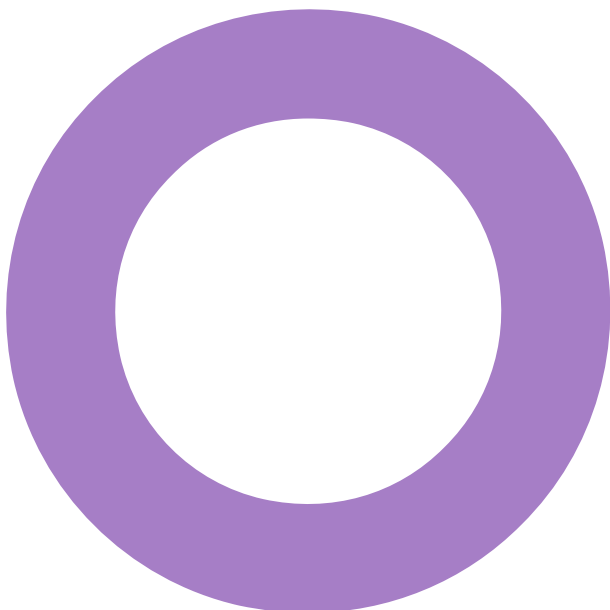


Heckington Fen Wind Farm. Lincolnshire. Ecotricity.

ACOUSTICS
VARIATION APPLICATION SUPPORT
NOISE
REVISION 3 – 08 MAY 2018



Audit sheet.

Rev.	Date	Description of change / purpose of issue	Prepared	Reviewed	Authorised
1	04/05/2018	First version for comment	MMC	RC	RC
2	08/05/2018	Revised version with minor clarifications	MMC		
3	08/05/2018	Further minor clarifications	MMC		

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Executive summary

The assessments of operational and construction noise from the Heckington Fen Wind Farm previously submitted were undertaken using guidance and standards which remain relevant based on national planning policy. The baseline previously determined remains representative. Therefore, the assessment of impacts presented in previous submissions remains valid.

1. Introduction

- 1.1 Ecotricity are proposing to vary condition 4 of the consent¹ for the Heckington Fen Wind Farm (“the Development”) which describes the timescale by which construction of the Development should commence. To support this application, the present report sets out a review of the changes to the relevant policy, baseline and likely effects in relation to noise since the original application in 2011.

2. Statement of competence

- 2.1 Dr Matthew Cand (Dipl Eng PhD MIOA) is the main author of this report. Matthew is a senior associate with Hoare Lea and a member of the Institute of Acoustics (IOA). Matthew has more than 12 years of experience in the field of environmental noise, having assessed several large-scale residential, transport, industrial and infrastructure projects across the UK, including over 50 wind farm projects. Matthew is one of the authors of the IOA’s Good Practice Guide on the application of ETSU-R-97 and of the IOA’s proposed methodology for assessing amplitude modulation in wind turbine noise.
- 2.2 Matthew’s work included undertaking noise assessments to support several Environmental Impact Assessments (EIAs) for wind farm planning applications and he is therefore a competent expert for undertaking such EIA work.

3. Policy and Guidance

- 3.1 Chapter 10 of the Heckington Fen Wind Park Environmental Statement (2011 ES) included a review of the relevant planning policy and advice relating to noise. An updated review was presented in 2015 in Chapter 9 of the Heckington Fen Wind Park Variation of Consent Environmental Statement (“the 2015 Variation ES”).
- 3.2 The review of planning policy presented in the 2015 Variation ES remains applicable at present. Both the National Policy Statement for Renewable Energy Infrastructure (EN-3) and National Planning Practice Guidance (NPPG) recommend the use of the ETSU-R-97 methodology when assessing operational noise from Wind Farms. Reference to EN-3 is made in National Planning Policy Framework when assessing the impacts of wind energy developments. NPPG also makes reference to Good Practice Guidance for the application of ETSU-R-97 produced by the Institute of Acoustics in 2013 (IOA GPG).
- 3.3 The assessment of operational noise impacts undertaken in the ES was made in accordance with the ETSU-R-97 methodology which remains recommended in national planning policy. Furthermore, the 2015 Variation ES considered the assessment presented in the ES and concluded that it was consistent with the advice of the IOA GPG.
- 3.4 The ES and variation ES also included a discussion in relation to the subject of “blade swish” or “amplitude modulation” (AM), including a review of the available knowledge on this subject. Since then, additional publications on this subject have become available.
- 3.5 The IOA published in 2016 a standardised methodology² for the assessment and rating of AM magnitude. The method provides a decibel level each 10 minutes which represents the magnitude of the modulation in the noise, and minimises the influence of sources not related to wind turbines. The proposed method, unlike other methods that have previously been proposed, utilises as the core of its detection capability the fact that AM noise from wind turbines, by definition, exhibits periodicity at

¹ Consent Under Section 36 Of the Electricity Act 1989, DECC ref: 12.04.09.04/31C

² Institute of Acoustics (IOA) Amplitude Modulation Working Group, Final Report, A Method for Rating Amplitude Modulation in Wind Turbine Noise, June 2016.

a rate that is directly related to the rotational speed of the source wind turbine. The IOA document does not however provide any thresholds or criteria methodology for using the resulting AM values.

- 3.6 The UK Government (DECC or Department of Energy and Climate Change, now obsolete) commissioned a review focused on the subjective response to AM with a view to recommend how this feature may be controlled. The outcome of this research³ has been published in October 2016 by the department for Business, Energy & Industrial Strategy (BEIS). This report recommends the use of a “character penalty” approach, in which a correction is applied to the overall A-weighted noise level to account for AM in the noise in a manner similar to that used to assess tonality in the noise according to ETSU-R-97. This penalty is based on the IOA methodology for detecting AM.
- 3.7 These researchers make a number of recommendations for local authorities to consider and qualifications for the use of such controls, and note that the current state of knowledge on the subject and the implications of their proposed control is limited and that a period of testing and review over the next few years would be beneficial. The authors were however unable to provide clarity on how exactly the recommendations would operate in practice for any particular wind farm. On publication of the report, DBEIS encouraged local authorities in England to consider the research but provided limited guidance on how the outcomes were to be accounted for within the planning system.
- 3.8 In 2017, a number of acousticians published⁴ a proposed noise condition wording which included a penalty rating procedure for AM based on the above research recommendations published by DBEIS.
- 3.9 The 2015 Variation ES noted that, whilst there was no specific reference to the assessment of construction noise impacts within the NPPF, British Standard BS 5228:2009 (which was referenced in the ES) remains the extant UK guidance on the assessment of construction noise and therefore the appropriate methodology for assessing construction noise impacts

4. Baseline

- 4.1 Ecotricity undertook a review of new residential properties neighbouring the Development, either new build or from changes of use, and the outcome of this review was provided to Hoare Lea. Several new dwellings were identified, but it was concluded that the assessment locations previously considered remained representative of the properties in the area neighbouring the Development, including any new dwellings created since the ES.
- 4.2 In addition, a review by Ecotricity concluded that there were no significant changes to the road and general infrastructure in the vicinity of the Development such that significant changes to the noise environment in the area would be expected. At several properties, the background was strongly influenced by road traffic noise during day-time periods. It is generally assumed, for example in modelling by the Department for Transport, that road traffic levels increase over time in line with several factors including population growth. Traffic levels on the roads neighbouring the Development are therefore expected to have increased since 2011, and therefore the previous measurements are likely to represent a conservative representation of the noise environment at these locations.
- 4.3 The baseline site characterisation presented in the ES, and referenced in the 2015 Variation ES, therefore remains representative of the area and the noise-sensitive dwellings neighbouring the site.

³ Review of the evidence on the response to amplitude modulation from wind turbines, WSP/ Parsons Brinckerhoff for Department for Business, Energy & Industrial Strategy. Wind Turbine AM Review, Phase 2 report, August 2016.

⁴ A Planning Condition for Wind Turbines, Andy McKenzie, Matthew Cand, Dick Bowdler, Mark Jiggins, Gavin Irvine, Michael Reid, Richard Perkins, Michael Lotinga, Malcolm Hayes and Andrew Bullmore. Institute of Acoustics, Acoustics Bulletin, Nov/December 2017.

5. Assessment of Impacts

- 5.1 As set out in Section 2, the assessments of operational and construction noise impacts set out in the 2011 ES and 2015 Variation ES were undertaken using guidance and standards which remain relevant based on national planning policy. The baseline previously determined remains representative. Therefore, the assessments of impacts presented in the 2011 ES and 2015 Variation ES remain valid.
- 5.2 On the basis of the research and guidance on AM available since the publication of the ES, there are no specific additional effects associated with the Development which can be predicted at this stage. However, based on the publications listed in Section 2 above, it would be possible, if considered appropriate by BEIS, to revise condition 24 of the consent, for example in line with the recommended condition wording⁴ published in 2017. This condition wording is included as an Appendix to the present report, with the noise limit tables from the previous consent for the Development inserted in the relevant section.

Appendix – proposed alternative wind farm noise condition wording

The following condition wording is taken from the Acoustics Bulletin, Nov/December 2017 article referenced in the above report. Tables 1 and 2 have been inserted from the consent under Section 36 for the Development.

Proposed planning conditions on noise for Heckington Fen Wind Farm

The rating level of noise immissions from the combined effects of the wind turbines hereby permitted (including the application of any tonal penalty and amplitude modulation (AM) penalty), when determined in accordance with the attached Guidance Notes, shall not exceed the values for the relevant integer wind speed set out in or derived from Tables 1 and 2 attached to these conditions and:

- A) Within 21 days from receipt of a written request of the Planning Authority, following a complaint to it alleging noise disturbance at a dwelling, the wind farm operator shall, at its expense, employ an independent consultant and provide a written protocol to be approved by the Planning Authority. The protocol shall describe the procedure to assess the level and character of noise immissions from the wind farm at the complainant's property in accordance with the procedures described in the attached Guidance Notes. The written request from the Planning Authority shall set out as far as possible the time or meteorological conditions to which the complaint relates and time or conditions relating to tonal noise or AM if applicable. Measurements to assess compliance with the noise limits shall be undertaken in accordance with the assessment protocol which shall be approved in writing by the Planning Authority.
- B) The wind farm operator shall provide to the Planning Authority the independent consultant's assessment of the rating level of noise immissions undertaken in accordance with the protocol within 2 months of the date of the approval of the protocol by the Local Authority unless otherwise agreed by the Planning Authority. The assessment shall include all data collected for the purposes of undertaking the compliance measurements and analysis, such data to be provided in a format to be agreed with the Planning Authority. Certificates of calibration of the equipment shall be submitted to the Planning Authority with the report.
- C) Where a further assessment of the rating level of noise immissions from the wind farm is required pursuant to Guidance Note 5 of the attached Guidance Notes, the wind farm operator shall submit a copy of the further assessment within 21 days of submission of the independent consultant's initial assessment unless otherwise agreed by the Planning Authority.

Table 1 - Between 07:00 and 23:00 - Noise level dB L_{A90}, 10-minute

Property Easting, Northing	Standardised wind speed at 10 metres height (m/s) within the site averaged over 10-minute periods									
	3	4	5	6	7	8	9	10	11	12
	L _{A90} Decibel Levels									
1 - 4 New Cottage, Side Bar Lane 518616, 345176	40.0	40.4	40.9	41.6	42.3	43.0	43.8	43.8	43.8	43.8
2 Council House, East Heckington 520190, 343985	46.9	47.6	48.3	49.0	49.7	50.2	50.2	50.2	50.2	50.2
Catlins Farm 521762, 344327	40.0	40.0	40.0	40.9	42.5	44.2	46.0	47.7	47.7	47.7
College Farm 521901, 344438	40.0	40.0	40.0	40.9	42.5	44.2	46.0	47.7	47.7	47.7
Derwent Cottage, Side Bar Lane 518666, 344950	40.0	40.4	40.9	41.6	42.3	43.0	43.8	43.8	43.8	43.8
Elm Grange Farm, East Heckington 519065, 344484	46.9	47.6	48.3	49.0	49.7	50.2	50.2	50.2	50.2	50.2
First Cottage, Side Bar Lane 518697, 344809	40.0	40.4	40.9	41.6	42.3	43.0	43.8	43.8	43.8	43.8
Five Willow Wath Farm, Side Bar Lane 518592, 346871	40.0	40.0	40.0	40.0	41.2	43.0	44.8	46.8	46.8	46.8
Glebe Farm, Side Bar Lane 518472, 346187	40.0	40.0	40.0	40.0	41.2	43.0	44.8	46.8	46.8	46.8
Home Farm, East Heckington 519347, 344435	46.9	47.6	48.3	49.0	49.7	50.2	50.2	50.2	50.2	50.2
Mill Green Farm 519952, 347320	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.7	40.7	40.7
Rakes Farm, East Heckington 520807, 343779	46.9	47.6	48.3	49.0	49.7	50.2	50.2	50.2	50.2	50.2
Rectory Farm House, East Heckington 519660, 344208	46.9	47.6	48.3	49.0	49.7	50.2	50.2	50.2	50.2	50.2
Six Hundreds Drove, East Heckington 520605, 343705	46.9	47.6	48.3	49.0	49.7	50.2	50.2	50.2	50.2	50.2
Spinney Farm 522812, 346067	40.0	40.0	40.0	40.0	40.0	40.4	44.5	49.1	49.1	49.1
Swineshead House 521150, 343583	46.9	47.6	48.3	49.0	49.7	50.2	50.2	50.2	50.2	50.2

The Chapel House, Side Bar Lane 518378, 345871	40.0	40.4	40.9	41.6	42.3	43.0	43.8	43.8	43.8	43.8
The Old Church 521899, 347226	40.0	40.0	40.0	40.0	40.0	40.4	44.5	49.1	49.1	49.1

Table 2 - Between 23:00 and 07:00 - Noise level dB LA90, 10-minute

Property Easting, Northing	Standardised wind speed at 10 metres height (m/s) within the site averaged over 10-minute periods									
	3	4	5	6	7	8	9	10	11	12
	LA90 Decibel Levels									
1 - 4 New Cottage, Side Bar Lane 518616, 345176	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
2 Council House, East Heckington 520190, 343985	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Catlins Farm 521762, 344327	43.0	43.0	43.0	43.0	43.0	43.0	45.1	49.1	51.3	51.3
College Farm 521901, 344438	43.0	43.0	43.0	43.0	43.0	43.0	45.1	49.1	51.3	51.3
Derwent Cottage, Side Bar Lane 518666, 344950	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Elm Grange Farm, East Heckington 519065, 344484	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
First Cottage, Side Bar Lane 518697, 344809	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Five Willow Wath Farm, Side Bar Lane 518592, 346871	43.0	43.0	43.0	43.0	43.0	43.0	44.3	48.9	51.5	51.5
Glebe Farm, Side Bar Lane 518472, 346187	43.0	43.0	43.0	43.0	43.0	43.0	44.3	48.9	51.5	51.5
Home Farm, East Heckington 519347, 344435	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Mill Green Farm 519952, 347320	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.3	44.3
Rakes Farm, East Heckington 520807, 343779	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0

Rectory Farm House, East Heckington 519660, 344208	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Six Hundreds Drove, East Heckington 520605, 343705	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Spinney Farm 522812, 346067	43.0	43.0	43.0	43.0	43.0	43.0	43.0	48.1	48.1	48.1	48.1
Swineshead House 521150, 343583	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
The Chapel House, Side Bar Lane 518378, 345871	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
The Old Church 521899, 347226	43.0	43.0	43.0	43.0	43.0	43.0	43.0	48.1	48.1	48.1	48.1

Guidance Notes for Noise Condition

These notes are to be read with and form part of the planning condition on noise. The measured data is to be split into bins as described below. The rating level in each bin is the arithmetic sum of the wind farm noise level, any tonal penalty applied in accordance with Note 3 and any AM penalty applied in accordance with Note 4. Reference to ETSU-R-97 refers to the publication entitled "The Assessment and Rating of Noise from Wind Farms" (1997) published by the Energy Technology Support unit (ETSU) for the Department of Trade and Industry (DTI). IOAGPG is "A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise" or any update of that report current at the time of measurement. The IOA Metric is "A Method for Rating Amplitude Modulation in Wind Turbine Noise" dated 9th August 2016 or any update of that current at the time of measurement.

Note 1 – Data Collection

- a. Values of the $L_{A90,10\text{-minute}}$ noise index should be measured in accordance with the IOAGPG. Measurements shall be undertaken in such a manner to enable a tonal penalty to be calculated and to allow an AM penalty to be calculated for selected periods where a tonal or AM assessment is required.
- b. To enable compliance with the conditions to be evaluated, the wind farm operator shall continuously log arithmetic mean wind speed in metres per second (m/s) and arithmetic mean wind direction in degrees from north in each successive 10-minutes period in a manner to be agreed in writing with the Planning Authority. The wind speed at turbine hub height shall be 'standardised' to a reference height of 10 metres as described in ETSU-R-97 at page 120 using a reference roughness length of 0.05 metres. It is this standardised 10 metre height wind speed data which are correlated with the noise measurements determined as valid. The wind farm operator shall continuously log arithmetic mean nacelle anemometer wind speed, arithmetic mean nacelle orientation, arithmetic mean wind direction as measured at the nacelle, arithmetic mean rotor RPM and whether each wind turbine is running normally during each successive 10-minutes period for each wind turbine on the wind farm. All 10-minute periods shall commence on the hour and in 10-minute increments thereafter synchronised with Universal Time (UT).

Note 2 – Data Analysis

- a. The independent consultant shall identify a sub-set of data having had regard to:-
- the conditions (including time of day and corresponding wind directions and speeds) at times in which complaints were recorded;
 - the nature/description recorded in the complaints if available;
 - information contained in the written request from the local planning authority;
 - likely propagation effects (downwind conditions or otherwise);
 - the results of the tonality/AM analysis where relevant.

In cases where it is possible to identify patterns of clearly different conditions in which complaints have arisen additional sub-sets may be considered provided this does not introduce unreasonable complexity in the analysis and can be justified by the independent consultant.

- b. Within each of the sub-set(s) of data identified, data shall be placed into separate 1 m/s wide wind speed bins.

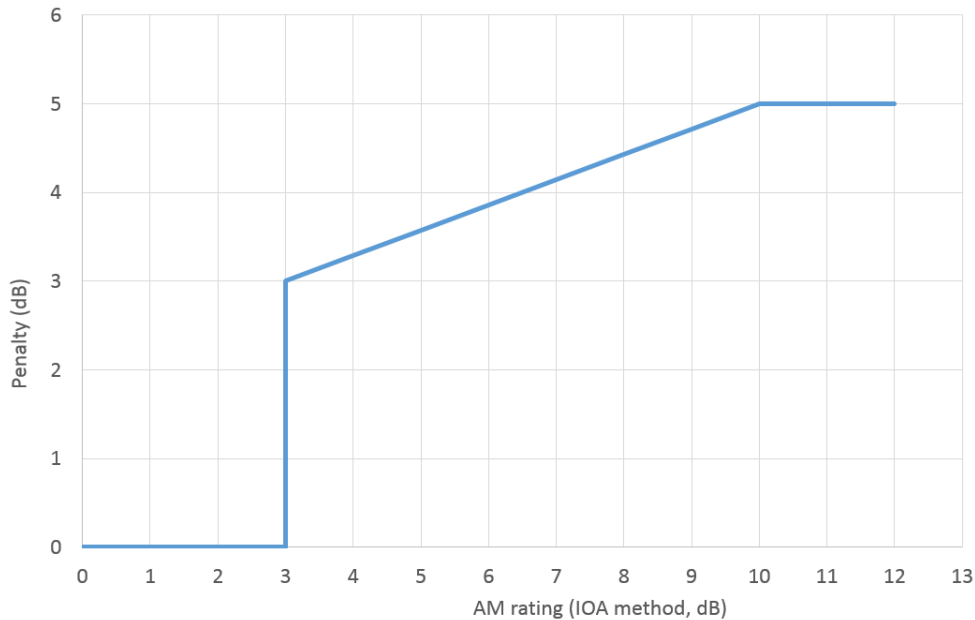
Note 3 – Tonal Penalty

- a. Where, in accordance with the protocol, the noise contains or is likely to contain a tonal component, a tonal audibility shall be calculated for each ten-minute period using the following procedure.
- b. For each 10-minute period for which a tonal assessment is required this shall be performed on noise immissions during 2-minutes of each 10-minute period. The 2-minute periods should be spaced at 10-minute intervals provided that uninterrupted uncorrupted data are available ("the standard procedure").
- c. For each of the 2-minute samples the tone level above audibility shall be calculated by comparison with the audibility criterion given in Section 2.1 on pages 104 -109 of ETSU-R-97. Samples for which the tones were below the audibility criterion or no tone was identified, a value of zero audibility shall be substituted. Where data for a ten-minute period are corrupted, that period shall be removed from the tonal analysis.
- d. The tone level above audibility for each ten-minute period shall be placed in the appropriate data sub-set and wind speed bin.

Note 4 – AM Penalty

- a. Where, in accordance with the protocol, the noise contains or is likely to contain AM, an AM penalty shall be calculated for each ten-minute period using the following procedure.
- b. For each 10-minute interval for which an AM assessment is required this shall be performed in accordance with The IOA Metric. The value of AM for each ten-minute period shall be converted to a penalty in decibels in accordance with the graph below and the penalty shall

be placed in the appropriate data sub-set and wind speed bin. Where a penalty is zero it should be placed in the bin in the same way.



Note 5 – Calculation of Rating Level

- a. The L_{A90} sound pressure level for each data sub-set and wind speed bin is the arithmetic mean of all the 10 minute sound pressure levels within that data sub-set and wind speed bin except where data has been excluded for reasons which should be clearly identified by the independent consultant. The tonal penalty for each bin is the arithmetic mean of the separate 10-minute tonal audibility levels in the bin converted to a penalty in accordance with Fig 17 on page 104 of ETSU-R-97. The AM penalty for each bin is the arithmetic mean of the AM penalties in the bin. The assessment level in each bin is normally the arithmetic sum of the bin L_{A90} , the bin tonal penalty and the bin AM penalty except where the AM penalty and the tonal penalty relate to the same characteristic (e.g. amplitude modulated tones) when the sum of both penalties may overly penalise the characteristics of the noise. Such cases should be identified and only the larger of the AM or tonal penalty should be applied.
- b. If the assessment level in every bin lies at or below the values set out in the Table(s) attached to the conditions then no further action is necessary. In the event that the assessment level is above the limit(s) set out in the Tables attached to the noise conditions in any bin, the independent consultant shall undertake a further assessment of the rating level to correct for background noise so that the rating level relates to wind turbine noise immission only. Correction for background noise need only be undertaken for those wind speed bins where the assessment level is above the limit.
- c. The wind farm operator shall ensure that all the wind turbines in the development are turned off for such periods as the independent consultant requires to undertake the further assessment. The further assessment shall be undertaken in accordance with the following steps:-

- i. Repeating the steps in Note 1, with the wind farm switched off, and determining the background noise (L_3) in each bin as required in the protocol. At the discretion of the consultant and provided there is no reason to believe background noise would vary with wind direction, background noise in bins where there is insufficient data can be assumed to be the same as that in other bins at the same wind speed.
- ii. The wind farm noise (L_1) in each bin shall then be calculated as follows where L_2 is the measured level with turbines running but without the addition of any tonal nor AM penalty:

$$L_1 = 10 \log \left[10^{L_2/10} - 10^{L_3/10} \right]$$

- iii. The rating level shall be calculated by adding the tonal and AM penalties to the derived wind farm noise L_1 in that bin.
- iv. If the rating level after adjustment for background noise contribution and adjustment for tonal and AM penalties in every bin lies at or below the values set out in the Tables attached to the condition at all wind speeds then no further action is necessary. If the rating level at any integer wind speed exceeds the values set out in the Table(s) attached to the condition then the development fails to comply with the planning condition in the circumstances represented by that bin.



MATTHEW CAND
SENIOR ASSOCIATE

+44 1454 806 620
matthewcand@hoarelea.com

HOARELEA.COM

155 Aztec West
Almondsbury
Bristol
BS32 4UB
England

