6 Noise

6.1 Introduction

The Noise Impact Assessment will identify and assess potential noise effects of the proposed development on Noise Sensitive Receptors (NSRs).

Noise impacts could arise from three distinct areas of a wind farm development:

- Construction of the wind farm;
- Operation of the wind farm; and
- Increased traffic flow during the construction and operational phases.

6.2 The Existing Environment

The proposed wind farm development is located to the east of the A83, which is likely to be the main noise sources in the vicinity of the proposed development. In addition, there are farming and forestry activities where, on occasion, noise generating activities may be occurring.

6.2.1 Baseline Conditions

Noise measurements will be undertaken at representative NSRs in the vicinity of the proposed development so that existing background noise levels ($L_{A90,T}$) can be determined. At this stage the exact locations for background noise level requirements have not been determined. However, given the remote location of the site and NSRs it is likely that noise monitoring will not be required at each and every property, as well-selected monitoring locations can be used such that they can act as proxy background measurements for the other locations. The locations where noise monitoring is likely to be required include areas to the west and south west of the site at:

- Drumnamucklach (National Grid Reference (NGR) 169623, 643941);
- Beachmenach (NGR 168908, 642803);
- Crubasdale (NGR 168734, 641141);
- Low Clachaig (NGR 169496, 640395); and
- Arnicle (NGR 170982, 638139)

These locations are shown in Figure 6. Given the extent of the areas covered more than one noise monitoring location may be required to sufficiently characterise the noise climate in each area. Alternatively, depending on the ambient noise levels at adjacent locations, a proxy background noise level measurement location could be chosen that is representative of both locations.

6.3 Methods

6.3.1 Proposed Surveys

Background noise level measurements will be undertaken at representative NSRs. Noise monitoring will be undertaken for a minimum period of two weeks at each location. However, the noise monitoring period may be extended if insufficient noise level data across the full range of wind speeds is measured during this initial two week period due to lack of variability in the wind speed or because of precipitation. Type 1 sound level meters will be used to continuously log, as a minimum the $L_{A90,T}$, using a 10 minute sample period. The noise level measurements will be synchronised with the 10 minute anemometer and precipitation gauge measurements.

6.3.2 Proposed Assessment Methodology

Planning Advice Note 1/2011: Planning and Noise (PAN 1/2011) and its associated Technical Advice Note provides guidance on planning and noise in Scotland. With regard to wind farm assessments PAN 1/2011 makes reference to the Scottish Governments document "*Onshore Wind Turbines*" (Onshore wind turbines information (First published February 11, 2011 updated January 27, 2012 , March 14, 2012 and last updated May 02, 2012)). This document states that:

> *"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."*

ETSU-R-97 recommends that the current practice on controlling noise from wind turbines is by the application of noise limits at neighbouring dwellings. It suggests separate noise limits for the daytime and the night-time period, which are derived from background noise levels measured during the quiet periods of the day and during the night.

The approach is to limit the noise from the wind turbines relative to (5dB higher than) the existing background noise, but that it is not necessary to restrict wind turbine noise below certain fixed limits in order to provide a reasonable degree of protection. Compliance with the noise limits derived constitutes the measure of significance of the potential impact.

Accordingly, ETSU-R-97 will be used to assess the noise effects associated with the proposed wind farm development. Where appropriate, the noise assessment methods will be supplemented with the additional Institute of Acoustic guidance contained in their March/April 2009 Acoustic Bulletin to assess and rate proposed wind farm noise. In addition, AECOM is cognisant of the UK Government's and others' current position regarding low frequency noise, vibration and amplitude modulation (see below).

With regard to sound propagation, in accordance with the Institute of Acoustics (IOA) guidance contained in its March/April 2009 bulletin, the preferred sound propagation method for wind turbine noise is ISO 9613-2; and when using this standard:

- The model input turbine sound power levels should be supported by documentation from the manufacturer with a statement of their status;
- The assumed atmospheric conditions are: 10^{o}C temperature and 70% relative humidity;
- The assumption of soft ground should not be made, and ground absorption (G) should be in the range 0 and 0.5 in conjunction with sound power test reports and manufacturer's warranty, respectively;
- Generally, no account should be taken of barrier attenuation by the land form unless there is no line of sight between the highest point of the rotor and the receiver, when normally a maximum attenuation of 2dB(A) can be used. Any higher barrier attenuation must be fully justified;
- Sound power levels using IEC 61400-11 standard and the relationship to convert an $LA_{eq,10min}$ to $LA_{90,10min}$ by subtracting 2dB remains valid; and
- Agreement was also reached within the working group that there is no robust evidence that low frequency sound, infrasound and ground-borne vibration from wind farms, generally has adverse effects on neighbours. As a result, these effects would not been assessed further within this ES.

The Institute of Acoustics has launched a consultation on "Good Practice Guidance to the application of ETSU-R-97 for wind turbine noise assessment".

The 80-page main consultation document (also referred to as the discussion document) has been produced by a five-strong working group and an eight-strong review panel which was set up last year following a request from the

Department of Energy and Climate Change (DECC) to take forward the recommendation of the Government-commissioned Hayes McKenzie report on Analysis of How Noise Impacts are considered in the Determination of Wind Farm Planning Applications. (Ref HM: 2293/R1 dated 6 April 2011).

The group has also published a second document which contains some commentary on the discussion document, and a questionnaire response for consultation feedback. The documents have been produced specifically to promote discussion of the relevant issues during the consultation period, which ended on 28 September 2012. Currently, the publication date of this guidance on good practice document is anticipated to be April / May 2013. Accordingly, it is anticipated that on the publication of this document that future assessment of wind farm noise impacts will incorporate advice and guidance contained therein.

6.3.3 Summary of Methods

To undertake the assessment of noise effects in accordance with the foregoing methods, the following is undertaken:

- Specify the number and locations of the wind turbines;
- Identify the locations of the nearest, or most noise sensitive, neighbours;
- Determine the daytime and night-time criterion curves, based on background noise level data, at the nearest noise sensitive receptors, using measured background noise level data where appropriate;
- Specify the type and noise emission characteristics of the proposed wind turbines;
- Calculate the noise emission levels due to the operation of the wind turbines as a function of site wind speed at the nearest noise sensitive receptors;
- Compare the calculated wind farm noise emission levels with the derived criterion curves; and
- Assess cumulative effects.

When predicting noise levels at NSRs due to the operation of the wind farm it is assumed that the hub height wind speed is the same at all of the installed turbines and, as such, each turbine emits the same level of sound power.

6.3.3.1 Rating Standard Compliance

The daytime criterion is derived from background noise level 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).

- In accordance with ETSU-R-97, for wind speeds where the best fit curve to the background noise data lies below a level of 30-35dB(A) the criterion curve can be chosen to be a fixed level in the range 35-40dB(A). The precise choice of criterion curve level within the range 35-40 dB(A) depends on a number of factors as described on page 65 of ETSU-R-97, including:
- The number of dwellings in the neighbourhood of the wind farm – more stringent limits should be considered in areas where there are many dwellings within the vicinity of the wind farm and conversely a more lenient limit should be considered for wind farms with few neighbouring dwellings;
- The effect of noise limits on the number of kWh generated – consideration should be given to more stringent noise criteria for schemes where there is low potential to effect generation, whereas more lenient noise criteria should be applied to schemes with greater potential to effect generation; and
- Duration and level of exposure - consideration should be given to more stringent criteria at properties where the ambient noise is relatively low for a substantial proportion of the time, whereas more lenient criteria can be applied to dwellings that experience higher levels of ambient noise.

The night time noise criterion curve is derived from background noise level data measured during the night time periods (23:00 to 07:00), with no differentiation being made between weekdays and weekends. The 10-minute $L_{A90,T}$ noise levels measured over the night time periods are plotted against concurrent wind speed data and a 'best fit' correlation is made. The night time noise limit is also based on a level 5 dB above the best fit curve over the wind speed range of 0 - 12ms^{-1}. Where the night time criterion curve is found to be below 43dB(A), it is fixed at 43dB(A). This night-time absolute lower limit is based on the World Health Environmental Health Criteria 12 (EH12), for the protection of sleep indoors with windows open and an assumed a composite façade sound reduction of 10dB(A).

6.4 Aspects to be Scoped Out of the Assessment

6.4.1 Construction Noise

During the construction period, a range of activities would take place within the site, but those with the greatest potential to cause noise would occur during the early stages of the proposed development: primarily the laying of forest roads; and excavating and laying turbine foundations. Wind farm developments construction activities are typically restricted to the hours of 07:00 through to 19:00 on weekdays and 07:00 through to 16:00 on Saturdays. Work outside these hours is not usual, though if it was required to meet specific demands (as some activities are highly weather dependent e.g. low wind speeds for turbine tower erection), permission for short term extensions to these hours would be sought from the Local Planning Authority (LPA).

Construction noise can largely be controlled through the implementation of mitigation measures (such as limiting construction hours) and undertaking construction works in accordance with good practices as described in BS 5228 (such as using well maintained and serviced plant, and the appointment of a site contact to whom complaints/queries can be directed). Notwithstanding these measures, construction noise may be perceptible at the closest residential receptors. However, given the distances between the proposed development site and the NSRs, and the type and duration of expected construction activities, it is unlikely that construction noise will result in significant adverse impacts.

E.ON would therefore seek agreement that construction noise is be scoped out of the EIA, with the intention that the wind farm construction noise can be dealt with through the imposition of planning conditions requiring the submission and approval of mitigation and/or management plans.

6.4.2 Traffic Noise

With regard to potential noise effects associated with increased traffic flows during the construction and operational phases of the proposed development, typically, only small increases in traffic are observed on local roads as a result of the construction of the wind farms which are unlikely to cause a significant increase in traffic noise. Moreover, any noise effects associated with construction traffic will be temporary. Accordingly, potential traffic noise effects could be adequately managed by implementing a construction traffic management plan, which would include restrictions on the times that heavy construction traffic can access the proposed development site.

The operation of the wind farm is unlikely to significantly affect traffic flows on surrounding roads as only light goods vehicles are required to travel to and from the site for ongoing maintenance of the proposed wind farm. As part of the scoping request, E.ON seeks agreement that construction and operational and decommissioning traffic noise can be scoped out of the EIA.

6.4.3 Low Frequency Noise

Bowdler et al (2009) presented a review of published literature and concluded that '*there is no robust evidence that low frequency noise (including infrasound) or ground-borne vibration from wind farms generally has effects on wind farm neighbours*'. It is therefore proposed that this EIA will not include an assessment of low frequency noise.

6.4.4 Amplitude Modulation of Aerodynamic Noise (AM)

Renewable UK has recently produced a draft letter to Planning Authorities that differentiates between two types of amplitude modulation, namely, 'Normal' Amplitude Modulation (NAM) and 'Other' Amplitude Modulation (OAM).

The sound level from turbine blades is often not completely steady, but is modulated (fluctuates) in a cycle of increased and then decreased levels of noise, sometimes called "blade swish". Typically, the modulation depth may be up to 2-3dB(A). This is the normal form of amplitude modulation and is taken into account in the ETSU-R-97 derived noise limit.

However, it is possible that under certain conditions the modulation depth may increase to the point where it can become more pronounced and potentially give rise to increased annoyance. This phenomenon is known as the 'Other' form of amplitude modulation (OAM) of aerodynamic noise.

OAM is a much rarer phenomenon than NAM that is atypical and intermittent; it can be higher than 5dB and is occasionally audible at larger distances (500m - 1km). Unlike the high frequency 'swish' of NAM, OAM has a lower frequency. Due to its rare and intermittent nature the source mechanism is less well understood. However Renewable UK has undertaken research to establish casual mechanisms and develop mitigation measures.

Whilst all of the causes of AM are not known, AM tends to occur only under certain meteorological conditions and is likely to be manifest at only a minority of wind farms. Moreover, it is a highly technical area, which despite research by numerous investigators over the last 20 years, there is to date no universally accepted explanation as to the causes of AM or means to predict its occurrence.

Research, undertaken by Salford University in 2007, found that out of 133 operational wind farms investigated, AM was considered to be a factor in noise complaints at only four and a possible factor in a further eight locations.

The UK Government has commented in regard to the Salford study as follows:

"Based on these findings, Government does not consider there to be a compelling case for further work into AM and will not carry out any further research at this time; however it will continue to keep the issue under review."

However, it is clear that whatever the actual number of occurrence of AM is, it only occurs at a small minority of wind farms for a minority amount of the time. Moreover, as previously stated, with regard to NAM, ETSU-R-97 states that it takes "blade swish" into account in the noise limits it recommends.

It is therefore proposed that this EIA will not include an assessment of Amplitude Modulation.

6.5 Conclusions and Summary

An EIA is an iterative process that contributes to the good design of any proposed development. It requires a system whereby the noise specialist identifies issues, opportunities and constraints, and feeds them into the wind farm design in an ongoing process.

The ES chapter will focus on operational noise at sensitive receiver locations resulting from the proposed wind turbines and will be undertaken in accordance with ETSU-R-97. It is proposed that construction noise be addressed through the imposition of planning conditions requiring the submission and approval of mitigation and/or management plans.

6.6 References

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(Hayes Mckenzie, 2006), "The measurement of low frequency noise at three UK wind farms", Hayes Mckenzie Partnership Ltd, report to the Department of Trade and Industry

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