



# **Wind Farms Noise**

## ***The sacrifice of the rural minorities***

**SAS Conference 24<sup>th</sup> November 2013**

**By Mike Stigwood of**

**MAS**  
ENVIRONMENTAL

# Passion and position on wind farms

- I am not opposed to sensible renewable energies, provided:
- the risks and effects are properly evaluated
- we do not sacrifice the countryside and its people.
- Recent weeks have provided hope the landscape is changing but it remains the case rural communities are being sacrificed and harmed due to noise.

# Harm to well-being

## Overwhelming evidence exists of harm to well-being

☹️ Ignored by Government

☹️ Hidden by the Industry for years

🌐 The evidence indicates - gathering information of the problems is avoided.

🌐 When there is an analysis the wrong data is often recorded and then interpreted as “there is not a problem”

# ETSU-R-97 - Guidance on Wind Farm Noise

## - The illusion of protection

*Many ingredients of ETSU give an illusion of protection BUT simply avoid impediments to wind farm development.*

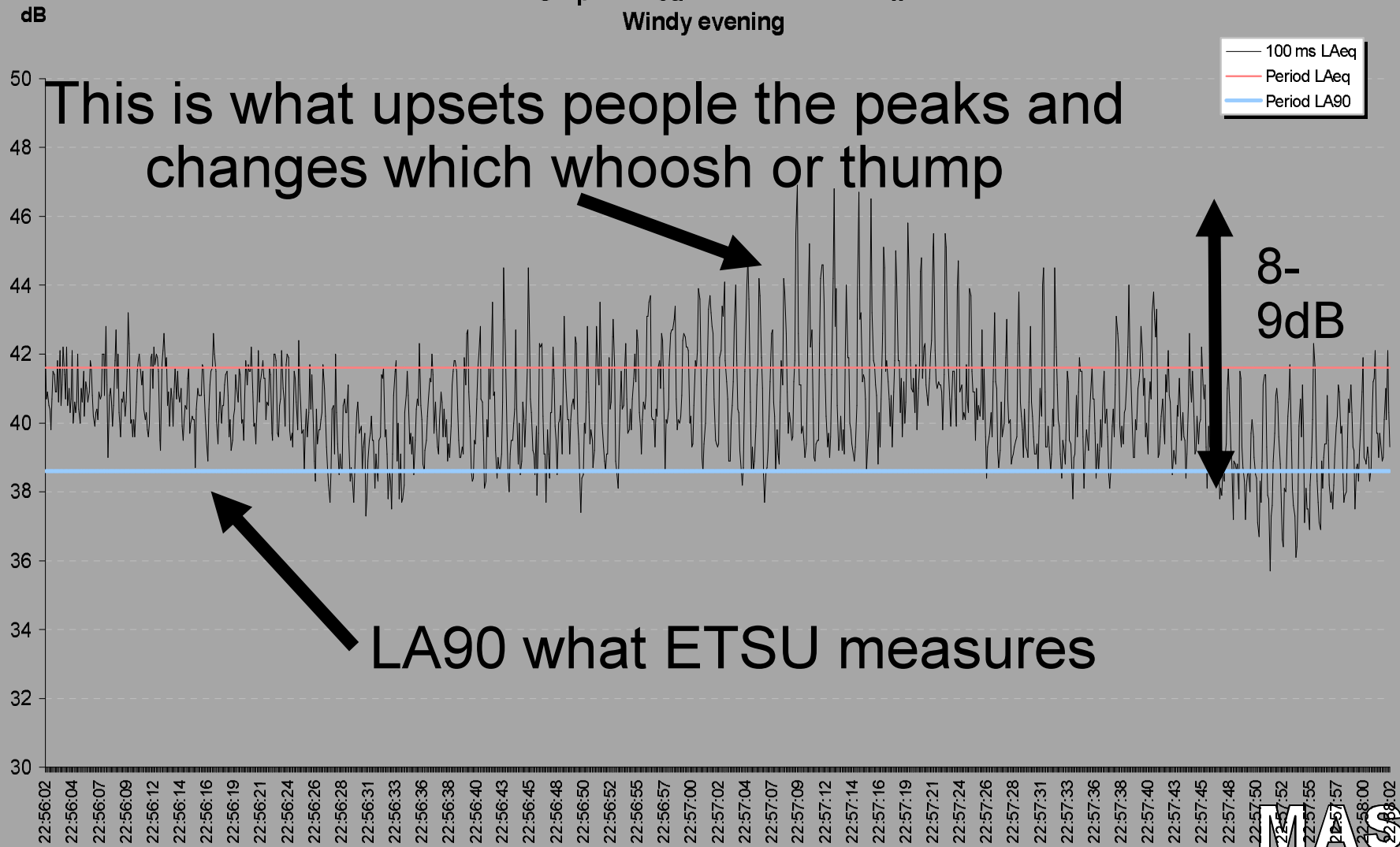
- Only controls the quiet content of wind farm noise.
- Averages background noise and ignores quiet periods.
- Averages emissions = **average compared to average.**
- It ignores the increased impact inside dwellings.
- Assumes noise is benign and masked = allows more
- PLUS NOW averages effect of meteorology on background noise rather than reflect actual conditions

# Amplitude Modulation at 1Km from a wind farm

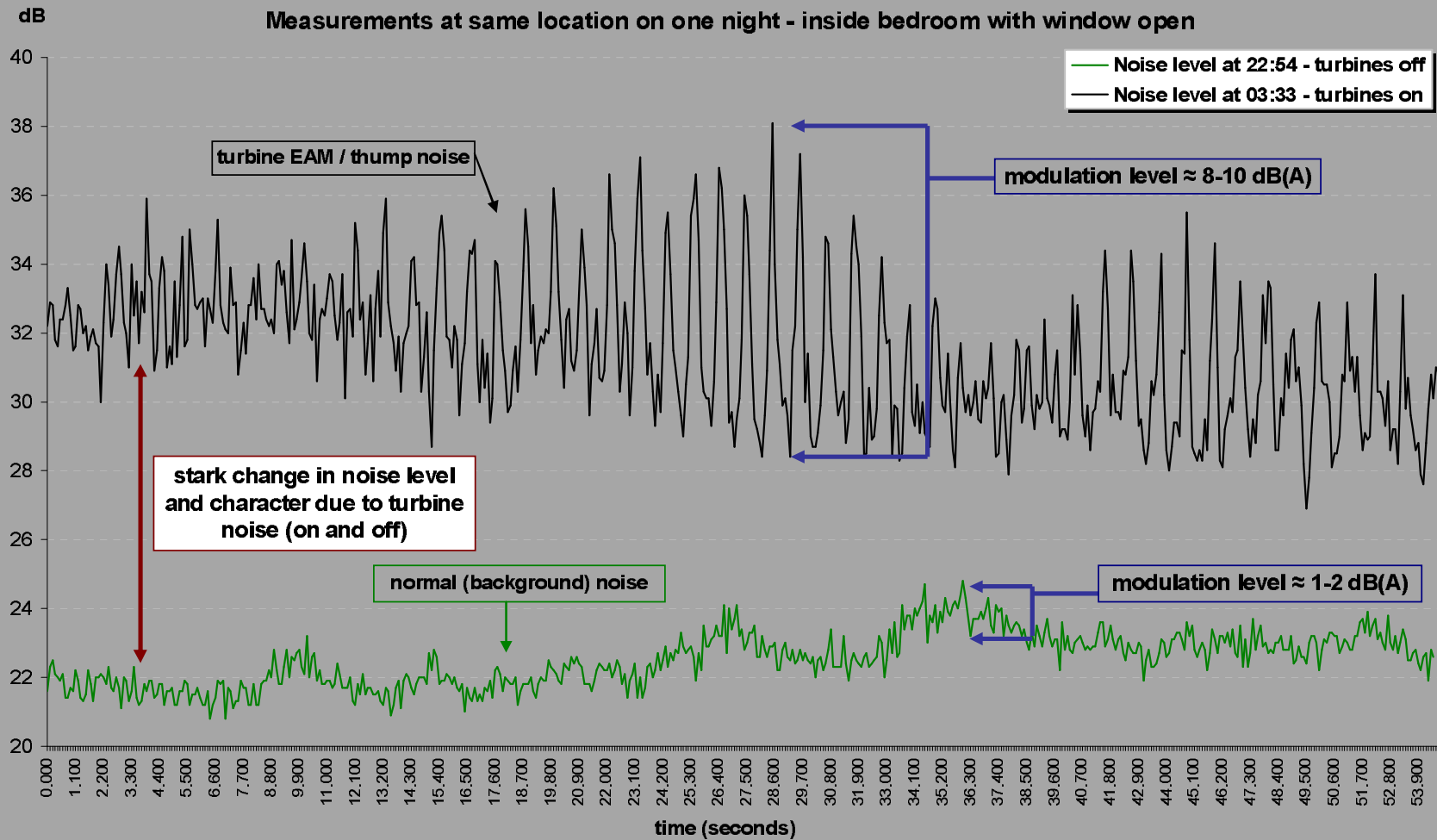
## There is no mistaking it contrary to the Industry claims

Noise Data Graph - 21 Jun 2013 - 1km from wind farm

Windy evening



28/11/2013





## **Wind Farm Noise**

### **Sacrificing the rural minorities**

- Lets look at the problems, demonstrate how ETSU fails to work and LISTEN to the noise.
- There are more examples on our website.



## The Main Problem

**Character in the wind farm noise = mainly**

**Excess Amplitude Modulation.**

**Noise character** like your neighbours music through the wall – *It intrudes as soon as you hear it and the annoyance grows the more it intrudes in your life with sleep loss a serious issue.*

**Control of EAM** – Rejected by Govt & Industry who rely on an old inadequate study containing serious mistakes – Helpful to the industry.

## ETSU-R-97 – The Emperors new clothes

**False illusion of control presented =**

Meet the guidance ETSU-R-97 = Okay  
*(Complete false façade hiding what's behind).*

Government and industry argue – *It was recently reviewed by the Institute of Acoustics so it must be okay.*

Provides false arguments of low impact

## The **FALSE** ETSU-R-97 Arguments

**ETSU considered AM noise and included it in its limits = it is addressed.**

**All wind farms tested comply with ETSU (one marginal case exceeds 0.5dB).**

**= you are suitably protected & can have confidence as the guidance has recently been reviewed.**

**= Complainants are unreasonable as it complies.**

**= you must be too sensitive to noise compared to most people – you are anti wind farms**

# The FACTS on these FALSE Arguments

## 1. AM included in ETSU limits is different

ETSU AM	Large Turbine AM
<ul style="list-style-type: none"><li>➤ 2-3dB(A) fluctuation but close to turbines.</li><li>➤ Reduces over distance = it is smaller than 2dB(A)</li><li>➤ 800-1000Hz (mid frequency)</li><li>➤ Not hear inside.</li><li>➤ Minor contribution.</li></ul>	<ul style="list-style-type: none"><li>☹️ 2-13dB(A) fluctuations in community.</li><li>☹️ Increases over distance up to 1500m – then reduces.</li><li>☹️ 125-630Hz (lower frequency that penetrates buildings)</li><li>☹️ Often worse inside v out.</li><li>☹️ Usually dominates &amp; highly intrusive even at low decibel levels.</li></ul>

## **The FACTS on these FALSE Arguments**

- **Correct that All wind farms tested comply** (minor exception 0.5 decibels on one). **BUT**
- **Major complaints from 80+ sites** we know of and estimate 160 =

**Either most rural residents are unreasonable people or the guidance is wrong.**

- **PLUS ETSU REVIEW allowed more noise by stealth.**
- **MOST complain after time because they cannot live with the noise; NOT because of anti-attitude.**

**90% + complaints are about or include AM**

# THE EVIDENCE OF EXCESS AM

- Widely missed as the cause due to lack of understanding.
- People just complain about the wind farm noise – Few know what it is supposed to sound like and what AM is.
- Powerful evidence the descriptions were misunderstood.
- MAS field study now 13 wind farms.
- 100% causing Excess Amplitude Modulation.
- **100% correct prediction of occurrence by MAS = always found when you know the conditions when to look / where to look AND what to record.**

## **THE EVIDENCE OF EXCESS AM is building**

- **Japanese research 2013 at 34 Wind Farms found**
  - **AM was generally contained in wind farm noise (NOT RARE).**
  - **The AM contained causes serious annoyance.**
- **Lee et al 2013**
  - **All turbines emit this type of AM.**
  - **It has directional effects leading to hot spots.**
  - **Low frequency dominates over distance.**
  - **Impulse content (thumps) at larger distances.**
- **ALSO – Sweden, Germany, China, Italy, Australia, Canada, USA, Holland and Others found this AM and serious effects.**

# Factors identified by researchers supported by our measurements

## Van den Berg

- Atmospheric stability
- Synchronicity effects
- Low frequency prominence

## Oerlemans et al

- Cross wind peak to trough increases close to turbine

## Di Napoli

- Importance of weather
- Measure at night
- 5-12dB(A) peak to trough

## Bakker & Rapley

- Heightened Noise Zones occur
- Levels in zones vary 6-13dB
- Equipment location critical

## Larsson et al

- AM prominence at greater distance
- Meteorology important
- Synchronicity
- Variations 6-14dB(A)
- Occurs most commonly evening and night

## Lee et al

- All turbines can emit AM
- Spectrum varies due to angle and distance.
- Longer distances = increasing low frequency dominance
- 3-4dB(A) enhancement wind speed gradient significant

## Wilson

- 3-4dB(A) enhancement when downwind and downward refraction significant.



## **Position of UK Government and Industry**

**Remains (despite contrary evidence) as:**

- It is RARE.
- When it occurs it is not serious or not for long.
- Communities are protected by existing powers.

**Responses are reminiscent of the denials of the Tobacco and Asbestos industries.**

# **DENIAL & REFUSAL TO ACCEPT CONTROLS MAKES THEM RESPONSIBLE FOR**

- **Large increase in complaints and problems.**
- **Long term damage to communities.**
- **Some people abandoning homes or parts of them for periods or permanently.**
- **Well-being of minorities in rural areas sacrificed either for policy or profit.**
- **Feeling no one is listening or cares.**

## RESPONSE OF MAS TO THE PROBLEM

- **Funded our own extensive research – more than Government and Industry.**
- **13 sites now measured and data for 4 more.**
- **Permanent monitoring Cotton Farm (Local funding helping that)**
- **Powerful data from Cotton Farm case being made public for all to see and hear. [www.masenv.co.uk/~remote\\_data](http://www.masenv.co.uk/~remote_data)**
  - 33-50% nights 5dB(A) peak to trough AM = serious
  - Upwind AM can be as bad as downwind AM
  - Prediction procedures understate impact.

## COTTON WIND FARM – Who said what

- Dr Bullmore (Hoare Lea) for Developer (Note not a nuisance expert) – Said:
- *"Given the very small number of occurrences of increased levels of 'blade swish' or AM, it is my view that an appropriate way to control the potential for the noise from a wind farm to contain increased levels of AM is by way of statutory nuisance action.*

COMMENT: Statutory Nuisance has failed every case so far and is incapable of addressing the issues

## Cotton Farm Continued

- **MAS said:** *the risk of AM was high and has long been under-estimated. A condition was essential.*
- The Inspector rejected concerns. He said:

*“I place greater weight on the results of” the Salford study “than on the research carried out by Mr Stigwood ... it is simply not possible to predict in advance ... statistically the odds are very much against it being a problem at Cotton Farm. I appreciate that some similarity with problem sites ... but not to the extent that it can reasonably be regarded as a distinct possibility, let alone a probability,*

- **He was wrong but only the community suffer!!!!**

## Cotton Farm Continued

### Early community response:

*"A considerable number of noise complaints by residents have been made to the Environmental Health Officers. **Each village appears to be affected at different times depending on the wind direction and speed** ... The Action Group is also aware of residents who have been affected by turbine noise but have not formally complained yet."*

- **DESPITE THE PROBLEMS** Hayes McKenzie advised it complied with ETSU and **noise could be increased**. 8 months on the Council's fail to act.

**The site is now owned by a Company owned mainly by the UK Government**

## CURRENT INDUSTRY POSITION ON EAM

- **Trust us we are looking at it**
  - They were due to report 2 years ago and we still wait.
  - No public consultation on their work.
  - All data is withheld on all their research on wind farms.
  - They even made the IoA working group sign confidential clauses not to divulge.

## Den Brook Condition on EAM

- **Developed 2009 by MAS - 3dB(A) peak to trough**
- **Attacked by Industry in every conceivable way** (IoA gave biased access to publishing the Industry position):

### ARGUMENTS ATTACKING DEN BROOK CONDITION

- **Rare** – Now proven as WRONG
- **Falsely triggered** – Now proven as WRONG – We have provided working examples on our website.
- **3dB(A) value not supported and not tested.** WRONG - extensive evidence provided.
- **Meaningless control mechanism** – Nonsense argument ignoring logic.

**Attacks accepted by decision makers for 4 years**



# Current position on Den Brook Condition

☺ Evidence 100% occurrence (every site) **now very strong** – some still deny

☺ False trigger – **accepted by most as invalid** including at Inquiry – In practice “stupidly easy” to prevent this.

☺ Not tested – **Overwhelming evidence it has been** and emerging evidence it should be lower than 3dB(A).

☺ Meaningless – **Defeated** by simple logic and a report by Inst. Sound and Vibration research.

## Finale: Den Brook arguments (Round 2)

1. Developer RES withdrawn all attempts to change condition (Sept 2013) – **Agrees it can work.**
2. Dr J Bass (Developer's acoustician) who raised the "false trigger" argument said (Nov 2013) that they have:

***abandoned** what they describe as the "industry line" that AM is rare, that no AM condition is necessary and that it could be dealt with by statutory nuisance - "that idea has been completely exploded by the weight of evidence presented by Mike Stigwood in particular."*

## Den Brook Finale (Round 2)

21<sup>st</sup> November 2013 - Dr M Cand of Hoare Lea (on the Renewables UK research group) – and after the new wealth of evidence and 2 hours cross examination admitted that:

- **A condition was necessary.**
  - **Applying a condition was reasonable**
- AND**

***“If I had to pick a number, I don’t think 3dB is a bad number”***

# Consequences of resistance to control

- **4 years of obfuscation and misinforming decision makers**
- **Now admitted the Den Brook condition**
  - was at the appropriate level,
  - is reasonable and
  - necessary
- Who now is going to address all those cases without control where communities are exposed to serious noise impact?

- ***Is Government and most IoA Working Group members going to continue arguing it does not need control?***
- ***Will decision makers now treat with caution what the Industry and its acousticians tell them?***

# **Inst. of Acoustics - Good Practice Guide 2013**

- **Working Party dominated by Industry acousticians of known persuasion.**
- **Adopted method allowing more noise – about 5dB(A) higher.**
- **Hugely complex procedure – impenetrable to most.**
- **No research supports the method or its concept.**
- **2 research papers (MAS and REF) show it allows substantially more noise.**

## Good Practice Guide – The Consequences

**At the same time WF noise gets worse because:**

**Larger turbines** = more Low Frequency Noise which penetrates dwellings and is more annoying.

**EAM** impact dramatically increases in % of time.

**Increasing intrusive characteristics.**

Greatest impact during **evenings** and at **night**.

our Government approves a method allowing increased noise levels.

# HOW ETSU LIMITS HAVE CHANGED

**Historical approach under ETSU**  
and generally for industrial noise control

=

The decibel limit tracks the level of masking noise  
present in the environment.

As masking noise goes up as the decibel limit goes up.

Thus when you have a clear night with no wind near the ground  
then the masking noise is lower & the limit is lower BUT this is when  
the operators want the turbines running flat out.



## **Current Institute of Acoustics idea**

**=**

**As the turbine noise increases the decibel limit increases.**

This protects the developer but not the residents.

Sometimes as the wind turbine noise increases the masking noise increases.

Sometimes as the wind turbine noise goes up the masking noise drops or does not rise

especially during evenings and at night  
(typically 1/3<sup>rd</sup> of the time or more).

# IoA method in Good Practice Guide

## MEANS

- YOU NO LONGER look at what happens on an individual night but the long term averages.
- IN EFFECT If 4 out of 7 nights masked = deemed okay all of the time
- Thus 60% okay then deemed not a problem.

***Like saying I was not responsible for an accident when driving too fast as my average speed over the week was below the limit.***

## IoA Good Practice Guide Endorsed

- Government endorsed the Guide as IoA “Independent”.
- IoA Dominated by Industry Acousticians
- IoA working party dominated by Wind Industry consultants
- Working Party dominated by those of a known persuasion allowing more noise.

Now Government prosper as they own companies who buy problem windfarms they permitted through inadequate rules they applied

# ETSU-R-97 in perspective using BS4142

(1)=assumes BNL=25dB

(2)= Conditions likely for Excess AM to occur

Mixed industrial & residential area criteria	Rural area WTN
<b>Benign Industrial noise</b> Councils typically seek average noise = <b>BNL plus or minus 5dB</b>	<b>Benign WTN</b> Night = BNL+ up to <b>20dB<sub>(1)(2)</sub></b> Day = BNL+ up to <b>15dB<sub>(1)(2)</sub></b> Min noise allowed = <b>BNL+7dB</b>
<b>Industrial noise with character</b> = typically BNL plus 0dB to minus 10dB	<b>WTN with character</b> Night = BNL+ up to <b>25dB<sub>(1)(2)</sub></b> Day = BNL+ up to <b>20dB<sub>(1)(2)</sub></b> Min. noise allowed = <b>+12dB</b>

→ **BUT** IoA Article method uses artificial BNL = 3-5dB more ←

**WTN = serious noise impact risk**

Env Agency in England propose BNL minus 10dB as Industry criteria.

## Facts on Wind Farm Noise

- It industrialises countryside
- It impacts more during evenings and at night.
- Some people are badly affected by Low Frequency Noise / Infrasound (I have seen this).
- It is up to 4 x louder than should be allowed (range 12-25dB more than other industry).
- The imbalance is sacrificing the quality of life of a minority.

## The future and lessons to learn

- **Recall the Hillsborough tragedy.** We can learn from that tragedy when inquiry after inquiry came to the wrong conclusions on such a serious matter. It was not the selection of stupid people but perhaps zealots who could not accept error by the Police and the State institutions.
- The Wind Farm problem and Renewable Industry may suffer a similar disease in the pursuit of their cause and with subtle cover up by those who think wind farms at any cost.
- I am concerned over the State's role and the lasting damage to our society of the impact on a rural minority.
- Many suffer serious noise to the extent they either **abandon their homes or parts of them.**

Nobody abandons  
their home without  
good cause!

## Passion

- Industry words remind of the Tobacco and Asbestos industries 40 years ago
- “trust us its safe”
- “The evidence of harm is not there”
- “We are subject to rigorous controls”
- “Benefits outweigh the harm”



## Passion and Facts

- I am a private individual running a business and it could not be more unprofitable to spend the huge resources we have researching this issue and taking on the industry but we have because there are sometimes issues you cannot ignore.
- The answer is overwhelming: it is a serious problem. I cannot countenance a response that the industry or State are now unaware.
- **I have personally made the Secretary of State aware and**
- **the evidence the Industry have suppressed the evidence of a problem is now exposed.**

## **Listening to AM and interactive graphs**

Any listening experience needs to be carefully constructed.

I cannot provide such an experience in the conference hall today due to:

Poorer reproduction of the sound and LF content. Higher background – Masking of features and syncopation.

**Example graphs played today and these slides are mainly on-line to listen**

See [http://www.masenv.co.uk/listening\\_room](http://www.masenv.co.uk/listening_room)

The levels heard today  
are elevated but they  
give you an idea of  
the character

## Passion and Facts

- You can make your own minds up and attend a **Listening Room Experience** we developed to inform on the problems OR JUST LISTEN TO THE CHARACTER HEAR AND NOW.
- The solution for Government is not one where you hide the problems and let some future administration pick up the mess.
- **IF** it is necessary to sacrifice our countryside then **properly protect and compensate those affected** so they can start a new life or new business.

## FINDINGS INCLUDE

- All large wind farms cause Amplitude Modulation. Theory suggests - **confirmed by us** with occurrence **at 100%** of those checked.
- Impact **NOT rare** but COMMON.
- **We identified over 75 WF** causing complaints of AM. The true figure is estimated as over double this.
- Impact arises at **hot spots**. These vary in location. **Dozens of different descriptions** are used BUT all come down to the same thing – **AM manifests itself in a variety of forms**.
- Hot spots commonly hit dwellings the more densely populated an area and the closer the turbines.

## FINDINGS on Amplitude Modulation

- Safe level is probably 15dB lower than UK limits in most areas. To protect people means almost no wind farms.
- Wind farms are **allowed 12-25dB more noise** than other renewables and generally = Unfair advantage.
- Believing the UK system, others nations have followed leading to world wide problems and loss of UK credibility.

## **FINDINGS on AM – Field Studies Show**

- **The DECIBEL level fails to reflect impact**
- **Listening Room Exercise is needed to inform regulators**  
– Careful rules on how conduct. Even this does not do the impact justice.
- **High levels of misinformation are presented** by many through ignorance and evasion of the evidence.
- **THERE ARE HEALTH EFFECTS** and serious blight on communities. Denial is concerning – I have seen too many cases. Effects increase over time.
- **LOW FREQUENCY NOISE is a significant problem.**
- External measurements understate internal impact =  
**Acousticians measure in the wrong place**

## Passion

- Industry words remind of the Tobacco and Asbestos industries 40 years ago
- “trust us its safe”
- “The evidence of harm is not there”
- “We are subject to rigorous controls”
- “Benefits outweigh the harm”



## Passion and Facts

- The claw for renewable energy is exploited and leads to misdirected criticisms:
- “*You must be a climate change denier*” WRONG
- “*People only complain because they are NIMBYs*”  
WRONG – many supported before impact occurred.
- “*We suffer more noise in the Cities so get over it*”  
WRONG – It is not noise level but the type of noise.

**DO NOT DESTROY OUR FAITH IN THE UK  
& OUR FUTURE**

# Amplitude Modulation in UK

## Our Findings in more detail

- Straightforward to find.
- **Occurrence is common** / All turbines cause it & long known as a complaint cause.
- **Looked at 75+ wind farms causing complaints – AM cause of vast majority.**
- **Measured at 13 wind farms + analysed data for 4 more – All generated excess AM.**

# Amplitude Modulation background in UK

## Approach to field investigation

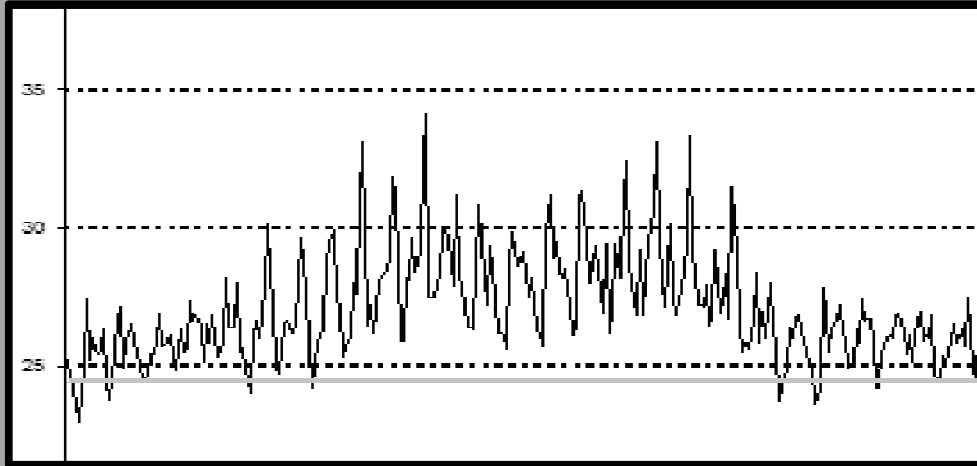
- Visit when light to determine likely spots.
- Visit when a stable atmosphere but high winds at hub height.
- Observe and measure after sunset.
- Choose a location within 60 degrees of downwind line at 500m-1km (unless elevated ground).
- Ensure near ground wind speeds low / almost non-existent.
- Record 100ms LAeq with spectrum at each interval (0.4-10Khz).
- Record audio 24 bit and 48Khz (16 bit 44KHz could suffice).

## **Main conclusions of field investigations at 11 wind farms**

- All wind turbines cause AM.**
- AM occurs in heightened noise zones (HNZ)**
- Meter location & site observations need to mirror positions found during survey when AM occurring.**
- HNZ vary** with wind direction, synchronicity and meteorology (especially wind shear)
- Some locations regularly experience higher AM** than others.
- Crosswind AM** exhibiting large peak to trough values can arise **at significant distances** in excess of 400m.

➤ AM exhibits a **range of features** / characteristics.

➤ Heightened peak to trough occurs typically for 6-20 seconds, subsides and rises again (**erratic and sudden changes arise**).



➤ The greater the **atmospheric stability** the less **variance** in the AM trace.

➤ Sometimes **high peak to trough values can continue many hours**. Likely under steady wind direction, wind strength and when stable atmosphere.

## Spectrum of AM depends on

- Distance from turbines
- Meteorological effects - the extent of refraction,
- Synchronisation of separate turbine emissions
- Frequency content emitted in the direction of the receiver.

### Leads to a wide range of variations

**Increasing lower frequency dominance within peaks at greater distances** (approaching 1km+)

**Spectrum (content and modulation) varies with distance, direction and meteorology**

*= complex interaction    = complex sounds result & ever changing impact type and level.*

➤ **Array of turbines** - Experience different spectrum AM from different turbines at the same time or in succession = **highly variable sound character**.

➤ Some characteristics **commonly repeated**

➤ Peak to trough values can exceed **10dB(A)** & 20dB (typically 10-15dB) in 1/3<sup>rd</sup> Octave bands (400-1000+m distance) .

➤ Modulation **less than 3dB(A)** – can still be **highly intrusive** as constituents may modulate dramatically = changing sound character greater than the level change suggests.

## **Coherence / synchronisation effects occur**

- Divergence and partial coherence changes over time changing the noise character increasing, perception and impact.**
- Complex change in spectrum common.**
- The changing sound content = constantly changing notice-ability and impact.**
- Many characteristics not reflected in “A” weighted values which is poor measure of AM and its psycho-acoustic characteristics.**
- Changes in sound character are dependent on a complex interaction of meteorological factors.**



## Assessing acceptability of AM

If you identify “A” weighted peak to trough variations due to AM of the order of **3dB or more**, found in 100ms LAeq data it is **likely to reflect adverse impact**.

When variations of only 2-3dB(A) are measured, larger variations are also likely for large modern turbines.

AM displays many features that attract attention both on a basic and complex level of auditory processing. Subjective and psycho-acoustic perception of AM is usually underestimated when assessing acceptability of wind farms.

## Listening experiences and decision makers

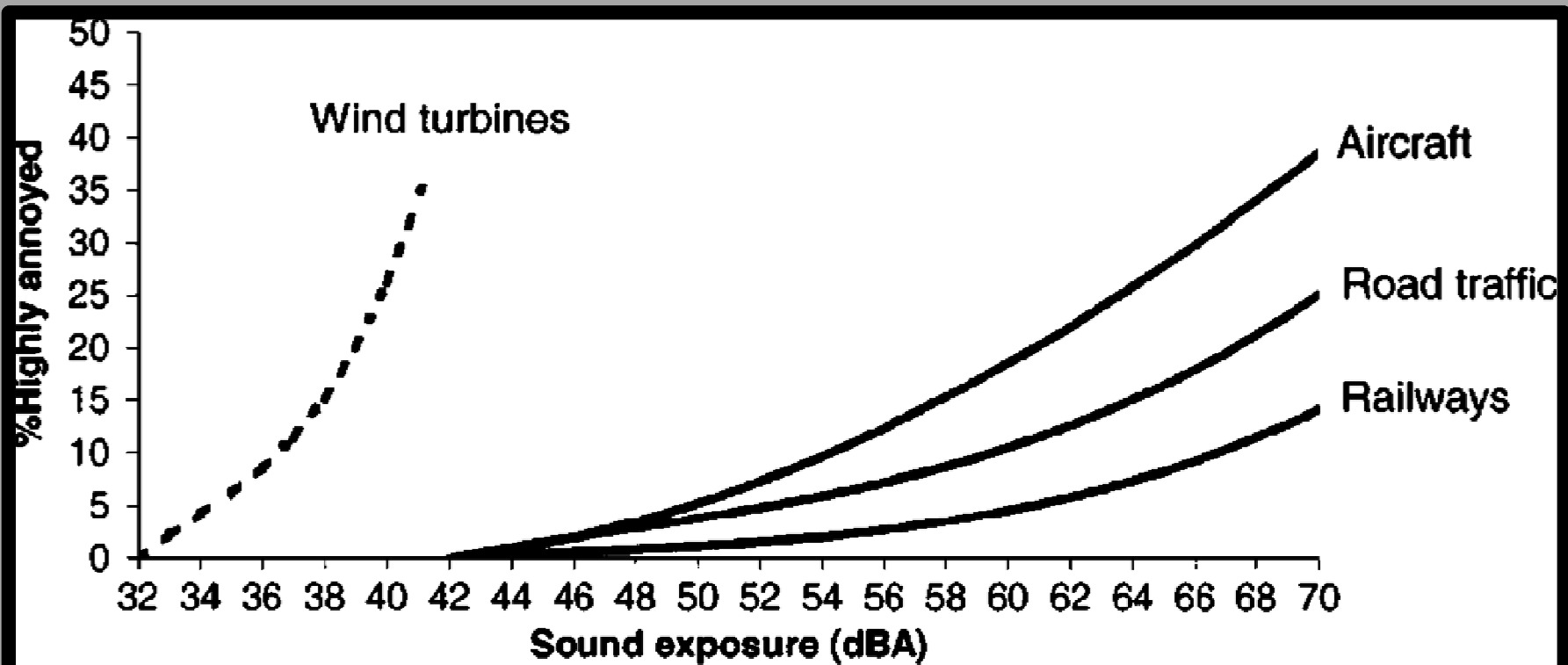
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➤ Decision makers need to experience the effects of AM to fully understand.

➤ As a substitute to living with it:

➤ The Listening Room Experience discussed in the paper provides **a reasonable way of experiencing and understanding the impact.**

## Facts on AM



Sound exposure is for wind turbines calculated A-weighted  $L_{eq}$  for a hypothetical time period and for transportation DNL.

# ETSU-R-97 in perspective using BS4142

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**WTN = serious noise impact risk**

Env Agency in England propose BNL minus 10dB as Industry criteria.

**Noise character** – psycho-acoustical factors which render noise more intrusive – Identify and record

- Incongruous – unique sound which stands out.
- Low frequency content & different spectrum shape
- Fluctuations (Amplitude Modulation) with peaks which emerge
- Regularity – whooshes, beats or thumps every second
- Rate of change in noise level = whether impulse content
- Duration - can be 20 minutes to several hours
- Times of occurrence – Day or night
- Sleep disturbance – Awakenings are common
- Lack of pattern or predictability = cannot plan for
- Loudness and emergence above the internal background level.

