

Note on Amplitude Modulation – a reply to Mr Geoffrey Weller’s Concerns

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I hold the degree of Bachelor of Science in Electronics and Communication Engineering from The Polytechnic of North London. I am a member of the Institute of Acoustics.

I have been employed as an acoustic consultant for 28 years. I held the posts of Assistant Engineer, Consultant Engineer, Senior Consultant Engineer and Associate Director within Hann Tucker Associates between 1985 and 1991. My experience during this time covered all aspects of noise and vibration control for industrial and residential development, the assessment of noise from industrial sources for litigation purposes, the development of performance and ride criteria for lifts and the assessment of vibration within building structures, in particular, relating to underground railways.

In May 1991, I moved to form The Hayes McKenzie Partnership. My personal involvement with wind farms has covered over 350 separate sites throughout Cornwall, Devon, Mid-Wales, Anglesey, Pembrokeshire, South Coast of England, Scotland, USA, Canada, Portugal, Spain, Holland, Germany, New Zealand and Australia. I have acted for developers and for Local Authorities at the planning stage of wind farm applications and as an expert witness at planning inquiries. I have presented evidence at 37 inquiries in the UK, two planning hearings and an appeal hearing in the State of Victoria, Australia and to the Environment Court in New Zealand for an appeal under the Resource Management Act.

The Partnership, as a whole, has now undertaken work on over 700 wind farm/turbine developments since 1991. I have undertaken studies for the Department of Trade and Industry, through ETSU (Energy Technology Support Unit), dealing with the noise impact of wind farms including the study of the Mynydd y Cemmaes Wind Farm. I have also undertaken projects with turbine manufacturers for the reduction of emitted noise from wind turbines.

I was a member of the Working Group on Wind Turbine Noise which was sponsored by ETSU on behalf of the Department of Trade and Industry and that provided detailed guidance with respect to noise issues raised through wind farm development. I am currently sitting on the Institute of Acoustics Working Group on Wind Farm Noise Assessment which was formed at

the request of Department of Energy and Climate Change (DECC). The aim of the group is to review the available evidence, and to produce good practice guidance on wind turbine noise assessment. This IoA GPG was issued on 23rd May 2013.

The Partnership has also provided a representative to the joint working group formed by the Institute of Acoustics and Institute of Environmental Assessment to provide guidance for noise assessment for Environmental Assessment. The Partnership provided advice for the assessment of Industrial Noise.

I undertook a study of low frequency noise emissions associated with wind turbines at the three wind farms in the UK, the results of which were reported during August 2006. As a consequence of this work, the Noise Working Group for Wind Turbine Noise was reconvened to consider the findings and to review the report. The Noise Working Group on Wind Turbine Noise subsequently recommended that additional work be undertaken, under separate contract, to assess the potential for aerodynamic noise associated with the operation of wind turbines incident at neighbouring dwellings to UK wind farms. This work was undertaken during 2007 and reported in July 2007.

I was a member of the organising committee for the 1st, 2nd ,3rd ,4th and 5th International Conferences on Wind Turbine Noise held in Berlin (2005), Lyon (2007), Aalborg (2009), Rome (2011) and Denver (2013). I have published and presented papers at conference dealing with the issues raised with the assessment of existing background noise levels within wind environments and the assessment of wind farm noise.

I provided technical support to Standards Australia in the drafting of an Australian Standard for the measurement and assessment of wind farm noise.

I am currently sitting on the Institute of Acoustics Working Group on Wind Turbine Noise set up at the request of DECC to take forward the recommendations of the Hayes McKenzie report on Analysis of How Noise Impacts are considered in the Determination of Wind Farm Planning Application Ref HM: 2293/R1 dated 6th April 2011. This group published its report on 22nd May 2013.

I have been requested by the applicant for Fferm Wynt Llaithddu to consider the submission by Geoffrey Weller dealing with the issue of Wind Turbine Amplitude Modulated Noise.

I have prepared a short statement which considers some of the points which have been raised. Where I remain silent on some of the issues considered by Mr Weller it should not be considered that I accept the points which have been made.

Within Paragraph 6 of Mr Weller's submission, it is indicated that an awareness of the issue of the problems of AM started with the publication of the Salford Report in 2007. This clearly is contradicted within Mr Weller's own evidence where he refers to the discussion of "Blade Swish" within ETSU-R-97, which relates to the modulation of the aerodynamic noise from wind turbines. This was considered during the drafting stage of ETSU-R-97 between 1994 and 1996. Therefore, within the UK an awareness of the potential problem of AM existed even at this early stage. At one of the first meetings held by the DTI dealing with wind turbine noise (in 1992 – 1993) the issue of source noise identification and the potential for AM was discussed.

The issue of Enhanced AM, i.e. EAM, which is greater than might be expected from normal operation of wind turbines, was first identified within the paper by Van den Berg (VdB) in 2004. The primary result of the study undertaken by VdB was that the assumption that wind shear profiles remained unstable during the night-time period was wrong. The consequence of this was that due to the changing nature of wind turbine operation (from fixed speed wind turbines to variable speed wind turbines) the determination of the operating conditions for the turbine based upon measurements at 10m agl could result in errors of noise level prediction of the order of 15 dB. Existing historical site wind speed data for the Llaithddu Wind Farm indicate that such errors will not occur for the proposal.

Furthermore, due to the intense level of wind shear found at the site in North Western Germany, the normal aerodynamic noise associated with the rotation of the turbine blades became more intrusive. VdB developed a model that attributed this increased AM to the angle of attack seen by the wind turbine blade at different locations on the disk described by the wind turbine blades.

In January 2004, Hayes McKenzie Partnership undertook a study of low frequency noise which was alleged to have caused ill health to some of the occupants of properties neighbouring wind farms in the UK. This study indicated that rather than low frequency noise and infrasound (sound located in the frequency spectrum range between 0 and 200 Hz) giving rise to noise annoyance, the data indicated that it was the audible modulation of the sound which was being identified as causing the complaints. In general, the incident noise levels external to properties and noise levels measured inside properties associated with the operation of the wind turbines was not sufficient to awaken a sleep resident. However, in the event that an occupant awoke during the night, then there could be periods of turbine operation (dependent upon weather conditions and operating conditions of the wind turbines) which resulted in the sound being audible within the properties. The recommendations from this report were that this issue should be further studied. As a consequence, the University of Salford were awarded a contract to consider the issue of AM in more detail.

The Salford Report indicated that, at the time of the investigations, four wind farms were identified as potential experiencing EAM. Mr Weller indicates within his submission at paragraph 17 that MAS Environmental assert that they have evidence of it occurring at over 30 wind farms, although no detail is provided as to which wind farms these may be. There are currently over 430 operational wind farms. Therefore, if we assume that the assertions of MAS Environmental are correct then this would equate to around 7% of wind farms currently operating may experience this issue. This compares with the original Salford Report analysis of around 3% confirmed EAM wind farms (4 out of 133) and around 12 % confirmed and possible wind farms that may experience EAM. Therefore, it would seem that despite the continued installation of larger wind turbines since 2007, there is no significant change in the potential for this character in the noise to have increased.

Mr Weller then continues with a review of various reports and documents which have been issued since this date. However, I would comment as follows on two of his identified documents.

At paragraph 74, reference is made to the IoA Good Practice Guide. It is of benefit to inform the Inspector that the issue of AM was considered by the IoA Working Group. The statement within the IoA GPG dealing with AM should be considered with respect to the evidence

available at the time. A prime issue is that there is no objective measurement method which has been tested to determine a dose-response relationship. As a consequence, suggesting any “limit” for the acceptability or not of EAM would be a shot in the dark. It should be noted that the IoA GPG is free to be updated as and when further research becomes available. Since this is a document owned by the IoA, it is for the IoA to review the document when and if they think sufficient additional evidence has become available to inform and provide recommendations for the assessment of this potential character of wind turbine noise.

Mr Weller also makes reference to the Den Brook Condition dealing with AM at paragraph 66. For exactly the same reasons as I have detailed above, since no dose response relationship exists, the setting of the arbitrary noise limit of 3 dB is based at best as a “hunch” and at worst a means by which to stop all wind turbine development in the UK.

The criterion for a breach of the Den Brook Condition for AM is that:

- a) A change in the measured $L_{Aeq, 125 \text{ milliseconds}}$ turbine noise level of more than 3 dB (represented as a rise and fall in sound energy levels each of more than 3 dB) occurring within a 2 second period.
- b) The change identified in (a) above shall not occur less than 5 times in any one minute period provided the $L_{Aeq, 1 \text{ minute}}$ turbine sound energy level for that minute is not below 28 dB.
- c) The changes identified in (a) and (b) above shall not occur for fewer than 6 minutes in any hour.

The criterion means that a modulation of the noise level as identified within ETSU-R-97 as typical of wind turbines (a peak to trough of 3 dB); that occurs for a period of no more than 10 seconds in any 1 minute period; and more than 6 times in an hour (i.e. a total of 1 minute exposure in an hour) is considered a breach of the condition. This condition seems to be designed to ensure no further wind farm development in the UK.

As a consequence, I consider it inappropriate to propose a Condition dealing with AM which is based upon no objective measurement method which has not been tested and compared to a dose–response relationship for the test method that might be specified.

It should be borne in mind that the tone penalty method within ETSU-R-97 was subject to such a rigorous study before adoption within ETSU-R-97 and the proposed conditions for the site.