

A personal perspective on trends and changing emphasis in UK wind farm noise assessments

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ABSTRACT

This paper draws on the author's previous experience as a noise consultant and specifically as a UK Expert Witness at Public Inquiries and Planning Committees in the UK from 2005 to 2011 to consider emerging themes and changes in wind farm assessment over the last 7 years. The paper looks at trends in the focus of assessments, changes in techniques and in the level of detail, and then considers some of the factors that have led to these trends. In summary, the paper draws out parallels and discussion points for how future wind farm noise assessment trends could develop in Australia. Through reviewing the key issues presented as evidence, the paper considers the related changes in public perception to windfarm noise including the organisation of groups opposed to schemes, as well as the spread of ideas and perceptions through internet forums. From this follows a discussion of how differing scrutiny from various bodies helps to drive the direction of assessment trends, whether it is due to pressure from specific focus groups or the championing of causes from consultants. A brief consideration of current noise topics discussed in the public domain in Australia will provide lead-in discussion points for how the approval challenges currently facing on-shore wind development in the UK could be mirrored or avoided in Australia.

INTRODUCTION

This paper considers various elements of wind farm noise assessment that the author has been involved with over the past 11 years, drawing on his personal experience from four UK Public Inquiries, together with his involvement with developing a technical research paper for the UK Sustainable Development Commission. In passing, the paper also considers the various relevant papers and guidance notes that have been published over the period. As such, a short commentary on the status and role of the key UK guidance document ETSU-R97 is provided.

The personal experience detailed here is specific to the UK, with particular reference to the English and Scottish planning systems and especially the adversarial nature of the Public Inquiry system. The aim of relating this particular experience, however, is to draw out some of the key recurring themes in the consideration of noise issues and to highlight any evolution in these themes. By relating a number of these themes to current topics of discussion for regulators, noise consultants and opposition groups in Australia it is hoped that informative parallels or contrasts will be drawn.

It should be noted that one common feature of the noise assessments being discussed is that the scope and depth of the assessments are, in part, driven by the key requirements of the client, which are to identify and address in detail those issues that might prevent the gaining of planning approval. Hence the level of consideration given to the individual topic is an indicator of the contemporary level of scrutiny that the topic received from a planning perspective at the time of the assessment.

This paper considers six issue topics in turn: validity of ETSU-R97; calculated turbine noise levels; background noise levels; low frequency noise; health; and Amplitude Modulation.

SOURCE MATERIAL AND TIMESCALES

ETSU-R-97 – The Assessment and Rating of Noise from Wind Farms

This guidance document was published in 1996 (DTI, 1996) and is, at the time of writing, the UK Government's preferred method of assessing wind farm noise for planning. At present if a scheme meets ETSU-R-97 then it is generally deemed to have passed the planning noise test in the UK.

Wind power in the UK – a guide to the key issues.

The Sustainable Development Commission was an independent body in the UK whose remit was to 'hold Government to account to ensure the needs of society, the economy and the environment were properly balanced in the decisions it made'. The aim of this peer-reviewed report (Sustainable Development Commission, 2005) was to outline the main issues relating to onshore wind power and comment on their validity from a sustainable development perspective. The author of this paper was a key contributor to Chapter 8 'Noise' of this report.

Drumderg Wind Farm Public Inquiry, 2005-2006

This was a Public Inquiry held under the Scottish Planning system into the refusal of planning permission for a 16 turbine wind farm by Perth and Kinross Council. Noise was not listed as a specific ground for refusal by the relevant planning authority but the authority subjected the development to noise conditions. In addition the Inquiry considered submissions from an opposition group NOD with regards to noise impacts. The author of this paper acted as noise Expert Witness for the developer, Scottish and Southern Energy and produced a precognition (proof of evidence) for this (Simpson, 2006a). The proposed development was given planning permission on 25 September 2006 after the Public Inquiry.

St John’s Hill Wind Farm, 2007

This was a Public Local Inquiry held under the Scottish Planning system into the refusal of planning permission for a 9 turbine wind farm by Aberdeenshire Council. Impact on amenity was not listed as a specific ground for refusal by the relevant planning authority but the Inquiry considered submissions from neighbouring community councils which had expressed concern over amenity. The author of this paper acted as noise Expert Witness for the developer, St John’s Hill Limited and produced a precognition (proof of evidence) for this (Simpson, 2007a). The proposed development was given planning permission in 2007 after the Public Inquiry.

Ray Wind Farm, 2008-2010

A Public Inquiry was held under Schedule 8 to the Electricity Act 1989 into a 56 MW wind farm on land at Ray Estate near Kirkwhelpington, The Public Inquiry also considered an application made by Steadings Windfarm Limited and considered an appeal by Wind Prospect Developments Limited against the failure to determine an application for the erection and operation of 18 wind turbines on nearby land at Green Rigg Fell. Thus this Inquiry considered the cumulative effects of three potential wind farms, affecting three developers and two local authorities. The author of this paper acted as noise Expert Witness for the developer of Ray Wind Farm, AMEC Wind Energy and produced a proof of evidence for this (Simpson, 2007b). On 11 November 2010, the Secretary of State for DECC granted consent for the Ray Wind Farm.

Blackcraig Hill Wind Farm, 2008-2011

This was a Public Local Inquiry into a 23 turbine wind farm held in Scotland in 2008 for deemed planning permission by the Scottish Ministers. Ministers considered the objections raised within the 618 public representations received, in particular the concerns over the proposal’s effect on visual impact, tourism, and noise pollution. The author of this paper acted as noise Expert Witness for the developer, Scottish and Southern Energy and produced a precognition (proof of evidence) for this (Simpson, 2008b). The proposed development was given planning permission on March 2011 after the Public Inquiry.

ISSUE TOPIC 1 - VALIDITY OF ETSU-R-97

This methodology (DTI 1996) was developed by a ‘Noise Working Group’ (NWG) comprised of a cross section of relevant experts including environmental health officers, wind farm operators and independent acoustic experts. The document had the stated aim of providing a robust basis for assessing the noise implications of a wind farm. The ETSU-R97 guidance note defined a framework which can be used to measure and rate the noise from wind turbines and to provide indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours and to encourage best practice in turbine design and wind farm siting and layout.

The UK Government adopted the guidance and recommends its use in planning policy in England and the devolved administrations of Scotland, Wales and Northern Ireland.

In general, the guidance requires the predicted noise levels from turbines under a range of wind speeds to be compared with the background noise level at noise sensitive premises under similar wind conditions. Noise from the wind farm should be limited to 5 dB(A) above background for both day and night-time, subject to a lower limit of 35 to 40 dB(A)

during the day and 43 dB(A) at night. An illustration of this derivation process for the Ray Inquiry is shown in Figure 1.

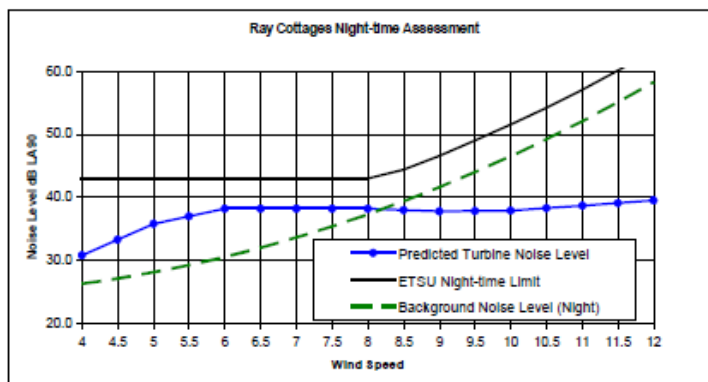


Figure 1. ETSU-R-97 Night-time Criteria defined for Ray Cottage (Simpson, 2007)

It is the use of the ‘lower limits’ in order not to place ‘unreasonable restrictions on wind farm development’ that has been the subject of much debate over the years, since it applies a judgemental consideration of Government policy onto the setting of noise limits.

The SDC report in 2005 noted that ETSU-R97 describes a framework for measuring wind farm noise and offers indicative acceptable noise levels for developments.

At the Drumderg public inquiry there was a challenge to the application of ETSU-R97 by the planning authority, Perth and Kinross Council, as summarised in p29 of the Inspector’s decision letter (Scottish Executive 2006):

Whilst the council agreed the ETSU-R-97 methodology with the appellant at the time of scoping the noise section for the EIA, it has since taken and accepted expert advice on the ES. That advice is that levels different from the ETSU-R-97 approach are to be preferred in the particular circumstances of this appeal.

The consultant acting for the local authority and representing the authority as expert witness was Dick Bowdler, a member of the original ETSU-R-97 steering committee. His alternative approach was to use categories of amenity loss derived from British Standard BS4142 which were arrived at by comparison of predicted turbine levels to, in the absence of monitoring, a derived background level. This approach was debated at the Inquiry and in p52 of the decision letter it was noted that:

ETSU-R-97 is intended to strike a balance between the protection of windfarm neighbours and placing restrictions on windfarm development. By its use of BS4142, the council, supported by NOD, seeks to ignore that balancing aspect and is therefore acting contrary to national advice without justification.

At the St John’s Hill Inquiry, ESTU-R97 was presented as the assessment framework and there was no challenge to its use from the planning authority or opposition groups.

At the Ray/Steadings/Green Rigg Inquiry, all three parties presenting developments used ETSU-R-97 by consensus, with no challenge from the planning authorities. However there was criticism to the use of the ETSU-R97 presented by a non-local witness, Mrs Davis, who presented similar statements on behalf of opposition groups at a number of Public

Inquiries in the UK. An example is given in p6 of her evidence to the Bickham Moor Inquiry (Davis 2009).

The government's preferred guidance for assessing the noise from wind turbines known as ETSU-R-97, uses an LA90 10 minutes descriptor. This ignores all but the quietest 10% of noise in each 10 minute measurement period so has the effect of removing any noise peaks. Thus it is easy to see why the use of the ETSU -R-97 guidance is not in fact effective to either protect or guarantee residential amenity if a residence is exposed to noise from turbines.

The continued need to justify the use of ETSU-R97 is illustrated by the precognition produced for the Blackcraig Hill Inquiry which describes the planning context for the standard, and provided details on public inquiries where the use of ETSU has been upheld by Inspector decision. The views of the opposition groups at the Blackcraig Inquiry were presented in p75 of the Inspectors report (Scottish Government 2010a), which includes the following views of Mrs Robson:

The ETSU-R-97 standards for measuring noise have been discredited. They were devised when turbines were one fifth the size of the SSE proposal.

The conclusion of the Inspector's report (p97) includes the statement that:

Some objectors claimed that existing background noise levels were unusually low and that lower limits should be applied to their situations. However, that would be contrary to the guidelines and would place unreasonable restrictions on the proposed windfarm development. I am not persuaded that the circumstances described are unusual or that there are any exceptional grounds for departing from those guidelines.

Again, this illustrates the recurring theme that unreasonable restrictions should not be placed on windfarm development.

ETSU-R-97 has not been withdrawn or amended and is still the extant guidance document referred to by planning guidance in the UK. However Hayes McKenzie, on behalf of DECC have produced a review of how noise assessments are considered in wind farm planning applications by planning authorities and developers (Hayes McKenzie 2011). This review has highlighted the potential problems faced by local planning authorities dealing with noise assessments for wind farm sites, both in terms of the way the documents are structured, and in the variations in the way some factors are taken into account in the assessments. They suggest best practice guidance is required to confirm and, where necessary, clarify and add to the way ETSU-R-97 should be implemented in practice. The UK Government is currently working with industry (including the Institute of Acoustics) to draft better guidance.

An indication of the changing shift of emphasis is that the National Planning Guidance Note for Renewable Energy EN-3 (DECC, 2011), in its discussion on windfarm noise now includes a footnote (added since the published draft) that states that all references to ETSU-R-97 in this section should be taken to include any successor or supplementary guidance to it endorsed by the Government.

It is also interesting to note that Dick Bowdler, who represented Perth Council at the Drumderg was recently the author of a paper published in the UK Acoustics Bulletin

(Bowdler, 2012) where he comes back to the discussion tested at Drumderg, presenting an alternative methodology, based on BS4142 looking at amenity, with no lower restriction to the limit values.

ISSUE TOPIC 2 – CALCULATED TURBINE NOISE LEVELS

The fundamentals of noise prediction are well understood and are rarely challenged at Inquiry. It should be noted that ETSU-R-97 is sometimes wrongly assumed to be a prediction tool and it does not provide guidance on appropriate prediction techniques. In general, the methodology which is most often used is the methodology set out in the International Standard ISO 9613 Acoustics 'Attenuation of sound during propagation outdoors – Pt 2: General method of calculation'.

The SDC report notes that much of the interest in wind turbine noise is focused on the noise anticipated from proposed wind turbine installations, based on the information which is provided by manufacturers. Wind turbines are too big to test for noise levels in a special acoustic test chamber and it is therefore necessary to deduce the noise source power by indirect means.

In the author's experience the discussion at Inquiries revolve primarily around the application of the various assumptions that are required for ISO 9613 predictions or, more rarely, through misunderstanding of basic principles of noise modelling.

At the Drumderg Inquiry the turbine noise levels were challenged by the opposition group, NOD, leading to discussions over whether manufacturer's data should include a margin of error factor, and as to whether appropriate atmospheric absorption data had been used as insertion parameters for the noise modelling. The conclusions of the Inspector's decision letter include the comment at p52 that:

Although there were debates about many aspects of turbine noise at the inquiry, it was common ground that this was not an issue which went to the acceptability of the windfarm. Rather it related to what were to be the maximum levels of turbine noise to be permitted in the relevant planning condition.

At the St John's Hill Inquiry there had been prior agreement with the local authority over the prediction methodologies used and no challenge from the opposition groups. However there was still a requirement to update the turbine noise predictions', taking into account the noise attributes of an additional candidate turbine type and using updated prediction assumptions.

The requirements and the scrutiny associated with the Ray/Steadings/Green Rigg Inquiry meant that a supplementary noise appendix was produced to accompany the author's proof of evidence. This tabulated the results of a noise prediction exercise into resultant noise levels from the operation of Ray Wind Farm in two different layout scenarios and to compare different operating modes. The appendix also contains results from a similar prediction exercise to determine the cumulative noise impacts of the operation of the three wind farms which were the subject of the Inquiry. The three noise expert witnesses, namely this author, Malcolm Hayes and Ian Bennett, on behalf of their respective clients, agreed on methodologies, criteria and noise data in order to calculate the resultant cumulative turbine noise levels for the relevant receptor locations.

During the Ray/Steadings/Green Rigg Inquiry there was a detailed discussion on whether wind shear had been taken into account sufficiently, with detailed evidence provided by a witness opposing the development, Mr Short. A specific rebuttal proof of evidence (Simpson 2008a) was required to address these issues in order to demonstrate that the level of wind shear incorporated into the noise modelling was appropriate for the site.

At the Blackcraig Inquiry there was limited discussion around prediction methods, although local residents were concerned about the potential funnelling effect of noise down their valley, specifically as a result of reflection effects. The precognition dealt with this concern by indicating that the spatial noise model took into account the partial reflection of sound waves off the landscape elements.

An important article in the UK Acoustics Bulletin (Bowdler, Bullmore et al 2009) highlighted in its introduction that there were continuing disputes at Public Inquiries, and presented an approach to 'enhance the quality of wind farm noise assessments and usefully limit areas of disagreement between parties acting for developers and those acting for objectors'. The authors of the article included members of the Noise Working Group responsible for the preparation of ETSU-R-97, and a sample of those who represent both developers and objectors groups. The recommendations addressed, amongst other topics appropriate assumptions for atmospheric conditions, absorption criteria and turbine level treatments for input to ISO9613 to predict wind turbine noise immission level at receptors locations.

Although not universally adopted, in this author's opinion, there appears to be increasing acceptance of the enhancements offered by this 'Acoustics Bulletin Agreement'.

ISSUE TOPIC 3 – BACKGROUND NOISE LEVELS

Crucially, the suggested limits of ETSU-R97 are based on having a robust understanding of the existing noise environment since the existing background is the base against which the planning criteria are set. Hence the definition of appropriately representative background levels is an abiding theme at Public Inquiries, and the need to redefine background levels by additional monitoring at additional cost is a recurring feature.

In the SDC report it was stated that 'it is crucial to measure the background ambient noise levels for all the wind conditions in which the wind turbine will be operating.'

The focus of the Drumderg Inquiry was largely on the use of acceptable baseline data to use for setting conditions, as noted in the decision letter:

The council has pointed out the 2002 study was invalid because the noise level meters used were inappropriate. The 2006 study is unreliable because it took measurements at only two sites; it appears that wind speed data were not accurately synchronised with the acoustic data; and measurements were taken for only 4-5 days, rather than a minimum of seven as recommended. This indicates a need for the study to be repeated so that the noise level limits can be calculated on an accurate basis (using the ETSU-R-97 approach).

The arguments presented by NOD, listed in the decision letter (Scottish Executive 2006), illustrate the range of issues that

were discussed throughout the Inquiry: 'The background noise levels as measured for SSE cannot be accepted as presenting a true picture. This is partly because: the accuracy of the equipment used is unreliable for measurements below 32dB; an unsuitable windscreen was used for the microphone; and the windscreen may have been creating noise at higher wind speeds. It also appears that the equipment was malfunctioning at times. Some atypically high background noise levels have neither been explained nor removed from the data. There are large differences between background noise measurements from the same position at different times.' Such arguments were therefore addressed by means of additional rebuttal evidence (e.g photographic evidence of equipment as shown on Figure 2).



Figure 2. Noise Monitoring Equipment used at Corb, 2002 (Simpson 2006)

Discussions over representative background levels were also extensive at the Ray/Steadings/Green Rigg Inquiry. As noted in the author's proof 'The initial baseline noise monitoring undertaken in 2005 and reported in the ES has been supplemented by more recent monitoring results for the same location and monitoring results for additional locations.' Following this, the rebuttal document to J William Short's evidence responds to further criticism of this additional monitoring, that the monitoring exercise was carried out at an unrepresentative time of year, and that the data was unduly affected by noise assumed to be the 'dawn chorus'.

The precognition for the Blackcraig Hill Inquiry addresses the concerns of a resident at a local property, Bartaggart where no 'noise pollution testing' was carried out and hence raising the issue of how the property could be protected. The ability to set strict lower limits for distant receptors, without background monitoring is one of the features of ETSU-R-97.

There was interestingly no debate at the St John's Hill Inquiry regarding the acceptability of the background data, but there was a need to provide a noise monitoring verification report. This report reviewed the noise data that had been collected 3 years earlier, with regards to potential interference from rain noise. It should also be noted that the planning conditions, that were agreed, proposed limits set against 'background' as oppose to actually defining what the background levels were. It may be that this process of leaving the definition of background until a later date avoided lengthy discussion at Inquiry.

The Acoustics Bulletin Agreement (Bowdler, Bullmore et al 2009) provides an agreed approach to the acquisition of baseline data, which goes some way to addressing some of the common arguments involving background noise.

ISSUE TOPIC 4 – LOW FREQUENCY NOISE

Low Frequency Noise, as a general topic, was considered in this context several years ago, when a review of low frequency noise was completed for DEFRA (Leventhall 2003), which concluded that the very low levels of low frequency noise and infrasound which occur from wind turbines will not cause adverse health effects.

Nevertheless this topic is still often interlinked with health when presented as a reason for concern, and is frequently mentioned by groups opposing wind farm developments.

At the time of the SDC report in 2005, it was stated that ‘Research continues to take place and the DTI have commissioned a study looking into low frequency noise at three wind farms in the UK.’ This report was published in 2006.

The precognitions for both the Drumderg Inquiry and the St John’s Hill Inquiry were not required to explicitly address Low Frequency Noise, nor was it brought up as an issue for debate at either Inquiry.

At the Ray Inquiry there was the need to rebut various statements from opposition groups (including the local Parish Council) linking wind farms to low frequency noise and linking this to potential health effects. The author’s proof of evidence noted that following on from the identification of apparent misunderstandings of the conclusions reached in the various reports on low frequency noise, and how these conclusions should be applied to the consideration of low frequency noise from wind turbines, the British Wind Energy Association (BWEA) had issued a fact sheet relating to the subject. This fact sheet (BWEA 2005) concludes:

It has been repeatedly shown by measurements of wind turbine noise undertaken in the UK, Denmark, Germany and the USA over the past decade, and accepted by experienced noise professionals, that the levels of infrasonic noise and vibration radiated from modern, upwind configuration wind turbines are at a very low level; so low that they lie below the threshold of perception, even for those people who are particularly sensitive to such noise, and even on an actual wind turbine site. In response to concerns that wind turbines emit infrasound and cause associated health problems

Dr Geoff Leventhall, author of the Defra Report on Low Frequency Noise and its Effects, is also quoted in the BWEA briefing paper on low frequency noise that: “I can state quite categorically that there is no significant infrasound from current designs of wind turbines” (BWEA, 2005).

A similar statement was presented in the author’s proof of evidence for the Blackcraig Hill Inquiry, in order to address concerns raised by recent publications. It may be of note that this argument took up nine paragraphs in the main text and three paragraphs of supplementary response to concerns, rather than the six paragraphs needed for the Ray Inquiry.

Further concern raised over infrasound being dangerous and disruptive enough for the MOD to have created an exclusion zone of 10km. around Eskdalemuir, was rebutted by reference to the original authors of the relevant study (Styles 2005) who noted that “There is no possibility of humans sensing the vibration and absolutely no risk to human health”.

In his report on the Blackcraig Hill Inquiry (Scottish Government 2010b), the Inspector noted that:

Objectors’ arguments regarding ultrasound, vibration and associated matters were not specific to this development. These matters have been studied by the World Health Organisation, the DTI, DEFRA and the Ministry of Defence (organisations whose credentials I prefer to those on whom the objectors rely). They have provided no support to the objectors’ fears. Nor were any peer reviewed scientific studies produced to indicate causal relationships between wind turbine noise and adverse health effects.

There is currently no requirement to add a ‘penalty’ for excessive low frequency noise in the UK under ETSU-R97 or related supplementary advice.

ISSUE TOPIC 5 – HEALTH

At the time of the SDC report there was no requirement to write a specific section on health effects from wind farms since it was not regarded as a key issue. It was noted that “The public’s concern about noise from turbines is often related to perceptions rather than actual” It was also noted that “Detailed studies have shown that the very low levels of low frequency noise from wind turbines will not normally cause adverse health effects”

No health effects issues were raised at either of the Drumderg or the St John’s Hill Inquiries.

The level of public concern had been raised by the time of the Ray/Steadings/Green Rig Inquiry such that it was needed to state explicitly in the author’s proof of evidence that:

Despite the operation of numerous wind farms in the UK and worldwide, some of which have been in operation for more than a decade, it is only relatively recently that wind farm noise has been linked with adverse health effects. Furthermore, to the best of my knowledge, all such evidence is anecdotal with no peer reviewed or scientific studies having found any causality relationships between the two.

The BWEA summary note on wind farm noise also stated that “There are no direct health effects from noise at the level of noise generated by wind turbines.”

At the Blackcraig Hill Inquiry there was a need to respond to health issues raised by residents opposed to the scheme, quoting from published research and stating that “that this proposal has not taken account of the health risk to those householders who dwell within 1.5 miles of the proposed site. Medical and scientific research has been published showing adverse effects on human beings living near industrial turbines’. Text in the author’s precognition stating that evidence in support of health effects of environmental noise, other than annoyance and some indicators of sleep disturbance, is limited, was not challenged at the Inquiry and, as noted earlier, health concerns were dismissed by the Inspector.

The Acoustic Bulletin Agreement in 2009 focussed on a potential health issue that was current at the time, namely Vibro-acoustic Disease

A Portuguese group has been researching ‘Vibro-acoustic Disease’ (VAD) for about 25 years. Their research initially focussed on aircraft technicians who were exposed to very high overall noise levels, typically over 120dB.... However other research has not confirmed this. Wind farms expose people

to sound pressure levels orders of magnitude less than the noise levels to which the aircraft technicians are exposed. The Portuguese VAD group has not produced evidence to support their new hypothesis that infrasound and low frequency noise from wind turbines causes similar health effects to those experienced by the aircraft technicians.

A recent report on Wind Farm Noise Statutory Nuisance Complaint methodology produced by AECOM for DEFRA (AECOM 2011) noted that a review by the American Wind Energy Association and the Canadian Wind Energy Association highlights the poor science and weak methodologies used by researchers making claims with regards to VAD and Wind Turbine Syndrome and notes that 'any attempt to bring a case based on such unproven hypotheses as WTS and VAD is considered unlikely to succeed.

ISSUE TOPIC 6 – AMPLITUDE MODULATION

The phenomenon of 'Blade Swish' was taken into account by the Noise Working Group when the noise limits defined in ETSU R-97 were established. This change in received sound, both in frequency and level, experienced as the blades travel round the rotor disc is often referred to by the descriptor Amplitude Modulation, or shortened to AM.

In 1995 AM was given no specific focus in the SDC report which merely stated that "the audibility of these periodic audible swishes have recently been linked to stable atmospheric conditions and also to the possibility of the heightening of these effects due to the partial synchronising of these pulses from several turbines in a wind farm."

At the Drumderg Inquiry, no account was regarded regarding AM, whilst for St John's Hill Inquiry, the Ray/Steadings/Green Rigg Inquiry and the Blackcraig Hill Inquiry the following text was provided without challenge:

The wind energy industry and government bodies are continually reviewing the various aspects that are discussed within the ETSU-R-97 report. A report published by the DTI, researching wind farm noise complaints, reported that some complaints were related to periods of increased levels of amplitude modulation, and noted that, in some isolated circumstances, this phenomenon was occurring in ways not anticipated by ETSU-R-97. Following this, the DTI and DEFRA commissioned Salford University to undertake a study to ascertain the prevalence of Amplitude Modulation from UK wind farms. The report concludes that the incidence of Amplitude Modulation (AM) at wind farms is very limited in terms of the number of people affected. The Government response to this report, issued by DBERR states that "Based on these findings, Government does not consider there to be a compelling case for further work into AM and will not carry out any further research at this time; however it will continue to keep the issue under review." There is currently no requirement to reflect AM further in the context of the ETSU-R-97 rating advice.

The raising of the profile of this issue can be seen by the need to specially respond, in the author's Ray Inquiry Proof of Evidence, to a comment on 'drumming noise' in a Parish Council Statement of Case. This was then followed at the Inquiry by a witness statement from Mrs Jane Davies which covered the subject of AM in depth and argued for a correction to ETSU-R97 to account for AM.

It is interesting to note that for none of the wind farms which were the subject of the four Public Inquiries were subject to draft or final conditions that included for Amplitude Modulation effects. There is currently no requirement to add a 'penalty' for excessive AM under ETSU-R97 or related supplementary advice.

Following the example of a high profile case (Den Brook Wind Farm Inquiry) in the UK, specific conditions are being proposed by groups and councils opposing wind farms, with prolific work being carried out by MAS Environmental, whose Director Mike Stigwood is referenced in a quote from Jeremy Bass in a personal letter to Acoustics Bulletin (Bass, 2012):

I would like to take the opportunity to applaud Mr Stigwood for his personal contribution: were it not for his efforts to pursue his interests in AM, it is unlikely that our collective understanding of amplitude modulation would have reached the level of sophistication that it currently does.

This is another good example of 'championing' of a specific issue by individuals or groups, which has led to increased focus and research on that issue. The debate on AM continues, as evidenced by a recent published Proof of Evidence from Iain Bennett (Bennett, 2011):

As a result of the publicity surrounding one particular instance of excessive AM, the issue has become a feature of objections to wind farm developments in recent years and is consistently raised by objector groups. There is a wide consensus among acousticians working in the wind energy industry (for developers, local planning authorities and opposition groups) that the technical definition of 'unacceptable AM' appearing in such suggested AM conditions is flawed. This is because the description of what constitutes 'unacceptable AM' is also a description of other ambient noise likely to occur, such as the noise of birdsong or of the wind blowing through trees. If such natural sources were present when unacceptable AM was alleged, then the AM test could be failed regardless of whether the turbines were the cause. This means that, for example, an AM penalty could be invoked regardless of whether or not the phenomenon was actually occurring.

It can be seen that, as is often the case with these issues, there is currently fairly entrenched positions on both sides of this debate in the UK.

SUMMARY OF UK THEMES

This overview of personal experience in wind farm noise assessments has provided an indication of the themes that have been raised at a number of Public Inquiries.

Figure 3 provides an illustration of the 'level of interest' in each of the issue topics that have been discussed in this paper, for the four Public Inquiries.

The author's arbitrary definition of interest level used for the purpose of this illustration is as follows: 0 = Issue not raised at inquiry; 1 = Issue covered in proof of evidence; 2 = Issue raised by opposition and 3 = Specific rebuttal required on issue.

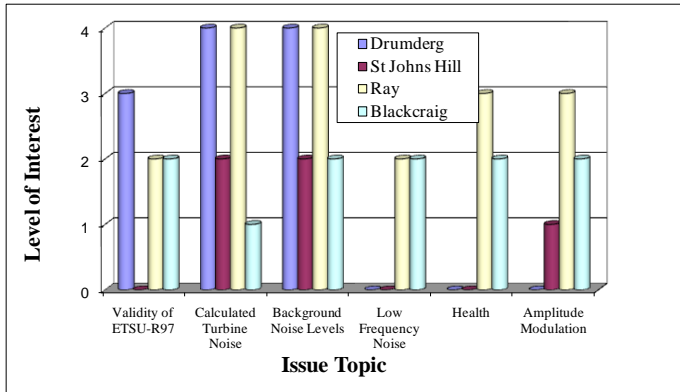


Figure 3. Summary of 'Level of Interest'

This simple illustration suggests that measurement and calculation issues were addressed at every Inquiry, whilst low frequency noise, amplitude modulation were addressed in detail at the most recent Inquiries.

COMMENTARY ON AUSTRALIAN GUIDANCE/RECENT PRESS

Here in West Australia, the current Guidelines for Wind Farm Development (Western Australian Planning Commission 2004) state that, until such time as a formal policy is adopted in Western Australia, the Department of Environment (DoE) endorses the criteria and approach of assessing wind farms based on background noise levels, as described in the South Australian guidelines Environmental Protection Authority – Wind Farms Environmental Noise Guidelines.'

The South Australia EPA - 'Wind Farms Environmental Noise Guidelines' published in 2009 sets noise criteria for new wind farm development. This sets limits of 35dB(A) at relevant receivers in localities which are primarily intended for rural living or 40dB(A) at relevant receivers in localities in other zones, or the background noise (LA90,10) by more than 5dB(A), whichever is the greater. The background noise should be as determined by the data collection and regression analysis procedure recommended in the Guidelines

This is a similar approach to the UK (including the regression analysis of background noise measurements), as is the fact that the guidance note also indicates that annoying characteristics that are not fundamental to a typical well-maintained wind farm should be rectified. Such characteristics may include infrasound or adverse mechanical noise (perhaps generated as a failure of a component).

In New South Wales, the announcement by Planning Minister Brad Hazzard (Tovey 2012) of a 6 month audit of 3 wind farms in New South Wales where there have been regular complaints, draws parallels with the similar exercise that was undertaken in the UK in 2006 (DTI 2006).

Additional guidance of note is the draft planning guidelines for wind farms in New South Wales Draft produced in Dec 2011 (NSW Government 2011). These note that:

'For a new wind farm development the predicted equivalent noise level (Leq, 10 minute), adjusted for any excessive levels of tonality, amplitude modulation or low frequency, but including all other normal wind farm characteristics, should not exceed: 35dB(A) or the background noise (L90) by more than 5dB(A), whichever is the greater, at all relevant receivers

not associated with the wind farm, for wind speed from cut-in to rated power of the WTG and each integer wind speed in between. The noise criteria must be established on the basis of separate daytime (7am to 10pm) and night-time (10pm to 7am) periods.'

There are general similarities with the UK here (a lower level and a level above background) and differences (use of Leq instead of L90) in this approach but notable differences are the penalties on calculated or measured noise levels for amplitude modulation:

An excessive level of modulation is taken to be a variation of greater than 4dB(A) at the blade passing frequency. If excessive modulation is found to be a repeated characteristic of the wind turbine noise, 5dB(A) should be added to the predicted or measured noise level from the wind farm. If modulation is only identified for certain wind directions and speeds, the penalty shall only be applied to measurements made under those meteorological conditions. The modulation characteristic penalty applies only if the modulation from the wind turbine is audible at the relevant receiver. Absence of excessive modulation in noise emissions measured at an intermediate location is sufficient proof that the modulation is not a feature of the wind farm.

And similar penalties for low frequency noise:

If it is shown that the C-weighted noise (measured from 20Hz upwards) from a wind farm (excluding any wind induced or extraneous C-weighted noise) is repeatedly greater than 65dB(C) during the daytime or 60dB(C) during the night-time a more detailed low frequency noise assessment should be undertaken. Should a detailed assessment confirm that excessive levels of low frequency noise above the human threshold of hearing are occurring internally at non-associated residences, then a 5dB(A) penalty should be applied to the predicted or measured noise level from the wind farm for the periods and meteorological conditions under which the low frequency noise has been identified.

Although, presumably, there may often be discussion on the actual measurement of AM and low frequency noise required by these guidelines, the author of this paper expects that the definition of a relatively straightforward 'penalty' may well avoid some of the ongoing debate that has been a feature of UK wind farm noise assessments.

However, a brief consideration of published articles in Australia, indicates that that the issue around health effects from windfarms is still the subject of discussion and that concern is raised by some commentators.

An article in the recent press (Tovey 2012) quotes the NSW Planning Minister, Brad Hazzard as maintaining the "jury is out" on the health impacts of wind farms.

In the Australian (Delingpole 2012a) the article by James Delingpole which addresses the wind farm industry in general, suggests that

The infrasonic waves that attack the balance mechanism in the ear and against which not even home insulation can defend you. Its effects can be felt more than 10km away.

It is interesting that this commentary, whilst very similar to the concerns comprehensively rebutted in the UK at the Blackcraig Hill Inquiry in 2007, is being reinforced by addi-

tional articles by the same author in the UK (Delingpole 2012b).

CONCLUSION

Although no definitive conclusions can be drawn from such a personal and limited account of wind farm noise issues, it is hoped that the themes of 'clear guidance avoiding undue discussion'; 'robust data being the foundation of appropriate assessment' and 'championing leads to increased focus and research' can be seen to be common and relevant themes, which may help acoustics consultants to advise their clients appropriately.

REFERENCES

- AECOM (2011), Wind Farm Noise Statutory Nuisance Complaint Methodology, Report Prepared for Defra: Contract No. NANR 277, April 2011
- Bass (2012), Letters, Acoustic Bulletin, May/June 2012
- Bennett (2011) appeal by the Co-operative group against the refusal of planning permission by Central Bedfordshire Council for the proposed wind farm on land north of Edworth Road, Langford, Bedfordshire, Proof of Evidence of Ian Bennett. Available from: <http://www.southbedsfoe.co.uk/Windfarm/Noise.%20proof%20of%20evidence.PDF>
- Bowdler, Bullmore et al (2009) 'Prediction and assessment of wind turbine noise', Acoustics Bulletin, March April 2009, p35
- Bowdler, (2012) 'ETSU-R-97 an alternative view' Acoustics Bulletin May/June 2012
- British Standards Institute, BS4142, 'Method for Rating Industrial Noise affecting mixed Residential and industrial Areas', 1997
- British Wind Energy Association (2005) (BWEA), 'Low Frequency Noise and Wind Turbines', BWEA website
- Davis (2009) on behalf of Rural Exmoor Alliance Inspectorate reference: APP/X1118/A/08/2083682 LPA reference: 45489, Proof of Evidence of Jane Davis, SRN BA. Available from: www.huntspillwindfarms.org.uk/resources/Jane+Davis+noise+evidence.pdf
- British Wind Energy Association (2005) (BWEA), 'Low Frequency Noise and Wind Turbines', Available from: www.bwea.com/pdf/briefings/lfn_summary.pdf
- Delingpole 2012 'Wind farm scam a huge cover-up' The Australian May 03, 2012
- Delingpole 2012 'Wind farms: even worse than we thought...' James Delingpole Environment, Telegraph blog March 8th, 2012
- Department for Business, Enterprise and Regulatory Reform, 'Research into aerodynamic modulation of wind turbine noise', report by University of Salford, August 2007
- DECC (2010), letter dated 11 November 2010, to Mr David Hodgkinson, Vattenfall Wind Power Ltd. Available from: www.og.decc.gov.uk/EIP/pages/projects/KirkwhelpingtonConsent.pdf
- DECC (2011), National Policy Statement EN-3, Planning for New Energy Infrastructure, July 2011
- DTI (1996) Working Group on Noise from Wind Turbines, 'The Assessment and Rating of Noise from Windfarms', ETSU Report ETSU-R-97, 1996
- DTI (2006) 'The measurement of low frequency noise at three UK wind farms' 2006
- Hayes McKenzie (2011), Analysis of How Noise Impacts are Considered in the Determination of Wind Farm Planning Applications DECC Research contract 01.08.09.01/429A
- International Organisation for Standardization (ISO), 'Acoustics - Attenuation of Sound During Propagation Outdoors, Part 2: A General Method of Calculation', ISO 9613-2:1996
- Leventhall, G (2003), 'A Review of Published Research on Low Frequency Noise and Its Effects', Report for DEFRA, May 2003.
- NSW Government (2011) 'NSW Planning Guidelines Wind Farms, Draft, December 2011
- Scottish Executive (2006), letter dated 25 September 2006, Ref: P/PPA/340/459. Available from: www.dpea.scotland.gov.uk/CaseDetails.aspx?id=qJ6923
- Scottish Government (2010), Directorate for Planning and Environmental Appeals, Report to the Scottish Minister, dated 9 April 2010, Ref: IEC 3/153. Available from: www.scotland.gov.uk/Resource/Doc/917/0115664.pdf
- Scottish Government (2010), letter dated 26 November 2007, Ref: P/PPA/110/634. Available from: www.dpea.scotland.gov.uk/CaseDetails.aspx?id=qJ6923
- Simpson, (2006), on behalf of SSE Generation Ltd, 'Proposed Windfarm Development at Drumderg, Bridge of Cally, Perthshire Perth & Kinross Council Ref: 03/01917/FUL SEIRU Ref: P/PPA/340/459, Precognition of Pete Simpson, Noise, March 2006.
- Simpson, (2006), on behalf of SSE Generation Ltd, 'Proposed Windfarm Development at Drumderg, Bridge of Cally, Perthshire Perth & Kinross Council Ref: 03/01917/FUL SEIRU Ref: P/PPA/340/459, Supplementary Precognition of Pete Simpson Noise, March 2006.
- Simpson, (2007), on behalf of St John's Hill Ltd, 'Proposed Windfarm Development at St John's Hill Council Ref: KM/APP/2004/4666 SEIRU Ref: P/PPA/110/634, Precognition of Pete Simpson, September 2007.
- Simpson, (2007), on behalf of Amec Project Investments Ltd, 'Proposed Windfarm Development at Ray Estate and surrounding area. Application Reference GBDC/001/00247C, Proof of Evidence of Pete Simpson, Noise, December 2007.
- Simpson, (2008), on behalf of Amec Project Investments Ltd, 'Proposed Windfarm Development at Ray Estate and surrounding area. Application Reference GBDC/001/00247C, Second Rebuttal Proof of Evidence of Pete Simpson, Noise, January 2008.
- Simpson, (2008), on behalf of SSE Generation Ltd, In respect of a Section 36 Wind Farm Application, at Blackcraig Hill, Near New Galloway, Dumfries and Galloway, Section 57 Town and Country Planning (Scotland) Act 1997, Precognition of Pete Simpson, in Relation to noise, February 2008.
- South Australian EPA (2009) Wind Farm Environmental Noise Guidelines, ISBN 978-1-876562-43-9. July 2009
- Styles 2005 Keele University Rejects Renewable Energy Foundation's Low Frequency Noise Research Claims, The Scotsman August 2005 Available from http://www.bwea.com/ref/lfn_keeel.html
- Sustainable Development Commission (2005) Wind power in the UK – a guide to the key issues
- Tovey 2012 Scepticism over Hazzard's audit of wind farm noise' Article in Sydney Morning Herald, Feb 21 2012
- West Australian Planning Commission (2004), Guidelines for Wind Farm Development Planning Bulletin 67 May 2004