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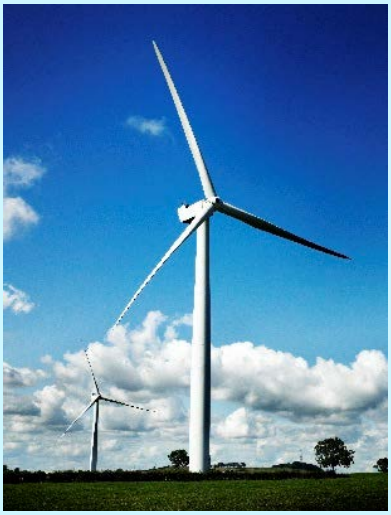
Appendix 16.2



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Quality Assurance

TNEI Services Ltd operates an Integrated Management System covering Quality (ISO 9001) Environmental (ISO 14001) and Health and Safety (OHSAS 18001). TNEI was audited in 2015 and holds certification to all three standards.

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EXECUTIVE SUMMARY

TNEI Services Ltd was commissioned by Peel Wind Farms (Yell) Ltd to undertake predictions of the wind turbine noise that would be emitted by the operation of the proposed Beaw Field Wind Farm. The noise predictions were used to assess the potential impact of operational noise from the Proposed Development on the nearest noise sensitive receptors.

The Scottish Government's web based renewables advice on *'Onshore Wind Turbines'* states: *'The Report, "The Assessment and Rating of Noise from Wind Farms" (Final Report, Sept 1996, DTI), (ETSU-R-97), describes a framework for the measurement of wind farm noise, which should be followed by applicants and consultees, and used by planning authorities to assess and rate noise from wind energy developments, until such time as an update is available. This gives indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable burdens on wind farm developers, and suggests appropriate noise conditions.'* Whilst the advice then goes on to state: *'The Institute of Acoustics (IOA) has since published Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise. The document provides significant support on technical issues to all users of the ETSU-R-97 method for rating and assessing wind turbine noise, and should be used by all IOA members and those undertaking assessments to ETSU-R-97. The Scottish Government accepts that the guide represents current industry good practice.'* The guidance contained within ETSU-R-97 and current good practice has been used to assess the potential operational noise impact of the Proposed Development.

The noise assessment has been undertaken in three stages, which involved setting the Total ETSU-R-97 Noise Limits (which is defined in this assessment as being the greater of 40dB or background noise plus 5dB for daytime periods, and 43dB or background noise plus 5dB for night time periods. For properties with financial involvement in any given scheme the limits can be increased to 45dB or background noise plus 5dB for both day and night periods) at the nearest noise sensitive receptors, predicting the likely effects (undertaking a cumulative noise assessment where required) and setting site specific noise limits for the Proposed Development.

Background noise monitoring was undertaken at six receptors which were considered to be representative of the noise sensitive receptors located closest to the Proposed Development. After one week the batteries failed on one of the noise meters therefore due to insufficient data points recorded, noise data from a representative proxy location was used to derived noise limits for that receptor. The quietest unfiltered dataset was used and this approach was agreed during a telephone conversation with Shetland Isles Council Environmental Health Department.

A total of fifteen noise sensitive receptors were chosen as assessment locations. The assessment locations were chosen to represent the noise sensitive receptors located closest to the Proposed Development but also to consider receptors located further away but in proximity to the small operational wind turbine developments to the south of the Proposed Development. For the assessment locations where no background noise measurements were undertaken, noise data collected at proxy locations deemed representative of the expected background noise environment was used to assess the wind turbine noise impact at those receptors.

Wind speed was measured at various heights using a Triton SODAR unit which was located within the proposed site. The data collected at 80m and 100m height was used to calculate hub height wind speeds (95m) which were then standardised to 10m height, in accordance with current good practice. Analysis of the measured data has been undertaken in accordance with ETSU-R-97 and current good practice to determine the pre-existing background noise environment and to establish the quiet daytime and night-time noise limits for each of the assessment locations.

Following a review of the guidance in ETSU-R-97 the daytime limit was set at 40dB(A) or background plus 5dB whichever is the greater. The night time limit has been set at 43dB or background plus 5dB whichever is the greater. A fixed limit of 45dB(A), or a permissible limit above background was used as appropriate where the occupiers of a property have financial involvement with the wind turbine development. For the purposes of this assessment the occupiers of the dwellings located in close proximity to the small operational wind turbine developments to the south of the Proposed Development have been assumed to have a financial involvement with the single wind turbine developments.

There are a number of small operational wind turbines to the south of the site. In accordance with good practice a cumulative assessment was undertaken at the noise sensitive receptors where predictions from the Proposed Development were found to be within 10dB of the noise predictions from all other schemes. The cumulative assessment results show that the predicted cumulative wind farm noise immission levels would meet the Total ETSU-R-97 Noise Limits at receptor locations surrounding the Proposed Development for both quiet daytime and night-time periods.

Predictions of wind turbine noise were made based upon sound power level data for candidate wind turbine models, the Senvion 3.4M 104 (3.4MW) and the Nordex N100 (3.3MW) (for the Proposed Development), and the Evance Iskra (5kW), Proven (6kW) and Eoltech (6kW) (for the other schemes) and a noise propagation model which accords with current good practice and is considered to provide a realistic impact assessment.

Site specific ETSU-R-97 noise limits have also been derived which take account (if and where required) of the other wind turbine developments. Where wind turbine immissions from the other wind turbines at a given receptor were found to be at least 10dB below the Total ETSU-R-97 Noise Limit, they will be using a negligible proportion of the limit, as such it was considered appropriate to allocate the entire noise limit to the Proposed Development. For the receptors where turbine predictions were found to be within 10dB of the Total ETSU-R-97 noise limit, apportionment of the Total ETSU-R-97 Noise Limits was undertaken in accordance with current good practice.

An assessment was undertaken to determine whether the Proposed Development could operate to within the Site Specific Noise Limits (which is defined in this assessment as the noise limit which would be applicable to the Proposed Development which has been set whilst fully taking account of cumulative wind farm noise impacts) and it was found that at all receptors wind turbine noise immissions were below the Site Specific Noise Limits when considering the Senvion 3.4M and Nordex N100 as candidate turbines. Those turbine models were selected as being representative of the type of turbine that could be installed at the site.

TNEI understand that the small wind turbine located in close proximity to Cluness Cottage (T20) may be removed therefore for the purposes of this assessment modelling has been undertaken with and without that turbine. The calculations included within the main sections of this report assume that the turbine is operational, however an

alternative set of noise limits and predictions have been presented within Annex 9 which would apply if the turbine is removed.

Should the Scottish Ministers grant consent for the Proposed Development it would be appropriate to include noise related planning conditions which detail the noise limits applicable to the Proposed Development together with a method of assessment which could be used in the event of a complaint. A set of suggested planning conditions are included within Appendix 22.1 of the ES.

There are a number of wind turbine makes and models that may be suitable for the proposed wind farm. Should the Proposed Development receive consent, the final choice of turbine would be subject to a competitive tendering process. The final choice of turbine would have to meet the noise limits determined and contained within any condition imposed.

Contents

TABLES

ANNEXES

1 INTRODUCTION

1.1 Background

1.1.1 The Proposed Development is located approximately 1km north west of Burravoe and 1km south of Gossabrough on the Isle of Yell in the Shetland Islands. The approximate OS grid reference for the site centre is 450461, 1182092. The proposal is for the installation and operation of seventeen wind turbine generators with a maximum tip height of up to 145m with a generating capacity greater than 50MW.

1.1.2 The turbines will each have a design envelope of a maximum height to blade tip of 145m. In the absence of a confirmed turbine model, this noise assessment models two different candidate turbines, the Senvion 3.4M 104, 3.4MW and the Nordex N100, 3.3MW. These turbines have been selected as they are representative of the scale of turbine which would be installed on the site.

1.1.3 There are a number of small operational wind turbine developments to the south of the Proposed Development. The operational wind turbines have been considered in the cumulative noise assessment.

2 NOISE PLANNING POLICY AND GUIDANCE

2.1 Overview of Noise Planning Policy and Guidance

2.1.1 In assessing the potential noise impacts of the Proposed Development the following guidance and policy documents have been considered:

- Local Policy
- National Planning Policy[1]
- Web Based Renewables Advice: *'Onshore Wind **T**urbines'*;[2]
- Planning Advice Note PAN 1/2011: *'Planning and Noise'*;[3]
- ETSU-R-97 *'The Assessment and Rating of Noise from Wind Farms';*[4]
- Institute of Acoustics '*A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise'* (IOA GPG) May 2013.[5]

2.2 Local Policy

Shetland Local Development Plan

2.2.1 The adopted Development Plan for the area comprises the Shetland Local Development Plan (LDP) which was adopted in September 2014. The LDP assists with the delivery of sustainable economic growth and the preservation of the natural and built environment of Shetland. It sets out the Council's land use strategy which recognises existing developments, promotes sustainable economic growth and conserves Shetland's natural and built environment.

2.2.2 The LDP contains a number of overarching polices, the aim of which is to deliver high standards of development. Policy GP1: Sustainable Development in relation to general amenity states that:

'Development will be planned to meet the economic and social needs of Shetland in a manner that does not compromise the ability of future generations to meet their own needs and to enjoy the area's high quality environment. Tackling climate change and associated risks is a major consideration for all development proposals.'

2.2.3 This general development policy takes into account the need to mitigate and adapt to the causes of climate change. It also aims to ensure the amenity of those adjacent users affected by development proposals.

2.2.4 Policy RE1 covers the principal policy guidance in relation to renewable energy. It states:

'Proposals for renewable energy developments will be supported where it can be demonstrated that there are no unacceptable impacts on people'.

Draft Shetland Supplementary Guidance Documents – Onshore Wind Energy

2.2.5 The policy detailed above is supported by more detailed guidance contained within Supplementary Guidance (SG) – Onshore Wind Energy. This SG is in draft format, dated July 2015 and there is currently no set date for adoption. One purpose of this SG is to provide developers with information and guidance on where, in principle, large-scale onshore wind energy developments and all associated infrastructure are likely to be acceptable.

2.2.6 Section 2 of the SG sets out the Proposed Development Criteria which proposals that fall within Spatial Policy 3 must comply with. In relation to amenity, DC4 Impacts on Communities states that:

'Development proposals must, in combination with existing and consented wind energy developments, assess the likely impact on communities and the long term impacts on amenity including outdoor access, recreation and tourism opportunities. Planning application must be accompanied by an assessment of the effects on these locations covering a range of factors including noise and shadow flicker.'

2.2.7 The ETSU-R-97 methodology is designed to protect amenity whilst balancing the need for renewable energy developments. The noise assessment of the potential impacts during the construction and decommissioning stages of the Proposed Development can be found in Technical Appendix 16.1 of the Environmental Statement.

2.3 National Planning Policy

2.3.1 Scottish Planning Policy (SPP) was published in 2014. It states (paragraph 169) that proposals for energy infrastructure should take account of spatial frameworks for wind farms (where relevant) and that considerations may include noise impacts on communities and individual dwellings.

Planning Advice Note PAN 1/2011: Planning and Noise

2.3.2 PAN 1/2011[6] provides advice o**n** the role of the planning system in helping to prevent and limit the adverse effects of noise. Paragraph 29 contains some specific information on noise from wind farms and states the following:

'There are two sources of noise from wind turbines - the mechanical noise from the turbines and the aerodynamic noise from the blades. Mechanical noise is related to engineering design. Aerodynamic noise varies with rotor design and wind speed, and is generally greatest at low speeds. Good acoustical design and siting of turbines is essential to minimise the potential to generate noise. Web based planning advice on renewable technologies for Onshore wind turbines provides advice on 'The Assessment and Rating of Noise from Wind Farms' (ETSU-R-97) published by the former Department of Trade and Industry [DTI] and the findings of the Salford University report into Aerodynamic Modulation of Wind Turbine Noise.'

Web Based Planning Advice – Onshore Wind Turbines

2.3.3 The 'Onshore Wind Turbines' web based document describes the types of noise (mechanical and aerodynamic) that wind turbines generate. Mechanical noise is generated by the gearbox and generator and other parts of the drive train which can be radiated as noise through the nacelle, gear box, tower and supporting structures together with the aerodynamic noise generated by the action of the blades rotating through the air. The document states *'there has been significant reduction in the mechanical noise generated by wind turbines through improved turbine design'* and goes on to note:

'The Report, "The Assessment and Rating of Noise from Wind Farms" (Final Report, Sept 1996, DTI), (ETSU-R-97), describes a framework for the measurement of wind farm noise, which should be followed by applicants and consultees, and used by planning authorities to assess and rate noise from wind energy developments, until such time as an update is available. This gives indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable burdens on wind farm developers, and suggests appropriate noise conditions.'

2.3.4 The web based document then refers to the IOA GPG as a source which provides:

'significant support on technical issues to all users of the ETSU-R-97 method for rating and assessing wind turbine noise, and should be used by all IOA members and those undertaking assessments to ETSU-R-97. The Scottish Government accepts that the guide represents current industry good practice.'

2.3.5 The document also refers to the role of PAN1/2011 'Planning and Noise' to:

'provide advice on the role of the planning system in helping to prevent and limit the adverse effects of noise. The associated Technical Advice Note[7] *provides guidance which may assist in the technical evaluation of noise assessment.'*

2.4 ETSU-R-97 The Assessment and Rating of Noise from Wind Farms

2.4.1 As wind farms started to be developed in the UK in the early 1990's, it became apparent that existing noise standards did not fully address the issues associated with the unique characteristics of wind farm developments and there was a need for an agreed methodology for defining acceptable noise limits for wind farm developments. This methodology was developed for the former Department of Trade and Industry (DTI) by the Working Group on Noise from Wind Turbines (WGNWT).

2.4.2 The WGNWT comprised a number of interested parties including, amongst others, Environmental Health Officers, wind farm operators, independent acoustic consultants and legal experts who:

'…between them have a breadth and depth of experience in assessing and controlling the environmental impact of noise from wind farms.'

2.4.3 In this way it represented the views of all the stakeholders that are involved in the assessment of noise impacts of wind farm developments. The recommendations of the WGNWT are presented in the DTI Report – ETSU-R-97 *'The Assessment and Rating of Noise from Wind Farms (1996).'*

2.4.4 The basic aim of the WGNWT in arriving at the recommendations was the intention to provide:

'Indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable restrictions on wind farm development or adding to the costs and administrative burdens on wind farm developers or local authorities.'

2.4.5 ETSU-R-97 makes it clear from the outset that any noise restrictions placed on a wind farm must balance the environmental impact of the wind farm against the national and global benefits that would arise through the development of renewable energy sources:

'The planning system must therefore seek to control the environmental impacts from a wind farm whilst at the same time recognising the national and global benefits that would arise through the development of renewable energy sources and not be so severe that wind farm development is unduly stifled.'

2.4.6 Where noise at the nearest noise sensitive receptors is limited to an $L_{A90,10min}$ of 35dB(A) up to wind speeds of 10ms^{-1} at 10m, then it does not need to be considered in the noise assessment, as protection of the amenity of these properties can be controlled through a simplified noise limit, as detailed in ETSU-R-97. ETSU-R-97 states that:

'For single turbines or wind farms with very large separation distances between the turbines and the nearest properties, a simplified noise condition may be suitable. If the noise is limited to an $L_{A90,10min}$ of 35dB(A) up to wind speeds of 10m/s at 10m height, then this condition alone would offer sufficient protection of amenity, and background noise surveys would be unnecessary.'

2.4.7 The ETSU-R-97 assessment procedure specifies that where noise is greater than the simplified limit of 35dB noise limits should be set relative to existing background noise levels at the nearest receptors and that these limits should reflect the variation in both turbine source noise and background noise with wind speed. Absolute lower limits, different for quiet daytime and night-time, are applied where low levels of background noise are measured. The wind speed range that should be considered ranges between the cut-in wind speed for the turbines (usually about 2-3ms^{-1}) and up to 12ms^{-1}, where all wind speeds are referenced to a 10 metre measurement height.

2.4.8 Separate noise limits apply for quiet daytime and for night-time. Quiet daytime limits are chosen to protect a property's external amenity, and night time limits are chosen to prevent sleep disturbance indoors, with windows open.

2.4.9 The quiet daytime noise limit is derived from background noise data measured during so-called 'quiet periods of the day', which comprise weekday evenings (18:00 to 23:00), Saturday afternoons and evenings (13:00 to 23:00) and all day and evening on Sundays (07:00 to 23:00). Multiple samples of 10 minute background noise levels using the $L_{A90,10min}$ measurement index are logged continuously over a range of wind speed conditions. These measured noise levels are then plotted against simultaneously measured wind speed data and a 'best fit' curve is fitted to the data to establish the background noise level as a function of wind speed. The ETSU–R-97 quiet daytime noise limit, sometimes referred to as a 'criterion curve', is then set at a level 5dB(A) above the best fit curve to the background noise data over a 0 - 12 ms^{-1} wind speed range; subject to an appropriate day time fixed minimum limit:

'For wind speeds where the best fit curve to the background noise data lies below a level of 30 - 35dB(A) the criterion curve is set at a fixed level in the range 35 - 40dB(A). The precise choice of criterion curve level within the range 35 - 40dB(A) depends on a number of factors: the number of noise affected properties, the likely duration, the level of exposure and the potential impact on the power output of the wind farm. The quiet daytime limits have been set in ETSU-R-97 on the basis of protecting the amenity of residents whilst outside their dwellings in garden areas.'

2.4.10 The night time noise limit is derived from background noise data measured during the night time periods (23:00 to 07:00), with no differentiation being made between weekdays and weekends. The 10 minute L_{A90} noise levels measured over the night time periods are plotted against concurrent wind speed data and a 'best fit' correlation is established. The night time noise limit is also based on a level 5dB(A) above the best fit curve over the 0-12ms^{-1} wind speed range. Where the night time noise limit derived from background noise measurements is found to be below 43dB L_{A90}, it is fixed at 43dB L_{A90}.

2.4.11 The exception to the setting of both the quiet daytime and night time fixed minimum on the noise limits occurs where a property occupier has a financial involvement in the wind farm development. Paragraph 24 of ETSU-R-97 states:

'The Noise Working Group recommends 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 the property has some financial involvement in the wind farm.'

2.4.12 ETSU-R-97 provides a robust basis for determining the noise limits for wind turbine(s) and since its introduction has become the accepted standard for such developments across the UK.

2.5 Current Good Practice

A Good Practice Guide on the Application of ETSU-R-97

2.5.1 In May 2013, the Institute of Acoustics issued *'A Good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise'* (IOA GPG). The document provides guidance on background data collection, data analysis and limit derivation, noise predictions, cumulative issues, reporting requirements and other matters such as noise related planning conditions.

2.5.2 The Authors of the IOA GPG sets out the scope of the document in Section 1.2:

'This guide presents current good practice in the application of the ETSU-R-97 assessment methodology for all wind turbine developments above 50 kW, reflecting the original principles within ETSU-R-97, and the results of research carried out and experience gained since ETSU-R-97 was published. The noise limits in ETSU-R-97 have not been examined as these are a matter for Government.'

2.5.3 The guidance document was endorsed, on behalf of the Government, by the Cabinet Secretary for Finance, Employment and Sustainable Growth, Mr John Swinney MSP[8]. The recommendations included in the IOA GPG have been considered and applied in the noise assessment for the Proposed Development.

2.5.4 The IOA GPG refers to six Supplementary Guidance Notes and where applicable have been considered in this report.

2.5.5 The most recent support for continuing use of ETSU-R-97 in Scotland can be found in Hansard[9], as a response to a parliamentary question on 21 November 2012 from Murdo Fraser (Mid Scotland and Fife) (Scottish Conservative and Unionist Party):

'*To ask the Scottish Government whether it will review the ETSU-R-97 spatial regulation on wind farm deployments and housing in light of recently published studies on the effects of wind farms on health'.*

2.5.6 On behalf of the Scottish Government, Derek Mackay replied:

'*ETSU-R-97 is a UK Government publication and has become an industry standard, the Scottish Government is not currently reviewing it. However we are working with the UK Government and the Institute of Acoustics on the production of good practice guidance for the application of ETSU-R-97.'*

2.5.7 The guidance contained within ETSU-R-97 and the IOA GPG has therefore been used to assess and rate the operational noise emissions from the Proposed Development.

3 POTENTIAL IMPACTS

3.1 Operational Noise Sources

3.1.1 Wind turbines may emit two types of noise. Firstly aerodynamic noise which is a more natural sounding 'broad band' noise, albeit with a characteristic modulation, or 'swish', which is produced by the movement of the rotating blades through the air. Secondly, mechanical noise which may emanate from components within the nacelle of a wind turbine. Historical sources of mechanical noise comprise gearboxes or generators. Modern turbine designs have evolved to ensure that mechanical noise radiation from wind turbines is negligible.

3.1.2 Aerodynamic noise is usually perceived when the wind speeds are fairly low. At very low wind speeds the blades do not rotate, or rotate very slowly, and so at these wind speeds negligible aerodynamic noise is generated. In higher winds aerodynamic noise may be masked by the normal sound of wind blowing through the trees and around buildings. The level of this natural 'masking' noise relative to the level of wind turbine noise is one of the several factors that determine the subjective audibility of the wind turbines.[10]

3.2 Infrasound, Low Frequency Noise and Vibration

3.2.1 The term infrasound is usually defined as the frequency range below 20Hz, while low frequency noise describes sound in the frequency range 20-200Hz. An average young healthy adult has an audible range from 20Hz to 20,000Hz, although the sensitivity of the ear varies with frequency and is most sensitive to sounds with frequencies between 500Hz and 4,000Hz. Wind turbines do produce low frequency sounds[11], but our threshold of hearing at such low frequencies is relatively high and they therefore go unnoticed. Infrasound from wind turbines is often at levels below that of noise generated by wind around buildings and other obstacles.

3.2.2 In 2004, the former DTI commissioned The Hayes McKenzie Partnership to report on claims that infrasound or low frequency noise (LFN) emitted by wind turbine generators (WTGs) were causing health effects. Of the 126 wind farms operating in the UK, five had reported low frequency noise problems, therefore, such complaints are the exception rather than a general problem which exists for all wind farms. Hayes McKenzie investigated the effects of infrasound and LFN at three wind farms for which complaints had been received, the results were reported in May 2006[12]. The report concluded that:

- 'infrasound associated with modern wind turbines is not a source which will result in noise levels which may be injurious to the health of a wind farm neighbour;
- low frequency noise was measurable on a few occasions but below the existing permitted Night Time Noise Criterion. Wind turbine noise may result in internal noise levels within a dwelling that is just above the threshold of audibility, however at all sites it was always lower than that of local road traffic noise;
- that the common cause of complaint was not associated with LFN, but the occasional audible modulation of aerodynamic noise especially at night. Data collected showed that the internal noise levels were insufficient to wake up residents at these three sites. However once awoken, this noise can result in difficulties in returning to sleep.'

3.2.3 The Applied and Environmental Geophysics Research Group at Keele University were commissioned by the MOD, the DTI and the British Wind Energy Association to undertake microseismic and infrasound monitoring of low frequency noise and vibrations from wind farms for the purposes of siting wind farms in the vicinity of Eskdalemuir in Scotland. Whilst the testing showed that vibration can be detected several kilometres away from wind turbines, the levels of vibration from wind turbines were so small that only the most sophisticated instrumentation can reveal their presence and they are almost impossible to detect. Nevertheless, the Renewable Energy Foundation alleged potential adverse health effects and when that story was picked up in the popular press, notably the Scotsman, the report's authors expressed concern over the way in which their work had been misinterpreted and issued a rebuttal statement[13] in August 2005:

'Vibrations at this level and in this frequency range will be available from all kinds of sources such as traffic and background noise – they are not confined to wind turbines. To put the level of vibration into context, they are ground vibrations with amplitudes of about one millionth of a millimetre. There is no possibility of humans sensing the vibration and absolutely no risk to human health.'

3.2.4 In response to concerns that wind turbines emit infrasound and cause associated health problems, Dr Geoff Leventhall, Consultant in Noise Vibration and Acoustics and author of the Defra Report on Low Frequency Noise and its Effects, said in the article in the Scotsman ('Wind farm noise rules 'dated'- James Reynolds, 5 August 2005')

'I can state quite categorically that there is no significant infrasound from current designs of wind turbines.'

3.2.5 An article[14] published in the IOA Bulletin (March/April 2009) concluded that there is no robust evidence that either low frequency noise (including 'infrasound') or ground-borne vibration from wind farms, has an adverse effect on wind farm neighbours.

3.2.6 Recent[15] work by Dr Leventhall looked at infrasound levels within the ear compared to external sources and concluded:

'The conclusion is that the continuous inner ear infrasound levels due to internal sources, which are in the same frequency range as wind turbine rotational frequencies, are higher than the levels produced in the inner ear by wind turbines, making it unlikely that the wind turbine noise will affect the vestibular systems, contrary to suggestions made following the measurements at Shirley. The masking effect is similar to that in the abdomen (Leventhall 2009). The body, and vestibular systems, appear to be built to avoid disturbance from the high levels of infrasound which are produced internally from the heartbeat and other processes. In fact, the hearing mechanisms and the balance mechanisms, although in close proximity, have developed to minimise interaction. (Carey and Amin 2006).'

3.3 Amplitude Modulation of Aerodynamic Noise (AM)

3.3.1 In the context of wind turbine noise amplitude modulation describes a variation in noise level over time; for example observers may describe a 'whoosh whoosh' sound, which can be heard close to a wind turbine as the blades sweep past. Amplitude Modulation of aerodynamic noise is an inherent characteristic of wind turbine noise and was noted in ETSU-R-97, on page 68:

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

This modulation of blade noise may result in a variation of the overall A-weighted noise level by as much as 3dB(A) (peak to trough) when measured close to a wind turbine. As distance from the wind turbine [or] *wind farm increases, this depth of modulation would be expected to decrease as atmospheric absorption attenuates the high frequency energy radiated by the blade.'*

3.3.2 In recent times the Acoustics community has sought to make a distinction between AM discussed within ETSU-R-97, which is expected at most wind farms and as such may be considered as 'Normal Amplitude Modulation' (NAM), compared to the unusual AM that has sometimes been heard at some wind farms, hereinafter referred to as 'Other Amplitude Modulation' (OAM). The term OAM is increasingly used to describe an unusual feature of aerodynamic noise from wind turbines, where a greater than normal degree of regular fluctuation in sound level occurs at blade passing frequency, typically once per second. In some appeal decisions it may also be referred to as 'Excess Amplitude Modulation' (EAM). The terms OAM and EAM are interchangeable. The noise assessment and rating procedure detailed in ETSU-R-97 fully takes into account the presence of the intrinsic level of NAM when setting acceptable noise limits for wind farms.

3.3.3 On 16 December 2013, RenewableUK (RUK) released six technical papers[16] on AM which reflect the outcomes of research commissioned over the last three years, together with a template planning condition. Whilst this research undoubtedly improves understanding of Other Amplitude Modulation (OAM) and its effects, it should be noted that at the time of writing although some of the work has been presented at various conferences it has not been peer reviewed, or endorsed by any relevant body such as the Institute of Acoustics (IOA).

3.3.4 On 22 January 2014, the IOA released a statement regarding the RUK research and the proposed planning condition to deal with the issue of amplitude modulation from a wind turbine and stated:

'This research is a significant step forward in understanding what causes amplitude modulation from a wind turbine, and how people react to it. The proposed planning condition, though, needs a period of testing and validation before it can be considered to be good practice. The IOA understands that RenewableUK will shortly be making the analysis tool publicly available on their website so that all interested parties can test the proposed condition, and the IOA will review the results later in the year. Until that time, the IOA cautions the use of the proposed planning condition.'

3.3.5 Research regarding amplitude modulation is ongoing. In April 2015, the Institute of Acoustics issued a discussion document entitled *'Methods for Rating Amplitude Modulation in Wind Turbine Noise'*[17]. The document presents three methods which can be used to quantify the level of AM at a given measurement location. At the Institute of Acoustics autumn Conference at Harrogate in October 2015 a representative fro the AM Working Group presented a paper on their preferred option, although at the time of writing no official announcement had been made. Once a preferred method has been agreed, potentially it may be possible to relate the metric to a dose response relationship and determine an acceptable level of AM. Consultation is ongoing.

3.3.6 On 3rd August 2015 the Department for Energy and Climate Change (DECC) awarded a contract for further research, with the stated aims as follows:

- To review the available evidence on Amplitude Modulation (AM) in relation to wind turbines, including but not limited to the research commissioned and published by RenewableUK in December 2013;
- To work closely with the Institute of Acoustics' AM working group, who are expected to recommend a preferred metric and methodology for quantifying and assessing the level of AM in asample of wind turbine noise data;
- To review the robustness of relevant dose response relationships, including the one developed by the University of Salford as part of the RenewableUK study, on which the correction (or penalty) for amplitude modulation proposed as part of its template planning condition is based;
- To consider how, in a policy context, the level(s) of AM in a sample of noise data should be interpreted, in particular determining at what point it causes a significant adverse impact;
- To recommend how excessive AM might be controlled through the use of an appropriate planning condition; and
- To consider the engineering/cost trade-offs of possible mitigation measures.

3.3.7 It is understood the DECC work package is due for completion by early March 2016. In summary, at the time of writing:

- Having regard to hundreds of wind farms across the UK, problems with OAM have occurred rarely and are usually intermittent;
- It is not possible to predict whether or not OAM will occur at any particular site; and
- There is limited evidence available that a manufacturer has demonstrated an effective mitigation strategy for a particular model of turbine by modifying blade pitch to reduce the liklihood of stalling, at a site believed to exhibit OAM. The power losses associated with such a strategy were not made public. There is insufficient evidence to suggest this approach could be applied reliably elsewhere at this time.

- At the present time the advice from the IOA GPG remains unchanged. Paragraph 7.2.1 states:

  '7.2.1 The evidence in relation to "Excess" or "Other" Amplitude Modulation (AM) is still developing. At the time of writing, current practice is not to assign a planning condition to deal with AM.'

4 METHODOLOGY

4.1 Assessing Operational Noise Impact

4.1.1 To undertake an assessment of the operational noise impact in accordance with the requirements of ETSU-R-97, the following steps are required:

- Specify the location and candidate turbine model(s) for the Proposed Development and the operational nearby wind turbines.
- Measure the background noise levels as a function of on site wind speed at a selection of representative Noise Monitoring Locations (NML).
- Identify the locations of all nearby noise sensitive receptors and select a sample of relevant Noise Assessment Locations (NAL). For each NAL, identify the most representative measured background noise data.
- Establish for each NAL the Total ETSU-R-97 Limits based on analysis of the measured background noise levels and fixed minimum limits.
- Specify the likely noise emission characteristics of the wind turbines for the Proposed Development and the nearby operational wind turbines.
- Calculate the likely noise immission levels due to the cumulative operation of all relevant wind turbines and compare it to the Total ETSU-R-97 Limits.
- Determine the site specific noise limits which take allowance of the noise limit already allocated to other schemes.
- Calculate the likely noise immission levels due to the operation of the Proposed Development on its own and compare it to the Proposed Development specific noise limits.

4.1.2 In order to consider the steps outlined above the assessment has been split into three separate stages:

- Stage 1 – establish the Total ETSU-R-97 noise limits for each NAL based on the measured background noise levels and fixed minimum limits.
- Stage 2 – undertake noise predictions to determine whether noise predictions from the Proposed Development on its own are within 10 dB of the total noise predictions from the other wind turbines within the area. Where turbine predictions are within 10 dB then a likely cumulative noise assessment will be undertaken; and
- Stage 3 – establish the Proposed Development specific noise limits (at levels below the Total ETSU-R-97 limits, where limit apportionment required) and compare the noise predictions from the Proposed Development on its own against the Proposed Development specific noise limits.

4.1.3 There are a range of turbine makes and models that may be appropriate for the Proposed Development. The final selection of turbine will follow a competitive tendering process and thus the final model of turbine may differ from those on which this assessment has been based. However the final choice of turbine will be required to comply with the noise limits which have been established for the site.

4.1.4 Note that in the above, and subsequently in this report, the term ‘noise emission’ relates to the sound power level actually radiated from each wind turbine, whereas the term ‘noise immission’ relates to the sound pressure level (the perceived noise) at any receptor location due to the operation of the wind turbines.

4.2 Setting the Total ETSU-R-97 noise limits (Stage 1)

Consultation

Scoping

4.2.1 The Scoping Opinion issued by the Local Energy and Consents of the Scottish Government contains a response from Shetland Isles Council (SIC) on noise which states:

'The Shetland Islands Council's Environmental Health Service has noted to the Planning Authority that at 7.1.10 on the Scoping Report (page 84) that:

'Initial modelling results based on the preliminary 20 turbine layout indicate that wind turbine noise will be greater than 35dB(A) at the nearest noise sensitive receptors and as such a full ETSU-R-97 assessment will be undertaken. A background noise assessment will be undertaken to establish noise limits, which will be set in accordance with ETSU-R-97.

I await the full background noise assessment.'

Background Noise Survey

4.2.2 Prior to the commencement of the noise impact assessment for the Proposed Development, consultation was undertaken with the Environmental Health Department at Shetland Islands Council (SIC) in order to agree the approach to the noise assessment and the noise monitoring locations. The Environmental Health Officer (EHO) was also invited to attend the installation of the noise monitoring equipment.

4.2.3 The EHO at SIC responded to the consultation by email and agreed with the methodology and noise monitoring locations. The EHO also attended the installation of the noise monitoring equipment at three of the six receptors. The EHO was also present for the installation of the remote sensing SoDAR Unit within the proposed site.

4.2.4 A copy of the original consultation letter and subsequent email correspondence is included in Annex 2.

Post Noise Monitoring

4.2.5 Following the background noise survey, TNEI undertook some additional consultation with the EHO where the initial results of the assessment were presented and discussed during a teleconference. TNEI also sought the Councils views regarding the choice of quiet day time fixed minimum limit and provided information explaining why TNEI felt a 40dB fixed minimum limit would be appropriate for the site. Copies of the consultation are included within Annex 2.

Wind Shear

4.2.6 Wind shear can be defined as *'the change in the relationship between wind speed at different heights'*. Due to wind shear, wind speeds recorded on one meteorological mast at different heights are usually different, generally the higher the anemometer the higher the wind speed recorded. For example, if a wind speed of 4ms^{-1} is recorded at 80m height, 3.5ms^{-1} may be recorded at 40m and 2.5ms^{-1} may be recorded at 10m.

4.2.7 It is considered that hub height wind speed is the key wind speed for a wind farm noise assessment, as it is the wind speed at hub height which informs the turbine control system and will determine the noise emitted by the wind turbines. Ideally, both wind turbine noise predictions and background noise level measurements should refer to hub height wind speed (or a representation thereof), ensuring that there is no discrepancy between the wind speed at which the noise is emitted and the wind speed at which the corresponding background noise is measured.

4.2.8 The IOA GPG states that three methods of wind speed measurement may be adopted:

'A) Direct measurement at hub height using either:

i. A met mast carrying one or more anemometer(s) at the proposed turbine hub height.

ii. A LIDAR or SODAR system (installed in a suitable location) to determine hub height wind speed directly, or at the two nearest heights to allow hub-height wind speed to be derived using an exponential profile.

B) A met mast lower than hub height but carrying anemometers at two different heights; these are then used to calculate hub height wind speed; and

C) A met mast carrying an anemometer at 10 metres height.'

4.2.9 The IOA GPG states that methods A and B are preferred whilst in Section 2.6.5 noting that Method C, which involves installing a 10m mast for the purpose of the background noise survey:

'should only be adopted for smaller-scale developments for which the installation of a tall met mast or deployment of a SODAR or LIDAR system at the planning stage might not be justified economically.'

4.2.10 For this assessment wind speeds were recorded using method A)ii.

Noise Impact Criteria in ETSU-R-97

4.2.11 Analysis of the measured data has been undertaken in accordance with ETSU-R-97 and current good practice to determine the pre-existing background noise environment and to establish, for each NAL, the quiet daytime and night-time Total ETSU-R-97 noise limits which would apply for the cumulative operation of all wind turbines in the area. The Total ETSU-R-97 quiet daytime limit has been set at 40 dB(A) or background plus 5 dB whichever is the greater and the Total ETSU-R-97 night-time has been set at 43 dB(A) or background plus 5 dB whichever is the greater. Further information on the justification for the use of the upper quiet daytime noise limit is included within Section 6.4 below.

4.2.12 The acceptable limits for wind turbine operational noise are clearly defined in relation to existing ambient levels for all periods by the application of the ETSU-R-97 methodology. Consequently, the test applied to operational noise is whether or not the predicted wind turbine noise immission levels at nearby noise sensitive properties lie below the noise limits derived in accordance with ETSU-R-97. Depending on the levels of background noise, the satisfaction of the ETSU-R-97 derived limits can lead to a situation whereby, at some locations under some wind conditions and for a certain proportion of the time, the wind turbine noise will be audible.

4.3 Assessment of likely effects and the requirement for a cumulative noise assessment (Stage 2)

4.3.1 The IOA GPG includes a detailed section on cumulative noise and provides guidance on where a cumulative assessment is required. Section 5.1.4 and 5.1.5 state:

'During scoping of a new wind farm development consideration should be given to cumulative noise impacts from any other wind farms in the locality. If the proposed wind farm produces noise levels within 10 dB of any existing wind farm/s at the same receptor location, then a cumulative noise impact assessment is necessary.

Equally, in such cases where noise from the proposed wind farm is predicted to be 10 dB greater than that from the existing wind farm (but compliant with ETSU-R-97 in its own right), then a cumulative noise impact assessment would not be necessary.'

4.3.2 An assessment will be undertaken at each of the noise sensitive receptors proximate to the Proposed Development and nearby operational wind turbines to determine whether the wind turbine noise immissions from the Proposed Development are within 10dB of the total cumulative wind turbine noise immissions from the other schemes. If the predictions are within 10dB of each other then a cumulative noise assessment will be undertaken to determine the likely impacts of the Proposed Development. If wind turbine immissions are greater than 10dB apart then a cumulative noise assessment is not required.

4.3.3 The IOA GPG provides current good practice for wind turbines above 50kW, however the wind turbines to the south of the site are less than 50kW. In order to consider the noise immissions from those turbines the turbine source data has been analysed using the data provided by the manufacturers. The location and the numbering of the wind turbines for the Proposed Development (Turbines 1 – 17) and the small operational wind turbines to the south (Turbines 18 – 25) are shown on Figure A1.3.

4.3.4 In the absence of any noise limits these small turbines have therefore been considered in the context of the noise limits established in this report using the guidance contained in ETSU-R-97.

Noise Prediction / Propagation Model

4.3.5 The ISO9613: 1996 *'Acoustics – Attenuation of sound during propagation outdoors Part 2: General method of calculation'*[18] model algorithm provides a robust prediction method for calculating the noise immission levels at the nearest receptors. A European Commission research project into wind farm noise propagation over large distances, published as *'Development of a Wind Farm Noise Prediction Model,'* JOULE project JOR3-CT95-0051 in 1998, identified a simplified version of ISO 9613 as the most suitable at that time, but the full method has been used for this assessment.

4.3.6 The use of ISO 9613-2 is discussed in the IOA GPG which states, in Section 4.1.4:

'ISO 9613-2 standard in particular, which is widely used in the UK, can be applied to obtain realistic predictions of noise from on-shore wind turbines during worst case propagation conditions (i.e. sound speed gradients due to downwind conditions or temperature inversions), but only provided that the appropriate choice of input parameters and correction factors are made.'

4.3.7 Whilst it is impossible to specify exact error bands on noise predictions, Table 5 of ISO 9613-2 suggests, at best, potential error bands of ± 3dB(A). The work undertaken as part of the EC research study concluded that the ISO 9613-2 algorithm reliably predicted noise levels that would generally occur under downwind propagation conditions.

4.3.8 The ISO 9613-2 model can take account of the following factors that influence sound propagation outdoors:

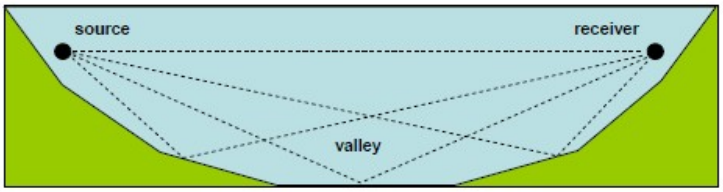
- Geometric divergence;
- Air absorption;
- Reflecting obstacles;
- Screening;
- Vegetation; and
- Ground reflections.

4.3.9 The model uses as its acoustic input data the octave band sound power output of the turbine and calculates, on an octave band basis, attenuation due to the factors above, as appropriate.

4.3.10 The IOA GPG quotes a comparative study undertaken in Australia which indicated ISO9613-2 can underpredict ground effects and the potential for additional reflection paths 'across a valley' while slightly overpredicting on flat terrain. It should be noted that the wind farm layouts studied were untypical for the UK, with rows of turbines spreading over 10km on an elevated ridge. It also should be noted that no correction for background contribution was undertaken and the monitoring locations were located as far as 1.7km from the nearest turbine where turbine noise may be at similar levels to background noise and therefore difficult to differentiate. For their modelling work topographic height data was included as an input, which is consistent with ISO 9613-2 methodology generally, but use of topographic data is not used for predictions of wind turbine noise in the UK, in accordance with the IOA GPG.

4.3.11 The IOA GPG states that a '*further correction of +3dB should be added to the calculated* overall *A-weighted level for propagation 'across a valley', i.e. a concave ground profile or where the ground falls away significantly between a turbine and the receiver location.'* The potential reflection paths are illustrated in Schematic 4.1 below.

Schematic 4.1: Multiple reflection paths for sound propagation across concave ground



Source: IOA GPG, page 21, Figure 5

4.3.12 A formula from the JOULE Project JOR3-CT95-0051 dated 1998 is suggested for determining whether a correction is required.

$$h_m \geq 1.5 \times (abs\ (h_s - h_r) / 2)$$

where h_m is the mean height above the ground of the direct line of sight from the receiver to the source (as defined in ISO 9613-2, Figure 3), and h_s and h_r are the heights above local ground level of the source and receiver respectively).

4.3.13 It should be noted that the calculation of h_m requires consideration of the digital terrain model and needs to be performed for each path between every turbine and every receiver. Interpretation of the results of the calculation above and the subsequent inclusion of a concave ground profile correction requires careful consideration with any topographical variation considered in the context of a site.

4.3.14 The IOA GPG also discusses the potential for topographical screening effects of the terrain surrounding a wind farm and the nearby noise sensitive receptors. Although barrier screening effects in ISO 9613-2 can make corrections of up to 15 dB, the IOA GPG states that where there is no line of sight between the highest point on the rotor and the receiver location a reduction of no more than 2dB may be applied.

4.3.15 The modelling parameters used for this assessment are detailed in Sections 6.3.

4.4 Setting the Development specific noise limits (Stage 3)

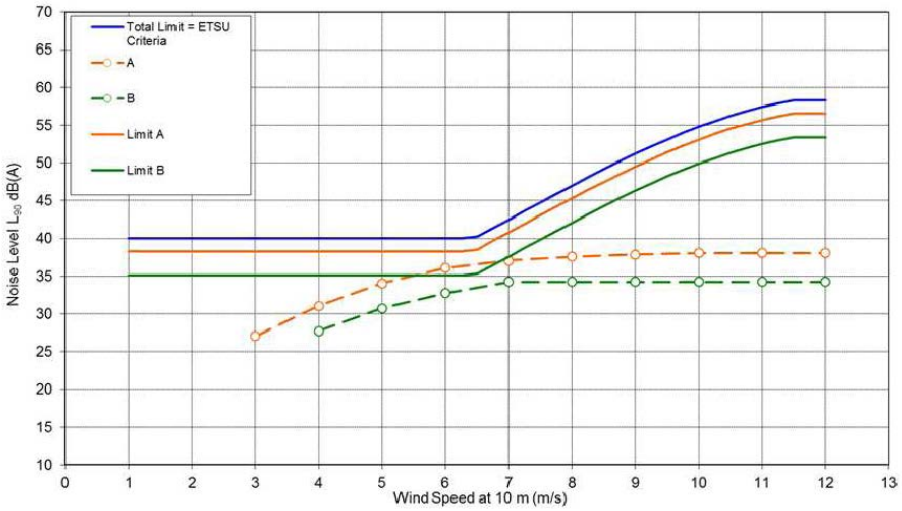
4.4.1 Summary Box 21 of the IOA GPG states:

'Whenever a cumulative situation is encountered, the noise limits for an individual wind farm should be determined in such a way that no cumulative excess of the total ETSU-R-97 noise limit would occur.'

4.4.2 In order to determine site specific limits at receptors in proximity to the Proposed Development and the other operational wind turbines, limit apportionment will be undertaken. The limit apportionment will consider the predicted operational noise levels from the small wind turbines plus an additional margin as specific noise limits have not been set (as detailed in Section 4.3.5 above).

4.4.3 This approach is demonstrated in Graph 1 below, whereby the total limit (shown in blue) is shared between the operational turbines (A) and the Proposed Development B. The two noise limits for a given receptor (the solid orange and green lines) when added together equate to the Total ETSU-R-97 noise limit, and the predicted levels for each wind farm (the dashed lines) meet the specific limits established for the operational wind turbines and the Proposed Development.

Graph 1: Limit Apportionment Example



5 BASELINE

5.1 Identification of Potential Noise Receptors

5.1.1 At the start of the noise assessment, preliminary desktop noise modelling was undertaken using the 'WindFarm'[19] software in order to locate noise sensitive receptors which may be affected and to identify suitable locations at which to monitor background noise. An initial wind turbine layout was input into the 'WindFarm' software and using noise data for a candidate turbine representative of the type that could be installed on the site a noise contour plot was produced.

5.1.2 The noise contour plot predicted wind turbine noise levels at the noise sensitive receptors surrounding the Proposed Development with predicted turbine noise (measured in dB(A), L_{90}) decreasing with distance from the Proposed Development. All properties or clusters of properties within the 35dB(A) contour were then identified and assessed to determine which properties would provide representative background noise data for others in the area. One receptor (NML 6 – Hamnavoe) was located outside of the 35dB contour but was included as a monitoring location to allow flexibility in the wind farm layout design. Other properties outside of the 35dB(A) contour were not considered in the assessment as protection of the amenity of those receptors would be controlled through a simplified noise condition as detailed in ETSU-R-97 (see Section 2.4.6).

5.1.3 In accordance with ETSU-R-97, the noise contour plot is based on a noise level at a wind speed of $10ms^{-1}$ (as standardised to 10m height) as the manufacturer determined that this is the wind speed with the highest predicted noise level between 0 and $10ms^{-1}$ for the candidate turbine (See Section 6.1.2).

5.1.4 PAN1/2011 *'Planning and Noise'* states that housing, hospitals, educational establishments, offices, places of worship, nursing homes and some livestock farms should generally be regarded as noise sensitive land uses. The IOA GPG notes that *'noise-sensitive receptors,* [are] *principally houses (existing or for which planning consent is being sought / has been given) and any building used for long-term residential purposes (such as a nursing home)*'. Following a review of noise sensitive receptors surrounding the Proposed Development, the closest receptors were found to be residential properties.

5.1.5 The properties identified for the noise assessment were the closest ones to the Proposed Development, as it was assumed that if noise limits can be achieved at those locations, the limits will also be achieved at other properties located at greater distance from the Proposed Development.

5.2 Background Noise Survey

5.2.1 Background noise monitoring was undertaken over the period 24th June 2015 to 22nd July 2015. Details of the exact monitoring periods, the rationale behind the exact kit location and the dominant noise sources observed at each of the Noise Monitoring Location (NML) are detailed in the Field Data Sheets (FDS) and installation report included in Annex 3.

5.2.2 The NMLs describe the position of the noise meter in each garden and are shown on Figure A1.1 included in Annex 1 and are summarised in Table 5.1 below. Noise monitoring equipment was installed at NML6 Hamnavoe, however the batteries on the noise meter failed after one week which resulted in insufficient data points being recorded to provide a robust assessment at that location. It was subsequently agreed during a telephone conversation with the SIC, that noise data collected at another location (NML 1, Holligarth) was representative of the expected background noise environment, and as such the noise data from NML1 was used as a proxy to derive noise limits at Noise Assessment Location (NAL) 6 Hamnavoe. NML1 was the quietest unfiltered noise monitoring location, so using it as a proxy provided conservative noise limits at NML6. No FDS has been included within Annex 3 for NML6.

Table 5.1 Noise Monitoring Locations

NML Number	Receptor
1	Lower Holligarth
2	Whirliegarth
3	Easterlee
4	Nessview
5	Heatherlea
6	Hamnavoe

5.3 Noise Monitoring Equipment

5.3.1 Section 2.4 of the IOA GPG includes information on the type and specification of noise monitoring equipment which should be used for background noise surveys and states:

'Noise measurement equipment and calibrators used on site should comply with Class 1/Type 1 of the relevant standard(s). Enhanced microphone windscreens should be used. Standard windshields of a diameter of less than 100 mm cannot be relied upon to provide sufficient reduction of wind noise in most circumstances.'

5.3.2 The noise monitoring equipment used for the background noise survey meets with the requirements of the IOA GPG. Details of the noise monitoring equipment used, the calibration drift recorded and photographs at each NML are detailed in the FDS included in Annex 3. The IOA GPG states that for calibration drift greater than 0.5dB but less than 1dB results may still be valid, but should be corrected by the amount of calibration drift where such corrections would result in lower noise levels. The maximum positive calibration drift recorded during the noise survey was <0.5dB as detailed in the FDS (included in Annex 3) therefore no correction has been applied to the noise data.

5.3.3 Copies of the calibration/conformance certificates for the sound level meters and sound level calibrator used for the noise survey are included in Annex 4.

5.3.4 The microphones were all mounted between 1.2m and 1.5m above local ground level, situated between 3.5m and 20m from the dwelling and were located '*in an area frequently used for rest and relaxation'* (Section 2.5.1 of IOA GPG), where appropriate, on the wind farm side of the property in question (where feasible), away from obvious local sources of noise such as boiler flues, fans and running water. The noise meters were situated as far away from hard reflective surfaces such as fences and walls as practicable.

5.3.5 All measurement systems were set to log the L_{A90} and L_{Aeq} noise levels over the required ten minute intervals continuously over the deployment period.

5.4 Meteorological Data

5.4.1 ETSU-R-97 states on Page 84 that:

'background noise measurements should be correlated with wind speed measurements performed at the proposed site, such that the actual operating noise levels from the turbines may be compared with the noise levels that would otherwise be experienced at a dwelling.'

5.4.2 The preferred methodologies for measuring or calculating wind shear are detailed in Section 4.2 above.

5.4.3 For the Proposed Development, concurrent wind speed/direction were recorded using a Remote sensing SODAR, located at the site (grid reference 451614, 1181627). The meteorological data was collected and provided by Dulas. Further information on the unit can be found included in Annex 5.

5.4.4 Tipping bucket rain gauges were installed at NML's 2 and 6 for the duration of the noise survey to record periods of rainfall. Another rain gauge was installed at NML 4, however, a fault occurred shortly after the gauge was activated and the data was irretrievable; data for the other two gauges is considered to provide robust data for the site. All rain data was collected by TNEI Services Ltd. As per the recommendations in Section 3.1.9 of the IOA GPG, 10 minute periods which contain registered rainfall events (on either or both rain gauge) and the preceding 10 minute period have been excluded. All excluded rainfall periods are shown on Figures A1.2a-A1.2e (Annex 1) as blue squares.

5.4.5 Wind speed/direction data and rainfall data were collected over the same time-scale, and averaged over the same ten minute periods as the noise data to provide the analysis of the measured background noise as a function of wind speed and direction.

5.4.6 In accordance with the IOA GPG, methodology A)ii (detailed within Section 4.2.8), has been adopted for this assessment which involved using data collected at 80m and 100m on the Remote Sensing SODAR which were used to calculate hub height (95m) wind speeds which, in turn, were standardised to a height of 10m.

5.5 Influence of Existing Turbines on Background Measurements

5.5.1 ETSU-R-97 details that measurements of background noise should be made in the absence of wind turbine noise. Where operational turbines are likely to influence measured levels the IOA GPG provides four methods which can be used to account for the impact (Section 5.2.3).

5.5.2 There are a number of operational micro turbines located in or around the village of Burravoe. These turbines were not audible at the noise monitoring locations close to Burravoe (NML's 3 and 4) during the installation and decommissioning of the noise equipment. In addition the residents at both monitoring locations confirmed that the turbines were not audible. However during discussions with the EHO the potential influence of these turbines on background noise levels were discussed and the EHO requested that direction filtering be undertaken to determine whether they were having an influence. Filtering was undertaken at NML3 and NML4 (using a 90º angle, 45º either side of the downwind direction) and although the turbine noise is not clearly evident within the filtered data, the datasets overall were found to be quieter at the key wind speeds therefore the filtered datasets have been used to derive noise limits at those receptors. The filtered periods are shown as orange crosses on Figures A1.2c and A1.2d.

5.6 Directional Filtering of Background Noise

5.6.1 In Section 3.1.22 of the IOA GPG the need to directionally filter background noise data is discussed. Where a receiver is located upwind of a dominant local noise source whilst also being systematically downwind of the turbines then it may be necessary to filter background noise data particularly when this corresponds to the prevailing wind direction.

5.6.2 For this site directional filtering was undertaken at NML2 (180º angle (315-135º)) due to the influence of sea noise at that receptor. The filtered periods are shown as orange crosses on Figure A1.2b. The orange data has been removed from the assessment which resulted in lower average background noise levels.

5.7 Analysis of Measured Data

5.7.1 Analysis of the measured data has been undertaken in accordance with the recommendations in ETSU-R-97 and the IOA GPG.

5.7.2 Meteorological data was screened upon receipt by TNEI and where rainfall occurred, the noise and wind speed data has been excluded from the assessment as detailed in Section 5.4 above.

5.7.3 Time series graphs are provided in Annex 6, which show the variation in measured wind speed/direction and noise level over the monitoring period. These graphs also show where data was excluded, either due to rainfall or manual exclusions for each noise dataset.

5.8 Prevailing Background Noise Level

5.8.1

5.8.2 Table 5.2 summarises the range of background noise levels experienced during the noise monitoring period, after filtering of the individual datasets as discussed above.

Table 5.2 Summary of Background Noise Levels during ETSU-R-97 Periods (dB(A))

Noise Monitoring Location	Quiet Daytime $L_{A90,10\ min}$	Night-Time $L_{A90,10\ min}$
NML 1 - Lower Holligarth	15.9-44.2	15.8-43.1
NML 2 - Whirliegarth	18.0-43.5	17.3-43.5
NML 3 - Easterlee	18.0-46.9	17.7-46.5
NML 4 - Nessview	17.3-52.0	17.3-47.0
NML 5 -Heatherlea	16.6-52.7	16.2-51.7

5.8.3 A series of graphs are presented for each of the NML to illustrate the data collected, these are included as Figures A1.2a - A1.2e (Annex 1). There is a set of graphs for each of the NML, which show the range of wind speeds and directions recorded during the survey and the 10 minute average wind speeds plotted against the 10 minute average recorded noise levels at the NML along with a calculated 'best fit' plot for the quiet daytime and night-time periods. Each Figure also includes a Table with the number of recorded data points per integer wind speed bin and the prevailing measured background noise levels.

5.8.4 The prevailing measured background noise levels have been calculated using a best fit polynomial regression line of no more than a fourth order through the measured $L_{A90\ 10min}$ noise data, as required by ETSU-R-97 and the IOA GPG.

5.8.5 In line with the recommendations included in Section 3.1.21 of the IOA GPG, where relevant, the polynomial background curve for the low speed conditions has been flatlined at the lower wind speeds where the derived minimum occurs. This is presented on the Figures, the final regression analysis curve is shown as a continuous black line and the original polynomial line of best fit through the data is shown as a dashed black line.

5.8.6 Section 2.9.5 of the IOA GPG recommends that no fewer than 200 valid data points should be recorded in each of the quiet daytime and night time periods, with no fewer than 5 valid data points in any 1 ms^{-1} wind speed bin. Where the background noise data has been filtered by wind direction the IOA GPG (Section 2.9.6) recommends that 100 data points and 3 per wind speed bin may be appropriate. Where the minimum number of data points in a wind speed bin was not achieved, data in that bin has been manually excluded from the assessment.

5.8.7 ETSU-R-97 states (Page 101) that data may not be extrapolated beyond the measured range of wind speeds. It is however reasonable to assume that background noise levels will not decrease at higher wind speeds. As such, where turbine noise meets the noise limits at, for example, 10 ms^{-1} there is a low likelihood of exceedance at wind speeds between 11 and 12 ms^{-1}.

5.8.8 In the interest of protecting residential amenity the noise limits for higher wind speeds where data has not been collected have been set equal to those derived for lower wind speeds as set out below (as per Section 3.1.20 of the IOA GPG).

5.8.9 A summary of the analysis applied to the individual datasets as recommended by the IOA GPG is included in Table 5.3 below.

Table 5.3 Analysis of measured datasets

Noise Monitoring Location	Quiet Daytime	Night-Time
NML 1 - Lower Holligarth	Flatlined below 3ms^{-1} (minimum level recorded) and beyond 11ms^{-1} (insufficient number of datapoints recorded in 12 ms^{-1} bin).	-
NML 2 - Whirliegarth	Flatlined below 3ms^{-1} (minimum level recorded) and beyond 10ms^{-1} (insufficient number of datapoints recorded in 11 and 12 ms^{-1} bins).	Flatlined below 3ms^{-1} (minimum level recorded) and beyond 11ms^{-1} (insufficient number of datapoints recorded in 12 ms^{-1} bin).
NML 3 - Easterlee	Flatlined beyond 11ms^{-1} (insufficient number of datapoints recorded 12 ms^{-1} bin).	Flatlined beyond 11ms^{-1} (insufficient number of datapoints recorded 12 ms^{-1} bin).
NML 4 - Nessview	Flatlined below 2ms^{-1} (minimum level recorded) and beyond 11ms^{-1} (insufficient number of datapoints recorded 12 ms^{-1} bin).	Flatlined beyond 11ms^{-1} (insufficient number of datapoints recorded 12 ms^{-1} bin).
NML 5 - Heatherlea	Flatlined below 2ms^{-1} (minimum level recorded) and beyond 11ms^{-1} (insufficient number of datapoints recorded in 12 ms^{-1} bin).	-

5.8.10 The number of data points measured in each wind speed bin for each receptor once exclusions were applied are summarised in Figures A1.2a - A1.2e (Annex 1). The Figures also show the final prevailing background noise levels which have been determined following the analysis detailed above.

6 NOISE ASSESSMENT RESULTS

6.1 Noise Assessment Locations

6.1.1 Noise assessment locations (NAL) refer to the position on the curtilage denoted by the house symbol on Figure A1.1 (Annex 1). A total of fifteen noise sensitive receptors were chosen as representative NALs. The NALs chosen were the closest receptors to the Proposed Development and the other wind turbine developments. Predictions of wind turbine noise have been made at each of the NAL as detailed in Table 6.1. This approach ensures that the report models the worst case (loudest) noise immission level expected at the noise sensitive receptor. Table 6.1 details which NML has been used to set noise limits for each NAL.

Table 6.1 Noise Assessment Locations

Noise Assessment Location	Easting (m)	Northing (m)	Elevation (m AOD)	Approximate Distance to Nearest Turbine * (m)	Background Noise Data Used
NAL1- Lower Hollingarth	452188	1183917	34	1353	NML1
NAL2- Whirliegarth	452739	1183016	30	909	NML2
NAL3- Easterlee	451773	1180569	56	879	NML3
NAL4 - Gentletown	452415	1180263	51	992	NML4
NAL5 - Littlester	451022	1180133	34	1426	NML5
NAL6 - Hamnavoe	449726	1180866	33	1860	NML1
NAL7 - Helnaquhida	452013	1180138	35	1168	NML3
NAL8 - Kettlester	451861	1180049	29	1303	NML3
NAL9 - Islesview	451819	1180372	47	1033	NML3
NAL10 - Westerlee	451775	1180241	32	1168	NML3
NAL11 - Kletterlea	451404	1180170	30	1279	NML5
NAL12 - The School House	451203	1179999	20	1490	NML5
NAL13 – Cluness Cottage	451955	1179932	27	1382	NML3
NAL14 - Staneygarth	451936	1179890	24	1427	NML3
NAL15 - Giggleswick	452261	1179936	30	1319	NML4

** Please note the distances to nearest turbines quoted above may differ from those reported elsewhere. Distances for the noise assessment are taken from the nearest turbine to the closest edge of the amenity area (usually the garden).*

6.1.2 Table 6.1 above summarises which dataset has been used as proxy data for other noise sensitive receptors. H1 Lower Hollingarth was chosen as a proxy location chosen for H6 Hamnavoe (where the batteries failed) as this was found to be quietest unfiltered dataset for the majority of the wind speed range recorded; this is considered to be a cautious approach. For the other proxy locations the baseline datasets were chosen based on the proximity of the NALs to the NMLs and observations of background noise levels on site.

6.2 Noise Emission Characteristics of the Candidate Wind Turbines

6.2.1 There are a range of wind turbine models which may be suitable for installation at the Proposed Development. This assessment considers the following candidate turbine models:

- Senvion 3.4M, 3.4MW; and
- Nordex N100, 3.3MW.

6.2.2 Noise data for the candidate wind turbines has been obtained from the manufacturers and have been analysed in detail by TNEI. Due to the differences in the way in which levels are provided by the different manufacturers, TNEI has accounted for uncertainty using the guidance contained within Section 4.2 of the IOA GPG. Details of the sound power level, octave data and measurement uncertainty used for each candidate turbine considered in this assessment are included in Annex 7. All calculations within this report refer to the Senvion 3.4M 104 as it is the louder of the two candidate turbines. Predictions of the wind turbine noise immissions levels at the NALs when considering the Nordex N100, 3.3MW are shown on Figures A1.5a-o.

6.2.3 Manufacturer data is usually supplied based on a specific hub height whilst values are presented as standardised to 10m height. The noise model used in this assessment alters turbine noise data to account for different hub heights, where applicable. The hub height considered in this assessment is 95m.

6.2.4 The location of the proposed wind turbines are shown on Figure A1.1 and grid references are included in Annex 8.

6.3 Noise Propagation Parameters

6.3.1 As detailed in Section 4.3 above the full version of the ISO 9613-2 model has been used to calculate the noise immission levels at the nearest receptors. Only the downwind condition was considered in this assessment, that is wind blowing from the proposed wind turbines towards the noise sensitive receptors. When wind is blowing in the opposite direction (i.e. away from the noise sensitive receptors) noise levels will be significantly lower, especially if there is any screening between the wind turbines and the noise sensitive receptors.

6.3.2 For the purposes of the present assessment, all noise level predictions have been undertaken using a receiver height of 4.0m above local ground level, mixed ground (G=0.5) and air absorption co-efficients based on a temperature of 10°C and 70% relative humidity to provide a realistic impact assessment. The modelling parameters reflect current good practice as detailed within the IOA GPG.

6.3.3 A topographical assessment has been undertaken between each noise sensitive receptor and wind turbine location to determine whether any concave ground profiles exist between the source and receiver (noise sensitive receptor). Analysis undertaken using a combination of CadnaA[20] and an Excel model found that if the formula in the IOA GPG is applied directly a +3dB correction is required for some turbines at a number of receptors as summarised in Annex 8.

6.3.4 In addition, an assessment has been undertaken to determine whether any topographical screening effects of the terrain occur where there is no direct line of site between the highest point on the turbine rotor and the receiver location. Upon analysis of each noise sensitive receptor it was found that a barrier correction of -2dB could be applied for some turbines at a number of receptors as detailed in Annex 8.

6.3.5 It should be noted that the IOA GPG is only relevant to turbines greater than 50kW, accordingly topographical corrections have not been applied to the small turbines considered in this report. For the Proposed Development, all corrections have been applied, where necessary, in all of the Tables and Graphs in this report.

6.3.6 The need to include a concave ground/screening correction may change depending on the final location of the turbines (following micrositing) and the final turbine hub height. Nevertheless, turbine noise levels will have to meet the noise limits applied by planning condition regardless of any increases in noise propagation caused by topography. Should planning permission be granted, the need to apply a concave slope correction will need to be considered by the Applicant prior to the final selection of a turbine model for the Proposed Development.

6.4 Total ETSU-R-97 Noise Limits (Stage 1)

6.4.1 The ETSU-R-97 noise limits are derived by establishing the 'best fit' correlation between background noise level and wind speed. These limits, sometimes referred to as the 'criterion curve', are based on a level 5dB(A) above this best fit correlation curve, over a wind speed range from 0 to 12ms^{-1}. Where the derived criterion curve for the quiet daytime period lies below a fixed level in the range 35 - 40dB(A) then ETSU-R-97 provides that the criterion curve may be set at an absolute level somewhere within that range.

6.4.2 The quiet daytime limits are chosen to protect external amenity, the precise choice of level within the range 35dB(A) to 40dB(A) depends on a number of factors, including:

- the number of noise affected properties;
- the effect of using tighter limits on the potential power output of the wind farm; and
- the duration of exposure of these properties.

6.4.3 These are discussed further in paragraphs 65-66 of ETSU-R-97 and in Section 3.2.4 of the Institute of Acoustics *'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise'* (IOA GPG).

6.4.4 Current good practice on the three criteria is as follows:

1. *'The number of neighbouring properties will depend on the nature of the area, (rural, semi-rural, urban) and is sometimes considered in relation to the size of the scheme and study area. The predicted 35 dB L_{A90} contour (at maximum noise output up to 12 m/s) can provide a guide to the dwellings to be considered in this respect.*

2. *This is in practice mainly based on the relative generating capacity of the development, as larger schemes have relatively more planning merit (for noise) according to the description in ETSU-R-97. In cases when the amenity fixed limit has little or no impact on the generating capacity (i.e. noise is not a significant design constraint) then a reduced limit may be applied.*

3. *This last test is more difficult to formulate. But ETSU-R-97 notes that the likely excess of turbine noise relative to background noise levels should be a relevant consideration. In rural areas, this will often be determined by the sheltering of the property relative to the wind farm site. Account can also be taken of the effects of wind directions (including prevailing ones at the site) and likely directional effects. For cumulative developments, in some cases the effective duration of exposure may increase because of cumulative effects.'*

6.4.5 The guidance contained in ETSU and the current good practice detailed in the IOA GPG has been used to assess each of the three criteria.

Number of Affected Properties

6.4.6 Although distance is not a key criterion when assessing noise, distance was initially used to quantify the number of sensitive receptors located within 1km and 2km of the turbine locations. Using both address point data and aerial photography a total of 8 receptors were identified within 1km and 99 receptors within 2km.

6.4.7 Once the closest properties were identified, an assessment was undertaken to determine where predicted wind turbine noise levels from the Proposed Development at these receptors would exceed 35dB or background plus 5dB (the quiet daytime fixed minimum limit), in order to identify the number of receptors where a higher quiet daytime noise limit would be required (potentially up to 40dB or background plus 5dB). Properties which were financially involved with a development were excluded from the analysis as they were subject to the higher fixed minimum limits of 45dB as detailed in ETSU-R-97. It was found that, based on the current candidate turbine, the Senvion 3.4M 104, an exceedance of the lower quiet daytime noise limit could occur at nine receptors in Gossabrough (to the north east) and at two receptors, Easterlee and Islesview to the south (under certain wind speeds and wind directions). This represents a worst case scenario in relation to the number of properties affected.

6.4.8 Whilst the exact number of properties that may be affected will depend on the final choice of candidate turbine, it is expected that the number of properties affected i.e. potentially exposed to noise immissions greater than 35dB or background noise plus 5dB will be eleven or less. This is considered by TNEI to be a low number, which given the scale of the development suggests a limit towards the upper end of the range between 35-40dBA.

6.4.9 The requirement for a 40dB or background plus 5dB fixed minimum limit at the other receptors is due to the presence of several micro wind turbines, particularly to the south of the site. The imposition of the upper quiet daytime limit would enable both the Proposed Development and the micro wind turbines to co-exist, while noise immissions would still be within the Total ETSU-R-97 noise limits.

The Effect on the Power Output of the Wind Farm

6.4.10 In order for the Proposed Development to operate within the lower fixed minimum noise limit of 35dB or background plus 5dB, several turbines would need to be removed or operated using mode management to reduce the noise output. In simple terms, in order to meet a 35dB(A) or background plus 5dB lower noise limit, turbines 5, 7, 9-10 and 12-13 would need to be removed, resulting in a reduction of up to 20MW power generation (based on the proposed candidate turbine) i.e. 35% of the scheme overall.

6.4.11 In reality it may be more appropriate to operate some turbines in a low noise mode rather than removing them all together. Based on the proposed candidate turbine and the current mode management noise data available, 9 of the 17 turbines proposed would have to operate in SMII B mode for certain wind speeds and wind directions.

6.4.12 There are numerous permutations available for mode management to achieve a similar noise output, but based on the mode management undertaken to date, operating the 9 turbines in the lower noise mode SMII B (at the key wind speed) would result in a power reduction from the output from those turbines of approximately 19% each at that wind speed. The turbines would need to be operated in the lower mode for a significant proportion of time as the majority of the receptors are located to the north east of the Proposed Development. In terms of the impact on the power output of the wind farm, the imposition of a lower noise limit would clearly impact upon potential power generation because of the prevailing wind direction.

6.4.13 The figures relate to the worst case losses for each turbine under the worst case conditions. The overall impact on total annual energy production will therefore be less than this figure.

The Level and Duration of Exposure

6.4.14 In terms of duration and level of exposure, ETSU states (on page 65):

'The proportion of the time at which background noise levels are low and how low the background noise level gets are both recognised as factors which could affect the setting of an appropriate lower limit. For example, a property which experienced background noise levels below 30dB(A) for a substantial proportion of the time in which the turbines would be operating could be expected to receive tighter noise limits than a property at which the background noise levels soon increased to levels above 35dB(A). This approach is difficult to formulate precisely and a degree of judgment should be exercised.'

6.4.15 The cut in wind speed for the Senvion 3.4M 104 is 3.5ms^{-1} at 95m hub height, which equates to 2.5ms^{-1} when standardised to 10m height. Comparing the turbine cut in wind speed against the background noise plots on the attached Figures indicates that the fixed minimum limits would apply for wind speeds between 2.5ms^{-1} and 8.5 ms^{-1} after which the background +5dB levels exceed 40dB(A). Within this wind speed range background noise levels of 30dB(A) or less only occur for a proportion of the time when the turbines would be operating. The proportion of time for each noise monitoring location is detailed in Table 6.2 below.

6.4.16 It should also be noted that at the lower region of this wind speed range the turbine noise immissions would be significantly less than 40dBA, as is evident on attached Figures. The key wind speeds where the upper quiet daytime fixed minimum noise limit of 40dB or background plus 5dB would be required is 5.5 to 8.5ms^{-1}, therefore the number of data points which are below 30dB within this wind speed range has also been considered. The proportion of time for each noise monitoring location (NML) is detailed in Table 6.2 below.

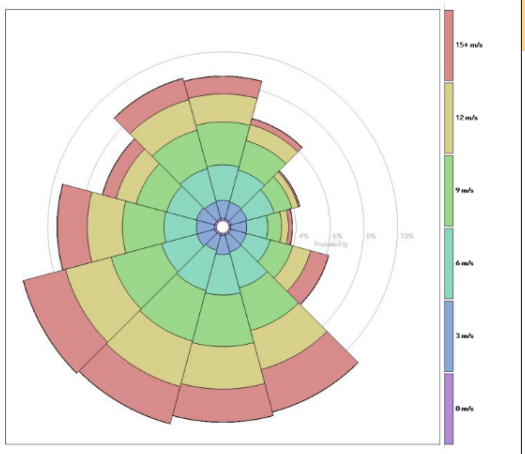
Table 6.2 Proportion of time where turbines are operating and background noise levels are 30dB(A) or below

Receptor	Downwind Direction from Centre of Wind Farm (°)	No of data points <30dB/total no of datapoints	Proportion of Time (%)	No of data points <30dB, wind speed 5.5-8.5ms^{-1}, /total no of datapoints	Proportion of Time (%)
NML1- Lower Hollingarth	195	694/1393	50	99/1393	7
NML2- Whirliegarth	230	412/658	63	66/658	10
NML3- Easterlee	360	489/1059	46	68/1059	6
NML4 - Gentletown	340	511/1004	51	69/1004	7
NML5 - Littlester	18	501/1361	37	28/1361	2

6.4.17 Considering the quietest location, Whirliegarth, background noise levels are less than 30dB(A) for 63% of the time when the turbines would be operating but only 10% of the time when the upper quiet daytime fixed minimum noise limit would be required.

6.4.18 To put the levels into context Graph 6.1 below shows a predicted long term wind rose using predicted long term wind data (supplied by Peel Wind Farm (Yell) Ltd). Whirliegarth is located to the north east of the Proposed Development so would be downwind of the turbines for a reasonable proportion of the time. The wind rose for the site does however, suggest that the area will experience a wide range of wind directions which would limit the exposure. The reliance of the fixed minimum limits is for a relatively small range of wind speeds for the properties to the north east 5.5 to 8.5 ms^{-1} as background noise increases with wind speed meaning that the limit at higher wind speeds would be based on background plus 5dB rather than the fixed minimum limits. When considering the reduced wind speed range at Whirliegarth the percentage time where noise levels are below 30dB in the wind speed range 5.5-8.5m^{s-1} is 10%.

Graph 6.1: Predicted long-term wind rose at Beaw Field Wind Farm at 100m height



Sector [Degrees N]	Probability [%]
0	8.6
30	6.3
60	4.3
90	3.7
120	6.1
150	11.0
180	11.2
210	11.7
240	11.9
270	9.5
300	7.0
330	8.8

Summary

6.4.19 As detailed above, each of the three criterion included within ETSU-R-97 and the IOA GPG has been considered in detail. A summary of the key findings for each criterion is included below:

- the number of properties affected by the adoption of the upper daytime fixed minimum limit will be eleven or less. TNEI would consider this to be a relatively small number given the scale of the Proposed Development.
- the effect on the power generation - based on the Senvion 3.4M 104, 9 turbines would need to be operated in a low noise mode resulting in a 19% loss of power per turbine for a proportion of the time (key receptors are located downwind). Alternatively, if turbines were to simply be removed until the lower limit was met this would result in a 35% decrease in the rated capacity of the scheme. Either option would clearly have an impact on power generation of the wind farm.
- The level and duration of exposure - at the quietest location, Whirliegarth, background noise levels are less than 30dB(A) for 10% of the time when the turbines would be operating and the upper quiet daytime fixed minimum noise limit would be required (between 5.5-8.5ms^{-1}). The predicted long term wind rose also suggests that the area will experience a wide range of wind directions which would limit the exposure. Based on TNEIs experience the level and duration of exposure is not considered to be a significant proportion of the time.

6.4.20 All of the analysis above has been based on a candidate turbine, the Senvion 3.4M 104 which is considered to be representative of the type of turbine which could be installed at the proposed wind farm. The final choice of turbine would however have to meet the noise limits determined and contained within any conditions imposed. After due consideration of the three criterion and TNEIs experience, TNEI considers that the upper quiet daytime limit of 40dB(A) is appropriate for the wind farm.

6.4.21 The Total ETSU-R-97 noise limits have been established for each of the NALs as detailed in Table 6.3 and Table 6.4 below, based on a fixed minimum of 40dB(A) (Quiet daytime) or 43 dB(A) (Night-time) or background plus 5 dB(A).

6.4.22 There are a number of small wind turbine developments to the south of the Proposed Development, some of which are located in close proximity to some of the NALs considered in this assessment. As such it has been assumed that the occupiers of NAL11, NAL13, and NAL15 are financially involved with the wind turbine developments therefore as detailed in Section 2.4.11 above, a higher fixed minimum limit of 45dB or higher permissible margin above background noise has been assumed for those receptors during the quiet daytime and night time periods. The prevailing background noise levels are shown on Figures A1.2a-A1.2e. The noise limits included within the tables below assume that turbine (T20) at Cluness Cottage is operational. However TNEI understands that the turbine at Cluness Cottage may be removed therefore an alternative set of predictions and limits without T20 are included within Annex 9 to reflect that possible scenario.

6.4.23 For NAL13 Cluness Cottage the limits have been set equal to 45dB or the background noise plus 8dB (whichever is the greater) during the quiet daytime and 10dB (whichever is the greater) during the night time period in accordance with ETSU-R-97. The limits reflect the predicted wind turbine noise levels resulting from the existing wind turbines in the area and the fact that the Council must have been satisfied with those noise levels when the development was consented. It should be noted that the Proposed Development is having a negligible contribution to cumulative wind turbine noise levels at this location as detailed in Section 6.5 below. At NAL11 and NAL15 the noise limits have been set at 45dB or the background noise level plus 5dB (whichever is the greater).

Table 6.3 Total ETSU-R-97 Noise Limits Quiet Daytime

Noise Assessment Location	Wind Speed (ms^{-1}) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NAL1- Lower Hollingarth	40	40	40	40	40	40	40	40.1	41.8	42.6	42.6	42.6
NAL2- Whirliegarth	40	40	40	40	40	40	40	40	40.5	42.9	42.9	42.9
NAL3- Easterlee	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
NAL4 - Gentletown	40	40	40	40	40	40	40	41.8	44.6	46.8	48	48
NAL5 - Littlester	40	40	40	40	40	40	41.3	44.4	47.2	49.6	51.3	51.3
NAL6 - Hamnavoe	40	40	40	40	40	40	40	40.1	41.8	42.6	42.6	42.6
NAL7 - Helnaquhida	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
NAL8 - Kettlester	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7

NAL9 - Islesview	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
NAL10 - Westerlee	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
NAL11 - Kletterlea*	45	45	45	45	45	45	45	45	47.2	49.6	51.3	51.3
NAL12 - The School House	40	40	40	40	40	40	41.3	44.4	47.2	49.6	51.3	51.3
NAL13 – Cluness Cottage*	45	45	45	45	45	45	45	45	45.4	47.6	49.7	49.7
NAL14 - Staneygarth	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
NAL15 - Giggleswick *	45	45	45	45	45	45	45	45	45	46.8	48	48

* assumes FI with the nearby operational wind turbine

Table 6.4 Total ETSU-R-97 noise limits Night-Time

Noise Assessment Location	Wind Speed (ms^{-1}) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NAL1- Lower Hollingarth	43	43	43	43	43	43	43	43	43	43	43	44.1
NAL2- Whirliegarth	43	43	43	43	43	43	43	43	43	43	43.7	43.7
NAL3- Easterlee	43	43	43	43	43	43	43	43	43	43	45.1	45.1
NAL4 - Gentletown	43	43	43	43	43	43	43	43	43	44	46.1	46.1
NAL5 - Littlester	43	43	43	43	43	43	43	43	44.5	47.3	49.8	51.8
NAL6 - Hamnavoe	43	43	43	43	43	43	43	43	43	43	43	44.1
NAL7 - Helnaquhida	43	43	43	43	43	43	43	43	43	43	45.1	45.1
NAL8 - Kettlester	43	43	43	43	43	43	43	43	43	43	45.1	45.1
NAL9 - Islesview	43	43	43	43	43	43	43	43	43	43	45.1	45.1
NAL10 - Westerlee	43	43	43	43	43	43	43	43	43	43	45.1	45.1
NAL11 - Kletterlea	45	45	45	45	45	45	45	45	45	47.3	49.8	51.8
NAL12 - The School House	43	43	43	43	43	43	43	43	44.5	47.3	49.8	51.8
NAL13 – Cluness Cottage*	45	45	45	45	45	45	45	45	45.6	48	50.1	50.1
NAL14 - Staneygarth	43	43	43	43	43	43	43	43	43	43	45.1	45.1
NAL15 - Giggleswick*	45	45	45	45	45	45	45	45	45	45	46.1	46.1

* assumes FI with the nearby operational wind turbine

6.5 Predicting the likely effects and the requirement for a cumulative noise assessment (Stage 2)

6.5.1 A comparison has been undertaken of the predicted wind turbine noise immission levels from the Proposed Development alongside all other wind turbine developments at each of the identified noise sensitive receptors in order to demonstrate whether predictions are within 10dB of each other. Figure A1.3 (Annex 1) shows the location of the Proposed Development and the other single wind turbine developments.

6.5.2 Table 6.5 below summarises the results and the whether a cumulative noise assessment is required. As is detailed in Section 4.3 above, if the predictions are greater than 10dB apart then a cumulative noise assessment is not required. Where predictions are found to be within 10dB of each other then a cumulative assessment is required.

Table 6.5 Cumulative Assessment Requirement

Noise Assessment Location	Are predicted wind turbine noise levels within 10dB?	Is a cumulative assessment required?
NAL1- Lower Hollingarth	NO	NO
NAL2- Whirliegarth	NO	NO
NAL3- Easterlee	YES	YES
NAL4 - Gentletown	YES	YES
NAL5 - Littlester	YES	YES
NAL6 - Hamnavoe	NO	NO
NAL7 - Helnaquhida	YES	YES
NAL8 - Kettlester	YES	YES
NAL9 - Islesview	YES	YES
NAL10 - Westerlee	YES	YES
NAL11 - Kletterlea	YES	YES
NAL12 - The School House	YES	YES
NAL13 – Cluness Cottage	YES	YES
NAL14 - Staneygarth	YES	YES
NAL15 - Giggleswick	YES	YES

6.5.3 A likely cumulative noise assessment is required at twelve receptors as detailed in Table 6.5. A detailed list of all of the wind turbine developments considered in the noise predictions are included in Annex 7. In addition details of the noise prediction comparisons are included in Table 1 in Annex 8.

6.5.4 In order to protect residential amenity, the IOA GPG recommendations are that cumulatively, all schemes operate within the Total ETSU-R-97 limits. This can be found in summary box SB21 of the IOA GPG which states:

'Whenever a cumulative situation is encountered, the noise limits for an individual wind farm should be determined in such a way that no cumulative excess of the total ETSU-R-97 noise limit would occur'

6.5.5 These results are summarised in tabular form in Table 6.7 and Table 6.8 and shows that the predicted cumulative wind turbine noise immission levels meet the Total ETSU-R-97 noise limits under all conditions and at all locations for both quiet daytime and night-time periods.

Table 6.6 Compliance Table - Likely Cumulative Noise - Quiet Daytime

Location		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Lower Hollingarth	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40.1	41.8	42.6	42.6	42.6
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.6	31.2	35	36.4	36.5	36.5	36.5	36.5	36.5
	Exceedance Level L_{A90}	-	-	-	-12.4	-8.8	-5	-3.6	-3.6	-5.3	-6.1	-6.1	-6.1
NAL2 - Whirliegarth	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40	40.5	42.9	42.9	42.9
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.5	34.1	37.8	39.2	39.4	39.4	39.4	39.4	39.4
	Exceedance Level L_{A90}	-	-	-	-9.5	-5.9	-2.2	-0.8	-0.6	-1.1	-3.5	-3.5	-3.5
NAL3 - Easterlee	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.6	34.1	37.8	39.2	39.5	39.7	40	40.5	40.5
	Exceedance Level L_{A90}	-	-	-	-9.4	-5.9	-2.2	-0.8	-0.5	-2.7	-4.6	-6.2	-6.2
NAL4 - Gentletown	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	41.8	44.6	46.8	48	48
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.1	31.5	35.1	36.6	37	37.4	37.9	38.8	38.8
	Exceedance Level L_{A90}	-	-	-	-11.9	-8.5	-4.9	-3.4	-4.8	-7.2	-8.9	-9.2	-9.2
NAL5 - Littlester	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	41.3	44.4	47.2	49.6	51.3	51.3
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.6	31.6	34.8	36.5	37.5	38.8	40.3	42	42
	Exceedance Level L_{A90}	-	-	-	-11.4	-8.4	-5.2	-4.8	-6.9	-8.4	-9.3	-9.3	-9.3
NAL6 - Hamnavoe	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40.1	41.8	42.6	42.6	42.6
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	24.6	28.2	31.9	33.3	33.5	33.5	33.6	33.7	33.7
	Exceedance Level L_{A90}	-	-	-	-15.4	-11.8	-8.1	-6.7	-6.6	-8.3	-9	-8.9	-8.9
NAL7 - Helnaquhida	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.4	31.6	35	36.6	37.3	38.2	39.4	40.9	40.9
	Exceedance Level L_{A90}	-	-	-	-11.6	-8.4	-5	-3.4	-2.7	-4.2	-5.2	-5.8	-5.8
NAL8 - Kettlester	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.6	31.7	35	36.6	37.4	38.4	39.7	41.2	41.2
	Exceedance Level L_{A90}	-	-	-	-11.4	-8.3	-5	-3.4	-2.6	-4	-4.9	-5.5	-5.5
NAL9 -Isleview	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.3	32.8	36.4	37.9	38.2	38.6	39.2	40.1	40.1
	Exceedance Level L_{A90}	-	-	-	-10.7	-7.2	-3.6	-2.1	-1.8	-3.8	-5.4	-6.6	-6.6
NAL10 - Westerlee	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.9	32.2	35.7	37.2	37.8	38.5	39.4	40.6	40.6
	Exceedance Level L_{A90}	-	-	-	-11.1	-7.8	-4.3	-2.8	-2.2	-3.9	-5.2	-6.1	-6.1
NAL11 - Kettlerlea	Total ETSU-R-97 Noise Limit	45	45	45	45	45	45	45	45	47.2	49.6	51.3	51.3
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	32.6	35.3	38	40	41.6	43.4	45.4	47.5	47.5
	Exceedance Level L_{A90}	-	-	-	-12.4	-9.7	-7	-5	-3.4	-3.8	-4.2	-3.8	-3.8
NAL12 - The School House	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	41.3	44.4	47.2	49.6	51.3	51.3
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.7	30.5	33.6	35.4	36.7	38.2	39.9	41.8	41.8
	Exceedance Level L_{A90}	-	-	-	-12.3	-9.5	-6.4	-5.9	-7.7	-9	-9.7	-9.5	-9.5
3 - Clun ess	Total ETSU-R-97 Noise Limit	45	45	45	45	45	45	45	45	45.4	47.6	49.7	49.7

	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	34.7	37.1	39.6	41.6	43.4	45.4	47.4	49.5	49.5
	Exceedance Level L_{A90}	-	-	-	-10.3	-7.9	-5.4	-3.4	-1.6	0	-0.2	-0.2	-0.2
NAL14 - Staneygarth	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.6	32.4	35.3	37.1	38.4	39.9	41.6	43.5	43.5
	Exceedance Level L_{A90}	-	-	-	-10.4	-7.6	-4.7	-2.9	-1.6	-2.5	-3	-3.2	-3.2
NAL15 - Giggleswick	Total ETSU-R-97 Noise Limit	45	45	45	45	45	45	45	45	45	46.8	48	48
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	31.2	33.9	36.7	38.6	40.2	42	44	46	46
	Exceedance Level L_{A90}	-	-	-	-13.8	-11.1	-8.3	-6.4	-4.8	-3	-2.8	-2	-2

Table 6.7 Compliance Table - Likely Cumulative Noise - Night time

Location		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Lower Hollingarth	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	43	44.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.6	31.2	35	36.4	36.5	36.5	36.5	36.5	36.5
	Exceedance Level L_{A90}	-	-	-	-15.4	-11.8	-8	-6.6	-6.5	-6.5	-6.5	-6.5	-7.6
NAL2 - Whirliegarth	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	43.7	43.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.5	34.1	37.8	39.2	39.4	39.4	39.4	39.4	39.4
	Exceedance Level L_{A90}	-	-	-	-12.5	-8.9	-5.2	-3.8	-3.6	-3.6	-3.6	-4.3	-4.3
NAL3 - Easterlee	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	45.1	45.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.6	34.1	37.8	39.2	39.5	39.7	40	40.5	40.5
	Exceedance Level L_{A90}	-	-	-	-12.4	-8.9	-5.2	-3.8	-3.5	-3.3	-3	-4.6	-4.6
NAL4 - Gentletown	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	44	46.1	46.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.1	31.5	35.1	36.6	37	37.4	37.9	38.8	38.8
	Exceedance Level L_{A90}	-	-	-	-14.9	-11.5	-7.9	-6.4	-6	-5.6	-6.1	-7.3	-7.3
NAL5 - Littlester	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	44.5	47.3	49.8	51.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.6	31.6	34.8	36.5	37.5	38.8	40.3	42	42
	Exceedance Level L_{A90}	-	-	-	-14.4	-11.4	-8.2	-6.5	-5.5	-5.7	-7	-7.8	-9.8
NAL6 - Hamnavoe	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	43	44.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	24.6	28.2	31.9	33.3	33.5	33.5	33.6	33.7	33.7
	Exceedance Level L_{A90}	-	-	-	-18.4	-14.8	-11.1	-9.7	-9.5	-9.5	-9.4	-9.3	-10.4
NAL7 - Helnaquhida	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	45.1	45.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.4	31.6	35	36.6	37.3	38.2	39.4	40.9	40.9
	Exceedance Level L_{A90}	-	-	-	-14.6	-11.4	-8	-6.4	-5.7	-4.8	-3.6	-4.2	-4.2
NAL8 - Kettlester	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	45.1	45.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.6	31.7	35	36.6	37.4	38.4	39.7	41.2	41.2
	Exceedance Level L_{A90}	-	-	-	-14.4	-11.3	-8	-6.4	-5.6	-4.6	-3.3	-3.9	-3.9
NAL9 -Isleview	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	45.1	45.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.3	32.8	36.4	37.9	38.2	38.6	39.2	40.1	40.1
	Exceedance Level L_{A90}	-	-	-	-13.7	-10.2	-6.6	-5.1	-4.8	-4.4	-3.8	-5	-5
NAL10 - Westerlee	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	45.1	45.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.9	32.2	35.7	37.2	37.8	38.5	39.4	40.6	40.6
	Exceedance Level L_{A90}	-	-	-	-14.1	-10.8	-7.3	-5.8	-5.2	-4.5	-3.6	-4.5	-4.5
NAL11 - Kletterlea	Total ETSU-R-97 Noise Limit	45	45	45	45	45	45	45	45	45	47.3	49.8	51.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	32.6	35.3	38	40	41.6	43.4	45.4	47.5	47.5
	Exceedance Level L_{A90}	-	-	-	-12.4	-9.7	-7	-5	-3.4	-1.6	-1.9	-2.3	-4.3
NAL12 - The School House	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	44.5	47.3	49.8	51.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.7	30.5	33.6	35.4	36.7	38.2	39.9	41.8	41.8
	Exceedance Level L_{A90}	-	-	-	-15.3	-12.5	-9.4	-7.6	-6.3	-6.3	-7.4	-8	-10

NAL13 - Cluness Cottage	Total ETSU-R-97 Noise Limit	45	45	45	45	45	45	45	45	45.6	48	50.1	50.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	34.7	37.1	39.6	41.6	43.4	45.4	47.4	49.5	49.5
	Exceedance Level L_{A90}	-	-	-	-10.3	-7.9	-5.4	-3.4	-1.6	-0.2	-0.6	-0.6	-0.6
NAL14 - Staneygarth	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	45.1	45.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.6	32.4	35.3	37.1	38.4	39.9	41.6	43.5	43.5
	Exceedance Level L_{A90}	-	-	-	-13.4	-10.6	-7.7	-5.9	-4.6	-3.1	-1.4	-1.6	-1.6
NAL15 - Giggleswick	Total ETSU-R-97 Noise Limit	45	45	45	45	45	45	45	45	45	45	46.1	46.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	31.2	33.9	36.7	38.6	40.2	42	44	46	46
	Exceedance Level L_{A90}	-	-	-	-13.8	-11.1	-8.3	-6.4	-4.8	-3	-1	-0.1	-0.1

6.6 Derivation of Site Specific Noise Limits (Stage 3)

6.6.1 Site specific noise limits have been derived for each of the noise sensitive receptors considered within the Tables 6.1 above. As shown in Table 6.9, for some of the receptors surrounding the Proposed Development noise from the other schemes will be negligible and will be at least 10dB below the Total ETSU-R-97 noise limits detailed in Tables 6.5 and 6.6. At the receptors where turbine predictions are at least 10dB below it would be appropriate to allocate the entire noise limit to the Proposed Development as the other wind turbines will use a negligible proportion of the total noise limit.

6.6.2 For the other receptors limit apportionment was required. When considering the predictions from the small wind turbine developments it has been assumed that the turbines are operating in full mode.

Table 6.8 Requirement for Noise Limit Apportionment

Noise Assessment Location	Are predicted wind turbine noise levels within 10dB of Total ETSU-R-97 Noise limit?	Is it necessary to apportion Noise Limits?
NAL1- Lower Hollingarth	NO	NO
NAL2- Whirliegarth	NO	NO
NAL3- Easterlee	NO	NO
NAL4 - Gentletown	NO	NO
NAL5 - Littlester	YES	YES
NAL6 - Hamnavoe	NO	NO
NAL7 - Helnaquhida	YES	YES
NAL8 - Kettlester	YES	YES
NAL9 - Islesview	YES	YES
NAL10 - Westerlee	YES	YES
NAL11 - Kletterlea	YES	YES
NAL12 - The School House	YES	YES
NAL13 – Cluness Cottage	YES	YES
NAL14 - Staneygarth	YES	YES
NAL15 - Giggleswick	YES	YES

6.6.3 As summarised in Table 6.9 above apportionment is required at NALs 5 and 7-15 in order to allow the Proposed Development and the other wind turbine developments to co-exist to within the Total ETSU-R-97 Noise Limits. In order to apportion the noise limits, predictions of wind turbine noise immissions were calculated for the Proposed Development operating concurrently with the other wind turbine developments. These predicted noise levels (including the additional uncertainty detailed in Section 4.3.5) were then subtracted from the Total ETSU-R-97 limit to determine the residual limit available for the Proposed Development (the suggested 'site specific noise limits').

6.6.4 Figures A1.5a-A1.5o (Annex 1) show the site specific noise limits and the noise predictions for the Proposed Development when considering the Senvion 3.4M 104 3.4MW and the Nordex N100 3.3MW. Tables 6.10 and 6.11 show the site specific noise limits for the Proposed Development and the predicted wind turbine noise levels based on the Senvion 3.4M 104 which is the louder of the two candidate turbines. A negative exceedence demonstrates compliance with the site specific noise limits.

Table 6.9 Site Specific Limits Compliance Table - Quiet Daytime

Location		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Lower Hollingarth	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	40	40	40	40.1	41.8	42.6	42.6	42.6
	Predicted Wind Turbine Noise LA90	-	-	-	27.3	30.9	34.7	36.1	36.2	36.2	36.2	36.2	36.2
	Exceedance Level LA90	-	-	-	-12.7	-9.1	-5.3	-3.9	-3.9	-5.6	-6.4	-6.4	-6.4
NAL2 - Whirlegarth	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	40	40	40	40	40.5	42.9	42.9	42.9
	Predicted Wind Turbine Noise LA90	-	-	-	30.5	34.1	37.8	39.2	39.4	39.4	39.4	39.4	39.4
	Exceedance Level LA90	-	-	-	-9.5	-5.9	-2.2	-0.8	-0.6	-1.1	-3.5	-3.5	-3.5
NAL3 - Easterlee	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	39.9	39.9	39.8	39.7	42.1	44.3	46.4	46.4
	Predicted Wind Turbine Noise LA90	-	-	-	30.3	33.9	37.6	39.1	39.2	39.2	39.2	39.2	39.2
	Exceedance Level LA90	-	-	-	-9.7	-6	-2.3	-0.7	-0.5	-2.9	-5.1	-7.2	-7.2
NAL4 - Gentletown	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	39.9	39.9	39.8	41.6	44.4	46.6	47.8	47.8
	Predicted Wind Turbine Noise LA90	-	-	-	27.5	31.1	34.8	36.2	36.4	36.4	36.4	36.4	36.4
	Exceedance Level LA90	-	-	-	-12.5	-8.8	-5.1	-3.6	-5.2	-8	-10.2	-11.4	-11.4
NAL5 - Littlester	Site Specific Noise Limit : ETSU-R-97	39.9	39.9	39.9	39.9	39.7	39.6	40.7	44	46.8	49.2	50.9	50.9
	Predicted Wind Turbine Noise LA90	-	-	-	25.8	29.5	33.2	34.6	34.7	34.7	34.7	34.7	34.7
	Exceedance Level LA90	-	-	-	-14.1	-10.2	-6.4	-6.1	-9.3	-12.1	-14.5	-16.2	-16.2
NAL6 - Hamnavoe	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	40	40	40	40.1	41.8	42.6	42.6	42.6
	Predicted Wind Turbine Noise LA90	-	-	-	24.5	28.1	31.8	33.2	33.4	33.4	33.4	33.4	33.4
	Exceedance Level LA90	-	-	-	-15.5	-11.9	-8.2	-6.8	-6.7	-8.4	-9.2	-9.2	-9.2
NAL7 - Helnaquhida	Site Specific Noise Limit : ETSU-R-97	39.9	39.9	39.9	39.9	39.8	39.7	39.5	39.2	41.6	43.8	45.9	45.9
	Predicted Wind Turbine Noise LA90	-	-	-	26.6	30.2	34	35.4	35.5	35.5	35.5	35.5	35.5
	Exceedance Level LA90	-	-	-	-13.3	-9.6	-5.7	-4.1	-3.7	-6.1	-8.3	-10.4	-10.4
NAL8 - Kettlester	Site Specific Noise Limit : ETSU-R-97	39.9	39.9	39.9	39.9	39.8	39.7	39.5	39.2	41.6	43.8	45.9	45.9
	Predicted Wind Turbine Noise LA90	-	-	-	26.4	30	33.7	35.1	35.3	35.3	35.3	35.3	35.3
	Exceedance Level LA90	-	-	-	-13.5	-9.8	-6	-4.4	-3.9	-6.3	-8.5	-10.6	-10.6
NAL9 - Isleview	Site Specific Noise Limit : ETSU-R-97	39.9	39.9	39.9	39.9	39.9	39.9	39.8	39.6	42	44.2	46.3	46.3
	Predicted Wind Turbine Noise LA90	-	-	-	28.7	32.3	36	37.4	37.6	37.6	37.6	37.6	37.6
	Exceedance Level LA90	-	-	-	-11.2	-7.6	-3.9	-2.4	-2	-4.4	-6.6	-8.7	-8.7
NAL10 - Westerlee	Site Specific Noise Limit : ETSU-R-97	39.9	39.9	39.9	39.9	39.9	39.8	39.6	39.3	41.8	44	46	46
	Predicted Wind Turbine Noise LA90	-	-	-	27.7	31.3	35	36.4	36.6	36.6	36.6	36.6	36.6
	Exceedance Level LA90	-	-	-	-12.2	-8.6	-4.8	-3.2	-2.7	-5.2	-7.4	-9.4	-9.4
NAL11 - Kletterlea	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	40	40	41.3	43.2	45.3	47.8	49.2	49.2
	Predicted Wind Turbine Noise LA90	-	-	-	26.5	30.2	33.9	35.3	35.4	35.4	35.4	35.4	35.4
	Exceedance Level LA90	-	-	-	-13.5	-9.8	-6.1	-6	-7.8	-9.9	-12.4	-13.8	-13.8
NAL12 – The School House	Site Specific Noise Limit : ETSU-R-97	39.8	39.8	39.8	39.8	39.7	39.5	40.7	43.9	46.8	49.2	50.8	50.8
	Predicted Wind Turbine Noise LA90	-	-	-	23.7	27.3	31.1	32.5	32.6	32.6	32.6	32.6	32.6
	Exceedance Level LA90	-	-	-	-16.1	-12.4	-8.4	-8.2	-11.3	-14.2	-16.6	-18.2	-18.2
NAL13 - Cluness Cottage	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	40	40	40	40	35.4	37.6	39.1	39.1
	Predicted Wind Turbine Noise LA90	-	-	-	25.6	29.2	32.9	34.3	34.5	34.5	34.5	34.5	34.5
	Exceedance Level LA90	-	-	-	-14.4	-10.8	-7.1	-5.7	-5.5	-0.9	-3.1	-4.6	-4.6
NAL14 - Staneygarth	Site Specific Noise Limit : ETSU-R-97	39.8	39.8	39.8	39.8	39.6	39.3	38.7	37.7	40.2	42.5	44.5	44.5
	Predicted Wind Turbine Noise LA90	-	-	-	25.2	28.9	32.6	34	34.1	34.1	34.1	34.1	34.1
	Exceedance Level LA90	-	-	-	-14.6	-10.7	-6.7	-4.7	-3.6	-6.1	-8.4	-10.4	-10.4
NAL15 - Giggleswick	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	40	40	40	41.8	42.7	44.1	44.1	44.1
	Predicted Wind Turbine Noise LA90	-	-	-	25.4	29	32.7	34.2	34.3	34.3	34.3	34.3	34.3
	Exceedance Level LA90	-	-	-	-14.6	-11	-7.3	-5.8	-7.5	-8.4	-9.8	-9.8	-9.8

Table 6.10 Site Specific Limits Compliance Table - Night-time

Location		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Lower Hollingarth	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	43	43	43	43	43	43	44.1
	Predicted Wind Turbine Noise LA90	-	-	-	27.3	30.9	34.7	36.1	36.2	36.2	36.2	36.2	36.2
	Exceedance Level LA90	-	-	-	-15.7	-12.1	-8.3	-6.9	-6.8	-6.8	-6.8	-6.8	-7.9
NAL2 - Whirllegarth	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	43	43	43	43	43	43.7	43.7
	Predicted Wind Turbine Noise LA90	-	-	-	30.5	34.1	37.8	39.2	39.4	39.4	39.4	39.4	39.4
	Exceedance Level LA90	-	-	-	-12.5	-8.9	-5.2	-3.8	-3.6	-3.6	-3.6	-4.3	-4.3
NAL3 - Easterlee	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	43	42.9	42.9	42.8	42.6	44.7	44.7
	Predicted Wind Turbine Noise LA90	-	-	-	30.3	33.9	37.6	39.1	39.2	39.2	39.2	39.2	39.2
	Exceedance Level LA90	-	-	-	-12.7	-9.1	-5.4	-3.8	-3.7	-3.6	-3.4	-5.5	-5.5
NAL4 - Gentletown	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	42.9	42.9	42.9	42.7	43.7	45.7	45.7
	Predicted Wind Turbine Noise LA90	-	-	-	27.5	31.1	34.8	36.2	36.4	36.4	36.4	36.4	36.4
	Exceedance Level LA90	-	-	-	-15.5	-11.9	-8.1	-6.7	-6.5	-6.3	-7.3	-9.3	-9.3
NAL5 - Littlester	Site Specific Noise Limit : ETSU-R-97	42.9	42.9	42.9	42.9	42.9	42.8	42.6	42.4	43.7	46.6	49.2	51.4
	Predicted Wind Turbine Noise LA90	-	-	-	25.8	29.5	33.2	34.6	34.7	34.7	34.7	34.7	34.7
	Exceedance Level LA90	-	-	-	-17.1	-13.4	-9.6	-8	-7.7	-9	-11.9	-14.5	-16.7
NAL6 - Hamnavoe	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	43	43	43	43	43	43	44.1
	Predicted Wind Turbine Noise LA90	-	-	-	24.5	28.1	31.8	33.2	33.4	33.4	33.4	33.4	33.4
	Exceedance Level LA90	-	-	-	-18.5	-14.9	-11.2	-9.8	-9.6	-9.6	-9.6	-9.6	-10.7
NAL7 - Helnaquhida	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	42.9	42.9	42.8	42.6	42.3	41.8	43.9	43.9
	Predicted Wind Turbine Noise LA90	-	-	-	26.6	30.2	34	35.4	35.5	35.5	35.5	35.5	35.5
	Exceedance Level LA90	-	-	-	-16.4	-12.7	-8.9	-7.4	-7.1	-6.8	-6.3	-8.4	-8.4
NAL8 - Kettlester	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	42.9	42.9	42.8	42.6	42.3	41.8	43.9	43.9
	Predicted Wind Turbine Noise LA90	-	-	-	26.4	30	33.7	35.1	35.3	35.3	35.3	35.3	35.3
	Exceedance Level LA90	-	-	-	-16.6	-12.9	-9.2	-7.7	-7.3	-7	-6.5	-8.6	-8.6
NAL9 - Isleview	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	42.9	42.9	42.8	42.6	42.4	44.5	44.5
	Predicted Wind Turbine Noise LA90	-	-	-	28.7	32.3	36	37.4	37.6	37.6	37.6	37.6	37.6
	Exceedance Level LA90	-	-	-	-14.3	-10.7	-6.9	-5.5	-5.2	-5	-4.8	-6.9	-6.9
NAL10 - Westerlee	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	42.9	42.9	42.8	42.7	42.5	42	44.1	44.1
	Predicted Wind Turbine Noise LA90	-	-	-	27.7	31.3	35	36.4	36.6	36.6	36.6	36.6	36.6
	Exceedance Level LA90	-	-	-	-15.3	-11.6	-7.9	-6.4	-6.1	-5.9	-5.4	-7.5	-7.5
NAL11 - Kletterlea	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	43	43	43	41.1	43.6	46.3	50
	Predicted Wind Turbine Noise LA90	-	-	-	26.5	30.2	33.9	35.3	35.4	35.4	35.4	35.4	35.4
	Exceedance Level LA90	-	-	-	-16.5	-12.8	-9.1	-7.7	-7.6	-5.7	-8.2	-10.9	-14.6
NAL12 - The School House	Site Specific Noise Limit : ETSU-R-97	42.9	42.9	42.9	42.9	42.9	42.8	42.6	42.3	43.7	46.6	49.1	51.4
	Predicted Wind Turbine Noise LA90	-	-	-	23.7	27.3	31.1	32.5	32.6	32.6	32.6	32.6	32.6
	Exceedance Level LA90	-	-	-	-19.2	-15.6	-11.7	-10.1	-9.7	-11.1	-14	-16.5	-18.8
NAL13 - Cluness Cottage	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	43	43	41	36.7	40.3	42.4	42.4
	Predicted Wind Turbine Noise LA90	-	-	-	25.6	29.2	32.9	34.3	34.5	34.5	34.5	34.5	34.5
	Exceedance Level LA90	-	-	-	-17.4	-13.8	-10.1	-8.7	-6.5	-2.2	-5.8	-7.9	-7.9
NAL14 - Staneygarth	Site Specific Noise Limit : ETSU-R-97	42.9	42.9	42.9	42.9	42.8	42.7	42.4	42	41.2	39.4	41.4	41.4
	Predicted Wind Turbine Noise LA90	-	-	-	25.2	28.9	32.6	34	34.1	34.1	34.1	34.1	34.1
	Exceedance Level LA90	-	-	-	-17.7	-13.9	-10.1	-8.4	-7.9	-7.1	-5.3	-7.3	-7.3
NAL15 - Giggleswick	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	43	43	43	42.7	39.7	36.1	36.1
	Predicted Wind Turbine Noise LA90	-	-	-	25.4	29	32.7	34.2	34.3	34.3	34.3	34.3	34.3
	Exceedance Level LA90	-	-	-	-17.6	-14	-10.3	-8.8	-8.7	-8.4	-5.4	-1.8	-1.8

6.6.5 The assessment shows that the predicted wind turbine noise immission levels meet the Proposed Development specific noise limits under all conditions and at all locations for both quiet daytime and night-time periods at all receptors.

6.7 Micrositing

6.7.1 It should be noted that the need to include a concave ground profile correction and/or barrier correction may change depending on the final location of the turbines (following micrositing) and the final turbine hub height. Nevertheless, turbine noise levels will have to meet the noise limits established in this report regardless of any increases and decreases in noise propagation caused by topography. Should consent be granted, the need to apply a concave ground profile/ barrier correction will need to be considered by the Applicant prior to the final selection of a turbine model for the site.

7 CONCLUSIONS

7.1.1 This report has assessed the potential impact of operational noise from the Proposed Development on the residents of nearby receptors. The guidance contained within ETSU-R-97 and current good practice (IOA GPG) has been used to assess the potential noise impact of the Proposed Development.

7.1.2 Six residential receptors neighbouring the Proposed Development were selected as being representative of the closest properties. Background noise monitoring was undertaken at six receptors. After one week the batteries failed on one of the noise meters therefore due to insufficient data points recorded. The quietest unfiltered dataset was used and this approach was agreed during a telephone conversation with Shetland Isles Council Environmental Health Department.

7.1.3 A total of fifteen noise sensitive receptors were chosen as noise assessment locations. The assessment locations were chosen to represent the noise sensitive receptors located closest to the Proposed Development but also to consider receptors located further away but in proximity to the small operational wind turbine developments to the south of the Proposed Development. For the assessment locations where no background noise measurements were undertaken, noise data collected at proxy locations considered representative of the expected background noise environment was used to assess the wind turbine noise impact at those receptors.

7.1.4 Wind speed data was collected using a Triton SODAR Unit. The data collected at 80m and 100m height was used to calculate hub height wind speeds (95m) which were then standardised to 10m height, in accordance with current good practice.

7.1.5 Analysis of the measured data was undertaken in accordance with ETSU-R-97 and current good practice to determine the pre-existing background noise environment and to establish the quiet daytime and night-time noise limits for each of the assessment locations. Following a review of the guidance in ETSU-R-97 the daytime limit at uninvolved properties has been set at 40dB(A) or background plus 5dB whichever is the greater. The night time limit at uninvolved properties has been set at 43dB or background plus 5dB whichever is the greater.

7.1.6 There are a number of small operational wind turbines to the south of the site. A cumulative assessment was undertaken at the noise sensitive receptors where predictions from the Proposed Development were found to be within 10dB of the noise predictions from all other schemes. The cumulative assessment results show that the predicted cumulative wind farm noise immission levels would meet the Total ETSU-R-97 derived noise limits at receptor locations surrounding the Proposed Development for both quiet daytime and night-time periods.

7.1.7 Predictions of wind turbine noise were made based upon sound power level data for the candidate wind turbine models, the Senvion 3.4M and Nordex N100 (for the Proposed Development), and the Evance Iskra (5kW), Proven (6kW) and Eoltech (6kW) (for the other schemes) and a noise propagation model which accords with current good practice and is considered to provide a realistic impact assessment.

7.1.8 Site Specific ETSU-R-97 Noise Limits have also been derived which take account (where required) of the other wind turbine developments. Where immissions from the other wind turbines at a given receptor were found to be at least 10dB below the Total ETSU-R-97 Noise Limit; the other wind turbines would be using a negligible proportion of the limit. As such it is considered appropriate to allocate the entire noise limit to the Proposed Development. For receptors where turbine predictions were found to be within 10dB of the Total ETSU-R-97 noise limit, apportionment of the Total ETSU-R-97 Noise Limits was undertaken.

7.1.9 An assessment was undertaken to determine whether the Proposed Development could operate within the Site Specific Noise Limits and it was found that at all receptors wind turbine noise immissions were below the Site Specific Noise Limits when considering the Senvion 3.4M and Nordex N100 as candidate turbines. Those turbine models were chosen as they are considered representative of the type of turbine that could be installed at the site.

7.1.10 TNEI understands that the small wind turbine located in close proximity to Cluness Cottage (T20) may be removed therefore for the purposes of this assessment modelling has been undertaken with and without that turbine. The calculations included within the main sections of this report assume that the turbine is operational, however an alternative set of noise limits and predictions have been presented within Annex 9 which would apply if the turbine is removed.

7.1.11 Should the Scottish Ministers grant consent for the Proposed Development it would be appropriate to include noise related planning conditions which detail the noise limits applicable to the development and a methodology which could be used in the event of a complaint. Draft conditions have been included within Appendix 22.1 of the ES and include noise limits which have been set in accordance with ETSU-R-97 and good practice.

7.1.12 There are a number of wind turbine makes and models that may be suitable for the Proposed Development. Should the proposal receive planning permission, the final choice of turbine would be subject to a competitive tendering process. The final choice of turbine would, however, have to meet the noise limits determined and contained within any condition imposed.

8 GLOSSARY OF TERMS

Amplitude Modulation: a variation in noise level over time; for example observers may describe a 'whoosh whoosh' sound, which can be heard close to a wind turbine as the blades sweep past.

Attenuation: the reduction in level of a sound between the source and a receiver due to any combination of effects including: distance, atmospheric absorption, acoustic screening, the presence of a building façade, etc.

Background Noise: the noise level rarely fallen below in any given location over any given time period, often classed according to day time, evening or night time periods. The L_{A90} indices (see below) is often used to represent the background noise level.

Bin: subset or group into which data can be sorted; in the case of wind speeds, bins are often centred on integer wind speeds with a width of 1 m/s. For example the 4 m/s bin would include all data with wind speeds of 3.5 to 4.5 m/s.

Dawn Chorus: noise due to birds which can occur at sunrise.

Broadband Noise: noise with components over a wide range of frequencies.

Decibel (dB): the ratio between the quietest audible sound and the loudest tolerable sound is a million to one in terms of the change in sound pressure. A logarithmic scale is used in noise level measurements because of this wide range. The scale used is the decibel (dB) scale which extends from 0 to 140 decibels (dB) corresponding to the intensity of the sound level.

dB(A): the ear has the ability to recognise a particular sound depending on its pitch or frequency. Microphones cannot differentiate noise in the same way as the ear, and to counter this weakness the noise measuring instrument applies a correction to correspond more closely to the frequency response of the human ear. The correction factor is called 'A Weighting' and the resulting measurements are written as dB(A). The dB(A) is internationally accepted and has been found to correspond well with people's subjective reaction to noise. Some typical subjective changes in noise levels are:

- a change of 3dB(A) is just perceptible;
- a change of 5dB(A) is clearly perceptible;
- a change of 10dB(A) is twice (or half) as loud.

Directivity: the property of a sound source that causes more sound to be radiated in one direction than another.

Frequency: the pitch of a sound in Hz or kHz. See Hertz.

Ground Effects: the modification of sound at a receiver location due to the interaction of the sound wave with the ground along its propagation path from source to receiver. Described using the term 'G', and ranges between 0 (hard), 0.5 (mixed) and 1 (soft).

Hertz (Hz): sound frequency refers to how quickly the air vibrates, or how close the sound waves are to each other (in cycles per second, or Hertz (Hz)).

L_w: is the sound power level. It is a measure of the total noise energy radiated by a source of noise, and is used to calculate noise levels at a distant location. The L_{WA} is the A-weighted sound power level.

L_{eq}: is the equivalent continuous sound level, and is the sound level of a steady sound with the same energy as a fluctuating sound over the same period. It is possible to consider this level as the ambient noise encompassing all noise at a given time. The $LA_{eq,T}$ is the A-weighted equivalent continuous sound level over a given time period (T).

L_{90}: index represents the noise level exceeded for 90 percent of the measurement period and is used to indicate quieter times during the measurement period. It is often used to measure the background noise level. The $L_{A90,10min}$ is the A-weighted background noise level over a ten minute measurement sample.

Noise emission: the noise energy emitted by a source (e.g. a wind turbine).

Noise immission: the sound pressure level detected at a given location (e.g. the nearest dwelling).

Night Time Hours: ETSU-R-97 defines the night time hours as 23.00 to 07.00 every day.

Quiet Daytime Hours: ETSU-R-97 defines the amenity hours as 18.00 to 23.00 Monday to Friday, 13.00 to 23.00 on Saturdays and 07.00 to 23.00 on Sundays.

Sound Level Meter: an instrument for measuring sound pressure level.

Sound Power Level: the total sound power radiated by a source, in decibels.

Sound Pressure Level: a measure of the sound pressure at a point, in decibels**.**

Standardised Wind Speed: a wind speed measured at a height different than 10 m (generally measured at the turbine hub height) which is expressed to a reference height of 10 m using a roughness length of 0.05 for standardisation purpose (in accordance with the IEC 61400-11 standard).

Tonal Noise: noise which covers a very restricted range of frequencies (e.g. a range of ≤20 Hz). This noise can be more annoying than broadband noise.

Wind Shear: the increase of wind speed with height above the ground.

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ANNEX 1 - Figures

ANNEX 2 - Correspondence with the Environmental Health Department at the Council

ANNEX 3 – Field Data Sheets

ANNEX 4 - Calibration/ Conformance Certificates for Sound Level Meters and Calibrator

ANNEX 5 –Technical Information on SODAR Unit

ANNEX 6 – Time Histories

ANNEX 7 – Summary of Wind Turbine Noise Source Data

ANNEX 8 – Topographical Corrections

ANNEX 9 – Alternative Noise Limits which would apply if Turbine 20 is removed

ANNEX 1 - Figures

Legend

- Noise Monitoring Location
- H1 Noise Assessment Location
- T1 Proposed Turbine Layout

Rev.	DETAILS	DRAWN	CHK'D	APP'D	DATE
R1	FIRST ISSUE	JB	GC	GC	20/01/2016

Project:	Beaw Field Wind Farm
Client:	Peel Wind Farms (Yell) Ltd
Figure Title:	Noise Monitoring and Assessment Locations
Figure Number:	A1.1
Scale:	1 to 20,000@A3
Document Reference:	10081-004

PEEL Energy

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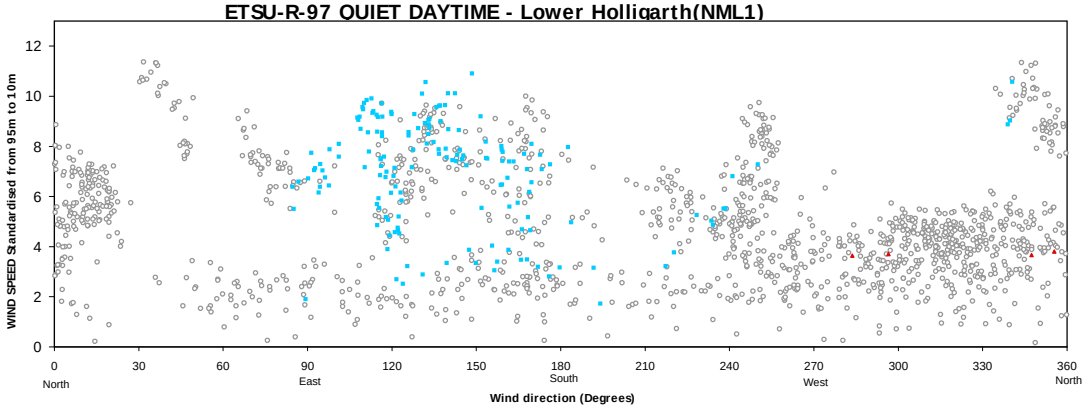
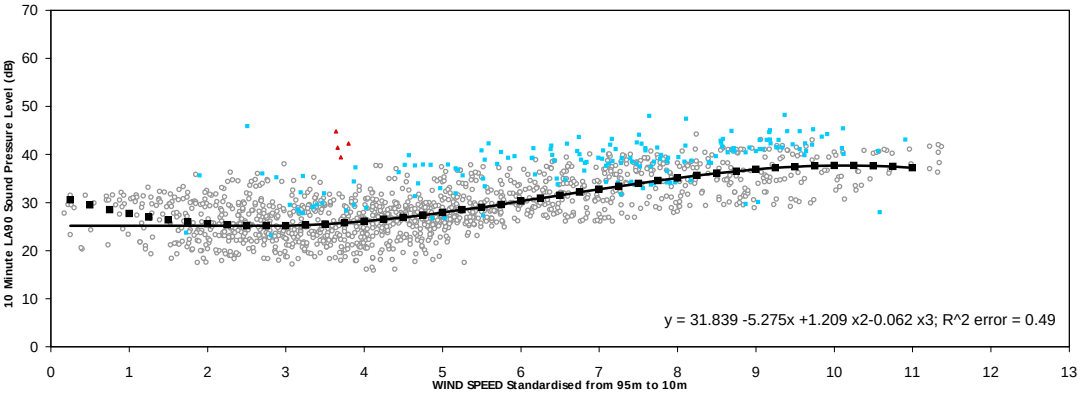
ETSU-R-97 QUIET DAYTIME - Lower Holligarth(NML1)

Wind Conditions Quiet Daytime



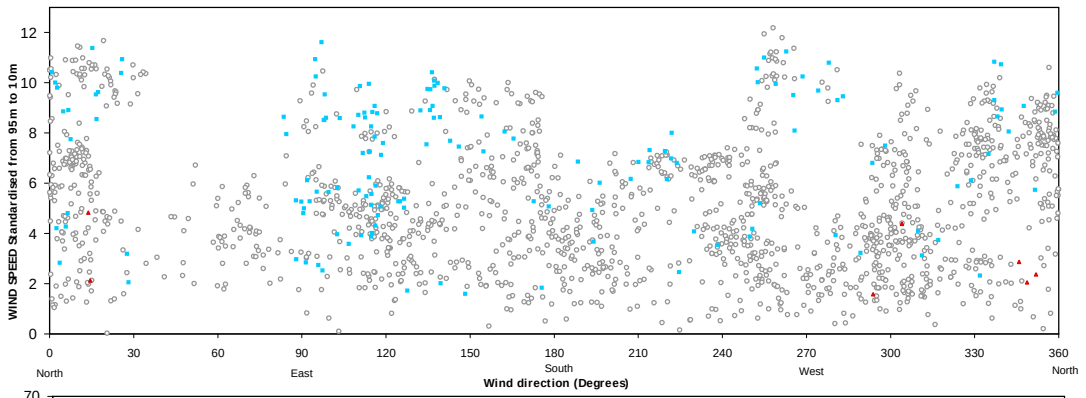
Regression Analysis Quiet Daytime



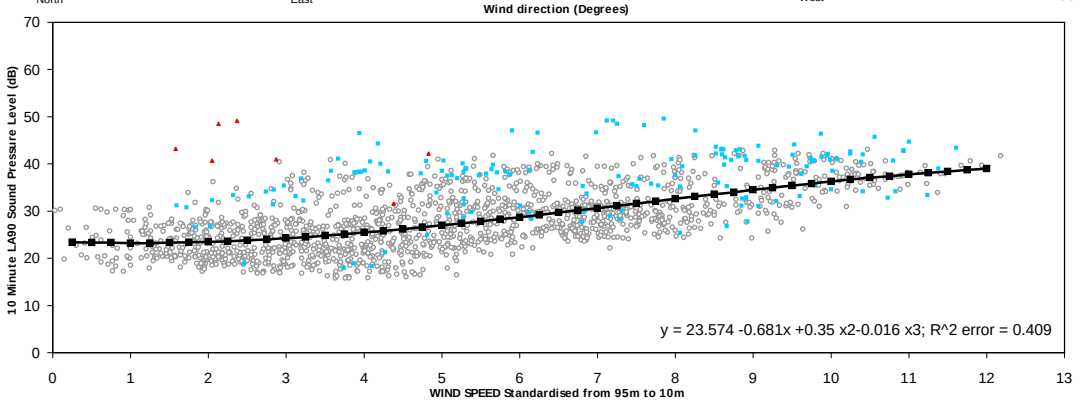
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	169	211	234	254	128	128	84	78	34	17	0	1337
Prevailing Background	25.2	25.2	26.1	27.9	30.3	32.8	35.1	36.9	37.7	37.2	-	

ETSU-R-97 NIGHT-TIME - Lower Holligarth(NML1)

Wind Conditions Night-Time



Regression Analysis Night-Time



Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	189	201	233	209	171	196	115	71	62	29	4	1480
Prevailing Background	23.5	24.3	25.5	27	28.7	30.6	32.6	34.5	36.3	37.8	39	

Legend:

- L_{A90} 10 Minute Measurement Point
- Line of best fit
- Line of best fit flat lined where appropriate(Prevailing Background)
- Excluded Data-Manual exclusion
- Excluded Data-Rain

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Wind Conditions&Regression Analysis
Figure Number	A1.2a
Scale	NTS
Drawn	JB
Checked	GC
Date	20/ 01/ 2016
Document Reference	10081-005

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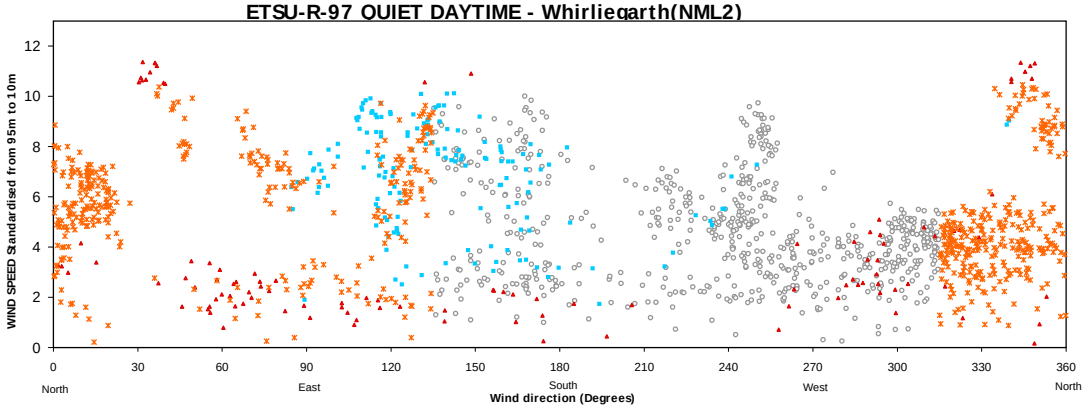
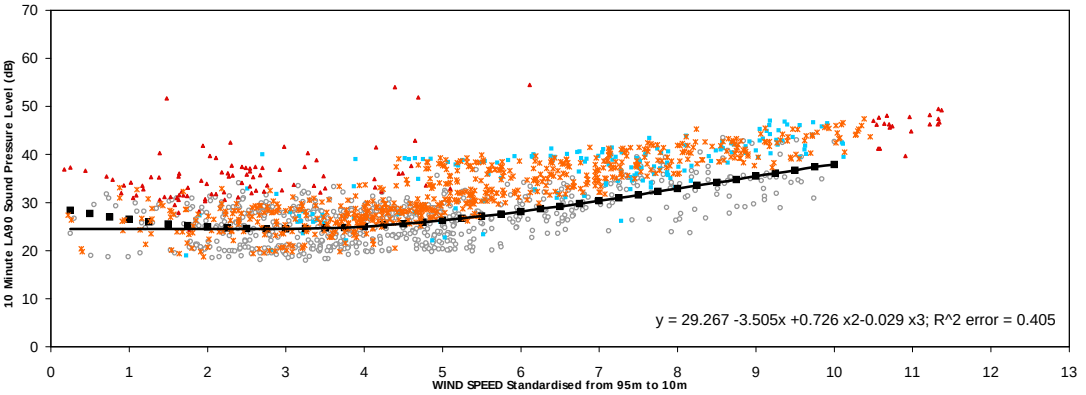
ETSU-R-97 QUIET DAYTIME - Whirliegarth(NML2)

Wind Conditions Quiet Daytime



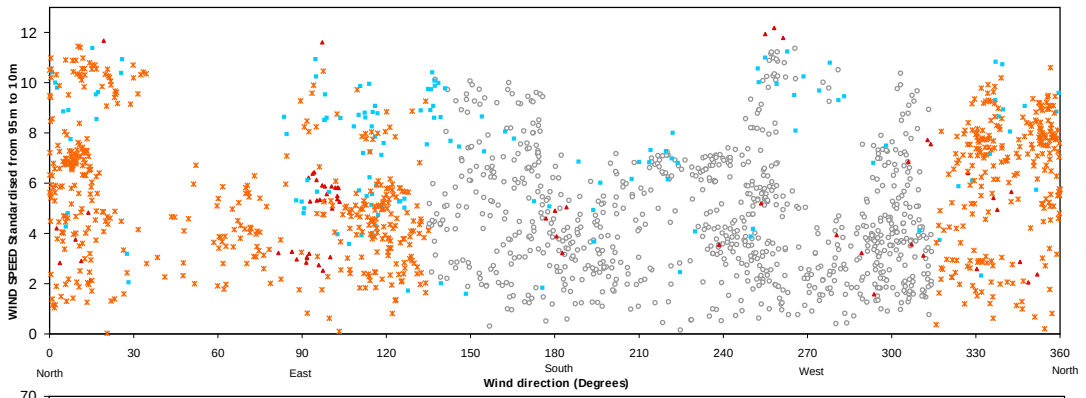
Regression Analysis Quiet Daytime



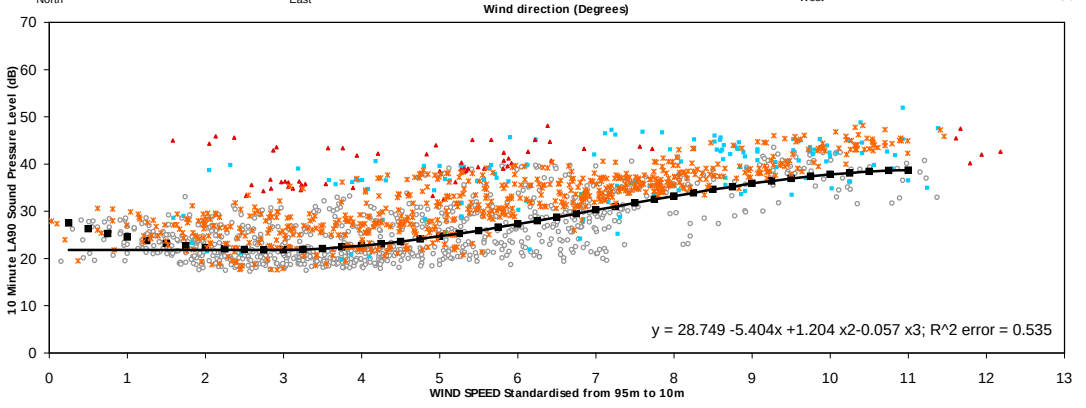
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	88	120	120	131	51	52	38	33	7	0	0	640
Prevailing Background	24.5	24.5	25	26.3	28.1	30.4	32.9	35.5	37.9	-	-	

ETSU-R-97 NIGHT-TIME - Whirliegarth(NML2)

Wind Conditions Night-Time



Regression Analysis Night-Time



Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	127	128	150	104	87	100	27	29	26	10	0	788
Prevailing Background	21.8	21.8	22.7	24.7	27.3	30.3	33.2	35.9	37.8	38.7	-	

Legend:

- L_{A90} 10 Minute Measurement Point
- Line of best fit
- Line of best fit flat lined where appropriate(Prevailing Background)
- Excluded Data-Manual exclusion
- Excluded Data-Rain
- Excluded Data-Filtered Wind Direction

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Wind Conditions&Regression Analysis
Figure Number	A1.2b
Scale	NTS
Drawn	JB
Checked	GC
Date	20/ 01/ 2016
Document Reference	10081-005

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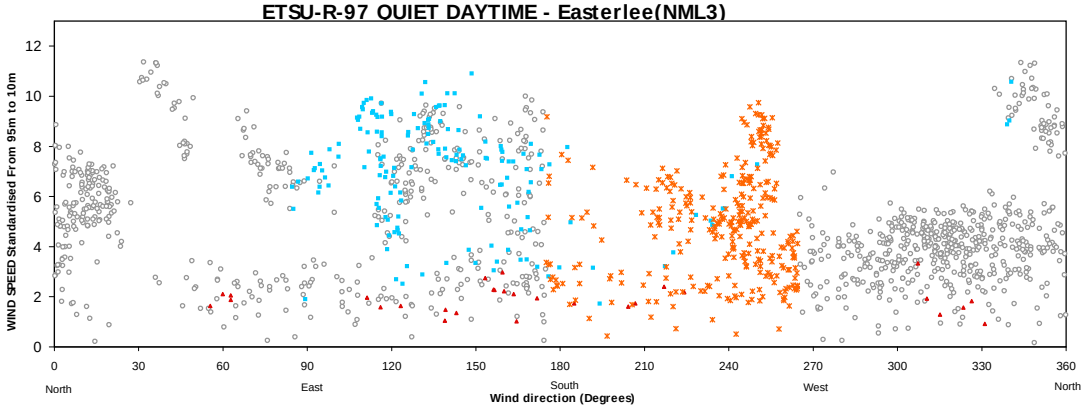
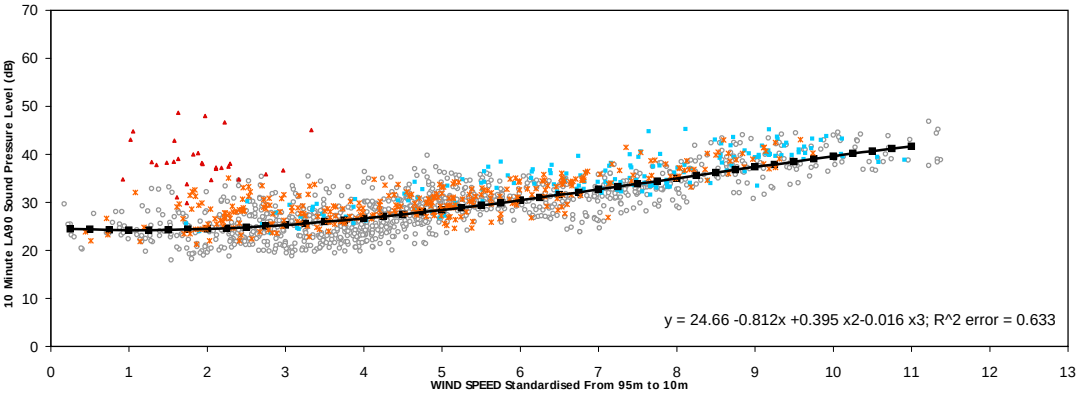
Newcastle upon Tyne Website www.tnei.co.uk

ETSU-R-97 QUIET DAYTIME - Easterlee(NML3)

Wind Conditions Quiet Daytime



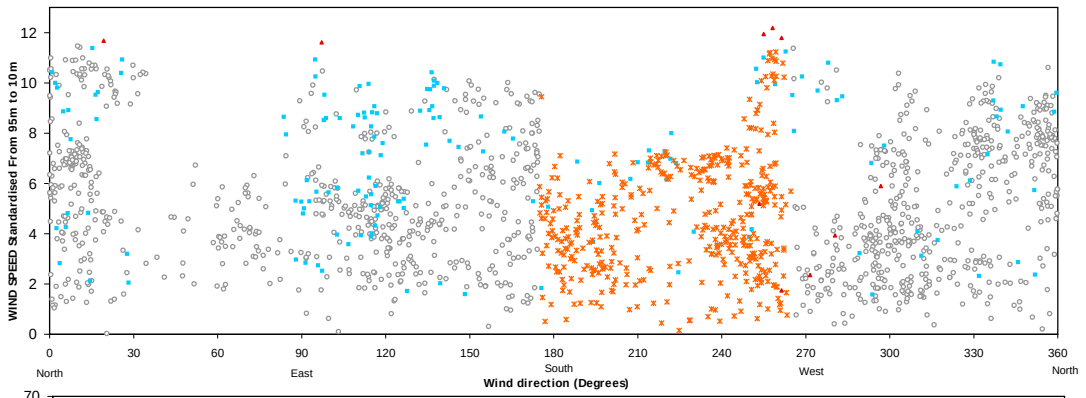
Regression Analysis Quiet Daytime



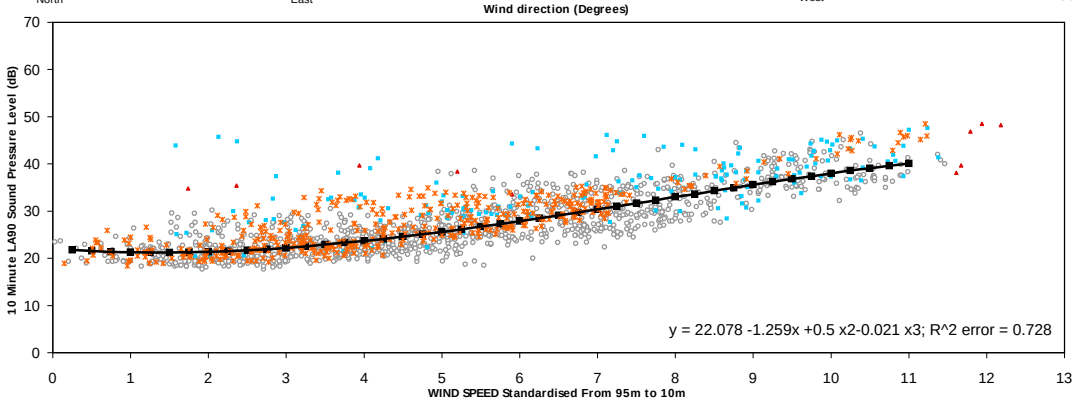
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	103	167	196	190	91	95	65	60	32	17	0	1016
Prevailing Background	24.5	25.3	26.7	28.4	30.5	32.7	35	37.4	39.6	41.7	-	

ETSU-R-97 NIGHT-TIME - Easterlee(NML3)

Wind Conditions Night-Time



Regression Analysis Night-Time



Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	145	129	166	148	117	139	108	64	54	21	0	1091
Prevailing Background	21.4	22.2	23.7	25.6	27.9	30.4	33	35.6	38	40.1	-	

Legend:

- L_{A90} 10 Minute Measurement Point
- Line of best fit
- Line of best fit flat lined where appropriate(Prevailing Background)
- Excluded Data-Manual exclusion
- Excluded Data-Rain
- Excluded Data-Filtered Wind Direction

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Wind Conditions&Regression Analysis
Figure Number	A1.2c
Scale	NTS
Drawn	JB
Checked	GC
Date	20/ 01/ 2016
Document Reference	10081-005

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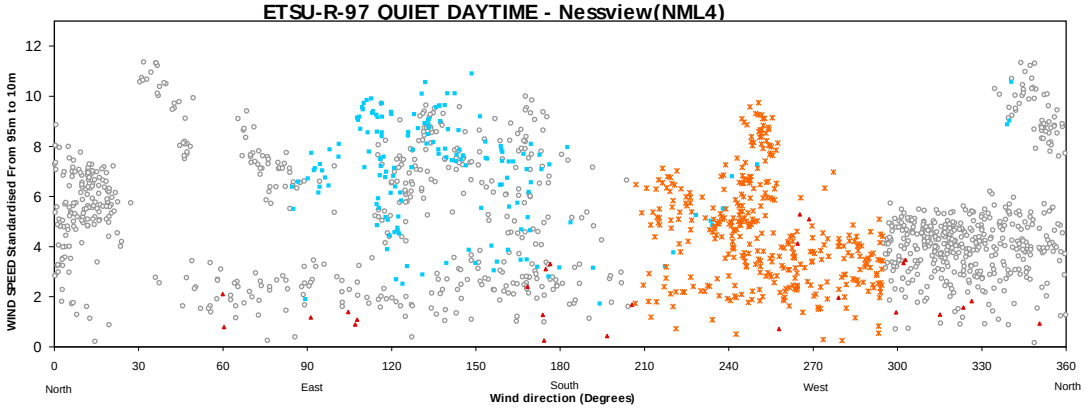
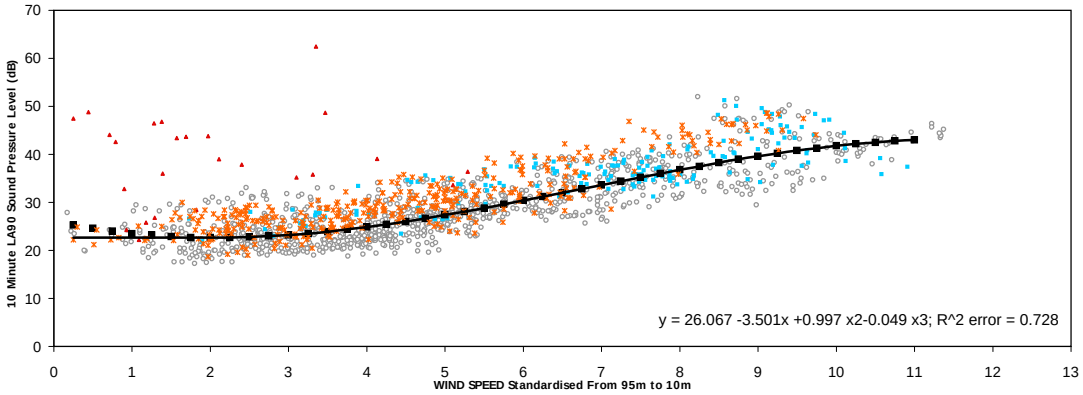
ETSU-R-97 QUIET DAYTIME - Nessview(NML4)

Wind Conditions Quiet Daytime



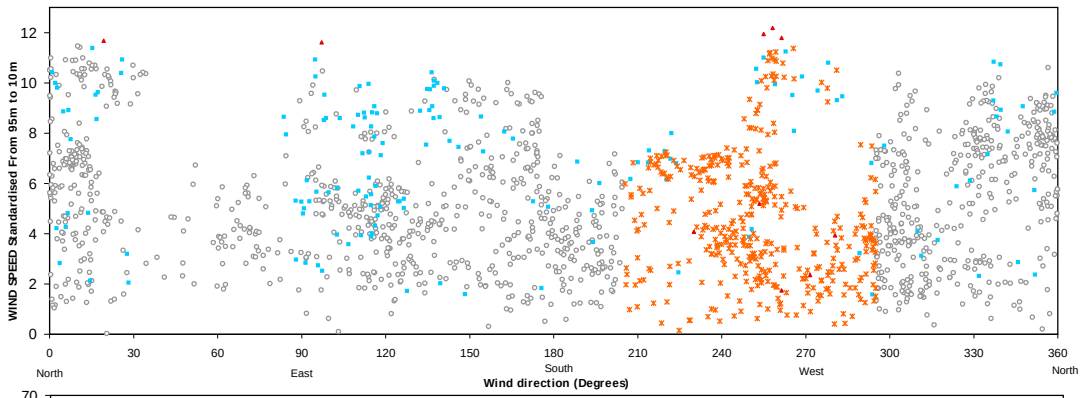
Regression Analysis Quiet Daytime



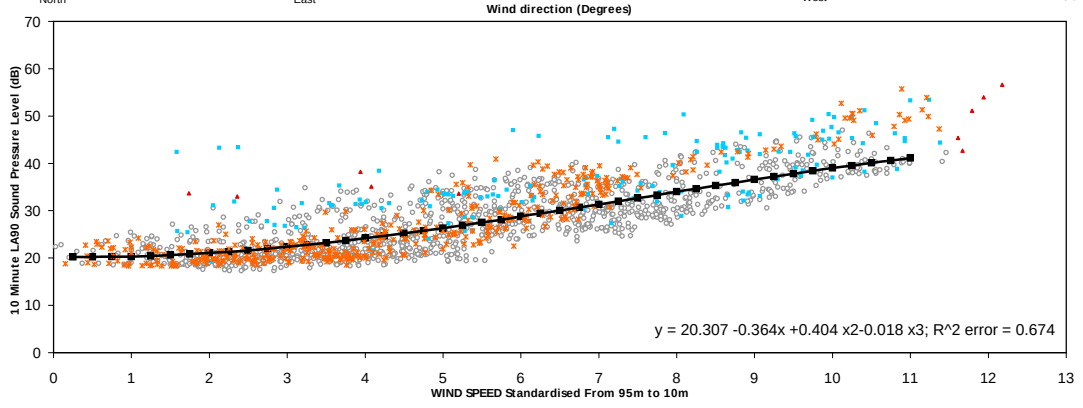
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	102	151	165	188	89	99	66	61	32	17	0	970
Prevailing Background	22.7	23.2	24.9	27.4	30.4	33.6	36.8	39.6	41.8	43	-	

ETSU-R-97 NIGHT-TIME - Nessview(NML4)

Wind Conditions Night-Time



Regression Analysis Night-Time



Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	132	138	168	166	125	142	107	64	51	19	0	1112
Prevailing Background	21.1	22.4	24.2	26.3	28.8	31.3	34	36.6	39	41.1	-	

Legend:

- L_{A90} 10 Minute Measurement Point
- Line of best fit
- Line of best fit flat lined where appropriate(Prevailing Background)
- Excluded Data-Manual exclusion
- Excluded Data-Rain
- Excluded Data-Filtered Wind Direction

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Wind Conditions&Regression Analysis
Figure Number	A1.2d
Scale	NTS
Drawn	JB
Checked	GC
Date	20/ 01/ 2016
Document Reference	10081-005

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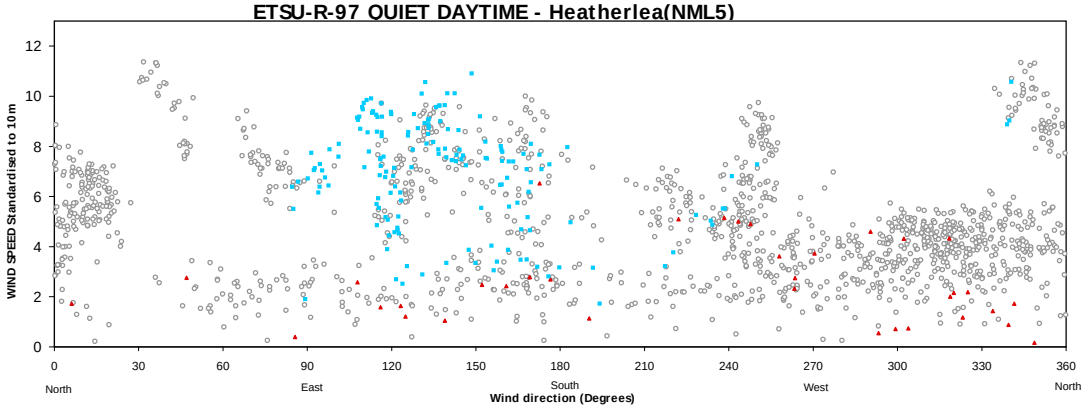
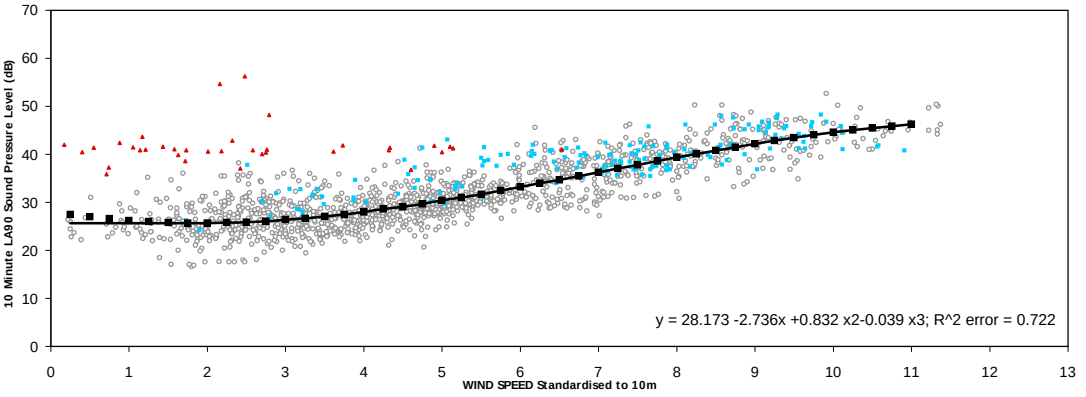
ETSU-R-97 QUIET DAYTIME - Heatherlea(NML5)

Wind Conditions Quiet Daytime



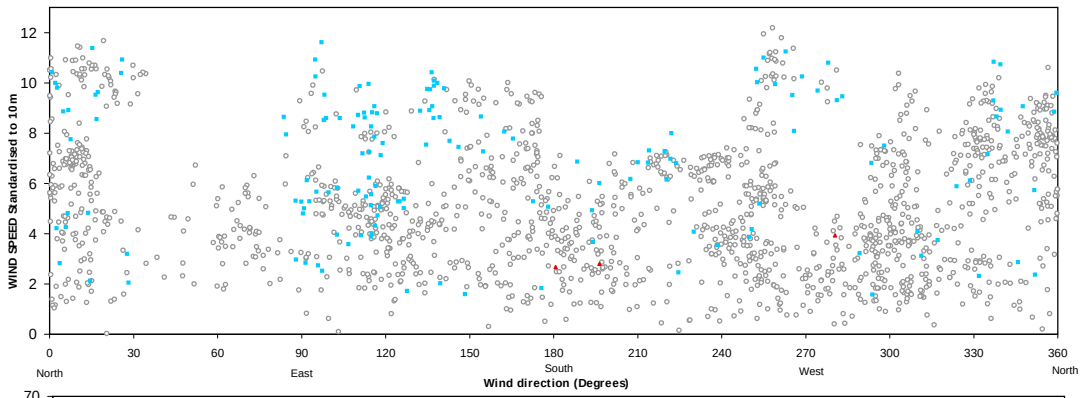
Regression Analysis Quiet Daytime



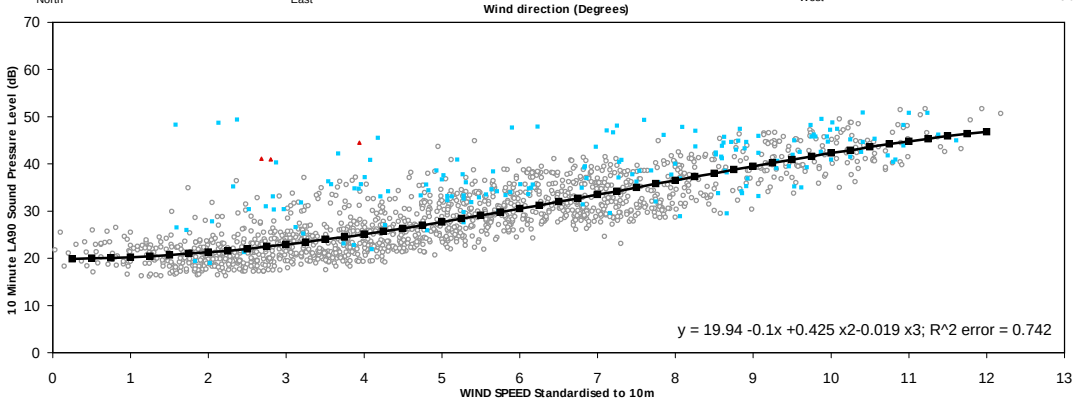
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	159	206	234	249	128	127	84	78	34	17	0	1316
Prevailing Background	25.7	26.4	28	30.4	33.2	36.3	39.4	42.2	44.6	46.3	-	

ETSU-R-97 NIGHT-TIME - Heatherlea(NML5)

Wind Conditions Night-Time



Regression Analysis Night-Time



Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	190	199	234	209	171	196	115	71	62	29	4	1480
Prevailing Background	21.3	22.9	25.1	27.7	30.5	33.5	36.5	39.5	42.3	44.8	46.8	

Legend:

- L_{A90} 10 Minute Measurement Point
- Line of best fit
- Line of best fit flat lined where appropriate(Prevailing Background)
- Excluded Data-Manual exclusion
- Excluded Data-Rain

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Wind Conditions&Regression Analysis
Figure Number	A1.2e
Scale	NTS
Drawn	JB
Checked	GC
Date	20/ 01/ 2016
Document Reference	10081-005

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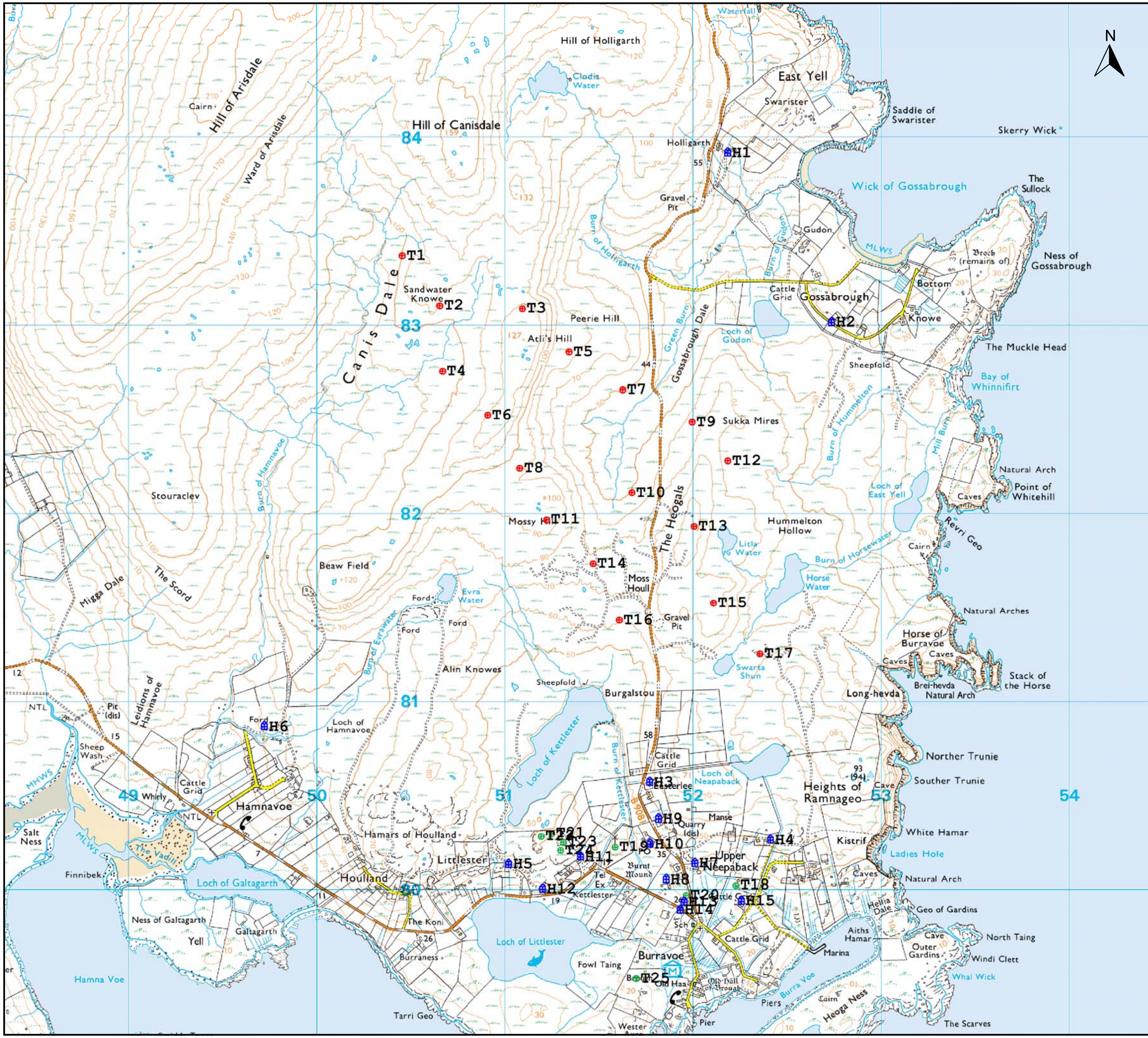

Legend

Hx	Noise Assessment Location
Tx	Proposed Turbine Layout
Tx	Existing Turbines

R1	FIRST ISSUE	JB	GC	GC	20/01/2016
Rev.	DETAILS	DRAWN	CHK'D	APP'D	DATE

Project:	Beaw Field Wind Farm
Client:	Peel Wind Farms (Yell) Ltd
Figure Title:	Cumulative Turbine Locations
Figure Number:	A1.3
Scale:	1 to 20,000@A3
Document Reference:	10081-004

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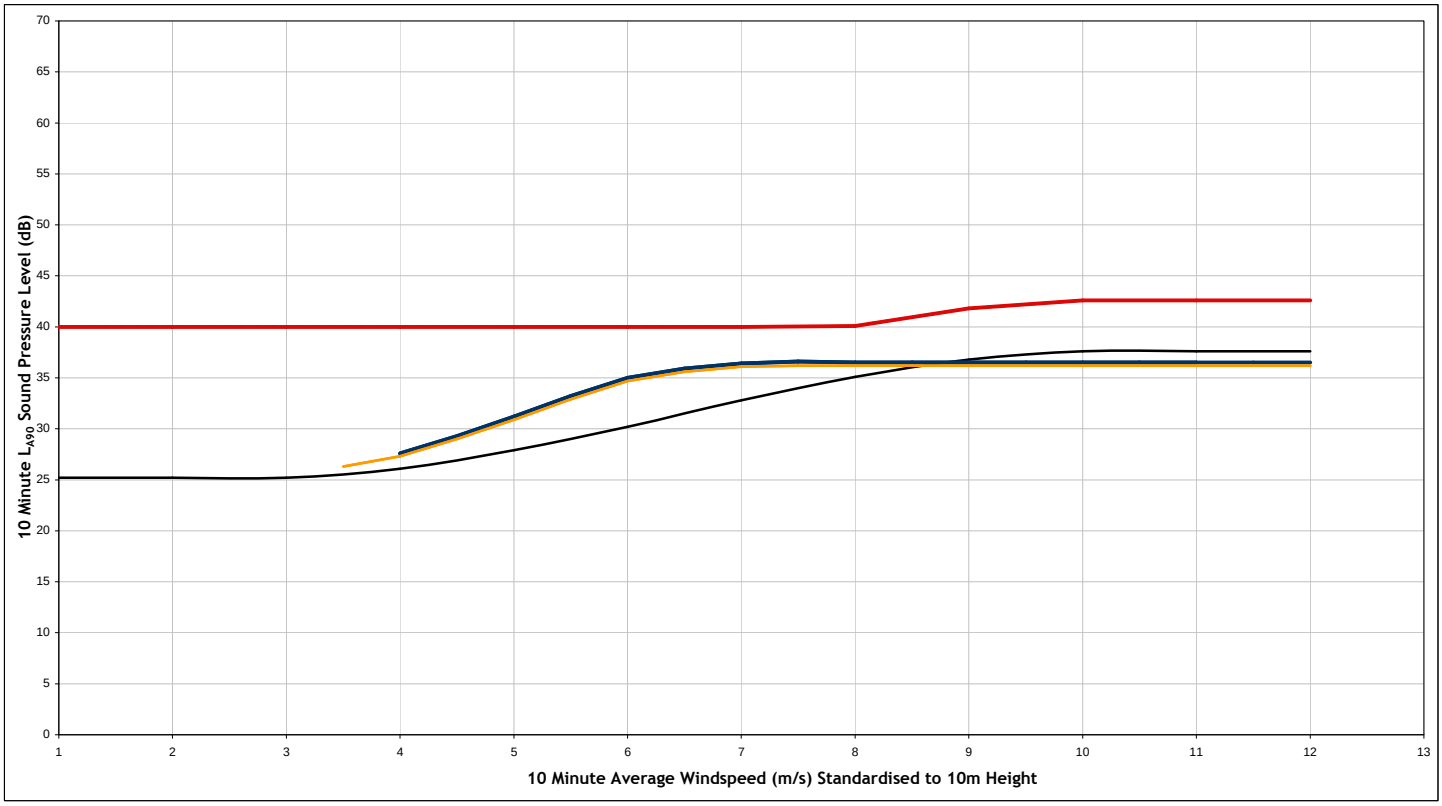
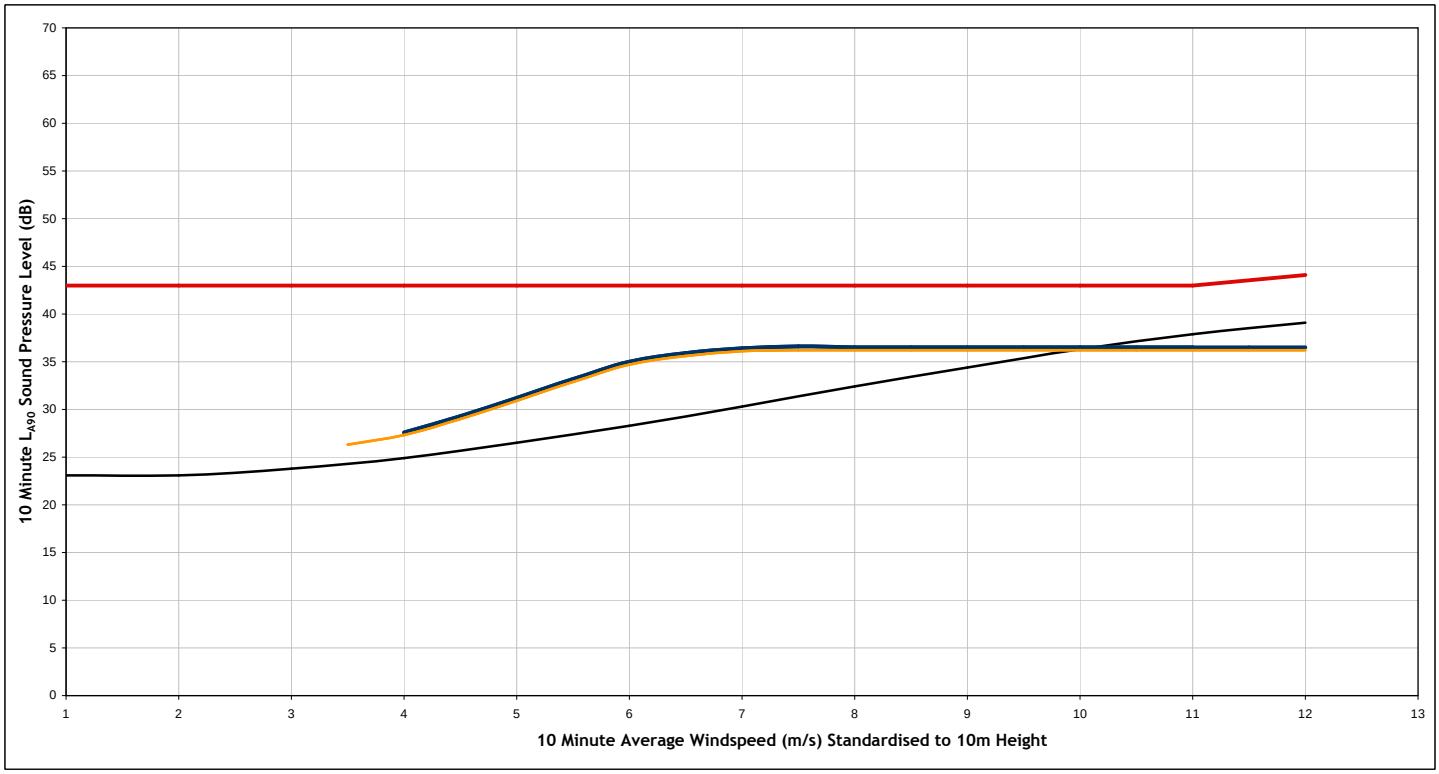
ETSU-R-97 QUIET DAYTIME - Lower Holligarth (H1)



ETSU-R-97 NIGHT-TIME - Lower Holligarth (H1)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- All Turbines
- Beaw Field Only - Senvion 3.4M

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Total Limits Lower Holligarth (H1)
Figure Number	A1.4a
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

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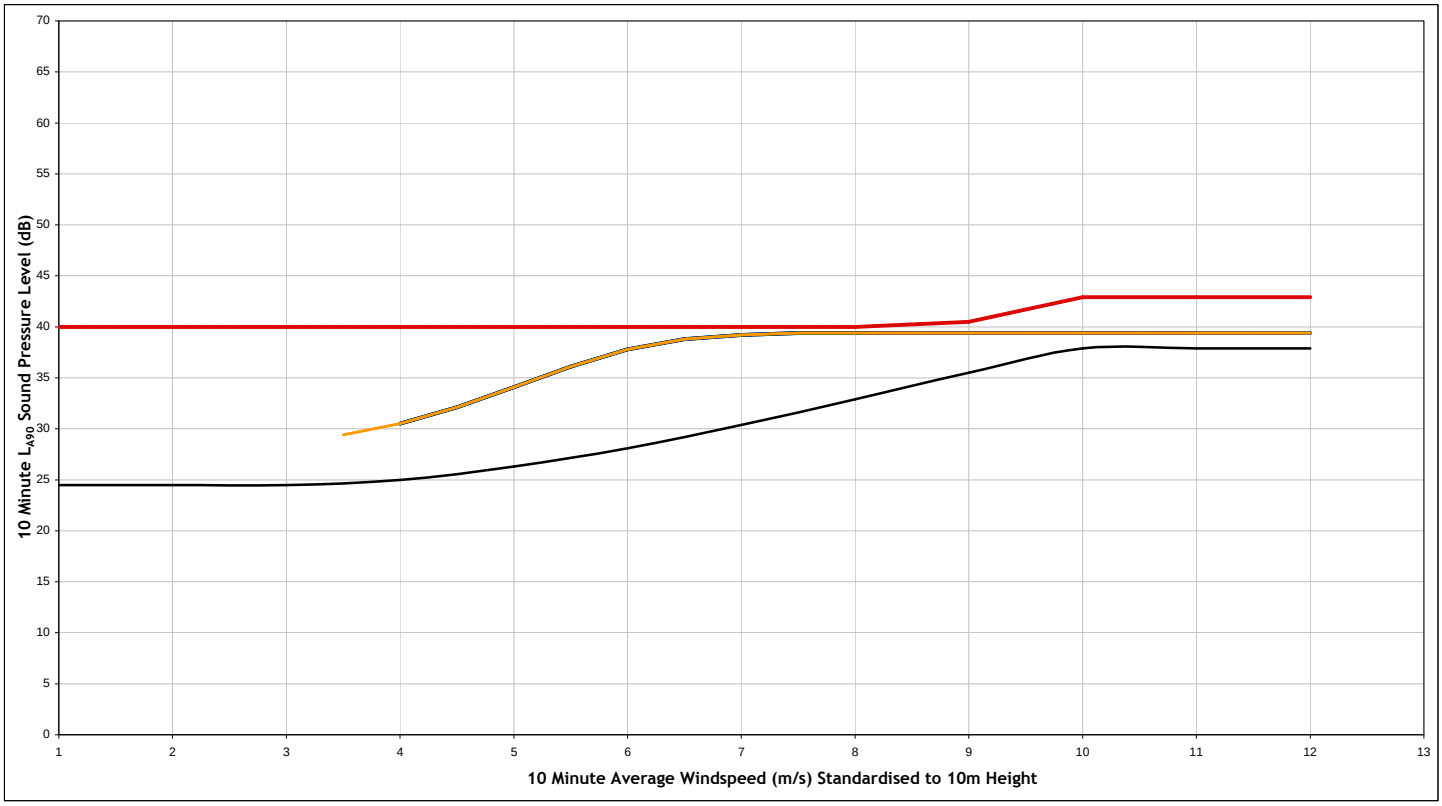
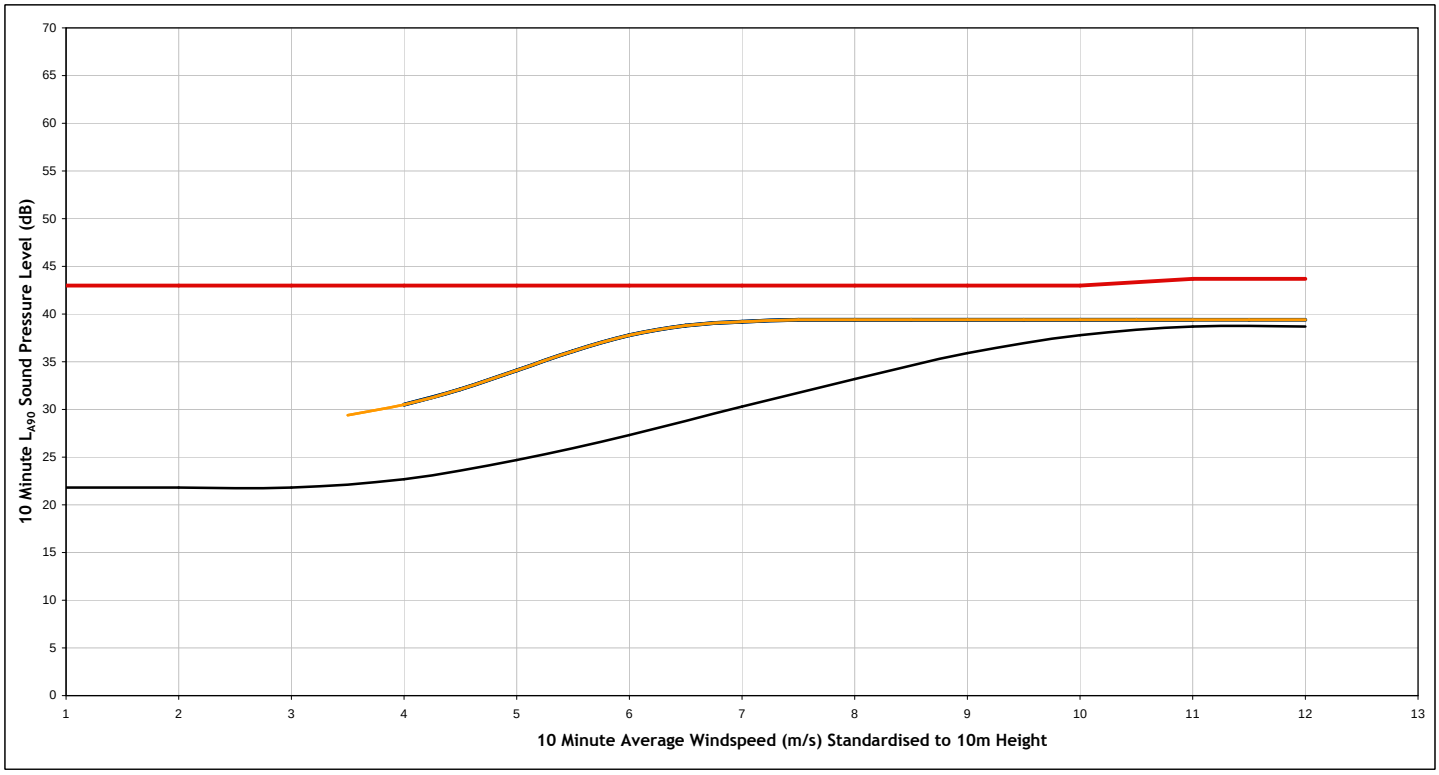
ETSU-R-97 QUIET DAYTIME - Whirliegarth (H2)



ETSU-R-97 NIGHT-TIME - Whirliegarth (H2)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- All Turbines
- Beaw Field Only - Senvion 3.4M

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Total Limits Whirliegarth (H2)
Figure Number	A1.4b
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

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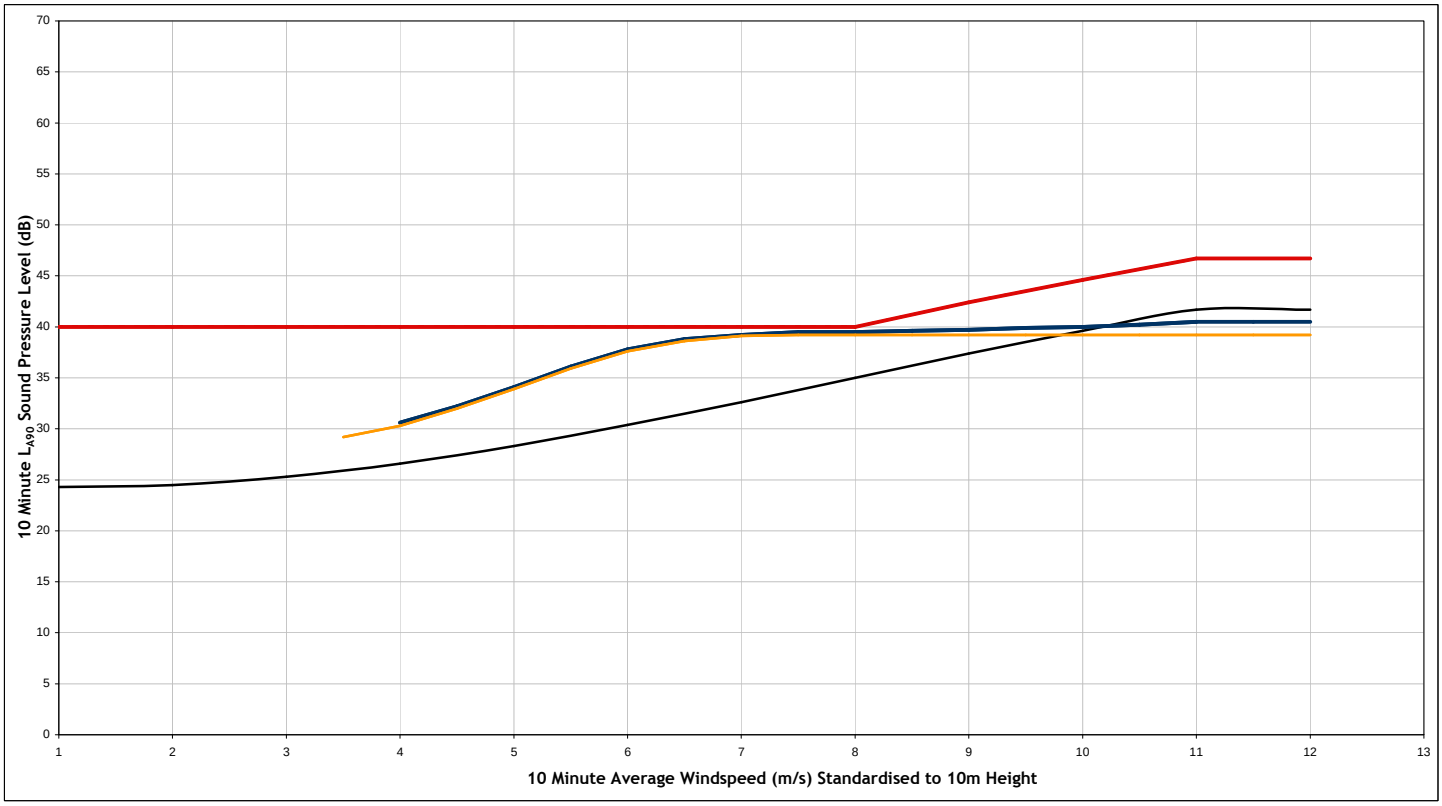
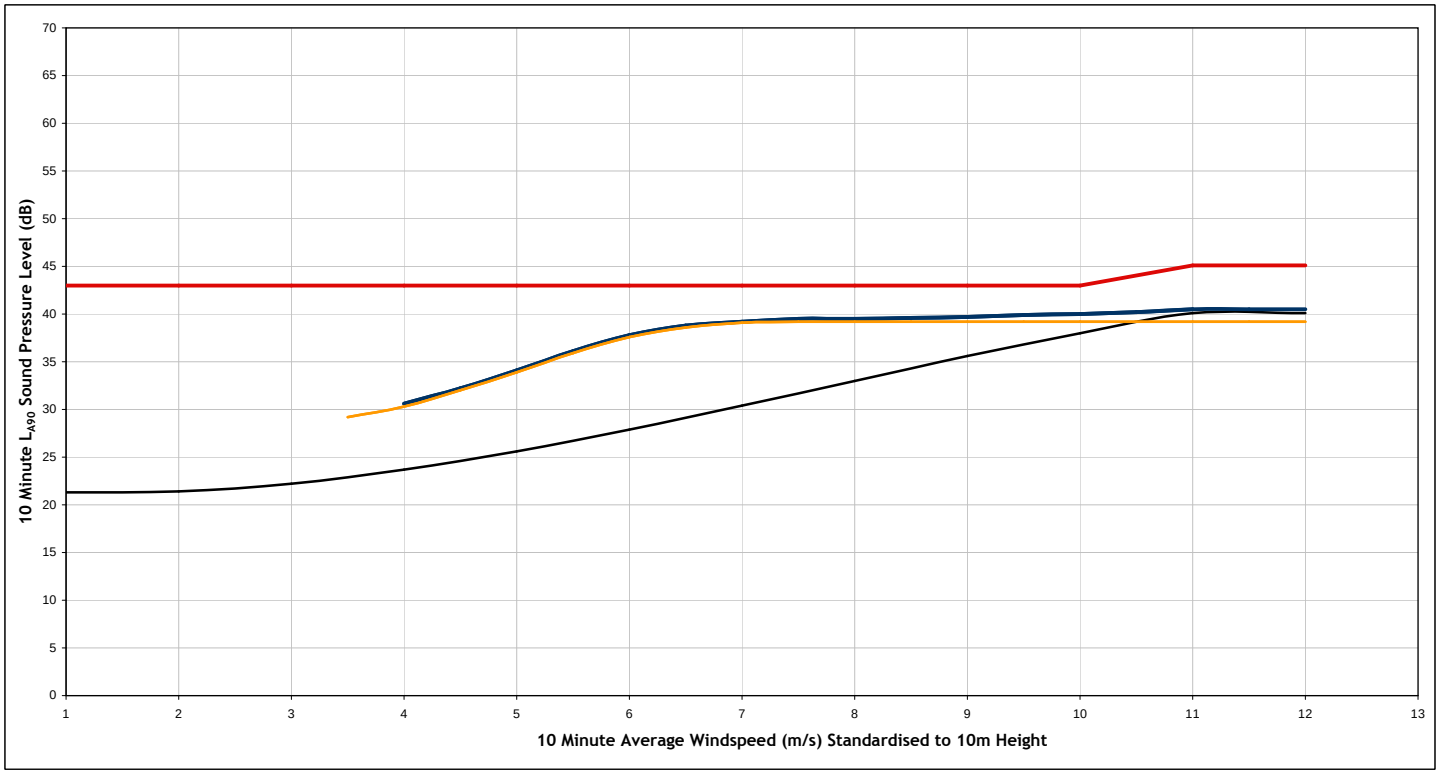
ETSU-R-97 QUIET DAYTIME - Easterlee (H3)



ETSU-R-97 NIGHT-TIME - Easterlee (H3)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- All Turbines
- Beaw Field Only - Senvion 3.4M

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Total Limits Easterlee (H3)
Figure Number	A1.4c
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

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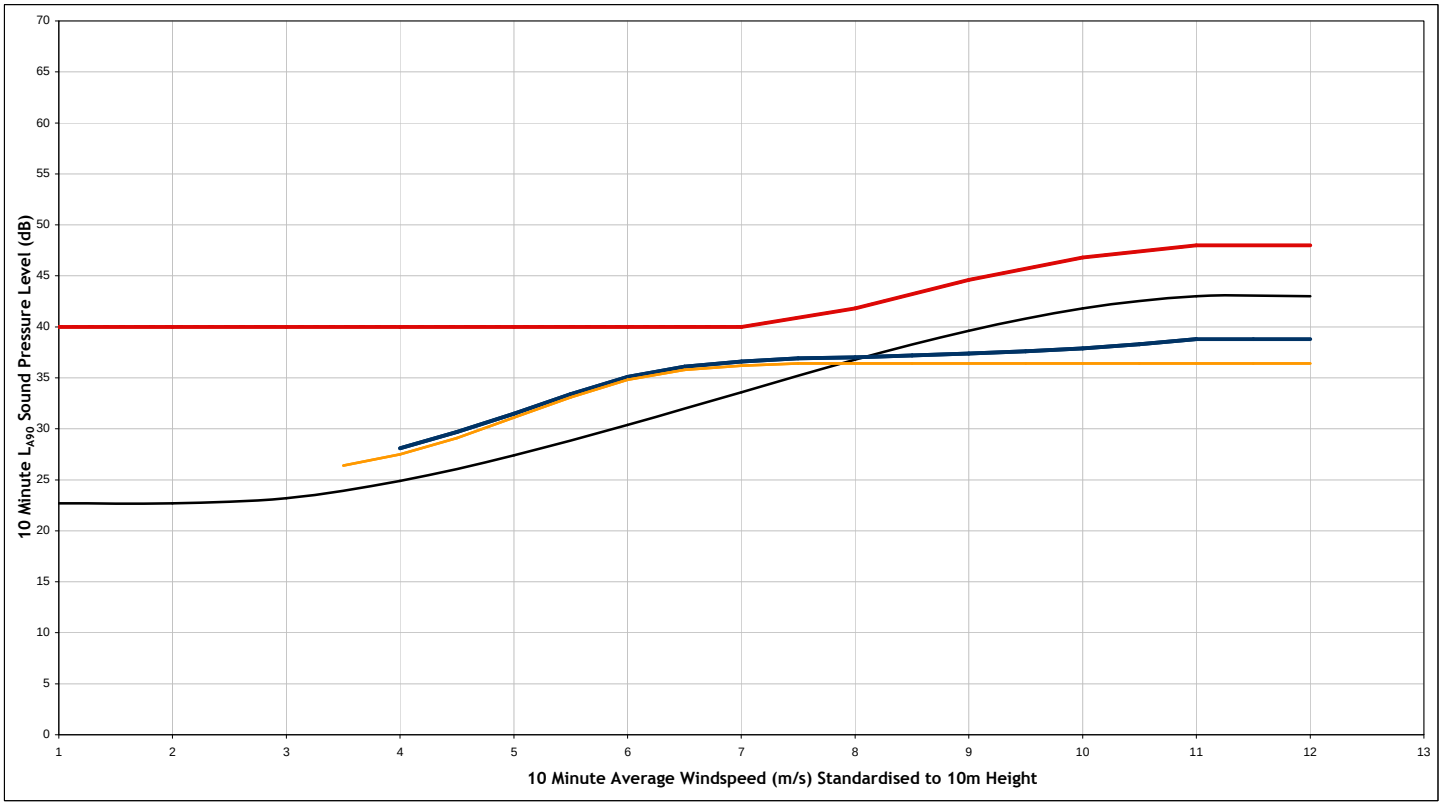
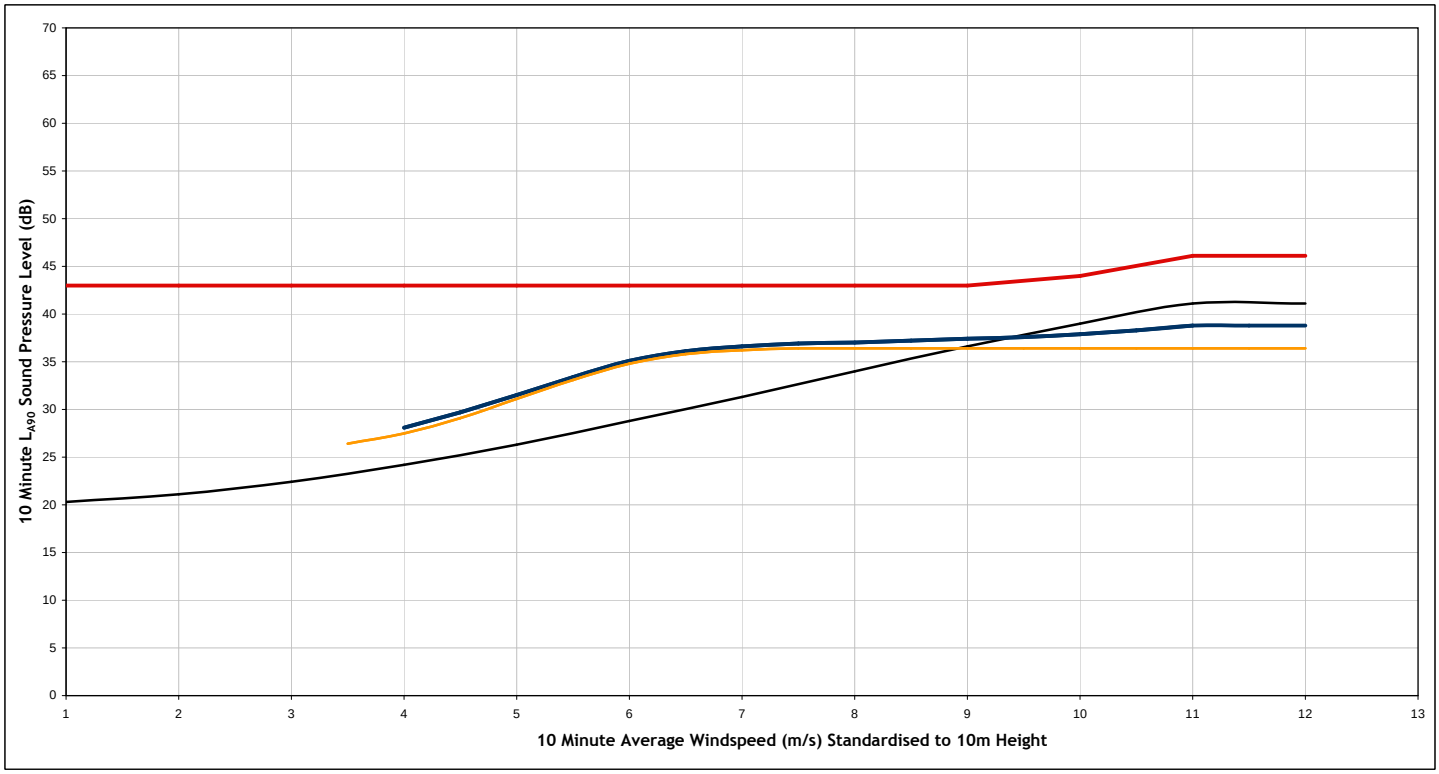
ETSU-R-97 QUIET DAYTIME - Gentletown (H4)



ETSU-R-97 NIGHT-TIME - Gentletown (H4)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- All Turbines
- Beaw Field Only - Senvion 3.4M

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Total Limits Gentletown (H4)
Figure Number	A1.4d
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

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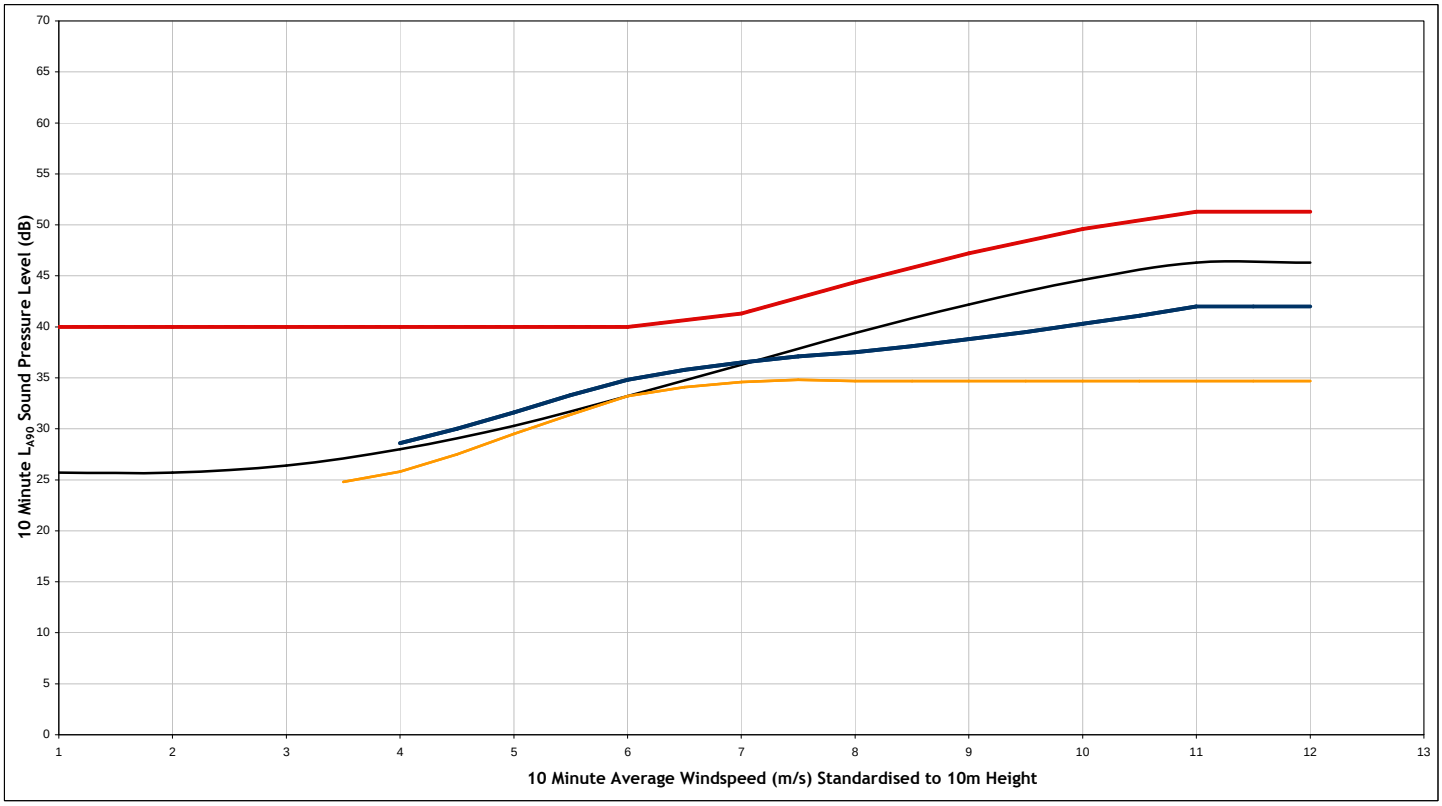
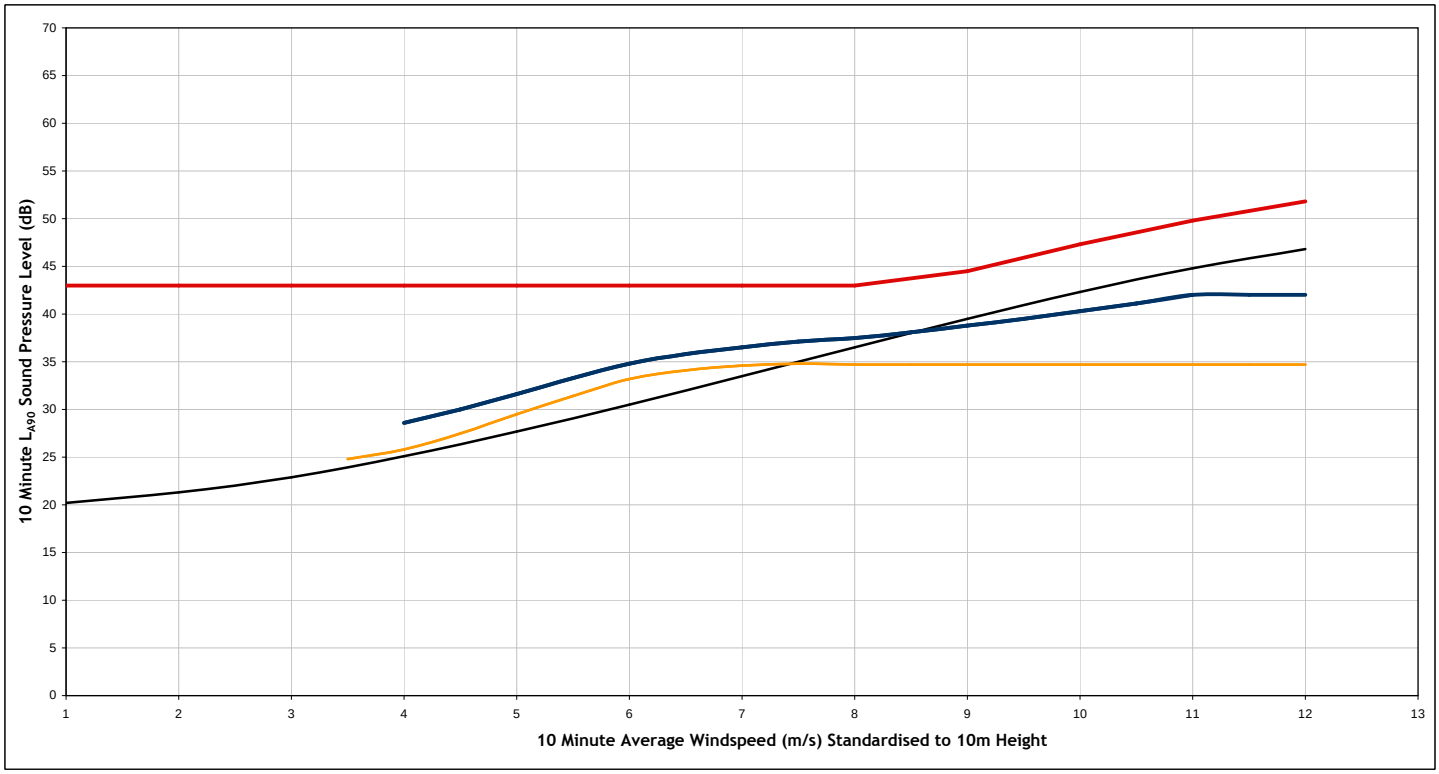
ETSU-R-97 QUIET DAYTIME - Littlester (H5)



ETSU-R-97 NIGHT-TIME - Littlester (H5)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- All Turbines
- Beaw Field Only - Senvion 3.4M

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Total Limits Littlester (H5)
Figure Number	A1.4e
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

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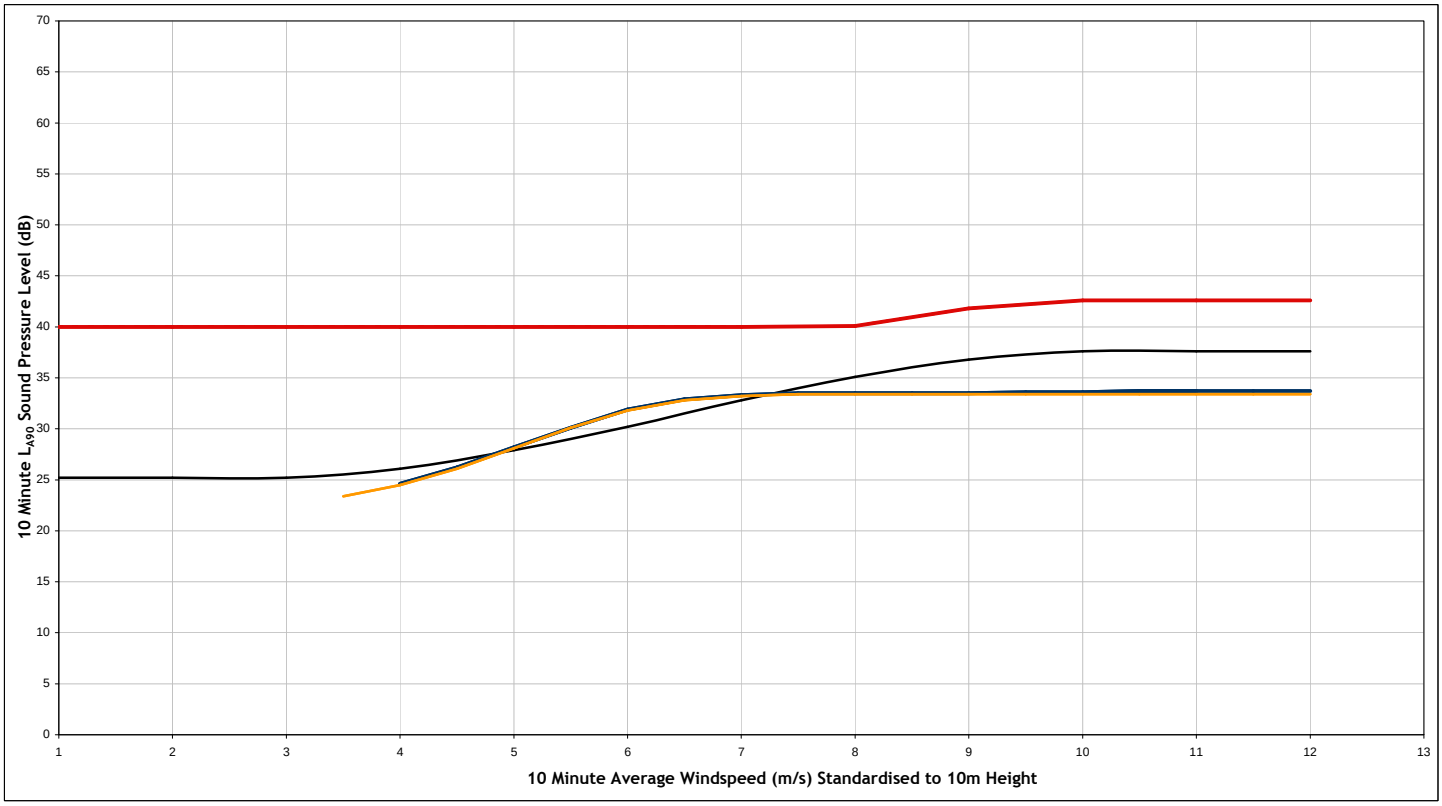
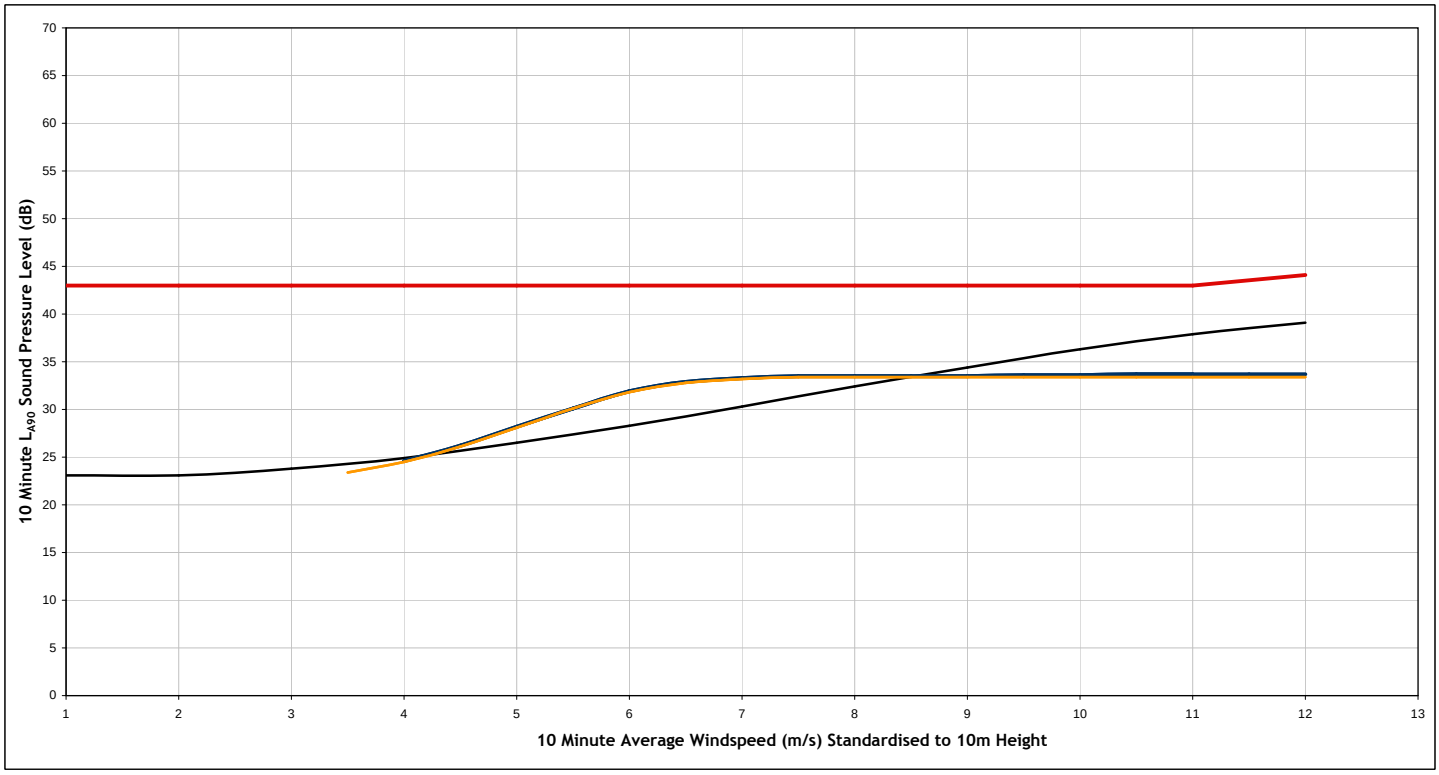
ETSU-R-97 QUIET DAYTIME - Hamnavoe (H6)



ETSU-R-97 NIGHT-TIME - Hamnavoe (H6)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- All Turbines
- Beaw Field Only - Senvion 3.4M

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Total Limits Hamnavoe (H6)
Figure Number	A1.4f
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

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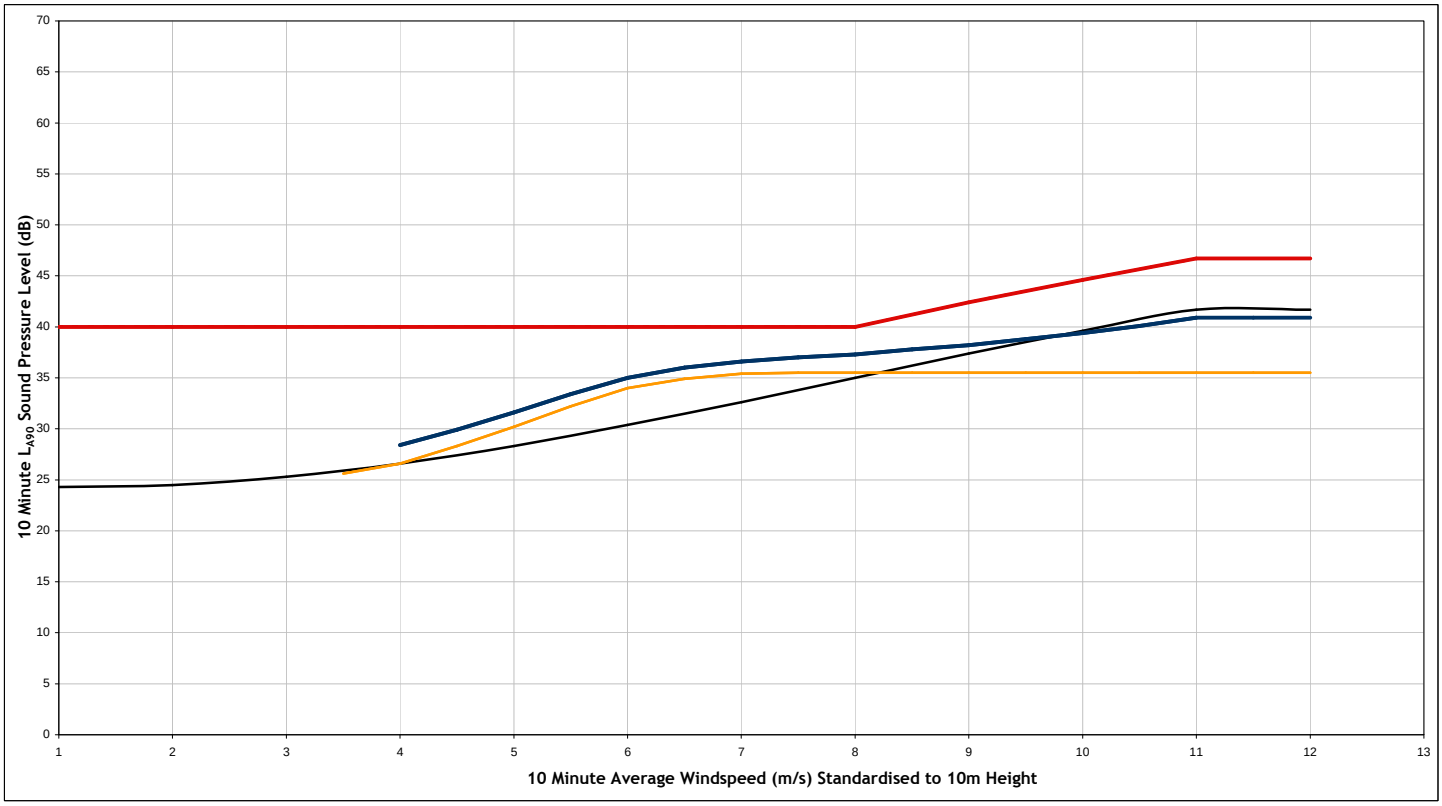
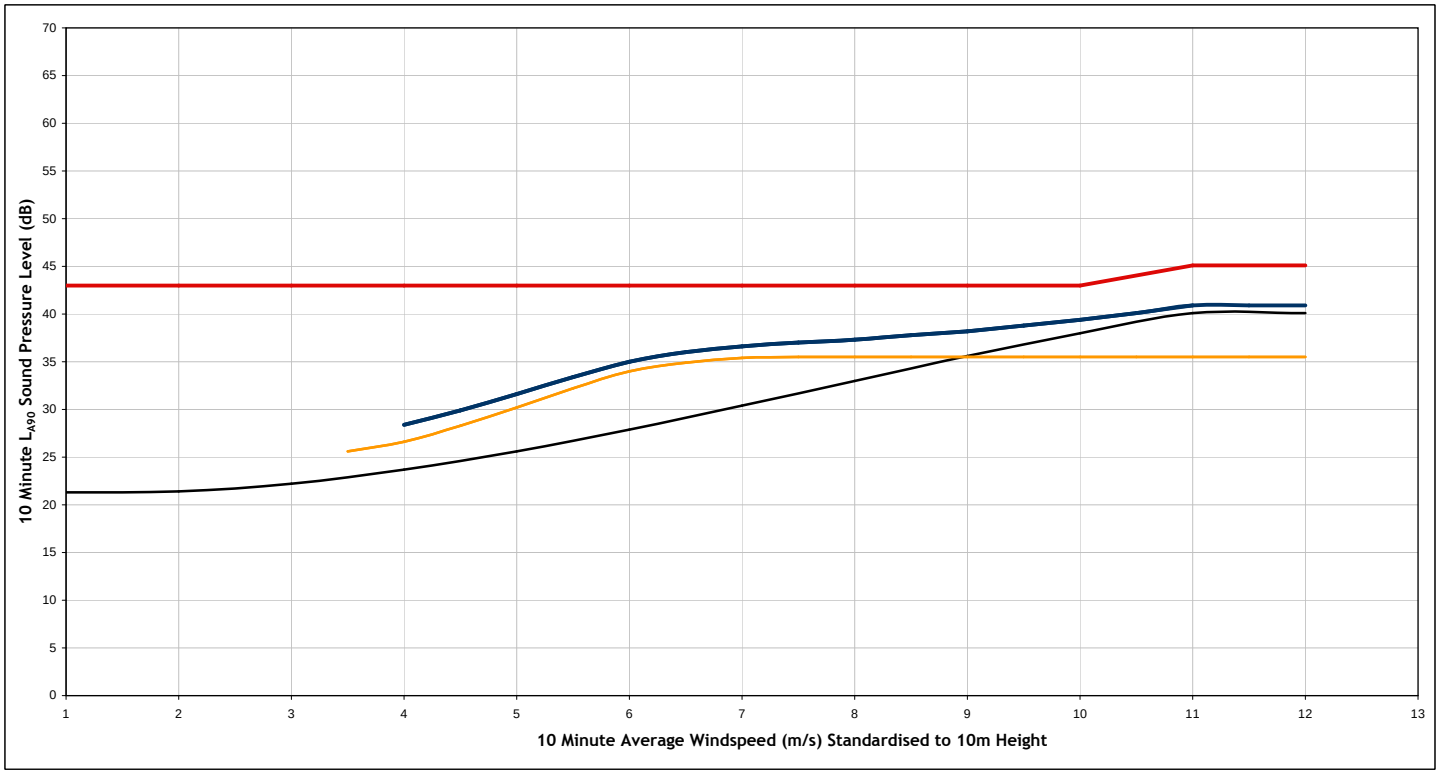
ETSU-R-97 QUIET DAYTIME - Helnaquhida (H7)



ETSU-R-97 NIGHT-TIME - Helnaquhida (H7)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- All Turbines
- Beaw Field Only - Senvion 3.4M

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Total Limits Helnaquhida (H7)
Figure Number	A1.4g
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

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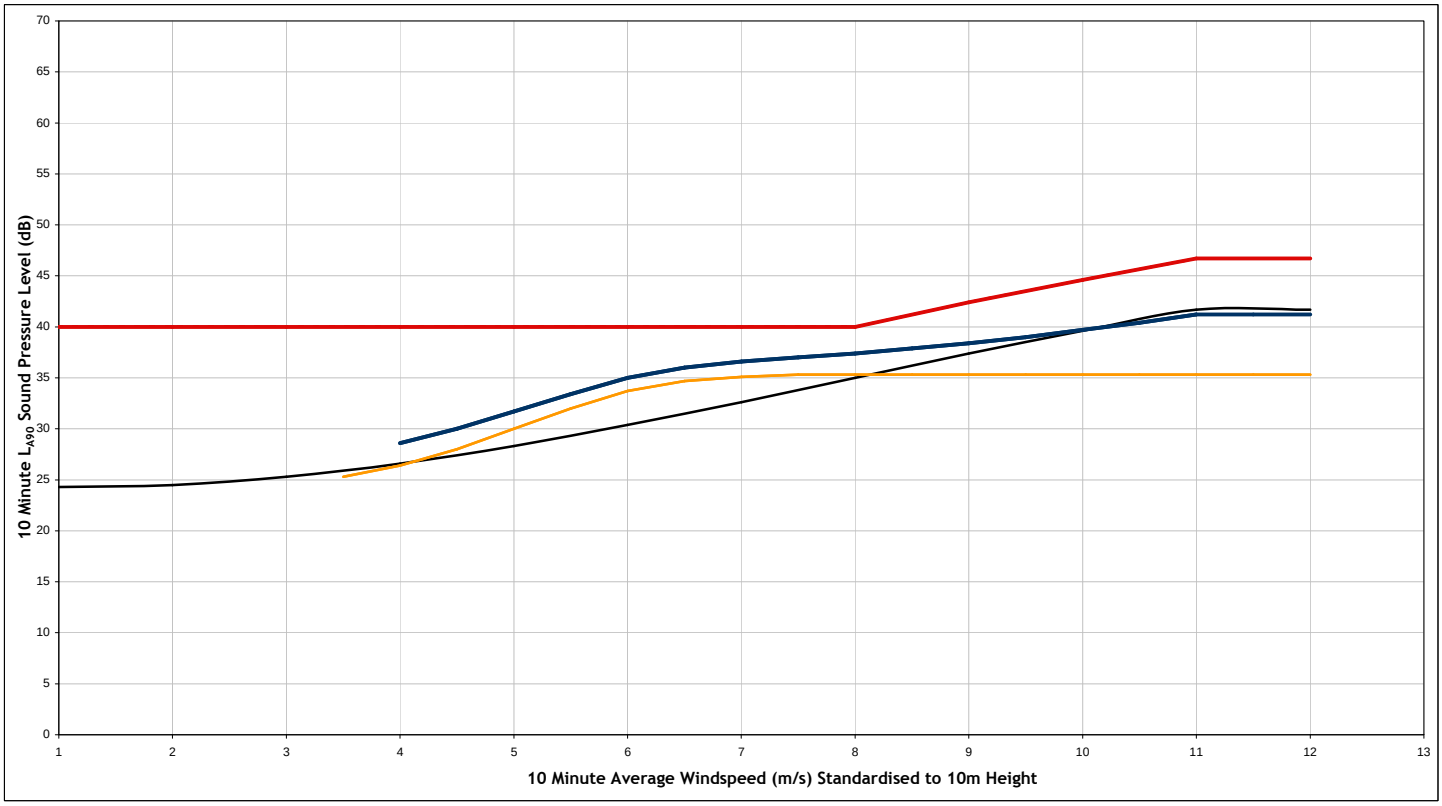
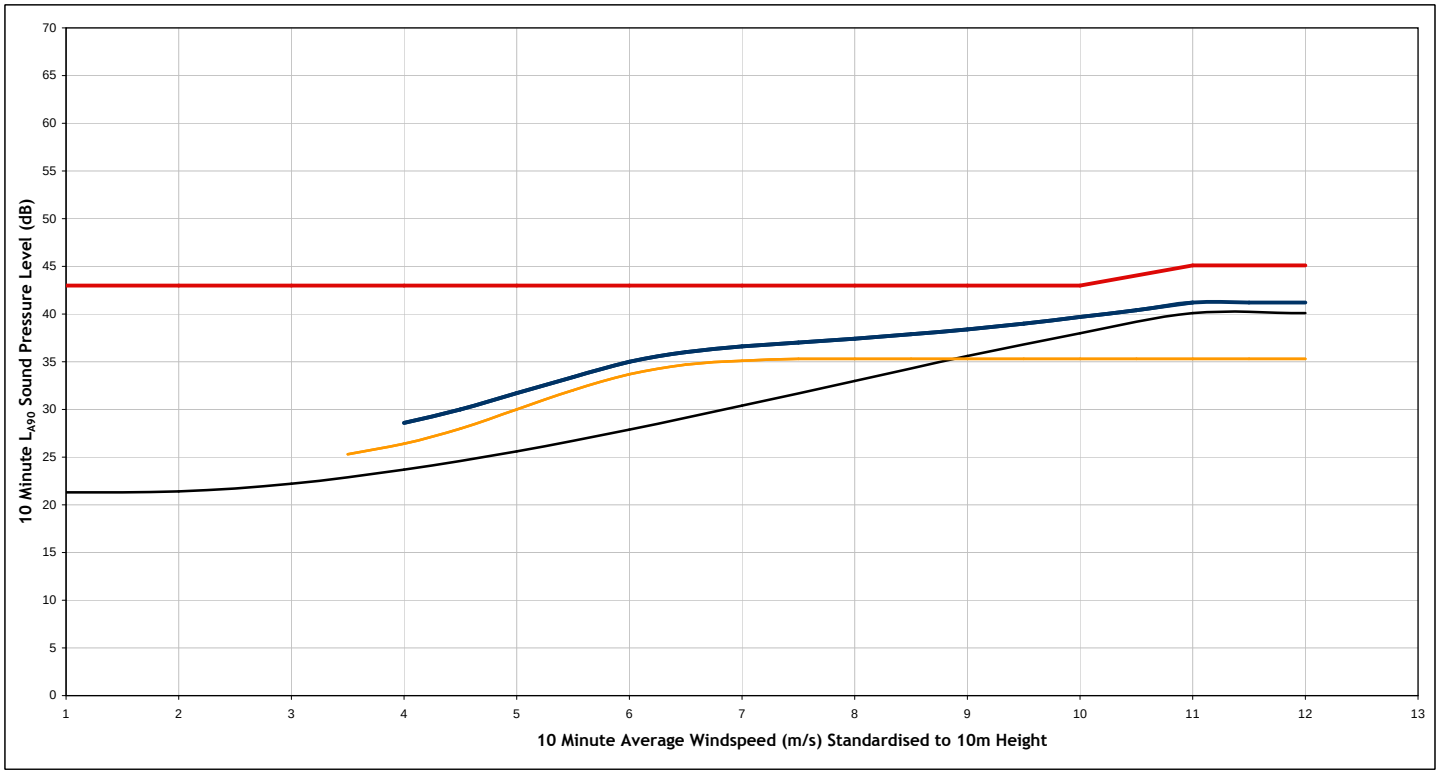
ETSU-R-97 QUIET DAYTIME - Kettlester (H8)



ETSU-R-97 NIGHT-TIME - Kettlester (H8)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- All Turbines
- Beaw Field Only - Senvion 3.4M

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Total Limits Kettlester (H8)
Figure Number	A1.4h
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

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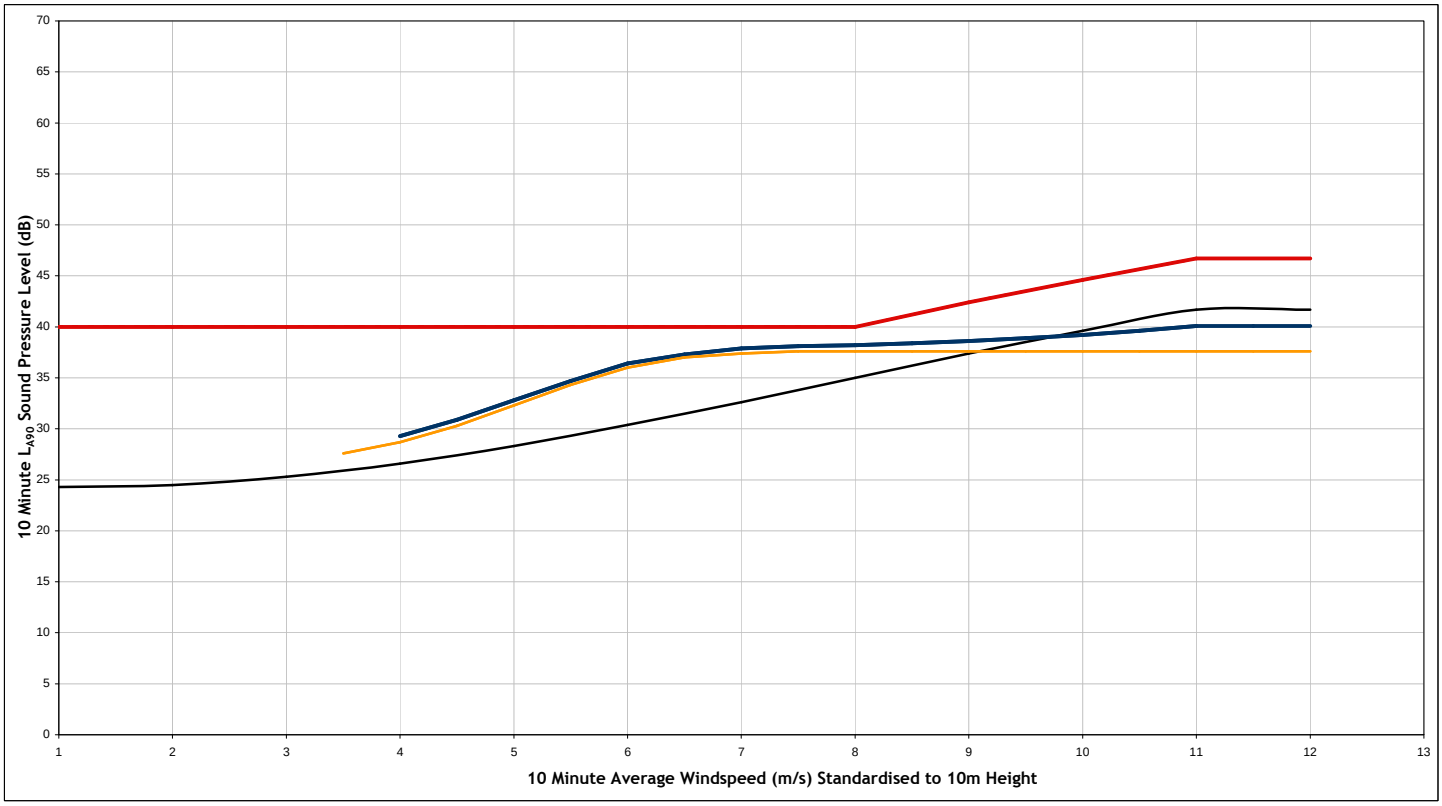
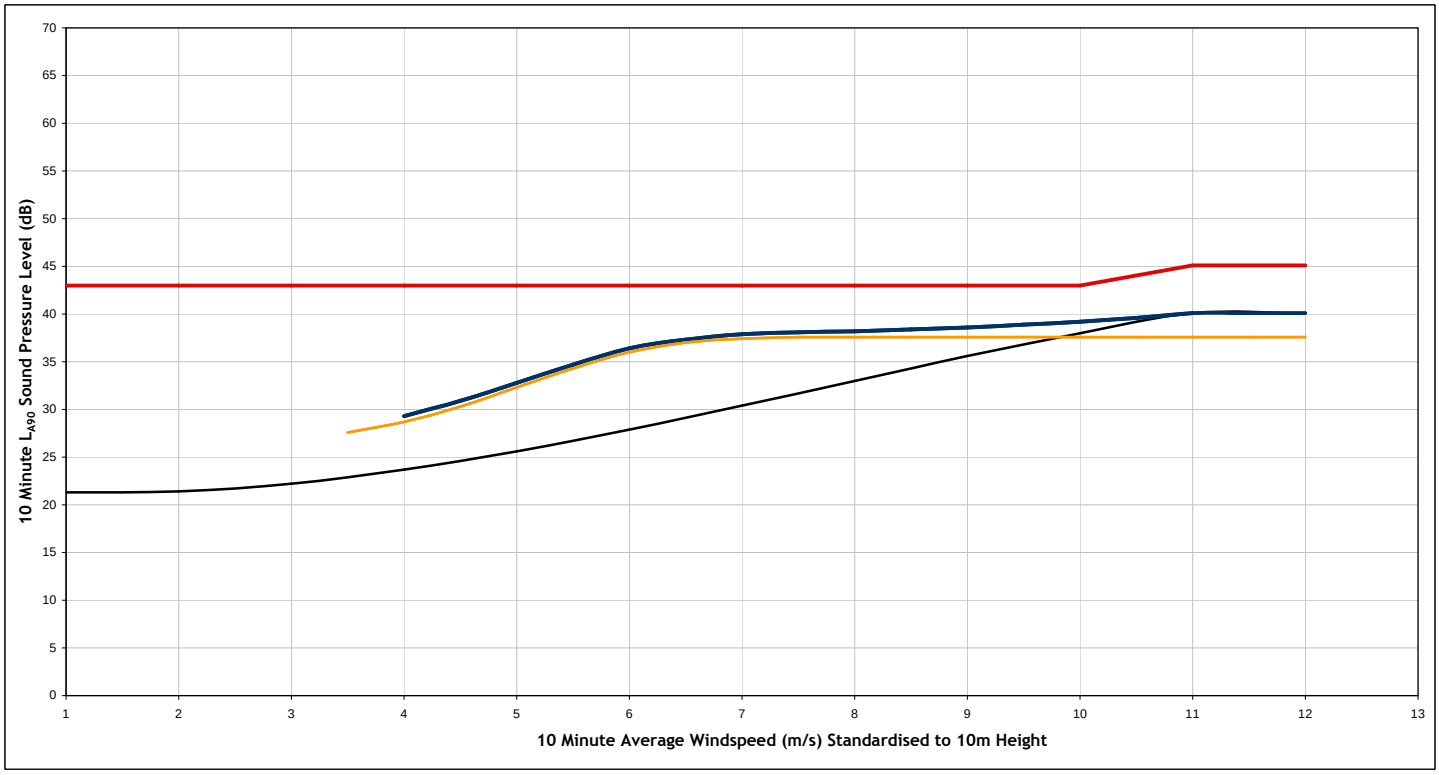
ETSU-R-97 QUIET DAYTIME - Islesview (H9)



ETSU-R-97 NIGHT-TIME - Islesview (H9)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- All Turbines
- Beaw Field Only - Senvion 3.4M

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Total Limits Islesview (H9)
Figure Number	A1.4i
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

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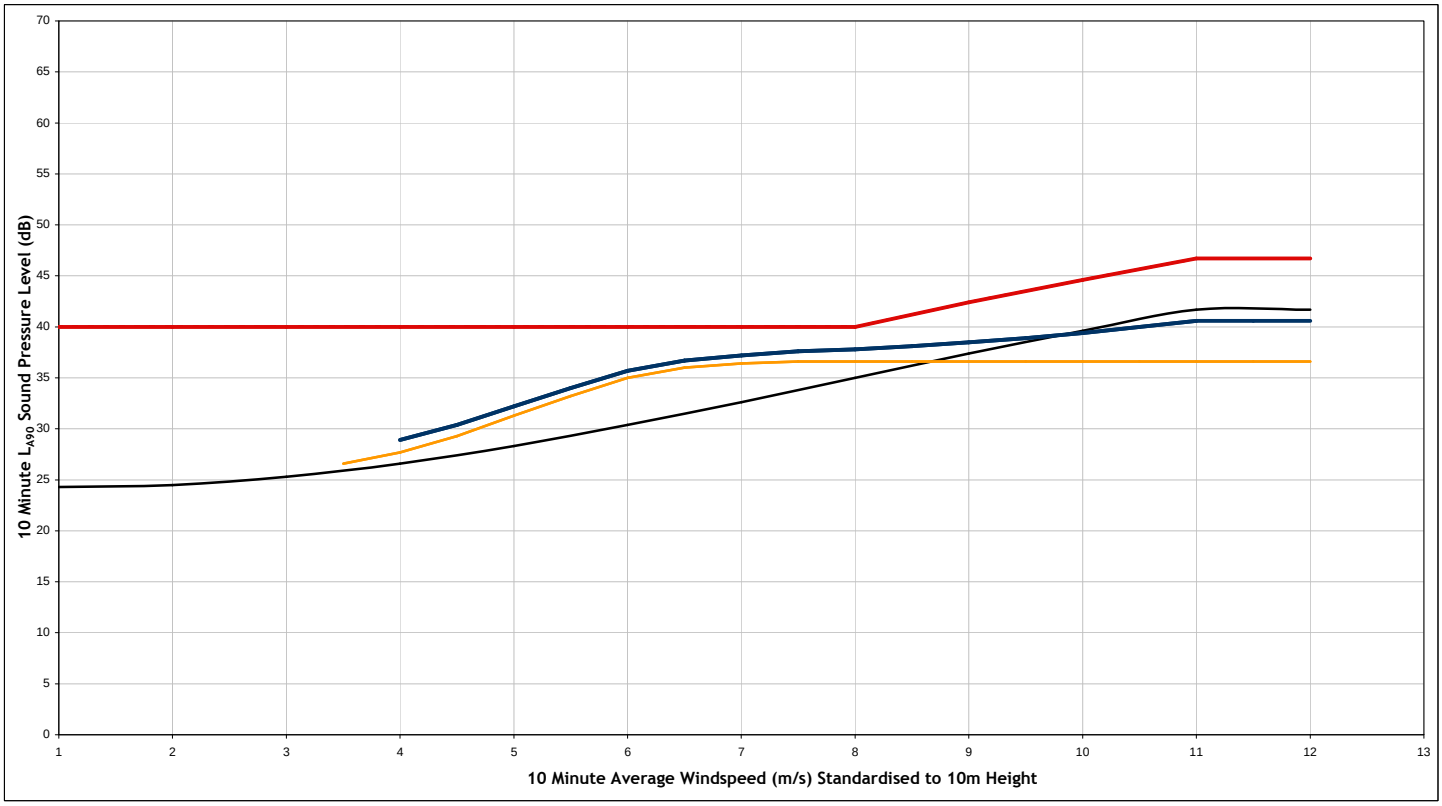
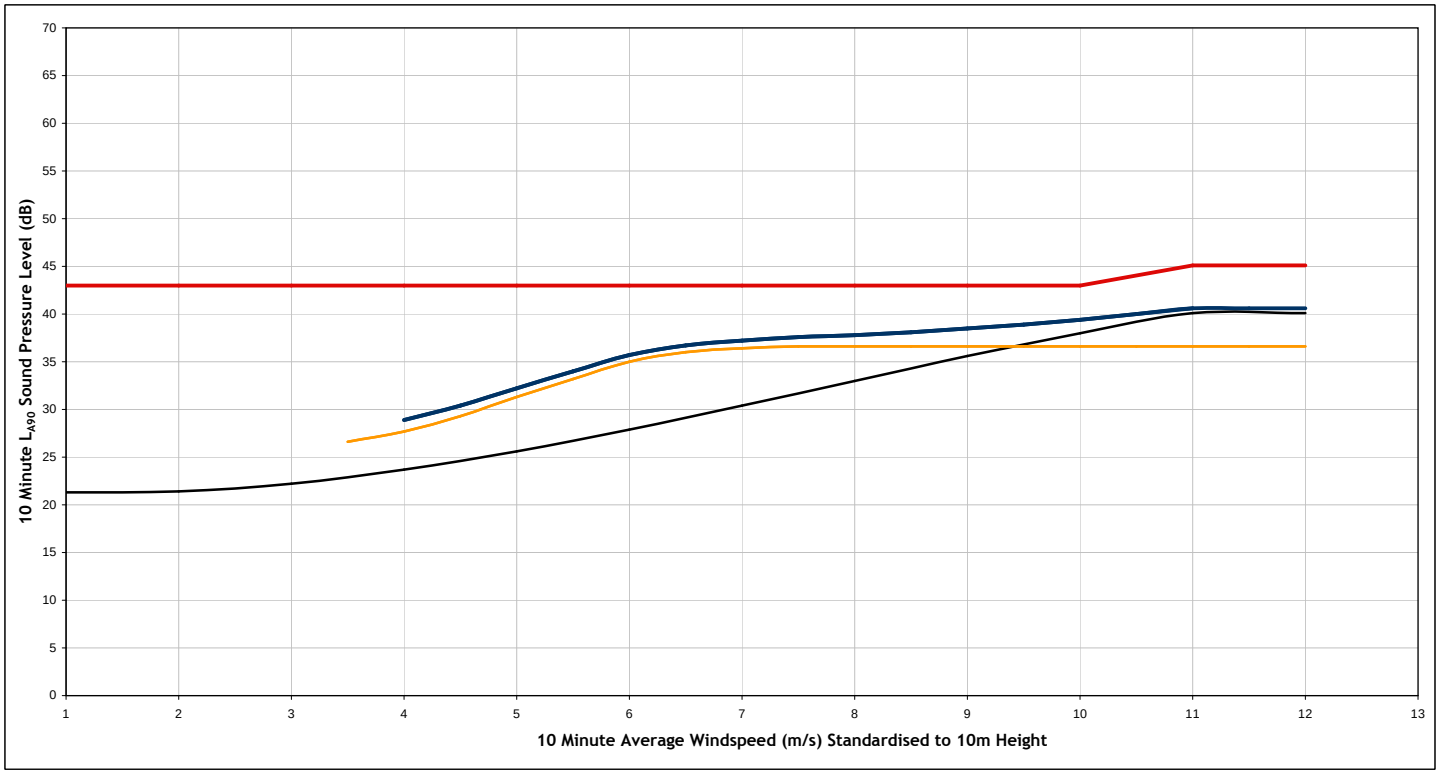
ETSU-R-97 QUIET DAYTIME - Westerlee (H10)



ETSU-R-97 NIGHT-TIME - Westerlee (H10)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- All Turbines
- Beaw Field Only - Senvion 3.4M

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Total Limits Westerlee (H10)
Figure Number	A1.4j
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

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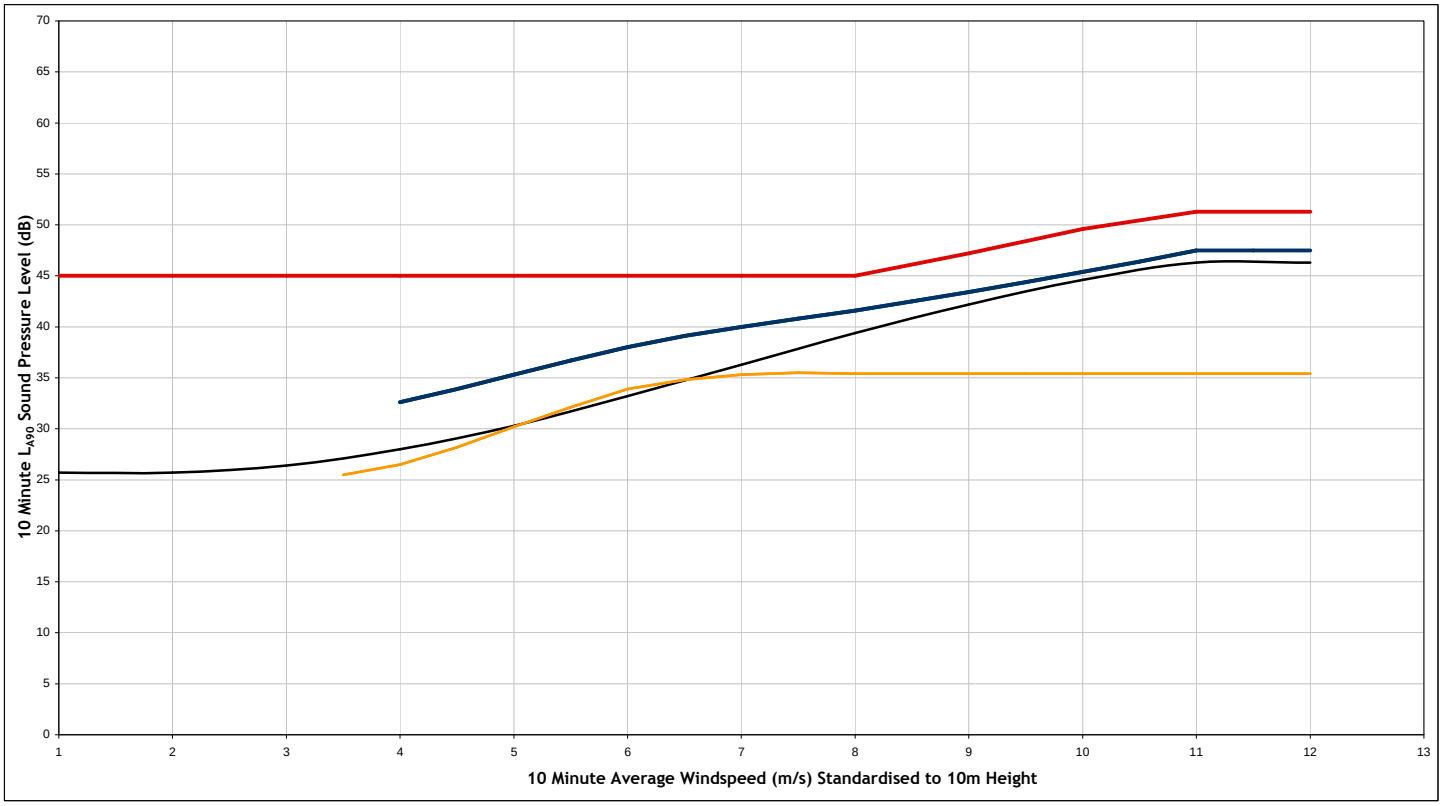
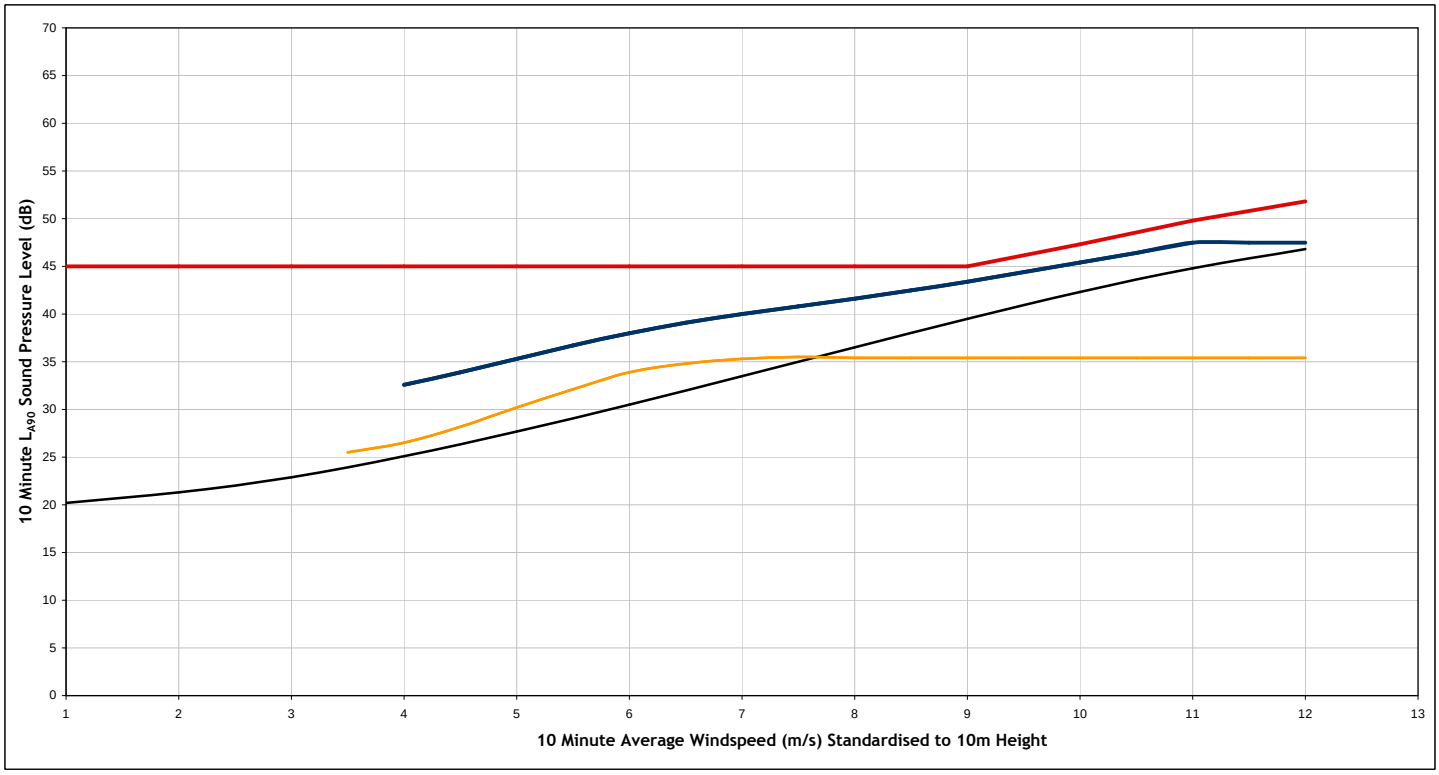
ETSU-R-97 QUIET DAYTIME - Kletterlea (H11)



ETSU-R-97 NIGHT-TIME - Kletterlea (H11)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- All Turbines
- Beaw Field Only - Senvion 3.4M

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Total Limits Kletterlea (H11)
Figure Number	A1.4k
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

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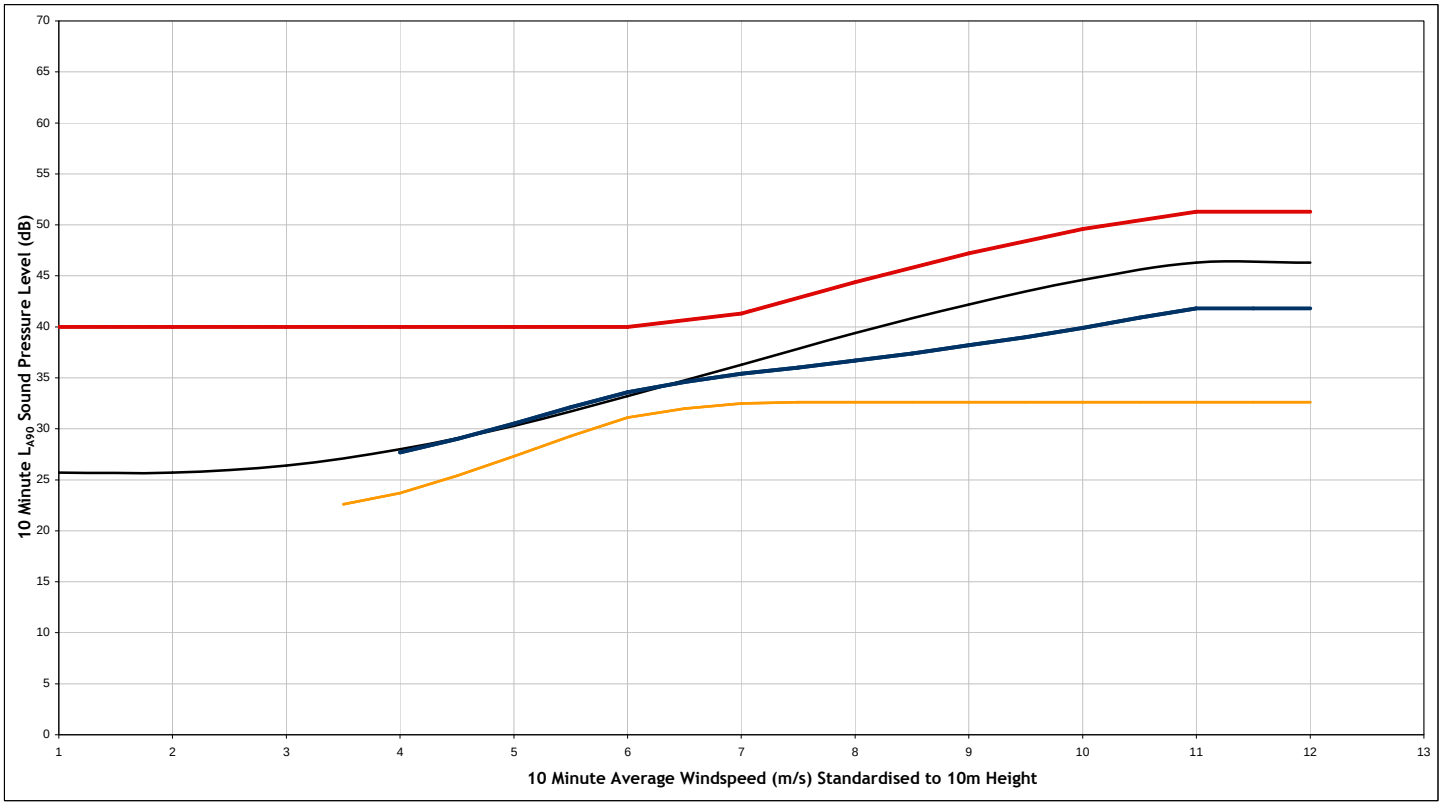
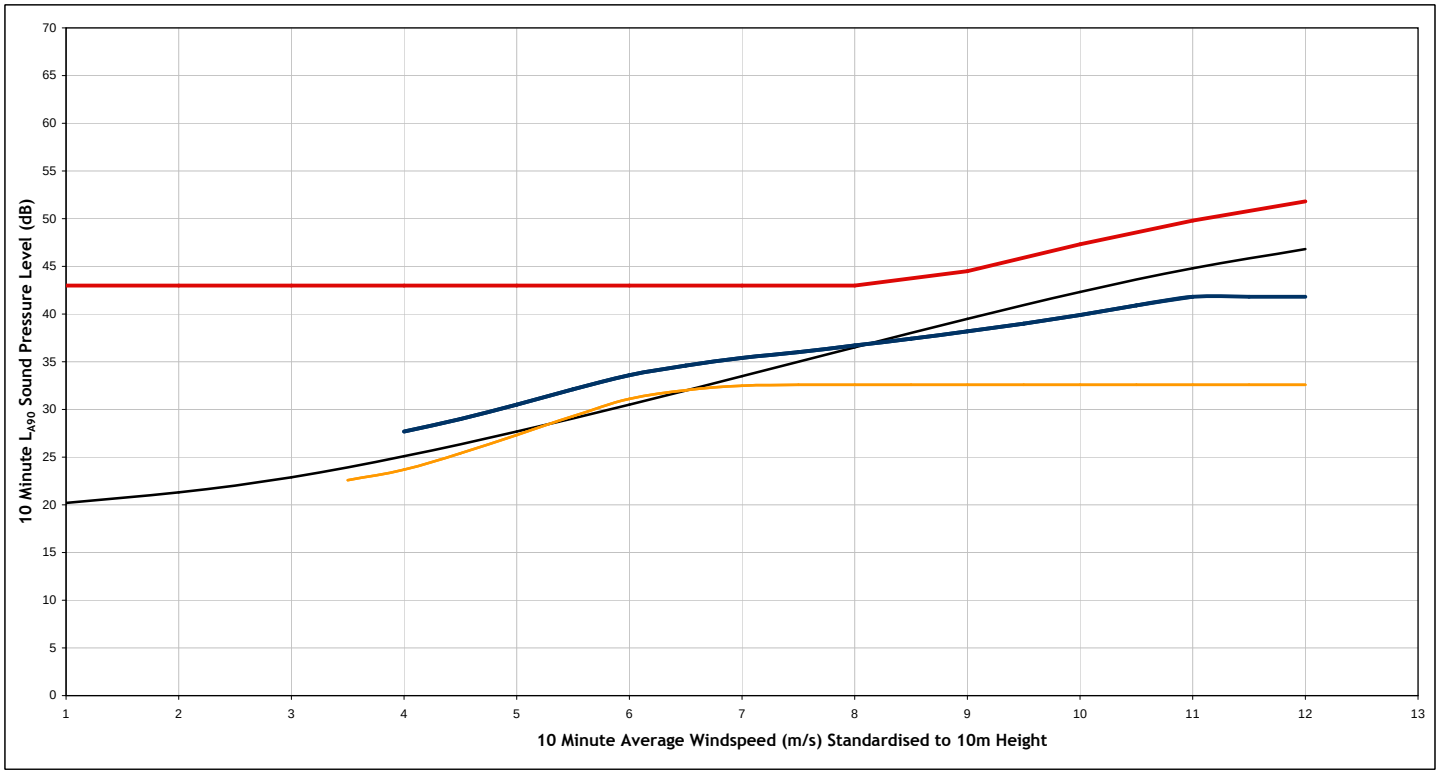
ETSU-R-97 QUIET DAYTIME - The School House (H12)



ETSU-R-97 NIGHT-TIME - The School House (H12)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- All Turbines
- Beaw Field Only - Senvion 3.4M

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Total Limits The School House (H12)
Figure Number	A1.4l
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

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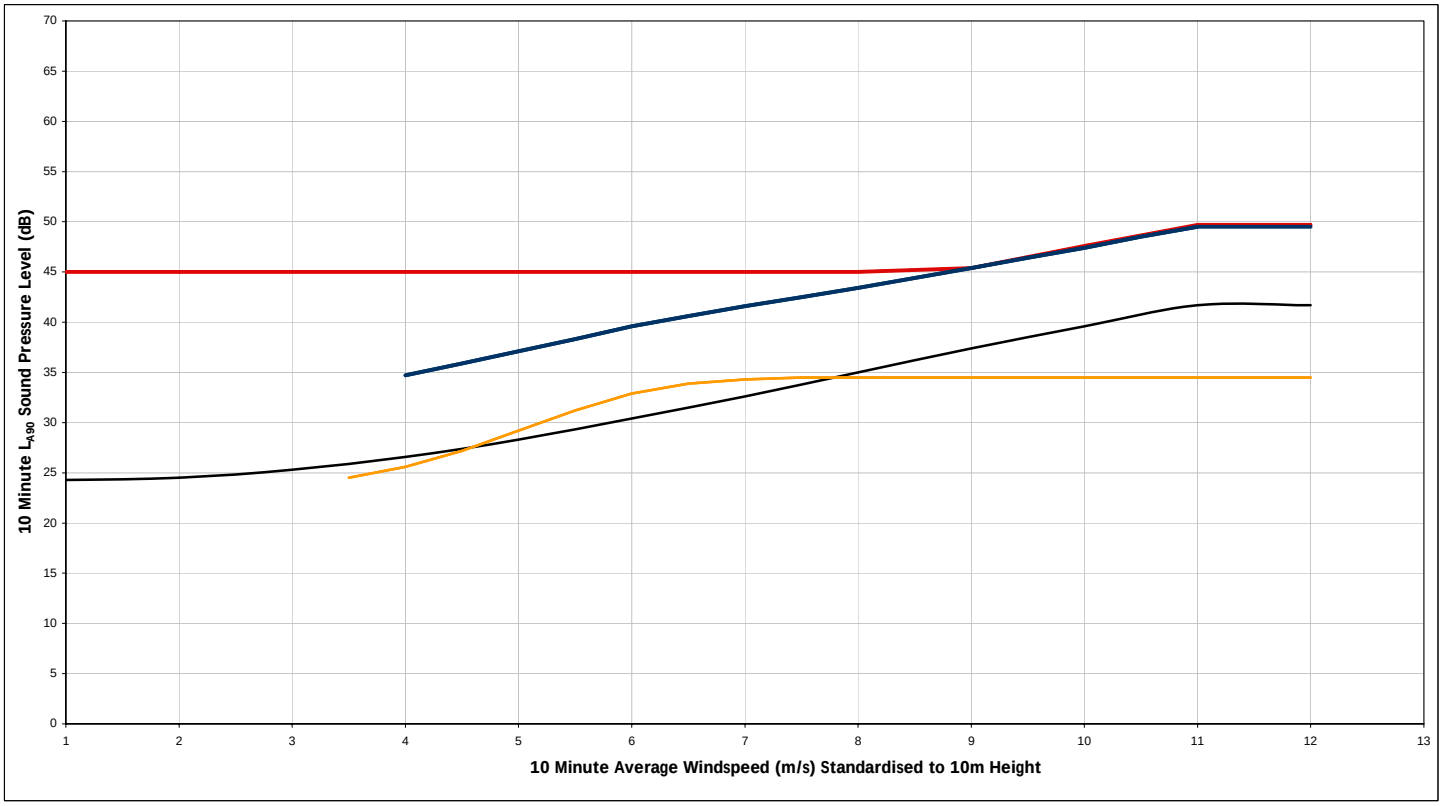
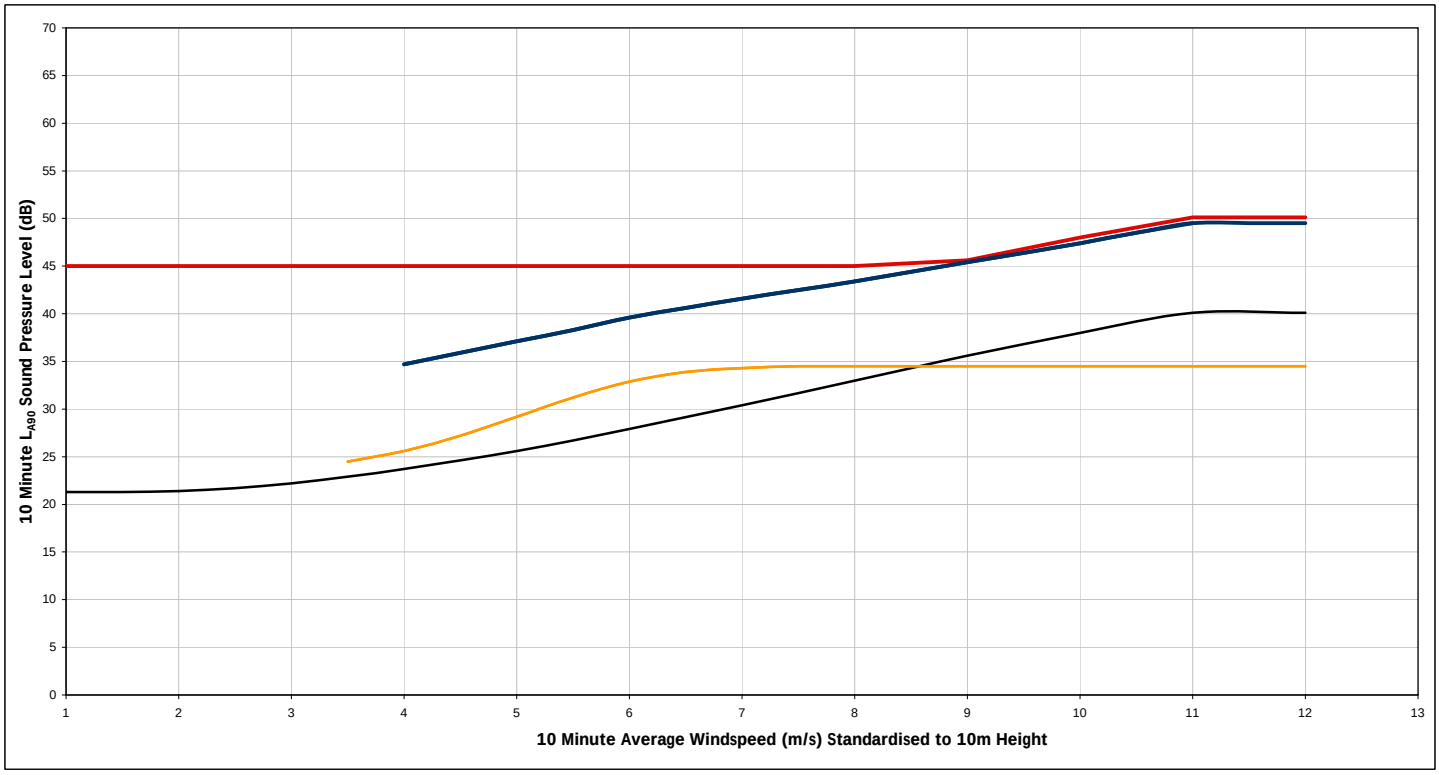
ETSU-R-97 QUIET DAYTIME - Cluness Cottage (H13)



ETSU-R-97 NIGHT-TIME - Cluness Cottage (H13)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- All Turbines
- Beaw Field Only - Senvion 3.4M

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Total Limits Cluness Cottage (H13)
Figure Number	A1.4m
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

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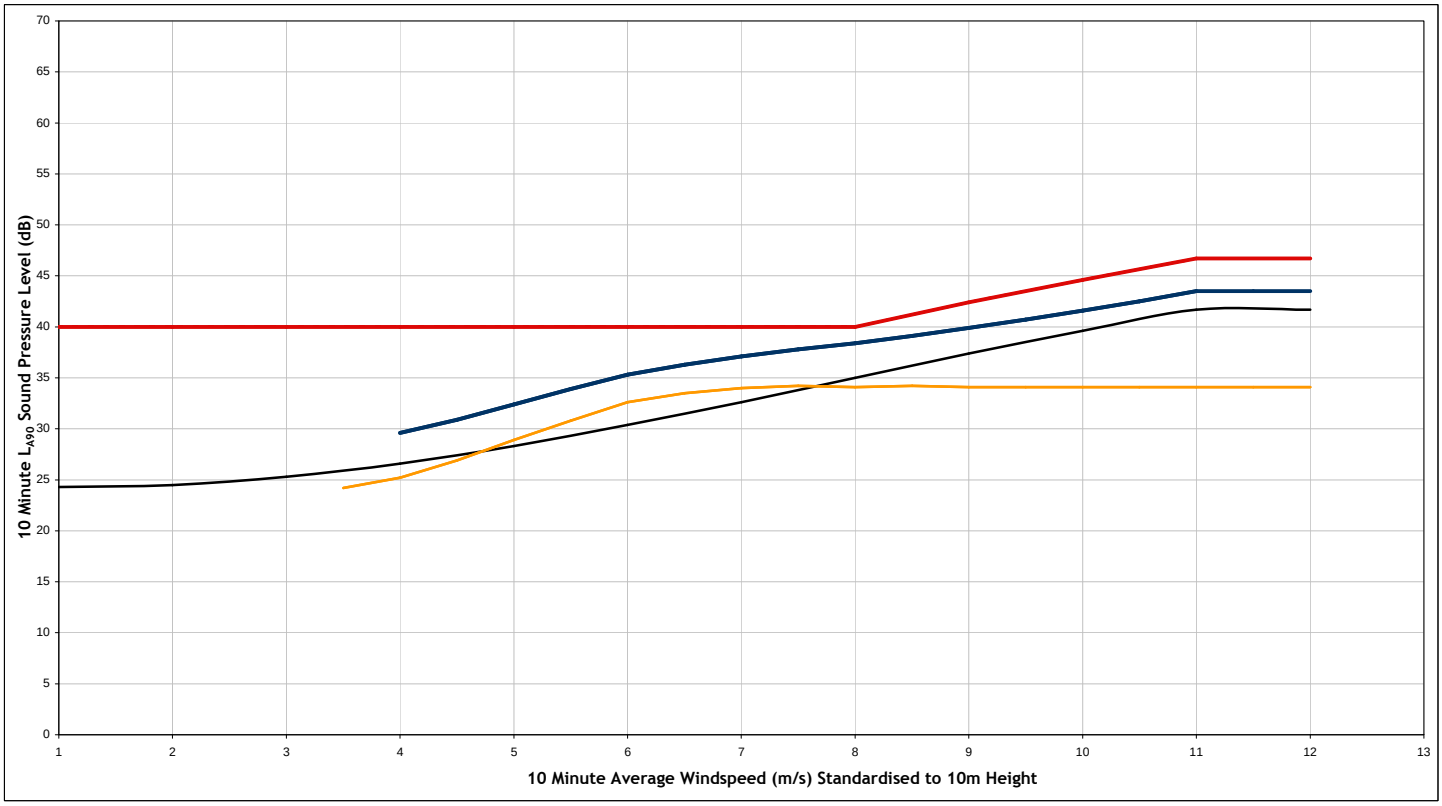
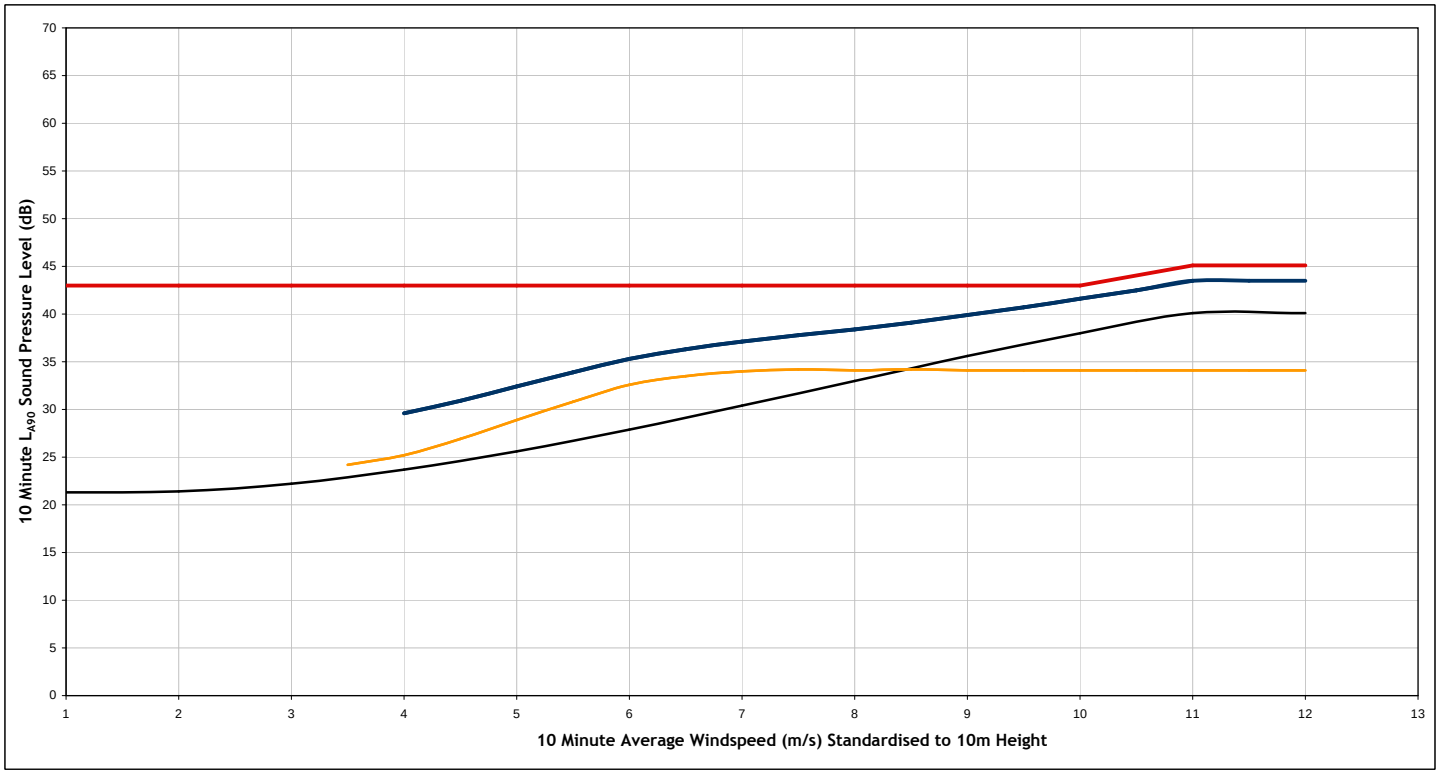
ETSU-R-97 QUIET DAYTIME - Staneygarth (H14)



ETSU-R-97 NIGHT-TIME - Staneygarth (H14)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- All Turbines
- Beaw Field Only - Senvion 3.4M

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Total Limits Staneygarth (H14)
Figure Number	A1.4n
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

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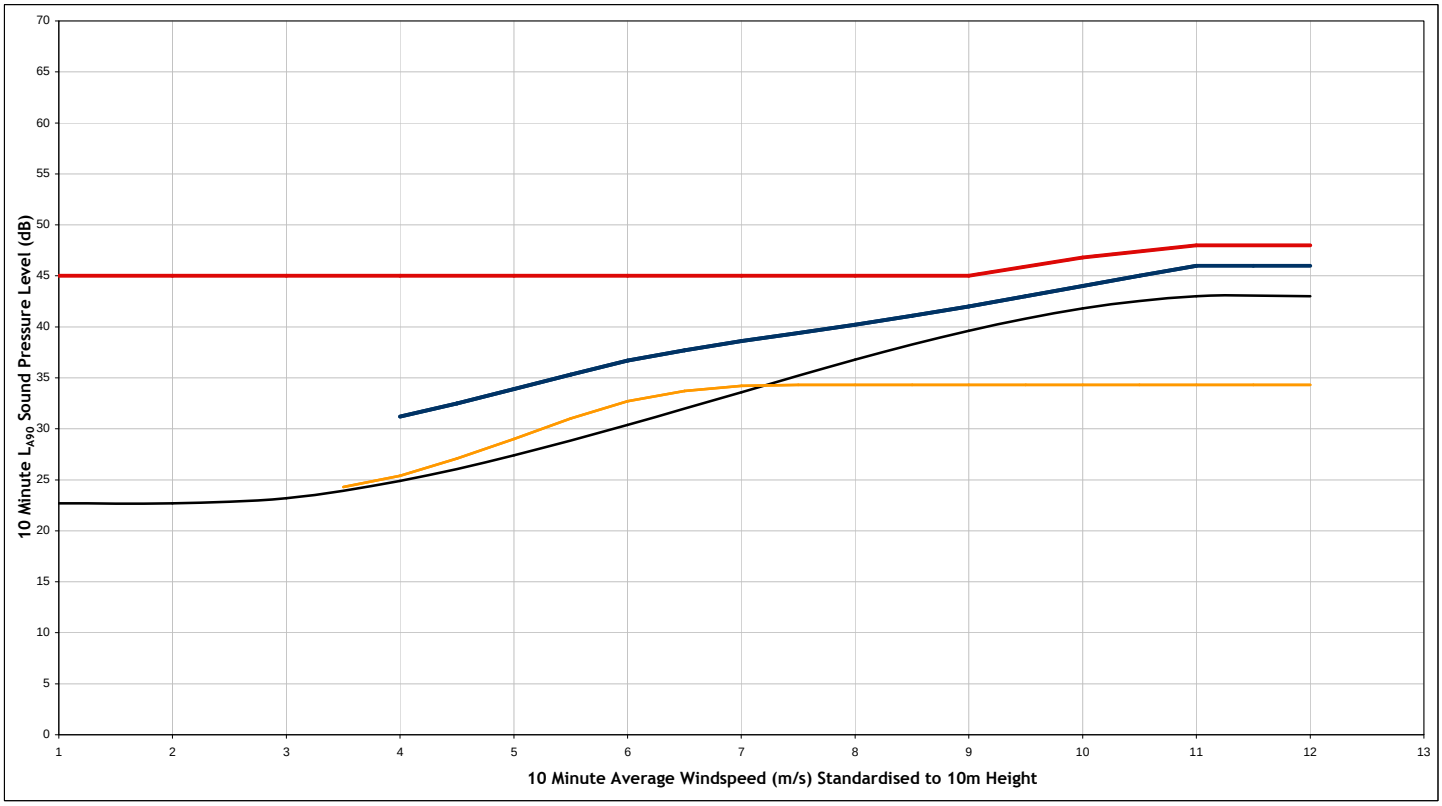
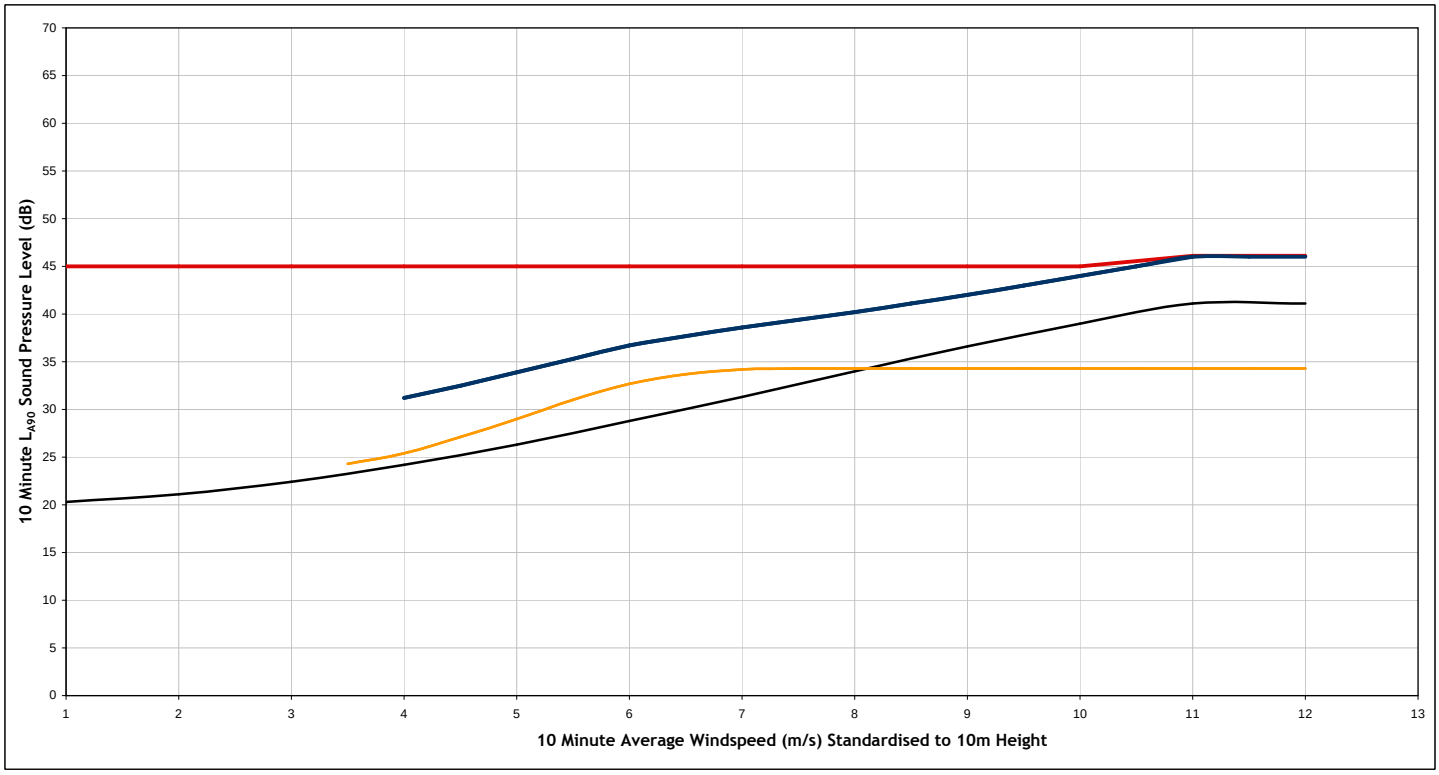
ETSU-R-97 QUIET DAYTIME - Giggleswick (H15)



ETSU-R-97 NIGHT-TIME - Giggleswick (H15)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- All Turbines
- Beaw Field Only - Senvion 3.4M

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Total Limits Giggleswick (H15)
Figure Number	A1.4o
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

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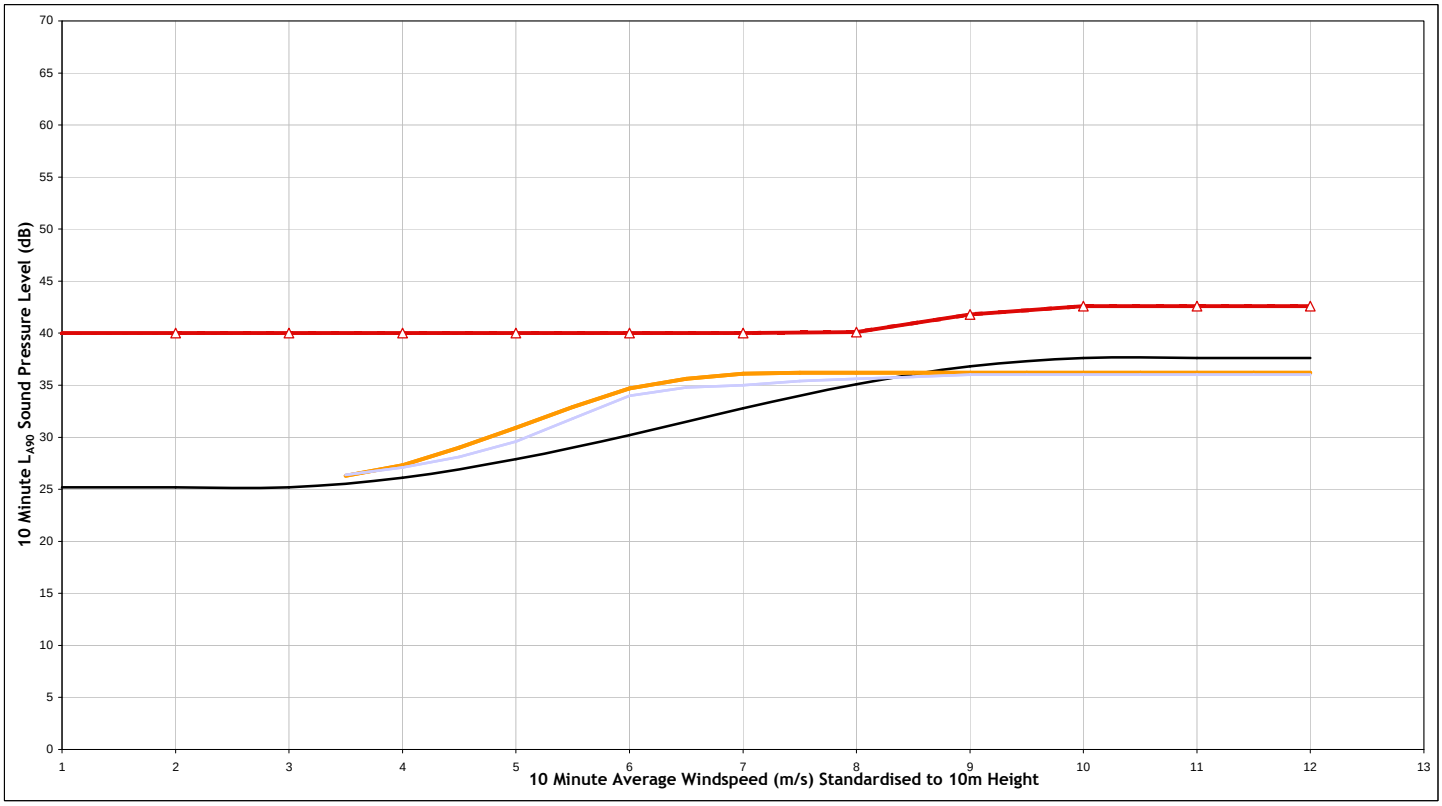
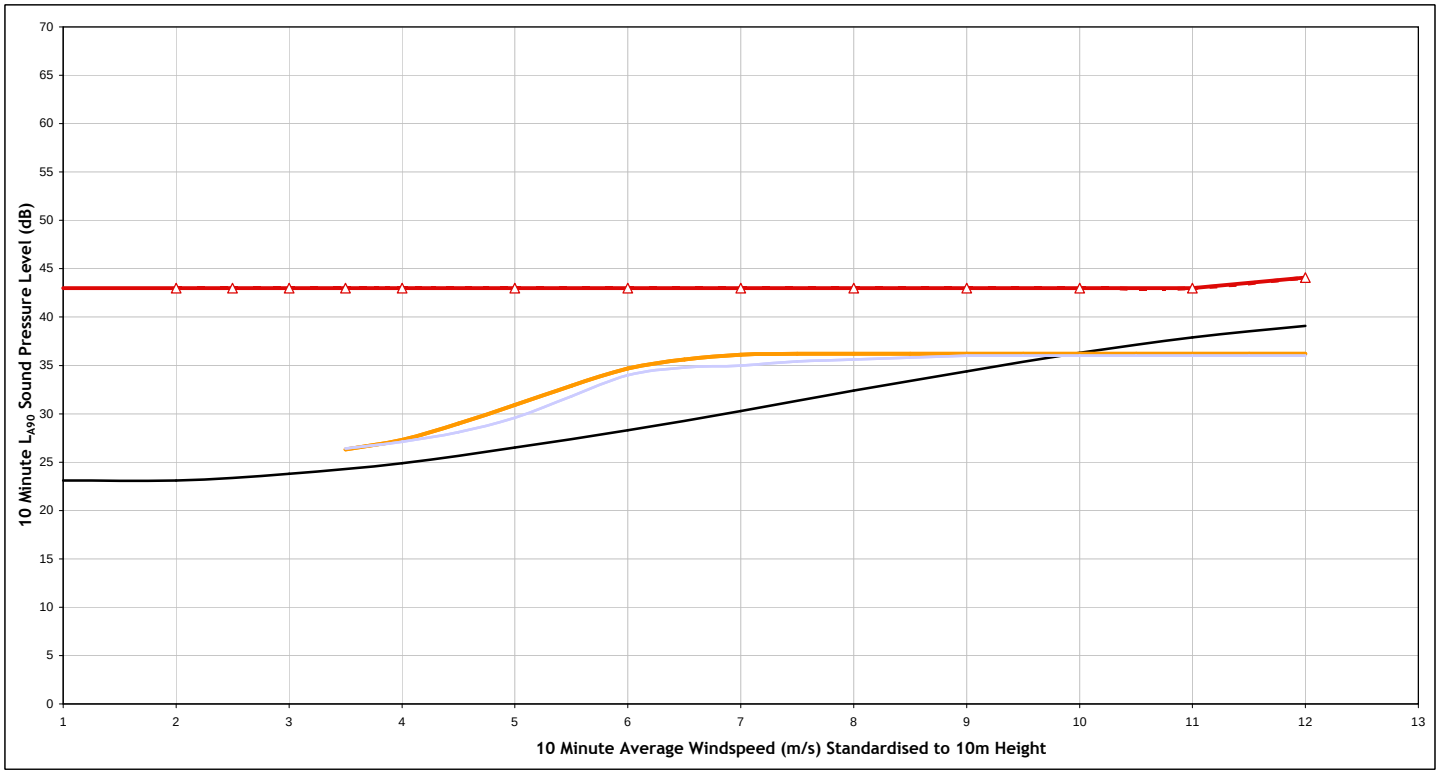
ETSU-R-97 QUIET DAYTIME - Lower Holligarth (H1)



ETSU-R-97 NIGHT-TIME - Lower Holligarth (H1)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- Beaw Field Site Specific Limit
- Beaw Field Only - Senvion 3.4M
- Beaw Field Only - Nordex N100

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Specific Limits Lower Holligarth (H1)
Figure Number	A1.5a
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

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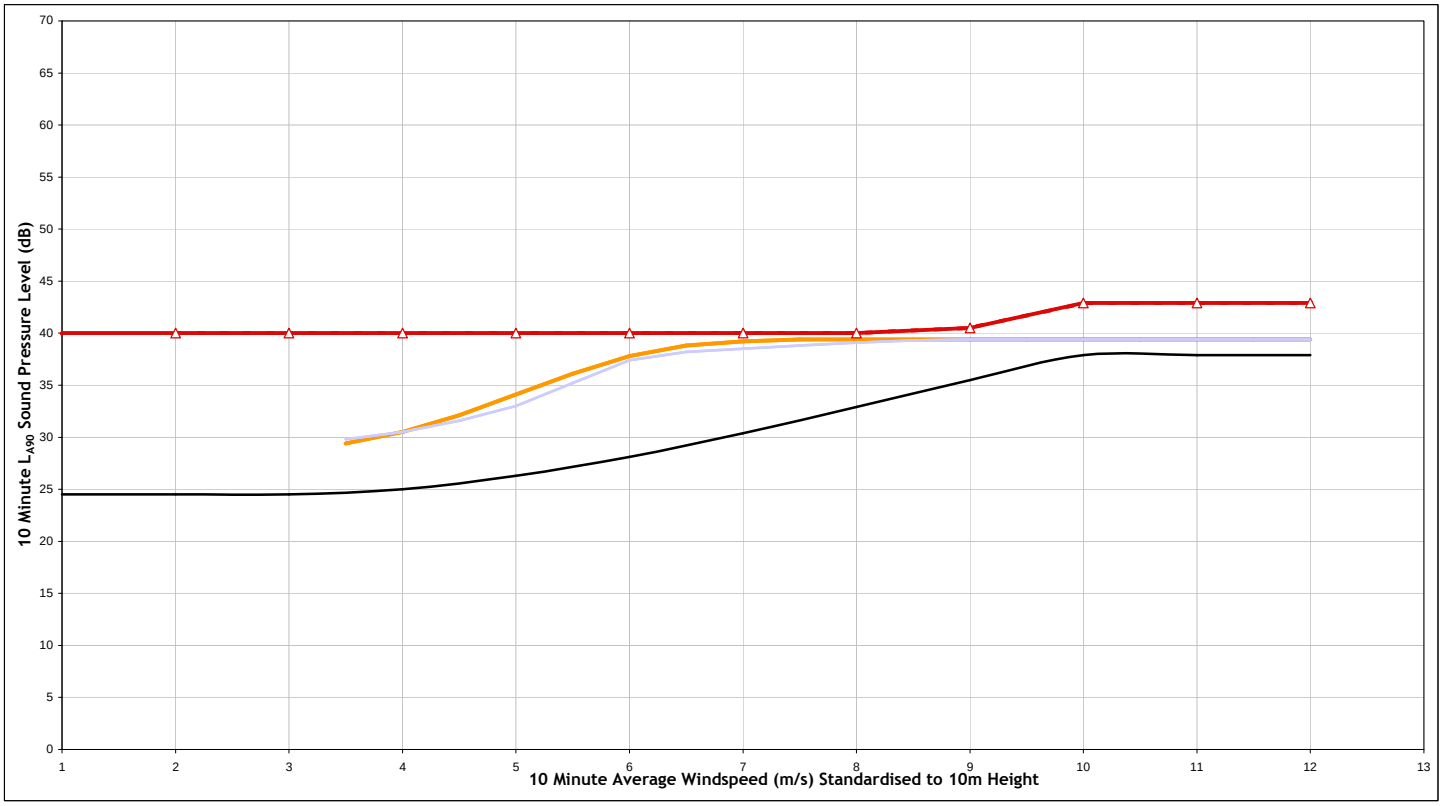
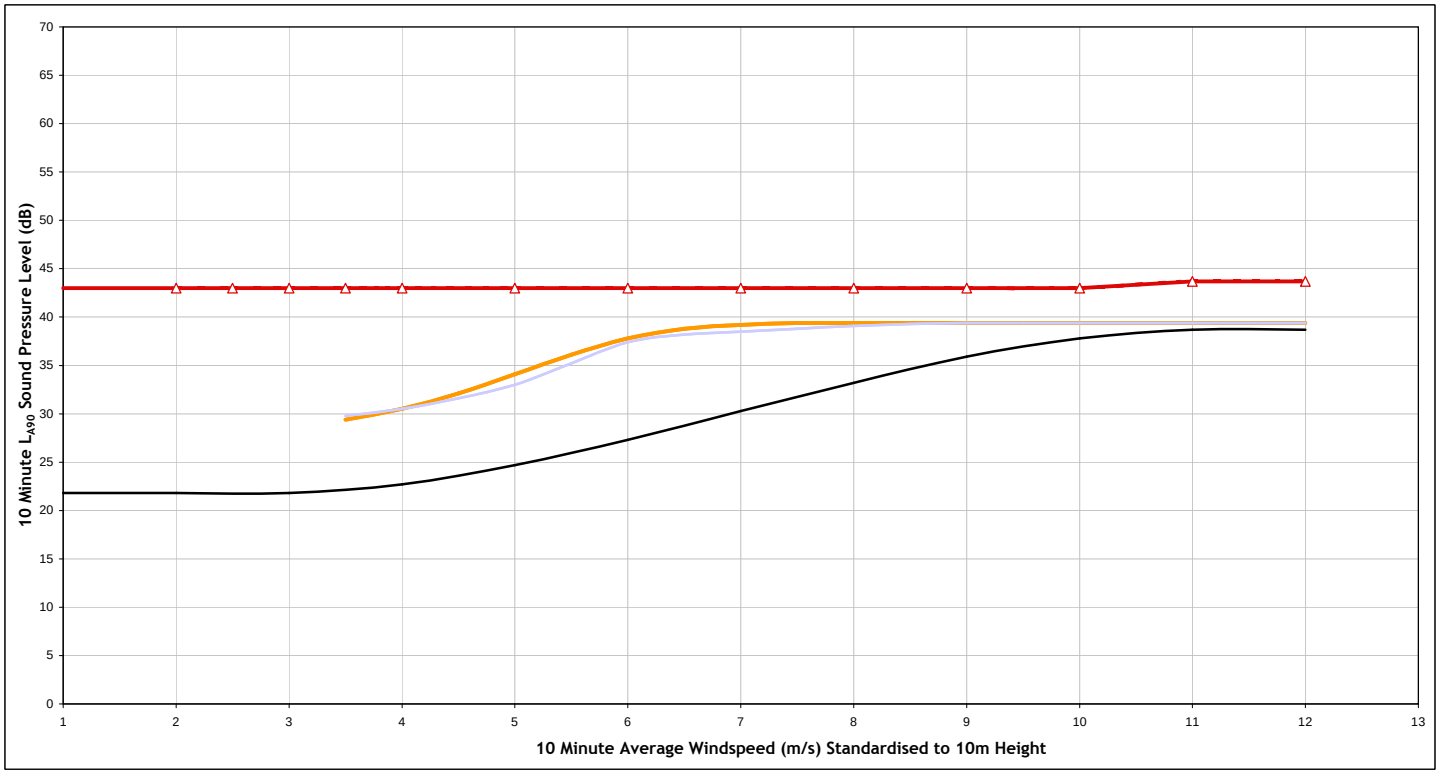
ETSU-R-97 QUIET DAYTIME - Whirliegarth (H2)



ETSU-R-97 NIGHT-TIME - Whirliegarth (H2)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- Beaw Field Site Specific Limit
- Beaw Field Only - Senvion 3.4M
- Beaw Field Only - Nordex N100

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Specific Limits Whirliegarth (H2)
Figure Number	A1.5b
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

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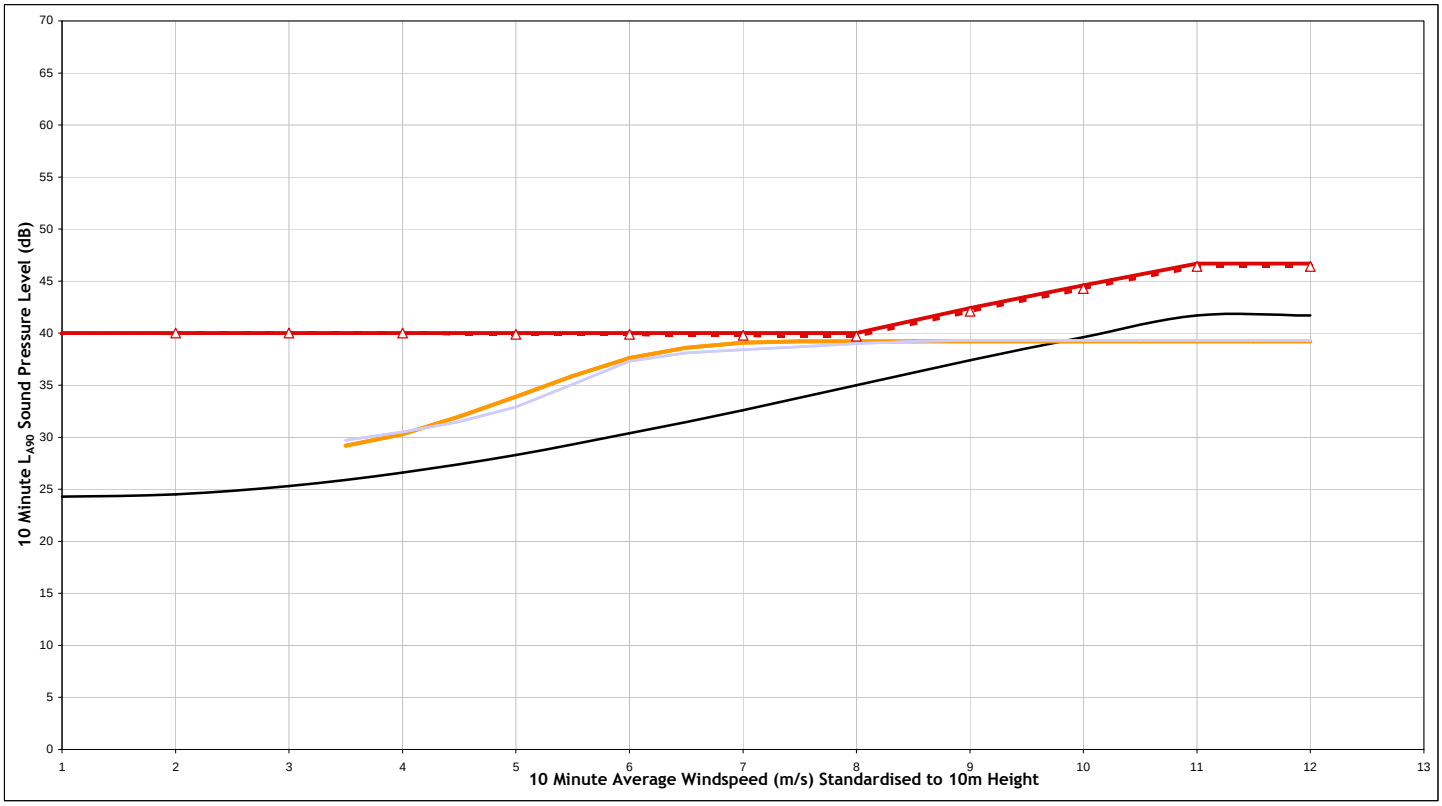
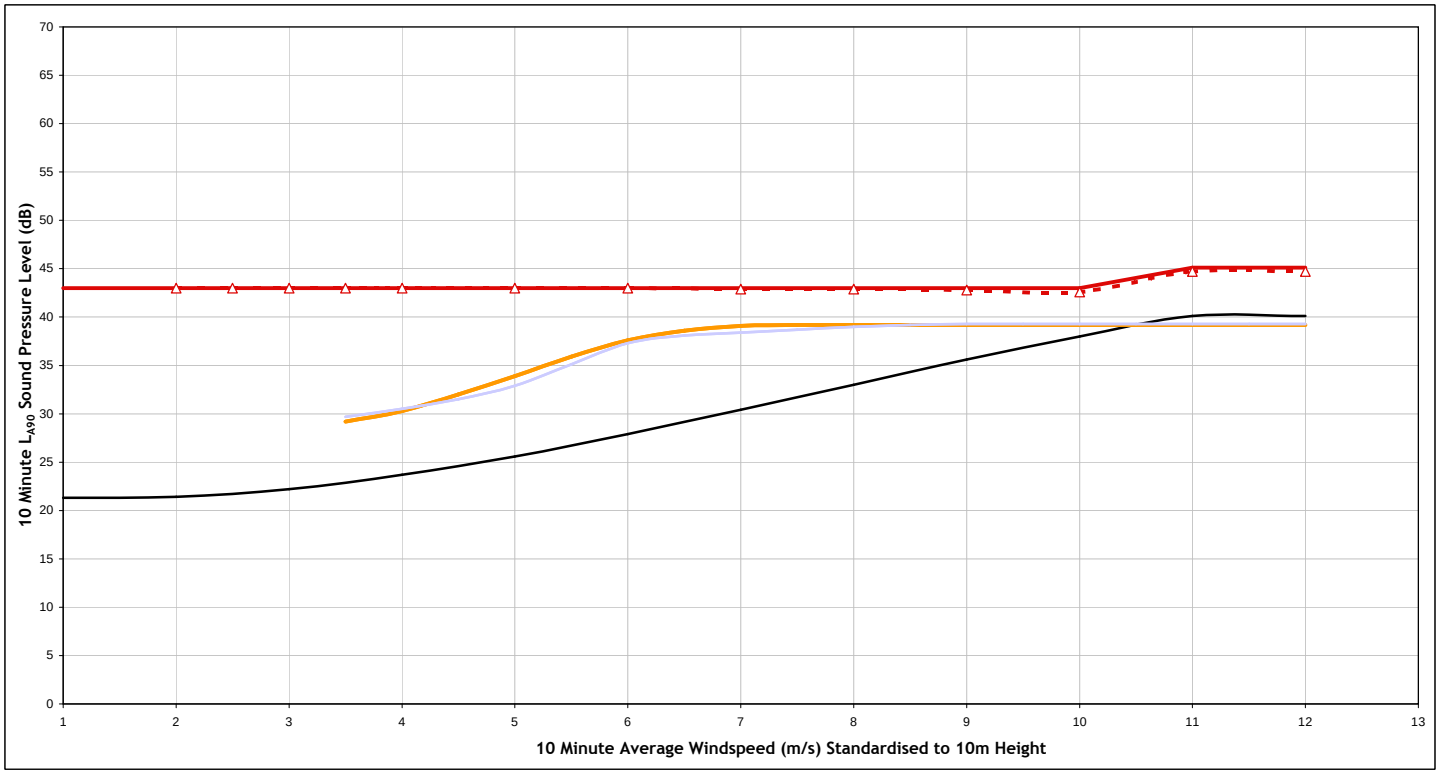
ETSU-R-97 QUIET DAYTIME - Easterlee (H3)



ETSU-R-97 NIGHT-TIME - Easterlee (H3)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- Beaw Field Site Specific Limit
- Beaw Field Only - Senvion 3.4M
- Beaw Field Only - Nordex N100

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Specific Limits Easterlee (H3)
Figure Number	A1.5c
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

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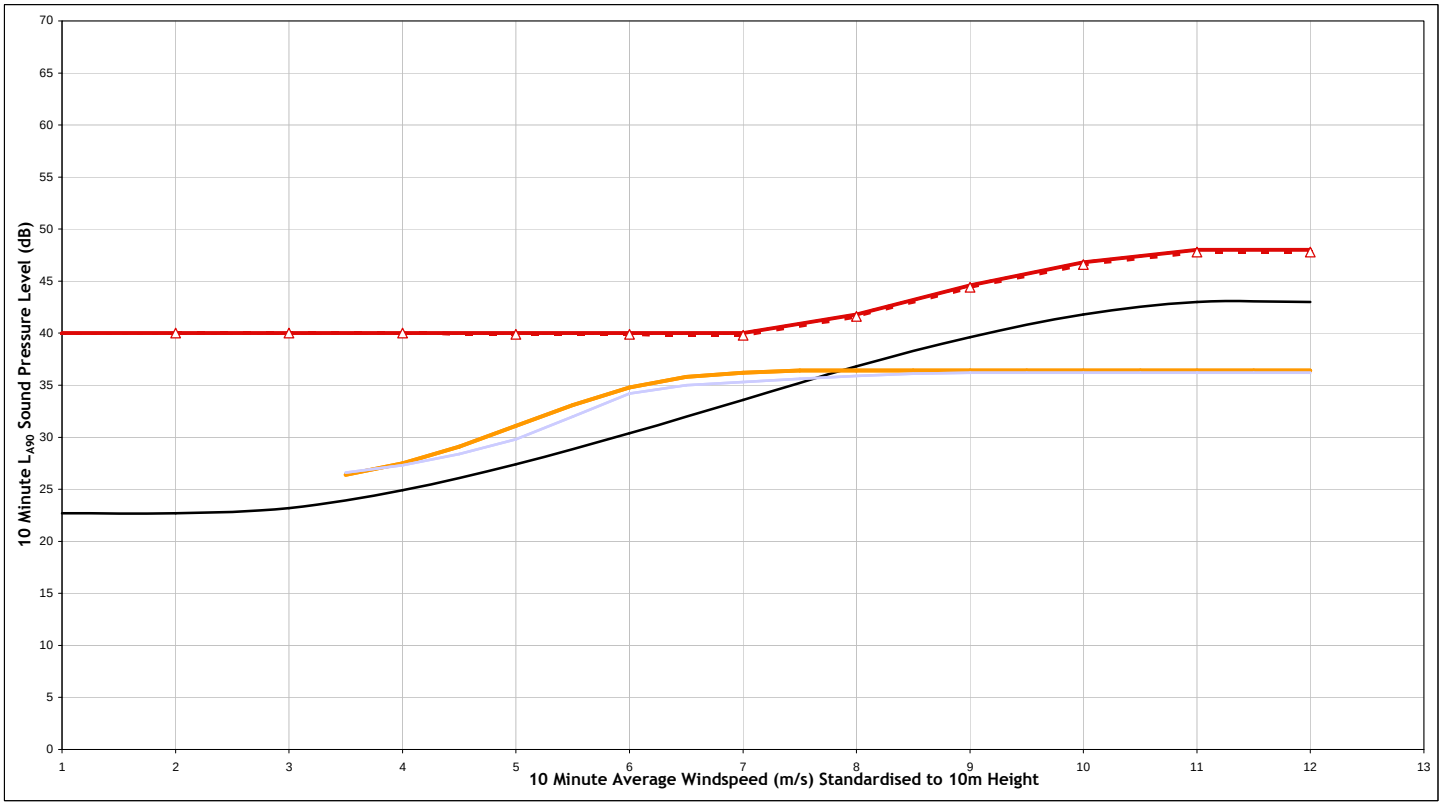
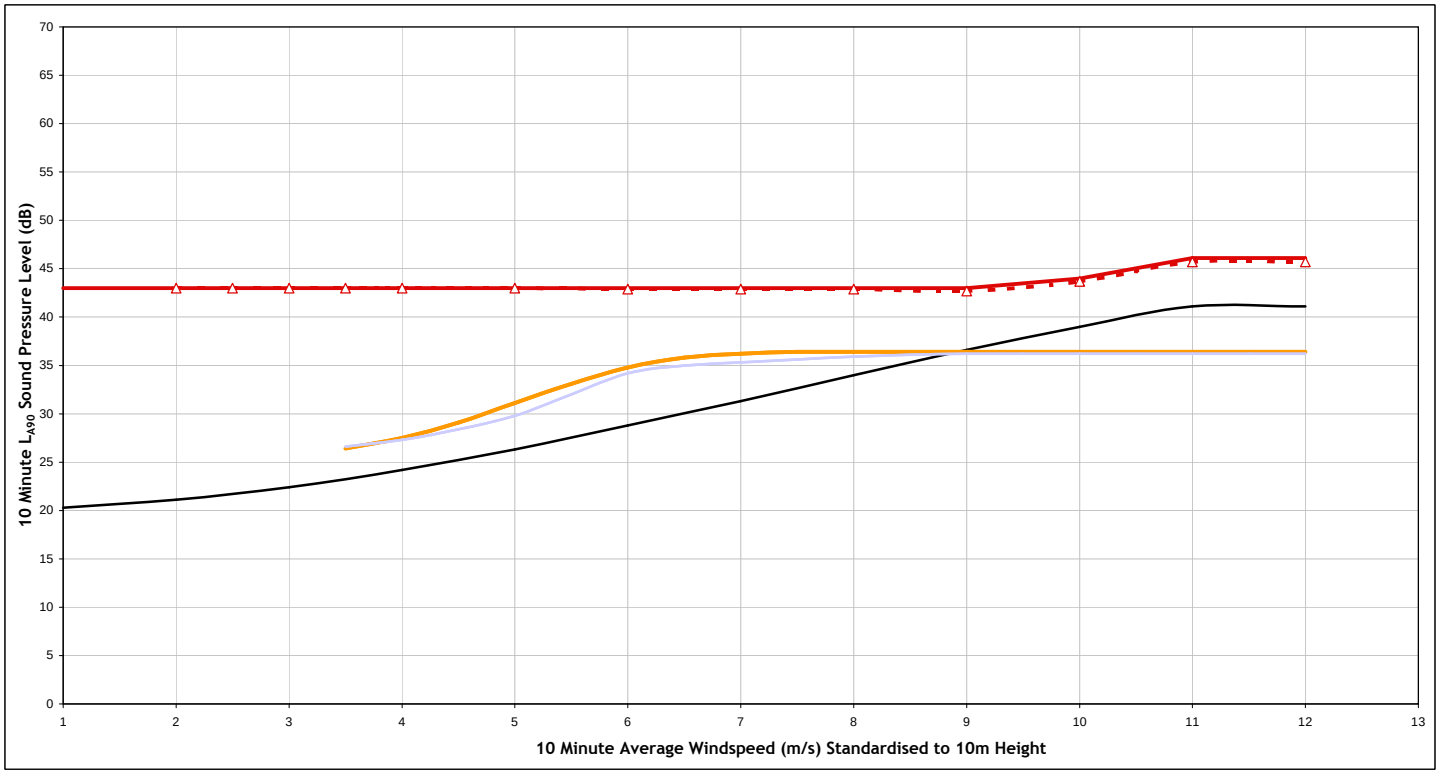
ETSU-R-97 QUIET DAYTIME - Gentletown (H4)



ETSU-R-97 NIGHT-TIME - Gentletown (H4)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- Beaw Field Site Specific Limit
- Beaw Field Only - Senvion 3.4M
- Beaw Field Only - Nordex N100

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Specific Limits Gentletown (H4)
Figure Number	A1.5d
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

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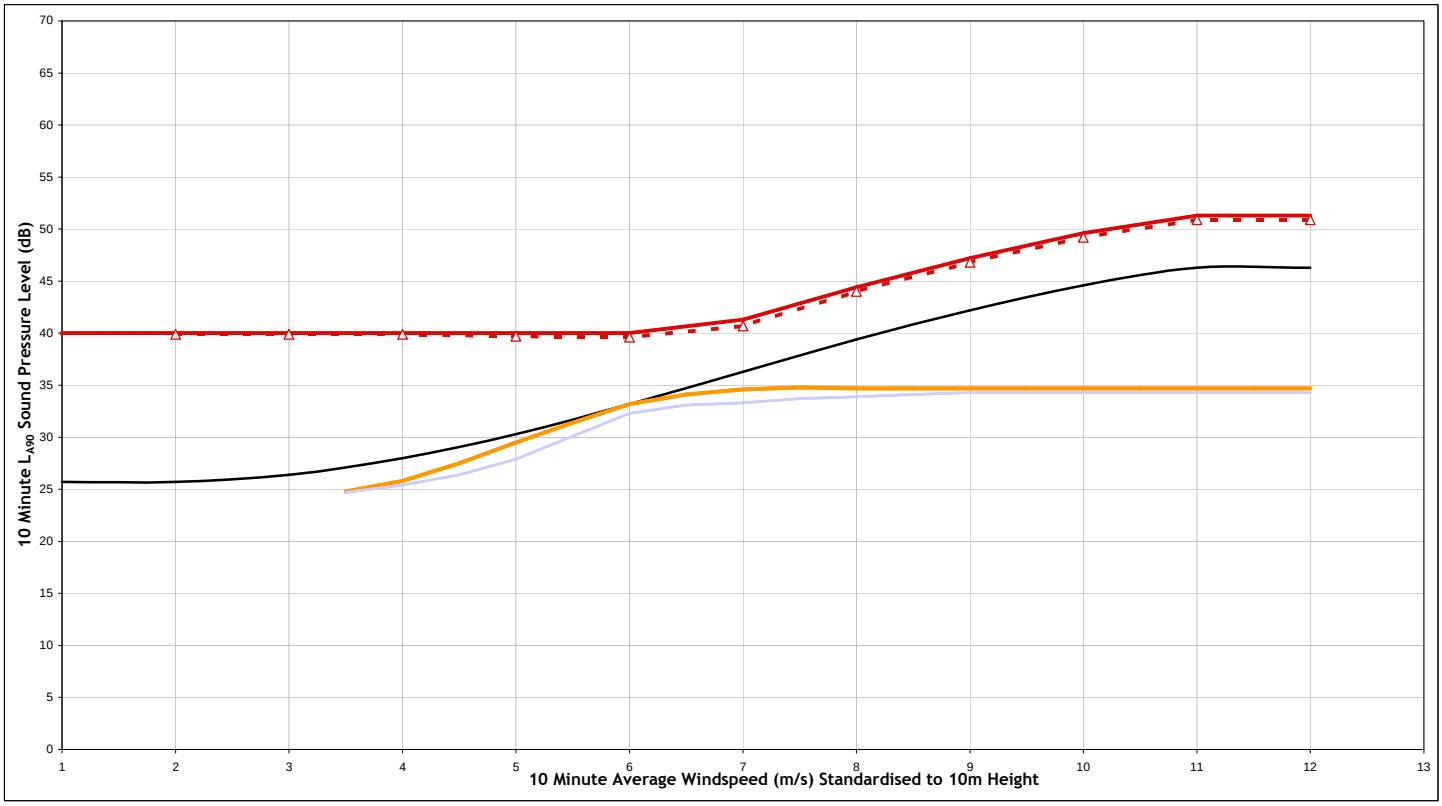
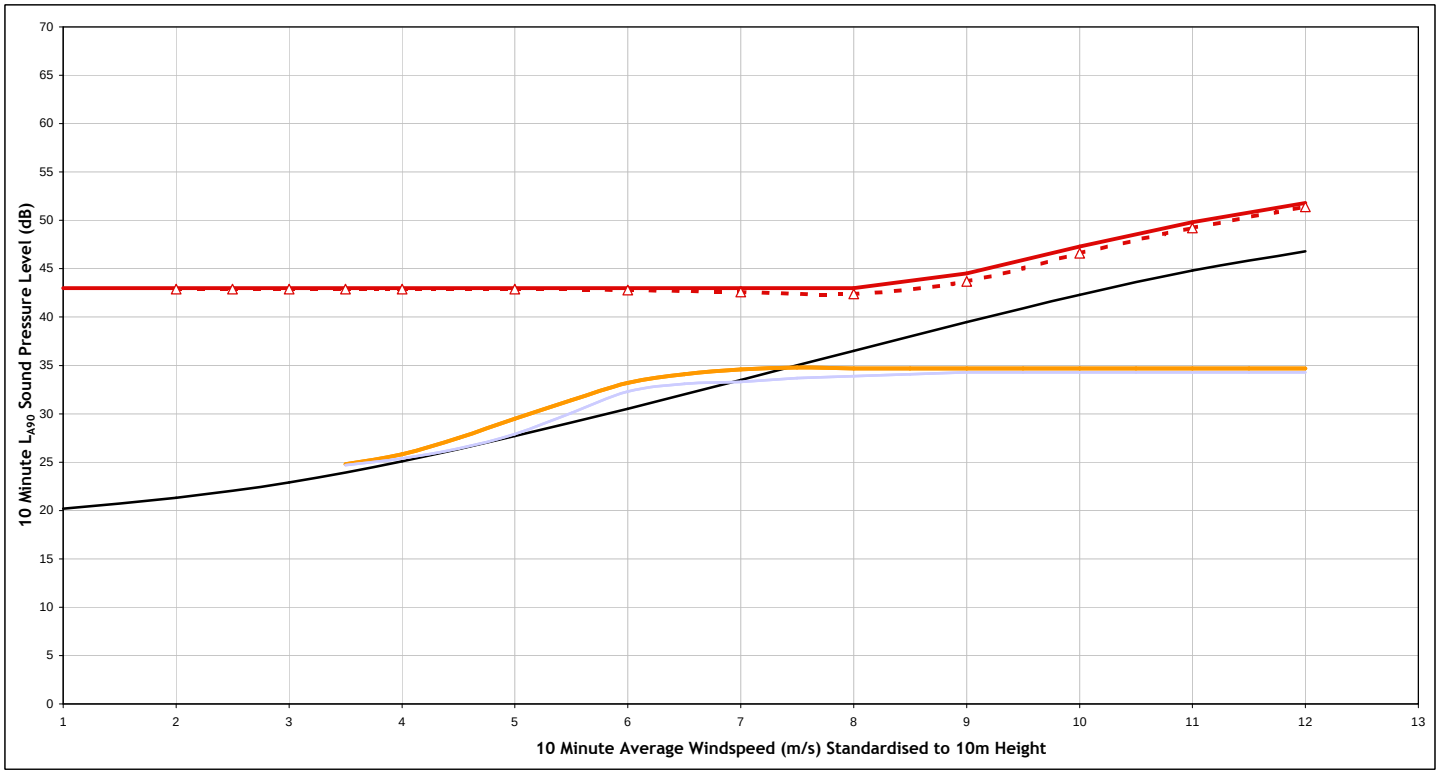
ETSU-R-97 QUIET DAYTIME - Littlester (H5)



ETSU-R-97 NIGHT-TIME - Littlester (H5)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- Beaw Field Site Specific Limit
- Beaw Field Only - Senvion 3.4M
- Beaw Field Only - Nordex N100

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Specific Limits Littlester (H5)
Figure Number	A1.5e
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

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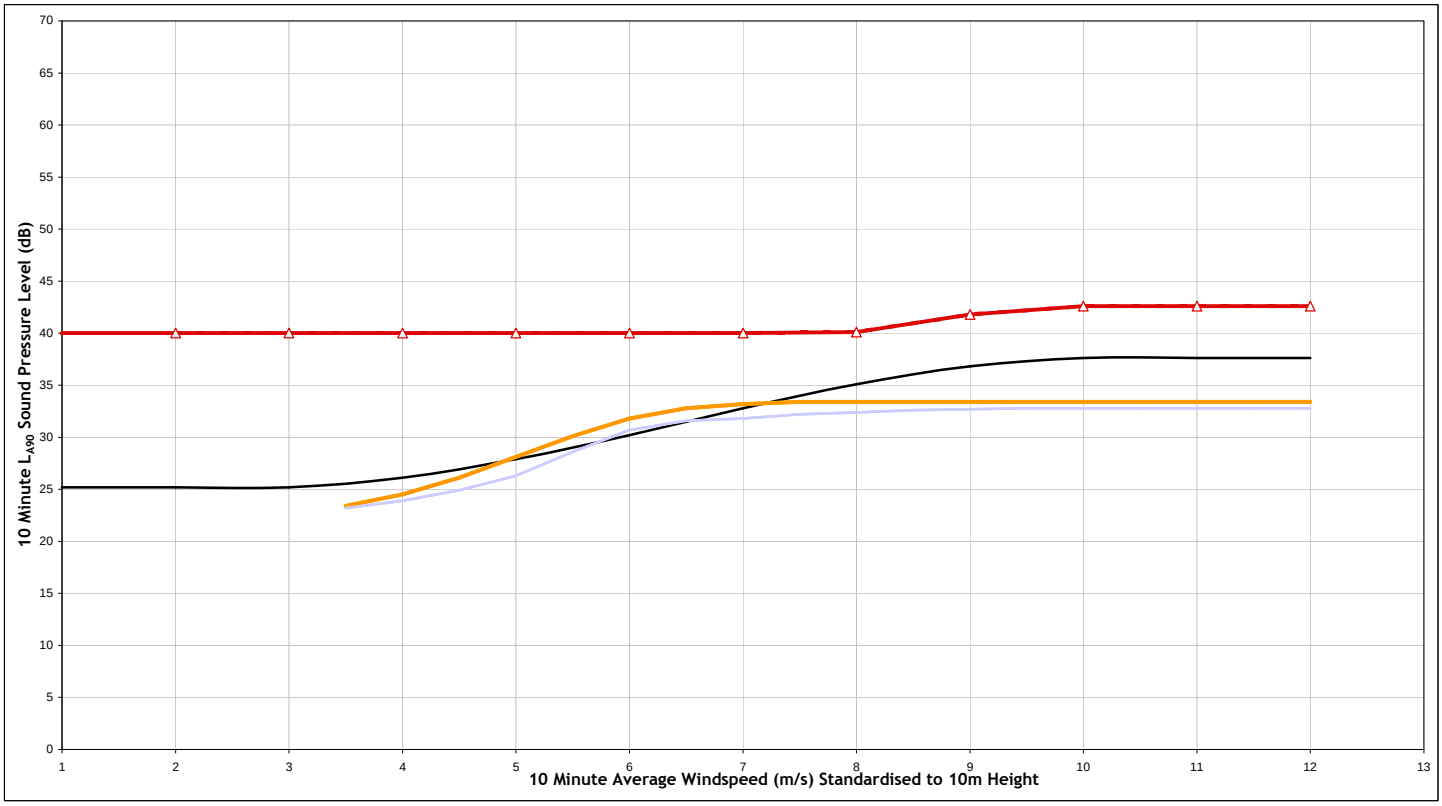
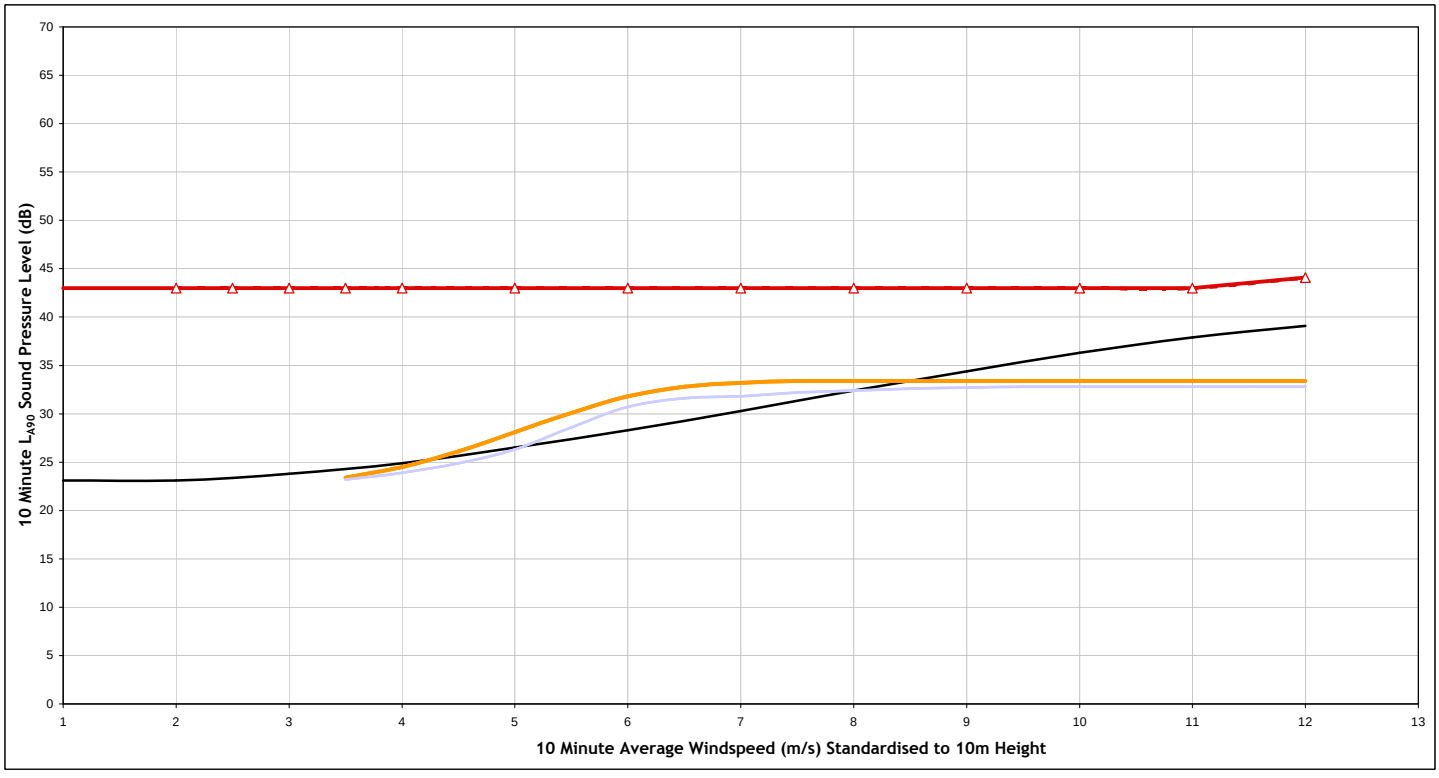
ETSU-R-97 QUIET DAYTIME - Hamnavoe (H6)



ETSU-R-97 NIGHT-TIME - Hamnavoe (H6)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- Beaw Field Site Specific Limit
- Beaw Field Only - Senvion 3.4M
- Beaw Field Only - Nordex N100

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Specific Limits Hamnavoe (H6)
Figure Number	A1.5f
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

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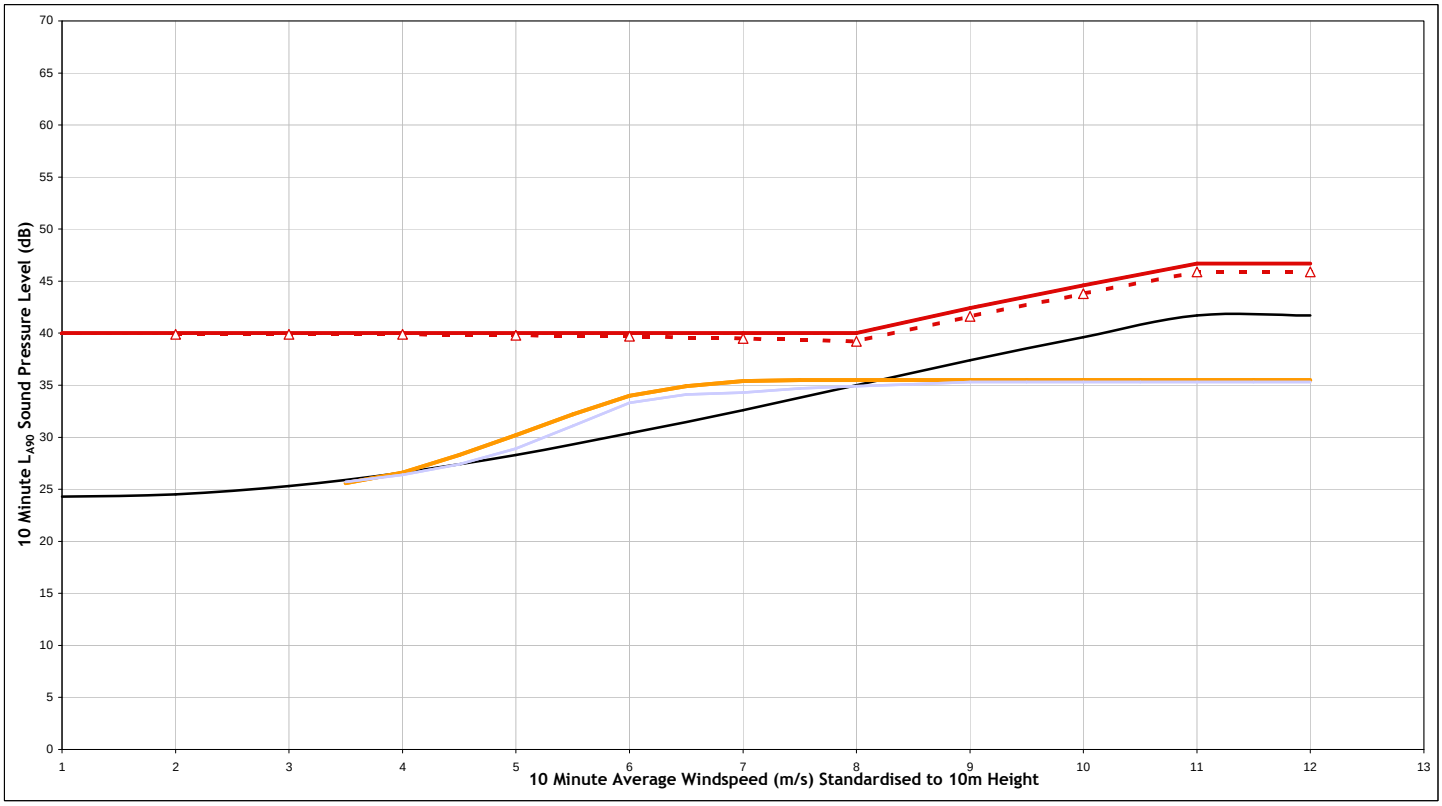
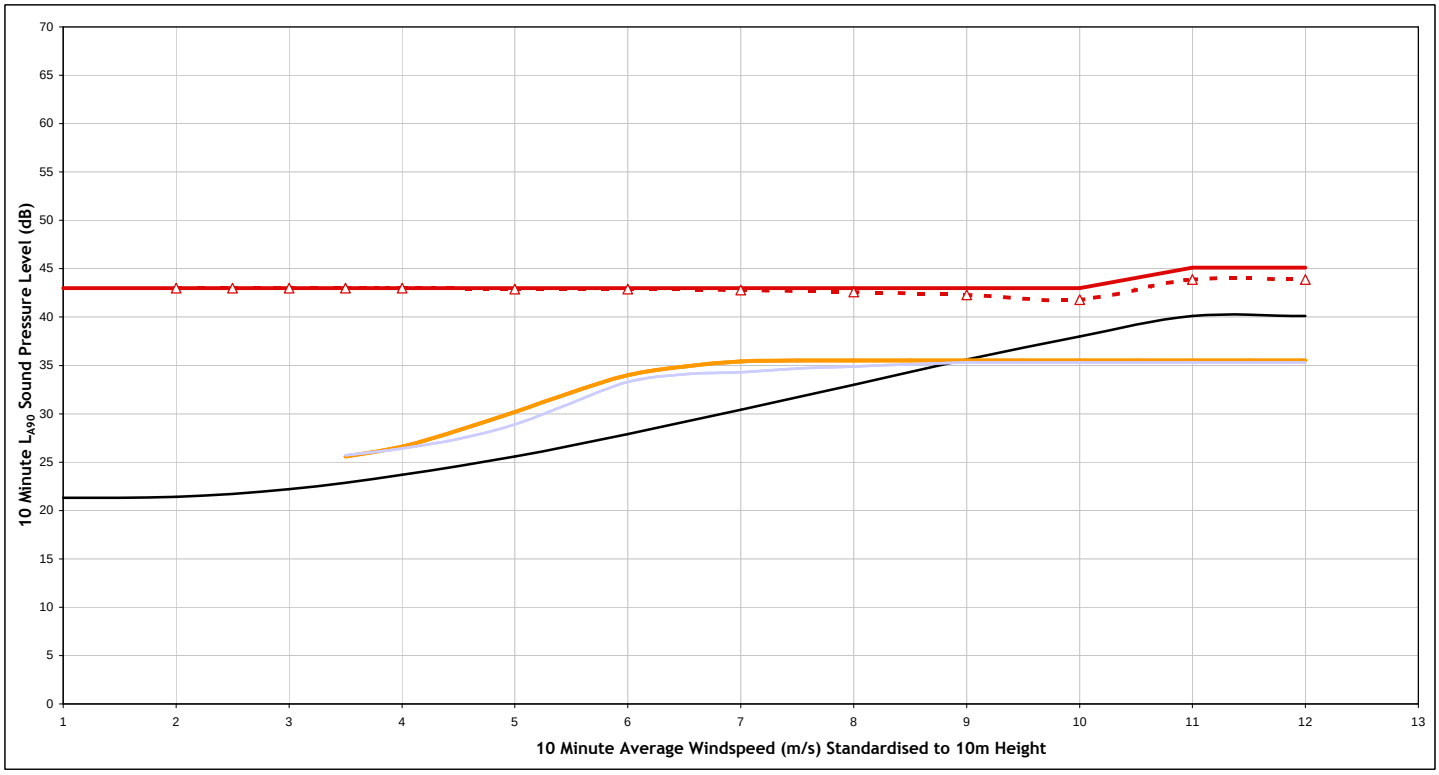
ETSU-R-97 QUIET DAYTIME - Helnaquhida (H7)



ETSU-R-97 NIGHT-TIME - Helnaquhida (H7)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- Beaw Field Site Specific Limit
- Beaw Field Only - Senvion 3.4M
- Beaw Field Only - Nordex N100

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Specific Limits Helnaquhida (H7)
Figure Number	A1.5g
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

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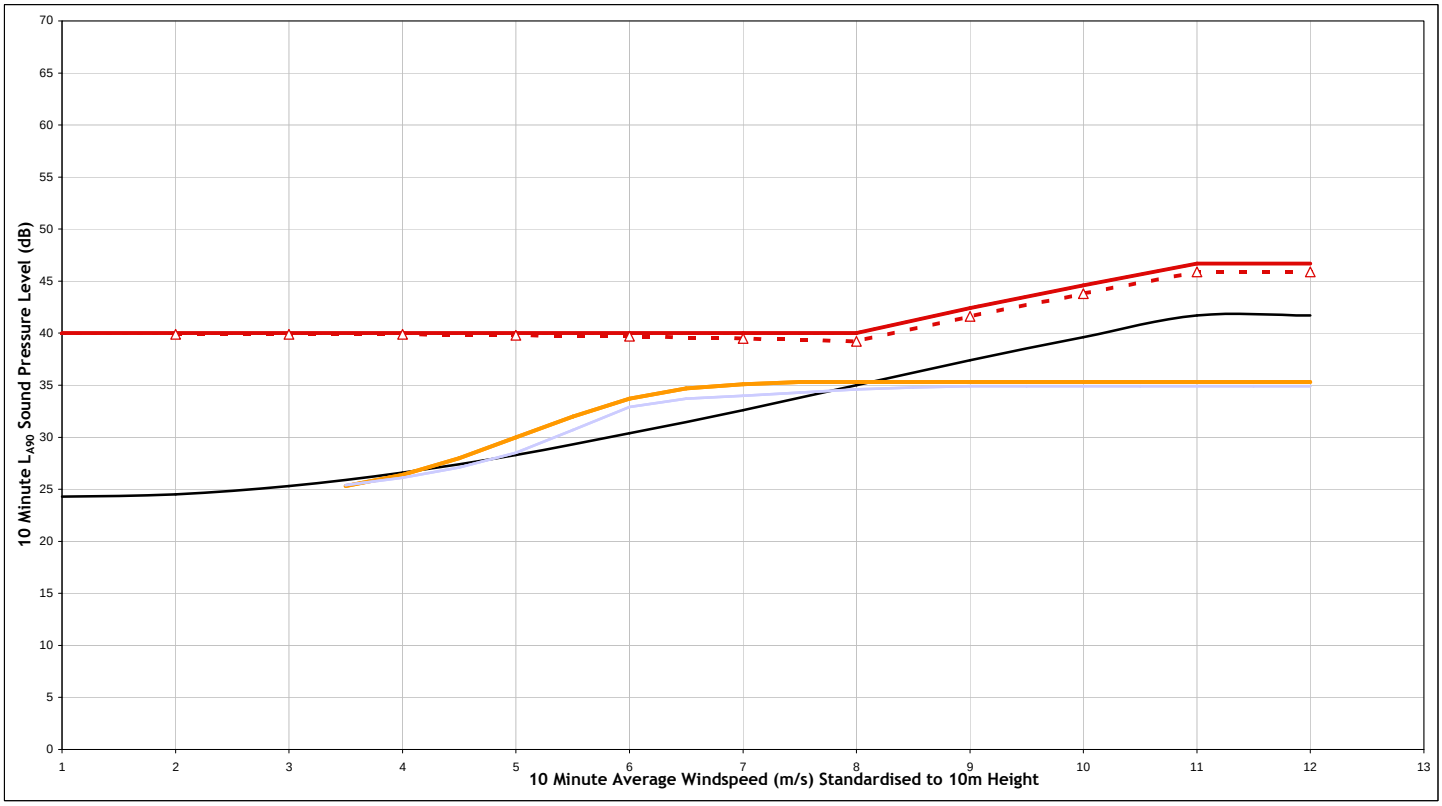
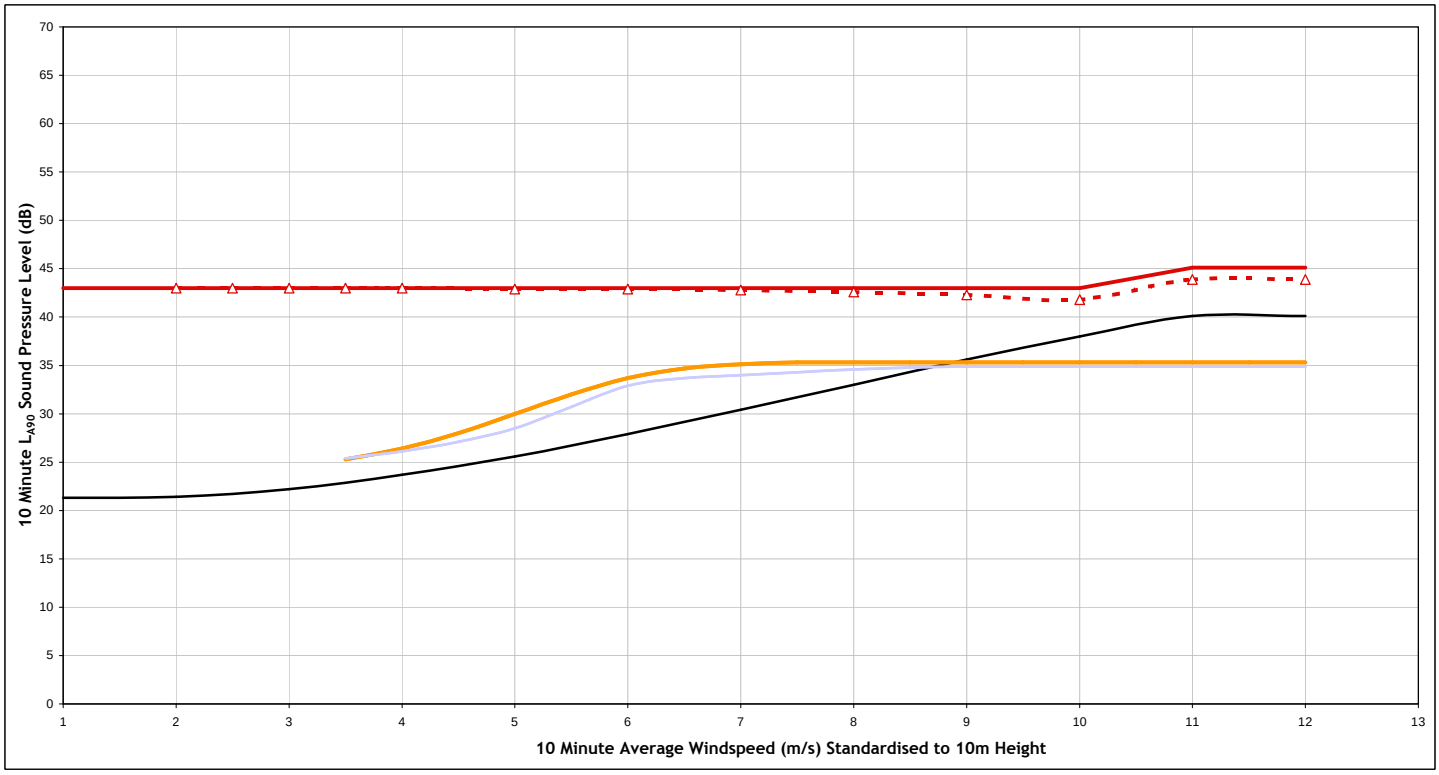
ETSU-R-97 QUIET DAYTIME - Kettlester (H8)



ETSU-R-97 NIGHT-TIME - Kettlester (H8)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- Beaw Field Site Specific Limit
- Beaw Field Only - Senvion 3.4M
- Beaw Field Only - Nordex N100

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Specific Limits Kettlester (H8)
Figure Number	A1.5h
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

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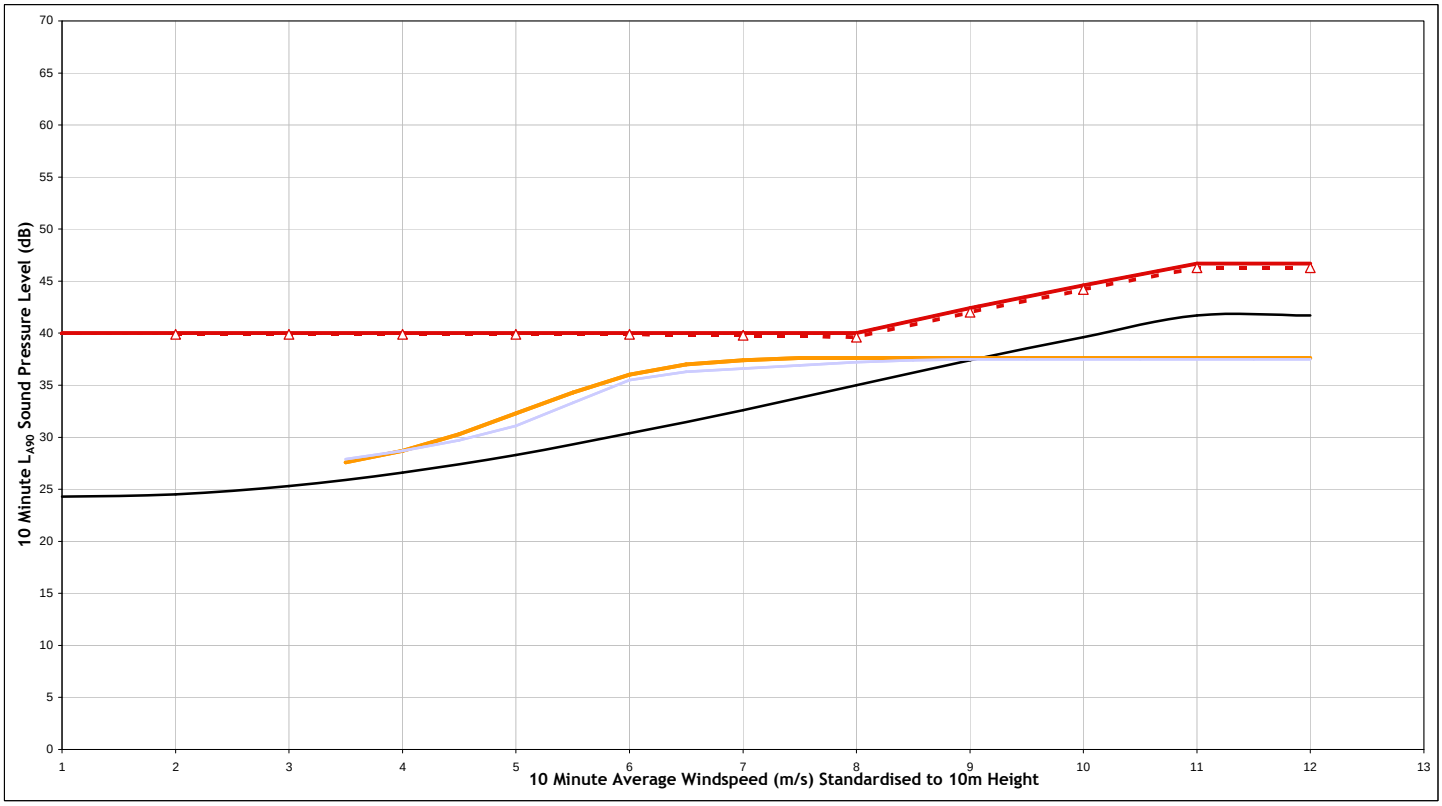
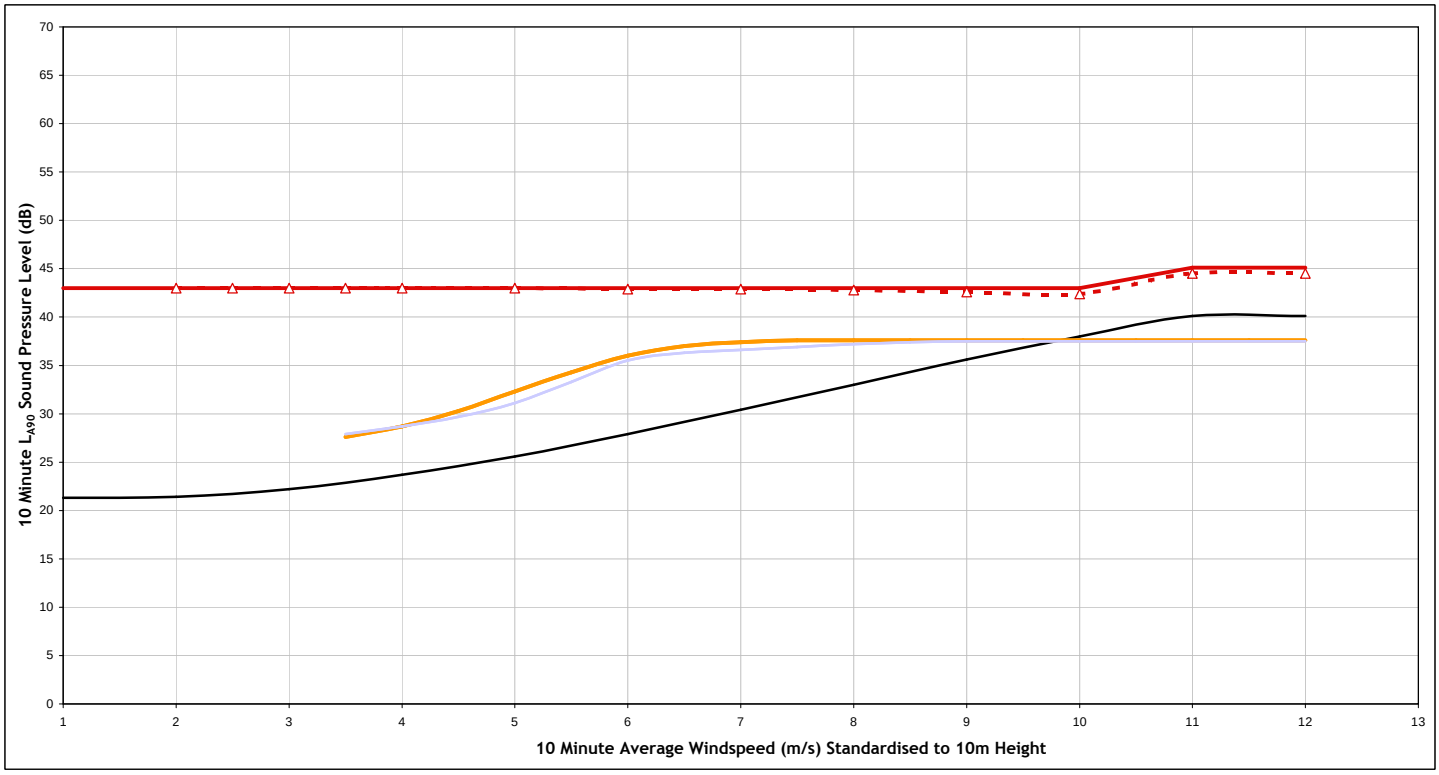
ETSU-R-97 QUIET DAYTIME - Islesview (H9)



ETSU-R-97 NIGHT-TIME - Islesview (H9)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- Beaw Field Site Specific Limit
- Beaw Field Only - Senvion 3.4M
- Beaw Field Only - Nordex N100

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Specific Limits Islesview (H9)
Figure Number	A1.5i
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

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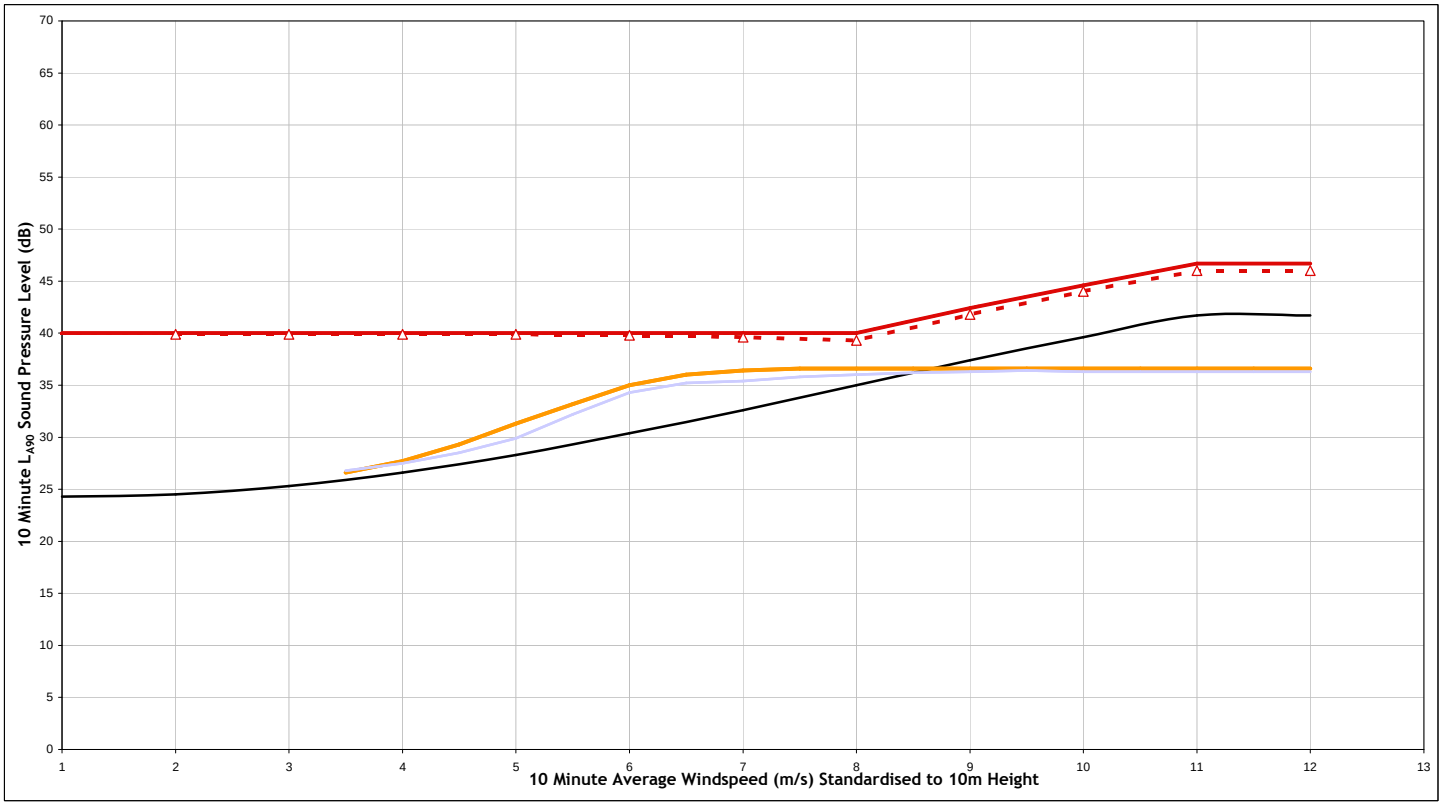
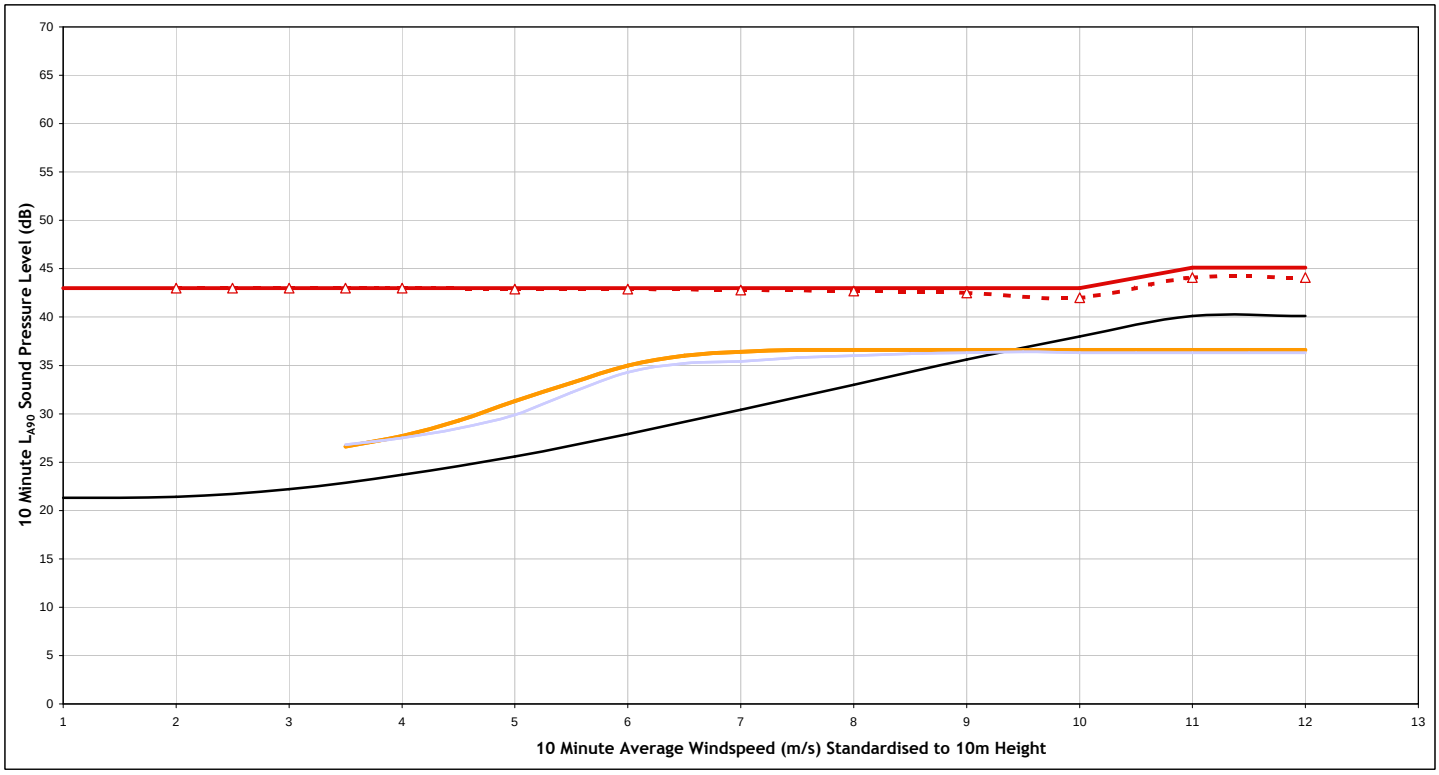
ETSU-R-97 QUIET DAYTIME - Westerlee (H10)



ETSU-R-97 NIGHT-TIME - Westerlee (H10)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- Beaw Field Site Specific Limit
- Beaw Field Only - Senvion 3.4M
- Beaw Field Only - Nordex N100

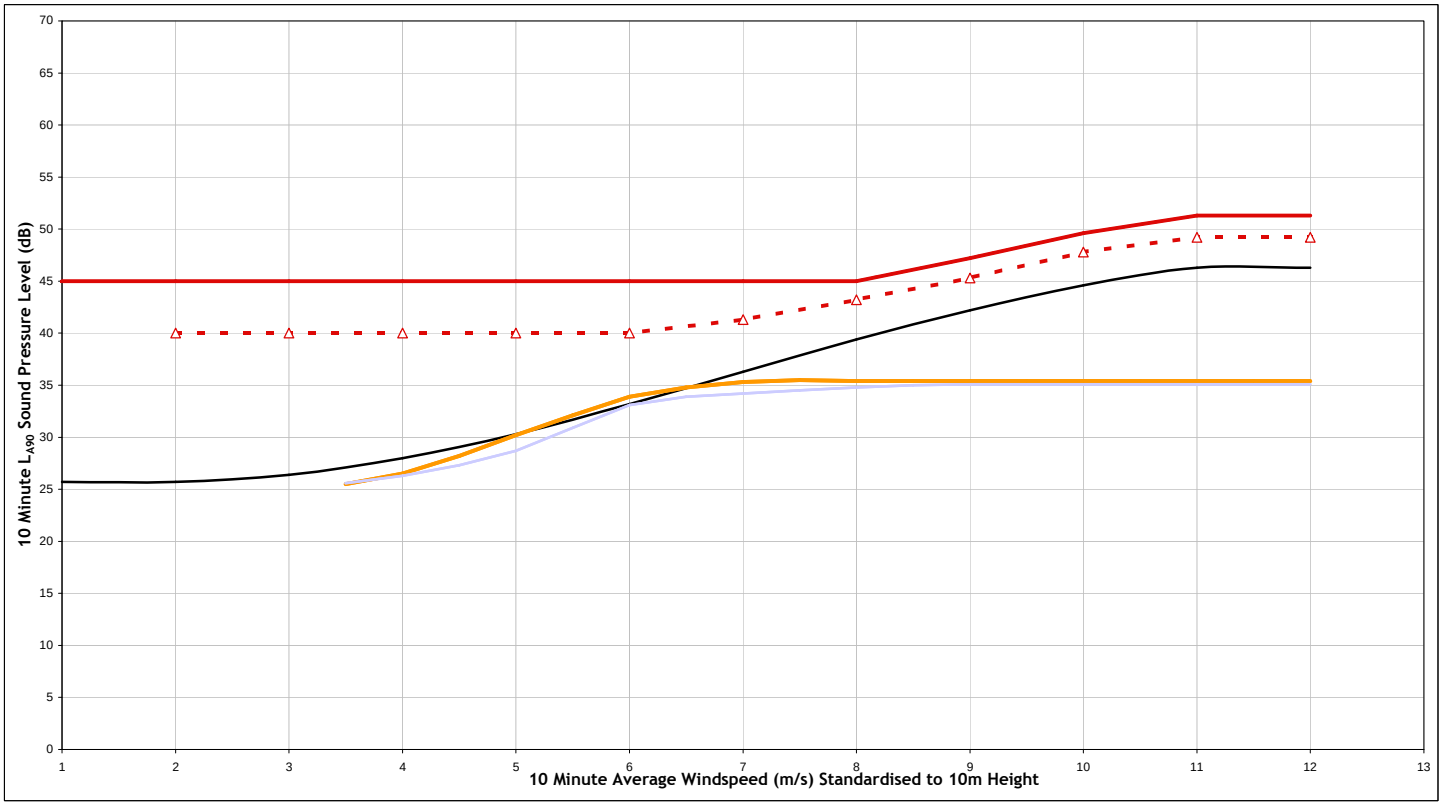
Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Specific Limits Westerlee (H10)
Figure Number	A1.5j
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

PEEL Energy

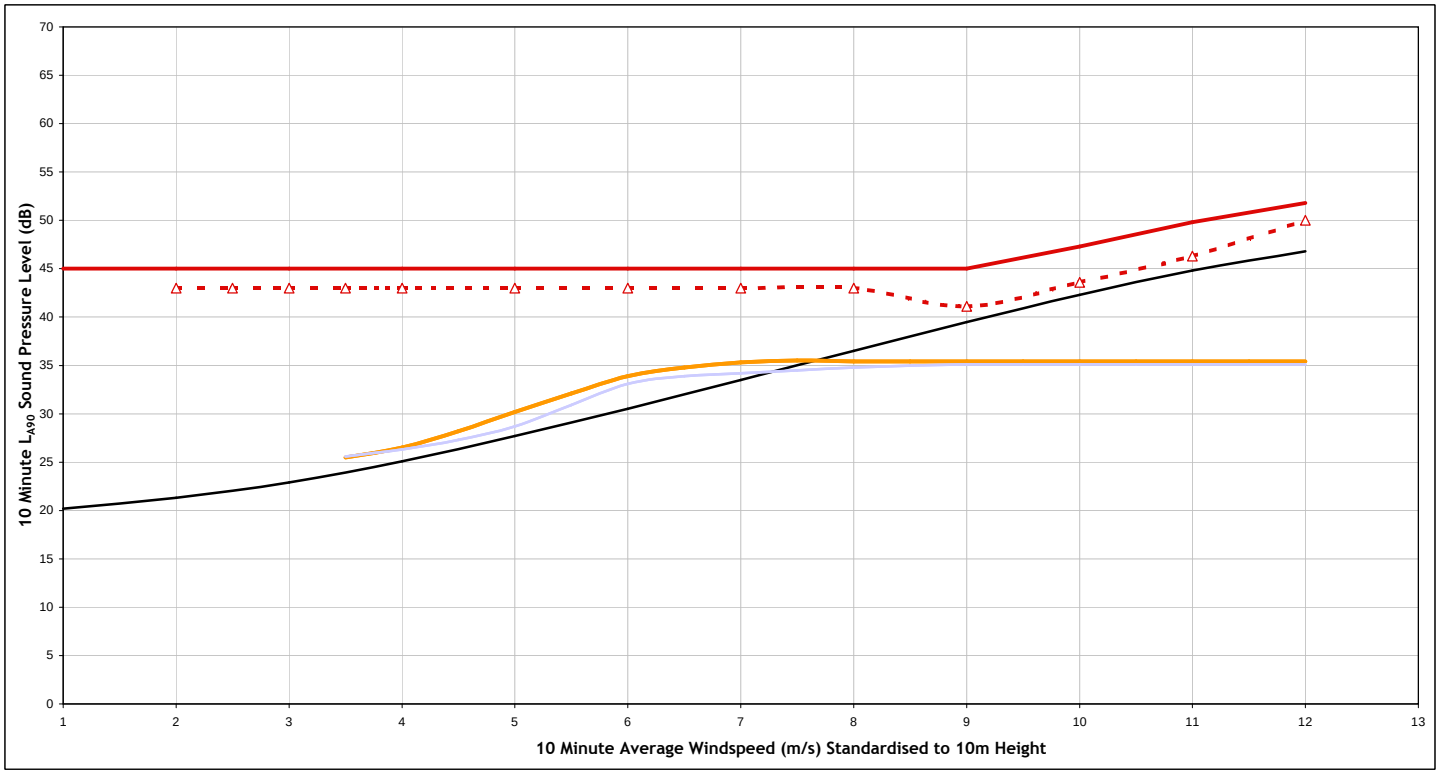
tnei enterprise with energy

TNEI Services Limited
Newcastle upon Tyne
Telephone 01912111400
Website www.tnei.co.uk

ETSU-R-97 QUIET DAYTIME - Kletterlea (H11)



ETSU-R-97 NIGHT-TIME - Kletterlea (H11)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- Beaw Field Site Specific Limit
- Beaw Field Only - Senvion 3.4M
- Beaw Field Only - Nordex N100

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Specific Limits Kletterlea (H11)
Figure Number	A1.5k
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

PEEL Energy

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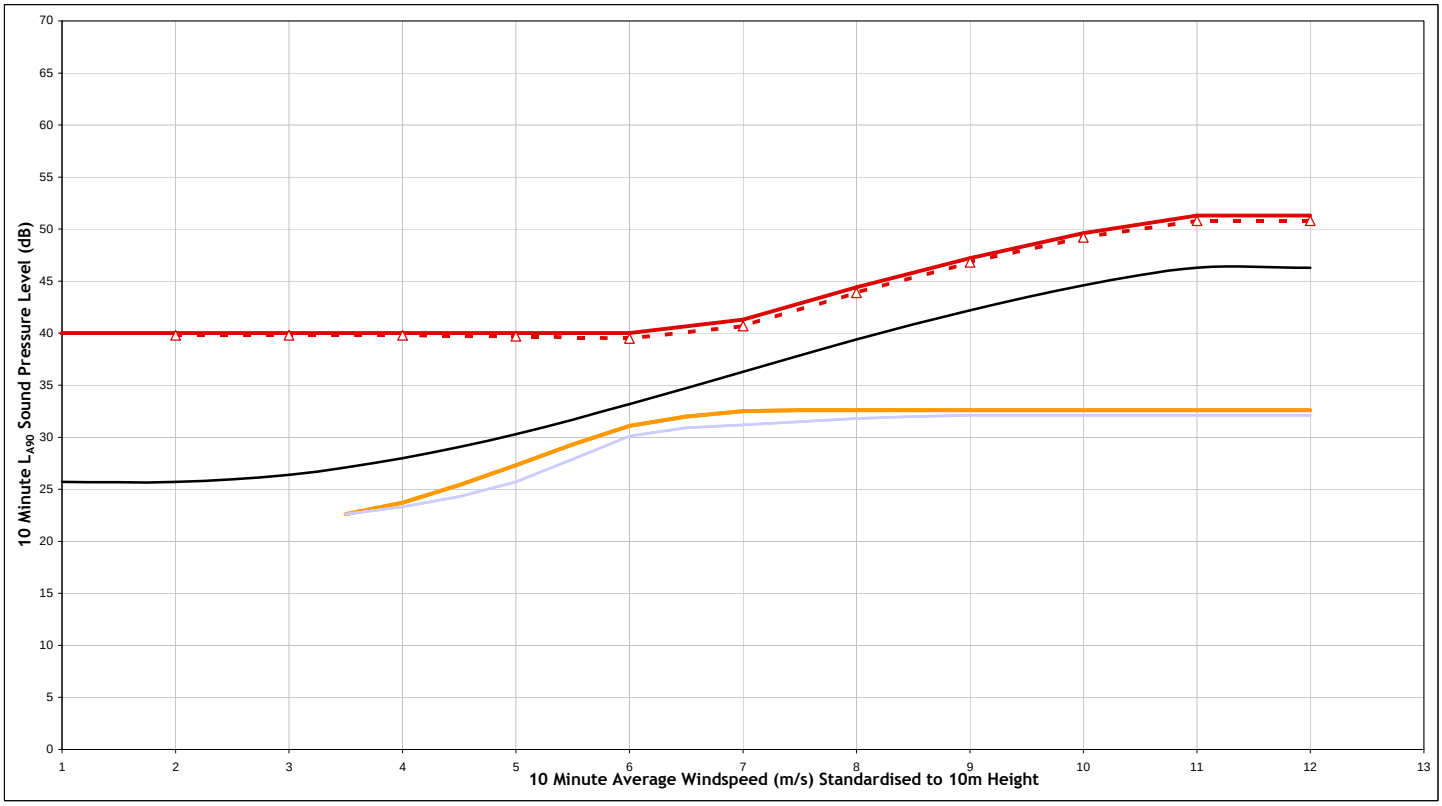
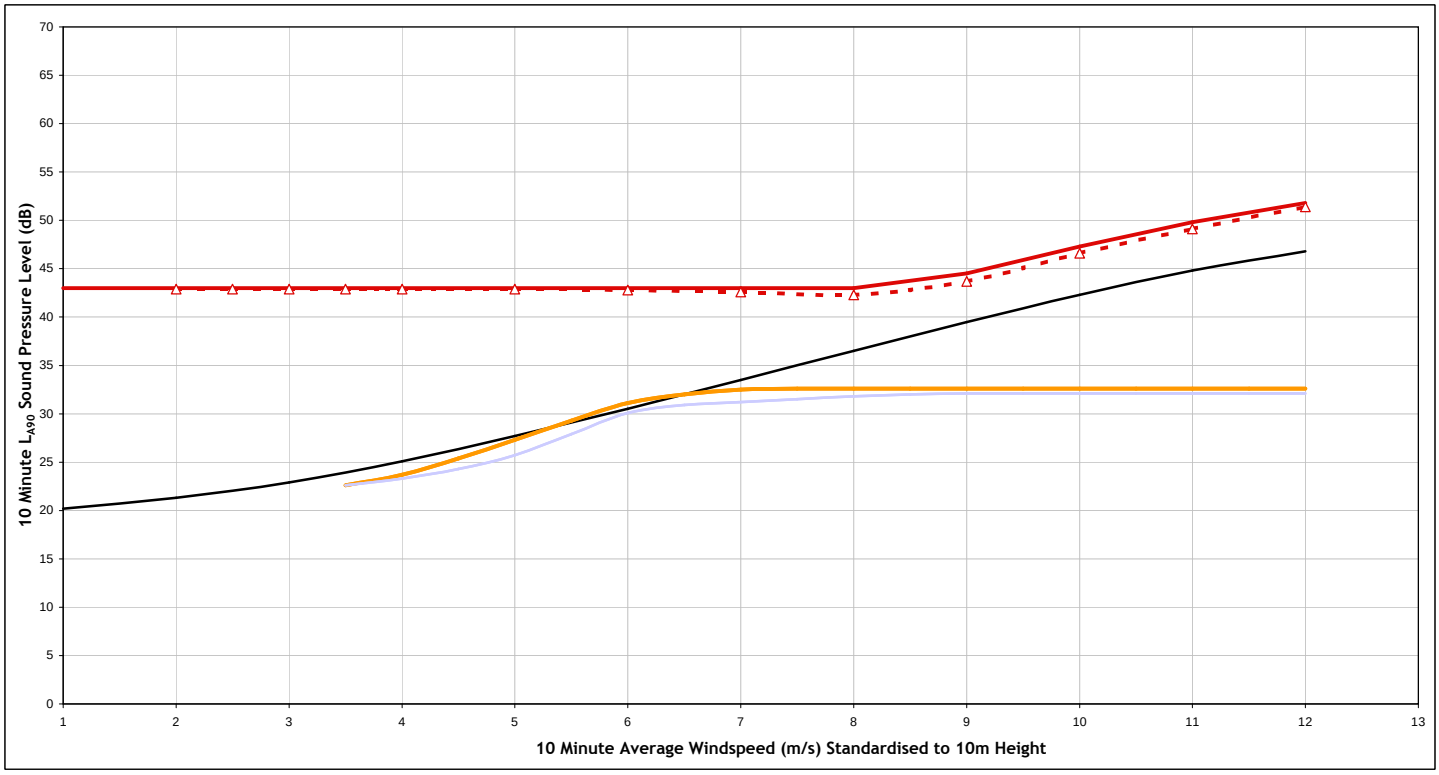
Newcastle upon Tyne
Telephone 01912111400
Website www.tnei.co.uk

ETSU-R-97 QUIET DAYTIME - The School House (H12)



ETSU-R-97 NIGHT-TIME - The School House (H12)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- Beaw Field Site Specific Limit
- Beaw Field Only - Senvion 3.4M
- Beaw Field Only - Nordex N100

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Specific Limits The School House (H12)
Figure Number	A1.5l
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

PEEL Energy

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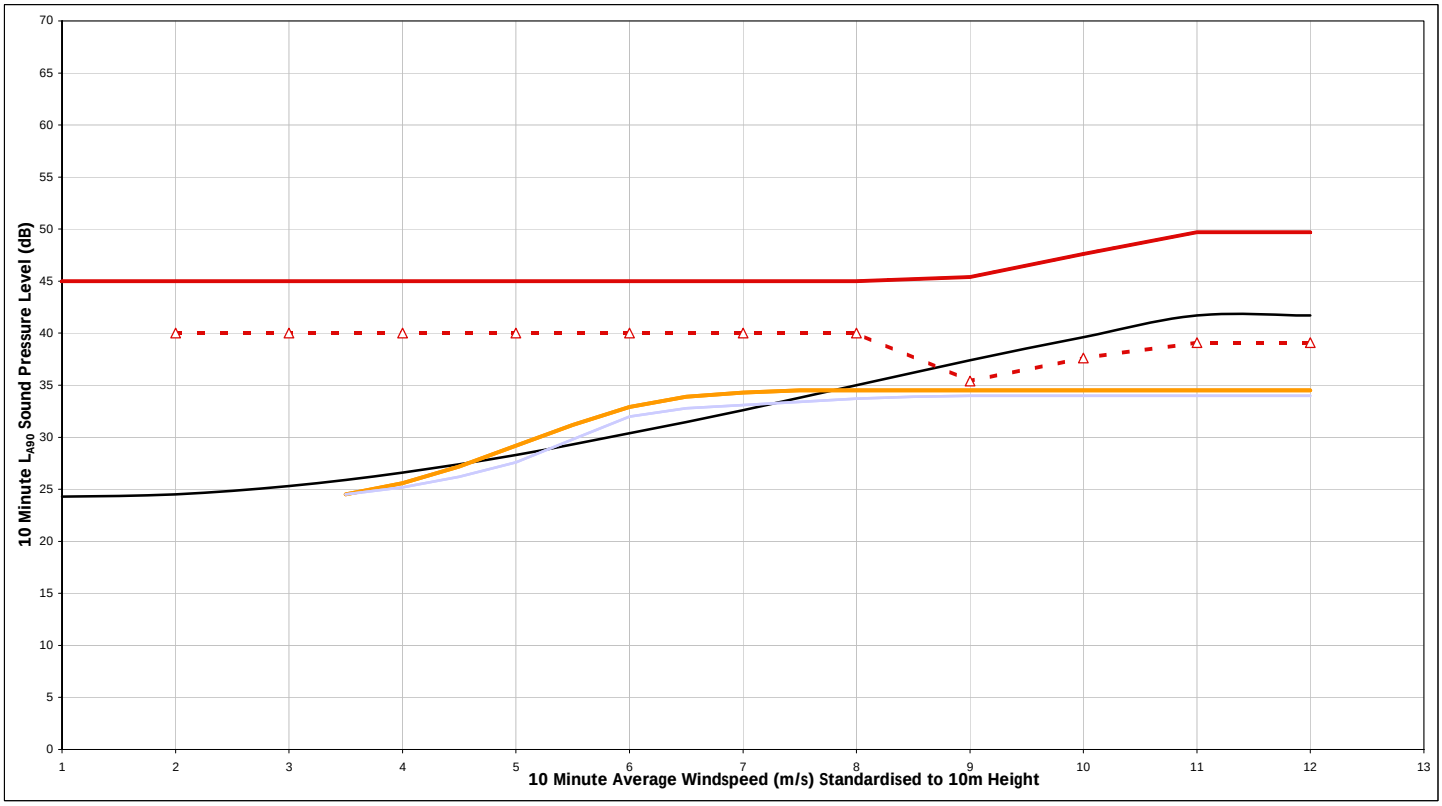
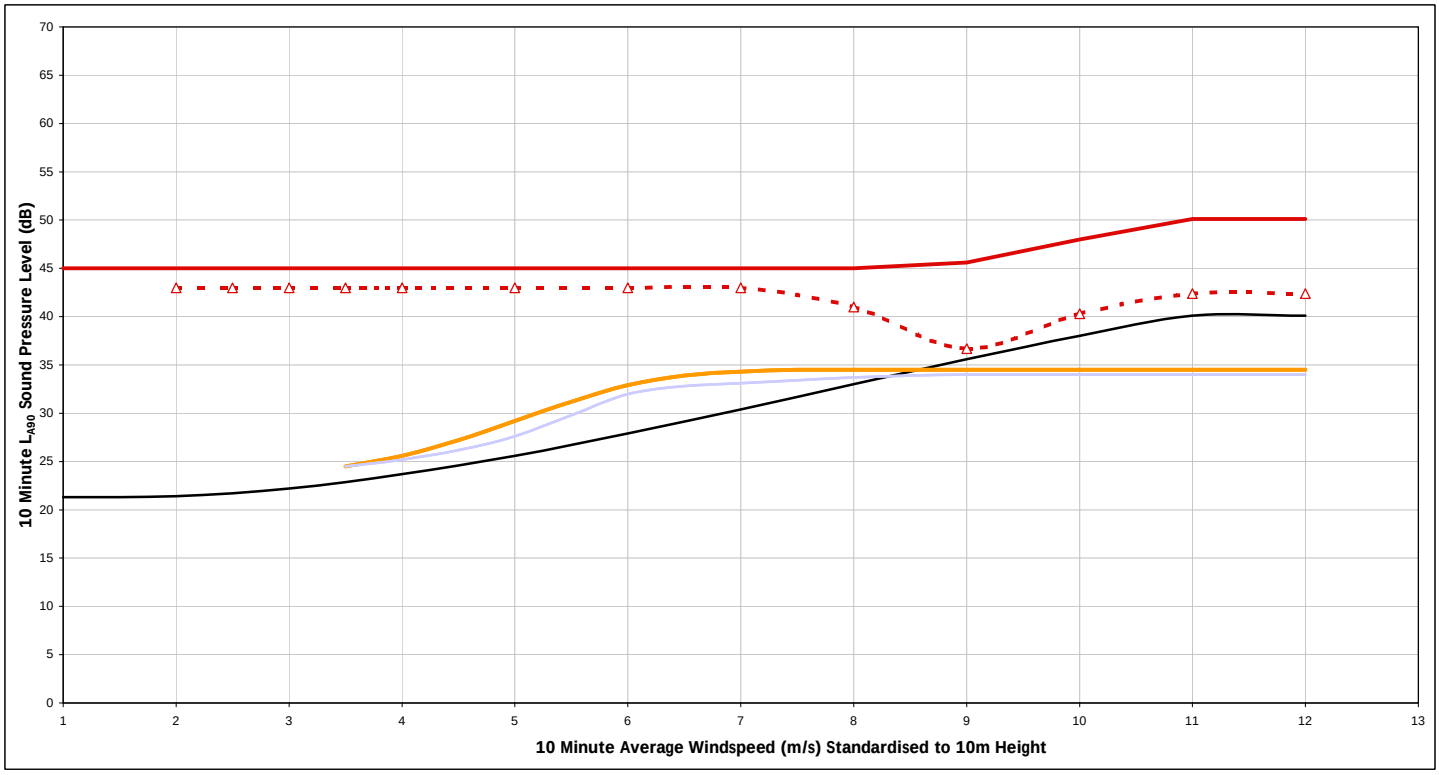
TNEI Services Limited
Newcastle upon Tyne
Telephone 01912111400
Website www.tnei.co.uk

ETSU-R-97 QUIET DAYTIME - Cluness Cottage (H13)



ETSU-R-97 NIGHT-TIME - Cluness Cottage (H13)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- Beaw Field Site Specific Limit
- Beaw Field Only - Senvion 3.4M
- Beaw Field Only - Nordex N100

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Specific Limits Cluness Cottage (H13)
Figure Number	A1.5m
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

PEEL Energy

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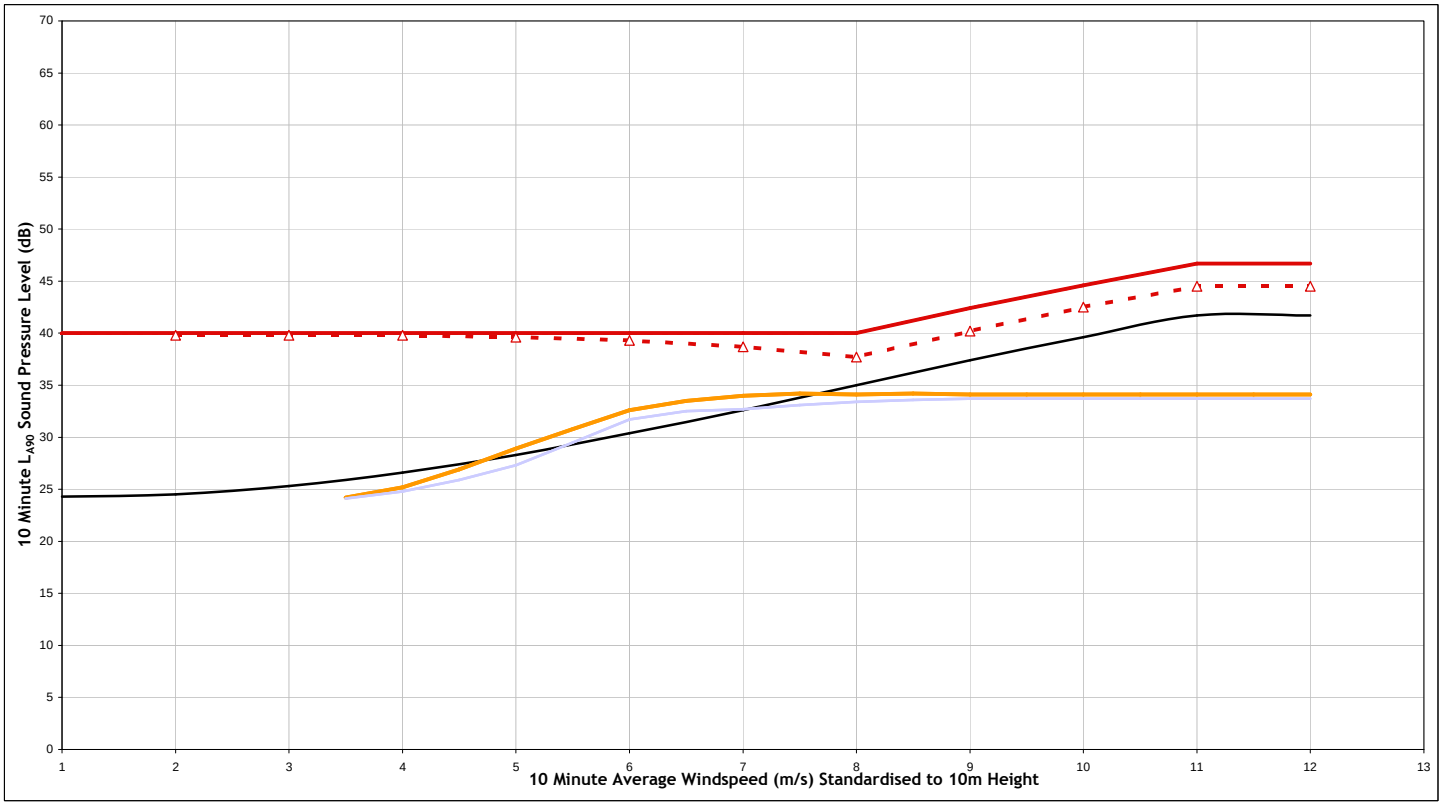
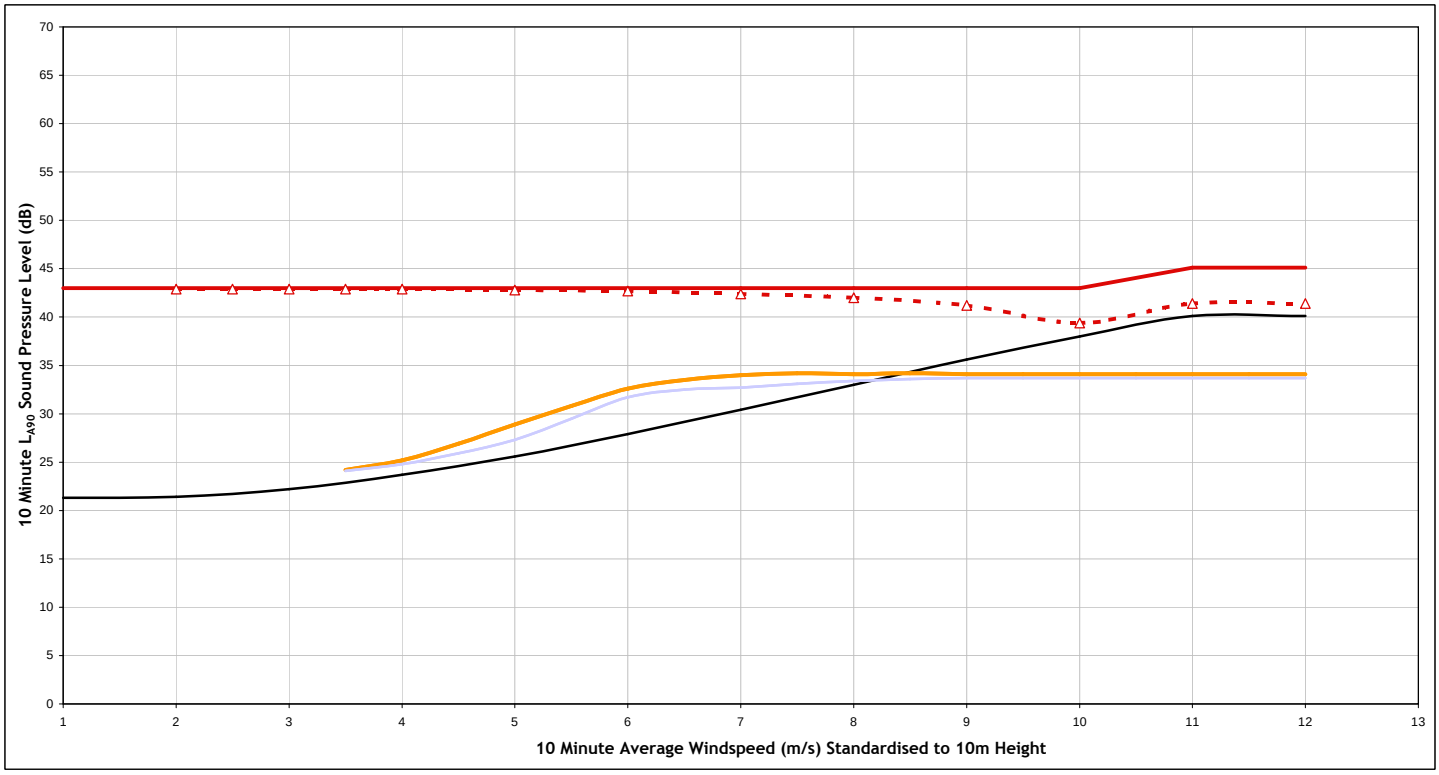
TNEI Services Limited
Newcastle upon Tyne
Telephone 01912111400
Website www.tnei.co.uk

ETSU-R-97 QUIET DAYTIME - Staneygarth (H14)



ETSU-R-97 NIGHT-TIME - Staneygarth (H14)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- Beaw Field Site Specific Limit
- Beaw Field Only - Senvion 3.4M
- Beaw Field Only - Nordex N100

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Specific Limits Staneygarth (H14)
Figure Number	A1.5n
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

PEEL Energy

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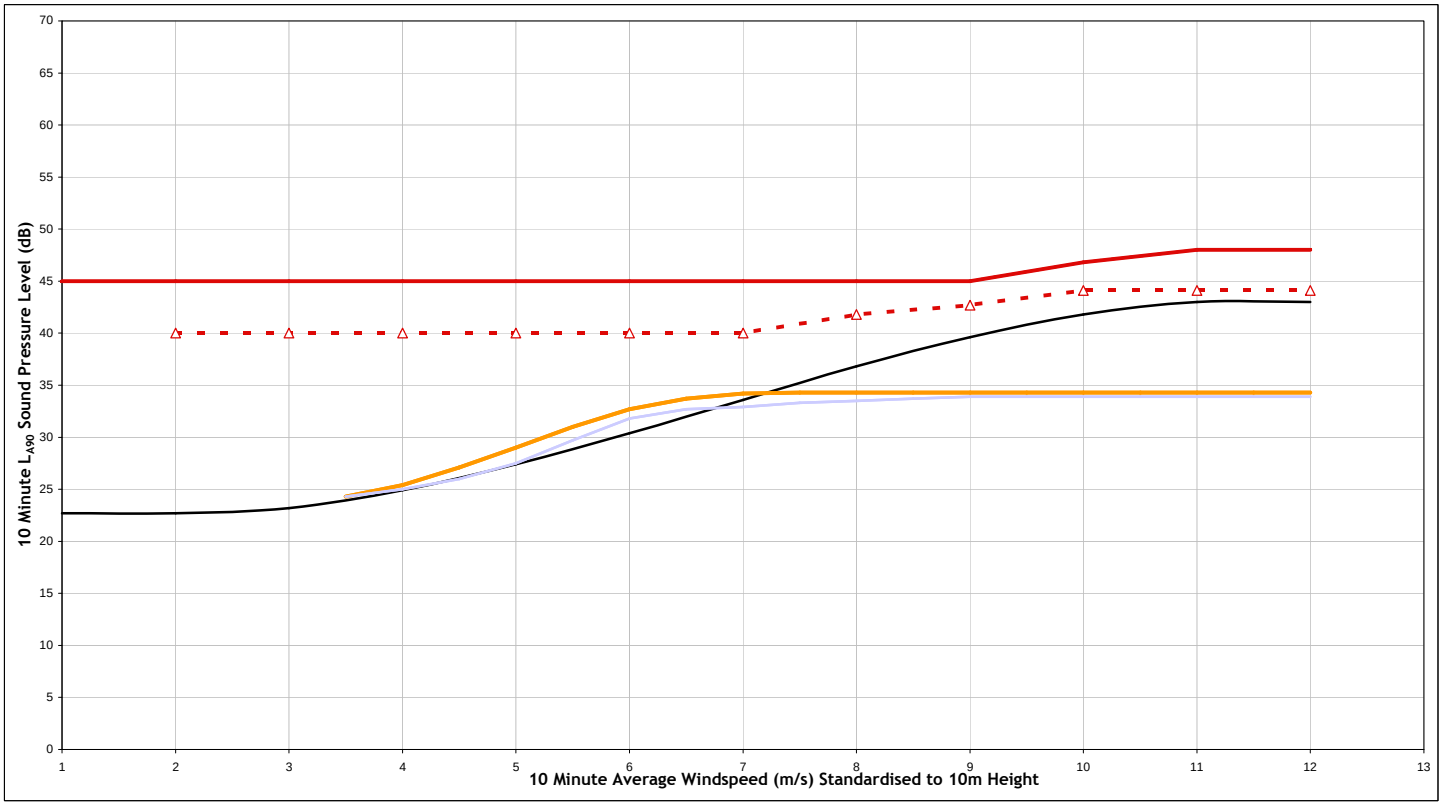
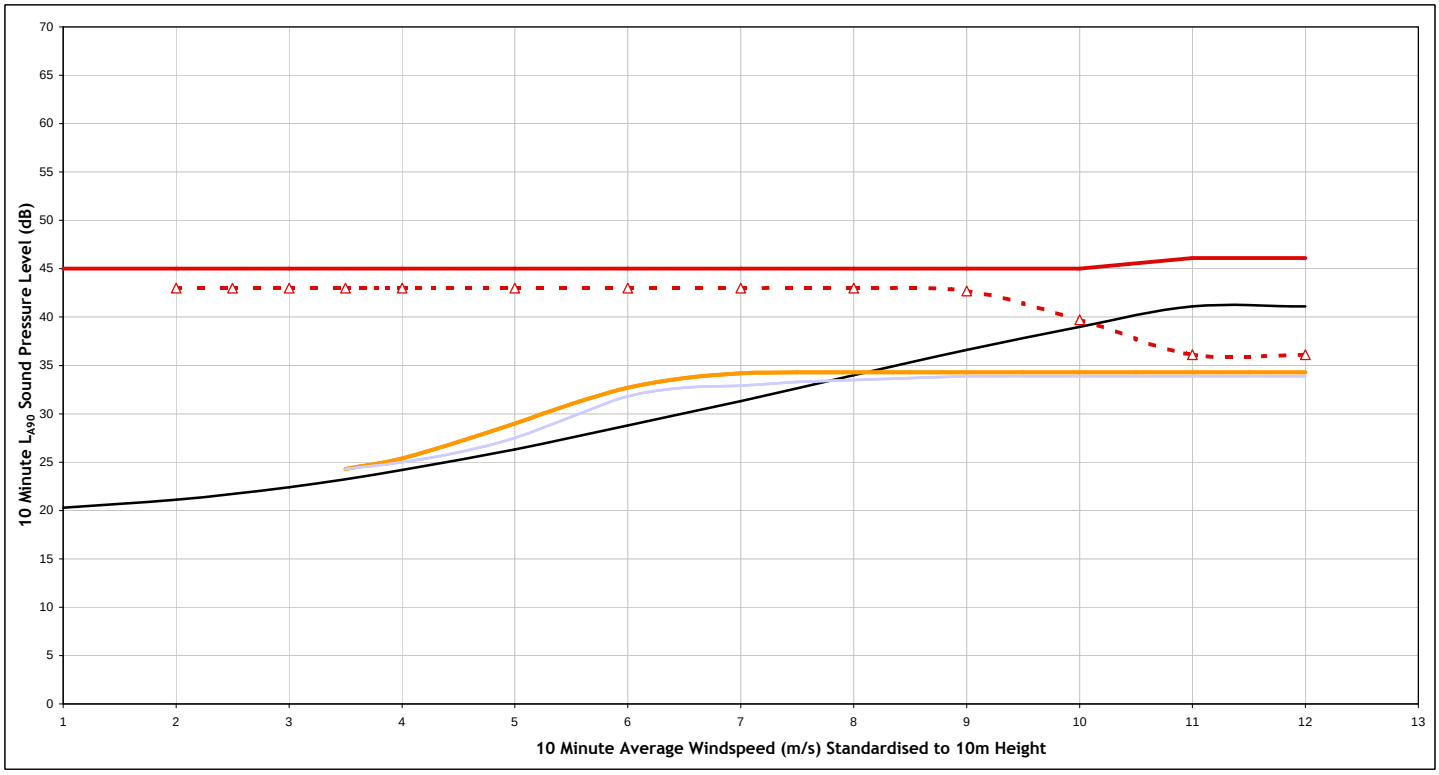
TNEI Services Limited
Newcastle upon Tyne
Telephone 01912111400
Website www.tnei.co.uk

ETSU-R-97 QUIET DAYTIME - Giggleswick (H15)



ETSU-R-97 NIGHT-TIME - Giggleswick (H15)



Legend:

- Background Noise Trend
- Total ETSU Noise Limits
- Beaw Field Site Specific Limit
- Beaw Field Only - Senvion 3.4M
- Beaw Field Only - Nordex N100

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Noise Assessment against Specific Limits Giggleswick (H15)
Figure Number	A1.5o
Scale	NTS
Drawn	JB
Checked	JM
Date	24/02/2016
Document Reference	10081-005

PEEL Energy

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ANNEX 2 - Correspondence with the Environmental Health Department at the Council

Jason Baldwin

From: James Mackay
Sent: 23 December 2015 16:07
To: richard.cooper@shetland.gov.uk
Subject: RE: Beaw Field
Attachments: SD-3.1-WT.PC.00-B-D-EN PowerSound3.4M104 (RVD 28-05-2015).pdf

Hi Richard

Please find my responses in red below. I appreciate you taking the time to look through what we have sent, I know it is a very busy time of year.

For the avoidance of doubt I am not asking or expecting you to confirm you have no objection to the scheme at this stage as I appreciate you will need to consider our final report in detail in due course. It would however be really helpful if you could provide any feedback on the fixed minimum limits, is this something you have discussed internally?

As you know, in the absence of any feedback to date we have adopted 40dB (as we feel this is appropriate when assessed in accordance with ETSU-R-97) and this is what is included in our assessment. I believe our client wants to submit the application asap next year so we will proceed on this basis for now unless you have any other questions or comments?

If I do not speak to you again beforehand I hope you have a great Christmas break.

Kind Regards

James Mackay

Head of Technical Services
TNEI Services Limited

Tel: +44 (0)191 2111414
Mob: +44 (0)7974 077846
Fax: +44 (0)191 2111432
Website: http://www.tnei.co.uk
E-mail: james.mackay@tnei.co.uk
Address: Milburn House, Dean Street, Newcastle upon Tyne, NE1 1LE

Registered in England & Wales No. 03891836, Registered office: Brook House, 88-100 Chertsey Road, Woking, Surrey, GU21 5BJ

From: richard.cooper@shetland.gov.uk [mailto:richard.cooper@shetland.gov.uk]
Sent: 23 December 2015 15:32
To: james.mackay@tnei.co.uk
Subject: RE: Beaw Field

Hi James

Just some further information please.

- Have you decided on the Senvion 3.4 or another turbine and have you decided the number of turbines? The final choice of turbine will probably follow a competitive tendering process should the development receive consent (as is common for wind farms) the final choice of turbine would however have to meet the noise limits established in accordance with ETSU-R-97. Based on the turbines currently available on the market the 3.4M is considered to be representative of the type of turbine which could be used. This is discussed in the IOA GPG which states:

4.1.6 Whilst some developments may already have a preferred turbine selection, most sites will not at this stage of the project, and it is therefore standard practice to consider a "candidate turbine" at the planning stage, which is representative of the range of turbines which may be installed at the site, to provide an appropriate estimate. The suitability of the final turbine model (post-consent) can be secured through the imposition of adequate planning conditions.

- Could you send the declared Sound Power Level (Lw) of the Senvion 3.4 or any other candidate turbine? I have attached the data we hold for the 3.4M, please note that being third party data it may be subject to change.
- Will there be any penalties for any tonal noise? As you will see in the Senvion document states *'Senvion SE warrants that there is no tonal audibility >0dB (for V10 ≥ 6m/s)'*. As noted above however this is only a candidate turbine and we would recommend that this is controlled through a suitable planning condition in accordance with ETSU-R-97. There is some useful text on this in the GPG which states:

Tonality

4.2.7 It is highly unlikely that any specific information on tonality at representative receptor separation distance accordance with the ETSU-R-97 methodology will be available at the planning application stage. When s information is available, it should be appropriately applied. It is standard to control the potential presenc tones in practice through the use of suitable planning conditions.

- I am looking at the 10 minute average windspeed (m/s) Standardised to 10 m height / 10 min L_{A90} SPL dB (ETSU-R-97) QUIET DAYTIME - 'The School House' (H13). Does this mean that the sensitive receptor could be subjected to >50dB on occasions?
  Also, Night Time – H5 – 'Heatherlea'; it appears that the receptors could be subjected to >50dB. The scatter graphs show the noise levels measured during our baseline noise survey; there are a couple of ten minute data points which are over 50dB, this is in the absence of the proposed development; this is however at some quite high wind speeds (12m/s or ~27mph). Using H5 as an example you can see that predicted wind turbine noise at the same point is only 35dB so, if consented and built, it would be providing a negligible contribution to the overall noise level.

Sorry for the delay James; you must understand that we have a tight team dealing with food inspections, animal health, licensing, housing, complaints etc.

Regards

Richard Cooper
Environmental Health Officer
Environmental Health & Trading Standards
Shetland Islands Council
Infrastructure Services
Charlotte House
Commercial Road
Lerwick
ZE1 0LX

Direct Dial: 01595 744816
Fax: 01595 744802
ehadmin@shetland.gov.uk
www.shetland.gov.uk

From: James Mackay [mailto:james.mackay@tnei.co.uk]
Sent: 21 December 2015 13:50
To: Cooper Richard@Environmental Health & Trading Standards
Subject: RE: Beaw Field

Hi Richard

That would be great thanks. I will be in the office until about 2pm on Xmas eve if you have any questions.

Kind Regards

James Mackay

Head of Technical Services
TNEI Services Limited

Tel: +44 (0)191 2111414
Mob: +44 (0)7974 077846
Fax: +44 (0)191 2111432
Website: http://www.tnei.co.uk
E-mail: james.mackay@tnei.co.uk
Address: Milburn House, Dean Street, Newcastle upon Tyne, NE1 1LE

From: richard.cooper@shetland.gov.uk [mailto:richard.cooper@shetland.gov.uk]
Sent: 21 December 2015 13:48
To: james.mackay@tnei.co.uk
Subject: RE: Beaw Field

Hi James

I will look at this before Xmas.

Regards

Richard Cooper
EHO
774816

From: James Mackay [mailto:james.mackay@tnei.co.uk]
Sent: 21 December 2015 10:52
To: Cooper Richard@Environmental Health & Trading Standards
Cc: Jason Baldwin; Gemma Clark; Bernadette Barry
Subject: RE: Beaw Field

Hi Richard

I hope you are well and not too busy in the run up to Christmas.

Further to the emails below please can you let me know when you will be able to provide your thoughts on our appraisal of the fixed minimum limits?

Kind Regards

James Mackay

Head of Technical Services
TNEI Services Limited

Tel: +44 (0)191 2111414
Mob: +44 (0)7974 077846
Fax: +44 (0)191 2111432
Website: http://www.tnei.co.uk
E-mail: james.mackay@tnei.co.uk
Address: Milburn House, Dean Street, Newcastle upon Tyne, NE1 1LE

From: richard.cooper@shetland.gov.uk [mailto:richard.cooper@shetland.gov.uk]
Sent: 16 December 2015 09:10
To: gemma.clark@tnei.co.uk
Subject: RE: Beaw Field

Thank you Gemma

Regards
Richard Cooper
Environmental Health Officer
Environmental Health & Trading Standards
Shetland Islands Council
Infrastructure Services
Charlotte House
Commercial Road
Lerwick
ZE1 0LX

Direct Dial: 01595 744816
Fax: 01595 744802
ehadmin@shetland.gov.uk
www.shetland.gov.uk

From: Gemma Clark [mailto:gemma.clark@tnei.co.uk]
Sent: 15 December 2015 11:16
To: Cooper Richard@Environmental Health & Trading Standards
Cc: James Mackay; Jason Baldwin
Subject: FW: Beaw Field

Hi Richard,

My colleague James is out of the office at the moment so he has asked me to send you the draft section of our assessment which discusses the choice of day time fixed minimum limit for the proposed Beaw Field Wind Farm. Please see the email below and attached information.

We look forward to hearing from you soon.

Kind regards

Gemma

From: James Mackay [mailto:james.mackay@tnei.co.uk]
Sent: 24 November 2015 15:20
To: Jason Baldwin; richard.cooper@shetland.gov.uk
Cc: Gemma Clark; Bernadette Barry
Subject: RE: Beaw Field

Hi Richard

Further to our telephone discussion last week, please find attached a draft copy of the section of our assessment which discusses the choice of day time fixed minimum limit for the proposed Beaw Field Wind Farm. As we have previously discussed ETSU-R-97 and the IOA GPG detail three criterion to consider when determining which fixed minimum noise limit is appropriate and we have discussed each of those criterion in detail within the note and detailed why we think 40dB should be adopted.

We hope that you find this information useful. If you have any questions or require additional information, please do not hesitate to contact me. We look forward to hearing from you soon.

Kind Regards

James Mackay

Head of Technical Services
TNEI Services Limited

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Mob: +44 (0)7974 077846
Fax: +44 (0)191 2111432
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E-mail: james.mackay@tnei.co.uk
Address: Milburn House, Dean Street, Newcastle upon Tyne, NE1 1LE

Registered in England & Wales No. 03891836, Registered office: Brook House, 88-100 Chertsey Road, Woking, Surrey, GU21 5BJ

From: Jason Baldwin [mailto:jason.baldwin@tnei.co.uk]
Sent: 11 November 2015 16:35
To: richard.cooper@shetland.gov.uk
Cc: Gemma Clark; James Mackay; Bernadette Barry
Subject: RE: Beaw Field

Hi Richard,

I hope you are well.

I was just wondering whether you are any closer to providing your comments on the fixed minimum limits yet? If not do you know when we are likely to receive your comments?

Additionally, have you had a chance yet to pull together the application numbers for the turbines you outlined previously?

We are looking to finalise the noise assessment ASAP and so would very much appreciate your comments at your earliest convenience.

Many thanks,

--

Jason Baldwin

Technical Consultant
TNEI Services Limited

Tel: +44 (0)191 2111412
Fax: +44 (0)191 2111432
Website: http://www.tnei.co.uk
E-mail: jason.baldwin@tnei.co.uk
Address: Milburn House, Dean Street, Newcastle upon Tyne, NE1 1LE

Registered in England & Wales No. 03891836, Registered office: Chester House, 76-78 Chertsey Road, Woking, United Kingdom, GU21 5BJ

From: Jason Baldwin [mailto:jason.baldwin@tnei.co.uk]
Sent: 03 November 2015 12:58
To: 'richard.cooper@shetland.gov.uk'
Cc: Gemma Clark; James Mackay
Subject: RE: Beaw Field

Hi Richard,

Thanks for the email you sent last week.

We will need to consider the small wind turbines so please could you send me through the application numbers? There would be no requirement to undertake another background noise survey as we have already determined background noise levels at the various properties around the wind farm.

I was also wondering whether you have any comments yet regarding the fixed minimum limits?

Many thanks,

--

Jason Baldwin

Technical Consultant
TNEI Services Limited

Tel: +44 (0)191 2111412
Fax: +44 (0)191 2111432
Website: http://www.tnei.co.uk
E-mail: jason.baldwin@tnei.co.uk
Address: Milburn House, Dean Street, Newcastle upon Tyne, NE1 1LE

From: richard.cooper@shetland.gov.uk [mailto:richard.cooper@shetland.gov.uk]
Sent: 28 October 2015 11:58
To: jason.baldwin@tnei.co.uk
Subject: RE: Beaw Field

Hi Jason

Planning/Development have consulted Environmental Health regarding 15 -20 small wind turbines yesterday and today including on Yell. I understand that proposed changes to domestic Feed-in Tariff Scheme is expected to be in January 2016 – hence the number of applications. I will send you any relevant planning applications for any small wind turbines in Yell. If there is a number of new small turbines in the scheme, how would you undertake a new background noise assessment or similar?

Regards

Richard Cooper
Environmental Health Officer
Environmental Health & Trading Standards
Shetland Islands Council
Infrastructure Services
Charlotte House
Commercial Road
Lerwick
ZE1 0LX

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ehadmin@shetland.gov.uk
www.shetland.gov.uk

From: Jason Baldwin [mailto:jason.baldwin@tnei.co.uk]
Sent: 27 October 2015 17:12
To: Cooper Richard@Environmental Health & Trading Standards
Cc: Gemma Clark; Bernadette Barry; James Mackay
Subject: RE: Beaw Field

Hi Richard, I hope you are well.

Just following up with the below email correspondence, did you manage to send the report to your manager regarding the fixed minimum limits last week, if so would you be in a position to provide this please?

We're looking to finalise the noise assessment early next week and are obviously keen to get your feedbag to ensure it is incorporated into the final report.

Many thanks,

--

Jason Baldwin

Technical Consultant
TNEI Services Limited

Tel: +44 (0)191 2111412
Fax: +44 (0)191 2111432
Website: http://www.tnei.co.uk
E-mail: jason.baldwin@tnei.co.uk
Address: Milburn House, Dean Street, Newcastle upon Tyne, NE1 1LE

From: Jason Baldwin [mailto:jason.baldwin@tnei.co.uk]
Sent: 20 October 2015 13:30
To: 'richard.cooper@shetland.gov.uk'
Cc: Gemma Clark; 'Bernadette Barry'
Subject: RE: Beaw Field

Thanks very much Richard that's very useful.

Please don't hesitate to ask if you need any additional information from us to produce the report for your manager. We have some examples of schemes where the 40dB FML has been adopted if that would be useful?

Kind regards,

--

Jason Baldwin

Technical Consultant
TNEI Services Limited

Tel: +44 (0)191 2111412
Fax: +44 (0)191 2111432
Website: http://www.tnei.co.uk
E-mail: jason.baldwin@tnei.co.uk
Address: Milburn House, Dean Street, Newcastle upon Tyne, NE1 1LE

From: richard.cooper@shetland.gov.uk [mailto:richard.cooper@shetland.gov.uk]
Sent: 20 October 2015 10:59
To: jason.baldwin@tnei.co.uk
Subject: RE: Beaw Field

Hi Jason

I have identified 12 small wind turbines in the locality. I have to produce a report to my manager regarding the fixed minimum limits – definitely this week.

Regards

Richard

From: Jason Baldwin [mailto:jason.baldwin@tnei.co.uk]
Sent: 19 October 2015 16:08
To: Cooper Richard@Environmental Health & Trading Standards
Cc: Gemma Clark; James Mackay
Subject: RE: Beaw Field

Hi Richard,

That's much appreciated, I wondered if it would be possible to send over the planning applications for the turbines in order that we are as accurate as possible with the actual positionings etc?

Additionally, we would still very much appreciate your comments regarding the fixed minimum limits, please could you advise when you will be coming back on this?

Many thanks,

--

Jason Baldwin

Technical Consultant
TNEI Services Limited

Tel: +44 (0)191 2111412
Fax: +44 (0)191 2111432
Website: http://www.tnei.co.uk
E-mail: jason.baldwin@tnei.co.uk
Address: Milburn House, Dean Street, Newcastle upon Tyne, NE1 1LE

From: richard.cooper@shetland.gov.uk [mailto:richard.cooper@shetland.gov.uk]
Sent: 16 October 2015 10:33
To: jason.baldwin@tnei.co.uk

Cc: john.holden@shetland.gov.uk
Subject: Beaw Field

Hi Jason

I counted 10 small wind turbines in the immediate area:

1. 'The Hall' 1.2km due North from the ferry terminal
2. 'Anchorlea' 290m from the above due North-West
3. The turbine next to the 'Schoolhouse'
4. 'Heatherlea' (next to above)
5. The turbine next to 'Heatherlea'
6. 'Leabreck' (next to 'Heatherlea')
7. 'Kletterlea'
8. 'Burravoe Public Hall'
9. 'Old Hall of Brough'
10. Burravoe Primary School
11. Giggleswick
12. South of Giggleswick
13. Corn Hill – East Yell, on the B9081 going north

I will come back to you regarding the fixed minimum limit of 40dB.

Regards

Richard Cooper
EHO
x4816

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Jason Baldwin

From: richard.cooper@shetland.gov.uk
Sent: 16 October 2015 09:24
To: jason.baldwin@tnei.co.uk
Subject: RE: 10081 - Beaw Field Noise Summary Email

Hi Jason

We are a little thin on the ground; however I will reply today.

Regards

Richard

From: Jason Baldwin [mailto:jason.baldwin@tnei.co.uk]
Sent: 14 October 2015 17:48
To: Cooper Richard@Environmental Health & Trading Standards
Cc: Bernadette Barry; James Mackay; Gemma Clark
Subject: RE: 10081 - Beaw Field Noise Summary Email

Good evening Richard,

Thanks very much for your time on the phone earlier with regards to the proposed Beaw Field Wind Farm.

Just for information, we discussed the below email with regards to the baseline data, cumulative methodology, and fixed minimum limits. To clarify, I noted you were happy with the points that we requested your feedback on (baseline data, cumulative methodology, and choice of fixed minimum limits) and you said that you were going to formally come back fairly shortly to confirm.

Additionally you mentioned that you were going to double check the miniature turbines in the area, just to ensure we have included them all in the assessment. As far as you are aware though no more turbines are due to be erected, nor are there any in the planning stages that you are aware of.

If you could confirm again that you are happy with the points below then that would be much appreciated, as you can imagine we are very keen to progress onto the final reporting stage of the assessment.

Kind regards,

--

Jason Baldwin

Technical Consultant
TNEI Services Limited

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Fax: +44 (0)191 2111432
Website: http://www.tnei.co.uk
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From: Jason Baldwin [mailto:jason.baldwin@tnei.co.uk]
Sent: 02 October 2015 17:33
To: 'richard.cooper@shetland.gov.uk'

Cc: 'Bernadette Barry'; James Mackay
Subject: 10081 - Beaw Field Noise Summary Email

Hi Richard,

Thanks very much for your time on the phone last Friday.

I have produced a bit of a summary note for your information to recap on the actions discussed during the call.

As discussed, I have attached the information on the operational wind turbines in and about the area. From a mixture of looking on the council website as well as the site visit undertook, we have noted 8 small turbines;

- Four just to the south of Loch of Kettlester;
- One to the south east of NML 3 – Easterlee
- One just to the north of Burravoe School
- One to the north and
  One to the south of Giggleswick – to the east of Burravoe School

I would be very grateful if you could confirm whether you know of any more in the area that we may have missed?

In terms of the audibility of the turbines, I noted at the time that at Noise Monitoring Location 3 (NML 3) – Easterlee we could not hear the turbines located closest to the properties - to the south and south east, I also noted it was a fairly calm day and the turbines were all operating. Obviously you did not witness the noise kits going in for locations NML4 or NML5 but we again could not hear the turbines and this is something the residents confirmed whilst on site. NMLs 1 and 2 to the north of the site do not have any turbines installed in the area.

Whilst we did not hear the turbines on site when installing the noise monitoring equipment, we will look to undertake some filtering of the measured data to understand whether there is an influence from the turbines, and if so, remove the data from the datasets to ensure that you are happy that no influence from the turbines is included. You mentioned that you would have a think back to consider the locations and let us know if you had any specific comments, I have attached the noise kit installation report for each of the properties which may be of assistance.

The Council noted in the call that residents around other sites/turbines on the islands have complained about shadow flicker occurring at distances greater than 10 rotor diameters. This is something that Peel will look at as part of the shadow flicker assessment for the Environmental Statement (as TNEI are not involved with the Shadow Flicker assessment for this site).

It was requested by TNEI and Peel that the Council consider the fixed minimum limits for the assessed properties around the site. TNEI have looked at the three tests as part of ETSU-R-97 to aide in the decision, for clarity these are;

- 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

In terms of the number of dwellings in the area that would be affected by a 40dB fixed minimum limit, TNEI has noted that only the properties to the north east, and a property to the south would be affected, whilst all other properties would not be using the increased limit as predicted noise from the wind farm would be within 35dB or background +5dB. Whilst the exact number of properties that may be affected will depend on the final layout and the candidate turbine it is expected that the number of properties affected will be nine or less, this is considered to be a low number given the scale of the development which suggests a limit towards the upper end of the range.

With regard to the number of kWh generated, TNEI stated that, crudely, four of the turbines would need to be removed from the current layout to keep within the 35dB FML. This would equate to up to 14MW installed capacity or just under 25% of the total scheme and so would have a large impact upon the generating potential of the scheme. Accordingly TNEI feel that a limit towards the upper end of the range would be justified based on this test.

In relation to the level and duration of exposure, the key properties are located to the north east of the proposed development so would be downwind of the turbines for a reasonable proportion of the time. The wind rose for the site does however suggest that the area will experience a wide range of wind directions which would limit the exposure. The reliance of the fixed minimum limits is for a relatively small range of wind speeds for the properties to the north east 5.5 to 8.5 m/s and a very small range to the south 6 – 6.5m/s as background noise increases with wind speed meaning that the limit at higher wind speeds is based on background plus 5dB rather than the fixed minimum limits.

Additionally, it may be appropriate to consider the fact that the site is within Group 3 as indentified in the Onshore Wind Supplementary Guidance. With reference to areas identified for wind farms, the IOA GPG states that;

'3.2.6 Other planning considerations, such as the identification in local planning policy of areas of preferred windfarm development, may also influence or determine the choice of the absolute fixed amenity noise limit.'

We have worked on many sites with similar characteristics to Beaw Field, where a 40dB limit has been consented, more information on these schemes and the decision notices/ conditions can be provided to you if you feel it would be helpful.

It is quite common for large scale wind farms in remote areas to be given a FML of 40dB and having due regards to the tests outlined in ESTU-R-97 we feel that adoption of a 40dB daytime fixed minimum limit would be appropriate for this site.

As discussed we hope to be in a position to finalise the noise assessment in the next couple of weeks so we would be very keen to obtain your feedback as soon as possible. In particular we would be very grateful if you could:

- Confirm that you are happy with the baseline data sets as discussed on the call (or alternatively to detail any locations where you feel the measured levels could be unduly influenced by extraneous noise sources);
- Provide your opinion on the suggested fixed minimum limit of 40dB; and
- Confirm that you are happy with the proposed approach to cumulative noise (setting site specific limits by determining the total ETSU-R-97 noise limit then subtracting the noise that is already being used by the existing turbines in the area).

I hope that this email is useful and we look forward to hearing back from you regarding the points above. If you have any further questions on the above please do not hesitate to get in touch.

Kind regards,

--

Jason Baldwin

Technical Consultant
TNEI Services Limited

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04 June 2015

Ref: 10081-001

Sent by email only.

Mr Richard Cooper
Environmental Health Officer
Environmental Health & Trading Standards
Shetland Islands Council
Infrastructure Services
Charlotte House
Commercial Road
Lerwick
ZE1 0LX

Dear Mr Cooper,

PROPOSED BEAW FIELD WIND FARM ON LAND TO THE NORTH EAST OF ULSTA AND NORTH WEST OF BURRAVOE, ISLE OF YELL: NOISE ASSESSMENT

As you may be aware, Peel Wind Farms (Yell) Limited (Peel) is considering developing a wind farm on the south of Yell in the Shetland Islands, approximately 4 km northeast of Ulsta and 1 km northwest of Burravoe. An initial draft wind turbine layout is shown on the enclosed Figure 1 (in Appendix 1).

Noise will be emitted from the proposed development during the construction, operation and decommissioning phases of the project. Noise emitted during the construction phase will be temporary and short term in nature and can be minimised through careful construction practices. Operational noise from wind energy developments is controlled through the use of appropriate noise limits which are imposed to protect the amenity of neighbouring properties without unduly restricting wind energy development. Noise limits need to be derived at an early stage of the development to ensure they are satisfied throughout the design process.

TNEI Services has been appointed by Peel to undertake the noise assessments for the proposed development, and prior to commencing the noise assessments we would like to agree with you the noise assessment methodologies and proposed background noise monitoring locations.

Construction and Decommissioning Noise

A construction noise assessment will be undertaken to determine the potential noise impacts during the construction phase of the wind farm development. The construction noise assessment will be undertaken in accordance with the methodology outlined in British Standard (BS) 5228-1:2009+A1:2014 and ISO9613:1996 ('Acoustics - Attenuation of sound during propagation outdoors' -Part 2: General method of calculation'). Impacts will be assessed using criteria contained within 5228-1:2009+A1:2014 and, where appropriate, mitigation measures will be proposed. Noise impacts arising from the decommissioning phase of the project will be considered in the construction noise assessment.

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Operational Noise

An operational noise assessment will be undertaken in accordance with ETSU-R-97 '*The Assessment and Rating of Noise from Wind Farms'* (ETSU-R-97) and the Institute of Acoustics document *'A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise'* (IOA GPG). In relation to wind turbine noise PAN 1/2011 '*Planning and Noise'* refers to the Scottish Governments *'Onshore Wind Turbines'* web based document which states that:

"ETSU-R-97 describes a framework for the measurement of wind farm noise, which should be followed by applicants and consultees, and used by planning authorities to assess and rate noise from wind energy developments, until such time as an update is available".

And;

"The Institute of Acoustics (IOA) has since published Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise The document provides significant support on technical issues to all users of the ETSU-R-97 method for rating and assessing wind turbine noise, and should be used by all IOA members and those undertaking assessments to ETSU-R-97. The Scottish Government accepts that the guide represents current industry good practice."

The noise limits derived in the assessment would inform appropriate noise related planning conditions should an application be made and should the Council be minded to grant consent.

ETSU-R-97

ETSU-R-97 describes the findings of the Working Group on Noise from Wind Turbines, the aim of which was to provide information and advice to developers and planners on the environmental assessment of operational noise from wind turbines.

ETSU-R-97 recommends noise limits should be set at 5dB(A) above existing background noise levels, subject to fixed minimum limits (35-40dB for quiet daytime and 43dB for night-time periods), and that these limits should reflect the variation in background noise with wind speed. Different limits apply to those properties that have a financial interest in the wind energy development.

The choice of quiet daytime fixed minimum limits should be considered in light of the guidance contained within ETSU-R-97. We would be very keen to work with the Council with a view to agreeing suitable daytime fixed minimum limits at an early stage to ensure the development can be designed accordingly. Some further information on fixed minimum limits is included in Appendix 2.

In order to establish noise limits in accordance with ETSU-R-97 it is necessary to determine the relationship between wind speed measured at the proposed wind farm site and background noise levels measured at the closest noise sensitive receptors. This requires the installation of noise monitoring equipment at representative properties surrounding the site as well as the installation of wind monitoring equipment on the site itself.

It is anticipated that Peel will arrange the installation of a LIDAR / SODAR unit or large meteorological mast prior to a noise survey taking place, which will be used to collect wind speed and direction data at various heights. Data from the LIDAR / SODAR unit or large meteorological mast will be used to determine the wind speed at turbine hub height (currently expected to be up to 100m) this will then be adjusted to a height of 10m using a standardised roughness length of 0.05m to derive 'wind speed as standardised to 10m height'. Wind speed as standardised to 10m height will be used in the assessment. This is consistent with method A or B as outlined in the IOA GPG (on page 10 of 40). A rain logger will also be installed at one of the noise monitoring locations

to record any periods of rainfall. A series of simultaneous ten-minute measurements will be taken by each piece of equipment over a period of at least two weeks.

Background noise levels will be monitored at a height of between 1.2m and 1.5m above ground, in line with the ETSU-R-97 / IOA GPG guidance. The noise monitoring equipment will be located in a free-field position at least 3.5m away from hard reflective surfaces where practicable and within the residential amenity area.

The following steps summarise the proposed entire noise assessment process for this scheme:

- measure the background noise levels at each receptor. This will involve the continuous logging of the $L_{A90,\ 10min}$ values at each receptor for a minimum period of two weeks;
- obtain simultaneous ten minute average wind speed data from the wind farm site;
- edit baseline noise data to remove any unrepresentative readings (such as periods of rainfall) and split the data into night-time and quiet daytime hours;
- determine the quiet day-time and night-time criterion curves (i.e. noise limits) from the measured background noise levels at the nearest neighbours using regression analysis and recommendations within ETSU-R-97;
- specify the type and noise emission characteristics of a candidate wind turbine suitable for the site;
- calculate the predicted noise immission levels of the operation of the wind farm as a function of on-site wind speed at the nearest noise sensitive receptors;
- compare the calculated wind farm noise immission levels with the derived criterion curves to assess compliance with ETSU-R-97; and
- change the proposed locations of the wind turbines (if necessary) so that the noise limits are achieved.

Prior to commencing the noise survey we would like to agree suitable locations at which to monitor background noise levels in order to provide a representative dataset for the area. Figure 1 shows the indicative predicted wind farm noise contours based on a current draft wind farm layout and proposed background noise monitoring locations.

We have undertaken initial modelling based on a draft twenty turbine layout. In line with current good practice, noise predictions have been undertaken using the propagation model contained within Part 2 of International Standard ISO 9613:1996, *Acoustics – Attenuation of sound during propagation outdoors – Part 2 General method of calculation*. The model assumes mixed ground conditions and data for a candidate turbine, the Senvion 3.4M, 3.4MW which was chosen to be representative of the size of turbine that could be installed at the site. Figure 1 shows which of the neighbouring properties to the proposed wind farm development fall within the 35dB(A) L_{90} contour. Generally, any property outside the 35dB(A) contour does not need to be considered in the assessment, as protection of the amenity of these properties can be controlled through a simplified noise condition as detailed in ETSU-R-97 (given below). TNEI propose to include H6 which is located just outside the 35dB(A) contour to allow for flexibility in the wind farm layout / final choice of turbine model.

ETSU-R-97 states that '*For single turbines or wind farms with very large separation distances between the turbines and the nearest properties, a simplified noise condition may be suitable. If the noise is limited to an $L_{90,10min}$ of 35dB(A) up to wind speeds of 10m/s at 10m height, then this condition alone would offer sufficient protection of amenity, and background noise surveys would be unnecessary.*'

We believe noise monitoring equipment installed at six dwellings would provide a sufficient sample of representative background noise data for the area. The proposed monitoring locations are detailed in Table 1 below. The properties identified for the assessment will be the closest ones to the site in each direction. Hence, it can be assumed that if noise limits can be achieved at these locations then limits will also be achieved at other properties located at greater distances from the wind farm.

Table 1 - Suggested Noise Monitoring Locations for the Proposed Beaw Field Wind Farm

Property/Location	Justification
H1-Property at Holligarth	Closest receptor to the north/north east of the proposed development.
H2-Property to south of Gossabrough	Closest receptor to the east/north east of the proposed development to represent properties at Gossabrough.
H3-Easterlee	Closest receptor to the south of the proposed development.
H4- Property to north east of Upper Neepaback	Closest receptor to the south/south east of the proposed development to represent properties at Upper Neepaback.
H5- Littlester	Closest receptor to the south/south west of the proposed development to represent properties at Littlester.
H6-Property at Hamnavoe	Closest receptor to the south west of the proposed development to represent properties at Hamnavoe.

Monitoring at the locations listed in Table 1 is subject to consent from the owners/occupiers. If we are unable to gain access to monitor at the proposed properties representative alternative locations will be selected and we will inform you of these alternative locations.

Cumulative Operational Noise Assessment

TNEI is aware that there is an operational micro wind turbine to the north of Kettlester which may require some consideration particularly when siting the noise monitoring equipment but are not aware of any other schemes in the area that would warrant inclusion in a cumulative noise assessment.

If possible we would be very keen for you or one of your colleagues to attend the installation of the noise monitoring equipment in order for you to agree the exact noise monitoring locations.

To enable us to progress the assessment I would be very grateful if you confirm whether:

- You are happy with the proposed assessment methods outlined above (BS5228, ETSU-R-97 and the IOA GPG);
- You agree with the general monitoring locations proposed (subject to exact siting);
- You or one of your colleagues can attend the noise kit installation (which will take place on Wednesday 24th June); and
- if the Council are aware of any schemes which should be included in the cumulative noise assessment.

We are proposing to install the noise monitoring equipment on Wednesday 24th June; therefore, we would appreciate a response to this letter at your earliest convenience. If you have any

immediate concerns or queries, please do not hesitate to contact me or my colleague Gemma Clark. We look forward to hearing from you soon.

Yours sincerely,

Jason Baldwin
BSc(Hons),Dip, AMIOA

Technical Consultant
jason.baldwin@tnei.co.uk
Tel: 0191 211 1417

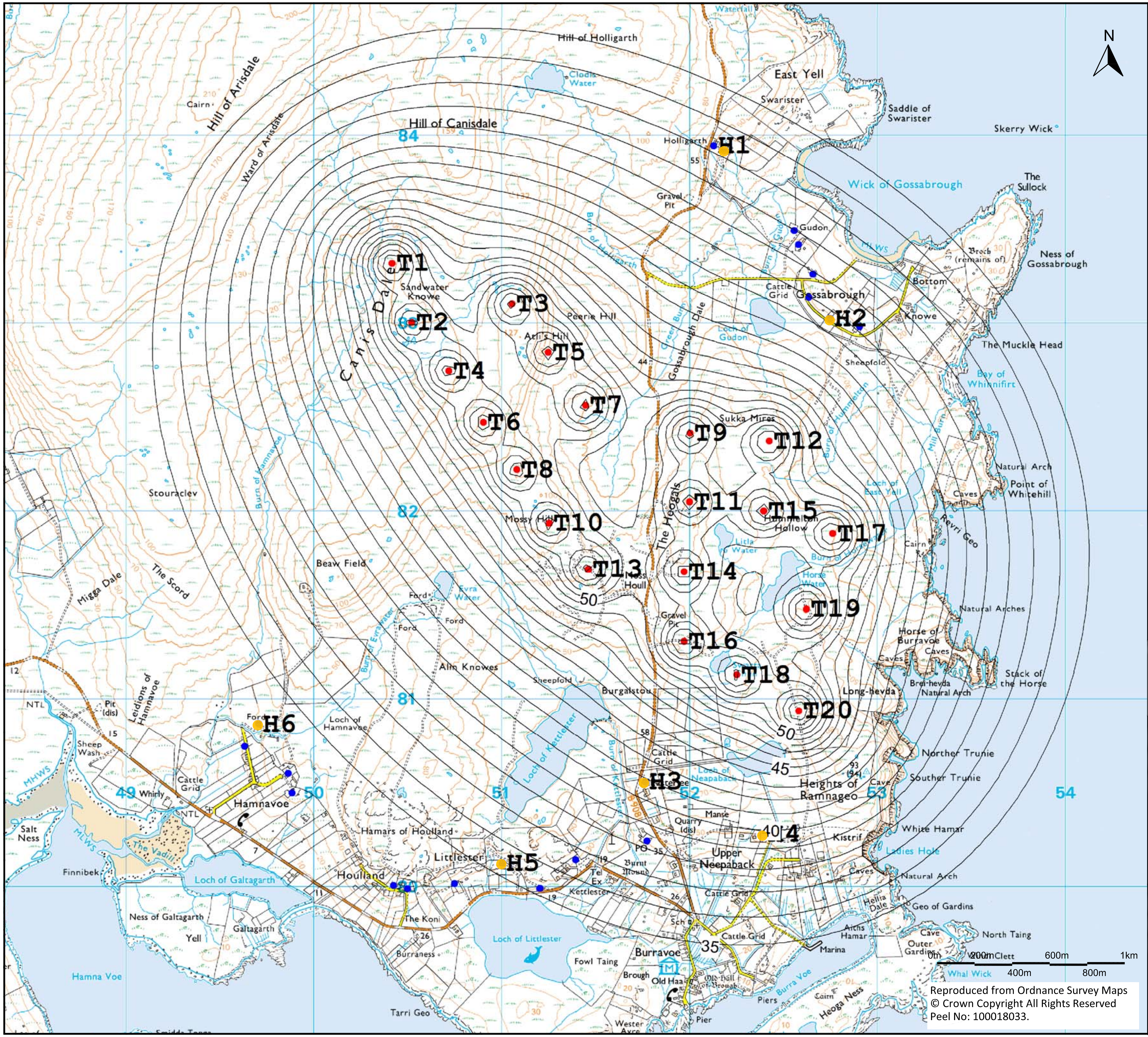
Reviewed and approved by:

Gemma Clark
BSc(Hons), MSc, TechIOA

Senior Technical Consultant
gemma.clark@tnei.co.uk
Tel: 0191 2111418

Enc.
Appendix 1 – Figure 1
Appendix 2 – Choice of day time fixed minimum limits

Appendix 1 – Figures



Legend

- H1 — Proposed Noise Monitoring Location
- Noise Sensitive Receptor
- 1 — T1 to T20 Indicative Turbine Layout
- 45 — Predicted Turbine Noise dB(A), L90 based on the Senvion 3.4M wind turbine*

*Noise predictions have been undertaken using mixed ground (G=0.5). The contour plot models the highest noise output predicted between 0 and 10m/s.

Rev.	DETAILS	DRAWN	CHK'D	APP'D	DATE
R1	FIRST ISSUE	JB	JM	JM	29/05/2015

Project:	Beaw Field Wind Farm
Client:	Peel Wind Farms (Yell) Ltd
Figure Title:	Noise Contour plot
Figure Number:	1
Scale:	1 to 20,000@A3
Document Reference:	10081-002

PEEL Energy

tnei enterprise with energy

Appendix 2 – Choice of Day Time Fixed Minimum Limits

The quiet daytime limits are chosen to protect external amenity, the precise choice of level within the range 35dB(A) to 40dB(A) depends on a number of factors, including the number of noise affected properties, the duration of exposure of these properties and the effect of using tighter limits on the potential power output of the wind farm. ETSU-R-97 provides the following guidance (p65):

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 planning process is trying to balance the benefits arising out of the development of renewable energy sources against the local environmental impact. The more dwellings that are in the vicinity of a wind farm the tighter the limits should be as the total environmental impact will be greater. Conversely if only a few dwellings are affected, then the environmental impact is less and noise limits towards the upper end of the range may be appropriate...

The effect of noise limits on the number of kWh generated.

Similar arguments can be made when considering the effect of noise limits on uptake of wind energy. A single wind turbine causing noise levels of 40dB(A) at several nearby residences would have less planning merit (noise considerations only) than 30 wind turbines also causing the same amount of noise at several nearby residences.

Duration and level of exposure.

The proportion of the time at which background noise levels are low and how low the background noise level gets are both recognised as factors which could affect the setting of an appropriate lower limit. For example, a property which experienced background noise levels below 30dB(A) for a substantial proportion of the time in which the turbines would be operating could be expected to receive tighter noise limits than a property at which the background noise levels soon increased to levels above 35dB(A). This approach is difficult to formulate precisely and a degree of judgement should be exercised.

Clearly a detailed assessment regarding fixed minimum limits can only be made once background noise data is available and once some additional draft layouts are available. As detailed above we would welcome the opportunity to discuss the choice of fixed minimum limits with you once information becomes available, at an early stage of the assessment, to ensure that the scheme is designed appropriately in light of data measured at the site.

Gemma Clark

From: Jason Baldwin
Sent: 10 June 2015 11:33
To: richard.cooper@shetland.gov.uk
Cc: Patti.Hammond-Dinsdale@shetland.gov.uk; Gemma Clark
Subject: Beaw Field wind farm noise assessment

Dear Mr Cooper,

Thank you for responding to my colleague Gemma Clark on our proposal below.

I can confirm that we intend to install three rain gauges during the noise monitoring; located at either H1 or H2, H4 and H6, shown on figure 1 in the consultation letter.

Peel are currently in the process of contacting residents regarding the installation of noise equipment at their properties and we have determined a date of the 24th June to undertake the installation. Would you or one of your colleagues be available on that date to attend the installation of the noise equipment?

If you have any further queries on the noise assessment, please do not hesitate to get in touch.

Kind regards,

--

Jason Baldwin

Technical Consultant
TNEI Services Limited

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From: richard.cooper@shetland.gov.uk [mailto:richard.cooper@shetland.gov.uk]
Sent: 08 June 2015 16:33
To: gemma.clark@tnei.co.uk
Cc: Patti.Hammond-Dinsdale@shetland.gov.uk
Subject: Beaw Field wind farm noise assessment

Dear Ms Clark

Thank you for your email and attachment. I have looked at the proposal and I am happy regarding the monitoring locations and the proposed assessment methods (ETSU, BS 5228 etc). Could you confirm how many rain loggers will be installed at the noise monitoring locations please?

Communication in Shetland is imperative especially in remote locations. I recommend that TNEI contact local residents at the start and during the initial assessment, construction and operational noise – including completion dates etc.

Regards

Richard Cooper
Environmental Health Officer
Environmental Health & Trading Standards
Shetland Islands Council
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ANNEX 3 – Field Data Sheets

Noise Monitoring Field Data Sheet

Project Title	Beaw Field Wind Farm	Project Number	10081
Client	Peel Wind Farms (Yell) Ltd	Surveyor	JB, MT

MONITORING LOCATION

Location Name	Noise monitoring location 1 – Lower Holliegarth
Equipment Position	In the rear garden area within some enclosed fencing. In a free field position as far as was reasonably possible from any hard reflecting surface except the ground.
Approximate Grid Reference	Easting: 452207 Northing: 1183916
Dominant noise sources noted during installation, weekly inspection and removal	Birdsong, cattle, distant road traffic and light winds.

MONITORING EQUIPMENT

	Kit Number	Model	Serial Number	Last Calibrated/ Conformance Checked
Sound Level Meter	SLM 012	NL-32	01273087	13/02/15
Pre Amplifier	SLM 012	NH-21	26006	13/02/15
Microphone	SLM 012	UC-53A	313365	13/02/15
Calibrator	CAL001	NC-74	34762316	24/02/15

EQUIPMENT SETTINGS

	Required	Selected
Noise Weighting	'A' Weighting	Yes
Measurement Interval	10 Minutes	Yes
Time Weighting	FAST	Yes
Measurement Range	20-110 dB	Yes

DATA

File Name	Start Time	End Time	Calibration at Start	Calibration at End	Drift	Observations
0101	12:00 24/06/15	10:09 30/07/15	94.0	94.0	-	Noise from birdsong, cattle, light wind and distant road traffic.

Photographs

Project Title	Beaw Field Wind Farm	Project Number	10081
Client	Peel Wind Farms (Yell) Ltd	Surveyor	JB, MT

MONITORING LOCATION

Location Name	H1 - Lower Holliegarth

Photograph:

H1 – NE

H1 – NW

H1 – SE

H1 – SW

Location Description	The noise kit was placed in the rear garden area within enclosed mesh fencing to the south east of the dwelling. The location was chosen due to it being the main amenity area at the property. The kit was situated in a free field position more than 3.5m away from any hard reflecting surface except the ground.

Noise Monitoring Field Data Sheet

Project Title	Beaw Field Wind Farm	Project Number	10081
Client	Peel Wind Farms (Yell) Ltd	Surveyor	JB, MT

MONITORING LOCATION

Location Name	Noise monitoring location 2 – Gossabrough
Equipment Position	In the rear garden area of the property. In a free field position more than 3.5m away from any hard reflecting surface except the ground.
Approximate Grid Reference	Easting: 452800 Northing: 1183060
Dominant noise sources noted during installation, weekly inspection and removal	Sea noise, bird song, sheep, light traffic and wind induced noise.

MONITORING EQUIPMENT

	Kit Number	Model	Serial Number	Last Calibrated/ Conformance Checked
Sound Level Meter	SLM 2	NL-32	00661768	18/02/15
Pre Amplifier	SLM 2	NH-21	19772	18/02/15
Microphone	SLM 2	UC-53A	310459	18/02/15
Calibrator	CAL001	NC-74	34762316	24/02/15

EQUIPMENT SETTINGS

	Required	Selected
Noise Weighting	'A' Weighting	Yes
Measurement Interval	10 Minutes	Yes
Time Weighting	FAST	Yes
Measurement Range	20-110 dB	Yes

DATA

File Name	Start Time	End Time	Calibration at Start	Calibration at End	Drift	Observations
0201	11:10 24/06/15	10:47 30/07/15	94.0	94.2	+0.2	Noise from the sea, wind induced noise, birdsong, sheep, and odd car going past

Photographs

Project Title	Beaw Field Wind Farm	Project Number	10081
Client	Peel Wind Farms (Yell) Ltd	Surveyor	JB, MT

MONITORING LOCATION

Location Name	H2 - Gossabrough

Photograph:

H2 – NE

H2 – NW

H2 – SE

H2 – SW

Location Description	The noise kit was placed in the rear garden area of the property. The location was chosen due to it being the main amenity area at the property. The kit location is situated in a free field position more than 3.5m away from any hard reflecting surface except the ground. A rain gauge was installed next to the noise monitoring kit to monitor periods of rain fall.

Noise Monitoring Field Data Sheet

Project Title	Beaw Field Wind Farm	Project Number	10081
Client	Peel Wind Farms (Yell) Ltd	Surveyor	JB, MT

MONITORING LOCATION

Location Name	Noise monitoring location 3 – Easterlee
Equipment Position	In the front garden area to the west of the property. In a free field position as far as was reasonably possible from any hard reflecting surface except the ground.
Approximate Grid Reference	Easting: 451760 Northing: 1180551
Dominant noise sources noted during installation, weekly inspection and removal	Birdsong, dogs bark, helicopter overhead and light wind generated noise.

MONITORING EQUIPMENT

	Kit Number	Model	Serial Number	Last Calibrated/ Conformance Checked
Sound Level Meter	SLM 008	NL-32	00972336	16/02/15
Pre Amplifier	SLM 008	NH-21	25121	16/02/15
Microphone	SLM 008	UC-53A	313226	16/02/15
Calibrator	CAL001	NC-74	34762316	24/02/15

EQUIPMENT SETTINGS

	Required	Selected
Noise Weighting	'A' Weighting	Yes
Measurement Interval	10 Minutes	Yes
Time Weighting	FAST	Yes
Measurement Range	20-110 dB	Yes

DATA

File Name	Start Time	End Time	Calibration at Start	Calibration at End	Drift	Observations
0301	12:30 24/06/15	11:38 30/07/15	94.0	93.9	-0.1	Birdsong, slight wind, dogs barking and helicopter overhead

Photographs

Project Title	Beaw Field Wind Farm	Project Number	10081
Client	Peel Wind Farms (Yell) Ltd	Surveyor	JB, MT

MONITORING LOCATION

Location Name	H3 - Easterlee

Photograph:

H3 – N

H3 – E

H3 – S

H3 – W

Location Description	The noise kit was placed in the front garden area to the western side of the property. The location was chosen due to it being the main amenity area at the property. Miniature wind turbines are situated to the south west of the property. The distance between the turbines and the monitoring location was considered sufficient such that no influence of turbine noise on the noise monitoring measurements would occur. Additionally the resident stated that the turbines were never audible during their time there, and could not be heard by the EHO or noise kit installer whilst on site. The kit location is situated in a free field position more than 3.5m away from any hard reflecting surface except the ground.

Noise Monitoring Field Data Sheet

Project Title	Beaw Field Wind Farm	Project Number	10081
Client	Peel Wind Farms (Yell) Ltd	Surveyor	JB, MT

MONITORING LOCATION

Location Name	Noise monitoring location 4 – Nessview
Equipment Position	In the front garden area to the northern side of the property. Located in a free field position more than 3.5m from any hard reflecting surface except the ground.
Approximate Grid Reference	Easting: 452498 Northing: 1180134
Dominant noise sources noted during installation, weekly inspection and removal	Intermittent car traffic, birdsong, cattle, and wind induced noise.

MONITORING EQUIPMENT

	Kit Number	Model	Serial Number	Last Calibrated/ Conformance Checked
Sound Level Meter	SLM 005	NL-32	00861871	18/02/15
Pre Amplifier	SLM 005	NH-21	21094	18/02/15
Microphone	SLM 005	UC-53A	310625	18/02/15
Calibrator	CAL001	NC-74	34762316	24/02/15

EQUIPMENT SETTINGS

	Required	Selected
Noise Weighting	'A' Weighting	Yes
Measurement Interval	10 Minutes	Yes
Time Weighting	FAST	Yes
Measurement Range	20-110 dB	Yes

DATA

File Name	Start Time	End Time	Calibration at Start	Calibration at End	Drift	Observations
0401	10:10 24/06/15	12:05 30/07/15	94.0	94.0	-	Birdsong, sheep noise, intermittent car traffic. Small turbines not audible

Photographs

Project Title	Beaw Field Wind Farm	Project Number	10081
Client	Peel Wind Farms (Yell) Ltd	Surveyor	JB, MT

MONITORING LOCATION

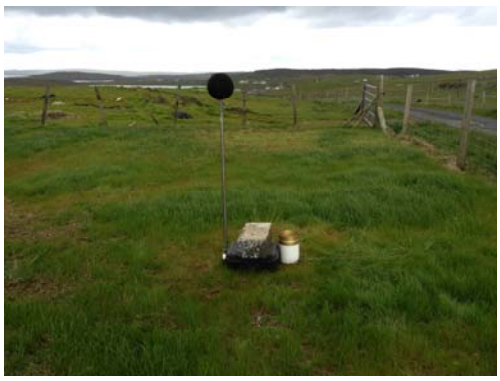
Location Name	H4 - Nessview

Photograph:

H4 – N

H4 – E

H4 – S



H4 – SW

Location Description	The noise kit was placed in the front garden area on the northern side of the dwelling. The location was chosen due to it being the main amenity area at the property. The kit location is situated in a free field position more than 3.5m away from any hard reflecting surface except the ground. A rain gauge was installed at the property to monitor periods of rain fall. The small turbines were not audible.

Noise Monitoring Field Data Sheet

Project Title	Beaw Field Wind Farm	Project Number	10081
Client	Peel Wind Farms (Yell) Ltd	Surveyor	JB, MT

MONITORING LOCATION

Location Name	Noise monitoring location 5 – Heatherlea
Equipment Position	In the rear garden area to the west of the property. In a free field position as far as was reasonably possible from any hard reflecting surface except the ground.
Approximate Grid Reference	Easting: 451286 Northing: 1180038
Dominant noise sources noted during installation, weekly inspection and removal	Birdsong, helicopter overhead, DIY hammering, and light wind generated noise.

MONITORING EQUIPMENT

	Kit Number	Model	Serial Number	Last Calibrated/ Conformance Checked
Sound Level Meter	SLM 004	NL-32	00861870	18/02/15
Pre Amplifier	SLM 004	NH-21	21093	18/02/15
Microphone	SLM 004	UC-53A	310623	18/02/15
Calibrator	CAL001	NC-74	34762316	24/02/15

EQUIPMENT SETTINGS

	Required	Selected
Noise Weighting	'A' Weighting	Yes
Measurement Interval	10 Minutes	Yes
Time Weighting	FAST	Yes
Measurement Range	20-110 dB	Yes

DATA

File Name	Start Time	End Time	Calibration at Start	Calibration at End	Drift	Observations
0501	11:50 24/06/15	12:47 30/07/15	94.0	94.0	-	Birdsong, helicopter overhead, DIY noise (hammering). Small wind turbines not audible.

Photographs

Project Title	Beaw Field Wind Farm	Project Number	10081
Client	Peel Wind Farms (Yell) Ltd	Surveyor	JB, MT

MONITORING LOCATION

Location Name	H5 - Heatherlea

Photograph:

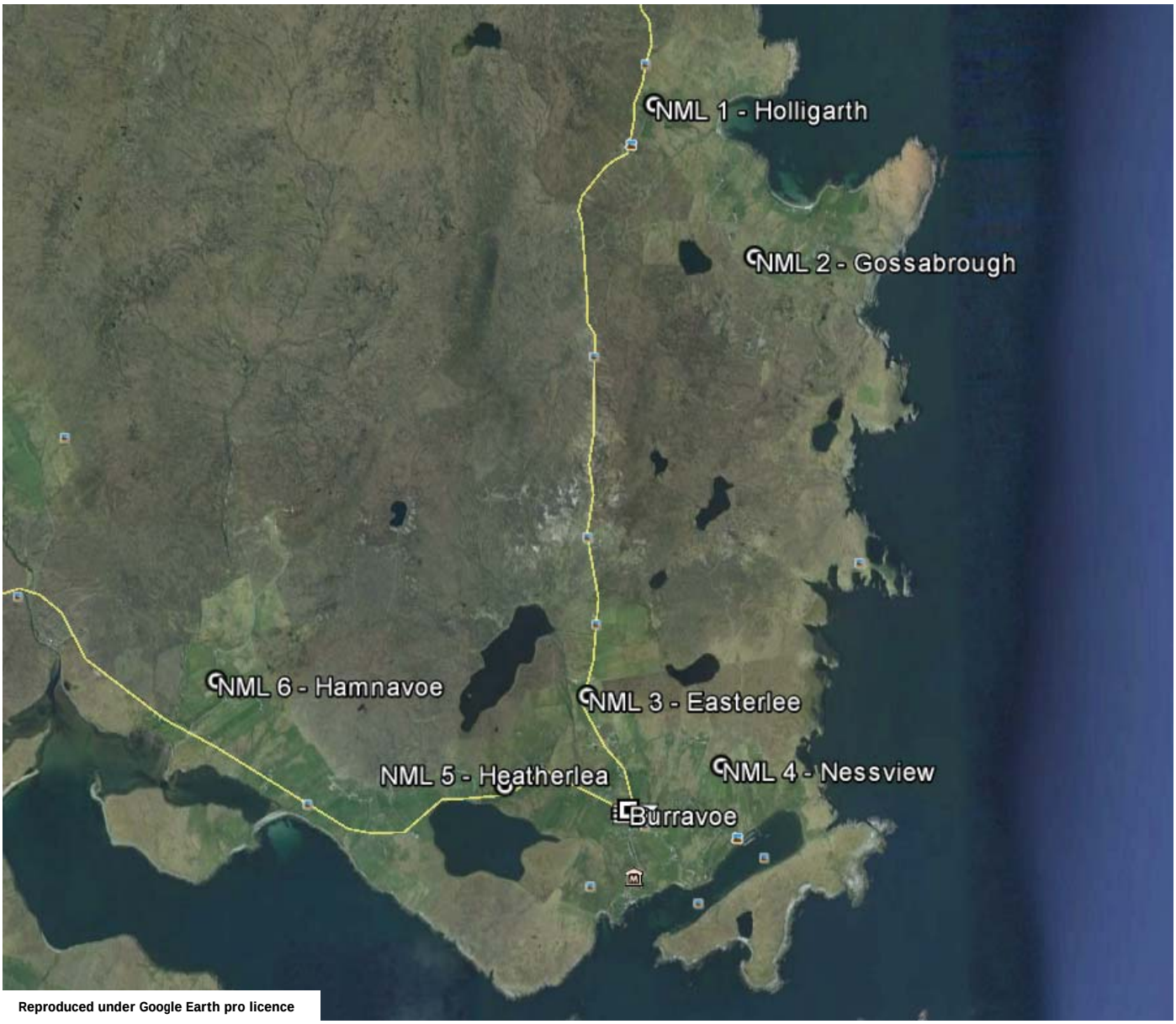
H5 – NE

H5 – NW

H5 – SE

H5 – SW

Location Description	The noise kit was placed in the rear garden area to the south west side of the property. The location was chosen due to it being the main amenity area at the property. Miniature wind turbines are situated to the north east of the property. The distance between the turbines and the monitoring location was considered sufficient such that no influence of turbine noise on the noise monitoring measurements would occur. Additionally the resident stated that the turbines were never audible during their time there, and could not be heard by the EHO or noise kit installer whilst on site. The kit location is situated in a free field position more than 3.5m away from any hard reflecting surface except that of the ground.



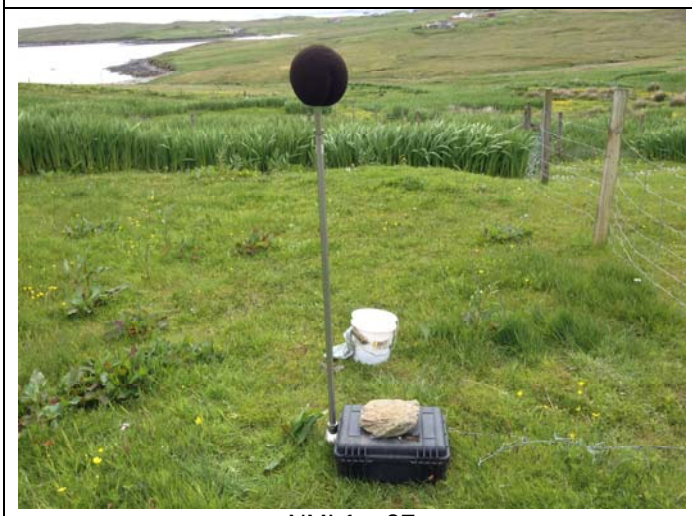
NML1 - Holligarth

Reproduced under Google Earth pro licence

Photographs:

NML1 – NE

NML1 – NW



NML1 – SE

NML1 – SW

Location Description

The noise kit was placed in what was considered to be the resident's main amenity area to the south east of the property. The monitoring location is situated approximately 1.4km to the north east of the proposed wind farm.

The predominant sounds that were audible during the installation were from intermittent cars travelling along the B9081 road, helicopters occasionally flying overhead, wind in the surrounding vegetation, and birdsong. The weather conditions were relatively calm with a slight breeze present during the installation.

The noise meter was located in a free field position, greater than 3.5m from any hard reflecting surface except the ground.

NML2 - Gossabrough

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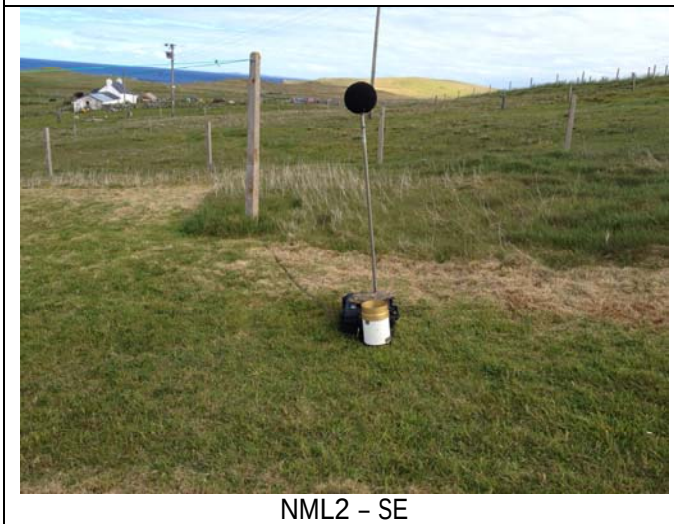
Photographs:

NML2 – NE

NML2 – NW



NML2 – SE

NML2 – SW

Location Description

The noise kit was placed in the resident's main amenity area to the north east of the property. The monitoring location is situated approximately 725m to the north east of the proposed wind farm.

The predominant sounds that were audible during the installation were from helicopters occasionally flying overhead, wind in the surrounding vegetation, the sea, and birdsong. The weather conditions were relatively calm with a slight breeze present during the installation.

The noise meter was located in a free field position, greater than 3.5m from any hard reflecting surface except the ground.

A rain gauge was installed at the property in order to record any period of rainfall during the monitoring exercise.

NML3 - Easterlee

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Photographs:

NML3 – E

NML3 – S

NML3 – W

Location Description

The noise kit was placed in the resident's main amenity area to the west of the property. The monitoring location is situated approximately 750m to the south of the proposed wind farm.

The predominant sounds that were audible during the installation were from dogs barking, wind in the surrounding vegetation, and birdsong. The weather conditions were relatively calm with a slight breeze present during the installation.

Miniature wind turbines are situated to the south west of the property. The sound level meter was located as far as possible from the turbines to minimise the risk of turbine noise influencing the measurements. Whilst on site it was recorded that the miniature turbines were not audible at the measurement location.

The noise meter was located in a free field position, greater than 3.5m from any hard reflecting surface except the ground.

NML4 - Nessview

Reproduced under Google Earth pro licence

Photographs:

NML4 – E

NML4 – S

NML4 – N

NML4 – W

Location Description

The noise kit was placed in the resident's main amenity area to the north of the property. The monitoring location is situated approximately 1km to the south of the proposed wind farm.

The predominant sounds that were audible during the installation were from cars occasionally travelling past, wind in the surrounding vegetation, and birdsong. The weather conditions were relatively calm with a slight breeze present during the installation.

A mini turbine is operating to the south west of the property, however no sound was audible from it during installation. This was later verified by the resident who said it had not been audible during his time at the property.

The noise meter was located in a free field position, greater than 3.5m from any hard reflecting surface except the ground.

A rain gauge was installed at the property in order to record any period of rainfall during monitoring. Unfortunately the gauge malfunctioned during the monitoring exercise and as such no data was recorded. The two other rain gauges will be used for the purposes of excluding heightened noise data periods as a result of rain, and have both recorded comparable datasets to each other. In accordance with the IOA GPG 10 minute periods of rain will be excluded for periods both before and after rain was recorded.

NML5 – Heatherlea

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Photographs:

NML5 – NE

NML5 – NW

NML5 – SE

Location Description

The noise kit was placed in the resident's main amenity area to the west of the property. The monitoring location is situated approximately 1.4km to the south of the proposed wind farm.

The predominant sounds that were audible during the installation were from cars occasionally travelling past on the B9081, wind in the surrounding vegetation, and birdsong. The weather conditions were relatively calm with a slight breeze present during the installation.

Four mini turbines are operating to the north east of the property, however the noise kit was in a sheltered location within the property and no sound was audible from them during the installation. The resident was asked specifically whether the turbines were ever audible and he confirmed they were not during his time at the property.

The noise meter was located in a free field position, greater than 3.5m from any hard reflecting surface except the ground.

NML6 – Hamnavoe

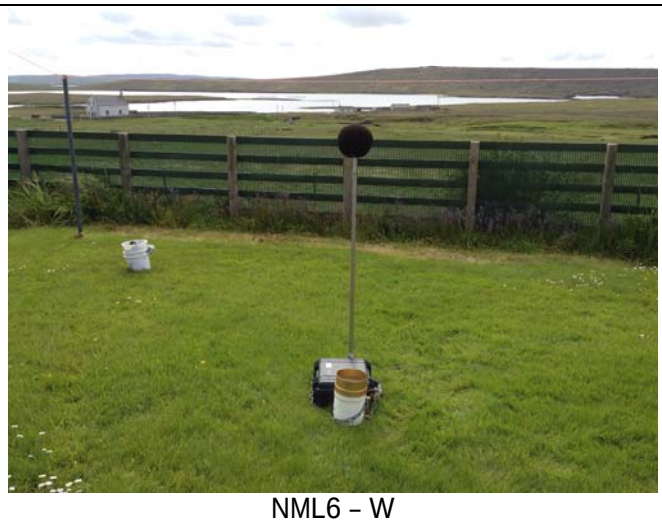
Reproduced under Google Earth pro licence

Photographs:

NML6 – E

NML6 – S

NML6 – N



NML6 – W

Location Description

The noise kit was placed in the resident's main amenity area to the west of the property. The monitoring location is situated approximately 2km to the south east of the proposed wind farm.

The predominant sounds that were audible during the installation were from cars occasionally travelling past on the B9081, wind in the surrounding vegetation, DIY noise from the property beside the monitoring location, and birdsong. The weather conditions were relatively calm with a slight breeze present during the installation.

Unfortunately, due to battery issues the noise monitoring equipment ceased recording one week into the monitoring exercise, as such the data has been excluded for the purposes of the assessment due to a lack of measured data points. The one weeks worth of data which was collected was compared to the datasets collected at other properties to determine a suitable data set to be used for this location.

The noise meter was located in a free field position, greater than 3.5m from any hard reflecting surface except the ground.

A rain gauge was installed at the property in order to record any period of rainfall during the monitoring exercise.

ANNEX 4 - Calibration/ Conformance Certificates for Sound Level Meters and Calibrator

CERTIFICATE OF CALIBRATION

UKAS CALIBRATION
7623

Date of Issue: 24 February 2015 **Certificate Number: UCRT15/1049**

Issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Approved Signatory

M. Breslin [ ] K. Mistry [ ]

Customer	TNEI Services Ltd Milburn House Dean Street Newcastle Upon Tyne NE1 1LE			
Order No.	5001			
Test Procedure	Procedure TP 1 Calibration of Sound Calibrators			
Description	Acoustic Calibrator			
Identification	*Manufacturer*	*Instrument*	*Model*	*Serial No.*
	Rion	Calibrator	NC-74	34762316

The calibrator has been tested as specified in Annex B of IEC 60942:2003. As public evidence was available from a testing organisation (PTB) responsible for approving the results of pattern evaluation tests, to demonstrate that the model of sound calibrator fully conformed to the reqirements for pattern evaluation decribed in Annex A of IEC 60942:2003, the sound calibrator tested is considered to conform to all the class 1 requirements of IEC 60942:2003.

ANV Job No.	UKAS15/02023	
Date Received	20 February 2015	
Date Calibrated	24 February 2015	
Previous Certificate	*Dated*	26 February 2014
	Certificate No.	UCRT14/1033
	Laboratory	7623

Measurements

The sound pressure level generated by the calibrator in its WS2 configuration was measured five times by the Insert Voltage Method using a microphone as detailed below. The mean of the results obtained is shown below. It is corrected to the standard atmospheric pressure of 101.3 kPa (1013 mBar) using original manufacturers information.

Test Microphone	*Manufacturer*	*Type*
	Brüel & Kjær	4192

Results

The level of the calibrator output under the conditions outlined above was

94.02 ± 0.10 dB rel 20 µPa

Functional Tests and Observations

The frequency of the sound produced was	1002.4 Hz	±	0.13 Hz
The total distortion was	1.46 %	±	6.6 % of Reading

During the measurements environmental conditions were

Temperature	22	to	23	°C
Relative Humidity	33	to	39	%
Barometric Pressure	99.4	to	99.5	kPa

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k =2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

The uncertainties refer to the measured values only with no account being taken of the ability of the instrument to maintain its calibration.

A small correction factor may need to be applied to the sound pressure level quoted above if the device is used to calibrate a sound level meter which is fitted with a free-field response microphone. See manufacturers handbook for details.

..... END .....

Note:

Calibrator adjusted prior to calibration?	NO	
Initial Level	N/A	dB
Initial Frequency	N/A	Hz

Additional Comments

None

Calibrated by: A Patel

CERTIFICATE OF CALIBRATION

Date of Issue: 18 February 2015 **Certificate Number: TCRT15/1059**

Issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Approved Signatory

M. Breslin [ ] K. Mistry [✓]

Customer	TNEI Services Ltd Milburn House Dean Street Newcastle Upon Tyne NE1 1LE
Order No.	5001
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator

Identification

Manufacturer	*Instrument*	*Type*	*Serial No. / Version*
Rion	Sound Level Meter	NL-32	00661768
Rion	Firmware		1.0009
Rion	Pre Amplifier	NH-21	19772
Rion	Microphone	UC-53A	310459
Rion	Calibrator	NC-74	34536109
	Calibrator adaptor type if applicable		NC-74-002

Performance Class 1

Test Procedure TP 2.SLM 61672-3 TPS-49

Procedures from IEC 61672-3:2006 were used to perform the periodic test.

Type Approved to IEC 61672-1:2002 No Approval Number

If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

Date Received 12 February 2015 ANV Job No. TRAC15/02024

Date Calibrated 18 February 2015

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2002 because evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002 and because the periodic tests of IEC 61672-3:2006 cover only a limited subset of the specifications in IEC 61672-1:2002.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	03 March 2014	TCRT14/1073	ANV Measurement Systems

CERTIFICATE OF CALIBRATION

Sound Level Meter Instruction manual and data used to adjust the sound levels indicated.

SLM instruction manual title	NL-22 NL-32 Instruction Manual	
SLM instruction manual ref / issue	33625 09-06	
SLM instruction manual source	Manufacturer	
Internet download date if applicable	N/A	
Case corrections available	Yes	
Uncertainties of case corrections	No	See comment on page 3
Source of case data	Manufacturer	
Wind screen corrections available	Yes	
Uncertainties of wind screen corrections	No	See comment on page 3
Source of wind screen data	Manufacturer	
Mic pressure to free field corrections	Yes	
Uncertainties of Mic to F.F. corrections	No	See comment on page 3
Source of Mic to F.F. corrections	Manufacturer	
Total expanded uncertainties within the requirements of IEC 61672-1:2002	Yes	
Specified or equivalent Calibrator	Specified	
Customer or Lab Calibrator	Lab Calibrator	
Calibrator adaptor type if applicable	NC-74-002	
Calibrator cal. date	04 February 2015	
Calibrator cert. number	UCRT15/1037	
Calibrator cal cert issued by Lab.	ANV Measurement Systems	
Calibrator SPL @ STP	94.01 dB	Calibration reference sound pressure level
Calibrator frequency	1001.90 Hz	Calibration check frequency
Reference level range	30 - 120 dB	

Accessories used or corrected for during calibration - Wind Shield WS-10
Note - if a pre-amp extension cable is listed then it was used between the SLM and the pre-amp.

Environmental conditions during tests	Start	End	
Temperature	22.29	20.90	± 0.20 °C
Humidity	36.6	34.6	± 3.00 %RH
Ambient Pressure	102.67	102.63	± 0.03 kPa

Response to associated Calibrator at the environmental conditions above.

Initial indicated level	94.0	dB	Adjusted indicated level	94.0	dB
The uncertainty of the associated calibrator supplied with the sound level meter ±				0.10	dB

Self Generated Noise — This test is currently not performed by this Lab.

Microphone installed (if requested by customer) = Less Than	N/A	dB	A Weighting
Uncertainty of the microphone installed self generated noise ±	N/A	dB	

Microphone replaced with electrical input device - UR = Under Range indicated

Weighting	A			C			Z		
	12.1	dB	UR	19.0	dB	UR	24.9	dB	
Uncertainty of the electrical self generated noise ±							0.12	dB	

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor $k=2$, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

Comments

For the test of the frequency weightings as per paragraph 12. of IEC 61672-3:2006 the Actual microphone free field response was used.
The acoustical frequency tests of a frequency weighting as per paragraph 11 of IEC 61672-3:2006 were carried out using an electrostatic actuator.

If any of the "Uncertainties of ....." are set to NO above, then the following applies.
No information on the uncertainty of measurement, required by 11.7 of IEC 61672-3:2006, of the adjustment data given in the instruction manual or obtained from the manufacturer or supplier of the sound level meter, or the manufacturer of the microphone, or the manufacturer of the multi-frequency sound calibrator, or the manufacturer of the electrostatic actuator was published in the instruction manual or made available by the manufacturer or supplier. The uncertainty of the measurement of the adjustment data has therefore been assumed to be numerically zero for the purpose of this periodic test. If these uncertainties are not actually zero, there is a possibility that the frequency response of the sound level meter may not conform to the requirements of IEC 61672-1:2002.

Calibrated by: A Patel

..... END .....

Additional Comments
None

CERTIFICATE OF CALIBRATION

Date of Issue: 18 February 2015 **Certificate Number: TCRT15/1060**

Issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Approved Signatory

M. Breslin [ ] K. Mistry [ ]

Customer	TNEI Services Ltd Milburn House Dean Street Newcastle Upon Tyne NE1 1LE
Order No.	5001
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator

Identification

Manufacturer	*Instrument*	*Type*	*Serial No. / Version*
Rion	Sound Level Meter	NL-32	00661767
Rion	Firmware		1.0009
Rion	Pre Amplifier	NH-21	19771
Rion	Microphone	UC-53A	310458
Rion	Calibrator	NC-74	34536109
	Calibrator adaptor type if applicable		NC-74-002

Performance Class 1

Test Procedure TP 2.SLM 61672-3 TPS-49

Procedures from IEC 61672-3:2006 were used to perform the periodic test.

Type Approved to IEC 61672-1:2002 No Approval Number

If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

Date Received 12 February 2015 ANV Job No. TRAC15/02024

Date Calibrated 18 February 2015

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2002 because evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002 and because the periodic tests of IEC 61672-3:2006 cover only a limited subset of the specifications in IEC 61672-1:2002.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	03 March 2014	TCRT14/1072	ANV Measurement Systems

CERTIFICATE OF CALIBRATION

Sound Level Meter Instruction manual and data used to adjust the sound levels indicated.

SLM instruction manual title	NL-22 NL-32 Instruction Manual		
SLM instruction manual ref / issue	33625 09-06		
SLM instruction manual source	Manufacturer		
Internet download date if applicable	N/A		
Case corrections available	Yes		
Uncertainties of case corrections	No	See comment on page 3	
Source of case data	Manufacturer		
Wind screen corrections available	Yes		
Uncertainties of wind screen corrections	No	See comment on page 3	
Source of wind screen data	Manufacturer		
Mic pressure to free field corrections	Yes		
Uncertainties of Mic to F.F. corrections	No	See comment on page 3	
Source of Mic to F.F. corrections	Manufacturer		
Total expanded uncertainties within the requirements of IEC 61672-1:2002	Yes		
Specified or equivalent Calibrator	Specified		
Customer or Lab Calibrator	Lab Calibrator		
Calibrator adaptor type if applicable	NC-74-002		
Calibrator cal. date	04 February 2015		
Calibrator cert. number	UCRT15/1037		
Calibrator cal cert issued by Lab.	ANV Measurement Systems		
Calibrator SPL @ STP	94.01	dB	Calibration reference sound pressure level
Calibrator frequency	1001.90	Hz	Calibration check frequency
Reference level range	30 - 120	dB	

Accessories used or corrected for during calibration - Wind Shield WS-10
Note - if a pre-amp extension cable is listed then it was used between the SLM and the pre-amp.

Environmental conditions during tests	Start	End	
Temperature	21.39	22.02	± 0.20 °C
Humidity	38.5	35.2	± 3.00 %RH
Ambient Pressure	102.62	102.54	± 0.03 kPa

Response to associated Calibrator at the environmental conditions above.

Initial indicated level	93.8 dB		Adjusted indicated level	94.0	dB
The uncertainty of the associated calibrator supplied with the sound level meter ±				0.10	dB

Self Generated Noise	This test is currently not performed by this Lab.								
Microphone installed (if requested by customer) = Less Than					N/A	dB	A Weighting		
Uncertainty of the microphone installed self generated noise ±					N/A	dB			

Microphone replaced with electrical input device - UR = Under Range indicated

Weighting	A			C			Z		
	10.4	dB	UR	17.2	dB	UR	23.4	dB	
Uncertainty of the electrical self generated noise ±							0.12	dB	

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor $k=2$, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

Comments

For the test of the frequency weightings as per paragraph 12. of IEC 61672-3:2006 the Actual microphone free field response was used.

The acoustical frequency tests of a frequency weighting as per paragraph 11 of IEC 61672-3:2006 were carried out using an electrostatic actuator.

If any of the "Uncertainties of ....." are set to NO above, then the following applies.
No information on the uncertainty of measurement, required by 11.7 of IEC 61672-3:2006, of the adjustment data given in the instruction manual or obtained from the manufacturer or supplier of the sound level meter, or the manufacturer of the microphone, or the manufacturer of the multi-frequency sound calibrator, or the manufacturer of the electrostatic actuator was published in the instruction manual or made available by the manufacturer or supplier. The uncertainty of the measurement of the adjustment data has therefore been assumed to be numerically zero for the purpose of this periodic test. If these uncertainties are not actually zero, there is a possibility that the frequency response of the sound level meter may not conform to the requirements of IEC 61672-1:2002.

Calibrated by: A Patel

..... END .....

Additional Comments
None

CERTIFICATE OF CALIBRATION

Date of Issue: 18 February 2015 **Certificate Number: TCRT15/1061**

Issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Approved Signatory

M. Breslin [ ] K. Mistry [ ]

Customer	TNEI Services Ltd Milburn House Dean Street Newcastle Upon Tyne NE1 1LE
Order No.	5001
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator

Identification

Manufacturer	*Instrument*	*Type*	*Serial No. / Version*
Rion	Sound Level Meter	NL-32	00861870
Rion	Firmware		1.0009
Rion	Pre Amplifier	NH-21	21093
Rion	Microphone	UC-53A	310623
Rion	Calibrator	NC-74	34536109
	Calibrator adaptor type if applicable		NC-74-002

Performance Class 1

Test Procedure TP 2.SLM 61672-3 TPS-49

Procedures from IEC 61672-3:2006 were used to perform the periodic test.

Type Approved to IEC 61672-1:2002 No Approval Number

If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

Date Received 12 February 2015 ANV Job No. TRAC15/02024

Date Calibrated 18 February 2015

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2002 because evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002 and because the periodic tests of IEC 61672-3:2006 cover only a limited subset of the specifications in IEC 61672-1:2002.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	28 February 2014	TCRT14/1071	ANV Measurement Systems

CERTIFICATE OF CALIBRATION

Certificate Number
TCRT15/1061

Sound Level Meter Instruction manual and data used to adjust the sound levels indicated.

SLM instruction manual title	NL-22 NL-32 Instruction Manual		
SLM instruction manual ref / issue	33625 09-06		
SLM instruction manual source	Manufacturer		
Internet download date if applicable	N/A		
Case corrections available	Yes		
Uncertainties of case corrections	No	See comment on page 3	
Source of case data	Manufacturer		
Wind screen corrections available	Yes		
Uncertainties of wind screen corrections	No	See comment on page 3	
Source of wind screen data	Manufacturer		
Mic pressure to free field corrections	Yes		
Uncertainties of Mic to F.F. corrections	No	See comment on page 3	
Source of Mic to F.F. corrections	Manufacturer		
Total expanded uncertainties within the requirements of IEC 61672-1:2002	Yes		
Specified or equivalent Calibrator	Specified		
Customer or Lab Calibrator	Lab Calibrator		
Calibrator adaptor type if applicable	NC-74-002		
Calibrator cal. date	04 February 2015		
Calibrator cert. number	UCRT15/1037		
Calibrator cal cert issued by Lab.	ANV Measurement Systems		
Calibrator SPL @ STP	94.01	dB	Calibration reference sound pressure level
Calibrator frequency	1001.90	Hz	Calibration check frequency
Reference level range	30 - 120	dB	

Accessories used or corrected for during calibration - Wind Shield WS-10
Note - if a pre-amp extension cable is listed then it was used between the SLM and the pre-amp.

Environmental conditions during tests	Start	End	
Temperature	22.01	21.97	± 0.20 °C
Humidity	35.0	34.8	± 3.00 %RH
Ambient Pressure	102.36	102.29	± 0.03 kPa

Response to associated Calibrator at the environmental conditions above.

Initial indicated level	94.0	dB		Adjusted indicated level	94.0	dB
The uncertainty of the associated calibrator supplied with the sound level meter ±					0.10	dB

Self Generated Noise	This test is currently not performed by this Lab.								
Microphone installed (if requested by customer) = Less Than					N/A	dB	A Weighting		
Uncertainty of the microphone installed self generated noise ±					N/A	dB			

Microphone replaced with electrical input device - UR = Under Range indicated

Weighting	A			C			Z		
	10.4	dB	UR	17.3	dB	UR	23.3	dB	
Uncertainty of the electrical self generated noise ±							0.12	dB	

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor $k=2$, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

Comments

For the test of the frequency weightings as per paragraph 12. of IEC 61672-3:2006 the Actual microphone free field response was used.

The acoustical frequency tests of a frequency weighting as per paragraph 11 of IEC 61672-3:2006 were carried out using an electrostatic actuator.

If any of the "Uncertainties of ....." are set to NO above, then the following applies.
No information on the uncertainty of measurement, required by 11.7 of IEC 61672-3:2006, of the adjustment data given in the instruction manual or obtained from the manufacturer or supplier of the sound level meter, or the manufacturer of the microphone, or the manufacturer of the multi-frequency sound calibrator, or the manufacturer of the electrostatic actuator was published in the instruction manual or made available by the manufacturer or supplier. The uncertainty of the measurement of the adjustment data has therefore been assumed to be numerically zero for the purpose of this periodic test. If these uncertainties are not actually zero, there is a possibility that the frequency response of the sound level meter may not conform to the requirements of IEC 61672-1:2002.

Calibrated by: A Patel

..... END .....

Additional Comments
None

CERTIFICATE OF CALIBRATION

Date of Issue: 18 February 2015 **Certificate Number: TCRT15/1063**

Issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Approved Signatory

M. Breslin [ ] K. Mistry [ ]

Customer	TNEI Services Ltd Milburn House Dean Street Newcastle Upon Tyne NE1 1LE
Order No.	5001
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator

Identification

Manufacturer	*Instrument*	*Type*	*Serial No. / Version*
Rion	Sound Level Meter	NL-32	00861871
Rion	Firmware		1.0009
Rion	Pre Amplifier	NH-21	21094
Rion	Microphone	UC-53A	310625
Rion	Calibrator	NC-74	34536109
	Calibrator adaptor type if applicable		NC-74-002

Performance Class 1

Test Procedure TP 2.SLM 61672-3 TPS-49

Procedures from IEC 61672-3:2006 were used to perform the periodic test.

Type Approved to IEC 61672-1:2002 No Approval Number

If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

Date Received 12 February 2015 ANV Job No. TRAC15/02024

Date Calibrated 18 February 2015

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2002 because evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002 and because the periodic tests of IEC 61672-3:2006 cover only a limited subset of the specifications in IEC 61672-1:2002.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	28 February 2014	TCRT14/1069	ANV Measurement Systems

CERTIFICATE OF CALIBRATION

Sound Level Meter Instruction manual and data used to adjust the sound levels indicated.

SLM instruction manual title	NL-22 NL-32 Instruction Manual		
SLM instruction manual ref / issue	33625 09-06		
SLM instruction manual source	Manufacturer		
Internet download date if applicable	N/A		
Case corrections available	Yes		
Uncertainties of case corrections	No	See comment on page 3	
Source of case data	Manufacturer		
Wind screen corrections available	Yes		
Uncertainties of wind screen corrections	No	See comment on page 3	
Source of wind screen data	Manufacturer		
Mic pressure to free field corrections	Yes		
Uncertainties of Mic to F.F. corrections	No	See comment on page 3	
Source of Mic to F.F. corrections	Manufacturer		
Total expanded uncertainties within the requirements of IEC 61672-1:2002	Yes		
Specified or equivalent Calibrator	Specified		
Customer or Lab Calibrator	Lab Calibrator		
Calibrator adaptor type if applicable	NC-74-002		
Calibrator cal. date	04 February 2015		
Calibrator cert. number	UCRT15/1037		
Calibrator cal cert issued by Lab.	ANV Measurement Systems		
Calibrator SPL @ STP	94.01	dB	Calibration reference sound pressure level
Calibrator frequency	1001.90	Hz	Calibration check frequency
Reference level range	30 - 120	dB	

Accessories used or corrected for during calibration - Wind Shield WS-10
Note - if a pre-amp extension cable is listed then it was used between the SLM and the pre-amp.

Environmental conditions during tests	Start	End	
Temperature	21.93	22.12	± 0.20 °C
Humidity	34.8	35.2	± 3.00 %RH
Ambient Pressure	101.06	101.02	± 0.03 kPa

Response to associated Calibrator at the environmental conditions above.

Initial indicated level	94.2	dB	Adjusted indicated level	94.0	dB
The uncertainty of the associated calibrator supplied with the sound level meter ±				0.10	dB

Self Generated Noise	This test is currently not performed by this Lab.							
Microphone installed (if requested by customer) = Less Than			N/A	dB	A Weighting			
Uncertainty of the microphone installed self generated noise ±			N/A	dB				

Microphone replaced with electrical input device - UR = Under Range indicated

Weighting	A			C			Z		
	11.6	dB	UR	18.8	dB	UR	24.5	dB	
Uncertainty of the electrical self generated noise ±							0.12	dB	

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor $k=2$, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

Comments

For the test of the frequency weightings as per paragraph 12. of IEC 61672-3:2006 the Actual microphone free field response was used.

The acoustical frequency tests of a frequency weighting as per paragraph 11 of IEC 61672-3:2006 were carried out using an electrostatic actuator.

If any of the "Uncertainties of ....." are set to NO above, then the following applies.
No information on the uncertainty of measurement, required by 11.7 of IEC 61672-3:2006, of the adjustment data given in the instruction manual or obtained from the manufacturer or supplier of the sound level meter, or the manufacturer of the microphone, or the manufacturer of the multi-frequency sound calibrator, or the manufacturer of the electrostatic actuator was published in the instruction manual or made available by the manufacturer or supplier. The uncertainty of the measurement of the adjustment data has therefore been assumed to be numerically zero for the purpose of this periodic test. If these uncertainties are not actually zero, there is a possibility that the frequency response of the sound level meter may not conform to the requirements of IEC 61672-1:2002.

Calibrated by: A Patel

..... END .....

Additional Comments
None

CERTIFICATE OF CALIBRATION

Date of Issue: 16 February 2015 **Certificate Number: TCRT15/1054**

Issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Approved Signatory

M. Breslin [ ] K. Mistry [ ]

Customer	TNEI Services Ltd Milburn House Dean Street Newcastle Upon Tyne NE1 1LE
Order No.	5001
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator

Identification

Manufacturer	*Instrument*	*Type*	*Serial No. / Version*
Rion	Sound Level Meter	NL-32	00972336
Rion	Firmware		1.4
Rion	Pre Amplifier	NH-21	25121
Rion	Microphone	UC-53A	313226
Rion	Calibrator	NC-74	34536109
	Calibrator adaptor type if applicable		NC-74-002

Performance Class 1

Test Procedure TP 2.SLM 61672-3 TPS-49

Procedures from IEC 61672-3:2006 were used to perform the periodic test.

Type Approved to IEC 61672-1:2002 No Approval Number

If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

Date Received 12 February 2015 ANV Job No. TRAC15/02024

Date Calibrated 16 February 2015

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2002 because evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002 and because the periodic tests of IEC 61672-3:2006 cover only a limited subset of the specifications in IEC 61672-1:2002.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	03 March 2014	TCRT14/1074	ANV Measurement Systems

CERTIFICATE OF CALIBRATION

Certificate Number
TCRT15/1054

Sound Level Meter Instruction manual and data used to adjust the sound levels indicated.

SLM instruction manual title	NL-22 NL-32 Instruction Manual		
SLM instruction manual ref / issue	33625 09-06		
SLM instruction manual source	Manufacturer		
Internet download date if applicable	N/A		
Case corrections available	Yes		
Uncertainties of case corrections	No	See comment on page 3	
Source of case data	Manufacturer		
Wind screen corrections available	Yes		
Uncertainties of wind screen corrections	No	See comment on page 3	
Source of wind screen data	Manufacturer		
Mic pressure to free field corrections	Yes		
Uncertainties of Mic to F.F. corrections	No	See comment on page 3	
Source of Mic to F.F. corrections	Manufacturer		
Total expanded uncertainties within the requirements of IEC 61672-1:2002	Yes		
Specified or equivalent Calibrator	Specified		
Customer or Lab Calibrator	Lab Calibrator		
Calibrator adaptor type if applicable	NC-74-002		
Calibrator cal. date	04 February 2015		
Calibrator cert. number	UCRT15/1037		
Calibrator cal cert issued by Lab.	ANV Measurement Systems		
Calibrator SPL @ STP	94.01	dB	Calibration reference sound pressure level
Calibrator frequency	1001.90	Hz	Calibration check frequency
Reference level range	30 - 120	dB	

Accessories used or corrected for during calibration - Wind Shield WS-10
Note - if a pre-amp extension cable is listed then it was used between the SLM and the pre-amp.

Environmental conditions during tests	Start	End	
Temperature	22.67	22.77	± 0.20 °C
Humidity	33.3	38.0	± 3.00 %RH
Ambient Pressure	100.27	100.28	± 0.03 kPa

Response to associated Calibrator at the environmental conditions above.

Initial indicated level	94.2	dB		Adjusted indicated level	94.0	dB
The uncertainty of the associated calibrator supplied with the sound level meter ±					0.10	dB

Self Generated Noise	This test is currently not performed by this Lab.		
Microphone installed (if requested by customer) = Less Than	N/A	dB	A Weighting
Uncertainty of the microphone installed self generated noise ±	N/A	dB	

Microphone replaced with electrical input device - UR = Under Range indicated

Weighting	A			C			Z		
	12.8	dB	UR	19.2	dB	UR	25.0	dB	
Uncertainty of the electrical self generated noise ±					0.12			dB	

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

Comments

For the test of the frequency weightings as per paragraph 12. of IEC 61672-3:2006 the Actual microphone free field response was used.

The acoustical frequency tests of a frequency weighting as per paragraph 11 of IEC 61672-3:2006 were carried out using an electrostatic actuator.

If any of the "Uncertainties of ....." are set to NO above, then the following applies.
No information on the uncertainty of measurement, required by 11.7 of IEC 61672-3:2006, of the adjustment data given in the instruction manual or obtained from the manufacturer or supplier of the sound level meter, or the manufacturer of the microphone, or the manufacturer of the multi-frequency sound calibrator, or the manufacturer of the electrostatic actuator was published in the instruction manual or made available by the manufacturer or supplier. The uncertainty of the measurement of the adjustment data has therefore been assumed to be numerically zero for the purpose of this periodic test. If these uncertainties are not actually zero, there is a possibility that the frequency response of the sound level meter may not conform to the requirements of IEC 61672-1:2002.

Calibrated by: A Patel

..... END .....

Additional Comments
None

CERTIFICATE OF CALIBRATION

Date of Issue: 16 February 2015

Certificate Number: TCRT15/1053

Issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Approved Signatory

M. Breslin [ ] K. Mistry [ ]

Customer

TNEI Services Ltd.
Milburn House
Dean Street
Newcastle Upon Tyne
NE1 1LE

Order No. 5001

Description Sound Level Meter / Pre-amp / Microphone / Associated Calibrator

Identification

Manufacturer	*Instrument*	*Type*	*Serial No. / Version*
Rion	Sound Level Meter	NL-32	00703296
Rion	Firmware		1.4
Rion	Pre Amplifier	NH-21	33387
Rion	Microphone	UC-53A	317048
Rion	Calibrator	NC-74	34536109
	Calibrator adaptor type if applicable		NC-74-002

Performance Class 1

Test Procedure TP 2.SLM 61672-3 TPS-49

Procedures from IEC 61672-3:2006 were used to perform the periodic test.

Type Approved to IEC 61672-1:2002 No Approval Number

If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

Date Received 12 February 2015 ANV Job No. TRAC15/02024

Date Calibrated 16 February 2015

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2002 because evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002 and because the periodic tests of IEC 61672-3:2006 cover only a limited subset of the specifications in IEC 61672-1:2002.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	23 December 2013	TCRT13/1406	ANV Measurement Systems

CERTIFICATE OF CALIBRATION

ANV MEASUREMENT SYSTEMS

Certificate Number
TCRT15/1053

Sound Level Meter Instruction manual and data used to adjust the sound levels indicated.

SLM instruction manual title	NL-22 NL-32 Instruction Manual	
SLM instruction manual ref / issue	33625 09-06	
SLM instruction manual source	Manufacturer	
Internet download date if applicable	N/A	
Case corrections available	Yes	
Uncertainties of case corrections	No	See comment on page 3
Source of case data	Manufacturer	
Wind screen corrections available	Yes	
Uncertainties of wind screen corrections	No	See comment on page 3
Source of wind screen data	Manufacturer	
Mic pressure to free field corrections	Yes	
Uncertainties of Mic to F.F. corrections	No	See comment on page 3
Source of Mic to F.F. corrections	Manufacturer	
Total expanded uncertainties within the requirements of IEC 61672-1:2002	Yes	
Specified or equivalent Calibrator	Specified	
Customer or Lab Calibrator	Lab Calibrator	
Calibrator adaptor type if applicable	NC-74-002	
Calibrator cal. date	04 February 2015	
Calibrator cert. number	UCRT15/1037	
Calibrator cal cert issued by Lab.	ANV Measurement Systems	
Calibrator SPL @ STP	94.01 dB	Calibration reference sound pressure level
Calibrator frequency	1001.90 Hz	Calibration check frequency
Reference level range	30 - 120 dB	

Accessories used or corrected for during calibration - Wind Shield WS-10
Note - if a pre-amp extension cable is listed then it was used between the SLM and the pre-amp.

Environmental conditions during tests	Start	End	
Temperature	22.44	22.36	± 0.20 °C
Humidity	35.2	36.8	± 3.00 %RH
Ambient Pressure	100.27	100.26	± 0.03 kPa

Response to associated Calibrator at the environmental conditions above.

Initial indicated level	94.1	dB		Adjusted indicated level	94.0	dB
The uncertainty of the associated calibrator supplied with the sound level meter ±					0.10	dB

Self Generated Noise — This test is currently not performed by this Lab.

Microphone installed (if requested by customer) = Less Than				N/A	dB	A Weighting			
Uncertainty of the microphone installed self generated noise ±				N/A	dB				

Microphone replaced with electrical input device - UR = Under Range indicated

Weighting	A			C			Z		
	10.9	dB	UR	17.4	dB	UR	23.4	dB	
Uncertainty of the electrical self generated noise ±				0.12	dB				

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor $k=2$, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

Comments

For the test of the frequency weightings as per paragraph 12. of IEC 61672-3:2006 the Actual microphone free field response was used.

The acoustical frequency tests of a frequency weighting as per paragraph 11 of IEC 61672-3:2006 were carried out using an electrostatic actuator.

If any of the "Uncertainties of ....." are set to NO above, then the following applies.
No information on the uncertainty of measurement, required by 11.7 of IEC 61672-3:2006, of the adjustment data given in the instruction manual or obtained from the manufacturer or supplier of the sound level meter, or the manufacturer of the microphone, or the manufacturer of the multi-frequency sound calibrator, or the manufacturer of the electrostatic actuator was published in the instruction manual or made available by the manufacturer or supplier. The uncertainty of the measurement of the adjustment data has therefore been assumed to be numerically zero for the purpose of this periodic test. If these uncertainties are not actually zero, there is a possibility that the frequency response of the sound level meter may not conform to the requirements of IEC 61672-1:2002.

Calibrated by: A Patel

..... END .....

Additional Comments
None

CERTIFICATE OF CALIBRATION

Date of Issue: 13 February 2015 **Certificate Number: TCRT15/1051**

Issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Approved Signatory

M. Breslin [ ] K. Mistry [ ]

Customer	TNEI Services Ltd Milburn House Dean Street Newcastle Upon Tyne NE1 1LE
Order No.	5001
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator

Identification

Manufacturer	*Instrument*	*Type*	*Serial No. / Version*
Rion	Sound Level Meter	NL-31	01273087
Rion	Firmware		1.05
Rion	Pre Amplifier	NH-21	26006
Rion	Microphone	UC-53A	313365
Rion	Calibrator	NC-74	34536109
	Calibrator adaptor type if applicable		NC-74-002

Performance Class 1

Test Procedure TP 2.SLM 61672-3 TPS-49

Procedures from IEC 61672-3:2006 were used to perform the periodic test.

Type Approved to IEC 61672-1:2002 No Approval Number

If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

Date Received 12 February 2015 ANV Job No. TRAC15/02024

Date Calibrated 13 February 2015

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2002 because evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002 and because the periodic tests of IEC 61672-3:2006 cover only a limited subset of the specifications in IEC 61672-1:2002.

Previous Certificate

Dated	*Certificate No.*	*Laboratory*
05 March 2014	TCRT14/1081	ANV Measurement Systems

CERTIFICATE OF CALIBRATION

Sound Level Meter Instruction manual and data used to adjust the sound levels indicated.

SLM instruction manual title	NL-21 NL-31 Instruction Manual		
SLM instruction manual ref / issue	32006 09-04		
SLM instruction manual source	Manufacturer		
Internet download date if applicable	N/A		
Case corrections available	Yes		
Uncertainties of case corrections	No	See comment on page 3	
Source of case data	Manufacturer		
Wind screen corrections available	Yes		
Uncertainties of wind screen corrections	No	See comment on page 3	
Source of wind screen data	Manufacturer		
Mic pressure to free field corrections	Yes		
Uncertainties of Mic to F.F. corrections	No	See comment on page 3	
Source of Mic to F.F. corrections	Manufacturer		
Total expanded uncertainties within the requirements of IEC 61672-1:2002	Yes		
Specified or equivalent Calibrator	Specified		
Customer or Lab Calibrator	Lab Calibrator		
Calibrator adaptor type if applicable	NC-74-002		
Calibrator cal. date	04 February 2015		
Calibrator cert. number	UCRT15/1037		
Calibrator cal cert issued by Lab.	ANV Measurement Systems		
Calibrator SPL @ STP	94.01	dB	Calibration reference sound pressure level
Calibrator frequency	1001.90	Hz	Calibration check frequency
Reference level range	30 - 120	dB	

Accessories used or corrected for during calibration - Wind Shield WS-10
Note - if a pre-amp extension cable is listed then it was used between the SLM and the pre-amp.

Environmental conditions during tests	Start	End	
Temperature	22.64	22.24	± 0.20 °C
Humidity	37.1	38.5	± 3.00 %RH
Ambient Pressure	98.75	98.62	± 0.03 kPa

Response to associated Calibrator at the environmental conditions above.

Initial indicated level	94.0	dB		Adjusted indicated level	94.0	dB
The uncertainty of the associated calibrator supplied with the sound level meter ±					0.10	dB

Self Generated Noise — This test is currently not performed by this Lab.

Microphone installed (if requested by customer) = Less Than							N/A	dB	A Weighting
Uncertainty of the microphone installed self generated noise ±							N/A	dB	

Microphone replaced with electrical input device - UR = Under Range indicated

Weighting	A			C			Z		
	9.9	dB	UR	16.1	dB	UR	22.8	dB	
Uncertainty of the electrical self generated noise ±							0.12	dB	

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor $k=2$, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

Comments

For the test of the frequency weightings as per paragraph 12. of IEC 61672-3:2006 the Actual microphone free field response was used.

The acoustical frequency tests of a frequency weighting as per paragraph 11 of IEC 61672-3:2006 were carried out using an electrostatic actuator.

If any of the "Uncertainties of ....." are set to NO above, then the following applies.
No information on the uncertainty of measurement, required by 11.7 of IEC 61672-3:2006, of the adjustment data given in the instruction manual or obtained from the manufacturer or supplier of the sound level meter, or the manufacturer of the microphone, or the manufacturer of the multi-frequency sound calibrator, or the manufacturer of the electrostatic actuator was published in the instruction manual or made available by the manufacturer or supplier. The uncertainty of the measurement of the adjustment data has therefore been assumed to be numerically zero for the purpose of this periodic test. If these uncertainties are not actually zero, there is a possibility that the frequency response of the sound level meter may not conform to the requirements of IEC 61672-1:2002.

Calibrated by: A Patel

..... END .....

Additional Comments
None

ANNEX 5 –Technical Information on SODAR Unit

Installation Report

Client – Peel Wind Farms

Date – 24/06/2015

Completed by – Raymond Gillies

solar wind hydro biomass

Site Information Form & Checklist

1. Triton Information				
Triton Site Name:	Isle of Yell			
Triton Owner:	Dulas			
Install Date:	24/06/2015			
Triton Serial #:	497			
Triton Model:	Circle/Highlight:	STD	HP	HR
Personnel Present:	Raymond Gillies & Neil Bassett			
Installed Co-ordinates:	HU 451614 1181627			

2. Site Information	
Surrounding Site Description (i.e. Windfarm, Forest, Field etc.)	Peat bog, peat hags, moorland. Peat very dry at time of visit. Hard underfoot, very dusty which may become an issue unless it rains.
Road Access Description (i.e. 4WD required)	4WD required, drove straight to location with trailer towed by defender, no problems. Although dry at time of deployment.
Gate Key Location/Security Details	Only 100m from road, in view, remote Shetland Island, security issues – negligible.
Front Door Lock Details (Combo or Key Location)	
Property Management Contacts	

3. Fixed Object Vista Table				
Description of Object	Azimuth (Deg)	Distance (m)	Height of Object (m)	Relative Elevation to Top of Triton (m)
Peat Hags	345° - 350°	30-40m	1 - 1.5m	1 – 2m

4. Installation Checklist			
Item		Unit	Value
Mechanical Inspection		List Damage/Defects	Pressure sensor not working
Triton Properly Oriented		Record Azimuth of B-Beam (deg mag)	000^{o}
Triton Secured		Method (i.e. earth anchors, trailer, snow platform, etc.)	Only one earth anchor secured properly. Some stones on each anchor and inside.
Batteries Charged (>12.7V)		Record voltage level, V - DC	13.51
Solar Panels Installed, Connected		# of Panels	
Solar Panels Charging		V - DC	18.11
Operator Panel: GPS		Red/Green/Rapid/Off	Green
Operator Panel: SENSORS		Red/Green/Rapid/Off	Red (barometer faulty)
Operator Panel: SUPPLIES		Red/Green/Rapid/Off	Green
Operator Panel: SD CARD		Red/Green/Rapid/Off	Green
Operator Panel: NOTA (self-test)		Red/Green/Rapid/Off/NA	
Operator Panel: ARRAY		Red/Green/Rapid/Off	Green
Operator Panel: SODAR		Red/Green/Rapid/Off	Green
Operator Panel: SNR		Red/Green/Rapid/Off	Green
Operator Panel: INTERNET		Red/Green/Rapid/Off	Green
Operator Panel: TSP		Red/Green/Rapid/Off	Green
Operator Panel: SKYSERVE		Red/Green/Rapid/Off	Green
Operator Panel: HEATER		Red/Green/Rapid/Off	
Take Photos or Videos		Pictures of 360deg site and Anchored Triton	
Ambient Noise Description		(i.e. Birds, Crickets, Highway)	Road approx. 100m to east of Triton, a lot of bird noise when first arrived at site.
Triton Information (1) Section Complete		none	
Site Information (2) Section Complete		none	
Fixed Obstacle Vista Table (3) Complete		none	
Heater Option Checklist			
Antifreeze Fluid Level (Heater Only)		none	
Propane Tanks installed		Tank capacity and level	
Propane Leak Test (Heater Only)		none	
Exterior Warning Sign Cover Removed		none	
GPRS Option Checklist			
SIM Card Inserted		none	
GPRS Parameters Set in Triton		none	
Extended Power Option Checklist			
Methanol Cartridges Connected		none	

Photos:

View from Triton, looking North

View from Triton, looking North-east

View from Triton, looking East

View from Triton, looking South-east

View from Triton, looking South

View from Triton, looking South-west

View from Triton, looking West

View from Triton, looking North-west

View towards Triton, looking South

View towards Triton, looking South-west

View towards Triton, looking West

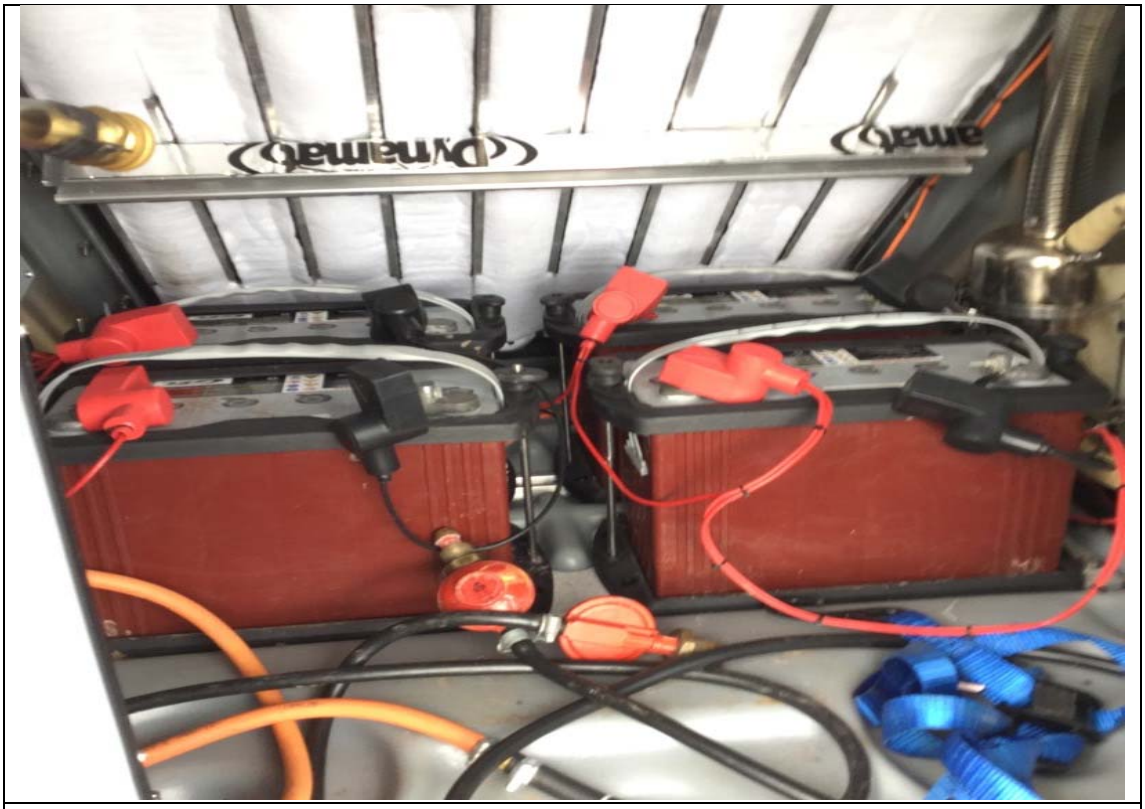
View towards Triton, looking North-west

View towards Triton, looking North

View towards Triton, looking North-east

View towards Triton, looking East

View towards Triton, South-east



Batteries

PV Module: Front

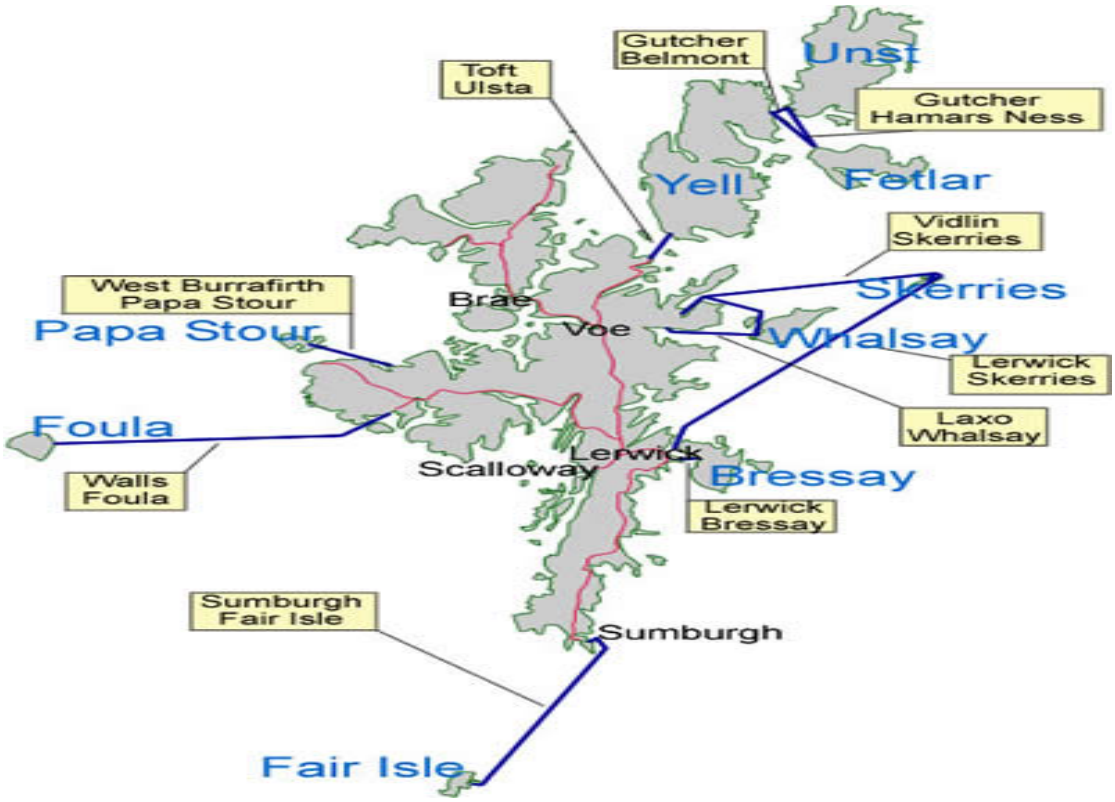
PV Module: Back

PV Junction Box Wiring

Anchoring system

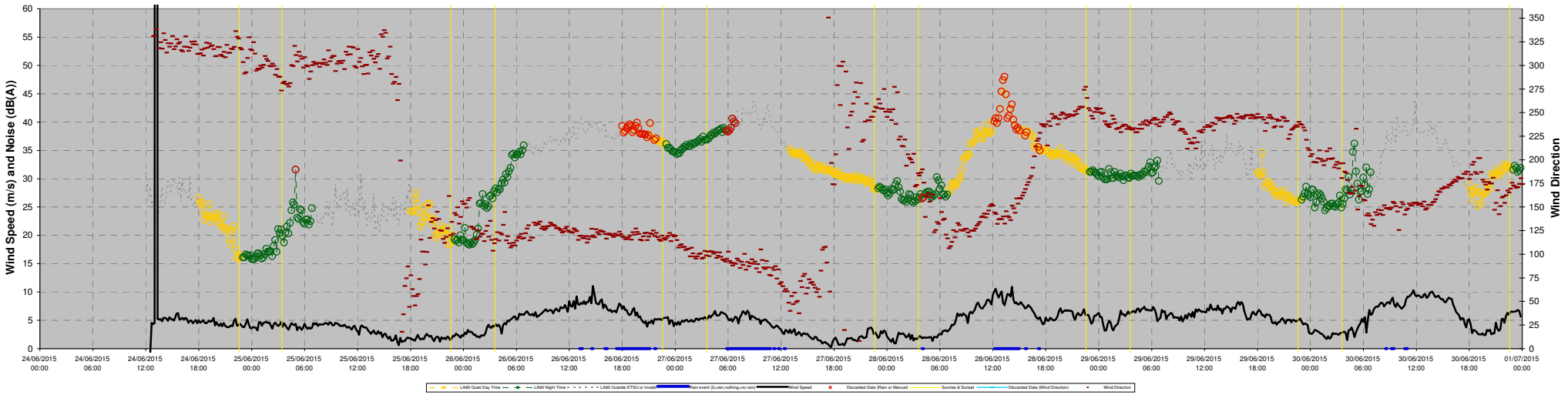
Fencing System

Access Route



ANNEX 6 – Time Histories

24/06/2015 to 01/07/2015



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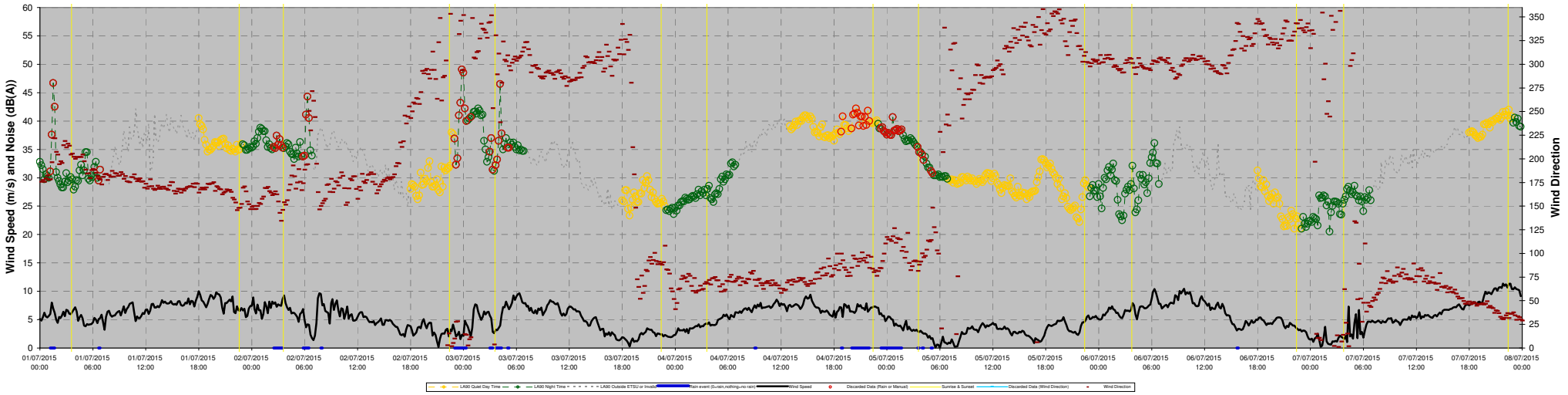

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Time Serie for H1 - Lower Holligarth Page 1 of 3
Date	15/10/2015

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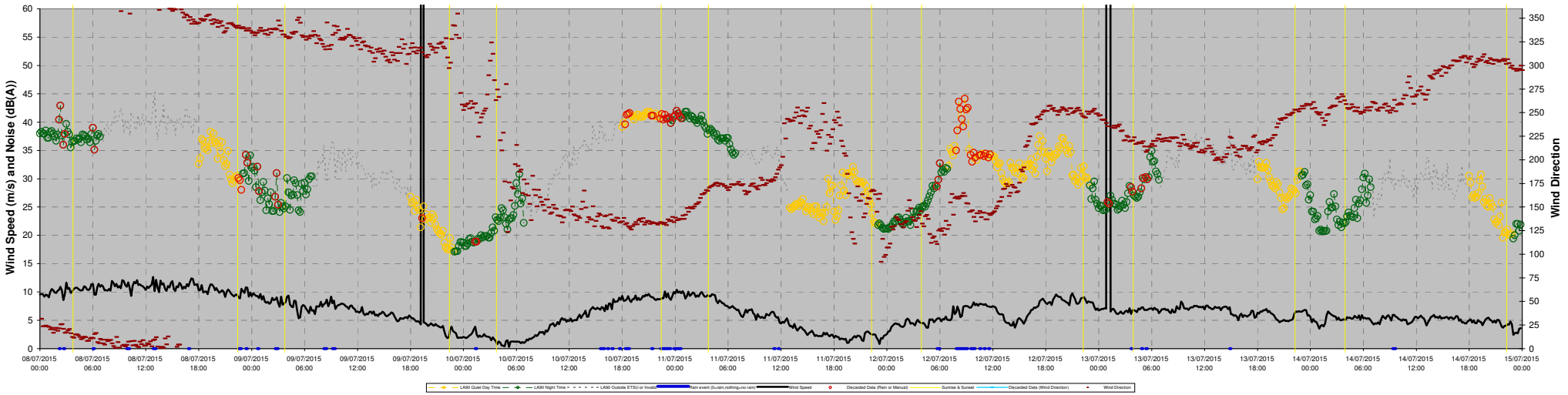

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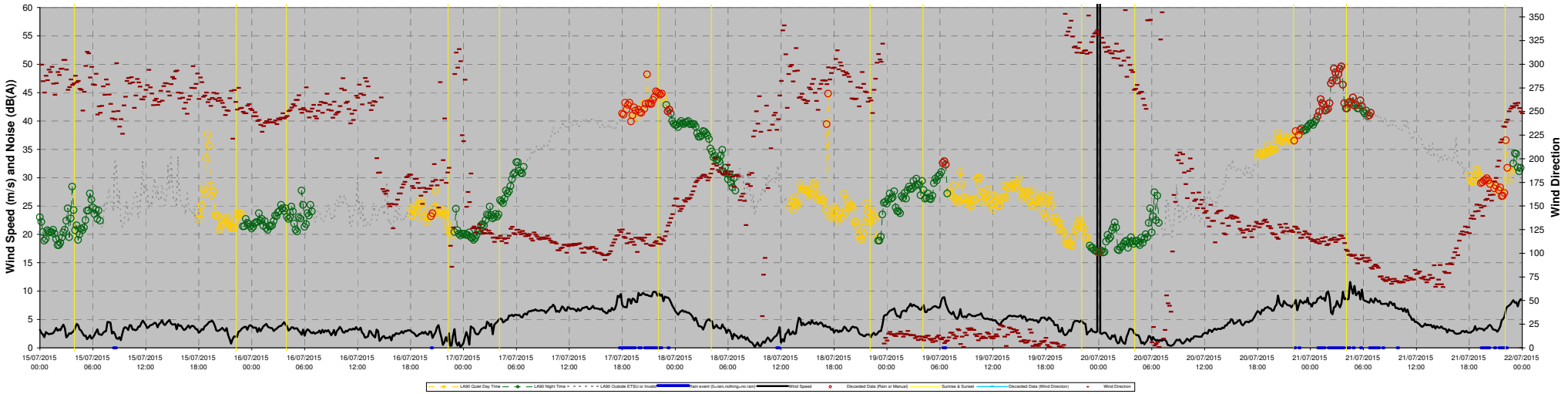

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Time Serie for H1 - Lower Holligarth Page 2 of 3
Date	15/10/2015

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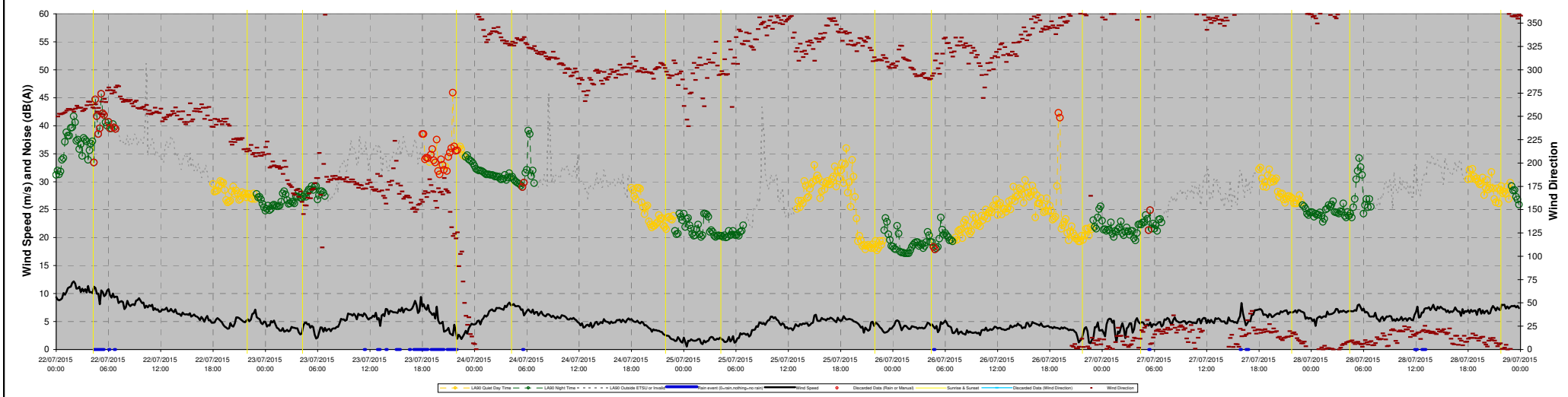
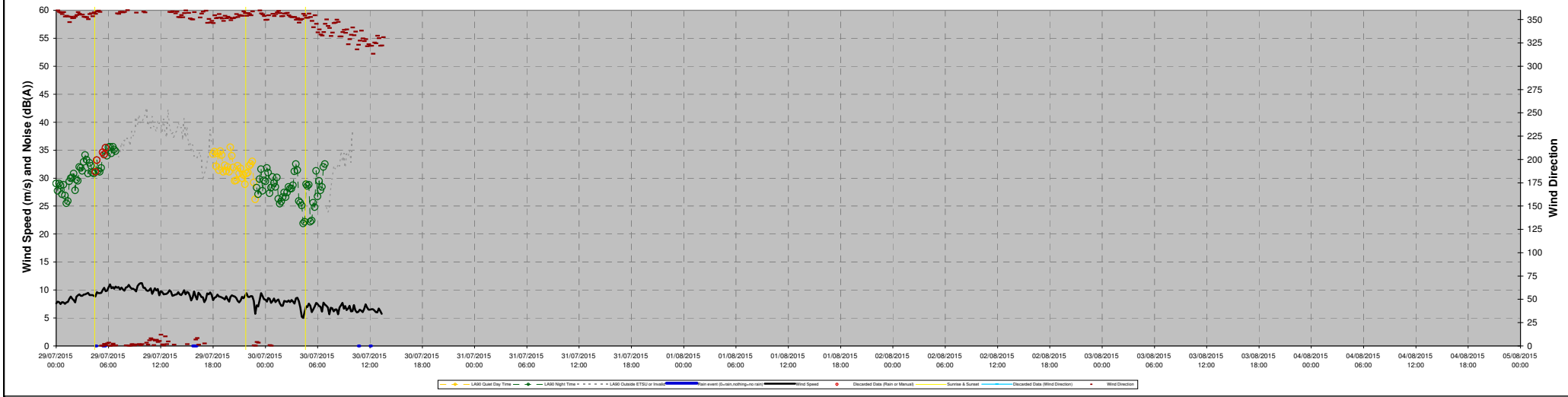


29/07/2015 to 05/08/2015



Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Time Serie for H1 - Lower Holligarth Page 3 of 3
Date	15/10/2015

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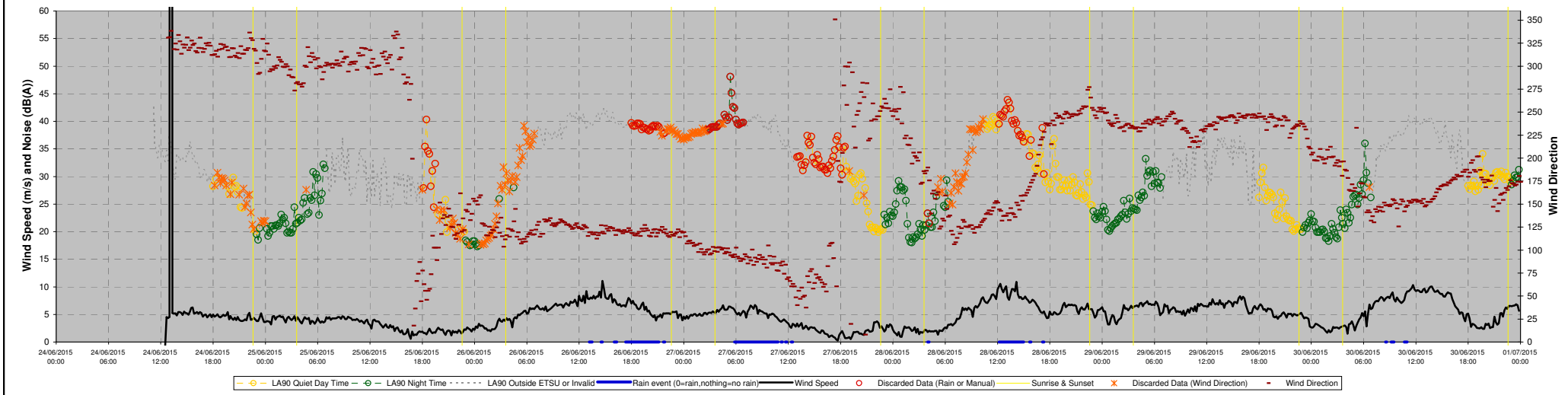

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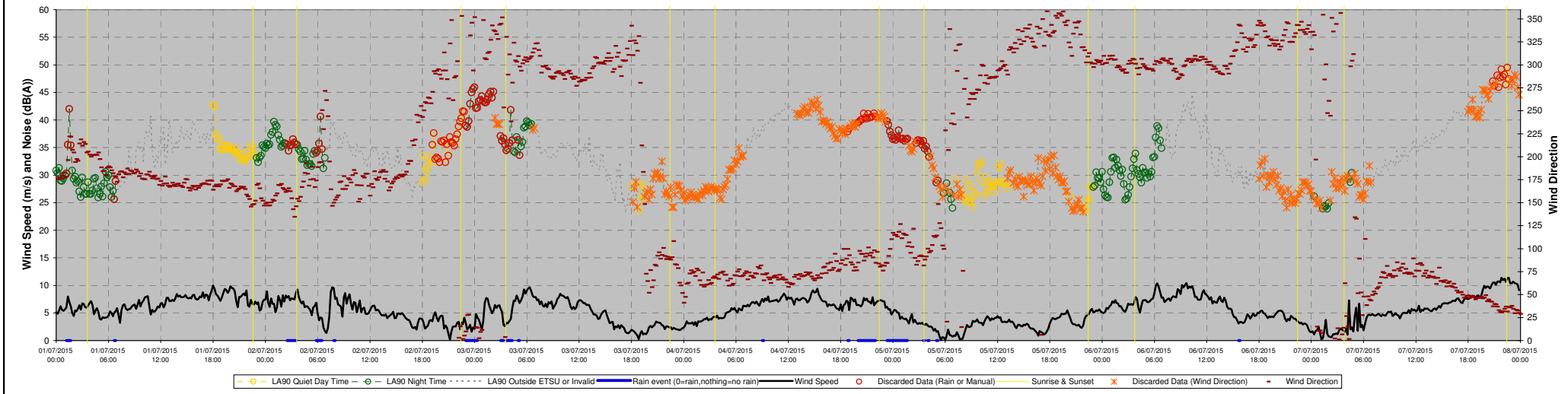

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Time Serie for Whirliegarth Page 1 of 3
Date	15/10/2015

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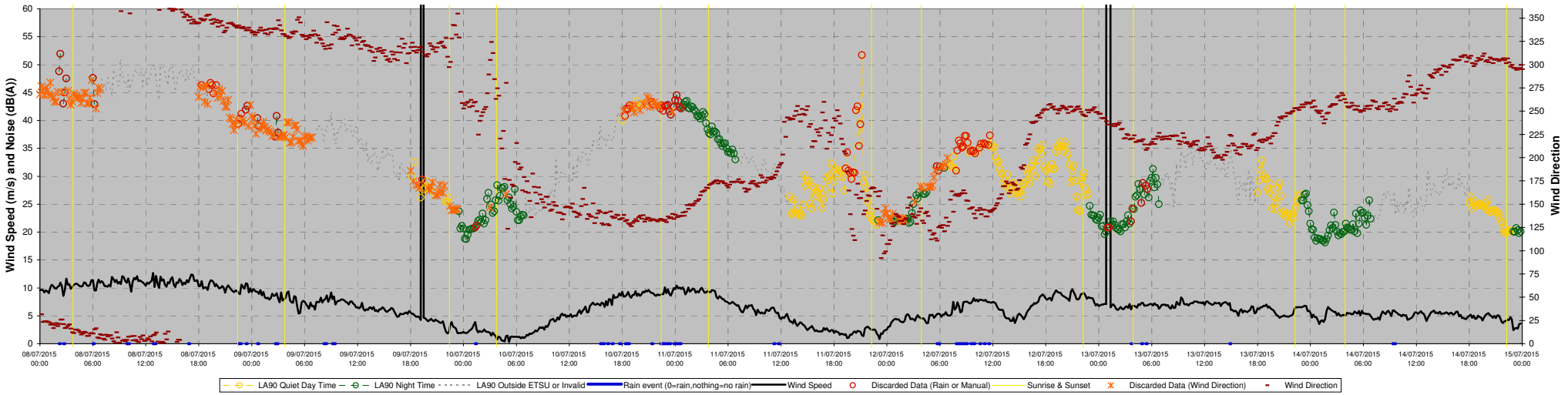

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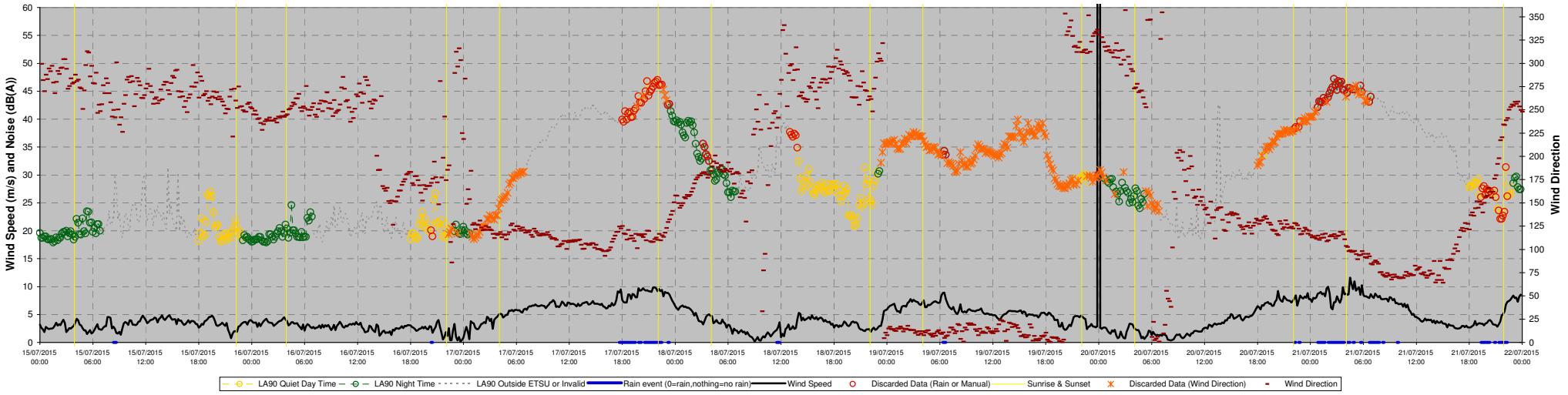

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Time Serie for Whirliegarth Page 2 of 3
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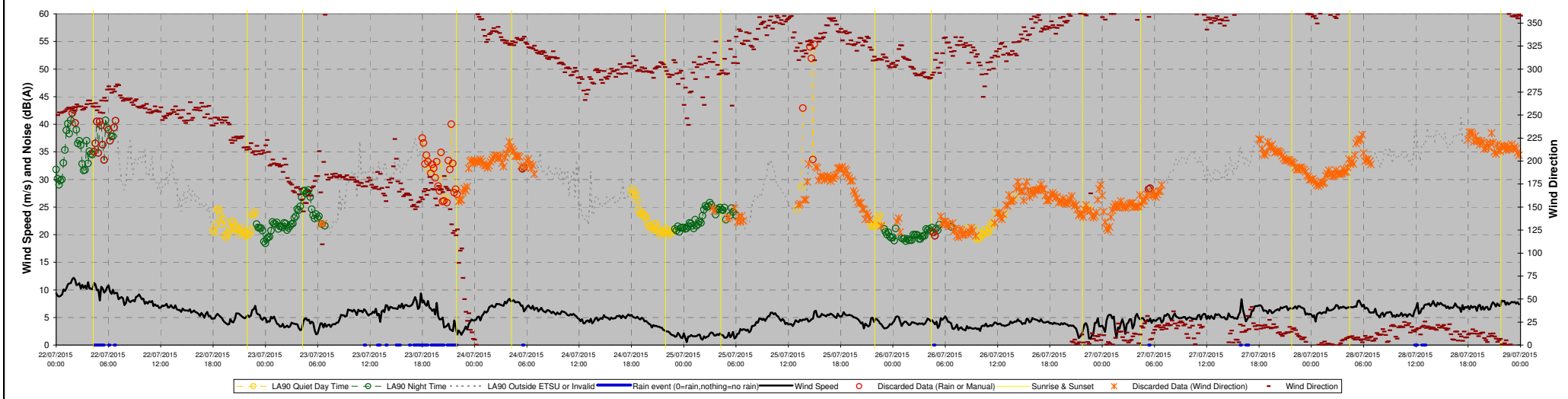

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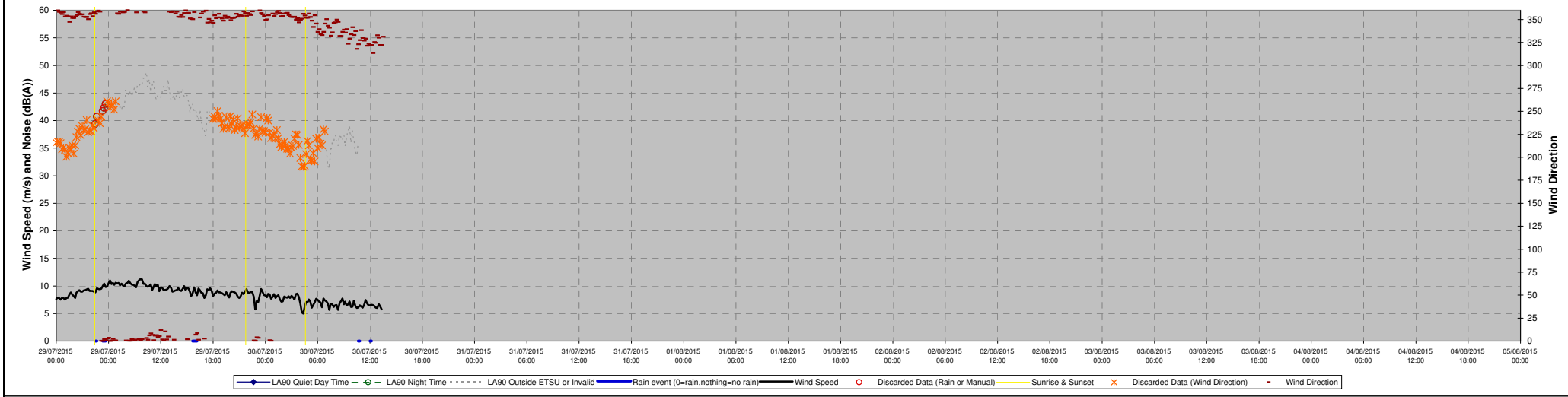

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Time Serie for Whirliegarth Page 3 of 3
Date	15/10/2015

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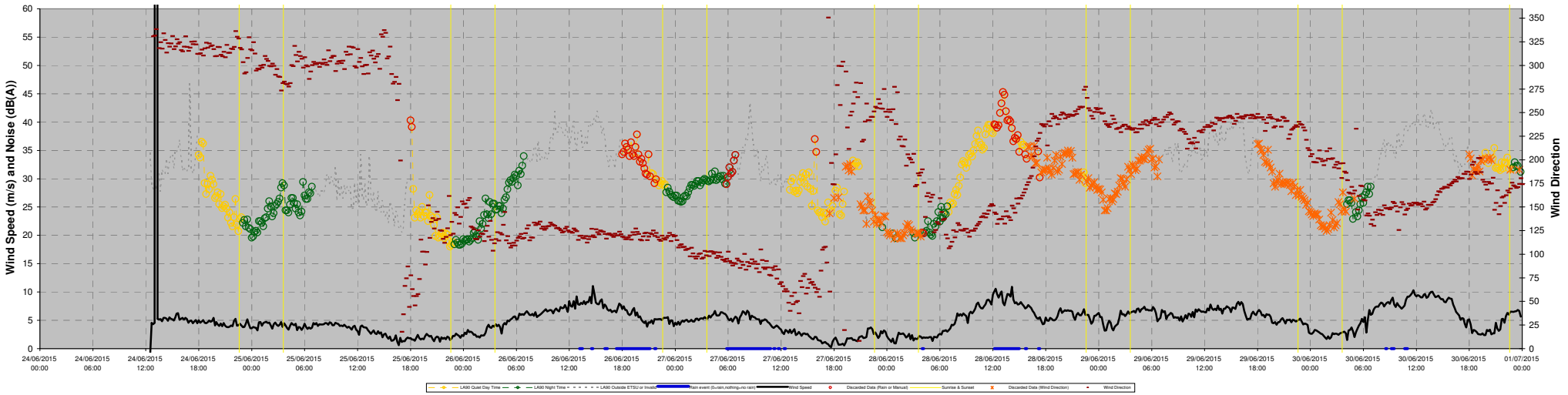

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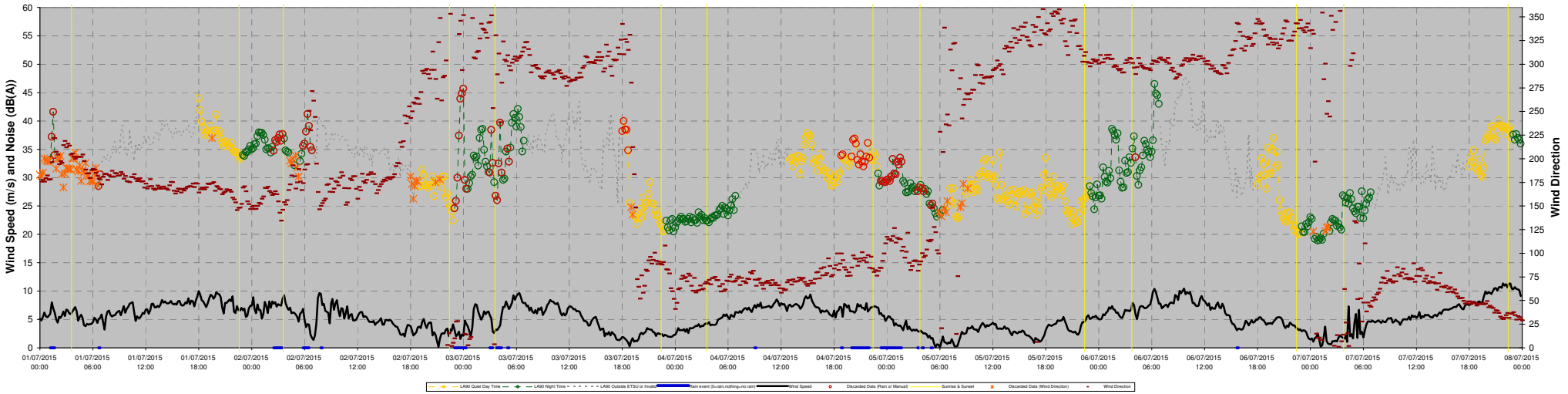

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Time Serie for H3 - Easterlee Page 1 of 3
Date	15/10/2015

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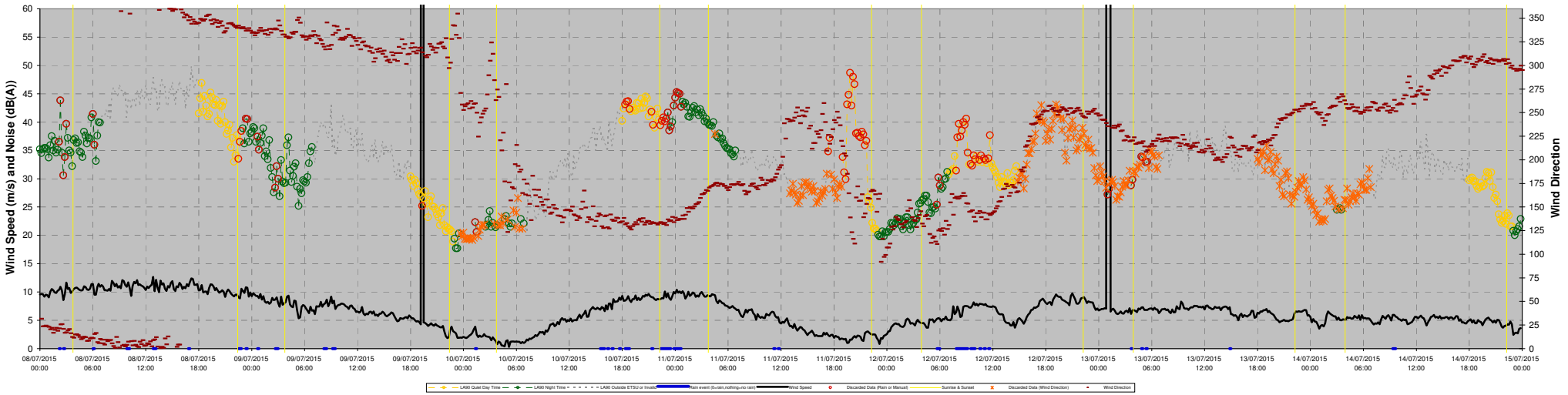

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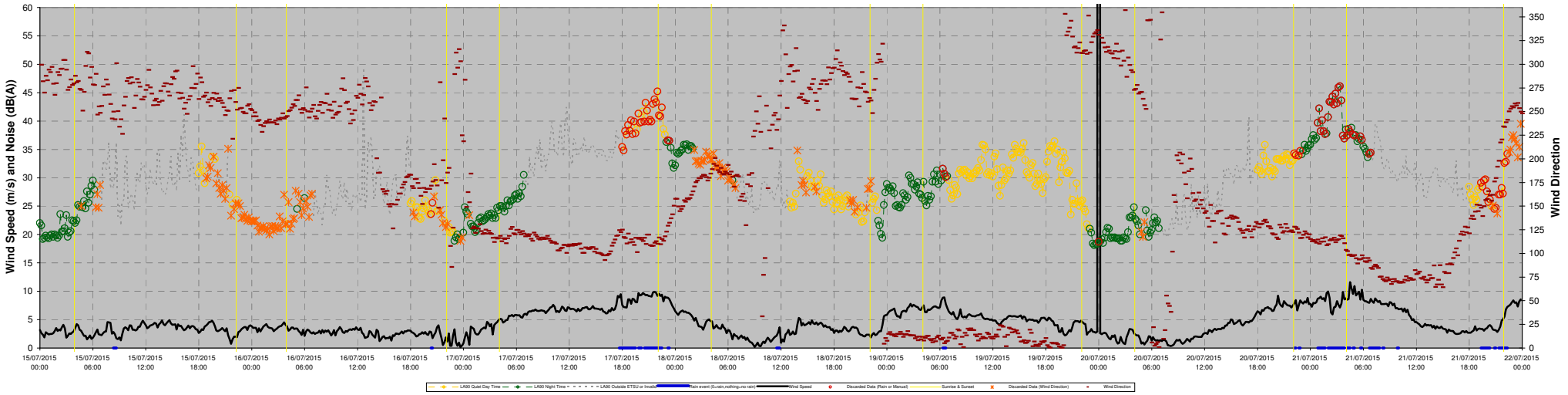

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Time Serie for H3 - Easterlee Page 2 of 3
Date	15/10/2015

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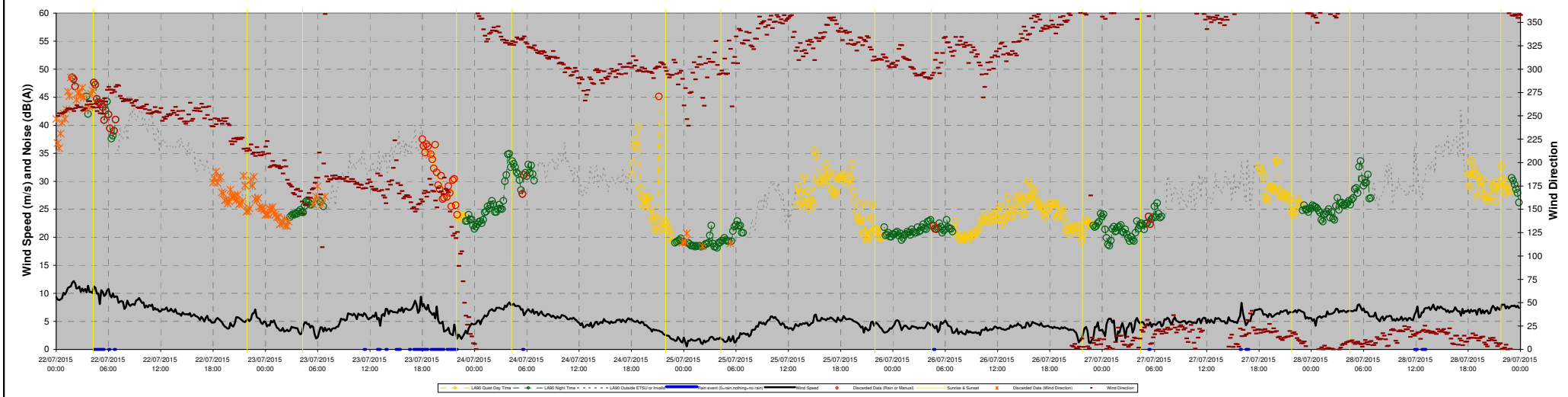

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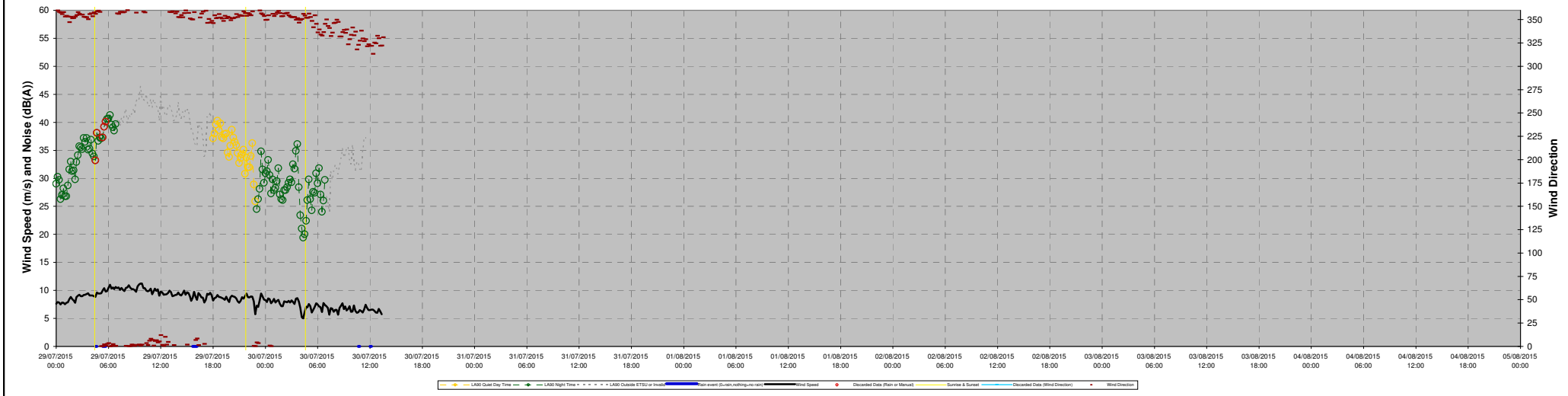

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Time Serie for H3 - Easterlee Page 3 of 3
Date	15/10/2015

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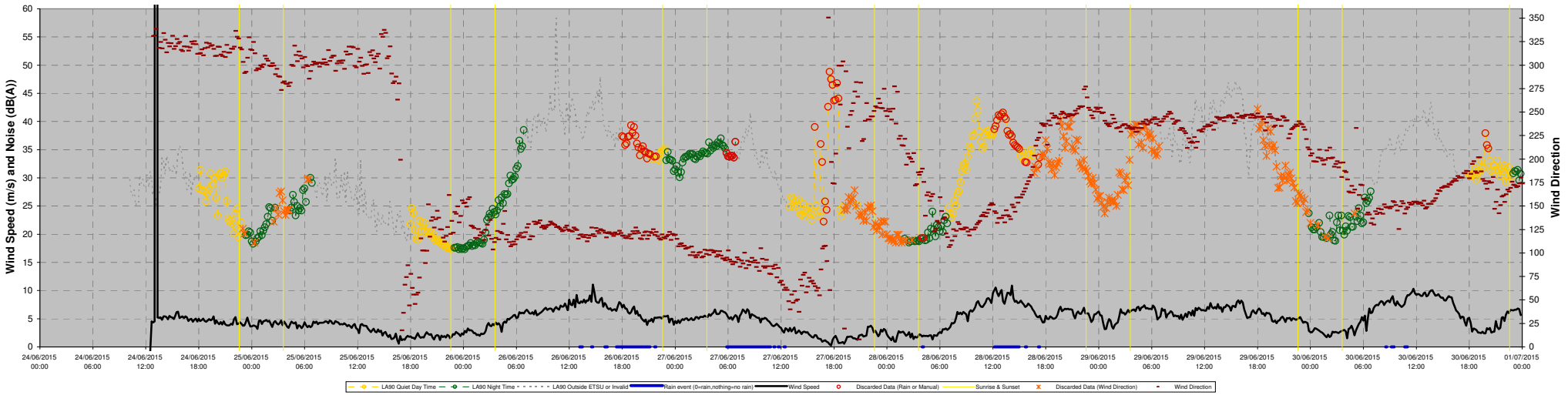

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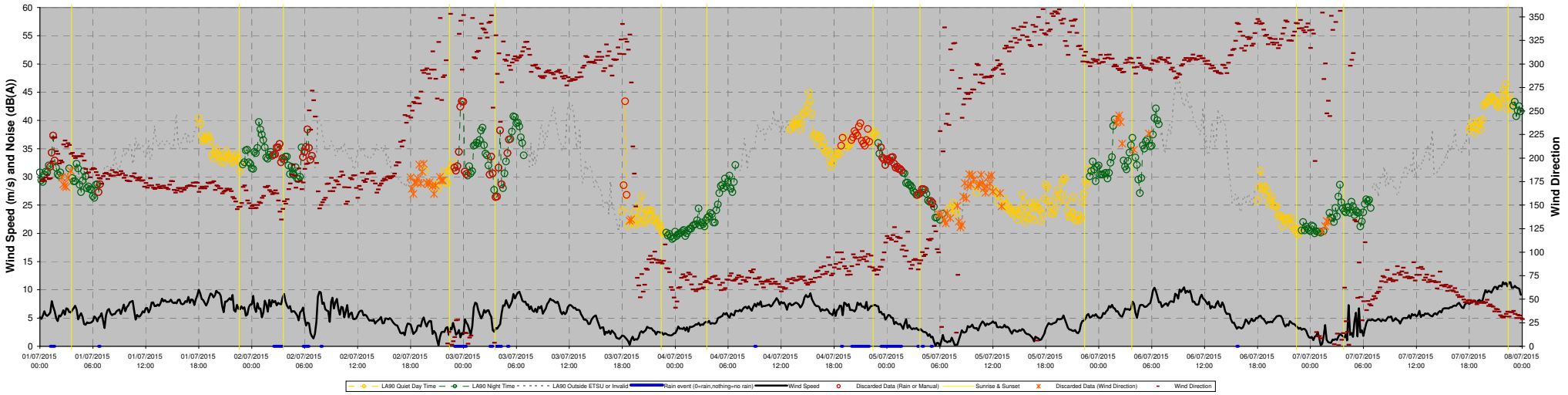

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Time Serie for Nessview Page 1 of 3
Date	15/10/2015

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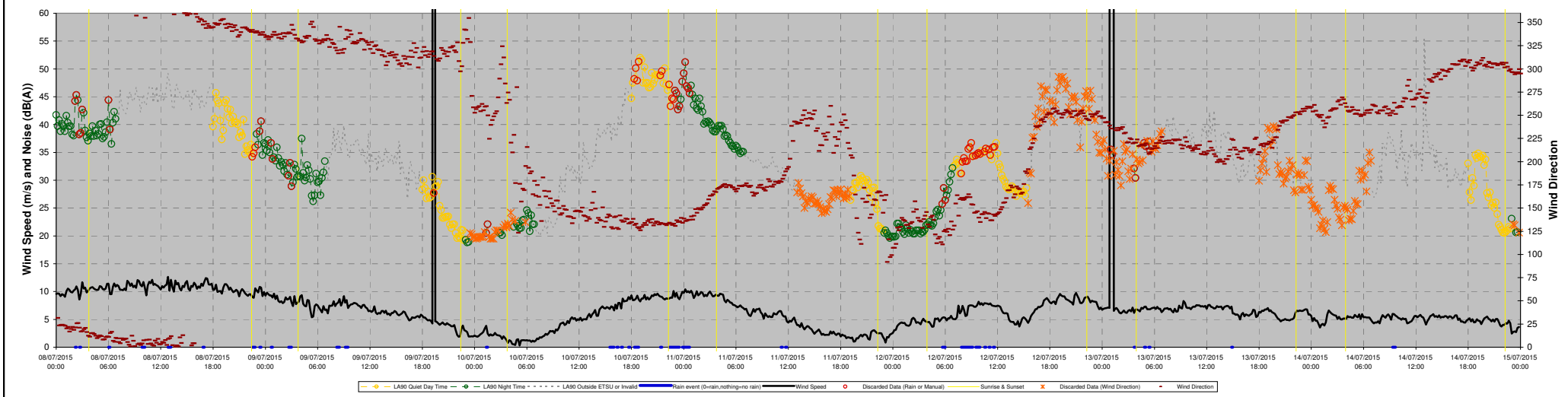

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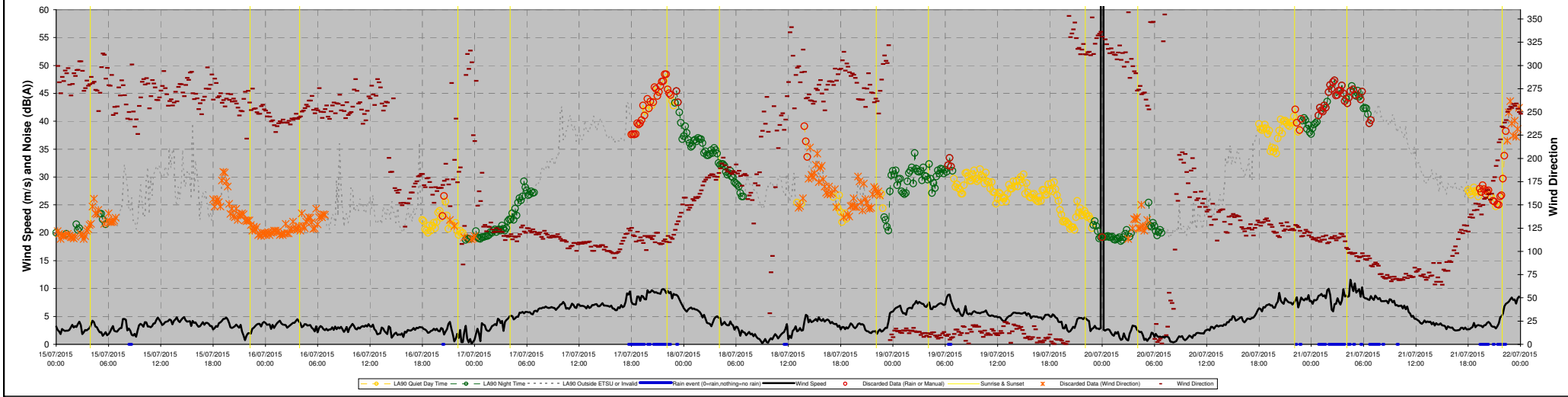

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Client	Peel Wind Farms (Yell) Ltd
Title	Time Serie for Nessview Page 2 of 3
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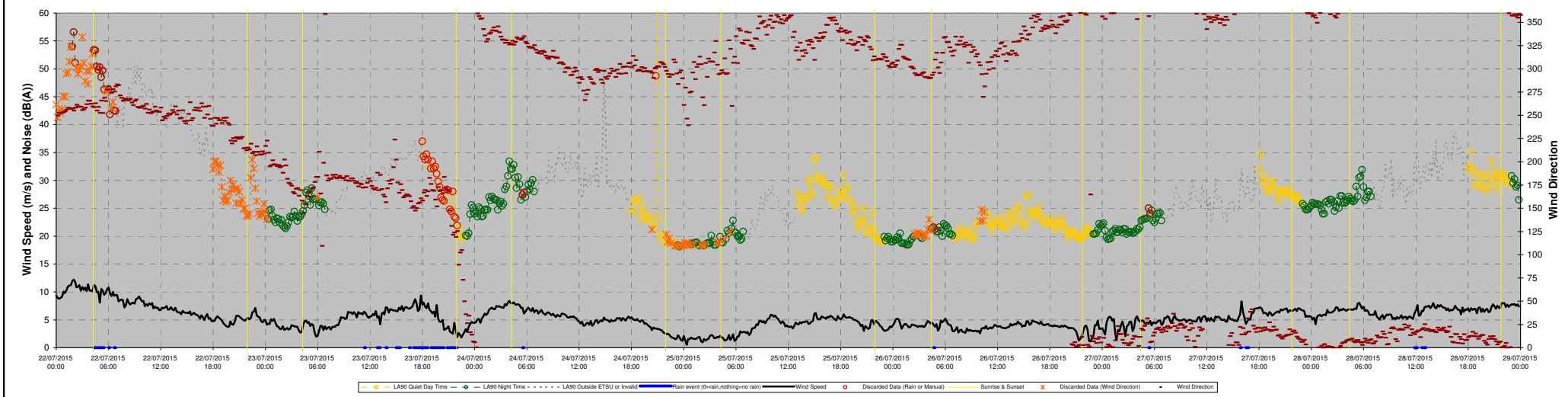

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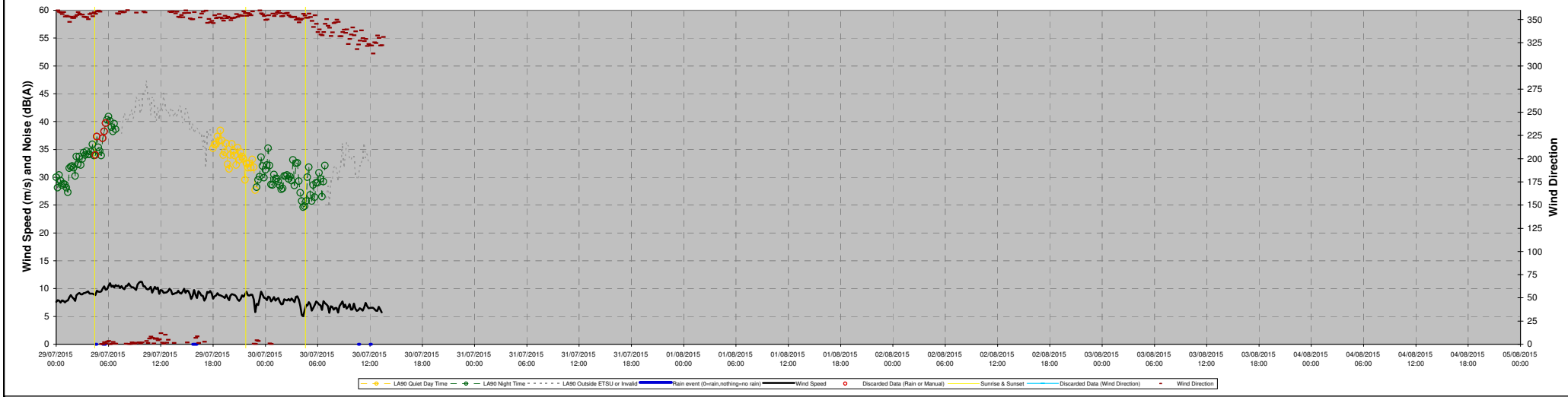

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Time Serie for Nessview Page 3 of 3
Date	15/10/2015

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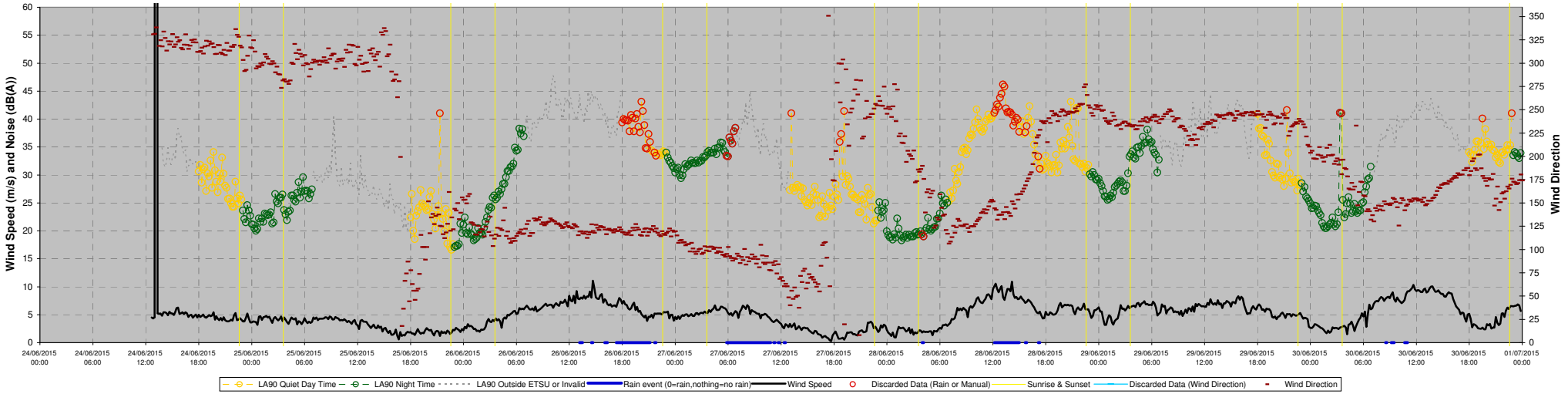

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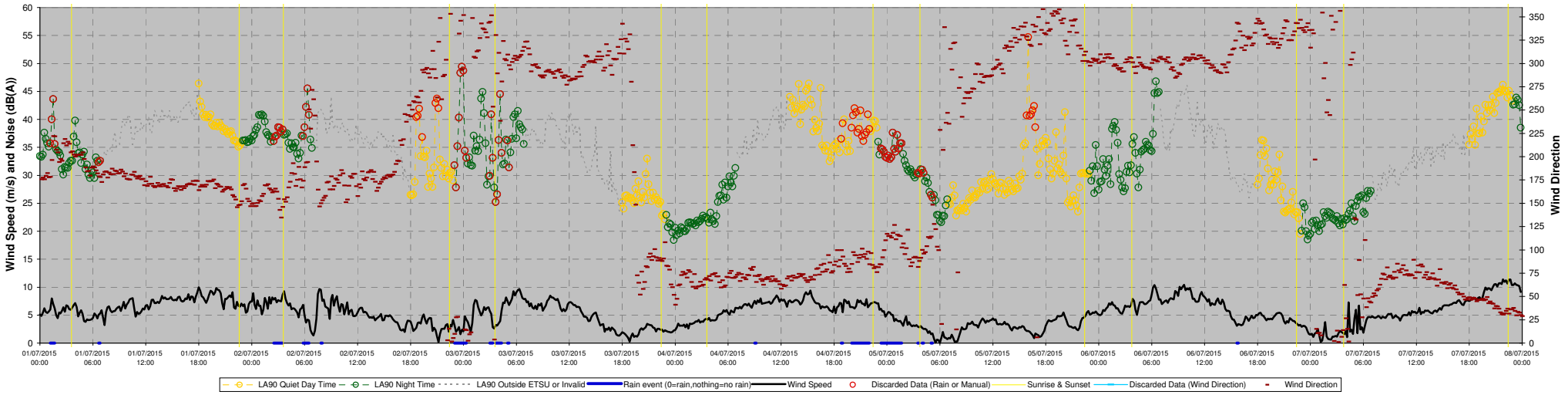

Project	Beaw Field Wind Farm
Client	Peel Wind Farms (Yell) Ltd
Title	Time Serie for Heatherlea Page 1 of 3
Date	15/10/2015

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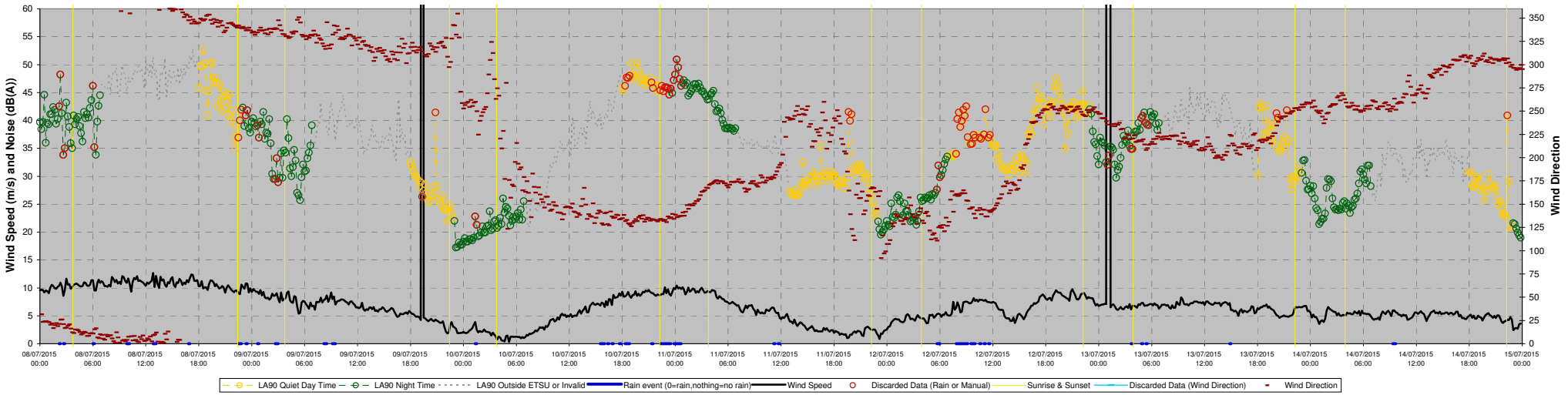
08/07/2015 to 15/07/2015



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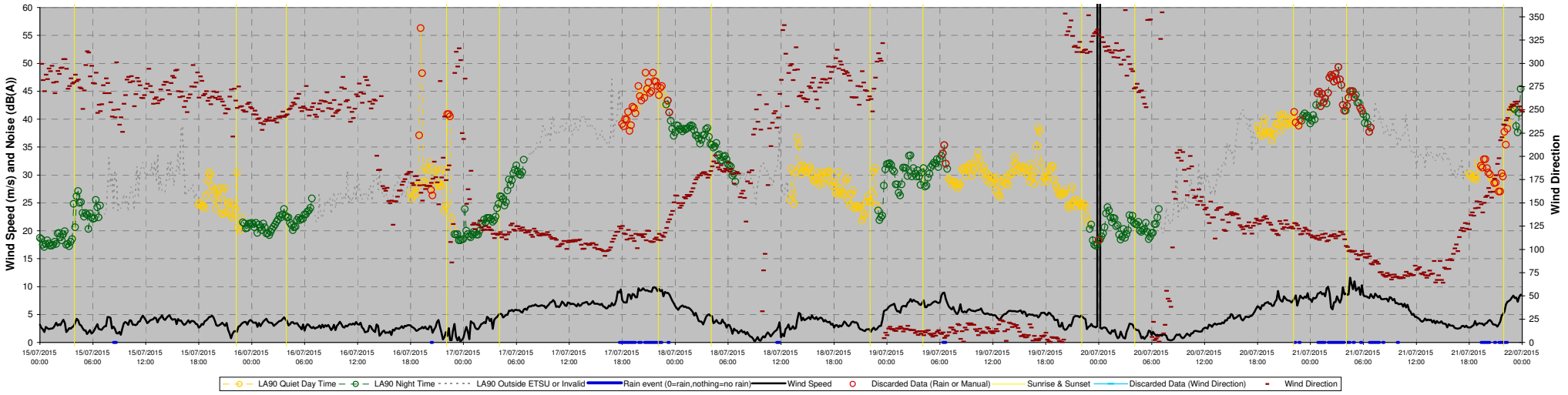

Project	Beaw Field Wind Farm
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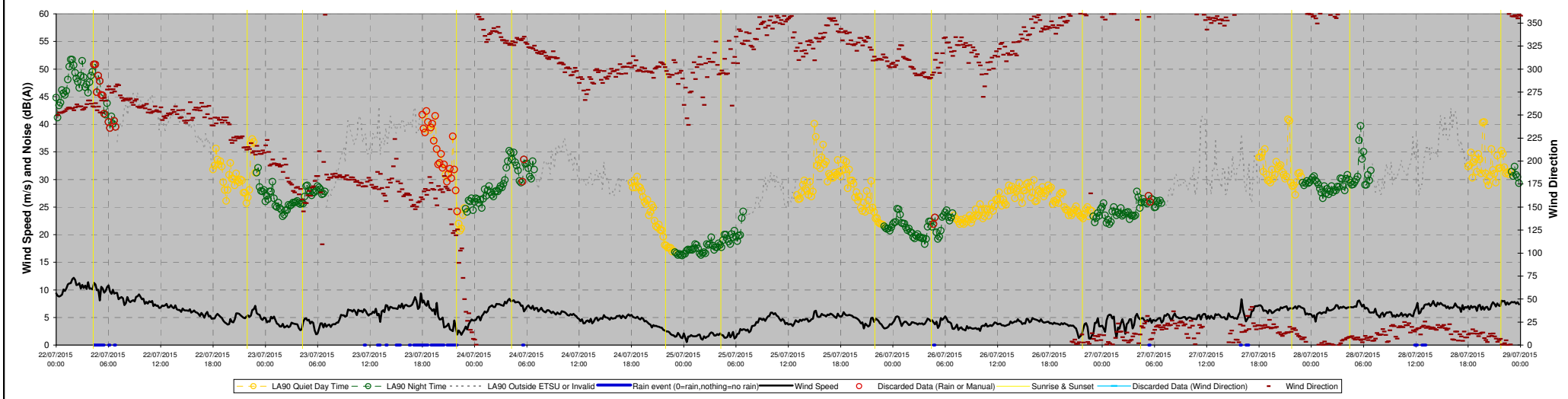

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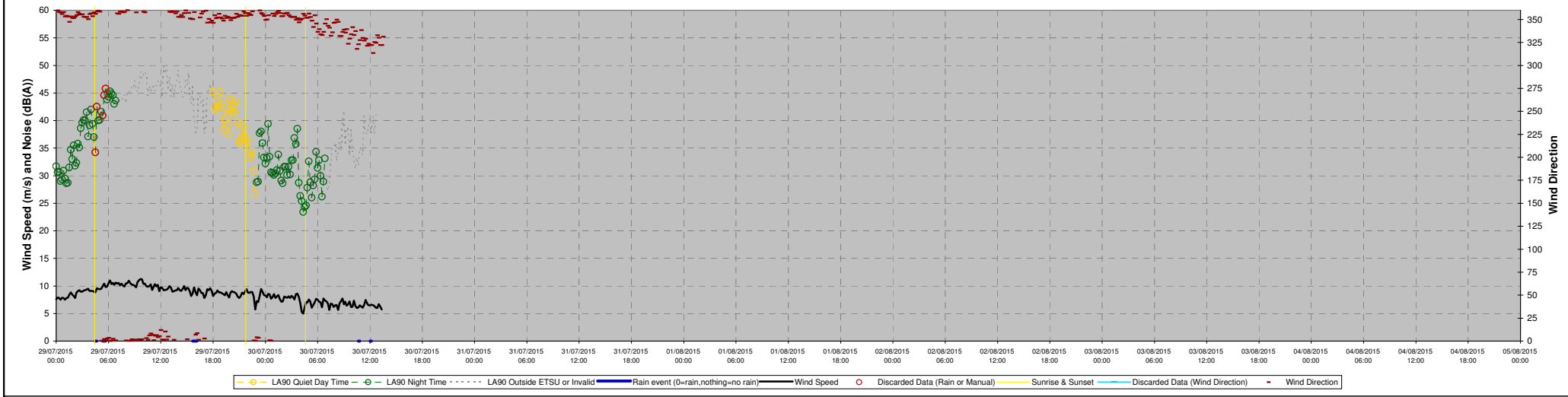

Project	Beaw Field Wind Farm
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Title	Time Serie for Heatherlea Page 3 of 3
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ANNEX 7 – Summary of Wind Turbine Noise Source Data

TNEI SUMMARY ANALYSIS OF NOISE DATA FOR : REpower-3.4M 104-RE50.8 blade-Full mode-100hub

Turbine identification:	
Manufacturer:	REpower
Model Name:	3.4M 104
Blade Type/Name:	RE50.8
Operational Mode:	Full
Hub Height:	100

Available Noise Document(s) Considered in the analysis of this turbine:

	Doc. Date	Doc. Name
Manufacturer doc:	02/08/2011	SD-3.1-WT.PC.00-B-D-EN Power-Curve_Sound-Power-Level_[3.4M104_50Hz]
Test Report1:	29/04/2010	D-3.1-VM.SM.04-D.A-EN
Test Report2:		
Test Report3:		

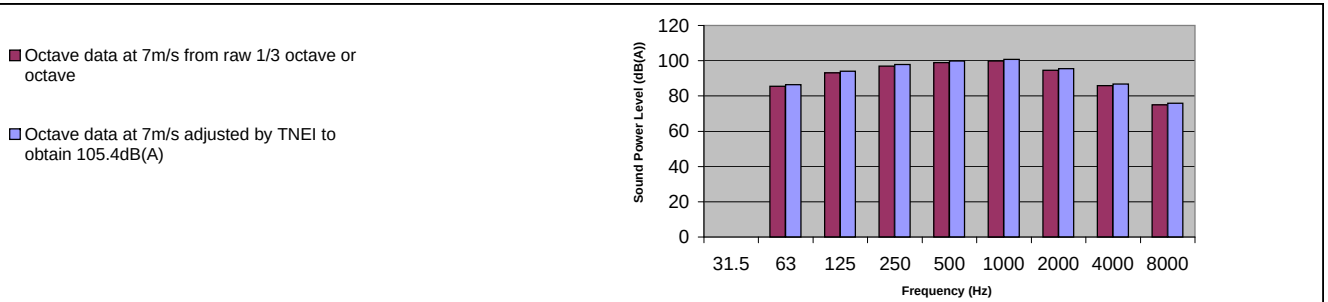
Summary of Sound Power Levels(Lw_{Aeq}) at various wind speeds:

Wind Speed (standardised 10m)	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Manufacturer Lw raw as found in document		95.0	96.7	100.4	104.1	105.4	105.5	105.0	104.8	104.8	104.8
Manufacturer specified Lw +Manufacturer Uc+TNEI Uc (used for modeling by TNEI)		95.0	96.7	100.4	104.1	105.4	105.5	105.5	105.5	105.5	105.5
Comment: Measurement report which includes measurement uncertainty suggests no additional uncertainty required beyond the noise levels specified by the manufacturer.											

Summary of Octave Data (LwA_{eq}) used for modelling:

Octave data is from Test Report1 at 7m/s										
Frequency (Hz)	31.5	63	125	250	500	1000	2000	4000	8000	Overall
Octave data at 7m/s from raw 1/3 octave or octave	0.0	85.5	93.1	97.0	98.9	99.8	94.6	85.9	75.0	104.5
Octave data at 7m/s adjusted by TNEI to obtain 105.4dB(A)	0.0	86.4	94.0	97.9	99.8	100.7	95.5	86.8	75.9	105.4
Comment: Third octave data from report1 at 7m/s.										

Plot of Octave Data



Additional Comment:

Data analysed in accordance with the guidance from the IOA GPG May 2013.

3.2 Guaranteed sound power level according to IEC

The sound power level guaranteed by Senvion SE excludes measurement uncertainty. Senvion SE warrants that there is no tonal audibility $\Delta L_{a.k} > 0$ dB (for $v_{10} \geq 6$ m/s).

Sound Power Level according to IEC for wind speed in hub height

Wind speed v [m/s]	Sound Power Level L_{WA} [dB(A)]
4.0	95.0
4.5	95.1
5.0	95.5
5.5	96.2
6.0	97.2
6.5	98.5
7.0	99.9
7.5	101.4
8.0	102.9
8.5	103.9
9.0	104.6
9.5	105.1
10.0	105.4
10.5	105.6
11.0	105.6
11.5	105.5
12.0	105.3
12.5	105.1
13.0	105.0
13.5	104.9
14.0 - 25.0	104.8

Sound Power Level according to IEC for wind speed in 10 m height

Wind speed v_{10} [m/s]	Sound Power Level L_{WA} [dB(A)]		
	78 - 80 m	96.5 - 100 m	125 - 128 m
3.0	95.0	95.0	95.1
3.5	95.4	95.5	95.7
4.0	96.4	96.7	97.1
4.5	97.9	98.3	98.9
5.0	99.8	100.4	101.1
5.5	101.9	102.6	103.2
6.0	103.6	104.1	104.5
6.5	104.7	104.9	105.2
7.0	105.3	105.4	105.5
7.5	105.6	105.6	105.6
8.0	105.6	105.5	105.3
8.5	105.4	105.2	105.1
9.0	105.1	105.0	104.9

Wind speed v_{10} [m/s]	Sound Power Level L_{WA} [dB(A)]		
	78 - 80 m	96.5 - 100 m	125 - 128 m
9.5	104.9	104.9	104.8
10.0 - v_{out}	104.8	104.8	104.8

3.3 Guaranteed sound power level according to FGW Guideline at 95 % of rated power

The sound power level measured according to the "Technische Richtlinie für Windenergieanlagen Teil1: Rev. 18 der FGW" at 95 % of the rated power is independent of the hub height:

$$L_{WA,95\ \%} = 105.6\ \text{dB(A)}$$

Summary of results of the noise emission measurement, in accordance with IEC 61400-11, of a WTGS of the type REpower 3.4M 104

WINDTEST A GL company

Recalculation of L_{WA} for different hub heights in dB(A) (WS at a height of 10 m) **:**

Hub height [m]	L_{WA} (6 m/s)	L_{WA} (7 m/s)	L_{WA} (8 m/s)	L_{WA} (9 m/s)	L_{WA} (10 m/s)
78	102,3	104,2	104,1	103,4	102,9
80	102,3	104,2	104,1	103,4	102,8
96,5	102,8	104,3	104,0	103,2	102,6

** A direct recalculation of the tonality is not possible, as other acoustic effects may arise due to the different length of the tower.

Third octave sound power spectrum in dB(A) for the wind speed in 10 m height corresponding to the maximum sound power level given on page 1:

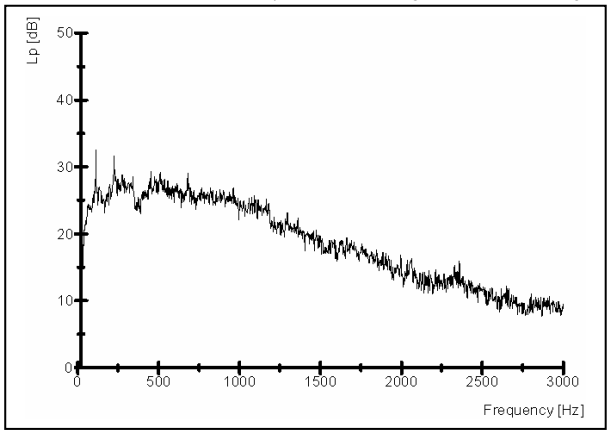
1/3 octave freq. [Hz]	50	63	80	100	125	160	200	250	315	400	500	630
L_{WA} (7,0 m/s)	77,6	80,5	82,7	85,7	86,9	90,7	92,2	92,2	92,3	92,1	94,8	94,9
1/3 octave freq. [Hz]	**800**	**1000**	**1250**	**1600**	**2000**	**2500**	**3150**	**4000**	**5000**	**6300**	**8000**	**10000**
L_{WA} (7,0 m/s)	95,5	95,5	93,9	92,1	89,0	86,7	84,0	80,0	75,8	72,4	69,7	67,1

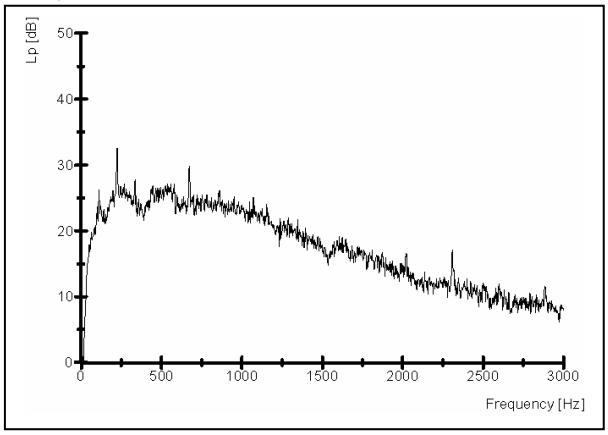
Linear third octave sound power 1/3- octave spectrum in dB for the wind speed in 10 m height

1/3 octave freq. [Hz]	10	12,5	16	20	25	31,5	40	50	63	80	100
L_{WA} (6,0 m/s)	111,3	112,8	108,7	111,9	109,1	107,5	108,0	106,5	105,2	103,6	103,4
L_{WA} (7,0 m/s)	112,7	114,2	110,1	113,3	110,5	108,9	109,4	107,9	106,6	105,0	104,8
L_{WA} (8,0 m/s)	113,0	114,1	109,7	113,1	109,9	108,3	109,1	107,8	106,1	104,8	105,2
L_{WA} (9,0 m/s)	112,5	113,3	108,3	112,6	108,5	107,4	107,8	106,4	105,0	103,4	104,1
L_{WA} (10,0 m/s)	114,1	114,7	109,5	113,3	109,9	108,2	109,0	107,4	105,8	103,9	104,3

Tonality according to IEC 61400-11/Ed.2:

Representative FFT - Spectra (left 8 m/s and right 10 m/s at a height of 10 m):





WS in 10 m height [m/s]	6,0	7,0	8,0	9,0	10,0
Freq. of most prevalent tone, f [Hz]	110	224	112	226	226
Tonality, ΔL_k [dB]	-5,98	-12,30	-7,56	-8,43	-5,35
Audibility, $\Delta L_{a,k}$ [dB]	-3,97	-10,25	-5,55	-6,38	-3,29

Remarks: --

Checked:

Dipl.-Ing. K. Buchmann
Head of Department Acoustics & Inspection

Engineer:

Dipl.-Ing. J. Dedert

Laboratory accredited by DAP Deutsches Akkreditierungssystem Prüfwesen GmbH according to DIN EN ISO/IEC 17025. This accreditation is valid for the test and measurement procedures given in the certificate.

Deutscher Akkreditierungs Rat DAR DPT-PL-1556.01

Kaiser-Wilhelm-Koog,2010-06-30

TNEI SUMMARY ANALYSIS OF NOISE DATA FOR : Nordex -N100 3300-NA blade-Full mode-100hub

Turbine identification:	
Manufacturer:	Nordex
Model Name:	N100 3300
Blade Type/Name:	NA
Operational Mode:	Full
Hub Height:	100

Available Noise Document(s) Considered in the analysis of this turbine:

	Doc. Date	Doc. Name
Manufacturer doc:	02/11/2012	F008_242_A03_EN Revision 00, 2012-11-02
Test Report1:		
Test Report2:		
Test Report3:		

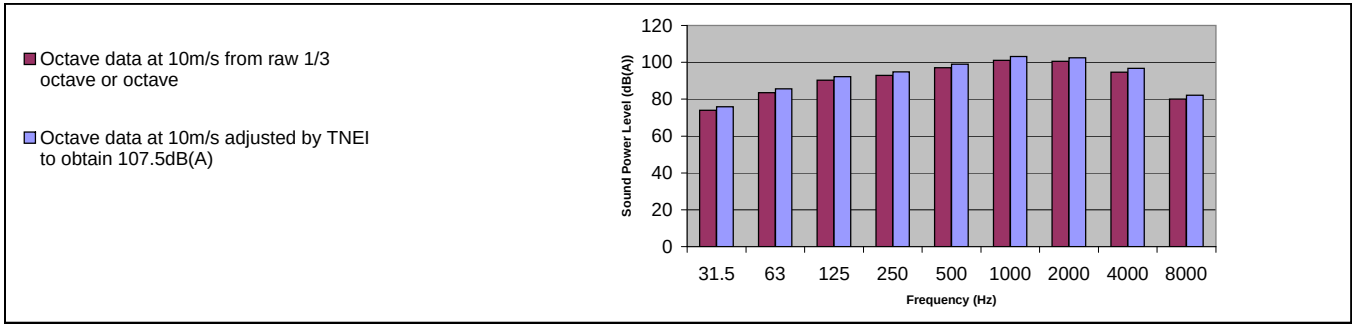
Summary of Sound Power Levels(Lw_{Aeq}) at various wind speeds:

Wind Speed (standardised 10m)	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Manufacturer Lw raw as found in document		95.6	96.7	99.2	103.6	104.6	105.2	105.5	105.5	105.5	105.5
Manufacturer specified Lw +Manufacturer Uc+TNEI Uc (used for modeling by TNEI)		97.6	98.7	101.2	105.6	106.6	107.2	107.5	107.5	107.5	107.5
Comment: No measurement reports available +2dB added											

Summary of Octave Data (LwA_{eq}) used for modelling:

Octave data is from Test Report at 10m/s										
Frequency (Hz)	31.5	63	125	250	500	1000	2000	4000	8000	Overall
Octave data at 10m/s from raw 1/3 octave or octave	73.9	83.6	90.3	92.9	97.0	101.1	100.5	94.7	80.1	105.5
Octave data at 10m/s adjusted by TNEI to obtain 107.5dB(A)	75.9	85.6	92.3	94.9	99.0	103.1	102.5	96.7	82.1	107.5
Comment: Octave data are taken from octave sound power level report F008_242_A13_EN - dated 24-06-13.										

Plot of Octave Data



Additional Comment:

Data analysed in accordance with the guidance from the IOA GPG May 2013.

Noise level - Nordex N100/3300

Standardized wind speed $v_{S(10m)}$ [m/s]	Apparent sound power level			
	hub height 75 m		hub height 100 m	
	L_{WA} [dB(A)]	v_H [m/s]	L_{WA} [dB(A)]	v_H [m/s]
3.0	95.5	4.1	95.6	4.3
4.0	96.5	5.5	96.7	5.7
5.0	98.5	6.9	99.2	7.2
6.0	102.8	8.3	103.6	8.6
7.0	104.4	9.7	104.6	10.0
8.0	105.0	11.0	105.2	11.5
9.0	105.5	12.4	105.5	12.9
10.0	105.5	13.8	105.5	14.3
11.0	105.5	15.2	105.5	15.8
12.0	105.5	16.6	105.5	17.2

2.2 Hub height 100 m

The octave sound power levels of the Nordex N100/3300 are determined on basis of aerodynamical calculations and expected sound power levels according to Nordex Document F008_242_A03_EN_R01. These values are valid for the hub height 100 m.

	Octave sound power levels at standardized wind speeds v_s in dB(A)									
Frequency	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s
31.5 Hz	64.0	65.1	66.3	73.3	73.8	74.7	73.9	73.9	73.9	73.9
63 Hz	73.7	74.8	76.1	82.5	82.9	83.8	83.6	83.6	83.6	83.6
125 Hz	79.3	80.4	80.4	86.6	88.9	90.1	90.3	90.3	90.3	90.3
250 Hz	85.4	86.5	87.6	92.0	93.3	93.8	92.9	92.9	92.9	92.9
500 Hz	88.6	89.7	92.6	96.3	97.6	97.9	97.0	97.0	97.0	97.0
1000 Hz	89.8	90.9	94.2	98.8	99.9	100.6	101.1	101.1	101.1	101.1
2000 Hz	90.4	91.5	93.8	98.0	98.8	99.5	100.5	100.5	100.5	100.5
4000 Hz	85.8	86.9	88.7	94.0	93.9	94.5	94.7	94.7	94.7	94.7
8000 Hz	72.5	73.6	74.8	80.4	80.6	80.9	80.1	80.1	80.1	80.1
Total sound power level	**95.6**	**96.7**	**99.2**	**103.6**	**104.6**	**105.2**	**105.5**	**105.5**	**105.5**	**105.5**

3 Protection Notice ISO 16016

TNEI SUMMARY ANALYSIS OF NOISE DATA FOR : Evance-R9000-Generic blade-Full mode-10hub

Turbine identification:	
Manufacturer:	Evance
Model Name:	R9000
Blade Type/Name:	Generic
Operational Mode:	Full
Hub Height:	10

Available Noise Document(s) Considered in the analysis of this turbine:

	Doc. Date	Doc. Name
Manufacturer doc:	12/08/2010	Evance R9000 UK MCS Certification Summary
Test Report1:		
Test Report2:		
Test Report3:		

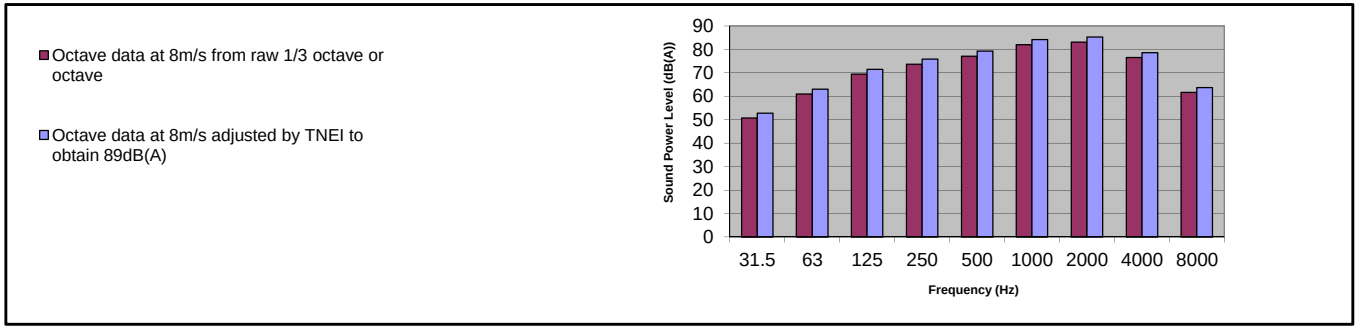
Summary of Sound Power Levels(Lw_{Aeq}) at various wind speeds:

Wind Speed (standardised 10m)	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Manufacturer Lw raw as found in document		78.5	80.6	82.7	84.8	86.9	89.0	91.1	93.2	95.3	97.4
Manufacturer specified Lw +Manufacturer Uc+TNEI Uc (used for modeling by TNEI)		78.5	80.6	82.7	84.8	86.9	89.0	91.1	93.2	95.3	97.4
Comment: No additional Uc as accounted for enough. See summary on left.											

Summary of Octave Data (LwA_{eq}) used for modelling:

Octave data is from Test Report1 at 8m/s										
Frequency (Hz)	31.5	63	125	250	500	1000	2000	4000	8000	Overall
Octave data at 8m/s from raw 1/3 octave or octave	50.7	60.9	69.4	73.7	77.1	82.0	83.1	76.5	61.6	86.9
Octave data at 8m/s adjusted by TNEI to obtain 89dB(A)	52.8	63.0	71.5	75.8	79.2	84.1	85.2	78.6	63.7	89.0
Comment: See comments to left										

Plot of Octave Data



Additional Comment:

Data analysed in accordance with the guidance from the IOA GPG May 2013.

Product Certification

Evance R9000 Acoustic Noise Assessment

Issue 04

Certificate Number MCS WT0039
Small Wind Turbine

List of contents

List of figures

List of tables

1. Introduction

This document presents the results of an acoustic sound test conducted on an Evance R9000, in accordance with BS EN 61400-11[1] and with the additional guidance stated in BWEA Performance and Safety standard[2].

A summary of the report is shown below in Figure 1. The key results are the Declared Apparent Emission Sound Power Level, $L_{Wd,8m/s}$, at 8m/s hub height wind speed and noise immission predictions for a range of slant distances and hub height wind speeds.

2. Test Summary

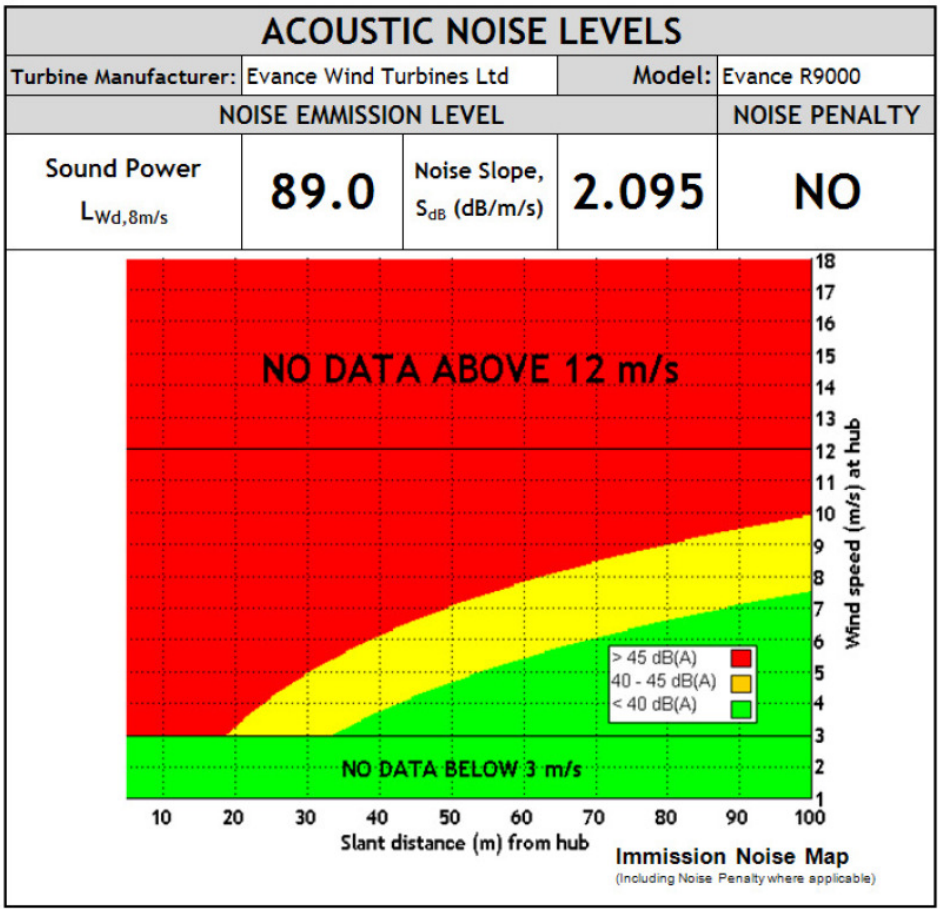


FIGURE 1 – NOISE LABEL

No measurements of directivity were undertaken but the turbine was subjectively much quieter in the plane of the blades (perpendicular to wind direction) than the measured downwind location.

The assessment established the turbine should not be declared as 'tonal' and therefore no penalty should be applied.

The BWEA Reference Sound Levels at 25m and 60m at an 8m/s hub height wind speed are:

$$L_{p,25m} = 53dB(A)$$
$$L_{p,60m} = 45.5dB(A)$$

3. Characterisation of Wind Turbine

TABLE 1 – EVANCE R9000 TEST TURBINE SPECIFICATION

WIND TURBINE DETAILS	
MANUFACTURER	Evance Wind Turbines Ltd
MODEL	Evance R9000
SERIAL NUMBER	280
OPERATING DETAILS	
ROTOR ORIENTATION	Upwind
HAWT OR VAWT	Horizontal Axis Wind Turbine
HUB HEIGHT	12.24m
HORIZONTAL DISTANCE FROM ROTOR CENTRE TO TOWER AXIS	0.63m
ROTOR DIAMETER	5.5m
TOWER TYPE	Freestanding (tube)
CONTROL SYSTEM	Patented Reactive Pitch™ Control
ROTATIONAL SPEED	200 rpm nominal, 230 rpm maximum
BWEA REFERENCE POWER (POWER AT 11M/S)	4628W
CUT-IN WIND SPEED	3m/s
SURVIVAL WIND SPEED	42.5m/s 10 minute mean
YAW CONTROL	Passive - Tail Vane and rotor
ROTOR DETAILS	
BLADE TYPE	Glass Fibre Reinforced Composite, low reflection, UV and anti-erosion coatings
NUMBER OF BLADES	3
BLADE SERIAL NUMBERS	781,782,778
GEARBOX	
GEARBOX	None
GENERATOR DETAILS	
GENERATOR	Patented brushless direct drive air-cored high efficiency Permanent Magnet Alternator
BRAKE	
BRAKE	Patented Automatic ElectroBrake™ (with manual control for servicing).

4. Physical Environment

Table 2 presents the key details of the certification test site and turbine.

TABLE 2 - DETAILS OF TEST SITE

Post Code:	TR19 7TS
Wind Turbine Coordinates:	Lat: 50.1542° Long: -5.64296°
Met Mast Coordinates:	Lat: 50.1541° Long: -5.64317° (16.5m, 250° from wind turbine)
Turbine:	Evance R9000
Hub Height:	12.24m

The certification test site for the Evance R9000 wind turbine is located just outside of Pendeen, 4 miles Northeast of Penzance, Cornwall. The site is at an elevation of 143m with Southwesterly prevailing winds. Figure 2 shows an aerial photograph of the test site. The white line on the photograph is 110m long (20D). Figure 3 shows an OS map of the test site and surrounding area. The nearby area is very open but slopes down to the North and up to the South. The surface is mostly short grass with stone walls separating individual fields. The general layout is shown in Figure 4, Figure 5 and Figure 6.

FIGURE 2 - AERIAL PHOTOGRAPH OF TEST SITE

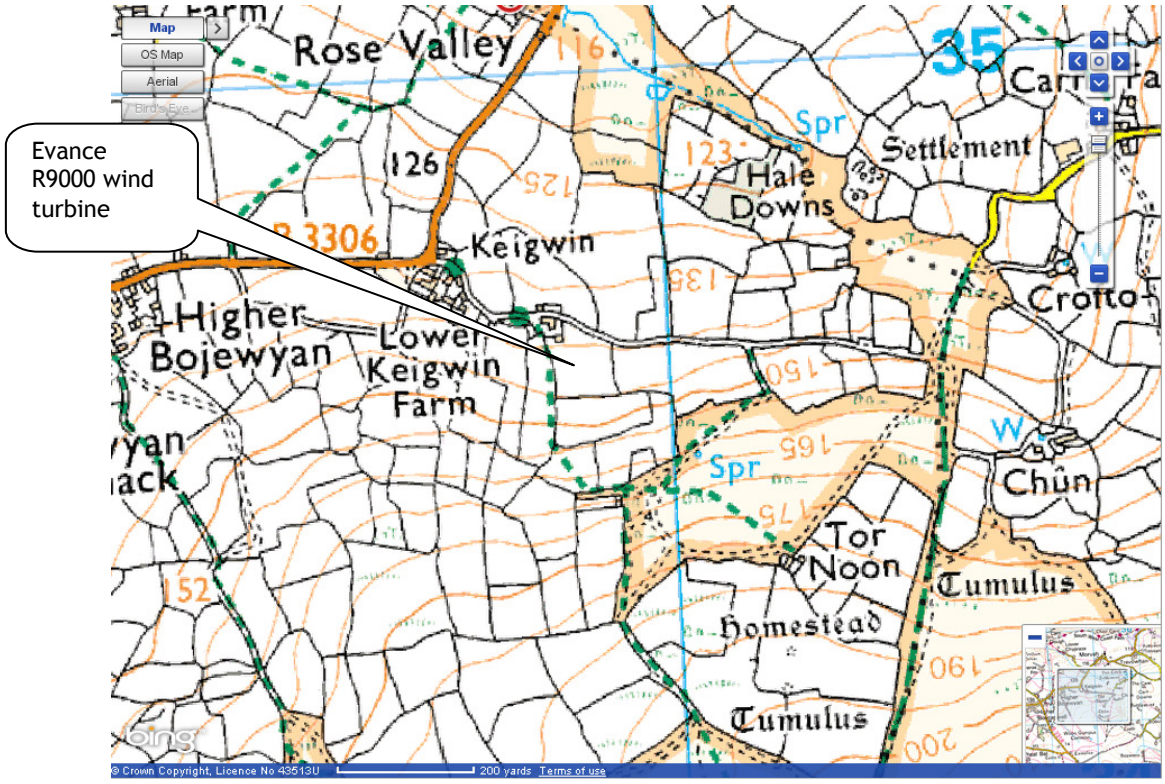


FIGURE 3 - MAP OF THE TEST SITE SHOWING CONTOUR LINES

FIGURE 4 – PHOTOGRAPH OF TURBINE FROM MICROPHONE

FIGURE 5 – PHOTOGRAPH OF TURBINE FROM MET MAST

FIGURE 6 – PHOTOGRAPH OF MICROPHONE ON MEASUREMENT BOARD

5. Instrumentation

Measurements were based on the approach described in the BWEA standard[1] using the instrumentation described in Table 3.

TABLE 3 – INSTRUMENTATION DETAILS

Equipment Item	Make and Model	Serial Number	Calibration Date
Integrating sound level meter	Pulsar P33 Real Time Analyzer	T226566	14/01/10
Microphone	Pulsar MK:224	20042763	13/01/10
Acoustic calibrator	Pulsar Model 105	45109	14/01/10
Anemometer	Vector Instruments A100LK	5461/TJW	08/01/09
Wind Vane	Vector Instruments W200P	13578	N/A
Data Logger	Campbell Scientific CR1000	4033	02/06/09

Wind speed was measured at a height of hub height +2% (flow correction factors applied during analysis). Wind direction was measured at 11m AGL. Both instruments were located 16.5m (3D) from the wind turbine. The met mast was at 250° when referenced from the wind turbine.

6. Acoustic Data

6.1 Set-up and Measurement Sessions

Audible noise measurements were made using a Pulsar P33 sound level meter with a ½ inch microphone. The microphone was positioned at the centre of a 1 metre diameter, 18mm thick ground board made from plywood. The board was accurately placed 15m downwind of the tower for each measurement series, resulting in a slant distance (rotor centre to microphone) of 19.85m. The microphone had a primary wind shield only.

The sound level meter had a calibration check before and after each measurement session.

Noise, wind speed, wind direction, temperature and pressure were all measured at a sampling rate of 1 Hz and over a 1 minute averaging period. The sound level meter was synchronised with the data logger at the start of each measurement series. If the sound level meter did not successfully synchronise or the synchronisation drifted over the duration of the measurement session the records would become void.

In order to always have the anemometer in the upwind sector, noise measurements were only accepted when the wind direction was between 170° and 290°. Sectors 160°-170° and 290°-340° were not used due to incomplete site calibration flow correction factors – these sectors would have made up the 180° sector (250° ±90°) stated in the BWEA standard[2].

Details of each measurement session are shown in Table 4.

TABLE 4 – DETAILS OF MEASUREMENT SESSIONS

Session / Register	Date	Hub Height Wind Speed range (m/s)	Wind Direction (°)	Microphone Location (°)	Average Pressure (kPa)	Average Temperature (°C)	Average Turbulence Intensity (%)
0	26/02/2010 10:13:00	8.86-11.01	282.7-296.9	85	98	7.1	14.2%
1	void	void	void	void	void	void	void
2	26/02/2010 10:36:00	8.5-11.84	279.5-295.5	85	98.1	7.6	12.9%
3	void	void	void	void	void	void	void
4	26/02/2010 11:46:00	7.52-9.2	271.7-279.7	85	98.1	8	14.5%
5	void	void	void	void	void	void	void
6	26/02/2010 12:06:00	7.77-10.06	268.7-277.3	85	98.2	7.7	13.2%
7	26/02/2010 13:45:00	6.4-9.12	257.9-263.4	85	98.2	8.1	13.9%
8	26/02/2010 13:56:00	6.56-9.62	260.4-271.5	85	98.2	8.6	15.9%

9	26/02/2010 14:05:00	5.55-8.96	256.1-270.4	85	98.2	8.2	13.6%
10	26/02/2010 14:23:00	5.48-10.72	247.8-270.5	85	98.2	8.5	12.9%
11	26/02/2010 15:33:00	6.8-10.05	249.3-260.8	85	98.2	8.6	13.2%
12	26/02/2010 16:29:00	5.27-6.80	245.4-254.2	85	98.2	7.8	15.6%
13	26/02/2010 16:45:00	4.84-7.36	239.5-247.9	85	98.1	7.6	13.2%
14	26/02/2010 17:14:00	5.11-7.47	236.6-246.9	85	98.1	7.3	12.8%
15	26/02/2010 17:34:00	4.54-6.46	235.6-240.3	85	98.1	7.3	12.9%
16	27/02/2010 09:54:00	3.57-5.84	220.1-245	40	97.4	7.4	12.1%
17	void	void	void	void	void	void	void
18	27/02/2010 10:19:00	3.33-4.61	246-259.2	40	97.4	7.8	12.0%
19	27/02/2010 10:34:00	4.11	261	40	97.4	8	16.3%
20	27/02/2010 10:59:00	2.36-6.5	223.7-265.7	40	97.4	7.8	14.0%
21	27/02/2010 11:35:00	5.29-6.71	231.5-242.8	40	97.4	8.2	11.0%
22	27/02/2010 11:45:00	4.55-6.26	230.8-246.3	40	97.4	8.2	13.0%
23	27/02/2010 12:03:00	4.13-5.82	224.4-235.1	40	97.4	8.5	12.8%
24	27/02/2010 12:22:00	3.72-5.17	231.5-253.4	40	97.4	8.5	13.2%
25	18/03/2010 08:21:00	7.47-9.26	163.2-176.9	15	99.4	10.3	16.4%
26	void	void	void	void	void	void	void
27	void	void	void	void	void	void	void
28	18/03/2010 11:24:00	9.67-12.08	178.2-184.4	15	99.3	10.4	13.8%
29	void	void	void	void	void	void	void
30	void	void	void	void	void	void	void
31	void	void	void	void	void	void	void
32	18/03/2010 13:38:00	9.21-12.32	183.9-189.7	15	99.1	10.2	14.7%

33	void	void	void	void	void	void	void
34	18/03/2010 14:12:00	10.29-11.06	192-193.8	15	99.1	10.4	14.2%
35	void	void	void	void	void	void	void
36	test	test	test	test	test	test	test
37	test	test	test	test	test	test	test
38	test	test	test	test	test	test	test
39	test	test	test	test	test	test	test
40	void	void	void	void	void	void	void
41	29/04/2010 08:11:00	4.31	207.2	60	99.6	10.6	8.7%
42	29/04/2010 08:14:00	4.14-4.44	217.4-219.6	60	99.6	10.6	6.5%
43	void	void	void	void	void	void	void
44	29/04/2010 08:38:00	1.65-2.98	211.2-221.6	60	99.6	10.7	11.2%
45	29/04/2010 09:58:00	0.67-1.18	157.3-209.8	60	99.5	11.3	11.1%

6.2 Broadband

Noise versus wind speed at hub height was measured for the turbine running and for the turbine stopped (i.e. background noise). 154 data pairs of wind speed and noise for the turbine running and 89 data pairs of wind speed and noise for the turbine parked were obtained. Figure 7 shows the relationship between these two sets of data.

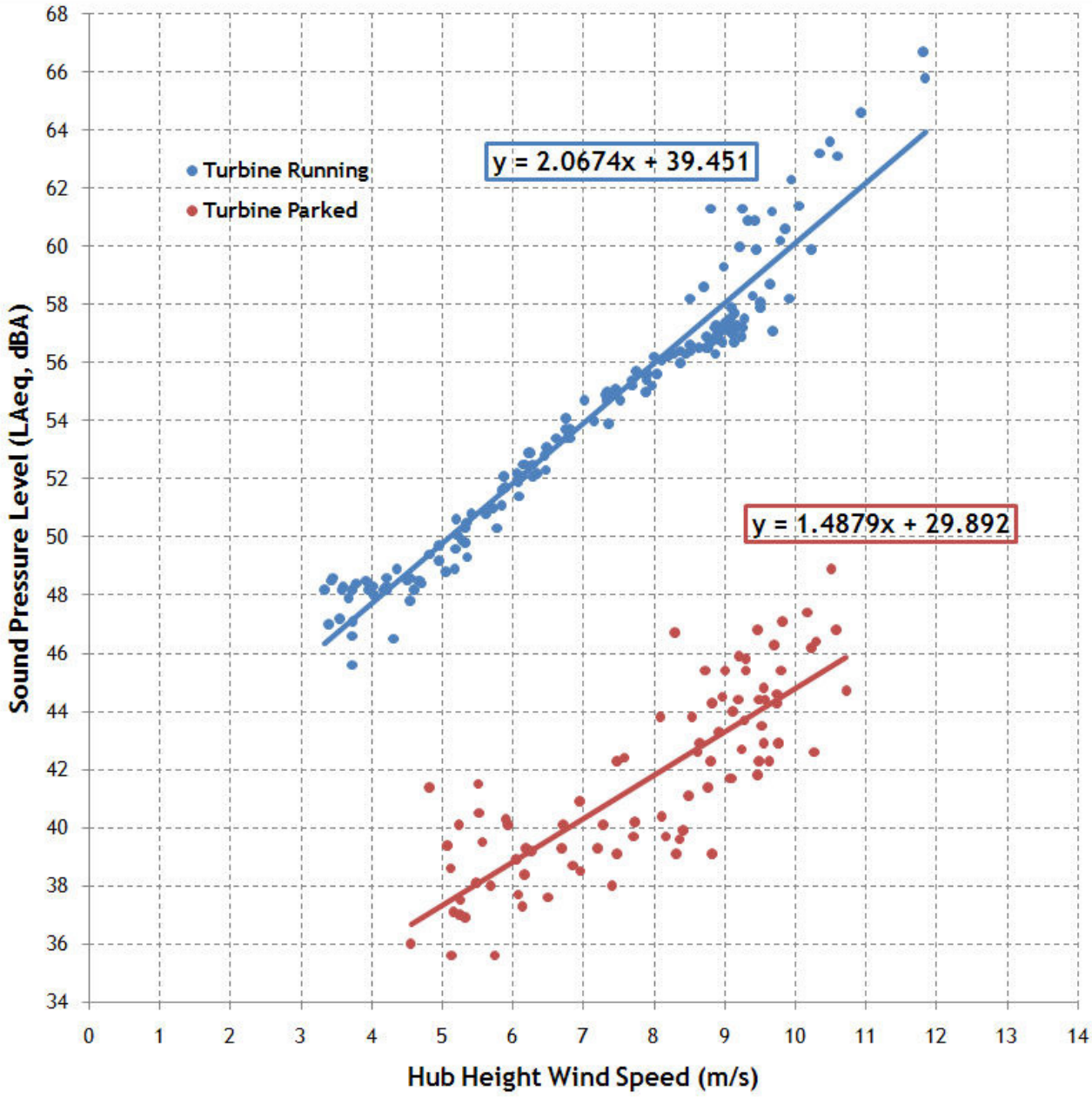


FIGURE 7 - SOUND PRESSURE LEVEL ON THE GROUND BOARD AT A SLANT DISTANCE OF 19.85M (1)

The uncertainty, S_{ey} (U_A) of the linear regression for the turbine running was 1.055dB. This type A uncertainty is used with the type B uncertainties in Section 6 to estimate a combined uncertainty (U_C) of 1.37dB. This procedure was performed in accordance with BS EN 61400-11:2003[1] Annex D.

Figure 8 shows the data from Figure 7 plus the background corrected sound pressure levels (i.e. the wind turbine specific noise after the removal of the contribution from the background noise). These points were calculated from the turbine running and turbine parked linear regression lines.

A combined uncertainty, U_C of 1.37dB was used to determine the uncorrected and corrected levels plus $1.645U_C$, these lines are also shown in Figure 8. It is the background corrected level plus $1.645U_C$ which is used as the basis of calculation of declared power levels. The $1.645U_C$ is used in accordance with the BWEA standard[2] and equates to a 95% confidence level that the noise will be below the value.

From Figure 8 it can be seen that correcting for background has the effect of increasing the slope of the linear regression. It was this slope – 2.095dB/m/s that was used in the calculations of the noise map. The background corrected regression line was then used to calculate the Declared Emission Sound Power Level for a hub height wind speed of 8m/s by applying a -6dB correction for the board reflection and a +36.9dB correction for the slant distance of 19.85m. Table 5 shows a summary of the results.

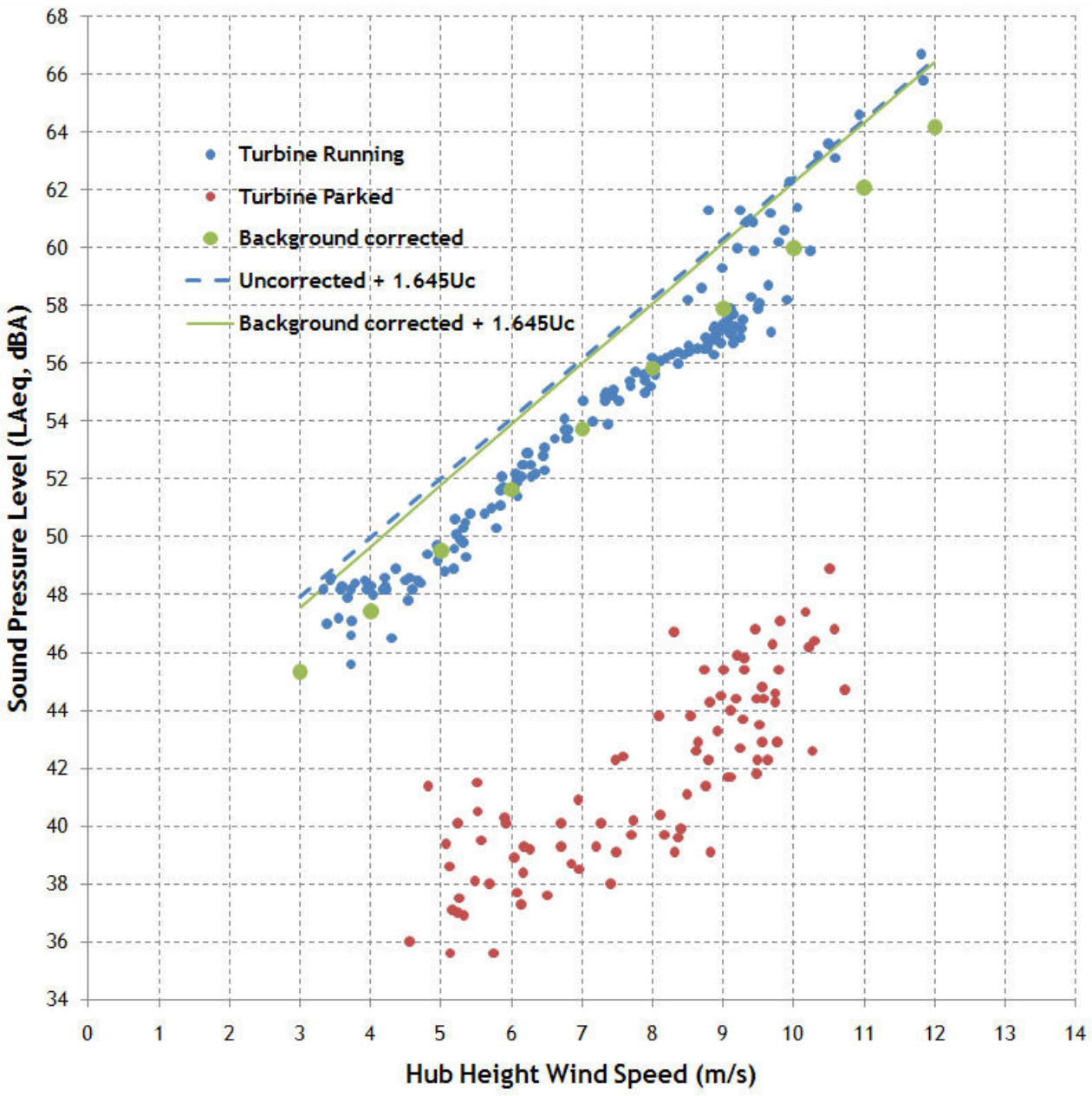


FIGURE 8 - SOUND PRESSURE LEVEL ON THE GROUND BOARD AT A SLANT DISTANCE OF 19.85M (2)

TABLE 5 – NOISE EMISSION SOUND POWER LEVELS

Parameter	Value at a Hub Height Wind Speed of 8m/s
Apparent Emission Sound Power Level, $L_{W,8m/s}$ (dB)	**86.8**
Declared Apparent Emission Sound Power Level, $L_{W,8m/s}$ (dB)	**89.0**
Estimated Combined Uncertainty, U_C (dB)	**1.37**
Wind Speed Dependence, S_{dB} (dB/m/s)	**2.095 (σ of fit on slope 0.01dB)**

6.3. Noise Character

Two aspects of the turbine noise character were investigated:

- The frequency content
- Tonality

1/3rd octave data was obtained for wind speeds around cut-in (3m/s), reference (8m/s) and speed control (12m/s). For each of these wind speeds, data was collected while the turbine was running and while the turbine was parked. The measured frequency bands were first energy averaged and then corrected for background levels. Figure 9 shows the turbine frequency content at 2.82m/s (energy average of 3 1-minute spectra). Figure 10 shows the turbine frequency content at 7.99m/s (energy average of 10 1-minute spectra). Figure 11 shows the turbine frequency content at 11.64m/s (energy average of 3 1-minute spectra).

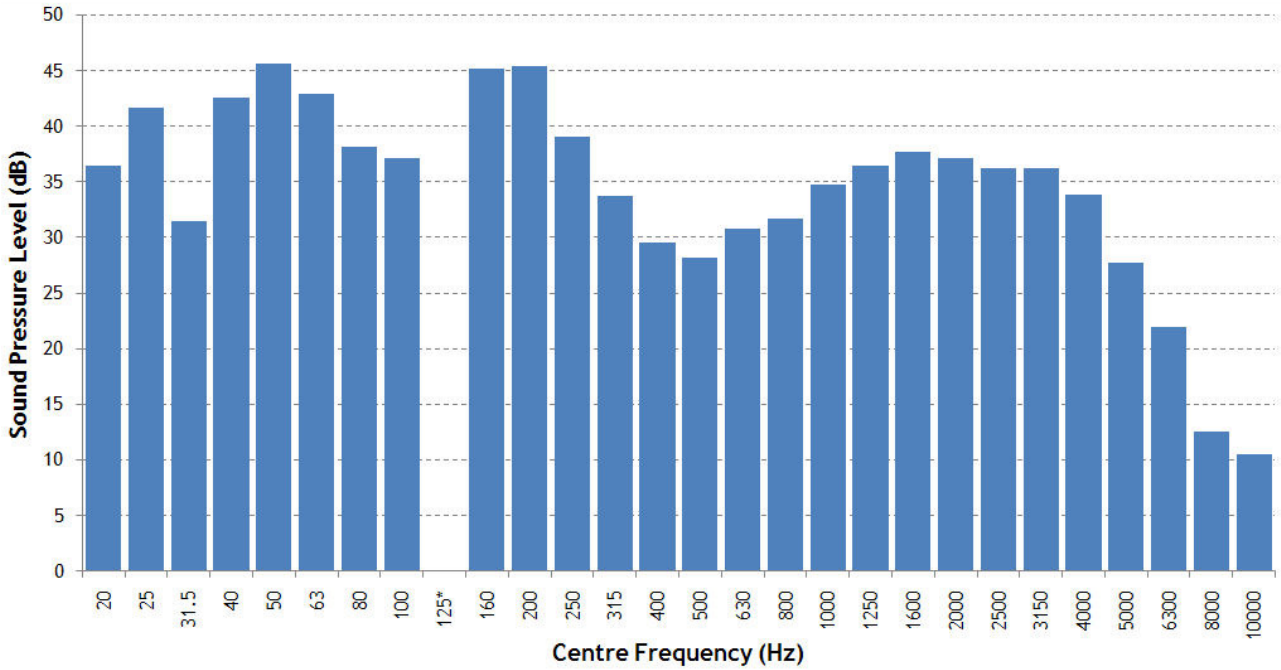


FIGURE 9 - UNWEIGHTED 1/3RD OCTAVE BAND FREQUENCY SPECTRUM FOR 2.82M/S AT A SLANT DISTANCE OF 19.85M

The 125Hz band in Figure 9 was not measureable because the background noise at 125Hz was louder than when the turbine was running. The dB(Lin), dB(A) and dB(C) for the spectrum was 53.4,44.9 and 52.9 respectively.

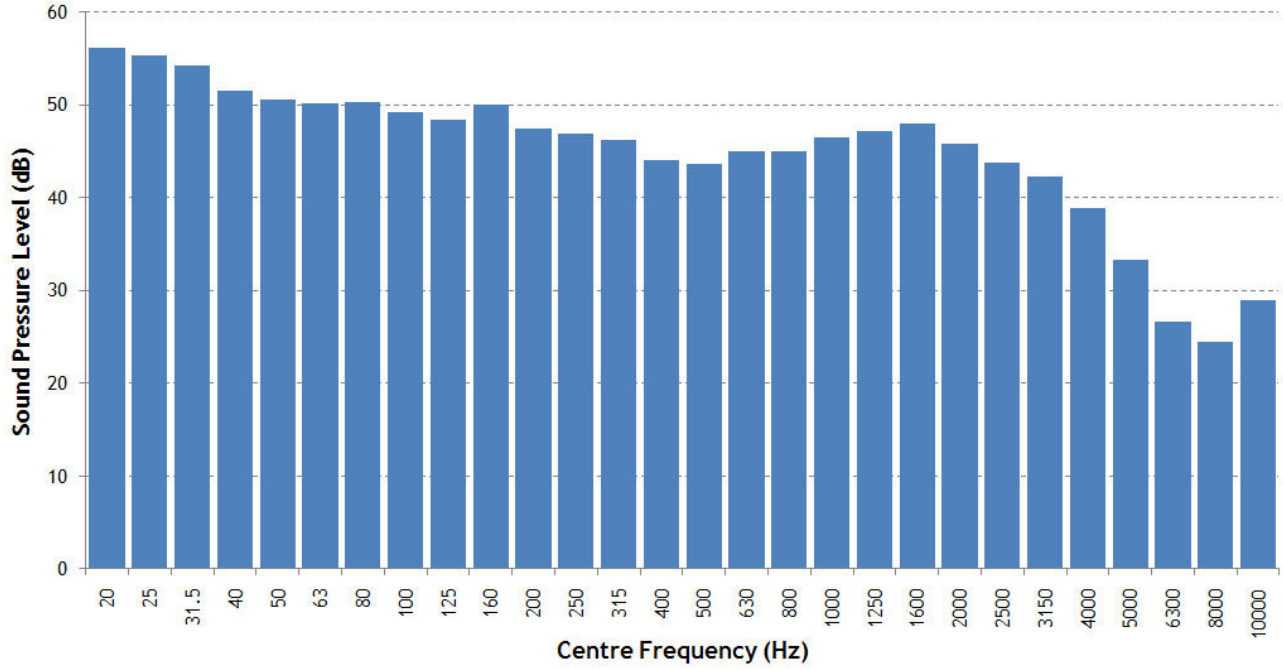


FIGURE 10 - UNWEIGHTED 1/3RD OCTAVE BAND FREQUENCY SPECTRUM FOR 7.99M/S AT A SLANT DISTANCE OF 19.85M

The dB(Lin), dB(A) and dB(C) for the 7.99m/s spectrum was 63.5, 54.2 and 61.6 respectively.

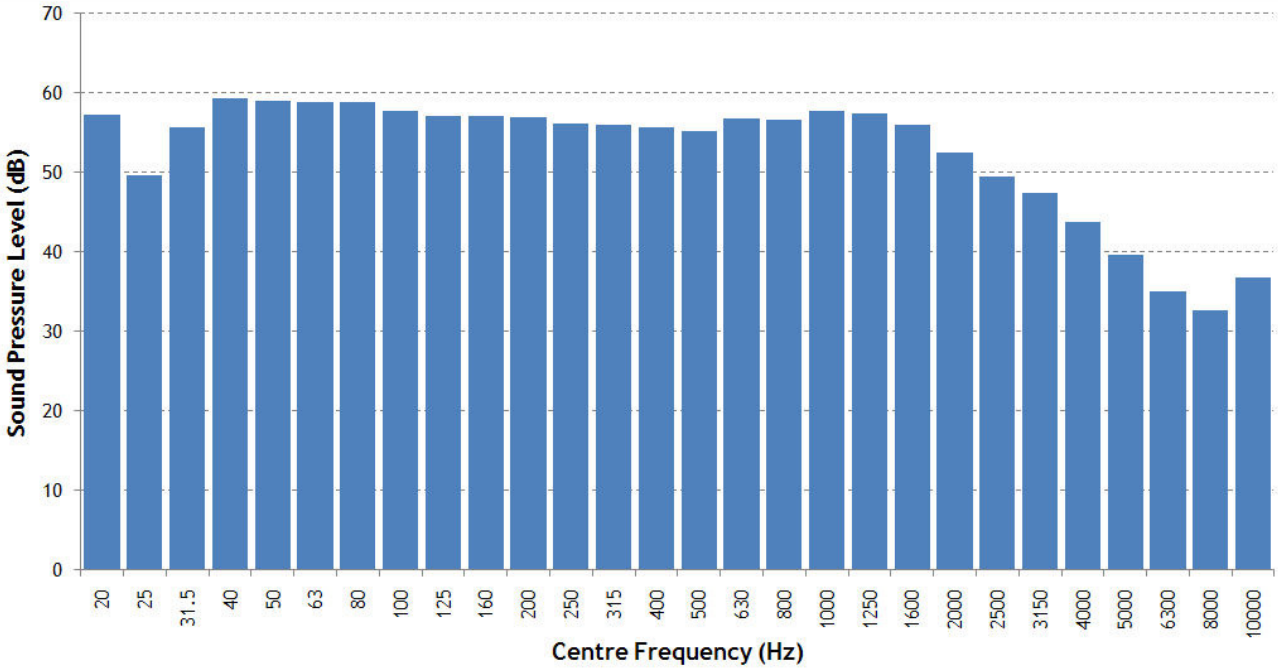


FIGURE 11 – UNWEIGHTED 1/3RD OCTAVE BAND FREQUENCY SPECTRUM FOR 11.64M/S AT A SLANT DISTANCE OF 19.85M

The dB(Lin), dB(A) and dB(C) for the 11.64m/s spectrum was 70.3, 63.4 and 69.5 respectively.

According to the tonal procedure required by the BWEA standard[2] the turbine does not have any tonal content.

6.4. Noise Immission

All measurements were made 15m (horizontal distance) downwind of the turbine on a ground board. Estimates can however be made for free field noise immission at any distance from the turbine using the results in Table 5. The method used was that provided in the BWEA standard2. The standardised noise map for the Evance R9000 is shown in Figure 12. For planning applications that require greater than 100m slant distances an extended noise map can be found in Figure 13.

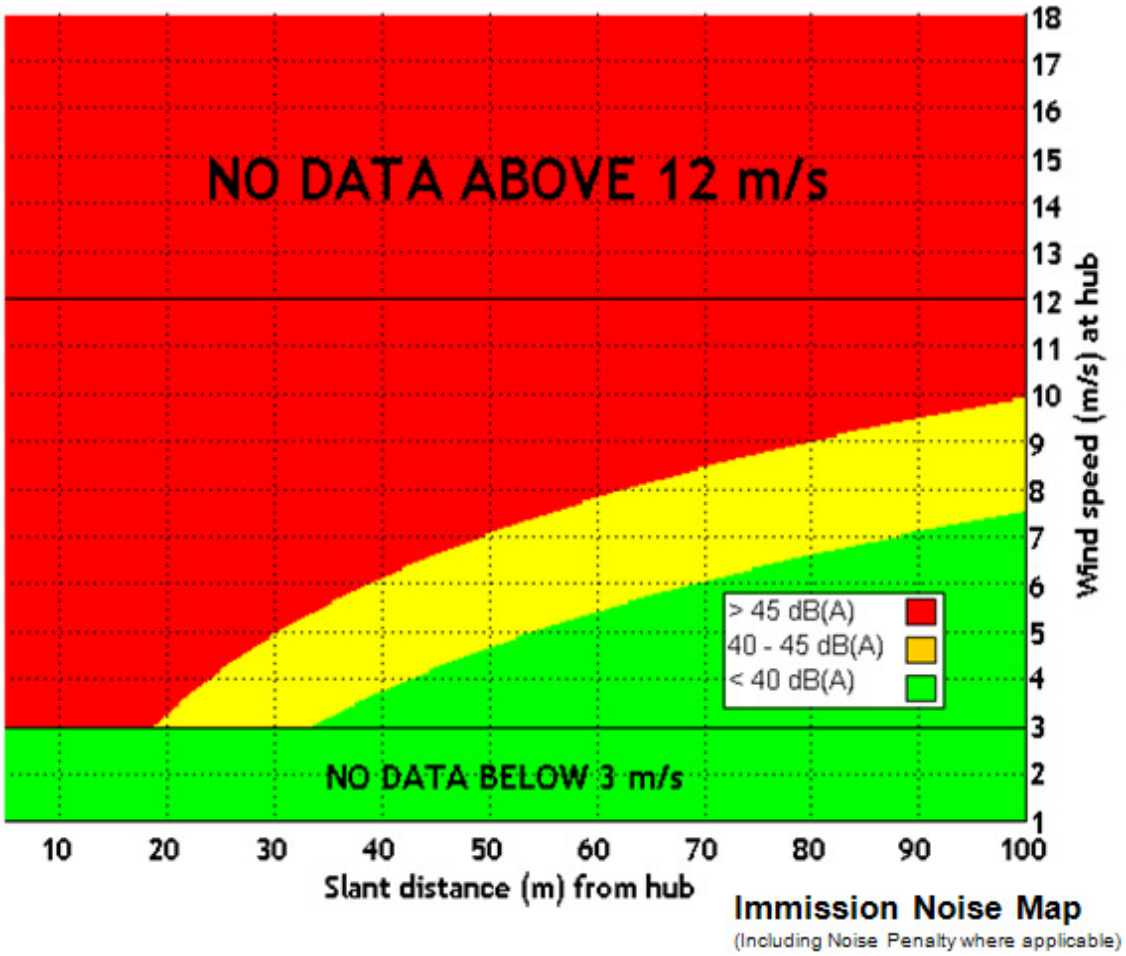


FIGURE 12 - NOISE MAP

In addition to the noise map two indicators were calculated at fixed slant distances (25m and 60m) at the reference hub height wind speed of 8m/s. For the Evance R9000 these are:

- The BWEA reference 25m sound level, $L_{p,25m}$ = **53dB(A)**
- The BWEA reference 60m sound level, $L_{p,60m}$ = **45.5dB(A)**

No measurements of directivity were undertaken but the turbine was subjectively much quieter in the plane of the blades (perpendicular to wind direction) than the measured downwind location.

Guidance on the use of the Immission Noise Map can be found in Appendix 1 of this report and the BWEA standard[2].

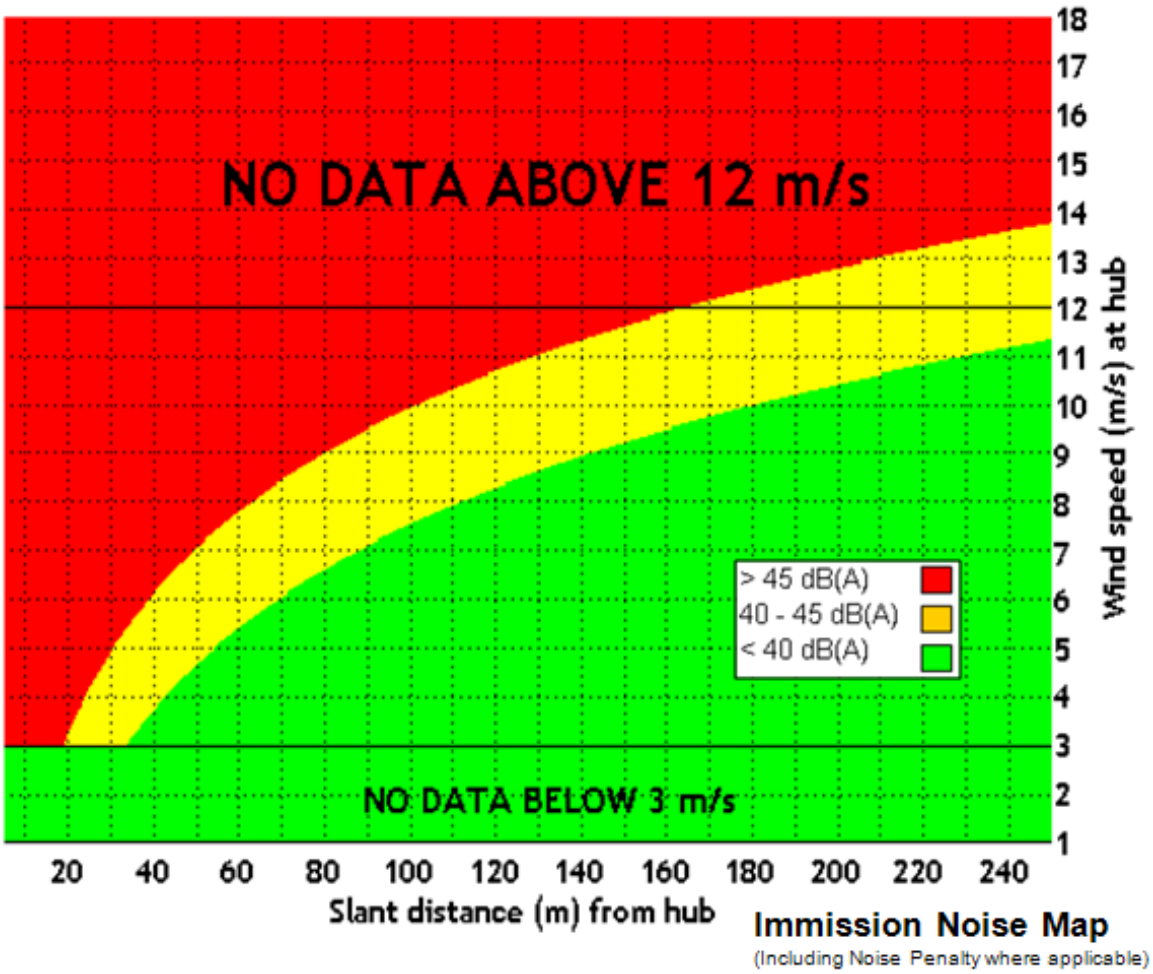


FIGURE 13 - EXTENDED NOISE MAP

7. Uncertainty

Table 6 shows the parameters involved in the calculation of the standard error for the noise map. The uncertainty is made up of a Type A component (obtained from the linear regression of the 'turbine running') and several Type B components (site effects). The procedure used was that described in BS EN 61400-11:2003[1] Annex D.

The combined uncertainty, U_C is calculated using the equation:

$$U_C = \sqrt{U_A^2 + U_{B1}^2 + U_{B2}^2 + U_{B3}^2 + U_{B4}^2 + U_{B5}^2 + U_{B6}^2 + U_{B7}^2 + U_{B8}^2 + U_{B9}^2}$$

TABLE 6 - ESTIMATION OF UNCERTAINTY IN APPARENT SOUND POWER LEVEL

Component	Possible Typical Standard Uncertainty (dB)	Assumed Standard Uncertainty (dB)	Comments
Type A - Measured, U_A			
Noise Versus Wind Speed	--	**1.055**	From linear regression
Type B - Estimated, U_B			
Calibration, U_{B1}	0.2	0.2	Typical value
Instrument, U_{B2}	0.2	0.2	Typical value
Board, U_{B3}	0.3	0.3	Typical value
Distance, U_{B4}	0.1	0.1	Within 2%
Impedance, U_{B5}	0.1	0.1	Typical value
Turbulence, U_{B6}	0.4	0.4	Typical value
Wind Speed, U_{B7}	0.9	0.6	Site calibration completed on test site
Direction, U_{B8}	0.3	0.3	Typical value
Background, U_{B9}	0.1	0.06	0.21/(2*√3) - Average applied correction
Combined Uncertainty, U_C		**1.370**	

8. Deviations from BWEA Small Wind Turbine Performance and Safety Standard

There were no exceptions to the standards.

9. References

1. BS EN 61400-11:2003, Wind Turbine Generator Systems, Part11 – Acoustic Noise Measurement Techniques, 2003

2. Small Wind Turbine Performance and Safety Standard. British Wind Energy Association. 29 Feb 2008

10. Appendix 1 - Guidance on the use of the Immission Noise Map

The following procedure can be used to assist the reader in considering the suitability of a prospective site. This method is the same as in the BWEA standard[2], except that it also includes a look-up chart based on the noise map provided in this report to simplify the process.
The method is based on the NOABL mean wind speed database which provides wind data at 45m, 25m and 10m height in 1 km squares covering Great Britain and Northern Ireland.

The BWEA standard defines the following process:

1. Find the national grid reference for the proposed site. This can be found from a map or from the Postcode if a suitable conversion program is available. Shorten the reference to the NOABL required format; e.g. if the Grid Reference is NS641532, then the NOABL input value is NS 64 53.

2. Use NOABL to get the average annual wind, $V_{avg,10}$ at 10m height for the location.

3. Assume a Rayleigh wind speed distribution and therefore calculate the 90% wind $V_{90,10}$ for 10m height as:

$$V_{90,10} = 1.52 * V_{avg,10}$$

4. Apply a wind correction factor from 10m height using a power law (in accordance with IEC 61400-2) to get an estimate of wind at the installed rotor centre height, H, as:

$$V_{90,H} = V_{90,10} * (H/10)^{0.2}$$

5. Draw a horizontal line on the immission noise map at the $V_{90,H}$ wind speed.

6. Read off the distance for the 45dB(A) and 40dB(A) values.

7. Compare these distances with the slant distances to the nearest noise sensitive location(s) for the planned installation.

The value of 45dB(A) is based on World Health Organisation (WHO) guidance. The second line at 40dB(A) has been included in the standard since at the time of writing firm criteria had not been agreed and adopted by all parties involved in the planning process relating to wind turbines and it therefore this provides a measure of the sensitivity of the process to the assumed noise criteria.

In order to simplify the process, Stages 3 to 6 in the list above have been carried out for a 12m, 15m and 18.3m tower, as shown in Figure 14.

The x-axis is the annual mean wind speed at 10m height and can be found from the NOABL database as described above. The solid lines provide the slant distance (straight line distance between rotor hub and noise sensitive location) that is predicted to meet the 45dB(A) noise criterion for the wind speed that will be exceeded 10% of the time. The dotted lines are for the 40dB(A) criterion.

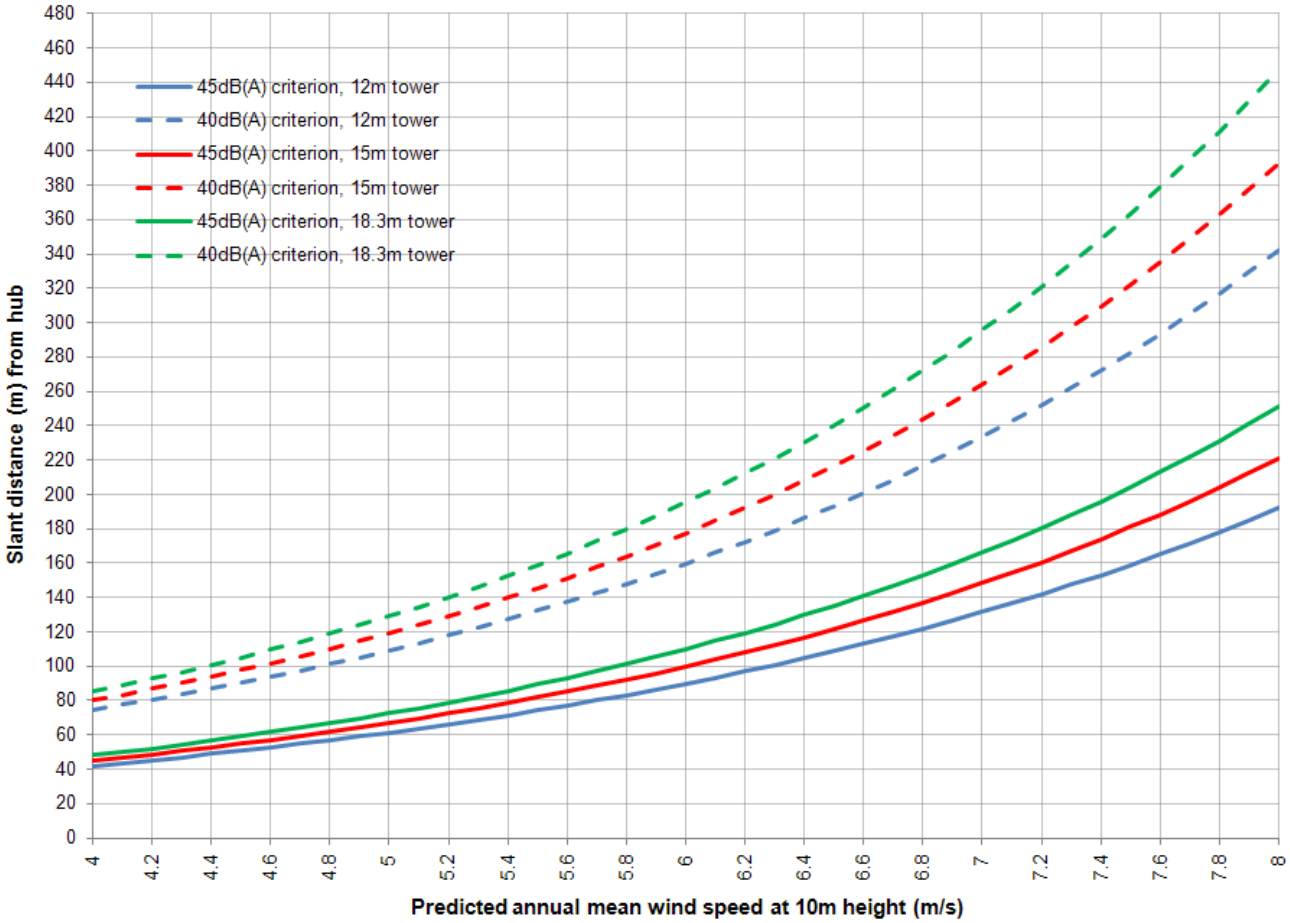


FIGURE 14 - AMWS NOISE IMMISSION SUMMARY

11. Appendix 2 – Broadband Raw Data

11.1. Turbine Running

L_{Aeq} (dBA)	L90 (dBA)	Wind Speed (m/s)	Wind Speed Standard Deviation (m/s)	Corrected Wind Speed (m/s)	Wind Direction (°)	Microphone Location (°)	Pressure (kPa)	Temperature (°C)	Turbulence Intensity	Angle between Microphone and Wind Direction (°)
58.7	55.3	9.6	1.267	9.64	287.2	85	98.0	6.8	13.2%	22.2
60.9	55.2	9.39	1.486	9.43	287.4	85	98.0	6.8	15.8%	22.4
56.3	54.2	8.83	1.159	8.86	288.7	85	98.0	7.1	13.1%	23.7
61.2	55.2	9.63	1.859	9.67	285.7	85	98.0	7.5	19.3%	20.7
56.9	54.4	8.83	1.437	8.86	287.5	85	98.0	7.3	16.3%	22.5
57.3	55.6	8.98	1.274	9.01	288.7	85	98.0	7.3	14.2%	23.7
61.3	54.4	8.76	1.547	8.79	285.6	85	98.1	7.6	17.7%	20.6
66.7	62.1	11.76	0.884	11.80	285.3	85	98.0	7.6	7.5%	20.3
65.8	59.1	11.73	1.366	11.84	279.5	85	98.1	7.5	11.6%	14.5
63.1	56.7	10.55	1.208	10.59	283	85	98.1	7.5	11.5%	18
61.3	55.8	9.21	1.6	9.24	283	85	98.1	7.6	17.4%	18
60.9	55.8	9.29	1.374	9.33	287.6	85	98.1	7.5	14.8%	22.6
59.9	56.8	10.19	1.019	10.23	288.8	85	98.1	7.6	10.0%	23.8
62.3	55.2	9.9	1.953	9.94	289.2	85	98.1	7.1	19.7%	24.2
63.6	56.5	10.45	1.683	10.49	286.8	85	98.1	7.1	16.1%	21.8
60.6	55.3	9.82	1.55	9.86	285	85	98.1	7.3	15.8%	20
57.1	55.4	9.64	0.871	9.68	287	85	98.1	7.6	9.0%	22
58.2	53.6	8.47	1.599	8.50	287.5	85	98.1	7.6	18.9%	22.5
60.2	56.8	9.75	1.026	9.79	287.3	85	98.1	7.7	10.5%	22.3
64.6	57.5	10.89	1.568	10.93	287.8	85	98.1	7.6	14.4%	22.8
56.4	54	8.48	0.936	8.51	285.9	85	98.1	7.7	11.0%	20.9
56.9	54.1	9.2	1.004	9.23	284	85	98.1	7.9	10.9%	19
63.2	56.5	10.3	1.242	10.34	287.7	85	98.1	8.0	12.1%	22.7
55	52	7.814	0.999	7.89	279.7	85	98.2	7.4	12.8%	14.7
55.2	53.5	7.616	1.099	7.69	273.3	85	98.2	7.4	14.4%	8.3
56.1	53.5	8.03	1.131	8.10	276	85	98.2	7.4	14.1%	11
57	55	9.03	1.148	9.11	277.3	85	98.2	7.5	12.7%	12.3
55.4	53.9	7.61	1.092	7.68	273.5	85	98.2	7.8	14.3%	8.5
56.7	54.8	8.88	1.195	8.96	276.6	85	98.1	8.1	13.5%	11.6
54.7	52.6	7.452	1.037	7.52	276.3	85	98.1	8.3	13.9%	11.3
55.2	51.1	7.894	1.404	7.97	279.1	85	98.1	8.5	17.8%	14.1
55.6	52.9	7.964	1.322	8.04	271.7	85	98.1	8.6	16.6%	6.7
57.7	55.7	9.06	1.162	9.14	277.4	85	98.1	8.7	12.8%	12.4
56.4	53.1	8.29	1.405	8.37	277.4	85	98.1	8.5	16.9%	12.4
60	54.4	9.12	1.523	9.20	275.4	85	98.1	8.2	16.7%	10.4
57.5	54.1	8.99	1.086	9.07	275.2	85	98.1	8.0	12.1%	10.2
55.6	53.7	7.83	0.868	7.90	274.8	85	98.2	7.9	11.1%	9.8

53.4	49.2	6.773	1.386	6.80	260.8	85	98.2	8.7	20.5%	-4.2
58.6	54.6	8.67	1.412	8.69	252.7	85	98.2	8.8	16.3%	-12.3
54.7	51.6	6.993	1.489	7.01	256.8	85	98.2	8.8	21.3%	-8.2
58.3	54.9	9.37	1.087	9.40	251.5	85	98.2	8.9	11.6%	-13.5
57.9	53.6	9.07	1.486	9.10	256.8	85	98.2	8.9	16.4%	-8.2
57.5	55.5	9.2	1.271	9.28	249.3	85	98.2	8.8	13.8%	-15.7
57.2	55.6	9.23	0.914	9.26	253.9	85	98.2	8.8	9.9%	-11.1
56.7	55.6	9.11	0.712	9.14	253.5	85	98.2	8.8	7.8%	-11.5
56.8	54.8	8.89	1.096	8.92	253.2	85	98.2	8.7	12.3%	-11.8
56.5	54.8	8.71	1.03	8.73	257.4	85	98.2	8.7	11.8%	-7.6
56.6	53.8	8.48	1.352	8.50	252.4	85	98.2	8.7	15.9%	-12.6
56.2	53.5	7.972	1.493	7.99	256.3	85	98.2	8.8	18.7%	-8.7
57.1	55.2	8.91	1.242	8.94	255.8	85	98.2	8.8	13.9%	-9.2
61.4	55.3	10.02	1.209	10.05	254.7	85	98.2	8.7	12.1%	-10.3
58.2	56.8	9.88	0.896	9.91	254.7	85	98.2	8.6	9.1%	-10.3
58.1	56.4	9.48	0.96	9.51	253.5	85	98.2	8.6	10.1%	-11.5
57.3	55.7	9.14	0.893	9.17	254.1	85	98.2	8.6	9.8%	-10.9
56.9	55.7	8.72	1.04	8.74	252.1	85	98.2	8.6	11.9%	-12.9
56.5	54.7	8.74	1.048	8.76	250.5	85	98.2	8.6	12.0%	-14.5
54.9	53.8	7.41	0.605	7.43	253.4	85	98.2	8.6	8.2%	-11.6
55.4	52.6	7.869	1.384	7.89	253	85	98.2	8.6	17.6%	-12
56.3	54.4	8.25	1.295	8.27	252.8	85	98.2	8.6	15.7%	-12.2
55.1	53.4	7.427	1.009	7.45	258.9	85	98.2	8.6	13.6%	-6.1
54.9	52.8	7.291	0.877	7.31	254.2	85	98.2	8.5	12.0%	-10.8
55	52.8	7.312	1.166	7.33	252.7	85	98.2	8.4	15.9%	-12.3
57.2	55.7	8.83	1.026	8.85	252.2	85	98.2	8.3	11.6%	-12.8
59.9	56	9.41	1.142	9.44	253.3	85	98.2	8.3	12.1%	-11.7
55.7	52.7	7.726	1.369	7.75	251.8	85	98.2	8.4	17.7%	-13.2
56.5	54.6	8.61	1.014	8.63	255.7	85	98.2	8.5	11.8%	-9.3
57.1	55.4	9.05	0.933	9.08	253.6	85	98.2	8.6	10.3%	-11.4
59.3	54.5	8.96	1.546	8.99	257.3	85	98.2	8.5	17.3%	-7.7
57.2	55.3	9.13	1.069	9.16	255.2	85	98.2	8.5	11.7%	-9.8
57.3	54.9	8.85	1.207	8.88	252.7	85	98.2	8.5	13.6%	-12.3
57.9	55.9	9.47	1.156	9.50	255	85	98.2	8.5	12.2%	-10
57.2	55.1	9.14	1.26	9.17	252.6	85	98.2	8.4	13.8%	-12.4
57.2	55.4	9.02	0.978	9.05	251.7	85	98.2	8.5	10.8%	-13.3
57.2	55.8	8.95	1.005	8.98	253.8	85	98.2	8.5	11.2%	-11.2
57.4	54.9	8.98	1.185	9.01	253.6	85	98.2	8.5	13.2%	-11.4
56	53.7	8.34	1.324	8.36	251.8	85	98.2	8.5	15.9%	-13.2
56.3	54.6	8.42	0.854	8.44	253.7	85	98.2	8.4	10.1%	-11.3
56.2	54.4	8.17	0.993	8.19	256	85	98.2	8.4	12.2%	-9
54.7	52.4	7.302	1.293	7.32	253.5	85	98.2	8.4	17.7%	-11.5
55.6	53.3	7.849	1.296	7.87	254.2	85	98.2	8.4	16.5%	-10.8
56.7	55.2	8.77	0.88	8.79	256.3	85	98.2	8.4	10.0%	-8.7
53.7	50.7	6.782	1.152	6.80	252.1	85	98.2	8.0	17.0%	-12.9

53.4	51.4	6.595	0.748	6.61	254.2	85	98.2	7.7	11.3%	-10.8
49.9	47.9	5.229	0.88	5.27	248.3	85	98.2	7.7	16.8%	-16.7
51.6	48.8	5.787	0.717	5.84	247.4	85	98.1	7.6	12.4%	-17.6
53.4	51.5	6.712	0.831	6.77	243.3	85	98.1	7.6	12.4%	-21.7
52.5	50.4	6.091	0.865	6.14	244.1	85	98.1	7.7	14.2%	-20.9
52.1	49.8	6.227	0.815	6.28	243.8	85	98.1	7.8	13.1%	-21.2
52.2	48.5	6.283	0.952	6.34	246.1	85	98.1	7.9	15.2%	-18.9
54.1	52.8	6.69	0.635	6.75	247.9	85	98.1	8.0	9.5%	-17.1
53.9	53	7.295	0.398	7.36	243.3	85	98.1	8.0	5.5%	-21.7
52.5	51.5	6.121	0.553	6.17	245.3	85	98.1	8.0	9.0%	-19.7
50.6	48	5.151	1.052	5.20	244.4	85	98.1	8.0	20.4%	-20.6
50.1	47.5	5.166	0.803	5.21	245.5	85	98.1	7.9	15.5%	-19.5
52.1	50.6	6.081	0.835	6.13	244.7	85	98.1	7.8	13.7%	-20.3
52.2	50.1	6	0.765	6.05	245.5	85	98.1	7.7	12.8%	-19.5
51	48.2	5.667	1.001	5.72	243.3	85	98.1	7.7	17.7%	-21.7
53.7	50.5	6.69	1.056	6.75	243.1	85	98.1	7.6	15.8%	-21.9
52.8	49.5	6.39	1.19	6.44	246.1	85	98.1	7.5	18.6%	-18.9
52.5	49.6	6.221	0.922	6.27	240.2	85	98.1	7.5	14.8%	-24.8
54	52.9	7.086	0.84	7.15	243.3	85	98.1	7.5	11.9%	-21.7
52.1	49.6	5.815	0.847	5.86	240.8	85	98.1	7.4	14.6%	-24.2
52.9	51.4	6.164	0.746	6.22	241.1	85	98.1	7.4	12.1%	-23.9
53.1	52.2	6.391	0.498	6.47	239.5	85	98.1	7.4	7.8%	-25.5
52.9	50.6	6.19	0.808	6.24	242.8	85	98.1	7.4	13.1%	-22.2
51.4	49.4	6.033	0.57	6.08	246.1	85	98.1	7.3	9.4%	-18.9
49.8	48.2	5.273	0.851	5.32	244	85	98.1	7.3	16.1%	-21
50.8	48.6	5.363	0.624	5.41	244.1	85	98.1	7.3	11.6%	-20.9
51.9	49.1	6.02	0.933	6.07	240.3	85	98.1	7.3	15.5%	-24.7
50.8	49	5.569	0.674	5.62	240.2	85	98.1	7.3	12.1%	-24.8
49.6	47.2	5.14	0.691	5.18	240.2	85	98.1	7.3	13.4%	-24.8
50.5	48.8	5.277	0.709	5.34	235.9	85	98.1	7.3	13.4%	-29.1
49.4	48	4.751	0.588	4.81	239.5	85	98.1	7.3	12.4%	-25.5
47.8	46.6	4.48	0.614	4.54	238.3	85	98.1	7.3	13.7%	-26.7
48.4	46.8	4.647	0.618	4.71	235.6	85	98.1	7.2	13.3%	-29.4
51.7	49.5	5.812	0.801	5.89	236.6	85	98.1	7.2	13.8%	-28.4
52.3	50.6	6.382	0.707	6.46	237.5	85	98.1	7.2	11.1%	-27.5
50.3	48.7	5.704	0.493	5.78	236.6	85	98.1	7.3	8.6%	-28.4
50.3	47.3	5.25	0.748	5.32	236.9	85	98.1	7.2	14.2%	-28.1
49.3	48.4	5.261	0.63	5.35	225.7	40	97.4	7.3	12.0%	5.7
48.9	48	4.278	0.54	4.35	226.5	40	97.4	7.3	12.6%	6.5
46.6	45	3.673	0.47	3.72	230.4	40	97.4	7.3	12.8%	10.4
45.6	45.1	3.66	0.331	3.72	222.4	40	97.4	7.4	9.0%	2.4
46.5	45.8	4.226	0.556	4.30	229.1	40	97.4	7.4	13.2%	9.1
48	47.3	3.966	0.39	4.04	229.5	40	97.4	7.4	9.8%	9.5
48.4	47.5	3.886	0.764	3.95	228.6	40	97.4	7.4	19.7%	8.6
49.2	48.2	4.868	0.641	4.95	220.1	40	97.4	7.4	13.2%	0.1

48.8	47.8	4.963	0.463	5.05	227.7	40	97.4	7.4	9.3%	7.7
49.7	48.4	4.861	0.475	4.95	225.7	40	97.4	7.4	9.8%	5.7
48.2	47.8	4.167	0.417	4.22	233	40	97.4	7.4	10.0%	13
48.2	47.8	3.884	0.465	3.95	228.8	40	97.4	7.5	12.0%	8.8
48.2	47.7	3.527	0.527	3.57	233.2	40	97.4	7.5	14.9%	13.2
48.2	47.4	4.539	0.471	4.60	236.8	40	97.4	7.5	10.4%	16.8
48.5	47.6	4.62	0.634	4.68	235.1	40	97.4	7.5	13.7%	15.1
51.1	49.5	5.787	0.697	5.84	245	40	97.4	7.5	12.0%	25
47.2	46	3.532	0.346	3.54	259.2	40	97.4	7.8	9.8%	39.2
48.5	47.8	3.88	0.613	3.91	248.5	40	97.4	7.7	15.8%	28.5
48.2	45.9	3.319	0.4	3.33	254.3	40	97.4	7.7	12.1%	34.3
48.6	47.8	3.412	0.436	3.44	248.4	40	97.4	7.8	12.8%	28.4
48.3	47.7	3.58	0.714	3.59	252.2	40	97.4	7.8	19.9%	32.2
47	45.6	3.374	0.503	3.38	250.7	40	97.4	7.8	14.9%	30.7
47.1	46.1	3.721	0.272	3.73	255	40	97.4	7.9	7.3%	35
48.5	47.7	3.401	0.45	3.43	248	40	97.4	7.9	13.2%	28
48.4	47.8	3.717	0.626	3.78	223.8	40	97.4	8.6	16.8%	3.8
47.9	46.6	3.638	0.89	3.67	247.2	40	97.4	8.7	24.5%	27.2
48.6	48	4.507	0.64	4.55	245.4	40	97.4	8.7	14.2%	25.4
48.5	47.8	4.617	0.479	4.66	244.8	40	97.4	8.6	10.4%	24.8
48.9	48.1	5.129	0.506	5.17	249	40	97.4	8.5	9.9%	29
48.2	47.7	3.689	0.5	3.72	244.9	40	97.4	8.4	13.6%	24.9
48.5	47.8	4.459	0.542	4.50	245.5	40	97.4	8.4	12.2%	25.5
48.3	47.7	3.973	0.515	4.01	243.1	40	97.4	8.4	13.0%	23.1
48.3	47.8	4.172	0.43	4.21	240.5	40	97.4	8.4	10.3%	20.5
48.6	48.2	4.153	0.551	4.21	237.1	40	97.4	8.4	13.3%	17.1
48.2	47.3	4.116	0.3	4.17	231.5	40	97.3	8.2	7.3%	11.5

11.2. Turbine Parked

L_{Aeq} (dBA)	L90 (dBA)	Wind Speed (m/s)	Wind Speed Standard Deviation (m/s)	Corrected Wind Speed (m/s)	Wind Direction (°)	Microphone Location (°)	Pressure (kPa)	Temperature (°C)	Turbulence Intensity	Angle between Microphone and Wind Direction (°)
38.1	35.8	5.456	1.018	5.48	268.5	85	98.2	8.1	18.7%	3.5
39.3	36.5	7.165	1.068	7.20	264.4	85	98.2	8.3	14.9%	-0.6
41.1	36.9	8.45	0.952	8.49	268.1	85	98.2	8.4	11.3%	3.1
39.1	36	8.74	0.987	8.82	270.5	85	98.2	8.5	11.3%	5.5
42.3	38.6	9.44	1.034	9.48	263.8	85	98.2	8.5	11.0%	-1.2
46.7	37.6	8.26	0.645	8.30	261.7	85	98.2	8.5	7.8%	-3.3
42.9	39.4	8.62	0.933	8.64	259.8	85	98.2	8.6	10.8%	-5.2
45.4	41.6	9.27	0.983	9.30	256.5	85	98.2	8.8	10.6%	-8.5
44.6	39.9	9.71	0.847	9.74	256.8	85	98.2	8.8	8.7%	-8.2
42.7	39.6	9.21	1.343	9.24	255.2	85	98.2	8.8	14.6%	-9.8
46.8	42.5	10.55	1.081	10.58	258.2	85	98.2	8.7	10.2%	-6.8
47.4	40.3	10.14	1.479	10.17	258.6	85	98.2	8.6	14.6%	-6.4
44	39.7	9.08	1.193	9.11	256.5	85	98.2	8.5	13.1%	-8.5
40.1	35.6	7.249	1.142	7.27	259.6	85	98.2	8.4	15.8%	-5.4
44.4	38.4	9.16	1.294	9.19	259.6	85	98.2	8.4	14.1%	-5.4
44.3	40.8	9.71	0.841	9.74	258	85	98.2	8.4	8.7%	-7
42.3	38.9	9.6	1.041	9.63	258	85	98.2	8.4	10.8%	-7
40.2	37.1	7.703	1.152	7.72	257	85	98.2	8.4	15.0%	-8
44.3	37.2	8.79	1.398	8.81	257.9	85	98.2	8.4	15.9%	-7.1
41.7	38.3	9.04	0.768	9.07	259.8	85	98.2	8.4	8.5%	-5.2
46.3	42	9.67	1.043	9.70	257	85	98.2	8.4	10.8%	-8
40.9	37.4	6.923	1.056	6.94	259.6	85	98.2	8.6	15.3%	-5.4
42.9	38.1	9.47	1.251	9.55	247.8	85	98.2	8.8	13.2%	-17.2
39.7	36.1	7.676	1.029	7.70	254.5	85	98.2	8.8	13.4%	-10.5
42.3	37.9	8.77	1.044	8.79	253.3	85	98.2	8.9	11.9%	-11.7
44.4	39.5	9.45	1.317	9.48	254.1	85	98.2	8.9	13.9%	-10.9
42.6	39.6	8.59	1.183	8.61	250.4	85	98.2	8.9	13.8%	-14.6
44.4	39.9	9.54	1.252	9.57	251.3	85	98.2	8.9	13.1%	-13.7
45.8	37.7	9.27	1.305	9.30	255.6	85	98.2	8.8	14.1%	-9.4
40.4	37.4	8.08	0.948	8.10	254	85	98.2	8.7	11.7%	-11
43.8	37.4	8.06	1.236	8.08	253.1	85	98.2	8.7	15.3%	-11.9
42.6	39.8	10.18	0.822	10.27	249.9	85	98.2	8.6	8.1%	-15.1
44.5	38.1	8.94	1.106	8.97	251.2	85	98.2	8.6	12.4%	-13.8
42.9	38.9	9.73	0.93	9.76	252.2	85	98.2	8.6	9.6%	-12.8
47.1	39	9.78	1.365	9.81	254.2	85	98.2	8.6	14.0%	-10.8
43.5	38.5	9.49	2.077	9.52	252.1	85	98.2	8.6	21.9%	-12.9
44.8	38.4	9.52	1.58	9.55	254.7	85	98.2	8.6	16.6%	-10.3
39.7	36.9	8.14	1.288	8.16	259.4	85	98.2	8.6	15.8%	-5.6
46.8	37.2	9.43	1.434	9.46	251.3	85	98.2	8.7	15.2%	-13.7
45.4	38.8	8.7	1.348	8.72	253.8	85	98.2	8.7	15.5%	-11.2
46.4	41.8	10.26	0.876	10.29	254.8	85	98.2	8.7	8.5%	-10.2
45.9	38.7	9.17	1.618	9.20	254.3	85	98.2	8.6	17.6%	-10.7
39.9	37.9	8.38	0.882	8.40	251	85	98.2	8.5	10.5%	-14

41.7	38.6	9.07	1.444	9.10	251.8	85	98.2	8.6	15.9%	-13.2
46.2	40.5	10.19	1.011	10.22	252.3	85	98.2	8.5	9.9%	-12.7
41.4	37.9	8.73	1.251	8.75	253.5	85	98.2	8.4	14.3%	-11.5
48.9	42.3	10.48	1.02	10.51	251.4	85	98.2	8.3	9.7%	-13.6
43.3	40	8.89	1.058	8.92	255.8	85	98.2	8.2	11.9%	-9.2
45.4	40.2	9.76	1.476	9.79	259.1	85	98.2	8.3	15.1%	-5.9
44.7	40.7	10.69	0.84	10.72	256.7	85	98.2	8.4	7.9%	-8.3
41.8	39.2	9.44	0.884	9.47	257.4	85	98.2	8.5	9.4%	-7.6
43.7	39.8	9.25	1.307	9.28	257.4	85	98.2	8.6	14.1%	-7.6
43.8	38.3	8.51	1.539	8.53	255.9	85	98.2	8.6	18.1%	-9.1
45.4	38	8.98	1.64	9.01	256.7	85	98.2	8.4	18.3%	-8.3
42.3	36.7	7.447	1.036	7.47	259.5	85	98.2	8.3	13.9%	-5.5
42.9	39.5	9.74	0.936	9.77	257.6	85	98.2	8.3	9.6%	-7.4
38	34.9	7.37	0.879	7.40	260.2	85	98.2	8.4	11.9%	-4.8
39.1	36.5	8.29	0.985	8.31	258.2	85	98.2	8.5	11.9%	-6.8
39.6	37.1	8.32	0.869	8.36	262.3	85	98.2	8.6	10.4%	-2.7
42.4	36.4	7.543	1.084	7.58	261	85	98.2	8.6	14.4%	-4
38.9	35.8	5.99	0.83	6.04	246.2	85	98.1	7.3	13.9%	-18.8
40.5	36.5	5.473	0.551	5.52	244.4	85	98.1	7.2	10.1%	-20.6
39.3	36.1	6.638	1.148	6.69	245.1	85	98.1	7.2	17.3%	-19.9
37.6	35.5	6.443	0.575	6.50	242.2	85	98.1	7.2	8.9%	-22.8
37.3	35.3	6.079	0.845	6.13	246.9	85	98.1	7.2	13.9%	-18.1
38.4	36.5	6.112	0.763	6.16	243.1	85	98.1	7.3	12.5%	-21.9
38.5	36.2	6.896	1.185	6.96	242.7	85	98.1	7.3	17.2%	-22.3
39.1	36.5	7.411	0.592	7.47	242.7	85	98.1	7.3	8.0%	-22.3
38.7	36.7	6.76	0.621	6.85	239.6	85	98.1	7.4	9.2%	-25.4
40.1	37	6.645	0.774	6.70	241.1	85	98.1	7.4	11.6%	-23.9
39.3	36.3	6.122	0.689	6.17	245.8	85	98.1	7.4	11.3%	-19.2
37.7	35.4	6.022	1.309	6.07	241.9	85	98.1	7.4	21.7%	-23.1
38	35.1	5.633	0.691	5.68	241.7	85	98.1	7.4	12.3%	-23.3
38.6	36.4	5.05	0.507	5.11	236.6	85	98.1	7.4	10.0%	-28.4
37.5	36.2	5.21	0.578	5.25	240.8	85	98.1	7.3	11.1%	-24.2
37	35.8	5.195	0.793	5.24	240.1	85	98.1	7.3	15.3%	-24.9
36.9	33	5.258	0.876	5.32	234.9	40	97.4	8.2	16.7%	14.9
39.5	36.5	5.495	0.901	5.56	239.6	40	97.4	8.2	16.4%	19.6
39.4	33	5.005	1.226	5.07	231.2	40	97.4	8.3	24.5%	11.2
40.1	35.1	5.849	0.714	5.92	230.8	40	97.4	8.2	12.2%	10.8
40.3	36	5.849	0.7	5.90	245.8	40	97.4	8.1	12.0%	25.8
39.2	35.6	6.182	0.565	6.26	239.9	40	97.4	8.2	9.1%	19.9
35.6	31.2	5.67	0.432	5.74	238	40	97.4	8.1	7.6%	18
35.6	30.2	5.084	0.528	5.13	242.9	40	97.4	8.1	10.4%	22.9
40.1	33.9	5.191	0.456	5.24	246.3	40	97.4	8.1	8.8%	26.3
41.5	35.9	5.459	0.525	5.51	241.4	40	97.4	8.1	9.6%	21.4
41.4	33.8	4.773	0.68	4.81	244.9	40	97.4	8.1	14.2%	24.9
36	31.5	4.514	0.731	4.55	244.6	40	97.4	8.2	16.2%	24.6
37.1	33	5.094	0.566	5.16	236.1	40	97.4	8.3	11.1%	16.1

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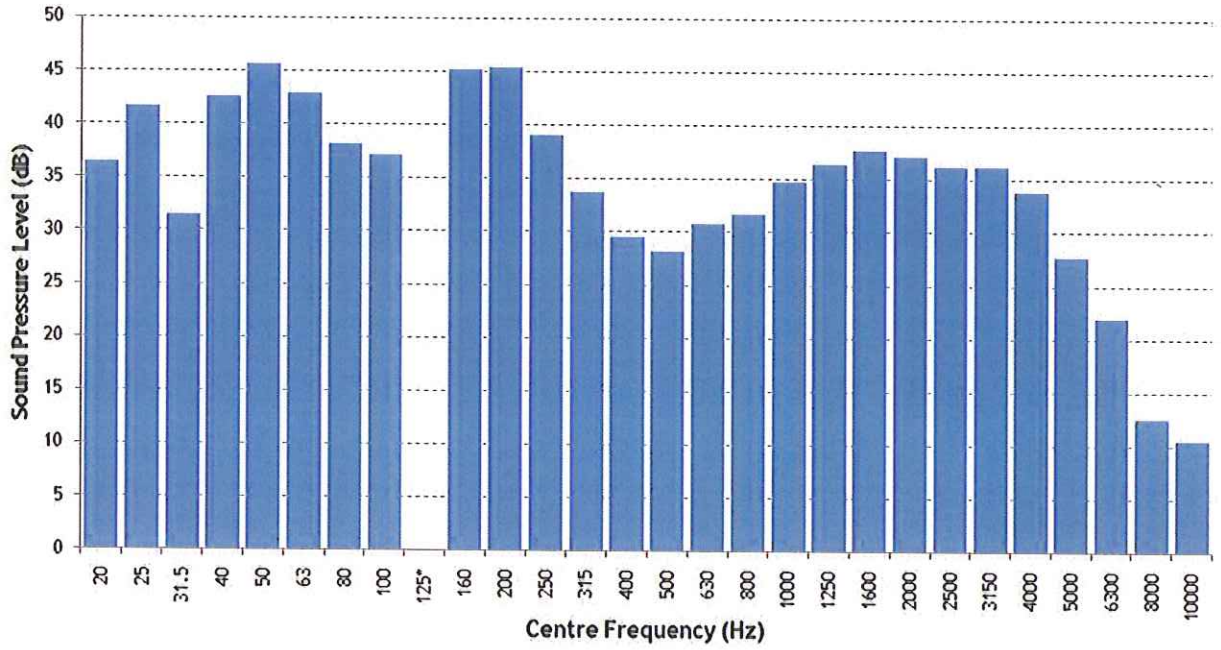


FIGURE 9 - UNWEIGHTED 1/3RD OCTAVE BAND FREQUENCY SPECTRUM FOR 2.82M/S AT A SLANT DISTANCE OF 19.85M

The 125Hz band in Figure 9 was not measureable because the background noise at 125Hz was louder than when the turbine was running. The dB(Lin), dB(A) and dB(C) for the spectrum was 53.4,44.9 and 52.9 respectively.

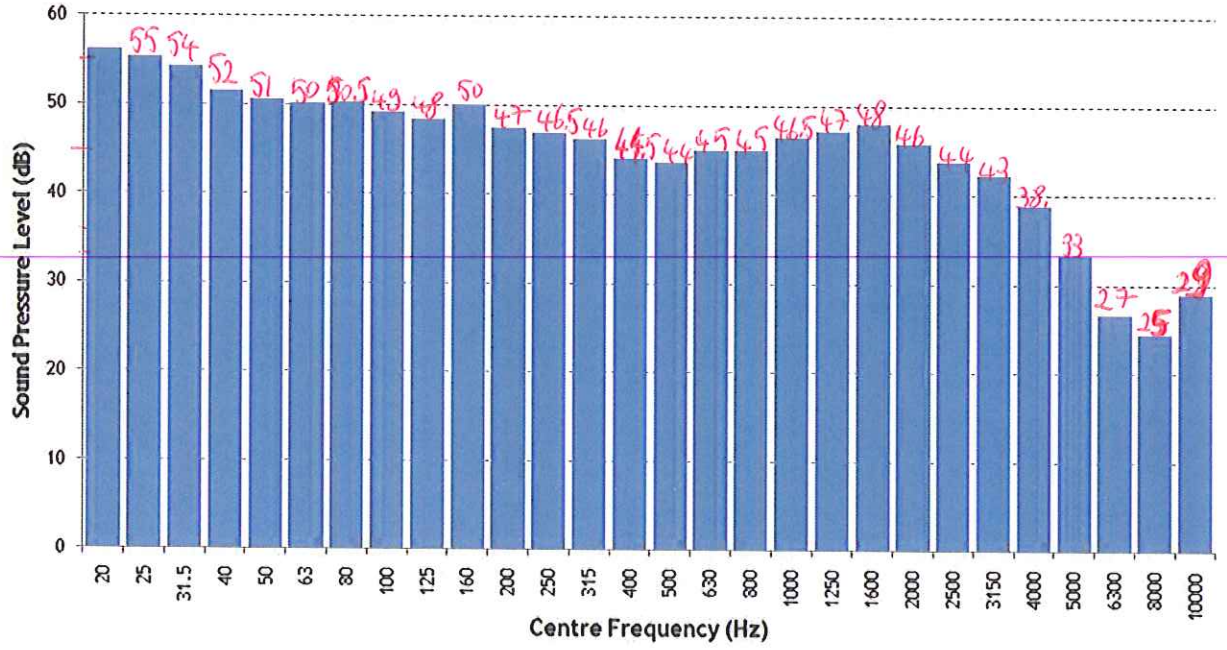


FIGURE 10 - UNWEIGHTED 1/3RD OCTAVE BAND FREQUENCY SPECTRUM FOR 7.99M/S AT A SLANT DISTANCE OF 19.85M

The dB(Lin), dB(A) and dB(C) for the 7.99m/s spectrum was 63.5, 54.2 and 61.6 respectively.

TNEI SUMMARY ANALYSIS OF NOISE DATA FOR : Eoltech-Scirocco-Generic blade-Full mode-15hub

Turbine identification:	
Manufacturer:	Eoltech
Model Name:	Scirocco
Blade Type/Name:	Generic
Operational Mode:	Full
Hub Height:	15

Available Noise Document(s) Considered in the analysis of this turbine:

	Doc. Date	Doc. Name
Manufacturer doc:	15/03/2011	Narec: 1580/04
Test Report1:	10/04/2007	HM:1820/R1
Test Report2:		
Test Report3:		

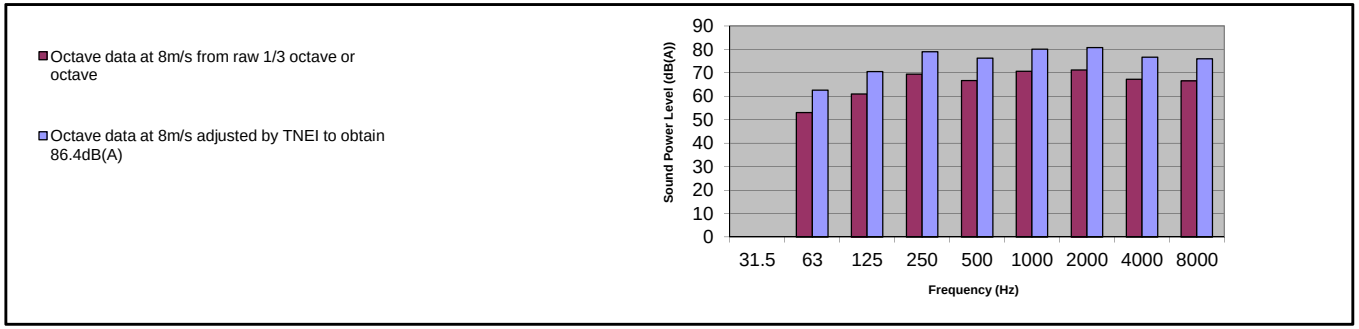
Summary of Sound Power Levels(Lw_{Aeq}) at various wind speeds:

Wind Speed (standardised 10m)	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Manufacturer Lw raw as found in document		75.6	77.7	79.9	82.1	84.2	86.4	88.6	90.7	92.9	95.1
Manufacturer specified Lw +Manufacturer Uc+TNEI Uc (used for modeling by TNEI)		75.6	77.7	79.9	82.1	84.2	86.4	88.6	90.7	92.9	95.1
Comment: No Uc added as reports have accounted enough											

Summary of Octave Data (LwA_{eq}) used for modelling:

Octave data is from Test Report1 at 8m/s										
Frequency (Hz)	31.5	63	125	250	500	1000	2000	4000	8000	Overall
Octave data at 8m/s from raw 1/3 octave or octave	0.0	53.1	61.0	69.4	66.7	70.6	71.2	67.2	66.5	76.9
Octave data at 8m/s adjusted by TNEI to obtain 86.4dB(A)	0.0	62.6	70.5	78.9	76.2	80.1	80.7	76.7	76.0	86.4
Comment: Used 1/3 Octave data from Hayes Mckenzie report HM:1820/R1										

Plot of Octave Data



Additional Comment:

Data analysed in accordance with the guidance from the IOA GPG May 2013.

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8.1 Immission Noise Map

In accordance with section 3.1.4 of the BWEA standard, the immission noise map for the Eoltec Scirocco E5.6-6 is shown in Figure 5 below;

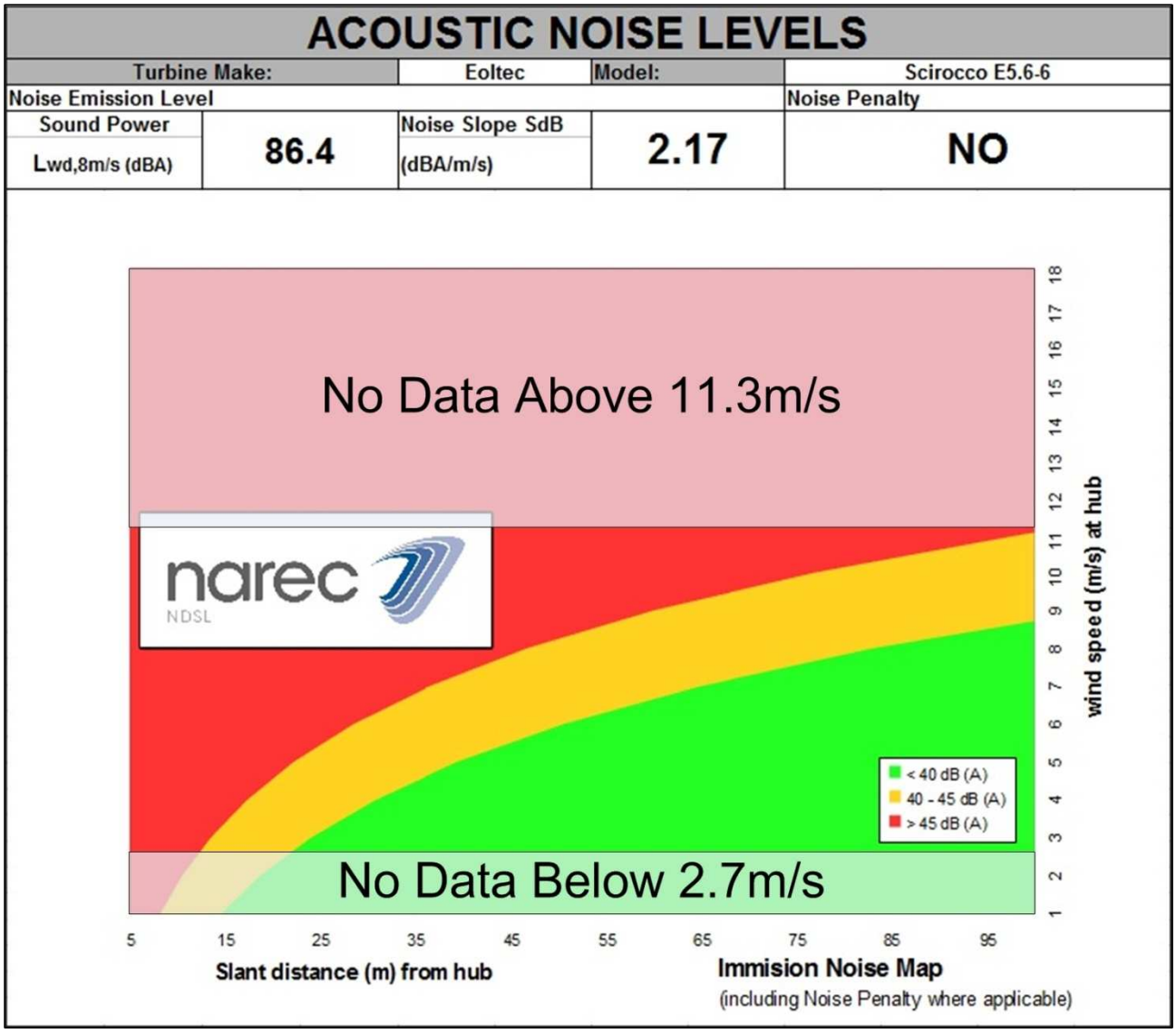


Figure 5 - Immission Noise Map – Eoltec Scirocco E5.6-6

TNEI SUMMARY ANALYSIS OF NOISE DATA FOR : Proven-6KW-Generic blade-Full mode-15hub

Turbine identification:	
Manufacturer:	Proven
Model Name:	6KW
Blade Type/Name:	Generic
Operational Mode:	Full
Hub Height:	15

Available Noise Document(s) Considered in the analysis of this turbine:

	Doc. Date	Doc. Name
Manufacturer doc:		No manufacturer data used. Used measufred level from test report1 + 1.5dB (1.645*0.9)
Test Report1:	01/04/2007	6kW 15m Noise Sgurr 2007 test report.
Test Report2:		
Test Report3:		

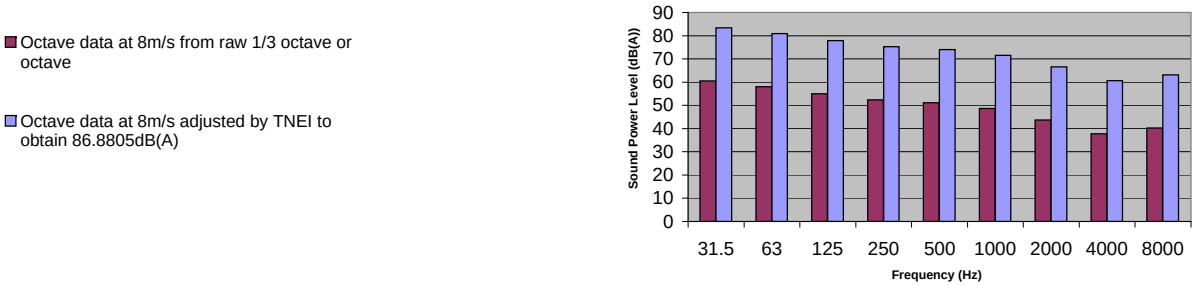
Summary of Sound Power Levels(Lw_{Aeq}) at various wind speeds:

Wind Speed (standardised 10m)	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Manufacturer Lw raw as found in document											
Manufacturer specified Lw +Manufacturer Uc+TNEI Uc (used for modeling by TNEI)			77.9	80.2	82.4	84.7	86.9	89.1	91.4	93.6	95.9
Comment: No manufacturer data used. Used measufred level from test report1 + 1.5dB (1.645*0.9)											

Summary of Octave Data (LwA_{eq}) used for modelling:

Octave data is from Test Report1 at 8m/s										
Frequency (Hz)	31.5	63	125	250	500	1000	2000	4000	8000	Overall
Octave data at 8m/s from raw 1/3 octave or octave	60.5	58.0	55.0	52.4	51.2	48.6	43.7	37.7	40.2	64.0
Octave data at 8m/s adjusted by TNEI to obtain 86.8805dB(A)	83.4	80.9	77.9	75.3	74.1	71.5	66.6	60.6	63.1	86.8
Comment: 1/3 octave data from "6kW 15m Sgurr additional Freq Graphs.pdf"										

Plot of Octave Data



Additional Comment:

Data analysed in accordance with the guidance from the IOA GPG May 2013.

Document No. 6414/001/O/R/07/001
Issue : B3

sgurrENERGY
sustainable energy solutions

Proven Energy

6kW WTGS at Neilston
Noise Survey

April 2007

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Proven Energy

6kW WTGS at Neilston Noise Survey

SUMMARY:

A noise survey has been conducted on an installed Proven 6kW wind turbine generator system (WTGS) for the purposes of characterising its noise emissions. The WTGS had been installed to provide electricity to a consumer and the site was not entirely suitable for a survey where all the parameters of interest could be fully controlled. Notwithstanding this, and although there is not yet a recognised standard by which noise emissions from small WTGS can be measured, a procedure was designed and the noise emissions were characterised in accord with the procedure.

CLIENT: **Proven Energy**

Contact: Jonathan Nowill

DISTRIBUTION :

Client:

SgurrEnergy:
Adam Spearey

	Name	Job Title	Signature
Prepared by	Jim Clive	Principal Noise Consultant	
Checked by	Adam Spearey	Renewable Energy Consultant	
Authorised by	Ian Irvine	Technical Director	
Date of Issue	April 2007	**Classification:**	Confidential

9002/000/SF/04/023 B4

AMENDMENT RECORD			
Issue	**Date of Issue**	**Changes from Previous Issue**	**Purpose of Issue**
A1	April 2007		Internal review
B1	April 2007	Minor edits, Figure 1 added	Issue to Client
B2	April 2007	Minor Revisions, Glossary added	Issue to Client
B3	April 2007	Figure 2 added	Issue to Client

Certificate No. FS 85385
ISO 9001:2000

Certificate No. EMS 85386
ISO 14001:2004

Contents

1 INTRODUCTION

Prior to the installation of a wind turbine generating system (WTGS) it is often required to conduct an assessment of its environmental impact. Part of this exercise can involve predictions of the impact of noise attributable to the operation of the WTGS upon the surroundings wherein it is intended to be installed. Such an exercise requires knowledge of the noise emissions from the WTGS and the character of these emissions. A standard exists describing the techniques to be applied in acoustic measurements for large WTGSs, Reference 1. This European standard has the status of a British Standard and thus has wide international recognition. The power of the WTGSs that this standard applies to is currently in the range of hundreds of kilowatts to several megawatts. This existing standard presents measurement and reporting procedures that can be expected to provide accurate results that can be replicated. No standard is yet available for measuring the acoustic character of small WTGSs. Experience of others in deriving such tests, together with reference to other standards, can lead to a standard procedure for characterising acoustic emissions from small WTGSs in a repeatable manner. Such a procedure will require that many of the parameters involved will have to be carefully controlled, so much so that many sites will be inappropriate for the purpose of repeatable measurements of WTGS acoustic characteristics.

Operational noise from WTGSs varies with windspeed, as does the residual noise in the area adjacent to the WTGS. The noise attributable to the WTGS, and that attributable to residual sources, therefore has to be related to windspeed, which itself is normally a time variable.

Sgurr Energy were asked to measure acoustic characteristics on a Proven 6kW WTGS already installed at a site for the purposes of producing electrical power to a consumer. It is not the purpose of this report to specify a procedure by which acoustic characteristics of small WTGSs should be measured. Rather it is to describe the procedure for this particular WTGS in its present location, together with the results obtained.

2 TOPOGRAPHY

The speed of the wind, and the turbulence within it, depends upon features of the topography within which the WTGS is situated. Ideally the ground surface should be flat and of a known roughness and there should be an absence of obstruction to free flow of wind for a considerable area around the WTGS being examined. Such obstructions will include trees, bushes, buildings and transmission lines etc all of which can increase turbulence in wind regimes.

3 WIND SPEED

It is necessary to measure the speed with which the wind encounters the rotor of the WTGS. Wind speed across ground surfaces varies for several reasons one of which is height above ground. It is an industry standard that noise emissions from WTGSs be related to the windspeed at a height of 10m above ground level as measured between 2 and 4 rotor diameters upwind of the rotor.

4 GROUND REFLECTION OF SOUND

4.1 When sound from a source encounters the ground it is partly reflected and partly absorbed. The relationship between these two phenomena depends upon the acoustic nature of ground surface. To make this determinate and repeatable a ground board is normally laid under the position of the measuring microphone and an allowance made for the reflection.

4.2 Wind blowing across a measuring microphone generates noise that can add to that of the measured source. To minimise this contribution the microphone is fitted with a wind shield and fitted low to the ground where wind speed, and hence generated noise is least.

5 RESIDUAL NOISE

Ambient noise normally has a contribution from the source of interest and a residual contribution from other sources. To accurately discriminate between the two requires that the contribution from the source of interest is sufficiently greater than the residual noise.

6 PROCEDURE

The objective of the exercise was to measure the sound power level and the coefficient of regression for a Proven 6kW WTGS. The procedure adopted in measuring the noise characteristics of the Proven 6kW WTGS installed at a site near Neilston was designed to comply, as best as possible, with the above listed, and other considerations. The sound pressure levels measured were averaged over contiguous 10 second intervals as were the mean wind speeds with which the sound levels were compared. The survey was done for periods when the WTGS was in service and for similar periods when it had been removed from service. The periods with the WTGS in operation gave us the ambient noise against wind speed whilst those with the WTGS out of service gave us the residual noise against wind speed. The anemometer mast was located so that it would be upwind of the WTGS when the wind was from a direction of least obstruction. The client required the test results early so that particular aspect of the procedure was not fully complied with.

A one third octave bandwidth spectrum was measured and the results examined for evidence of the presence of a prominent tone that, using an appropriate criterion, would perhaps attract a correction to the apparent sound power level when assessed.

7 RESULTS

7.1 Measurements

The results of the noise survey are shown in the attached Figure 1. The best fit second order polynomials drawn through the data scatter are very close to the first order polynomials through the same scatters.

7.2 Calculations

The symbols and units are the same as in Reference 1.

Ro	= 10m
H	= 15m
R_1	= 18m
SPL of ambient noise at a 10m high wind speed of 8ms^{-1}	= 55.5dB(A)
SPL of residual noise at a 10m high wind speed of 8ms^{-1}	= 42.5dB(A)
SPL attributable to WTGS operation at 10m high wind speed of 8ms^{-1}	= 55.3dB(A)
SWL of WTGS at a 10m high wind speed of 8ms^{-1}	= 85.4dB(A)
Coefficient of Regression	= 2.24dB/ms^{-1}

8 DISCUSSION OF RESULTS

It should be noted that the conditions under which the survey was conducted were unavoidably removed from the ideal case that would have prevailed if the WTGS had been installed at a suitable test site. The sound power level and the coefficient of regression obtained should be treated as provisional until a test under properly controlled conditions is conducted.

The measured one third octave spectra were examined for evidence of prominent tones that would attract a correction to the measured apparent sound power level when assessed in accord with an appropriate criterion. No such prominent tone occurred at the measurement point under the conditions prevailing in the survey.

9 CONCLUSIONS

9.1 The sound power level of a 6kW Proven WTGS has been estimated from a survey conducted on such a WTGS previously installed at an existing site for the purposes of supplying power to an electricity consumer.

9.2 The site at which the WTGS was installed was not ideal with regard to topographical, wind direction and other requirements.

9.3 The sound power level measured for a 10m height wind speed of 8ms^{-1} was 85.4dB(A) with a coefficient of regression of 2.24dB/ms^{-1}. These values should be treated as provisional until a test under suitably controlled conditions can be performed.

9.4 The sound pressure level attributable to the WTGS at a horizontal distance of 10m from the base of the tower was measured as 55.3dB(A) (for a 10m height wind speed of 8ms^{-1}). Figure 2 shows how the SPL attributable to the WTGS varies with distance. These values should be treated as provisional until a test under suitably controlled conditions can be performed.

REFERENCES

1 British Standard BS EN 61400 – 11:2003 Wind turbine generator systems - Part 11: Acoustic noise measurement techniques.

Figure 1 - Noise Survey Results - 6kW Proven WTGS

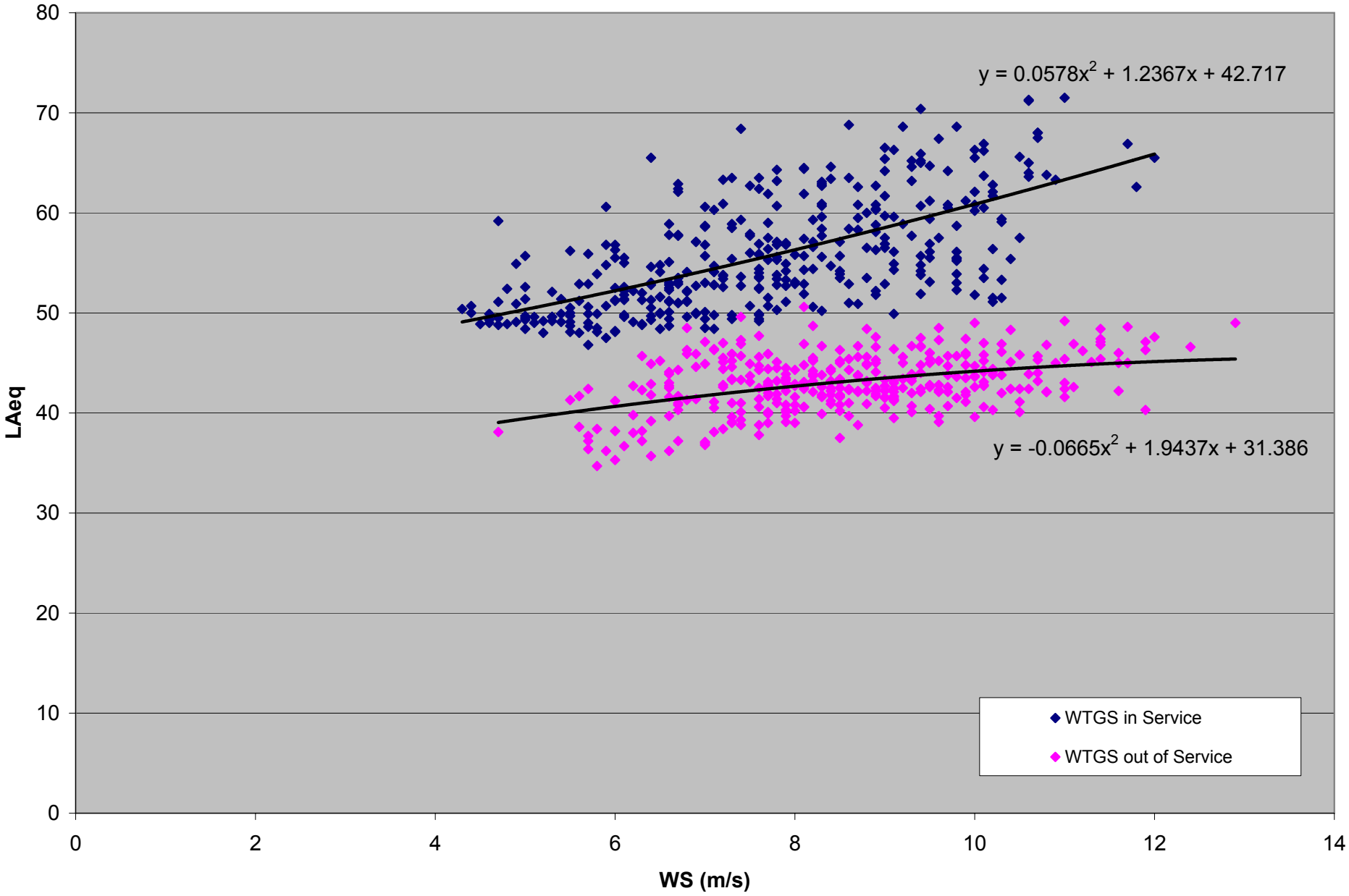
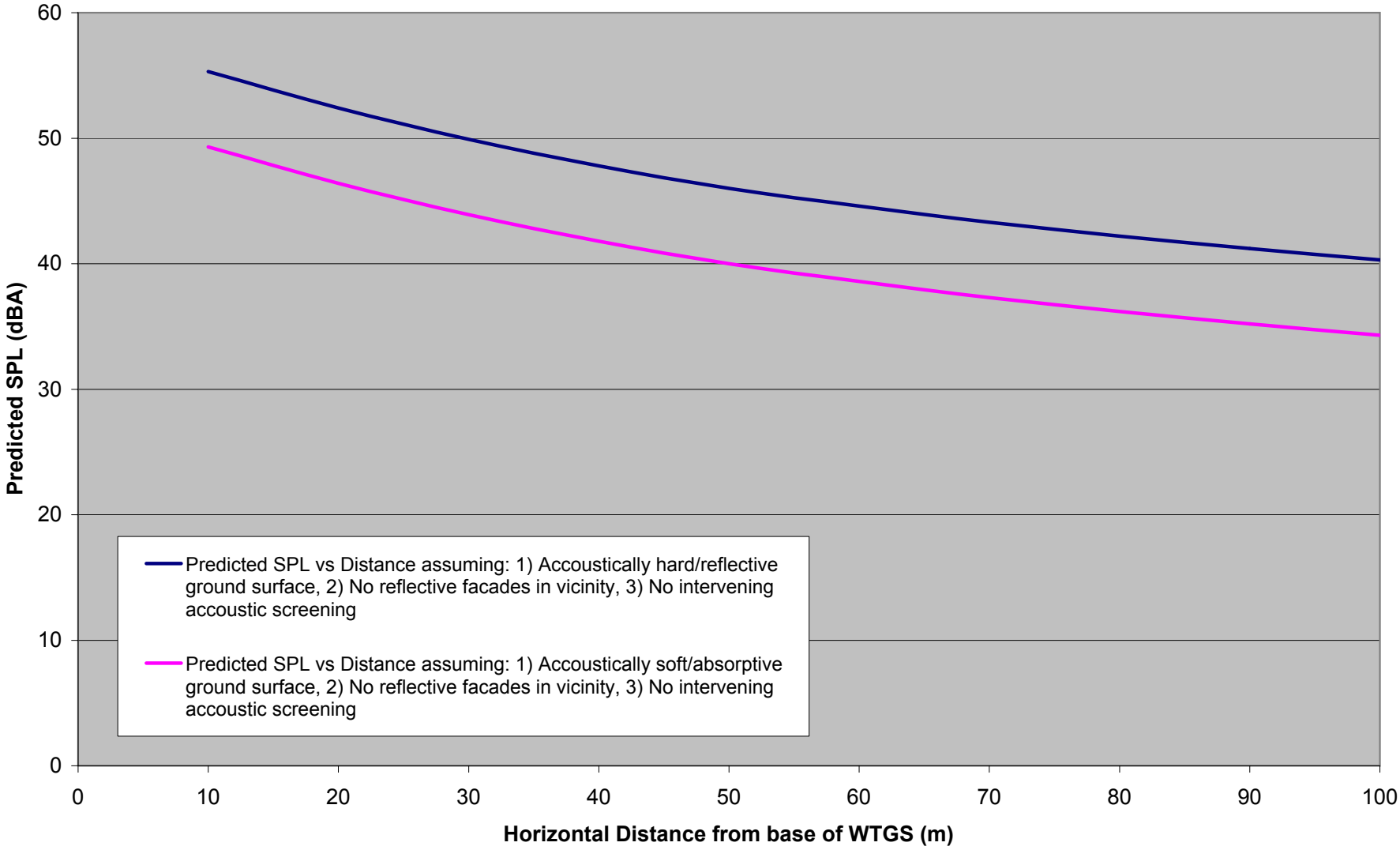


Figure 2 - 6kW Proven WTGS - SPL vs Distance



GLOSSARY OF TERMS

Sound

The word describes everything that the ears can hear; it can be music, spoken words, traffic, wind or just noise. The word noise is often used to describe unwanted sound. The properties of sound can be given objectively in physical terms. As a result of the psychological and physiological differences between individuals, reactions of persons or animals to noise, such as being disturbed or annoyed, are subjective and therefore difficult to predict.

Sound Power

Most sound sources can be conveniently described by giving their rate of production of noise energy. This rate is called sound power and has the symbol W (unit Watt). Sound power is intrinsic to a sound source, it is independent of influences resulting from interaction with the surrounding environmental acoustic features.

Sound Power Level, SWL

Ten times the logarithm to the base 10 of the ratio of the source sound power, W, to a standard reference power, W_{ref}, of standardised value, 1 picowatt. In this form the sound power is expressed as a level in decibels.

Sound Pressure

The increase or decrease in the atmospheric pressure due to the passage of a sound wave. The unit of measure in the SI system of units is the Pascal, (Pa). The human ear can detect sound pressure over a range from 20 micropascals to 20 Pascals. The sound pressure by itself is not characteristic of the sound source. The sound pressure is dependent on the sound power of the source, distance from the source and acoustic features in the environment surrounding both source and receiver.

The decibel

Sound pressure and sound power are expressed on a logarithmic scale simply because of the large difference in linear terms between the weakest and strongest audible sounds perceived by humans. The word level is added to indicate the use of a scale. The decibel is therefore not a unit of measurement.

Sound Pressure Level, L_p or SPL

Ten times the logarithm to the base 10 of the square of the ratio of the effective or root mean square of the sound pressure fluctuations, P, and a standard reference pressure, P_{ref}, of 20 micropascals. In this form the sound pressure is expressed as a level in decibels.

A-weighting

The human ear is not equally sensitive over the audible spectrum. It is most sensitive at frequencies around 4000Hz. It is much less sensitive at low frequencies. This non linearity is level dependent. In order to make the reading of the sound level meter correspond to loudness as perceived by normal human hearing frequency weighting is employed. The internationally standardised 'A' weighting is designed to mimic hearing response at a loudness of 40 Phons. Response to noise has been found to correlate well with levels measured using this weighting.

Typical Approximate Noise Levels	
Source	**Sound Pressure Level dB(A)**
Whisper	30
Library Reading Room	40
Quiet Office	50
Normal Conversation at 1m	60
Noisy Office	70
Domestic Vacuum Cleaner at 1m	80
Factory Machinery at 1m	90

Frequency

The time rate of repetition measured in number of cycles per second, expressed as Hertz (abbreviated to Hz).

Sound Level Meter (SLM)

An instrument used to measure sound in an accurate reproducible manner.

dB(A)

This indicates that the A - weighting has been applied to the measurements.

Specific noise source

The noise source under investigation.

Ambient noise

Totally encompassing sound in a given situation at a given time.

Residual noise

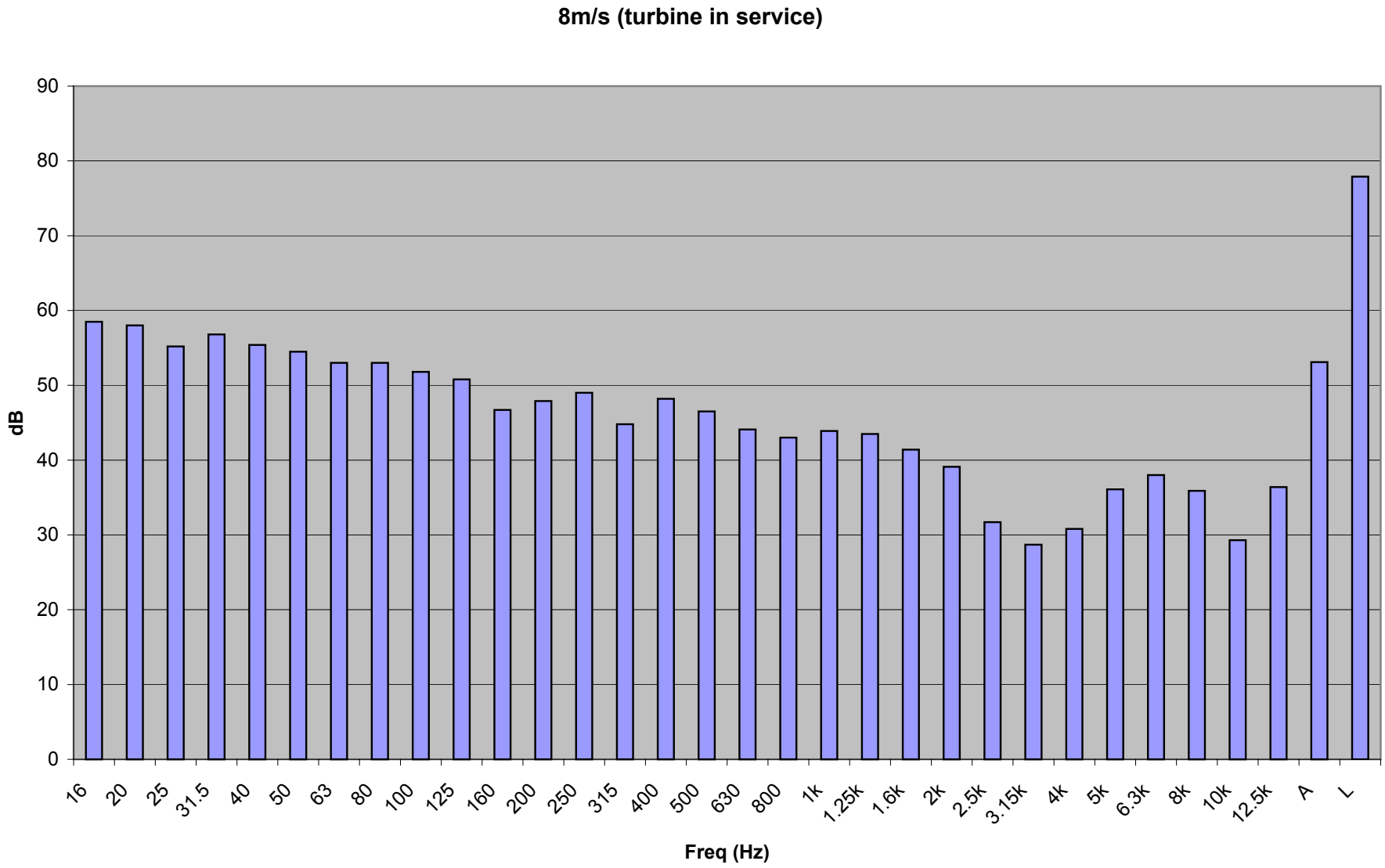
The noise remaining when a specific noise source is suppressed to such a degree that it does not contribute to the ambient noise.

Background noise level, $L_{A90,\,T}$.

The A-weighted percentile sound pressure level of the residual noise exceeded for 90% of a given time interval, T.

Equivalent continuous sound pressure level, $L_{eq,T}$.

The equivalent continuous steady sound pressure level that gives the same noise exposure as a fluctuating noise measured over the same time interval.


8m/s (turbine in service)
dB
90
80
70
60
50
40
30
20
10
0
16
20
25
31.5
40
50
63
80
100
125
160
200
250
315
400
500
630
800
1k
1.25k
1.6k
2k
2.5k
3.15k
4k
5k
6.3k
8k
10k
12.5k
A
L
Freq (Hz)

ANNEX 8 – Topographical Corrections

Table 1 Likely Effects Calculations

Location		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Lower Hollingarth	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	27.3	30.9	34.7	36.1	36.2	36.2	36.2	36.2	36.2
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	-2.6	-0.3	1.9	4.2	6.4	8.7	10.9	13.2	13.2
	Difference	-	-	-	-	31.2	32.8	31.9	29.8	27.5	25.3	23	23
NAL2 - Whirligarth	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	30.5	34.1	37.8	39.2	39.4	39.4	39.4	39.4	39.4
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	0	2.3	4.5	6.8	9	11.2	13.5	15.7	15.7
	Difference	-	-	-	-	31.8	33.3	32.4	30.4	28.2	25.9	23.7	23.7
NAL3 - Easterlee	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	30.3	33.9	37.6	39.1	39.2	39.2	39.2	39.2	39.2
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	18.9	21.2	23.4	25.7	27.9	30.2	32.4	34.7	34.7
	Difference	-	-	-	-	12.7	14.2	13.4	11.3	9	6.8	4.5	4.5
NAL4 - Gentletown	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	27.5	31.1	34.8	36.2	36.4	36.4	36.4	36.4	36.4
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	19.3	21.5	23.8	26	28.3	30.5	32.8	35	35
	Difference	-	-	-	-	9.6	11	10.2	8.1	5.9	3.6	1.4	1.4
NAL5 - Littlester	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	25.8	29.5	33.2	34.6	34.7	34.7	34.7	34.7	34.7
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	25.3	27.5	29.8	32.1	34.3	36.6	38.8	41.1	41.1
	Difference	-	-	-	-	2	3.4	2.5	0.4	-1.9	-4.1	-6.4	-6.4
NAL6 - Hamnavoe	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	24.5	28.1	31.8	33.2	33.4	33.4	33.4	33.4	33.4
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	6.6	8.8	11.1	13.3	15.6	17.8	20.1	22.3	22.3
	Difference	-	-	-	-	19.3	20.7	19.9	17.8	15.6	13.3	11.1	11.1
NAL7 - Helenquhida	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	26.6	30.2	34	35.4	35.5	35.5	35.5	35.5	35.5
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	23.4	25.6	27.8	30	32.3	34.5	36.7	38.9	38.9
	Difference	-	-	-	-	4.6	6.2	5.4	3.2	1	-1.2	-3.4	-3.4
NAL8-Kettlester	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	26.4	30	33.7	35.1	35.3	35.3	35.3	35.3	35.3
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	23.5	25.7	27.9	30.1	32.3	34.5	36.7	38.9	38.9
	Difference	-	-	-	-	4.3	5.8	5	3	0.8	-1.4	-3.6	-3.6
NAL9 - Islesview	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	28.7	32.3	36	37.4	37.6	37.6	37.6	37.6	37.6
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	20.6	22.9	25.1	27.4	29.6	31.9	34.1	36.4	36.4
	Difference	-	-	-	-	9.4	10.9	10	8	5.7	3.5	1.2	1.2
NAL10 - Westerlee	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	27.7	31.3	35	36.4	36.6	36.6	36.6	36.6	36.6
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	22.5	24.8	27	29.3	31.5	33.7	36	38.2	38.2
	Difference	-	-	-	-	6.5	8	7.1	5.1	2.9	0.6	-1.6	-1.6
NAL11 - Kletterlea	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	26.5	30.2	33.9	35.3	35.4	35.4	35.4	35.4	35.4
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	31.4	33.6	35.9	38.1	40.4	42.7	44.9	47.2	47.2
	Difference	-	-	-	-	-3.4	-2	-2.8	-5	-7.3	-9.5	-11.8	-11.8
NAL12 - The School House	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	23.7	27.3	31.1	32.5	32.6	32.6	32.6	32.6	32.6
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	25.5	27.7	30	32.3	34.5	36.8	39	41.3	41.3
	Difference	-	-	-	-	-0.4	1.1	0.2	-1.9	-4.2	-6.4	-8.7	-8.7
NAL13 - Cluness Cottage	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	25.6	29.2	32.9	34.3	34.5	34.5	34.5	34.5	34.5
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	34.1	36.3	38.5	40.6	42.8	45	47.2	49.3	49.3
	Difference	-	-	-	-	-7.1	-5.6	-6.3	-8.3	-10.5	-12.7	-14.8	-14.8

NAL14 - Staneygarth	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	25.2	28.9	32.6	34	34.1	34.1	34.1	34.1	34.1
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	27.4	29.6	31.8	34	36.2	38.4	40.5	42.7	42.7
	Difference	-	-	-	-	-0.7	0.8	0	-2.1	-4.3	-6.4	-8.6	-8.6
NAL15 - Giggleswick	Predicted Wind Turbine Noise L_{A90} Beaw Field	-	-	-	25.4	29	32.7	34.2	34.3	34.3	34.3	34.3	34.3
	Predicted Wind Turbine Noise L_{A90} Other Schemes	-	-	-	29.9	32.2	34.4	36.7	39	41.2	43.5	45.7	45.7
	Difference	-	-	-	-	-3.2	-1.7	-2.5	-4.7	-6.9	-9.2	-11.4	-11.4

Table 2 - Wind Turbines

Wind Farm/ Turbine	Turbine Modelled	Easting	Northing
Beaw Field 1	Senvion-3.4M 104-RE50.8 blade-Full mode	450454	1183369
Beaw Field 2	Senvion-3.4M 104-RE50.8 blade-Full mode	450654	1183105
Beaw Field 3	Senvion-3.4M 104-RE50.8 blade-Full mode	451094	1183089
Beaw Field 4	Senvion-3.4M 104-RE50.8 blade-Full mode	450670	1182757
Beaw Field 5	Senvion-3.4M 104-RE50.8 blade-Full mode	451343	1182860
Beaw Field 6	Senvion-3.4M 104-RE50.8 blade-Full mode	450910	1182525
Beaw Field 7	Senvion-3.4M 104-RE50.8 blade-Full mode	451627	1182659
Beaw Field 8	Senvion-3.4M 104-RE50.8 blade-Full mode	451079	1182243
Beaw Field 9	Senvion-3.4M 104-RE50.8 blade-Full mode	451998	1182488
Beaw Field 10	Senvion-3.4M 104-RE50.8 blade-Full mode	451678	1182109
Beaw Field 11	Senvion-3.4M 104-RE50.8 blade-Full mode	451223	1181970
Beaw Field 12	Senvion-3.4M 104-RE50.8 blade-Full mode	452188	1182283
Beaw Field 13	Senvion-3.4M 104-RE50.8 blade-Full mode	452008	1181933
Beaw Field 14	Senvion-3.4M 104-RE50.8 blade-Full mode	451469	1181732
Beaw Field 15	Senvion-3.4M 104-RE50.8 blade-Full mode	452111	1181525
Beaw Field 16	Senvion-3.4M 104-RE50.8 blade-Full mode	451610	1181433
Beaw Field 17	Senvion-3.4M 104-RE50.8 blade-Full mode	452358	1181254
Other Turbines 18	EVANCE ISKRA R9000 5KW 10m Hub	452229	1180022
Other Turbines 19	Proven-6KW-Generic blade-Full mode	451588	1180224
Other Turbines 20	Eoltech-Scirocco-Generic blade-Full mode	451966	1179967
Other Turbines 21	EVANCE ISKRA R9000 5KW 10m Hub	451250	1180300
Other Turbines 22	EVANCE ISKRA R9000 5KW 10m Hub	451194	1180286
Other Turbines 23	EVANCE ISKRA R9000 5KW 10m Hub	451313	1180253
Other Turbines 24	EVANCE ISKRA R9000 5KW 10m Hub	451297	1180208
Other Turbines 25	EVANCE ISKRA R9000 5KW 10m Hub	451700	1179525

Concave/Barrier Corrections

Wind Farm	Hub	T ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Beaw Field 1	95	1	-2	0	0	0	0	0	-2	0	0	0	-2	-2	0	0	0
Beaw Field 2	95	2	-2	0	0	0	0	-2	-2	0	0	0	-2	-2	0	0	0
Beaw Field 3	95	3	0	3	0	0	0	-2	-2	0	0	0	-2	-2	0	0	0
Beaw Field 4	95	4	-2	0	0	0	0	-2	0	0	0	0	-2	-2	0	0	0
Beaw Field 5	95	5	0	0	0	0	0	0	-2	0	0	0	0	-2	0	0	0
Beaw Field 6	95	6	0	0	0	0	0	0	0	0	0	0	-2	-2	0	0	0
Beaw Field 7	95	7	0	0	0	0	0	0	-2	0	0	0	0	-2	-2	-2	-2
Beaw Field 8	95	8	0	0	0	0	0	0	0	0	0	0	-2	-2	0	0	0
Beaw Field 9	95	9	0	0	0	0	0	0	-2	0	0	0	0	-2	0	-2	0
Beaw Field 10	95	10	0	0	0	0	0	0	-2	0	0	0	0	-2	0	0	0
Beaw Field 11	95	11	0	0	0	0	0	0	0	0	0	0	0	-2	0	0	0
Beaw Field 12	95	12	0	0	0	0	0	0	-2	0	0	0	0	-2	0	0	0
Beaw Field 13	95	13	0	0	0	0	0	0	0	0	0	0	0	-2	0	0	0
Beaw Field 14	95	14	0	0	0	0	0	0	0	0	0	0	0	-2	0	0	0
Beaw Field 15	95	15	0	0	0	0	0	0	0	0	0	0	0	-2	0	0	0
Beaw Field 16	95	16	0	0	0	0	0	0	0	0	0	0	0	-2	0	0	0
Beaw Field 17	95	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

ANNEX 9 – Alternative Noise Limits which would apply if Turbine 20 is removed

Annex 9 – Alternative noise limits should the Cluness Turbine (T20) be removed

TNEI understand that the small turbine on land at Cluness Cottage may be removed. As such a revised set of Total and Site Specific noise limits and cumulative noise predictions have been produced for each of the Noise Assessment Locations. The relevant tables from the main report have been reproduced below to detail the revised limits and predictions.

Should T20 be removed the tables below detail the Site Specific Noise Limits which should be adopted for the Proposed Development.

Total ETSU-R-97 Noise Limits (Stage 1)

The Total ETSU-R-97 noise limits have been established for each of the NALs as detailed in Table 6.3 and Table 6.4 below, based on a fixed minimum of 40dB(A) (Quiet daytime) or 43 dB(A) (Night-time) or background plus 5 dB(A).

Due to the proximity of small wind turbine developments to NAL11 and NAL15 it has been assumed that the occupiers are financially involved with the wind turbine developments as such, a higher limit of 45dB or permissible margin above background noise (5dB) has been assumed for those receptors during the quiet daytime and night time periods.

Table 6.3 Total ETSU-R-97 Noise Limits Quiet Daytime

Noise Assessment Location	Wind Speed (ms^{-1}) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NAL1- Lower Hollingarth	40	40	40	40	40	40	40	40.1	41.8	42.6	42.6	42.6
NAL2- Whirliegarth	40	40	40	40	40	40	40	40	40.5	42.9	42.9	42.9
NAL3- Easterlee	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
NAL4 - Gentletown	40	40	40	40	40	40	40	41.8	44.6	46.8	48	48
NAL5 - Littlester	40	40	40	40	40	40	41.3	44.4	47.2	49.6	51.3	51.3
NAL6 - Hamnavoe	40	40	40	40	40	40	40	40.1	41.8	42.6	42.6	42.6
NAL7 - Helnaquhida	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
NAL8 - Kettlester	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
NAL9 - Islesview	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
NAL10 - Westerlee	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
NAL11 - Kletterlea*	45	45	45	45	45	45	45	45	47.2	49.6	51.3	51.3
NAL12 - The School House	40	40	40	40	40	40	41.3	44.4	47.2	49.6	51.3	51.3
NAL13 – Cluness Cottage	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
NAL14 - Staneygarth	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
NAL15 - Giggleswick *	45	45	45	45	45	45	45	45	45	46.8	48	48

* assumes FI with the nearby operational wind turbine

Table 6.4 Total ETSU-R-97 noise limits Night-Time

Noise Assessment Location	Wind Speed (ms^{-1}) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NAL1- Lower Hollingarth	43	43	43	43	43	43	43	43	43	43	43	44.1
NAL2- Whirliegarth	43	43	43	43	43	43	43	43	43	43	43.7	43.7
NAL3- Easterlee	43	43	43	43	43	43	43	43	43	43	45.1	45.1
NAL4 - Gentletown	43	43	43	43	43	43	43	43	43	44	46.1	46.1
NAL5 - Littlester	43	43	43	43	43	43	43	43	44.5	47.3	49.8	51.8
NAL6 - Hamnavoe	43	43	43	43	43	43	43	43	43	43	43	44.1
NAL7 - Helnaquhida	43	43	43	43	43	43	43	43	43	43	45.1	45.1
NAL8 - Kettlester	43	43	43	43	43	43	43	43	43	43	45.1	45.1
NAL9 - Islesview	43	43	43	43	43	43	43	43	43	43	45.1	45.1
NAL10 - Westerlee	43	43	43	43	43	43	43	43	43	43	45.1	45.1
NAL11 - Kletterlea	45	45	45	45	45	45	45	45	45	47.3	49.8	51.8
NAL12 - The School House	43	43	43	43	43	43	43	43	44.5	47.3	49.8	51.8
NAL13 – Cluness Cottage	43	43	43	43	43	43	43	43	43	43	45.1	45.1
NAL14 - Staneygarth	43	43	43	43	43	43	43	43	43	43	45.1	45.1
NAL15 - Giggleswick*	45	45	45	45	45	45	45	45	45	45	46.1	46.1

* assumes FI with the nearby operational wind turbine

Predicting the likely effects and the requirement for a cumulative noise assessment (Stage 2)

Table 6.7 and Table 6.8 and shows that the predicted cumulative wind turbine noise immission levels (without T20) meet the Total ETSU-R-97 noise limits under all conditions and at all locations for both quiet daytime and night-time periods

Table 6.7 Compliance Table - Likely Cumulative Noise - Quiet Daytime

Location		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Lower Hollingarth	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40.1	41.8	42.6	42.6	42.6
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.6	31.2	35	36.4	36.5	36.5	36.5	36.5	36.5
	Exceedance Level L_{A90}	-	-	-	-12.4	-8.8	-5	-3.6	-3.6	-5.3	-6.1	-6.1	-6.1
NAL2 - Whirliegarth	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40	40.5	42.9	42.9	42.9
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.5	34.1	37.8	39.2	39.4	39.4	39.4	39.4	39.4
	Exceedance Level L_{A90}	-	-	-	-9.5	-5.9	-2.2	-0.8	-0.6	-1.1	-3.5	-3.5	-3.5
NAL3 - Easterlee	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.6	34.1	37.8	39.2	39.5	39.7	40	40.5	40.5
	Exceedance Level L_{A90}	-	-	-	-9.4	-5.9	-2.2	-0.8	-0.5	-2.7	-4.6	-6.2	-6.2
NAL4 - Gentletown	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	41.8	44.6	46.8	48	48
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28	31.5	35.1	36.6	36.9	37.3	37.9	38.6	38.6
	Exceedance Level L_{A90}	-	-	-	-12	-8.5	-4.9	-3.4	-4.9	-7.3	-8.9	-9.4	-9.4
NAL5 - Littlester	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	41.3	44.4	47.2	49.6	51.3	51.3
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.6	31.6	34.8	36.5	37.5	38.7	40.2	42	42
	Exceedance Level L_{A90}	-	-	-	-11.4	-8.4	-5.2	-4.8	-6.9	-8.5	-9.4	-9.3	-9.3
NAL6 - Hamnavoe	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40.1	41.8	42.6	42.6	42.6
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	24.6	28.2	31.9	33.3	33.5	33.5	33.6	33.7	33.7
	Exceedance Level L_{A90}	-	-	-	-15.4	-11.8	-8.1	-6.7	-6.6	-8.3	-9	-8.9	-8.9
NAL7 - Helnaquhida	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.9	31.2	34.7	36.2	36.8	37.5	38.4	39.7	39.7
	Exceedance Level L_{A90}	-	-	-	-12.1	-8.8	-5.3	-3.8	-3.2	-4.9	-6.2	-7	-7
NAL8 - Kettlester	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.4	30.8	34.3	35.8	36.3	36.9	37.8	38.9	38.9
	Exceedance Level L_{A90}	-	-	-	-12.6	-9.2	-5.7	-4.2	-3.7	-5.5	-6.8	-7.8	-7.8
NAL9 -Isleview	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.3	32.7	36.3	37.8	38.2	38.5	39.1	39.9	39.9
	Exceedance Level L_{A90}	-	-	-	-10.7	-7.3	-3.7	-2.2	-1.8	-3.9	-5.5	-6.8	-6.8
NAL10 - Westerlee	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.8	32.1	35.6	37.1	37.7	38.3	39.2	40.3	40.3
	Exceedance Level L_{A90}	-	-	-	-11.2	-7.9	-4.4	-2.9	-2.3	-4.1	-5.4	-6.4	-6.4
NAL11 - Kletterlea	Total ETSU-R-97 Noise Limit	45	45	45	45	45	45	45	45	47.2	49.6	51.3	51.3
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	32.6	35.3	38	40	41.6	43.4	45.4	47.5	47.5
	Exceedance Level L_{A90}	-	-	-	-12.4	-9.7	-7	-5	-3.4	-3.8	-4.2	-3.8	-3.8
NAL12 - The School House	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	41.3	44.4	47.2	49.6	51.3	51.3
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.7	30.5	33.6	35.3	36.7	38.1	39.9	41.8	41.8
	Exceedance Level L_{A90}	-	-	-	-12.3	-9.5	-6.4	-6	-7.7	-9.1	-9.7	-9.5	-9.5
Cluness Cottage	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	26.9	30.2	33.6	35.2	35.8	36.5	37.6	38.8	38.8
	Exceedance Level L_{A90}	-	-	-	-13.1	-9.8	-6.4	-4.8	-4.2	-5.9	-7	-7.9	-7.9
NAL14 - Staneygarth	Total ETSU-R-97 Noise Limit	40	40	40	40	40	40	40	40	42.4	44.6	46.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	26.5	29.9	33.3	34.9	35.5	36.2	37.2	38.5	38.5
	Exceedance Level L_{A90}	-	-	-	-13.5	-10.1	-6.7	-5.1	-4.5	-6.2	-7.4	-8.2	-8.2
NAL15 - Giggleswick	Total ETSU-R-97 Noise Limit	45	45	45	45	45	45	45	45	45	46.8	48	48
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	31.2	33.8	36.6	38.5	40.2	41.9	43.9	45.9	45.9
	Exceedance Level L_{A90}	-	-	-	-13.8	-11.2	-8.4	-6.5	-4.8	-3.1	-2.9	-2.1	-2.1

Table 6.8 Compliance Table - Likely Cumulative Noise - Night time

Location		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Lower Hollingarth	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	43	44.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.6	31.2	35	36.4	36.5	36.5	36.5	36.5	36.5
	Exceedance Level L_{A90}	-	-	-	-15.4	-11.8	-8	-6.6	-6.5	-6.5	-6.5	-6.5	-7.6
NAL2 - Whirlegarth	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	43.7	43.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.5	34.1	37.8	39.2	39.4	39.4	39.4	39.4	39.4
	Exceedance Level L_{A90}	-	-	-	-12.5	-8.9	-5.2	-3.8	-3.6	-3.6	-3.6	-4.3	-4.3
NAL3 - Easterlee	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	45.1	45.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.6	34.1	37.8	39.2	39.5	39.7	40	40.5	40.5
	Exceedance Level L_{A90}	-	-	-	-12.4	-8.9	-5.2	-3.8	-3.5	-3.3	-3	-4.6	-4.6
NAL4 - Gentletown	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	44	46.1	46.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28	31.5	35.1	36.6	36.9	37.3	37.9	38.6	38.6
	Exceedance Level L_{A90}	-	-	-	-15	-11.5	-7.9	-6.4	-6.1	-5.7	-6.1	-7.5	-7.5
NAL5 - Littlester	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	44.5	47.3	49.8	51.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.6	31.6	34.8	36.5	37.5	38.7	40.2	42	42
	Exceedance Level L_{A90}	-	-	-	-14.4	-11.4	-8.2	-6.5	-5.5	-5.8	-7.1	-7.8	-9.8
NAL6 - Hamnavoe	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	43	44.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	24.6	28.2	31.9	33.3	33.5	33.5	33.6	33.7	33.7
	Exceedance Level L_{A90}	-	-	-	-18.4	-14.8	-11.1	-9.7	-9.5	-9.5	-9.4	-9.3	-10.4
NAL7 - Helnaquhida	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	45.1	45.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.9	31.2	34.7	36.2	36.8	37.5	38.4	39.7	39.7
	Exceedance Level L_{A90}	-	-	-	-15.1	-11.8	-8.3	-6.8	-6.2	-5.5	-4.6	-5.4	-5.4
NAL8 - Kettlester	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	45.1	45.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.4	30.8	34.3	35.8	36.3	36.9	37.8	38.9	38.9
	Exceedance Level L_{A90}	-	-	-	-15.6	-12.2	-8.7	-7.2	-6.7	-6.1	-5.2	-6.2	-6.2
NAL9 -Isleview	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	45.1	45.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.3	32.7	36.3	37.8	38.2	38.5	39.1	39.9	39.9
	Exceedance Level L_{A90}	-	-	-	-13.7	-10.3	-6.7	-5.2	-4.8	-4.5	-3.9	-5.2	-5.2
NAL10 - Westerlee	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	45.1	45.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.8	32.1	35.6	37.1	37.7	38.3	39.2	40.3	40.3
	Exceedance Level L_{A90}	-	-	-	-14.2	-10.9	-7.4	-5.9	-5.3	-4.7	-3.8	-4.8	-4.8
NAL11 - Kletterlea	Total ETSU-R-97 Noise Limit	45	45	45	45	45	45	45	45	45	47.3	49.8	51.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	32.6	35.3	38	40	41.6	43.4	45.4	47.5	47.5
	Exceedance Level L_{A90}	-	-	-	-12.4	-9.7	-7	-5	-3.4	-1.6	-1.9	-2.3	-4.3
NAL12 - The School House	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	44.5	47.3	49.8	51.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.7	30.5	33.6	35.3	36.7	38.1	39.9	41.8	41.8
	Exceedance Level L_{A90}	-	-	-	-15.3	-12.5	-9.4	-7.7	-6.3	-6.4	-7.4	-8	-10
Cluness Cottage	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	45.1	45.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	26.9	30.2	33.6	35.2	35.8	36.5	37.6	38.8	38.8
	Exceedance Level L_{A90}	-	-	-	-16.1	-12.8	-9.4	-7.8	-7.2	-6.5	-5.4	-6.3	-6.3
NAL14 - Stanegarth	Total ETSU-R-97 Noise Limit	43	43	43	43	43	43	43	43	43	43	45.1	45.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	26.5	29.9	33.3	34.9	35.5	36.2	37.2	38.5	38.5
	Exceedance Level L_{A90}	-	-	-	-16.5	-13.1	-9.7	-8.1	-7.5	-6.8	-5.8	-6.6	-6.6
NAL15 - Giggleswick	Total ETSU-R-97 Noise Limit	45	45	45	45	45	45	45	45	45	45	46.1	46.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	31.2	33.8	36.6	38.5	40.2	41.9	43.9	45.9	45.9
	Exceedance Level L_{A90}	-	-	-	-13.8	-11.2	-8.4	-6.5	-4.8	-3.1	-1.1	-0.2	-0.2

Derivation of Site Specific Noise Limits (Stage 3)

Tables 6.10 and 6.11 show the site specific noise limits for the proposed development and the predicted wind turbine noise levels based on the Senvion 3.4M 104 which is the louder of the two candidate turbines. A negative exceedence demonstrates compliance with the site specific noise limits.

Table 6.10 Site Specific Limits Compliance Table - Quiet Daytime

Location		Wind Speed (ms-1) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Lower Hollingarth	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	40	40	40	40.1	41.8	42.6	42.6	42.6
	Predicted Wind Turbine Noise L_{A90}	-	-	-	27.3	30.9	34.7	36.1	36.2	36.2	36.2	36.2	36.2
	Exceedance Level L_{A90}	-	-	-	-12.7	-9.1	-5.3	-3.9	-3.9	-5.6	-6.4	-6.4	-6.4
NAL2 - Whirliegarth	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	40	40	40	40	40.5	42.9	42.9	42.9
	Predicted Wind Turbine Noise L_{A90}	-	-	-	30.5	34.1	37.8	39.2	39.4	39.4	39.4	39.4	39.4
	Exceedance Level L_{A90}	-	-	-	-9.5	-5.9	-2.2	-0.8	-0.6	-1.1	-3.5	-3.5	-3.5
NAL3 - Easterlee	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	39.9	39.9	39.8	39.7	42.1	44.3	46.4	46.4
	Predicted Wind Turbine Noise L_{A90}	-	-	-	30.3	33.9	37.6	39.1	39.2	39.2	39.2	39.2	39.2
	Exceedance Level L_{A90}	-	-	-	-9.7	-6	-2.3	-0.7	-0.5	-2.9	-5.1	-7.2	-7.2
NAL4 - Gentletown	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	39.9	39.9	39.8	41.6	44.4	46.6	47.8	47.8
	Predicted Wind Turbine Noise L_{A90}	-	-	-	27.5	31.1	34.8	36.2	36.4	36.4	36.4	36.4	36.4
	Exceedance Level L_{A90}	-	-	-	-12.5	-8.8	-5.1	-3.6	-5.2	-8	-10.2	-11.4	-11.4
NAL5 - Littlester	Site Specific Noise Limit : ETSU-R-97	40	39.9	39.9	39.9	39.7	39.6	40.8	44	46.8	49.2	50.9	50.9
	Predicted Wind Turbine Noise L_{A90}	-	-	-	25.8	29.5	33.2	34.6	34.7	34.7	34.7	34.7	34.7
	Exceedance Level L_{A90}	-	-	-	-14.1	-10.2	-6.4	-6.2	-9.3	-12.1	-14.5	-16.2	-16.2
NAL6 - Hamnavoe	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	40	40	40	40.1	41.8	42.6	42.6	42.6
	Predicted Wind Turbine Noise L_{A90}	-	-	-	24.5	28.1	31.8	33.2	33.4	33.4	33.4	33.4	33.4
	Exceedance Level L_{A90}	-	-	-	-15.5	-11.9	-8.2	-6.8	-6.7	-8.4	-9.2	-9.2	-9.2
NAL7 - Helnaquhida	Site Specific Noise Limit : ETSU-R-97	40	39.9	39.9	39.9	39.9	39.8	39.7	39.5	41.9	44.1	46.2	46.2
	Predicted Wind Turbine Noise L_{A90}	-	-	-	26.6	30.2	34	35.4	35.5	35.5	35.5	35.5	35.5
	Exceedance Level L_{A90}	-	-	-	-13.3	-9.7	-5.8	-4.3	-4	-6.4	-8.6	-10.7	-10.7
NAL8 - Kettlester	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	39.9	39.9	39.8	39.7	42.1	44.3	46.4	46.4
	Predicted Wind Turbine Noise L_{A90}	-	-	-	26.4	30	33.7	35.1	35.3	35.3	35.3	35.3	35.3
	Exceedance Level L_{A90}	-	-	-	-13.6	-9.9	-6.2	-4.7	-4.4	-6.8	-9	-11.1	-11.1
NAL9 -Isleview	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	39.9	39.9	39.8	39.6	42	44.2	46.3	46.3
	Predicted Wind Turbine Noise L_{A90}	-	-	-	28.7	32.3	36	37.4	37.6	37.6	37.6	37.6	37.6
	Exceedance Level L_{A90}	-	-	-	-11.3	-7.6	-3.9	-2.4	-2	-4.4	-6.6	-8.7	-8.7
NAL10 - Westerlee	Site Specific Noise Limit : ETSU-R-97	40	39.9	39.9	39.9	39.9	39.8	39.7	39.4	41.8	44	46.1	46.1
	Predicted Wind Turbine Noise L_{A90}	-	-	-	27.7	31.3	35	36.4	36.6	36.6	36.6	36.6	36.6
	Exceedance Level L_{A90}	-	-	-	-12.2	-8.6	-4.8	-3.3	-2.8	-5.2	-7.4	-9.5	-9.5
NAL11 - Kletterlea	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	40	40	41.3	43.2	45.3	47.8	49.2	49.2
	Predicted Wind Turbine Noise L_{A90}	-	-	-	26.5	30.2	33.9	35.3	35.4	35.4	35.4	35.4	35.4
	Exceedance Level L_{A90}	-	-	-	-13.5	-9.8	-6.1	-6	-7.8	-9.9	-12.4	-13.8	-13.8
NAL12 - The School House	Site Specific Noise Limit : ETSU-R-97	40	39.8	39.8	39.8	39.7	39.6	40.7	43.9	46.8	49.2	50.9	50.9
	Predicted Wind Turbine Noise L_{A90}	-	-	-	23.7	27.3	31.1	32.5	32.6	32.6	32.6	32.6	32.6
	Exceedance Level L_{A90}	-	-	-	-16.1	-12.4	-8.5	-8.2	-11.3	-14.2	-16.6	-18.3	-18.3
NAL13 Clunes Cottage	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	39.9	39.9	39.8	39.6	42	44.2	46.3	46.3
	Predicted Wind Turbine Noise L_{A90}	-	-	-	25.6	29.2	32.9	34.3	34.5	34.5	34.5	34.5	34.5
	Exceedance Level L_{A90}	-	-	-	-14.4	-10.7	-7	-5.5	-5.1	-7.5	-9.7	-11.8	-11.8
NAL14 - Staneygarth	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	39.9	39.9	39.8	39.7	42.1	44.3	46.4	46.4
	Predicted Wind Turbine Noise L_{A90}	-	-	-	25.2	28.9	32.6	34	34.1	34.1	34.1	34.1	34.1
	Exceedance Level L_{A90}	-	-	-	-14.8	-11	-7.3	-5.8	-5.6	-8	-10.2	-12.3	-12.3
NAL15 - Giggleswick	Site Specific Noise Limit : ETSU-R-97	40	40	40	40	40	40	40	41.8	42.7	44.1	44.3	44.3
	Predicted Wind Turbine Noise L_{A90}	-	-	-	25.4	29	32.7	34.2	34.3	34.3	34.3	34.3	34.3
	Exceedance Level L_{A90}	-	-	-	-14.6	-11	-7.3	-5.8	-7.5	-8.4	-9.8	-10	-10

Table 6.11 Site Specific Limits Compliance Table - Night-time

Location		Wind Speed (ms^{-1}) as standardised to 10m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 - Lower Hollingarth	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	43	43	43	43	43	43	44.1
	Predicted Wind Turbine Noise L_{A90}	-	-	-	27.3	30.9	34.7	36.1	36.2	36.2	36.2	36.2	36.2
	Exceedance Level L_{A90}	-	-	-	-15.7	-12.1	-8.3	-6.9	-6.8	-6.8	-6.8	-6.8	-7.9
NAL2 - Whirliegarth	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	43	43	43	43	43	43.7	43.7
	Predicted Wind Turbine Noise L_{A90}	-	-	-	30.5	34.1	37.8	39.2	39.4	39.4	39.4	39.4	39.4
	Exceedance Level L_{A90}	-	-	-	-12.5	-8.9	-5.2	-3.8	-3.6	-3.6	-3.6	-4.3	-4.3
NAL3 - Easterflee	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	43	42.9	42.9	42.8	42.6	44.7	44.7
	Predicted Wind Turbine Noise L_{A90}	-	-	-	30.3	33.9	37.6	39.1	39.2	39.2	39.2	39.2	39.2
	Exceedance Level L_{A90}	-	-	-	-12.7	-9.1	-5.4	-3.8	-3.7	-3.6	-3.4	-5.5	-5.5
NAL4 - Gentletown	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	43	42.9	42.9	42.8	43.7	45.8	45.8
	Predicted Wind Turbine Noise L_{A90}	-	-	-	27.5	31.1	34.8	36.2	36.4	36.4	36.4	36.4	36.4
	Exceedance Level L_{A90}	-	-	-	-15.5	-11.9	-8.2	-6.7	-6.5	-6.4	-7.3	-9.4	-9.4
NAL5 - Littlester	Site Specific Noise Limit : ETSU-R-97	43	42.9	42.9	42.9	42.9	42.8	42.6	42.4	43.8	46.7	49.2	51.4
	Predicted Wind Turbine Noise L_{A90}	-	-	-	25.8	29.5	33.2	34.6	34.7	34.7	34.7	34.7	34.7
	Exceedance Level L_{A90}	-	-	-	-17.1	-13.4	-9.6	-8	-7.7	-9.1	-12	-14.5	-16.7
NAL6 - Hamnavoe	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	43	43	43	43	43	43	44.1
	Predicted Wind Turbine Noise L_{A90}	-	-	-	24.5	28.1	31.8	33.2	33.4	33.4	33.4	33.4	33.4
	Exceedance Level L_{A90}	-	-	-	-18.5	-14.9	-11.2	-9.8	-9.6	-9.6	-9.6	-9.6	-10.7
NAL7 - Helnaquhida	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	42.9	42.9	42.8	42.6	42.3	44.4	44.4
	Predicted Wind Turbine Noise L_{A90}	-	-	-	26.6	30.2	34	35.4	35.5	35.5	35.5	35.5	35.5
	Exceedance Level L_{A90}	-	-	-	-16.4	-12.8	-8.9	-7.5	-7.3	-7.1	-6.8	-8.9	-8.9
NAL8 - Kettlester	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	42.9	42.9	42.8	42.7	42.6	44.6	44.6
	Predicted Wind Turbine Noise L_{A90}	-	-	-	26.4	30	33.7	35.1	35.3	35.3	35.3	35.3	35.3
	Exceedance Level L_{A90}	-	-	-	-16.6	-13	-9.2	-7.8	-7.5	-7.4	-7.3	-9.3	-9.3
NAL9 -Isleview	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	42.9	42.9	42.8	42.7	42.5	44.5	44.5
	Predicted Wind Turbine Noise L_{A90}	-	-	-	28.7	32.3	36	37.4	37.6	37.6	37.6	37.6	37.6
	Exceedance Level L_{A90}	-	-	-	-14.3	-10.7	-6.9	-5.5	-5.2	-5.1	-4.9	-6.9	-6.9
NAL10 - Westerflee	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	42.9	42.9	42.8	42.7	42.5	42.1	44.2	44.2
	Predicted Wind Turbine Noise L_{A90}	-	-	-	27.7	31.3	35	36.4	36.6	36.6	36.6	36.6	36.6
	Exceedance Level L_{A90}	-	-	-	-15.3	-11.6	-7.9	-6.4	-6.1	-5.9	-5.5	-7.6	-7.6
NAL11 - Kletterflea	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	43	43	43	44.1	43.6	46.3	50
	Predicted Wind Turbine Noise L_{A90}	-	-	-	26.5	30.2	33.9	35.3	35.4	35.4	35.4	35.4	35.4
	Exceedance Level L_{A90}	-	-	-	-16.5	-12.8	-9.1	-7.7	-7.6	-5.7	-8.2	-10.9	-14.6
NAL12 - The School House	Site Specific Noise Limit : ETSU-R-97	43	42.9	42.9	42.9	42.9	42.8	42.6	42.4	43.7	46.6	49.2	51.4
	Predicted Wind Turbine Noise L_{A90}	-	-	-	23.7	27.3	31.1	32.5	32.6	32.6	32.6	32.6	32.6
	Exceedance Level L_{A90}	-	-	-	-19.2	-15.6	-11.7	-10.1	-9.8	-11.1	-14	-16.6	-18.8
NAL13 Cluness Cottage	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	42.9	42.9	42.8	42.7	42.4	44.5	44.5
	Predicted Wind Turbine Noise L_{A90}	-	-	-	25.6	29.2	32.9	34.3	34.5	34.5	34.5	34.5	34.5
	Exceedance Level L_{A90}	-	-	-	-17.4	-13.8	-10	-8.6	-8.3	-8.2	-7.9	-10	-10
NAL14 - Staneygarth	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	42.9	42.9	42.8	42.7	42.5	44.6	44.6
	Predicted Wind Turbine Noise L_{A90}	-	-	-	25.2	28.9	32.6	34	34.1	34.1	34.1	34.1	34.1
	Exceedance Level L_{A90}	-	-	-	-17.8	-14.1	-10.3	-8.9	-8.7	-8.6	-8.4	-10.5	-10.5
NAL15 - Giggleswick	Site Specific Noise Limit : ETSU-R-97	43	43	43	43	43	43	43	43	42.7	39.9	36.5	36.5
	Predicted Wind Turbine Noise L_{A90}	-	-	-	25.4	29	32.7	34.2	34.3	34.3	34.3	34.3	34.3
	Exceedance Level L_{A90}	-	-	-	-17.6	-14	-10.3	-8.8	-8.7	-8.4	-5.6	-2.2	-2.2

The results in this Annex show that predicted wind turbine noise from the proposed development meets the site specific noise limits at all locations during both daytime and night time periods (assuming turbine T20 is removed).