IOA good practice guide, excess amplitude modulation and the failure of wind farm noise controls

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In August 2013 at the 5th International Conference on Wind Turbine Noise in Denver, we presented extensive research which amongst other things identified that excess amplitude modulation is common and the main noise problem and source of annoyance caused by wind farms. Unbeknown to me prior to the conference, a major Japanese study looking at 34 wind farms had also concluded AM was common and warranted controls similar to those I have previously promoted with small peak to trough values [1]. The good practice guide (GPG) focuses on ETSU-R-97 (ETSU) as do councils investigating complaints about wind farm noise. This obfuscates the real problem and leaves communities unprotected. Focus on ETSU procedures rather than the main problem, EAM, provides a powerful distraction. Unfortunately, it remains necessary to continue debating the issues surrounding this distraction.

In 2009 a group of acousticians devised a new way of interpreting ETSU to address wind shear. They had not based this on any empirical data or published research and assumed that of the two options available to address wind shear both gave similar results. This was the thrust of a talk by one of the authors of the article which appeared in Acoustics Bulletin in March-April 2009. They were wrong. Our research comparing actual data from sites and then separate subsequent research by the Renewable Energy Foundation found repeatedly the method adopted allowed more noise, levels up to 5dB(A) higher [2,3]. This equates to significant reductions in separation distance. Our research remains unchallenged and every wind farm site we have evaluated since that study provides the same results.

At best the article authors try to argue our research is flawed but do not contradict our findings with any meaningful research or data. Dick Bowdler has reiterated erroneous arguments in an article in the Bulletin (September-October 2013) to which I need and intend to respond. In short, predicted turbine noise referencing 10m standardised wind speeds can be directly compared to 10m measured wind speeds (“apples with apples”); it roughly approximates the situation where the wind shear between 10m height and turbine hub height (approx 80m) is equal to 0.16.

It is of interest that the same group of acousticians effectively concluded, in the same article, that low frequency noise was not an element of concern in wind farm noise impact despite emerging research demonstrating this was wrong. I had personally presented some evidence of low frequency impact at an IOA meeting two months earlier. The evidence of low

frequency impact is now abundantly clear including an extensive Japanese study which has recently confirmed that these claims were wrong. Researchers have identified significant LFN issues in various papers since 2009. None of the authors has retracted their claims in the three and a half years since.

In 2012 the Institute of Acoustics selected a noise working group which was dominated by individuals who were party to the 2009 article, either originally or shortly after the article was released and before it was tested. They had effectively agreed to a method that allowed an increase in wind farm noise and from whatever position they approached the change, they had arguably compromised their future impartiality in that process. They had certainly argued the article was correct creating difficulty in any retraction. It is also of note that the majority of the working group are primarily employed by the wind industry, are promoting its aims or prosper from wind farm development. That is not necessarily unusual or disadvantageous, but it is not surprising that in these circumstances the new IOA working group endorsed their original idea, the article method shown to allow more turbine noise, in May 2013 in the GPG. Despite the lack of any contrary evidence to our research highlighting the issues with their method, the noise working group members defended their position.

The fact that the method does allow more turbine noise, including in their recommended prediction methodology, is also manifesting itself in reduced separation distances between turbines and housing. This is further testament that the method is allowing more noise. Simple comparison of sound power level versus separation distance demonstrates this in a simplistic way. A major problem with the change is that it has sidestepped the procedure in ETSU, and which is generally adopted for noise impact assessment, that would normally expose excess noise. The new method cannot enable investigation of noise levels under the conditions leading to complaint. Adopting the change recommended in the article gives the illusion that this is still achieved, but in reality it is now prevented as conditions are assessed at hub height and standardised to 10m height. They cannot determine the conditions or crucially the wind shear leading to complaints experienced at 10m height, the conditions people experience around their homes. We now see industry acousticians re-interpreting existing planning conditions that used 10m measured wind speeds as if standardised wind speeds were originally intended. This thereby allows a greater margin and minimises the likelihood that a breach will be shown.

Dick Bowdler is one of the original authors and he defends their position in his article in the Bulletin, arguing standardised wind speeds are better. The science is so complex on this issue that few understand it and many readily confirm they do not understand it. Phrases are then banded such as “like with like” and “apples and pears” attempting to imply one method is correct and the other incorrect as a way of deflecting from the significant noise increases standardised wind speeds now allow. Further deflection arises through implying the whole ETSU methodology is wrong. The latter may well be the case but it is arguably misguided when it allows more noise.

Dick suggests the Renewable Energy Foundation (REF) criticisms of the standardised method come from the MAS Environmental research. That assumption is wrong. REF undertook its own research without reference to MAS using different data and applied different methods. It led to similar conclusions; the standardised method allowed more noise.

Dick suggests either 10m measured or 10m standardised could have been adapted for wind shear, but this is a misconceived assumption as they both give very different results. In the

standardised procedure wind shear effects are aggregated with a large number of other variables influencing background noise levels and so are effectively subsumed and diluted in the process. Using 10m measured controls wind shear effects are considered independently and influence wind turbine noise as a separate variable. This is why our research shows case by case that the article and GPG method allows more noise.

Dick asks if the GPG method gives less protection but this is already answered in both the MAS and REF research with a resounding yes. Every case compared has allowed more noise, a finding demonstrated in both the REF and MAS research using actual data from a number of sites. Every site we have considered since has produced the same results. It is a complex interaction of meteorology, acoustics, statistics and physics, and has taken us countless hours of analysis. In part this is why we conducted the research, to better understand the interactions.

Dick accuses me of perpetuating a scientific inaccuracy, which professionally I cannot allow to go unanswered. It is misconceived and incorrect, arising from a misunderstanding of the relevant principles. Our research was scrutinised by many including independent non UK-based acousticians who peer reviewed the work. We had to go overseas as most we approached in the UK did not have sufficient understanding of meteorology to comment. Incorrect assumption from a failure to fully read and understand the research is part of a wider problem, a common trap most of us have fallen into from time to time. It could be argued, from a cynical perspective, that wind industry acousticians have capitalised on those misunderstandings.

In as simple terms as I can express it:

- The generation of power and hence turbine noise is related to the wind speed at the turbine hub height, whereas the background noise masking the turbine noise is related to the actual (not standardised) wind speed at or near ground level. The object of the ETSU methodology is to derive limits to protect residents in dwellings at ground level. Those limits should only rise in decibel level as the near ground masking noise rises. ETSU was not designed to derive limits that increase as the turbine noise rises whilst the background noise does not. This allows uncontrolled operation. The ETSU principle intends setting limits to control the level of turbine noise so that it does not emerge excessively above the background/masking noise. That is how context based limits and BS4142, on which ETSU was framed, work. In other words, we do not say "let us set noise limits to match the noise of the turbines" but "let us set noise limits which match the levels of masking noise present". The standardised wind speed approach adopts the former and departs from the latter. Adopting this approach abandons the basic mechanisms commonly applied to control any site noise.

- High wind shear results in greater turbine noise and lower background masking noise than assumed in ETSU. The ETSU document discusses why it considered turbine noise would rarely exceed the background noise except by levels of up to 5dB and then only for a limited range of wind speeds. The standardised wind speed method abandons this concept by ignoring those circumstances when turbines emit maximum noise but background levels are low.

As a consequence of adopting standardised wind speeds, the GPG now mandates a sophisticated and deceptive averaging process for wind shear that fails to consider the periods

when wind shear is higher than average. Unfortunately, this occurs at key times of the evening and night and as such is when complaints most commonly arise. The use of hub height wind speeds, recommended in the standardised method, does not differentiate high wind shear conditions. I am content that time will demonstrate those supporting the standardised method will be shown to have allowed significant noise increases and promoted a method that prevents assessment of actual conditions causing complaints. We are documenting this and will continue to publish the consequences of adopting this procedure. Residents who suffer the increased noise are not content and regrettably we are seeing a large increase in complaints. Ultimately it is our profession which is likely to be seriously tarnished.

The problem arises from a loss of sight of the purpose of assessment and controls. The assessment is not an exercise in determining the maximum energy that can be extracted from wind farms for a given decibel level, or through changing how that is defined to further allow more energy extraction, but what controls actually protect residents. To understand this latter point, we need to look again at decibel level objectives and also reflect on how these have become muddled to benefit developers.

In essence, there are two separate decibel control regimes with different aims and objectives.

- **Threshold levels.** Protecting human health from excessive general environmental noise where that noise does not convey a message. We would normally consider this benign anonymous noise. I call this "general noise". General noise is normally considered to cause harm when it exceeds certain thresholds.

- **Context levels.** These are used to protect amenity, welfare and sometimes health from noise which intrudes because of its character rather than its level. It is the message it imparts to the inadvertent listener. In other words, context levels are used for irritating noise that triggers adverse response because the noise conveys a message. I call this "site noise" as it normally arises from a particular site or source. Site noise is generally considered unacceptable when it reaches a certain level of audibility or dominance.

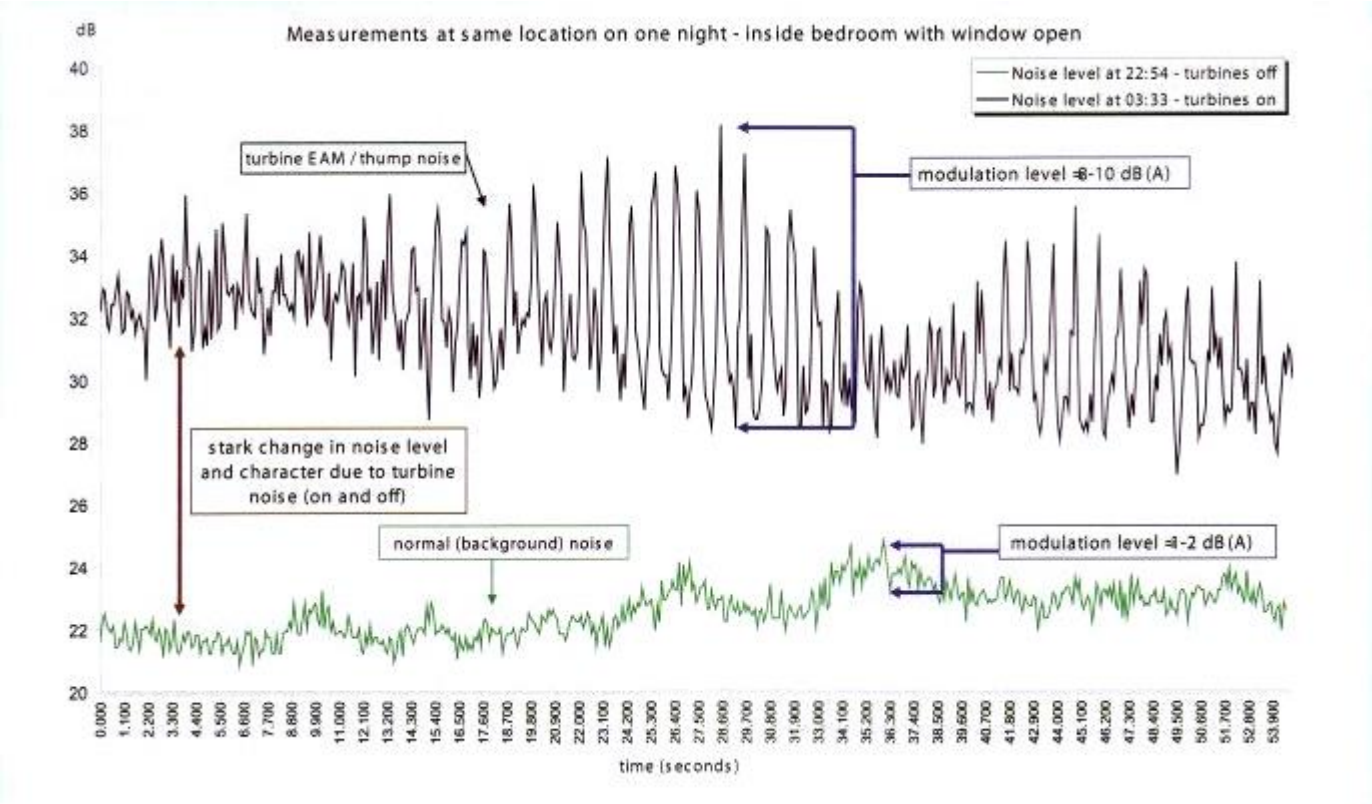
The latter can equally impact upon health but not so much in terms of active damage, because of its energy levels, but in terms of a psychological stressor because of the psycho-acoustical responses of listeners. Naturally there is noise which falls within both categories and we may need to look differently at how we control this, especially if we seek to combine both objectives.

We can readily see examples of both. An example of the first is road traffic noise which we tend to filter out of our thought processes and so ignore any message it may impart. It is just there and many do not notice it. It may cause difficulty getting to sleep or lead to lower quality sleep but we are not consciously listening to it. An example of the second is noise from a party at a neighbour's which continues, albeit at low levels, into the core sleep hours. Commonly we cannot avoid listening to it and interpret messages such as the lack of care for neighbours' sleep by revellers, the irritating nature of an individual's laugh and so on. It can be quieter than the road traffic noise but impacts significantly more.

ETSU assessed wind turbine noise as primarily falling in the general noise category. An element of context is recognised in the application of a penalty for tonality and relationship to

background noise. The first and most serious error was to assume wind farm noise did not or still does not contain substantial psycho-acoustic messages other than tonality. Unfortunately, even the tonal element of wind farm noise considered in ETSU and its adjustment assumes that impact can be applied to general noise thresholds, rather than relate it to its dominance or audibility. That is a fundamental error of analysis and is one reason why wind farms that are considered compliant cause so many complaints.

In summary, it all promotes bad science allowing more noise by varying the procedure increasing the margin of error. The graph below shows a comparison of context; the background noise level in a bedroom without turbine noise and the turbine noise inside the bedroom post development but which complies with ETSU.



An example confirming the bad science of ETSU is the Bilberry Farm planning inquiry in 2012. A small turbine had been built in the wrong place without a noise control. It caused a tonal nuisance and statutory nuisance action was taken. Planning enforcement action was also taken and appealed. All experts for all parties at the appeal agreed it caused nuisance. Works were being implemented to reduce the tonal noise content and decibel levels but were not completed by the time of the appeal hearing. Nuisance was not continuing as the turbine had been parked for some considerable time. Tests during the inquiry showed nuisance level noise continued. The appellants proposed a condition based on the lowest levels in ETSU, including its tonal penalty, to control the noise in the event that the inspector approved the new turbine position. It was promoted on the basis it would render the turbine compliant with ETSU. Cross-examination of the evidence confirmed the ETSU-based condition did not prevent the noise that had already been judged a nuisance. In other words, the ETSU controls permitted undisputed statutory nuisance. The failure of the condition was acknowledged by the inspector but it is instructive it was not specifically identified as an ETSU condition in the decision letter. That would amount to an open criticism of ETSU by a government inspector.

Returning to the issue of the noise working group and interpretation of ETSU, no published research supports the standardised procedure. It cannot as the change introduces an averaging process. not originally envisaged by the authors, which effectively subsumes the effect of wind shear averaging it with other influences and thereby losing its effect. The outcome of the IOA GPG working group is very helpful for the wind industry and the acousticians who work for it. Arguably it is also procedurally convenient; it avoids an argument about how it gives a false illusion of protection.

The harm of all of this process is ultimately to the profession. We see politicians vilified and a number of other professions also. Acousticians who promote procedures that give a false illusion of protection must expect the same attacks on professionalism but from which we will all suffer.

The simple fact is that proportionately a huge number of wind farms cause noise complaints but almost every wind farm causing complaints has been deemed to comply with ETSU-R-97. Only in one case has a wind farm been confirmed to marginally exceed limits that I am aware of. There is an obvious anomaly in that. Either we have a very high percentage of unreasonable/abnormal people in society living near wind farms, the controls and those who devised them are wrong, the method of applying those controls and those who apply those methods are wrong or it is a combination of all of these factors. It is of note that many complainants were in support of the wind farm development before it became operational.

We need to learn from this problem and so it is now a matter of documenting the harm caused, who said what, who endorsed those processes and procedures causing that harm and who allowed those promoting an erroneous approach to wind farm noise to do so. Currently we see environmental statements confidently claim that excess amplitude modulation is only a rare problem. In reality it is the main problem with almost all the wind farms that cause complaints. We are in the process of documenting these cases. Some difficulty has arisen as wind farms are not built for several years allowing a time lapse before the evidence emerges that decision makers have been misled. Many of the sites approved in 2009-2011 are now being completed and are leading to widespread complaints.

We need to return to environmental noise assessment basics and look at the principles we have abandoned in wind farm noise assessment without any research to support that abandonment. We need to look at why bad science prevails and before it is too late. In the words of the World Health Organisation, only one third of noise nuisance is due to the decibel level. We need to properly evaluate the other two thirds. We need to stop averaging the quietest 10% of the source of noise for comparison with the average of the background noise. We need to stop assuming noise with substantial psycho-acoustic character can be assessed as if it is benign and anonymous noise.

In the acoustics profession we assess noise generally by:

- Looking at short term noise impact and not long term averages.

- Looking at the impact at a moment in time and the disruption that it causes, such as sleep disturbance on a particular night, and not what the average noise is.

If we looked at average speed on a journey it would not tell us if inappropriate speed was applied in relevant circumstances, whether the driver was too close to the car in front or

drove erratically and dangerously. In the same way the average of the noise during periods when it was not excessive does not inform us of adverse impact. The averaging now applied by those using the standardised method was not the original intent of ETSU or, if its authors now claim it was so, meant to be worded that way and it does not mean what it literally says (as they have claimed in relation to wind shear) then the intent was clearly wrong.

We assume too much in acoustics. It was assumed thalidomide would not be passed genetically but this was a serious error. It was assumed the people of Liverpool would ultimately accept repeated inquiries using individuals with known persuasions with a view that they were responsible for the Hillsborough disaster but this was wrong. It is wrong to assume people will accept the noise they suffer from wind farms, accept disturbed sleep and associated heath effects and move out of their homes just because it meets an illusionary standard. The growing evidence is they will not. The sooner we recognise the failings and get back to basics the better.

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Acoustics Bulletin November/December 2013 pages 18-22

References

1. Several papers have resulted from the study, see for example: Tachibana, H., Yano, H., & Fukushima, A. (2013). Assessment of wind turbine noise in imission areas. 5th International Conference on Wind Turbine Noise. Denver. [link]

2. http://www.masenv.co.uk/publications

3. Renewable Energy Foundation (REF) (2012) A Critique of the IOA Treatment of Background Noise for Wind Farm Noise Assessments. Available online: http://www.reforg.uk/attachments/article/255/ref%20info%20note%20120403%20IoA%20Shear%20Methodology.pdf