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Information Note

19 March 2014

The Efficacy of the Renewables UK (RUK) Condition in Controlling Wind Farm Amplitude Modulation (AM) Noise

1. Summary of findings

1.1. 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.

1.2. We 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.

1.3. 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.

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

1.5. The RUK AM condition is limited to a maximum penalty of 5dB linked to overall noise levels, so where there is 5dB headroom – which is often the case at night-time when ETSU-R-97 wind farm noise limits are higher, background noise levels lower and AM more likely to be a nuisance – there is no sanction against AM of any level or duration.

1.6. It is unreasonable to treat the annoyance arising from the beating noise character of wind farm AM noise as an adjunct to the total sound levels rather than as a distinct problem in its own right. Applying a correction to the measured sound levels will not address the issue of noise complaints arising from excess AM noise; it should be treated as a standalone problem. This is because annoyance is not linked to overall noise level, but to its modulation even at low noise levels. It is AM that has to be removed not just compensated for in a way which is demonstrably ineffective.

2. Introduction

2.1. The distinctive and repetitive blade swish noise of wind turbines, known as amplitude modulation (AM), is the cause of most wind farm noise complaints. In December 2009 a specific AM noise condition was included by a planning inspector in the permission for the Den Brook wind farm. REF published a note in October 2011 demonstrating that this Den Brook Amplitude Modulation condition could be applied in a straightforward and transparent way to actual wind farm noise data and employed to demonstrate the presence of excess AM likely to cause complaints.[1]

2.2. The wind industry has fiercely resisted the Den Brook condition, but in 2010 acknowledged that AM could not be ignored, and as a consequence Renewable UK (RUK), the wind industry trade lobby, set up a working group to investigate the issue. This working group published a number of reports in December 2013, including an alternative AM noise condition.[2]

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[1] http://www.ref.org.uk/publications/242-the-den-brook-amplitude-modulation-noise-condition

[2] See reports dated 16 December 2013 at http://www.renewableuk.com/en/publications/reports.cfm. There are separate publications for the RUK AM condition and the Rationale for the RUK AM condition. High resolution copies of the 8 research papers are available via the following links.

Work Package A1: Source generation effects modelling;

Work Package A2 Fundamental Research into Possible Causes of Amplitude Modulation;

Work Package B1 Development of an Objective AM Measurement Methodology;

Work Package B2 Development of an AM Dose-Response Relationship;

2.3. This current note is a companion piece to our investigation of the Den Brook noise condition and carries out the analogous exercise of applying the RUK AM condition to real wind farm data.

3. The RUK AM condition

3.1. The proposed RUK AM noise condition is not accompanied by any evidence demonstrating its efficacy. It is complex, computationally intensive and compliance or breaches cannot be transparently demonstrated. In fact, such is the level of complexity that testing compliance with the condition requires a bespoke computer program written by a wind energy company, and whose underlying source code is commercially confidential.

3.2. It was proposed by the RUK in December 2013[3] that software would be provided in the form of a 'black box' program. By 'black box' we mean software where the underlying code is not available and so cannot be validated or easily replicated in free, open-source software. This 'black box' was not provided in December 2013 with the rest of the material but is now available on the RUK website.[4]

3.3. Like the Den Brook AM condition the threshold depth of AM deemed to be unacceptable is 3dB. However, unlike the Den Brook AM condition, the RUK condition does not treat AM noise as a distinct problem related to the annoyance produced by the beating character of the noise and requiring a standalone noise condition. Instead, it defines a maximum penalty of 5dB to be linked to the overall wind farm noise level. This means that where there is 5dB headroom between turbine noise and noise limit, AM noise of any magnitude and for any duration is permitted.

3.4. The choices of a penalty mechanism and its range of 3dB to a maximum of 5dB were apparently based on the results of listening tests carried out by the

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Work Package C Collation and Analysis of Existing Acoustic Recordings

Work Package D Measurement and Analysis of New Acoustic Recordings

Work Package F Collation of Work Package Reports and Final Reporting

Work Package G Mechanism and Causes of AM

[3] See Question 2 Page 8 of the Rationale of the RUK AM Condition

[4] http://www.renewableuk.com/en/OAMsoftware/

University of Salford and described in Work Package B2. We believe the logic linking the test results to the AM condition is flawed and the tests themselves inadequate. A commentary on the Salford testing is covered in Appendix 1.

3.5. As we demonstrate in the following section, the multiple steps required by the proposed condition involve repeated averaging of the blade swish noise resulting in a final scaled-down result that bears little resemblance to the actual magnitude of the blade swish noise experienced in reality, and is consequently highly unlikely ever to be breached. For this reason alone, we believe the RUK AM noise condition is not fit-for-purpose.

4. Noise data used in testing the RUK AM condition

4.1. We have used data from two separate wind farms to test the proposed RUK AM condition: the single E66 1.8 MW turbine known as Swaffham II located at Sporle Road, Swaffham, Norfolk; and the seven Vestas V47 660/200 kW turbines installed at Askam in Cumbria in August 1999.

4.2. The Askam data formed part of a Government sponsored study into wind turbine noise carried out by the Hayes Mackenzie Partnership (HMP) and released following a Freedom of Information request.[5] Askam is a key example for benchmarking the efficacy of any AM noise condition because a greater number of noise complaints concerning the beating noise of the turbines have been made for that site than at any other site in the UK.[6] Following early complaints, the owners of the wind farm implemented a Noise Reduction Management System involving the reduction of turbine output for selected wind directions and wind speeds. However, these measures do not appear to have been successful since neighbours are still complaining of excess and unacceptable noise.

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[5] Described in http://www.ref.org.uk/publications/242-the-den-brook-amplitude-modulation-noise-condition

[6] Salford Report on AM http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/files/file40570.pdf and http://www.ref.org.uk/publications/151-ref-publishes-data-on-wind-farm-noise-obtained-under-the-freedom-of-information-act

4.3. The 2006 study by HMP for the DTI reported that the audibility of the high levels of AM with peak-to-trough levels of up to 5-6dB inside dwellings caused sleep problems at night for the Askam neighbours.[7] This resulted in a recommendation that overall wind farm noise levels should be reduced at night with additional penalties where noise contained high levels of AM.[8]

4.4. The complaints about and measurements of AM at Askam were the trigger for subsequent Government and industry work on the impacts of AM and thus it is obvious that a reasonable test of a proposed AM noise condition is whether it is breached by the Askam noise data collected for the 2006 DTI report. In other words, if the Askam data does not breach the condition, the condition can hardly be expected to offer any significant degree of protection to residents.

4.5. The Swaffham dataset containing AM noise was measured in September 2013 by the acoustician Mike Stigwood as part of the evidence presented at the fourth Shipdham wind farm public inquiry. This data has the advantage of being measured 487 metres from a single turbine at a time of high wind shear when the turbine noise displayed very large AM peak to trough variations of 10dB and above, and consequently would also be expected to breach the RUK AM noise condition.

5. Worked example of the RUK AM condition

5.1. The detailed procedures for the RUK AM condition are described in Guidance Note 4 of the condition and are complex, involve multiple steps and are computationally intensive.

5.2. The condition seeks to obtain a value of parameter **A**, which is described as the “overall, objective measure of the level of amplitude modulation”. The value of parameter **A** is *related* to the peak-to-trough level of the blade swish noise but by virtue of the processing needed to obtain the value *understates* the true peak-to-trough levels, as will be subsequently demonstrated in this section.

5.3. In summary, there are four fundamental problems with the condition:

- The use of a succession of averages scales down the impacts

[7] http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/files/file31270.pdf#page=63

[8] http://www.denbrookvalley.co.uk/resources/FOI+Commentary_+HMP+Draft+Reports+-7+Dec+09-2.pdf

- The condition is extremely complex and precludes the Local Authority from testing for compliance
- The particular use made of the mathematical Fourier transform technique understates the true peak-to-trough of the AM noise
- The use of a small sliding penalty, derived from the averaged Fourier transform data and tied to the overall noise levels, means breaches of the condition will be highly unlikely even for very high levels of AM.

5.4. In the following sections these problems will be considered in turn and in greater detail from various perspectives and under a variety of headings.

The RUK Condition averages AM over long time intervals understating the true impact

5.5. Guidance Note 4(b) (via the reference back to Guidance Note 2) prescribes a **minimum** length of time of 200 minutes for compliance testing. There is no maximum length of time specified and this means that it is possible, by measuring over a sufficiently long period of time, to obtain an average AM level that will inevitably fall below the threshold at which the condition would be breached.

The Complexity and size of datasets required preclude Local Authority (LA) testing for compliance

5.6. The condition requires the minimum 200 minutes (or greater) noise sample to be broken down into its constituent ten minute periods. Each ten minute period out of the minimum of twenty such periods, is further broken down into ten second chunks, each consisting of 100 LAeq noise levels measured every 0.1 of a second. Thus, a minimum of 120,000 measurements[9] must be analysed to determine compliance. This clearly precludes a simple semi-manual analysis as is possible with the Den Brook AM condition.

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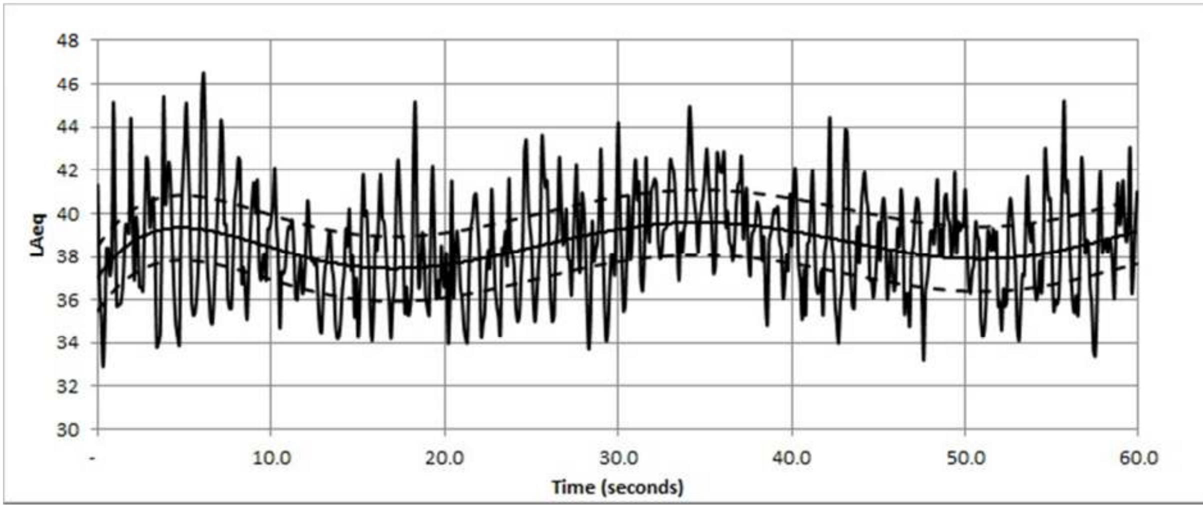
[9] 120,000 = 20 ten minute periods x 10 minutes per period x 60 seconds per minute x 10 measurements per second as specified in the condition

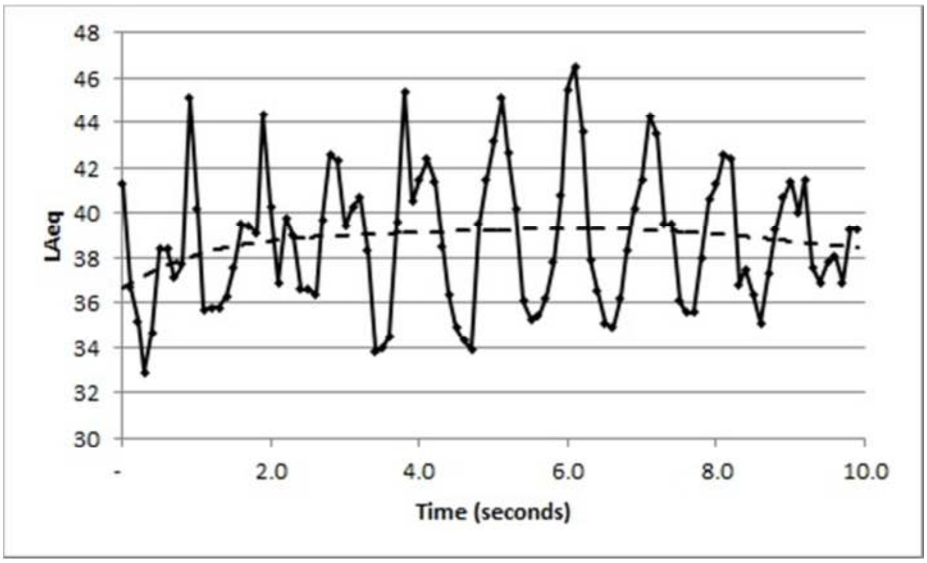
Figure 1. A sample of 1 minute of AM data measured at 02:06 on 30 September 2013 at Swaffham. The RUK AM condition requires this one minute sample to be split into 10 second chunks as identified by the vertical bars. The dotted lines show the amplitude of 3dB amplitude peak-to-trough to give a sense of the level of AM present.



The succession of mathematical manipulations results in understated peak-to-trough values

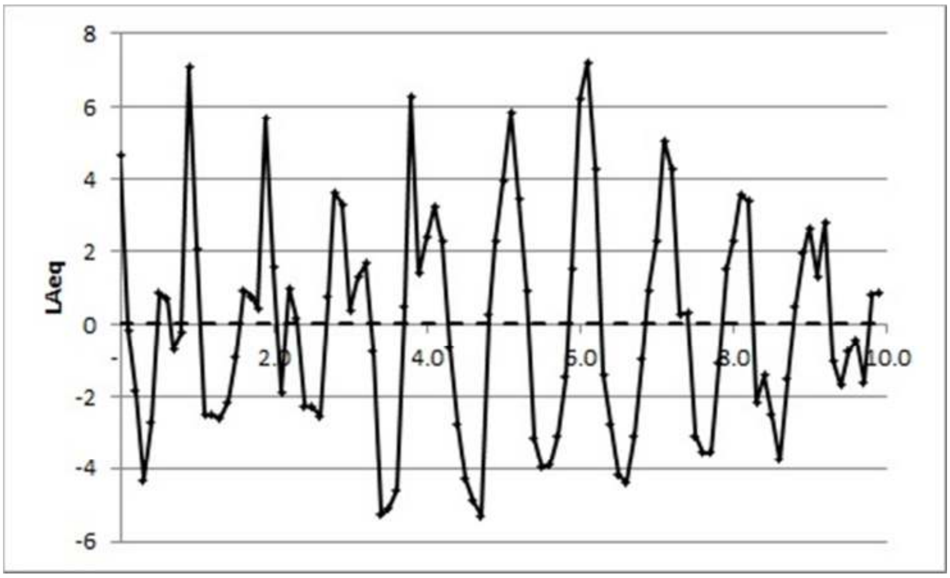
5.7. The RUK AM condition then specifies at Guidance Note 4(c)(iii) that each 10 second section of the data should be transformed by the mathematical procedure known as a Fourier transform (which is explained below). However, this procedure requires that the oscillations typical of the AM need to be adjusted such that they fluctuate about zero rather than the actual noise level. To achieve this, the condition requires a 5^{th} order polynomial (4(c)(ii)) to be fitted to the data, and this is used to approximate the midpoint of the oscillations. Figure 2 shows this stage of the condition using the first ten seconds of the example in Figure 1 above.

Figure 2. The first 10 seconds of data from Figure 1 with the dotted line showing the best fit 5th order polynomial as required by the RUK AM condition for the 'de-trending'. Guidance Note 4(c)(ii)



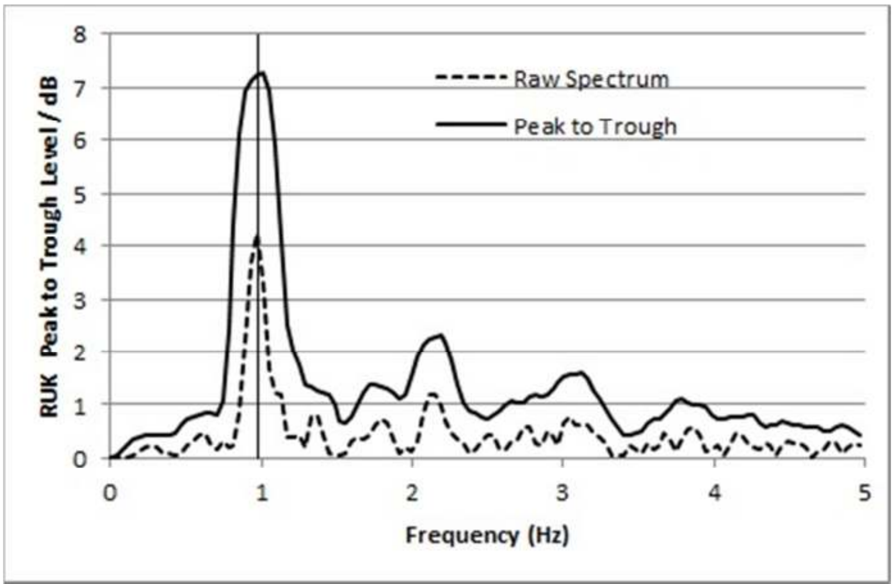
5.8. The RUK AM condition uses the word 'de-trending'; this means subtracting the dotted line in Figure 2 from the noise data to yield a plot as in Figure 3, where the AM noise is supposed to oscillate evenly about zero. However, it is clear that the peaks extend further above the horizontal axis than below, indicating that the detrending process has not been successful. This is probably a result of the peaks being sharper than the troughs, and indicates flaws in the 'de-trending' methodology.

Figure 3. The first 10 seconds of data from Figure 1 after 'de-trending' (subtracting the best fit 5th order polynomial). Guidance Note 4(c)(ii)



5.9. The next step, 4(c)(iii), requires the data above to be 'Fourier-transformed' and scaled. This is described in very general terms in Guidance Note 4(c)(iii), (v) and (vi), but the actual methodology can be gleaned from the RUK Matlab script.[10] To aid explanation, it is useful to see the output of this stage, which is shown in Figure 4. The output consists of the constituent frequencies of the oscillating noise levels in Figure 3. The peak shows the frequency of the turbine blade swish beats per second.

Figure 4. The results of the Fourier transform of the data in Figure 3 after scaling according to the RUK AM condition software. The main peak indicates a blade passing frequency of 0.98 Hz and a peak-to-trough depth of 7.2dB.



5.10. A Fourier-transform is a mathematical technique to convert data that varies periodically with time into its constituent frequency components. In other words, when Fourier-transformed, the oscillating data in Figure 3 yields the main peak in Figure 4 at 0.98 Hz. This is marked with the vertical line in the figure. This indicates that the turbine at Swaffham was emitting AM noise with beats at the rate of 0.98 per second or roughly 1 per second. This is equivalent to 60 beats per minute, which is also equivalent (since there are 3 blades contributing to the beating noise) to the turbine rotating at approximate 20 rpm

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[10] Matlab is proprietary computer software useful for complex mathematical and statistical processing. The RUK 'black box' code for the AM condition is written in Matlab script. The actual code underpinning the Matlab script is commercially confidential. However, we can provide copies of the Matlab script on request.

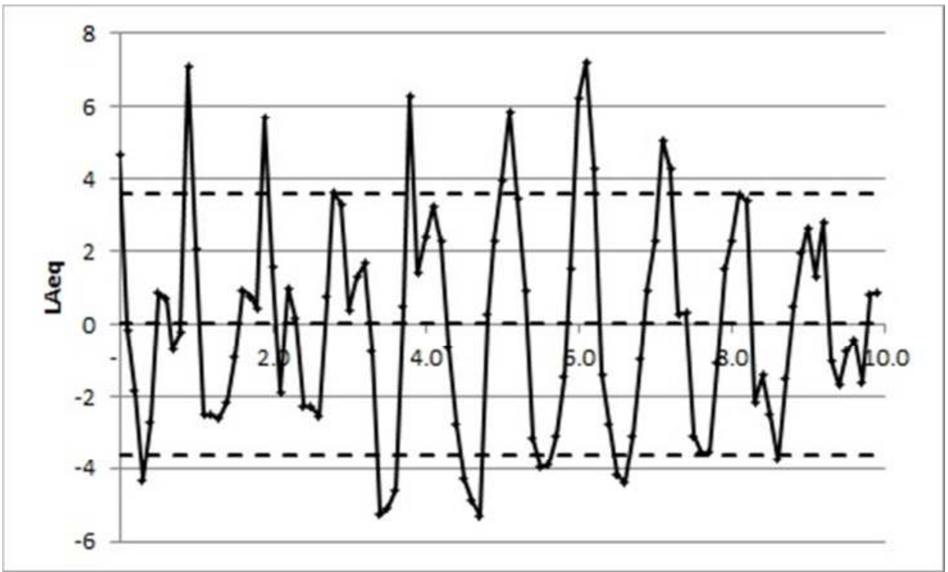
(60/3). This agrees with what we see in the raw data at Figure 2 where there are ten peaks or 'beats' in the 10 seconds.

5.11. The RUK AM condition specifies that the estimate of the peak-to-trough of the AM noise is the area under the main peak in the dotted line in Figure 4, including frequencies from 10% below the peak frequency to 10% above the peak frequency. The solid line in the figure is a cumulative total of a window 20% wide and its peak gives the quantity required in the RUK AM condition (i.e. the value of **A** referred to in Guidance Note 4(c)(vi) is 7.2dB in this example).

The RUK AM condition calculation significantly understates true peak-to-trough values

5.12. The following figure is a plot of the RUK value for the AM level superimposed onto the original time plot of the data. The dotted lines at +3.6 dB and –3.6 dB (i.e. a peak-to-trough value of 7.2 dB) show how the RUK condition figure understates the true amplitude modulation with the majority of the peaks and troughs exceeding the RUK result. This is a classic instance of averaging tending mask reality.

Figure 5. The dotted lines at +/- 3.6 dB show the RUK assessed level of AM plotted against the real AM oscillations revealing that the RUK value understates the true value.



The RUK AM condition results are less than peak-to-trough values used in RUK listening tests

5.13. Using the Salford University methodology of averaging peaks and troughs, as in Work Package B2, yields a peak-to-trough value of 9 dB (i.e. some 2dB greater than the RUK AM condition methodology which relies on the results of that work package).

5.14. This understatement of the true level of AM by the RUK condition methodology is not surprising because it only takes into account the size of the fundamental frequency component and neglects any harmonics occurring at two and three times the fundamental frequency.[11]

The condition requires very large numbers of calculations to test compliance

5.15. We have already noted the process for a single 10 second sequence of data. This process has to be repeated a minimum of 1,200 times to obtain 60 values of the RUK condition value of **A** (as defined at 4(c)(vi)) for each of the minimum of 20 ten minute periods. The twelve highest values of **A** in each ten minute period are averaged, and if the frequency obtained at the Fourier-transform stage is plausibly that of the blade rotational frequency of the wind turbine(s).

The RUK AM condition prescribes two further averaging steps

5.16. These average values are then plotted against the wind speed during that ten minute period (4(g)). (However, the condition does not specify how that wind speed measurement should be taken: is it 10m measured wind speed, hub height wind speed, or 10m standardised wind speed?)

5.17. A least squares line is fitted to the data to find the average of these averages (4(h))

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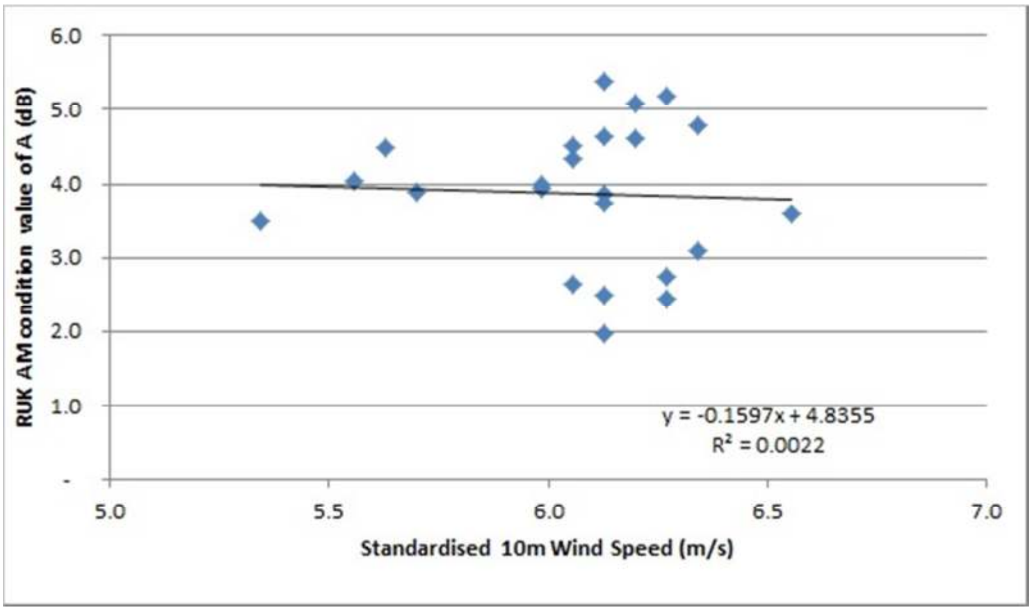
[11] If the AM noise was a pure tone there would be a single peak in the Fourier-transformed plot. However, because the AM noise is distorted with sharp rises the Fourier transformed plot has peaks at the fundamental blade passing frequencies and peaks at integer multiples of that frequency. Only by including the amplitude contributions from these higher order harmonics does one get close to accurately deriving the true peak-to-trough values of the AM.

5.18. Carrying out this process for the Swaffham dataset gives the results shown in the following graph.

*Figure 6. A plot of the average RUK amplitude **A** values as determined by the RUK AM condition with a "best fit" linear regression line to find the average of the averages following 4(h) and 4(g) of the proposed RUK AM condition.*



The result of the RUK AM condition processes is the minimum possible penalty

5.19. The final result of all these calculations is that the **average** of the **average** peak-to-trough AM at Swaffham on the night of 29/30 September 2013 is 4dB for a wind speed of 6m/s. The condition at 4(i) indicates that this level attracts a penalty of 3dB.

The RUK Condition's minimum penalty with increased headroom means no breach

5.20. This penalty is applied to the ordinary noise levels. The measured ordinary noise level at Swaffham was approximately 36dB, so a 3dB penalty would raise that level to 39dB. The **minimum** ETSU-R-97 night time noise limit is normally 43dB, so it can be seen that this high level of AM, when subjected to the series of successive averages prescribed in the RUK AM noise condition, will fall a long way short of breaching that condition.

5.21. The conclusion is that the very high level of AM recorded at Swaffham is still not high enough to trigger a breach of the proposed RUK AM condition. It follows that such a condition will not protect neighbours from AM noise nuisance.

6. Results for the Askam dataset

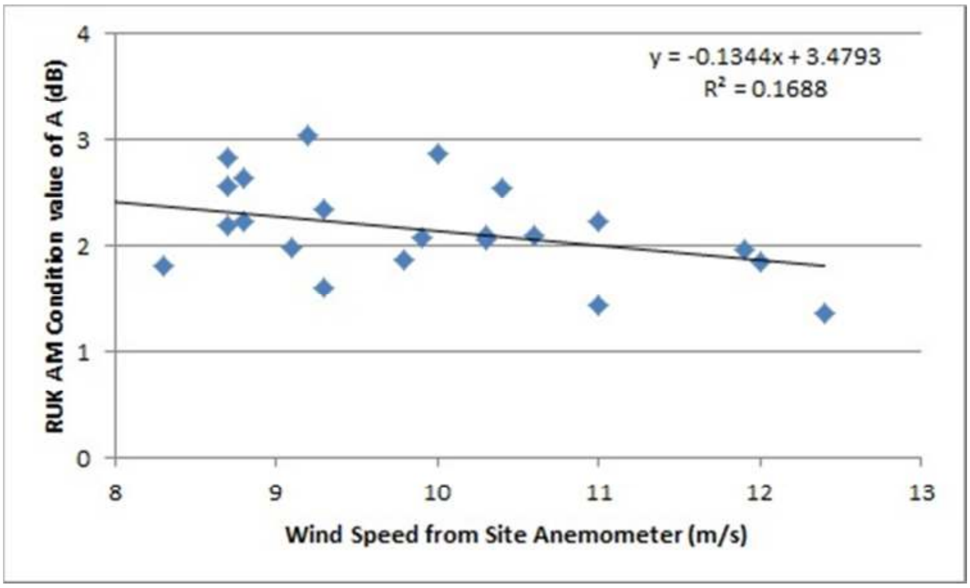
6.1. The same procedure as described above in relation to the Swaffham data was applied to Askam dataset, namely to the measured noise levels at Location 1, Site 1 for the 14 May 2005 from midnight until 4am. This cut-off was chosen because of the onset of the dawn chorus.

6.2. Although AM noise is clearly audible in the measured data and visible in the plotted data over these 4 hours, the data contained a contaminating intermittent 'squeak'. The presence of this intermittent contaminant combined with the RUK AM methodology requiring the average of so many consecutive periods of data reduced the number of valid periods for analysis.

6.3. Furthermore, it is clear that the multiple turbines result in periods of elevated AM when the rotational rate of several turbines are synchronised followed by periods of reduced AM as the turbines move out of synchronicity. The RUK AM condition is poor at addressing this situation for two reasons. Firstly, the varying rpm of the turbines result in a spread-out Fourier transform with extra energy in the second and higher harmonics exacerbating the understatement of the peak-to-trough values. Secondly, neighbours specifically complain that the way that AM noise levels rise and fall is a particular irritant, whereas the RUK AM condition offsets rises against falls via the averaging process.

6.4. The following graph shows the measured parameter **A** for the Askam data plotted against wind speed from the on-site anemometer.

*Figure 7. A plot of the average RUK amplitude **A** values for the Askam data measured between 00:00 and 03:00 on 14 May 2005 as determined by the RUK AM condition with a "best fit" linear regression line to find the average of the averages following 4(h) and 4(g) of the proposed RUK AM condition.*



6.5. The RUK AM condition requires the fitted line in Figure 7 at any integer wind speed to be equal or greater than 3dB before any penalty for AM noise is deemed necessary. Thus Figure 7 shows that the noise levels at Askam do not breach the RUK AM condition.

6.6. If the RUK AM condition is incapable of protecting the neighbours at Askam from AM problems that are generally recognised to be severe, and which have been the trigger of successive reports and investigations since 1999, it is clear that the condition is unlikely to be generally fit for purpose. In other words, no wind farm neighbours where the RUK AM condition is applied can have any confidence that they are protected from conditions such as those at Askam, which are acknowledged to be severe.

7. Conclusions

7.1. We have shown that 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.

7.2. We 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.

7.3. 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.

7.4. Furthermore the process prescribed by the condition results in an understated value of the true peak-to-trough levels of the AM noise. This is obviously unacceptable.

7.5. The RUK AM condition is limited to a maximum penalty of 5dB linked to overall noise levels, so where there is 5dB headroom – which is often the case at night-time when ETSU-R-97 wind farm noise limits are higher, background noise levels lower and AM more likely to be a nuisance – there is no sanction against AM of any level or duration.

7.6. It is unreasonable to treat the annoyance arising from the beating noise character of wind farm AM noise as an adjunct to the total sound levels rather than as a distinct problem in its own right. Applying a correction to the measured sound levels will not address the issue of noise complaints arising from excess AM noise; it should be treated as a standalone problem. This is because annoyance is not linked to overall noise level, but to its modulation even at low noise levels. It is AM that has to be removed not just compensated for in a way which is demonstrably ineffective.

Appendix 1. Commentary on RUK's Justification for their AM Metric

1. Accompanying the released RUK material is an unattributed document entitled '*The Development of a Penalty Scheme for Amplitude Modulated Wind Farm Noise: Description and Justification*' which explains the claimed rationale for the noise levels selected in the proposed AM penalty scheme and purports to be based on the results of listening tests carried out at Salford University.
2. In our view the logic used is flawed, as are the results on which it is based.
3. The University of Salford testing is described in RUK Work Package B. There are a number of problems with the results of this testing:
    a. The age, number and representativeness of the participants is questionable
    b. The benchmarking of the responses is flawed
    c. Synthetic noise data is used rather than real-world recordings
    d. Flawed error test results have been relied upon for the RUK condition
    e. RUK AM noise condition AM not comparable to Listening Test AM
4. We will discuss each of these concerns in turn, as follows:

a. Age, Number and Representativeness of Participants

5. Firstly, the participants chosen to carry out the listening tests were few in number and consisted largely of students and young people attached to the University; for example, five of the participants were from the local secondary school on work placement. In the case of the tests particularly relied upon in setting the AM condition metric, there were only 20 participants, 15 of whom were aged 30 or under. The two oldest participants were under 55 years of age.
6. The authors were obviously conscious that the participants were not representative of a rural community. At page 86, it states 'To widen the age range and background we also attempted to recruit participants from a rural area away from existing wind farms to avoid pre-sensitisation bias.' It is not made explicit whether this attempt was successful.
7. We see at page 112 that one of the participants did not understand the word 'annoyance'. In such a small sample size, such problems with individual participants undermine the validity of the conclusions drawn.

b. Benchmarking of responses flawed

8. Among the tests, the participants were asked to listen to a synthesised noise designed to represent garden noise through headphones in a computer music room and to set the volume to the level "that you would hear in your garden (imagine your garden has trees and/or bushes in it, even if it doesn't in reality)". (page 110, Work Package B2)
9. The response to this garden noise became the reference to which all other responses could be compared (page 36, Work Package B2). This is clearly problematical because it seems highly unlikely that young people based at a university in metropolitan Manchester have access to a garden with background noise levels comparable to a rural garden, and thus the benchmarking from the outset is flawed.

c. Synthetic data used instead of real wind farm AM noise

10. The testing was carried out using mathematically synthesised wind turbine AM (and garden) noise, not real noise. The sample plots of this artificial noise shown at page 101 and 102 of Work Package B are too regular in amplitude to be typical of real AM noise.
11. Participants listened to samples of the synthesised data of twenty seconds in duration, and could loop these if required. Quantifying annoyance based on such short samples cannot be considered comparable to the annoyance experienced by real-life neighbours who complain of AM noise occurring for many hours/days and particularly through the evening and night hours. It is a well-known attribute of wind farm AM noise that it becomes increasingly annoying over time due to exposure.

d. Flawed Error Test results relied upon for RUK AM condition

12. There were two types of test carried out in a controlled listening room environment. The first was used to rate the annoyance of the noise samples on a scale of 0 to 10. This showed that noise with AM is more annoying than noise without an AM component. It also found that the greater the peak-to-trough levels, the more annoying is the noise.

13. The second test, on which the RUK AM condition is based, asked the participants to adjust a sound sample without AM noise to the level that was as annoying as noise containing AM with various peak-to-trough levels. This is obviously inappropriate as the participants being asked to adjust the noise level of a waterfall until it is as annoying as the beat of a neighbours hi-fi playing rock music. Unsurprisingly, the participants found this adjustment task difficult (page 56, Work Package B2).
14. Such was their difficulty, that when asked to compare two noise samples where neither contained AM noise, they still adjusted the first sample to higher or lower levels. This should have been interpreted as indicating the test had failed, but instead it is these results in particular that have been used to justify the RUK AM condition.[12]

e. The RUK AM noise condition AM is not comparable to Listening Test AM

15. Thus, although the final listening test in Work Package B produced acknowledged error results and, with no valid or indeed scientifically coherent justification, it was used to set the parameters of the RUK AM penalty levels.
16. In addition to concerns at the validity of the listening test results, the peak-to-trough values used for the listening tests are not the same as the peak-to-trough levels obtained by following the RUK AM condition procedures.
17. This can be seen by examining the Figures on pages 101 and 102 of Work Package B. This shows that the measurement of the peak-to-trough for the listening tests was done straightforwardly by measuring the difference between peaks and troughs.
18. It is demonstrated above that a smaller peak-to-trough measurement would be obtained from the RUK AM procedure involving the Fourier transform

[12] Figure 9.4 page 59, Work Package B2. The figure shows that tests for all noise levels on the y axis, were wrongly adjusted by the participants when the Modulation Depth equalled 0. i.e. when the source noise level was 25dB it was increased by participants when they attempted to match it to another source noise of 25dB. The data in Figure 9.4 and Figure 9.5 is the basis for the justification of the metric set in the RUK AM condition – see page 4 of "The Development of a Penalty Scheme…".

methodology. Thus, the scale of the penalty devised is not accurately linked to the results of the erroneous listening test.

19. Nor can the average of 200 minutes of noise data containing a variable amount of AM as specified by the RUK AM condition be fairly compared with a 20 second listening test of synthesised and unvarying AM.

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