

Application: CB/12/00718/VOC

Location: The Marston Vale Millennium Country Park, Station Road, Marston Moretaine, Bedford, MK43 0PR

Proposal: Variation of Condition: removal of condition 9 (refers to noise levels) of planning permission CB/11/04077/FULL (Erection of a wind turbine, up to 120.5 metres in height, and ancillary infrastructure)

Supporting statement on Amplitude Modulation

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on behalf of Blue Energy Marston Vale Ltd

1 INTRODUCTION

- 1.1 TNEI Services Limited (TNEI) have been appointed by Blue Energy Marston Vale Limited to provide technical support in respect of Application CB/12/00718/VOC. TNEI specialise in the planning and development of renewables, predominantly wind energy, and provide support and advice to both developers and public sector clients.
- 1.2 I hold the degree of Bachelor of Science in Environmental Sciences, a Diploma in Acoustics and Noise Control and a Diploma in Environmental Health, together with a Master of Science degree in Applied Acoustics. I have been involved with noise measurement and assessment since 1981 and have been a member of the UK Institute of Acoustics since 1987. I regularly attend both national and international conferences on acoustics topics, including wind farm noise, as part of my continuing professional development.
- 1.3 As a professional acoustician I am involved with the measurement, prediction and assessment of all types of community, workplace and environmental noise, and appear as an expert witness at public inquiry. My practical experience was gained initially during 10 years in the public sector working as an Environmental Health Officer (EHO) and for the last 20 years working within the private sector. I have experience of drafting and reviewing noise conditions related to the control of operational noise, including Other Amplitude Modulation (OAM). I will discuss the merit of such conditions within this statement.
- 1.4 In preparing this statement TNEI have considered:
- The noise assessment prepared by AMEC dated April 2010;
 - The report by MAS Environmental MASRepMMEAMCondMay2012;
 - The Planning Officers Report (Agenda item 13 Pages 119-140);
 - Supporting letter by Eversheds dated 12 February 2012; and
 - Site specific wind data.

2 What is amplitude modulation?

- 2.1 When used in the context of wind turbine noise amplitude modulation describes a variation in noise level over time; for example observers may describe a 'whoosh whoosh' sound which can be heard close to a wind turbine.
- 2.2 Amplitude Modulation is a frequent cause for concern raised by both opposition groups and occasionally Environmental Protection Officers. This phenomenon of amplitude modulation was recognised in ETSU-R-97 (p68):

'The modulation or rhythmic swish emitted by wind turbines has been considered by some to have a characteristic that is irregular enough to attract attention. The level and depth of modulation of the blade noise is, to a degree, turbine-dependent and is dependent upon the position of the observer. Some wind turbines emit a greater level of modulation of the blade noise than others. Therefore, although some wind turbines might be considered to have a character that may attract one's attention, others have noise characteristics which are considerably less intrusive and unlikely to attract one's attention and be subject to any penalty.'

- 2.3 By way of distinction I would term the AM discussed with the ETSU-R-97 and expected at most wind farms 'Normal Amplitude Modulation' (NAM). The noise assessment and rating procedure detailed in ETSU-R-97 fully takes into account the presence of this intrinsic level of NAM when setting acceptable noise limits for wind farms. Whilst NAM is not given a specific definition within ETSU-R-97 it has been suggested that at some operational wind farms Other Amplitude Modulation (beyond that anticipated within ETSU-R-97) has occurred, I shall refer to this feature of wind turbine noise as OAM.
- 2.4 The causes are not fully understood and consequently there is no agreed methodology that can be applied to predict OAM. The term OAM is increasingly used to describe an unusual feature of aerodynamic noise from wind turbines, where a greater than normal degree of regular fluctuation in sound level occurs at blade passing frequency, typically once per second. In 2008 Bowdler¹ reviewed available literature and conference papers on amplitude modulation and described the observed noise characteristics including directivity. At that time only speculative mechanisms for generation were described.
- 2.5 In a recent publication van den Berg notes² that even now few measurement results have been published in scientific journals and in describing possible causes he suggests several mechanisms may be operating, both in terms of noise generation and propagation. Although van den Berg is attributed with first

¹ Bowdler, R 'Amplitude Modulation of wind turbine noise', *Acoustics Bulletin*, pp31-35, July/Aug 2008

² Bowdler, R., Leventhall, G. (Ed), *Wind Turbine Noise, Chapter 5, Multi Science Publishing Limited, Essex 2011*

observing high night time shear conditions resulting in higher turbine noise levels, he now suggests this in itself may not be enough to result in enhanced levels of AM, but postulates that the ground level wind that generates background noise may be too low to mask the normal AM, thus making it more audible. He acknowledges this is pure speculation. He has shown, in theory, that changes in wind speed seen by the blade tip at top and bottom of its range for tall turbines can result in periodic variations in sound power level, also that periodicity (the variation in turbines moving into and out of synchronization) can occur frequently under stable atmospheric conditions. This latter mechanism is not relevant to single turbines.

2.6 MAS state (paragraph 1.39) that there is a significant risk of amplitude modulation that requires control in this case and that a 3dB peak to trough level allows an adverse impact, noting it is not a cut off point but a significant intrusion. Clearly ETSU-R-97 anticipated variations of 3dB and deemed it acceptable. The application of ETSU-R-97 is endorsed by national policy, specifically NPS EN-1³ identifies [Section 5.11.4] key issues to be addressed by an ES noise assessment, referring to further guidance on renewables in EN-3⁴ which in turn provides explicit support for the use of ETSU-R-97 [para 2.7.56]. Should the Local Authority choose to embrace the MAS viewpoint this would clearly be at odds with national policy, which deems the impacts identified within ETSU-R-97 as acceptable.

2.7 In 2005 consultancy Hayes McKenzie Partnership were commissioned by the DTI to investigate reports of low frequency noise emissions from wind farms. Their report⁵ concluded that the complaints were not in fact caused by low frequency noise, but by amplitude modulation of aerodynamic noise from the wind turbines. They noted:

'the presence of aerodynamic modulation which is greater than that originally foreseen by the authors of ETSU-R-97, particularly during the night hours, can result in internal wind farm noise levels which are audible and which may provoke an adverse reaction from a listener. This may take the form of increased time in returning to sleep for an occupant, although noise associated with the wind farms was not found to awaken the occupant.'

³ *Overarching National Policy Statement for Energy (EN-1)*, DECC July 2011

⁴ *National Policy Statement for Renewable Energy Infrastructure (EN-3)*, DECC July 2011

⁵ *'The Measurement of Low Frequency Noise at Three UK Wind Farms'* URN No: 06/1412, Berr, 2006

- 2.8 In response, the Government commissioned a further independent report to ascertain the prevalence of OAM on UK wind farm sites, to try to gain a better understanding of the likely causes, and to establish whether further research into OAM is required. That study⁶, undertaken by the Acoustics Research Centre of Salford University in conjunction with Hayes McKenzie Partnership, was carried out in four parts:
- A survey of Local Authorities with wind farms in their areas;
 - Further investigation of sites for which AM was identified as a factor;
 - A literature review; and
 - A survey of wind turbine manufacturers.
- 2.9 The questionnaires asked the Local Authority staff to select from a series of subjective terms to describe the noise complaints they had received. Multiple descriptions were possible for any complaint. The results showed that 27 of the 133 wind farm sites operational across the UK at the time of the survey had attracted noise complaints at some point. OAM was considered to be a factor in just four of those sites, and a possible factor in another eight. This range of figures was due in part to the ambiguity of the descriptions used. No effort was made to characterise the noise associated with any complaint using objective parameters.
- 2.10 Regarding the four sites, the authors noted that analysis of meteorological data suggests that the conditions for OAM would prevail between about 7% and 15% of the time. OAM would not therefore be present most days, although it could occur for several days running over some periods. The report noted that subsequently complaints had subsided at three out of these four sites, in one case as a result of remedial treatment in the form of a wind turbine control system.
- 2.11 The report did not identify a cause for OAM, but did make useful observations which add to our broader understanding of this phenomenon such as (page 39):
- 'Measurements of wind farm noise at sites in the UK indicate that where a wind farm has periods of increased AM, these are not necessarily related to periods of high wind shear'.*
- 2.12 This seems to be at odds with the findings suggested by MAS, where wind shear is cited as a key feature. TNEI has reviewed the site specific data on wind and the shear values observed are not unusual. These are summarised in Table 2.1 whilst further details on the analysis performed are provided in Appendix 1.

⁶ 'Research into Aerodynamic Modulation of Wind Turbine Noise: Final report', July 2007, Contract no NANR233

Table 2.1 Site specific shear values

	Quiet daytime (as described in ETSU-R-97)	Night time (as described in ETSU-R-97)
Shear value	0.26	0.28

- 2.13 Following release of the Salford Report a statement⁷ released by the Department for Business Enterprise and Regulatory reform (BERR) stated:

'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.'

- 2.14 No further work was undertaken. Following a successful Freedom Of Information request for the raw data, the original questionnaire responses were reviewed by others. Their reinterpretation of the original data suggested the incidence of OAM was higher, perhaps between 10%-16%. To my knowledge, none of the Local Authorities who originally provided responses were asked to clarify either their responses or their practical experience of OAM and no new questionnaires were prepared and circulated. No additional sites or new sites commencing operations since the original survey were considered, so any percentages expressed reflect only the original 144 sites. Questionnaires are difficult to construct, but any flaws inherent in the original study, due to lack of clarity either in the questions posed or the responses given, could not in my view be addressed by simply reinterpreting them.

- 2.15 There was no further response from any government department and to my knowledge there have been no further surveys of this nature. The Government response, which effectively gave very low priority to the issue of AM, was noted at the recent Langford inquiry (APP/P0240/A/11/2150950 19 Jan 2012), where Inspector Robin Brooks observed:

'56. However, although the Council's acoustic witness [Mr Stigwood of MAS] contended that there was general acceptance that EAM occurred at 10-16% of wind farms nationally, no cogent evidence was advanced to support that figure. A study by the University of Salford in 2007 considered that AM could be a factor in 4 of the 133 wind farms then operational in the UK and a possible factor in another 8. It concluded that the incidence of AM in the UK was low. Even taking account of the Council's acoustics witness' criticism that the study may have underestimated the incidence of the phenomenon, and his assessments at certain wind farm sites, there is no real challenge to that conclusion.'

⁷ Government statement on the findings of the Salford University report into Aerodynamic Modulation of Wind Turbine Noise, Department for Business, Enterprise and Regulatory Reform, July 2007. URN 07/1276

Importantly too the Government have seen no reason to change advice in PPS22 on using the ETSU methodology in response to the Salford report.'

3 The need for a condition

3.1 The Application seeks to remove Condition 9 of the planning permission CB/11/04077/FULL relating to Excess Amplitude Modulation. The Planning Officers report details the condition (pages 126-128) and for brevity there is no need to repeat that here.

3.2 I can state at the outset that I consider the Planning Officers report to be balanced and fairly comprehensive and I agree with the recommendation made.

3.3 MAS state (para 1.1):

'The question is, is there a foreseeable risk of this impact and can that risk be controlled by a condition'. Historically this has always equated with the requirement that a condition is "necessary".'

3.4 The historical context is not relevant, the appropriate guidance can be found in Circular 11/95. That guidance⁸ is extant and the principles it embodies are reiterated in the recently published National Planning Policy Framework.

3.5 MAS helpfully cite the recent Inspectors decision at Woolley Hill (APP/H0520/A/11/2158702), where at paragraphs 192 & 193 he stated:

'Whether or not an excess amplitude modulation condition would be necessary or precautionary is a matter of fine balance as the possibility of occurrence, or absence, cannot be gauged. In this particular case, the clamour for a condition is largely based on the experience of limited, largely unexplained, problems elsewhere; the doubts cast on the Salford study; and the example of Den Brook where an Inspector imposed two conditions relating to 'greater than expected amplitude modulation immissions'. The shortcomings of the statutory nuisance process are also a factor.'

3.6 However, none of these aspects, compounded by the lack of understanding on excess amplitude modulation, provide good reason for the imposition of a condition as a matter of routine or precaution. To my mind, on the basis of the evidence before me, the test of necessity has not been fully met.

⁸ Circular 11/95: Use of conditions in planning permission (para 15), DCLG, May 2006

- 3.7 Exactly the same situation has now arisen at Marston Vale, the evidence to support a condition relying upon limited and still largely unexplained occasional occurrences at a few other sites. MAS have provided no site specific evidence to support their claims of a higher than remote risk of OAM at this site.
- 3.8 Throughout the UK there are currently 342 operational windfarms⁹ ranging in size from single turbines such as the one proposed here to the largest site at Whitelee, Eaglesham Moor in Scotland with 140 turbines.
- 3.9 At paragraph 1.11 MAS express the view that 20-25% of windfarms exhibit OAM. That would equate to 85 wind farms exhibiting OAM and I can find no evidence to support this claim, either in documentation produced by MAS or elsewhere. If there is such evidence available I would question why MAS did not present this at the Langford inquiry.
- 3.10 My understanding of planning conditions, as an Acoustician rather than a Planner, is that any condition should be site specific, based upon necessity and determined by the facts of a particular case. Planning conditions must be necessary. The guidance provided is clear, the argument that a condition will do no harm is no justification for its imposition; no substantive, site specific evidence has been presented here to indicate a higher than usual remote risk of OAM and conditions should not be imposed unless there is a specific need for them. This same argument was put to Inspector Griffiths at Low Spinney (paragraphs 82 & 83 APP/F2415/A/09/2109745) during the conditions session who declined to impose an OAM condition. That site was subsequently built and now operates, as anticipated, without incident.
- 3.11 MAS seem to be suggesting in paragraph 1.14 and 1.21 that the case for necessity has already been demonstrated and all that remains is to consider the sufficiency of the metric that they, and they alone, propose. That in my view is not the case.
- 3.12 Here at Marston Vale the Local Authority have imposed an OAM condition on the recommendations of MAS, despite the absence of any evidence or specific circumstances suggesting more than a reasonable likelihood of OAM. In my experience this is most unusual, I am aware of only two other sites where this has occurred.
- 3.13 The issue of necessity has been considered at numerous public inquiries. I have reviewed a number of decisions from the last two and a half years, to help put the OAM question into context and to demonstrate that OAM conditions have not been considered necessary at any Inquiry since Swinford and Den Brook.
- 3.14 At Swinford (Dec 2009 APP/F2415/A/09/2096369), the Secretary of State imposed (para 24) a subjective OAM condition, which had been agreed between the parties. Then again in that same month, at the second Den Brook Inquiry (Dec 2009 APP/Q1153/A/06/2017162), Inspector Pykett imposed a condition, noting

⁹ RenewableUK website <http://www.bwea.com/ukwed/index.asp> (last accessed 19/6/2012)

that the factors he identified from the evidence given were largely based on anecdotal evidence; two and a half years on and the situation is still much the same, although a number of prominent researchers are investigating the phenomenon. These two appeal decisions stand at odds, both with the earlier decisions up to that point and with subsequent decisions, such as Sober Hill (Feb 2010 APP/E2001/A/09/2101421), Low Spinney (29 March 2010 APP/F2415/A/09/2109745) and Wryde Croft (APP/J0540/A/08/2090541).

- 3.15 The issue for potential OAM has been debated extensively at Inquiry across the UK, consuming significant amounts of inquiry time without any real benefit. At Cotton Farm (APP/H0520/A/09/2119385, 14 December 2010) Inspector Martin Pike (para 87) reviewed evidence from MAS on behalf of the local opposition group, who suggested that several factors pointed to an increased risk of OAM and proposed a precautionary approach. In allowing the appeal the Inspector stated:

'89. Given the small number of sites where excess AM has been proven, statistically the odds are very much against it being a problem at Cotton Farm. I appreciate that some similarity with problem sites (such as Deeping St Nicholas) might be argued to reduce the odds somewhat, but not to the extent that it can reasonably be regarded as a distinct possibility, let alone a probability, in my view. Thus I find no compelling evidence that warrants an approach to AM in this case which differs from that taken in ETSU-R-97. In these circumstances I do not believe that the suggested condition satisfies the test of necessity, even on a precautionary basis.'

- 3.16 That was one of the earlier inquiries where evidence put forward by MAS failed to satisfy the Inspector. Since then at inquiries where I have personally been involved an OAM condition has been proposed by opposition groups but rejected consistently e.g. Westnewton (6 May 2011 APP/G0908/A/10/2132949), Burnthouse (6 July 2011 APP/D0515/A/10/2131194) and at Spaldington (APP/E2001/A/10/2137617 29 September 2011) where Inspector Baird found the condition proposed by MAS on behalf of the opposition group, based upon the Den Brook condition, failed the tests of Circular 11/95.

- 3.17 Similar conditions have more recently been rejected at Kirkharle (APP/P2935/A/10/2136112, 4 Nov 2011) both by the Local Authority and by Inspector David Rose who concluded that the proposed condition failed the test of necessity, was unenforceable, imprecise and unreasonable (para 106 to 111). Again at Langford (APP/P0240/A/11/2150950 19 Jan 2012) where Inspector Robin Brooks said (para 58) he was unconvinced there was a real possibility of amplitude modulation at the site and expressed concern over the enforceability of the proposed condition.

- 3.18 Most recently at the Woolley Hill appeal (APP/H0520/A/11/2158702 23 March 2012), in response to requests for a condition by the opposition group Inspector Rose demonstrated he had comprehensively assessed both the need for and lawfulness of an OAM condition. He concluded that such a condition was not necessary and would fail the tests set out in Circular 11/95. He stated:

'202. Overall, without an agreed robust methodology for measuring

excess amplitude modulation, based on convincing research, it would be unreasonable to impose a condition on such an uncertain basis.

203. In conclusion, despite the findings of the Inspector in the Den Brook case, the evidence presented to me does not provide convincing justification that an excess amplitude modulation condition would be necessary. In addition, such a condition, if imposed, would be unreasonable given the current limited knowledge and understanding of excess amplitude modulation and a lack of consensus beyond the guidance of ETSU-R-97.'

- 3.19 I agree with the detailed analysis given by Inspector Rose in this decision letter and see no reason to depart from his findings in this case.
- 3.20 All of the appeal decisions I have reviewed from both the Secretary of State and the Planning Inspectorate since Den Brook have not included an OAM condition, despite the enthusiastic promotion of such conditions by MAS on behalf of both Councils and third party objectors.

4 The suitability of the metric proposed by MAS

4.1 Since an OAM condition was imposed at Den Brook, discussions surrounding its limitations, suitability and wording have been a feature of many wind farm inquiries. Proponents including MAS naturally point to the Court of Appeal decision¹⁰ as validation of such conditions, but fail to consider the limitations of that judgement; it focussed primarily on the construction of the specific wording of Conditions 20 and 21, where they were criticised for being difficult to interpret and opaque. Most importantly we must note that the Court was not asked to consider the science of OAM and was not deciding on the need for an OAM condition in any general way. Successive variants of the OAM condition have endeavoured to overcome some of the concerns identified at Den Brook.

4.2 My principal technical concerns with the condition is that it has not been developed in a scientific way. The essential characteristics said to represent OAM are defined typically in sub paragraphs of the condition. Each of these is based upon arbitrary numbers, such as a 3dB change, a 2 second period, 5 times in one minute, fewer than 6 minutes in an hour, not less than 28dB; none of these is based upon any peer reviewed evidence published in a recognised journal or debated by the wider acoustics community. The psycho-acoustic basis for their choice is untested. This was recognised in the AECOM report¹¹ (p21):

'It is suggested that the above method, whilst not simple or easy to implement, may provide a starting point in trying to quantify AM by direct measurement, although it does not represent a validated method of assessing the significance of any impact or effect on amenity, and does not constitute a threshold for Statutory Nuisance.'

4.3 At the Spaldington Inquiry (APP/E2001/A/10/2137617) I was able to satisfy Inspector Baird that these criteria could be met by birdsong I had recorded in my garden, which most people find to be innocuous, and he (para 81) subsequently found the condition failed the tests of Circular 11/95.

4.4 Others have also highlighted the failings of the condition. A recent article¹² by Dr Jeremy Bass of RES presented a detailed study they conducted on the application of the 'Den Brook' condition (which was their scheme). They took 184 hours of measurements at their proposed Turncole¹³ Wind Farm in Essex. Detailed analysis indicated that 41% of the measurements failed the 2 second criteria, 72% failed the 1 minute criteria and 92% failed the 1 hour criteria. This suggests that the site comprehensively failed the conditions, yet there are no wind turbines and no OAM, just rural background noise. At the IOA Wind Turbine conference in Cardiff 25th January 2012, Dr Bass stated he had revised these figures slightly due to errors in the original data processing but this has not altered the overall result. It is evident that the Den Brook style of condition, as drafted and presented albeit

¹⁰ [2011] EWCA Civ 638 *Hulme v Sec State for Comms and Local Govt & Ors* , para 31

¹¹ Wind farm Noise statutory Nuisance Complaint methodology, Defra Contract NANR277, AECOM, April 2011

with subtle amendments in this case, is not robust or reliable and cannot be considered fit for purpose. MAS suggest (paragraph 1.23) that concern over false positives are simply red herrings. I cannot share that view.

4.5 As Dr Bass points out, there are no references to the testing of the method, nor is the basis of the underlying method given.

4.6 The Renewable Energy Foundation recently published a web article¹⁴ on the Den Brook AM condition, which concludes:

'We believe that this exercise demonstrates that the Den Brook condition is straightforward and that it is possible for this condition to be employed in a transparent and objective manner to demonstrate the existence of excess AM in wind turbine noise'.

4.7 The analysis of background noise by RES clearly shows this not to be the case. In my opinion, any condition based around the original Den Brook condition format is fatally flawed.

¹² Bass, J. Investigation of the 'Den Brook' Amplitude Modulation methodology for wind turbine noise, IOA Bulletin November /December 2011

¹³ <http://www.turncolewindfarm.co.uk/the-project/turncole-wind-farm.aspx>

¹⁴ <http://www.ref.org.uk/publications/242-the-den-brook-amplitude-modulation-noise-condition>

5 Conclusions

- 5.1 In my opinion the noise condition included as Condition 8 is sufficient to protect the amenity of residents.
- 5.2 MAS suggest that wind shear is a key factor relevant for this site, although the exact role wind shear plays in the occurrence of amplitude modulation is still subject to debate and investigation. TNEI have reviewed the available wind shear data and the calculated shear figures are not unusual.
- 5.3 MAS have presented no site specific evidence to demonstrate a higher than remote chance of OAM occurring.
- 5.4 Any assertion by MAS that an OAM condition is both necessary and reasonable, despite the lack of any evidence to support such a proposal, is unfounded and does not meet the tests cited in circular 11/95. The recent adoption of the National Planning Policy Framework does not alter that requirement.

Appendix 1 - Wind Shear Analysis Method

Wind shear coefficients have been calculated using measured data from a wind monitoring mast installed onsite. A 30m wind monitoring mast was installed at the site. Anemometers measuring wind speed are located on the mast at heights of 15m and 30m.

Original calibration certificates and the mast installation report were not available and as such the raw data has been taken 'as read' and it has been assumed that any calibration adjustments have been applied in by the data logger (which is typical). Nevertheless calibration adjustments are usually very minor and as such TNEI feel that even if the adjustments have not been applied any differences to the shear results are unlikely to be significant.

Wind data recorded from 26/06/2007 to 06/12/2007 was analysed by TNEI. The data was screened upon receipt to remove any suspect or erroneous values.

Wind shear has been calculated using wind speed measured at 15m and 30m using the power law. The power law is a widely used empirical relation used to represent the atmospheric boundary layer wind profile and takes the form:

$$\frac{U_2}{U_1} = \left(\frac{H_2}{H_1} \right)^m$$

Where m is the wind shear coefficient, U is the horizontal velocity and H is the height above ground level.

Shear calculations for the site have been based upon 6 months of data, a wind shear model known as the "parameter-averaged" approach and splitting time periods according to ETSU-R-97. The results of calculated wind shear coefficients are given in Table A1.

Table A1 Average Wind Shear Coefficient

	Quiet daytime (as described in ETSU-R-97)	Night time (as described in ETSU-R-97)
Shear value	0.26	0.28