Independent Noise Working Group

# Consultation response to the draft guidance titled;

# Assessment and Rating of Wind Turbine Noise

Released by the UK Government
Department for Energy Security & Net Zero
on 4 July 2025 for consultation

**Prepared and submitted by the INWG team**

**27 August 2025**

**"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."**

From a discourse on ETSU by Mike Stigwood 2013

Notes:

Text in this report quoted from reference documents; *"is shown in brown italics"*

Hyperlinks are included to access the referenced documents and websites. Best endeavours have been taken to ensure third party hyperlinks are active but cannot be guaranteed.

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# Contents

# Executive Summary

The governments proposed update to the wind turbine noise guidance has been reviewed in this consultation response and found to be a life extension of the existing ETSU-R-97 guidance (referred to as ETSU throughout this report) repackaged with some relatively minor and cosmetic changes. The fundamental assessment methodology is unchanged.

This consultation response provides the evidence and arguments justifying the immediate replacement of ETSU with BS4142. ETSU is responsible for untold suffering by a significant rural minority who have had wind turbines noise imposed on them with the risk that this may now be extended to more urban areas.

While wind turbine noise may not impact the community around every wind turbine site or indeed every member of that community, it has affected a sufficient number to show that the methods for determining noise impacts from wind turbines and controlling these impacts are not working, except for the benefit of the wind industry. Evidence and opinion deemed to conflict with the deployment of wind turbines has been systematically ignored by the government over three decades. Evidence supporting the use of ETSU as was and as proposed, is absent.

There can be no good reason for the continued use of the ETSU methodology in either its current form, essentially unchanged from 1996 or as in this latest government proposal in slightly changed form. This consultation response and its reference material provides irrefutable evidence that the methodologies set out in this latest version of ETSU and the original ETSU are deeply flawed.

The documents identified as supporting the government proposal are;

- The IOA Good Practice Guide (released May 2013)
- IOA proposed planning condition for Amplitude Modulation (released Aug 2016)
- WSP report (released February 2023)

Each of these three supporting documents are critiqued in this consultation response which includes evidence that they are based on bad science.

Despite multiple representations to government, they have failed to engage in meaningful discussion or open scientific debate and have eliminated the effective checks and balances intended to protect this process. Consultations have not included communities impacted by wind turbine noise or organisations representing them, and when they are finally permitted to participate, their representations are routinely ignored. Such an approach by government does not lend itself to sound policy making.

Discussion in this consultation response extends to the bad science and the government's denial of evidence in relation to;

- Wind shear correction and noise limits
- Amplitude modulation
- Measurement uncertainties throughout the assessment process
- Low frequency sound and health effects

The government has also ignored recommendations to use BS4142 instead of ETSU to the extent that they have failed to even mention the existence or purpose of BS4142 in relation to ETSU or wind turbine noise.

This is extraordinary given that BS4142 is the British Standard used for assessing a majority of industrial and commercial noise sources. Such censorship stifles open debate on the merits of BS4142, but no doubt alleviates the risk of awkward questions by decision makers.

**The omission of any consideration of BS4142 by government or industry leads to the conclusion that government policy, official or unofficial, aims to impose greater levels of noise from wind turbines than is permitted for most other industrial or commercial noise sources. It is disingenuous that the government does not address this matter head on and instead conceals the truth.**

The argument justifying the replacement of ETSU with BS4142 is discussed at **Appendix B** and also in the Key issues section below.

# Introduction

The objective of this report is to analyse the UK government's proposed update to the existing ETSU guidance, and to use the results of this analysis to inform the INWG consultation response. Therefore, this report comprises the full INWG consultation response and includes a discussion of the key issues arising from a detailed review of the proposed ETSU update [Ref 66] and the consultation questionnaire [Ref 67]. This detailed analysis is included in three separate documents included as Appendices A, B and C. We also consider some pertinent legal cases that have arisen both in the UK and abroad.

**Appendix A** is a review of the proposed guidance document identifying the main issues of concern.

**Appendix B** is an expanded discussion on the main issues identified in Appendix A and is structured in line the INWG **ESTSU-Gate** report, **Campaign Story** section [Ref 64]. The **ETSU-Gate** report was released during June 2025 in anticipation of this government proposed guidance, and documents the three decades long battle by highly qualified, experienced and informed parties, including the Independent Noise Working Group, to ensure effective and quantifiable control of wind turbine noise.

These advocates should not be simply dismissed as; *"a small but vocal group of anti-onshore wind lobbyists"*. (Note the DESNZ response when refusing the Freedom of Information request for details of the ETSU update specification, Ref: ICO response IC-350501-T5Y4, Para 42 included the statement, *"that it is mindful that noise from onshore wind turbines is an emotive topic that attracts intense interest from a small but vocal group of anti-onshore wind lobbyists".)*

The ETSU-Gate report **Campaign Story** chapters provide a convenient structure for this expanded discussion. Each chapter is summarised in Appendix B so as to be more relevant for this government consultation, expanded where appropriate into the contentious areas.

These expanded discussions are focused on;

- **Wind shear and noise limits**
- **Amplitude modulation**
- **Low frequency sound and health effects**
- **BS4142 as the alternative to ETSU**

**Appendix C** provides the INWG response to the consultation questionnaire [Ref 67]. Since the online consultation invites responses to a limited range of questions in a fixed format, this full report will be submitted by email as the full INWG consultation response, in accordance with the consultation instructions.

The arguments for and against the ETSU-R-97 (ETSU) noise guidance has been ongoing since its introduction in 1996 and this has been documented in the INWG report titled, **ETSU-Gate-Three Decades of Deception** [Ref 64] released in June 2025. In this report the ETSU-Gate scandal is revealed where it is compared with the Post Office (also known as the Horizon) scandal that is still being unravelled. Similarities with the Post Office scandal include deception, complicit contractors, the cover up by officials, abuse of Freedom of Information (FOI) laws, the shifting of blame to the complainant and government ministers ignoring the evidence presented to them.

ETSU is responsible for untold suffering by a significant rural minority who have had wind turbines imposed on them. While this may not occur in respect of every wind turbine site or neighbouring community, it has affected a sufficient number to show that the methods for determining noise impacts (acoustic pollution) from wind turbines are not working except for the benefit of the wind industry. The ETSU-Gate report serves to record and preserve the evidence relating to this deception until such time as the scandal is finally acknowledged by government and the inevitable public inquiry.

This facilitation of bad science has by default, caused the Institute of Acoustics (IOA) to effectively become a vassal of the wind industry which is clearly evident throughout INWG's ETSU-Gate expose'. It is with profound concern that the IOA continues to endorse the bad science that has perpetuated ETSU as the official government noise guidance for wind turbine noise assessment for three decades. As a result, ETSU remains in use despite credible health and scientific evidence that it fails to protect host communities and is clearly unfit for purpose.

We believe that a number of acousticians, particularly new ones, have felt that they must support the use of ETSU even if they privately feel that it does not properly protect the public. (This is based on some of our private conversations with acousticians). While it is easy to be critical of those acousticians, such criticism should be tempered by an acknowledgement of the dilemma they probably faced and whether they were sufficiently principled to potentially sacrifice their career and future livelihood.

Chapter 20 of the ETSU-Gate report discusses developments over the past year with the expectation of a revision to the guidance to be released by the UK government during the summer of 2025. That expected guidance was released on 4 July 2025 proposing a replacement for the existing ETSU wind turbine noise assessment guidance [Ref 66]. Additionally, a separate document was released [Ref 67] providing information relating to the consultation on this proposal, advising a consultation response deadline of 29 August 2025. It would be cynical to suggest that it is more than a coincidence that this consultation period coincided with the parliamentary summer recess.

# Key issues and discussion

In this section we discuss the three appendices following detailed review and analysis of the proposed update to ETSU and the consultation questionnaire.

## Discussion of draft guidance from Appendix A

The proposed guidance document [Ref 66] titled, **Assessment and Rating of Wind Turbine Noise,** is reviewed at **Appendix A** of this report where the key issues and profound concerns are identified. These key issues and concerns include;

Most if not all of the individuals, that have been involved by DESNZ in producing this proposed guidance have been active proponents of the ETSU guidance for decades and are well known to be closely aligned with and predominantly act on behalf of the wind industry. **There can be no pretence that this updated guidance is based on an independent or impartial basis.**

It is also of interest as to why Dick Bowdler, shown as a project steering group member and seen to be a prominent wind industry acoustician is now promoting the ETSU methodology when previously he was highly critical as illustrated in his 2005 paper titled, **ETSU-R-97 Why it is wrong** [Ref 2] Not only was he critical of ETSU but he showed a strong preference for the use of BS4142 for wind turbine noise.

BS4142 has been recommended more recently by independent groups as the replacement for ETSU but this recommendation has been ignored. Additionally, there has not been any involvement in this latest guidance or any earlier government sponsored studies or reports into wind turbine noise, by independent parties. This exclusion of opposing views by both government and the IOA includes the exclusion of individuals with a firsthand negative experience of living with the adverse impacts of wind turbine noise (acoustic pollution); civic or community group representatives; scientists and acousticians critical of the current ETSU guidance; or outsiders to the selected government / industry / consultant communities.

Despite the involvement of the INWG in the wind turbine noise debate for over a decade with multiple representations to government ministers and officials, there has been a total failure by government to engage in debate in any meaningful way. **Such an approach by government does not lend itself to sound policy making.**

The executive summary confirms that the existing ETSU methodology will be carried forward into the proposed guidance. Additionally, it will continue to **prioritise the development and operation of wind farms over the protection of wind farm neighbours from noise and the adverse effects on health and quality of life.**

The continuation of the ETSU assessment methodology is confirmed at Para 1.5 with confirmation that the new guidance is based on:

- The existing ETSU-R-97 (released 1996)
- The IOA Good Practice Guide (released May 2013)
- IOA proposed planning condition for Amplitude Modulation (released Aug 2016)
- WSP report (released February 2023)

**Each of these methodologies and reports underpinning the proposed guidance have been produced by affiliated wind industry acousticians and each has been heavily criticised by independent parties. Each of these ETSU methodologies have been shown to be the result of bad science, and are unfit for purpose**. These topics are discussed in more detail at Appendix B and also in the ETSU-Gate report.

The Noise Policy Statement for England (NPSE) **Ref 8** and the principles of LOAEL and SOAEL are introduced into the proposed guidance. However, Para 1.15 provides confirmation that defining the LOAEL and SOAEL for wind turbine noise is outside the scope of this new guidance. Although the LOAELs and SOAELs are not defined, so are by definition unknown, it is still claimed that the SOAEL whatever it is, should not be exceeded, but the LOAEL whatever it is, may be exceeded. **How this can be possible without the LOAEL and SOAEL being defined is not explained.**

The statements at Paras 1.18, 1.19 & 1.21 establish a government policy statement claiming the effects of low frequency sound (and infrasound) are considered to be negligible and excluding them from consideration in the assessment process. The inclusion of these statements would appear to be based on the 2023 WSP report **Ref 54**. This WSP report was heavily criticised by INWG in their analysis report **Ref 55**. **This government position statement on low frequency sound is unsupported by substantive evidence and would conflict the World Health Organisation position**. The significance of low frequency sound and infrasound, with wind turbine noise complaints and evidence as to its relevance to the noise assessment is discussed in detail at Appendix B and also in the ETSU-Gate report.

Pages 12 to 21, Section 2 covers the proposed assessment method. This is based on the current ESTU methodology with the declared intention of increasing the day time minimum noise limit (LLV) from 35 $dB_{A90}$ to 37$dB_{A90}$. There is also a declared intention to retain the higher night time LLV of 43 $dB_{A90}$. The description provided at Paras 2.11 & 2.12 is unclear regarding government intentions and could lead to different interpretations. While the proposal document **Ref 66** indicates a higher daytime LLV and a higher night time LLV, the consultation document **Ref 67** question 1, 2 & 3 indicate otherwise.

Para 2.9 confirms that sound measurement based on $L_{A90}$ is also being retained despite evidence that the use of $L_{Aeq}$ is more suitable when assessing the impact of wind turbine noise. These noise assessment topics of concern identified above are discussed in detail at Appendix B.

The proposed treatment of wind shear legitimised by the IOA **Good Practice Guide** [Ref 13] and the proposed treatment of amplitude modulation, set to be formalised by the adoption of the IOA methodology titled, **A Method for Rating Amplitude Modulation in Wind Turbine Noise** [Ref 44] are of great concern to campaigners. **These methodologies based on bad science are considered to be the root cause of the failure of ETSU to protect from wind turbine noise**. These topics are discussed further at Appendix B.

# Discussion of key issues from Appendix B

The key issues and concerns identified at **Appendix A** of this report are then examined at **Appendix B** along with the key issues and events documented in the ETSU-Gate report [Ref 64]. The Appendix B discussions are arranged by ETSU-Gate report Chapters. The ETSU-Gate report released in June 2025 documents the long-term campaign to replace ETSU in the form of a summary of events and issues, with convenient links to the supporting evidence.

## ETSU-Gate Chapter 1: ETSU release & conflicts of interest

This chapter discusses the release of ETSU in 1996 where it was designed primarily to ensure that wind turbine noise would not become a constraint to the deployment of wind power. This became a unique arrangement where existing noise controls, BS4142 that apply for other types of similar industrial activity were replaced with a much more permissive noise control regime specifically for wind turbines.

**This misplaced prioritisation of business interest over the effects of wind turbine noise is to be challenged since the protection of human health and wellbeing should be the prime responsibility for government.**

In addition to the more permissive noise control regime, a conflict of interest was created where the same government department (currently DESNZ) responsible for the deployment of renewable energy including wind power was also given responsibility for policing the environmental impact of wind power. This is also unique as similar polluting industries are regulated by the Environment Agency providing some checks and balances.

We now see a continuation of this overly permissive noise control regime and the conflict of interest within DESNZ. The prioritisation of wind power development over the protection of affected communities is set to continue with DENSZ also in control of the updated guidance with little in the way of checks and balances.

**This conflict of interest within government has been responsible for an unprecedented level of suffering, ill health and financial loss for a significant number of mostly rural wind farm neighbours.**

## ETSU-Gate Chapter 2: ETSU criticism & noise complaints beginnings

This chapter covers the beginnings of the criticism of ETSU with one of the first critics being Dick Bowdler, at that time an independent acoustician with his paper released in 2005 titled, **ETSU-R-97 Why it is wrong** [Ref 2]. This well-argued paper questions the entire ETSU methodology and argues a strong case for the use of the then BS4142:1990 for use with wind turbine noise. It should be noted that BS4142 has since been updated making it even more suitable for use with wind turbine noise and this is discussed later. Bowdler concludes his paper with;

- *"ETSU-R-97 is so poor technically that its conclusions have to be queried. It is put together through a series of unfounded assertions and there has been no research drawn on to justify them."*
- *"Even if one were minded to accept the suggestion that you should use very low background noise levels and that there ought to be a level below which it would be appropriate to use an absolute noise level, the levels proposed by the NWG are not acceptable. The night time level is 45dB($L_{Aeq}$) and the day time level is 37 to 42dB($L_{Aeq}$). Most wind farm sites are in rural areas where background noise levels can easily be 20 to 25dBA when turbines are operating and so the margin above background could be up to 20dB or more."*

This argument alone from 2005 demonstrates why ETSU fails to protect from wind turbine noise in quiet rural locations. **It is hardly surprising that there have been so many noise complaints and so much individual suffering by wind farm neighbours over the intervening twenty years.**

**While people can change their minds, reasons are normally given for doing this. We are not aware of Bowdler giving any reason for changing his mind so dramatically with regard to ETSU.**

Chapter 2 also discusses the start of the wind industry disinformation campaign with the denial of AM, the denial of low frequency noise and the denial of noise complaints. The first major industry attempt at denial of noise problems came with the Salford report released August 2007 titled, **Research into 'Aerodynamic Modulation of Wind Turbine Noise** [Ref 4].

While the 2007 Salford report played down the significance of AM, a FOI release [Ref 5] during 2009 provided details previously withheld of noise complaints from 27 windfarms. This FOI release requested by the Renewable Energy Foundation demonstrated that already **acousticians and officials supporting the wind industry were complicit in withholding and then resisting the release of critical information relating to the extent of these noise complaints.**

## ETSU-Gate Chapter 3: Wind shear & assessment uncertainty

Titled the **Article or Bulletin Method**, this chapter focuses on wind shear. Although amplitude modulation has been given more prominence in the arguments related to noise complaints, it is the treatment of wind shear and the associated methodology of derived noise limits that are the root cause of the failure of ETSU to protect.

The **Article Method** [Ref 6] was introduced by a group of IOA acousticians in March 2009 in response to criticism of ETSU, in the guise of clarifying the treatment of wind shear during the assessment process. This group of acousticians who are by definition financially involved with the wind industry included Bowdler, Bullmore, Hayes and McKenzie who in 2025 are also members of the latest steering group for the proposed ETSU update. This same wind shear methodology proposed by these acousticians was subsequently incorporated into the IOA **Good Practice Guide** during 2013, discussed later and is now being incorporated into the latest proposed update to ETSU.

The **Article Method** for wind shear treatment was tested by Stigwood, described in his September 2011 paper [Ref 9] and also by Moroney and Constable, described in their April 2012 paper [Ref 10]. The Stigwood study revealed an opaque methodology involving a manipulation of the wind shear exponent, that allows higher levels of wind turbine noise, and makes any subsequent noise enforcement actions much more difficult. The Moroney & Constable study confirmed the Stigwood findings and when tested they found that the Article Method is less protective of wind farm neighbours than even the standard ETSU methodology. As a result, it allows developers to site turbines closer to homes.

**The Article Method was found to be a very cleverly designed example of bad science, opaque and such that very few are able to fully understand it. It is inconceivable that the Article Method was designed this way by accident and no doubt the authors are proud of their achievement and the advantage it provides to wind power developers.** Fortunately, the Stigwood and Moroney studies were able to identify the deception and then prove the Article Method allowed higher levels on noise while still remaining 'compliant' with ETSU.

The technical aspects of wind shear, how it affects the noise assessment, and the Article Method are examined in Chapter 3 using material taken from the report released by campaigners during 2012 titled, **Wind Turbine Noise Impact Assessment - Where ETSU is Silent Ref?** (subsequently referred to as **Where ETSU is Silent** or **WEIS**) [Ref 11]

The report **WEIS** also identified other faults with ETSU that compromise a valid noise assessment including the 'flexible' procedure to determine the noise limits from background noise. Additionally, WEIS highlights one of the most important defects of ETSU in its failure to accounts for **uncertainty** in the assessment process.

Noise assessment is no different from any other area of science or engineering in that any process requiring measurement and calculation will be subject to tolerances or uncertainty.

Quantifying and acknowledging the expected range of any uncertainty or tolerance is fundamental to science and engineering. **The omission of consideration of uncertainty makes the ETSU noise assessment possibly the only area of science that assumes every measurement and process achieves perfect accuracy with zero errors or tolerances.**

Assessment by the **Where ETSU is Silent** authors identified the **levels of uncertainties inherent to the ETSU methodology that when combined in the standard way to be of the order of +/- 10dB.** This is a significant level as a 10dB increase in noise level represents a doubling in loudness, and a 10dB decrease represents a halving in loudness. It is therefore not surprising for the large numbers of noise complaints given that some planning application noise assessments show a margin of only 1dB or 2dB between predicted noise and the noise limit. These claimed margins being based on zero uncertainty, clearly a physical impossibility.

## ETSU-Gate Chapter 4: The Good Practice Guide & bad science presentation

This chapter titled the Good Practice Guide examines the report released by the IOA noise working group in May 2013 titled, A **Good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise** [Ref 13], also referred to as the Good Practice Guide or GPG. Release of The Good Practice Guide was in defence of criticisms of the Article Method, especially the treatment of wind shear, but also other aspects of ETSU and was seen as an attempt to formalise the way acousticians had been interpreting ETSU when preparing noise assessments as part of planning applications.

Following analysis of the Good Practice Guide, campaigners presented their findings to Ed Davey MP, Secretary of State and DECC officials at Westminster on 9 October 2013. Two documents were presented. The first presentation titled, **A Summary of the Bad Science behind the Wind Turbine Guidelines** [Ref 15] focused on the bad science being promulgated by the IOA noise working group in their GPG. This areas of bad science included;

- Background noise measurement
- Noise limits
- Wind shear
- Assessment uncertainties
- Low frequency noise

The treatment of wind shear originally proposed in the Article Method and transferred to the GPG offers what on first impression looks like an elegant solution to wind shear correction. **In practice it fails to provide the protection required and is overly complex. There is no doubt it offers a neat solution for developers by reducing operational risk from noise complaints and provides for reduced separation distances.**

The second presentation by Mike Stigwood of MAS titled, **Evidence of failure of wind farm guidance to protect well-being** [Ref 16] demonstrated the extent of the noise nuisance problem at that time. Stigwood confirmed to the Minister;

- More than 75 wind farms known to be causing noise complaints
- ETSU is incapable of preventing these adverse noise impacts
- **Amplitude modulation is the main problem**,
- AM is caused by all large wind farms and is common, not rare as claimed by wind industry advocates.

**Additionally, all the wind farms causing noise complaints that MAS has investigated were considered to be 'ETSU compliant'**.

As far as could be determined the evidence presented was ignored.

## ETSU-Gate Chapter 5: Amplitude modulation & IOA Newport presentation

By 2013 it was evident that the wind industry could not continue to deny the existence of AM or deny that it was a significant factor in noise complaints or deny that it needed to be controlled. RenewableUK (ReUK) the wind industry trade body responded with their own sponsored research report titled, **Wind Turbine Amplitude Modulation** [Ref 17] released December 2013. Their report included sections covering the causes of AM, the measurement of AM and a proposed planning condition to control AM.

The ReUK report was analysed by independent parties where all the main claims were systematically challenged and disproved. Moroney and Constable of REF in their report titled, **The Efficacy of the RenewableUK (ReUK) Condition in controlling wind farm amplitude modulation (AM) noise** [Ref 18] released March 2014 are highly critical of the ReUK template planning condition. When tested they discovered it failed to protect wind farm neighbours from AM as claimed. The REF report conclusions to the ReUK report included:

- The proposed ReUK AM planning condition would not be breached by recorded wind farm noise data with high levels of AM measured at Askam, a site widely recognised to be producing severe AM problems, and at Swaffham, where the AM is significant in magnitude.
- The ReUK AM planning condition is too complex and computationally intensive to provide a reasonably accessible and transparent methodology for assessing AM.
- The ReUK method results in an understated value of the true peak-to trough levels of the AM noise.

**This analysis by REF of the ReUK report highlights the attempt by the wind industry to introduce an opaque methodology in the guise of 'controlling' AM.**

The IOA meeting for wind turbine noise held on 20 March 2014 at Newport provided an opportunity for campaigners to present an evidenced critique of the ReUK report to an audience of mostly wind industry acousticians. The presentation titled, **A Critique of the RenewableUK report on wind turbine amplitude modulation** [Ref 19] also referred to as the **Newport** presentation included;

- The ReUK claim of AM being caused by blade stall was disproved, with the cause shown to be a consequence of the propagation of rotating blade trailing edge noise.
- Disproving the cause of AM as stated by ReUK demonstrated that the proposed ReUK solution to mitigate against blade stall, (a solution that did not actually exist), could never work to control AM.
- ReUK proposed an automated signal processing technique to measure the value of AM. Testing of this opaque and cumbersome methodology by REF revealed it understated the value of the true peak-to trough levels of the AM noise so negating any realistic potential to control AM.

- ReUK proposed an AM planning condition based on an AM penalty system but failed to quantify the AM dose response relationship to justify the proposed penalty. In doing so they ignored research evidence from Tachibana and Fukushima that contradicts the ReUK proposal.
- It was also shown how control of AM based on the ReUK AM planning application incorporating their penalty system would fail to be triggered with even the highest levels of AM as demonstrated above by Moroney [Ref 18]. A clear demonstration of the failure to protect from AM
- Also, during the 3 years duration of the ReUK AM research project they did not bother to survey the incidence of AM and quantify the noise nuisance.

**The Newport presentation fully rebutted the ReUK report arguments on the cause and solutions to AM**.

The later release of the INWG work package report WP1 during 2015 titled, **The fundamentals of amplitude modulation of wind turbine noise** [Ref 26] by Dr John Yelland provides what is still arguably the most comprehensive discussion and understanding to date on the science behind wind turbine noise including AM and low frequency sound. Yelland is highly critical of the ReUK methodology for measuring and controlling AM and especially of the proposed automated, complex and opaque signal processing technique.

**From the available evidence it was clear that this attempt by the wind industry to impose an automated AM measurement process and penalty system to control AM is simply bad science, designed to frustrate any attempts at resolving future noise complaints.**

## ETSU-Gate Chapter 12: The wind industry fights back

In what was likely a response to the criticism of the IOA Good Practice Guide and the ReUK study into AM, the IOA announced a new noise working group and a study into wind turbine AM during August 2014. In response to the IOA announcement, independent campaigners formed the Independent Noise Working Group (INWG). The primary objective of the INWG at that time was to conduct an independent study into wind turbine noise AM that would be able to credibly challenge the methodologies and recommendations of the Institute of Acoustics sponsored study. The INWG formation is discussed at Chapter 6. And the release of the INWG study work packages is discussed at Chapter 10.

Chapter 11 describes the launch of the INWG study work packages completed by volunteers in only one year. On 13 October 2015 a joint INWG and MAS presentation was made at Westminster to Andrea Leadsom MP, Minister of State and DECC officials. The INWG presentation titled, **Discussion document for DECC meeting** [Ref 39] of the findings and recommendation of the AM study including:

- **ETSU noise guidance to be replaced with a code of practice based on BS4142:2014**
- **Independent research is required into the health effects of wind turbine noise including AM and LFN.**
- **An effective AM planning condition required for every wind turbine planning approval**
- **Continuous noise monitoring (with data transparency) should be required for every medium & large wind turbine planning approval.**
- **Effective remedy required for retrospectively dealing with noise nuisance including AM from existing wind turbines.**
- **Government should disassociate itself from the IOA until the conflict of interest and ethics issues are resolved and full transparency restored.**

Two days later the INWG also presented their AM study at the IOA annual conference at Harrogate on 15 October 2015. The INWG paper titled, **Wind Turbine Amplitude Modulation & Planning Control Study** [Ref 41] was published in the Proceedings of the Institute of Acoustics conference, October 2015; (Vol.37. Pt.2 2015). The presentation with the same title [Ref 42] was delivered at the conference on 15 October 2015.

In what appeared to be a coordinated response in August 2016 to the criticisms by campaigners of wind industry acousticians and government officials was the simultaneous launch of the IOA study into AM and the government sponsored research into AM by the consultant WSP/PB. Both the IOA report titled, **Final Report - A Method for Rating Amplitude Modulation in Wind Turbine Noise** [Ref 44] and the WSP report titled, **A review of research into the human response to amplitude-modulated wind turbine noise and development of a planning control method** [Ref 45] were presented at the Internoise conference on 23 August 2016. The full WSP/PB report was initially withheld but finally obtained by interested parties in October 2016 following a FOI request.

Following the coordinated release of the IOA AM study and the WSP/PB research into AM for the government, the INWG conducted a detailed review of both reports as a belated INWG AM study work package. WP 8.1 titled, **Review of WSP/Parsons Brinckerhoff and Institute of Acoustics Amplitude Modulation Studies** [Ref 48] and **WP8.1 Appendices**, was released on 12 January 2017.

WP 8.1 reveals that these latest IOA NWG and WSP/PB AM proposals are basically reworked versions of the heavily criticised methodology from the 2013 ReUK AM study with some of the same authors and all commercially involved in the wind industry.

When tested, the IOA recommendations for controlling AM were shown to fail. Les Huson of L Huson Associates tested the IOA NWG report hybrid AM methodology using real turbine noise data and this is shown at **WP8.1 Appendices F and G**. The conclusion from this testing, is that the IOA AMWG measurement metric under records the actual level of AM at best and will completely miss recording intermittent AM and situations where there are multiple turbines operating at different rotational speeds. This under recording of AM by the latest IOA AM metric is consistent with the previous schemes tested. **It seems inconceivable that the authors of the IOA AM metric had not thoroughly tested this and were unaware that it would fail to protect in this manner.**

The findings from the analysis of the IOA and WSP/PB reports in the form of an **INWG Discussion Document** [Ref 49] were presented to government at Westminster in a joint INWG and MAS Environmental presentation to Jessie Norman MP Energy Minister and DECC officials on 1 March 2017. The key messages conveyed to the minister were:

- That the WSP/PB report is 'unfit for purpose', is misleading and should be rejected by Government.
- That there is a clear attempt in this report to bury the health effects of WTN despite overwhelming evidence to the contrary.
- The combined Parsons Brinckerhoff and Institute of Acoustics reports propose virtually the same AM control scheme as proposed by RenewableUK in their 2013 report. This report by the wind industry trade association was heavily criticised and was shown not to control AM.

INWG repeated the recommendation that ETSU be replaced by BS4142 and referred to a FOI response dated 3 Feb 2017 that released government internal emails confirm that, **if ETSU is withdrawn, BS4142 could be used to fill the gap**.

Once again, the government appears to have ignored the recommendations and failed to engage with the INWG in any way after the meeting.

## ETSU-Gate Chapter 13: WSP review of ETSU

Following the release of INWG WP8.1 and its presentation to government in 2017 there was no visible progress for several years. After the evidence-based arguments put forward by campaigners challenging the science behind the government sponsored Good Practice Guide and proposals for the measurement and control of AM, it appeared to present a setback in the strategy for updating ETSU. It was only some four years later during August 2021 that campaigners discovered a government DBEIS contract had been awarded to WSP to review the noise guidance (ETSU) for onshore wind. The WSP contract included a stakeholder engagement survey with participation by invitation only and the INWG were clearly not invited. Following a request directly to DBEIS, the INWG was finally allowed to participate, and a consultation response was submitted to WSP on 24 September 2021. The WSP report titled, **A review of noise guidance for onshore wind turbines** [Ref 54] by Michael Lotinga and Toby Lewis was released on the WSP website on 10 February 2023.

The 400-page WSP report was subsequently analysed by the INWG and a report released titled, **INWG Analysis of WSP Report titled: A review of noise guidance for onshore wind turbines** [Ref 55] and submitted directly to the government DESNZ on 15 April 2023. The INWG analysis of the WSP report, concluded that this review of ETSU by WSP is heavily biased with an obvious author conflict of interest.

Given the strength of the evidence revealed within the WSP report, there is a clear and obvious disconnect between this evidence, and the report's conclusions and recommendations. The INWG recommendations communicated to government DESNZ included:

- *"Reject the recommendations made by WSP in their review for ETSU-R-97 to be retained albeit with some revisions.*
- *Replace ETSU-R-97 with BS4142:2014+A1:2019 as the official guidance for wind turbine noise assessment.*
- *Reject the WSP suggested proposal for a government 'position statement' on low frequency noise. This proposal is unsupported by the evidence and would conflict with the World Health Organisation (WHO) position.*
- *Conduct independent research into the effects on health and well-being of wind turbine neighbours including impacts from long term exposure, low frequency noise, infrasound, amplitude modulation and tonal noise as recommended by the WHO.*
- *Introduce licencing and regulation of wind power generation by a national agency such as the Environment Agency.*

**The INWG analysis concluded that this review of ETSU by WSP has not taken account of scientific developments or legal findings and the report recommendations were predetermined. Additionally, there is the suspicion that the WSP review of ETSU was being used as the basis of justifying a replacement for ETSU that is equally permissive or more so to permit even higher levels of noise, both audible and infrasonic.**

## ETSU-Gate Chapter 15: Low frequency noise

The ETSU-Gate report Chapter 15 discussion on low frequency noise (LFN) is expanded in Appendix B with additional evidence. The statements in the WSP report denying the relevance of LFN have been carried forward into the proposed update of ETSU at Paras 1.18 and 1.19 as identified in Appendix A.

**In the same way as that AM was denied by the wind industry until faced with overwhelming evidence that forced its reluctant recognition, LFN and infrasound is also being denied, with substantive and increasing scientific evidence challenging this claim still being ignored by the wind industry and by government.** The ETSU-Gate report Chapter 15 brings together recent evidence and advances in the understanding of wind turbine LFN and infrasound.

The INWG WP2.1 titled, **Review of Reference Literature** [Ref 27] dated July 2015 provides details of the evidence base at that time starting with research from the 1980s. This 1980s evidence confirmed that people do react to a low frequency noise environment and use of the A-weighted measurement is not an adequate indicator of annoyance when low frequencies are dominant.

This 1980s research also confirmed that wind turbine noise could cause annoyance and that it contains a large low frequency component that can excite building structures such that low frequency noise levels could be higher inside than outside buildings. Kelly found internal sound pressure levels of **up to 10dB greater** than external where low frequencies are present.

The **Wisconsin report** [Ref 12] from December 2012 compiled by four different consultants agreed that;

- "Residents report being intensely affected despite inaudibility and to be aware of turbine operation even when the turbines are not visible", also;
- "the study also showed that a wind turbine is indeed a unique source with ultra-low frequency energy. In general, enough was learned by these investigators, all with quite different past experiences, that it can be mutually agreed that infrasound from wind turbines is an important issue that needs to be resolved".

The **Cape Bridgewater report** [Ref 21] from Australia dated November 2014 provided a significant advance in the recognition and understanding of LFN effects. **Resident's observations identified 'sensation' as the major form of disturbance from the Cape Bridgwater wind farm.**

One reason for the lack of wider recognition of low frequency noise from wind turbines is the limitation of the sound meters used for noise measurement. In a 2015 paper titled, **Constraints imposed by and limitations of IEC 61672 for the measurement of wind farm**

**sound emissions** [Ref 25], Les Huson discusses these constraints. Huson provides evidence that available sound meters compliant with IEC 61672 are unsuitable for measurements where infrasound is present as typically found in WTN emissions at frequencies below 6 Hz or where there are low background noise levels. Data presented in wind farm noise assessment reports that are below the lower measurement range of the instrument are not compliant with the specification requirements of IEC 61672.

Dr John Yelland provides a very helpful discussion of amplitude modulation and the closely related LFN in his paper INWG WP1 titled, **The Fundamentals of Amplitude Modulation of Wind Turbine Noise** [Ref 26] dated November 2015. Dr Yelland provides this description from the perspective of a physicist. Yelland confirms at page 5 that AM is, *"the sum of incoherent noise, modulated both in frequency and in amplitude, together with high levels of very low frequency tones".* He is also critical of the ReUK AM research report [Ref 17] regarding the exclusion of any consideration of acoustic emissions below 100Hz.

Yelland stresses the importance of the considering the acoustic energy as well as the loudness and shows that the power of wind turbine noise in the 1Hz to 20Hz band represents 99.9% of the total spectrum acoustic energy. Yelland continues with, *"it is most unwise to ignore the existence of the acoustic energy below 20Hz just because that frequency defines a normal lower limit of human hearing."*

Yelland questions the reasoning offered in ETSU for setting the night time noise limit at 43dB(A), as opposed to the outdoor limit of 35dB(A), is the assumption of 8dB sound attenuation in passage through an open window. Continuing with, *"This assumption is valid at normal audio frequencies but certainly does not apply at very low frequencies; even with windows closed there is usually little or no attenuation from outdoors to indoors, and sometimes amplification due to room resonances. It is therefore not surprising that the majority of noise complaints relate to sleep deprivation indoors, and not to annoying noise levels outdoors."*

Yelland argues against the use of A-weighting or even G-weighting when measuring LFN, showing that it is inappropriate to use any weighting in these instances. He is also critical of current industry practice to exclude the measurement of low frequency noise below 100Hz where he states;

*"The IOA Good Practice Guide endorses the use of ISO 9613-2 for wind farm immission noise level prediction and of IEC 61400-11 for turbine noise measurement. Both these standards require measurement only down to 45Hz, a seemingly perverse movement upwards in frequency from 20Hz over a 16 year period during which turbine noise emissions decreased considerably in frequency due to the increase in turbine dimensions. That the lower frequency limit should be raised even further to 100Hz for EAM measurement, which clearly have a significant content below 100Hz, seems yet more perverse."*

**This exclusion of sound measurement at the lower frequencies and the use of A-weighting is being justified by the wind industry claim that there is nothing of relevance to measure, however there is a growing evidence base showing just how significant this LFN is.**

More recent research by the International Acoustics Research Organisation (IARO) provides a significant advance in our understanding of wind turbine low frequency noise and infrasound, how it should be measured and how the data should be analysed.

This IARO research is based on much higher precision sound measurement enabling measurement down to 0.5Hz, increased time resolution, increased frequency resolution from the industry standard of 1/3 of an octave to 1/36 of an octave, and the use of unweighted sound pressure level in place of A, G or C weighting.

The IARO data analysis includes the use of Sonograms and harmonic analysis that enable the wind turbine acoustic signature (WTAS) to be identified. The IARO report titled, **Report on the High-Resolution Infrasonic and Low-Frequency Sound Recordings Conducted Within a Rural Farm in Scotland in 2022 and 2023** [Ref 58] and its Appendix A titled, **Technical Background for Laypersons** [Ref 59] are summarised here in Appendix B.

This research provides evidence of the direct link between wind turbine low frequency noise and health effects. In doing so it challenges the wind industry denials surrounding the health effects from LFN and infrasound.

## ETSU-Gate Chapter 16: Health & wellbeing

The driver behind the campaign to replace ETSU is wind turbine noise and the impact it is having on rural communities, plus the inability to obtain a resolution to these complaints. While not all wind farms are causing noise complaints and not all rural communities are affected, a significant minority are impacted. This noise impact can result in a range of effects ranging from annoyance, through loss of sleep, to more serious health issues. In some cases, families are being forced to vacate their homes. This message copied below from a desperate wind farm neighbour in Scotland during April 2025 describes the torment being experienced;

*"There is absolutely no abatement in our suffering as a consequence of [Redacted] wind farm. It has been particularly bad with predominantly wind blowing between South and East over the last 3-4weeks. Our health and that of all the residents at [Redacted] is steadily deteriorating with the passage of time. Personally my sleep pattern is such that I now only have two hours of proper sleep (when I first go to bed) - the rest of the night very difficult to get back to sleep. This is seven days/week..... I don't know how much longer we can bear the situation we are in before the consequences are much more serious than just constant exhaustion."*

Wind turbine noise complaints are not being driven by the loudness of the noise or concerns of hearing damage that typically applies to aircraft noise or loud music as examples, but the character of the noise. In some case the noise is not even audible and the complaints relate to 'sensation'. Additionally, in most cases the complaints relate to night time impact when background noise levels are lower.

Legal aspects of noise complaints are discussed in the ETSU-Gate report at Chapter 14. This chapter discusses the difficulties in taking legal action and obtaining a resolution to noise complaints. The barriers to taking nuisance legal action are prohibitive with very few cases ever reaching the Courts. ETSU-Gate Chapter 14 provides some examples of success in Australia and Ireland but to date none in England. The combination of legal barriers and ineffective ETSU noise guidance have created a situation where once a wind farm becomes operational it is effectively immune to action to curtail operation to reduce noise. This was demonstrated in 2021 following the case known as **Mr Keith Holl v Greencoat UK Wind UK** relating to the Cotton Farm wind farm in Cambridgeshire discussed in Appendix B.

**The Cotton Farm case demonstrates the virtual impossibility for the victims of wind turbine noise to obtain justice under English law. This leaves wind farm operators effectively immune to prosecution for noise nuisance under the Statutory Nuisance procedure contained in the Environmental Protection Act 1990.**

So far, there has been no legal finding of Nuisance in an English civil court but there are now cases from Australia and Ireland (see further below) where Nuisance has been found or admitted. These cases have followed the Supreme Court judgment of Coventry v Lawrence

[2014] UKSC13. The inability to obtain resolution to noise nuisance complaints through the Courts is directly relevant to the associated health impacts documented in Chapters 14 and 16. The ETSU-Gate report Chapter 16 discussion on health and wellbeing is expanded in Appendix B with additional evidence included. The protection of wind farm neighbour health and wellbeing is the major failing of the existing ETSU guidance. The proposed update to ETSU will only continue and significantly worsen this situation.

The connection between wind turbine noise and ill health effects have long been disputed and continues to be denied by the wind industry and its acousticians. This chapter explores the extensive evidence base spanning many years that disproves this industrywide denial.

Dr Amanda Harry in her 2007 paper titled, **Wind turbines, noise and health** [Ref 3] concludes with; *"I think it is clearly evident from these cases that there are people living near turbines who are genuinely suffering from health effects from the noise produced by wind turbines. These neighbours of turbines clearly state that at times the noise from turbines is unbearable. The developers are usually heard to say that noise is not a problem. Clearly this cannot be the case."*

The five consultant who compiled the **Wisconsin report** [Ref 12] discussed at Chapter 15 concluded that; "**Residents report being intensely affected despite inaudibility and to be aware of turbine operation even when the turbines are not visible**" and:

"Nauseogenicity is a factor at Shirley. Acceleration of the inner ear is suggested due to extremely low-frequency pulsations at the rotation and blade pass rates that occur in or near the frequencies of highest potential for nauseogenicity and, are coupled strongly into the homes now abandoned."

Additionally, residents were forced to leave their homes due to the effects of noise.

The Cape Bridgewater paper [Ref 21] also discussed in Chapter 15 reported;

- *"The residents observations and identification of sensation (separately to vibration and noise) indicates that the **major source of complaint from the operation of the turbines would appear to be related to sensation rather than noise or vibration**.*

- ***Residents reported that at times they have to leave the area to seek relief.***

- *For some residents experiencing adverse sensation effects the impact can be exacerbated by bending over, rather than standing, with the effect in some cases being reported as extremely severe and lasting for a few hours."*

The health effects of wind turbine noise are also explored by Dr Chris Hanning in his March 2015 INWG WP3.2 paper titled, **Excessive Amplitude Modulation, Wind Turbine Noise, Sleep and Health** [Ref 30] This comprehensive report examines the effects of wind turbine noise on people living close to wind turbines including annoyance, sleep disturbance and health

effects through a review of the available health related literature. Hanning's extensive evidence is discussed at Appendix B.

The 2017 paper by Prof Alun Evans titled, **Environmental Noise Pollution: Has Public Health Become Too Utilitarian**? [Ref 50] questions the acceptance of the Collateral Damage caused by wind farms. In the abstract he states;

- *"Wind turbines produce a range of sound but it is the Infrasound and low frequency noise which deserves special attention. Infrasound is considered to be below the range of human hearing so it is not measured in routine noise assessments in the wind farm planning process. There is, however, evidence that many can register it and a sizeable minority is sensitive, or becomes sensitised to it. The actual route of transmission still requires elucidation.*

- *Governments, anxious to meet Green targets and often receiving most of their advice on health matters from the wind industry, must commission independent studies so that the Health and Human Rights of their rural citizens is not infringed. Public Health, in particular, must remember its roots in Utilitarianism which condoned the acceptance of some Collateral Damage provided that the greatest happiness of the greatest number was ensured. The degree of Collateral Damage caused by wind farms should be totally unacceptable to Public Health which must, like good government, fully exercise the Precautionary Principle."*

The IARO paper titled, **Health Report on a Rural Sheep Farm in Scotland** [Ref 63] released June 2024 follows on from their earlier research and report discussed at Chapter 15 regarding low frequency noise recordings and analysis at this sheep farm. This scientific investigation was carried out following a request by the residents and workers at the farm and is discussed at Appendix B Chapter 16. The report summary includes;

- *"High-resolution acoustic recordings were conducted at Rural Sheep Farm in 2022 and 2023. The corresponding Acoustics Report (IARO23-C1) was submitted in January 2024, showing a practically continuous exposure of Rural Sheep Farm residents to strong wind turbine acoustic signature (WTAS) and low frequency tones.*

- ***WTASs are trains of multiple, short-duration pressure pulses that can reach 20 dB above background level. WTAS have already been correlated to adverse health effects, namely sleep disturbance.***

- *WTASs are not detectable with the methodologies imposed by current UK legislation and guidelines regarding wind turbine noise, and low frequency tones are also greatly deemphasized by these methodologies.*

- *On 14 February 2023 and then again on 6 April 2023, the local General Practitioner [name redacted] for family Z, stated that Mrs Z, Mr Z and Ms Z1 "have been experiencing a significant impact of noise pollution from the nearby windfarm. The impact is such, that it has caused considerable physical and mental health issues.*

- *Since the installation of WPP B, Mr Z, 76, has been hospitalized twice, in March 2023 and in June 2023 (airlifting required); Ms. Z1 (53, daughter) was hospitalized from June 2023 to January 2024; and Ms. Z2-4 (14, granddaughter), diagnosed with high spectrum autism at age 2, has seen her behaviour greatly and seriously aggravated, causing a devastating impact on the entire family."*

The Rural Sheep Farm wind turbine noise case demonstrates a total and catastrophic failure of the ETSU R 97 noise guidance and subsequent IOA GPG. This latest ETSU review likewise compounds this absolute travesty and failure to protect genuine complainants from wind turbine acoustic pollution.

A recent judgment in Ireland dated 5 June 2025, **Bryne and Moorhead v ABO Energy and Wexwind**, known as the **Gibbet Hill** judgment [Ref 65] confirms the role of low frequency noise in noise nuisance complaints. This judgment deals with a wind turbine noise nuisance case creating a legal precedent in Ireland. It has taken the residents 12 years to obtain this resolution and is also described in the ReNews, Renews Gibbet Hill June 2025 ; and at Beale & Co, Beale Gibbet Hill June 2025.

During the court proceedings the defendant admitted liability for the nuisance. Both sides agreed the wind farm complied with the planning conditions, with the noise assessment being based on the UK ETSU guidance. **During the hearing the defendant accepted the noise nuisance being the result of amplitude modulation and low frequency noise**.

The Gibbet Hill judgement is similar to the **Meenacloghspar judgement** [Ref 61] delivered by Justice Emily Egan High Court Judgement a year earlier on 8 March 2024. - This was another High Court case in Co Wexford Ireland, between Margaret Webster and Keith Rollow & Ross Shorten and Joan Carty as Co plaintiffs and Meenacloghspar (Wind) Limited as the defendant.

As with the **Gibbet Hill judgment** low frequency noise was a significant factor as confirmed at Para 9 of the Judgement when considering the characteristics of the plaintiff's complaints;

Justice Emily Egan reports: *"Wind turbine aerodynamic noise is typically broadband in nature in the sense that it is evenly distributed across the frequency spectrum; but it can exhibit lower frequency content. Sound with significant lower frequency content is both more intrusive and less effectively attenuated by barriers such as windows, walls and insulation.*

*75. Ms. Webster also emphasised that in addition to windspeed and speed of rotation , wind direction and weather conditions have a huge impact on how noise and vibration would be*

*experienced. These factor all influence thump AM, which is described as the most intrusive aspect of the WTN at Ballyduff.*

*80. The impact of the noise affected Mr. Rollo most profoundly through his sleep. At night, the turbine frequently makes a thumping, whacking and slapping noise; like the side of the house was being hit by something.*

*Like Ms. Webster, Mr. Rollo's sense is that the noise and vibrations come though the walls of the house. At times, the whole house vibrates with the noise. As a result, all attempts to mask the WTN using both professional noise cancelling headphones and industrial earplugs (which he had obtained from work) were unsuccessful because, he could still feel the noise 'through my bones'."*

## ETSU-Gate Chapter 19: The argument for BS4142

The evidence included in this report and referenced elsewhere demonstrates the strength of the argument for replacing ETSU with BS4142. The overwhelming evidence against ETSU proves it to be ineffective at controlling wind turbine noise including AM and LFN or protecting the health and wellbeing of wind farm neighbours, additionally;

- BS4142 is used widely across industry and has been regularly updated to remain relevant.
- BS4142 has been tested and found to work well for wind turbine noise.
- Government internal emails released in 2017 following a FOI request confirmed that "if ETSU is withdrawn, BS4142 could be used to fill the gap".

The noise assessment methodology adopted by BS4142 is fundamentally different to ETSU, with simplified descriptions being;

- BS4142 compares the **actual noise impact** at a **specific location** by assessing noise loudness and character **compared with the actual background noise level**. The assessment provides for graduated corrections for both tonal and impulsive character including AM and the corrections are cumulative. **There are no fixed noise limits.** Although BS4142 does not assess LFN noise directly, if LFN is present then it requires an assessment using the DEFRA NAN45 procedure.

- In the case of ETSU, the measured noise (or predicted noise in the case of a planning application) is **compared with fixed noise limits derived via a complex and opaque averaging process using data from a background noise and wind speed survey.** These derived noise limits are then **fixed for the duration of the project**. ETSU provides a graduated correction for tonal noise but does not correct for impulsive character including AM and does not require any assessment for LFN. Crucially, ETSU relies on the masking effect of wind induced noise to mask the turbine noise through the derived noise limits. This process being the root cause of ETSUs failure to protect.

Chapter 19 summarises this argument in Table 1 and provides a detailed comparison of BS4142 with ETSU. There can be no technical or administrative reason for rejecting the replacement of ETSU with BS4142.

Adopting BS4142 as the official noise guidance would provide a viable, cost-effective solution to wind turbine noise assessment bringing it into line with similar industries. It would also provide a more straightforward route for wind farm neighbours impacted by noise nuisance to obtain speedy redress at the LPA level so avoiding legal action by individuals. All professional acousticians and LPA EHOs will be familiar with the use of BS4142 so providing for greater transparency and ease of use.

An additional benefit of adopting BS4142 is that use of sound measurement in $L_{AEQ}$ allows for the correct mathematical assessment of cumulative impact from other noise sources including ancillary equipment, substations and battery energy storage systems.

**Adopting BS4142 would force wind farm operators to adopt a more responsible attitude while the impact on renewable generation nationally would likely be minimal**.

**The omission of any consideration to date of BS4142 by government or industry leads to the conclusion that this situation could only exist as a result of government policy, official or unofficial, to impose levels of noise from wind turbines that are higher than is permissible from any other forms of industrial activity.**

# Discussion of Consultation from Appendix C

The timing of the government consultation by DENSZ is the first aspect of the consultation to be criticised. It cannot be a naïve coincidence that the consultation period coincides with the government parliamentary recess. A period when the potential risk for parliamentary scrutiny is at a minimum.

When we review the consultation questionnaire it is clear that the questions have been carefully framed to focus attention on minor issues, particularly the lower noise limits (LLV) that are applied during the assessment. These are relatively minor issues where undoubtedly DENSZ are intending to provide some limited flexibility in their final guidance document. This focus on minor issues appears to be a diversion from the 'elephant in the room' issues including wind shear correction, amplitude modulation control, low frequency sound and health effects. It is anticipated that following the consultation, DENSZ will offer to relax the noise limits just enough to be able to claim they have listened to feedback and responded by increasing protection for wind farm neighbours.

In reality the likely changes to noise limits that DENSZ will voluntarily offer will have minimal effect on the overall ETSU assessment as it will still permit the continuation of 'business as usual' for wind power developers and operators. **The effective immunity for wind farm operators from noise complaints will remain.**

The consultation response format of six questions for submission via an online portal may be convenient for DENSZ but hinders the submission of constructive criticism of the wider ETSU update. The 'elephant in the room' issues where consultation responses are not invited include:

**The IOA Good Practice Guide & the IOA planning condition for AM**

The failures with these methodologies have been included in the response to question 3 and refers to Appendix B, Chapters 3, 4, 5 and 12 for details.

**Uncertainty**

The failure to allow for measurement and assessment uncertainty has been included in the response to question 6 and refers to Appendix B, Chapter 3 for details.

**Low frequency sound and health effects**

The failure to consider LF sound and its health effects has been included in the response to question 5 and refers to Appendix B, Chapters 13, 15 and 16 for details.

**The alternative to ETSU**

The recommendation to replace ETSU with BS4142 is included in the response to question 6 and refers to Appendix B, Chapter 19 for details.

# Glossary

| Name / Abbreviation | Description / Definition |
|---|---|
| | |
| AM | Amplitude Modulation; of audible wind turbine noise. See also EAM and OAM |
| | |
| AMWG | Amplitude Modulation Working Group of the IOA |
| | |
| Acoustics Bulletin | Also known as the 'Bulletin' is a bi-monthly journal published by the Institute of Acoustics. |
| | |
| BS4142 | The British Standard titled: 'Method for rating and assessing industrial and commercial sound'. Published by BSI and available via subscription. |
| | |
| BSI | British Standards Institute |
| | |
| BWEA | British Wind Energy Association, now known as RenewableUK, also ReUK, is the UK wind power industry trade association. |
| | |
| dB | Decibel, the logarithmic scale used to quantify sound levels. |
| | |
| DBEIS | Government Department for Business, Energy & Industrial Strategy |
| | |
| DECC | Government Department of Energy & Climate Change |
| | |
| DEFRA | Government Department for Environment, Food & Rural Affairs |
| | |
| DESNZ | Government Department for Energy Security & Net Zero |
| | |
| DLUHC | Government Department for Levelling Up, Housing & Communities |
| | |
| DTI | Government Department of Trade and Industry |
| | |
| EAM | Excessive (or Excess) Amplitude Modulation of audible wind turbine noise, also referred to as Other Amplitude Modulation (OAM). |
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| EHO | Environmental Health Officer within a Local Planning Authority |
| | |
| EIR | Environmental Information Request. Is similar to a FOI but relates to requests for environmental information. See also FOI |

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| ETSU | See ETSU-R-97 |
| | |
| ETSU-R-97 | Also known as ETSU is the official guidance for wind turbine noise assessment. Titled: 'The assessment and rating of noise from wind turbines' it was released by the Energy Technology Support Unit on behalf of the DTI in 1996. |
| | |
| FOI | A Freedom of Information (FOI) request allows anyone to ask any public authority in the UK for information they hold, promoting transparency and accountability, with the authority requested having 20 working days to respond. See also EIR. |
| | |
| GPG | The Good Practice Guide released by the IOA NWG during 2013 titled, A Good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise. |
| | |
| HMP | Hayes McKenzie Partnership, a UK acoustic consultancy |
| | |
| IARO | The International Acoustics Research Organisation is an international group of researchers based in New Zealand with a mission to investigate acoustical environments, especially with respect to features that affect humans and animals, and to publish the results. |
| | |
| Immission | The sound incident (arriving at) at a given location resulting from the sound emitted by a source |
| | |
| Infrasound | Commonly considered to be sound with frequencies below 20 Hz. There being some overlap with low frequency sound. 20 Hz is often considered to be the lower limit of audible sound although sound below 20Hz may be audible at sufficiently high levels. See also LFN. |
| | |
| INWG | The Independent Noise Working Group |
| | |
| IOA | The Institute of Acoustics is the UK's professional body for those working in acoustics, noise and vibration. It is a nominated body of the Engineering Council. |
| | |
| IOA NWG | Institute of Acoustics Noise Working Group. |
| | |
| $L_{Aeq,T}$ | The A weighted energy average sound pressure level over the time interval, T |
| | |
| $L_{A90,T}$ | A weighted sound pressure level that is exceeded for 90% of a given time interval (T) measured using the fast time weighting, often used |

| | |
|---|---|
| | for the measurement of background sound. In the case of wind turbine noise assessment, the time interval T is 10 minutes. |
| | |
| LFN | Low frequency noise, generally considered to be sound with frequencies in the range of 10 Hz to 200Hz. There being some overlap with Ultrasound. The threshold of audibility is generally around 20 Hz and varies between individuals. See also Infrasound. |
| | |
| LLV | Lower limiting value as used in the proposed Assessment and Rating of Wind Turbine Noise. This is the value of the fixed element of the noise limit and which is not related to a margin above background sound levels but is set at a fixed value irrespective of wind speed. |
| | |
| LOAEL | From the Noise Policy Statement for England, Para 2.20 – The 'Lowest Observed Adverse Effect Level' (LOAEL) is defined as the level above which adverse effects on health and quality of life can be detected. |
| | |
| LPA | Local Planning Authority, the council / body responsible for local planning matters. |
| | |
| MAS | MAS Environmental is an independent UK noise and environmental consultancy. |
| | |
| NAWAG | National Alliance of Wind Action Groups |
| | |
| Net Zero | The UK government Net Zero strategy sets out policies and proposals for decarbonising all sectors of the UK economy to meet the net zero target by 2050. |
| | |
| OEM | 'Other' Amplitude Modulation of audible wind turbine noise, also referred to a 'Excessive' Amplitude Modulation (EAM) but now generally referred to as simply AM. |
| | |
| REF | The Renewable Energy Foundation is a registered charity promoting sustainable development for the benefit of the public by means of energy conservation and the use of renewable energy. |
| | |
| ReUK | 'RenewableUK' is the UK wind power industry trade association, formerly known as the British Wind Energy Association |
| | |
| RES | Renewable Energy Systems, a UK wind farm developer and operator |
| | |
| SOAEL | From the Noise Policy Statement for England, Para 2.21 – The 'Significant Observed Adverse Effect Level' (SOAEL) is defined as the level above which significant effects on health and quality of life can be detected. |

| | |
|---|---|
| Tone | The concentration of acoustic energy into a very narrow frequency range. |
| | |
| WHO | World Health Organisation |
| | |
| WSP | WSP is a global engineering and professional services consulting company |
| | |
| WSP / PB | Parsons Brinkerhoff, a UK consulting company was acquired by WSP during 2014 and during 2017 was combined with the parent company WSP Global. The PB brand has since been retired. |
| | |
| WTN | Wind Turbine Noise |
| | |

# Appendix A
# Review of the draft guidance document

In this appendix the proposed guidance document titled, **Assessment and Rating of Wind Turbine Noise** [Ref 66] released by the UK government DESNZ on 4 July 2025 for consultation is reviewed. The key issues and concerns are identified here for expanded discussion later in Appendix B.

## Pages 2 & 3 – Acknowledgements

To maintain objectivity and ensure diverse perspectives, the project steering and peer review groups should comprise of different members. This has not occurred for this project.

The project steering and peer review group includes names commonly associated with the wind power industry. Malcolm Hayes and Andy McKenzie are directors of **Hayes McKenzie Partnership Ltd**, and Andrew Bullmore is a director of **Hoare Lea LLP**. Both of these acoustic consultancies are significantly commercially involved with the wind power industry and have been for at least three decades. Bullmore and Hayes were members of the original ETSU noise working group for the original ETSU guidance methodology devised during the late 1990s. Their allegiances and history suggest a likely element of ownership and protection of the ETSU methodology and this is reflected in the retention of the core ETSU methodology

Dick Bowdler is shown as an independent acoustic consultant; however, this claim to be independent is considered to be questionable. He was initially very critical of ETSU, his 2005 paper titled, **ETSU-R-97 Why it is wrong** [Ref 2] demonstrating preference for the use of the British Standard industrial noise assessment BS4142 instead of ETSU. This is discussed further at Appendix B, Chapters 2 and 19. However, since his 2005 paper, Bowdler has become a supporter of ETSU, becoming active on IOA working groups and now regularly criticises those challenging the ETSU guidance and those raising legitimate concerns regarding infrasound and low frequency noise impacts.

His letter titled, **Wind turbine noise: the search for an alternative truth** [Ref 51] published in the IOA **Acoustics Bulletin Nov 2017** edition page 38, demonstrates a less than professional attempt at discrediting credible scientific evidence that challenges the wind industry and DESNZ position on low frequency noise and amplitude modulation. It is a letter that should never have been published by a supposedly professional Institute.

The inclusion of Professor Charlotte Clark in the project steering and peer review group is significant as she is not an acoustician, she is an environmental and mental health epidemiologist and chartered psychologist currently at City St Georges, University of London and also employed at consulting firm, Arup.

Professor Clark's experience with transport noise is well documented but not her experience with wind turbine noise. Given the unsubstantiated dismissal in the draft guidance of low frequency noise and infrasound, Professor Clark's role requires clarification; there is no record of the information and data with which she was briefed or of what she was asked to do. The World Health Organisation [Ref 52] page 85, states *"Wind turbines can generate infrasound or lower frequencies of sound than traffic sources. However, few studies relating exposure to such noise from wind turbines to health effects are available."*

No information is provided on the purpose and objectives of the workshop(s), the workshop outputs, or the role of the workshop attendees and if and how they influenced the new guidance.

Richard Perkins, another familiar acoustician is listed as a workshop attendee representing the Institute of Acoustics. His online profile shows he currently works for Mott MacDonald and was formerly with WSP / Parsons Brinkerhoff. During his time with WSP / PB he was seconded to DEFRA for 7 years. Perkins has been a key player in the wind turbine noise debate for many years acting at the heart of the interface between government, the wind industry and the Institute of Acoustics, defending the industry and government position on ETSU. Although not on this steering group for this ETSU update, he has been on other wind turbine noise working groups and will have been in a position to influence the update to ETSU and retains further influence through his position as a workshop attendee.

Other workshop attendees include various departmental government officials from the UK, Scottish, Welsh and Northern Ireland governments, plus representatives from the wind industry. Significantly, the steering and peer review group and workshop attendee lists do not include members of the public with a firsthand negative experience of living within the influence of wind turbine noise; civic or community group representatives; scientists and acousticians critical of the current ETSU guidance; or outsiders to the selected government / industry / consultant communities.

As documented in the INWG **ETSU-Gate** report [Ref 64] June 2025, this exclusion of opposing views continues from earlier government and IOA sponsored studies and reports related to wind turbine noise. Such an approach does not lend itself to sound policy making.

## Page 4 – Executive Summary

This executive summary is short and vague. The first paragraph includes a statement of the overall objective of the new guidance, quote; *"It provides guidelines for the control of wind turbine noise, such that wind farm neighbours receive a reasonable degree of protection without placing unreasonable restrictions on wind farm development."*

This equivalent statement in the introduction to the original ETSU 1996 guidance [Ref 1] states, quote; *"This document describes a framework for the measurement of wind farm noise and gives indicative noise levels thought to offer a reasonable degree of protection to wind farm*

*neighbours, without placing unreasonable restrictions on wind farm development or adding unduly to the costs and administrative burdens on wind farm developers or local authorities".*

These two statements are essentially the same and confirm the intention to carry over the objectives from ETSU to prioritise the development and operation of wind farms over the protection of wind farm neighbours from noise – acoustic pollution and the adverse effects on health and quality of life.

The second paragraph confirms that the existing ETSU methodology of noise limits being derived from background noise and fixed lower limits is being carried over to the new guidance.

## Pages 7 to 11 – Section 1 Introduction

**Para 1.1**
The evolutions, developments, established best practice, and latest available evidence in the field, which this targeted technical update was undertaken to reflect, are not specified.

**Para 1.2**
Provides confirmation that the new guidance was produced jointly by Hoare Lea LLP, Hayes McKenzie Partnership and Noise Consultants Limited. Hayes McKenzie Partnership Limited and Hoare Lea LLP are discussed above at **Pages 2&3 – Acknowledgements.**

It is understood that Noise Consultants Limited are the contracted consultants for the production of the guidance, and are also closely connected with and financially involved with the wind power industry. While it is claimed the project team has drawn on the experience of external peer reviewers, (pleural), only one peer reviewer, Prof Charlotte Clark is listed in the acknowledgement section, discussed above at **Pages 2&3 - Acknowledgements**. There is no evidence of an independent peer review process having been conducted.

**Para 1.3**
Reiterates the objective statement from the introduction prioritising the development of wind power over and above the protection of wind farm neighbours from noise. There does not appear to be any meaningful intention of protecting the health and well-being of wind farm neighbours.

**Para 1.4**
Clarification that this noise assessment criteria is consistent with achieving Net Zero through the adoption of renewable energy sources and this is being prioritized above the protection of people that may be impacted.

**Para 1.5**
Confirmation that the new guidance is based on:

The existing ETSU-R-97 (released 1996) [Ref 1]
The IOA Good Practice Guide (released May 2013) [Ref 13]
IOA proposed planning condition for Amplitude Modulation (released Aug 2016) [Ref 44]
WSP report (released February 2023) [Ref 54]

**Para 1.6 & 1.7**
It is interesting that *"other elements that may be incorporated into a wind energy development which can produce operations noise"*, also *"construction or decommissioning noise "*are assessed through the application of alternate assessment methods. Presumably these alternative assessment methods would include BS4142.

**Para 1.8**
Provides confirmation that the new guidance excludes the methodology for prediction of wind turbine noise. Also provides confirmation that noise prediction is addressed in the IOA Good Practice Guide. This is critiqued in at Appendix B, Chapters 3, 4 & 5 and referenced documents.

**Para 1.12**
Introduces the **Noise Policy Statement for England** (NPSE) [Ref 8] and the principles of LOAEL, the exposure level for adverse effects of health and quality of life, and SOAEL the exposure level for significant effects on health and quality of life. Also, the NPSE aim to 'minimise' non-significant adverse noise impacts as far as reasonably practical. Clearly, the interpretation of what is 'reasonably practical' will be different for impacted wind farm neighbours to the interpretation by government and developers.

**Para 1.15**
Provides confirmation that defining the LOAEL and SOAEL for wind turbine noise is outside the scope of this new guidance. Although the LOAELs and SOAELs are not defined, so are by definition unknown, it is still claimed that the SOAEL whatever it is, should not be exceeded, but the LOAELs whatever it is, may be exceeded. **How this can be possible without the LOAEL and SOAEL being defined is not explained**.

**Para 1.16**
This makes clear that wind turbine noise exposure above the undefined LOAEL creating '**adverse effects on health and quality of life**' will be permitted and it will not be necessary to further minimise noise levels. We can therefore expect developers to design wind farms up to the severe (SOAEL) level, whatever that level may eventually defined as. Future noise disputes will therefore be restricted to whether the noise is considered adverse (allowed) or severe (not allowed).

However, until LOAEL and SOAEL are properly defined they are effectively 'red herrings' and irrelevant as noise compliance will be determined by the assessment process and dB noise limits defined elsewhere in the guidance, a methodology that is essentially unchanged from the original ETSU.

**Paras 1.19**
**Infrasound** is being ignored in the new guidance despite mounting evidence to the contrary. The WSP scoping review is being quoted as the justification for this statement despite the evidence submitted to government criticising the WSP report. Infrasound and low frequency sound are discussed later in this report at Appendix B, Chapter 15.

**Para 1.21**
As with infrasound, the adverse effects of **low frequency sound** are also being ignored despite evidence to the contrary. Infrasound and low frequency sound should be considered together since the frequency ranges overlap and both often occur together. Although these subjects are discussed later, it should be noted that the use of A-weighted noise measurement as mandated by ETSU and the proposed update is unsuited for measuring low frequency sound or infrasound.

## Pages 12 to 21 – Section 2 Assessment method

**Summary**
This describes what is essentially the methodology employed by the current ESTU guidance. The higher night time limit is being retained despites decades of criticism and recognition by both sides of the ETSU debate as being fundamentally wrong. Retaining these higher lower night time limits will provide additional headroom to permit any AM correction penalties to be applied and still allow ETSU compliance to be claimed. Effectively nullifying the pretence of controlling AM. This is discussed at Appendix B, Chapters 3 & 5.

This proposed assessment criteria now includes an increase in the day time LLV from 35dB $_{LA90}$ to 37dB $_{LA90}$. The night time LLV is unchanged at 43dB $_{LA90}$ and the financially involved LLV is unchanged at 45dB LA90. The higher noise limit for financially involved occupiers is considered to be morally wrong.

Whereas sound measurement based on $L_{A90}$ is relevant for background noise measurement, it is also being retained in the proposed guidance and despite evidence of its unsuitability when assessing the impact of wind turbine noise. In this case $L_{Aeq}$ has been shown as being more suitable.

**Para 2.1**
The noise limits will apply to residential dwellings only and will not apply to schools unless they are also residential, where higher noise levels will be permitted. No limits are specified in these cases.

**Para 2.2**
This new guidance specifies free-field measurement only. This retains the outdoor free-field measurement from the existing ETSU guidance and ignores inside noise levels. The screening effect close to a façade can result in background noise around 3dB lower than in a

free field location whereas reflection of a specific noise such as from a turbine can be 3dB higher, giving a 6dB difference in the developer's favour using a free field location.

The noise assessment criteria should be defined to protect primarily the indoor environment as most noise complaints relate to noise levels inside homes, and mostly during the evening and night time. Whereas free-field measurement is applicable for background noise monitors, when investigating compliance or complaints, measurements should be undertaken where and when the nuisance is being experienced. This is usually inside homes and during the night.

**Para 2.5**
The new guidance retains the use of standardised wind shear (roughness) that ignores the times when wind shear is high, typically during the nighttime through the averaging effect. The use of standardised wind shear introduced by the Article Method and then carried through to the Good Practice Guide ensures that periods of high amplitude modulation, coincident with high wind shear are masked through the averaging process. Wind shear is discussed at Appendix B, Chapter 3.

**Para 2.7**
States that character correction should not be added at the planning/application stage since AM cannot be predicted. Although the precise timing and severity of AM cannot be predicted, evidence shows that all wind turbines suffer from AM to varying degrees. If wind farms are designed up to the noise limits, as is expected, without consideration of an effective AM character correction, then the noise limits will almost certainly be exceeded with even relatively low levels of AM.

**Para 2.8**
Confirmation that the ETSU style derived limit line related to wind speed will be retained. Although shown as being optional, developer / operators will obviously opt for the higher margin above baseline background sound levels.

**Para 2.9**
Confirmation that wind turbine sound will continue to be measured using $L_{A90,10min}$ as per the existing ETSU. The use of $L_{Aeq}$ as proposed by others for measuring wind turbine noise has been summarily excluded. It should be noted that BS4142 adopts the use of $L_{Aeq}$ and even the WSP report authors concede the merits of $L_{Aeq}$ in their November 2023 **Acoustics Bulletin article** [Ref 57].

**Para 2.10**
This confirms the retention of the old ETSU derived noise limit criteria.

**Paras 2.11 & 2.12**
This description is unclear and could lead to different interpretations. It has been interpreted here as one set of background sound level and one limit curve will apply the same limit line for day and night. This also aligns with question 1 from the consultation questionnaire [Ref 67] However, this needs clarification as it conflicts with the statement at the Summary above at page 12. This indicates separate day and night LLVs with a higher night time LLV of 43dB.

**Para 2.16**
The new guidance proposes a daytime LLV increase range from 35dB to 40dB for the current ETSU, to a proposed range from 37dB to 40dB. The new guidance proposes the retention of the higher 43 dB nighttime limit despite criticism of having a higher limit at night that goes against standard practice in other areas of noise control in the UK and internationally.

**Paras 2.17 to 2.24**
Confirms the intentions to formalise permitted noise levels at the higher end of the LLV scale for larger schemes, where fewer people are exposed and where downwind exposure is considered minimal. Those unfortunate wind farm neighbours living close to large wind farms in remote rural location are to be considered as '**acceptable collateral damage**' resulting from wind power deployment. It should be expected that developers will continue to design the wind farm noise emissions up to the noise limits with minimal or no margin, and without any allowance for uncertainty. Neither ETSU or its proposed replacement require uncertainty to be considered. Uncertainty is discussed at Appendix B, Chapter 3.

**Para 2.22**
A failure to recognise that AM, the main feature generating noise complaints occurs upwind as well as downwind. Therefore, this method of estimating duration and level of exposure is flawed.

**Para 2.25**
It is unclear whether 'financial involvement' applies to the property or the residents although it does state it applies for the life of the scheme. Is it still relevant and does it still apply if not all residents are financially involved such as or children or other family members? What happens if the property is sold and the new owners are not financially involved? What happens if the property is occupied by tenants, or is later rented out with the tenants not financially involved? The entire concept of applying a higher noise limit justified by financial involvement is discriminatory, morally wrong and should be abandoned.

**Paras 26 to 28**
The process for determining background sound levels and then determining average noise level curves is essentially the same as the current ETSU. This process for deriving noise limits from survey data has been shown to be integral to the ETSU methodology and why it fails to protect. This is discussed at Appendix B, Chapter 3 and **Where ETSU is Silent** [Ref 11].

## Pages 22 to 26 - Section 3 Operational noise monitoring

**Para 3.1**
The new guidance specifically excludes the requirement for any post-completion compliance monitoring or any periodic monitoring despite recommendations that such monitoring is essential.

**Para 3.7**
Evidence shows that AM is often occurring upwind and this is being ignored in the new guidance. Upwind impact from AM is discussed at Appendix B, Chapter 5 & 8 and the **Newport presentation** [Ref 19].

**Para 3.8**
The new guidance continues with the 10 minute averaging of the $L_{A90}$ noise level that effectively removes the noise fluctuations including AM.

**Para 3.13**
The new guidance only allows either a tonal correction or an AM correction, not both. This is unlike BS4142 that allow correction for tonality and impulsivity (similar to AM) to be cumulative when determining the Rated value.

**Paras 3.19 to 3.22**
The new guidance now formalises the IOA methodology titled, **A Method for Rating Amplitude Modulation in Wind Turbine Noise** [Ref 44] This proposed AM methodology has been tested and shown to under report the level of AM, and as a result fails to control AM.

With a maximum of 5dB correction, typical high levels of AM during quiet nighttime's would still leave rated sound levels below the noise limit. This would enable compliance with the planning condition to be demonstrated so would allow the AM nuisance to continue. AM is discussed at Appendix B, Chapter 5.

**Para 3.23**
Confirms that only the highest of either the tonal and AM character correction is applied.

## Pages 27 to 32 - Section 4 Planning conditions

**Para 4.6**
Continues the practice of allowing the wind farm operator to select the noise consultant to assess the noise complaint leading to the obvious conflict of interest. To avoid this conflict of interest the Planning Authority should select and employ the consultant, to be paid for by the wind farm operator. These noise complaint investigations typically take many months to conclude when following the existing ETSU methodology. This is unsatisfactory, whereas the

use of BS4142 for noise assessment and noise complaints could result in a significantly faster process.

Additionally, the consultant's report, the data and calculations applied should be made freely available on request to ensure full transparency to third parties.

The example planning condition and planning condition technical guidance notes are highly prescriptive and are written around the ETSU Good Practice Guide that is critiqued elsewhere in this report.

**Para 4.9**
This wind farm operational data described should also be made freely available to third parties when the wind farm is subject to noise complaints and investigations.

## Page 33 – Section 5 References

BS 4142:2014+A1:2019 is listed as a reference document but is not mentioned elsewhere in the document.

## Pages 43 to 47 – Appendix C Day LLV Examples

This discussion of Day LLV and its determination is something of a red herring, and a distraction from the issues that really matter. The range of day LLV to be applied is relatively small, 37dB $_{LA90}$ to 40dB $_{LA90}$, and unlikely to have any real impact on whether a wind farm is compliant or not. Noise complaints are predominantly during the nighttime when higher wind shear and AM occur, coincident with the higher 43dB $_{LA90}$ night time LLV.

However, if the higher night time LLV is abandoned to give just one LLV, then the determination of the LLV becomes more relevant. The day LLV lowest proposed value of 37dB $_{LA90}$ is an increase of 2dB above the current ETSU minimum value, and is far too high.

With background noise levels in some rural locations down to around 20dB $_{LA90}$, a minimum LLV of 37dB $_{LA90}$ or even the existing 35dB $_{LA90}$ value much too high. Permitting wind turbine noise at the LLV, a level more than 10bB above background, we almost guarantee noise complaints.

Not only is the LLV much too high, basing the LLV on the factors and criteria described at Appendix C is considered to be discriminatory. All wind farm neighbours should be given the same level of protection from noise.

# Appendix B
# ETSU-Gate report summary and expanded discussion

## Contents

## Introduction

The **ETSU-Gate** report [Ref 64], released by the INWG during June 2025 documents the three decades long battle by campaigners against the wind power industry and government to ensure proper control of wind turbine noise. It covers the period from the release of ETSU in 1996 up to May 2025, and just prior to the release on 4 July 2025 by the UK government DENSZ of the proposed update to ETSU [Ref 66] and the consultation [Ref 67].

Cognizance of the history and evolution of the ETSU campaign and the agendas of the parties involved is essential to enable a full appreciation of how wind turbine noise assessment and science has developed the way it has. This understanding of the history is also essential to appreciate the scale of this corruption of the science that has evolved over the last three decades.

This bad science, the exclusion of inconvenient evidence and obfuscation may have started small scale during the 1990s but has since expanded, corrupting acousticians, the Institute of Acoustics and misleading decision makers such that it has become institutionalised within the wind industry and government. The driving force behind this deception and denial of scientific truths appears to be an obsession with Net Zero and a blind belief that the 'ends justify the means'.

It has also become more evident over recent years that government officials as well as the wind industry would prefer much of this evidence challenging the corruption of science to remain hidden and forgotten. The ETSU-Gate report was prepared with this and the anticipated government revision of ETSU in mind to bring together this evidence base into a readily accessible format.

The body of the ETSU-Gate report is presented in the form of a **Campaign Story** consisting of a series of discrete chapters, where each of the main issues are discussed. A **Campaign Time Line** and a **Reference List** are included as supporting appendices. The ETSU-Gate Campaign Story chapters are summarised here in Appendix B so as to be more relevant to this discussion of the proposed ETSU replacement, creating a convenient format for expanded discussion on the key issues. These expanded discussions focus on the main deficiencies and areas of contention identified in Appendix A including;

- **Wind shear and noise limits**
- **Amplitude modulation**
- **Low frequency sound and health effects**
- **The BS4142 alternative to ETSU**

## Chapter 1: In the beginning ETSU was created

ETSU-Gate Chapter 1 discussed the creation of **ETSU-R-97** [Ref 1], during the late 1990s and the prioritisation of wind power development over the protection of affected communities. Additionally, there is an inherent conflict of interest where the same government department responsible for the deployment of renewable energy is also responsible for policing the environmental impact of this deployment of renewables.

***This conflict of interest within a single government department with its prioritisation of business and political interests over the health and wellbeing of local communities lies at the heart of the ETSU-Gate campaign and is arguable its root cause.***

***Consequently, this failure of government has been responsible for an unprecedented level of suffering, ill health and financial loss for a significant number of mostly rural wind farm neighbours.***

This prioritisation of wind power development over the protection of affected communities is set to continue with the replacement for ETSU as is also the conflict of interest with DENSZ continuing to be responsible for wind power deployment and policing its environmental impact.

## Chapter 2: The start of noise complaints and industry denials

This chapter covers approximately the first decade following the release of ETSU, when we experienced the start of noise complaints, industry denials of noise nuisance and the beginning of criticism of the then new ETSU guidance.

One of the first to criticise ETSU was Dick Bowdler, an independent acoustician with his paper released in 2005 titled, **ETSU-R-97 Why it is wrong** [Ref 2]. In the Introduction he states;

- *"The conclusions of ETSU-R-97 are so badly argued as to be laughable…."*
- *"ETSU-R-97 bears no resemblance to standards used for other industrial developments."*
- *"Other renewable energy developments have to meet much stricter standards."*

In the body of his report at Section 3 Bowdler argues against the poorly thought out ETSU methodology while presenting well-argued reasons for the adoption of BS4142. In arguing for the use of BS4142 Bowdler also argues the use of $L_{Aeq}$ when measuring wind turbine noise. It should be noted that since 2005, BS4142 has been revised two more times making an even stronger case for its application with wind turbine noise. This has been argued by the INWG since 2015 and is discussed later at Chapter 19.

At Para 3.18 Bowdler states;
"*Then, on page 63 there is another leap of credibility: There is no evidence for or against the assertion that wind farm noise with no audible tones is acceptable up to and including $L_{A90,10min}$ levels of 40dB(A) even when background noise levels are 30dB or less. This is just nonsense. There most certainly is evidence against this assertion. The 40dB is actually 42dB in BS4142 units. This is at least 12dB above background noise level of "30dB or less" and BS4142 says there are likely to be complaints at turbine levels of plus 10dB. Furthermore there is no argument that BS4142 is not applicable. Even BS 4142:1990 (which was current when ETSU-R-97 was written) might easily be applicable here. If the wind speed is 5m/s, the background noise 30dB and the turbine noise 42dB(LAeq) then there is no reason not to use BS4142, it does not exclude itself in these circumstances. This noise level is also 12dB more than (twice as loud as) the WHO considers necessary for you to be able to get to sleep*."

Bowdler's paper concludes with;

- *"ETSU-R-97 is so poor technically that its conclusions have to be queried. It is put together through a series of unfounded assertions and there has been no research drawn on to justify them."*
- *"Even if one were minded to accept the suggestion that you should use very low background noise levels and that there ought to be a level below which it would be appropriate to use an absolute noise level, the levels proposed by the NWG are not acceptable. The night time level is 45dB($L_{Aeq}$) and the day time level is 37 to 42dB($L_{Aeq}$). Most wind farm sites are in rural areas where background noise levels*

*can easily be 20 to 25dBA when turbines are operating and so the margin above background could be up to 20dB or more.*"

Given Bowdler's arguments in 2005, it is hardly surprising that there have been so many noise complaints and so much individual suffering by wind farm neighbours over the intervening twenty years. It should also be noted that Bowdler's paper was written before the introduction of the later generations of larger wind turbines, and the wider impact of amplitude modulation.

The significance of the Bowdler 2005 paper is that twenty years later he is a member of the steering group for this latest update of the ETSU guidance. In doing so he is now endorsing a continuation of the same deeply flawed ETSU methodology he previously criticised so strongly.

The steering group has ignored the past recommendation by Bowdler to apply BS4142 for wind turbine noise and has ignored more recent recommendations from the INWG and others to adopt the use of BS4142. Additionally, great care appears to have been taken to ensure that BS4142 or even its existence is not even mentioned in any government sponsored reports relating to wind turbine noise.

The first major industry attempt at denial of noise problems came with the Salford report released August 2007 titled, **Research into 'Aerodynamic Modulation of Wind Turbine Noise** [Ref 4]. This report downplayed the significance of AM or the need for further research.

Fortunately, the Renewable Energy Foundation (REF) initiated a FOI request for information withheld from the Salford report. This FOI request was initially refused but was provided January 2009 [Ref 5] following an appeal.

***The Salford report survey FOI information release shows details of complaints arising from 27 wind farms. It also demonstrated that the report authors were complicit in withholding and then resisting the release of critical information relating to the extent of these noise complaints.***

## Chapter 3: The Article (or Bulletin) Method

The ETSU-Gate Chapter 3 discussion is expanded here in order to address wind shear as the treatment of wind shear is one of the main deficiencies of the ETSU methodology, a deficiency that is being carried over to the proposed update.

In response to ongoing criticisms of ETSU, a group of acousticians closely connected to the wind industry published an article in the IOA journal, Acoustic Bulletin, March 2009 edition titled, **Prediction and assessment of wind turbine noise** [Ref 6]. Subsequently known as the **Article Method** or **Bulletin Method** it recommended a methodology for the treatment of wind shear, also commented on the prediction of wind turbine noise and the significance of low frequency noise.

This methodology for the treatment of windshear subsequently carried forward to the IOA Good Practice Guide, and now being proposed to be formalised into the update to ETSU has resulted in far reaching implications for wind turbine noise assessment. It is most unlikely that policy makers or planning decision makers will understand the overly complex and thoroughly opaque nature of the **Article Method**, relying instead on a group of wind industry acousticians to verify its credibility.

The acousticians authoring the **Article Method** were widely seen to be predominately acting on behalf of the wind power industry, some of whom were also original authors of ETSU. These **Article Method** authors included Bowdler who had by this time fundamentally shifted his position to full support for ETSU, in addition to Bullmore, Hayes and McKenzie, who are listed as integral participant members of the steering group for the latest update to ETSU.

Wind shear is the effect of a change of wind speed and direction with height above ground level caused by a combination of ground roughness and atmospheric stability. If high shear is present and not factored correctly into the predictions, the result is to underestimate wind speed at the turbine hub height and to overestimate it at near ground level. The effects of this are that with high wind shear we have more noise emitted by the turbine at hub height and less masking of this noise near ground level than under low shear conditions.

The **Article Method** as proposed was tested by Stigwood of MAS and described in his September 2011 paper, **The effect of a common wind shear adjustment methodology on the assessment of wind farms when applying ETSU-R-97** [Ref 9] where Stigwood states,

*"The study concluded that the desired benefit using the article method at all wind speeds, and especially at 5-7m/s where the article method was expected to perform best, is not realised. Where standardised wind shear conditions as implemented by the article, which do not relate to those conditions causing complaint, were substituted for the actual wind shear conditions likely to cause complaint more turbine noise was allowed."*

Stigwood demonstrated that the use of standardised wind shear and the averaging process inherent in the ETSU Article Method **does not relate to actual wind shear when the noise nuisance was being experienced.**

The Stigwood paper was followed by Moroney and Constable of REF with their April 2012 paper titled, **A critique of the IOA treatment of background noise for wind farm noise assessment** [Ref 10]. Moroney & Constable confirmed the Stigwood findings and stated;

- *"The Acoustics Bulletin revision increases the uncertainty of the background noise curves and reduces confidence in the reliability of noise conditions based on them.*

- *We also show how the wind speed data accumulated from an on-site anemometer can be used to predict the likelihood and frequency of noise complaints from neighbours for a hypothetical site layout, taking into account the bearing and proximity of the turbines to dwellings. The results demonstrate that separation distances that could be judged acceptable under the new methodology, would nevertheless be likely to trigger significant numbers of noise complaints from neighbouring dwellings."*

**The Stigwood study revealed a clever and opaque methodology involving a manipulation of the wind shear exponent, developed by wind industry acousticians that allows higher levels of wind turbine noise, and makes any subsequent noise enforcement actions much more difficult. The Moroney & Constable findings also confirm that the Article Method is less protective of wind farm neighbours than even the standard ETSU methodology and as a result allows developers to site turbines closer to homes.**

Remarkably, despite the criticisms, this IOA '**Article Method**' methodology was subsequently adopted as part of the IOA **Good Practice Guide**, and is now being proposed to be formalised into the latest revision of ETSU, championed throughout by the same group of wind industry acousticians.

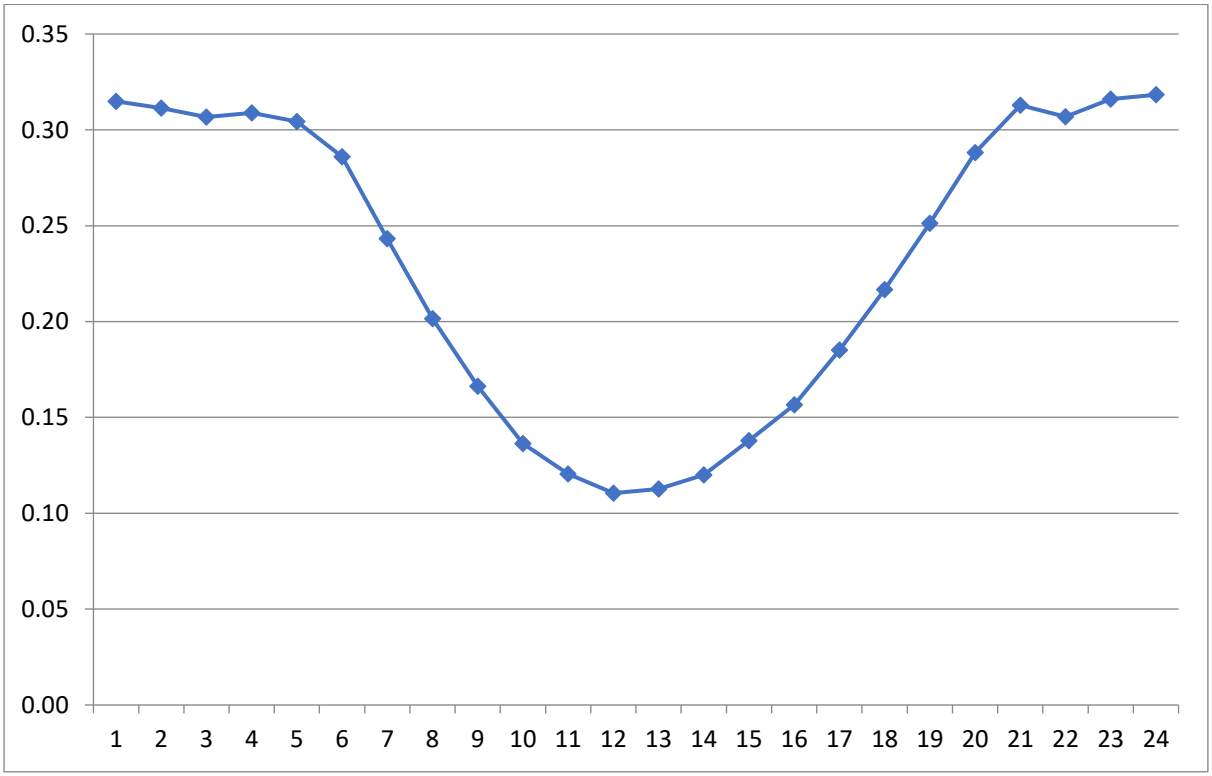
During July 2012 a group of Northamptonshire campaigners, Cox, Sherman & Unwin with professional assistance, released a comprehensive critique detailing the shortcomings of ETSU including the Article Method. Their report titled, **Wind Turbine Noise Impact Assessment - Where ETSU is Silent** [Ref 11] (subsequently known as **Where ETSU is Silent** or **WEIS**) identified the key deficiencies of ETSU including:

- A failure to adequately consider the effects of wind shear in noise assessments so underestimating turbine noise levels;
- A failure to correctly analyse background noise data when deriving average noise curves so overestimating background masking noise;
- A failure to correctly use the ISO 9613-2 noise propagation model resulting in an under prediction of turbine noise;

- A failure to allow for measurement tolerances (or uncertainties) that can easily amount to +/- 10dB resulting in a doubling or halving of the WTN;

'WEIS' provides a detailed examination of wind shear, its importance in the assessment process and the implications of the Article Method at WEIS Section 6 – Wind Shear, and is still fully relevant in 2025. Wind shear is first described, how it is measured and how the wind shear exponent is calculated. The standard ETSU treatment of wind shear is discussed followed by the Article Method methodology. Perversely, the Article Method adjusts the background noise levels, even though the effect of wind shear in on the turbine noise.

The Article Method is unnecessarily complicated, making it more difficult for decision makers during the planning application stage to assess how close to the limit the predicted turbine noise may be. This over complication makes it almost impossible for the layman to understand and also makes any subsequent noise nuisance enforcement by local authorities virtually impossible.




**WEIS Figure 5: Hourly average wind shear**

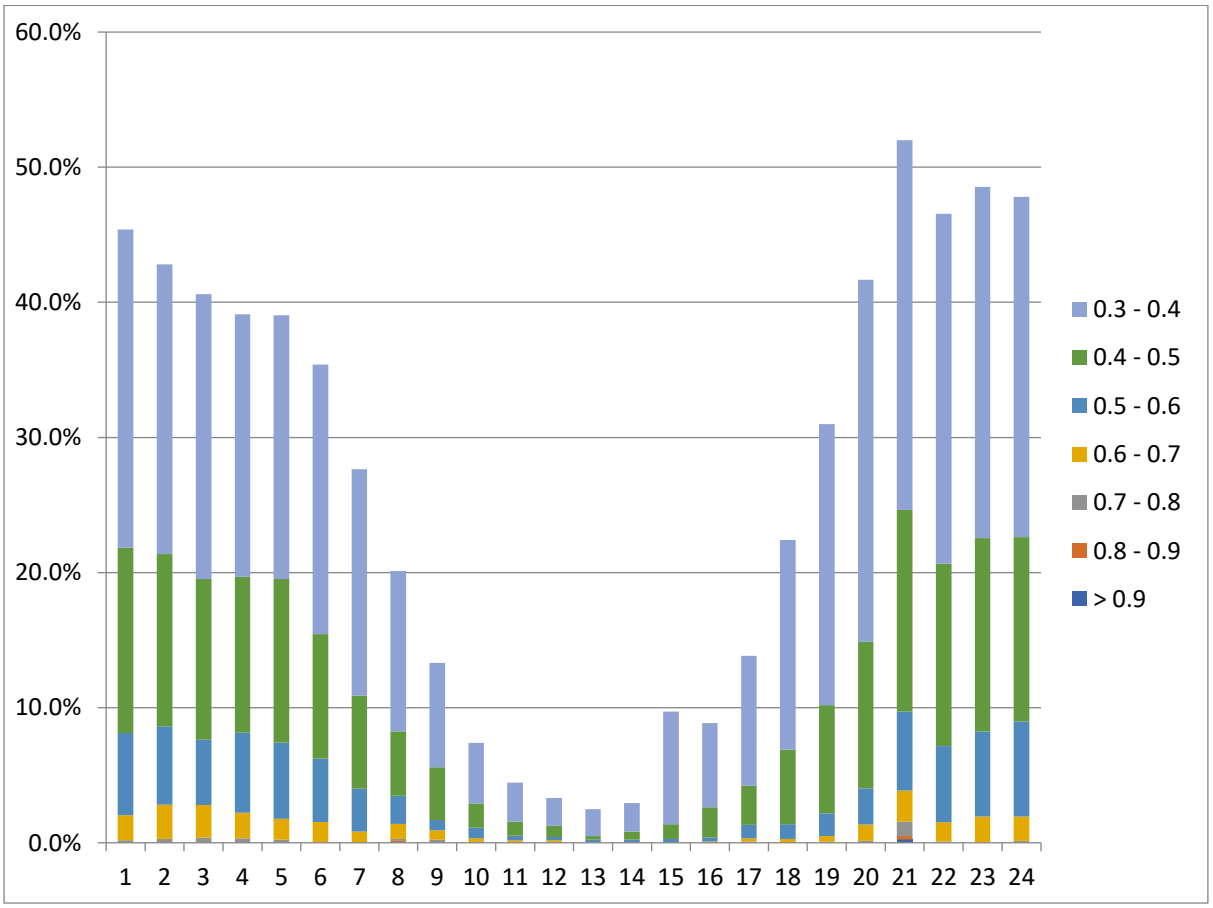
WEIS Section 6 continues with a case study analysis of the Winwick wind farm wind shear analysis based on anemometer mast data taken over a 12 month period. WEIS Fig 5 (reproduced here) shows the **annual hourly average** wind shear exponent (vertical axis) against the time of day (horizontal axis). This shows the hourly average shear exponent at a

minimum of 0.11 occurring around mid-day and a maximum of 0.32 occurring around midnight.

WEIS Fig 6 (reproduced here) provides a breakdown of the **hourly averages** to show the wind shear spectrum in bands. A shear exponent of 0.4 or greater occurs for more than 19% of the time from 8pm to 5am, and a shear exponent of greater than 0.5 occurs for more than 7% of the time from 8pm to 5am.

WEIS Table 1 reproduced below shows the wind shear correction values applied by the Winwick wind farm developer. These 'averaged' shear corrections are significantly lower than the levels of shear obtained from the data analysis that occur for significant periods of time.

In the case of Winwick we determined that the $V_{10}$ wind speeds when high wind shear occurs as being below 5m/s and that shear values of 0.5 occur for significant periods of time. Referring to WEIS Table 2, to the range of shear offsets at column 8 corresponding to $V_{10}$ wind speeds below 5m/s and above the turbine cut-in point, are found to vary from 2.03m/s to 5.07m/s. In the case of Winwick it is believed that an offset of 3m/s to be a modest and reasonable correction to apply to the predicted noise curves.




**WEIS Figure 6: Hourly average wind shear exponent breakdown**

To better understand the significance of applying the wind shear offset correction, WEIS Figure 7 shows as an example the day-time noise level curves in dB $L_{A90}$ vs. $V_{10}$ 10 min averaged wind speed for the receptor location 'Winwick Warren The Cottages'. The effects of applying shear offsets of 2m/s and 3m/s show that for this location the wind shear correction causes a 'compliant' situation with 2.6dB of headroom to become 'non-compliant' with predicted noise 3.5dB above the limit curve.

| 10m Wind speed bands | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Quiet Daytime (18:00 – 23:00) | 0.27 | 0.26 | 0.20 | 0.16 | 0.12 | 0.12 | 0.11 | 0.10 | 0.10 | 0.09 | 0.09 |
| Night-time (23:00 – 07:00) | 0.36 | 0.29 | 0.23 | 0.19 | 0.15 | 0.13 | 0.13 | 0.12 | 0.11 | 0.10 | 0.10 |

**WEIS Table 1: Average wind shear values applied at Winwick wind farm**

This analysis shows that wind shear is high at this site with a shear exponent of greater than 0.5 occurring for more than 7% of the time from 8pm through to 5am. Subsequent data examined for other sites indicates that the Winwick high level of wind shear is in fact typical and not unusual. In contrast to the actual high wind shear profile for the site, the developer was allowed to use the 'standard' shear exponent of 0.16 (or the equivalent ground roughness length of 0.05m) in line with ETSU and an averaged level of shear correction.

Further discussion of wind shear and the assessment process is provided in the paper titled, **Wind farm noise assessments: ETSU-R-98 and the three legged stool**, [Ref 14] by Unwin and Cox published in Science in Parliament Summer 20013.

An alternate discussion that may help in understanding wind shear and its significance is provided by Dick Bowdler in his June 2009 paper titled, **Wind shear and its effect on noise assessment of wind turbines** [Ref 7]. Bowdler explains how wind shear above the standard roughness value results in a higher turbine noise than expected. He then describes the effect being to move the turbine noise curve to the left on his Fig 3, exactly the same method as described above in WEIS. However, despite demonstrating the effect by moving the turbine noise curve, he makes the comment, "*In fact, in the UK it is now becoming more common to shift the background noise curve to the right using background noise levels standardised to a roughness length of 0.05m and leave the turbine noise the same. The result is the same.*"

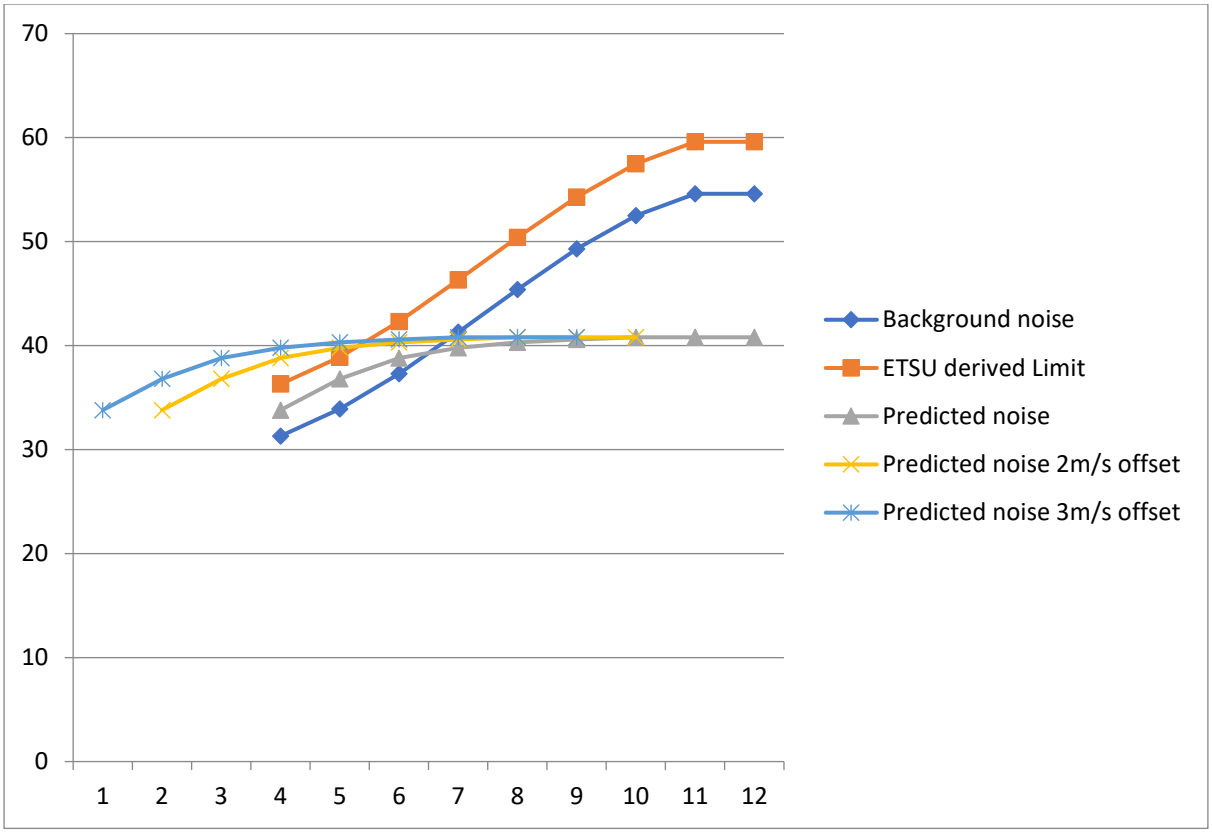
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| Reference Wind Speed | Calculated from $V_{10}$ using α = 0.16 | Calculated from $V_{10}$ ref using α = 0.3 | Shift from reference required for α = 0.3 | Calculated from $V_{10}$ ref using α = 0.4 | Shift from reference required for α = 0.4 | Calculated from $V_{10}$ ref. using α = 0.5 | Shift from reference required for α = 0.5 | Calculated from $V_{10}$ ref. using α = 0.6 | Shift from reference required for α = 0.6 |
| $V_{10}$ | $V_{80}$ | $V_{10}$ | V offset | $V_{10}$ | V offset | $V_{10}$ | V offset | $V_{10}$ | V offset |
| | α = 0.16 | α = 0.3 | Ref - α = 0.3 | α = 0.4 | Ref - α = 0.4 | α = 0.5 | Ref - α = 0.5 | α = 0.6 | Ref - α = 0.6 |
| | | | | | | | | | |
| 3.0 | 4.18 | 2.24 | 0.76 | 1.82 | 1.18 | 1.48 | 1.52 | 1.20 | 1.80 |
| 4.0 | 5.58 | 2.99 | 1.01 | 2.43 | 1.57 | 1.97 | 2.03 | 1.30 | 2.70 |
| 5.0 | 6.97 | 3.74 | 1.26 | 3.04 | 1.96 | 2.47 | 2.53 | 2.00 | 3.00 |
| 6.0 | 8.37 | 4.48 | 1.52 | 3.64 | 2.36 | 2.96 | 3.04 | 2.40 | 3.60 |
| 7.0 | 9.76 | 5.23 | 1.77 | 4.25 | 2.75 | 3.45 | 3.55 | 2.80 | 4.20 |
| 8.0 | 11.16 | 5.98 | 2.02 | 4.86 | 3.14 | 3.94 | 4.06 | 3.20 | 4.80 |
| 9.0 | 12.55 | 6.73 | 2.27 | 5.46 | 3.54 | 4.44 | 4.56 | 3.60 | 5.40 |
| 10.0 | 13.95 | 7.47 | 2.53 | 6.07 | 3.93 | 4.93 | 5.07 | 4.01 | 5.99 |
| 11.0 | 15.34 | 8.22 | 2.78 | 6.68 | 4.32 | 5.42 | 5.58 | 4.41 | 6.59 |
| 12.0 | 16.74 | 8.97 | 3.03 | 7.29 | 4.71 | 5.92 | 6.08 | 4.81 | 7.19 |

**WEIS Table 2: Wind shear offset calculations**

Bowdler provides no reasoning for this illogical statement that contradicts his own description of wind shear. In fact, on first inspection, one may consider the overall effect of applying wind shear correction to the background noise curve as proposed in the Article Method instead of to the turbine noise curve should not make any difference overall. However, as the investigations by Stigwood and then by Moroney have confirmed it does make an important difference and it is difficult to imagine that the authors of the Article Method have also not understood the relevance of this difference offering an advantage to the wind industry.

It should also be noted that around the year 2009 was when Bowdler appears to have fundamentally shifted from being an 'ETSU sceptic' to an 'ETSU supporter' and lending his name to the Article Method published March 2009. His wording of his paper appears to have been carefully chosen so as not to contradict the Article Method.

In his 2009 paper Bowdler uses the exponent method for wind shear analysis as used in WEIS and arrives at similar conclusions. In comparing his Figs 8 and 9 he states on page 8, *"Perhaps the most striking result is the much greater spread of 80m wind speeds at night. This means that, at a 10m wind speed of 2m/s, when background noise is likely to be very low the turbines could be running at full sound power in a wind of 8m/s for a small but significant amount of time whilst during the day the hub height wind speed would never exceed 6m/s."*




**WEIS Figure 7: Wind shear correction illustration**

On page 10 he states, "*The average wind shear exponent in winter is 0.35 and in summer is 0.30 for this site. The figures suggest a slightly greater wind shear in winter but it might be expected that there would be higher wind shear in winter because of the longer nights*."

His conclusions at page 13 include, "*At a hub height wind speed of between 7 and 10m/s the sound power level of most turbines levels off and as wind speed further increases the background noise rises more quickly than the turbine noise. Hence this is the area where turbine noise is at its greatest margin over background noise and so is most intrusive*."

Although Bowdler provides a good explanation of wind shear and its effects, he fails to discuss how it should be corrected for in the ETSU noise assessment. To have done so would have risked contradicting and undermining the Article Method.

WEIS at **Section 7 – Assessment Uncertainties** examines the uncertainties associated with the ETSU methodology. **Critically, this failure of ETSU to recognise uncertainty is being carried forward to the proposed revision of ETSU.**

Noise assessment is **no** different from any other area of science or engineering in that any process requiring measurement and assessments will be subject to tolerances or uncertainty. Identifying the expected range for any uncertainty or tolerance is fundamental

to science and engineering. The omission of consideration of uncertainty makes the ETSU wind turbine noise assessment possibly the **only** area of science that assumes every measurement and process provide perfect accuracy with zero errors or tolerances. WEIS Section 7 discusses the likely uncertainties associated with the ETSU noise assessment process and concludes with,

*"In summary we have arrived at estimates of the uncertainties in the ETSU process of +/-5dB, +/-2dB, +/-3.6dB and +/-5dB for the basic sound data, the 'average' curve, the predicted turbine noise and the reference wind speeds. Of course some of these will cancel, but by the same token some will be additive. Combining these estimates in the standard way yields a token of +/-8.2dB but how they combine in any specific assessment would have to be dealt with on its merits, but we conclude by observing that a sound difference of up to 10dB from prediction could easily occur that will either double or halve noise loudness. This would be in addition to the errors arising from microphone wind induced noise and correction for wind shear."*

Additionally, this does not include the effects of amplitude modulation discussed later in this report. It should also be noted that BS4142 now requires consideration of uncertainty to be factored into the noise assessment providing another justification for its use with wind turbine noise. The detailed discussion of uncertainty within WEIS is provided at:

**Section 3 – Background Noise Measurement.** This examines sources of uncertainty in the measurement of the background noise upon which the entire process rests. It is shown that there are serious issues of sampling in time (is the period for which data collected truly representative?) and space (have the most at risk locations been adequately monitored or even identified?).

**Section 4 – Background Noise Analysis** and Appendix **A** examine a second area where ETSU is also silent and where current practice fails to recognise unavoidable intrinsic uncertainty. ETSU asks that a 'best fit curve' is fitted to the background noise data plotted against wind speed in order to determine the average reference background noise over the range of wind speeds. It is from these curves that the noise limits are derived. It is shown that no acoustic theory guides the choice of curve so that typically quadratic, cubic, or even quartic polynomial functions all seem to provide a reasonable statistical fit to the data and are used interchangeably providing a degree of 'flexibility' for the developer's acoustician. It is shown that, although it can add an uncertainty of at least +/- 2dB to the values used as reference, the choice of function is more-or-less arbitrary. Almost any curve threaded through the data could have been used.

**Section 5 – Turbine Noise Prediction** deals with uncertainties that arise from hypothetical (model) calculations of the turbine noise at the 'at risk' locations and times. Typically, developers do not specify which model of turbine is to be installed relying instead on noise emission data for a 'candidate turbine'. Here it is shown that there is uncertainty in the ways by which manufacturers report the emitted noise, between different 'candidate

turbines', and in all probability engineering variations between turbines of nominally the same design. These data are then input into a standard noise prediction model defined in ISO9613-2 and used, together with essentially arbitrary assumptions about the absorption of the noise *en-route*, to predict the noise at the at risk locations. Even the ISO9613-2 model itself recognises at least +/-3dB of calculation uncertainty in these predictions, but in any specific implementation the engineering and turbine choice variability will add to this perhaps +/- 2dB giving a total uncertainty in this part of the process of around +/- 4dB.

## Chapter 4: The Good Practice Guide

The next stage in the campaign by the wind industry to defend ETSU was the release during May 2013 by the IOA noise working group of their Good Practice Guide titled, **A Good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise** [Ref 13]. The report page 2 identifies the report authors as Cand, Davis, Jordan, Hayes and Perkins. Although the initial report was released without the all important GPG Supplementary Guidance Notes, a preliminary review of the IOA guidance concluded:

- The Noise Working Group is almost entirely made up of representatives from the wind industry supply chain.
- No representatives from groups or consultants having an interest in protecting wind farm neighbours from turbine noise were included. Neither were any statisticians, meteorologists, health professional or academics included. By no stretch of the imagination can this new guidance be considered impartial or independently peer reviewed.
- The new guidelines make no significant changes to current practice so allow the wind industry to continue 'business as usual'

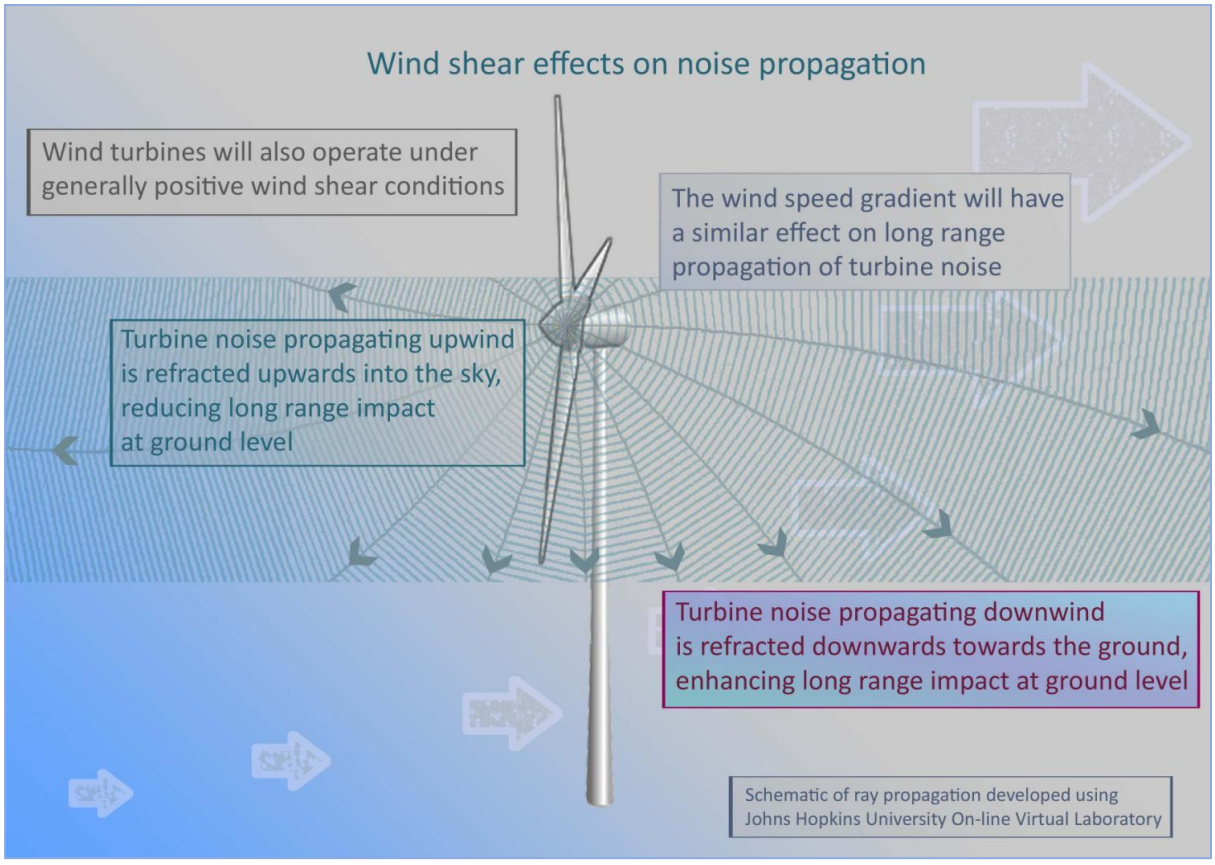
Subsequent analysis of the Good Practice Guide (GPG) was presented by campaigners at Westminster to the Secretary of State and DECC officials on 9 October 2013. Titled, **A Summary of the Bad Science behind the Wind Turbine Guidelines** [Ref 15] the presentation focused on the bad science being promulgated by the IOA noise working group in their GPG. This presentation discusses the bad science and highlights at:

**Slides 9-11** Background noise measurement
**Slides 12-19** Turbine noise correction for wind shear
**Slides 20-21** Effects of wind shear on noise propagation
**Slide 23** Assessment uncertainties
**Slide 25** Noise limits
**Slides 26-27** Low frequency noise

This presentation demonstrated the failure of the GPG to adequately allow for wind shear in the assessment process. The IOA GPG adopts the wind shear methodology proposed in the IOA Article Method, discussed earlier at Chapter 3. It is the treatment of wind shear where we find the most serious consequences of the bad science on the assessment process and the most blatant attempt to mislead. By manipulation of the methodology for assessing the wind shear effect, the GPG mandates a sophisticated and deceptive averaging process for wind shear that fails to consider the periods when wind shear is higher than average. This methodology permits higher noise levels to the advantage of the wind farm operator. Additionally, the IOA NWG failed to demonstrate that a 'grown-up conversation' had taken place with the wider scientific community and that the outcome is demonstrably based on sound science.

Wind shear also affects noise propagation as shown below on slide 21. Wind shear shapes the propagation paths of outdoor noise in all directions through refraction, strongly affecting the intensity of sound at receiving locations. Wind shear is a principal cause of noise levels being often unexpectedly enhanced at locations a long way downwind of a noise source. Note that the enhanced propagation of noise downwind from a noise source is due to refraction downwards due to wind shear, not the commonly held belief that it is 'blown along' by the wind.

**Wind shear thus plays a major role in determining noise impact at longer range from turbines, but this is not given explicit consideration by the guidance.**




Credit: MW Toft

**Westminster Presentation Slide 21: Wind shear effects on noise propagation**

The meeting at Westminster also included a second presentation to the Secretary of State by Mike Stigwood of MAS. His presentation titled, **Evidence of failure of wind farm guidance to protect well being** [Ref 16] demonstrated the extent of the noise nuisance problem at that time. Stigwood confirmed to the Minister;

- *"A large number of wind farms are causing noise complaints and obvious evidence of harm to well-being such as sleep disturbance (more than 75 we know of and likely to double) = ETSU-R-97 fails to protect.*
- *ETSU-R-97 is incapable of controlling / preventing adverse effects or being modified to achieve that purpose.*
- *Proportionally wind farms causing problems is higher than any noise source investigated in my career, including music venues, metals recycling sites and transport noise. Reason = sleep disturbance and stark contrast in noise character.*
- *Well-being of a significant minority of communities are being jeopardised for the policies. Potentially between 80-160 wind farms causing problems and 1000's homes affected.*
- *Research shows Excess Amplitude Modulation (EAM) = main problem and caused by all large wind farms. It is common and not rare as suggested by UK Government policy. Wider international acceptance."*

**Additionally, all the wind farms causing noise complaints that MAS has investigated at this time were considered to be 'ETSU compliant'. This alone provides evidence that ETSU is failing to protect wind farm neighbours.**

## Chapter 5: Industry recognition of amplitude modulation

The ETSU-Gate Chapter 5 discussion is expanded here in order to address amplitude modulation (AM). **The treatment of AM is one of the main failures of the ETSU methodology and its proposed update**.

By 2013 it will have been likely that the wind industry had concluded that they could not continue to deny the significance of amplitude modulation and were losing the argument based on denial. The industry response came during December 2013 when the UK wind industry trade body, RenewableUK (ReUK), released their research report (six documents) titled, **Wind Turbine Amplitude Modulation** [Ref 17]. The ReUK research report included sections covering the causes of AM, the measurement of AM and proposed a planning condition to control AM.

The ReUK report was soon being analysed by independent parties. The first analysis appeared in the report by Moroney and Constable of REF and released March 2014. This report titled, **The Efficacy of the RenewableUK (ReUK) Condition in controlling wind farm amplitude modulation (AM) noise** [Ref 18] is highly critical of the ReUK template planning condition that was claimed would control AM and so protect wind farm neighbours.

The REF report compared the ReUK methodology with the Den Brook AM condition as was included with the planning permission for the Den Brook wind farm in Devon. This is discussed in detail at **INWG WP4 Den Brook** [Ref 31] where Mike Hulme documents the enormous efforts the wind farm developer, Renewable Energy Systems (RES) made first to have the planning condition not applied, then to have the applied planning condition removed. The REF report conclusions to the ReUK report included:

- *" The proposed RUK AM condition would not be breached by recorded wind farm noise data with high levels of AM measured at Askam, a site widely recognised to be producing severe AM problems, and at Swaffham, from data where the AM is clear and significant in magnitude. By comparison, data from both the Askam and Swaffham sites would be in breach of the Den Brook AM condition.*
- *The authors conclude from these facts that the RUK AM condition is manifestly inferior to the Den Brook condition and does not offer to wind farm neighbours any realistic or significant protection against AM disturbance.*
- *The RUK AM condition is too complex and computationally intensive to provide a reasonably accessible and transparent methodology for assessing excessive AM noise. Even acoustic professionals will struggle with this method, and Local Authority Environmental Health Officers are extremely unlikely to have either the resources or the training to undertake such compliance tests. This is unacceptable, particularly when more effective alternatives, such as the Den Brook method, suffer no such defects.*

- *The RUK condition method results in an understated value of the true peak-to trough levels of the AM noise. This is obviously unacceptable"*

**This analysis by REF of the ReUK report highlights the attempt by the wind industry to introduce an opaque methodology in the guise of 'controlling' AM.**

The next critique of the ReUK report into AM was a presentation by campaigners at the IOA meeting at Newport on 20 March 2014. Known as the **Newport presentation** titled, **A Critique of the RenewableUK report on wind turbine amplitude modulation** [Ref 19] by Cox, Hulme, Sherman & Unwin included a detailed technical critique including the following comments:

- The ReUK report has highlighted aspects of turbine noise previously denied by the wind industry and includes an admission that the AM problem is 'too large to ignore'.
- The claims that AM is rare and infrequent have not been substantiated since no survey was carried out; however, evidence elsewhere shows it to be widespread.
- The report claims are not supported by the evidence from the study and indicates a disconnect between ReUK who commissioned the study and the authors who carried it out.
- The claimed root cause of OAM being blade stall is unproven and admitted to as such by the report authors. As a result, the proposed mitigation strategy, even if it was available would fail to work.

Much of the ReUK report appeared to be a smoke screen to justify the replacement of the Den Brook AM planning condition, a planning condition that had already been shown to work.

The **Newport presentation** made at this IOA one day meeting on turbine noise provided an opportunity to present a fully evidence critique of the wind industry response to AM to most of the wind industry acousticians and supporters assembled in one meeting room. The presentation in two parts included a critique of the ReUK AM report followed by implications for noise assessment and planning approvals. The most relevant parts of the presentation are discussed as follows;

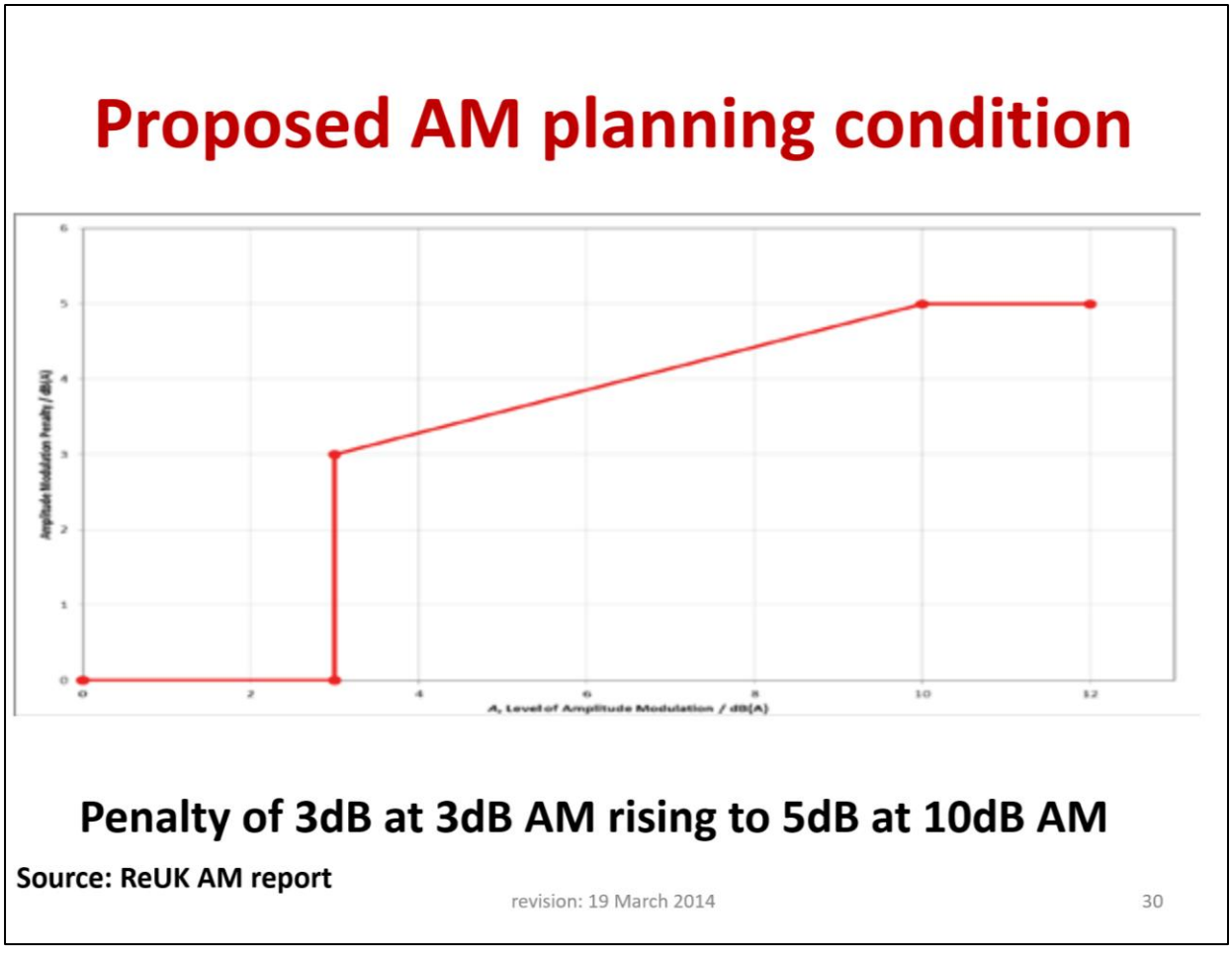
**Slides 8-11** examine, what is AM?

**Slides 12-23** examine at the causes of AM. ReUK claimed AM is caused by blade stall yet offer no hard evidence and contradictions within their report. The Newport presentation instead presented conclusive evidence that AM is a physical consequence of the propagation of rotating turbine blade trailing edge noise, disproving the ReUK claim of AM being caused by blade stall.

**Slides 24-25** examine the mitigation of AM. ReUK make the claim that software adjustment to the turbine blade control adjusting the angle of the blades at times AM occurs would

mitigate the problem. However, they provide no evidence that such a system exists or would work. Since the Newport presentation demonstrates that blade stall is not the cause of AM, the ReUK blade angle mitigation would be totally ineffective. **It is difficult to believe that ReUK were not aware of this when making their unsubstantiated mitigation claim.**

**Slides 26-28** examine how annoying is AM? ReUK failed to quantify the AM dose response yet went ahead with a planning condition without properly understanding the dose response relationship. However, they acknowledge annoyance is more pronounced when noise levels are low and acknowledge a 3dB threshold. This 3dB threshold is disputed as Fukushima (slide 28) shows the AM threshold is around 2dB, is not dependent upon overall noise levels and is occurring frequently at around three quarters of the measuring locations.



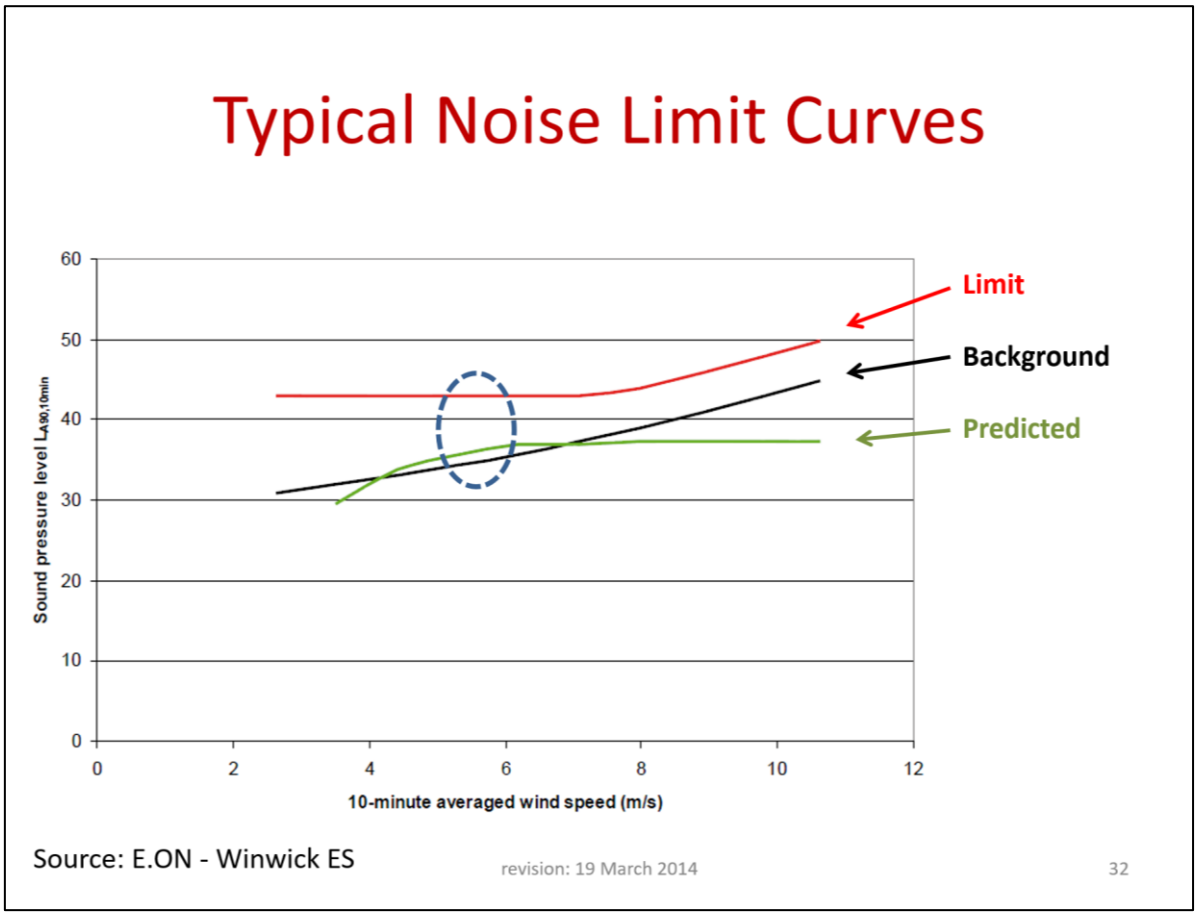

**Newport Presentation Slide 30: ReUK proposed AM penalty scheme**

**Slides 29-33** examine the AM planning condition proposed by ReUK. The Den Brook AM planning condition is summarily dismissed by ReUK and the report then goes to great lengths to justify a replacement. Crucial to this new planning condition is a new methodology for the measurement of AM. This is found to be essentially the same measurement methodology proposed by the developer RES to replace the Den Brook AM

planning condition. Fortunately, the RES proposed planning condition was tested by Dr Swinbanks (Slide 33) who found,

*"this particular procedure significantly underestimates the true Peak-to-Trough amplitude of wind-turbine Amplitude Modulation; in one specific example, the result is in error by almost a factor of 2"*

The proposed AM penalty system is shown at Slide 30, reproduced here, with a graduated penalty of 3dB starting at 3dB modulation depth rising to 5dB at 10dB modulation depth and above. This penalty was proposed even though the ReUK study failed to quantify the AM dose response relationship and ignored evidence from Tachibana and Fukushima (Slide 27). This AM penalty scheme devised originally by RES for the ReUK study and despite being shown to be ineffective on controlling AM was subsequently carried forward by the IOA noise working group in their AM study. This same penalty scheme is now being proposed to be formalised into the updated ETSU shown as Figure 3 on page 26 [Ref 66], championed by the same group of wind industry acousticians throughout. **It is difficult to believe that these acousticians are unaware that this AM methodology is ineffective and is simply bad science.**



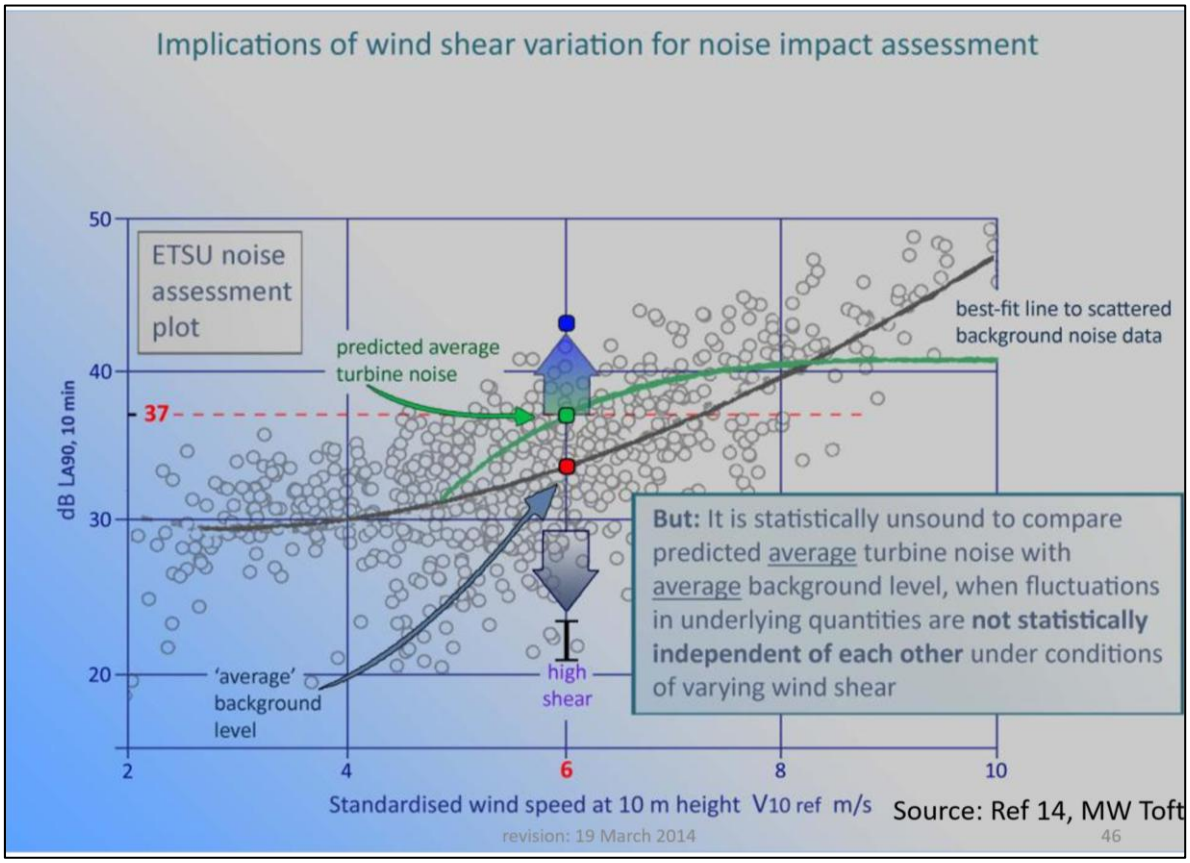

**Newport Presentation Slide 32: Noise Limit Curves**

The proposed AM condition runs counter to the evidence relating to AM noise nuisance and how it is perceived, (Slide 31). AM is not a loudness issue associated with high noise levels but a noise character issue. It usually occurs at night time when background noise is lowest. The EAM should arguably be a YES or NO determination, is it intrusive and annoying, or not.

Slide 32 reproduced here, is used to further illustrate the ineffectiveness of the ReUK AM planning condition. This chart taken from a typical Environmental Statement (Winwick ES for Winwick Manor during the night time period and produced by E.ON) is used to illustrate the concerns with the ReUK planning condition.

Assume measured noise ($L_{A90}$ 10 min) is 36dB, (within blue dotted circle) and AM is occurring at 10dB to 12dB peak to trough. The ReUK method would require a 5dB penalty adding to the measured 36dB so increasing the effective (Rated) measured noise level to 41dB.

This is still well below the 43dB night time limit with the result that turbine operation would not be curtailed even though this level of AM would be regarded as very intrusive. It is most unlikely that the proposed ReUK AM condition would ever be triggered, irrespective of the level of AM, and that is assuming the AM is being accurately measured. It is this same scheme now being proposed for formalising into the revised ETSU.




**Newport Presentation Slide 46: Implications of wind shear variation**

**Slide 35-46** of the Newport presentation examines the assessment process and builds on the concept of the three-legged stool devised by Prof Unwin in his Science in Parliament paper titled, **Wind farm noise assessments: ETSU-R-97 and the three legged stool** [Ref 14] representing the three noise assessment legs.

**Slide 46** reproduced here, considers the implication of wind shear. Under high wind shear the background noise will be less than average while the turbine noise will more than average. Additionally, through the use of the standardised 10m height wind speeds, the GPG methodology makes proving breaches of the noise limits virtually impossible.

**Slide 45** provides a summary of the defects with the Good Practice Guide wind shear methodology. The main problem being the averaging where background masking noise is effectively averaged and through the use of Standardised wind speeds, the wind shear correction applied is also averaged. High wind shear occurs typically for 10% to 15% of the time, mostly at night, and this is when noise nuisance is usually occurring. The averaging process will allow significantly higher noise levels when the masking background noise is at its lowest even with the AM penalty applied.

With the release of the INWG study into AM during 2015, WP1 by Dr John Yelland provides what is arguably the most comprehensive discussion and understanding to date on the science behind wind turbine noise. WP1 titled, **The fundamentals of amplitude modulation of wind turbine noise** [Ref 26] investigates the science behind wind turbine noise and AM. Yelland also examines the ReUK report and measurement problems.

In section 2 he describes the characteristics of AM and how the modulation known as blade swish is a function of the doppler effect as the blade rotates such that the distance between the turbine blade and the observer varies. The same doppler effect is experienced when observing a train approaching, and then passing.

At section 3 he discusses the causes of AM. He confirms on page 10 that, ***"The higher nocturnal wind shear can thus increase peak wind turbine noise at night by three different mechanisms. In addition to the higher aerodynamic noise emission levels from the turbines from transient blade stall and higher noise immission levels at homes due to wind shear enhanced noise propagation there will also be very low frequency noise due to blade rebound and possible resonance***".

At section 4.2 Yelland comments on the ReUK report WP A1 authored by Oerlemans. In his critique Yelland demolishes Oerlemans claims regarding the cause of AM summarising his critique with,

***"In summary, the objective was to demonstrate that the proven and well established BPM model supports the hypothesis that stall-at-blade-zenith can account for observed levels of***

***EAM. But in truth the model predicts only a doubling of the modulation height on stall (from 3dB to 6dB), not an increase to 30dB. So the target was lowered from 30dB to 10dB and the BPM prediction of 3dB was increased by a declared but nevertheless arbitrary unjustified 7dB to achieve even that lowered target. Thus the paper offers no 'plausible explanation', even though it purports to do so, for any levels of EAM measured and reported in Oerlemans' references or indeed those measured and reported for example by Cooper, Huson, and Stigwood and many others at wind farms around the world***".

At section 4.3 Yelland comments on the ReUK report WP B1 authored by Paul White proposing a method for automating the measurement of AM. Yelland demolished the ReUK and IOA NWG argument for automated measurement by stating,

"***This paper addresses a problem which in my view does not exist: the search for an automated process to determine whether or not the amplitude modulation height of a time series waveform is of acceptable magnitude.*** *Taking figure 1 as an example as a sample of EAM, albeit a fairly extreme example, it is abundantly clear that there is a typical modulation height of around 20dB, peaking to 25 dB. All that is required to determine the modulation height is the eye and a ruler; all that is required to verify that the signal is indeed from a wind turbine and not some other source is the ear, for which purpose sound is recorded along with the* $L_{Aeq}$.

***There is no legitimate benefit to be derived from the use of complex and opaque signal processing techniques to derive a 'metric' from a time series signal with clear and stable periodicity***. *It is noticeable that all the methods proposed by the IOA AMWG understate the modulation height when compared with the simple observation of the time series signal, as demonstrated by Large in INWG Work Package 7.* ***Whatever method is used transparency is essential, and must include independent evaluation*** *of the final method chosen by the IOA NWG and the release of the source code for MatLab software proposed by the IOA AMWG for the signal processing, not forgetting that the latter is in fact entirely redundant*".

**From the available evidence it is clear that this attempt by the wind industry to impose an automated AM measurement process is simply bad science, designed to deceive and frustrate any attempts at resolving future noise complaints.**

## Chapter 6: Formation of the Independent Noise Working Group

The damming criticism by independent campaigners to the IOA GPG and the ReUK AM report had a significant impact on the wind industry and policy makers. The IOA responded by forming a new AM working group and launching a new study into wind turbine amplitude modulation under the auspices of the IOA, with an announcement on the IOA website on 1 August 2014.

The launch of this IOA AM study raised immediate concerns among independent campaigners around the country who were fighting the wind turbine noise problem. Over a period of just a few days these independent parties, experts and non-experts who had previously been loosely collaborating came together during August 2014 and formed the Independent Noise Working Group (INWG).

**The primary objective of the INWG at that time was to conduct an independent study into wind turbine noise AM that would be able to credibly challenge the methodologies and recommendations of the Institute of Acoustics sponsored AM study.**

Refer to ETSU-Gate Chapter 6 for further discussion relating to the Independent Noise Working Group (INWG).

## Chapter 7: Ethics and the Engineering Council

In a coordinated nationwide campaign, letters of complaint against the Institute of Acoustics and its Noise Working Group (NWG) were sent to the Engineering Council during September 2014. The INWG are aware of at least 10 letters from organisation and individuals having been sent.

These letters questioned the IOA NWG's professional independence, its credibility, and compliance with the Engineering Council Codes of Conduct and Ethical Principles. It also questioned compliance with the IOA's own Code of Conduct and Ethical Principles. It was requested that the Engineering Council urgently investigate these allegations of bias in favour of the commercial interests of the wind industry, and of its consultants for prioritising commercial interests ahead of protecting the public from wind turbine noise and its associated effects on health.

Professional institutions including the Institute of Acoustics are regulated by the Engineering Council and are required to comply with the Engineering Council Codes of Conduct and its Ethical Principles. A template response letter received by each of the complainants from the Engineering Council dated 17 October 2014 informed that the complaints against the IOA should be taken up directly with the IOA itself. This being a most unhelpful response given the circumstances.

**Although the complaint letters to the Engineering Council failed to have any immediate effect on the behaviour of the IOA NWG, it did highlight the way the 'Establishment' had closed ranks in support of wind power development. It became clearer now that 'establishment' support extends to the retention of ETSU and its overly permissive noise limits. This was being given a higher priority than protecting public health and wellbeing.**

Refer to ETSU-Gate Chapter 7 for further discussion on Ethics and the Engineering Council.

## Chapter 8: Cotton Farm community noise monitoring

The Cotton Farm wind farm located in Cambridgeshire operates eight Senvion MM92 wind turbines, each rated at 2MW with a turbine rotor diameter of 92.5m and tip height of 126m. The wind farm commenced operation in January 2013 and very soon after started to generate noise complaints from the neighbouring villages. As a result, the local community decided to fund and install a long-term noise monitor.

The community monitor project from a local community perspective is available at INWG Work Package 9 dated August 2015, titled, **The Cotton Farm Monitor Experience** [Ref 37] by Bev Gray. The objective of the community noise monitor was to obtain evidence of the noise that was affecting the community. It is also believed that this is the first time a long-term noise monitor has been established by a local community to monitor wind turbine noise.

The monitoring equipment was installed during 2013 and managed by MAS Environmental. MAS provided details of the noise monitor in two papers. The paper titled, **Initial findings of the Cotton Farm wind farm long term community noise monitoring project** [Ref 20] by Stigwood, Stigwood & Large was presented November 2014 at Internoise, Melbourne. The paper abstract stated;

- *"This paper provides early results of a long-term study of community impact from wind farm noise and uses of the data obtained. A continuously recorded database of noise collected under different meteorological conditions has allowed detailed analysis of particular characteristics such as amplitude modulation and also the reliability of assessment methodologies for predicting and quantifying impact.*

- *Surprising outcomes are explored including upwind impact. In 2013 MAS Environmental established a permanent monitoring station to record and publish data online located 600m from the nearest turbine to correlate the impact upon the community and provide an extensive database. This paper maps the evolution of the project. Online data enables a wider study of the effect of meteorological change on noise immission in a flat eastern area of the UK."*

The second paper titled, **Cotton Farm Wind Farm – Long term community noise monitoring project – 2 years on** [Ref 24] by Stigwood, Large & Stigwood was presented at the 6th International Conference on Wind Turbine Noise, Glasgow April 2015.

This paper includes further evaluation of the now extensive database collected over nearly 2 years and how noise features correlate with community response and complaints. This includes analysis of some of the prominent characteristics recognized as a feature of the noise as created by this wind farm and how they impact. This part of the long-term study focuses on the parameters and procedures used to identify AM noise. Analysis of the

inability of noise controls (ETSU) to reflect true impact in relation to Cotton Farm wind farm data is also explored.

The paper Summary Findings following analysis of the Cotton Farm data show;

- *"The quickest and most effective means of analysing the special characteristic AM within WTN is firstly through manual assessor checks. This provides a quick method of excluding unusable data that is not subject to the flaws in automated algorithms.*

- *Algorithms and procedures designed to automatically filter WTN datasets to exclude periods affected by extraneous noise but not exclude AM and based on FFT analysis of the BPF, have a high failure rate.*

- ***FFT procedures are yet to be shown to provide efficient algorithms for this type of highly variable sound energy and can miss periods of impact, be falsely triggered by extraneous noise or simply fail to reflect impact. The main procedure developed by ReUK was found to permit highly intrusive, erratic and unreasonable noise**.*

- *FFT derived procedures in a modified form to those currently presented by RES can be used as an extra evaluation tool to assist analysis of noise but only after initially filtering periods excessively corrupted by extraneous or absent AM.*

- *FFT procedures are unhelpful when dealing with sound data containing erratically varying AM and erratically varying extraneous noise sources. There are also problems identifying AM where there are other character features such as tonality or lower frequency noise.*

- *Impact from WTN containing special characteristics can best be assessed applying context procedures comparing against actual levels of background masking noise which are present during the periods of impact. This is best evaluated by comparing the periods before, during and after turbine switch off tests.*

- ***Application of special character penalties to threshold limits such as contained in ETSU-R-97 does not reflect impact and fails to reduce excess levels of adverse noise**.*

- ***The revised standard BS4142 2014 has addressed concerns which led to its exclusion when ETSU-R-97 was written and now includes extended analysis of special characteristics in noise. This renders it suitable to WTN containing AM. Comparative tests show it is better suited at determining impact than ETSU-R-97 derived methods which are formulated on the absence of any significant character content**.*

- *Many commonly held views over frequency and duration of AM, when it occurs and how it should be rated, require revisiting.* ***In particular the cumulative effect of AM and other characteristics of the wind turbine noise need to be considered and not just modulation depth.*****"**

The recent court proceedings by an affected resident at Cotton farm for Statutory Nuisance arising from noise did end in the case being dismissed. However, this was because of technical legal issues as discussed elsewhere in this report and had nothing to do with the merits of the case. **In short, the proceedings demonstrated finally that Statutory Nuisance is not an adequate remedy for noise problems arising from wind turbines**.

Wind turbine noise recordings from the Cotton Farm turbines and from other sites are available at the MAS website; https://www.masenv.co.uk/listening_room

## Chapter 9: The Northern Ireland Assembly report

The report titled, **Report on the committee's inquiry into wind energy** [Ref 23] contained in seven volumes was produced for the Northern Ireland Assembly (NIA) and released March 2015. This full inquiry into wind energy conducted by the NIA Committee for the Environment provided what is probably the most comprehensive and credible review of the impacts of wind turbines carried out at that time. Wind turbine noise is discussed at Volume 1 from page 20 (Para 125) onwards.

The report stated that the issue of wind turbine noise was the most contentious aspect of the inquiry. The key recommendations from the report regarding wind turbine noise included,

"***The Department should review the use of the ETSU-97 guidelines on an urgent basis, with a view to adopting more modern and robust guidance for measurement of wind turbine noise, with particular reference to current guidelines from the World Health Organisation***. *The Department should bear responsibility for ensuring that arrangements be put in place for ongoing long-term monitoring of wind turbine noise*"

ETSU was heavily criticised in the NIA report, which suggests that then current BS4142 revision (BS4141:2014) be considered when determining if ETSU should be updated.

**While the Northern Ireland Assembly report was highly significant and credible with its damming appraisal of ETSU, it appears to have been totally ignored by the UK establishment including the IOA.**

## Chapter 10: The INWG amplitude modulation study

The INWG study work packages were released during October 2015, providing an important evidence base and a milestone in the campaign to replace ETSU. It was a huge achievement and demonstrated what a dedicated team of volunteers working remotely from each other, without a formal organisation or budget could achieve when suitably motivated.

The scope of the INWG study was considerably wider than that adopted by the IOA for their study, and it was completed in only one year, achieving all its original objectives. Importantly, the INWG AM study proved to be highly credible, enabling it to successfully challenge the findings of the IOA study released a year later and is still relevant today. The INWG study consisted of multiple work packages summarised as follows:

**WP 1; The Fundamentals of Amplitude Modulation of Wind turbine Noise**
By Dr John Yelland [Ref 26] who investigates the science behind wind turbine noise and amplitude modulation. **Yelland provides what is arguably the most comprehensive discussion to date on the science behind wind turbine noise**.

Yelland is highly critical of current industry practice to exclude the measurement of low frequency noise below 100Hz based on the assumption that 'what you can't hear can't hurt you'. WP1 also includes a critical analysis of the of the ReUK AM report from Dec 2013.

**WP 2.1; Review of Reference Literature**
By Richard Cox [Ref 27] who presents the results of a review of the available literature on wind turbine noise (WTN). Over 160 documents are included in the review and of these at least 85 documents are technical in content. This contrasts with the IOA AMWG literature review, which lists a total of just 35 documents.

**WP 2.2; AM Evidence Review**
By Sarah Large of MAS Environmental [Ref 28] who looks primarily for evidence of audible amplitude modulation noise in support of its existence and prevalence. Amplitude modulation (AM) can be defined as the regular (cyclic) variation in noise level, usually at blade passing frequency, which exhibits a change in the noise character of the wind farm noise as the decibel level rises and falls.

The executive summary states; *"The data described below is conclusive that AM exists and it shows AM is being generated by the majority of wind energy developments. It also shows that AM can be generated by all turbines regardless of size, model or type. AM is not rare but is prevalent and whilst meteorology may not be the sole determinant, under certain meteorological conditions adverse AM can occur for long periods of time."*

**WP 3.1; Study of Noise and Amplitude Modulation Complaints Received by Local Planning Authorities in England**

By Trevor Sherman [Ref 29] who analyses responses from a survey of local planning authorities (LPAs) to determine the extent of the wind turbine noise problem across England.

The executive summary, at para 1.3 'Extent of the problem' states, *"In England, of the 203 responses to the survey 54 LPAs have received complaints about noise from industrial wind turbines. This should not be interpreted as 27% of wind farms giving rise to noise complaints; many of the LPAs which reported no complaints may well have no operating wind farms in close proximity to housing. Of the 54 LPAs, 17 have also investigated complaints about EAM. Over 600 individual complaints had been received with the majority being in the five year period 2010-14."*

At para 1.4 'Awareness of Mitigations' states; *"…Some LPAs show strong confidence in ETSUR-97 ('ETSU') and its companion Good Practice Guide (GPG). Others challenge its validity and are seeking a more robust way to deal with EAM at all stages in the application and development process. They are calling for objective science-based guidance on measuring and testing for EAM as well as nationally agreed standards that are consistently applied and proven mitigations for EAM. There are many frustrations with the current arrangements."*

**WP 3.2; Excessive Amplitude Modulation, Wind Turbine Noise, Sleep and Health**

By Dr Christopher Hanning [Ref 30] with contributions by Prof Alun Evans, Carmen Krogh and Dr Sarah Laurie who summarizes the effects of Excessive Amplitude Modulation (EAM) on people living close to wind turbines. This includes annoyance, sleep disturbance and health effects through a review of the available health related literature. His report discusses ETSU's inability to protect noise sensitive receptors from sleep disruption and therefore harm to their health and in this context to consider the contribution of EAM.

The executing summary states; "**A large body of evidence, presented below, demonstrates that human sleep and health are adversely affected at wind turbine noise levels permitted by ETSU.** There is particular concern for the health of children exposed to excessive wind turbine noise. The inadequate consideration of excessive amplitude modulation (EAM) is a major factor in the failure of ETSU to protect the human population".

**WP 4; Den Brook**

By Michael Hulme [Ref 31] who documents the legal, planning and technical issues surrounding the Den Brook AM planning condition (2009). This work package details the enormous effort Renewable Energy Systems (RES), the wind farm developer, has gone to over the previous 8 years to ensure first that an AM planning condition is not applied, then to have the applied planning condition removed, and finally to have it sufficiently weakened, presumably to ensure it prioritises operation of the wind farm rather than provide the intended protection against EAM.

The Den Brook wind farm and Michael Hulme gained national fame with the four-part BBC documentary titled 'Wind Farm Wars' screened during 2011. This documentary is still available on YouTube at; Wind Farm Wars BBC 2011

**WP 5; Towards a draft AM Condition**

By Sarah Large [Ref 32] who investigates options for the control of AM. Four main methods for assessing or limiting EAM have been critically examined in this work package. The executive summary at para 1.8 states,

*"The 2014 version of BS4142 was also used to assess impact at two of the six sites. BS4142 has previously been dismissed, both in ETSU-R-97 and by others, as an appropriate means of control for wind farm noise. The issues raised to support these arguments have been examined below and found inapplicable to the new version of the standard. BS4142:2014 was found to work very well for assessment and control of cumulative wind farm noise and character impact."*

**WP 6.1 & WP 6.1A; Legal Issues: The Control of Excessive Amplitude Modulation from Wind Turbines**

By Richard Cowen [Ref 33] who considers the legal issues surrounding wind turbine noise nuisance. The scope of WP6.1 includes:

- To assess the legality of the Den Brook Condition relating to EAM following the judgement of the Court of Appeal;
- To assess the legal appropriateness of other remedies such as Statutory and Private Nuisance that have been recommended since that judgement or may be available to persons affected by EAM;
- To recommend the most appropriate course of action that will provide legal protection to residents hosting wind farms should EAM occur.

In the Supplementary Paper 6.1A [Ref 34] Cowen considers the legal issues for claimants relating to shell companies.

It should be noted that since the release of WP 6.1, there have been further developments regarding the judgement of the Supreme Court in Coventry v Lawrence and the interpretation of that case in Australia and Ireland. These judgments show that compliance with a planning condition (in this case noise conditions relying on ETSU) is not of itself a defence to a claim for noise nuisance.

**WP 6.2; Control of AM noise without an AM planning condition using Statutory Nuisance**
By Bev Gray [Ref 35] who reviews from a community perspective the practical experiences and causal effects of Statutory Nuisance laws when used as a means of protection from Excessive Amplitude Modulation (EAM). The scope of WP6.2 includes:

- Review EAM noise nuisance complaints procedures and the difficulties of applying Statutory Nuisance by local authority officers.
- Proposals to ensure a more effective method of EAM control than the existing statutory nuisance. Refer also to Chapters 8 and 14.

**WP 8; Review of Institute of Acoustics Amplitude Modulation Study and Methodology**
By Richard Cox with contributions by Richard Cowen, Bev Gray, Melvin Grosvenor, Chris Hanning, Mike Hulme, Les Huson, Trevor Sherman, Mike Stigwood & John Yelland [Ref 36].
WP8 reviews the activities of the Institute of Acoustics and its Noise Working Groups with respect to wind turbine noise amplitude modulation. WP8 takes a highly critical look at the IOA noise working group's AM study and their methodologies. It should be noted that the IOA AM study final report was not released until August 2016. As a consequence, the INWG review, designated as WP8.1, of the IOA report and the WSP / Parsons Brinckerhoff report, was delayed and subsequently released January 2017. WP8.1 is discussed at Chapter 12.

**WP 9; The Cotton Farm Monitor Experience**
By Bev Gray with contributions by Jeff Tossell [Ref 37], WP9 provides a review of a rural community's experience in setting up and carrying out long term continuous noise monitoring and recording of wind farm noise. The long-term noise monitor experience pioneered by the local community around the Cotton Farm wind farm proves this is not only practical and cost effective but essential for contesting noise nuisance. Wind turbine noise recordings from the Cotton Farm turbines and from other sites are available at the MAS website; The Listening Room Experience - MAS Environmental Ltd

**WP10; Two Decades of Deception**
By Cox, Cowen, Gray, Hanning, Hulme, Sherman & Yelland of INWG and Large of MAS Environmental [Ref 38]. WP10 summarises all the study Work Packages and brings forward the INWG's key finding and recommendations. The number one recommendation to government being:

**As recommended by the Northern Ireland report of January 2015, ETSU should be replaced with a procedure based on the principles of BS4142: 2014. This will bring wind turbine noise assessment into line with other industrial noise controls. New guidance of this type should be formulated in a Code of Practice that sets out a BS4142: 2014 type methodology that reflects noise character and relates impact to the actual background noise level and not an artificial average.**

Refer to the ETSU-Gate report Chapter 10 for further discussion on the INWG AM study.

## Chapter 11: The INWG AM study launch

The completed INWG amplitude modulation study was launched at Westminster on 13 October 2015 at a joint INWG and MAS meeting with Andrea Leadsom MP, Minister of State at the Department of Energy and Climate Change and DECC officials. The meeting was facilitated by Chris Heaton-Harris MP where INWG presented a **Discussion document for DECC meeting** [Ref 39] including the findings and recommendation of the AM study to the Minister and DECC officials. The INWG AM study recommendations include:

- *"ETSU noise guidance to be replaced with a code of practice based on BS4142:2014*
- *Independent research is required into the health effects of wind turbine noise including EAM and LFN*
- *An effective AM planning condition required for every wind turbine planning approval*
- *Continuous noise monitoring (with data transparency) should be required for every medium & large wind turbine planning approval*
- *Effective remedy required for retrospectively dealing with noise nuisance including EAM from existing wind turbines*
- *Government should disassociate itself from the IOA until the conflict of interest and ethics issues are resolved and full transparency restored."*

MAS presented their **AM Discussion Document** [Ref 40] including their experience of AM from multiple wind farms and how it is affecting people living near to the turbines. The character and features of the noise were discussed along with the extent of the problem and the effects it is having.

Two days later the INWG also presented the AM study at the IOA conference at Harrogate October 2015. The INWG paper titled, **Wind Turbine Amplitude Modulation & Planning Control Study** [Ref 41] by Cox, Cowen, Gray, Hanning, Hulme, Sherman, Yelland & Large was published in the Proceedings of the Institute of Acoustics conference, October 2015; (Vol.37. Pt.2 2015). The presentation with the same title [Ref 42] was delivered at the conference on 15 October 2015.

## Chapter 12: The wind industry fights back

The IOA NWG finally released their amplitude modulation study report on 9 August 2016. The study titled, **Final Report - A Method for Rating Amplitude Modulation in Wind Turbine Noise** [Ref 44] was authored by Bass, Cand, Coles, Davis, Irvine (Chair), Leventhall, Levet, Miller, Sexton and Shelton. It was subsequently presented at the Internoise conference in Glasgow on 23 August 2016.

At the same Internoise conference, WSP / Parsons Brinckerhoff (WSP/PB) presented the results of their research into AM, commissioned by the government DECC. The paper titled, **A review of research into the human response to amplitude-modulated wind turbine noise and development of a planning control method** [Ref 45] was authored by Perkins, Lotinga, Berry, Grimwood & Stansfield.

Although the WSP/PB report was presented at the Internoise conference, the full report was withheld for reasons unknown. Following a Freedom of Information (FOI) request, a redacted version dated April 2015 of **WSP/PB wind turbine AM report** [Ref 46] was eventually released on 25 October 2016. The WSP/PB Phase 1 report dated October 2015 and the Phase 2 report dated August 2016 are now available on the government website.

On 7 December 2016 the IOA held a Workshop at Birmingham titled, **ETSU-R-97 - Time to move on**. A presentation was given by McKenzie & Bullmore titled, **What might an Alternative to ETSU-R-97 Look Like?** [Ref 47]. McKenzie and Bullmore are leading wind industry acousticians with Bullmore being one of the original authors of ETSU. In their Birmingham presentation they advocated two variations on the existing ETSU methodology, plus a third option to simply continuing with ETSU as it is. Incredibly BS4142 was not even mentions as an option despite being the British Standard noise guidance standard that applies to virtually all other similar industries.

The McKenzie, Bullmore paper indicated a realisation that after years of criticism of ETSU, it would eventually need to be replaced with something. The problem for the wind industry is how to replace ETSU with something equally or more permissive that will permit a continuation of 'business as usual' and in addition facilitate the deployment of the new generation of larger and noisier wind turbines?

**What we now see with the release of the proposed review of ETSU is that the third option of simply continuing with ETSU, albeit with some cosmetic changes has won out.**

Following the release of the IOA NWG AM study and the WSP/PB research into AM for the government, the INWG conducted a detailed review of both reports and published the results as a belated INWG AM study work package designated WP 8.1.

Titled, **Review of WSP/Parsons Brinckerhoff and Institute of Acoustics Amplitude Modulation Studies**, and **WP8.1 Appendices** [Ref 48] by Cox, Cowen, Gray, Grosvenor, Hanning, Hulme, Huson, Sherman, Stigwood & Yelland, WP 8.1 was released on 12 January 2017. WP8.1 highlights the coordination between the IOA NWG and the WSP/PB acousticians, all who are closely connected with the wind industry.

When tested, the IOA recommendations for controlling AM were shown to fail. Les Huson of L Huson Associates tested the IOA NWG report hybrid AM methodology using real turbine noise data and this is shown at **WP8.1 Appendices F and G**.

The conclusion from this testing, is that **the AMWG measurement metric under records the actual level of AM at best and will completely miss recording intermittent AM and situations where there are multiple turbines operating at different rotational speeds**. This under recording of AM by the latest IOA AM metric is consistent with the previous schemes tested. **It seems inconceivable that the authors of the IOA AM metric had not thoroughly tested this and were unaware that it would fail to protect in this manner.**

WP 8.1 reveals that these latest IOA NWG and WSP/PB AM proposals are basically reworked versions of the heavily criticised methodology from the 2013 ReUK AM study with some of the same authors involved. However, the following important admissions are made within these latest two reports after many years of denial:

- *"That modulating WTN-like sounds are more annoying than similar noise levels without significant modulation.*
- *The threshold of perception of AM is around 2dB and increasing modulation depth is associated with increased annoyance. That where there are high levels of AM, the adverse effects could be significant and on this basis a control for AM is required.*
- *That wind turbine related noise annoyance is associated with increased risk of sleep disturbance and stress. Additionally, the annoyance increases during normal resting periods during the late evening, night-time and early morning. However, the potential impacts on health are still not accepted by WSP/PB, and other reports which do suggest a causal link are heavily criticised.*
- *That AM cannot be predicted at the planning stage so the likely default position for a planning decision maker should be to apply an AM planning condition unless there is good reason not to."*

A joint INWG and MAS meeting to present analysis of the IOA NWG AM study and the WSP/PB AM research to government was held at Westminster with the Energy Minister, Jessie Norman MP and DECC officials on 1 March 2017.

An **INWG Discussion Document** [Ref 49] was presented and the full meeting notes handed over to the minister and officials. The key messages conveyed to the minister were:

- That the WSP/PB report is 'unfit for purpose', is misleading and should be rejected by Government.
- That there is a clear attempt in this report to bury the health effects of WTN despite overwhelming evidence to the contrary.
- The combined Parsons Brinckerhoff and Institute of Acoustics reports propose virtually the same AM control scheme as proposed by RenewableUK in their 2013 report. This report by the wind industry trade association was heavily criticised and was shown not to control AM.

INWG repeated the recommendation that ETSU be replaced by BS4142 and referred to a FOI response dated 3 Feb 2017 that released government internal emails showing:

- **Confirmation that if ETSU is withdrawn, BS4142 could be used to fill the gap**.
- Context aspect and noise limits would need to be applied
- BS4142 could result in some planning applications being rejected that would be granted under ETSU

Although INWG WP 8.1 was delayed while awaiting the IOA and WSP/PB reports, **it became arguably the most important INWG work package as it exposed the extent of the deception by wind industry acousticians.** There is no doubt that the forensic examination and exposure of the IOA NWG AM study and the WSP/PB research into AM report by the INWG through WP8.1, became a serious embarrassment and setback to the wind industry and government.

## Chapter 13: WSP review of ETSU

Following the release of INWG WP8.1 and its presentation to government in 2017 there was no visible progress for several years. It was only during the August of 2021 that campaigners discovered a government DBEIS contract had been awarded to WSP to review the noise guidance for onshore wind (ETSU).

The first stage of this contract was a stakeholder engagement survey with a closing date of September 2021. This consultation was by invitation only and the INWG were clearly not invited. It was only following a request directly to DBEIS that the INWG was allowed to participate, and by then at a very late stage in the proceedings. However, an INWG consultation response was submitted to WSP on 24 September 2021.

There was no further communication with DBEIS or WSP following the September 2021 consultation until the final WSP report was released on 10 February 2023. The report titled, **A review of noise guidance for onshore wind turbines** [Ref 54] by Michael Lotinga and Toby Lewis of WSP was released on the WSP website. However, the report to government is dated October 2022, so had been withheld for over three months.

The 400-page WSP report was subsequently analysed by the INWG. The report titled, **INWG Analysis of WSP Report titled: A review of noise guidance for onshore wind turbines** [Ref 55] by Cox, Crosthwaite, Gray & Grosvenor was released and submitted to the government DESNZ on 15 April 2023. The INWG analysis of the WSP report, concluded that this review of ETSU by WSP is heavily biased with an obvious conflict of interest, also;

- *"In the evidence review, WSP admit to examining a restricted evidence base and utilising an inferior review methodology.*
- *The stakeholder survey was by invitation only and judged to be highly deficient and unbalanced. Unsolicited consultation responses however relevant were ignored by the authors and were not considered in the WSP review.*
- *The LPA consultation response rate of just 9% is highly questionable. This compares poorly against the 77% response rate achieved by the INWG to a similar survey during 2014, documented at WP 3.1.*
- *Despite the deficient study methodology and stakeholder consultation, the limited evidence reviewed within the report clearly shows that ETSU is unfit for use and should be replaced."*

Given the strength of the evidence revealed within the WSP report, there is a clear and obvious disconnect between this evidence, and the report's conclusions and recommendations. **This leads to the conclusion that the WSP report recommendations were predetermined.**

The INWG recommendations communicated to government DESNZ included:

- "Reject the recommendations made by WSP in their review for ETSU-R-97 to be retained albeit with some revisions.
- Replace ETSU-R-97 with BS4142:2014+A1:2019 as the official guidance for wind turbine noise assessment.
- Reject the WSP suggested proposal for a government 'position statement' on low frequency noise. This proposal is unsupported by the evidence and would conflict with the World Health Organisation (WHO) position.
- Conduct independent research into the effects on health and well-being of wind turbine neighbours including impacts from long term exposure, low frequency noise, infrasound, amplitude modulation and tonal noise as recommended by the WHO.
- Introduce licencing and regulation of wind power generation by a national agency such as the Environment Agency. This to include continuous monitoring and recording of noise and turbine data (SCADA) with the data available for compliance and complaint purposes."

**The INWG analysis concluded that this review of ETSU by WSP has been a whitewash and the report recommendations were predetermined. Additionally, there is the suspicion that the WSP review of ETSU was being used as the basis of justifying a replacement for ETSU that is equally permissive or more so to permit even higher levels of noise, both audible and infrasonic.**

In what appears to be a response by the WSP authors to the INWG analysis of their ETSU review, a two-part article was published in the IOA Acoustic Bulletin. The articles titled, **Onshore wind turbine noise: A review of the current guidance framework for the UK Government – Part 1** [Ref 56] appeared in the Sept/Oct 2023 edition at page 26, and the 2nd article titled, **Onshore wind turbine noise: A review of the current guidance framework for the UK Government – Part 2** [Ref 57] appeared in the Nov/Dec 2023 edition at page 26.

Part 1 describes the project background, aims and methodologies employed. As such it generally summarises content from the main report and was not controversial. Part 2 was expected to continue with a summary of the evidence, conclusions and recommendations from the main report. However, instead it focused on what appears to be a response to criticisms made in the INWG critique of the WSP report. Importantly, it also included some apparent U-turns by WSP in the article compared to the original WSP report to government.

The INWG requested the IOA to be allowed to publish an article in the Acoustics Bulletin in order to respond to the two WSP articles published in the September and November 2023 editions. The IOA initially agreed to the INWG request but rejected the proposed INWG article, listing several objections. A revised article addressing all the IOA objections was subsequently submitted. This second version was also rejected but no reasons were given for the rejection this time.  Instead, the INWG were invited to submit a 'Letter to the Editor'.

The IOA did finally agree to the submitted INWG letter titled, **Onshore wind turbine noise guidance** [Ref 62] page 60, however, publication was delayed to the May 2024 edition.

In response to the IOA articles the INWG released a Briefing Paper titled, **Onshore wind turbine noise guidance** [Ref 60] on 28 March 2024. The paper authored by Cox, Cowen, Crosthwaite, Gray & Grosvenor was written to provide an update on the INWG report titled, **INWG Analysis of WSP Report** dated April 2023 and to incorporate an assessment of the two-part article by WSP published in the IOA Acoustics Bulletin promoting their review of ETSU to government.

There is no doubt that the WSP authors had read the INWG critique from April 2024 of their report, as the subsequent articles in the Acoustics Bulletin were in effect a response to that INWG critique. Additionally, in their Acoustics Bulletin articles, the WSP authors appeared to make some significant U-turns or softening of their position from their original report:

- The WSP authors discuss noise limits at length, pointing out that the ETSU pass/fail outcome is inconsistent with the wider policy frameworks in England and Northern Ireland. These frameworks require noise impacts to be addressed in a more nuanced way.
- The WSP authors discuss and now appear to recommend the use of $L_{Aeq}$ for wind turbine noise measurement, instead of $L_{A90}$ as is currently mandated by ETSU. This is a significant change from the main WSP report.

It should be noted that adopting BS4142 would address both these issues. In what seems to be a most significant U-turn, the WSP authors now appeared to recognise, if only indirectly that there may be some merit in the BS4142 type assessment methodology and use of $L_{Aeq}$ in place of $L_{A90}$.

**However, when we now examine the proposed revision of ETSU we find than none of this 'softening of position' has been implemented. The Acoustic Bulletin articles by the WSP authors may have been simple 'window dressing' to impress the IOA membership, when they had no intention of adopting a more reasoned approach. Wind turbine noise it still to be measured using $L_{A90}$ as with the existing ETSU and there is no mention of BS4142 anywhere.**

## Chapter 14: Legal judgements

In the event of noise complaints, the ETSU noise guidance is generally followed by local authorities (LPAs). ETSU permits the wind farm operator to conduct lengthy noise surveys that will generally allow them to claim the noise complies with the guidance, the noise limits and planning conditions. LPAs have been found to be extremely reluctant to pursue noise nuisance cases by taking on wind farm operators. As a result, local residents are effectively abandoned by their LPA at this point, usually after a lengthy investigation process. The legal and cost barriers to taking legal action are such that it is an extremely difficult route for wind farm neighbours to take. However, a few cases have proceeded with varying degrees of success. Further details concerning the difficulty in taking legal action are available at the INWG AM study WP6.1 [Ref 33] and WP6.2 [Ref 35].

Further to the release of the ETSU-Gate report, another relevant legal judgment was released, by the High Court in Ireland dated 5 June 2025. This judgement, **Bryne and Moorhead v ABO Energy and Wexwind**, is also known as the **Gibbet Hill judgment** [Ref 65]. This judgement addresses a wind turbine nuisance case that had been ongoing for 12 years will have created a legal precedent in Ireland (but not in the UK). It is also described in the ReNews, Renews Gibbet Hill June 2025 , and at Beale & Co, Beale Gibbet Hill June 2025. The Beale site description of the case includes:

*"The Claimants brought a tortious claim against the Gibbet Hill wind farm for noise nuisance. They alleged that the noise caused by the Defendants' site substantially interfered with the Claimant's day to day enjoyment and use of their house and garden. Midway through the six-week trial the Defendants admitted liability and partially abated the problem by switching off the turbines between 10pm and 7am.*

*At the end of the case, the Defendants further proposed that they would switch off the turbines between 7am and 11am on weekends and public holidays. They also proposed to pay damages to cover future ongoing nuisance and for the nuisance to date. To provide support for their proposal, they pointed out that wind turbines were important for contributing to Ireland's renewable energy needs.*

*The Court found in favour of the Claimants and ordered as follows:*

- *annualised general damages (€10k p.a. to the first Claimant, €15k p.a. to the second) for the twelve-year period of the amenity interference, totalling €300,000;*
- *a permanent injunction, shutting down the three offending turbines;*
- *aggravated damages of €24,000 and €36,000 respectively; and*
- *no exemplary damages."*

After 12 years of denying liability, failing to engage with the claimants or the local authority, or entertaining any mitigation of the nuisance, it was only during the court proceedings and

after the evidence of the nuisance had been presented that the defendant finally admitted liability.

At this point during the trial, the defendant offered to mitigate the nuisance by switching off the turbine during the night time and at weekends. They also proposed to pay damages to permit them to continue with the ongoing nuisance. These proposal were rejected in the judgment and the three offending turbines were ordered to be permanently shut down.

It should be noted that the acoustic consultants representing the claimants were Mike Stigwood and Sarah Large of MAS Environmental. The defendant was not represented by an acoustic consultant during the court hearings but had used Hayes McKenzie in their efforts to prove the wind farm complied with the planning condition. Both sides agreed the wind farm complied with the planning conditions, with the noise assessment guidance in Ireland being based on the UK ETSU guidance. However, **the defendant finally accepted the noise nuisance being the result of amplitude modulation and low frequency noise**.

This judgment demonstrates that when a wind farm operator believes they are immune to prosecution for creating noise nuisance, protected by the ETSU noise guidance, and a restrictive legal system, they will behave in the arrogant manner highlighted by the Gibbet Hill judgment. While this is an Irish case, the point that a planning permission may not be a defence to a nuisance claim is established by the Lord Neuberger in the Supreme Court judgment of Coventry v Lawrence (often referred to as Lawrence v Fen Tigers).

The **Gibbet Hill judgment** followed on from the similar **Meenacloghspar (Wind) Limited Judgement**, delivered March 2024, also by the High Court in Ireland. The **Meenacloghspar (Wind) Limited Judgement** is discussed in the ETSU-Gate report, Chapter 14.

The following is an extract from Justice Egan's **Meenacloghspar (Wind) Limited Judgement,** *"52. Ms. Webster's evidence was that, when turning quickly, T2 emits a range of distinctive sounds. In addition to a swishing sound, it emits whoomph and whump sounds and intermittent louder thumping or whacking noises. These sounds are often accompanied by disturbing vibration, meaning that she could regularly "**feel**" as well as hear the noise. This is perceived as pressure coming from the air as the blades rotate, which feels like "**a pummelling inside [her] body**". All of this, Ms. Webster states, is a frequent characteristic of the WTN, particularly at night."*

These cases determined under Irish law contrast with the Cotton Farm case in England. The Cotton Farm case known as **Mr Keith Holl v Greencoat UK Wind UK** is also discussed in the ETSU-Gate report Chapter 14.

The Cotton Farm case was very similar to the Gibbet Hill case. Both involved similar sized wind farms and turbines, similar noise nuisance issues, with the Cotton Farm nuisance subject to thousands of complaints over eight years. The same acousticians from MAS

represented the claimants in both of these cases. See also Chapter 8 relating to the Cotton Farm community noise monitoring.

The key difference being that Cotton Farm case was subject to English Law and instead of being pursued as a civil nuisance case, it was decided to take action under the statutory nuisance provisions of the Environmental Protection Act 1990. Instead of being civil proceedings, these are criminal, prosecuted only in the Magistrates' Court and are subject to the rule that proceedings must be commenced within 6 months of the action complained of.

In addition, there is a duty on the prosecution (in this case, the wind farm neighbour) to comply with the disclosure provisions of the Criminal Proceedings and Investigations Act 1996, a heavy duty that has frequently caught professional prosecutors off guard.

Due to these technicalities of English law, the defendant was able to exploit loopholes with delaying tactics that enabled the evidence to become inadmissible once it passed the 6-month time limit from the start of the proceedings. The MAS acousticians were then not allowed to present their evidence and the trial collapsed.

It should also be noted that courts have frequently held that Guidance such as the National Planning Policy Framework are not statutory documents and therefore not law. They are clearly material considerations but this has also played a part when courts have considered their role while considering the judgment in Coventry v Lawrence. We believe those drafting any revision of the ETSU Guidance should make themselves familiar with the issues raised by this judgment of the Supreme court, in particular from paragraph 77 onwards.

Refer to ETSU-Gate Chapter 14 for further discussion concerning legal judgments.

## Chapter 15: Advances with low frequency noise

The ETSU-Gate report Chapter 15 discussion is expanded here in order to address low frequency noise (LFN), including infrasound, as the lack of recognition of wind turbine LFN by the industry and government is one of the main defects with the ETSU methodology and its proposed update.

Some of the earliest research into low frequency noise from wind turbines was conducted by Kelly and others in the 1980s. INWG WP 2.1 titled, **Review of Reference Literature** [Ref 27] dated July 2015 provides further details. Evidence from the 1980s confirmed that:

- People do indeed react to a low frequency noise environment; and
- A-weighted measurements are not an adequate indicator of annoyance when low frequencies are dominant.

This 1980s research also confirmed that wind turbine noise could cause annoyance and that it contains a large low frequency component that can excite building structures such that low frequency noise levels could be higher inside than outside buildings. Kelly found internal sound pressure levels of up to 10dB greater than external where low frequencies are present.

The conclusion regarding LFN from the review of evidence at WP1 (page 20) demonstrates;

- *"LFN including infrasound is an integral component of WTN emissions;*
- *Conditions giving rise to noise complaints are often characterised by 'sensation' as being the major form of disturbance. The 'noise' may not even be audible in some cases;*
- *Noise measurement using the A weighting is unsuitable for measuring WTN where low frequency components are present;*
- *Noise measurements should be made inside homes when investigating noise complaints;*
- *Noise measurements where LFN is present should be made using suitable instrumentation. IEC 61672 compliant instrumentation is unsuitable for LFN or where background noise levels are low as in typical rural areas;*
- *ETSU is not 'fit for purpose' for assessing LFN in WTN."*

The release of the report, **A Cooperative Measurement Survey and Analysis of Low Frequency and Infrasound at the Shirley Wind Farm in Brown County, Wisconsin** [Ref 12], known as the **Wisconsin report** during December 2012 in the USA was a highly significant advance in the recognition of noise nuisance relating to low frequency noise including inaudible noise. Commissioned for the Wisconsin Public Service Commission, this paper consists of separate reports by four different consultants who between them represent both developers and resident groups. Testing was carried out at several homes that the

residents had been forced to abandon due to the wind turbine noise from the Shirley wind farm. The overall report conclusions agreed by all four consultants included:

- "Residents report being intensely affected despite inaudibility and to be aware of turbine operation even when the turbines are not visible", also;
- "the study also showed that a wind turbine is indeed a unique source with ultra-low frequency energy. In general, enough was learned by these investigators, all with quite different past experiences, that it can be mutually agreed that infrasound from wind turbines is an important issue that needs to be resolved".

The Wisconsin report combined **Conclusions** at page 6, is reproduced below showing the sound levels recorded inside and outside residence R2 quantifying the high levels of low frequency and infrasound present.

The Wisconsin report was followed by the paper titled, **The results of an acoustic testing program, Cape Bridgewater wind farm** [Ref 21] in November 2014 by Steven Cooper. This paper also referred to as the **Cape Bridgewater report** appears to be a first of its kind in Australia or elsewhere, in that it was a joint exercise between a wind farm operator and residents. Additionally, this paper provided a significant advance in the recognition and understanding of low frequency effects.

**Resident's observations identified 'sensation' as the major form of disturbance from the Cape Bridgwater wind farm**.

By including narrowband analysis in the description of the acoustic environment, the study confirms that the infrasound obtained in a wind farm effected environment is different to that in a natural acoustic environment. The Cape Bridgwater paper was highly praised by independent experts including Steve Ambrose from the USA who stated in his **Letter to S Cooper** [Ref 22] dated 22 January 2015,

*"Congratulations, I commend you for pursuing scientific truth by investigating the human response to large wind-turbines in the acoustic environment. Your correlation of human response journal entries with scientific waveform analysis clearly shows hearing is not limited to audible sounds. Research continues to reveal that the ear has multiple functions and capabilities. This study merits recognition by acoustic and public health professionals for more research."*

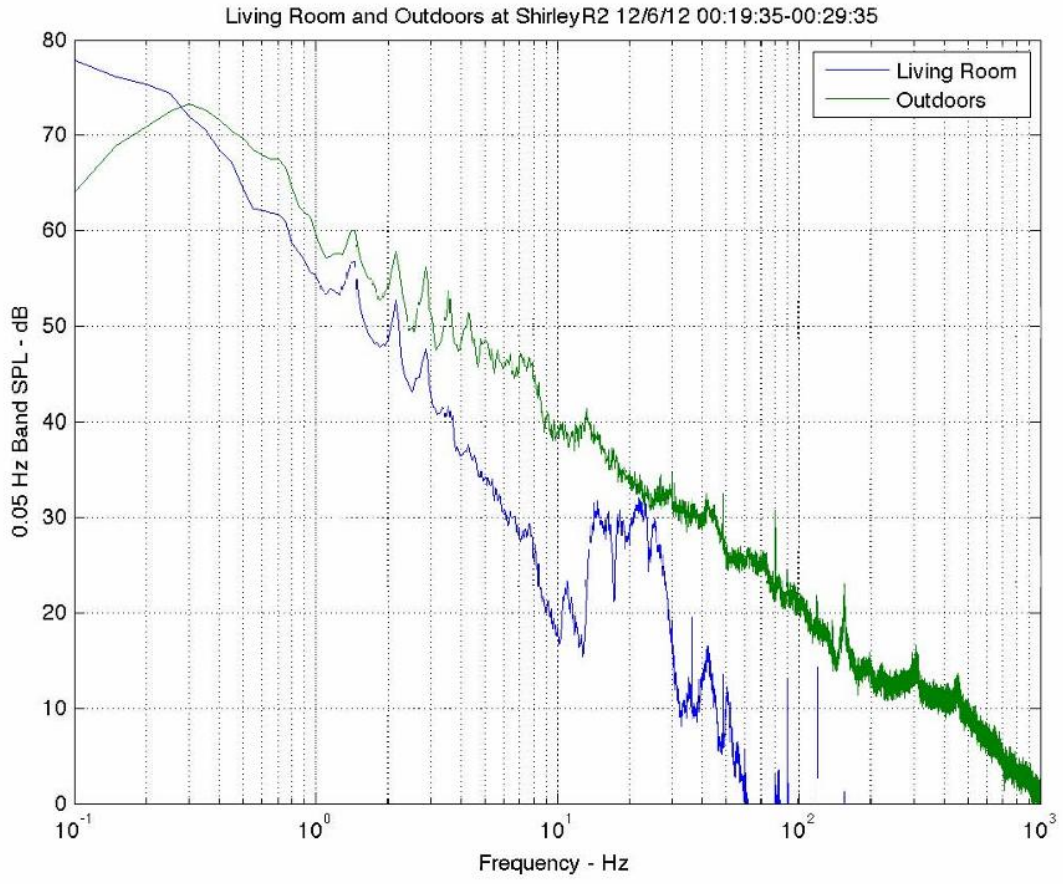
The letter continued with, *"Your study goes far beyond the 1980s Neil Kelley et al. studies that identified operating wind-turbines can produce airborne transmissions that humans detect as "sensations". Bray/James research showed that one-third octave band filters could not measure the low-frequency peaks produced wind-turbines. Neighbors' complaints were ignored by the majority. Acoustic experts failed to understand the limitations of their instruments and analysis methods".*

**The Ambrose letter highlights the concerns and issues with low frequency noise in the USA and Australia are exactly the same as in the UK. Also, that there are fortunately still a small minority of honest professional acousticians that are prepared to challenge the bad science that perpetrates throughout the wind industry.**

## 4.0_Conclusions

This cooperative effort has made a good start in quantifying low frequency and infrasound from wind turbines.

Unequivocal measurements at the closest residence R2 are detailed herein showing that wind turbine noise is present outside and inside the residence. Any mechanical device has a unique frequency spectrum, and a wind turbine is simply a very very large fan and the blade passing frequency is easily calculated by RPM/60 x the number of blades, and for this case; 14 RPM/60 x 3 = 0.7 Hz. The next six harmonics are 1.4, 2.1, 2.8, 3.5, 4.2 & 4.9 Hz and are clearly evident on the attached graph below. Note also there is higher infrasound and LFN inside the residence in the range of 15 to 30 Hz that is attributable to the natural flexibility of typical home construction walls. This higher frequency reduces in the basement where the propagation path is through the walls plus floor construction but the tones do not reduce appreciably.

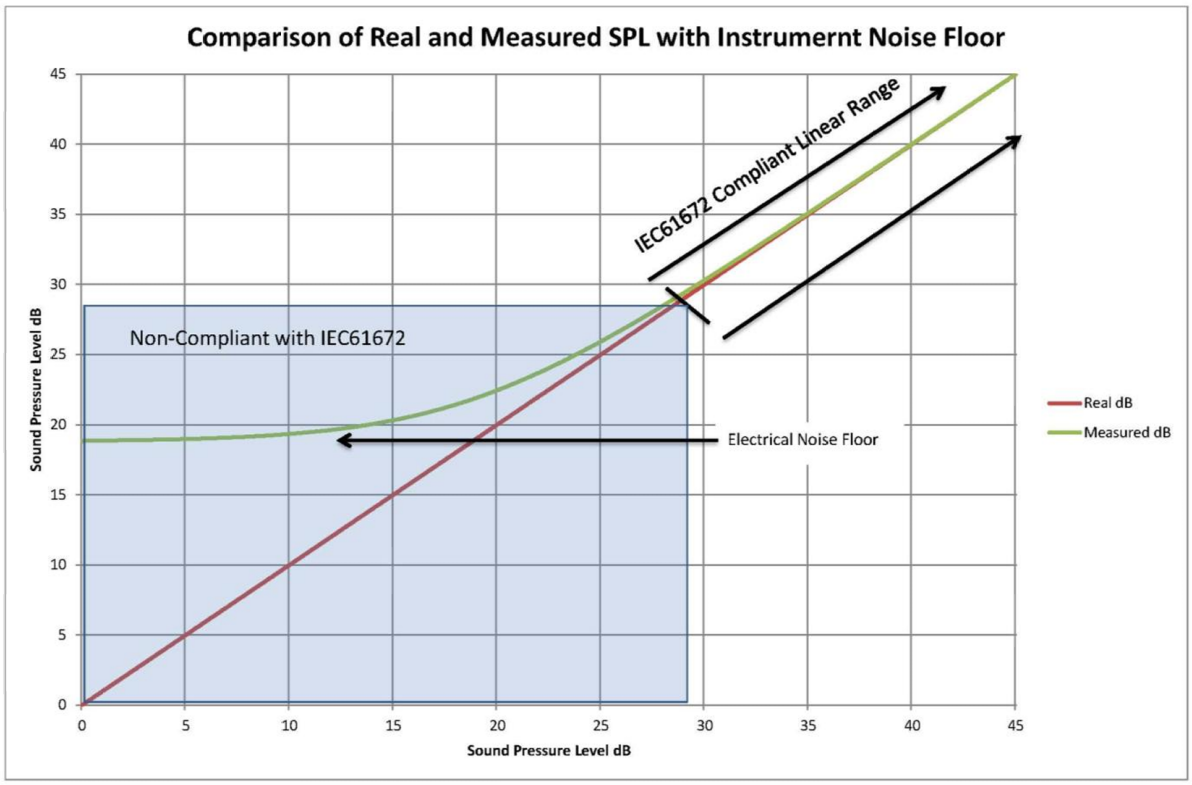



**Wisconsin report page 6 conclusions**

An important reason for the lack of wider recognition of low frequency noise from wind turbines is the limitation of the sound meters used for noise measurement. The paper titled, **Constraints imposed by and limitations of IEC 61672 for the measurement of wind farm sound emissions** [Ref 25] presented by Les Huson at the 6th International Conference on Wind Turbine Noise, Glasgow in April 2015 discusses these constraints.

Huson provides evidence that available sound meters compliant with IEC 61672 are unsuitable for measurements where infrasound is present as typically found in WTN emission at frequencies below 6 Hz or where there are low background noise levels. Data presented in wind farm noise assessment reports that are below the lower measurement range of the instrument are not compliant with the specification requirements of IEC 61672. Figure 1 below shows the compression effect that sound level meters have as the sound levels approach the instrument noise floor. In his conclusions Huson states;

*"The author is aware of numerous wind farm assessments, made in accordance with the ETSU-R-97 methodology, where data has been used in preparing trend lines from background and post-construction operating conditions that is outside the range of measurement for which the sound level monitoring equipment is compliant with IEC 61672. Such charts are presented as examples of good practice in the IoA Good Practice Guide. The author knows of no ETSU-R-97 type assessment where account has been made for such non-compliant data that is outside the measurement range of the instruments."*




**Huson 2015: Figure 1**

INWG WP1 titled, **The Fundamentals of Amplitude Modulation of Wind Turbine Noise** [Ref 26] By Dr John Yelland dated November 2015 explores aspects of amplitude modulation and the related low frequency sound from the perspective of a professional physicist. Although WP1 deals mainly with amplitude modulation, discussed in more detail elsewhere in this report, it does provide some useful explanations regarding low frequency sound.

Yelland confirms at page 5 that AM is, "***the sum of incoherent noise, modulated both in frequency and in amplitude, together with high levels of very low frequency tones***".

Yelland is critical of the ReUK AM research report [Ref 17] regarding the exclusion of any consideration of acoustic emission below 100Hz stating;

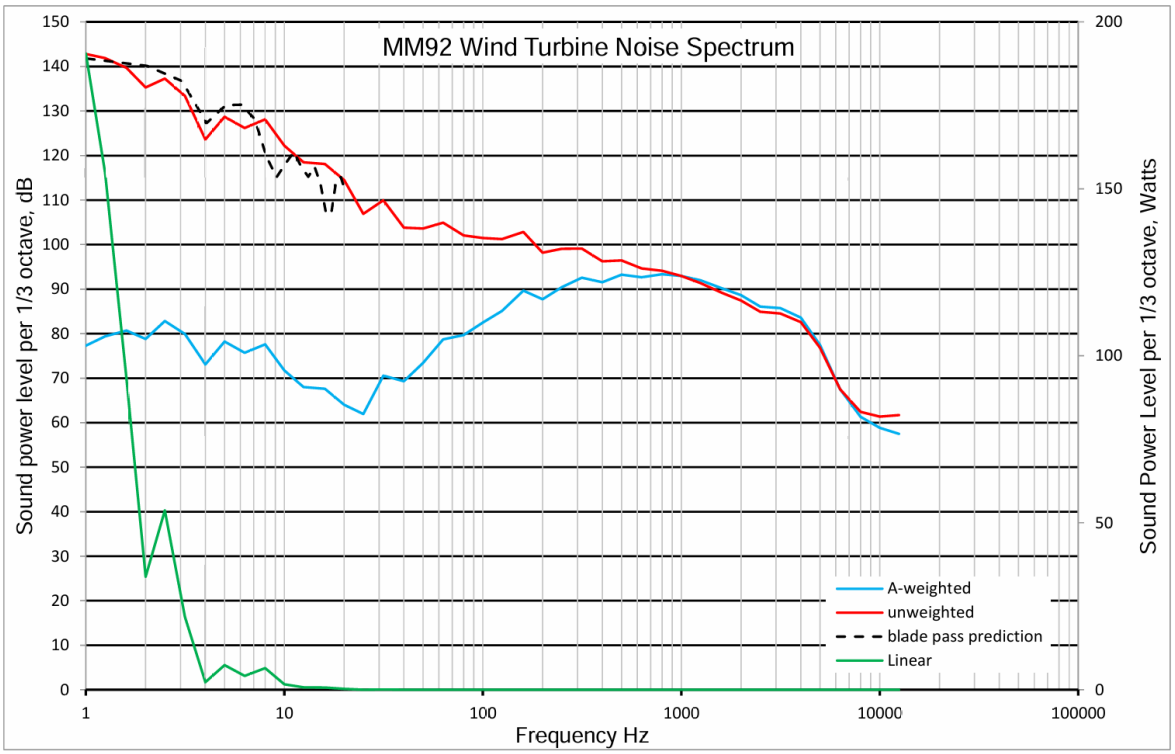
"*In truth the greatest observed modulation heights are fairly easily explained by consideration of the very low frequency emissions which are a consequence of the structural dynamics of large modern wind turbines rather than aerodynamic noise from the blades. These very low frequency emissions are well known to turbine manufacturers, but by reason of mechanical fatigue issues rather than noise nuisance*."

At section 2.3 Yelland discusses the normal wind turbine noise spectrum using data from the RePower (now Senvion) MM92 turbine. His WP1 Figure 2 is reproduced below.

Yelland explains his figure 2 with, *"it is seen that the A-weighted spectrum appears to have a gradient discontinuity at around 20Hz. This is because the data provided below 20Hz does not state what weighting (if any) was used, so I have assumed no weighting. The standard A-weighting curve is defined down to 10Hz, so this assumption may be incorrect, and may have caused understatement of the unweighted noise power level below 10Hz.* ***The essential point to grasp is just how much power, rather than how much perceived loudness, is in the 1Hz to 20Hz frequency band compared with that in the 20Hz to 12,500Hz frequency band; to illustrate this the linear green trace is plotted on the linear scale to the right of the chart. The answers are 99.94% and 0.06% respectively,*** *of a total of 572W."*

And continues with, "*it is most unwise to ignore the existence of the acoustic energy below 20Hz just because that frequency defines a normal lower limit of human hearing*."

Yelland questions the reasoning offered in ETSU for setting the night time noise limit at 43dB(A), as opposed to the outdoor limit of 35dB(A), is the assumption of 8dB sound attenuation in passage through an open window. Continuing with, "*This assumption is valid at normal audio frequencies but certainly does not apply at very low frequencies****; even with windows closed there is usually little or no attenuation from outdoors to indoors, and sometimes amplification due to room resonances. It is therefore not surprising that the majority of noise complaints relate to sleep deprivation indoors, and not to annoying noise levels outdoors****.*"




**WP1 Figure 2: Noise emission power data to IEC 61400-11 from measurements on a RePower MM92 wind turbine, 1Hz to 12.5kHz, by Windtest gmbh**

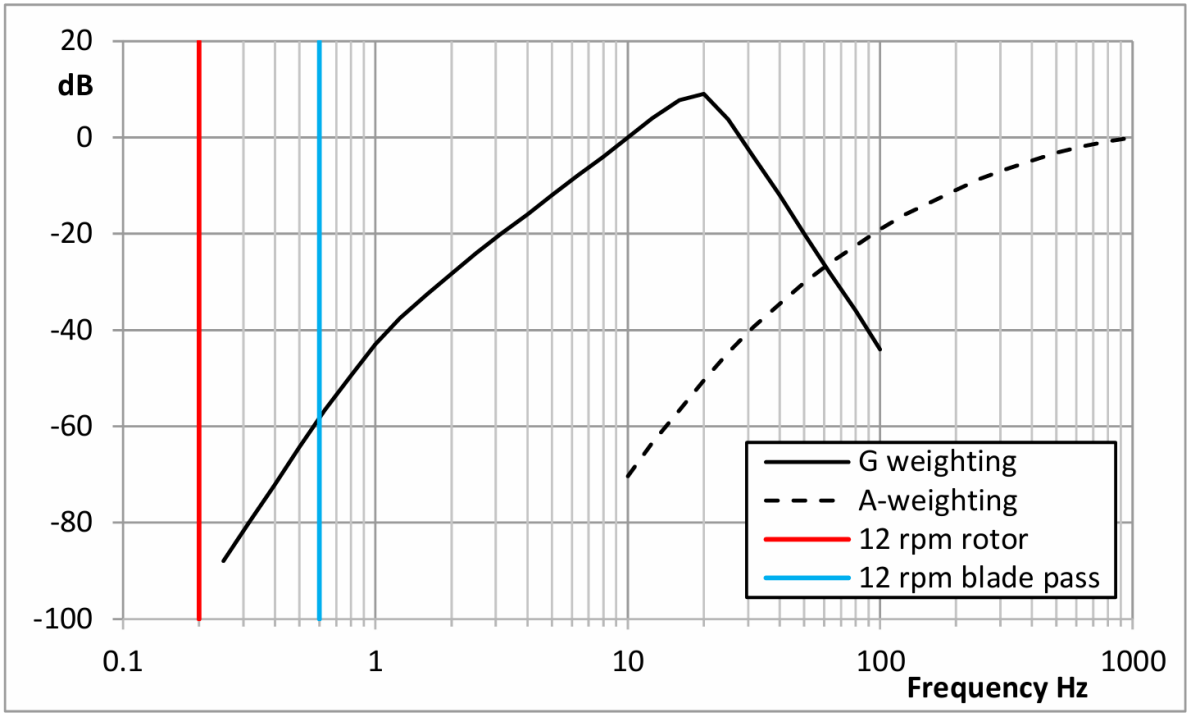
At WP1 section 3.4, page 12 Yelland provides additional comment, "*Turning again to figure 2, a most unusual feature of the chart (perhaps unique for published data) is its coverage of a bandwidth down to 1Hz. The blue trace is the usual 1/3 octave A-weighted noise emission power from SPL measurements at the rated turbine output power. The red trace is the same data with the A-weighting removed. The dashed black trace is the Fourier transform of a tower pass pressure impulse of arbitrary amplitude, that I have modelled at the BPF with a rise, dwell and fall consistent with the manufacturer's published turbine dimensions. The BPF of the turbine is less than 1Hz, so the fundamental at the BPF is not visible, but its amplitude is probably higher than that of any of its harmonics. It can be seen that the spectrum shape matches the measured values below 20Hz reasonably well. Although the MM92 is an upwind turbine the nacelle overhang is relatively small, and at full power the wind-strained blades pass fairly close to the tower, so there is significant interaction therewith.*

*The green trace shows the same unweighted data as the red trace, but plotted on a linear scale rather than a logarithmic (dB) scale. This provides a pictorial representation of where the noise power is at its highest level: below 10Hz. The two ordinate values at which the*

*logarithmic and linear plots coincide are 0dB and 140dB. The measurements were made in daytime wind shear so relate to turbine noise with normal AM, but without EAM*."

At WP1 section 4.4, page 18 Yelland questions the validity of the Salford listening room test commissioned by ReUK where he states; "*The listening room has a surprising inclusion in its sound reproduction system: a high pass filter with a corner frequency of 140Hz and 20dB attenuation at 100Hz (see figure 8 reproduced from the ReUK report, pdf page 229). The filtering out of all frequencies below 100Hz in the measurement of EAM will completely remove any and all of the turbine noise signals from sources described above in 3.3 to 3.7, along with some of the downward shifted frequency content of the aerodynamic noise in stall. This equipment was used to replay real wind farm noise recordings for volunteers to rate the degree of annoyance they caused. The ReUK report, wind industry developers and their IOA AMWG acousticians repeatedly assert that the noise of EAM is all aerodynamic and has little content below 100Hz; this would seem to make the 100Hz filter redundant. No special measurement have been published in the ReUK report to support this assertion; indeed independent measurement, such as reproduced in figure 1 above, demonstrate the contrary.* ***I must therefore conclude that this paper, whatever its intention, serves to obfuscate rather than to illuminate the matter that the ReUK report purports to address***."

**It seems inconceivable that the removal of sound data from below 100Hz by knowledgeable wind industry acousticians is accidental and not a deliberate act to deceive**.




**WP1 Figure 3: G-weighting and A-weighting curves with 12 rpm rotor and blade pass frequencies**

At WP1 section 4.5, page 19 Yelland discusses the use of noise measurement using G-weighting. G-weighting is a rarely used weighting curve which like A-weighting purports to model the frequency response curve of the ear, only at infrasound rather than audio frequencies. Yelland refers to his figure 3 reproduced below and continues with;

*At 10Hz its weighting is zero, but the ear's sensitivity and therefore the G-weighting curve, descend rapidly below 10Hz,; at a typical blade pass frequency around 0.6Hz the Z-weighting curve is close to-50dB, which is the same as the A-weighting curve at 20Hz. At 0.25Hz, the corresponding rotor rotation frequency, the G-weighting curve is not even defines, but extrapolates to -96dB. G-weighting is scarcely more relevant than A-weighting, as both assume that the human auditory response in the only relevant criterion.*"

Yelland continues at section 5.1 with; "*The use of A-weighting reduces the sound level measurement – but not of course the sound level – by 50db at 20 Hz. At these low frequencies G-weighting is equally inappropriate as it too reduces measurements, by 50 to 100 dB at blade pass frequencies. Any weighting is inappropriate. As even the straightforward unweighted measurement of sound power level is referred to as 'Z-weighting' the concept of weighting is obviously well entrenched in the acoustic mind set; inaudible pulsing pressure waves around 1 Hz however are far better understood in terms of physics rather than acoustics*,"

At section 5.2 Yelland is also critical of current industry practice to exclude the measurement of low frequency noise below 100Hz based on the assumption that it tends to be influenced by wind noise. He states;

"*The IOA Good Practice Guide endorses the use of ISO 9613-2 for wind farm immission noise level prediction and of IEC 61400-11 for turbine noise measurement. Both these standards require measurement only down to 45Hz, a seemingly perverse movement upwards in frequency from 20Hz over a 16 year period during which turbine noise emissions decreased considerably in frequency due to the increase in turbine dimensions.* ***That the lower frequency limit should be raised even further to 100Hz for EAM measurement, which clearly have a significant content below 100Hz, seems yet more perverse*****.**"

More recent research by the International Acoustics Research Organisation (IARO) provides a significant advance in our understanding of wind turbine low frequency noise and infrasound, how it should be measured and how the data should be analysed. This research also provides evidence of the direct link between low frequency noise and health effects. **In doing so it challenges the wind industry denials surrounding the health effects from LFN and infrasound**.

The report titled, **Report on the High-Resolution Infrasonic and Low-Frequency Sound Recordings Conducted Within a Rural Farm in Scotland in 2022 and 2023** [Ref 58] released December 2023 discusses noise measurements carried out at a rural sheep farm in Scotland

following complaints of severe health deterioration that only began following the commissioning of a nearby wind farm. The goal of the investigation was to provide high resolution analyses of the soundscape in and around the rural sheep farm, on behalf of all residents and farm workers (10 adults and 4 minors). The conclusions of this report from para 224 are;

- *"High-resolution infrasonic and low-frequency sound recordings were conducted at 9 different locations within Rural Sheep Farm, during three recording periods: 28-31 Mar 2022, 3-26 October 2022 and 22 February-17 March 2023, yielding close to 1140 hours of recordings (6839 10-minute sound files).*
- ***Wind turbine acoustic signatures (WTAS) were present in roughly 75% of the 10-minute recording segments. When combined with the presence of the 20-hertz tone only 2.6% of the recordings were free of any type of these emissions. i.e., in 1140 hours of recordings, only 30 non-consecutive hours did not register WTAS nor the 20-hertz tone.***
- *This means that the residents of Rural Sheep Farm and their livestock have been (and are being) continuously exposed to low-frequency sound and regular trains of short-duration pressure pulses, pulsating every 0.5 to 2.0 seconds, depending on the IWT model.*
- *These pressure pulses can be large—over 10 dB above background level—or very large —over 20 dB above background level.*
- *The WTAS that were identified and quantified emanated from WPP A as well as from the other four WPPs within 7 km of Rural Sheep Farm.*
- *Wind direction influenced the acoustic output of the WPPs. However, whatever the wind direction, a WTAS was present emanating from one of the 5 WPPs within 7 km of Rural Sheep Farm.*
- *Given that the presence of WTAS has been correlated with adverse health effects in humans, and that Rural Sheep Farm residents are under continuous exposure to WTAS, it is not entirely surprising that, since the WPP A began operations in November 2021:*
    - *Mr. Z, 76, has been hospitalized twice,*
    - *Ms. Z1 (53, daughter) was hospitalized and has still not returned home at the time of closure of this Report.*
    - *Ms. Z2-4 (14, granddaughter), diagnosed with autism at age 2, has seen her behaviour become greatly aggravated, causing a devastating impact on the entire family."*

The IARO report **Appendix A** titled, **Technical Background for Laypersons** [Ref 59] provides a more detailed description of the measurement and analysis methodology of the wind turbine acoustic signature (WTAS). The WTAS is the sound characteristic produced by all wind turbines at various noise levels and frequencies. It is seen as a series of pressure pulses over time that generally occur at a fixed rate, somewhere between about one pulse per every two seconds to two pulses per every second. The rate, or frequency of these pulses is

determined by the BPF (blade pass frequency) of the different turbine models. The BPF of wind turbines is defined as the frequency at which blades pass the tower of the turbine. A three-bladed turbine will have three blade-passes per full rotation. If such a turbine is rotating once every three seconds, 1/3 Hz, then its BPF will be three times this, that is, 1 Hz.

The SAM technology used by IARO is described at Section 2 of the report. The SAM system provide a high degree of linearity down to 0.5Hz, significantly lower compared to the 20Hz available with the Class 1 SLMs specified in the IOA Good Practice Guide [Ref 13]. The IARO methodology allows the identification of a wind turbine acoustic signature (WTAS) not possible with conventional methodologies such as ETSU due to:

- Increased time resolution from 10 minute averages to second by second recording.
- Increased frequency resolution from 1/3 of an octave to 1/36 of an octave.
- Use of unweighted sound pressure level (SPL) measurement in place of A, G or C weighting.

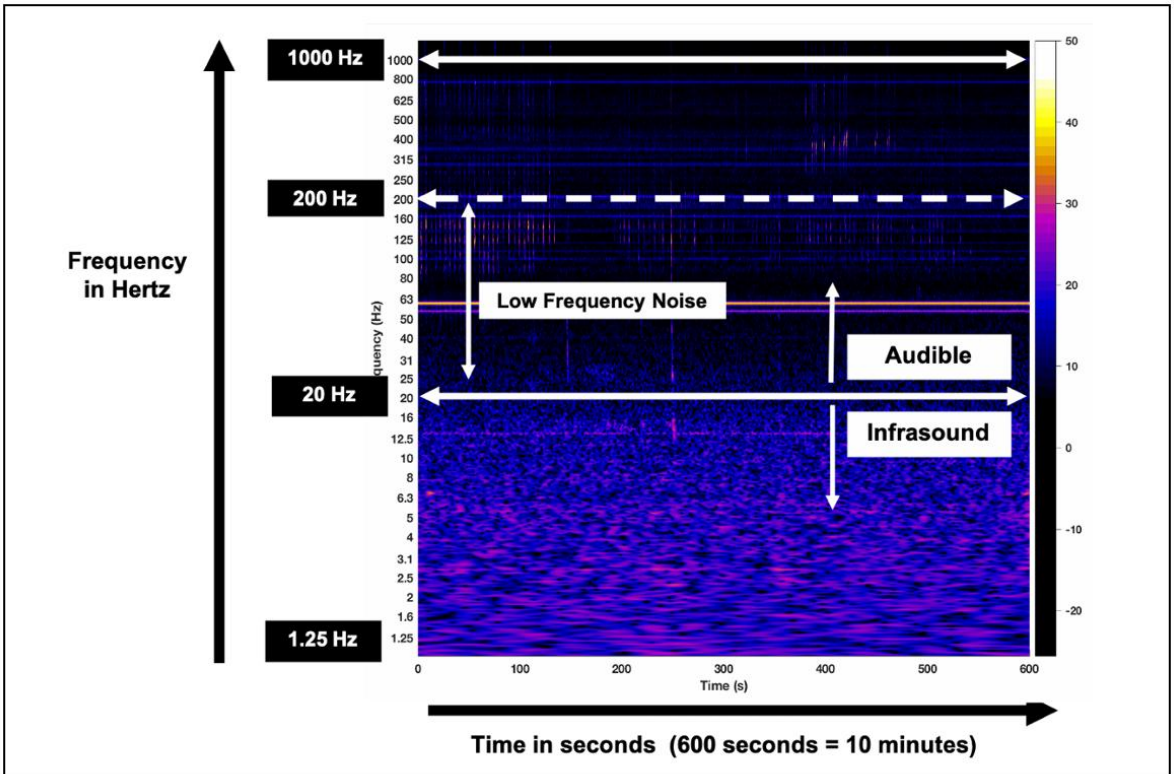



**Figure 5.** The classical segmentation of the acoustic spectrum is indicated: Infrasound below 20 Hz and Audible above 20 Hz. Here, the lower frequency components are also included—currently considered as the frequency range between 20 Hz and 100 or 200 Hz, depending on the authors.

**IARO Fig 5: Classic segmentation of acoustic spectrum**

The IARO data analysis includes the use of Sonograms and harmonic analysis. Figure 5 reproduced here shows a sonogram identifying the audible, low frequency and infrasound spectrum. Vertical lines represent momentary sounds such as snoring and horizontal lines show continuous tones.

The sonogram at figure 9 reproduced here shows the existence of a WTAS captured at the Rural Sheep Farm. Each of the horizontal lines seen in Figure 9 are equally spaced from each other: 1 Hz, 2 Hz, 3 Hz, 4 Hz, 5 Hz, 6 Hz, 7 Hz, 8 Hz, 9 Hz and 10 Hz. Mathematically, this is known as harmonic series where each frequency value is an integer value above the fundamental frequency (F0) which, in this case, is 1 Hz. This fundamental frequency of 1 Hz. corresponds to the infrasonic acoustic output of a wind turbine having a Blade Pass Frequency (BPF) of 1 Hz.

The data captured in a sonogram can also be viewed in a spectrogram. Figures 10 and 12 shows the harmonic series analysis that corresponds to figures 8 and 9. The sound pressure level (SPL) is averaged over each 600-second recording at each $1/36^{th}$ octave frequency. This SPL value, in dB-Linear or dB-unweighted is shown on the Y-axis and the corresponding frequency values (in Hertz) are shown on the X-axis. The upper right hand corner lists the fundamental frequencies of the strongest harmonic series in descending order. Figure 12 is reproduced here shows the fundamental 1Hz frequency and the harmonics at multiples of 1Hz. Figure 12 reflects the acoustic output of a wind turbine. Natural wind noise is not present as a harmonic series.

In contrast to the straight lines shown at figure 9 of the wind turbine acoustic output, figure 13 reproduced here shows four sonograms from recordings in different natural acoustic environments, wind gusts, beach waves and a river course, and where WTASs, if present, are barely visible. Nature does not tend to show itself in straight lines and well-defined harmonic series. These are features that can be traced back to the operation of man-made machines or structures.

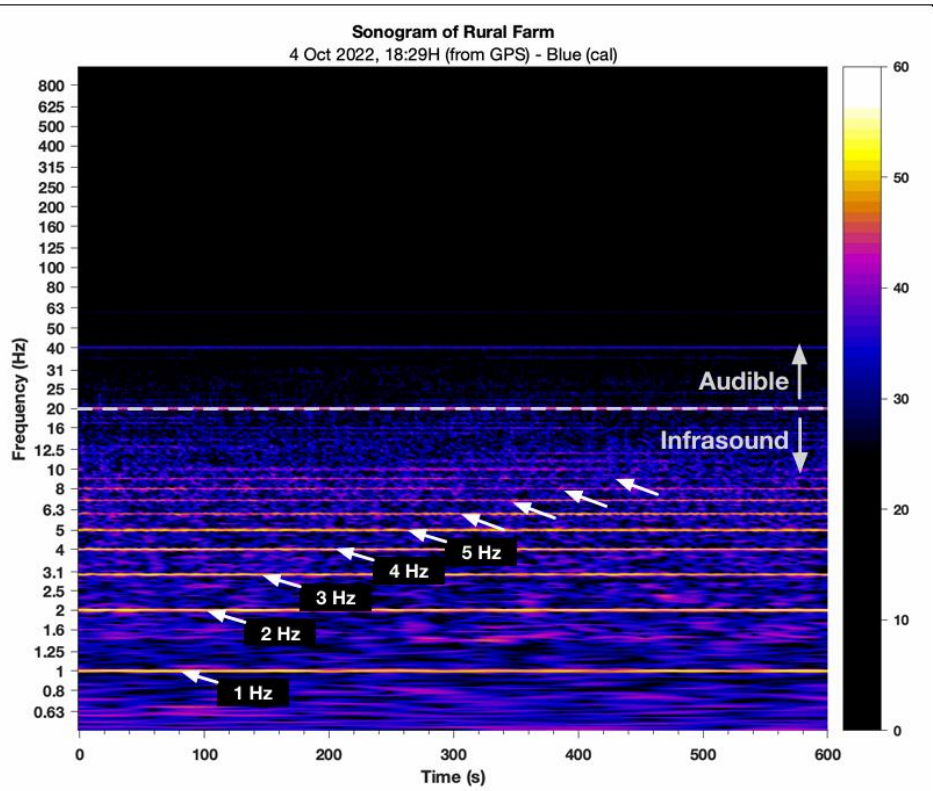



**Figure 9.** Each small white arrow points to one of the continuous horizontal lines that appear over the entire 10-minute segment. Each horizontal line is occurring at specific infrasonic frequencies, as indicated in the black boxes (and also on the YY-axis labelled "Frequency"). Noticeably, each of these lines is equally spaced from each other (see Para. 37). Collectively, these horizontal lines constitute the WTAS. The first five horizontal lines (1-5 Hz) are colour-coded at approximately 50 dB, with the remaining lines (6-10 Hz) color-coded at around 40 dB. There is also a 20-hertz harmonic series showing tones at 20 Hz (visible in Fig. 8 at about 40 dB), 40 Hz, and 60 Hz (very faint). Within the audible range of the frequency spectrum (above 20 Hz), there are no significant acoustic events, except for the continuous line at 40 Hz, color-coded at approximately 30 dB.

**IARO Fig 9: Sonogram of Rural Farm**

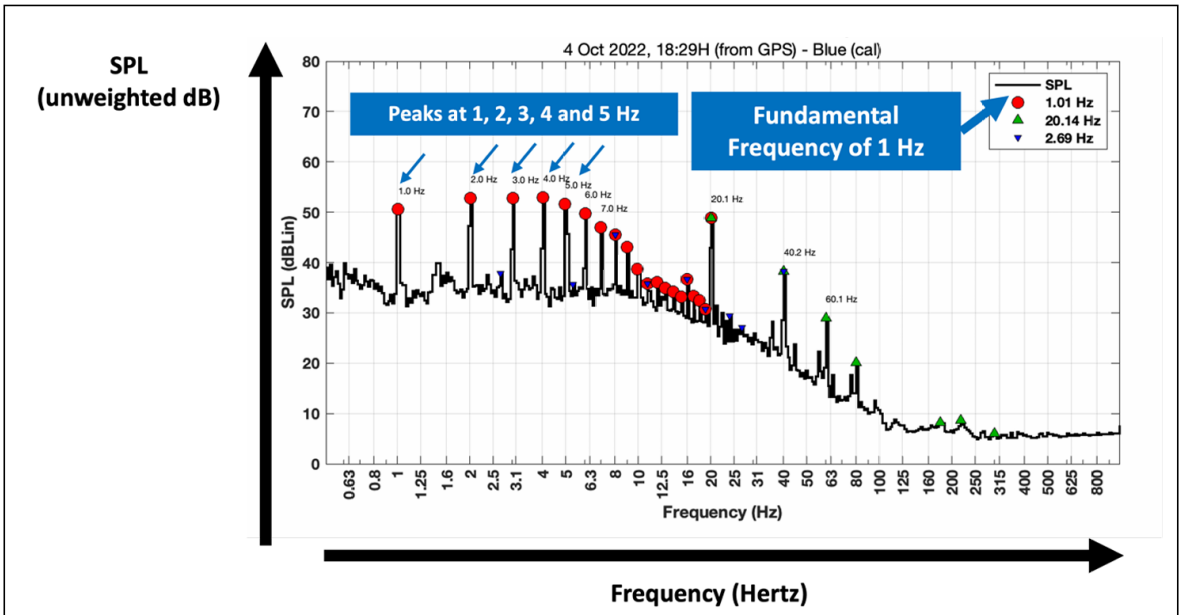



**Figure 12.** Spectrogram showing the SPL value per 1/36$^{th}$-octave band, in unweighted dB and averaged over the 600 seconds. The regularly spaced peaks, beginning at 1 Hz (=$F_0$) collectively represent the 1-hertz harmonic series.

## IARO Fig 12: Harmonic analysis of Rural Farm

Figure 15 reproduced below shows an example of a sonogram of a wind turbine with pronounced amplitude modulation co-existing with the WTAS. The brighter, vertical lines (in the upper, audible region) are the times when the sound becomes louder, leading to the "whoosh" sound that is often described. This occurs at one-second intervals (i.e., at a frequency of 1 Hz) as seen by the spacing between the vertical bars.

In the lower frequency and infrasonic region of the sonogram, horizontal lines are visible, indicating the presence of WTAS. These horizontal lines start at 1 Hz and repeat every hertz upwards, in other words, a 1-hertz harmonic series. Both the amplitude modulation and the WTAS have the same frequency, 1 Hz, because they are both produced by the blades at the blade-passing frequency (BPF). Both the amplitude modulation phenomena and WTAS appear in the Sonogram as straight lines, indicating that these acoustic disturbances of the natural soundscape are human-made.

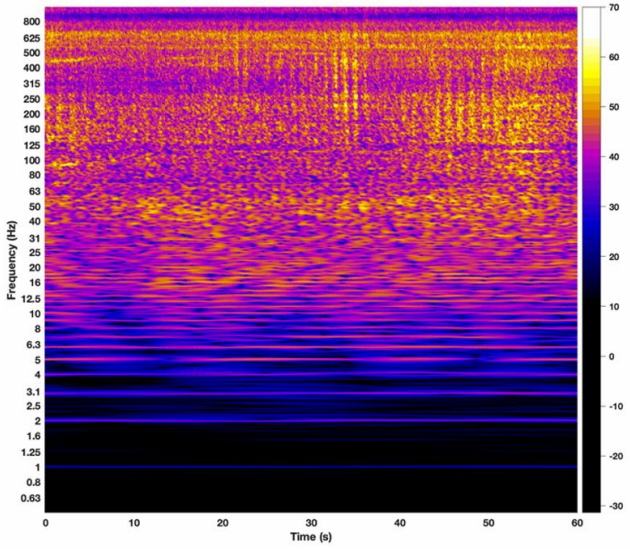



**Figure 15.** Sonogram of a 1-minute recording in the vicinity of the Makara WPP near Wellington in New Zealand (9 October 2009 at 02:39H, no wind data available). The phenomena of Amplitude Modulation as applied to wind turbines is shown as the bright yellow staccato-like pattern seen over a pink background, but only in the upper (audible) portion of the frequency spectrum. Notice that the corresponding WTAS is also present. Moreover, since Amplitude Modulation is a machine-generated acoustical phenomenon, it too appears at straight (vertical) lines.

**IARO Fig 15: Sonogram showing WTAS and amplitude modulation**

At Paras 102 to 122 the IARO report provides a reasoned discussion of the inappropriate use of A-weighting, C-weighting or G-weighting when measuring low frequency sound as most of the lower frequency content is effectively filtered out.

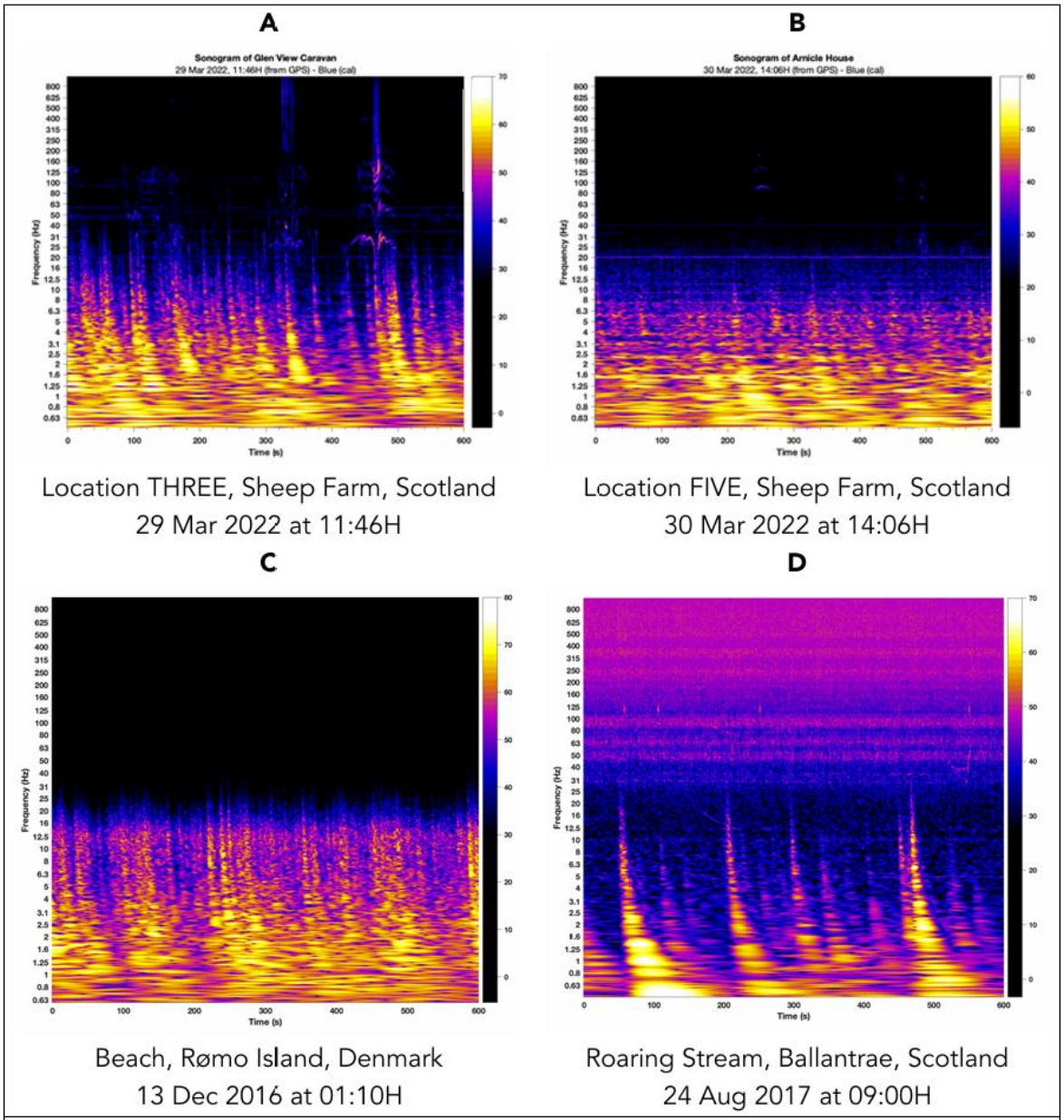



**Figure 13.** Four Sonograms showing examples of wind gusts (**A** and **B**), wave noise (**C**) and stream noise (**D**). Wind gusts, waves and water noise are characterized by tall, triangular shapes that skew to the right at the base (in the infrasonic range). Note the loudness of the stream (**D**) in the audible (upper pink region, continuously at or above 50 dB) region of the sonogram as compared with the other examples where audible sounds are at much lower levels.

**IARO Fig 13: Sonograms from natural acoustic environments**

## Chapter 16: Health & wellbeing

The ETSU-Gate report Chapter 16 discussion is expanded here in order to address health and wellbeing. The connection between wind turbine noise and ill health effects have long been disputed and continues to be denied by the wind industry and its acousticians. This chapter explores evidence spanning many years that disproves this industrywide denial.

The connection between wind turbine noise and ill health effects was highlighted in February 2007 by the paper,' titled, **Wind turbines, noise and health** [Ref 3] by Dr Amanda Harry. The paper examines the health effects caused by a wind farm in Cornwall, UK and concludes with:

*"I think it is clearly evident from these cases that there are people living near turbines who are genuinely suffering from health effects from the noise produced by wind turbines. These neighbours of turbines clearly state that at times the noise from turbines is unbearable. The developers are usually heard to say that noise is not a problem. Clearly this cannot be the case."*

The Amanda Harry paper highlights how wind industry acousticians are making claims regarding health effects that are outside their area of expertise and without any supporting evidence. This practice continues to the present day.

In the **Wisconsin report** discussed earlier at Chapter 15, released December 2012 titled, **A Cooperative Measurement Survey and Analysis of Low Frequency and Infrasound at the Shirley Wind Farm in Brown County, Wisconsin** [Ref 12] - the overall report conclusion by the five consultants states;

"**Residents report being intensely affected despite inaudibility and to be aware of turbine operation even when the turbines are not visible**";

and Appendix C states;

"Nauseogenicity is a factor at Shirley. Acceleration of the inner ear is suggested due to extremely low-frequency pulsations at the rotation and blade pass rates that occur in or near the frequencies of highest potential for nauseogenicity and, are coupled strongly into the homes now abandoned."

**Note that residents were forced to leave their homes due to the effects of the noise.**

The Cape Bridgwater wind farm paper titled, **The results of an acoustic testing program, Cape Bridgewater wind farm** [Ref 21] released in November 2014 by Steven Cooper is also discussed earlier at Chapter 15 in the context of low frequency noise. This paper reports on

a what was a joint exercise between a wind farm operator and residents and provided a significant advance in the recognition and understanding of low frequency effects.

In the papers' conclusions, 'non-acoustic findings' at section 11.1 Cooper states;

- *"The residents observations and identification of sensation (separately to vibration and noise) indicates that the **major source of complaint from the operation of the turbines would appear to be related to sensation rather than noise or vibration**.*

- *A significant sensation disturbance was found to be occurring when the turbines were seeking to start up, when there was apparent change in power output of the wind farm in the order of 20% (being either an increase in power or a decrease in power), and the situation when the turbine has reached maximum power (normally wind above 15 m/s) and the wind was increasing in strength thereby requiring the pitch angle to be changed so as to de-power the turbines. The latter situation with excessive winds can occur for extensive periods at Cape Bridgewater with **residents reporting that at times they have to leave the area to seek relief.***

- *For some residents experiencing adverse sensation effects the impact can be exacerbated by bending over, rather than standing, with the effect in some cases being reported as extremely severe and lasting for a few hours."*

The health effects of wind turbine noise are also explored by Chris Hanning at INWG WP3.2 dated March 2015. Dr Hanning's report is titled, **Excessive Amplitude Modulation, Wind Turbine Noise, Sleep and Health** [Ref 30.] This comprehensive report examines the effects of wind turbine noise on people living close to wind turbines including annoyance, sleep disturbance and health effects through a review of the available health related literature. His report discusses ETSU's inability to protect noise sensitive receptors from sleep disruption and therefore from harm to their health.

At his Para 4.6 Hanning quotes from a letter (his Ref 29) dated from 2013 from the acoustician Schomer to the Public Service Commission of Wisconsin; *"….this case as well as the literature and case studies all over the world have suggested that people are leaving their homes because they are being exposed to significant levels of pulsating ultra-low frequency sound produced by wind turbines. In addition there is no question that larger turbines produce more infrasound below 1 hertz which increases the likelihood that health problems will occur unless noise limits are dramatically reduced through the use of smaller turbines or lower noise limits are required at each house."*

Note; from the discussion at Chapter 15, high levels of low frequency sound (infrasound) at blade pass frequency (typically around 1Hz) and its harmonics are a confirmed feature of wind turbine sound emissions.

At his Para 5.2 Hanning quotes from a survey, WindVOiCe (Krogh 2011, his Ref 32), as the results have been published in a peer-reviewed journal. "*WindVOiCe is a self-reporting survey of Canadian communities affected by wind turbine noise. As of July 2010, 144 responses had been received of which 118 reported one or more health effects of which 84 (58%) reported sleep disturbance. There were no age differences between those that reported sleep disturbance (mean (range)) (51.5 yr (19-79)) and those that did not (52.2 yr (26-86)). All bar five of those reporting sleep disturbance live within 1500m of turbines adding further support to a minimum setback of at least that distance*."

At his Para 5.3 Hanning states; "*Anecdotal reports are commonly dismissed in industry sponsored reviews (eg Colby et al 2009 his Ref 33) as not acceptable evidence. Phillips, an epidemiologist, in a peer-reviewed article (Phillips 2011 his Ref 34), has examined these claims, reviewed the evidence and concluded:*

***There is overwhelming evidence that wind turbines cause serious health problems in nearby residents, usually stress-disorder type diseases, at a nontrivial rate**. The bulk of the evidence takes the form of thousands of adverse event reports. There is also a small amount of systematically-gathered data. The adverse event reports provide compelling evidence of the seriousness of the problems and of causation in this case because of their volume, the ease of observing exposure and outcome incidence, and case-crossover data. Proponents of turbines have sought to deny these problems **by making a collection of contradictory claims including that the evidence does not "count", the outcomes are not "real" diseases, the outcomes are the victims' own fault, and that acoustical models cannot explain why there are health problems so the problems must not exist.** These claims appeared to have swayed many non-expert observers, though they are easily debunked*."

Hanning's executive summary states; "*A large body of evidence, presented below, demonstrates that human sleep and health are adversely affected at wind turbine noise levels permitted by ETSU. There is particular concern for the health of children exposed to excessive wind turbine noise. The inadequate consideration of excessive amplitude modulation (EAM) is a major factor in the failure of ETSU to protect the human population.*"

The paper by Prof Alun Evans titled, **Environmental Noise Pollution: Has Public Health Become too Utilitarian**? [Ref 50] questions the acceptance of the Collateral Damage caused by wind farms. In the paper published May 2017 by the Centre for Public Health, Queens University, Belfast, the abstract states;

- *"Wind turbines produce a range of sound but it is the Infrasound and low frequency noise which deserves special attention. Infrasound is considered to be below the range of human hearing so it is not measured in routine noise assessments in the wind farm planning process. There is, however, evidence that many can register it and a sizeable minority is sensitive, or becomes sensitised to it. The actual route of transmission still requires elucidation.*

- *The net effect of the entire range of noise produced is interference with sleep and sleep deprivation. Sleep, far from being a luxury is vitally important to health and insufficient sleep, in the long term, is associated with a spectrum of diseases, particularly Cardiovascular. The physiological benefits of sleep are reviewed, as is the range of diseases which the sleep-deprived are predisposed to.*
- *Governments, anxious to meet Green targets and often receiving most of their advice on health matters from the wind industry, must commission independent studies so that the Health and Human Rights of their rural citizens is not infringed. Public Health, in particular, must remember its roots in Utilitarianism which condoned the acceptance of some Collateral Damage provided that the greatest happiness of the greatest number was ensured. The degree of Collateral Damage caused by wind farms should be totally unacceptable to Public Health which must, like good government, fully exercise the Precautionary Principle."*

The IARO paper titled, **Health Report on a Rural Sheep Farm in Scotland** [Ref 63] by Alves-Pereira, Bakker, Summers & Crosthwaite released June 2024 follows on from their earlier research and report regarding low frequency noise recordings and analysis at this sheep farm. This scientific investigation was carried out following a request by the residents and workers at the farm.

The report summary includes;

- "*In November 2021, the New Wind Power Plant (WPP) commenced testing operations adjacent to Rural Sheep Farm in Scotland. There are five WPPs within 7 km of Rural Sheep Farm. According to Mr & Mrs Z and the other Rural Sheep Farm residents, severe health deterioration only began after the installation of WPP B.*

- *High-resolution acoustic recordings were conducted at Rural Sheep Farm in 2022 and 2023. The corresponding Acoustics Report (IARO23-C1) was submitted in January 2024, showing a practically continuous exposure of Rural Sheep Farm residents to strong wind turbine acoustic signature (WTAS) and low frequency tones.*

- ***WTASs are trains of multiple, short-duration pressure pulses that can reach 20 dB above background level. WTAS have already been correlated to adverse health effects, namely sleep disturbance.***

- *WTASs are not detectable with the methodologies imposed by current UK legislation and guidelines regarding wind turbine noise, and low frequency tones are also greatly deemphasized by these methodologies.*

- *On 14 February 2023 and then again on 6 April 2023, the local General Practitioner [name redacted] for family Z, stated that Mrs Z, Mr Z and Ms Z1 "have been experiencing a significant impact of noise pollution from the nearby windfarm. The impact is such, that it has caused considerable physical and mental health issues.*

- *Since the installation of WPP B, Mr Z, 76, has been hospitalized twice, in March 2023 and in June 2023 (airlifting required); Ms. Z1 (53, daughter) was hospitalized from June 2023 to January 2024; and Ms. Z2-4 (14, granddaughter), diagnosed with high spectrum autism at age 2, has seen her behaviour greatly and seriously aggravated, causing a devastating impact on the entire family.*

- *In November 2023, the family Z received a Letter through unregistered post, sent by a Consultant in Public Health (Health Protection) [name redacted] representing NHS Highland (Inverness), where it was suggested that the symptoms developed by Rural Sheep Farm residents were due to psychosocial factors (I.e., a psychosomatic aetiology). Meditation, mindfulness and cognitive behavioural therapy were the recommended therapeutic courses of action.*

- *The goal of this Report is to strongly dispute the position taken by the NHS Highland medical representative, and respective decision-making hierarchies, who imagine that the disorders developed by Rural Sheep Farm residents are solely due to the existence of Psychosocial Factors.*

- *NHS-Highland attribute a psychosomatic aetiology to the disorders developed by Rural Sheep Farm residents, while proffering no clinical or scientific evidence to support their position— this is contrary to the rules of Evidence-based Medicine*."

The report discusses the 'Relieving factors' at Paras 139 onwards explaining that there is no respite from the noise effects except when residents physically leave the farm. Several emails from 2022 are quoted;

- *"They have toned down the whining but have caused something more distressing in that we are all suffering from headaches, pressure in our houses that is causing different problems with our ears including buzzing, blocked ears which goes away the minute we leave here. (21 March)*

- *The constant buzzing in my head from whatever the wind farm is throwing at us is upsetting me so much that I have to leave home and go and sit in the car on the beach or somewhere away from here. (22 April)*

- *We are finding it very hard to carry on living at [redacted] and have to go away most days for a few hours to get some relief from the windfarm. (7 July)*

- *Just now the interference is so bad we have to leave our home and go and sit in the car three miles away to get some respite. (11 July)*

- *Driving three miles from the farm gives everyone immediate relief but is no solution. (24 July)"*

The IARO report discusses the medical dose response relationship, Para 78 claims that the principal agent of disease at play here is infrasound and low frequency noise in addition to the audible portion of the acoustic spectrum, such as when amplitude modulation is deemed to be present.

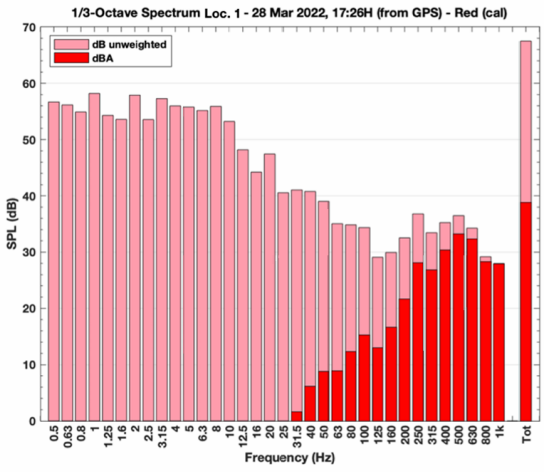



**Figure 2.** Ten-minute segment recorded at Location ONE, Rural Sheep Farm, Scotland, starting at 17:26H (28 Mar 2022, Wsp = 1.9 m/s (7 km/h), Wdir = NW (microphone in Office).[69]

**IARO Fig 2: Acoustic landscape at Rural Sheep Farm**

IARO figure 2 reproduced here provides an example of the acoustic landscape that is evaluated by the ETSU guidance shown by the red bars in dBA compared to the co-existing reality, the pink bars in unweighted dB. UK guidance (ETSU) does not acknowledge the relevance of infrasound and barely recognises the existence of low frequency sound.

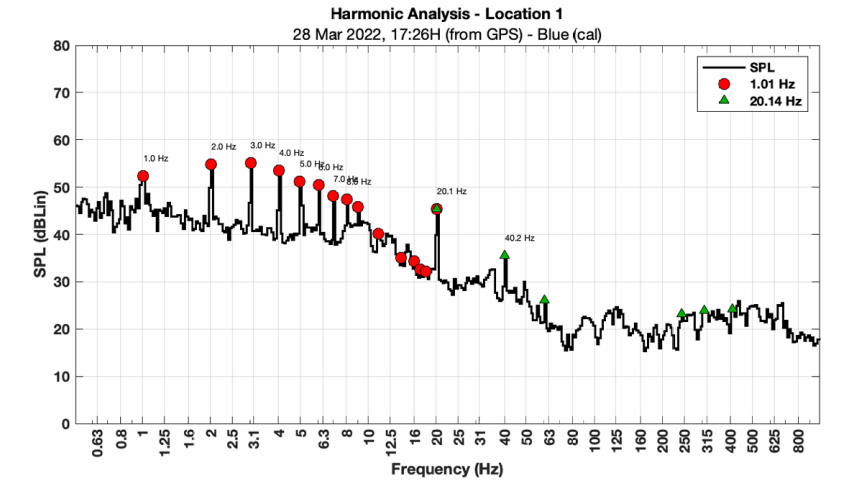



**Figure 3.** Ten-minute segment recorded at Location ONE, Rural Sheep Farm, Scotland, starting at 17:26H (28 Mar 2022, Wsp = 1.9 m/s (7 km/h), Wdir = NW, microphone in Office). IARO Analysis in 1/36th octave bands, sound pressure levels in unweighted dB, and 1-second time averages.[96]

The red dots indicate the peaks of airborne pressure waves emanating from a rotating wind turbine. Mathematically, this collection of peaks (indicated by the red dots) constitutes a harmonic series whose fundamental frequency (frequency at which the first peak appears) is, in this case, 1 Hz. This corresponds to the blade-pass-frequency (see Paragraph 93) of the wind turbine producing this signature.[97, 98, 99]

## IARO Fig 3: Harmonic analysis at Rural Sheep Farm

IARO Figure 3, report Para 96 provides the harmonic analysis of the same data presented in figure 2. Whereas the A-weighted (audible) noise levels are shown to be less than 40dBA on figure 2, the harmonic analysis at figure 3 shows a train of higher pulsed pressure waves that reach over 20dB above the background level. The pressure pulses are within the infrasonic range, below 10Hz and will be inaudible. **None of this infrasound is detectable using the ETSU methodology, allowing the wind industry to deny its existence**.

Note: Despite the numerous and continuous justified complaints to the LPA and the Wind Farm Operator since November 2021 to date (August 2025) by the residents at the Rural Sheep Farm, the LPA's stated position is:

***'The fact that the impacts from the noise from the windfarm is not disputed, the LPA's position is that there is no formal action available to the Council under the statutory nuisance provisions within the Environment Protection Act 1990, or through the planning controls relating to Blary Hill Windfarm'.***

***'Previous advice to consider pursuing a civil case remains pertinent and, as you will be aware, the level of proof and type of evidence required for a successful civil case is different to that required by a Council in establishing a statutory nuisance. Our findings could be used to support any private civil action'.***

The Rural Sheep Farm Wind Turbine Noise case demonstrates a total and catastrophic failure of the ETSU noise guidance and subsequent IOA GPG. The proposed ETSU review likewise compounds this absolute travesty and failure to protect genuine complainants from wind turbine acoustic pollution.

A recent judgment in Ireland dated 5 June 2025, **Bryne and Moorhead v ABO Energy and Wexwind**, known as the **Gibbet Hill** judgment [Ref 65] confirms the role of low frequency noise in noise nuisance complaints. This judgement is also discussed at Chapter 14. This judgment deals with a wind turbine noise nuisance case creating a legal precedent in Ireland. It has taken the residents 12 years to obtain this resolution and is also described in the ReNews, Renews Gibbet Hill June 2025 ; and at Beale & Co, Beale Gibbet Hill June 2025.

During the court proceedings the defendant admitted liability for the nuisance. Both sides agreed the wind farm complied with the planning conditions, with the noise assessment being based on the UK ETSU guidance. **During the hearing the defendant accepted the noise nuisance being the result of amplitude modulation and low frequency noise**.

## Chapter 17: Guidance and Regulation

Refer to the ETSU-Gate report chapter 17 for a discussion on other guidance and regulation relating to wind turbine noise. This chapter includes the paper dated April 2019 titled **Wind Turbine Noise and Shale Gas Extraction; Towards a Robust Regulatory Roadmap?** [Ref 53] by Pro David Unwin. Chapter 17 also includes a discussion of the role of British Standard BS4142, discussed in more detail later at Chapter 19.

## Chapter 18: Politics and Westminster

Refer to ETSU-Gate Chapter 18 for a full discussion on the politics of ETSU-Gate.

## Chapter 19: The argument for BS4142

The argument for the adoption of BS4142 as a replacement for ETSU goes back to shortly after ETSU was released. Referring to Chapter 2 and we see that one of the first to criticise ETSU was Dick Bowdler, at that time an independent acoustician with his paper released in 2005 titled, '**ETSU-R-97 Why it is wrong'** [Ref 2]. In the body of his report at Section 3, Bowdler argues against the poorly thought out ETSU methodology while presenting well-argued reasons for the adoption of BS4142.

In arguing for the use of BS4142 Bowdler also argues for the use of $L_{Aeq}$ when measuring wind turbine noise. It should be noted that since 2005, BS4142 has been updated two more times making an even stronger case for its application with wind turbine noise. At Para 3.18 Bowdler states;

*"Then, on page 63 there is another leap of credibility: There is no evidence for or against the assertion that wind farm noise with no audible tones is acceptable up to and including $L_{A90,10min}$ levels of 40dB(A) even when background noise levels are 30dB or less. This is just nonsense. There most certainly is evidence against this assertion. The 40dB is actually 42dB in BS4142 units. This is at least 12dB above background noise level of "30dB or less" and BS4142 says there are likely to be complaints at turbine levels of plus 10dB.*

***Furthermore there is no argument that BS4142 is not applicable**. Even BS 4142:1990 (which was current when ETSU-R-97 was written) might easily be applicable here. If the wind speed is 5m/s, the background noise 30dB and the turbine noise 42dB(LAeq) then **there is no reason not to use BS4142**, it does not exclude itself in these circumstances. This noise level is also 12dB more than (twice as loud as) the WHO considers necessary for you to be able to get to sleep."*

Since writing his paper in 2005, we find that Bowdler has changed his position on ETSU and is now on the steering group for the proposed ETSU. **By adopting this change of position, he is now endorsing the same ETSU methodology that he criticised so strongly in 2005**.

During March 2015 the Northern Ireland Assembly released their report titled, **Report on the committee's inquiry into wind energy** [Ref 23]. ETSU was heavily criticised in the NIA report, which suggested that the then current BS4142 revision (BS4141:2014) be considered when determining if ETSU should be updated.

During the summer of 2015 the INWG released its study into amplitude modulation. The key recommendation to government arising from this study was the replacement of ETSU with BS4142. INWG WP5, titled; **Towards a draft AM Condition** [Ref 32] by Sarah Large investigates the options for the control of AM.

The executive summary at para 1.8 states;

*"The 2014 version of BS4142 was also used to assess impact at two of the six sites. BS4142 has previously been dismissed, both in ETSU-R-97 and by others, as an appropriate means of control for wind farm noise. The issues raised to support these arguments have been examined below and found inapplicable to the new version of the standard. BS4142:2014 was found to work very well for assessment and control of cumulative wind farm noise and character impact."*

Government internal emails released on 3 Feb 2017 following a FOI request revealed:

- **Confirmation that if ETSU is withdrawn, BS4142 could be used to fill the gap.**
- Context aspect and noise limits would need to be applied
- BS4142 could result in some planning applications being rejected that would be granted under ETSU

The noise assessment methodology adopted by BS4142 is fundamentally different to ETSU, with simplified descriptions being;

- BS4142 compares the **actual noise impact** at a **specific location** by assessing noise loudness and character **compared with the actual background noise level**. The assessment provides for graduated corrections for both tonal and impulsive character including AM and the corrections are cumulative. **There are no fixed noise limits**. Although BS4142 does not assess LFN noise directly, if LFN is present then it requires an assessment using the DEFRA NAN45 procedure.

- In the case of ETSU, the measured noise (or predicted noise in the case of a planning application) is **compared with fixed noise limits derived and via a complex and opaque averaging process using data from a background noise and wind speed survey.** These derived noise limits are then fixed for the duration of the project. ETSU provides a graduated correction for tonal noise but does not correct for impulsive character including AM and does not require any assessment for LFN. Crucially, ETSU relies on the masking effect of wind induced noise to mask the turbine noise through the derived noise limits. This process being the root cause of ETSUs failure to protect.

A comparison of ETSU v BS4142 features is provided at Table 1 below.

The INWG report titled **Analysis of WSP Report titled: A review of noise guidance for onshore wind turbines** [Ref 55] was released and submitted to the government DESNZ on 15 April 2023. This report included from page 23, an updated argument for the use of BS4142.

Unfortunately, these recommendations to adopt BS4142, by the INWG and others has been ignored by government and wind industry acousticians. Not only have these

recommendations been ignored but government and the wind industry have gone to great lengths to exclude any consideration of or even any mention of the existence BS4142 in reports relating to wind turbine noise.

No doubt mention of BS4142 would have risked awkward questions by decision makers, and any informed and open debate on the merits of BS4142 as an alternative to ETSU would pose a risk to the wind industry and government agenda of maintaining the status quo.

**The omission of any consideration of BS4142 by government or industry leads to the conclusion that this situation could only exist as a result of government policy, official or unofficial, to impose levels of noise from wind turbines that are higher than is permissible from other forms of industrial activity.**

**Adopting BS4142 would force wind farm operators to adopt a more responsible attitude while the impact on renewable generation nationally would likely be minimal.**

Adopting BS4142 as the official noise guidance would provide a viable, cost-effective solution to wind turbine noise assessment bringing it into line with similar industries. It would also provide a more straightforward route for wind farm neighbours impacted by noise nuisance to obtain speedy redress. All professional acousticians and LPA EHOs will be familiar with the use of BS4142 so providing for greater transparency and ease of use.

# Table 1: BS4142 v ETSU-R-97 Comparison

| Feature / Question | BS4142 | ETSU-R-97 |
|---|---|---|
| | | |
| What is it? | Title: **Methods for rating and assessing industrial and commercial sound**, open here. | Title: **The assessment and rating of noise from wind farms**, open here. |
| What is it used for? | It is the British Standard for rating and assessing sound of an industrial and/or commercial nature. | For noise assessment of wind turbines only. |
| Where is it used? | Used for investigating complaints, assessing sound from proposed, new, modified or additional sources of sound of an industrial or commercial nature.<br><br>For virtually all industrial and commercial applications, except wind turbines.<br><br>It uses "*outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident*." | For wind turbine sound assessment only.<br><br>Primarily designed for noise assessments for wind turbine planning applications.<br><br>Has been adapted for use when investigating complaints and is usually included as a planning condition<br><br>Not designed for post construction compliance testing but has been used for such assessments. |
| What is their history? | Originally based on the Wilson Report of 1963, first published in 1967, amended in 1975, 1980 and 1982. Revised in 1990. Revised again in 1997 and 2014. Amended 2019 with the current version designated; BS4142:2014+A1:2019 (BS4142:2019) | Dated September 1996 and produced by a wind industry noise working group facilitated by the government department of trade & Industry (DTI).<br><br>ETSU-R-97 has not been revised since although the Institute of Acoustics issued a |

| | | |
|---|---|---|
| | | Good Practice Guide in 2013, open here. |
| Why was the Good Practice Guide (GPG) produced during 2013 and has it improved the situation? | | Was instigated in response to many years of criticism of ETSU-R-97.<br><br>The GPG clarified several areas of the assessment process but still left critical faults inherent with the basic ETSU-R-97 methodology.<br><br>The method for deriving noise limits and wind speeds is still the root cause of most of the noise complaints. Does not adequately account for wind shear and allows undue latitude with the setting of noise limit curves. Also fails to control AM or LFN. |
| Why was ETSU-R-97 created? | | The emerging wind industry considered BS4142:1990 to be too restrictive and claimed unsuitable for several reasons for wind turbine application.<br><br>ETSU-R-97 is described as;<br>*"...a framework for the measurement of wind farm noise and gives indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable restrictions on wind farm development or adding unduly to the costs and administrative burdens on wind farm developers or local authorities."* |

| | | |
|---|---|---|
| If BS4142:1990 was unsuitable, why is the current version of BS4142:104+A1:2019 now suitable? | Summarised by S. Large @ INWG WP5 page 160 11.5: *"The use of BS4142 has been shown to work with wind farm noise data. Concerns raised previously with low background sound levels and influence of meteorological conditions, namely wind speed, have been addressed in revisions along with advancement of the science and quashed."* | |
| Is BS4142 in its latest revision ready for use with wind turbine noise assessment | Yes<br>It is recommended though that some additional user guidance be produced specifically for use with wind turbine noise | |
| What are the main concepts or differences between ETSU-R-97 and BS4142 | Utilises the 'Rating' method of assessment.<br><br>Compares the noise **impact at a specific location** by assessing noise loudness and character (Rating) compared with the **actual background** noise level. | Utilises a 'derived limit' method of assessment.<br><br>Compares either predicted or measured noise with noise limits derived from data from a background noise and wind speed survey data. Relies on the masking effect of wind induced noise to mask the turbine noise. |
| How does it work? | The basic process being;<br><br>Make measurements of all noise at the assessment location, including the "problem" noise, in terms of $L_{Aeq}$ - termed the "ambient" noise level, then;<br><br>A measurement is then made of all the noise excluding the "problem" noise in terms of both LAeq and $L_{A90}$; these measurements are termed the "residual" and "background" noise levels respectively, then; | The basic process being;<br><br>Conduct a background measurement survey of the wind farm site either before the turbines are built or when not operating. Sound measurement in $L_{A9010min}$, also metrological data including wind speed. Sound measurement at receptor locations where the noise will be experienced, then;<br><br>Derive noise limits for day and night from the background |

| | | |
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| | The "residual" LAeq measurement is then subtracted (logarithmically) from the "ambient" $L_{Aeq}$ measurement to produce the noise level produced by the "problem" noise alone - termed the "specific" noise Level, then;<br><br>If the "problem" noise is tonal [containing a noticeable hiss, whine or hum] or if it is impulsive [contains bangs clatters, clicks or thumps] or if it is irregular enough to attract attention, a correction is added to the "specific" level to produce the "Rating level ", then;<br><br>The "background" $L_{A90}$ measurement is then compared against the "rating" level, then;<br><br>If the "rating" level exceeds the "background" by around 10 dBA or<br>more this "indicates a significant adverse impact". A difference of around 5 dBA 'indicates an adverse impact'; at a difference below 5<br>dBA, the lower the adverse impact and below 0dBA – Low adverse<br>impact likely – 'All dependant on the context'. | sound levels plus 5dB except for the lower limit over a range of derived wind speeds, then;<br><br>Predict turbine noise levels over a range of wind speeds, then;<br><br>Compare predicted noise levels with the ETSU-R-97 derived limits. If predicted noise exceeds the limit, the result is a fail. If the predicted noise is below the limit the result is a pass.<br><br>Noise limits are subject to separate regimes for day and night. For daytime, the minimum is 35 – 40 dB $L_{A9010min}$ increasing with increasing wind speed. For night time the minimum is 43dB $L_{A9010min}$ increasing with increasing wind speed. For financially involved receptors the minimum limit day and night is 45dB $L_{A9010min}$.<br><br>Not designed for compliance testing. |
| What was the purpose of the Good Practice Guide (GPG) for ETSU-R-97? | | Defined in the GPG para 1.2.1 by; *"This guide presents current good practice in the application of the ETSU-R-97 assessment methodology for all wind turbine developments above 50 kW, reflecting the original principles within ETSU-R-97, and the* |

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| | | *results of research carried out and experience gained since ETSU-R-97 was published. The noise limits in ETSU-R-97 have not been examined as these are a matter for Government*."<br><br>The GPG has been criticised as the fundamental defects with ETSU remain and as witnessed by the September 2012 WSP stakeholder survey. |
| Does the guidance control for tonal, impulse and amplitude modulation, and if so, how? | Yes<br><br>Applies graduated corrections for both tonal and impulsive character including AM. Tonal correction of up to 6dB, impulse correction of up to 9dB. Corrections are cumulative. | Tonal only.<br>Does not control impulsive character or AM.<br><br>The IOA have proposed a separate control method for AM but when tested by the INWG it was found to underestimate AM and declared not fit for purpose, see above. |
| Is low frequency noise controlled | Requires LFN to be assessed using DEFRA NANR45. | No |
| ETSU-R-97 is criticised for using the $L_{A9010min}$ index whereas BS4142 uses the $L_{Aeq}$ measurement index. What are the implications? | Uses the LAeq measurement index that effectively averages all the sound energy over the measurement period. A separate frequency analysis using fast time data is used to identify tonal and for impulsive calculations. | Uses the $L_{A9010min}$ measurement index effectively recording a sound level exceeded for 90% of the time and averaged over a 10-minute period. As such it fails to identify impulsive or modulating sound including AM. |
| Does the guidance allow for uncertainty in the process, also known as measurement error or tolerance | Yes - The latest version now allows for uncertainty. | No - Has been criticised as being possibly the only application of science where uncertainty has not been recognised. This assumes zero error in the measurements and calculations. |

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| | | The INWG has estimated that the cumulative uncertainty in a typical noise assessment with noise prediction could be as high as plus/minus 10dB.<br><br>The guidance should allow for the aggregation of errors representing a reasonable worst case |
| The ETSU-R-97 derived noise limits have been a topic for criticism for many years. What are the issues? | Does not use fixed limits or require derived noise limit curves. | Heavily criticised for improper statistical modelling of the background noise data when determining the noise limit curves.<br><br>Many noise assessments found to have poorly fitted curves unsupported by physics and determined mostly by the analytic method employed. They almost always favour the developer with higher noise limits than warranted. |
| There has been criticism of the fixed noise limits, what are the issues? | There are no fixed noise limits.<br><br>The Rating assessment method compares the impact of the noise at the receptor location.<br><br>This eliminates the ambiguity of derived wind speeds, derived noise limits and the effects of wind shear. | Limits are derived via a complex and opaque process to create limit curves based on background noise level, wind speed and minimum limits. This can result in significant adverse noise impact, typically during evenings and night and for extended periods while still remaining 'compliant' with ETSU-R-97. Failing to account correctly for high wind shear conditions, typically occurring during the night is a fundamental fault with ETSU-R-97.<br><br>Compared to other jurisdictions, ETSU-R-97 has some of the highest minimum noise limits for wind turbines. |

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| | | Is also unique in having night limits higher than day limits. |
| Is the guidance designed for post construction compliance testing | Yes | No<br><br>Ambiguity on this allows the operator considerable latitude in the assessment process such that it becomes inevitable that the wind farm is declared 'compliant'.<br><br>The LPA is therefore unlikely to challenge this finding by the operator's consultants. |
| Is the guidance designed for compliance testing or complaint resolution? | Yes | Ambiguity on this allows considerable latitude in the assessment process such that the wind farm can be claimed as compliant with ETSU, yet the complaints can continue. |
| How long does it take to do a compliance test or complaints investigation? | Can be completed in one day | Can take many weeks to assess with recent assessments taking months. |

# Appendix C
# Consultation response

The government consultation document titled, **Updated Guidance for the Assessment and Rating of Wind Turbine Noise** [Ref 66] was released on 4 July 2025 along with a consultation questionnaire, [Ref 67] with a consultation closing date of 29 August 2025.

The consultation questions (shown in blue), with their introductory notes (*shown in brown italics*) are copied here with the INWG response to each question shown (in green).

## Consultation questions

*"As set out above, this consultation is seeking views on proposed updates to noise guidance for onshore wind. Consultation questions should be considered alongside the Draft Assessment and Rating of Wind Turbine Noise Guidance provided on GOV.UK.*

*The independent technical scoping review identified two key areas of ETSU-R-97 which required updating: (I) noise limits and (II) the approach to controlling the impact of Amplitude Modulation (AM). These will be considered in turn, followed by discussion of other technical updates which seek to deliver on the wider recommendations made in the 2023 Scoping Review."*

### Noise limits

*"ETSU-R-97 sets noise limits defining how much noise from onshore wind turbines is acceptable. The primary purpose of this decibel level (dB) noise criteria is to balance opportunities for energy generation with noise emissions from turbines.*

*The dB noise criteria that are set have two practical implications. Firstly, they provide design criteria for pre-consent noise assessments, enabling developers and local planning authorities to assess and predict potential noise effects at different wind speeds and against baseline background noise levels. Secondly, and from these assessments, they provide limits' to be applied in consent conditions. Following noise complaints received during operation (if any are received), measurements can be carried out to determine compliance against these limits and, if found to be in breach, the criteria require the generator to take measures such as controlling turbine speeds (and, in turn, generation output) to stay within the noise limits. Developers will seek to avoid this scenario and will therefore aim to select suitable turbines and site them at distances that prevent any potential breaches.*

*ETSU-R-97 differentiates dB noise criteria by day and night, with the day-time lower limit range (35 - 40 dB) set lower than the night-time lower limit (43 dB), as measured at a noise*

*receptor outside any affected property. The noise limit at a given time is then determined by taking either a noise limit between 35 to 40 dB for day and 43 dB for night, or a noise limit 5 dB above the background noise level at each wind speed (whichever is greater).*

*ETSU-R-97 provides flexibility in the noise limit which can be set for day periods, with the actual limit used within the range dependent on site-specific factors. The night-time limit provided in ETSU-R-97 was rationalised with reference to protecting against sleep disturbance indoors, while taking into account the reduction in noise level from outside a building to inside. A separate criterion of 45 dB was also introduced for dwellings that are financially linked to the development, such as landowner properties. The ETSU-R-97 limits are also cumulative noise limits that apply to noise from all wind turbine developments in the vicinity.*

*The 2023 Scoping Review recommended that the noise limits defined in the original guidance should be revisited in view of advancements in turbine technology, knowledge and scientific evidence of the potential impact of turbine noise, and the evolution of government noise policies.*

*The Government has given careful consideration as to how this recommendation could be delivered. While we want to give due consideration to the findings of the scoping review, we are aware that changes to the noise assessment criteria may have implications on the amount of land made available for onshore wind and the financial viability of future projects, as well as residential amenity for wind farm neighbours. Therefore, we are seeking views on the proposed updated approach and encourage you to share data on possible implications for:*

- *the amount of land made available for onshore wind*
- *deployment of onshore wind*
- *energy generation from onshore wind*
- *residential amenity for neighbouring populations, including levels of annoyance for windfarm neighbours and any impact on sleep disturbance."*

## Aligning day-time and night-time noise criteria

*"The 2023 Scoping Review specifically recommended that noise limits during the night should not be higher (i.e. less stringent) than during the day. This was recommended due to the potentially increased prevalence of AM at night, which, combined with a higher noise limit, could increase night-time noise impacts compared with day-time. Additionally, the scoping review noted that the higher night-time limit is 'unusual' and appears to be unique to the UK and Ireland.*

*Whilst the draft updated guidance continues to allow for separate background noise*

*measurements to be taken across day and night, to deliver on this recommendation, it instructs developers and planning authorities to select a single 'limit' from these measurements to be applied across both periods. This single 'limit' is the minimum of the day and night limit at each wind speed and applies at all times."*

## Question 1

Do you agree with our proposed approach of using a single 'limit', which takes the minimum of the day and night limit at each wind speed and applies at all times? Please explain your answer and provide supporting evidence.

## Answer 1

The INWG consultation response relates to a wider range of topics than has been included for in the consultation questionnaire. The issues of concern for the INWG do not fit conveniently into the invited six questions, hence the need for a more comprehensive response document to be submitted. This response document will be submitted as a pdf document to DESNZ by email.

The INWG review of the draft guidance document is included at Appendix A with extended discussion of the key issues included at Appendix B which contains the main technical content of this consultation response. Responses to consultation questions 1 to 6 are included here at Appendix C. We confirm that the INWG consultation response is concerned primarily with the implications for residential amenity.

In response to question 1, the evidence regarding the ETSU assessment methodology based on derived noise limits is that it fails to correctly assess noise impact, particularly during evening and night time. While loudness or the dB level needs to be controlled, in the case of wind turbine noise it is the character of the noise, often associated with low frequency content, and sometimes not even audible that is the cause of most noise complaints.

The application of a minimum limit (LLV) is shown to permit high levels of AM, often generating noise complaints at times when background noise levels can be very low, typically 25dB or less in rural areas, and still remain ETSU compliant. The higher night time LLV only exacerbates this problem and the INWG have long argued against this higher night time LLV.

The justification for the higher night time LLV is a claimed 8dB attenuation through an open window. Whereas this 8dB attenuation may apply for the higher audible frequencies it does not apply at the low frequencies shown to be present in the wind turbine noise spectrum. At these low frequencies, there may be little or no attenuation even with windows closed and possibly amplification due to room resonances. This is discussed in the consultation response document Appendix B, Chapter 15. In short, we represent that the claim in the proposed update to ETSU that LFN is not an issue that needs to be pursued further is

unjustified and does not accord with current scientific evidence or recent court judgments discussed at Appendix B, Chapter 14.

Due to the proven failure of ETSU, the INWG and others have recommended that ETSU be replaced by BS4142. This would eliminate the use of fixed noise limits and allows the assessment to be based on the actual impact include corrections for noise character as applied to other forms of industrial noise. The justification for the use of BS4142 is included in Appendix B, Chapter 19.

### Raising the lower value for the day-time noise limit range

*"Additionally, government has reviewed the specific dB limits set by the guidance. To balance opportunities for energy generation with the impact of noise emissions from turbines on the public, government is proposing to raise the lower value for the day-time noise limit range to 37 dB. This results in a day-time noise limit range of 37-40 dB. While the night-time noise limit remains set at 43 dB, it is anticipated that at most windspeeds the single limit will be defined by the day-time noise limit."*

### Question 2

Do you agree with our proposal to raise the lower value for the day-time noise limit range to 37 dB? Please explain your answer and provide supporting evidence.

### Answer 2

For the reasons given at question 1, the INWG do not agree with increasing the lower value of the day LLV. It is simply seen as a move to increase the noise limit, making a bad situation worse at the expense of residential amenity.

### Alternative options for updating noise limits

"*While Government is proposing changes to the noise assessment criteria and day-time noise limit range as described above, this is not a final position. There are a number of alternative approaches updated guidance could take, including continuing to use the approach outlined in ETSU-R-97, which differentiates dB noise criteria by day and night*."

### Question 3

If you do not agree with the proposed approach of using a single 'limit', what would you suggest as an alternative approach and why? Please include discussion of the appropriate dB noise criteria for your suggested approach and provide supporting evidence.

### Answer 3

As discussed at answer 1, the INWG proposes the replacement of ETSU with BS4142 in order to move away from fixed noise limits. Additionally, the IOA Good Practice Guide and the IOA planning condition for AM are critiqued at Appendix B, Chapters 3, 4, 5 and 12 which show

that ETSU fails to protect residential amenity. The evidence supporting the use of BS4142 is also provided at Appendix B, Chapters 2, 9, 10 and 19.

## Amplitude Modulation

*"In some cases, the character of the noise arising from the operation of a wind farm may contain one or more distinctive acoustic characteristics that are not typical of wind turbine noise. As noise character may increase the impact of a noise, it is common practice to add a 'character correction'. In practice, this results in a penalty to the overall noise limits, to reflect the increased audibility and potential disturbance the noise character causes.*

*Amplitude Modulation (AM) is where the sound level (amplitude) varies with time in a repetitive manner (modulation). AM is an inherent feature of wind turbine sound and is acknowledged by ETSU-R-97. However, since the publication of ESTU-R-97 it has been identified that, in some instances, this modulation can become more pronounced and the magnitude of AM can exceed certain thresholds, leading to increased perception of turbine noise. AM is sometimes referred to as blade 'swish', but if the AM becomes more pronounced this can lead to the sound being described as thudding or pulsing.*

*The 2023 Scoping Review stated that previous guidance did not adequately control for the impact of AM and specifically recommended the development of advice for assessing and controlling the impact of AM, building on Government commissioned research published in 2016."*

### Question 4

Do you think the updated guidance provides adequate advice for assessing and controlling the impact of Amplitude Modulation? Please explain your answer and provide supporting evidence.

### Answer 4

The INWG consultation response provides irrefutable evidence that the IOA planning condition for AM does not control AM as claimed. When tested, the IOA method for controlling AM was shown to fail. The AM measurement metric was found to under record the actual level of AM at best and will completely miss recording intermittent AM and situations where there are multiple turbines operating at different rotational speeds. This under recording of AM by the latest IOA AM metric is consistent with the previous ReUK and IOA schemes tested. The evidence relating to AM measurement and control including the implication of averaging is provided in the INWG consultation response at Appendix B, Chapters 5 and 12.

## Technical guidance updates

*"A number of other technical updates have been made to the guidance, which seek to deliver on wider recommendations made in the 2023 Scoping Review. These include:*

- *Updated descriptions of the profile of noise emissions from wind turbines, and relevant*
- *wind speed references and range, given evolutions in the technology since 1996. Clarification of guidance on determining noise limits such that developments are prioritised according to generation capacity.*
- *Providing clarification on the interpretation of 'financially involved' receptors for the application of noise controls*
- *Developing further guidance on cumulative impacts, incorporating existing evidence and best practice advice.*
- *Providing example planning condition wording and associated technical notes which can be referenced to simplify planning controls.*
- *Defining the way in which character corrections are to be calculated and combined."*

### Question 5

Do you agree with the other technical updates to the 'Draft Assessment and Rating of Wind Turbine Noise Guidance'? Please explain your answer and provide supporting evidence.

### Answer 5

A line-by-line review of the proposed guidance document is provided at Appendix A of the INWG consultation response. Some additional comments are included here.

Para 1.12 introduces the Noise Policy Statement for England (NPSE). Then Para 1.15 provides confirmation that defining the LOAEL and SOAEL for wind turbine noise is outside the scope of this new guidance. Although the LOAELs and SOAELs are not defined, so are by definition unknown, it is still claimed that the SOAEL whatever it is, should not be exceeded, but the LOAELs whatever it is, may be exceeded. **How this can be possible without the LOAEL and SOAEL being defined is not explained.**

Para 1.19 confirms that Infrasound is being ignored in the new guidance despite mounting evidence to the contrary. The WSP scoping review is being quoted as the justification for this statement despite the evidence submitted to government criticising the WSP report. Infrasound and low frequency sound are discussed in this INWG consultation response at Appendix B, Chapters 13, 15 and 16.

Also at Para 1.21 is confirmation that the adverse effects of low frequency sound are also being ignored despite substantive evidence to the contrary. Infrasound and low frequency sound should be considered together since the frequency ranges overlap; both occur

together as part of the wind turbine acoustic spectrum. It should be noted that the use of A-weighted noise measurement as mandated by ETSU and the proposed update, is wholly unsuitable for measuring low frequency sound or infrasound as confirmed by the WHO report [Ref 52] where at page 85 it states, *"Wind turbines can generate infrasound or lower frequencies of sound than traffic sources*". Page 85 also states, *"Standard methods of measuring sound, most commonly including A-weighting, may not capture the low-frequency sound and amplitude modulation characteristic of wind turbine noise".*

The INWG disagree with the intention of determining noise limits (LLV value) prioritised according to generation capacity of the scheme, number of dwellings affected or estimated level of exposure as outlined at Paras 2.16 to 2.24. This policy is discriminatory against the rural minority and should be abandoned. Additionally, evidence shows that AM is often occurring upwind and this effect is being ignored in the new guidance. Upwind impact from AM is discussed in the INWG consultation response at Appendix B, Chapter 8.

Para 2.2 confirmed the continued use of free-field measurement only and ignores inside noise levels. The screening effect close to a façade can result in background noise around 3dB lower than in a free-field location whereas reflection of a specific noise such as from a turbine can be 3dB higher, giving a 6dB difference in the developer's favour using a free field location.

The noise assessment criteria should be defined to protect primarily the indoor environment as most noise complaints relate to noise levels inside homes, and mostly during the evening and night time. Whereas free-field measurement may be applicable for background noise monitoring, when investigating compliance or complaints, measurements should be undertaken where and when the nuisance is being experienced. This is usually inside homes and during the night. In some cases, wind farm neighbours have changed bedrooms or been forced to leave the house at night because of the continuous sleep disturbance from wind turbine noise, also known as acoustic pollution.

Para 2.25 discusses financial involvement. It is unclear whether 'financial involvement' applies to the property or the residents although it does state it applies for the life of the scheme. Is it still relevant and does it still apply if not all residents are financially involved such as or children or other family members? What happens if the property is sold and the new owners are not financially involved, does the limit then decrease? What happens if the property is occupied by tenants, or is later rented out with the tenants not financially involved? The entire policy of applying a higher noise limit justified by financial involvement is discriminatory, morally wrong and should be abandoned.

Para 2.5 confirms the continued use of standardised wind shear (roughness) that ignores the times when wind shear is high, typically during the nighttime through the averaging effect. The use of standardised wind shear introduced by the Article Method and then carried through to the Good Practice Guide ensures that periods of high amplitude modulation,

coincident with high wind shear are masked through the averaging process. Wind shear is discussed in the INWG consultation response at Appendix B, Chapter 3.

Character correction is discussed at Paras 3.12 onwards and Para 3.13 confirms that only the higher correction of either Tonal or AM should be applied. This differs from BS4142 where tonal and impulsive (AM) corrections are added together. No justification has been provided as to why ETSU requires only the highest correction to be applied whereas BS4142 requires both corrections to be added and then applied.

The correction curve for AM is shown at Figure 3 (Para 3.22) and has its origins in the ReUK AM study dated 2013. In turn the ReUK correction curve had its origins in a scheme proposed by RES for the Den Brook wind farm. This correction curve has now been included in the IOA AM planning condition included with this update to ETSU. Each iteration of this AM planning condition has been independently tested and each iteration has been shown to fail to control AM. Additionally, **at no time has this correction curve as now shown at Figure 3 been validated against dose response data**. This failure of the proposed AM control methodology is discussed in the INWG consultation response at Appendix B, Chapter 5

The section on operational monitoring at Para 3.7 requires filtering of data to include only downwind conditions. Evidence shows that AM is often occurring upwind and this is being ignored in the new guidance. Upwind impact from AM is discussed in the INWG consultation response at Appendix B, Chapter 8.

## Further comment

### Question 6

Do you have any further comments on the proposed updates to the 'Draft Assessment and Rating of Wind Turbine Noise Guidance' that you wish to make Government aware of? Please explain your answer and provide supporting evidence.

### Answer 6

The failure to consider uncertainty within the ETSU process is one of its most important failings. This makes the ETSU wind turbine noise assessment possibly the only area of science that assumes every measurement and process provide perfect accuracy with zero errors or tolerances.

Assessment of the levels of uncertainties inherent to the ETSU methodology that when combined in the standard way have been found to be of the order of +/- 10dB. This is a significant level as a 10dB increase in noise level represents a doubling in loudness, and a 10dB decrease represents a halving in loudness. It is therefore not surprising for the large numbers of noise complaints given that some planning application noise assessments show

a margin of only than 1dB or 2dB between predicted noise and the noise limit. Uncertainty is discussed at Appendix B, Chapter 3.

In contrast to this failure with ETSU, BS4142 now includes consideration of uncertainty in the assessment process, discussed at Appendix B, Chapter 19.

It should be noted that there are legal judgments in Australia and Ireland that have found a nuisance exists even if the noise limits in the planning permission have been complied with. In these cases, the noise limits have been determined using guidance based on ETSU. While there is no English or Welsh judgment about this, these judgments have followed the UK Supreme Court judgment in Coventry v Lawrence where Lord Neuberger considered the impact of a planning permission on a claim for nuisance. The potential impact of these judgments has not been addressed in this consultation into updating ETSU.

# Appendix D: References


| Ref No. | Date of Publication | Title & hyperlink | Organisation or Platform | Authors |
|---|---|---|---|---|
| 1 | September 1996 | The assessment and rating of noise from wind farms; ETSU-R-97 | Department of Trade and Industry | Meir, Legerton, Anderson, Berry, Bullmore, Hayes, Jiggins, Leeming, Musgrove, Spode, Thomas, Tomalin, Trinick, Warren |
| 2 | July 2005 | ETSU-R-97 Why it is wrong; ETSU Why it is wrong Bowdler | New Acoustics | Dick Bowdler |
| 3 | February 2007 | Wind turbines, noise and health; WT noise and health A Harry 2007 | Amanda Harry | Amanda Harry |
| 4 | August 2007 | Research into Aerodynamic Modulation of Wind Turbine Noise, (known as the 'Salford Report'); Salford Report Aug 2007 | Salford University | Moorhouse, Hayes, von Hunerbein, Piper & Adams |
| 5 | January 2009 | Salford report and data obtained under the Freedom of Information Act: Salford University Survey of Wind Farm Noise Complaints Released | Renewable Energy Foundation | Constable, Moroney |
| 6 | March 2009 | Prediction and assessment of wind turbine noise (known as the Article Method) 2009 Mar-Apr Vol.34 Pt.2.pdf | Institute of Acoustics, Acoustics Bulletin March/April 2009 | Bowdler, Bullmore, Davis, Hayes, Jiggins, Leventhall, McKenzie |

| | | | | |
|---|---|---|---|---|
| 7 | June 2009 | Wind shear and its effect on noise assessment of wind turbines<br>Bowdler 2009 - Wind Shear and its Effect | New Acoustics | Dick Bowdler |
| 8 | March 2010 | Noise Policy Statement for England (NPSE)<br>Noise Policy Statement for England | Department for Environment Food and Rural Affairs | DEFRA |
| 9 | September 2011 | The effect of a common wind shear adjustment methodology on the assessment of wind farms when applying ETSU-R-97; MAS Study of article method versus ETSU & Summary; MAS Study of Article Method v ETSU Summary | MAS Environmental | Mike Stigwood |
| 10 | April 2012 | A critique of the IOA treatment of background noise for wind farm noise assessment;<br>https://www.ref.org.uk/publications/255-ioa-critique | Renewable Energy Foundation | Lee Moroney, John Constable |
| 11 | July 2012 | Wind Turbine Noise Impact Assessment - Where ETSU is Silent; Wind Farm Noise Impact Assessment, Where ETSU is Silent | Chris Heaton-Harris MP (Now the INWG) | Cox, Unwin & Sherman with contributions by Temple, Greenough, Hulme, Moroney, Yelland, Whitehurst |
| 12 | December 2012 | A Cooperative Measurement Survey and Analysis of Low Frequency and Infrasound at the Shirley Wind Farm in Brown County, Wisconsin; Wisconsin report Shirley wind farm Dec 2012 | Public Service Commission, Wisconsin, USA | Walker, Hessler, Hessler, Rand, Schomer |
| 13 | May 2013 | A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise (known as the Good Practice Guide)<br>IOA - Good Practice Guide | Institute of Acoustics | Cand, Davis, Jordan, Hayes, Perkins |

| | | | | |
|---|---|---|---|---|
| 14 | Summer 2013 | Wind farm noise assessments: ETSU-R-97 and the three-legged stool; SIP SUMMER 2013 | Science in Parliament | Unwin, Cox |
| 15 | October 2013 | A Summary of the 'Bad Science' behind the Wind Turbine Noise Guidelines; Bad Science DECC Meeting Presentation 9 Oct 2013 Final | Presented to Secretary of State Ed Davey MP and DECC officials on 9 October 2013 at Westminster | David Unwin & Richard Cox |
| 16 | October 2013 | Evidence of failure of wind farm guidance to protect well being; Evidence-of-failure-of-wind-farm-guidance-Stigwood-Oct-2013 | Presented to Secretary of State Ed Davey MP and DECC officials on 9 October 2013 at Westminster | Mike Stigwood, MAS Environmental |
| 17 | December 2013 | Wind Turbine Amplitude Modulation: (6 documents);<br>Doc 1; 1.-ruk_brief_summary_v2<br>Doc 2; 2. Ruk report - Temple<br>Doc 3; 3. Ruk report - Temple<br>Doc 4; 4.-ruk wind turbine AM Dec2013v2<br>Doc 5; 5.-ruk_planning_condition_v2<br>Doc 6; 6.-ruk rationale for planning condition v2 | RenewableUK | RenewableUK |
| 18 | March 2014 | The Efficacy of the RenewableUK (ReUK) Condition in controlling wind farm amplitude modulation (AM) noise; REF Efficacy of ReUK AM condition 2014 | Renewable Energy Foundation | Lee Moroney, John Constable |
| 19 | March 2014 | A Critique of the RenewableUK report on wind turbine amplitude modulation; Cardiff IoA Presentation 20Mar2014 | Institute of Acoustics meeting, Newport titled; 'AM, and where next for ETSU-R-97' | Cox, Hulme, Sherman, Unwin. |
| 20 | November 2014 | Initial findings of the Cotton Farm wind farm long term community noise monitoring project; Stigwood MAS Internoise 2014 Cotton Farm | Inter-noise 2014, Melbourne | Mike Stigwood, Duncan Stigwood, Sarah Large, MAS Environmental, UK |

| | | | | |
|---|---|---|---|---|
| 21 | November 2014 | The results of an acoustic testing program, Cape Bridgewater wind farm; Cape Bridgwater report 2014 Cooper | The Acoustic Group, Australia | Steven Cooper |
| 22 | January 2015 | Letter from S Ambrose to S Cooper: Cape Bridgewater study; S Ambrose Letter Cape Bridgewater to StevenCooper-22Jan2015 | SE Ambrose & Associates, ME, USA | Stephen Ambrose |
| 23 | March 2015 | Report on the committee's inquiry into wind energy (7 documents);<br>Vol 1; wind-energy-volume-1.pdf<br>Vol 2; wind-energy-volume-2.pdf<br>Vol 3; wind-energy-volume-3.pdf<br>Vol 4; wind-energy-volume-4.pdf<br>Vol 5; wind-energy-volume-5.pdf<br>Vol 6; wind-energy-volume-6.pdf<br>Vol 7; wind-energy-volume-7.pdf | Northern Ireland Assembly | Northern Ireland Assembly |
| 24 | April 2015 | Cotton Farm Wind Farm – Long term community noise monitoring project – 2 years on; Cotton Farm monitoring Stigwood Glasgow 2015 | 6th International Conference on Wind Turbine Noise, Glasgow | Stigwood, Large, Stigwood; MAS Environmental |
| 25 | April 2015 | Constraints imposed by and limitations of IEC 61672 for the measurement of wind farm sound emissions; Huson2-constraints-imposed-by-and-limitations-of-IEC-61672-WTN Apr2015 | 6th International Conference on Wind Turbine Noise, Glasgow | Les Huson |
| 26 | October 2015 | WP 1; The Fundamentals of Amplitude Modulation of Wind turbine Noise; INWG WP1 Yelland 2015 | INWG | John Yelland |
| 27 | October 2015 | WP 2.1; Review of Reference Literature; INWG WP2.1 Cox 2015 | INWG | Richard Cox |

| | | | | |
|---|---|---|---|---|
| 28 | October 2015 | WP 2.2; AM Evidence Review; INWG WP2.2 Large 2015 | MAS / INWG | Sarah Large |
| 29 | October 2015 | WP 3.1; Study of Noise and Amplitude Modulation Complaints Received by Local Planning Authorities in England; INWG WP3.1 Sherman 2015 | INWG | Trevor Sherman |
| 30 | October 2015 | WP 3.2; Excessive Amplitude Modulation, Wind Turbine Noise, Sleep and Health; INWG WP3.2 Hanning 2015 | INWG | Christoper Hanning |
| 31 | October 2015 | WP 4; Den Brook; INWG WP4 Hulme 2015 | INWG | Michael Hulme |
| 32 | October 2015 | WP 5; Towards a draft AM Condition; INWG WP5 Large 2015 | MAS / INWG | Sarah Large |
| 33 | October 2015 | WP 6.1; Legal Issues: The Control of Excessive Amplitude Modulation from Wind Turbines; INWG WP6.1 Cowen 2015 | INWG | Richard Cowen |
| 34 | October 2015 | Supplementary paper WP 6.1A; Legal Issues: The Control of Excessive Amplitude Modulation from Wind Turbines; INWG WP6.1A Supp Cowen 2015 | INWG | Richard Cowen |
| 35 | October 2015 | WP 6.2; Control of AM noise without an AM planning condition using Statutory Nuisance; INWG WP6.2 Gray 2015 | INWG | Bev Gray |
| 36 | October 2015 | WP 8; Review of Institute of Acoustics Amplitude Modulation Study and Methodology; INWG WP8 Cox 2015 | INWG | Cox, Cowen, Gray, Grosvenor, Hanning, Hulme, Huson, Sherman, Stigwood, Yelland |

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| 37 | October 2015 | WP 9; The Cotton Farm Monitor Experience; INWG WP9 Gray 2015 | INWG | Bev Gray, Jeff Tossell |
| 38 | October 2015 | WP10; Two Decades of Deception; INWG WP10 Cox 2015 | INWG | Cox, Cowen, Gray, Hanning, Hulme, Large, Sherman, Yelland |
| 39 | October 2015 | Wind Turbine Amplitude Modulation and Planning Control Study Discussion document for DECC meeting at Westminster - 13 October 2015; DECC Meeting Cox INWG Oct 2015 | Meeting with Andrea Leadsome MP, Minister of State and Department of Energy and Climate Change and DECC officials | Cox, Sherman; IMWG |
| 40 | October 2015 | Amplitude Modulation Discussion Document; DECC Meeting Large MAS Oct 2015 | Meeting with Andrea Leadsome MP, Minister of State and DECC officials | Stigwood, Large; MAS Environmental |
| 41 | October 2015 | INWG Wind Turbine Amplitude Modulation & Planning Control Study paper; INWG Wind Turbine AM & Planning Control Study Harrogate 2015 | Proceedings of the Institute of Acoustics conference, October 2015; (Vol.37. Pt.2 2015) | Cox, Cowen, Gray, Hanning, Hulme, John Yelland, Large |
| 42 | October 2015 | INWG Wind Turbine Amplitude Modulation & Planning Control Study presentation; INWG AM Presentation Cox Harrogate 2015 | Institute of Acoustics conference, October 2015, Harrogate | Richard Cox |
| 43 | August 2016 | Wind turbine AM review Phase 2 report; Phase_2_Report_WT AM review | WSP / Parsons Brinckerhoff for Department of Energy and Climate Change | Lotinga, Perkins |
| 44 | August 2016 | Institute of Acoustics (IOA) Noise Working Group (Wind Turbine Noise) Amplitude Modulation Working Group Final Report; AMWG Final Report-09-08-2016 | Institute of Acoustics | Bass, Cand, Coles, Davis, Irvine, Leventhall, Levet, Miller, Sexton, Shelton |

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| 45 | August 2016 | A review of research into the human response to amplitude-modulated wind turbine noise and development of a planning control method; WSP AM paper Inter.noise 2016 | WSP/Parsons Brinckerhoff report to Government DECC | Perkins, Lotinga, Berry, Grimwood, Stansfeld |
| 46 | October 2016 | Wind turbine AM review; WSP_PB-AM-Proposalv5redacted-April2015.pdf<br>Phase 1 report: WSP-PB Phase 1 report WT AM_Issue_1_291015<br>Phase 2 report: WSP PB Phase 2 report WT AM Issue_3__FINAL | WSP/Parsons Brinckerhoff | Perkins, Singleton, Stansfeld, Grimwood, Berry. |
| 47 | December 2016 | What might an Alternative to ETSU-R-97 Look Like?; IoA WT Noise 2016 McKenzie and Bullmore | Presented at the Institute of Acoustics workshop titled: ETSU-R-97 - Time to move on | McKenzie, Bullmore |
| 48 | January 2017 | INWG WP 8.1; Review of WSP/Parsons Brinckerhoff and Institute of Acoustics Amplitude Modulation Studies; WP8.1: INWG WP8.1 Cox 2017 and WP81. Appendices; INWG WP8.1 Appendices Cox 2017 | INWG | Cox, Cowen, Gray, Grosvenor, Hanning, Hulme, Huson, Sherman, Stigwood, Yelland |
| 49 | March 2017 | Review of WSP/Parsons Brinckerhoff and Institute of Acoustics Amplitude Modulation Reports; Discussion document for DBEIS meeting on 1 March 2017; INWG discussion document for DBEIS meeting 1 Mar 2017 | Meeting with Jessie Norman MP, Parliamentary Under-Secretary of State for Industry and Energy at the Department of Energy and Climate Change and DECC officials | Cox, Cowen, Gray, Grosvenor, Yelland; INWG with Stigwood & Large; MAS Environmental |
| 50 | May 2017 | Environmental Noise Pollution: Has Public Health Become too Utilitarian?; Environmental Noise Pollution: Has Public Health Become too Utilitarian? | Centre for public health, Queens University, Belfast | Alun Evans |

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| 51 | November 2017 | A planning condition for wind turbines; Acoustics Bulletin Nov 2017 | Institute of Acoustics, Acoustics Bulletin | McKenzie, Cand, Bowdler, Jiggins, Irvine, Reid, Perkins, Lottinga, Hayes and Bullmore |
| 52 | January 2019 | Environmental noise guidelines for the European Region; Environmental noise guidelines for the European Region | World Health Organization | World Health Organization |
| 53 | April 2019 | Wind Turbine Noise & Shale Gas Extraction; Towards a Robust Regulatory Roadmap?; INWG Regulatory Roadmap Unwin 2019 | INWG | David Unwin |
| 54 | February 2023 | A review of noise guidance for onshore wind turbines; report to government DBEIS by WSP; WSP Linkedin announcement Lotinga Feb 2023 | WSP Linkedin site | Michael Lotinga, Toby Lewis, James Powison |
| 55 | April 2023 | INWG Analysis of WSP Report titled: A review of noise guidance for onshore wind turbines; INWG Analysis of WSP report April 2023 | Submitted to the government Department for Energy Security and Net Zero | Cox, Grosvenor, Gray, Crosthwaite |
| 56 | September 2023 | Onshore wind turbine noise: A review of the current guidance framework for the UK Government – Part 1; Acoustics-bulletin-september-october-2023 | Institute of Acoustics, Acoustics Bulletin | Lotinga, Lewis, Powison, Berry |
| 57 | November 2023 | Onshore wind turbine noise: A review of the current guidance framework for the UK Government – Part 2; Acoustics-bulletin-november-december-2023 | Institute of Acoustics, Acoustics Bulletin | Lotinga, Lewis, Powison, Berry |
| 58 | December 2023 | High-Resolution Infrasonic and Low-Frequency Sound Recordings Conducted Within a Rural Farm in Scotland in 2022 and 2023: Main report; Rural Farm Report - FINAL | International Acoustics Research Organisation (IARO) | Mariana Alves-Pereira, Huub Bakker and Rachel Summers of IARO and Susan Crosthwaite of Citizens' Initiative, Scotland with contributions by Bruce Rapley, Philip Dickenson and Les Huson |

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| 59 | December 2023 | Appendix A titled: Technical Background for Laypersons; IARO Acoustics Report Annex A Technical background Rural | International Acoustics Research Organisation (IARO) | Mariana Alves-Pereira, Huub Bakker and Rachel Summers of IARO and Susan Crosthwaite of Citizens' Initiative, Scotland |
| 60 | March 2024 | INWG Briefing Paper - Onshore wind turbine noise guidance; INWG Briefing Paper March 2024 | INWG | INWG |
| 61 | March 2024 | The Meenacloghspar (Wind) Limited Judgement; Meenacloghspar-judgement-March-2024.pdf | The High Court, Ireland | Justice Emily Egan |
| 62 | May 2024 | INWG letter to the Editor: Onshore wind turbine noise guidance; INWG Letter Acoustics Bulletin May 2024 also, Acoustics Bulletin May-June 2024 \| Institute of Acoustics | Institute of Acoustics, Acoustics Bulletin | Richard Cox |
| 63 | June 2024 | Health Report on a Rural Sheep Farm in Scotland; Rural Farm Health Report - Final | International Acoustics Research Organisation (IARO) | Mariana Alves-Pereira, Huub Bakker and Rachel Summers of IARO and Susan Crosthwaite of Citizens' Initiative, Scotland |
| 64 | June 2025 | ETSU-Gate Three Decades of Deception ETSU-Gate | Independent Noise Working Group | Cox, Cowen, Gray, Grosvenor, Sherman |
| 65 | June 2025 | Bryne and Moorhead v ABO Energy and Wexwind – known as Gibbet Hill; Gibbet-Hill-judgement-June-2025 | The High Court, Ireland | Mr Justice Quinn |

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| 66 | July 2025 | Draft updated guidance: Assessment and Rating of Wind Turbine Noise<br>Assessment and rating of wind turbine noise guidance: proposed updates - GOV.UK | Department for Energy Security & Net Zero | Bowdler, Bullmore, Clark, Hayes, McKenzie |
| 67 | July 2025 | Updated guidance for the Assessment and Rating or Wind Turbine Noise – Consultation closing date 29 Aug 2025<br>Updated Guidance for the Assessment and Rating of Wind Turbine Noise: consultation | Department for Energy Security & Net Zero | Department for Energy Security & Net Zero |