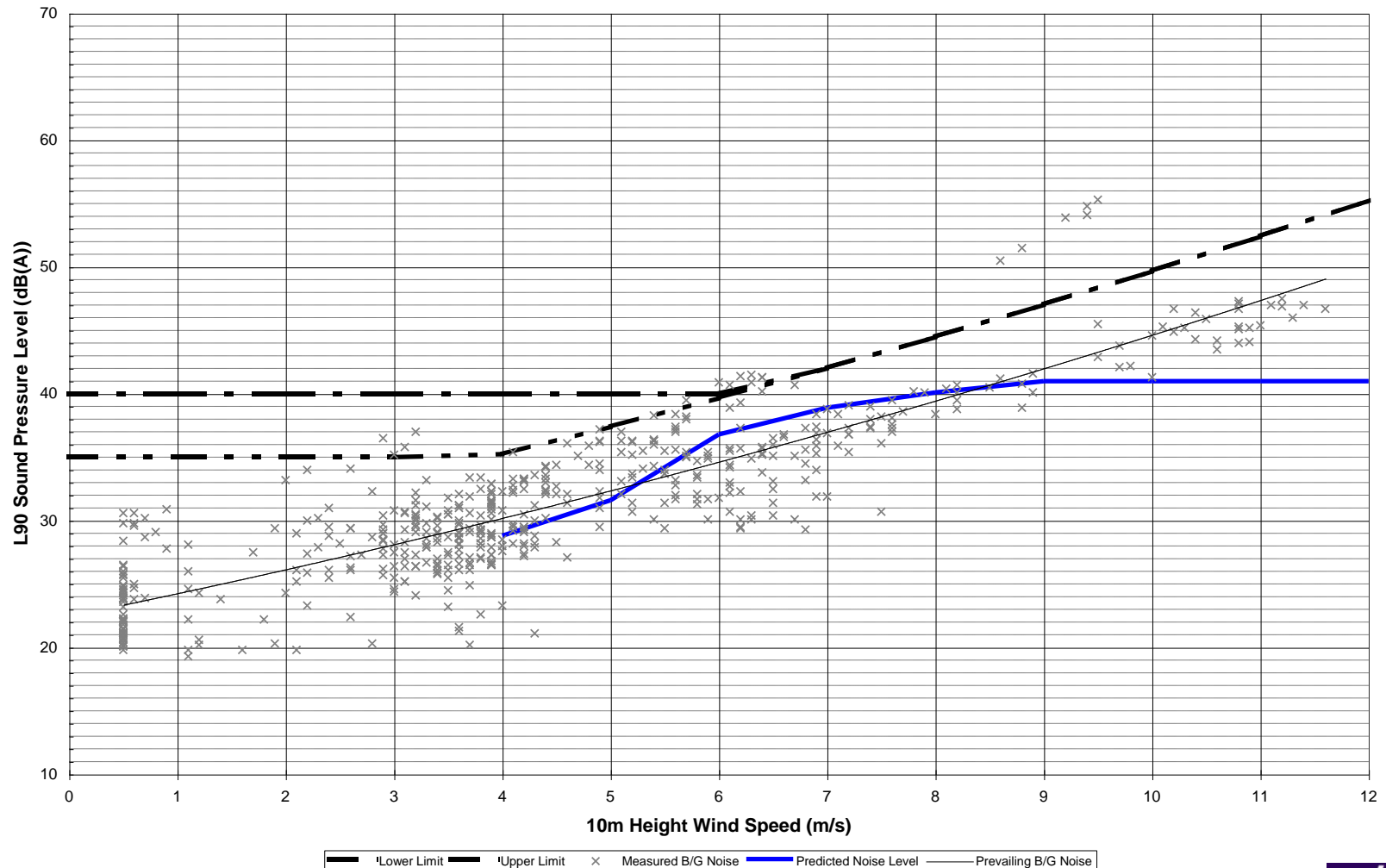
# Wind Shear

- Schalleistungspegelangaben von Herstellern bezogen auf 10 m Hoehe  
– but not really...!
- Probleme tauchen auf, wenn Hintergrundgeraeusch bezogen wird auf 10 m Hoehe  
– as required by ETSU...!



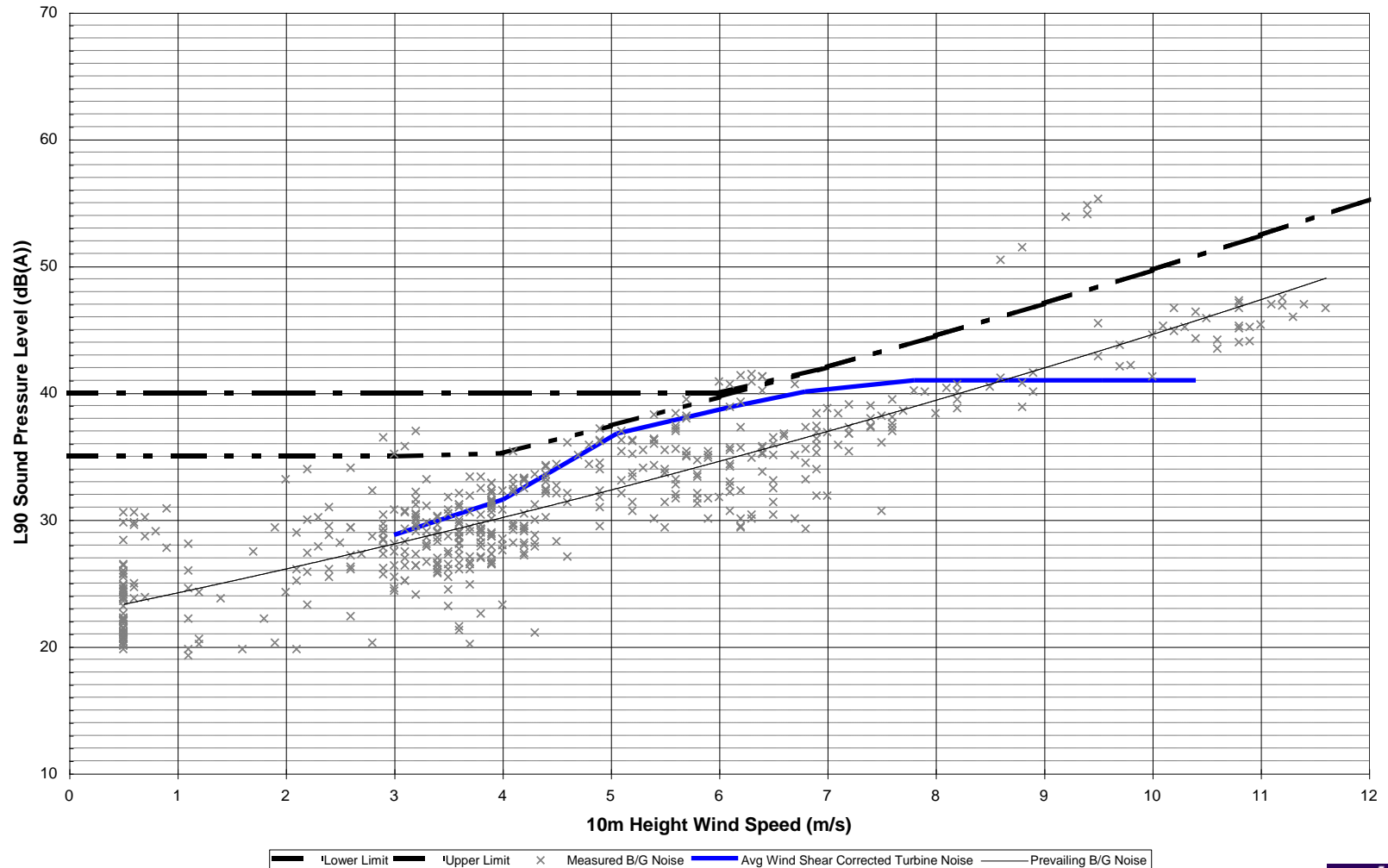
# Effects of Wind Shear with 10m Height Measurements

Wind Farm Noise Assessment  
Predicted Turbine Noise, Background Noise and Noise Limits vs Wind Speed  
(Quiet Day-Time Hours)



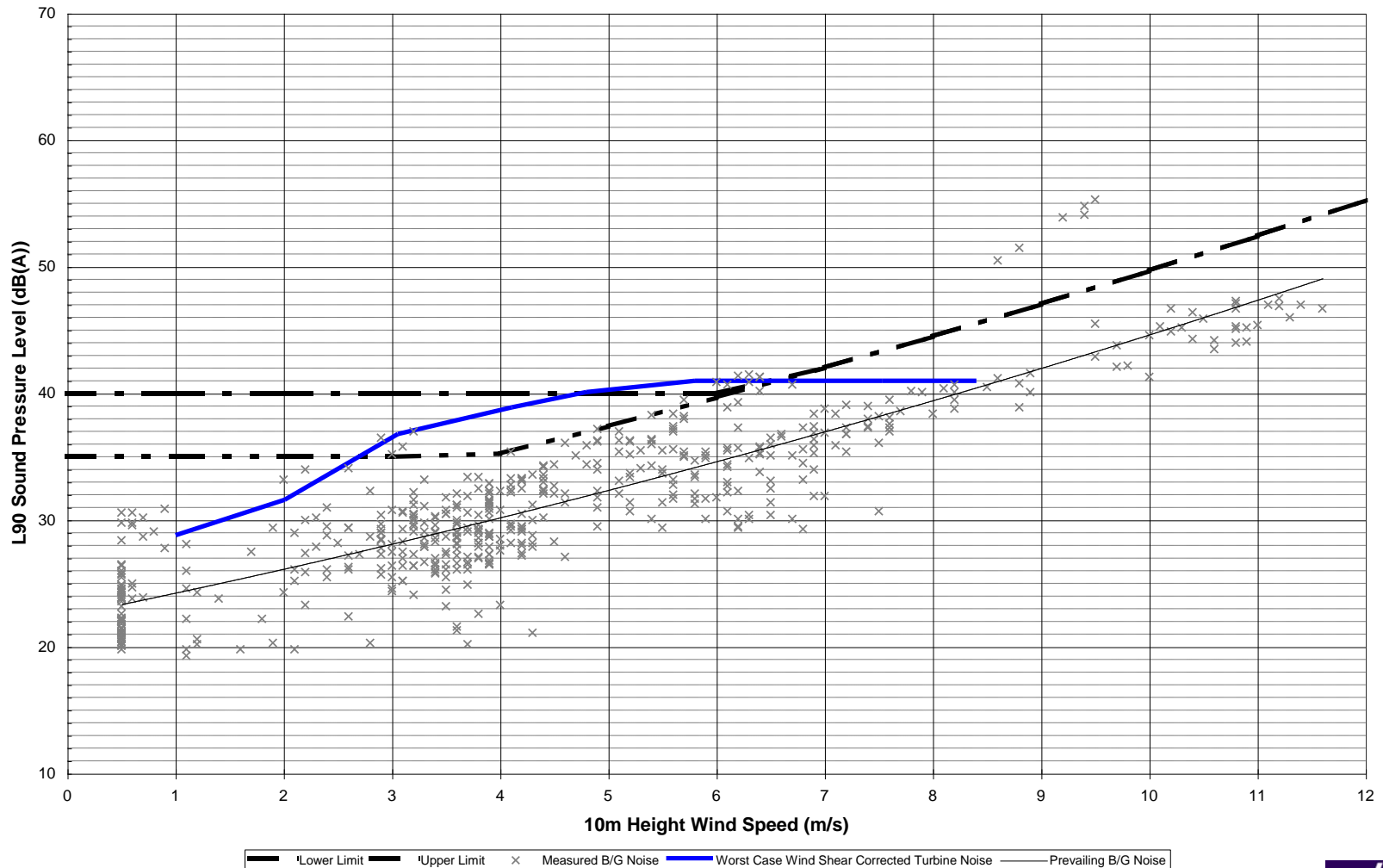
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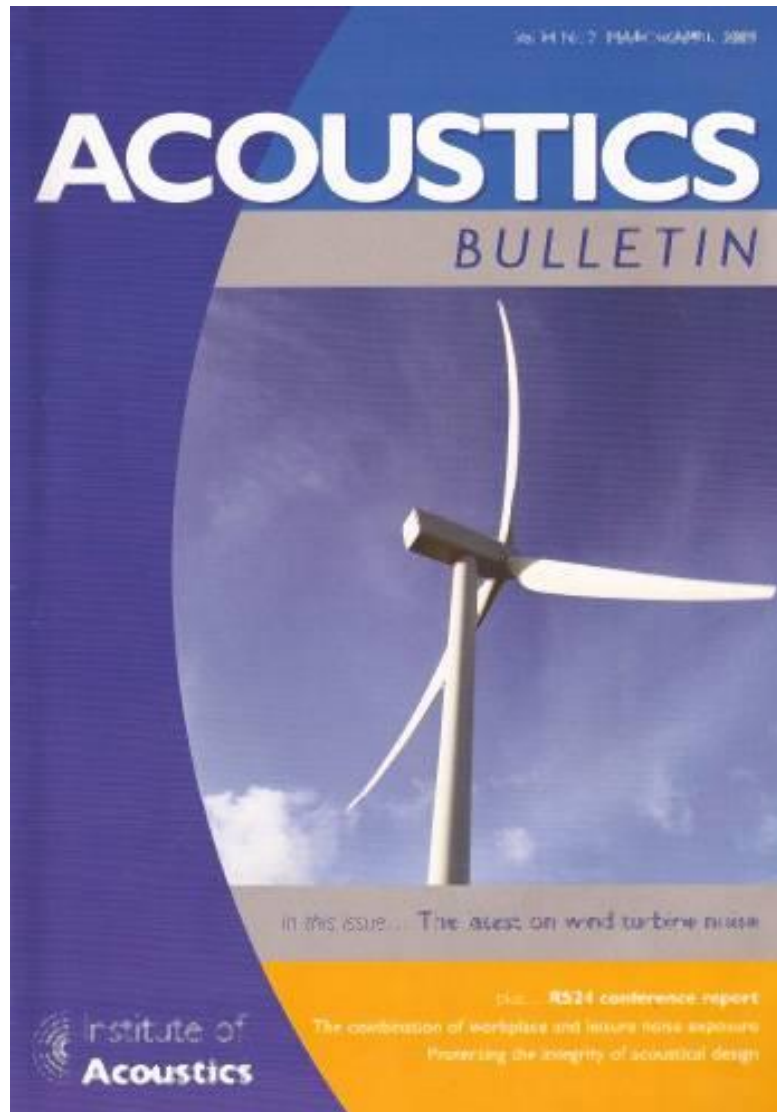


# Wie sollte mit dem Problem umgegangen werden?

- Hintergrundgeraeusch beziehen auf Nabenhoehenwindgeschwindigkeit
  - ‘Standardisierung’ auf 10 m Hoehe
- Idealerweise Messung der Winddaten direkt auf NH
- Oder Herleiten aus Messungen in niedrigeren Hoehen fuer 10 min Zeitraum



# The IoA Bulletin Agreement...



# Was steht drin?

- Vereinbarung einer ad-hoc Gruppe, deren Mitglieder sich viele Male bei Anhoerungen gegenueberstanden
  - Wind Shear (siehe vorherige Folien)
  - Schallausbreitungsberechnung
  - Vibrationen und niederfrequenter Schall
- Ist weder eine offizielle IoA noch offizielle Regierungsempfehlung

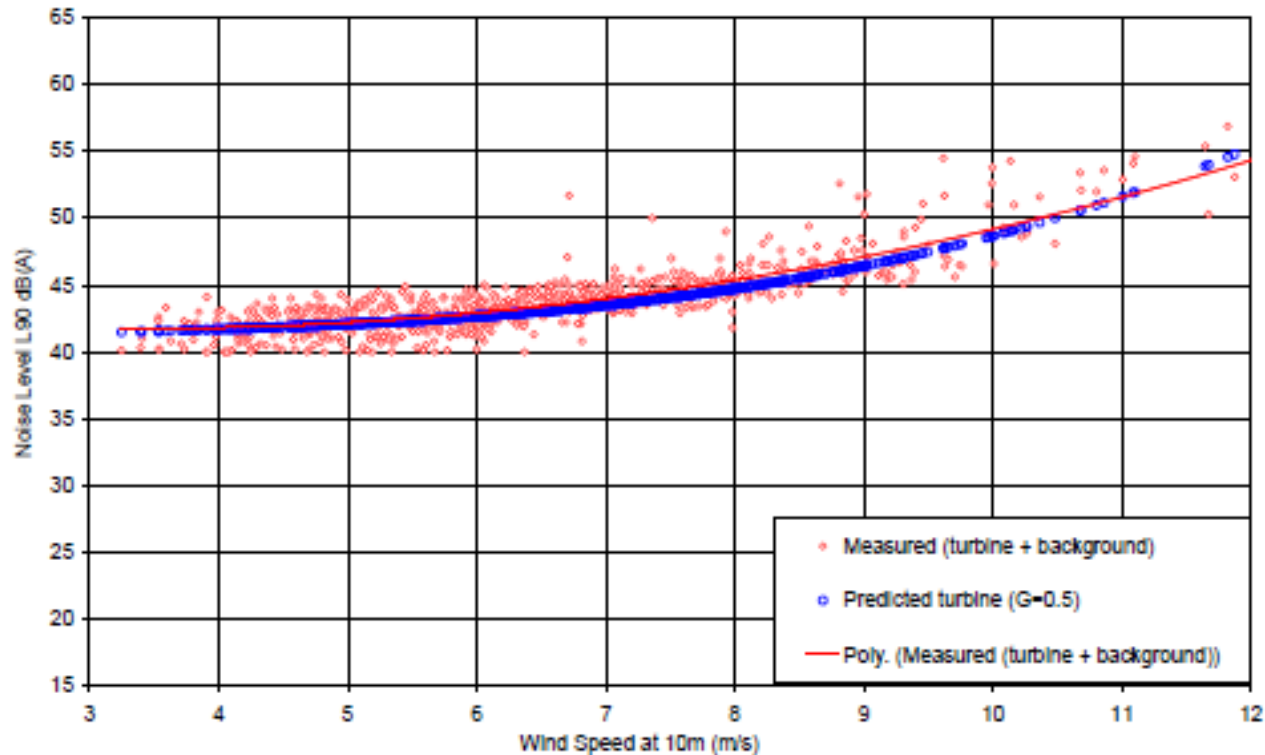


# Schallausbreitungsberechnung

- Schalleistungspegelangaben
  - Messbericht oder SWL Garantien
  - Windgeschwindigkeiten von 4 – 12 m/s re 10 m Hoehe
  - Oktavbanddaten
- Schallausbreitung
  - Bodeneffekt:  $G=0$  /  $G = 0.5$  (@4m). Not  $G=1!$
  - Atmospheric Attenuation:  $10^{\circ}\text{C}$  / 70% RH
  - Hindernis: Reduktion 2 dB. Muss begruendet werden, falls hoeherer Wert angenommen wird



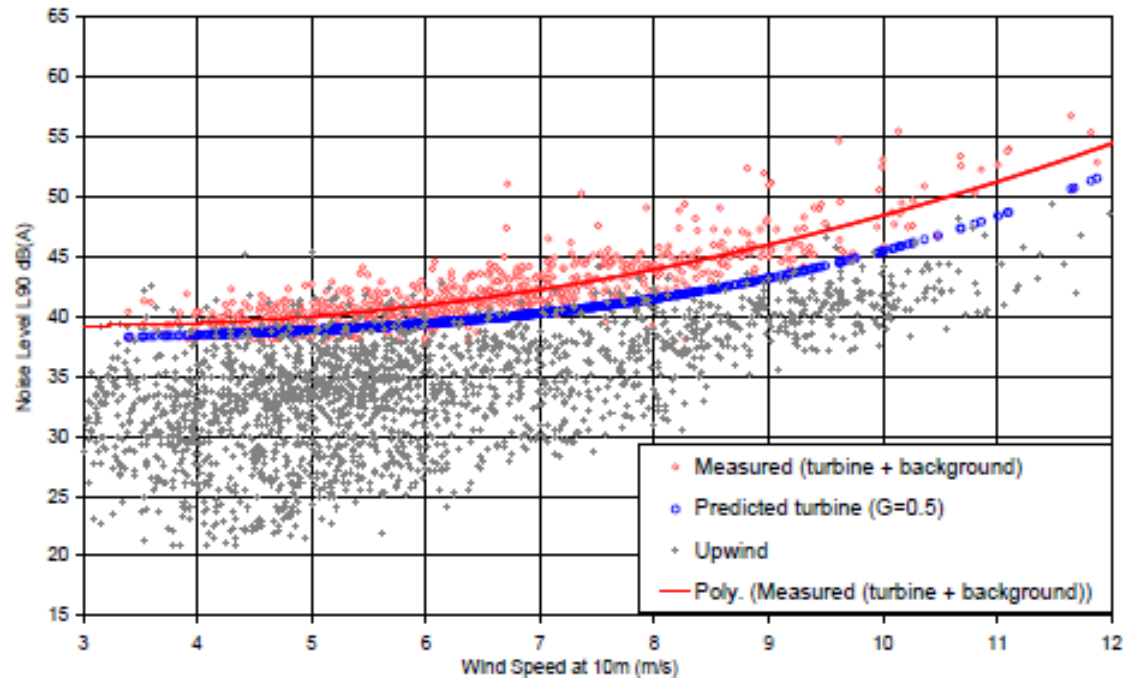
# Verification Measurements 450 m



**Figure 5a:** Levels Comparison of Site C measured and predicted noise levels at measurement location 2 (450 m distance). All downwind angles restricted to +/-45 degrees. Predicted noise levels based on a single site wind speed reference and  $G = 0.5$ .



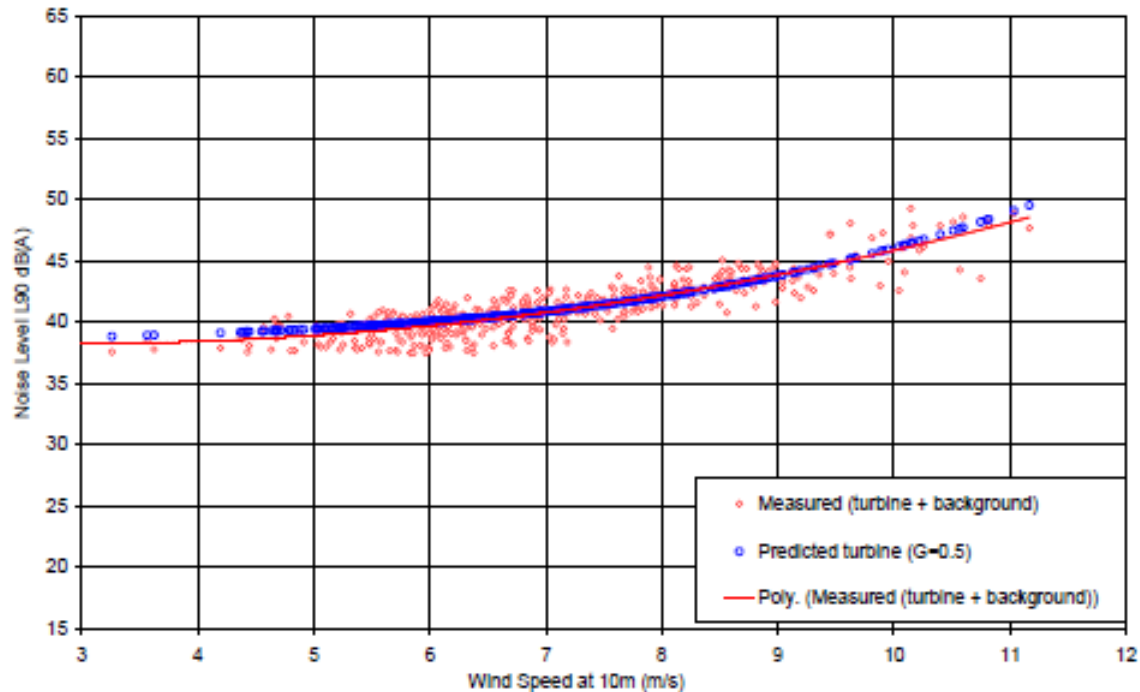
# Verification Measurements 750 m



**Figure 5b:** Levels Comparison of Site C measured and predicted noise levels at measurement location 3 (750 m distance). Downwind and upwind angles restricted to  $\pm 45$  degrees. Predicted noise levels based on a single site wind speed reference and  $G = 0.5$ . The low margin above background levels suggests that actual turbine noise levels will be closer to the predictions.



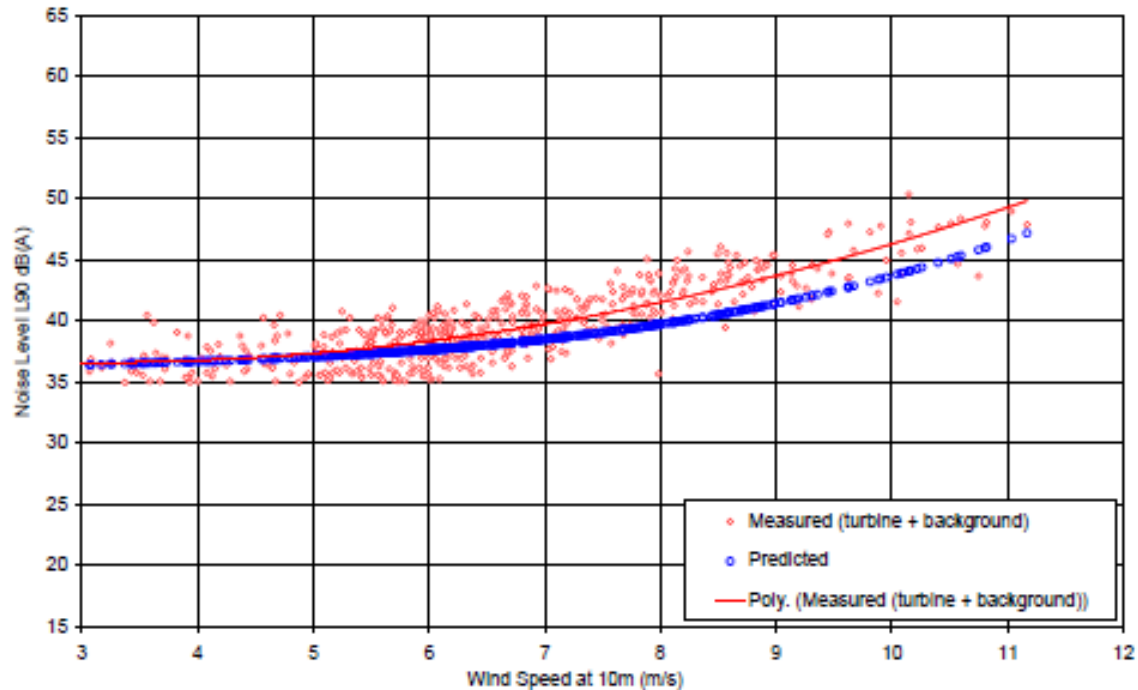
# Verification Measurements 700 m



**Figure 6a:** Levels Comparison of Site C measured and predicted noise levels at measurement location 4 (700 m distance). All downwind angles restricted to +/-45 degrees. Predicted noise levels based on a single site wind speed reference and  $G = 0.5$ .



# Verification Measurements 820 m



**Figure 6b:** Levels Comparison of Site C measured and predicted noise levels at measurement location 5 (820 m distance). All downwind angles restricted to  $\pm 45$  degrees. Predicted noise levels based on a single site wind speed reference and  $G = 0.5$ .



# Infrasound and Low Frequency Noise

- Hayes McKenzie Report for DTI on '*The Measurement of Low Frequency Noise at Three UK Wind Farms*'
- Concluded that '*Infrasound associated with modern wind turbines is not a source which will result in noise levels which may be injurious to the health of a wind farm neighbour*'.



# Infrasound and Low Frequency

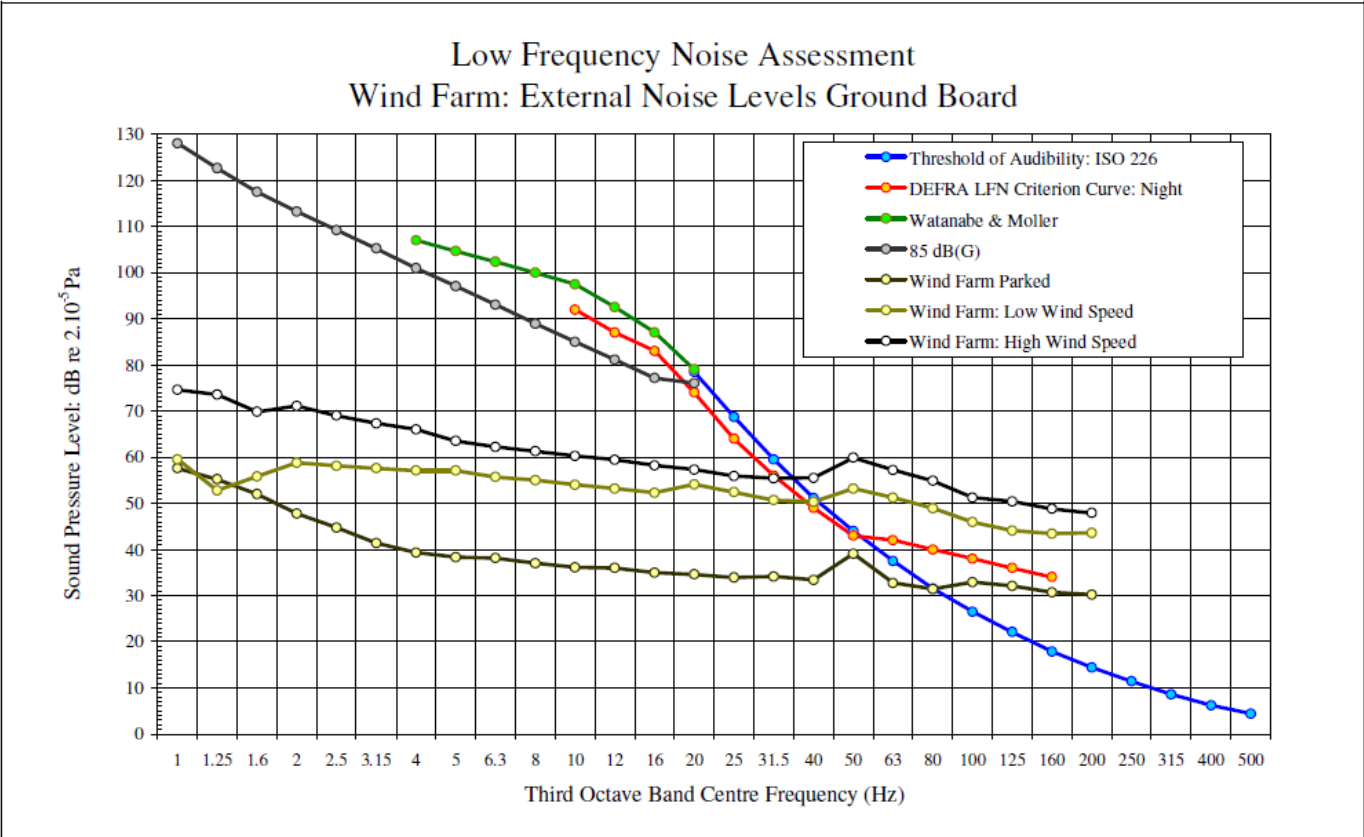


Figure 11: Measured Infrasound and Low Frequency Noise Levels: External Location on Ground Board (12 x 1.65 MW Turbines @ 360m)

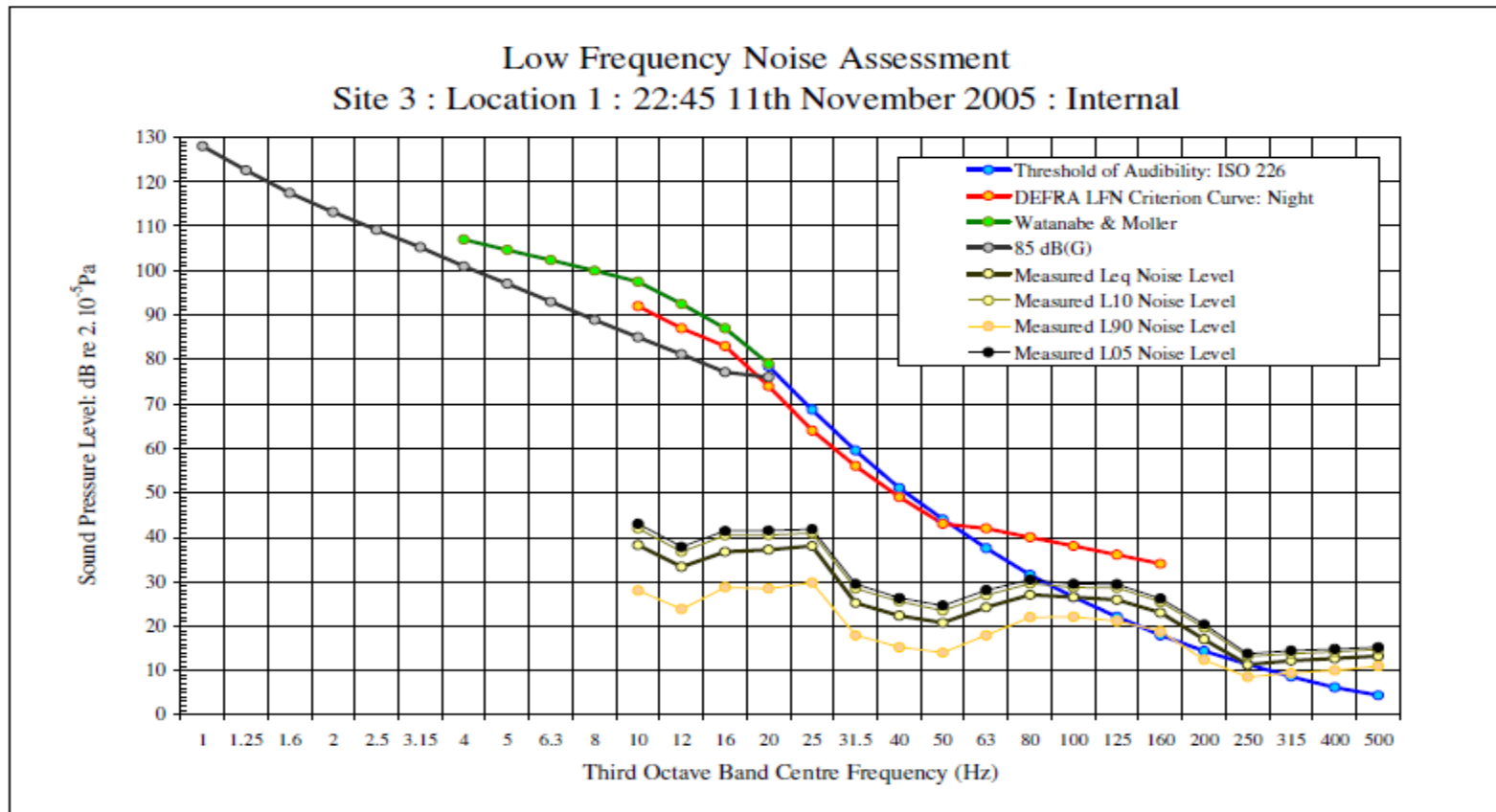


# Infrasound and Low Frequency

- Also concluded that, although audible, ‘the measurements performed at all three sites indicate that low frequency noise is measureable but below the DEFRA Night-Time Low Frequency Noise Criterion.



# Infrasound and Low Frequency Noise

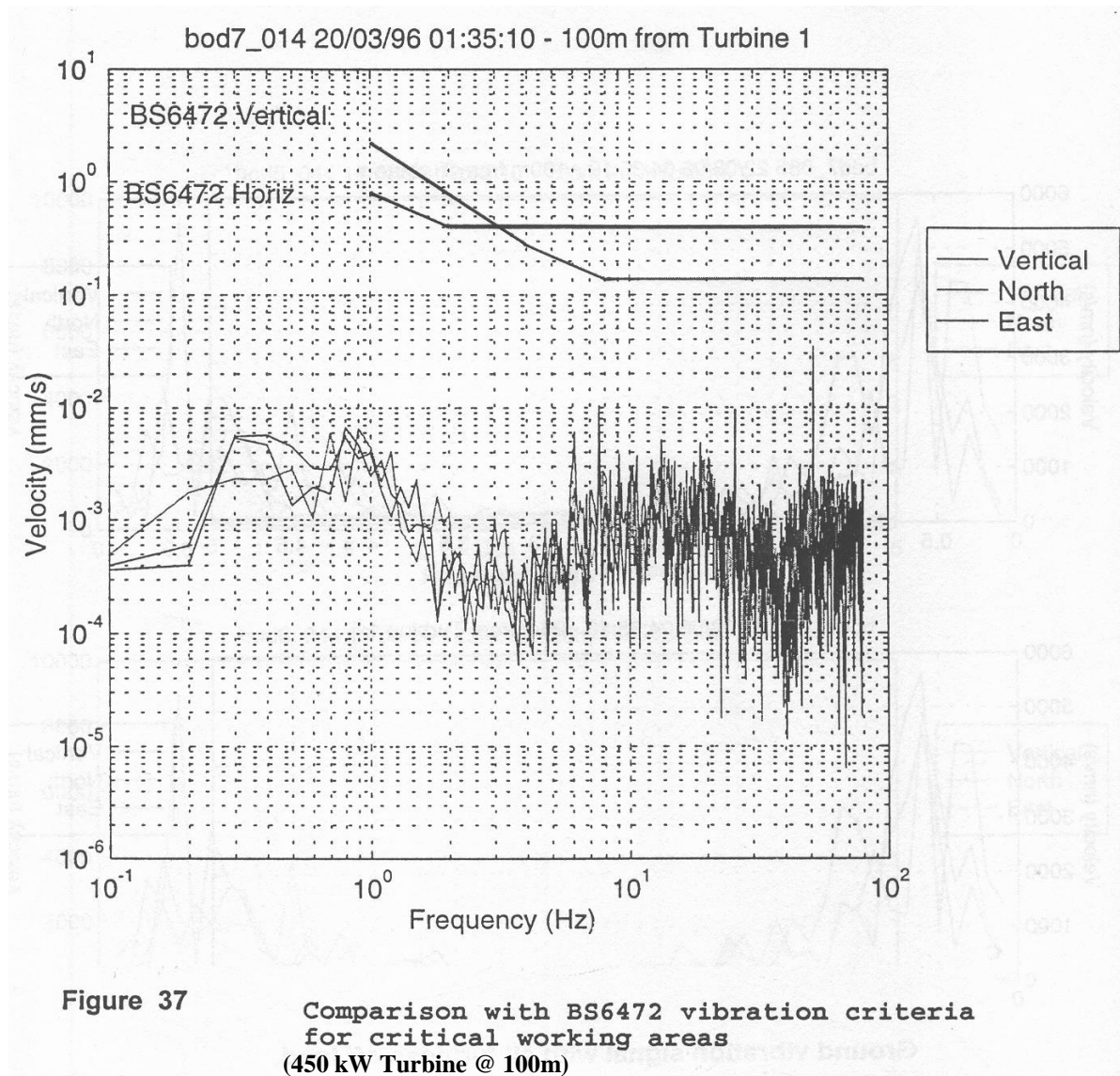


**Figure 48: Sample of internal noise levels when downwind of wind farm**

3 x 1.3MW Turbines @ 1km



# Vibration



# Amplitude Modulation

- Low Frequency Noise Report for DTI/BERR identified that low frequency and infrasound were not significant issues
- However
  - It also identified that what was being complained about was amplitude modulation which was being mis-referred to as LF noise.



# 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 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’.*

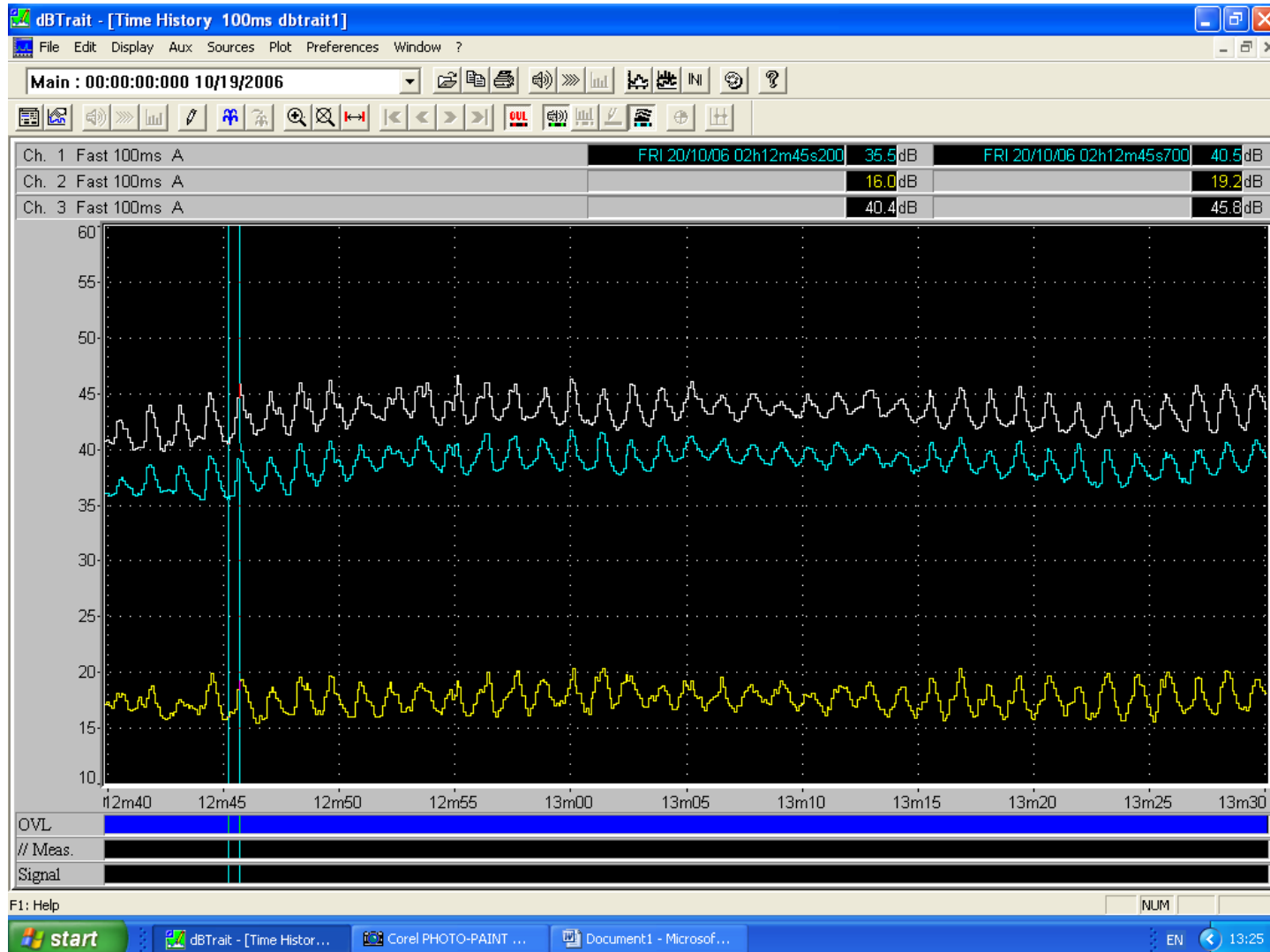


# Amplitude Modulation

- Salford University were commissioned to investigate the prevalence of Amplitude Modulation at wind farms across the whole of the UK
- Some debate over the interpretation of results which essentially stated it was a definite factor at 4 of the 133 sites operational at that time (2007) making it '*difficult to justify further research funding in preference to other more widespread noise issues*'.



# Amplitude Modulation



# Vibro-Acoustic Disease

- Alves-Pereira & Castelo Branco, Portugal
- Physiological symptoms attributed to LF exposure
  - Aircraft Maintenance Technicians ~120dB
  - Flight Crew ~ 70dB
  - Environmental Noise ~ 50-60dB



# Vibro-Acoustic Disease

- Family F
  - Complains of LF noise from grain terminal (@3km)
  - Shows 'VAD' type of symptoms
  - Must be due to Grain Terminal
- Family R
  - Complains about noise from nearby wind turbines
  - Measurements show similar noise levels to Family F
  - Therefore Family R will develop VAD

with thanks to Geoff Leventhall , IoA Bristol 2009



# Vibro-Acoustic Disease

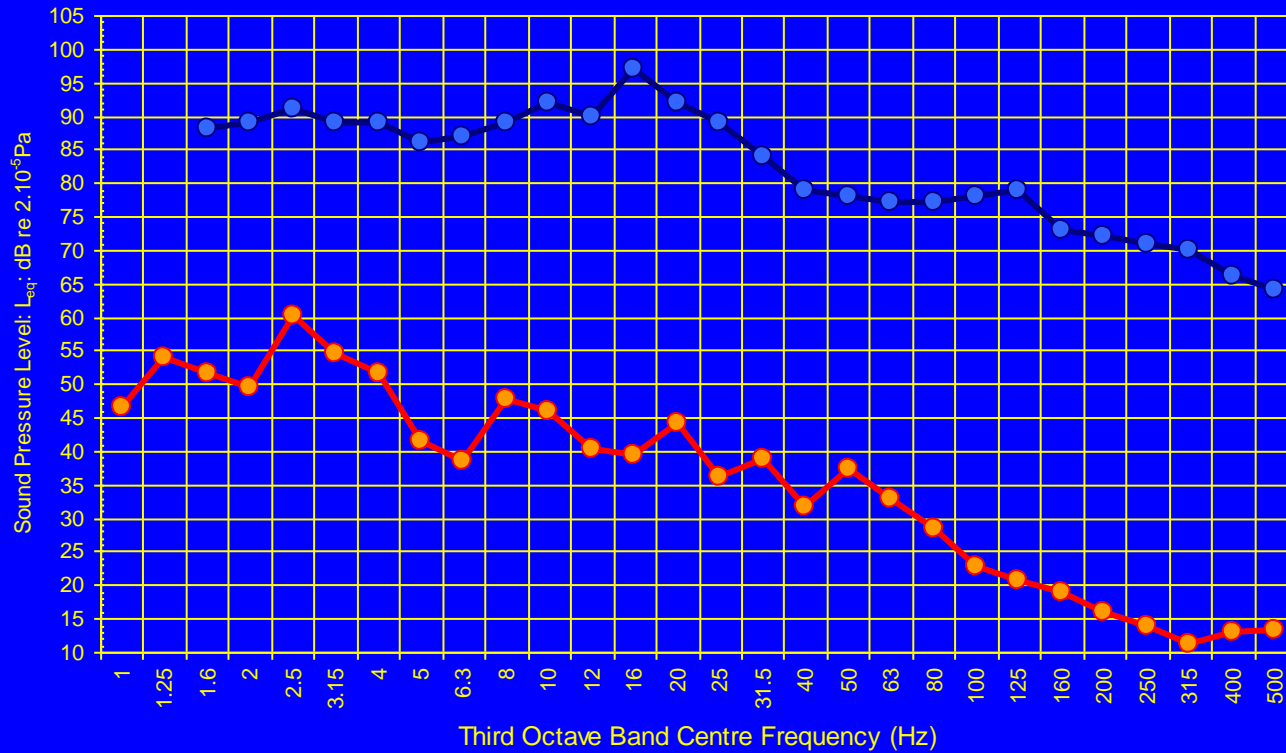
- *‘These results irrefutably demonstrate that wind turbines in the proximity of residential areas produce acoustical environments that can lead to the development of VAD in nearby home dwellers’*

Alves-Pereira & Castelo Branco, Press Release 2007



# Vibro-Acoustic Disease

Comparison of Sound Pressure Levels for Prolonged exposure for VAD with Measured Internal Wind Farm Noise Levels at Complainants House

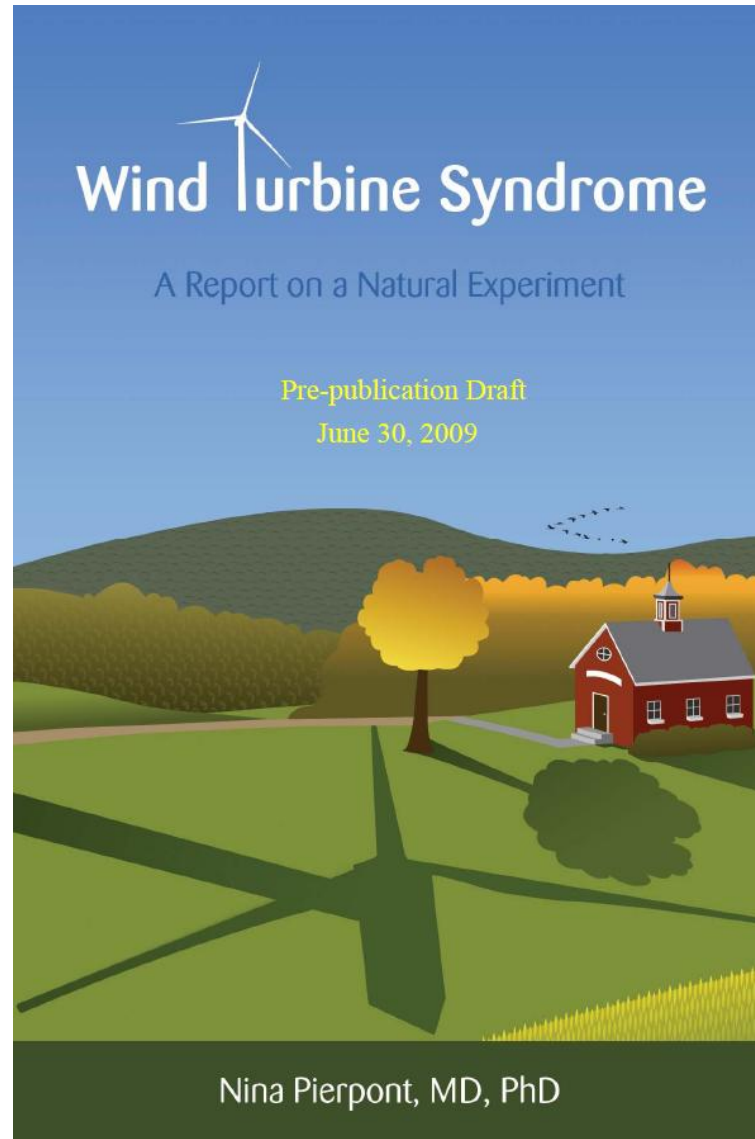


● Measured Leq Noise Level

● Automobile: from Ref



# Wind Turbine Syndrome



# Wind Turbine Syndrome

- A collection of symptoms which occur *'when turbines go into operation and resolve when the turbines are off or when the person is out of the area'* as follows:
  - *Sleep problems*
  - *Headaches*
  - *Dizziness, unsteadiness and nausea*
  - *Exhaustion, anxiety, anger, irritability and depression*
  - *Problems with concentration and learning*
  - *Tinnitus*



# Wind Turbine Noise

- Continued need for robust guidance
- Acknowledgement that audibility is unacceptable for some and complaints may occur
- Control of hysteria and attribution of mumbo-jumbo type effects to WT noise.



Thank you for your Attention!

