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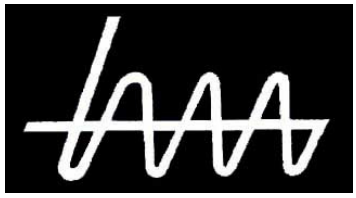

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Research Contract 01.08.09.01/492A (Analysis)

Analysis of How Noise Impacts are Considered in the Determination of Wind Farm Planning Applications

HM: 2293/R1

6th April 2011

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EXECUTIVE SUMMARY

Hayes McKenzie have carried out a review for the Department of Energy and Climate Change to investigate the way in which noise impacts for wind farms are determined in England, including the methods used in practice to implement the ETSU-R-97 guidance, in order to provide suggestions as to areas where it is considered that more detailed guidance is required.

The first part of this study consists of a review of noise assessments which have accompanied planning applications since 2004 when PPS22, *Renewable Energy*, was issued and which included advice on assessment of noise from wind farms. It was established at an early stage that it would not be possible, within the scope of the project, to review every application which had been made since 2004 and that a sampling process would be required to define the samples for review.

The sample for review comprised the most recent application by any developer submitted between 2004 and 2009 excluding sites which were in appeal, subject to challenge, or within the timescales for either of those processes to be started to avoid the potential for any prejudice to the outcome of an Appeal or Challenge to any decision as at the date this document was submitted for peer review. It was not possible to obtain documents for every application fitting this criteria and a total of 46 documents were reviewed.

A preliminary review identified many differences in the detail of the ways the noise assessments had been carried out for the different sites. These factors were discussed at a stakeholder review meeting mid-way through the study and form the basis of the factors considered in the review. It is important that the various factors described should not be seen as a 'check-list' of items to be included in an assessment of noise from a proposed wind turbine site but as an observation on the variation in the way such factors have been taken into account in the assessments studied.

The review has highlighted the potential problems faced by local planning authorities dealing with noise assessments for wind farm sites, both in terms of the way the documents are structured, and in the variations in the way some factors are taken into account in the assessments. This suggests best practice guidance is required to confirm and, where necessary, clarify and add to the way ETSU-R-97 should be implemented in practice.

The most striking comparison between sample noise assessments is the variation in the way the reports are structured and the way information has been presented. It is clear that the assumptions used and the details of the way the assessment has been carried out can be difficult to establish, even for those

who are familiar with the issues. For a planner or environmental health officer who may not be familiar with noise assessments for wind farm sites, the task of reviewing such a document may be challenging. Although it would be unreasonable to expect all noise assessments to be conducted and presented in an identical fashion due to the different interpretations of developers of presenting information in an Environmental Statement, some level of standardisation would undoubtedly be of assistance such as section headings and information to be included under each one.

The review has also highlighted a number of different interpretations of ETSU-R-97 which range from different approaches to measuring background noise levels, through to suggestions that background noise measurements are not required until planning consent is given. Any subsequent guidance on best practice could usefully be more prescriptive on the approach to background noise measurements, and interpretation of data, since this not only forms the basis of any assessment but is likely to determine the noise limits used in any eventual planning conditions on noise issues.

Some variation was also found in the prediction methodology used although these are usefully covered by an article in the Acoustics Bulletin, published by the Institute of Acoustics, although this has no official status and any best practice guidance should confirm the approach to be adopted.

Just over half the cases studied did not address the potential issue of wind shear although, where wind shear was addressed, it mostly followed the principles described in the Institute of Acoustics Bulletin Article referred to above. Since this has no official status, as discussed above, it would be appropriate for any best practice guidance to confirm an appropriate way of dealing with wind shear issues as this is fundamental to the assessment procedure.

The ETSU-R-97 recommendations allow a certain amount of flexibility in setting the day-time hours noise limit. Although ETSU-R-97 describes 3 tests to evaluate the appropriate value within the range which is permitted these are open to interpretation and best practice guidance could very usefully identify a more prescriptive and definitive approach.

There is currently no requirement in ETSU-R-97 to include any correction or penalty for any modulation in the noise and this is reflected in the way this has been dealt with in the assessments studied. This position would need to be re-stated, or otherwise addressed in any best practice guidance, in line with current research and guidance on this issue.

Some guidance could also usefully be provided on the issue of financially involved properties as the current guidance is a little unclear on exactly what constitutes financial involvement. It may also be

appropriate to cover the issue of what happens when land and properties change hands through possible guidance as to whether this should be dealt with in planning conditions.

Some consideration could be given to a simplified assessment procedure of limiting turbine noise to a fixed level, applicable at rated power, since a condition based on this approach could be simpler and more robust in practice and would address concerns over the assessment of representative background noise levels in rural areas which are becoming increasingly debated at Public Inquiry.

Although the application of planning conditions has not been covered in this review, it is considered that best practice guidance could usefully include advice on the structure of planning conditions and noise limits designed to regulate noise from operational wind turbine sites. There is also an increasing requirement to clarify the approach to be taken with respect to cumulative impact in so far as noise limits specified in planning conditions on an existing site may effectively mean that any further development is prevented even though the cumulative noise levels occurring in practice may meet the ETSU guidance.

Any guidance should also review, or at least acknowledge, the changes which have been made to some of the documents referred to in ETSU-R-97; such as the replacement of IEC651 with BS EN 61672, the update of BS4142 from the 1990 version to the 1997 version, and the latest WHO guidance on noise limits to prevent sleep disturbance.

Acknowledgements

Hayes McKenzie would like to acknowledge the contributions of Andrew Bullmore (Hoare Lea Acoustics), Sabine von Hunerbein (University of Salford), Dani Fiumicelli (AECOM) and Nicholas Jenkins (Cardiff University) who peer reviewed the report, the DECC Steering Group who over-saw the project and the contributors to the Stakeholder Meeting carried out during the project.

CONTENTS

DECC RESEARCH CONTRACT 01.08.09.01/492A (ANALYSIS)

ANALYSIS OF HOW NOISE IMPACTS ARE CONSIDERED IN THE DETERMINATION OF WIND FARM PLANNING APPLICATIONS

Report HM: 2293/R1

6th April 2011

1. INTRODUCTION

1.1 In August 2010, Hayes McKenzie were awarded a contract by the Department of Energy and Climate Change (DECC) to review the way noise assessments are being carried out as part of the application process for planning consent for wind turbine sites in England.

1.2 This review therefore required detailed analysis of a sample of noise assessments submitted with such planning applications and a list of criteria to define the sample set, with the specific subsequent requirement from DECC, subsequently partially adjusted, that sites currently in the planning system, or within a time period which allowed for the possibility of re-submission, appeal or challenge, should be excluded from the study.

1.3 This report describes the project objectives, the eventual sampling process by which sites were selected for analysis, the process by which the documents were obtained, the analysis of factors affecting noise assessment for wind turbine sites, and the results of how these factors have been taken into account, together with suggestions for improving consistency and robustness.

2. PROJECT OBJECTIVES

2.1 The original objectives of the study were twofold:

- To investigate the way in which noise impacts for a wind farm are determined in England, including methods used in practice to implement the ETSU-R-97 guidance;
- To provide recommendations to Government on ways in which ETSU-R-97 can be applied in a more consistent and effective manner, taking into account best practice.

A complete copy of the original brief is included at Appendix A.

2.2 It was recognised at an early stage, however, by the DECC Steering Group managing this project that any best practice guidance would require wider consultation and should not be restricted to the opinion of the author of this report. The brief was therefore changed to provide recommendations on areas where it is considered that more detailed guidance is required.

2.3 The first part of this study therefore consists of a review of noise assessments which have accompanied planning applications since 2004 when PPS22, *Renewable Energy*, was issued and which included advice on assessment of noise from wind farms. It was established at an early stage, prior to the tender for the work being submitted, that it would not be possible to review every application which had been made since 2004 and that a sampling process would be required to define the samples for review. The first stage of this work was, therefore, to define this sampling process, as discussed in Section 3 (below), and to determine the factors affecting noise assessments for wind turbine sites as discussed in Section 5 (also below).

2.4 Of particular importance is the way noise propagation from wind turbines is modelled since this is not covered by the ETSU-R-97 guidance which only deals with assessment of any such predicted noise levels. This issue was covered by a recent statement on agreed practice by a number of consultants acting for wind farm developers, local authorities and third party groups in an article published in the Institute of Acoustics Bulletin in 2009[1] together with the related issue of wind shear although this document has no official status and the recommendations it makes should be subject to further review.

3. SAMPLING PROCESS

3.1 It was agreed with DECC that, in order to provide an acceptable sample consistent with the scope and budget for the work, 50 sites would be selected, with proposed installed capacities[2] of at least 5 MW, for which applications for planning consent had been submitted. Information on applications for planning consent was taken from the RESTATS database which contains details of all applications submitted for renewable energy developments in the UK.

3.2 In order to obtain a representative sample, it was agreed with DECC that this should comprise the most recent application by any developer submitted between 2004 and 2009. On this basis the initial sample comprised 61 applications which fitted this criterion out of a total of 326

[1] Prediction and Assessment of Wind Turbine Noise, Institute of Acoustics Bulletin Vol.34 No.2, 2009

[2] The maximum power output available from the site.

applications listed in the database for this period. This sample was then filtered to include only those which were not currently in the planning system to avoid the potential for any prejudice to the outcome of any existing applications. This excluded any site for which, at November 1st 2010:

- planning consent had not been determined.
- had been refused consent less than 12 months previously by the Local Planning Authority (LPA), or by the planning inspectorate if the LPA had refused consent, and for which a re-submission was therefore a possibility.
- had been consented less than 3 months previously thus allowing for the possibility of a legal challenge.
- or any site for which an application for planning consent had been re-submitted.

3.3 This filtering process was discussed at a Stakeholder Review Meeting on 23rd November 2010 at DECC where Hayes McKenzie observed that, because of the number of more recent projects which the exclusions outlined above covered, the results of the study were likely to be biased towards older applications which therefore did not necessarily reflect current practice. It was agreed at the meeting that this would reduce the value of the work and it was subsequently decided by DECC, that the study should include sites which were still in planning but exclude sites which, at submission of the report for Peer Review, were either in Appeal, subject to challenge, or within the timescales for either of those processes to be started as it was unlikely to prejudice the sites considered within the study any more than any other sites in the planning system.

3.4 This revised filtering process was used to define the sites used for the final sample used for this review. Where cases were excluded as a result of the above, the next most recent application by each developer which fitted the above criteria was then used in place of the original selection. This resulted in a total number of 58 samples available for use in the review.

3.5 Copies of the noise assessment reports or chapters from the relevant application documents were then obtained from either LPA web sites, or from the site developers, where possible. In practice a total of 46 noise assessments were obtained for review with the remainder being unavailable due to various reasons including local authority restructuring, lack of archive information for documents corresponding to earlier applications within the time period considered and lack of response or reluctance on the part of developers to supply the information. Although some documents were incomplete, leaving question marks over some of the review criteria, this is still considered to be acceptable in fulfilling the requirements of the

project.

3.6 Table 1 shows the number of samples included by year of application.

Table 1: Number of Samples by Year of Application

	2004	2005	2006	2007	2008	2009	Total
Count of samples	3	4	4	3	16	16	46

3.7 Table 2 shows the number of samples included by Local Planning Authority.

Table 2: Number of Samples by Local Planning Authority

Local Authority	Count of Samples
Amber Valley Borough Council	1
Barnsley MBC	1
Bristol City Council	3
Calderdale Council	1
Cannock Chase Council	1
Central Bedfordshire Council	1
Cherwell District Council	1
City of York Council	1
Copeland Borough Council	1
Corby Borough Council	1
Cornwall Council	1
Craven District Council	1
Darlington Borough Council	1
Daventry District Council	2
Durham County Council	2
East Hertfordshire District Council	1
East Lindsey District Council	1
East Riding of Yorkshire Council	2
East Staffordshire Borough Council	1
Harborough District Council	2
Hartlepool Borough Council	1
Herefordshire Council	1
Kirklees Council	1
Mid Suffolk District Council	1
Newcastle Borough Council	1
North Devon Council	1
North Herts District Council	1
North Norfolk District Council	1
Northumberland County Council	3

Rochdale Borough Council	1
Selby District Council	2
South Gloucestershire Council	1
South Holland District Council	1
South Lakeland District Council	1
Uttlesford District Council	1
Vale Royal Borough Council	1
Waveney District Council	1

4. COLLATION OF SAMPLE ASSESSMENTS FOR REVIEW

4.1 The biggest challenge of this project was obtaining details on, and subsequently documents for, the agreed sample of planning applications. The information on the RESTATS database is not always consistent with LPA web sites or with the Renewable UK web site which was also used for researching details together with web sites run by third party groups objecting to specific developments. The RESTATS database is also not completely comprehensive in its content but, although this might have had a small effect on the number of projects chosen for review, it is not considered to have affected the outcomes of the project.

4.2 Most LPAs have documents associated with planning applications on line. In practice, however, obtaining these documents is not always straightforward because of the lack of functionality of some LPA web sites and the way documents are presented. Documents corresponding to planning applications which have been determined may also not be kept on line to minimise web space requirements and accessing hard copies in these cases proved difficult.

4.3 In order to simplify clarification on the status of applications and supply of source documents, wind farm site developers were approached directly in many cases. In some cases, even though sites may have been turned down without being appealed, been consented or, become operational, documents were not always supplied and a request was specifically refused on the basis of site sensitivity in 1 case.

4.4 A final concern is that of copyright issues since both the authors of application documents and LPAs often include warnings over the uses which are permitted for copyright material. Consultation has confirmed that, despite LPA statements on this issue, they generally consider copyright lies with the authors of the documents. Since no extracts have been included in this report or published elsewhere as a result of this study, it is considered that this should not form

an obstacle to this review.

5. ANALYSIS OF FACTORS AFFECTING NOISE ASSESSMENT OF WIND TURBINE SITES

5.1 An initial analysis of planning application documents for 10 sites was carried out to provide preliminary examples of the differences between the ways the noise assessments had been carried out. These factors, some of which may affect the outcome of the assessments, and some of which assist in interpretation or verification of the results, were built on and added to as an ongoing process as differences between the assessments carried out were analysed in greater detail taking into account issues raised at the Stakeholder Review meeting referred to in Paragraph 3.3. Each point is discussed in detail, in the following section (below). It should be noted that the various factors described should not be seen as a 'check-list' of factors to be included in an assessment of noise from a proposed wind turbine site but as an observation on the variation in the way such factors have been taken into account.

Assessment Methodology

5.2 This first item concerns the guidance used for informing the way the assessment was carried out. Government guidance in PPS22, *Renewable Energy*, states that '*local planning authorities should ensure that renewable energy developments have been located and designed in such a way to minimise increases in ambient noise levels*'. It clarifies this by stating that '*the 1997 report by ETSU for the Department of Trade and Industry should be used to assess and rate noise from wind energy development*'. The principles of the ETSU-R-97 methodology are that baseline noise measurements are used to derive the 'prevailing background noise level' for night-time[3] and quiet day-time hours[4] as it varies with wind speed. Noise limits are then derived from this prevailing background noise level according to the following:

- Day-time noise limit = 35-40 dB L_{A90}, or 5 dB above the prevailing background noise level for the quiet day-time hours, whichever is the greater. The limit within the 35-40 L_{A90} is selected according to site specific factors which are discussed at Paragraph 5.43 below.
- Night-time noise limit = 43 dB L_{A90}, or 5 dB above the prevailing background noise level for the night-time period, whichever is the greater.

[3] 2300-0700 local time

- Night-time and day-time noise limit = 45 dB L_{A90} or 5 dB above the prevailing background noise level for the night-time or quiet day-time hours, respectively, for properties occupied by persons with a financial interest in the wind farm.

Consultation

Consultation with Local Planning Authority

5.3 ETSU-R-97 states at P.83 that '*the prevailing background noise level at sensitive dwellings will need to be agreed with the local EHO* (Environmental Health Officer) *so that noise limits at different turbine operating wind speeds can be set'*. It is therefore common practice for some degree of consultation to be carried out with Environmental Health Departments of LPAs beyond that required as part of the scoping exercise. The focus of this is primarily on the baseline noise measurement locations. ETSU-R-97 also states, however, also on P.83, that '*during the planning stage of a wind farm, discussions are likely to have been held with the local Environmental Health Officer with respect to agreeing acceptable levels of noise from the proposed site'*. Pre-application discussions do not, however, usually extend to the selection of a day-time noise limit within the range specified since this is likely to depend on the results of survey work.

LPA Attendance at Installation of Baseline Noise Measurement Equipment

5.4 On occasion, representatives of the LPA, usually from the Environmental Services department or similar, may be invited to attend the installation of the measurement equipment or to advise on the exact positioning of the equipment. Background noise can be affected by local noise sources and the effect of this should be minimised in carrying out the baseline measurements or at least be representative of the area which is being assessed.

Baseline Measurements

Selection of Baseline Measurement Locations

Number of Monitoring Locations

5.5 The noise limits specified within ETSU-R-97 include a 'simplified' criterion of 35 dB L_{A90} for

[4] 1800-2300 every day plus 1300-1800 Saturdays and 0700-1800 Sundays

10 metre height wind speed up to 10 metres per second (m/s). Where it can be shown that predicted noise level from a proposed wind turbine site will meet this noise level then comparison with noise limits derived from baseline noise measurements is not strictly necessary. The number of monitoring locations will usually depend on the number of properties exposed to predicted noise levels above this simplified criterion although, where this extends to a large number, monitoring at every property is not usually possible nor is it required by ETSU-R-97. This is particularly significant where a proposed wind turbine development affects a village, a sub-urban or even an urban area. It will also depend on what assumptions are made as to turbine type and noise prediction methodology so a conservative approach may be taken to include more properties since, in theory, properties not included could be subject to a noise limit corresponding to the 'simplified' criterion referred to above, although this is rarely the case in practice.

% Monitoring Locations at Properties

5.6 It is not always possible, or sometimes desirable, for developers, or their noise advisors, to arrange access to residential properties to carry out the necessary noise monitoring. It is almost inevitable in such cases, therefore, that some monitoring may be carried out on nearby land such as fields, or other available land, which is deemed to be representative of the properties at which noise is being assessed.

Baseline Documentation

Map Showing Monitoring Locations

5.7 A map or aerial photograph of the area can be used to highlight the locations used for noise monitoring equipment as this is a succinct method for describing the proximity of houses and proposed turbines.

Description of Monitoring Locations

5.8 A description of the monitoring location can be supplied to detail the precise location of equipment including a justification for selecting the position. ETSU-R-97 advises, at P.83, that '*the measurement position should be selected to minimise the effects of reflections from buildings because the noise limits recommended refer to free-field measurements for the reasons given in Chapter 6* (of ETSU-R-97)'.

Description of Noise Environment

5.9 Description of the monitoring location can also include an indication of the type of noise

environment audible at the measurement location. Clearly it is not possible for the noise environment to be qualitatively identified throughout the duration of an unattended survey but it is, nevertheless, helpful to provide this as part of the assessment.

Photos of Monitoring Locations

5.10 Photographs can be used to show the location of the measurement equipment because of the importance of the context of the monitoring location in respect of the noise environment which is to be represented, and the importance of any local noise sources in the vicinity.. This is occasionally problematical when householders do not wish their properties to be identified for security or other reasons.

Wind Direction Information Provided

5.11 ETSU-R-97 states, at P.99, that '*it must be ensured that, during the* (background) *survey period, wind speeds over the range zero to at least 12 m/s (10 minute average at 10m height), and a range of wind directions that are typical of the site, are experienced*). Obtaining a complete range wind speeds over all possible wind directions can be very difficult but presenting wind direction data, as it varied over the survey period, may assist a decision maker, or reviewer, to evaluate how representative the wind data collected during the survey might be.

Noise and Wind Histograms

5.12 There is no specific requirement in ETSU-R-97 to provide an analysis of the way noise varies over the period of the noise survey at each location. Providing this information, together with measured wind speed on the site, will enable a decision maker, or reviewer, to see the synchronisation between the two, if any. It can also highlight any unusual data which may not be revealed by the usual scatter plots which are used to derive the ETSU-R-97 noise limits such as where particular activities occur regularly at certain times of the day but may otherwise be obscured. It may not, however, be appropriate to include this material within ES documentation because of the volume of data acquired and it may be sufficient to make it available on request.

Calibration Certificates

5.13 Noise measurement equipment is always 'field' calibrated (see also Paragraph 5.18 (below)) prior to noise measurements being carried out. More thorough laboratory calibration is also carried out on the measurement equipment, and the field calibrator itself, every one to two years by a calibration laboratory which carries out detailed checks on the equipment. Calibration certificates are sometimes included with assessment reports, consistent with the requirements of BS4142 (see Paragraph 5.17 (below)), to demonstrate the time which has elapsed since the

noise measurement equipment and field calibrator were last laboratory calibrated.

Scope and Quality of Baseline Data

Monitoring Period

5.14 ETSU-R-97 states, at P.99, that '*the background noise survey should be taken over a sufficient period of time to enable a reliable assessment of the prevailing background noise levels at each property to be made*' and that '*as a guideline an appropriate survey period might be 1 week...*'. It is normally necessary to carry out monitoring for longer periods than this, however, in order to obtain the necessary range of wind speeds and/or wind directions. It is not possible to be prescriptive about this since it depends on the weather conditions at the site during the survey period. It is likely to be effectively impossible to obtain a complete range of wind speeds over every wind direction since high wind speeds from some directions occur relatively rarely at many sites.

Wind Speed Range

5.15 As discussed above, the length of the monitoring period does not, of itself, determine the range of wind conditions over which baseline data is obtained. ETSU-R-97 goes on to state that '*the actual duration will depend upon the weather conditions, in particular the wind speed and direction during the survey period*'. Notwithstanding the comments noted at Paragraph 5.11 (above), the way this is interpreted in noise assessments varies according to developer. In some cases the noise limit is 'capped' at the highest wind speed for which data is available, where it does not extend to 12 m/s (see also Paragraph 5.47 (below)), such that no increase in background noise is assumed above this point as a conservative measure.

Description of Noise Measurement Equipment

5.16 Providing a description of the equipment used for conducting the baseline noise survey enables the suitability of the equipment to be determined.

Certification of Equipment Used

5.17 ETSU-R-97 states, at P.84, that certification and calibration of measurement equipment should be '*as specified in BS4142: 1990*'. Although BS4142[5] allows the use of lower specification equipment, it is common practice to use equipment corresponding to the IEC651 Type 1 or BS EN 61672 Class 1 specification. It should be noted that BS EN 61672 has effectively replaced

[5] BS4142, Method for Rating Industrial Noise Affecting Mixed Residential and Industrial Areas

IEC651 for the specification of noise measurement equipment but older measurement equipment, whilst still being fit for purpose, may not be certified against the newer BS EN 61672 standard. It should also be noted that BS4142 was revised in 1997.

Sound Level Field Calibrator Details Supplied

5.18 A field calibrator is always used to adjust the noise measurement equipment to give the correct reading for a known sound level applied to the measurement microphone. Supplying calibrator details can give additional confidence in the reliability of noise measurements.

Wind Shield

5.19 It is essential that any wind protection fitted to the microphone assembly is carefully considered because of the requirement to measure background noise levels in windy conditions, which would normally be precluded from determination of background noise levels,. A report was published by ETSU in 1996[6] describing the most appropriate wind shield design for protecting measurement microphones from the direct effects of wind.

Rainfall

5.20 ETSU-R-97 states that '*measurements should not be used from periods of heavy rainfall when noise levels will be high due to the noise of the rain itself…'*. It is therefore appropriate that measurements of rainfall are carried out during the baseline noise measurement period with measurements corresponding to periods of rainfall removed from the data set used to derive the noise limits. Rainfall may be monitored at one or more locations depending on the size of the site. Excluded data may be extended, in some cases, to cover periods before and after rainfall is logged by the instrumentation, especially where only a single rain monitoring station is used as well as to overcome any time lag inherent in tipping bucket instrumentation.

Data Exclusions

5.21 ETSU-R-97 states, at P.86, that '*measurements that are affected by human or animal activity during the night, ie traffic passing along nearby roads or owls in nearby trees, should be considered as the noise environment at the dwelling'*. Curiously it does not comment on the situation during the quiet day-time hours when there is likely to be more human and animal activity than at night. It is, however, sometimes necessary to exclude data points from the data set used to derive the noise limits because they are considered atypical of the noise environment which normally prevails at the property, or properties, which are being represented by the

[6] ETSU W/13/00386/REP, Noise Measurements in Windy Conditions

baseline noise measurements. Data points are sometimes removed corresponding to the dawn chorus where this is particularly dominant or considered to be unrepresentative of that which might occur at other times of the year. Similarly, where measurements have been carried out over periods corresponding to changes in water flow in nearby rivers and streams, the data points corresponding to higher levels of noise may be removed from the data set before final processing. It also states at P.85, that '*when sheltered dwellings are positioned close to a site within a deep valley, it is recommended that special consideration is given to noise data that are collected for the wind condition that affords maximum shelter to the property'*. Data points corresponding to certain wind directions may also be excluded where it is considered that these may give rise to a higher noise than that corresponding to worst case propagation of noise from the wind farm site.

Seasonally Affected Data

5.22 ETSU-R-97 states, at P.85, that '*the time of year that measurements are performed may also have an effect. Summer months may be expected to give higher ambient noise levels due to leaves on trees but lower levels due to reduced rainfall. Winter months may result in lower ambient noise levels due to no leaves on trees but higher levels due to more rain. Conversely, the increased wind resistance of trees and shrubs in Summer can increase the level of shelter at the property such that lower wind speeds and hence noise levels are experienced for a given wind speed at the wind farm. Periods of external amenity vary in time of year from site to site and this should be considered when planning background noise surveys'*. Some of this may seem curious given the later comments on exclusion of data acquired during rainfall (see Paragraph 5.20 (above)) but rainfall can also affect baseline levels due to running water which is also described at ETSU-R-97 on P.85. Baseline noise surveys may be carried out at different times of the year to allow for any seasonal effects in the results.

Calibration Drift

5.23 Any changes in the reading of the measurement equipment over the period of the survey, for a known sound level applied to the measurement microphone, is referred to as calibration 'drift'. If this is excessive (>0.5 dB), consideration may be given to allowing for this in the results of the assessment carried out to provide a 'worst case' approach.

Cumulative Issues in Baseline Assessment

5.24 ETSU-R-97 states, at P.58, that '*it is clearly unreasonable to suggest that, because a wind farm was constructed in the vicinity in the past which resulted in increased noise levels at some*

properties, the residents of those properties are now able to tolerate still higher noise levels. The existing wind farm should not be considered as part of the prevailing background noise'. It may therefore be necessary in cases where there is already an existing wind farm that such turbines are shut-down during all or part of the baseline monitoring period. Where this is not possible, other measures may be put in place such as exclusion of data from certain directions or subtraction of the predicted noise from the existing site from the results of measurements.

Noise Predictions

Prediction Methodology

5.25 ETSU-R-97 does not specify how noise predictions for a wind turbine development should be carried out. There is therefore some variation in the methodologies that are employed by different practitioners. Most noise prediction methodologies are based on assumed source sound power data and propagation models which include attenuation from various terms including geometric, atmospheric, ground, barrier/screening and other attenuation factors.

Turbine Source Noise Data

Final or Candidate Turbine

5.26 It is generally not possible for a wind farm developer to confirm the final turbine model which will be installed at the time the noise assessment submitted as part of the planning application is carried out. The approach to this is normally to base the assessment on noise levels from an example or 'candidate' turbine or on a range of different turbines.

Turbine Source Noise Levels

5.27 In order to carry out, and validate, noise predictions, the source noise level assumed for integer wind speeds, ideally from 'cut-in' up to 12 m/s, are usually provided. This may be referenced to manufacturers, or test report documents. Many manufacturers do not provide data for the lower and upper ends of this range as IEC 61400-11[7] only requires measurements for integer standardised 10 metre height wind speeds[8] from 6 m/s up to rated power[9]. It should be stated whether the source noise levels assumed are guaranteed or otherwise so that the appropriate un-certainty margins may be taken into account in evaluating comparisons between predicted noise levels and derived noise limits.

[7] IEC 61400-11, Wind Turbine Generator Systems - Part 11: Acoustic noise measurement techniques

[8] Wind speed at hub height converted to 10 metres height assuming a 'reference' ground roughness length of 0.05 metres.

[9] The specified power output for the turbine. The value for rated power may not be for an integer wind speed.

Octave Band Levels Stated

5.28 In order to carry out, and validate, noise predictions, the source noise level in octave bands is usually provided either for a single wind speed, with results extrapolated to other wind speeds, or over the whole wind speed range. These may be referenced to manufacturers, or test report documents.

Noise Propagation/Attenuation Factors

Atmospheric Attenuation - Assumed Temperature and Relative Humidity

5.29 Atmospheric absorption increases linearly with distance, affecting higher frequency sound more than lower frequency sound and varying with temperature and relative humidity. It is not appropriate to model all the possible variations in temperature and relative humidity so a reasonable worst case is usually assumed. It should be noted that this is covered by the Institute of Acoustics Bulletin Article referred to in Paragraph 2.4 (above) which recommends the assumption of a temperature of 10 degree C and relative humidity of 70%.

Ground Attenuation – Assumed Ground Category

5.30 Ground attenuation is caused by the interaction of the direct sound wave from the source with that reflected by the ground which depends, in turn, on the acoustic impedance of the ground between the source and receiver. This is modelled in different ways by different prediction methodologies but all categorise the ground around and between the source and receiver as hard, porous, semi-porous or other variant. In general terms 'hard' ground represents a more conservative approach (higher predicted noise levels) than 'porous' ground (lower predicted noise levels). This is also covered by the Institute of Acoustics Bulletin Article referred to in Paragraph 2.4 (above) which recommends the assumption of semi-porous ground (G=0.5) where manufacturers warranted sound power level data is assumed for the turbine noise level (see also Paragraph 5.27 (above)). Where test report data is assumed it recommends use of a ground factor of G=0 (hard ground). It should be noted that a ground factor of G=0.5 would not be appropriate over paved ground such as may occur in sub-urban or urban environments or for propagation across water and that G=0 should be used in such cases.

Ground Attenuation - Assumed Receiver Height

5.31 Although the assumed receiver height can have a very small (miniscule) effect on the separation distance between source and receiver and also (similarly miniscule in most cases) on barrier/screening attenuation, it can have a more significant effect on the ground attenuation. Although ETSU-R-97 specifies that '*the microphone should be tripod mounted at a height of*

1.2-1.5m above ground level in accordance with the requirements of BS4142', some practitioners assume a 1.2 metre (seated receiver) height for day-time predictions and a 4 metre (first floor window height) at night. Likewise, some assume a 4 metre receiver height under all conditions as this results in the inclusion of less ground attenuation under all conditions representing a more conservative approach. The Institute of Acoustics Bulletin Article referred to above recommends the assumption of a 4 metre receiver height.

Barrier/Screening Attenuation

5.32 It is generally acknowledged that the screening attenuation modelled in most noise prediction methodologies is likely to under-predict noise levels to a certain extent for attenuation due to topographical screening at wind turbine sites. Research carried out for ETSU[10] suggested that only 2-3dB should be allowed where there is no line of sight between receiver locations and turbines except where the barrier is located close to the receiver and provides a sharp cut-off to the direct line of sight. The Institute of Acoustics Bulletin Article referred to above recommends the assumption of no more than 2 dB attenuation except where any other assumption is fully justified.

Effect of Wind Direction

5.33 Noise predictions are normally carried out for worst case down-wind propagation conditions; i.e. with the wind blowing from the turbines towards receiver locations. In most cases, it is reasonable to assume that all properties will be effectively down-wind from all turbines simultaneously for some wind directions as a worst-case. There are some occasions, however, when, because of the relative positions of turbines and the nearby houses, this can never occur in practice. This can be particularly relevant where cumulative impacts from more than one wind farm are to be considered. In such circumstances an allowance can be made for the wind direction effects in noise predictions.

Assessment

5.34 As discussed in Paragraph 5.2 (above), the ETSU-R-97 methodology requires the derivation of prevailing background noise level, as it varies with wind speed, for the night-time and quiet day-time periods and subsequent derivation of noise limits. This is achieved by plotting individual values of background noise, normally measured in 10 minute periods, against concurrent wind speed measured on the site to form 'scatter' plots of noise vs. wind speed.

[10] ETSU W/13/00385/REP, A Critical Appraisal of Wind Farm Noise Propagation

Wind Shear

5.35 ETSU-R-97 states, at P.85, that '*the recommendations for noise limits have been made assuming wind speed measurements* (on the wind farm site) *corrected to 10m*'. Background noise level should therefore be referenced to measurements of wind speed made at, or corrected to, 10 metres height as indicative of the wind seen by the turbines. It also states, on P.87, that '*a potential additional benefit of using a wind speed measurement height of 10 metres is that the IEA Recommended Practice for the measurement of noise emissions from wind turbines proposes that the standardised sound pressure level and sound power of a wind turbine be quoted for a wind speed reference condition of 8 m/s at a height of 10 metres above ground level. Therefore the use of a 10m-high anemometer mast may provide additional consistency through the measurement and assessment procedure*'. Despite the aim being to provide consistency with measurement documents used at the time, it is now well established that, although stated in terms of wind speed at 10 metres height, manufacturers noise data is referenced to wind speeds measured, or otherwise derived, at hub height and 'standardised' to 10 metres height assuming neutral atmospheric conditions as required by the standard IEC61400-11 (see Paragraph 5.27 (above)), the successor to the IEA document. It is also clear that for a given wind speed at 10 metres height, the wind speed at hub height will vary depending on atmospheric stability[11] rather than being determined exclusively by ground roughness alone, as suggested by ETSU-R-97 at P.120, and that higher levels of stability produce greater hub height wind speeds, relative to 10 metres height wind speeds, than neutral or reference conditions.

5.36 This has the effect that the assumed source noise levels occur at lower 10 metre height wind speeds, under conditions of increased atmospheric stability, than under the neutral or reference conditions assumed for the quantification of the turbine source noise levels. It also means that, where background noise levels are referenced to 10 metre height wind speeds, predicted turbine noise level will be greater relative to background noise under conditions of increased atmospheric stability than for neutral conditions.

5.37 This can be accounted for in two ways in a wind turbine noise assessment. Where background noise is referenced to wind speed at 10 metres height, a correction has to be made to the turbine noise to allow for varying conditions of wind shear at the site. This means that some assumption has to be made as to the wind shear at the site, often derived from measurements at two or more heights on the site.

[11] See for instance Journal of Sound and Vibration Research Vol. 277, pp. 955-970, Effects of the Wind Profile at Night on Wind Turbine Sound

5.38 Alternatively, background noise can be referenced to wind speed at hub height and 'standardised' to 10 metres height in the same way that source noise level is 'standardised' to 10 metres height. In terms of a comparison between turbine noise and background this second method is essentially the same as referencing both to hub height wind speed and means that turbine noise is compared with the derived background noise as it occurs for the conditions under which the turbines are operating without any need for a further correction to account for wind shear. It also means that variation in atmospheric stability is taken into account in the averaging of the background noise data in deriving the prevailing background noise as it varies with wind speed which is likely to produce more scatter and reduce the correlation between background noise and wind speed. Although this method was identified as an agreed practice in the Institute of Acoustics Bulletin article referred to at Paragraph 2.4 (above) and means that limits specified in planning conditions can be set relative to wind speeds measured at hub height such that compliance with such limits can be predicted without making any assumptions about wind shear at the site, there is still some debate about the principles of the method and whether it should be universally applied.

5.39 There are a number of variations within the two methods identified such as the way wind shear for the site is quantified in the first method, given that it is not possible to model every possible wind shear condition occurring at the site, and the way hub height wind speed is determined in the second method. The individual site reviews will summarise the way this has been dealt with in each case.

Derivation of Prevailing Background Noise

Type and Order of 'Best Fit' Regression Line

5.40 ETSU-R-97 specifies, at P.59, that '*the variation in background noise level with wind speed will be determined by correlating $L_{A90,10min}$ noise measurements taken over a period of time with the average wind speeds measured over the same 10-minute periods and then fitting a curve to these data*'. It is not, however, specified what type of curve should be fitted to the data so it is up to the assessor to decide whether to use a polynomial or other type of fit for the regression line or curve[12]. If a polynomial line is used then it is also up to the assessor to decide on what order of polynomial line to use. A higher order polynomial may fit the data better but may also produce anomalies at high or low wind speeds and the choice of curve can have an effect on the derived baseline used to define the noise limits. Where there is no relationship between noise

[12] The best fit line or curve used to fit the data

and wind speed, it may be appropriate, in some cases, to determine the appropriate background noise level for use in the assessment by averaging all the data acquired in the night and quiet day-time hours periods, irrespective of wind speed, rather than by using a best fit curve. There is no particular requirement to use the lowest background noise levels in such circumstances as that would run contrary to the ETSU-R-97 recommendations which advocates the use of 'typical' noise levels.

Scatter Data Shown on Plots

5.41 The individual points are usually shown on scatter plots so that the 'fit' of the regression line and any significant outliers can be seen. The regression coefficient of the data, indicative of the goodness of fit, is sometimes included although this is not necessarily helpful since a low correlation merely indicates that there are significant factors other than wind affecting the background noise data. The derived regression line should not be seen as the relationship between noise and wind but the average background noise which occurs under different wind speed conditions.

Derivation of Noise Limits

Day-Time Noise Limit

5.42 The day-time noise limit is specified as 35-40 dB L_{A90} or 5 dB above the prevailing background noise level for the quiet day-time hours, whichever is the greater (see Paragraph 5.2 (above)). There is, therefore the option to choose a value within this range or to show both the upper and lower limits, which will be the same where background noise is high.

Justification for Day-Time Noise Limit Chosen

5.43 Where a specific value is used for the day-time noise limit, rather than a range, a justification may or may not be provided as to the choice of limit within the range. ETSU-R-97 states that '*the actual value chosen for the day-time lower limit, within the range of 35-40dB(A), should depend upon a number of factors:*

- *Number of dwellings in the neighbourhood of the wind farm*
- *The effect of noise limits on the number of kWh generated*
- *Duration and level of exposure'*

Night-Time Noise Limit

5.44 The night-time noise limit is specified as 43 dB L_{A90} or 5 dB above the prevailing background noise for the night-time hours, whichever is the greater. There is a view from some that this

limit should be reduced to reflect changes in the published World Health Organisation recommendations for internal noise levels required to prevent sleep disturbance[13]. Account may also be taken of the inclusion, in that document, of an external noise limit to apply '*at the outside facades of the living spaces*' to enable people to sleep with bedrooms windows open. It is instructive, also, to note the contents of the latest WHO position on noise at night[14] which specifies acceptable levels of noise in terms of average noise level over a whole year.

Financially Involved Noise Limit

5.45 ETSU-R-97 states, at page viii of the executive summary, that '*both day- and night-time lower fixed limits can be increased to 45dB (A) and that consideration should be given to increasing the permissible margin above background where the occupier of a property has some financial involvement in the wind* farm'. What constitutes financial involvement is not always clear and various interpretations are sometimes applied although in determining the planning application, the LPA would need to satisfy themselves that such properties were financially involved to the extent that the higher limits should apply. This would also need to cover what happened where a property changed hands.. The way financial involvement is taken into account in cumulative assessments is not specified in ETSU-R-97.

Allowance for High Level of Scatter

5.46 It is possible that, on occasion, limits could be reduced to allow for scatter in the data used to produce the prevailing background noise curve.

Capping of Noise Limits at Highest Wind Speed Measured

5.47 In order to remove the effects of extrapolating the trend in background noise data into a wind speed range where no data points were measured, assessors may 'cap' the noise limits at the level derived for the highest wind speed measured as discussed at Paragraph 5.15.

Comparison of Predicted Noise Level with Derived Noise Limits

Correction from L_{Aeq} to L_{A90}

5.48 ETSU-R-97 states, at P.vi in the Executive Summary, that '*the $L_{A90,10min}$ descriptor should be used for both the background noise and the wind farm noise, and that when setting limits it should be borne in mind that the $L_{A90,10min}$ of the wind farm is likely to be about 1.5-2.5dB(A) less than the L_{Aeq} measured over the same period. The use of the $L_{A90,10min}$ descriptor for wind*

[13] Guidelines for Community Noise, World Health Organisation 1999,

[14] Night Noise guidelines for Europe, World Health Organisation Europe, 2009

turbine noise allows reliable measurements to be made without corruption from relatively loud, transitory noise events from other sources'.

Potential Tonal Content

5.49 At the time when ETSU-R-97 was published, there was a lot of concern over tonal noise from wind farm sites. The noise limits in ETSU-R-97 assume that the measured and/or predicted noise levels which are compared with the noise limits include a correction or penalty[15] to allow for any tonal content if necessary. This is normally addressed by assuming that the turbine eventually installed at the site will be supplied free from any such tones but such a correction may be included in the assessment where this is considered necessary.

Potential for Modulation of Aerodynamic Noise at Blade Rotational Speed (Blade Swish)

5.50 ETSU-R-97 advises that '*the noise levels recommended in this report* (ETSU-R-97) *take into account the character of noise described in Chapter 3* (of ETSU-R-97) *as blade swish. Given that all wind turbines exhibit blade swish to a certain extent we feel this is a more common-sense approach given the current level of knowledge. Debates at public inquiries on whether a literal interpretation of clause 7.2 of BS4142:1990 would include blade swish have in general been unhelpful'*. It is not stated what noise limits would have been applied in the absence of the possibility of blade swish. Following a study by Salford University into this effect[16], the Government advised that it '*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*'. It went on that it '*continues to support the approach set out in Planning Policy Statement (PPS) 22 – Renewable Energy. This approach is for local planning authorities to "ensure that renewable energy developments have been located and designed in such a way to minimise increases in ambient noise levels", through the use of the 1997 report by ETSU to assess and rate noise from wind energy developments'*. This does not, however, specifically preclude such modulation effects being taken into account in some way in any wind turbine noise assessment and work commissioned by Renewable UK is currently being carried out to provide further guidance on this issue.

Properties Covered by Assessment

5.51 In general, a noise assessment with reference to noise limits derived from baseline noise

[15] The application of a correction or penalty is to allow for the fact that a noise with a significant tonal component is likely to give the impression of a noise which is louder than a noise of the same level without any tonal component by an amount depending on the level of the tone.

[16] Contract NANR233, Research into Aerodynamic Modulation of Wind Turbine Noise, Salford University, 2007

measurements needs to be provided for all properties potentially exposed above the ETSU-R-97 simplified noise limit discussed in Paragraph 5.5 (above). Where there are more properties than those where baseline noise measurements have been carried out, this will inevitably require baseline noise data to be extrapolated from one property to other properties.

Incorporated Mitigation (Turbines Running in Low Noise Mode)

5.52 The majority of variable speed pitch regulated turbines are able to run in a variety of low noise modes which is achieved by running machines at reduced rotational speed resulting in lower power output, and hence lower noise output, relative to that which would occur for normal operation. Although the requirement for such mitigation is not indicative of a noise or planning problem of itself, it will affect the performance of the site as a whole and the incorporation of such measures should be identified.

Reporting

Noise Contours Provided

5.53 Although not indicative of every situation, noise contours (sometimes referred to as isobels) can show the spread of noise across the surrounding area and are helpful in showing what properties may be affected above the ETSU-R-97 simplified criterion of 35 dB L_{A90}. These may be shown for one or more wind speeds.

Presentation of Results

5.54 Fundamental to the assessment procedure is the way results are presented. This may take the form of graphical or tabular presentation or both.

Cumulative Issues

5.55 ETSU-R-97 states that '*absolute noise limits and the margins above background should relate to the cumulative effect of all wind turbines in the area which contribute to the noise received at the properties in question'*. The reviews of individual site assessments comment on how cumulative issues have been accounted for in terms of other nearby existing sites, consented sites or sites in planning. One of the biggest problems is that noise limits specified in planning conditions on an existing site are likely to be set at the ETSU-R-97 values meaning that, assuming that the existing site is operating at its limit (which may or may not be the case in practice), the limits on the new site to prevent any cumulative exceedance of the ETSU-R-97 limits would have to be so low as to effectively prevent any further development in the vicinity of the existing site.

Assessment Beyond Requirements of ETSU-R-97

5.56 There is a view that determining whether a proposed wind farm site will meet the requirements of ETSU-R-97 is not sufficient to define noise impact. Consideration of this issue is outside the scope of this review but should be seen in the context of Government advice in PPS22 as discussed in Paragraph 5.2 (above). Any assessment carried out beyond that required by ETSU-R-97 will be identified in the individual site reviews.

Planning Conditions

5.57 It will be identified in the individual site reviews whether planning conditions are proposed within the assessment reports carried out for the sites.

6. RESULTS OF DETAILED REVIEWS

6.1 The results of the detailed reviews are presented in Appendix B, in date order so that changes over time are more easily seen, and are summarised below. The summaries do not include some of the details which are best gleaned from the Appendix itself. It should be noted that it was not possible to review all the issues identified in Section 5 (above) in every case as, despite endeavours, some ES chapters or appendices remain incomplete meaning that some review data for the issues identified are taken from slightly different sample sets. All issues on the review list have been addressed to a minimum of 43 documents and a maximum of 46.

Assessment Methodology

6.2 The ETSU-R-97 assessment methodology has been universally adopted for the assessment of noise from proposed wind turbine developments with 100% of cases stating it to be the appropriate guidance.

Consultation

6.3 Consultation with the LPA was carried out over the background measurement locations in 76% of cases with a representative of the LPA attending the installation or otherwise contributing to the precise positioning of measurement equipment at the selected locations in 13% of cases.

6.4 It was noted that none of the sampled documents included any specific details of consultations with the local authority.

Baseline Measurements

Selection of Locations

6.5 Monitoring was carried out at an average of 5 locations for each site and the number of properties above the ETSU-R-97 'simplified' criterion of 35 dB L_{A90} varied enormously from a minimum of 2 up to several thousand where the 35 dB L_{A90} contour extended over suburban or even larger village areas. An average of 80% of measurements at each site were carried out at the properties themselves with the remainder being carried out on nearby land such as fields, or other available land.

6.6 In some cases there was a detailed analysis of the nearest properties to the proposed wind farm with a lot of noise monitoring locations and specific assessments for each property whilst other documents showed fewer monitoring locations, focusing on the properties where predicted noise levels were highest.

Baseline Documentation

6.7 Baseline monitoring locations were indicated on maps or aerial photographs in 86% of the cases reviewed. Descriptions of monitoring locations were supplied in 84% of cases and 79% provided a description of the noise environment. Photographs were provided in 66% of cases.

6.8 Wind direction information over the period of the baseline noise survey was provided in 52% of cases with noise and wind histograms being provided in 30% of cases. It was also noted that whilst the height of wind speed measurements was given in 93 % of cases, information about the location or the type of anemometry equipment was generally not supplied.

6.9 Calibration certificates, or dates of the last laboratory calibration, for sound level meters were included in 39% of cases and for calibrators, in 37% of cases.

Scope and Quality of Baseline Data

6.10 An average (arithmetic mean) monitoring period of 21 days was used for baseline monitoring with maximum and minimum periods of 60 and 7 days being found respectively. The length of survey also tended to vary between monitoring locations on the same site, with monitoring being carried out across different dates. Equipment failure was cited as a common reason for

this but generally no explanations were provided.

6.11 The range of wind speeds varied as indicated in Table 3 (below).

Table 3 - Wind Speed Ranges for Baseline Noise Data

	Minimum	Maximum	Mean
Lowest Wind Speed (m/s) Night-Time hours	0	4.0	0.78
Highest Wind Speed (m/s) Night	6	15.5	10.14
Lowest Wind Speed (m/s) Quiet Day-Time hours	0	4.0	0.76
Highest Wind Speed (m/s) Quiet Day-Time hours	8.1	18.9	11.28

6.12 The noise measurement equipment was clearly described in 96% of cases and was stated to conform with IEC651 Type 1 or BS EN 61672 Class 1 in 70% of cases. Details of equipment used for field calibration were supplied in 74% of cases. The performance and specification of the wind shields used in the studies corresponding to the design recommended in ETSU W/13/00386/REP (see Paragraph 5.19 (above)) were used in 4% of cases with other high performance wind shield designs being used in 68% of cases and the remainder being unclear or not stated.

6.13 Reference to rain affecting measurements was vague in most cases with some documents stating that rainfall had been measured but not stating if data points corresponding to periods of rainfall had then been removed and some documents stating that such data had been excluded but not stating where rain data had been obtained. Rainfall measurements were specifically stated as having been carried out at the site in 50% of cases and in some cases data was stated as being Met Office data from a nearby weather station. Data corresponding to periods of rainfall were specifically excluded in 59% of cases. Other extraneous data was stated as having been removed in 50% of cases and data from certain wind directions was removed in 4% of cases.

6.14 In most cases it was difficult to ascertain precisely what data from non-rainfall sources had been excluded and the criteria for exclusion was often only alluded to with no specific explanation.

6.15 Calibration drift was reported in 63% of cases with a maximum of 1.5 dB being included in the data presented.

6.16 There was an identified potential for baseline data to be affected by noise from an existing wind turbine site in 11% of cases. In some of these cases turbines were shut down to enable measurements of the background noise and in the remainder turbine noise was considered to be low enough that it could be accepted as not having significantly influenced background noise.

Filtering of background noise by wind direction was not used to eliminate turbine noise in any of the cases studied.

Noise Predictions

Prediction Methodology

6.17 The ISO9613-2[17] noise prediction methodology was used for noise predictions in 93% of cases. The remaining cases described the methodology as '*IEA method supplemented with air absorption data extracted from the EEMUA 140 guidance'*. In some cases, ISO 9613-2 was combined with other methodologies and in some cases only an indication that the prediction was based upon ISO 9613 was given in the form of an output from noise prediction software.

Turbine Data

6.18 Predicted noise levels are usually based on a turbine that is described as being likely to be installed or a 'candidate' turbine and reference is often made to the procurement process by which developers select turbines. Data from a candidate turbine was used as the basis for the assessment in 83% of cases. Two cases included modelling of a range of different turbines. The assumed turbine source noise levels were supplied in 93% of cases with 27% referencing corresponding manufacturer's documentation or test reports. Noise data was supplied over a wind speed range of 4 – 12 m/s in 33% of cases, 3 – 12 m/s in 20% of cases and 4 – 10 m/s in 7% of cases. The remaining cases all gave data over different wind speed ranges with one assessment only providing data for a single wind speed and another having data from 1 m/s up to 12 m/s. Octave band data was supplied in 78% of cases with 24% referencing corresponding manufacturer's documentation or test reports. Data was described as either warranted, measured or indicative with the precise position not always being clear as can be seen in Appendix B.

Noise Propagation/Attenuation Factors

Atmospheric Attenuation - Assumed Temperature and Relative Humidity

6.19 A range of assumed temperature and relative humidities were found to have been used as given in Table 4 (below). In some cases the assumptions used were not stated. In other cases, where different prediction methodologies were used or where the ISO 9613-2 algorithm was supplemented with a different calculation of atmospheric absorption, temperature and relative humidity were not parameters in the prediction model and this point for review was not

[17] ISO9613-2, Acoustics – Attenuation of Sound During Propagation Outdoors: - Part 2: General method of calculation

applicable.

Table 4 – Temperature and Relative Humidity Combinations Used

10°/70%	15°/70%	20°/70%	Not stated or Not Applicable
35%	33%	4%	28%

Ground Attenuation - Assumed Ground Category and Receiver Height

6.20 A range of ground factors and receiver heights were found to have been used in the assessments. Where a ground factor of G=0 is used, receiver height has little effect on the results of noise predictions as discussed in Paragraph 5.31 (above). Table 5 shows the various ground factors used in the assessments and Table 6 shows the various receiver heights used where a non-zero ground factor was used. Again some cases precluded this review point where different prediction methodologies were used and ground factors were not included. It can be noted from Appendix B that the 4 metres receiver height was more commonly used in the later applications, possibly following a move to adopt the G=0.5 and receiver height of 4m standardisation proposed in the IoA Acoustics Bulletin article.

Table 5 – Ground Factors Used

0	0.5	0.7	1	0 and 1	Not stated or Not Applicable
50%	15%	2%	2%	2%	29%

Table 6 – Receiver Heights Used for Non-Zero Ground Factors

	1.2 m	1.5 m	2 m	4 m	Not stated
Assumed Receiver Height Day	18%	9%	9%	45%	19%
Assumed Receiver Height Night	18%	0%	9%	54%	19%

Barrier/Screening Attenuation

6.21 Barrier attenuation was assumed in 7% of cases and in some case, reference was made to the results of a study of propagation of noise from wind farm sites carried out for ETSU which recommends a maximum of 2 dB attenuation for topographical barriers that just break the line of sight. In 70% of cases barrier attenuation was not included and in the remainder of assessments it was unclear or not specifically stated.

6.22 It was evident in some cases that software predictions had included topographical screening

effects on noise contours but it was not specifically stated or was unclear as to whether barrier attenuation had been included in comparisons with derived noise limits.

Effect of Wind Direction

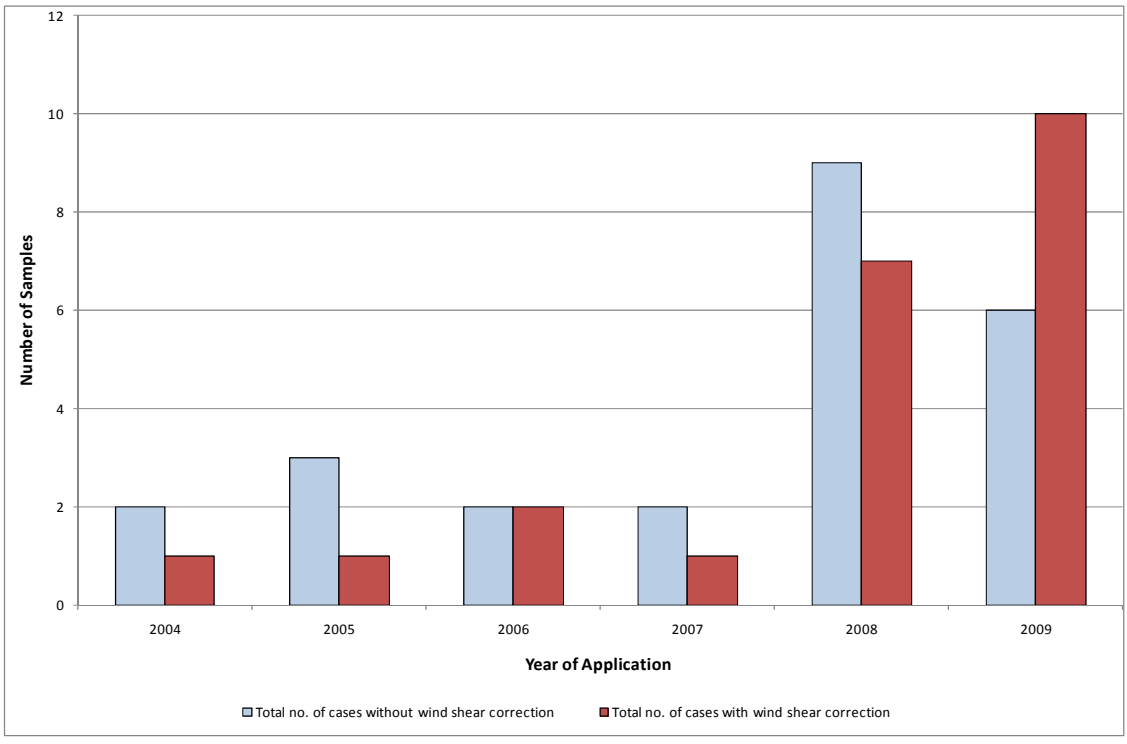
6.23 In all cases where this information was provided, noise predictions were carried out for downwind conditions in all directions as a worst-case.

Assessment

Wind Shear

6.24 The effects of wind shear were taken into account in 47% of cases and in the remainder of cases background noise measurements were referenced to wind speed measurements made at 10 metres height with no correction for wind shear applied to either the background noise curves or the predicted noise levels. In 41% of cases background noise was referenced to hub height wind speed and standardised to 10 metres height as per the IoA Bulletin agreement referred at Paragraph 5.38 (above). Figure 1 shows how the inclusion of wind shear effects has increased over time since 2004 with significantly more cases including than not in 2009, the year of publication of the IoA Bulletin article.

Figure 1 – Correction for Wind Shear Effects by Year



Derivation of Prevailing Background Noise

6.25 In some cases only linear regression lines were used where other curves may have been more appropriate. In a few cases derived limits were derived from best fit curves showing a reduction in noise level with wind speed rather than the normal increase. This may well reflect condition at a site which is dominated by traffic noise from one direction where increasing wind in the opposite direction has the effect of reducing any such noise.

Derivation of Noise Limits

6.26 In 50% of cases the predicted noise level is shown in the context of both upper and lower day-time limits. In 32% of cases a single day-time limit is shown. This was not justified with reference to the three ETSU-R-97 criteria referred to at Paragraph 5.43 (above) in any of the ones studied. In the remainder, derived upper and lower limits are the same because of high levels of background noise at all wind speeds and limits are 5 dB above background noise for all wind speeds. The ETSU-R-97 night-time limit of 43 dB L_{A90} or 5 dB above the prevailing background noise, whichever is the greater, was used in all cases. Financially involved limits were applied at certain properties in 39% of cases and noise limits were capped at the highest measured wind speeds in 25% of cases (see paragraph 5.47 above). No comment was made as to how financially involved properties were connected to the scheme in any of the cases studied and in many cases no comment was made at all other than to apply the higher limit on the assessment charts. No comments were included on how this should be dealt with in planning conditions or how the financial involvement of a property had been defined.

Tonal Content

6.27 Tonal content, and more specifically the tonal penalty described in ETSU-R-97, was addressed in 76% of cases. In the remaining 24% there was no mention of the potential for tonal content in the predicted turbine noise. No correction or penalty was added to the predicted noise levels in any assessment on the basis that either the tonal components in noise emitted by modern turbines is insignificant and/or that this lack of tonal content would be covered by manufacture's warranty documentation in the eventual turbine for the site.

Modulation Effects

6.28 The potential for modulation effects to occur was addressed in 63% of cases, with no mention of

the phenomenon in the remaining 37% of cases. No correction or other allowance was made for the possibility of such effects in any of the cases studied.

Comparison of Predicted Noise Level with Derived Noise Limits

6.29 The correction from predicted L_{Aeq} to L_{A90} was assumed to be 2 dB in 80% of cases and in 17% of cases the correction is not stated. In one case a correction of 1.5 dB was applied to correct from L_{Aeq} to L_{A90} and this is still within the suggested 1.5 – 2.5 dB suggested in ETSU-R-97.

6.30 Reference was made to properties not included within the background noise measurements, but potentially exposed above the ETSU-R-97 simplified noise limit, in 56% of cases.

6.31 Assessments were carried out for turbines stated to be running in noise reduced mode in 15% of cases. However, since the turbine noise levels are not always referenced and the prediction methodology is not always clear, it is difficult to say exactly how often noise reduced modes have been used for the assessments carried out.

Reporting

6.32 Noise contours for a sample wind speed were included with the assessments in 56% of cases. The results of the assessments were presented in graphical form in 91% of cases and in tabular form in 63% of cases. Both approaches were used in 54% of cases.

6.33 Assessments were required to include noise from other proposed, consented or existing sites in 17% of the cases studied. There was no discussion of the issue highlighted in Paragraph 5.55 (above) whereby if any other site(s) were to be operating at their planning limits, the limits on the new site would have to be severely restricted to prevent any cumulative exceedance of the ETSU-R-97 limits.

6.34 Additional assessments beyond the requirements of ETSU-R-97 were carried in 17% of cases. This generally took the form of audibility or sleep disturbance assessments, although comparison between ETSU-R-97 and BS4142 noise assessment criteria was given in one instance. There was also an assessment of audibility for animals in a nearby zoo in one instance.

6.35 Although reference is made to planning conditions and suggested ETSU-R-97 noise limits in

most cases, it was only in 17% of cases that possible planning conditions were explicitly stated and recommended to the planning authority.

6.36 The issue of monitoring of operational noise level after commissioning was mentioned in a few cases although there was no real discussion about the difficulties in measuring the inherently low levels of turbine noise at the assessment locations.

7. CONCLUSIONS

7.1 The review has highlighted the potential problems faced by local planning authorities dealing with noise assessments for wind farm sites, both in terms of the way the documents are structured, and in the variations in the way some factors are taken into account in the assessments. This suggests best practice guidance is required to confirm and, where necessary, clarify and add to the way ETSU-R-97 should be implemented in practice.

7.2 The most striking comparison between sample noise assessments has been the variation in the way the reports are structured and the way information has been presented. It is clear that the assumptions used and the details of the way the assessment has been carried out can be difficult to establish, even for those who are familiar with the issues. For a planner or environmental health officer who may not be familiar with noise assessments for wind farm sites, the task of reviewing such a document may be challenging. Although it would be unreasonable to expect all noise assessments to be conducted and presented in an identical fashion due to the different interpretations of developers of presenting information in an Environmental Statement, some level of standardisation would undoubtedly be of assistance such as section headings and information to be included under each one. A possible approach could be to have a 'standard form' noise assessment report included as an ES Appendix which would then be referenced in the main ES text.

7.3 The review has also highlighted a number of different interpretations of ETSU-R-97 which range from different approaches to measuring background noise levels, through to suggestions that background noise measurements are not required until planning consent is given. One sample revealed continuous noise monitoring and concurrent wind speed measurements at one location only, together with spot noise measurements at 'satellite' locations representative of nearby properties. This approach is based on the assumption that the general profile of the derived background noise curve would be the same at each satellite location but potentially at a

higher or lower level. Another approach was to assess the predicted noise levels against ETSU-R-97 fixed limits and refer to a future noise survey that would facilitate derivation of noise limits based on background noise + 5 dB. Any subsequent guidance on best practice could usefully be more prescriptive on the approach to background noise measurements, and interpretation of data, since this not only forms the basis of any assessment but is likely to determine the noise limits used in any eventual planning conditions on noise issues.

7.4 Some variation was also found in the prediction methodology used including the assumed temperature and relative humidity factors, ground effects, receiver heights and barrier attenuation. These are usefully covered in the 2009 Institute of Acoustics Bulletin Article although this document has no official status and the recommendations it makes should be subject to further review.

7.5 Just over half the cases studied did not address the potential issue of wind shear although, where wind shear was addressed, it mostly followed the principles described in the Institute of Acoustics Bulletin Article referred to above. Since this has no official status, as discussed above, it would be appropriate for any best practice guidance to confirm an appropriate way of dealing with wind shear issues as this is fundamental to the assessment procedure.

7.6 It was found that there was very little discussion about the actual value of the day-time hours fixed limit (35 – 40 dB L_{A90}). Although ETSU-R-97 describes 3 tests to evaluate the appropriate value within this range these are open to interpretation and best practice guidance could very usefully identify a more prescriptive and definitive approach.

7.7 There was an assumption in all the assessments that a correction or penalty for tonal content was not required at the assessment stage. There was an inherent assumption that this would be dealt with through a combination of manufacturer's guarantee and planning conditions requiring such a correction or penalty to be applied if found necessary by compliance measurements.

7.8 There is currently no requirement in ETSU-R-97 to include any correction or penalty for any modulation in the noise and this is reflected in the way this has been dealt with in the assessments studied. This position would need to be re-stated, or otherwise addressed in any best practice guidance, in line with current research, such as that recently commissioned by Renewable UK, and any other appropriate guidance on this issue.

7.9 Some guidance could also usefully be provided on the issue of financially involved properties as

the current guidance is a little unclear on exactly what constitutes financial involvement and whether this should be dealt with in planning conditions.

7.10 There is also an increasing requirement to clarify the approach to be taken with respect to cumulative impact. Unless a strategic approach is taken, noise limits specified in planning conditions on an existing site are likely to permit operation up to the ETSU-R-97 noise limits. This can effectively mean that any further development in the near vicinity is prevented even though the cumulative noise levels occurring in practice may meet the ETSU guidance.

7.11 The potential measurement of noise levels after commissioning, to ensure compliance with noise limits at assessment locations was mentioned in a few cases. However, there was no real discussion about the difficulties in measuring the inherently low levels of turbine noise at assessment locations. Some consideration could be given to a simplified assessment procedure of limiting turbine noise to a fixed level, applicable at rated power, since a condition based on this approach could be simpler and more robust in practice and would address concerns over the assessment of representative background noise levels in rural areas which are becoming increasingly debated at Public Inquiry. This should not necessarily preclude consideration of background noise level where appropriate.

7.12 Although the application of planning conditions has not been covered in this review, it is considered that best practice guidance could usefully include advice on the structure of planning conditions and noise limits designed to regulate noise from operational wind turbine sites.

7.13 Guidance should also review, or at least acknowledge, the changes which have been made to some of the documents referred to in ETSU-R-97; such as the replacement of IEC651 with BS EN 61672, the update of BS4142 from the 1990 version to the 1997 version, and the latest WHO guidance on noise limits to prevent sleep disturbance.

APPENDIX A

PROJECT BRIEF

Analysis of how noise impacts are considered in the determination of wind farm planning applications

SPECIFICATION OF WORK

1. Introduction

1.1 The 1997 report by ETSU (ETSU-R-97) for the Department of Trade and Industry (now DECC) sets out how to assess and rate noise from wind energy developments. Planning Policy Statement 22 on Renewable Energy states that local planning authorities should ensure that renewable energy developments have been located and designed in such a way to minimise increases in ambient noise levels. The PPS also states that ETSU-R-97 should be used to assess and rate noise from wind energy development.

1.2 The Government's draft National Policy Statement (NPS) on Energy Renewable Energy Infrastructure also refers to ETSU-R-97 as setting out the method for assessing the impact of noise from a wind farm on nearby residents. The draft PPS on Planning for a Low Carbon Future in a Changing Climate, which will replace PPS22 when finalised, states that where the proposed development is for a renewable energy technology included in the NPS for Renewable Energy Infrastructure (including wind farms) the approach to assessment set out in the NPS should be followed.

1.3 However, concerns have been expressed that ETSU-R-97 is not always being applied in a consistent way. DECC therefore wishes to let a contract to research and analyse matters arising in the consideration of noise impacts in the determination of wind farm planning applications in England. The project will seek to establish current good practice in assessing and rating wind turbine noise.

2. Aim

2.1 The aim of the project is to establish current good practice in assessing and rating wind turbine noise.

3. Objectives

The objectives of the study are as follows:

3.1 To investigate the way in which noise impacts for a wind farm are determined in England, including methods used in practice to implement the ETSU-R-97 guidance;

3.2 To provide recommendations to Government on ways in which ETSU-R-97 can be applied in a more consistent and effective manner, taking into account best practice.

4. Main Tasks

The following main tasks must be addressed:

4.1 Undertake a review of the key technical issues in the measurement and rating of noise from wind farms including the use of the ETSU-R-97 guidance on how noise impacts from wind farms are determined. This review will include a review of relevant literature and interviews with relevant stakeholders (such as developers, practitioners, Local Authority Planners and Environmental Health Officers).

The literature review should, as a minimum, include recent and current planning applications, recent planning inquiry decisions, reports of complaints under statutory nuisance legislation, relevant published papers in the past 10 years at UK wind farm noise conferences, and internet sources. If the quantity of data is such that inclusion of all of it is impractical, a methodology should be proposed (for approval by DECC before implementation) which ensures that a robust and useful sample is chosen.

4.2 Based on the information collected in 4.1, produce a report detailing the results of the review, and outline the ways in which noise impacts and the ETSU-R-97 guidance have been considered in wind farm applications in England since 2004 (when PPS22 was published), including any changes during that time. This should include ways in which ETSU-R-97 guidance has been applied in decisions taken under both Planning and Electricity Acts, any key trends that have occurred in the way that the guidance is used (or departed from), and a list of key issues to be investigated further. Findings of the review should be presented before proceeding to the next task.

4.3 Findings of the review should then be considered by key stakeholders for the purposes of further detail and refinement. This should include consideration of circumstances where the approach to measuring and rating wind farm noise has departed from the ETSU-R-97 guidance, why this has been the case, and any alternatives. Stakeholder consideration could take the form of a one day workshop, and may be organised in conjunction with a stakeholder (such as the Institute of Acoustics - tbc). Findings should be refined on the basis of stakeholder feedback as appropriate.

4.4 Building on the findings of the review and stakeholder feedback, produce a draft final and a final report including the results of the review, stakeholder feedback, and final recommendations to Government on action to be taken, along with recommendations for further research (if key issues cannot be resolved with the current state of knowledge).

4.5 Provide the following documents:

- A progress report of the results of the investigations carried out under tasks 4.1-4.2;
- A draft final report covering tasks 4.1 to 4.3;
- A final report incorporating comments from Government officials.

4.6 Prepare and present a PowerPoint presentation of the key results of the research to a meeting of a Government project board. This will be a one-off half day meeting in London after the final report is produced.

4.7 The final report should be suitable for publication both in printed form (in a format to be agreed with the Department's Nominated Officer) and on the Department's web site.

5. Output, Communications and Deliverables

5.1 Fortnightly progress updates by email to the Nominated Officer by email, and further ad hoc contact as necessary

5.2 One (1) hard copy and an electronic copy (by email) of a progress report on (4.1 & 4.2), within 5 weeks of commencing the project;

5.3 Two (2) hard copies and an electronic copy (by email) of a draft final report (4.1-4.4) within 13 weeks of commencing the project;

5.4 Following receipt of any feedback from DECC, four (4) bound hard copies of the final report covering tasks 4.1-4.4, appropriately reflecting any comments made by the Nominated Officer and others, plus four (4) electronic copies in CD-ROM format which would enable easy transposition to the relevant websites, and within 16 weeks of commencing the project;

5.5 A one-page project summary (on the appropriate SID form) of the project aims and results, for publication on the DECC website within 2 weeks of the final completion of the project; and

5.6 A draft and a final electronic copy of the PowerPoint presentation in task 4.5 in advance of the project board meeting (timescales to be agreed).

5.7 Electronic copies are to be provided in a distributable format (expected to be Adobe PDF) and also in a fully editable format (expected to be MS Word compatible).

6. Meetings

6.1 The contractor shall include an allowance for attending up to 4 meetings with the Nominated Officer and/or his/her representative(s) in connection with the contract as a whole. These would include at least the following:

- An inception meeting within 3 days of award of contract to enable points of clarification to be addressed; this is scheduled to be Friday 21 May if no interviews are required.

- A meeting to discuss the progress report for the findings from 4.2 and how the 2nd half of the project is going to be approached, within 7 weeks of the commencement of the project. Copies of the progress report must have been received by the Nominated Officer at least ten working days prior to the date of that meeting;

- A meeting to make a presentation to Government officials covering the findings from 4.1 to 4.4 of the draft final report and to discuss any amendments for inclusion in the final publication within 15 weeks from the commencement of the project; and

- A presentation to the project board at a later date (expected August/September 2010).

7. Information to be provided in the Tender Submission

7.1 The organisation should submit a Proposal on a SID 3 form, setting out the following:

- a statement setting out the understanding of the brief;
- a statement describing the likely methodology that would be adopted to meet the requirements of the specification. A high response rate is required from the work, and so contractors must demonstrate how this will be achieved;
- a statement of the relevant experience in this area of work of the organisation submitting a tender;
- a schedule of the key staff who would be assigned to this work together with a clear description of their experience and the topic areas on which they would work; and
- a schedule in the form of a GANTT chart, setting out the anticipated work programme showing, in particular, the expected timing of the submission of the draft report and the final report. All dates to be with reference to the date of the award of contract.

8. Fee Proposal

8.1 The organisation should include on the same SID 3 form a Financial Proposal setting out the following:

- the firm price, excluding VAT, for carrying out the work set out in Section 4 of the Specification, including the allowances made for the reporting required, as described in Sections 5 of the Specification, and for attending the meetings, as described in Section 6 of the Specification, and associated expenses;
- the daily rates that would be charged for work carried out by the key staff that would be engaged on this work and their expected time input;
- a separate rate, inclusive of travelling time and expenses but excluding VAT, for the attendance of any additional meeting(s) of a maximum duration of 2 hours that might be requested by the Department's Nominated Officer and to be held at the Department of Energy and Climate Change, 3-8 Whitehall Place, London, SW1A 2AW;
    - a schedule of milestone deliverables, as described in Section 5, against which invoices should be submitted for payment;
    - the element included in the fixed price to cover expenses; and

- confirmation of whether or not VAT would be charged.

9. The Criteria for Evaluating the Tender

9.1 The criteria for evaluating the tender will be based on the points set out in Section 7 of the specification together with a demonstration of the organisation's full understanding of the overall aims and requirements of the project.

9.2 Further detailed of the evaluation criteria are set out within paragraph 14 (Evaluation of Tender) of the Instructions to Tenderer.

APPENDIX B

DETAILED RESULTS OF NOISE ASSESSMENT REVIEWS

(Sorted by Year)

	Year	Assessment Methodology stated as ETSU-R-97?	Consulted with LPA?	LPA Attended Installation?	No. Monitoring Locations?	Approximate number of Properties ? above 35 dB LAeq Contour	% Monitoring Locations at Properties?	Map Showing Monitoring Locations included?	Description of Monitoring Locations included?	Description of Noise Environment included?	Photos of Monitoring Locations included?	Wind Direction Info Provided?	Noise and Wind Histograms included?	Monitoring Period (days)	Lowest Wind Speed Night	Highest Wind Speed Night	Lowest Wind Speed Day	Highest Wind Speed Day	IEC651 Type 1 / BSEN61672 Class 1 Equipment Used?	Equipment Manufacturer/Model Details Supplied?	Calibrator Details Supplied?	Wind shield conforms with ETSU Recommendation?	Other 'high performance' wind shield used?	Rainfall Measured?	Rainfall Excluded?	Wind Direction data excluded?	Other Data Excluded?	Calibration Checked at end?	Calibration Drift (max)	Equipment Calibration Certificates or Dates of Calibration Included?	Calibrator Calibration Certificate(s) or Date(s) of Calibration Included?	Wind Speed Measurement Height stated?	Cumulative Issues in Baseline?	Prediction Methodology (ISO 9613 Y/N?)	Candidate Turbine?	No. of other Turbines Modelled (for proposed site)	Overall Turbine Noise Level Stated?	Turbine noise levels stated as warranted?	Turbine noise levels stated as measured?	Turbine noise levels stated as indicative?	Turbine Noise Levels for a range of wind speeds Included?	Turbine noise data Wind Speed Range (Std. 10 m)	Turbine Noise Level Referenced?	Octave Band Levels Stated?	Octave Band Levels Referenced?	Octave Band Levels Included in prediction?
Site 23	2004	Yes	NK	NK	4	NK	NK	Yes	No	Yes	No	Yes	No	21	0	9.5	0	13	Yes	Yes	No	NK	Yes	No	No	No	No	Yes	0	No	No	Yes	No	Yes	3 -12 m/s	No	Yes	No	Yes
Site 24	2004	Yes	Yes	Yes	13	NK	NK	Yes	Yes	Yes	No	No	Yes	7	NK	NK	NK	NK	No	Yes	Yes	No	Yes	NK	No	No	No	Yes	NK	No	No	Yes	No	No	NK	No	No	No	Yes
Site 26	2004	Yes	No	No	6	NK	100%	Yes	Yes	Yes	Yes	Yes	Yes	14	1.2	12.1	0.9	10	Yes	Yes	Yes	No	Yes	NK	No	No	Yes	Yes	1.1	Yes	Yes	Yes	No	Yes	3 -12 m/s	Yes	Yes	Yes	Yes
Site 19	2005	Yes	Yes	Yes	2	NK	50%	No	Yes	Yes	Yes	No	No	21	0.1	9.8	0.3	10.4	Yes	Yes	Yes	No	Yes	No	No	No	No	No	NK	No	No	Yes	No	Yes	5 - 11 m/s	No	Yes	No	Yes
Site 20	2005	Yes	Yes	No	2	18	NK	Yes	No	No	No	No	No	11	3	10.4	3	9.8	NK	No	No	NK	NK	NK	NK	NK	Yes	NK	NK	No	No	No	No	No	No	NK	No	No	No	NK
Site 21	2005	Yes	No	No	5	60	100%	Yes	Yes	Yes	Yes	No	No	31	0.3	8.2	0.3	11	Yes	Yes	Yes	No	Yes	NK	NK	No	No	Yes	0.7	Yes	No	Yes	No	Yes	4 - 12 m/s	No	Yes	No	Yes
Site 22	2005	Yes	No	No	6	NK			Yes	Yes		Yes	Yes	31	0.4	7.7	0.4	8.2	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	0.7	Yes	Yes	Yes	No	Yes	3 -12 m/s	No	Yes	No	Yes
Site 08	2006	Yes	Yes	No	3	NK	67%	Yes	Yes	Yes	No	No	Yes	19	0.4	6.2	0.4	9.7	No	Yes	No	NK	NK	NK	Yes	No	Yes	Yes	NK	No	No	Yes	Yes	Yes	Yes	0	Yes								Yes
Site 17	2006	Yes	No	No	2	2	100%	Yes	Yes	No	Yes	No	Yes	19	0.1	11	0.1	12.3	No	Yes	Yes	No	Yes	No	No	No	Yes	No	NK	No	No	Yes	No	Yes	No	0	Yes	No	No	No	Yes	6 - 9 m/s	Yes	Yes	Yes	Yes
Site 18	2006	Yes	Yes	Yes	8	NK	100%	Yes	Yes	Yes	Yes	Yes	No	21	0.1	14.9	0.1	16.9	No	Yes	Yes	Yes	No	No	Yes	No	Yes	Yes	0.4	Yes	Yes	Yes	No	Yes	Yes	0	Yes	Yes	No	No	Yes	4 - 12 m/s	Yes	Yes	Yes	Yes
Site 33	2006	Yes	No	No	1	NK	NK	No	No	No	No	Yes	Yes	11	2.5	12	2.5	12	No	Yes	No	NK	NK	NK	Yes	No	Yes	Yes	NK	No	No	Yes	No	No	Yes	0	Yes	No	Yes	No	No	3 -12 m/s	No	No	No	NK
Site 16	2007	Yes	Yes	No	5	12400	20%	Yes	Yes	Yes	Yes	No	No	16	0.25	11.9	1.6	12	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	0.6	No	No	Yes	No	No	Yes	0	Yes	Yes	No	No	Yes	6 - 12 m/s	No	Yes	No	Yes
Site 29	2007	Yes	Yes	No	6	150	100%	Yes	Yes	Yes	No	No	No	14	0.6	12	1.7	11	Yes	Yes	Yes	No	NK	NK	Yes	No	No	Yes	NK	No	No	Yes	No	Yes	Yes	0	Yes	No	Yes	Yes	Yes	4 - 12 m/s	Yes	Yes	Yes	Yes
Site 45	2007	Yes	Yes	No	7	NK	NK	Yes	No	No	No	No	No	NA	NA	NA	NA	NA	NK	Yes	No	No	No	No	No	No	No	Yes	NK	No	No	No	No	Yes	0	NK	NK	NK	NK	NK	NK	NK	NK	NK	NK
Site 09	2008	Yes	Yes	No	5	220	100%	No	Yes	Yes	Yes	No	No	36	0.3	6.6	0.3	10.3	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	NK	Yes	Yes	Yes	No	Yes	Yes	3	Yes	No	No	No	Yes	6 - 10 m/s	Yes	Yes	Yes	Yes
Site 10	2008	Yes	Yes	No	7	NK	14%	Yes	Yes	Yes	No	Yes	No	15	0.5	7.8	0.5	8.5	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes	NK	Yes	Yes	Yes	No	Yes	Yes	0	No	No	No	No	No	9 m/s	No	No	No	Yes
Site 11	2008	Yes	Yes	No	7	21	NA	Yes	No	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Yes	Yes	0	Yes	No	No	No	No	NK	No	No	No	No
Site 12	2008	Yes	Yes	No	3	16	100%	Yes	Yes	Yes	Yes	No	Yes	14	0.1	14.9	1	14.9	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	0.3	Yes	Yes	Yes	No	Yes	Yes	0	Yes	Yes	No	No	Yes	3 - 12 m/s	No	Yes	No	Yes
Site 13	2008	Yes	Yes	Yes	6	60	100%	Yes	Yes	Yes	Yes	No	No	14	0.1	10.3	0.1	11.2	Yes	Yes	No	No	Yes	Yes	Yes	No	No	Yes	1	No	No	Yes	Yes	Yes	Yes	0	Yes	Yes	Yes	No	Yes	5 - 12 m/s	No	Yes	No	Yes
Site 14	2008	Yes	Yes	No	6	103	50%	Yes	Yes	Yes	Yes	No	No	15	1.2	9.3	0.7	10.5	Yes	Yes	Yes	No	Yes	No	No	No	No	Yes	0.3	No	No	Yes	No	Yes	No	0	Yes	Yes	Yes	No	Yes	4 - 12 m/s	No	Yes	No	Yes
Site 15	2008	Yes	Yes	No	3	63	100%	Yes	Yes	No	No	No	No	17	2	10.6	2	12.2	Yes	Yes	Yes	NK	NK	Yes	No	No	No	Yes	NK	No	No	Yes	No	Yes	Yes	0	Yes	Yes	No	No	Yes	5 - 10 m/s	No	No	No	NK
Site 27	2008	Yes	Yes	No	3	21	67%	Yes	Yes	Yes	Yes	No	No	15	0.4	6	1	8.3	Yes	Yes	Yes	No	Yes	NK	NK	No	No	Yes	0.5	No	No	Yes	No	Yes	Yes	0	Yes	Yes	Yes	No	Yes	5 - 10 m/s	No	Yes	No	Yes
Site 28	2008	Yes	Yes	No	4	NK	100%	Yes	Yes	Yes	Yes	Yes	No	33	0.8	10.5	1.4	11.8	No	Yes	Yes	No	Yes	NK	Yes	No	Yes	Yes	0.3	Yes	Yes	Yes	No	Yes	Yes	0	Yes	Yes	No	No	Yes	4 - 12 m/s	No	Yes	No	Yes
Site 37	2008	Yes	No	No	5	NK	40%	Yes	Yes	Yes	Yes	No	Yes	12	2	9.5	1	8.7	Yes	Yes	Yes	No	Yes	NK	Yes	No	No	Yes	1.5	Yes	Yes	Yes	No	Yes	Yes	0	Yes	No	No	No	Yes	4 - 12 m/s	No	Yes	No	Yes
Site 38	2008	Yes	Yes	No	4	18	100%	Yes	Yes	Yes	Yes	No	No	17	0	12	0	12	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No	Yes	0.2	Yes	Yes	Yes	No	Yes	Yes	0	Yes	No	No	No	Yes	4 - 12 m/s	Yes	Yes	Yes	Yes
Site 39	2008	Yes	No	No	4	NK	0%	Yes	Yes	No	No	Yes	Yes	18	2.5	12	2.5	11.6	No	Yes	No	No	No	NK	NK	No	Yes	Yes	NK	No	No	Yes	No	No	Yes	0	Yes	No	Yes	No	No	4 - 12 m/s	No	No	No	NK
Site 41	2008	Yes	Yes	No	6	58	67%	Yes	Yes	Yes	Yes	No	No	14	0	6	0	8.4	Yes	Yes	Yes	No	Yes	NK	No	No	Yes	Yes	0.7	No	No	Yes	No	Yes	No	0	Yes	Yes	No	No	Yes	4 -12 m/s	No	Yes	No	Yes
Site 42	2008	Yes	Yes	Yes	7	NK	57%	No	Yes	Yes	No	Yes	No	13					Yes	Yes	No	No	Yes	Yes	Yes	No	No	Yes	NK	No	No	Yes	No	Yes	Yes	0	Yes	No	Yes	Yes	Yes	4 - 12 m/s	Yes	Yes	Yes	Yes
Site 43	2008	Yes	Yes	No	3	12	100%	Yes	Yes	Yes	Yes	Yes	Yes	15	0.3	15.5	0.4	18	No	Yes	Yes	No	Yes	Yes	Yes	No	No	Yes	0.3	No	No	Yes	No	Yes	Yes	0	Yes	No	Yes	No	Yes	4 - 11 m/s	No	Yes	No	Yes
Site 44	2008	Yes	Yes	No	7	NK						Yes	No	35	0	13.1	0	11.4	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No	Yes	0.2	Yes	Yes	Yes	No	Yes	Yes	2	Yes	No	Yes	Yes	Yes	4 - 12 m/s	Yes	Yes	Yes	Yes
Site 01	2009	Yes	Yes	No	6	47	50%	Yes	Yes	Yes	Yes	No	No	15	2.4	6.8	0.8	8.1	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	0.4	No	No	Yes	No	Yes	Yes	0	Yes	Yes	No	No	Yes	4 - 10 m/s	No	Yes	No	Yes
Site 02	2009	Yes	Yes	No	6	NK	67%	Yes	Yes	Yes	Yes	Yes	No	49	0.2	10	0.2	12.8	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No	Yes	0.2	Yes	Yes	Yes	No	Yes	Yes	0	Yes	No	No	No	Yes	5 - 12 m/s	Yes	Yes	Yes	Yes
Site 03	2009	Yes	No	Yes	5	8	100%	Yes	Yes	Yes	Yes	Yes	No	22	0.2	9.9	0.2	9.6	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No	Yes	0.5	No	No	Yes	No	Yes	No	0	Yes	Yes	No	No	Yes	5 - 11 m/s	No	Yes	No	Yes
Site 04	2009	Yes	Yes	No	4	12	100%	Yes	Yes	Yes	Yes	No	No	21	0.1	12.6	0.1	18.9	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	0.1	Yes	Yes	Yes	Yes	Yes	Yes	0	Yes	Yes	No	No	Yes	4 - 10 m/s	Yes	Yes	Yes	Yes
Site 05	2009	Yes	Yes	No	5	33	100%	Yes	Yes	Yes	No	No	No	14	0.4	7.7	0.5	9.9	Yes	Yes	Yes	No	No	Yes	No	No	No	Yes	0.4	No	No	Yes	No	Yes	Yes	0	Yes	Yes	No	No	Yes	4 - 10 m/s	No	No	No	No
Site 06	2009	Yes	Yes	No	4	NK	100%	Yes	No	No	Yes	Yes	Yes	11	1.5	8.7	1.5	8.7	Yes	Yes	No	No	No	NK	No	No	Yes	Yes	NK	No	No	Yes	No	Yes	Yes	0	Yes	Yes	No	No	No	3 - 10 m/s	No	No	No	Yes
Site 07	2009	Yes	Yes	No	7	23	86%	Yes	Yes	Yes	Yes	Yes	Yes	22	0.4	9.9	0.5	10.2	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	0.4	No	No	Yes	No	Yes	Yes	0	Yes	Yes	No	No	Yes	3 - 12 m/s	No	Yes	No	Yes
Site 25	2009	Yes	Yes	No	5	NK	100%	Yes	Yes	Yes	Yes	Yes	No	39	0.3	10.2	0.3	12.8	No	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	0.2	Yes	Yes	Yes	No	Yes	Yes	0	Yes	Yes	No	No	Yes	4 - 12 m/s	No	Yes	No	Yes
Site 30	2009	Yes	Yes	No	5	13	NK				No	Yes	No	26	0	11.8	0	9.7	Yes	Yes	No	No	Yes	No	NK	No	No	Yes	0.5	No	No	Yes	No	Yes	Yes	0	Yes	No	No	No	Yes	3 -12 m/s	No	Yes	No	Yes
Site 31	2009	Yes	Yes	No	7	8	71%	Yes	Yes	Yes	Yes	Yes	No	21	4	10	4	11.7	Yes	Yes	Yes	No	Yes	NK	Yes	No	No	Yes	0.8	Yes	Yes	Yes	No	Yes	Yes	0	Yes	Yes	No	No	Yes	4 - 12 m/s	No	Yes	No	Yes
Site 32	2009	Yes	Yes	No	3	NK	NK	Yes	Yes	Yes	Yes	Yes	No	20					No	Yes	No	No	No	Yes	NK	No	Yes	Yes	NK	No	No	Yes	No	Yes	NK	0	Yes	No	No	No	Yes	1 - 12 m/s	Yes	Yes	No	Yes
Site 34	2009	Yes	Yes	No	7	NK	100%	Yes	Yes	Yes	Yes	Yes	Yes	21	0.2	11.5	0.3	11	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	0.5	Yes	Yes	Yes	No	Yes	Yes	0	Yes	No	Yes	No	Yes	3 -12 m/s	Yes	Yes	No	Yes
Site 35	2009	Yes	No	No	5	NK	100%	No	Yes	Yes	No	Yes	Yes	18	2.5	6.8	0.3	13.8	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	0.4	Yes	Yes	Yes	Yes	Yes	No	0	Yes	Yes	Yes	No	Yes	3 -12 m/s	No	Yes	No	Yes
Site 36	2009	Yes	Yes	No	4	NK	75%	No	No	No	Yes	Yes	No	NK	0	11.8	0	11.5	Yes	Yes	Yes	No	No	No	No	No	No	Yes	NK	No	No	Yes	Yes	Yes	Yes	0	Yes	No	Yes	No	No	6 - 9 m/s	No	Yes	No	Yes
Site 40	2009	Yes	No	No	7	120	86%	Yes	Yes	Yes	Yes	Yes	No	15	0.5	8.5	0.1	8.6	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	0.7	No	No	Yes	No	Yes	Yes	0	Yes	No	Yes	No	Yes	4 - 12 m/s	No	Yes	No	Yes
Site 46	2009	Yes	Yes	No	7	550	100%	Yes	Yes	Yes	Yes	Yes	No	60	0.2	9.7	0.2	11	No	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	0.5	Yes	Yes	Yes	No	Yes	Yes	0	Yes	Yes	No	No	Yes	4 - 12 m/s	No	Yes	No	Yes

= Blank cells where points could not be determined due to missing figures or appendices

NK = 'Not Known' where points were not explicitly stated or omitted

NA = 'Not Applicable' where points were not relevent to the method used in the assessment

	Year	Ground Factor	Assumed Receiver Height Day (m)	Assumed Receiver Height Night (m)	Any shielding Attenuation used?	Noise Contours Provided?	Tonal Content Addressed?	AM Addressed?	Background Noise referenced to Standardised 10m wind speed?	Other Wind Shear Correction used?	BG Noise Scatter Shown?	Upper and Lower Day Limits Shown?	Assumed Day-Time Fixed Limit	Justification for Day-Time Fixed Limit stated?	Regresion Line Type/Order	Mix of 2 or more regression line types used?	Average BG noise used where little correlation exists?	Capping of Limits due to WS Range?	Reduced Night-Time Lower Fixed Limit used?	Minimum difference between Daytime Limit and Predicted	Minimum difference between Night Limit and Predicted	All Properties Covered?	No. Assessment Locations	Use of Proxy Locations Clear ?	Mitigaton Incorporated (Reduced Noise Modes)?	Graphical Evaluation included?	Tabular Evaluation included?	Cumulative Issues in Assessment?	Any assessment beyond ETSU ?	Any comments re: BG noise levels/ sleep disturbance / audibility?	Statement of effects/significance included?	Predictions converted from LAeq to LA90?	Planning Conditions suggested?	Financially involved limit used?
Site 23	2004	0	2	2	No	No	No	No	No	No	Yes	NA	NA	NA	Linear	No	Not Used	No	No	4	-1	Yes	4	NA	No	Yes	Yes	No	No	None	No	-2 dB	No	Yes
Site 24	2004	0	NK	NK	No	No	Yes	No	No	No	No	No	Lower	No	Linear	No	Not Used	No	No	NK	NK	Yes	23	No	No	No	Yes	No	Yes	None	Yes	-2 dB	No	Yes
Site 26	2004	0	1.2	1.2	Yes	No	Yes	No	Yes	No	Yes	Yes	NA	NA	3rd Order	No	Not Used	Yes	No	-0.5	0.5	NK	15	Yes	No	Yes	No	No	Yes	A	No	-2 dB	No	Yes
Site 19	2005	NK	NK	NK	NK	No	Yes	No	Yes	No	Yes	NA	NA	NA	2nd Order	Yes	Not Used	No	NA	8	7	No	4	No	No	Yes	No	No	Yes	A	No	-2 dB	No	No
Site 20	2005	NK	NK	NK	NK	Yes	Yes	No	No	No	Yes	No	NA	NA	Linear	No	Not Used	Yes	No	NK	NK	No	5	Yes	No	No	No	No	No	None	No	NK	Yes	No
Site 21	2005	0	1.2	1.2	No	Yes	No	No	No	No	Yes	Yes	NA	NA	2nd Order	No	Not Used	No	No	0	1	Yes	8	No	Yes	Yes	Yes	No	No	None	No	-2 dB	No	No
Site 22	2005	0	1.2	1.2	NK	No	Yes	No	No	No	Yes	Yes	NA	NA	3rd Order	Yes	Not Used	No	No	1.5	4	Yes	6	NA	Yes	Yes	No	No	Yes	S	No	-2 dB	No	No
Site 08	2006	NK	NK	NK	NK	No	Yes	Yes	No	No	Yes	Yes	NA	NA	Other	No	Not Used	No	No	5	5	No	3	NA	No	Yes	No	No	No	None	Yes	NK	No	No
Site 17	2006	0.7	NK	NK	NK	Yes	No	No	Yes	No	Yes	No	Lower	No	Other	Yes	Not Used	Yes	No	10	8	Yes	2	NA	No	Yes	No	No	No	None	No	-2 dB	Yes	No
Site 18	2006	0.5	4	4	Yes	No	Yes	No	Yes	No	Yes	No	38	Yes	3rd Order	No	Not Used	Not required	No	1	2	NK	14	Yes	Yes	Yes	Yes	Yes	No	None	No	-2 dB	Yes	Yes
Site 33	2006	NK	NK	NK	NK	No	Yes	No	No	No	Yes	No	35	No	2nd Order	No	Not Used	Not required	No	1	7	NK	11	No	No	Yes	Yes	No	No	None	No	-2 dB	Yes	Yes
Site 16	2007	0	1.2	1.2	No	Yes	Yes	Yes	Yes	No	Yes	Yes	NA	NA	2nd Order	No	Not Used	No	No	3	0.3	Yes	7	Yes	No	Yes	No	No	No	None	No	-2 dB	No	No
Site 29	2007	NK	NK	NK	No	Yes	Yes	No	No	No	Yes	NA	NA	NA	Linear	No	Not Used	No	No	2	1	No	7	NA	No	Yes	Yes	No	No	None	Yes	NK	No	Yes
Site 45	2007	NK	NK	NK	NK	No	No	No	NK	NK	Yes	No	Lower	No	NK	Yes	NK	No	No	3	3	No	12	No	NK	Yes	No	Yes	No	None	Yes	NK	No	Yes
Site 09	2008	NK	4	4	No	Yes	No	Yes	No	No	Yes	No	NA	NA	Other	Yes	Not Used	Yes	No	2	0	No	13	Yes	No	Yes	Yes	No	No	None	Yes	-2 dB	No	Yes
Site 10	2008	1	1.2	1.2	No	No	Yes	Yes	No	No	Yes	No	Upper	No	Linear	No	Not Used	Not required	No	19	19	No	7	No	No	No	Yes	No	No	A	Yes	-2 dB	No	No
Site 11	2008	0	1.2	1.2	No	Yes	Yes	Yes	NA	NA	NA	No	Upper	No	NA	NA	Not Used	Not required	No	NA	NA	Yes	21	NA	No	No	Yes	No	No	None	No	-2 dB	Yes	No
Site 12	2008	0	4	4	Yes	Yes	No	No	Yes	No	Yes	Yes	NA	NA	3rd Order	No	Not Used	Not required	No	-3.2	4.8	Yes	16	Yes	No	Yes	No	No	Yes	S	No	-2 dB	No	No
Site 13	2008	0	1.2	1.2	No	Yes	No	Yes	Yes	No	Yes	Yes	NA	NA	2nd Order	No	Not Used	No	No	1.2	1.1	Yes	5	Yes	No	Yes	Yes	Yes	No	None	No	-2 dB	No	No
Site 14	2008	0 and 1	1.2	1.2	No	Yes	Yes	Yes	Yes	No	Yes	Yes	NA	NA	2nd Order	No	Not Used	No	No	-1.5	1	Yes	7	Yes	Yes	Yes	No	No	No	None	No	-2 dB	No	No
Site 15	2008	0	NK	NK	No	Yes	No	Yes	No	Yes	Yes	NA	NA	NA	2nd Order	No	Not Used	No	NA	20	13	No	3	NA	No	Yes	Yes	Yes	No	None	Yes	-2 dB	No	No
Site 27	2008	0	1.2	1.2	No	Yes	Yes	Yes	Yes	No	Yes	Yes	NA	NA	2nd Order	Yes	Not Used	No	No	2.5	3.5	Yes	3	NA	No	Yes	No	No	No	None	No	-2 dB	No	No
Site 28	2008	0.5	4	4	No	No	Yes	Yes	Yes	No	Yes	Yes	NA	NA	3rd Order	Yes	Not Used	No	No	-0.4	5.5	Yes	19	Yes	No	Yes	Yes	No	No	None	No	-2 dB	No	Yes
Site 37	2008	0	4	4	NK	No	Yes	Yes	No	No	Yes	Yes	NA	NA	Other	Yes	Not Used	Not required	No	0	3	Yes	25	Yes	No	Yes	Yes	No	Yes	S	No	-2 dB	No	No
Site 38	2008	NK	NK	NK	No	Yes	Yes	Yes	No	No	Yes	No	35	Agreed with council	3rd Order	Yes	Not Used	Not required	No	0	0	Yes	15	Yes	No	Yes	Yes	No	No	None	Yes	NK	No	Yes
Site 39	2008	NA	NK	NK	NK	No	Yes	No	No	No	Yes	NA	NA	NA	2nd Order	Yes	Not Used	Not required	No	3.9	2.4	Yes	10	Yes	No	Yes	Yes	No	No	None	No	-2 dB	Yes	NA
Site 41	2008	0	1.2	1.2	No	Yes	Yes	Yes	No	No	Yes	Yes	NA	NA	2nd Order	No	Not Used	No	No	9.5	8	Yes	6	Yes	No	Yes	No	No	No	None	Yes	-2 dB	No	No
Site 42	2008	0	4	4	NK	Yes	Yes	Yes	No	No										2.5	4.5	NK	8		No		Yes	No	No	None	Yes	-1.5 dB	No	
Site 43	2008	0	1.2	1.2	No	Yes	Yes	Yes	No	No	Yes	Yes	NA	NA	3rd Order	Yes	Not Used	No	No	0	0.5	No	4	Yes	Yes	Yes	Yes	Yes	No	None	No	-2 dB	No	Yes
Site 44	2008	0	2	2	No	No	Yes	Yes	No	Yes	Yes	Yes	NA	NA	3rd Order	No	Not Used	Yes	No	0.5	1	No	7	NA	No	Yes	Yes	No	No	None	Yes	NK	No	No
Site 01	2009	0	1.2	1.2	No	Yes	Yes	Yes	Yes	No	Yes	Yes	NA	NA	2nd Order	No	Night	No	No	2.5	1	Yes	6	Yes	No	Yes	No	No	No	None	No	-2 dB	No	No
Site 02	2009	0	2	2	No	No	Yes	Yes	No	Yes	Yes	No	Upper	No	3rd Order	Yes	Not Used	Yes	No	8.2	3.1	No	6	Yes	No	Yes	Yes	No	No	None	No	-2 dB	No	Yes
Site 03	2009	0	1.2	1.2	No	Yes	Yes	Yes	No	No	Yes	Yes	NA	NA	3rd Order	No	Not Used	Yes	No	1	2.5	Yes	6	Yes	No	Yes	No	No	No	None	No	-2 dB	No	No
Site 04	2009	0.5	2	2	No	Yes	Yes	Yes	No	No	Yes	No	Upper	No	3rd Order	Yes	Not Used	Not required	No	-1.6	-0.6	Yes	12	Yes	Yes	Yes	Yes	Yes	No	None	No	-2 dB	No	Yes
Site 05	2009	0.5	1.5	4	No	Yes	Yes	Yes	Yes	No	Yes	No	Upper	No	2nd Order	Yes	Not Used	No	No	7	5	Yes	10	Yes	No	Yes	Yes	No	No	None	Yes	NK	No	No
Site 06	2009	NK	NK	NK	NK	No	Yes	No	No	No	Yes	No	Upper	No	2nd Order	No	Not Used	No	No	-1	-1	No	15	Yes	No	Yes	Yes	No	No	None	No	-2 dB	No	Yes
Site 07	2009	NK	NK	NK	No	Yes	Yes	Yes	No	No	Yes	Yes	NA	NA	Linear	No	Day and Night	No	No	6	8	Yes	13	Yes	No	Yes	No	No	No	None	No	-2 dB	Yes	Yes
Site 25	2009	0.5	4	4	No	No	No	Yes	Yes	No	Yes	No	NK	NA	3rd Order	Yes	Not Used	Yes	No	6.6	4.3	No	9	Yes	No	Yes	Yes	No	No	None	No	-2 dB	Yes	No
Site 30	2009	NK	4	4	No	Yes	No	No	Yes	No	Yes	No	Lower	No	2nd Order	No	Not Used	No	No	2	3	No	5	NA	No	Yes	Yes	No	No	None	Yes	NK	No	No
Site 31	2009	0	1.2	1.2	No	Yes	Yes	Yes	Yes	No	Yes	Yes	NA	NA	3rd Order	Yes	Not Used	No	No	9	5.5	No	7	NA	No	Yes	Yes	No	No	None	No	-2 dB	No	No
Site 32	2009	0.5	4	4	No	Yes	No	Yes	Yes	No										4.4	4.9	NK	27		No		Yes	No	No	None	Yes	-2 dB	No	
Site 34	2009	0	4	4	No	No	Yes	Yes	Yes	No	Yes	Yes	NA	NA	Other	Yes	Not Used	Yes	No	0	0	Yes	20	Yes	No	Yes	No	No	Yes	S	No	-2 dB	No	No
Site 35	2009	0	1.2	1.2	No	No	Yes	Yes	No	No	Yes	Yes	NA	NA	3rd Order	Yes	Not Used	No	No	-0.7	2.3	Yes	5	NA	No	Yes	Yes	Yes	Yes	S	No	-2 dB	No	No
Site 36	2009	NK	NK	NK	No	No	Yes	No	No	No	No	Yes	NA	NA	Linear	No	Not Used	No	No	3	1.5	Yes	19	No	No	Yes	Yes	Yes	No	None	Yes	-2 dB	No	Yes
Site 40	2009	0	1.2	1.2	No	Yes	Yes	Yes	Yes	No	Yes	Yes	NA	NA	2nd Order	No	Not Used	Yes	No	-0.5	-0.5	Yes	8	Yes	No	Yes	No	No	No	None	No	-2 dB	No	Yes
Site 46	2009	0.5	4	4	No	Yes	Yes	Yes	Yes	No	Yes	No	35	No	3rd Order	Yes	Not Used	Yes	No	-0.6	0.4	Yes	16	Yes	Yes	Yes	Yes	No	No	None	Yes	-2 dB	No	No

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