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A specialist energy consultancy

Appendix 11.1

Operational Noise Report

Bhlaraidh Wind Farm Extension

SSE Generation Ltd

13813-009
03 June 2021

CLIENT'S DISCRETION

sse Renewables

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Executive Summary

TNEI Services was commissioned by SSE Generation Limited (the 'Applicant') to undertake predictions of the wind turbine noise that would be emitted by the operation of the proposed Bhlaraidh Wind Farm Extension (hereinafter referred to as the Proposed Development). 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.'* The advice document 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* [IOA GPG]. *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:

1) Setting the Total ETSU-R-97 Noise Limits (which are applicable to noise from all wind turbines in the area operating concurrently) at noise sensitive receptors;
2) Predicting the likely effects (undertaking a cumulative noise assessment where required) to determine whether noise immissions at noise sensitive receptors will meet the Total ETSU-R-97 Noise Limits; and
3) Setting Site Specific Noise Limits (which are a proportion of the Total ETSU-R-97 Noise Limits derived to fully take account of other existing wind farms) for the Proposed Development.

A total of three 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. Background noise monitoring was undertaken in 2015 at two receptors to the south of the Proposed Development as part of the pre-construction noise survey undertaken for the operational Bhlaraidh Wind Farm undertaken by Spectrum Acoustics. For the purposes of this assessment, where noise monitoring was previously undertaken, the data collected has been used to set noise limits at the property and at properties that are also within the same cluster as the monitoring location (for example the data collected at the monitoring location Levishie House has been used to set limits for properties at Levishie). At receptors where noise monitoring was not undertaken in proximity the assessment relies on the simplified assessment approach, as detailed within ETSU-R-97.

Predictions of wind turbine noise for the Proposed Development were made based upon the sound power level data for a representative candidate wind turbine under consideration for the site, the Vestas V150, 5.6 MW with standard blades (without serrated trailing edges). This wind turbine model has been chosen in order to allow a representative assessment of the noise impacts. Whatever the final turbine choice is, the Proposed Development would have to meet the Site Specific Noise Limits determined and contained within any condition applied as part of consent.

Modelling was undertaken using the ISO 9613: 1996 'Acoustics – Attenuation of sound during propagation outdoors Part 2: General method of calculation' noise prediction model which accords with current good practice and is considered to provide a realistic impact assessment. For the other schemes, predictions have been undertaken using sound power level data for the installed turbines. The model of turbine was either identified through an online search, or through the use of Highland Council's Planning Application Portal.

The cumulative assessment shows that the Proposed Development can operate concurrently with the existing operational wind farms, whilst still meeting the Total ETSU-R-97 Noise limits at all receptors.

Site Specific Noise Limits have also been derived that take account (where required) of the other wind farm developments. Apportionment of the Total ETSU-R-97 Noise Limits was undertaken in accordance with current good practice.

Predicted noise levels indicate that at all noise assessment locations, wind turbine noise immissions were below the Site Specific Noise Limits when considering the Vestas V150 (with standard blades) as a candidate turbine. The use of Site Specific Noise Limits would ensure that the Proposed Development could operate concurrently with other operational turbines in the area and would also ensure that the Proposed Development's individual contribution could be measured and if required, enforced.

Should consent be granted for the Proposed Development it would be appropriate to include a set of noise related planning conditions, which detail the noise limits applicable to the Proposed Development. A set of suggested planning conditions have been included within Annex 8.

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

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ANNEXES

1 Introduction

1.1 Brief

1.1.1 TNEI was commissioned by SSE Generation Limited to undertake an operational noise assessment for the proposed Bhlaraidh Extension Wind Farm (hereinafter referred to as the Proposed Development). The following steps summarise the noise assessment process:

- Determine the Total ETSU-R-97 Noise Limits applicable to all wind farms in the area with reference to existing Government Guidance and the recommendations of the Department of Trade and Industry Noise Working Group on Noise from Wind Turbines which are contained within ETSU-R-97 *'The Assessment and Rating of Noise from Wind Farms'* [1] and *'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise'* [2] (IOA GPG) which represents current good practice;
- Assess and undertake a cumulative noise assessment, where required, to take account of other proposed, consented or operational schemes near to the Proposed Development;
- Suggest Site Specific Noise Limits for the Proposed Development, suitable for inclusion in the noise related planning condition should Scottish Ministers be minded to grant consent for the Proposed Development;
- Undertake predictions of the operational wind turbine noise immissions from the Proposed Development that will be incident at neighbouring noise sensitive receptors;
- Compare predictions of the operational wind turbine noise immissions from the Proposed Development against the Site Specific ETSU-R-97 Noise Limits that will be incident at neighbouring noise sensitive receptors; and
- Assess the impact of noise from the Proposed Development with reference to existing Government Guidance and the recommendations of the Department of Trade and Industry Noise Working Group on Noise from Wind Turbines, which are contained within ETSU-R-97 and the IOA GPG (current good practice).

1.2 Background

1.2.1 The Proposed Development is located approximately 11 km to the south east of Fort Augustus on land adjacent to the operational Bhlaraidh Wind Farm. The approximate OS Grid Reference for the centre of the site is 239512, 820991 and the proposed layout can be seen on Figure A1.1 in Annex 1.

1.2.2 In the absence of a confirmed turbine model, this noise assessment models a candidate turbine, the Vestas V150 5.6 MW with standard blades (without serrated trailing edges). This turbine has been selected as it is representative of the turbine type which could be installed at the site.

1.2.3 The noise assessment has considered schemes which are operational, consented and proposed (planning application submitted) but not those in the pre-planning stage. There are a number of operational wind farm developments in proximity to the Proposed Development as summarised in Table 1.1:

Table 1.1 Cumulative Wind Farms

Wind Farm	Number of Turbines	Status	Make and Model of Turbine considered in Modelling
Bhlaraidh	32	Operational	Vestas V112, 3.45 MW, standard blade Vestas V117, 3.45 MW, standard blade
Corrimony	5	Operational	Enercon E70, 2.3 MW, standard blade

1.2.4 Figure A1.1a in Annex 1 shows the location of the above developments in relation to the Proposed Development. Due to the separation distances and predicted levels from Corrimony Wind Farm being so low, it could theoretically have been scoped out of the assessment but as it is the closest scheme other than Bhlaraidh it has been included for completeness.

1.2.5 For the consented schemes noise related planning conditions have been set within the relevant Decision Notices, as detailed in Annex 2. As such the Site Specific Noise Limits derived for the Proposed Development have taken account the noise limits already allocated to, or that could potentially be used by, the other schemes in the area.

1.2.6 For the purposes of assessing the above schemes in conjunction with the Proposed Development the following terms have been referred to throughout the assessment;

- 'Total ETSU-R-97 Noise Limits'; defined as being the limit that should not be exceeded from the cumulative operation of all wind farm developments, including the Proposed Development; and
- 'Site Specific Noise Limits'; defined as being the limit that is specific to the Proposed Development only, and derived through the apportionment (where required), of the 'Total ETSU-R-97 Noise Limits' in accordance with current good practice.

1.2.7 Note that 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 received noise) at any receptor location due to the operation of the wind turbines.

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 [3];
- Web Based Renewables Advice: *'Onshore Wind Turbines'* [4];
- Planning Advice Note PAN 1/2011: *'Planning and Noise'* [5];
- ETSU-R-97 *'The Assessment and Rating of Noise from Wind Farms'*; and
- 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.

2.2 Local Policy

2.2.1 In determining an application for planning permission the 'starting point' for decision makers is to consider the compliance of a proposal against the Proposed Development Plan taken as a whole. Plans often have policies tailored specifically to control certain kinds of Proposed Development and such policies should carry more weight and be more dominant in the minds of decision makers.

2.2.2 When considering planning applications, decision makers should have regard to any adopted Structure Plan Policies, Local Plan (or Local Development Plan) Policies and any accompanying Supplementary Planning Guidance. In determining planning applications due regard should be had to all other material considerations, including National Planning Policy.

The Highland-wide Local Development Plan

2.2.3 The Highland-wide Local Development Plan (HwLDP) was adopted by Highland Council (THC) on 5 April 2012. The HwLDP sets out the overarching vision statement, spatial strategy and general planning policies for the whole of the Highland Council area (with the exception of the area covered by the Cairngorms National Park Local Plan, which is subject to a separate Development Plan).

2.2.4 Policy 67 of the HwLDP relates to Renewable Energy Development. The policy is supportive of such schemes where the Council is satisfied that they are located, sited and designed such that they will not be significantly detrimental overall, having regard to a number of effects including the safety and amenity of any regularly occupied buildings and the grounds that they occupy having regard to, amongst other things, the likely effect of noise generation.

The Highland Council's 'Onshore Wind Energy Supplementary Guidance (2016)

2.2.5 The Highland Council's 'Onshore Wind Energy Supplementary Guidance' (2016) details how onshore wind energy development proposals would be managed. The guidance has a section that sets out the assessment methods and key guiding principles that should form the basis of the noise assessment. The guidance states that a noise assessment for proposed large-

scale wind turbine development should be undertaken in accordance with ETSU-R-97 and the IOA GPG.

2.2.6 The guidance goes on to state that due to the undeveloped nature of the Highlands, proposals should aim to achieve noise limits at the lower end of ranges given in national guidance at sensitive locations and may seek lower in certain circumstances.

2.2.7 With regard to the cumulative effects of noise from wind farms, THC states: *"Where noise from more than one wind turbine development may have a cumulative impact at any noise sensitive location, applicants must ensure this is adequately assessed in accordance with best practice, which includes consideration of both predicted and consented levels".*

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 provides advice on 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.'

2.4 Web Based Planning Advice – Onshore Wind Turbines

2.4.1 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.'

2.4.2 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.'

2.4.3 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 provides guidance which may assist in the technical evaluation of noise assessment.'

2.4.4 Examination of the Technical Advice Note [6] confirms it provides no further advice on wind farms other than referring to ETSU-R-97 and relevant parameters for modelling identified in the Institute of Acoustics Bulletin March 2009, on page 37. This has been superseded by the introduction of the IOA GPG in May 2013.

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

2.5.1 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).

2.5.2 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.'

2.5.3 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).'*

2.5.4 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.'

2.5.5 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.'

2.5.6 Where noise at the nearest noise sensitive receptors is limited to an L_{A90} of 35 dB(A) up to wind speeds of 10 ms^{-1} at a height of 10 m, 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. In this regard 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 35 dB(A) up to wind speeds of 10 m/s at 10 m height, then this condition alone would offer sufficient protection of amenity, and background noise surveys would be unnecessary.'

2.5.7 The ETSU-R-97 assessment procedure specifies that where noise is greater than the simplified limit of 35 dB L_{A90} noise limits should be set relative to existing background noise levels at the nearest receptors. These limits should reflect the variation in both turbine source noise and background noise with wind speed. Absolute lower limits, different for 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 to 3 ms^{-1}) and up to 12 ms^{-1}, where all wind speeds are referenced to a 10 metre measurement height.

2.5.8 Separate noise limits apply for daytime and for night-time. 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.

2.5.9 The 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 concurrent 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 daytime noise limit, sometimes referred to as a 'criterion curve', is then set at a level 5 dB(A) above the best fit curve over the desired wind speed range; subject to an appropriate daytime fixed minimum limit:

'For wind speeds where the best fit curve to the background noise data lies below a level of 30 - 35 dB(A) the criterion curve is set at a fixed level in the range 35 - 40 dB(A). The precise choice of criterion curve level within the range 35 - 40 dB(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.'

2.5.10 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 $L_{A90,\ 10\ minute}$ 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 5 dB(A) above the best fit curve over the 0 - 12 ms^{-1} wind speed range, with a fixed minimum limit of 43 dB L_{A90}.

2.5.11 The exception to the setting of both the daytime and night-time fixed minimum 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 45 dB(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.'

2.5.12 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.

2.6 Current Good Practice

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

2.6.1 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 (this included the use of standardised 10 m data as opposed to measured 10 m data as originally detailed within ETSU-R-97), noise predictions, cumulative issues, reporting requirements and other matters such as noise related planning conditions.

2.6.2 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.'

2.6.3 The guidance document was endorsed, on behalf of Scottish Government by the Cabinet Secretary for Finance, Employment and Sustainable Growth, Mr John Swinney MSP [(7).] The recommendations included in the IOA GPG have been considered and applied throughout this noise assessment for the Proposed Development.

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

2.6.5 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 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 may emanate from components within the nacelle of a wind turbine. Potential sources of mechanical noise include gearboxes or generators.

3.1.2 Aerodynamic noise is usually perceived when the wind speeds are fairly low although at very low wind speeds the blades do not rotate, or rotate very slowly, and so 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 [8].

3.2 Infrasound, Low Frequency Noise and Vibration

3.2.1 The term infrasound can be defined as the frequency range below 20 Hz, while low frequency noise (LFN) is typically in the frequency range 20 – 200 Hz [9]. An average young healthy adult has an audible range from 20 Hz to 20,000 Hz, although the sensitivity of the ear varies with frequency and is most sensitive to sounds with frequencies between 500 Hz and 4,000 Hz. Wind turbines do produce low frequency sounds [10], 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 the 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 LFN emitted by wind turbine generators (WTGs) were causing health effects. Of the 126 wind farms operating in the UK, five had reported LFN problems, therefore, such complaints are an exception, rather than a general problem that exists for all wind farms. Hayes McKenzie investigated the effects of infrasound and LFN at three wind farms for which complaints had been received and the results were reported in May 2006 [11]. 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 was commissioned by the Ministry of Defence (MOD), the DTI and the British Wind Energy Association (BWEA) to undertake microseismic and infrasound monitoring of LFN 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 [(12)] 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 [(13)] 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 Work [(14)] 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).'

3.2.7 More recently during a planning Appeal (PPA-310-2028, Clydeport Hunterston Terminal Facility, approximately 2.5 km south-west of Fairlie, 9 Jan 2018), the health impacts related to LFN associated with wind turbines were considered at length by the appointed Reporter (Mr M Croft). The Reporter considered evidence from Health Protection Scotland and the National Health Service. In addition, he also considered LFN surveys undertaken by the Appellant and the Local Authority, both of which demonstrated compliance with planning conditions and did not identify any problems attributable to the turbine operations; some periods with highest levels of low frequency noise were in fact recorded when the turbines were not operating.

3.2.8 The Reporter concluded that:

- The literature reviews by bodies with very significant responsibilities for the health of local people found insufficient evidence to confirm a causal relationship between wind turbine noise and the type of health complaints cited by some local residents.
- The NHS's assessment is that concerns about health impact are not supported by good quality research.
- Although given the opportunity, the Community Council failed to provide evidence that can properly be set against the general tenor of the scientific evidence.

3.2.9 It is therefore not considered necessary to carry out specific assessments of LFN and it has not been considered further in the noise assessment.

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 3dBA (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 the 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). It should be noted that 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 [15] on AM, which reflected the outcomes of research commissioned over the previous three years, together with a template planning condition. Whilst this research undoubtedly improved understanding of Other Amplitude Modulation (OAM) and its effects, it should be noted that at the time of writing it has not been 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 continued. In April 2015, the IOA issued a discussion document entitled *'Methods for Rating Amplitude Modulation in Wind Turbine Noise'*. The document presented three methods that can be used to quantify the level of AM at a given measurement location. After extensive consultation a preferred method of measuring OAM, which provides a framework for practitioners to measure and rate AM, was recommended by the IOA [16].

3.3.6 On 3 August 2015, the Department for Energy and Climate Change (DECC), now the Department for Business, Energy and Industrial Strategy (BEIS), commissioned independent consultants WSP Parsons Brinkerhoff to carry out a literature review on OAM (which they refer to simply as AM). The stated aims were 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 a sample 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 Their report, which was released in October 2016, concluded that there is sufficient robust evidence that excessive AM leads to increased annoyance from wind turbine noise and recommended that excessive AM is controlled through a suitably worded planning condition, which will control it during periods of complaint. Those periods should be identified by measurement using the metric proposed by the work undertaken by the IOA, and enforcement action would rely upon professional judgement by Local Authority Environmental Health Officers based on the duration and frequency of occurrence.

3.3.8 It is not clear within the body of the report which evidence the authors relied upon to arrive at their conclusions, although the Executive Summary states (page 4);

'It is noted that none of the Category 1 or 2 papers have been designed to answer the main aim of the current review in its entirety. The Category 1 studies have limited representativeness due to sample constraints and the artificiality of laboratory environments, whereas the Category 2 studies generally do not directly address the issue of AM WTN exposure-response. A meta - analysis of the identified studies was not possible due to the incompatibility of the various methodologies employed. Notwithstanding the limitations in the evidence, it was agreed with DECC that the factors to be included in a planning condition should be recommended based on the available evidence, and supplemented with professional experience'.

3.3.9 The report [17] states that any planning condition must accord with existing planning guidance, and should be subject to legal advice on a case by case basis. Existing guidance would include compliance with the six tests of a planning condition embodied in Circular 4/98. The report's authors did not dictate a particular condition to be used but did suggest that any condition should include the following elements (p5):

- *"The AM condition should cover periods of complaints (due to unacceptable AM);*
- *The IoA-recommended metric should be used to quantify AM (being the most robust available objective metric);*
- *Analysis should be made using individual 10-minute periods, applying the appropriate decibel 'penalty' to each period, with subsequent analysis;*
- *The AM decibel penalty should be additional to any decibel penalty for tonality;* [tonality means mechanical sound already covered by ETSU noise limits]*; and*
- *An additional decibel penalty is proposed during the night time period to account for the current difference between the night and day limits on many sites to ensure the control method works during the most sensitive period of the day."*

3.3.10 At the time of writing there has been no official response to those recommendations from the IOA Noise Working Group and, as yet, no endorsement from any Scottish Government Minister or Department. The recommendation to impose a planning condition and the associated penalty scheme is at odds with the advice from the IOA GPG, which currently states (paragraph 7.2.10):

'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.'

3.3.11 THC stated in their Scoping Response for the Proposed Development that there is no definitive Planning guidance on AM. They stated that in the event that there were any complaints linked to AM then they could be investigated in terms of the Statutory Nuisance provisions of the Environmental Protection Act 1990. On that basis Amplitude Modulation has not been considered further in this assessment.

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 and the IOA GPG, the following steps are required:

- Specify the location of the wind turbines for the Proposed Development;
- Measure the background noise levels as a function of on-site wind speed or adopt the simplified assessment methodology detailed in ETSU-R-97;
- Identify the locations of all nearby noise sensitive receptors and select a sample of relevant Noise Assessment Locations (NAL);
- Establish for each NAL the 'Total ETSU-R-97 Noise Limits' through consideration of the noise limit already allocated to other schemes in the area;
- Specify the likely noise emission characteristics of the wind turbines for the Proposed Development and all nearby cumulative 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 immissions due to other schemes; and
- Calculate the likely noise immission levels due to the operation of the Proposed Development on its own and compare it to the Proposed Development's 'Site 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 – determine existing Total ETSU-R-97 Noise Limits, which are already set for other wind farms within the vicinity of the proposed development at each NAL or establish the Total ETSU-R-97 Limits for each NAL (where noise limits are not already set) based on the measured background noise levels or the simplified ETSU-R-97 Criterion;
- Stage 2 – undertake a likely cumulative noise assessment to determine whether the proposed development can operate concurrently with other proposed, consented or operational wind farm developments; and
- Stage 3 – establish the proposed development's Site Specific Noise Limits (at levels below the Total ETSU-R-97 Noise Limits, where limit apportionment is required) and compare the noise predictions from the proposed development on its own against the proposed 'Site 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.

4.2 Consultation

Scoping Opinion (dated December 2018)

4.2.1 The Highland Council requested that the noise assessment consider operational noise in accordance with ETSU-R-97 and the IOA GPG.

4.2.2 It also detailed target noise levels based on simplified 35 dB or a composite level of 35 dB (daytime) or 38 dB (night time) or background plus 5 dB. Its states that due to low background noise levels in the highlands, the night time lower limit based on 43 dB is not considered acceptable. It is suggested that the limits detailed above should also apply to cumulative noise.

4.2.3 The response also details the requirements for the cumulative assessment including what predictions should be included in the assessment.

Consultation with Highland Council EHO (September 2020)

11.1.1 In September 2020, direct consultation was undertaken with the Environmental Health Department at THC in order to agree the methodology for the operational noise assessment. As part of the consultation letter, a summary of the background noise monitoring previously undertaken by Spectrum Acoustics at two properties (at Bhlaraidh and Levishie House) in 2015 was provided. The data was originally collected as part of the pre-construction noise survey undertaken for the operational Bhlaraidh Wind Farm and was reanalysed in accordance with ETSU-R-97 and the IOA GPG. Following a review of the datasets and a site visit to the monitoring locations, the noise data collected was deemed representative of the noise environment at the properties and the nearby properties within the same cluster. At both monitoring locations there are a small cluster of properties, Bhlaraidh comprises approximately 11 dwellings and Levishie comprises a cluster of approximately three dwellings. The individual clusters of properties are shown on Figure A1.1 included within Annex 1.

4.2.4 The datasets were provided to the Environmental Health Officer (EHO) as part of the consultation letter.

4.2.5 The EHO agreed that the previously collected datasets were appropriate for setting limits for Bhlaraidh and Levishie only. A full copy of the consultation letter and subsequent response is included in Annex 2.

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

Identify Existing Noise Limits

4.3.1 Noise limits have already been established at some of the closest receptors to the south of the site as part of the planning conditions set for the operational Bhlaraidh Wind Farm. The original noise assessment undertaken for the Operational Bhlaraidh Wind Farm was undertaken based on the simplified criteria in ETSU-R-97 therefore no background noise monitoring was undertaken. The conditioned noise limits are therefore a flat 35 dB $L_{A90\,minutes}$.

4.3.2 Prior to the construction of the wind farm a pre-construction background noise survey was undertaken at two receptors to the south of the Proposed Development. The data collected as part of that survey has been used to establish the Total ETSU-R-97 Noise Limits.

4.3.3 For Corrimony Wind Farm, conditioned noise limits are set at 1 km from the turbines and are based on 35 dB or background plus 5 dB daytime and 38 or background plus 5 dB during the night time period.

4.3.4 Extracts of the Decision Notices containing the noise conditions are included in Annex 2 and further information is included within Section 6.5 below.

Wind Shear

4.3.5 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 4 ms^{-1} is recorded at 80 m height, 3.5 ms^{-1} may be recorded at 40 m and 2.5 ms^{-1} may be recorded at 10 m.

4.3.6 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 will determine the noise emitted by the wind turbines and informs the turbine control system. 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.

4.3.7 The IOA GPG states that one of three methods of wind speed measurement may be adopted. For this assessment wind speeds were recorded by anemometers at two different heights, one at a height of more than 60% of the hub height and another located at least 15 metres below it. These were then used to calculate hub height wind speeds in line with 'Method B' of Section 2.6.3 of the IOA GPG to fully take account of wind shear.

Noise Impact Criteria in ETSU-R-97

4.3.8 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 daytime and night time Total ETSU-R-97 Noise Limits, which would apply for the cumulative operation of all wind turbines in the area. At receptors where background noise monitoring was undertaken, the Total ETSU-R-97 Noise Limits for the daytime has been set at 35 dB(A) or background plus 5 dB whichever is the greater, and the Total ETSU-R-97 Noise Limits at night time has been set at 43 dB(A) or background plus 5 dB whichever is the greater. At other receptors the Total ETSU-R-97 Noise Limits have been set at 35 dB during the daytime and night time periods. This 'Total' limit relates to noise from all wind farm developments in the area. The limits were chosen with due regard to the guidance in ETSU-R-97 and following a review of the predicted levels for existing wind farms in the area.

4.3.9 The acceptable limits for wind turbine operational noise are clearly defined for all time 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 ETSU-R-97 noise limits. 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 would be audible.

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

4.4.1 The IOA GPG (2013) 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 of the GPG 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.'

4.4.2 An assessment was undertaken at each of the noise sensitive receptors proximate to the Proposed Development and other nearby operational and proposed wind farm developments to determine whether the wind turbine noise immissions from the Proposed Development were within 10 dB of the wind turbine noise immissions from the other schemes. Where predictions were found to be within 10 dB of each other, then a cumulative noise assessment was undertaken to determine the likely impacts of the Proposed Development, however, if wind turbine immissions were greater than 10 dB apart then a cumulative noise assessment was not required.

Noise Prediction / Propagation Model

4.4.3 The ISO 9613-2: 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 (EC) 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 9613-2 as the most suitable at that time, but the full method has been used for this assessment.

4.4.4 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.'

4.4.5 There is currently no standard approach to specifying error bands on noise predictions. Table 5 of ISO 9613-2 suggests, at best, an estimated of accuracy of ± 3 dB(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. The error

bands referenced in the ISO standard itself relate to the general application of the standard. Additional, wind farm specific studies, have also been undertaken to validate the use of the standard to predict wind farm noise and these are referenced in Section 4 of the IOA GPG which goes on to conclude that: *"The outcome of this research has demonstrated that the 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."* TNEIs experience of undertaking compliance monitoring for operational wind farms indicates that the predictions undertaken using the guidance in the IOA GPG show a good correlation with measured levels.

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

- Geometric divergence;
- Atmospheric absorption;
- Reflecting obstacles;
- Screening;
- Vegetation; and
- Ground attenuation.

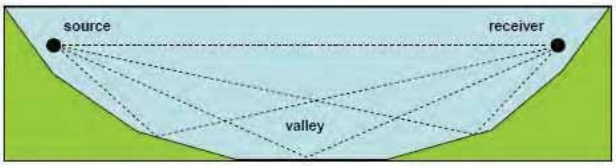
4.4.7 The model uses as its acoustic input data the octave band sound power output of the turbine and calculates, on an octave band basis, attenuation due to the factors above, as appropriate.

4.4.8 The IOA GPG quotes a comparative study undertaken in Australia that indicated ISO 9613-2 can, in some conditions, under-predict ground attenuation effects and the potential for additional reflection paths 'across a valley', whilst slightly over-predicting on flat terrain. It should be noted, however, that the wind farm layouts studied were untypical for the UK, with rows of turbines spreading over 10 km 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 1.7 km from the nearest turbine, where turbine noise may be at similar levels to background noise and therefore difficult to differentiate. For the study's modelling work topographic height data was included as an input, which is consistent with ISO 9613-2 methodology generally but not with the requirements of the IOA GPG.

4.4.9 The model used in this assessment does not model barrier attenuation using the method in ISO 9613-2, but instead uses the guidance in the IOA GPG to consider whether any topographical corrections are required as set out below in Sections 4.4.10 to 4.4.13. Any differences in ground height (AOD) between the receptors and the turbines are considered when calculating the propagation distance between each source and receiver.

4.4.10 The IOA GPG states that a *'further correction of +3 dB 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

4.4.11 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).

4.4.12 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.

4.4.13 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 2 dB may be applied.

4.4.14 The modelling parameters used for this assessment are detailed in Section 6.3.

4.5 Setting the Site Specific Noise Limits (Stage 3)

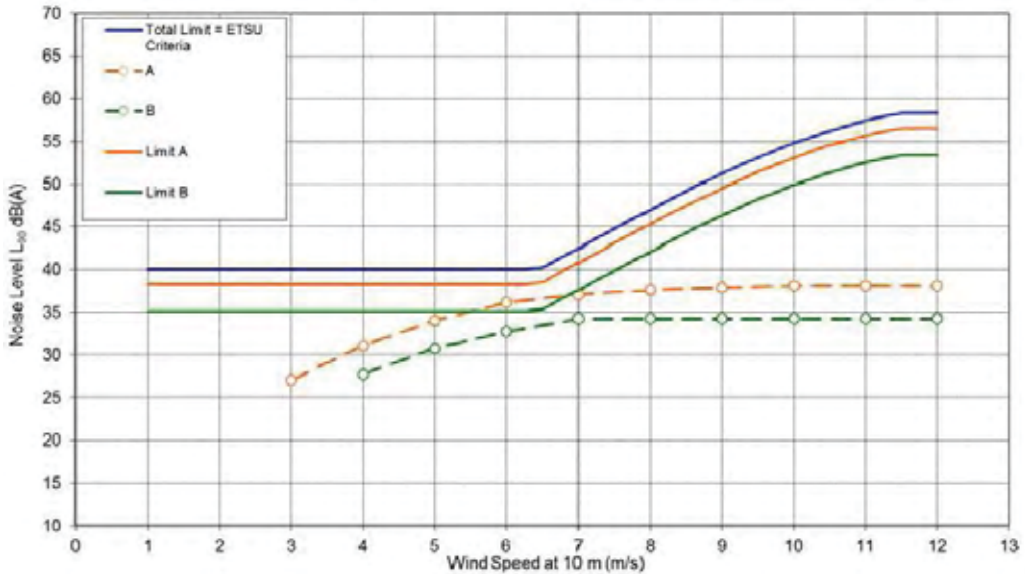
4.5.1 Summary Box 21 of the IOA GPG states:

'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.'

4.5.2 In order to determine site specific noise limits at receptors in proximity to the Proposed Development limit apportionment has been undertaken. The limit apportionment has considered the noise limit already allocated to other wind farms in the area.

4.5.3 This approach is demonstrated in Graph 4.1 below. In this example the total limit (shown in blue) is shared between a consented wind farm (A) and a 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 consented wind farm and the proposed development.

Graph 4.1: Limit Apportionment Example



4.5.4 The limit derivation can also be undertaken with consideration to the amount of headroom between another schemes(s) predictions and the Total Noise Limit. With regard to this Section 5.4.11 of the IOA GPG states:

'In cases where there is significant headroom (e.g. 5 to 10 dB) between the predicted noise levels from the existing wind farm and the Total Noise Limits, where there would be no realistic prospect of the existing wind farm producing noise levels up to the Total Noise Limits, agreement could be sought with the LPA as to a suitable predicted noise level (including an appropriate margin to cover factors such as potential increases in noise) from the existing wind farm to be used to inform the available headroom for the cumulative assessment without the need for negotiation or cumulative conditioning. This may be the case particularly at low wind speeds.'

4.5.5 With this in mind, where appropriate, an additional 2 dB buffer has been added to the other schemes' turbine noise predictions. This is considered to be a suitable buffer in accordance with Section 5.4.11 of the IOA GPG and would represent a 60% increase in emitted noise levels from the other schemes.

4.5.6 Where predicted wind turbine noise levels from the individual wind farm/ turbine schemes are found to be >10 dB below the Total ETSU-R-97 Noise Limits then it has been deemed appropriate to allocate the entire noise limit to the proposed development.

4.5.7 Further information on the approach to apportionment is provided in Section 6.6 below.

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 Resoft 'WindFarm' [18] software in order to locate noise sensitive receptors which may be affected and to identify suitable locations at which to monitor background noise.

5.1.2 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.

5.2 Background Noise Survey

5.2.1 Background noise monitoring was undertaken at two noise sensitive receptors to the south of the Proposed Development as part of the pre-construction baseline noise survey undertaken for the Operational Bhlaraidh Wind Farm. Data was recorded over the period 18 June - 30 July 2015. However only data collected between 18 June and 18 July was used as no rainfall data was collected between 18 and 30 July due to a battery failure on the portable weather station used in the survey. The original survey was undertaken by Spectrum Acoustics and the data collected was re-analysed by TNEI for purposes of this assessment.

5.2.2 The NML is the position that the sound level meter was sited at each property, as shown on Figure A1.1 (Annex 1) and summarised in Table 5.1 below.

Table 5.1 Noise Monitoring Locations

NML	Receptor Name	Easting	Northing
NML1	Bhlaraidh	238058	816633
NML2	Levishie House	240237	817661

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, and photographs at each NML are provided in Annex 3.

5.3.3 Copies of the calibration certificates for the sound level meters and sound level calibrator used for the noise survey are included in Annex 3. All sound level meters conform to Class 1/ Type 1.

5.3.4 The microphones were all mounted between 1.2 m and 1.5 m above local ground level, situated between 3.5 m and 20 m from the dwelling and were located *'in an area frequently used for rest and relaxation'* (Section 2.5.1 of IOA GPG), where appropriate, away from obvious local sources of noise such as boiler flues, fans and running water[1]. The sound level 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.

5.3.6 In October 2020, TNEI staff visited the NMLs and the surrounding areas to confirm that the siting of the kit was appropriate and that the locations were representative of other properties in the immediate area.

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 4.3.

5.4.3 For the proposed development, concurrent wind speed/direction were recorded using a 70 m meteorological mast which was located within the site (grid reference 238653, 820777). The meteorological data was collected and provided by the Applicant. The installation report and calibration information for the mast can be provided upon request.

5.4.4 An outdoor weather station was installed at NML1 for the duration of the noise survey to record periods of rainfall, time synchronised to the sound measurements. As per the recommendations in Section 3.1.9 of the IOA GPG, the rain data were re-analysed by TNEI and the 10 minute periods which contain the registered rainfall events and the preceding 10 minute period have been excluded. All excluded rainfall periods are shown on Figures A1.2a-A1.2b (Annex 1) as blue squares.

5.4.5 Wind speed and direction 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 B, has been adopted for this assessment which involved using data collected at 50 m and 70 m on the meteorological mast which

[1] Both monitoring locations were influenced by nearby watercourses. Further information is provided below and in Annex 2.

were used to calculate hub height (105 m) wind speeds which, in turn, were standardised to a height of 10 m above ground.

5.4.7 Whilst the hub height of the turbine is expected to be in the range 101 - 105 m, using 105 m to standardise to 10 m is considered conservative as the higher the hub height assumed the higher the wind speed and the further the shift of the wind speed data over to the right of the wind speed axis. This has the overall effect of lowering limits over the wind speed range necessary to be assessed in accordance with ETSU-R-97.

5.5 Influence of Existing Turbines on Background Measurements

5.5.1 ETSU-R-97 states that background noise levels should be determined such that they are not influenced by existing turbine noise. The IOA GPG details that, in situations where measurement locations are potentially influenced by existing turbine noise, the following approaches can be adopted:

1. The existing wind turbines can be switched off (assuming the applicant has control of those turbines and noting that there would be associated cost implications);
2. The contribution of the wind turbines can be accounted for by filtering the measured data by direction (only including background data when a receptor is upwind of the wind turbines) or by subtracting predicted turbine noise from the measured levels;
3. Limits can be set using 'proxy' datasets measured at location(s) outside of the influence of the wind turbines; or
4. Limits can be set using data collected as part of previous background noise assessments undertaken before the wind turbines were operational, providing the equipment and both noise and meteorological data obtained are appropriate.

5.5.2 There were no nearby operational wind farms at the time of the survey therefore no directional filtering was required. The operational Corrimony was ~8.5 km from the noise monitoring locations.

5.6 Analysis of Measured Data

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

5.6.2 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.

5.6.3 During the survey there were some periods of rainfall but they were not prolonged. The survey was undertaken during a relatively dry period of the year (where rainfall levels were below average as detailed in the Consultation letter included within Annex 2) and therefore is likely to have resulted in the collection of lower background noise measurements than would have been recorded in the wetter winter months. At NML1 and NML2 some additional data was removed where there were periods of increased noise following a period of rainfall, in accordance with Section 2.4 of the IOA GPG SGN2. All manually excluded data is shown on Figures A1.2a-A1.2b (Annex 1) as red triangles.

5.6.4 Time series graphs are provided in Annex 4, 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, birdsong or manual exclusions due to atypical data.

5.7 Directional Filtering of Background Noise

5.7.1 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.

5.7.2 The soundscape at both noise monitoring locations was affected by nearby watercourses and the equipment was sited to minimise the potential effects of the watercourses. Both NMLs were in proximity to the River Moriston to the south which was audible at both monitoring locations as well as two other watercourses Allt Bhlaraidh (which runs to the west of Bhlaraidh) and Levishie Burn (which runs through the centre of the properties at Levishie). During the survey there were some periods of rainfall which resulted in some prolonged elevated background noise levels. This data was removed in accordance with the IOA GPG. On that basis no directional filtering was undertaken at either monitoring location.

5.8 Prevailing Background Noise Level

5.8.1 Table 5.2 and 5.3 summarise the prevailing background noise levels measured during the noise monitoring period, after filtering of the individual datasets as discussed above.

Table 5.2 Summary of Prevailing Background Noise Levels during Quiet Daytime Periods (dB(A))

NML	Prevailing Background Noise Level $L_{A90,10\ min}$											
	1	2	3	4	5	6	7	8	9	10	11	12
NML1 – Bhlaraidh	*32.0 **	32.0	32.4	33.1	34.2	35.6	37.2	39.1	41.3	43.6	46.2	*46.2 **
NML2 – Levishie	*36.0 **	36.0	36.1	36.7	37.8	39.2	40.8	42.6	44.4	46.2	47.8	*47.8 **

**restricted where derived minimum occurs at lower wind speeds and derived maximum occurs at higher wind speeds, see 5.8.4.*

Table 5.3 Summary of Prevailing Background Noise Levels during Night time Periods (dB(A))

NML	Prevailing Background Noise Level $L_{A90,10\ min}$											
	1	2	3	4	5	6	7	8	9	10	11	12
NML1 – Bhlaraidh	*31.1 **	31.1	31.2	31.7	32.4	33.4	34.7	36.1	37.6	39.3	*39.3 **	*39.3 **
NML2 – Levishie	*36.0 **	*36.0 **	36.0	36.1	36.5	37.2	38.3	39.7	41.5	43.8	*43.8 **	*43.8 **

**restricted where derived minimum occurs at lower wind speeds and derived maximum occurs at higher wind speeds, see 5.8.4.*

5.8.2 A series of graphs are presented for each of the NMLs to illustrate the data collected, these are included as Figures A1.2a - A1.2b (Annex 1). There is a set of graphs for each of the NMLs, which show the range of wind speeds and directions recorded during the survey at the meteorological mast and the 10 minute average wind speeds plotted against the recorded $L_{A90, 10min}$ noise levels at the NML along with a calculated 'best fit' polynomial regression line 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.

5.8.3 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.

5.8.4 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 restricted 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.

5.8.5 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.

5.8.6 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, in the interest of protecting residential amenity, the noise levels 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).

5.8.7 A summary of the analysis applied to the individual datasets as recommended by the IOA GPG is included in Table 5.4 below.

Table 5.4 Analysis of Measured Datasets

NML	Quiet Daytime	Night Time
NML1 – Bhlaraidh	Restricted below 2 ms^{-1} (minimum level recorded) and restricted beyond 11 ms^{-1} (insufficient datapoints in the 12ms^{-1} bin).	Restricted below 2 ms^{-1} (minimum level recorded) and restricted beyond 10 ms^{-1} (insufficient datapoints in the 11-12ms^{-1} bin).
NML2 – Levishie	Restricted below 2 ms^{-1} (minimum level recorded) and restricted beyond 11 ms^{-1} (insufficient datapoints in the 12ms^{-1} bin).	Restricted below 3 ms^{-1} (minimum level recorded) and restricted beyond 10 ms^{-1} (insufficient datapoints in the 11-12ms^{-1} bin).

5.8.8 The number of data points measured in each wind speed bin for each receptor, once exclusions were applied, are summarised in Figures A1.2a - A1.2b (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 blue house symbol on Figure A1.1 (Annex 1). A total of three noise sensitive receptors were chosen as representative NALs. The NALs chosen were the closest receptors to the Proposed Development. Predictions of wind turbine noise have been made at each of the NAL as detailed in Table 6.1.

6.1.2 This approach ensures that the report models the worst case (loudest) noise immission level expected at each group of noise sensitive receptors, as, generally speaking, sound levels decrease due to the attenuating factors described in Section 6.3 and thus the closer to a noise source, the higher the noise level.

Table 6.1 Noise Assessment Locations

Noise Assessment Location (NAL)	Easting (m)	Northing (m)	Elevation (m Above Ordnance Datum)	Approximate Distance to Nearest Bhlaraidh Extension Turbine (m)
NAL1 – Bhlaraidh	238048	816664	70	3,690
NAL2 – Levishie	240246	817772	67	2,400
NAL3 - Achnaconeran	241628	817981	236	2,800

Note: A total of seven NALs were considered during the initial consultation undertaken with the Councils EHO but four were scoped out of the final assessment as predicted noise levels from the Proposed Development at the NALs were found to be very low ~16 dB and as such it was not deemed necessary to derive a set of noise limits at those properties.

6.2 Noise Emission Characteristics of the Wind Turbines

6.2.1 There are a range of wind turbine models that may be suitable for installation at the Proposed Development. This assessment considers the Vestas V150 5.6MW (with standard blades) with a 105 m hub height. For the cumulative assessment the turbines used are summarised in Annex 5.

6.2.2 Noise data for the various cumulative schemes considered in this assessment have been obtained from the manufacturers data 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 (2013). Details of the sound power level and octave data used for the turbines considered in this assessment are included in Annex 5.

6.2.3 Manufacturer data is usually supplied based on a specific hub height though values are presented as standardised to 10 m height. The noise model used in this assessment alters

turbine noise data to account for different hub heights where applicable. The hub height considered for the Proposed Development is 105 m. The hub heights considered for the other wind farm developments are summarised in Annex 5.

6.2.4 The location of the wind turbines are shown on Figure A1.1a and grid references are included in Annex 6.

6.3 Noise Propagation Parameters

6.3.1 As detailed in Section 4.4 above, the full version of the ISO 9613-2 model has been used to calculate the noise immission levels at the nearest receptors.

6.3.2 For the purposes of the present assessment, all noise level predictions have been undertaken using a receiver height of 4 m above local ground level, mixed ground (G=0.5) and air absorption coefficients 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 The wind turbine noise immission levels are based on the L_{A90} noise indicator in accordance with the recommendations in ETSU-R-97, which were obtained by subtracting 2 dB from the turbine sound power level data (L_{Aeq} indicator).

6.3.4 A topographical assessment has been undertaken between each NAL and each 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 [19] and an Excel model found that if the formula in the IOA GPG is applied directly a +3 dB correction is required for some turbines at a number of receptors and this is summarised in Annex 6.

6.3.5 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 NAL. Upon analysis of each NAL it was found that a barrier correction of -2 dB could be applied for some turbines at a number of receptors and this is also detailed in Annex 6. In reality, there is significant screening at some of the locations so more attenuation may occur in practice and the use of a 2 dB value is therefore considered to be conservative. 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 detailed in planning conditions regardless of any differences in noise propagation caused by topography. Therefore, should consent be granted for the Proposed Development, 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.

6.3.7 The cumulative assessment has taken into account directivity effects in line with good practice. The directivity of wind turbines has been recognised for some time. Building on earlier work by NASA, in 1988 Wyle Laboratories studied sound propagation using an omnidirectional loudspeaker source elevated 80 ft above ground, in upwind, downwind and cross wind situations, and in both flat and hilly terrain, then compared those measurements

to measured data from actual wind turbines. Their study quantified directivity factors for a limited frequency range, but was unable to conclusively demonstrate the anticipated directivity effects on real wind turbines. It also highlighted, but was unable to explain, measured differences observed between flat and hilly terrain.

6.3.8 Hubbard (1990) described a number of factors believed to influence propagation and directivity, notably refraction caused by vertical wind and temperature gradients. In the downwind direction the wind gradient causes the propagating sound to bend towards the ground, whereas in the upwind direction the sound will curve upwards, away from the ground. Upwind of the turbine this results in a region of increased attenuation termed the 'shadow zone'. The excess attenuation is frequency dependent, with lowest frequencies least attenuated. Relating this to the earlier NASA studies, Hubbard noted that the distance from the source to the edge of the shadow zone is relative to the wind speed gradient and the elevation of the source, which for a typical turbine source was calculated to be approximately 5 times the source height.

6.3.9 This observation was adopted in the IOA GPG, which states (4.4.2) 'Such reductions (due to "shadow zone" refraction effects) will in practice only progressively come into play at distances of between 5 and 10 turbine tip heights'. 4.4.3 of IOA GPG provides graphical examples of increasing broadband directivity with increasing tip height scaling in both flat and hilly terrain without qualifying either of those designations.

6.3.10 The IOA GPG recommends (Section 4.4.1) that directivity attenuation factors adopted in any assessment should be clearly stated. The TNEI noise model can consider the effect of directivity, and in line with current good practice the attenuation values used are in detailed in Table 6.2. These are based upon the examples given in the IOA GPG (Section 4.4.2), using interpolation where required. All NALs are at least 10 tip heights from a given turbine and therefore the full attenuation value has been used.

Table 6.2 Wind Directivity Attenuation Factors used in Modelling

Direction (º)	0	15	30	45	60	75	90	105	120	135	150	165
Attenuation, dB	-10	-9.9	-9.3	-8.3	-6.7	-4.6	-2	0	0	0	0	0
Direction (º)	**180**	**195**	**210**	**225**	**240**	**255**	**270**	**285**	**300**	**315**	**330**	**345**
Attenuation, dB	0	0	0	0	0	0	-2	-4.6	-6.7	-8.3	-9.3	-9.9

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

6.4.1 The Total ETSU-R-97 Noise Limits have been established for each of the NALs detailed in Table 6.1 above. At receptors where background noise monitoring was undertaken, the Total ETSU-R-97 Noise Limits for the daytime has been set at 35 dB(A) or background plus 5 dB whichever is the greater, and the Total ETSU-R-97 Noise Limits at night time has been set at 43 dB(A) or background plus 5 dB whichever is the greater. At other receptors the Total ETSU-R-97 Noise Limits have been set at 35 dB during the daytime and night time periods.

6.4.2 The Total ETSU-R-97 Noise limits are summarised in Tables 6.3 and 6.4 below.

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

Location	Wind Speed (ms^{-1}) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NAL1 – Bhlaraidh	37.0	37.0	37.4	38.1	39.2	40.6	42.2	44.1	46.3	48.6	51.2	51.2
NAL2 – Levishie	41.0	41.0	41.1	41.7	42.8	44.2	45.8	47.6	49.4	51.2	52.8	52.8
NAL3 - Achnaconeran	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0

Table 6.4 Total ETSU-R-97 Noise Limits – 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 – Bhlaraidh	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.3	44.3	44.3
NAL2 – Levishie	43.0	43.0	43.0	43.0	43.0	43.0	43.3	44.7	46.5	48.8	48.8	48.8
NAL3 - Achnaconeran	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0

6.5 Predicting the likely cumulative effects (Stage 2)

6.5.1 The results of the likely cumulative noise assessment are summarised in tabular form in Table 6.5 and Table 6.6 and show that the Proposed Development can operate concurrently with the existing operational wind farms, whilst still meeting the Total ETSU-R-97 Noise limits established in accordance with ETSU-R-97 at the three NALs. The predicted 'likely' cumulative levels are the actual levels expected at an NAL and include the addition of an appropriate level of uncertainty to the turbine data as per Section 4.2 of the IOA GPG. The uncertainty level added is generally +2 dB but this can vary depending on the turbine manufacturer data available for each turbine.

6.5.2 A series of graphs to show the predicted cumulative wind turbine noise from all schemes compared to the Total ETSU-R-97 Noise Limits are included as Figures A1.3a through to Figure A1.3c (Annex 1). There is a set of graphs for each of the NAL and these show the Total ETSU-R-97 Noise Limit (solid red line), the total cumulative noise (solid green line), the predicted noise from all other schemes minus the Proposed Development (solid green line), the predicted wind turbine noise from the Proposed Development (solid blue line with triangles) and predicted levels for individual schemes (solid lines, various colours).

Table 6.5 Total ETSU-R-97 Compliance Table – Likely Cumulative Noise – Daytime

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 – Bhlaraidh	Total ETSU-R-97 Noise Limit	37.0	37.0	37.4	38.1	39.2	40.6	42.2	44.1	46.3	48.6	51.2	51.2
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	27.4	31.2	32.9	33.2	33.2	33.2	33.2	33.2
	Exceedance Level L_{A90} (all schemes)	-	-	-	-	-11.8	-9.4	-9.3	-10.9	-13.1	-15.4	-18.0	-18.0
NAL2 - Levishie	Total ETSU-R-97 Noise Limit	41.0	41.0	41.1	41.7	42.8	44.2	45.8	47.6	49.4	51.2	52.8	52.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	28.9	32.4	33.7	34.2	34.2	34.2	34.2	34.2
	Exceedance Level L_{A90} (all schemes)	-	-	-	-	-13.9	-11.8	-12.1	-13.4	-15.2	-17.0	-18.6	-18.6
NAL3 - Achnaconeran	Total ETSU-R-97 Noise Limit	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	27.6	31.0	32.3	32.8	32.8	32.8	32.8	32.8
	Exceedance Level L_{A90} (all schemes)	-	-	-	-	-7.4	-4.0	-2.7	-2.2	-2.2	-2.2	-2.2	-2.2

Note: For the cumulative noise predictions the noise model considers the range of noise data available for each turbine type modelled. For some turbines noise data was not available for wind speeds less than 5 ms^{-1} therefore no cumulative predictions are included for wind speeds less than 5 ms^{-1}.

Table 6.6 Total ETSU-R-97 Compliance Table – Likely Cumulative Noise – Night time

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 – Bhlaraidh	Total ETSU-R-97 Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.3	44.3	44.3
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	27.4	31.2	32.9	33.2	33.2	33.2	33.2	33.2
	Exceedance Level L_{A90} (all schemes)	-	-	-	-	-15.6	-11.8	-10.1	-9.8	-9.8	-11.1	-11.1	-11.1
NAL2 - Levishie	Total ETSU-R-97 Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.3	44.7	46.5	48.8	48.8	48.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	28.9	32.4	33.7	34.2	34.2	34.2	34.2	34.2
	Exceedance Level L_{A90} (all schemes)	-	-	-	-	-14.1	-10.6	-9.6	-10.5	-12.3	-14.6	-14.6	-14.6
NAL3 - Achnaconeran	Total ETSU-R-97 Noise Limit	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	-	27.6	31.0	32.3	32.8	32.8	32.8	32.8	32.8
	Exceedance Level L_{A90} (all schemes)	-	-	-	-	-7.4	-4.0	-2.7	-2.2	-2.2	-2.2	-2.2	-2.2

Note: For the cumulative noise predictions the noise model considers the range of noise data available for each turbine type modelled. For some turbines noise data was not available for wind speeds less than 5 ms^{-1} therefore no cumulative predictions are included for wind speeds less than 5 ms^{-1}.

6.6 Derivation of Site Specific Noise Limits (Stage 3)

6.6.1 As requested by the Highland Council, modelling has been undertaken to consider the other nearby schemes operating at their consented levels or at a reduced level where it was deemed appropriate when considering the options outlined in the IOA GPG. In order to consider each scheme in isolation a comparison was undertaken of the predictions from the individual schemes against their individual noise limits. The apportionment options provided in the IOA GPG were then considered to determine the most appropriate option for each scheme. The findings are summarised below:

- Bhlaraidh - the difference between the predicted levels and the 35 dB noise limit set in the planning conditions for that development was less than 5 dB. The smallest margin between the limit and predictions was a difference of 3.1 dB at Bhlaraidh and 3.9 dB at Levishie. Therefore, there was no significant headroom and on that basis the predicted levels were set at the consented levels for that scheme by adding 3.1 dB to the predictions at Bhlaraidh and 3.9 dB to the predictions at Levishie; and
- Corrimony – at the NALs considered in the assessment the predicted levels from Corrimony are ~12 dB. The conditions include noise limits at 1 km from the turbines (see Annex 2 for an extract of the conditions) and the NALs considered in this assessment are ~8 km from the turbines. On that basis it has been assumed that no noise limits have been set for Corrimony wind farm at the NALs considered in this assessment. In the assessment, to be cautious, a 2 dB buffer has been added to the predictions due to there being significant headroom.

6.6.2 The addition of the buffers listed above resulted in the cautious predictions of wind farm noise taking account of the proportion of the Total ETSU-R-97 Noise Limit that the other existing wind farms have been allocated / could realistically use. Please note the buffers detailed above are in addition to the appropriate level of uncertainty already added to the turbine data as per Section 4.2 of the IOA GPG. Figures A1.4a-b show the addition of the buffers as detailed above.

6.6.3 Table 6.7 below summarises the approach adopted at each NAL in order to derive the Site Specific Noise Limits for the Proposed Development.

Table 6.7 Limit Derivation Strategy

NAL	Limit Derivation Strategy
NAL1-2	Bhlaraidh Wind Farm was consented with a simplified 35 dB(A) noise limit. The noise predictions from Bhlaraidh Wind Farm suggests that the wind farm is using the majority of the noise limit at the NALs (<5 dB headroom) therefore for the purposes of deriving site specific noise limits it has been assumed that Bhlaraidh uses its entire noise limit (a +3.1 dB buffer was added at NAL 1 and a +3.9 dB at NAL2). For Corrimony Wind Farm the predictions show that there is significant headroom (>5 dB buffer) between the predictions from the individual schemes and the 35 dB noise limit. In accordance with Section 4.5 above, a +2 dB buffer has therefore been added to the turbine noise predictions; this is considered to be a suitable buffer in accordance with Section 5.4.11 of the IOA GPG and would represent a 60% increase in emitted noise levels from the other schemes. The resulting 'cautious' predictions of cumulative wind turbine noise have then been logarithmically subtracted from the Total ETSU-R-97 Noise Limit to determine the 'residual noise limit' (Site Specific Noise Limits), which are detailed in Tables 6.8 and 6.9.
NAL 3	For the operational schemes (Bhlaraidh and Corrimony Wind Farms) the predictions show that there is significant headroom (>5 dB buffer) between the predictions from the individual schemes and the 35 dB noise limit. In order to determine the Site Specific Noise Limits, a +2 dB buffer was added to the turbine noise predictions; this is considered to be a suitable buffer in accordance with Section 5.4.11 of the IOA GPG and would represent a 60% increase in emitted noise levels from the other schemes. The resulting 'cautious' predictions of cumulative wind turbine noise have then been logarithmically subtracted from the Total ETSU-R-97 Noise Limit to determine the 'residual noise limit' (Site Specific Noise Limits), which are detailed in Tables 6.8 and 6.9.

6.6.4 Tables 6.8 and 6.9 show the Site Specific Noise Limits, noise predictions for the Proposed Development and the exceedance level. A negative exceedance demonstrates compliance with the Site Specific Noise Limits.

6.6.5 Further information on the calculations undertaken to derive the Site Specific Noise Limits are included within Tables A7.1 and A7.2 included in Annex 7. The tables also include limits based on THC preferred night time limit.

Table 6.8 Site Specific Noise Limits Compliance Table – Daytime

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 – Bhlaraidh	Site Specific Noise Limit	37.0	37.0	37.4	38.1	39.2	39.9	41.3	43.5	46.3	48.6	51.2	51.2
	Predicted Wind Turbine Noise L_{A90}	-	-	15.2	18.9	23.2	26.2	26.8	27.5	27.5	27.5	27.5	27.5
	Exceedance Level	-	-	-22.2	-19.2	-16	-13.7	-14.5	-16.0	-18.8	-21.1	-23.7	-23.7
NAL2 - Levishie	Site Specific Noise Limit	41.0	41.0	41.1	41.7	42.8	44.2	45.8	47.6	49.4	51.2	52.8	52.8
	Predicted Wind Turbine Noise L_{A90}	-	-	19.0	22.7	27.0	30.0	30.6	31.3	31.3	31.3	31.3	31.3
	Exceedance Level	-	-	-22.1	-19.0	-15.8	-14.2	-15.2	-16.3	-18.1	-19.9	-21.5	-21.5
NAL3 - Achnaconeran	Site Specific Noise Limit	35.0	35.0	35.0	35.0	35.0	33.8	32.9	32.7	32.7	32.7	32.7	32.7
	Predicted Wind Turbine Noise L_{A90}	-	-	18.0	21.7	26.0	29.0	29.6	30.3	30.3	30.3	30.3	30.3
	Exceedance Level	-	-	-17	-13.3	-9.0	-4.8	-3.3	-2.4	-2.4	-2.4	-2.4	-2.4

Table 6.9 Site Specific Noise Limits Compliance Table – Night time

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 – Bhlaraidh	Site Specific Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	42.3	42.3	42.3	43.8	43.8	43.8
	Predicted Wind Turbine Noise L_{A90}	-	-	15.2	18.9	23.2	26.2	26.8	27.5	27.5	27.5	27.5	27.5
	Exceedance Level	-	-	-27.8	-24.1	-19.8	-16.8	-15.5	-14.8	-14.8	-16.3	-16.3	-16.3
NAL2 - Levishie	Site Specific Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	42.6	44.2	46.5	48.8	48.8	48.8
	Predicted Wind Turbine Noise L_{A90}	-	-	19.0	22.7	27.0	30.0	30.6	31.3	31.3	31.3	31.3	31.3
	Exceedance Level	-	-	-24.0	-20.3	-16.0	-13.0	-12.0	-12.9	-15.2	-17.5	-17.5	-17.5
NAL3 - Achnaconeran	Site Specific Noise Limit	35.0	35.0	35.0	35.0	35.0	33.8	32.9	32.7	32.7	32.7	32.7	32.7
	Predicted Wind Turbine Noise L_{A90}	-	-	18.0	21.7	26.0	29.0	29.6	30.3	30.3	30.3	30.3	30.3
	Exceedance Level	-	-	-17.0	-13.3	-9.0	-4.8	-3.3	-2.4	-2.4	-2.4	-2.4	-2.4

6.6.6 The predicted wind turbine noise immission levels meet the Site Specific Noise Limits under all conditions and at all locations for all times of the day. A series of graphs to show the predicted wind turbine noise from the Proposed Development compared to the Site Specific Noise Limits are included as Figures A1.5a - A1.5c (Annex 1). There is a set of graphs for each of the NALs, which show the Total ETSU-R-97 Noise Limit (solid red line), the Site Specific Noise Limit (dashed red line with triangles) and the predicted wind turbine noise from the Proposed Development (solid blue line with triangles).

6.7 Micrositing

6.7.1 A 50 m micrositing distance is proposed. Clearly there are a large number of potential micrositing permutations but to put this into context the maximum increase in predicted noise level at any NAL if all turbines in the Proposed Development were moved 50 m closer would be 0.2 dB. The minimum margin in Tables 6.8 and 6.9 is 2.4 dB. 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 changes in noise propagation caused by topography. Should consent for the Proposed Development 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 Summary and 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 operational noise impact of the proposed development.

7.1.2 Background noise monitoring was undertaken at two noise sensitive receptors neighbouring the proposed development as part of the pre-construction baseline survey undertaken for Bhlaraidh Wind Farm. A total of three 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 and other nearby wind farms. For the assessment locations where no background noise measurements were undertaken, noise limits were derived using the simplified criteria detailed within ETSU-R-97.

7.1.3 Wind speed data was collected using a meteorological mast located within the site. The data collected at 50 m and 70 m height which were used to calculate hub height wind speeds 105 m) which were then standardised to 10 m height, in accordance with current good practice.

7.1.4 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 daytime and night time noise limits for each of the assessment locations. A 'Total ETSU-R-97 Noise Limit' of 35 dB(A) daytime or background plus 5dB (whichever is the greater) and 43 dB(A) night time or background plus 5dB (whichever is the greater) was used for this assessment.

7.1.5 There are a number of cumulative developments in proximity to the proposed development. 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 daytime and night time periods.

7.1.6 'Site Specific Noise Limits' have also been derived which take account (where required) of the other wind farms.

7.1.7 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 immission were below the 'Site Specific Noise Limits' when considering the Vestas V150, 5.6 MW with standard blades as a candidate turbine.

7.1.8 At some locations, under some wind conditions and for a certain proportion of the time operational wind farm noise from the proposed development would be audible; however, it would be at an acceptable level in relation to the ETSU-R-97 guidelines.

7.1.9 The Vestas V150 wind turbine model was chosen as it is considered to be representative of the type of turbine that could be installed at the site. There are a number of wind turbine makes and models that may be suitable for the proposed development. Should the proposed development be granted consent, 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. A suggested set of noise conditions are included within Annex 8.

8 Glossary of Terms

AOD: Above Ordnance Datum is the height above sea level.

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 daytime, 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 3 dB(A) is just perceptible;
- a change of 5 dB(A) is clearly perceptible;
- a change of 10 dB(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.

9 References

1. **ETSU for the DTI (Department of Trade and Industry.** *The Working Group on Noise from Wind Turbines ETSU-R-97 The Assessment and Rating of Noise from Wind Farms'.* 1996.

2. **Institute of Acoustics.** *Good Practice Guidance on the application of ETSU-R-97 for wind turbine noise assessment.* 2013.

3. **The Scottish Government.** Scottish Planning Policy (SPP) http://www.gov.scot/Publications/2014/06/5823. [Online] 2014.

4. —. Web Based Renewables Advice: 'Onshore Wind Turbines' – http://www.scotland.gov.uk/Resource/0045/00451413.pdf. [Online] 28 May 2014.

5. —. Planning Advice Note PAN 1/2011: Planning and Noise - http://www.scotland.gov.uk/Resource/Doc/343210/0114180.pdf. [Online] 2011.

6. —. Technical Advice Note Assessment of Noise (http://www.scotland.gov.uk/Resource/Doc/343341/0114220.pdf). [Online]

7. **Letter John Swinney, MSP Cabinet Secretary for Finance, Employment and Sustainable Growth to Prof B Shield.** http://www.ioa.org.uk/pdf/scottish-government-endorsement-of-ioa-gpg.pdf. [Online]

8. *Visual and acoustic impact of wind turbine farms in residents Final report.* **Frits van den Berg et al.** s.l. : FP6-2005-Science-and-Society-20 Specific Support Action, 3 June 2008.

9. *Low frequency noise and annoyance.* **HG, Leventhall.** 23, s.l. : Noise & Health Journal, 2004, Vol. 6.

10. *Do wind turbines produce significant low frequency sound levels? Conference paper 11th International Meeting on Low Frequency Noise and Vibration and its Control .* **Berg, G.P. van den.** Maastricht The Netherlands : s.n., 2004.

11. **Department of Trade and Industry.** *The Measurement of LFN at three UK Wind Farms .* 2006 : s.n.

12. **Keele University Rejects Renewable Energy Foundation.** http://archive.is/d3WB. *Low Frequency Noise Research Claims .* [Online]

13. **Institute of Acoustics Bulletin.** *Prediction and assessment of wind turbine noise.* 2009.

14. *Infrasound and the ear, 5th International conference on Wind Turbine Noise.* **Leventhall, G.** Denver : s.n., 2013.

15. **renewable UK.** http://www.renewableuk.com/search/all.asp?bst=amplitude+modulation. [Online]

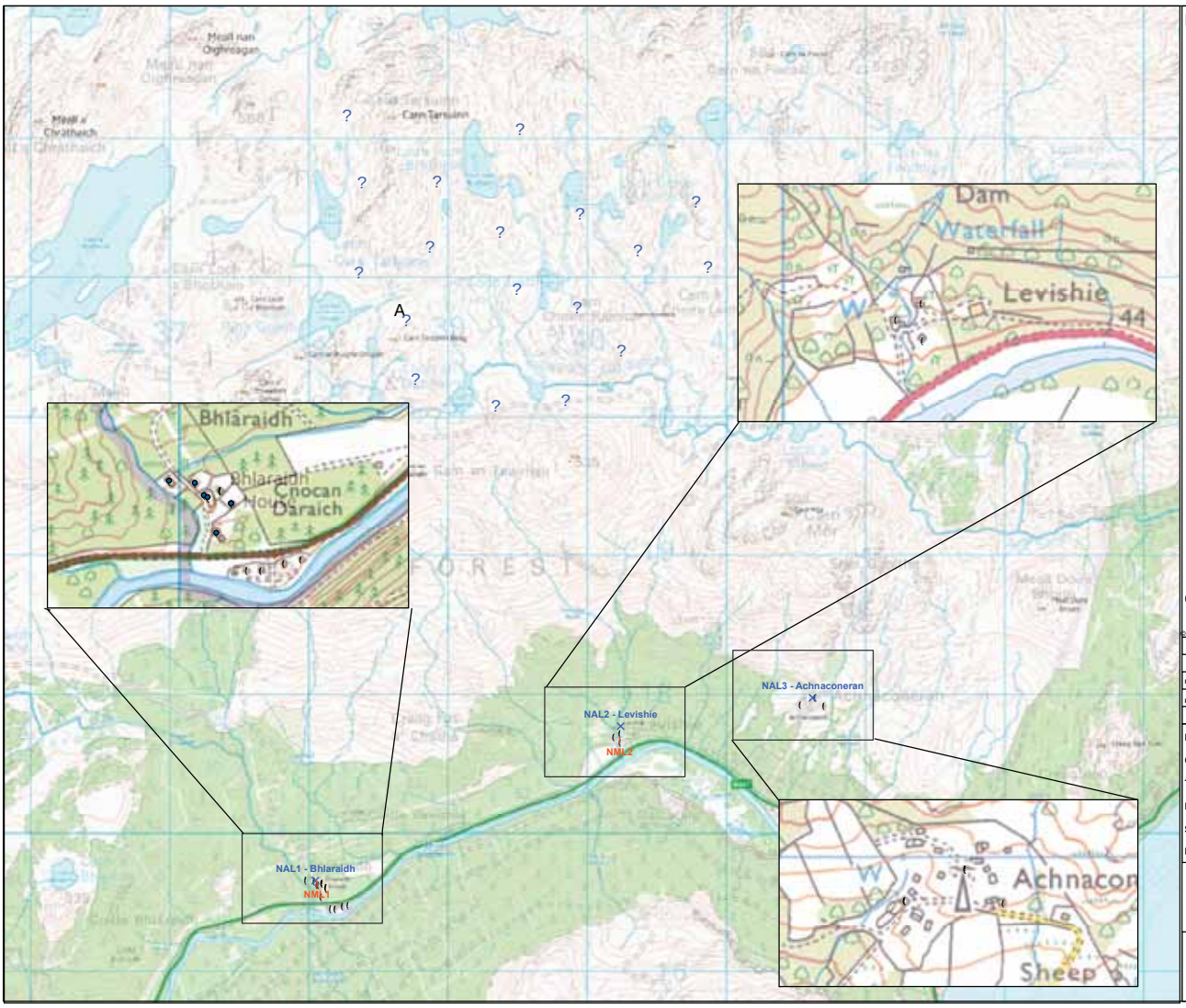
16. **Acoustics, Institute of.** https://www.ioa.org.uk/sites/default/files/AMWG%20Final%20Report-09-08-2016_0.pdf. [Online] August 2016. [Cited: 03 06 2021.]

17. **Department of Energy & Climate Change.** *Wind Turbine AM Review Phase 2 Report.* 2016.

18. **International Standards Organisation.** *ISO9613:1996 'Acoustics – Attenuation of sound during propagation outdoors' – Part 2: General method of calculation.* 1996.

19. **DataKustik Gmbh.** CadnaA Version 4.4.

Annex 1 – Figures



Legend

- ? Proposed Turbine Location
- ! Noise Monitoring Location (NML)
- × Noise Assessment Location (NAL)
- (Noise Sensitive Receptor
- A Temporary Met Mast Location

0 500 1,000 Metres

REV.	DETAILS	DRAWN	CHK'D	APP'D	DATE
R1	SECOND ISSUE	GC	JM	JM	25/05/2021
R0	FIRST ISSUE	GC	JM	JM	13/04/2021

Project	Bhlaraidh Extension Wind Farm
Client	SSE Generation Ltd
Title	Noise Monitoring and Assessment Locations
Figure No.	A1.1
Scale	1:25,000 @A3
Doc. Ref.	13813-008

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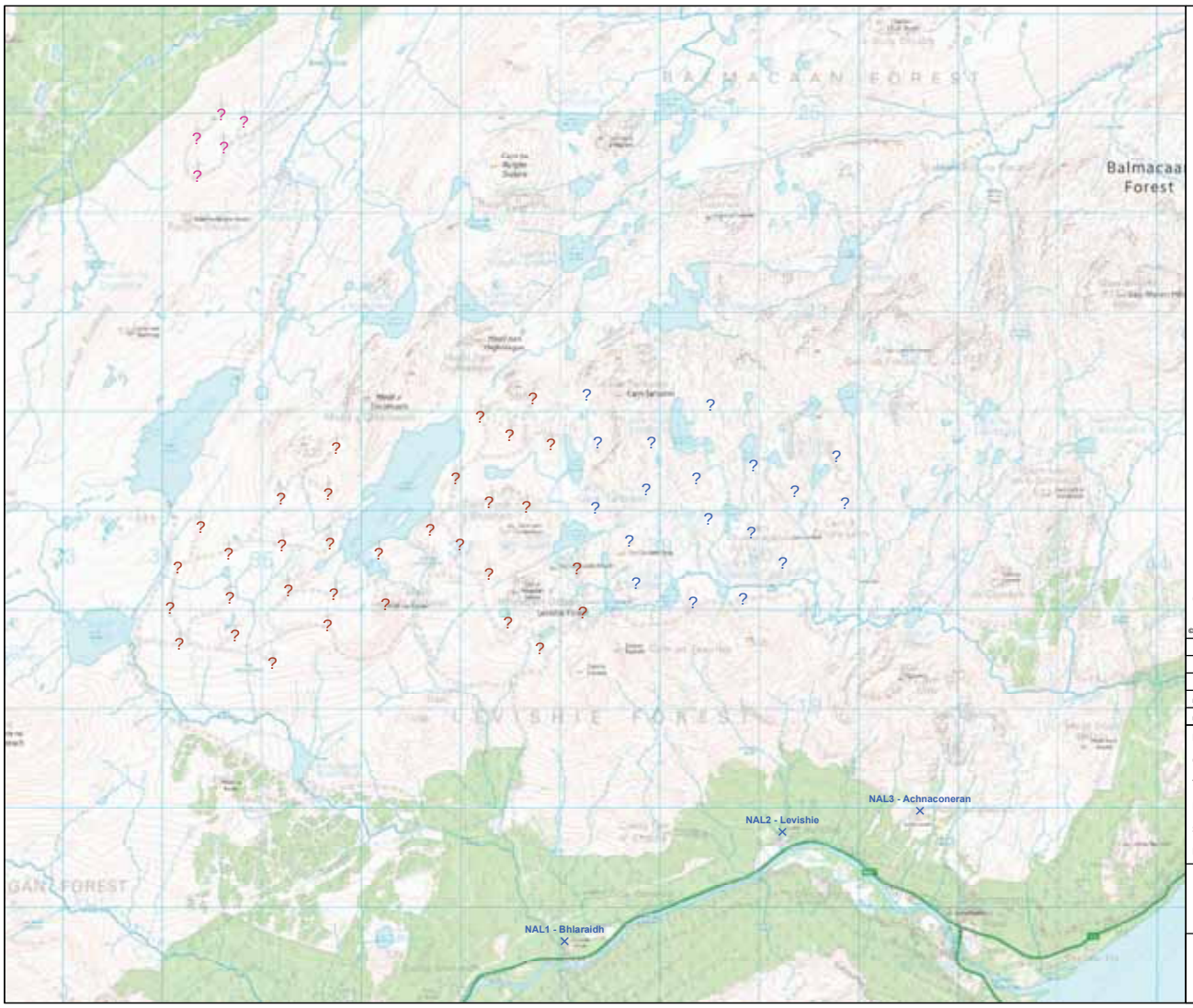

Legend

× Noise Assessment Location (NAL)

Wind Farm

? Bhlaraidh

? Bhlaraidh Extension

? Corrimony

0 500 1,000 Metres

REV.	DETAILS	DRAWN	CHK'D	APP'D	DATE
R0	FIRST ISSUE	GC	JM	JM	13/04/2021

Project	Bhlaraidh Wind Farm Extension
Client	SSE Generation Ltd
Title	Cumulative Wind Farms
Figure No.	A1.1a
Scale	1:35,000 @A3
Doc. Ref.	13813-010

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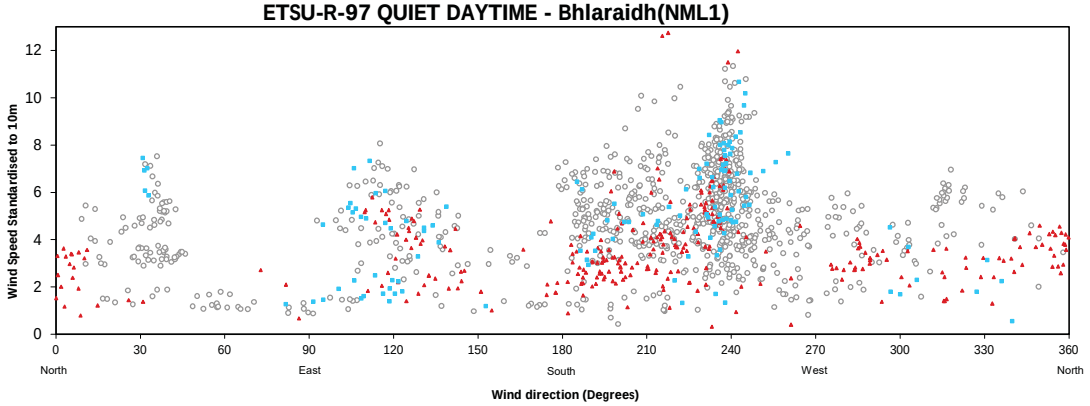
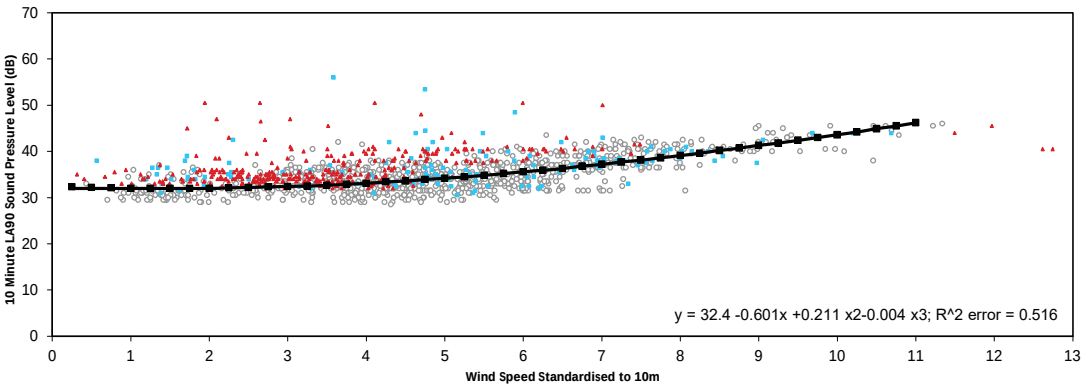
ETSU-R-97 QUIET DAYTIME - Bhlaraidh(NML1)

Wind Conditions Quiet Daytime



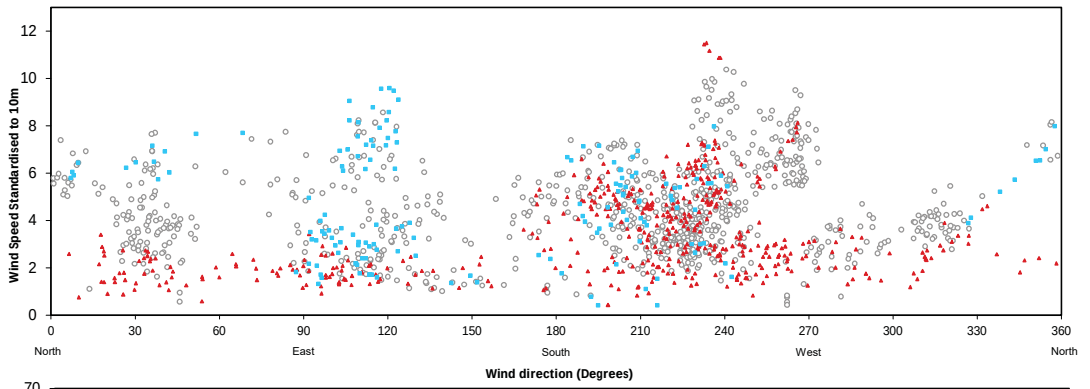
Regression Analysis Quiet Daytime



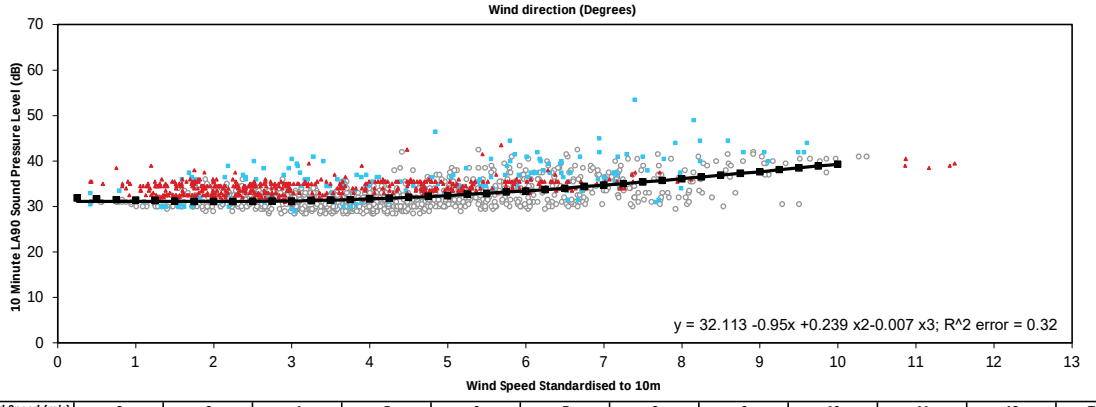
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	46	102	186	181	161	102	44	24	8	5	0	859
Prevailing Background	32	32.4	33.1	34.2	35.6	37.2	39.1	41.3	43.6	46.2	-	

ETSU-R-97 NIGHT-TIME - Bhlaraidh(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	79	177	188	137	107	71	37	18	9	0	0	823
Prevailing Background	31.1	31.2	31.7	32.4	33.4	34.7	36.1	37.6	39.3	-	-	

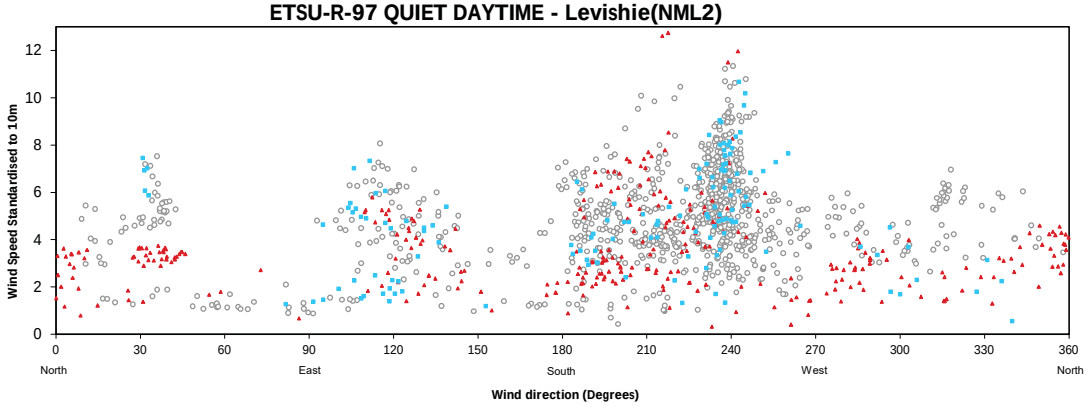
Legend:

- 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

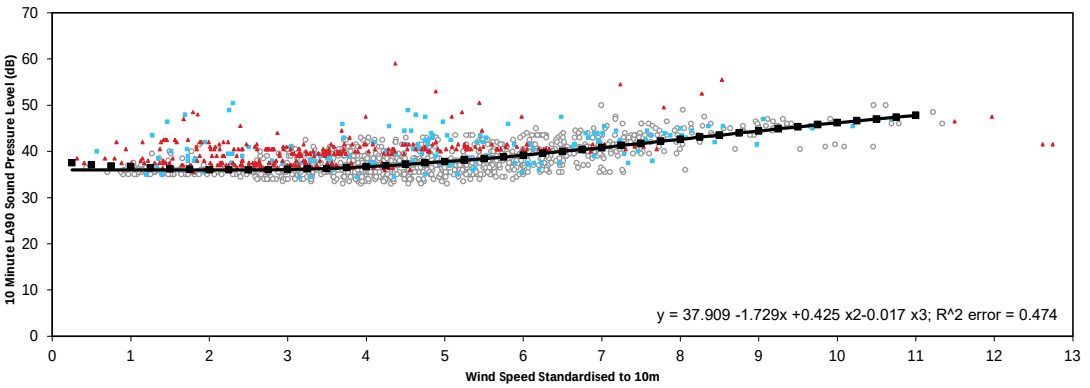
Project	Bhlaraidh Extension Wind Farm
Client	SSE Generation Ltd
Title	Wind Conditions&Regression Analysis
Figure Number	A1.2a
Drawn	GC
Checked	JM
Date	07/04/2021
Document Reference	13813-RA

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

Wind Conditions Quiet Daytime



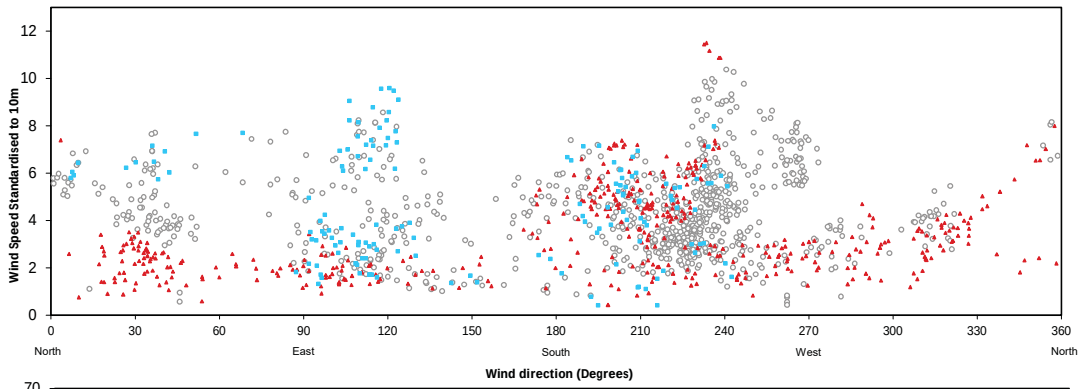
Regression Analysis Quiet Daytime



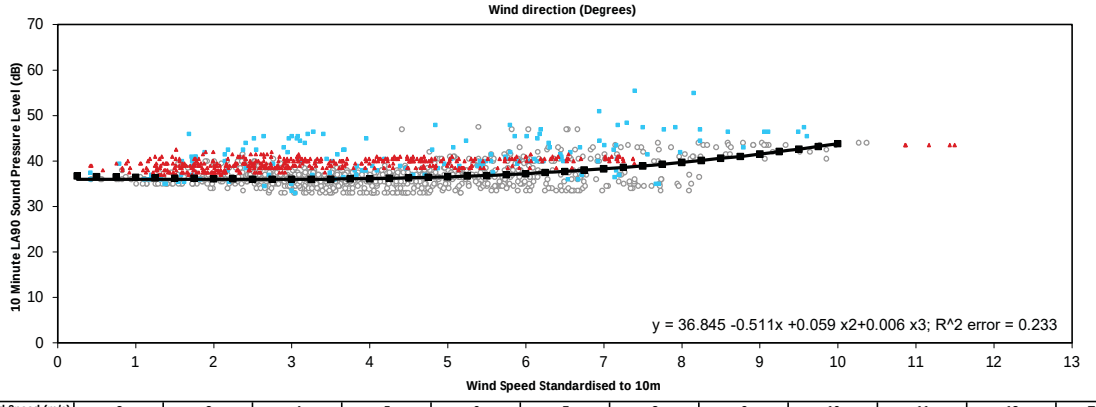
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	36	91	204	182	161	101	40	23	8	5	0	851
Prevailing Background	36	36.1	36.7	37.8	39.2	40.8	42.6	44.4	46.2	47.8	-	

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

Wind Conditions Night-Time



Regression Analysis Night-Time



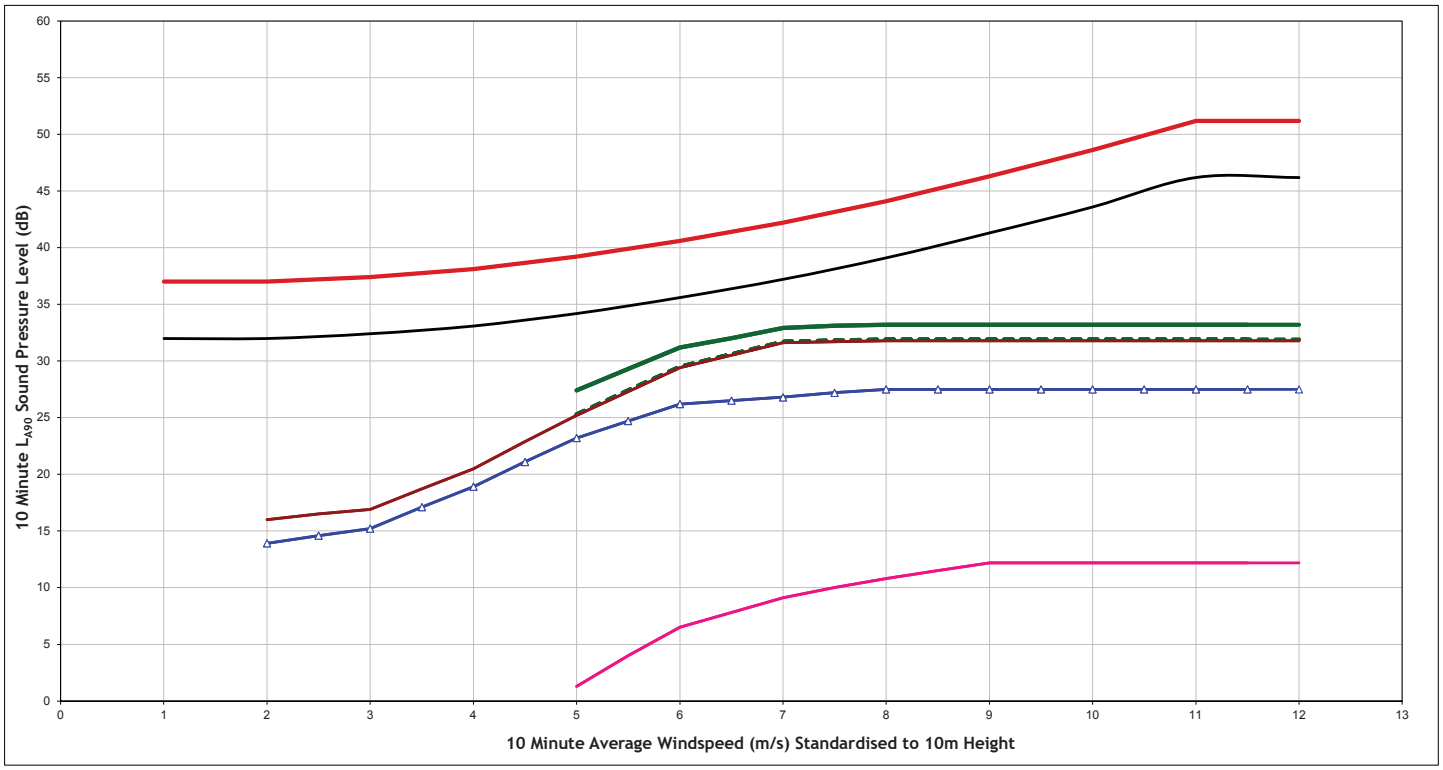
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	83	176	189	155	105	60	29	15	8	0	0	820
Prevailing Background	36	36	36.1	36.5	37.2	38.3	39.7	41.5	43.8	-	-	

Legend:

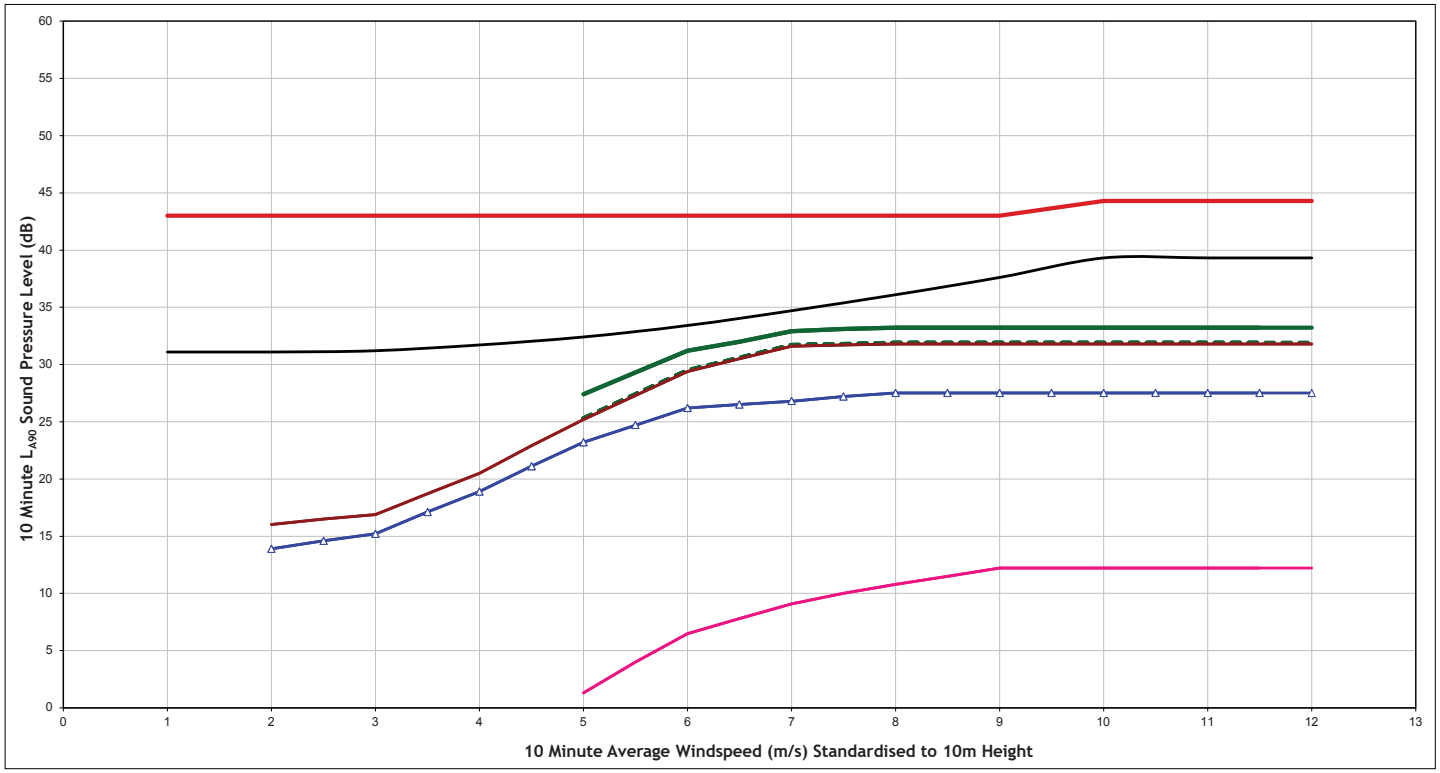
- L_{A90} 10 Minute Measurement Point
- Line of best fit
- Line of best fit flat lined where appropriate(Prevailing Background)
- Excluded Data-Manual exclusion
- Excluded Data-Rain

Project	Bhlaraidh Extension Wind Farm
Client	SSE Generation Ltd
Title	Wind Conditions&Regression Analysis
Figure Number	A1.2b
Drawn	GC
Checked	JM
Date	07/04/2021
Document Reference	13813-RA

Daytime - Bhlaraidh (NAL1)



Night Time - Bhlaraidh (NAL1)



Legend:

- Background Noise Trendline
- Total ETSU-R-97-Limit
- Cumulative Wind Farms
- Cumulative Wind Farms (Excluding Proposed Development)
- Proposed Development Only
- Bhlaraidh Wind Farm Only
- Corrimony Wind Farm Only

Project	Bhlaraidh Wind Farm Extension
Client	SSE Generation Ltd
Title	Noise Assessment - Likely Noise Predictions Bhlaraidh (NAL1)
Figure Number	A1.3a
Scale	NTS
Drawn	GC
Checked	JM
Date	02/06/2021
Document Reference	13813-Models

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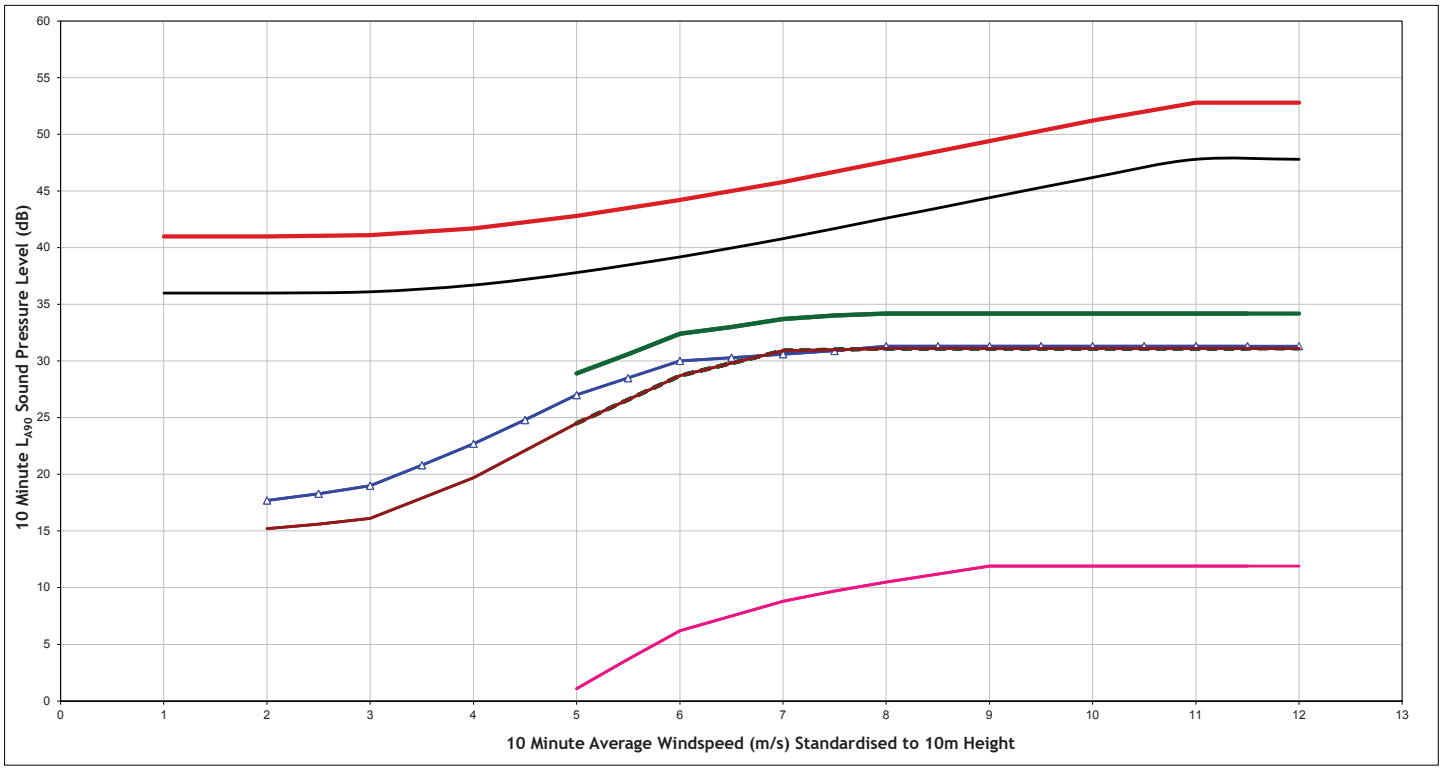
Daytime - Levishie Cottage (NAL2)



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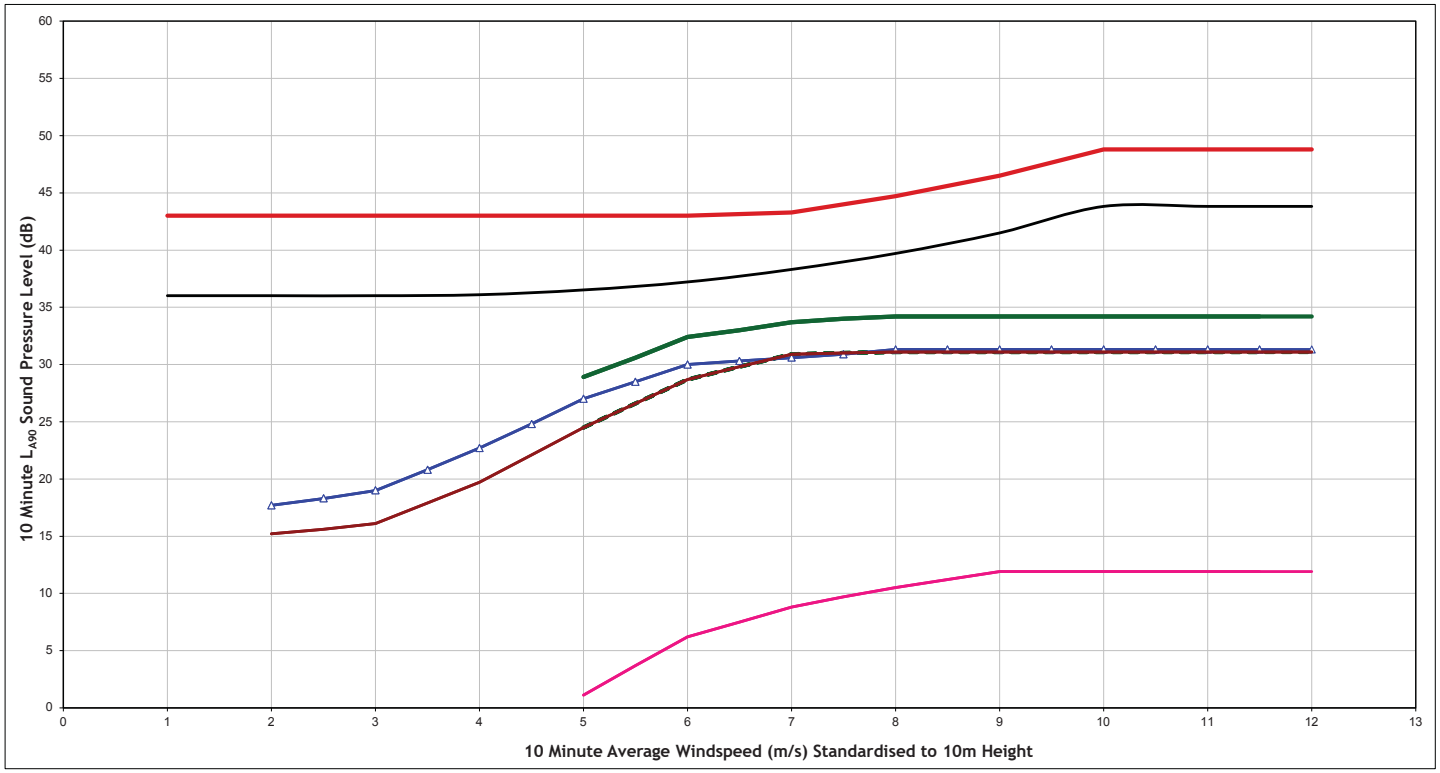

Legend:

- Background Noise Trendline
- Total ETSU-R-97-Limit
- Cumulative Wind Farms
- Cumulative Wind Farms (Excluding Proposed Development)
- Proposed Development Only
- Bhlaraidh Wind Farm Only
- Corrimony Wind Farm Only

Project	Bhlaraidh Wind Farm Extension
Client	SSE Generation Ltd
Title	Noise Assessment - Likely Noise Predictions Levishie Cottage (NAL2)
Figure Number	A1.3b
Scale	NTS
Drawn	GC
Checked	JM
Date	02/06/2021
Document Reference	13813-Models

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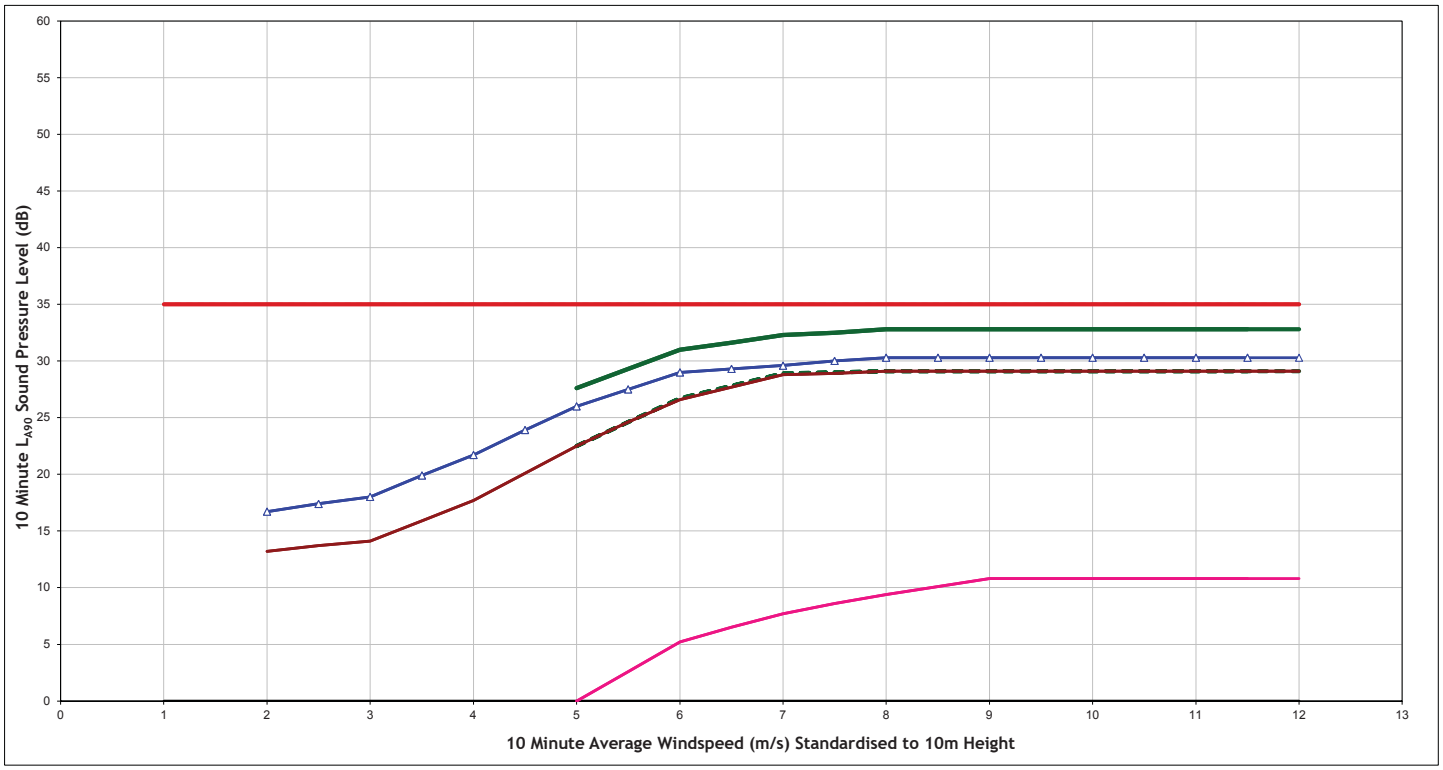
Daytime - Achnaconeran (NAL3)



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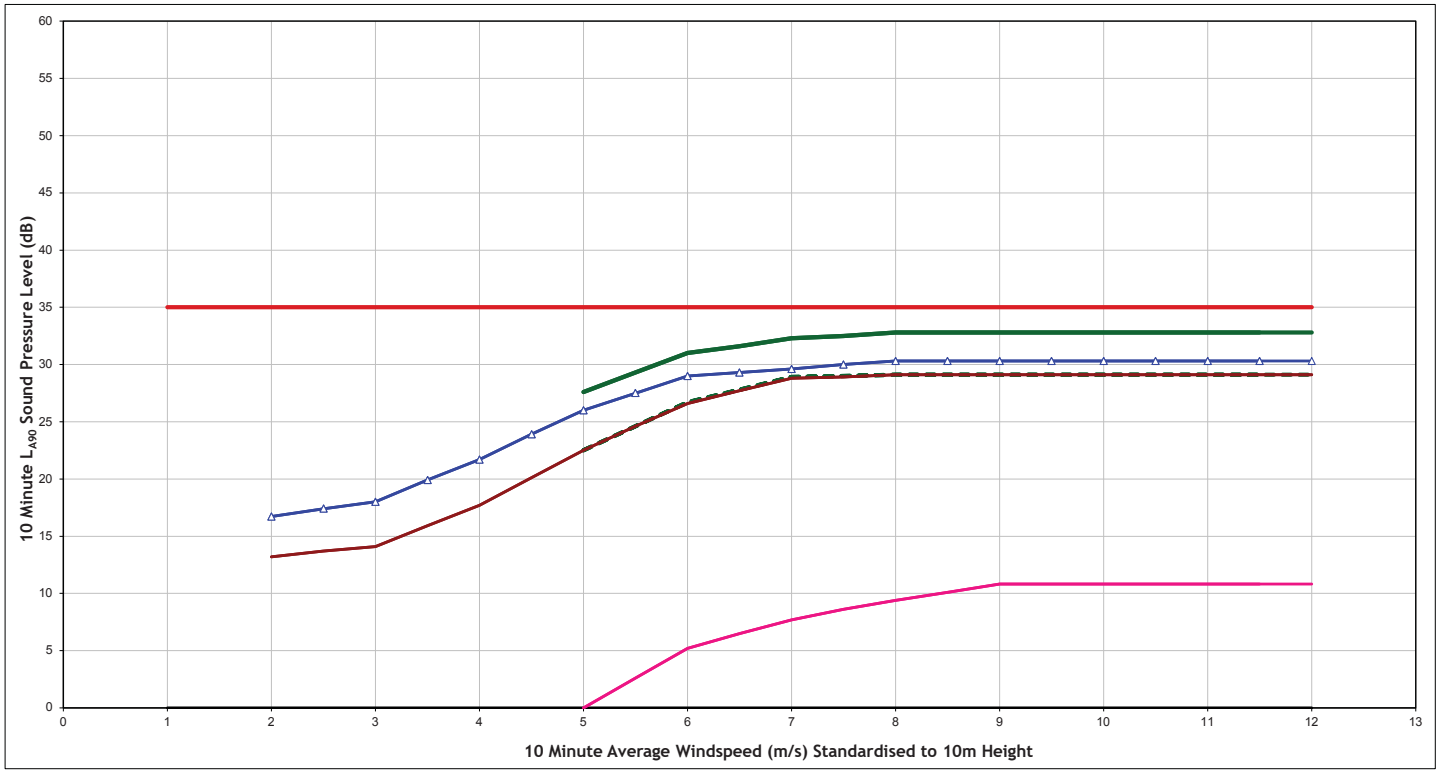

Legend:

- Background Noise Trendline
- Total ETSU-R-97-Limit
- Cumulative Wind Farms
- Cumulative Wind Farms (Excluding Proposed Development)
- Proposed Development Only
- Bhlaraidh Wind Farm Only
- Corrimony Wind Farm Only

Project	Bhlaraidh Wind Farm Extension
Client	SSE Generation Ltd
Title	Noise Assessment - Likely Noise Predictions Achnaconeran (NAL3)
Figure Number	A1.3c
Scale	NTS
Drawn	GC
Checked	JM
Date	02/06/2021
Document Reference	13813-Models

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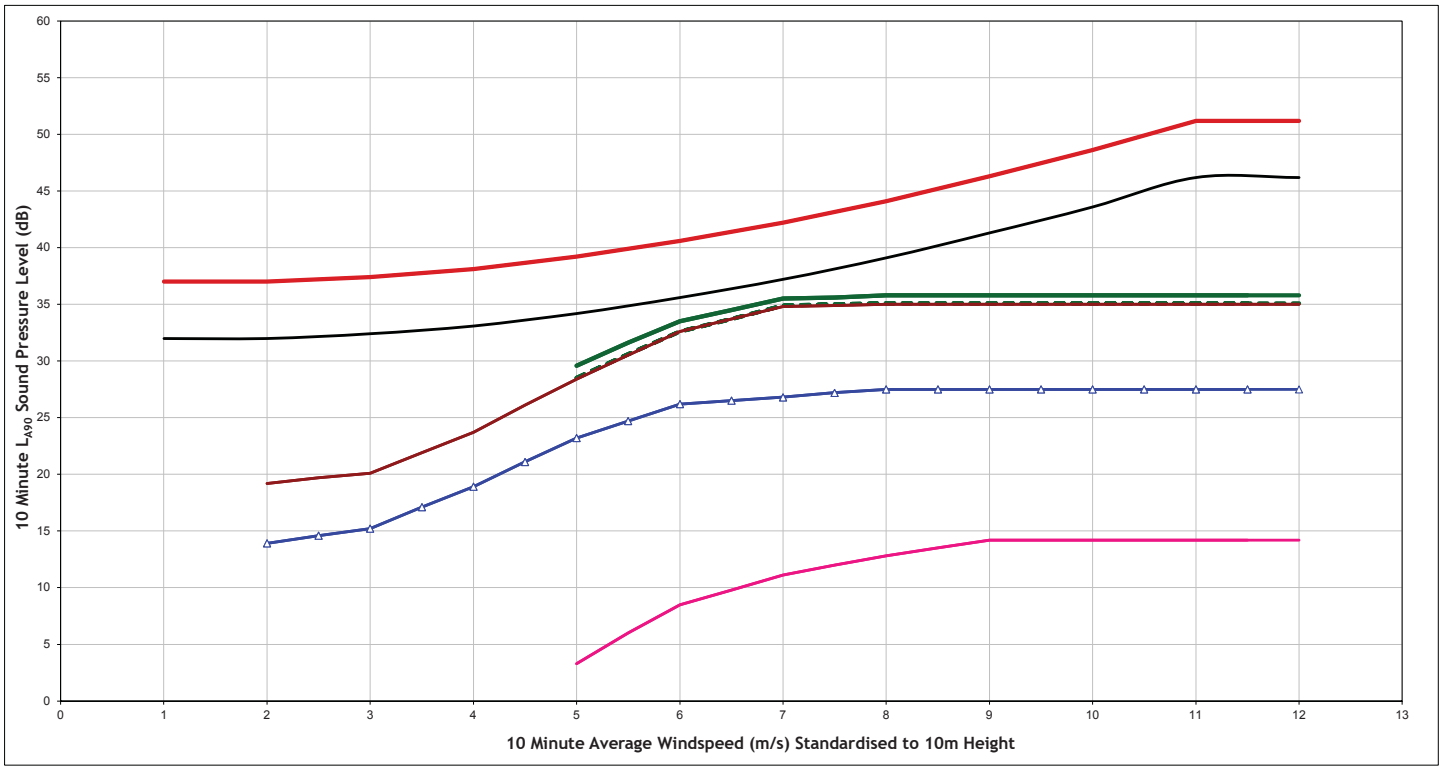
Daytime - Bhlaraidh (NAL1)



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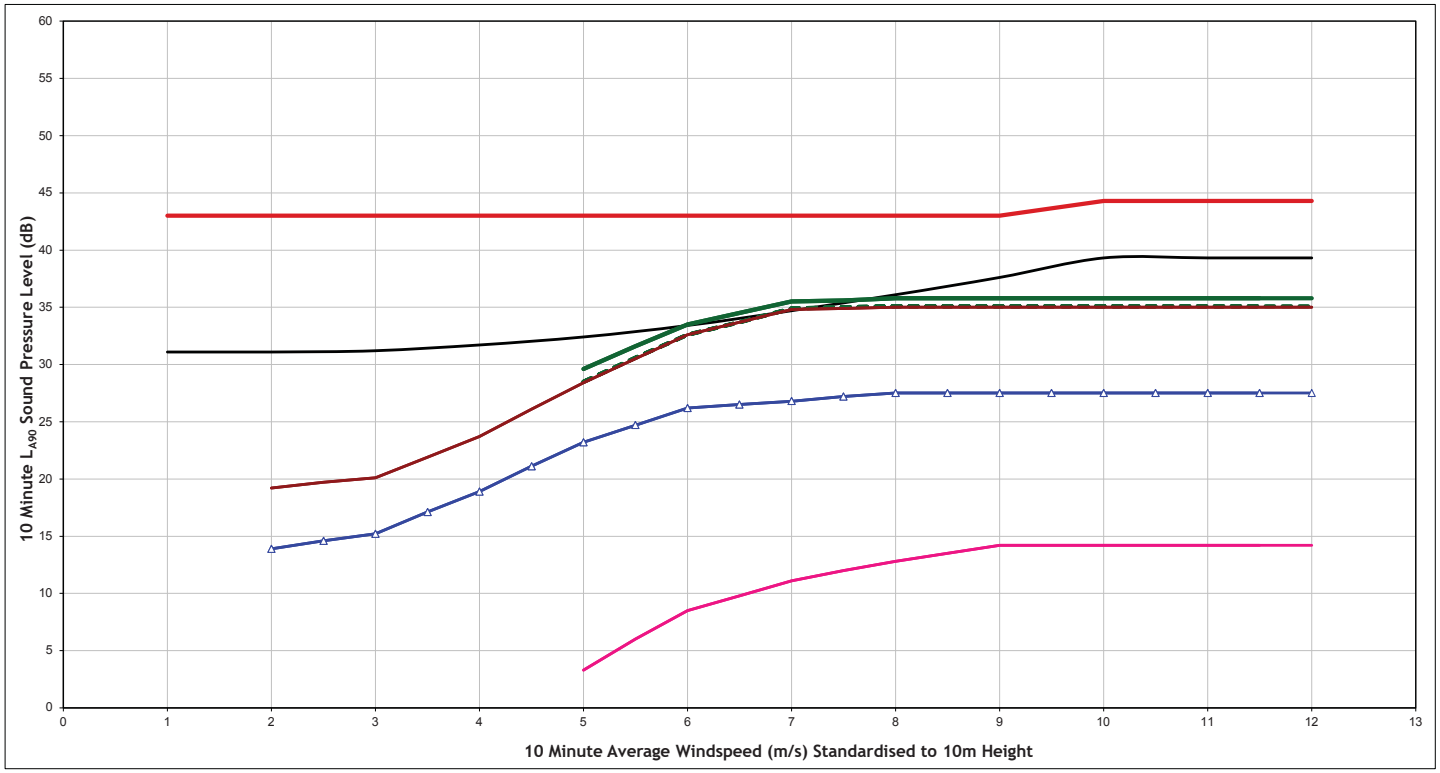

Legend:

- Background Noise Trendline
- Total ETSU-R-97-Limit
- Cumulative Wind Farms
- Cumulative Wind Farms (Excluding Proposed Development)
- Proposed Development Only
- Bhlaraidh Wind Farm Only
- Corrimony Wind Farm Only

Project	Bhlaraidh Wind Farm Extension
Client	SSE Generation Ltd
Title	Noise Assessment - Cautious Noise Predictions Bhlaraidh (NAL1)
Figure Number	A1.4a
Scale	NTS
Drawn	GC
Checked	JM
Date	03/06/2021
Document Reference	13813-Models

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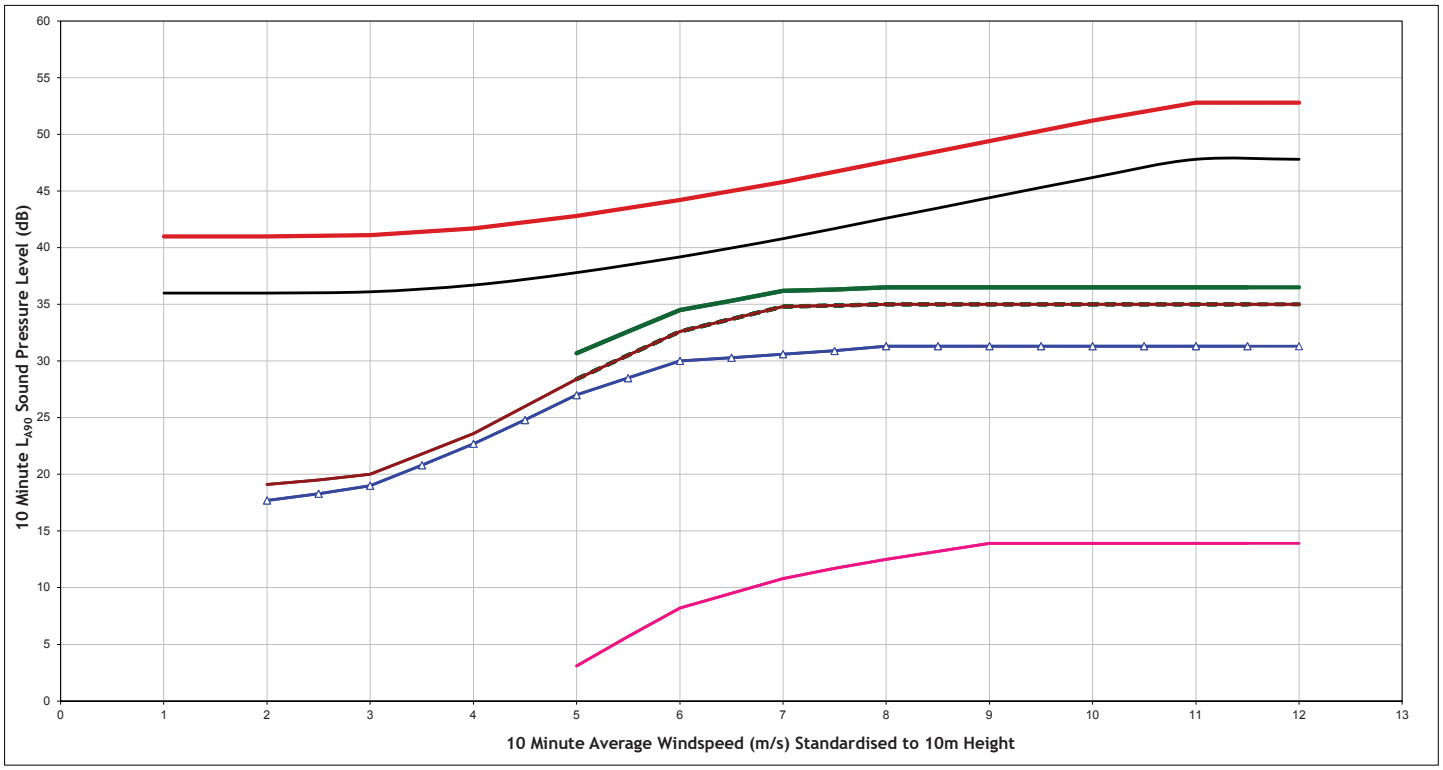
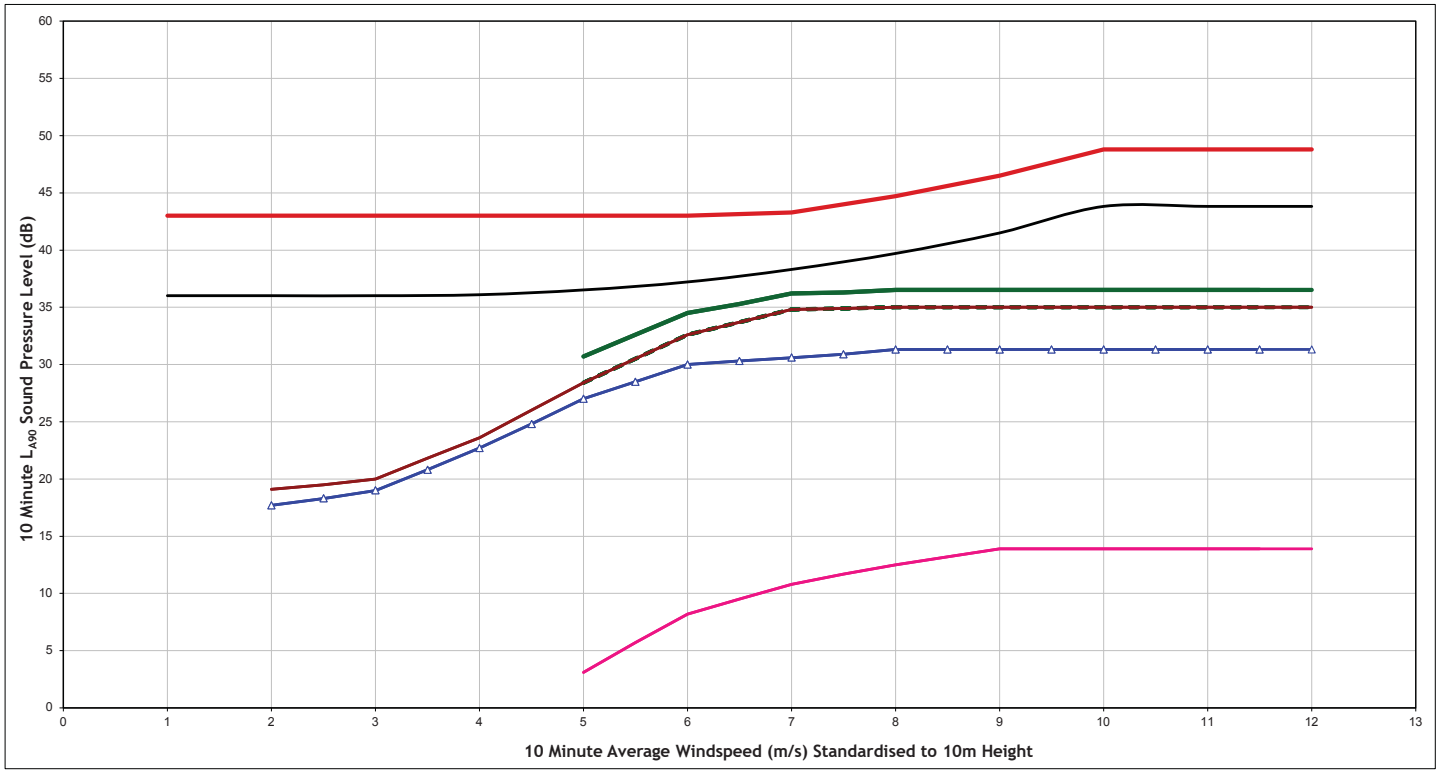
Daytime - Levishie Cottage (NAL2)



Night Time - Levishie Cottage (NAL2)



Legend:

- Background Noise Trendline
- Total ETSU-R-97-Limit
- Cumulative Wind Farms
- Cumulative Wind Farms (Excluding Proposed Development)
- Proposed Development Only
- Bhlaraidh Wind Farm Only
- Corrimony Wind Farm Only

Project	Bhlaraidh Wind Farm Extension
Client	SSE Generation Ltd
Title	Noise Assessment - Cautious Noise Predictions Levishie Cottage (NAL2)
Figure Number	A1.4b
Scale	NTS
Drawn	GC
Checked	JM
Date	03/06/2021
Document Reference	13813-Models

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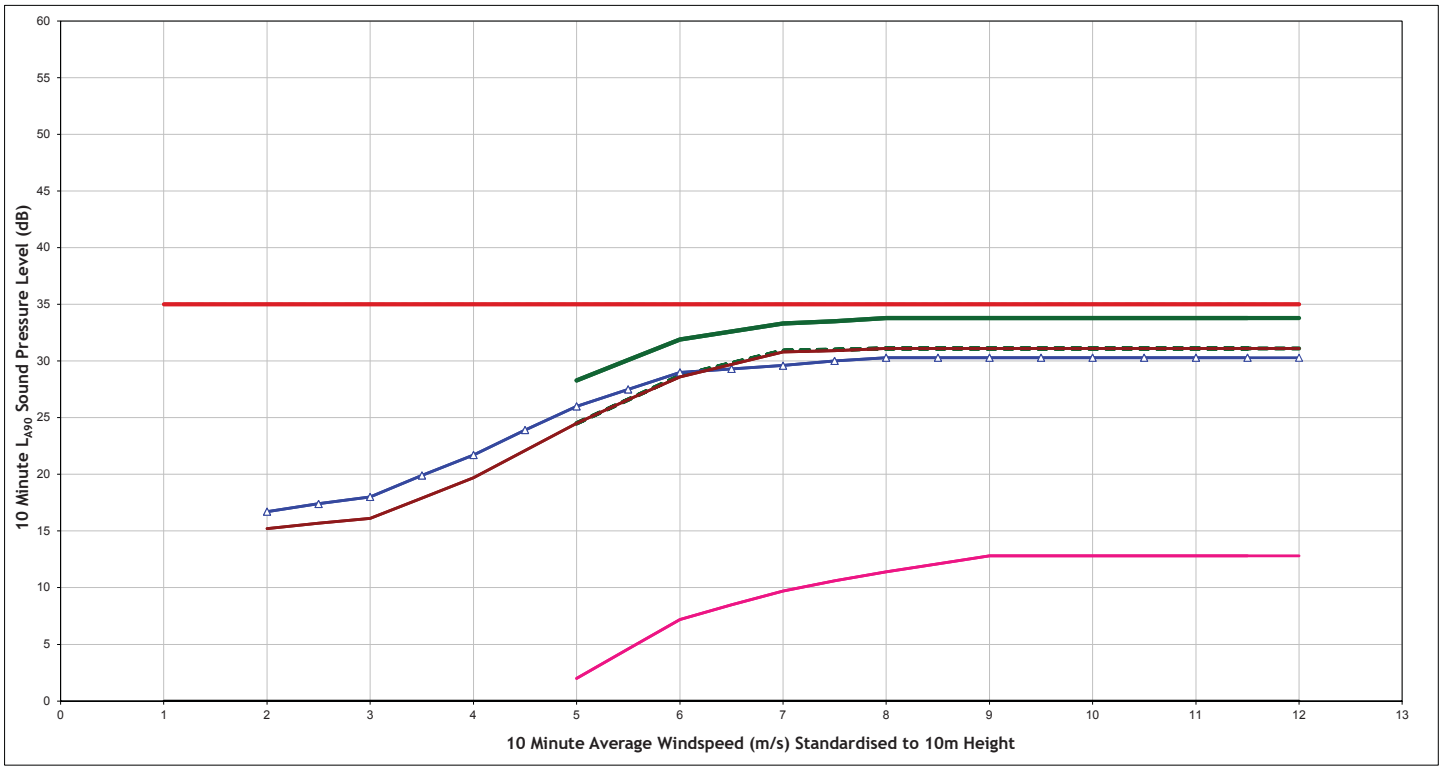
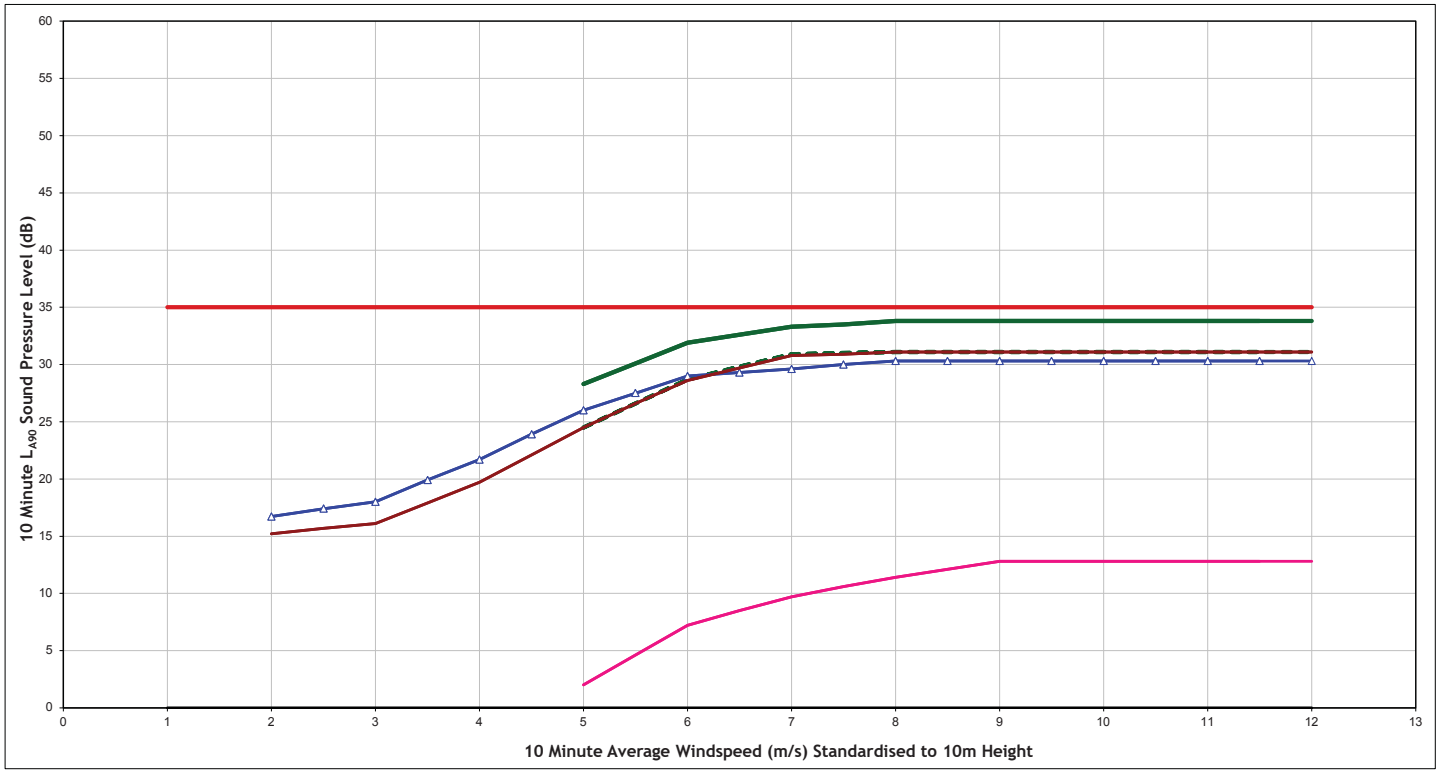
Daytime - Achnaconeran (NAL3)



Night Time - Achnaconeran (NAL3)



Legend:

- Background Noise Trendline
- Total ETSU-R-97-Limit
- Cumulative Wind Farms
- Cumulative Wind Farms (Excluding Proposed Development)
- Proposed Development Only
- Bhlaraidh Wind Farm Only
- Corrimony Wind Farm Only

Project	Bhlaraidh Wind Farm Extension
Client	SSE Generation Ltd
Title	Noise Assessment - Cautious Noise Predictions Achnaconeran (NAL3)
Figure Number	A1.4c
Scale	NTS
Drawn	GC
Checked	JM
Date	03/06/2021
Document Reference	13813-Models

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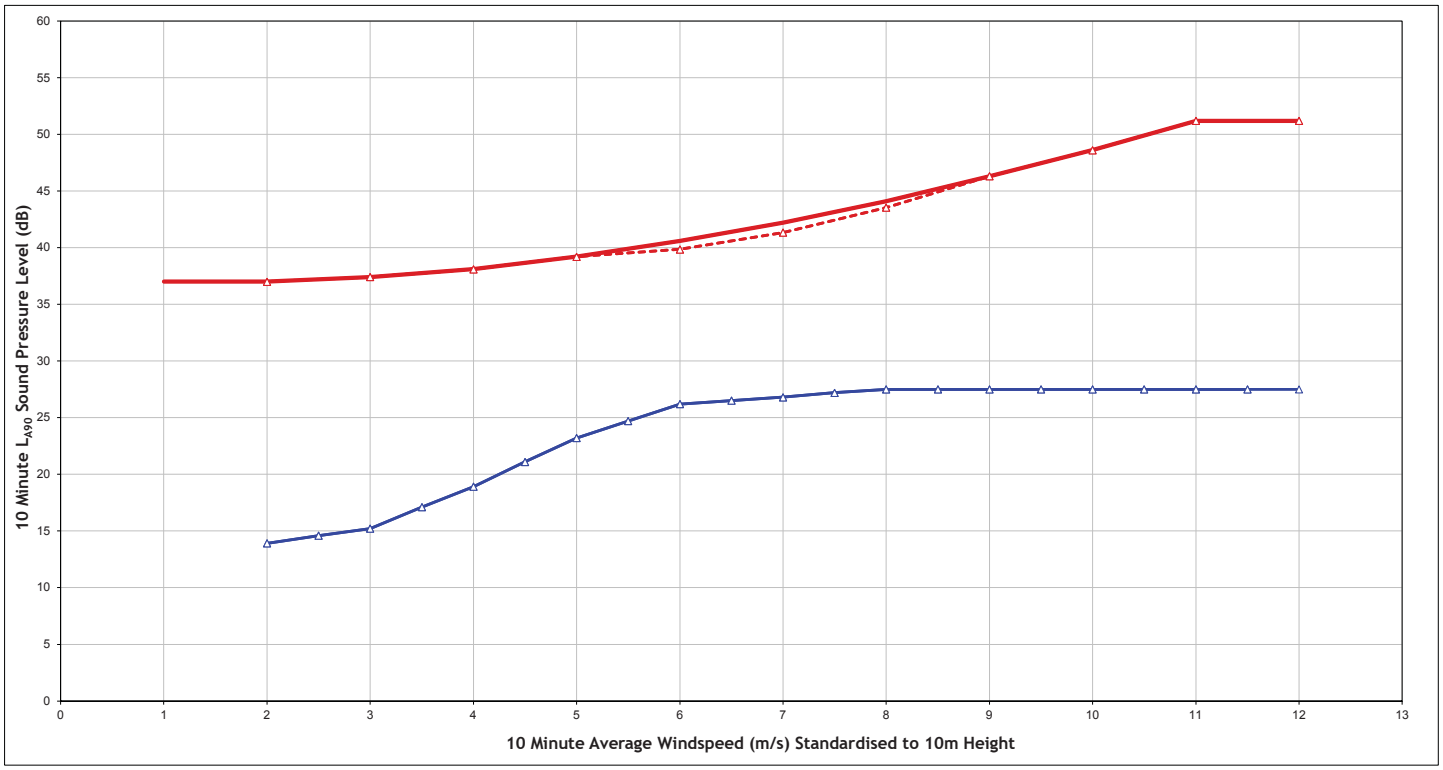
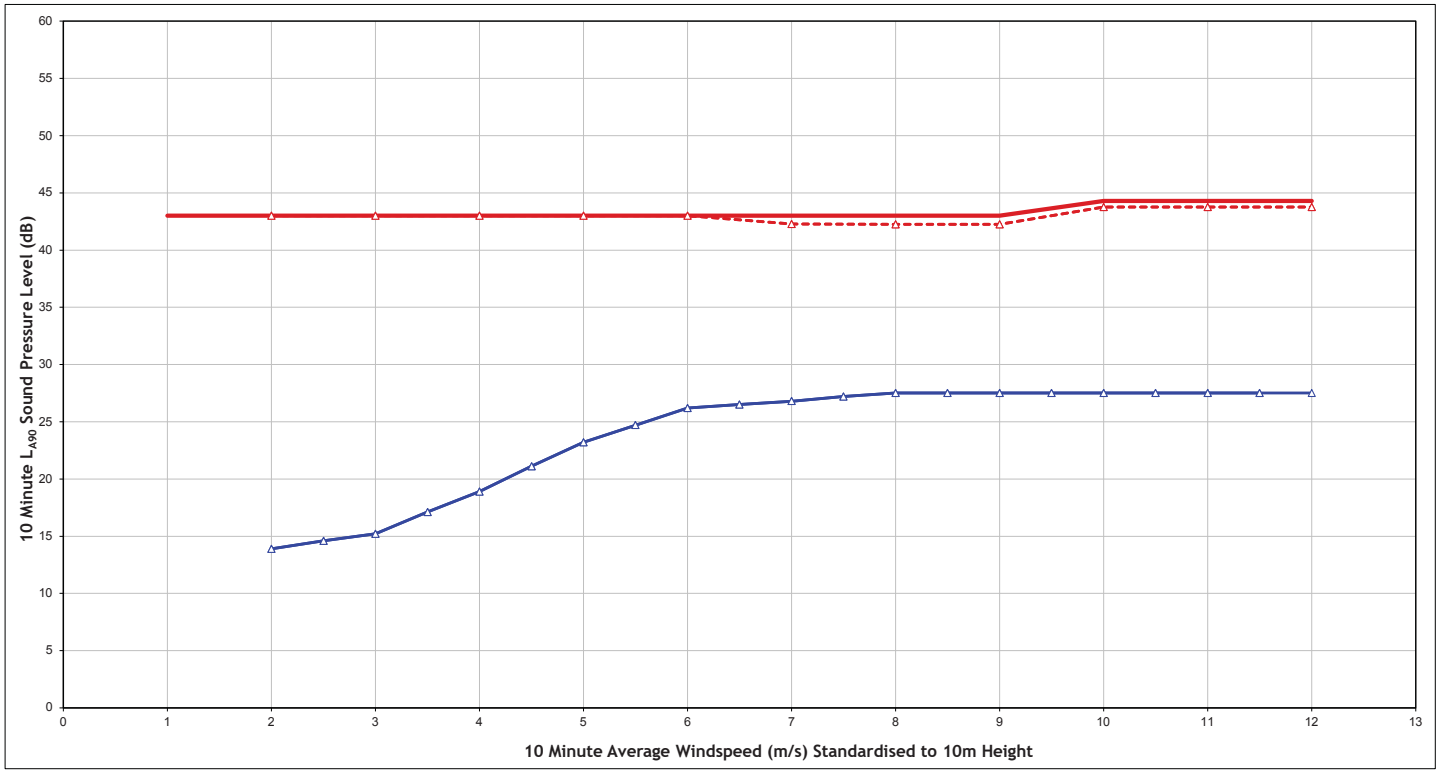
Daytime - Bhlaraidh (NAL1)



Night Time - Bhlaraidh (NAL1)

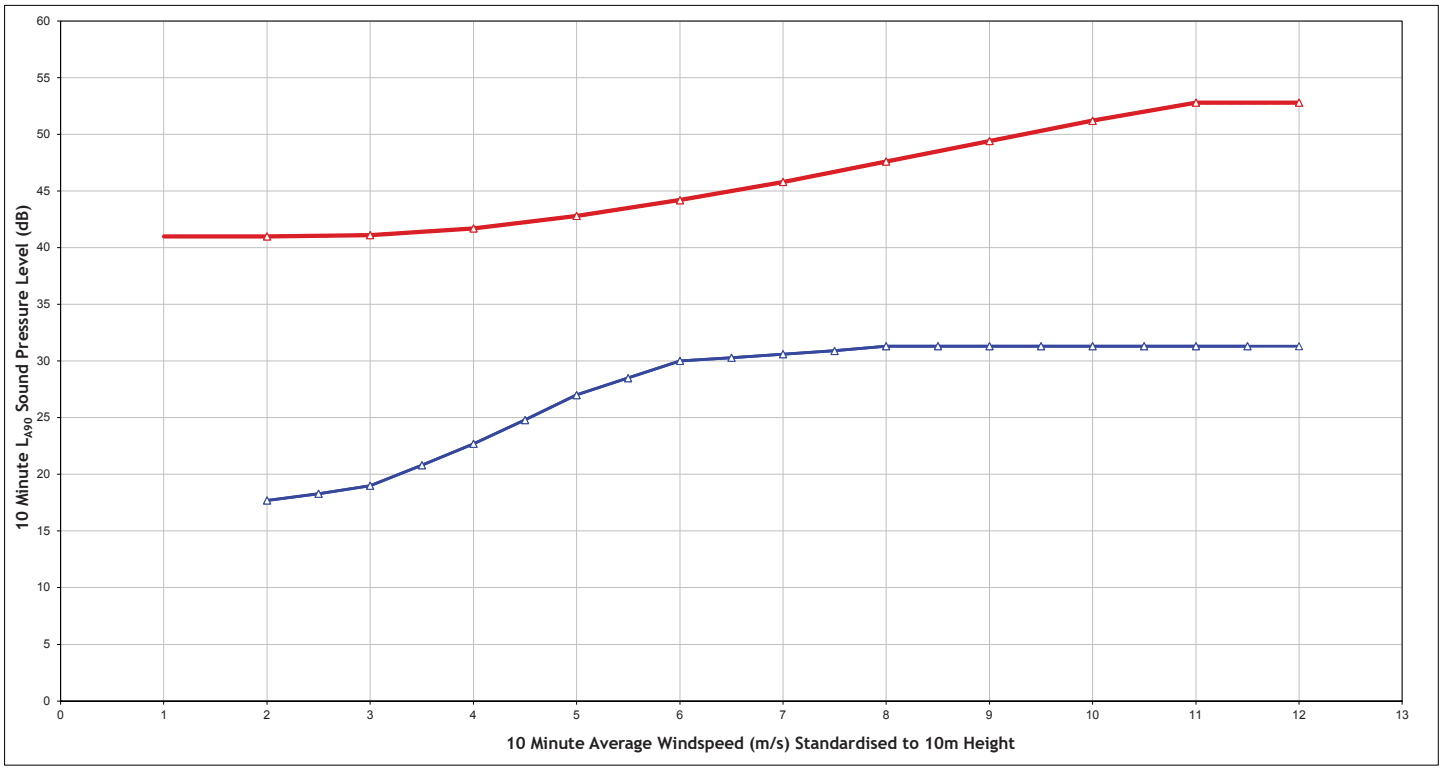


Legend:

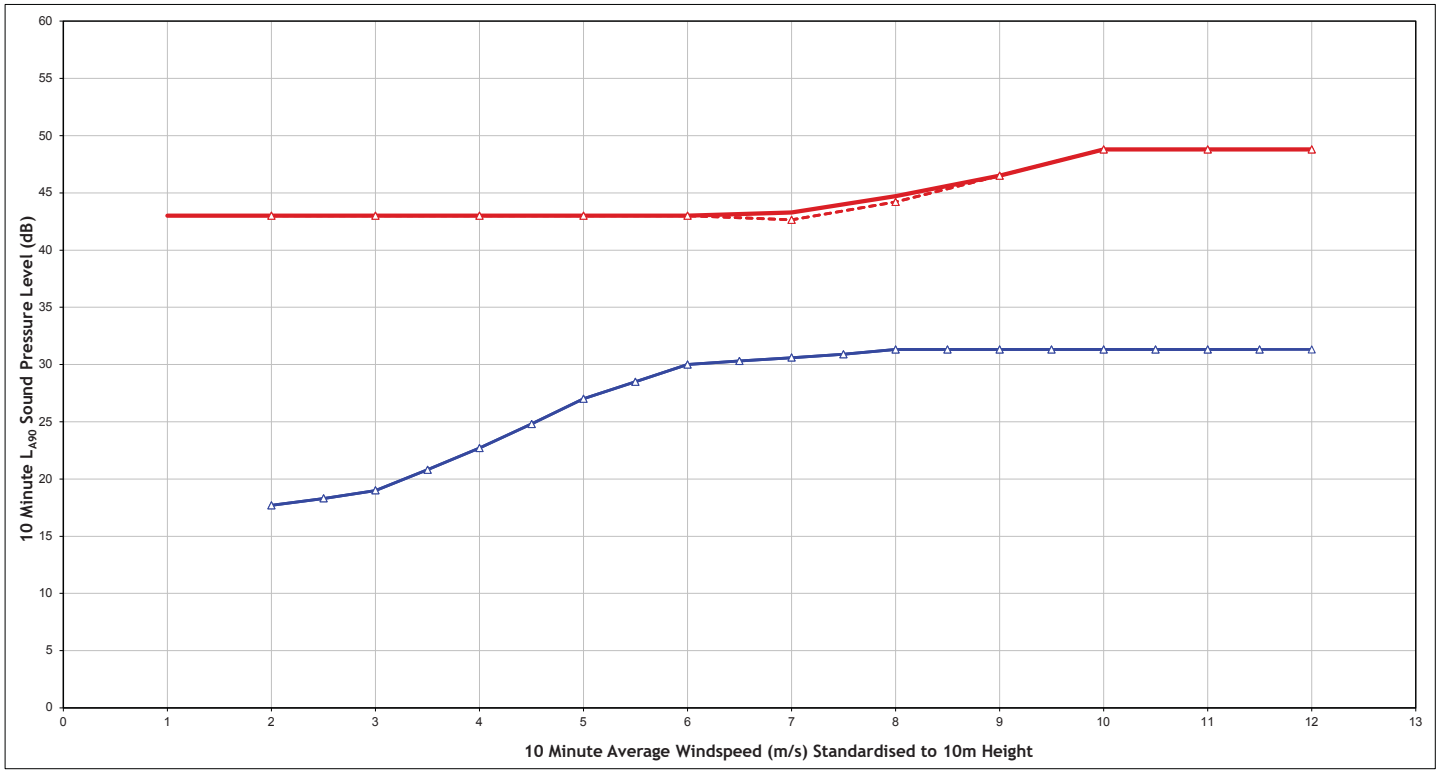
- Total ETSU-R-97-Limit
- Site Specific Noise Limit
- Proposed Development Only

Project	Bhlaraidh Wind Farm Extension
Client	SSE Generation Ltd
Title	Noise Assessment - Likely Noise Predictions Bhlaraidh (NAL1)
Figure Number	A1.5a
Scale	NTS
Drawn	GC
Checked	JM
Date	03/06/2021
Document Reference	13813-Models

Daytime - Levishie Cottage (NAL2)



Night Time - Levishie Cottage (NAL2)



Legend:

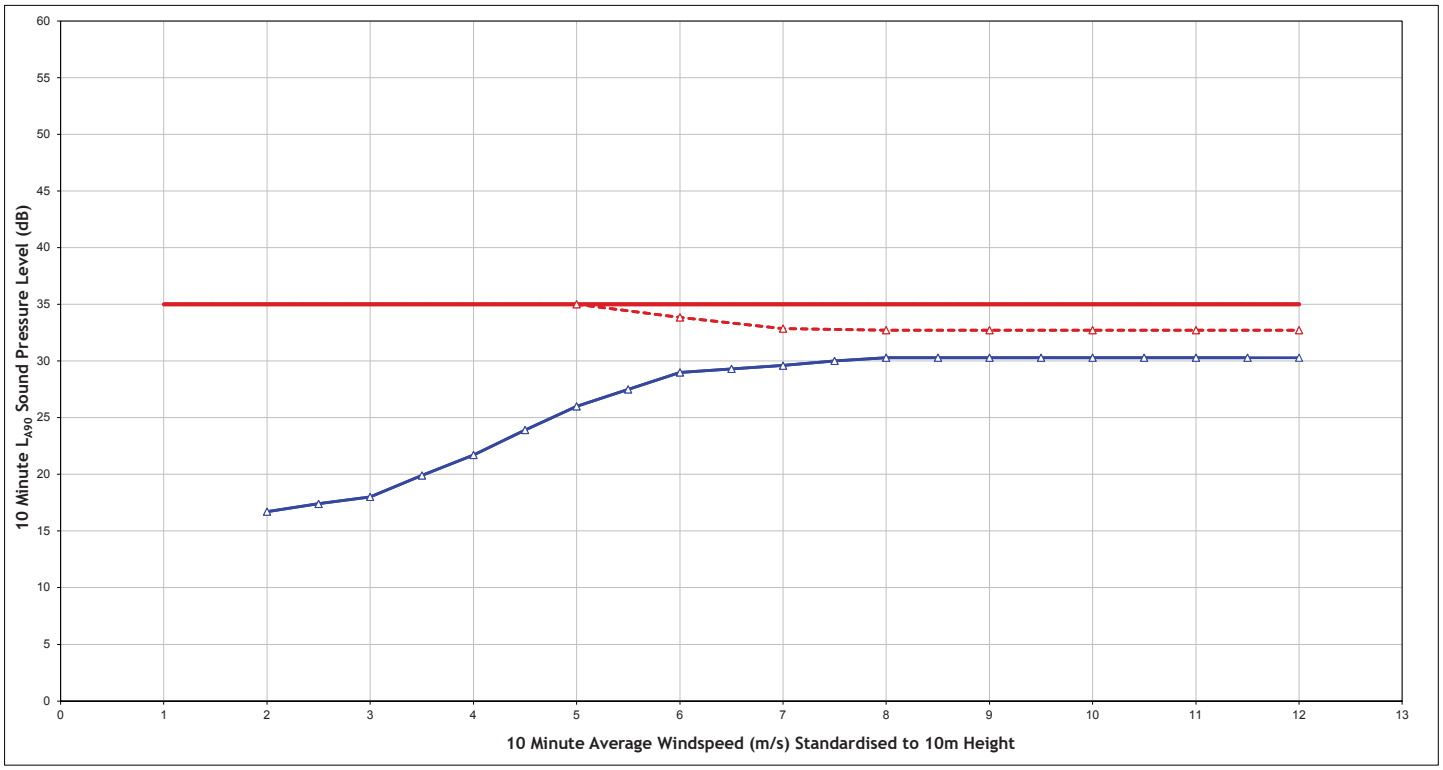
- Total ETSU-R-97-Limit
- Site Specific Noise Limit
- Proposed Development Only

Project	Bhlaraidh Wind Farm Extension
Client	SSE Generation Ltd
Title	Noise Assessment - Likely Noise Predictions Levishie Cottage (NAL2)
Figure Number	A1.5b
Scale	NTS
Drawn	GC
Checked	JM
Date	03/06/2021
Document Reference	13813-Models

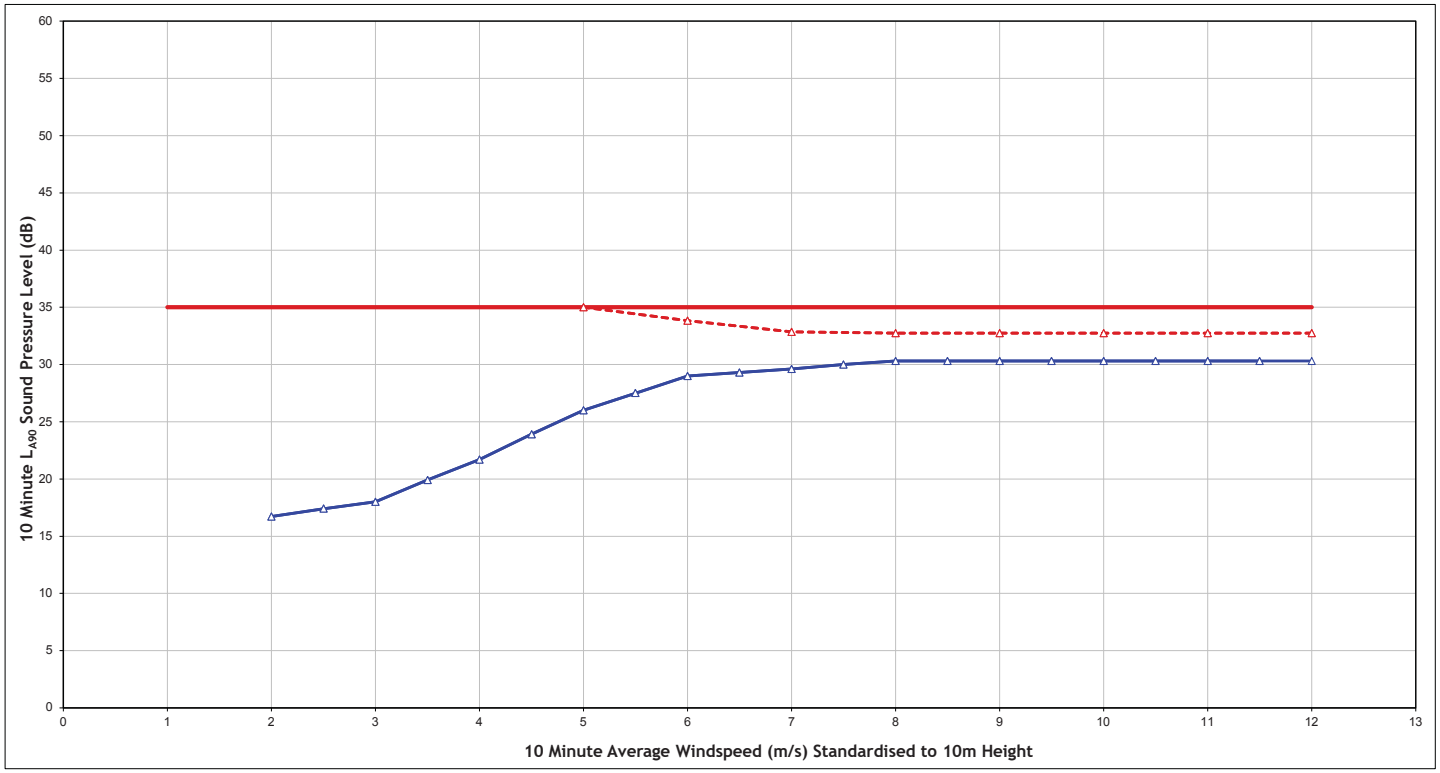
sse Renewables

tnei

Daytime - Achnaconeran (NAL3)



Night Time - Achnaconeran (NAL3)



Legend:

- Total ETSU-R-97 Limit
- Site Specific Noise Limit
- Proposed Development Only

Project	Bhlaraidh Wind Farm Extension
Client	SSE Generation Ltd
Title	Noise Assessment - Likely Noise Predictions Achnaconeran (NAL3)
Figure Number	A1.5c
Scale	NTS
Drawn	GC
Checked	JM
Date	03/06/2021
Document Reference	13813-Models

Annex 2 – Consultation Letter and Extract of Noise Conditions for Other Schemes

01 September 2020

Ref: 13813-001 – R0

Sent by email only.

Mr Robin Fraser
Environmental Health Officer
Highland Council
Community Services
38 Harbour Road
Inverness
IV1 UF

Dear Mr Fraser,

PROPOSED BHLARAIDH WIND FARM EXTENSION ON LAND TO THE NORTH WEST OF INVERMORISTON: NOISE ASSESSMENT

As you are aware, SSE Generation Ltd (SSE) is considering developing an extension to the operational Bhlaraidh Wind Farm ('the proposed development') to the north west of Invermoriston. An initial draft wind farm layout is shown on the enclosed Figure A1.1 (Appendix 1).

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

Construction and Decommissioning Noise

If required, a construction and decommissioning noise assessment will be undertaken to determine the potential noise impacts during the construction and decommissioning phases of the wind farm development. The construction and decommissioning noise assessment would 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 BS5228 and, where appropriate, mitigation measures will be proposed.

As per the Scoping Report, it is proposed that vibration is scoped out of the EIA.

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 Government's *'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".

Newcastle
7th Floor, West One
Forth Banks
Newcastle Upon Tyne
NE1 3PA
[redacted]
VAT Reg. GB 239 0116 20 | Company Reg. 03891836

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 Scottish Ministers 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. Higher fixed minimum limits apply to the occupiers of properties that have a financial interest in the wind farm development. The choice of daytime fixed minimum limits should be considered in light of the guidance contained within ETSU-R-97 and the IOA GPG. Noise limits established at properties in accordance with ETSU-R-97 shall be applicable to all existing / proposed wind turbines in the area, and will henceforth be referred to as the 'Total ETSU-R-97 Noise Limits'.

Site Specific Noise Limits would then be derived taking account of the noise limits already allocated to, or the limit that may be used by, other wind farm developments in the area. The Site Specific Noise Limits will be derived using the principles contained within the IOA GPG (which may include the use of the controlling property principal / determining if there is significant headroom etc). The Site Specific Noise Limits will be the limits that the proposed development would have to operate within should consent be granted.

Background Noise Survey

As part of the pre-construction work undertaken for Bhalaraidh Wind Farm a background noise assessment was undertaken in June/ July 2015 at two properties to the south to the proposed development. The noise monitoring was undertaken by Spectrum Acoustics. The two noise monitoring locations (NMLs) are shown on Figure A1.1 (Annex 1) and in the photographs below. At NML1 No.2 Bhlaraidh (approximate OS Grid Reference: 238064, 816644), the kit was sited in the north facing garden to the rear of the property and at NML2 Levishie House (approximate OS Grid Reference: 240263, 817682), the kit was sited to the north east of the property.

Photo 1 View of Position R1: No.2 Bhlaraidh, looking north across to the wind farm.

Photo 2 View of Position R2: Levishie House, looking North-West towards the house and in direction of wind farm

Bhlaraidh is comprised of a cluster of ~11 properties and Levishie a cluster comprising ~3 dwellings. Background noise levels were 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 was located in a free-field position at least 3.5m away from hard reflective surfaces where practicable and within the residential amenity area where possible.

There was a 70 m meteorological mast (met mast) installed to the north east of the Bhlaraidh Wind Farm site (within the proposed development site, See Figure A1.1) and that was used to collect wind speed and direction data at various heights during the noise survey.

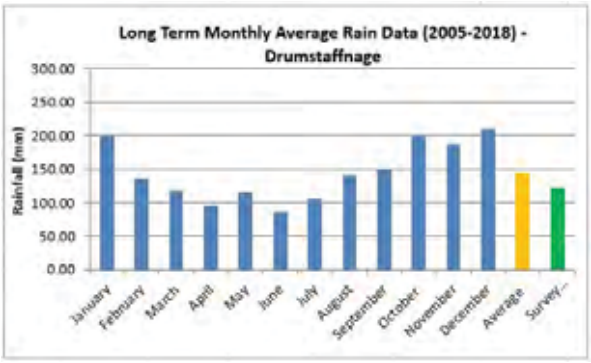
Operational Noise Assessment for the Proposed Development

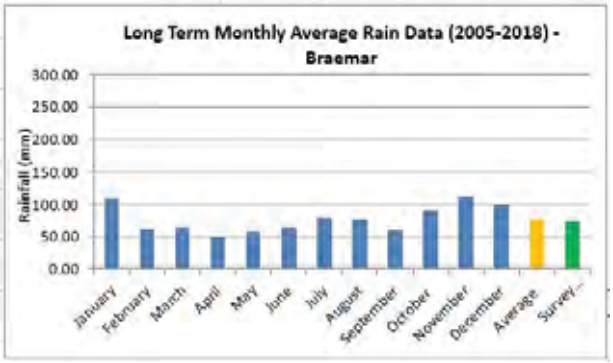
TNEI has undertaken a detailed review of the raw noise and meteorological data collected and re-analysed it in accordance with ETSU-R-97 and current good practice. The wind speed data collected at 50 m and 70 m height were used to calculate hub height wind speeds (114 m) which were then standardised to 10 m height, in accordance with current good practice. The hub height is subject to change but at this stage the 114 m hub represents a worst case in the design envelope currently being considered for the proposed development. The measurement heights of 70 m and 50 m conform with the IOA GPG stipulation that measurements should be taken at a height not less than 60 % of hub height and at least 15 m below.

The overall soundscape at both receptors is affected by the nearby watercourses. Both clusters of properties are in proximity to the River Moriston to the south which Spectrum Acoustics noted was audible at both monitoring locations as well as two other watercourses Allt Bhlaraidh (which runs to the west of Bhlaraidh) and Levishie Burn (which runs through the centre of the properties at Levishie). During the survey there were some periods of rainfall and some apparent lagging in the data following a rainfall event, however the noise levels remain relatively steady at both locations throughout the survey. The impacts of rainfall are discussed in SGN2 of the IOA GPG (Section 2.4).

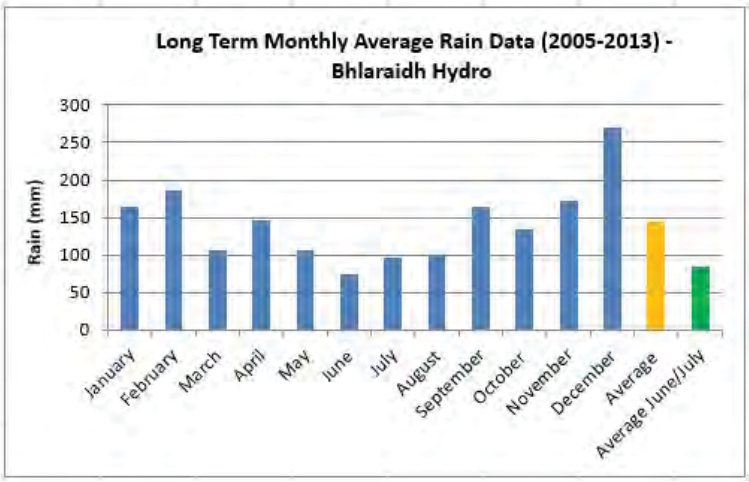
Section 2.4.1 of SGN2 states that *'if the rainfall and resulting watercourse flows are atypical then it may be appropriate to remove the data.'* However, Section 2.4.2 states that *'at some locations, the background noise environment will be dominated by noise from watercourses and the data may therefore show little correlation with wind speed. In such circumstances data filtering may not be necessary, this can sometimes be supported by using long term rain data for the area to show that rain fall during the survey period.'*

There appears to be a couple of periods of lagging in the noise data collected at both receptors and although this is most probably part of the natural variation at the receptors after a period of rainfall throughout the year the we have looked to remove periods, using data measured from the rain gauge, where short term increases in noise were apparent. To ensure that the level of rain measured during the monitoring period was representative of the long term rainfall, TNEI has reviewed the rain data collected at two of the closest weather stations to the site. As per Figure 5 of SGN 2 we compared the long term rain data from these weather station with the data collected during the months of the background noise survey and as can be seen on the two graphs below, the rainfall data collected during the survey months appears to be representative of typical conditions.





In addition, the graph below shows the long term rain data collected as part of the Bhlaraidh Hydro Scheme. Although the data collection period did not cover the survey year of 2015, it does show that the average yearly rainfall (yellow bar) compared to the average during the months when the survey was undertaken (June/July) (green bar).



A set of Regression Analysis Graphs showing the wind speed vs wind direction data for the daytime and night time periods at both NMLs are included within Appendix 1 as A1.2a and A1.2b. A set of Time Series Graphs have also been included which shows the variation of noise levels with wind speed and wind direction during the noise survey. Rainfall events are marked in blue on both sets of graphs and all excluded data in red. The excluded data reflects the data excluded due to lagging and also some atypical periods. We do intend to undertake a site visit to both locations (subject to any Covid 19 restrictions[1]) but we do anticipate that the data collected is representative of the two locations given their proximity to the watercourses.

[1] https://www.ioa.org.uk/sites/default/files/Joint%20Guidance%20On%20the%20Impact%20of%20Covid.IOA%20ANC%20V2.pdf

On that basis we propose to use the datasets to set noise limits at Bhlaraidh and Levishie as part of the noise assessment for the proposed development. The datasets will be used to derive the Total ETSU-R-97 Noise Limit (applicable to all schemes in the area) and the Site Specific Noise Limits for the proposed development which take account of the noise limit allocated to, or could be used by other schemes in the area.

Cumulative Noise Assessment

There are a number of operational wind farms and a proposed wind farm in the area and as such TNEI has undertaken some preliminary modelling to consider the schemes operating in conjunction with the proposed development. The schemes currently proposed for inclusion within the noise assessment are listed below:

- Corrimony (operational);
- Bhlaraidh (operational); and
- Fasnakyle (pre-planning).

TNEI understand that a planning application for the proposed Fasnakyle Wind Farm has not yet been submitted but it has been included within the initial modelling for completeness.

The wind turbines identified to date are shown on Figure A1.1. We would be grateful if you confirm whether you are aware of any other proposed, consented and operational wind turbine developments which are not listed above which would need to be included within the noise assessment.

Limit Derivation and Initial Noise Modelling

The preliminary noise modelling has been undertaken in three stages:

1) deriving the Total ETSU-R-97 Noise Limits (which are applicable to noise from all wind turbines in the area operating concurrently) at noise sensitive receptors;
2) predicting the likely effects (undertaking a cumulative noise assessment where required) to determine whether noise immissions at noise sensitive receptors will meet the Total ETSU-R-97 Noise Limits; and
3) deriving Site Specific Noise Limits for the proposed development (taking account of the noise limit that has already been allocated / could realistically be used by other schemes) and undertaking predictions against those limits.

A total of seven Noise Assessment Locations (NALs) have been identified for the initial modelling. The NALs were chosen to represent the noise sensitive receptors located closest to the proposed development and additional receptors were included to consider cumulative noise impacts. As detailed above TNEI propose to use the background noise data previously collected to set the noise limits.

As detailed above wind speed was measured at various heights using a temporary meteorological mast which was located on the proposed development site. The data collected at 50 m and 70 m height was used to calculate hub height wind speeds (114 m) which were then standardised to 10 m height, in accordance with current good practice. 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 daytime and night-time noise limits.

Having due regard to the guidance in ETSU-R-97 and the draft layout for the proposed development, at the two locations where background noise levels have been undertaken, some preliminary Total ETSU-R-97 Noise limit have been derived for information purposes. Once the Total ETSU-R-97 Noise limits have been finalised a set of Site Specific Noise Limits will be derived for each receptor for the daytime and night time period. At other receptors, where the baseline data collected at Bhlaraidh or Levishie is not deemed a suitable proxy or where noise limits have not already been set, it is proposed that the noise limits will be set based on the simplified ETSU-R-97 Noise Criterion of *35 dB(A)* $L_{90,10min}$ *up to wind speeds of 10 m/s at 10 m height.*

Predictions of wind turbine noise for the proposed development were made, based upon the sound power level data for a candidate wind turbine, the GE 158, 5.3 MW. This wind turbine model has been chosen as it is considered to be representative of the type of turbine that could be installed at the site. Whatever the final turbine choice is, the proposed development would have to meet the noise limits determined and contained within any condition applied as part of the consent. Modelling was undertaken using the ISO 9613: 1996 'Acoustics – Attenuation of sound during propagation outdoors Part 2: General method of calculation' noise prediction model which accords with current good practice and is considered to provide a realistic impact assessment. For the other schemes, predictions have been undertaken using sound power level data for the installed turbines or a suitable candidate. The model of turbine was either identified through an online search, or through the use of Highland Council's Planning Application Portal.

The likely cumulative assessment shows that the proposed development can operate concurrently with the proposed, consented and operational wind farms in the area, whilst still meeting the Total ETSU-R-97 Noise limits at all receptors except NAL6 (See Figures A1.4a-g). At NAL6 there is a slight exceedance of the limits but this is based on a draft Fasnakyle Wind Farm (which is the dominant development) so this is subject to change. It should also be noted that the likely contribution of the proposed development is negligible at this location (with predicted noise levels being nearly 20 dB(A) below the Total ETSU-R-97 Noise Limits) and on that basis it may be scoped out of the final assessment.

A set of preliminary Site Specific Noise Limits have also been derived which take account (where required) of the other wind farm developments. The process to derive the Site Specific Noise Limits at each NAL was a follows:

NAL1 and NAL2 – Bhlaraidh Wind Farm has a noise limit set at the receptors based on 35dB(A) L_{90}. On that basis the predicted noise levels for Bhlaraidh have been increased to meet the noise limits. The increase in level has been determined based on the minimum difference (seen at 8m/s) between the predicted level and the 35 dB limit and that difference has been applied across all wind speeds. For all other developments there is significant headroom at these properties so cautious predictions have been undertaken by adding 2 dB to the likely levels. The resulting cautious predictions for all other schemes have then been logarithmically subtracted from the Total ETSU-R-97 Noise Limit to determine the Site Specific Noise Limit for the proposed development.

NAL3 and 5 - The noise predictions for the other proposed and operational schemes show that there is, in theory, significant headroom between the likely predicted levels and the Total ETSU-R-97 Noise Limit (>5 dB). In accordance with Section 5.4.11 of the IOA GPG, a 2 dB buffer has been added to the turbine noise predictions for each of the other developments; this is considered to be a suitable buffer in accordance with the IOA GPG and would represent a 60% increase in emitted noise levels from the other schemes. The resulting cautious predictions of cumulative wind turbine noise have then been logarithmically subtracted from the Total ETSU-R-97 Noise Limit to determine the Site Specific Noise Limit for the proposed development.

NAL4 and 7 - The likely predictions level from other schemes were found to be more than 10 dB below the Total ETSU-R-97 Noise Limits and as such the entire noise limits has been allocated to the proposed development.

NAL6 - The likely predictions level from other schemes were found to equal the Total ETSU-R-97 Noise Limits, however the proposed development is having a negligible contribution.

A set of figures showing the preliminary Site Specific Noise Limits and predictions from the proposed development against the limits are included as Figures A1.5a-g in Annex 1.

Please note that the wind farm layout is still subject to change but we were keen to get your thoughts at this early stage on our proposed methodology for the noise assessment. To enable us to progress the assessment we would be very grateful if you confirm whether:

- You agree with our proposed approach to use the previously collected baseline noise data at Bhlaraidh and Levishie to set noise limits;
- You agree with the general approach we are proposing to set noise Total and Site Specific Noise Limits at the nearest receptors;
- The Council is aware of any schemes which should be included in the cumulative noise assessment or any other dwellings which should be considered; and
- You agree that a vibration assessment is not required.

If you have any immediate concerns or queries, please do not hesitate to contact me or my colleague James Mackay. We look forward to hearing from you soon.

Yours sincerely,

[redacted]

Gemma Clark
BSc(Hons), MSc, AMIOA

Principal Consultant

[redacted]

Reviewed and approved by:

[redacted]

BSc(Hons), Dip, MIOA

Director of Environment & Engineering

[redacted]

Enc.

Figure A1.1 - Noise Monitoring and Assessment and Turbine Locations
Figure A1.2a-b – Regression Analysis Graphs
Figure A1.3a-b – Time Series Graphs
Figure A1.4a-b – Cumulative Predictions – Likely Effects
Figure A1.5a-b – Site Specific Noise Modelling

NOTE: The Figures included within the original Consultation Letter have been superseded by the assessment presented in this report and as such they have not been included here.

Gemma Clark

From: [redacted]
Sent: 04 December 2020 12:03
To: [redacted]
Subject: RE: Bhlaraidh Extension - noise assessment

As per usual my apologies for taking so long to get back to you. To respond directly to your queries; -

-You agree with our proposed approach to use the previously collected baseline noise data at Bhlaraidh and Levishie to set noise limits;
I understand the background measurements were affected by noise from nearby watercourses but I am satisfied that for those NALs this noise can be considered as part of the background noise. I'm happy with the approach that has been taken with rain fall data to ensure the background levels are representative. I also note that at Achnaconeran, which is not impacted by noise from the river, a simplified ETSU limit of 35dB LA90 has been applied and I welcome that approach.

- You agree with the general approach we are proposing to set noise Total and Site Specific Noise Limits at the nearest receptors;
I'm happy with the approach taken on the understanding that the cumulative figures are based on the conditioned limits for Blaraidh and a 2dB margin over predicted levels for other developments due to significant headroom. At NALs where developments are more than 10db below ETSU limits, they have been discounted from the cumulative assessment. I'm happy with this approach.

With regard to site specific limits, to avoid repeating the same cumulative noise problems for future developments, my preference is to cap limits at 2db above predicted. In some cases this will result in very low limits which would be too low to undertake compliance monitoring. It may be that proxy monitoring locations could be used or it might be reasonable to set limits only for Levishie and Achnaconeran. The latter will undoubtably be the controlling property.

- The Council is aware of any schemes which should be included in the cumulative noise assessment or any other dwellings which should be considered; and
I'm not aware of any other schemes that should be considered however, I would advise that you seek confirmation from the planning Service.

- You agree that a vibration assessment is not required.
Agreed

Again, sorry for the delay. If there's anything you want to discuss please get in touch.

Regards,
Robin Fraser
Environmental Health Officer
Highland Council, Community Services, 38 Harbour Road, Inverness, IV1 1UF
Telephone: [redacted]

From: Cais, Calum [redacted]
Sent: 25 November 2020 16:06
To: Robin Fraser [redacted]
Subject: RE: Bhlaraidh Extension - noise assessment

Hi Robin

I hope you are keeping well?

Just wanted to follow up to see if you had any comments on the proposed approach to the EIA or whether you're happy for us to continue on the basis of the method proposed?

Thanks

Calum

From: Cais, Calum
Sent: 03 September 2020 09:08
To: Robin Fraser [redacted]
Subject: RE: Bhlaraidh Extension - noise assessment

Hi Robin

I hope you're keeping well? Please accept my apologies for the delay in getting this letter to you. As discussed at our previous meeting on Bhlaraidh wind farm extension James and Gemma at TNEI have prepared the attached letter for your consideration.

You will see that the letter is in line with the discussions we had on 3rd August, but with greater detail. Our intention is to agree some of the broad principles ahead of the full EIAR chapter and appendices.

As such I hope that you will find the letter useful, and that if you have any queries or issues that you can contact either myself or TNEI directly to discuss. If you are comfortable with the principles and approach proposed I would be grateful if you could confirm this, in which case we will continue with the assessment for the EIA as per the letter.

I look forward to hearing from you in due course.

Regards

Calum

From: Robin Fraser [redacted]
Sent: 31 July 2020 13:55
To: Cais, Calum [redacted]
Subject: [EXTERNAL] RE: Bhlaraidh Extension - noise assessment

WARNING: this email has originated from outside of the SSE Group. Please treat any links or attachments with caution.

Hi Calum, Monday afternoon would be best for me.

Regards,
Robin Fraser
Environmental Health Officer
Highland Council, Community Services, 38 Harbour Road, Inverness, IV1 1UF

Telephone: [redacted]

N.B. Any email message sent or received by the Council may require to be disclosed by the Council under the provisions of the Freedom of Information (Scotland) Act 2002

Environmental Health welcomes your feedback. Please help us improve our service by taking our short customer survey by clicking on this link
https://www.surveymonkey.com/s/highlandeh

From: Cais, Calum [redacted]
Sent: 31 July 2020 13:54
To: Robin Fraser [redacted]
Subject: Bhlaraidh Extension - noise assessment

Hi Robin

I hope you're well? I wondered if you might be available to talk through the noise assessment that we intend to carry out for Bhlaraidh Extension next week?

TNEI have been appointed by SSE to carry out the assessment and have availability at the following times. If you are able to attend a call to discuss the assessment at any of the times below please let me know and I can arrange a call.

Monday
11:00 – 17:30

Thursday
09:00 – 17:30

Regards

Calum Cais || Noise Analyst

Working days Mon. & Wed. to Fri.

SSE Renewables
One Waterloo Street
Glasgow, G2 6AY

[redacted]

sserenewables.com

Energy & Climate Change Directorate
Electricity Division

[redacted]

The Scottish Government
Riaghaltas na h-Alba

Mr A Sloan
Development Manager
SSE Generation Limited
1 Waterloo Place
Glasgow
G2 6AY

LEGACY 2014
XX COMMONWEALTH GAMES
GLASGOW

17 January 2014

Dear Mr Sloan

CONSENT AND DEEMED PLANNING PERMISSION BY THE SCOTTISH MINISTERS TO CONSTRUCT AND OPERATE THE BHLARAIDH WIND POWERED ELECTRICITY GENERATING STATION NEAR INVERMORISTON, HIGHLANDS

Application

I refer to the Application made by SSE Generation Limited ("The Company") dated 29 June 2012 as read with the Supplementary Environmental Information to the application dated 31 May 2013 for consent under section 36 of the Electricity Act 1989 ("The Electricity Act") for construction and operation of Bhlaraidh wind farm electricity generating station approximately 4km north west of Invermoriston, Highlands with a generation capacity of up to 108 MW. **This letter contains the Scottish Ministers decision to consent the application.**

Planning Permission
In terms of section 57(2) of the Town and Country Planning (Scotland) Act 1997 Scottish Ministers may on granting consent under section 36 of the Electricity Act direct that planning permission be deemed to be granted in respect of that generating station and any ancillary development (as described in Annex 1). This letter contains the Scottish Ministers decision on such a direction.

Consultation

In accordance with statutory requirements, advertisements of the Application had to be placed in the local and national press. Ministers note that these requirements have been met.

Under Schedule 8 of the Electricity Act, the relevant planning authority is required to be notified in respect of a section 36 consent application. Notifications were sent to

Reason: To ensure that all water crossings are free from flood risk and do not exacerbate flood risk elsewhere.

29. The Wind Turbine Noise Level, including the application of any tonal penalty specified in ETSU-R-97 at pages 99-109, shall not exceed 35 dB LA9O,10min at any Noise-Sensitive Premises. This condition shall only apply at wind speeds up to 10m/s measured or calculated using the methods described in "Prediction and Assessment of Wind Turbine Noise" (published in IQA Bulletin March/April 2009).

Reason: *To ensure that the noise impact of the built turbines does not exceed the predicted noise levels set out within the supporting Environmental Statement*.

30. The Company shall, beginning with the first day upon which the wind farm becomes operational, log wind speed and wind direction data continually and shall retain the data for a period of at least 12 months from the date that it was logged. The data shall include the average wind speed, measured in metres per second, over 10 minute measuring periods. These measuring periods shall be set to commence on the hour and at 10 minute consecutive increments thereafter. Measurements shall be calculated at 10m above ground level using the methods described in "Prediction and Assessment of Wind Turbine Noise" (published in IOA Bulletin March/April 2009). All wind speed data shall be made available to the Planning Authority on request in Microsoft Excel compatible electronic spreadsheet format.

Reason: *To ensure that the noise impact of the built turbines can be assessed, if necessary following a complaint, in order to demonstrate that they do/do not exceed the predicted noise levels set out within the supporting Environmental Statement*.

31. (1) At the reasonable request of the Planning Authority, the Company shall assess, at its own expense and using a suitably qualified consultant(s) not involved in the original noise assessment, the level of noise emissions from the Wind Turbines.

(2) Assessment shall be carried out in accordance with the Noise Measurement and Mitigation Scheme approved under condition **32** and a report of assessment shall be submitted to the Planning Authority within two months of a request under this condition, unless an alternative timescale is otherwise agreed in writing by the Planning Authority.

(3) If noise emissions are found to exceed limits prescribed under this planning permission at condition **29**, then the Company shall implement mitigation measures in full accordance with the approved Noise Measurement and Mitigation Scheme, or alternative equal or better mitigation measures as may first be approved in writing by the Planning Authority, in order to reduce noise levels to comply with prescribed limits. The time period for implementing mitigation measures shall be as outlined in the approved Noise Measurement and Mitigation Scheme or as otherwise may be specified writing by the Planning Authority.

Reason: *To ensure that, following a complaint, noise levels can be measured to assess whether or not the predicted noise levels set out within the supporting Environmental Statement have been breached, and where excessive noise is recorded, suitable mitigation measures are undertaken.*

32. (1) No development shall commence unless and until a Noise Measurement and Mitigation Scheme has been submitted to, and approved in writing by, the Planning Authority.

    (2) The Noise Measurement and Mitigation Scheme shall include:
    a. a framework for the measurement and calculation of noise levels to be undertaken in accordance with "The Assessment & Rating of Noise from Wind Farms", September 1996, ESTU report number ETSU-R-97 having regard to paragraphs 1-3 and 5-11 inclusive, of The Schedule, pages 95 to 97; and Supplementary Guidance Notes to the Planning Obligation, pages 99 to 109.Wind speeds shall be determined using the methods in "Prediction and Assessment of Wind Turbine Noise" (published in IOA Bulletin March/April 2009); and
    b. Mitigation measures to be enacted, along with a timetable(s) for implementation, should noise emissions exceed the limits prescribed under this planning permission at condition **29.**

Reason: *To ensure that the noise impact of the built turbines can be assessed, if necessary following a complaint, in order to demonstrate that they do/do not exceed the predicted noise levels set out within the supporting Environmental Statement, and where excessive noise is recorded, suitable mitigation measures can be undertaken.*

33. (1) No development shall commence unless and until a Habitat Management Plan (HMP) has been submitted to, and approved in writing by the Planning Authority, in consultation with SNH and SEPA.

    (2) The HMP shall set out measures to protect and manage habitat and species within and adjoining the Site and, shall include -

    (a) measures to minimise any impact on Black Grouse, their habitat and lekking stances;
    (b) measures to preserve, restore and manage native woodland within the application site and
    (c) more generally, the identification of management methods and opportunities to mitigate for any adverse impacts on sensitive habitats as identified in the Environmental Statement.

(3) The HMP shall be implemented in full unless otherwise agreed in writing by the Planning Authority, in consultation with SNH and SEPA.

Reason: *To protect and enhance the nature conservation interests of the area, including the management of vegetation and woodland on the site, mitigate any effects on Black Grouse and their habitat and avoid adverse effects on other species of nature conservation interest.*

The Highland Council
Comhairle na Gàidhealtachd

PLANNING PERMISSION

Reference No: 10/02132/FUL

To:
Corrimony Energy Ltd & Soirbheas Ltd
Per Mr John Girvan
13 East Road
Kirkwall
Orkney KW15 1HZ

Town & Country Planning (Scotland) Act 1997 as amended by the Planning Etc. (Scotland) 2006 Act

DECISION NOTICE

To erect 5 x 2MW wind turbines on the hill ground of Corrimony Farm on hill ground at Corrimony Farm, Glenurquhart, Inverness

The Highland Council in exercise of its powers under the above Acts **grants planning permission** for the above development in accordance with the particulars given in the application and the following plans/drawings:

Type of Plan	Plan Number	Version No.	Date Plan Received
Location/Site Plan			01.11.2010

This permission is granted subject to the following conditions: -

1. **The development to which this planning permission relates must commence within THREE YEARS of the date of this decision notice.**

   Reason: In order to accord with the statutory requirements of the Town and Country Planning (Scotland) Acts.

2. **The permission granted shall endure for a period of 25 years from the date when electricity is first exported from any of the wind turbines to the electricity grid network ("First Export Date"). Written confirmation of the First Export Date shall be provided to the Planning Authority within 1 month of the First Export Date.**

   Reason: The application is for a temporary period of 25 years.

3. **Not later than 12 months before the end of the consent period, a decommissioning and site restoration scheme shall be submitted for the written approval of the Planning Authority, such scheme to include the removal of above-ground elements of the development, management and timing of any works, environmental management provisions and a traffic management plan to address any traffic impact issues during the decommissioning period. The scheme shall be implemented as approved.**

   Reason: To ensure the decommissioning and removal of the development in an appropriate and environmentally acceptable manner and the restoration of the site, in the interests of safety, amenity and environmental protection.

Dated: 18th November 2010

[redacted]

Head of Planning and Building Standards

23. Two months prior to the commencement of development the applicant will provided both the Ministry of Defence and the Defence Geographic Centre (AIS Information Centre) with a statement, copied to the Planning Authority and Highland and Islands Airport Authority Ltd, containing the following information:-

- The date of commencement of the construction;
- The exact position of the turbine towers in latitude and longitude;
- A description of all structures over 300 feet high
- The maximum extension height of any construction equipment;
- The height above ground level of the tallest structure; and
- Turbines shall be fitted with 25 candela omni-directional red lighting at the highest practicable point on the turbines.

Reason: In order to ensure aviation safety.

24. The Wind Farm Operator shall log wind speed and wind direction data continually and shall retain the data which has been obtained for a period of no less than the previous 12 months. The data shall include the average wind speed in metres per second for each 10 minute period. The measuring periods shall be set to commence on the hour or in 10 minute increments thereafter. The wind speed data shall be made available to the Planning Authority on request. The data shall be provided on a Microsoft Excel spreadsheet in electronic format. In the case where the wind speed is measured at a height other than 10 m, the data shall be supplemented by adjusted values which allow for wind shear, normalised to 10m height. Details of the wind shear calculation shall be provided. At Wind Speeds not exceeding 12m/s, as measured or calculated at a height of 10m above ground level at the wind farm the Wind Turbine Noise Level at a distance of 1km from the edge of the nearest outer turbine shall not exceed:-

(a) during Night Hours, 38dB LA90,10min, or the Night Hours LA90, 10min Background Noise Level plus 5 dB(A), which ever is the greater;

(b) during Quiet Waking Hours, 35 dB LA90,10min or the Quiet Waking Hours LA90, 10min Background Noise Level plus 5 dB(A), which ever is the greater

At the request of the Planning Authority, following a valid complaint to the Planning Authority relating to noise emissions from the Wind Turbines, the Wind Farm Operator shall measure, at its own expense, the level of noise emissions from the Wind Turbines. The measurement and calculation of noise levels shall be undertaken in accordance with "The Assessment & Rating of Noise from Wind Farms", September 1996, ESTU report number ETSU-R-97 having regard to paragraphs 1-3and 5-11 inclusive, of The Schedule, pages 95 to 97; and Supplementary Guidance Notes to the Planning Obligation, pages 99 to 109. In comparing measured Wind Turbine Noise Levels with Background Noise Levels, regard shall be had to the prevailing Background Noise Levels as measured at specified locations.

"Wind Turbine Noise Level" means the rated noise level due to the combined effect of all the Wind Turbines at the Wind Farm, excluding existing background noise level but including any tonal penalty incurred under the methodology described in ETSU¿R ¿97, pages 99 - 109.

"Background Noise Level" means the ambient noise level already present within the environment (in the absence of noise generated by the Development) as measured and correlated with Wind Speeds.

[redacted]

Dated: 18th November 2010

Head of Planning and Building Standards

"Wind Speeds" means wind speeds measured or calculated at a height of 10 metres above ground level at the Met Mast locations on the wind farm site shown on Figure 4.1 Environmental Statement.

"Night hours" means 23:00 - 07:00 hours on all days.

"Quiet Waking Hours" means 18:00 - 23:00 hours on all days, plus 07:00 - 18:00 on Sundays and 13:00 - 18:00 hours on Saturdays.

Reason: In order to control noise in the interest of residential amenity.

FOR INFORMATION

1. **SEPA has advised that authorisation under CAR will be required for some proposed activities.**

2. **Contact should be made with TR-NMD Bridges Branch (Tel No 0131 244 4363) as to the feasibility of abnormal load movements from the nearest suitable port. Abnormal load authorisation from Scotland Transerve may be required contact Trunk Roads Development Management 0141 272 7338 for further information**

3. **Maintenance issues, requiring HGV or Abnormal traffic movements to the site, may be necessary throughout the 25 year lifetime of the development. Such access issues need prior discussion with the Council's TEC Services.**

4. **No development shall start on site until the completed Notice of Initiation of Development (NID) form attached to this decision notice has been submitted to and acknowledged by the Planning Authority.**

5. **Upon completion of the development the completed Notice of Completion form attached to this decision notice shall be submitted to the Planning Authority.**

Variations
During the processing of the application the following variations were made to the proposal:
1. None.

Section 75 Agreement
An Agreement in terms of Section 75 of the 1997 Planning Act relates to this development. The terms of the Section 75 Agreement are as follows:
1. None.

The full Section 75 Agreement can be inspected at the relevant planning office.

Dated: 18th November 2010

Head of Planning and Building Standards

Annex 3 – Noise Survey Information and Calibration Certificates

CERTIFICATE OF CALIBRATION

ISSUED BY AV CALIBRATION

Date of issue 14 April 2015 Certificate N° 1504220

AV Calibration
2 Warren Court
Chicksands, Shefford
Bedfordshire SG17 5QB
U.K.

[redacted]

[redacted]

Acoustics Noise and Vibration Ltd trading as AV Calibration

CLIENT	Spectrum Acoustic Consultants Ltd The Standish Centre Suite 103, 1st Floor Cross Street Standish Wigan WN6 0HQ
F.A.O.	Peter Jackson
ORDER No	PO1278/ELP Job No TRAC15/04097/02
DATE OF RECEIPT	07 April 2015
PROCEDURE	AV Calibration Engineer's Handbook section 3
IDENTIFICATION	Sound level meter Brüel & Kjær type 2238-F serial No 2285767 connected via a preamplifier type ZC 0030 to a half-inch microphone type 4188 serial No 2289858 fitted with a microphone protection cover type UA 1236. Associated calibrator Brüel & Kjær type 4231 serial No 2309049 with a one-inch housing and adapter type UC 0210 for half-inch microphone.
CALIBRATED ON	14 April 2015
PREVIOUS CALIBRATION	Calibrated on 09 April 2013, Certificate No. 1304148 issued by this laboratory.

CERTIFICATE OF CALIBRATION

ISSUED BY AV CALIBRATION

Date of issue 07 April 2015 Certificate N° 1504202

AV Calibration
2 Warren Court
Chicksands, Shefford
Bedfordshire SG17 5QB
U.K.
[redacted]

[redacted]

Acoustics Noise and Vibration Ltd trading as AV Calibration

CLIENT	Spectrum Acoustic Consultants Ltd The Standish Centre Suite 103, 1st Floor Cross Street Standish Wigan WN6 0HQ
F.A.O.	Peter Jackson
ORDER No	PO1278/ELP Job No TRAC15/04097/01
DATE OF RECEIPT	07 April 2015
PROCEDURE	AV Calibration Engineer's Handbook section 2
IDENTIFICATION	Sound Calibrator Brüel & Kjær type 4231 serial number 2309049 with one-inch housing and adapter type UC 0210 for half-inch microphone
CALIBRATED ON	07 April 2015
PREVIOUS CALIBRATION	Calibrated on 08 April 2013, Certificate No. 1304146 issued by this laboratory.

CERTIFICATE OF CALIBRATION

ISSUED BY AV CALIBRATION

Date of issue 03 February 2014 Certificate N° 1402073

AV Calibration
2 Warren Court
Chicksands, Shefford
Bedfordshire SG17 5QB
U.K.
[redacted]

[redacted]

Acoustics Noise and Vibration Ltd trading as AV Calibration

CLIENT	Spectrum Acoustic Consultants Ltd The Standish Centre Cross Street Standish Wigan WN6 0HQ
F.A.O.	Peter Jackson
ORDER No	PO.1187 Job No TRAC14/01022/02
DATE OF RECEIPT	17 January 2014
PROCEDURE	AV Calibration Engineer's Handbook section 3
IDENTIFICATION	Sound level meter Brüel & Kjær type 2238-E-F serial No 2246383 connected via a preamplifier type ZC 0030 serial No 4709 to a half-inch microphone type 4188 serial No 2249792 fitted with a microphone protection cover type UA 1236. Associated calibrator Brüel & Kjær type 4231 serial No 2594791 with a one-inch housing and adapter type UC 0210 for half-inch microphone.
CALIBRATED ON	03 February 2014

The measurements detailed herein are traceable to units of measurement realised at the National Physical Laboratory.

CERTIFICATE OF CALIBRATION

ISSUED BY AV CALIBRATION

Date of issue 31 January 2014 Certificate N° 1401069

AV Calibration
2 Warren Court
Chicksands, Shefford
Bedfordshire SG17 5QB
U.K.
[redacted]

[redacted]

Acoustics Noise and Vibration Ltd trading as AV Calibration

CLIENT	Spectrum Acoustic Consultants Ltd The Standish Centre Cross Street Standish Wigan WN6 0HQ
F.A.O.	Peter Jackson
ORDER No	PO1187 Job No TRAC14/01022/01
DATE OF RECEIPT	17 January 2014
PROCEDURE	AV Calibration Engineer's Handbook section 2
IDENTIFICATION	Sound Calibrator Brüel & Kjær type 4231 serial number 2594791 with one-inch housing and adapter type UC 0210 for half-inch microphone
CALIBRATED ON	31 January 2014
PREVIOUS CALIBRATION	Calibrated on 06 February 2012, Certificate No. 1202051 issued by this laboratory.

The measurements detailed herein are traceable to units of measurement realised at the National Physical Laboratory.

2. NOISE LIMIT CRITERIA

Condition 29 sets out the applicable noise limit for the wind farm operation, together with the reasons for applying this Condition:

The Wind Turbine Noise Level, including the application of any tonal penalty specified in ETSU-R-97 at pages 99-109, shall not exceed 35dB $L_{A90,10min}$ at any Noise Sensitive Premises. This condition shall only apply at wind speeds up to 10m/s measured or calculated using the methods described in ''Prediction and Assessment of Wind Turbine Noise'' (published in IOA Bulletin March/April 2009).

Reason: *To ensure that the noise impact of the built turbines does not exceed the predicted noise levels set out within the supporting Environmental Statement.*

In the *'reason for condition'* of Condition 29 it is suggested that there is a requirement for wind farm noise to meet the predicted levels set out in the project Environmental Statement (ES). However, due to the large separation distances, predicted wind farm noise levels are very low and significantly below the absolute noise target of $L_{A90,10min}$, 35dB(A), as defined in Condition 29.

The purpose of the ES predictions was not to set these levels as a noise limit requirement, but to serve as a demonstration that wind farm noise would meet the 35dB(A) objective. Consequently for the purpose of the project NMMS, Condition 29 noise limit is assumed to take precedence.

3. BACKGROUND NOISE SURVEY

In line with ETSU-R-97 advised procedures, together with guidance provided in the GPG, noise data for the purpose of describing background noise under a range of wind speeds, extending to at least 10m/s, has been acquired at the noise sensitive locations in closest proximity to Bhlaraidh Wind Farm.

3.1 MEASUREMENT LOCATIONS

The separation distances between residential receptors and Bhlaraidh Wind Farm are very large, with only two small community areas, Bhlaraidh and Levishie (to the west of Invermoriston), within 3km of a wind turbine. These positions, as described in Table 1 and Figure 1, have therefore been identified as the key receptor positions for the purpose of measuring background noise.

Receptor Position	Distance to nearest turbine (m)	OS Ref. No	Detail
R1: No. 2 Bhlaraidh	2973	238058E 816633N	This receptor position is to the south of the wind farm site, within the small community of Bhlaraidh. The noise monitor was located in the rear (north facing) garden of the property, looking across to the wind farm site. This receptor position is located 150m north of the A887 and 200m north of River Moriston. A small river, the Allt Bhlaraidh, runs approximately 50m to the west of the property, flowing south into River Moriston.
R2: Levishie House	2961	240237E 817661N	This receptor position is to the southeast of the wind farm site, within the small community of Levishie. The noise monitor was located in garden amenity land to the east of property, with an open view northwest to the wind farm site. This receptor position is located 80m north of the A887 and 120m north of River Moriston.

Table 1: Closest noise sensitive receptor positions to Bhlaraidh Wind Farm.

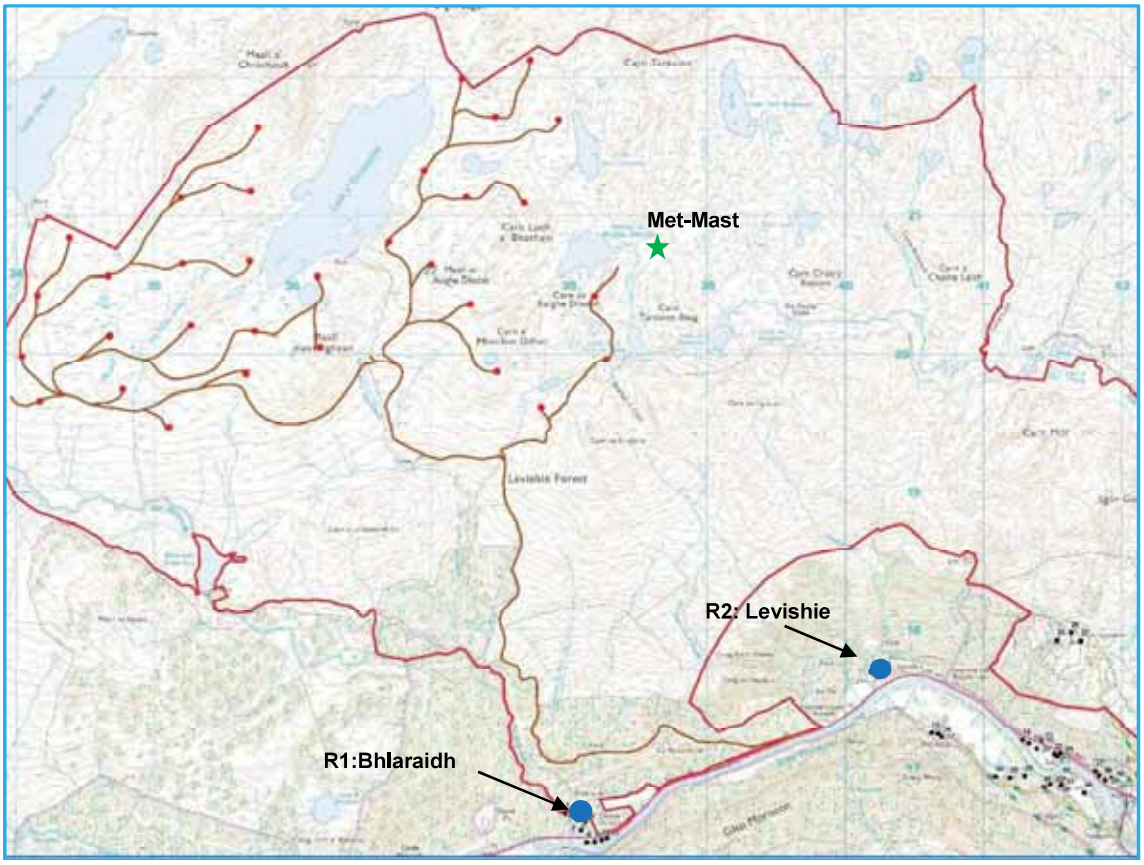


Figure 1: Plan showing Bhlaraidh Wind Farm and closest residential community receptor positions

Photos of the measurement positions at No.2 Bhlaraidh and Levishie House are included in Figure 2.

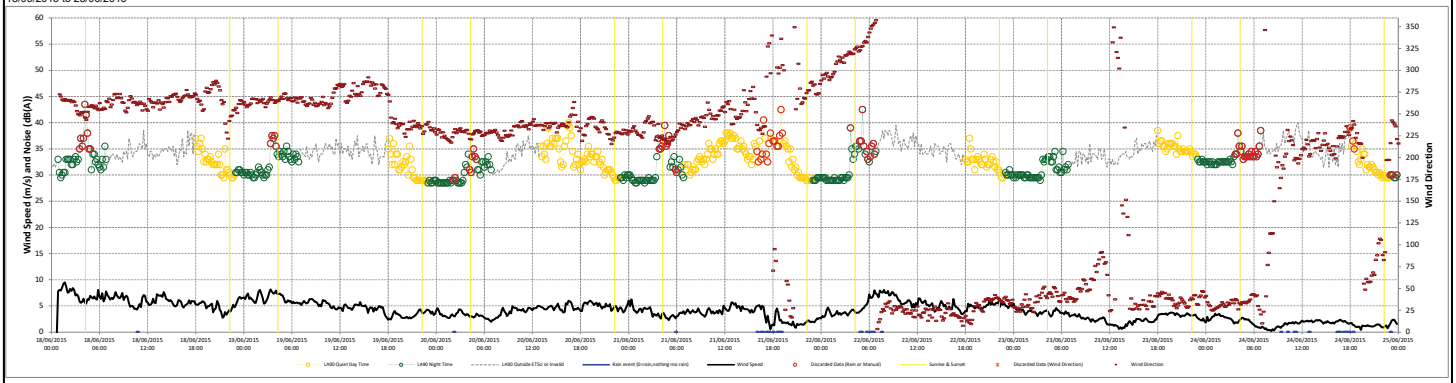
Photo 1 View of Position R1: No.2 Bhlaraidh, looking north across to the wind farm.

Photo 2 View of Position R2: Levishie House, looking North-West towards the house and in direction of wind farm

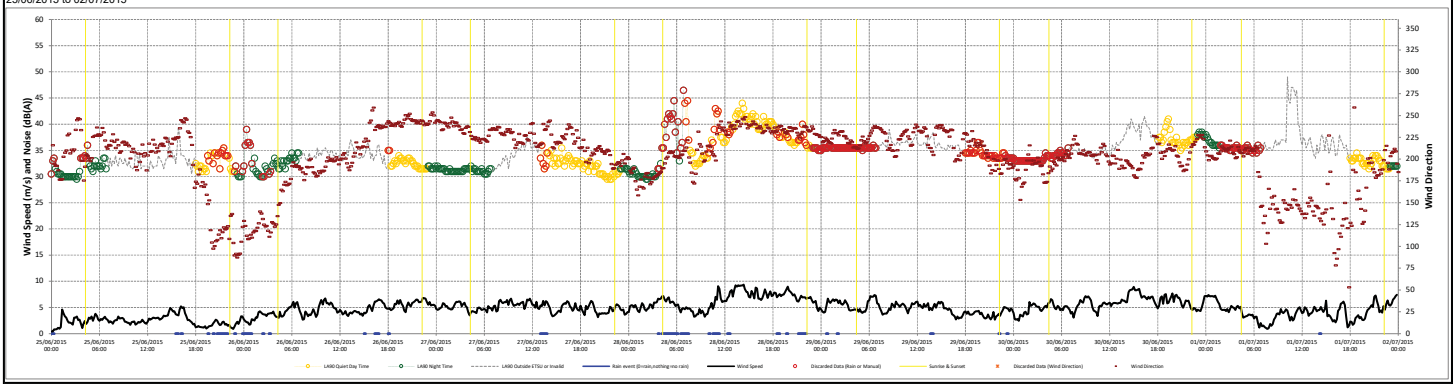
Figure 2: Photos of noise measurement position at R1: No.2 Bhlaraidh and R2: Levishie House

Annex 4 – Time Series Graphs

18/06/2015 to 25/06/2015

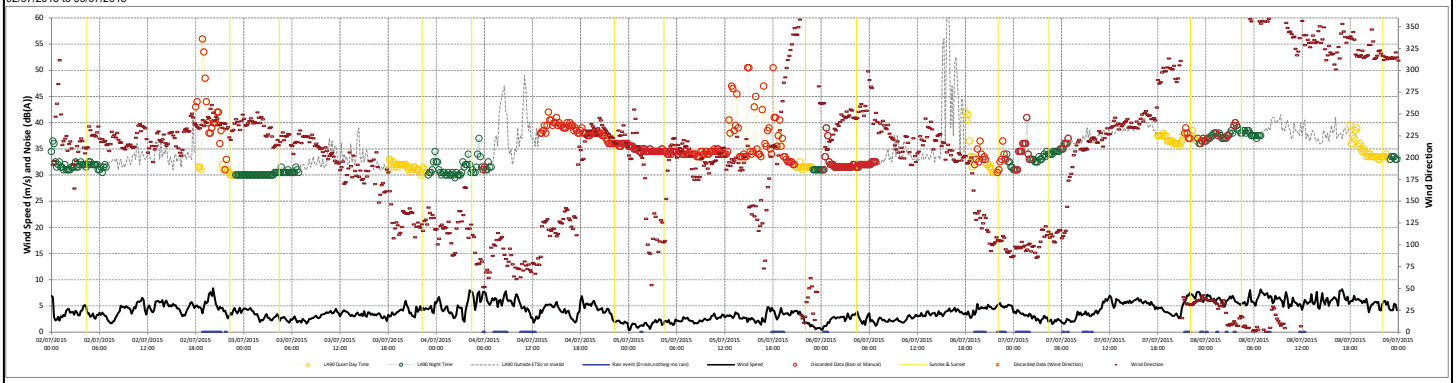


25/06/2015 to 02/07/2015

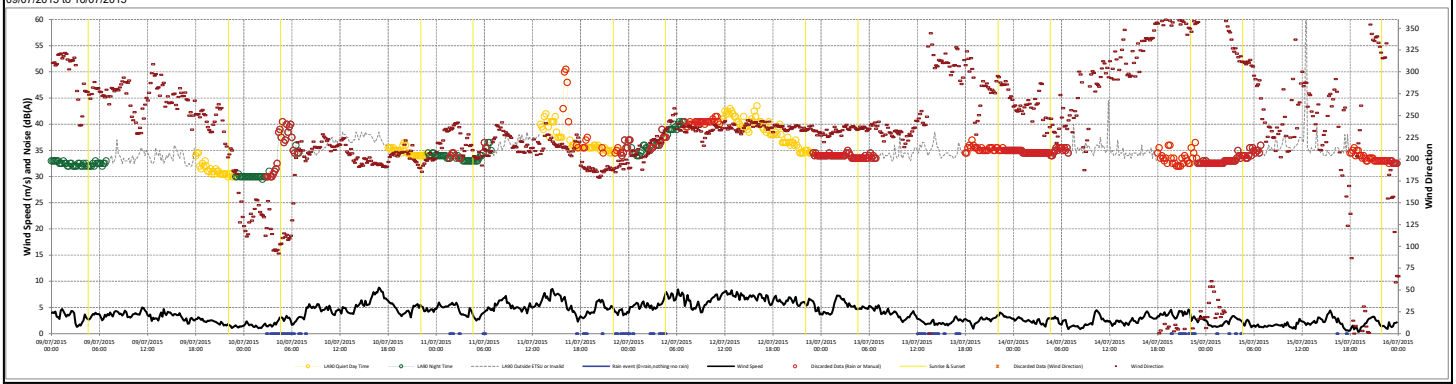


Project	Bhlaraidh Extension Wind Farm
Client	SSE Generation Ltd
Title	Time Series for Bhlaraidh Page 1 of 3
Date	07/04/2021

02/07/2015 to 09/07/2015



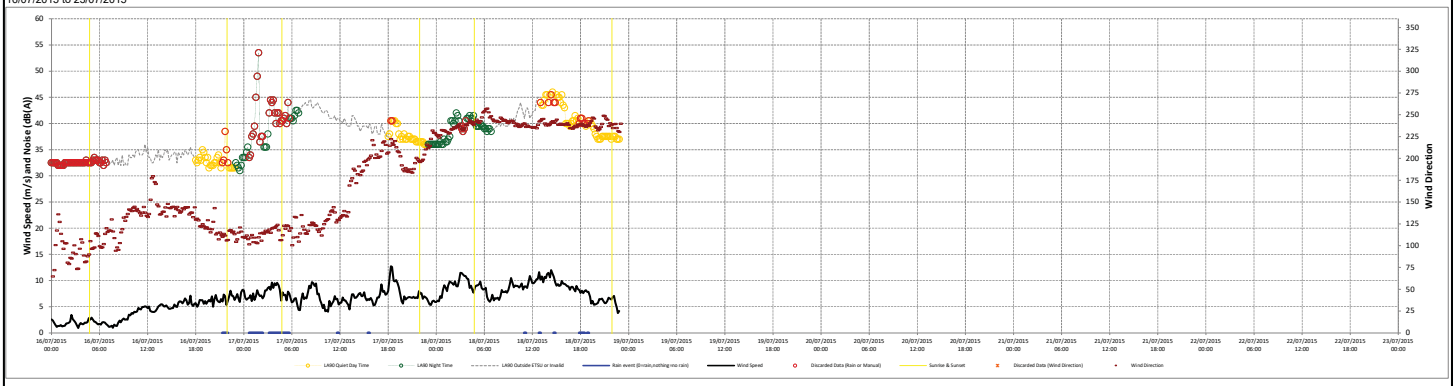
09/07/2015 to 16/07/2015



Project	Bhlaraidh Extension Wind Farm
Client	SSE Generation Ltd
Title	Time Series for Bhlaraidh Page 2 of 3
Date	07/04/2021

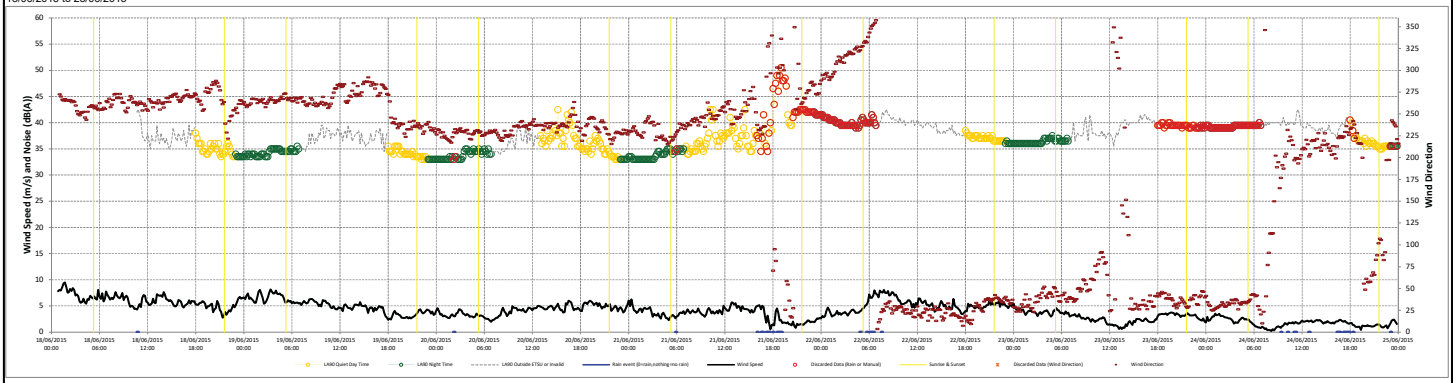
tnei

16/07/2015 to 23/07/2015

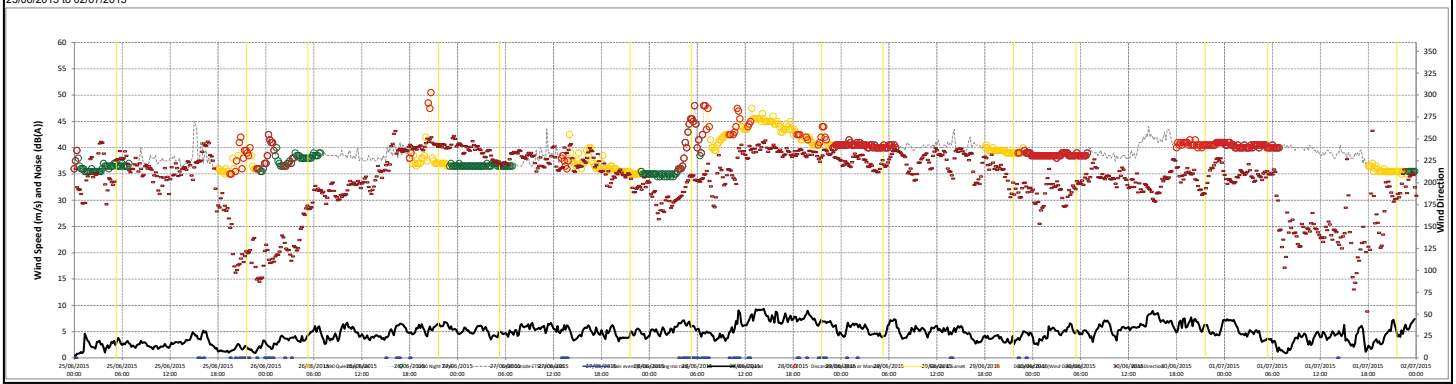


Project	Bhlaraidh Extension Wind Farm	
Client	SSE Generation Ltd	
Title	Time Series for Bhlaraidh Page 3 of 3	
Date	07/04/2021	

18/06/2015 to 25/06/2015

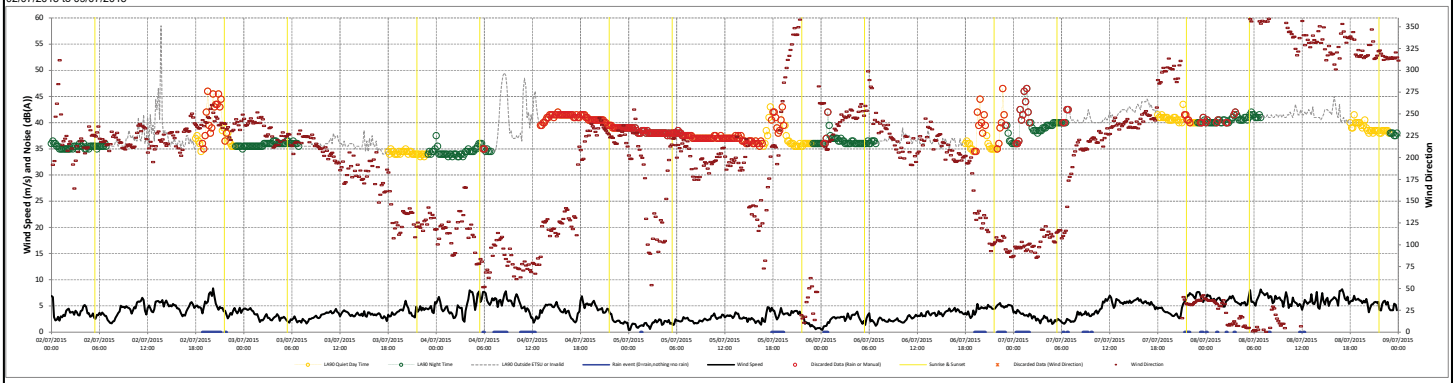


25/06/2015 to 02/07/2015

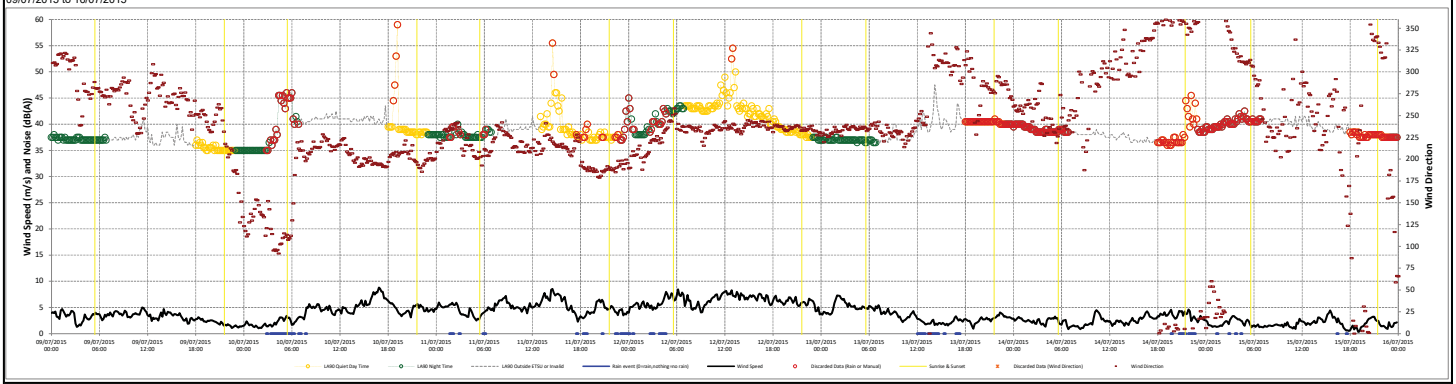


Project	Bhlaraidh Extension Wind Farm
Client	SSE Generation Ltd
Title	Time Series for Levishie Page 1 of 3
Date	07/04/2021

02/07/2015 to 09/07/2015

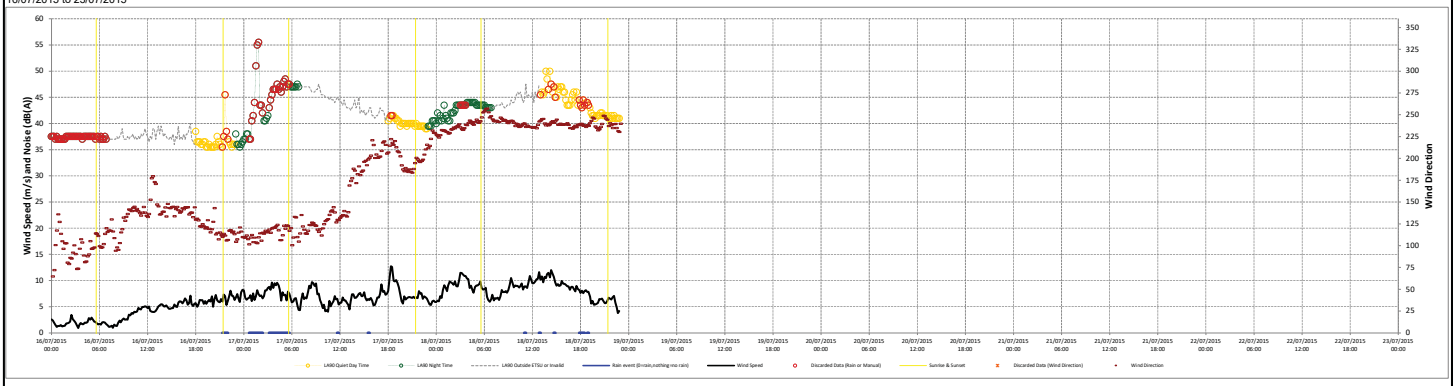


09/07/2015 to 16/07/2015



Project	Bhlaraidh Extension Wind Farm
Client	SSE Generation Ltd
Title	Time Series for Levishie Page 2 of 3
Date	07/04/2021

16/07/2015 to 23/07/2015



Project	Bhlaraidh Extension Wind Farm	
Client	SSE Generation Ltd	
Title	Time Series for Levishie Page 3 of 3	
Date	07/04/2021	

Annex 5 – Summary of Wind Turbine Noise Source Data

Noise data for the Vestas has not been included due to data confidentiality. Detailed noise data would be available upon request following the signing of the appropriate Non Disclosure Agreement

Table A5.1: Sound Power Level Data

Wind Farm	Turbine	Hub height	Uncertainty Included	Reference Wind Speed (ms^{-1}) Standardised to 10m Height									
				3	4	5	6	7	8	9	10	11	12
Bhlaraidh	Vestas V112, 3.45 MW, Standard Blade	69	2dB	96.2	99.9	104.7	108.9	111.1	111.3	111.3	111.3	111.3	111.3
	Vestas V117, 3.45 MW, Standard Blade	76.5	2 dB	96	98	102.3	106.2	108.4	108.7	108.7	108.7	108.7	108.7
Corrimony	Enercon E70, 2.3 MW - Standard Blade	64	2 dB	-	-	94.6	99.8	102.4	104.1	105.5	105.5	105.5	105.5

Table A5.2: Octave Band Data

Scheme	Turbine Modelled	Octave Band (Hz)									
		31.5	63	125	250	500	1000	2000	4000	8000	Overall
Bhlaraidh	Vestas V112, 3.45 MW, Standard Blade (at wind speed of $10ms^{-1}$)	80.1	92	98.9	103.4	105.1	106.6	103	97	82.4	111.3
	Vestas V117, 3.45 MW, Standard Blade (at wind speed of $10ms^{-1}$)	82.7	92.5	99.2	100.6	102.9	102.9	100.2	94.8	78.5	108.7
Corrimony	Enercon E70, 2.3 MW - Standard Blade (at wind speed of $10ms^{-1}$)	-	89.4	98.0	100.5	99.1	97.6	94.3	87.4	79.8	105.5

Annex 6 – Topographical Corrections and Wind Turbine Summary

Topographical (concave ground/ barrier) Noise Prediction Adjustment Table

Notes/Comments

Requirement to include a concave ground profile correction of +3dB has been calculated in accordance with section 4.3.9 of the IOA GPG
A barrier correction of -2dB is included where the landform completely obscures a turbine at the noise assessment location
Where analysis indicates that both are required the barrier correction take precedence and a correction of -2dB is applied

	Noise Assessment Locations																	
Wind Farm	**Hub**	**T ID**	**1**	**2**	**3**													
1 - Bhlaraidh - 1	69	1	-2	-2	-2													
2 - Bhlaraidh - 2	69	2	-2	-2	3													
3 - Bhlaraidh - 3	76.5	3	-2	-2	-2													
4 - Bhlaraidh - 4	76.5	4	-2	-2	-2													
5 - Bhlaraidh - 5	76.5	5	-2	-2	-2													
6 - Bhlaraidh - 6	76.5	6	-2	-2	-2													
7 - Bhlaraidh - 7	76.5	7	-2	-2	-2													
8 - Bhlaraidh - 8	76.5	8	-2	-2	-2													
9 - Bhlaraidh - 9	76.5	9	-2	-2	-2													
10 - Bhlaraidh - 10	76.5	10	-2	-2	-2													
11 - Bhlaraidh - 11	76.5	11	-2	-2	-2													
12 - Bhlaraidh - 12	76.5	12	-2	-2	-2													
13 - Bhlaraidh - 13	76.5	13	-2	-2	-2													
14 - Bhlaraidh - 14	76.5	14	-2	-2	-2													
15 - Bhlaraidh - 15	76.5	15	-2	-2	-2													
16 - Bhlaraidh - 16	76.5	16	-2	-2	-2													
17 - Bhlaraidh - 17	76.5	17	-2	-2	-2													
18 - Bhlaraidh - 18	76.5	18	-2	-2	-2													
19 - Bhlaraidh - 19	76.5	19	-2	-2	0													
20 - Bhlaraidh - 20	76.5	20	-2	-2	-2													
21 - Bhlaraidh - 21	76.5	21	-2	-2	-2													
22 - Bhlaraidh - 22	76.5	22	-2	-2	-2													
23 - Bhlaraidh - 23	76.5	23	-2	-2	-2													
24 - Bhlaraidh - 24	76.5	24	-2	-2	-2													
25 - Bhlaraidh - 25	76.5	25	-2	-2	-2													
26 - Bhlaraidh - 26	76.5	26	-2	-2	-2													
27 - Bhlaraidh - 27	76.5	27	-2	-2	-2													
28 - Bhlaraidh - 28	76.5	28	-2	-2	-2													
29 - Bhlaraidh - 29	76.5	29	-2	-2	-2													
30 - Bhlaraidh - 30	76.5	30	-2	-2	0													
31 - Bhlaraidh - 31	76.5	31	-2	-2	0													
32 - Bhlaraidh - 32	76.5	32	-2	-2	-2													

33 - Corrimony - 1	65	33	-2	-2	-2													
34 - Corrimony - 2	65	34	-2	-2	-2													
35 - Corrimony - 3	65	35	-2	-2	-2													
36 - Corrimony - 4	65	36	-2	-2	-2													
37 - Corrimony - 5	65	37	-2	-2	-2													
38 - Bhlaraidh Extension - 1	101	38	-2	-2	-2													
39 - Bhlaraidh Extension - 2	101	39	-2	-2	-2													
40 - Bhlaraidh Extension - 3	101	40	-2	-2	-2													
41 - Bhlaraidh Extension - 4	101	41	-2	-2	-2													
42 - Bhlaraidh Extension - 5	101	42	-2	-2	-2													
43 - Bhlaraidh Extension - 6	101	43	-2	-2	-2													
44 - Bhlaraidh Extension - 7	101	44	-2	-2	-2													
45 - Bhlaraidh Extension - 8	101	45	0	-2	0													
46 - Bhlaraidh Extension - 9	101	46	0	-2	0													
47 - Bhlaraidh Extension - 10	101	47	-2	-2	-2													
48 - Bhlaraidh Extension - 11	101	48	-2	-2	-2													
49 - Bhlaraidh Extension - 12	101	49	-2	-2	-2													
50 - Bhlaraidh Extension - 13	101	50	-2	-2	-2													
51 - Bhlaraidh Extension - 14	101	51	-2	-2	-2													
52 - Bhlaraidh Extension - 15	101	52	-2	-2	-2													
53 - Bhlaraidh Extension - 16	101	53	-2	-2	-2													
54 - Bhlaraidh Extension - 17	101	54	-2	-2	-2													
55 - Bhlaraidh Extension - 18	101	55	-2	-2	-2													

Note: The hub height modelled for Bhlaraidh Ext considers the lowest of the range being considered to represent a worst case scenario.

Wind Farm	Turbine Type	Easting	Northing	Height	Turbine hub height
Bhlaraidh - 1	Vestas V112 3.45MW	235666	819847	506	69
Bhlaraidh - 2	Vestas V112 3.45MW	235109	819468	476	69
Bhlaraidh - 3	Vestas V117 3.45MW	234733	819744	497	76.5
Bhlaraidh - 4	Vestas V117 3.45MW	234172	819657	483	76.5
Bhlaraidh - 5	Vestas V117 3.45MW	234076	820023	487	76.5
Bhlaraidh - 6	Vestas V117 3.45MW	234156	820427	487	76.5
Bhlaraidh - 7	Vestas V117 3.45MW	234387	820840	499	76.5
Bhlaraidh - 8	Vestas V117 3.45MW	234668	820566	530	76.5
Bhlaraidh - 9	Vestas V117 3.45MW	235206	820655	533	76.5
Bhlaraidh - 10	Vestas V117 3.45MW	235690	820674	535	76.5
Bhlaraidh - 11	Vestas V117 3.45MW	235193	821127	579	76.5
Bhlaraidh - 12	Vestas V117 3.45MW	235671	821170	570	76.5
Bhlaraidh - 13	Vestas V117 3.45MW	235752	821638	590	76.5
Bhlaraidh - 14	Vestas V117 3.45MW	234679	820129	510	76.5
Bhlaraidh - 15	Vestas V117 3.45MW	235267	820203	530	76.5
Bhlaraidh - 16	Vestas V117 3.45MW	235728	820162	526	76.5
Bhlaraidh - 17	Vestas V117 3.45MW	236245	820057	550	76.5
Bhlaraidh - 18	Vestas V117 3.45MW	236181	820563	530	76.5
Bhlaraidh - 19	Vestas V117 3.45MW	237482	819869	510	76.5
Bhlaraidh - 20	Vestas V117 3.45MW	237289	820361	513	76.5
Bhlaraidh - 21	Vestas V117 3.45MW	236997	820662	537	76.5
Bhlaraidh - 22	Vestas V117 3.45MW	236699	820811	540	76.5
Bhlaraidh - 23	Vestas V117 3.45MW	237290	821092	536	76.5
Bhlaraidh - 24	Vestas V117 3.45MW	237670	821040	539	76.5
Bhlaraidh - 25	Vestas V117 3.45MW	236954	821327	530	76.5
Bhlaraidh - 26	Vestas V117 3.45MW	237914	821665	510	76.5
Bhlaraidh - 27	Vestas V117 3.45MW	237498	821759	555	76.5
Bhlaraidh - 28	Vestas V117 3.45MW	237732	822129	546	76.5
Bhlaraidh - 29	Vestas V117 3.45MW	237201	821950	538	76.5
Bhlaraidh - 30	Vestas V117 3.45MW	237802	819615	483	76.5
Bhlaraidh - 31	Vestas V117 3.45MW	238235	819977	480	76.5
Bhlaraidh - 32	Vestas V117 3.45MW	238177	820425	498	76.5
Corrimony - 1	Enercon E70	234353.6	824377.2	463	65
Corrimony - 2	Enercon E70	234621.5	824655.9	460	65
Corrimony - 3	Enercon E70	234591.7	824998	450	65
Corrimony - 4	Enercon E70	234819.7	824921.6	450	65
Corrimony - 5	Enercon E70	234347.8	824756.2	452	65
Bhlaraidh Extension - 1	Vestas V150 5.6MW	238385	821688	520	105
Bhlaraidh Extension - 2	Vestas V150 5.6MW	238364	821034	517	105
Bhlaraidh Extension - 3	Vestas V150 5.6MW	238925	821693	537	105
Bhlaraidh Extension - 4	Vestas V150 5.6MW	239380	821326	500	105
Bhlaraidh Extension - 5	Vestas V150 5.6MW	239523	822070	537	105
Bhlaraidh Extension - 6	Vestas V150 5.6MW	238277	822170	526	105
Bhlaraidh Extension - 7	Vestas V150 5.6MW	238704	820694	498	105

Bhlaraidh Extension - 8	Vestas V150 5.6MW	238771	820273	500	105
Bhlaraidh Extension - 9	Vestas V150 5.6MW	239348	820077	462	105
Bhlaraidh Extension - 10	Vestas V150 5.6MW	239501	820920	470	105
Bhlaraidh Extension - 11	Vestas V150 5.6MW	238876	821220	533	105
Bhlaraidh Extension - 12	Vestas V150 5.6MW	239955	821460	517	105
Bhlaraidh Extension - 13	Vestas V150 5.6MW	240789	821549	528	105
Bhlaraidh Extension - 14	Vestas V150 5.6MW	240252	820478	451	105
Bhlaraidh Extension - 15	Vestas V150 5.6MW	239933	820784	491	105
Bhlaraidh Extension - 16	Vestas V150 5.6MW	239852	820120	443	105
Bhlaraidh Extension - 17	Vestas V150 5.6MW	240372	821198	491	105
Bhlaraidh Extension - 18	Vestas V150 5.6MW	240876	821077	495	105

Turbine Coordinate Source

Bhlaraidh	The 'as-built' coordinates provided by SSE
Corrimony	Highland Council Renewable Energy Wind Turbine List - January 2021

Annex 7 – Site Specific Noise Limit Calculations including THC Preferred Night Time Limits

Table A7.1: Site Specific Limit Derivation Calculations - Daytime

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 – Bhlaraidh	Background Noise Levels (dB(A), L_{90}) *(as shown in Table 5.2 and on Figure A1.2a)*	32.0	32.0	32.4	33.1	34.2	35.6	37.2	39.1	41.3	43.6	46.2	46.2
	Total ETSU-R-97 Noise Limit (dB(A)) *(as shown in Table 6.3 and on Figure A1.3a)* ***[A]***	37.0	37.0	37.4	38.1	39.2	40.6	42.2	44.1	46.3	48.6	51.2	51.2
	THC+ Preferred Total Noise Limit dB(A) **B]**	37.0	37.0	37.4	38.1	39.2	40.6	42.2	44.1	46.3	48.6	51.2	51.2
	Predicted Cumulative Noise Level (Likely) – All schemes dB(A) *(as shown in Table 6.5 and on Figure A1.3a)*	-	-	-	-	27.4	31.2	32.9	33.2	33.2	33.2	33.2	33.2
	Predicted Cumulative Noise Level (Likely)- Excluding Bhlaraidh Ext dB(A) (as shown *on Figure A1.3a)*	-	-	-	-	25.3	29.5	31.7	31.9	31.9	31.9	31.9	31.9
	Predicted Cumulative Noise Level (Cautious)- Excluding Bhlaraidh Ext dB(A) +3.1 dB (as shown *on Figure A1.4a)* ***[C]***	-	-	-	-	28.4	32.6	34.8	35.0	35.0	35.0	35.0	35.0
	Site Specific Noise Limit dB(A) (as shown *in Table 6.8 and on Figure A1.5a)* ***[A-C]***	37.0**	37.0**	37.4**	38.1**	39.2*	39.9	41.3	43.5	46.3*	48.6*	51.2*	51.2*
	Site Specific Noise Limit dB(A) (THC) ***[B-C]***	37.0**	37.0**	37.4**	38.1**	39.2*	39.9	41.3	43.5	46.3*	48.6*	51.2*	51.2*
	Predicted Noise Levels – Bhlaraidh Extension Only dB(A)	-	-	15.2	18.9	23.2	26.2	26.8	27.5	27.5	27.5	27.5	27.5
NAL2 - Levishie	Background Noise Levels (dB(A), L_{90}) *(as shown in Table 5.2 and on Figure A1.2a)*	36.0	36.0	36.1	36.7	37.8	39.2	40.8	42.6	44.4	46.2	47.8	47.8
	Total ETSU-R-97 Noise Limit (dB(A)) *(as shown in Table 6.3 and on Figure A1.3a)* ***[A]***	41.0	41.0	41.1	41.7	42.8	44.2	45.8	47.6	49.4	51.2	52.8	52.8
	THC Preferred Total Noise Limit dB(A) **B]**	41.0	41.0	41.1	41.7	42.8	44.2	45.8	47.6	49.4	51.2	52.8	52.8
	Predicted Cumulative Noise Level (Likely) – All schemes dB(A) *(as shown in Table 6.5 and on Figure A1.3a)*	-	-	-	-	28.9	32.4	33.7	34.2	34.2	34.2	34.2	34.2
	Predicted Cumulative Noise Level (Likely)- Excluding Bhlaraidh Ext dB(A) (as shown *on Figure A1.3a)*	-	-	-	-	24.5	28.7	30.9	31.1	31.1	31.1	31.1	31.1
	Predicted Cumulative Noise Level (Cautious)- Excluding Bhlaraidh Ext dB(A) +3.9 dB (as shown *on Figure A1.4a)* ***[C]***	-	-	-	-	28.4	32.6	34.8	35.0	35.0	35.0	35.0	35.0
	Site Specific Noise Limit dB(A) (as shown *in Table 6.8 and on Figure A1.5a)* ***[A-C]***	41.0**	41.0**	41.1**	41.7**	42.8*	44.2*	45.8*	47.6*	49.4*	51.2*	52.8*	52.8*
	Site Specific Noise Limit dB(A) (THC) ***[B-C]***	41.0**	41.0**	41.1**	41.7**	42.8*	44.2*	45.8*	47.6*	49.4*	51.2*	52.8*	52.8*
	Predicted Noise Levels – Bhlaraidh Extension Only dB(A)	-	-	19.0	22.7	27.0	30.0	30.6	31.3	31.3	31.3	31.3	31.3

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL3 - Achnaconeran	Background Noise Levels (dB(A), L_{90}) *(as shown in Table 5.2 and on Figure A1.2a)*	-	-	-	-	-	-	-	-	-	-	-	-
	Total ETSU-R-97 Noise Limit (dB(A)) *(as shown in Table 6.3 and on Figure A1.3a)* ***[A]***	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
	THC[+] Preferred Total Noise Limit dB(A) **B]**	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
	Predicted Cumulative Noise Level (Likely) – All schemes dB(A) *(as shown in Table 6.5 and on Figure A1.3a)*	-	-	-	-	27.6	31.0	32.3	32.8	32.8	32.8	32.8	32.8
	Predicted Cumulative Noise Level (Likely)- Excluding Bhlaraidh Ext dB(A) (as shown *on Figure A1.3a)*	-	-	-	-	22.5	26.7	28.9	29.1	29.1	29.1	29.1	29.1
	Predicted Cumulative Noise Level (Cautious)- Excluding Bhlaraidh Ext dB(A) +2 dB (as shown *on Figure A1.4a)* ***[C]***	-	-	-	-	24.5	28.7	30.9	31.1	31.1	31.1	31.1	31.1
	Site Specific Noise Limit dB(A) (as shown *in Table 6.8 and on Figure A1.5a)* ***[A-C]***	35.0**	35.0**	35.0**	35.0**	35.0*	33.8	32.9	32.7	32.7	32.7	32.7	32.7
	Site Specific Noise Limit dB(A) (THC) ***[B-C]***	35.0**	35.0**	35.0**	35.0**	35.0*	33.8	32.9	32.7	32.7	32.7	32.7	32.7
	Predicted Noise Levels – Bhlaraidh Extension Only dB(A)	-	-	18.0	21.7	26.0	29.0	29.6	30.3	30.3	30.3	30.3	30.3

**where the difference between A or B and C is > 10 dB then the entire noise limit has been allocated to the Proposed Development.*

*** where the predicted cumulative noise level for all schemes at 5 m/s is 10 dB or more below the Total ETSU-R-97 Noise Limits, then the Site Specific Noise Limit at lower windspeeds has been set equal to the Total ETSU-R-97 Noise Limit.*

[+] The Highland Council

Table A7.2: Site Specific Limit Derivation Calculations - Night Time

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1 – Bhlaraidh	Background Noise Levels (dB(A), L_{90}) *(as shown in Table 5.2 and on Figure A1.2a)*	31.1	31.1	31.2	31.7	32.4	33.4	34.7	36.1	37.6	39.3	39.3	39.3
	Total ETSU-R-97 Noise Limit (dB(A)) *(as shown in Table 6.3 and on Figure A1.3a)* ***[A]***	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.3	44.3	44.3
	THC Preferred Total Noise Limit dB(A) **B]**	38.0	38.0	38.0	38.0	38.0	38.4	39.7	41.1	42.6	44.3	44.3	44.3
	Predicted Cumulative Noise Level (Likely) – All schemes dB(A) *(as shown in Table 6.5 and on Figure A1.3a)*	-	-	-	-	27.4	31.2	32.9	33.2	33.2	33.2	33.2	33.2
	Predicted Cumulative Noise Level (Likely)- Excluding Bhlaraidh Ext dB(A) (as shown *on Figure A1.3a)*	-	-	-	-	25.3	29.5	31.7	31.9	31.9	31.9	31.9	31.9
	Predicted Cumulative Noise Level (Cautious)- Excluding Bhlaraidh Ext dB(A) +3.1 dB (as shown *on Figure A1.4a)* ***[C]***	-	-	-	-	28.4	32.6	34.8	35.0	35.0	35.0	35.0	35.0
	Site Specific Noise Limit dB(A) (as shown *in Table 6.8 and on Figure A1.5a)* ***[A-C]***	43.0**	43.0**	43.0**	43.0**	43.0*	43.0*	42.3	42.3	42.3	43.8	43.8	43.8
	Site Specific Noise Limit dB(A) (THC) ***[B-C]***	38.0**	38.0**	38.0**	38.0**	37.5	37.1	38.0	39.9	41.8	43.8	43.8	43.8
	Predicted Noise Levels – Bhlaraidh Extension Only dB(A)	-	-	15.2	18.9	23.2	26.2	26.8	27.5	27.5	27.5	27.5	27.5
NAL2 - Levishie	Background Noise Levels (dB(A), L_{90}) *(as shown in Table 5.2 and on Figure A1.2a)*	36.0	36.0	36.0	36.1	36.5	37.2	38.3	39.7	41.5	43.8	43.8	43.8
	Total ETSU-R-97 Noise Limit (dB(A)) *(as shown in Table 6.3 and on Figure A1.3a)* ***[A]***	43.0	43.0	43.0	43.0	43.0	43.0	43.3	44.7	46.5	48.8	48.8	48.8
	THC Preferred Total Noise Limit dB(A) **B]**	41.0	41.0	41.0	41.1	41.5	42.2	43.3	44.7	46.5	48.8	48.8	48.8
	Predicted Cumulative Noise Level (Likely) – All schemes dB(A) *(as shown in Table 6.5 and on Figure A1.3a)*	-	-	-	-	28.9	32.4	33.7	34.2	34.2	34.2	34.2	34.2
	Predicted Cumulative Noise Level (Likely)- Excluding Bhlaraidh Ext dB(A) (as shown *on Figure A1.3a)*	-	-	-	-	24.5	28.7	30.9	31.1	31.1	31.1	31.1	31.1
	Predicted Cumulative Noise Level (Cautious)- Excluding Bhlaraidh Ext dB(A) +3.9 dB (as shown *on Figure A1.4a)* ***[C]***	-	-	-	-	28.4	32.6	34.8	35.0	35.0	35.0	35.0	35.0
	Site Specific Noise Limit dB(A) (as shown *in Table 6.8 and on Figure A1.5a)* ***[A-C]***	43.0**	43.0**	43.0**	43.0**	43.0*	43.0*	42.6	44.2	46.5*	48.8*	48.8*	48.8*
	Site Specific Noise Limit dB(A) (THC) ***[B-C]***	41.0**	41.0**	41.0**	41.1**	41.5*	41.7	42.6	44.2	46.5*	48.8*	48.8*	48.8*
	Predicted Noise Levels – Bhlaraidh Extension Only dB(A)	-	-	19.0	22.7	27.0	30.0	30.6	31.3	31.3	31.3	31.3	31.3

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL3 - Achnaconeran	Background Noise Levels (dB(A), L_{90}) *(as shown in Table 5.2 and on Figure A1.2a)*	-	-	-	-	-	-	-	-	-	-	-	-
	Total ETSU-R-97 Noise Limit (dB(A)) *(as shown in Table 6.3 and on Figure A1.3a)* ***[A]***	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
	THC Preferred Total Noise Limit dB(A) **B]**	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
	Predicted Cumulative Noise Level (Likely) – All schemes dB(A) *(as shown in Table 6.5 and on Figure A1.3a)*	-	-	-	-	27.6	31.0	32.3	32.8	32.8	32.8	32.8	32.8
	Predicted Cumulative Noise Level (Likely)- Excluding Bhlaraidh Ext dB(A) (as shown *on Figure A1.3a)*	-	-	-	-	22.5	26.7	28.9	29.1	29.1	29.1	29.1	29.1
	Predicted Cumulative Noise Level (Cautious)- Excluding Bhlaraidh Ext dB(A) +3.2 dB (as shown *on Figure A1.4a)* ***[C]***	-	-	-	-	24.5	28.7	30.9	31.1	31.1	31.1	31.1	31.1
	Site Specific Noise Limit dB(A) (as shown *in Table 6.8 and on Figure A1.5a)* ***[A-C]***	35.0**	35.0**	35.0**	35.0**	35.0*	33.8	32.9	32.7	32.7	32.7	32.7	32.7
	Site Specific Noise Limit dB(A) (THC) ***[B-C]***	35.0**	35.0**	35.0**	35.0**	35.0*	33.8	32.9	32.7	32.7	32.7	32.7	32.7
	Predicted Noise Levels – Bhlaraidh Extension Only dB(A)	-	-	18.0	21.7	26.0	29.0	29.6	30.3	30.3	30.3	30.3	30.3

**where the difference between A or B and C is > 10 dB then the entire noise limit has been allocated to the Proposed Development.*

*** where the predicted cumulative noise level for all schemes at 5 m/s is 10 dB or more below the Total ETSU-R-97 Noise Limits, then the Site Specific Noise Limit at lower windspeeds has been set equal to the Total ETSU-R-97 Noise Limit.*

Annex 8 – Suggested Noise Conditions

Noise

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

    A) Prior to the operation of the wind farm, the wind farm operator shall submit to the Local Authority for written approval a list of proposed independent consultants who may undertake compliance measurements in accordance with this condition. Amendments to the list of approved consultants shall be made only with the prior written approval of the Local Authority.

    B) Within 21 days from receipt of a written request of the Local Authority, following a complaint to it alleging noise disturbance at a dwelling, the wind farm operator shall, at its expense, employ an independent consultant approved by the Local Authority to assess the level of noise immissions from the wind farm at the complainant's property (or a suitable alternative location agreed in writing with the Local Authority) in accordance with the procedures described in the attached Guidance Notes. The written request from the Local Authority shall set out at least the date, time and location that the complaint relates to. Within 14 days of receipt of the written request of the Local Authority made under this paragraph (B), the wind farm operator shall provide the information relevant to the complaint logged in accordance with paragraph (H) to the Local Authority in the format set out in Guidance Note 1(e).

    C) Where there is more than one property at a location specified in Tables 1 and 2 attached to this condition, the noise limits set for that location shall apply to all dwellings at that location. Where a dwelling to which a complaint is related is not identified by name or location in the Tables attached to these conditions, the wind farm operator shall submit to the Local Authority for written approval proposed noise limits to be adopted at the complainant's dwelling for compliance checking purposes. The proposed noise limits are to be those limits selected from the Tables specified for a listed location which the independent consultant considers as being likely to experience the most similar background noise environment to that experienced at the complainant's dwelling. The submission of the proposed noise limits to the Local Authority shall include a written justification of the choice of the representative background noise environment provided by the independent consultant. The rating level of noise immissions resulting from the combined effects of the wind turbines when determined in accordance with the attached Guidance Notes shall not exceed the noise limits approved in writing by the Local Authority for the complainant's dwelling.

    D) Prior to the commencement of any measurements by the independent consultant to be undertaken in accordance with these conditions, the wind farm operator shall submit to the Local Authority for written approval the proposed measurement location identified in accordance with the Guidance Notes where measurements for compliance checking purposes shall be undertaken. Where the proposed measurement location is close to the wind turbines, rather than at the complainants property (to improve the signal to noise ratio), then the operators submission shall include a method to calculate the noise level from the wind turbines at the complainants property based on the noise levels measured at the agreed location (the alternative method). Details of the alternative method together with any associated guidance notes deemed necessary, shall be submitted to and agreed in writing by the Local Authority prior to the commencement of any measurements. Measurements to assess compliance with the noise limits set out in the Tables attached to these conditions or approved by the Local

Authority pursuant to paragraph (C) of this condition shall be undertaken at the measurement location approved in writing by the Local Authority.

E) Prior to the submission of the independent consultant's assessment of the rating level of noise immissions pursuant to paragraph (F) of this condition, the wind farm operator shall submit to the Local Authority for written approval a proposed assessment protocol setting out the following:

i) the range of meteorological and operational conditions (the range of wind speeds, wind directions, power generation and times of day) to determine the assessment of rating level of noise immissions.

ii) a reasoned assessment as to whether the noise giving rise to the complaint contains or is likely to contain a tonal component.

The proposed range of conditions shall be those which prevailed during times when the complainant alleges there was disturbance due to noise, having regard to the information provided in the written request of the Local Authority under paragraph (B), and such others as the independent consultant considers necessary to fully assess the noise at the complainant's property. The assessment of the rating level of noise immissions shall be undertaken in accordance with the assessment protocol approved in writing by the Local Authority and the attached Guidance Notes.

F) The wind farm operator shall provide to the Local Authority the independent consultant's assessment of the rating level of noise immissions undertaken in accordance with the Guidance Notes within 2 months of the date of the written request of the Local Authority made under paragraph (B) of this condition unless the time limit is extended in writing by the Local Authority. The assessment shall include all data collected for the purposes of undertaking the compliance measurements, such data to be provided in the format set out in Guidance Note 1(e) of the Guidance Notes. The instrumentation used to undertake the measurements shall be calibrated in accordance with Guidance Note 1(a) and certificates of calibration shall be submitted to the Local Authority with the independent consultant's assessment of the rating level of noise immissions.

G) Where a further assessment of the rating level of noise immissions from the wind farm is required pursuant to Guidance Note 4(c) of the attached Guidance Notes, the wind farm operator shall submit a copy of the further assessment within 21 days of submission of the independent consultant's assessment pursuant to paragraph (F) above unless the time limit for the submission of the further assessment has been extended in writing by the Local Authority.

H) The wind farm operator shall continuously log power production, wind speed and wind direction, all in accordance with Guidance Note 1(d) of the attached Guidance Notes. The data shall be retained for a period of not less than 24 months. The wind farm operator shall provide this information in the format set out in Guidance Note 1(e) of the attached Guidance Notes to the Local Authority on its request within 14 days of receipt in writing of such a request.

Note: For the purposes of this condition, a "dwelling" is a building within Use Classes 7, 8 and 9 of the Town and Country Planning (Use Classes) (Scotland) Order 1997 which lawfully exists or had planning permission at the date of this permission.

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

Location (easting, northing grid coordinates)	Standardised wind speed at 10 metres height (m/s) within the site averaged over 10-minute periods											
	1	2	3	4	5	6	7	8	9	10	11	12
	L_{A90} Decibel Levels											
Bhlaraidh (238048, 816664)	37	37	37	38	39	40	41	44	46	49	51	51
Levishie (240246, 817772)	41	41	41	42	43	44	46	48	49	51	53	53
Achnaconeran (241628, 817981)	35	35	35	35	35	34	33	33	33	33	33	33

Table 2 - Between 23:00 and 07:00 - Noise level dB $L_{A90,\ 10\text{-minute}}$

Location (easting, northing grid coordinates)	Standardised wind speed at 10 metres height (m/s) within the site averaged over 10-minute periods											
	1	2	3	4	5	6	7	8	9	10	11	12
	L_{A90} Decibel Levels											
Bhlaraidh (238048, 816664)	43	43	43	43	43	43	42	42	42	44	44	44
Levishie (240246, 817772)	43	43	43	43	43	43	43	44	47	49	49	49
Achnaconeran (241628, 817981)	35	35	35	35	35	34	33	33	33	33	33	33

Note 1 to Tables 1 & 2: The geographical coordinates references set out in these tables are provided for the purpose of identifying the general location of dwellings to which a given set of noise limits applies. The standardised wind speed at 10 metres height within the site refers to wind speed at 10 metres height derived from those at hub height, calculated in accordance with the method given in the Guidance Notes.

Guidance Notes for Noise Condition

These notes are to be read with and form part of the noise condition. They further explain the condition and specify the methods to be employed in the assessment of complaints about noise immissions from the wind farm. The rating level at each integer wind speed is the arithmetic sum of the wind farm noise level as determined from the best-fit curve described in Note 2 of these Guidance Notes and any tonal penalty applied in accordance with Note 3 with any necessary correction for residual background noise levels in accordance with Note 4. Reference to ETSU-R-97 refers to the publication entitled "The Assessment and Rating of Noise from Wind Farms" (1997) published by the Energy Technology Support unit (ETSU) for the Department of Trade and Industry (DTI).

Note 1

(a) Values of the $L_{A90,10\text{-minute}}$ noise statistic should be measured at the complainant's property (or an approved alternative representative location as detailed in Note 1(b)), using a sound level meter of EN 60651/BS EN 60804 Type 1, or BS EN 61672 Class 1 quality (or the equivalent UK adopted standard in force at the time of the measurements) set to measure using the fast time weighted response as specified in BS EN 60651/BS EN 60804 or BS EN 61672-1 (or the equivalent UK adopted standard in force at the time of the measurements). This should be calibrated before and after each set of measurements, using a calibrator meeting BS EN 60945:2003 "Electroacoustics – sound calibrators" Class 1 with PTB Type Approval (or the equivalent UK adopted standard in force at the time of the measurements) and the results shall be recorded. Measurements shall be undertaken in such a manner to enable a tonal penalty to be calculated and applied in accordance with Guidance Note 3.

(b) The microphone shall be mounted at 1.2 - 1.5 metres above ground level, fitted with a two-layer windshield or suitable equivalent approved in writing by the Local Authority, and placed outside the complainant's dwelling. Measurements should be made in "free field" conditions. To achieve this, the microphone shall be placed at least 3.5 metres away from the building facade or any reflecting surface except the ground at the approved measurement location. In the event that the consent of the complainant for access to his or her property to undertake compliance measurements is withheld, the wind farm operator shall submit for the written approval of the Local Authority details of the proposed alternative representative measurement location prior to the commencement of measurements and the measurements shall be undertaken at the approved alternative representative measurement location.

(c) The $L_{A90,10\text{-minute}}$ measurements should be synchronised with measurements of the 10-minute arithmetic mean wind speed and wind direction data and with operational data logged in accordance with Guidance Note 1(d) and rain data logged in accordance with Note 1(f).

(d) To enable compliance with the conditions to be evaluated, the wind farm operator shall continuously log arithmetic mean wind speed in metres per second (m/s) and arithmetic mean wind direction in degrees from north in each successive 10-minutes period in a manner to be agreed in writing with the planning authority. Each 10 minute arithmetic average mean wind speed data as measured or calculated at turbine hub height shall be 'standardised' to a reference height of 10 metres as described in ETSU-R-97 at page 120 using a reference roughness length of 0.05 metres. It is this standardised 10 metre height wind speed data which is correlated with the noise measurements determined as valid in accordance with Note 2(b), such correlation to be undertaken in the manner described in Note 2(c). All 10-minute periods shall commence on the hour and in 10-minute increments thereafter synchronised with Greenwich Mean Time and adjusted to British Summer Time where necessary.

(e) Data provided to the Local Authority in accordance with paragraphs (E) (F) (G) and (H) of the noise condition shall be provided in comma separated values in electronic format with the exception of data collected to asses tonal noise (if required) which shall be provided in a format to be agreed in writing with the Local Authority.

(f) A data logging rain gauge shall be installed in the course of the independent consultant undertaking an assessment of the level of noise immissions. The gauge shall record over successive 10-minute periods synchronised with the periods of data recorded in accordance with Note 1(d).

Note 2

(a) The noise measurements should be made so as to provide not less than 20 valid data points as defined in Note 2 paragraph (b).

(b) Valid data points are those measured during the conditions set out in the assessment protocol approved by the Local Authority under paragraph (E) of the noise condition but excluding any periods of rainfall measured in accordance with Note 1(f).

(c) Values of the $L_{A90,10\text{-minute}}$ noise measurements and corresponding values of the 10-minute standardised ten metre height wind speed for those data points considered valid in accordance with Note 2(b) shall be plotted on an XY chart with noise level on the Y-axis and wind speed on the X-axis. A least squares, "best fit" curve of an order deemed appropriate by the independent consultant (but which may not be higher than a fourth order) shall be fitted to the data points to define the wind farm noise level at each integer speed.

Note 3

(a) Where, in accordance with the approved assessment protocol under paragraph (E) of the noise condition, noise immissions at the location or locations where compliance measurements are being undertaken contain or are likely to contain a tonal component, a tonal penalty shall be calculated and applied using the following rating procedure.

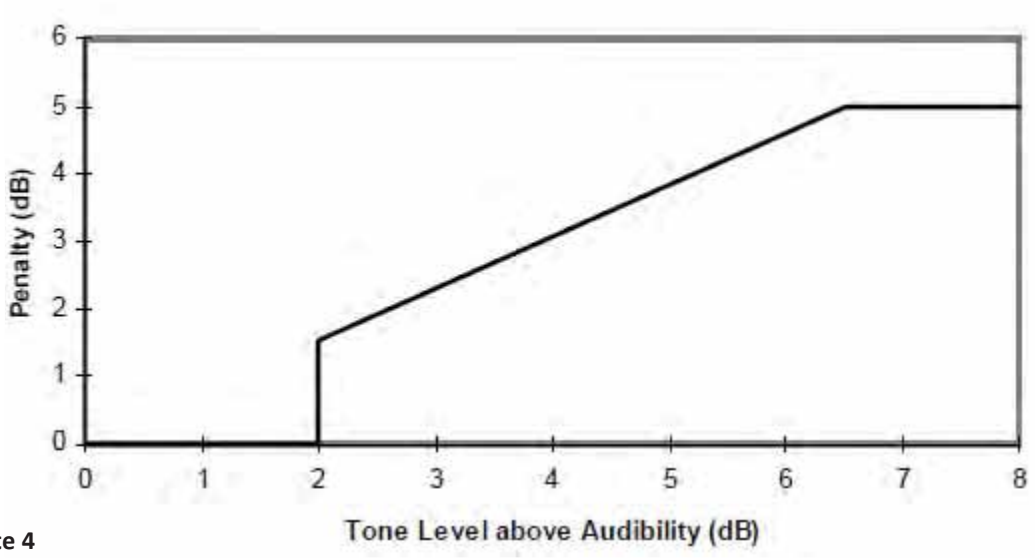
(b) For each 10-minute interval for which $L_{A90,10\text{-minute}}$ data have been determined as valid in accordance with Note 2, a tonal assessment shall be performed on noise immissions during 2-minutes of each 10-minute period. The 2-minute periods should be spaced at 10-minute intervals provided that uninterrupted uncorrupted data are available ("the standard procedure"). Where uncorrupted data are not available, the first available uninterrupted clean 2-minute period out of the affected overall 10-minute period shall be selected. Any such deviations from the standard procedure shall be reported.

(c) For each of the 2-minute samples the tone level above audibility shall be calculated by comparison with the audibility criterion given in Section 2.1 on pages 104 -109 of ETSU-R-97.

(d) The tone level above audibility shall be plotted against wind speed for each of the 2-minute samples. Samples for which the tones were below the audibility criterion or no tone was identified, a value of zero audibility shall be substituted.

(e) A least squares "best fit" linear regression shall then be performed to establish the average tone level above audibility for each integer wind speed derived from the value of the "best fit" line fitted to values within ± 0.5m/s of each integer wind speed. If there is no apparent trend with wind speed then a simple arithmetic mean shall be used. This process shall be repeated for each integer wind speed for which there is an assessment of overall levels in Note 2.

(f) The tonal penalty is derived from the margin above audibility of the tone according to the figure below derived from the average tone level above audibility for each integer wind speed.



Note 4

(a) If a tonal penalty is to be applied in accordance with Note 3 the rating level of the turbine noise at each wind speed is the arithmetic sum of the measured noise level as determined from the best fit curve described in Note 2 and the penalty for tonal noise as derived in accordance with Note 3 at each integer wind speed within the range set out in the approved assessment protocol under paragraph (E) of the noise condition.

(b) If no tonal penalty is to be applied then the rating level of the turbine noise at each wind speed is equal to the measured noise level as determined from the best fit curve described in Note 2.

(c) If the rating level at any integer wind speed lies at or below the values set out in the Tables attached to the conditions or at or below the noise limits approved by the Local Authority for a complainant's dwelling in accordance with paragraph (C) of the noise condition then no further action is necessary. In the event that the rating level is above the limit(s) set out in the Tables attached to the noise conditions or the noise limits for a complainant's dwelling approved in accordance with paragraph (C) of the noise condition, the independent consultant shall undertake a further assessment of the rating level to correct for background noise so that the rating level relates to wind turbine noise immission only.

(d) The wind farm operator shall ensure that all the wind turbines in the development are turned off for such period as the independent consultant requires to undertake the further assessment. The further assessment shall be undertaken in accordance with the following steps:

i. Repeating the steps in Note 2, with the wind farm switched off, and determining the background noise (L_3) at each integer wind speed within the range set out in the approved noise assessment protocol under paragraph (E) of this condition.

ii. The wind farm noise (L_1) at this speed shall then be calculated as follows where L_2 is the measured level with turbines running but without the addition of any tonal penalty:

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

iii. The rating level shall be re-calculated by adding the tonal penalty (if any is applied in accordance with Note 3) to the derived wind farm noise L_1 at that integer wind speed.

iv. If the rating level after adjustment for background noise contribution and adjustment for tonal penalty (if required in accordance with note (iii) above) at any integer wind speed lies at or below the values set out in the Tables attached to the conditions or at or below the noise limits approved by the Local Authority for a complainant's dwelling in accordance with paragraph (C) of the noise condition then no further action is necessary. If the rating level at any integer wind speed exceeds the values set out in the Tables attached to the conditions or the noise limits approved by the Local Authority for a complainant's dwelling in accordance with