A.12 NOISE

A.12.1 INTRODUCTION

The design of the proposed Viking Wind Farm has changed since the Section 36 application, and its associated Environmental Statement (ES), were submitted in the spring of 2009. This chapter describes how these changes would affect noise interests.

Before reading this chapter, please first read Addendum Chapter A1, the Introduction, and Chapter A4, the Development Description. Failure to read these two chapters carefully may lead to a misunderstanding of the assessment work described in this chapter. Furthermore, because this addendum chapter is not intended to provide a complete new assessment of the issues, but instead provides a discussion of the effects of the work which has taken place since the 2009 ES was submitted, it must be read in conjunction with the noise chapter of the 2009 Environmental Statement.

Whilst the policy of assessment of noise from wind farms remains unchanged, there has been a published "unofficial agreement" by a number of leading acousticians in the field of wind farm noise assessment. This agreement recommends a change in the calculation methodology used. BMT Cordah has taken the opportunity to introduce these new calculation methods into the re-assessment in order to maintain a robust and a realistic prediction of the likely impacts of operational noise on local receptors.

Please see Chapter 12 of the 2009 ES for a description of technical terms used in this chapter.

A.12.2 CONSULTATION RESPONSES

No objections to the proposed wind farm were based on noise impacts.

A number of comments and recommendations were received from Shetland Islands Council Environmental Health, and these are detailed in Appendix A1.1. All of these comments are addressed in this Addendum chapter.

A.12.3 CHANGES IN THE POLICY CONTEXT

There have been no changes in the policy context since the 2009 ES was prepared.

A.12.4 CHANGES IN METHODOLOGY

A.12.4.1 Operational noise levels from wind farms

Whilst ETSU-R-97 remains unchanged since its publication in 1996, disputes regarding the assessment methodology and the appropriateness of using ETSU-R-97 continue to be a major feature at wind farm public inquiries. In order to limit the disagreement between developers and objectors a group of acousticians, all of whom sat on the DTI/BERR Noise Working Group on wind farm noise 2006/2007, published an agreement [1] in the Institute of Acoustics' "Acoustics Bulletin" (March/April 2009). The paper, commonly referred to as the "IOA Bulletin Agreement," addresses both the acquisition of baseline data, taking into account local wind shear, and the prediction of immission levels at receptors. The re-

assessment of operational noise levels included within this addendum seeks to meet all of the recommendations contained therein.

Calculation of wind shear

The ETSU-R-97 assessment method requires that both measured background noise levels and turbine noise immission levels are referenced to a 10 metre height wind speed. This can lead to ambiguities when comparing background noise levels with turbine noise as the wind speed at hub height (which effectively determines the sound power level of the turbine) may be much higher than the wind speed at the receptor location. The IOA bulletin agreement addresses this issue by suggesting the following measurement and calculation methodology;

- *For the duration of baseline surveys wind speeds should be measured on the wind farm site at two heights H1 and H2, H1 being not less than 60% of the proposed turbine hub height and H2 being between 40% and 50% of the proposed hub height.*
- *For each ten minute period the mean wind speed measured at height H1 should be corrected to hub height using wind shear exponent "m" derived from the mean wind speeds U1 and U2 at heights H1 and H2, using the following standard equation.*

$$m = \frac{Log\left(\frac{U_1}{U_2}\right)}{Log\left(\frac{H_1}{H_2}\right)}$$

Where:-

m = *The shear exponent to be calculated*

U_1 *The wind speed measured at the lower height*

U_2 *The wind speed measured at the upper height*

H_1 *The height of the lower wind speed measurement*

H_2 *The height of the upper wind speed measurement*

- *The mean hub height wind speed (U_{hh}) calculated as above should then be corrected to a 10 metre height wind speed. Use of the derived 10 metre wind speed provides consistency between wind turbine manufacturers' sound power level test data and the baseline noise measurements at receptors and takes account of site-specific wind-shear.*

Prediction of wind turbine noise immission levels

ISO9613-2 : 1996 "*Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation*" is the recognised method of calculating noise immission levels of wind turbines at receptors. The IOA Bulletin agreement states:

The output from an ISO9613-2 prediction model depends on the model input parameters … in the interests of clarity we recommend that the results of wind turbine noise predictions should be qualified by a statement of all the model inputs used.

A number of variable input parameters are then detailed including

- turbine sound power levels used as input;
- the atmospheric conditions assumed;
- the ground factors G_s, G_m, G_r assumed; and

- the effects of barriers.

In line with this recommendation all model input values have been detailed in Section A12.6.1

A.12.4.2 Assessment of construction noise levels

The Control of Noise (Codes of Practice for Construction and Open Sites) (Scotland) Order 2002 defines BS 5228: Part 1 1997 (incorporating Amendment no. 1) [2] as suitable for the purpose of giving guidance on appropriate methods for minimising noise. This standard has now been updated to BS5228: Part 1 2009. Changes to the standard include restructuring of the standard into two parts, one dealing with noise and one with vibration; updating of information relating to legislative requirements; and updating of information relating to methods and equipment. The calculation methodology has, however, remained the same, meaning that all construction noise calculations made in the 2009 ES remain valid.

Any future construction noise calculations will now be referenced to the revised standard.

A.12.5 CHANGES IN BASELINE CONDITIONS

Baseline noise monitoring carried out for the 2009 ES was undertaken at sixteen receptor locations. However, changes to the wind farm layout, made after the monitoring was undertaken, meant that some of the monitoring locations were no longer in the necessary assessment areas. These monitoring data were therefore considered inappropriate and excluded from the noise assessment process. Using a CadnaA noise prediction model, a screening assessment was again undertaken to determine the locations of receptors likely to fall within a 35dBA noise contour of the new site layout. The results of this assessment have allowed identification of new monitoring locations. Predictions have been made using ISO 9613:2 methodology with turbine noise source levels at 10m/s wind speed.

The deletion of turbines from the 2009 design means that the predicted operational noise levels are lower at a number of previously assessed locations. The locations shown in Table A12.1, which were assessed in the 2009 ES, have therefore been screened out of the new assessment.

Table A12.1 : Receptor locations from 2009 ES screened out of re-assessment

Receptor	Coordinates	
Easterscord	441330	1166391
Hamars	440863	1164687
Tagon	440948	1164004
Stenswall	440346	1156483
Sursetter	439272	1152631
Hardwall	437454	1170088
Hill Cottage	438753	1171959
Trondavoe	437635	1170608

Further to the above, the buildings at Upper Kergord and Fern, which are disused, are no longer classed as receptors and have been removed from the assessment. The new assessment considers the assessment locations in the Table A12.2:

Table A12.2: Receptor locations included in the new assessment of operational noise

Receptor	Coordinates	
Grutin	440482	1168352
Graven	440674	1173139
Laxobigging	441344	1173230
Moorfield	442503	1172684
North Tararet	444753	1163124
Lower House	445852	1159623
Catfirth	443564	1154055
Sand Water	441745	1155203
Setter House	439806	1155033
Kergord	439478	1154328
Dury	445818	1160592
South Setter	439721	1154773
East Burrafirth	436736	1157774
Newing	447098	1156256

A.12.5.1 Baseline monitoring locations

The representative receptors identified for the purposes of background noise monitoring are described below with their approximate grid references and are annotated in Figure A12.1.

#1 Laxobigging , 441439, 1173279

Measurements were undertaken in the field adjacent to the property at Laxobigging. Background noise measurements at this location have been used as representative levels at the receptor at Graven. This location is subject to noise from Sullom Voe oil terminal and aircraft movement associated with the airfield at Scatsta.

#2 East Burrafirth, 436704, 1157815

Located to the west of the wind farm site, west of the Kergord quadrant, measurements were conducted in the garden of the property and are representative of this property alone.

#3 Moorfield, 442495, 1172786

Measurements were made approximately 100 metres in front of the property and are representative of this property alone. This location is subject to noise from Sullom Voe oil terminal and aircraft movement associated with the airfield at Scatsta.

#4 Grutin, 440791, 1168260

The monitoring equipment was installed in the driveway of two properties to the east of the A968. Baseline data from this monitoring location are representative of all the surrounding properties in Grutin.

#5 Dury 446241, 1159693

Monitoring was undertaken in the front garden of a property just north of Fern. Measurement data at this location have been used for the assessment of North Tararet, Lower House and Dury.

#6 Newing 446820, 1155858

Monitoring equipment was installed in the driveway of the property to the east of B9075 at Ayre of Whinnia Lea and the data used for the assessment of the property at Newing.

#7 Catfirth 443936, 1154124

Noise level data monitored at this location are representative of all properties in the Catfirth area.

#8 South Setter 439557, 1154745

Measurements were made approximately 150 metres along the track which leads west from the dwellings at South Setter towards the West Hill of Weisdale. Measurement data at this monitoring location have been used for the assessment of receptors at Kergord, Setter House and South Setter.

#9 Sand Water 441742, 1155324

Measurements were undertaken in a field adjacent to the isolated property at the junction of the A970 and the B9075 close to the boundary between the Kergord and Nesting quadrants.

A.12.5.2 Field survey

Norsonic NOR-118 (Type 1) sound level meters were located at each of the receptors identified in Section 12.5 for a three week period from 30th March to 21st April 2010. The meters were enclosed in environmental cases containing sufficient battery power for approximately 12 to 14 days. The microphones and environmental cases were equipped with appropriate wind and rain protection to ensure the accuracy of the monitoring. The sound level meters and microphones were calibrated prior to and after the monitoring exercise. Details of the sound level meters and microphones used are provided in Appendix A12.1. Batteries life varied between meters and all batteries were changed mid-way through the monitoring period. The varying battery lives meant that some meters have some measurement periods missing, however each meter was operating for long enough to accumulate a sufficient amount of data over the full range of wind speeds.

The sound level meters logged L_{A90} and L_{Aeq} levels at 10-minute intervals over the three-week monitoring period. The background noise levels (L_{A90}) measured at each of the receptors were correlated with the corresponding wind speed measured at the site.

During the period of background noise monitoring, operational anemometers were mounted at heights of 10, 30, 67 and 70 metres at grid coordinates HU 37263 52515. For the purposes of calculating wind shear, as recommended in the IOA Bulletin Agreement, wind speed data were taken at an upper height of 67m and a lower height of 30m.

Hourly rainfall data for Lerwick were obtained from the Met Office for the entire measurement period and all measurement data occurring during periods of rainfall ($>$2mm) were removed from the assessment.

The correlated noise and wind speed data for Quiet Daytime and Night-time periods at each receptor are presented in Graphs 12.1 to 12.18 in Appendix A12.2. A 'line of best fit' is plotted on each of the graphs to determine the typical noise level at each site during the assessment period for the range of wind speeds. The typical quiet daytime and night-time noise levels at each monitoring site are summarised in Tables A12.3 and A12.4.

Table A12.3 : Measured Quiet Daytime Background Noise Levels, LA90, 10min, dB

Receptor	Wind Speed (m/s)								
	4	5	6	7	8	9	10	11	12
#1 Laxobigging	36.9	38.0	39.0	40.1	41.1	42.0	42.9	43.8	44.6
#2 East Burrafirth	32.0	32.0	32.3	33.1	34.3	35.9	37.9	40.3	43.1
#3 Moorfield	34.0	35.2	36.2	37.1	37.8	38.3	38.6	38.7	38.7
#4 Grutin	40.2	40.2	40.3	40.4	40.5	40.8	41.0	41.4	41.8
#5 Dury	30.4	32.9	35.2	37.5	39.7	41.7	43.7	45.5	47.2
#6 Newing	44.4	44.4	44.7	45.4	46.4	47.7	49.3	51.3	53.6
#7 Catfirth	30.5	31.0	31.8	33.0	34.4	36.2	38.3	40.7	43.4
#8 South Setter	30.9	32.3	33.4	34.4	35.2	35.7	36.0	36.2	36.1
#9 Sand Water	29.4	30.9	32.4	33.8	35.3	36.8	38.4	39.9	41.4

The measured background noise levels vary from receptor to receptor. The lowest noise levels at low wind speeds were measured at Dury, Catfirth, South Setter, and Sand Water, all of which are located towards the southern end of the site near the Kergord and Nesting quadrants. The highest levels at low wind speeds were measured at Laxobigging, Grutin and Newing. At Laxobigging (and to some extent Moorfield) it is thought that noise from Sullom Voe oil terminal contributes to the raised background noise level whilst at Grutin and Newing the sound of water in water courses contributes to the measured noise levels. Although this raises the background noise level it is considered to be representative of the local natural environment. Noise from the sea is also likely to be a factor at Newing. At all locations the measured noise levels indicate a steady increase in measured background noise levels with wind speed.

At higher wind speeds, the measured background noise levels at some receptors are within 5dB of the ETSU lower limit of quiet daytime criteria. The secondary criterion of 'background + 5 dB' was therefore applied to establish operational noise limits for assessing the effects of wind farm noise at each receptor.

Table A12.4 : Measured Night-time Background Noise Levels, LA90, 10min, dB

Receptor	Wind Speed (m/s)								
	4	5	6	7	8	9	10	11	12
#1 Laxobigging	39.6	39.8	40.1	40.5	40.9	41.4	42.0	42.6	43.3
#2 East Burrafirth	31.4	31.6	32.0	32.5	33.3	34.2	35.3	36.7	38.2
#3 Moorfield	34.5	34.7	35.1	35.5	36.1	36.7	37.4	38.2	39.1
#4 Grutin	39.7	39.9	40.1	40.4	40.6	40.9	41.2	41.5	41.8
#5 Dury	27.8	28.5	29.4	30.3	31.4	32.5	33.8	35.1	36.6
#6 Newing	42.2	43.2	44.1	45.1	46.0	46.9	47.8	48.7	49.5
#7 Catfirth	24.8	26.0	27.2	28.7	30.2	32.0	33.8	35.9	38.0
#8 South Setter	31.7	32.9	34.4	36.2	38.3	40.7	43.3	46.2	49.4
#9 Sand Water	20.7	21.0	21.8	23.2	25.0	27.4	30.3	33.8	37.7

A.12.6 CHANGES IN THE PROPOSED WIND FARM

A.12.6.1 Operational noise

Noise immission values from the operational turbines at the nearest identified noise sensitive receptors have been calculated as described in the previous ES. In order to follow the recommendations of the IOA bulletin agreement the following input parameters have been used for the ISO 9613:2 calculations:

Turbine sound power levels used as input. The source noise levels used are manufacturer supplied "warranted levels." The noise spectrum used for the predictions has been taken from the measurement report provided by the turbine manufacturers for the reference wind speed of 8 m/s, normalised to the sound power level at each integer wind speed. A copy of the manufacturer supplied DANAK report, "Measurement of Noise Emission from a Siemens SWT-3.6-107 Wind Turbine Situated at Høvsøre, Denmark," can be found in Appendix 12.3. There are no changes between the source noise levels used in the re-assessment and the 2009 ES. Within the DANAK report, measurement uncertainty is detailed as 1.3dB at wind speeds of 6 – 9 m/s and 2.1dB at 10 m/s. These values have been added to the warranted noise levels and included in all calculations.

At the request of consultees, operational noise levels have also been included in the propagation models at wind speeds of 4 and 5 m/s. Although turbine noise level data for these wind speeds are not published in the public domain the manufacturer has confirmed that:

- At 5 m/s the single figure, A weighted, sound power level is 3.5dB below that of 6 m/s; and
- at 4 m/s the single figure, A weighted, sound power level is 13.3dB below that of 6 m/s.

The manufacturer has also confirmed that turbine noise levels do not increase above those at 10 m/s, up to wind speeds of 18 m/s.

The atmospheric conditions assumed. For all calculations, temperature is assumed to be 10°C and relative humidity as 70%.

The ground factors Gs, Gm, Gr assumed. A ground attenuation factor of 0.5 was assumed in the noise propagations calculations. Receptor heights were set to 4 metres in the calculation.

The effects of barriers. No barrier attenuation, including the effects of local topography, has been included in any calculation.

The predicted operational turbine noise immission levels at each receptor are presented in Table A12.5. The LA_{eq} source noise levels, calculated at each receptor, have been converted into the L_{A90} required for the assessment following the procedure stated within ETSU-R-97, where

$$LA_{90,10\_} = L_{Aeq} - 2dB$$

Table A12.5: Predicted Turbine Immission Levels, LA90, 10min, dB

	Wind speed						
Receptor	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Grutin	20.6	30.4	33.9	34.5	35.2	35.5	36.3
Graven	15.4	25.2	28.7	29.3	30.0	30.3	31.1
Laxobigging	18.0	27.8	31.3	31.9	32.6	32.9	33.7
Moorfield	21.2	31.0	34.5	35.1	35.8	36.1	36.9
North Tararet	18.7	28.5	32.0	32.6	33.3	33.6	34.4
Lower House	24.6	34.4	37.9	38.5	39.2	39.5	40.3
Catfirth	17.8	27.6	31.1	31.7	32.4	32.7	33.5
Sand Water	22.8	32.6	36.1	36.7	37.4	37.7	38.5
Setter House	20.9	30.7	34.2	34.8	35.5	35.8	36.6
Kergord	19.7	29.5	33.0	33.6	34.3	34.6	35.4
Dury	16.8	26.6	30.1	30.7	31.4	31.7	32.5

South Setter	19.8	29.6	33.1	33.7	34.4	34.7	35.5
East Burrafirth	19.1	28.9	32.4	33.0	33.7	34.0	34.8
Newing	17.7	27.5	31.0	31.6	32.3	32.6	33.4

A.12.6.2 Construction noise

The 2009 ES noise assessment identified six receptors where construction noise levels, due to the close proximity of borrow pits, may exceed the target 55dB noise level, as detailed in PAN50. Additionally, a number of consultee responses expressed concern over receptors being exposed to excessive noise levels resulting from concurrent or consecutive use of multiple borrow pits. In the revised site design, three primary and eight secondary borrow pit areas of search (including two which were assessed in detail in the Borrow Pit Report, Appendix 14.2) have been removed. One new borrow pit is proposed in Kergord. The net result is to reduce the potential for exposure to excessive noise levels. Please refer to chapter A4 for further details of borrow pit changes.

Removal of these borrow pits from the design has also meant that no receptor would be subjected to noise from multiple borrow pits. (Note that only one of borrow pits NBP03 and NBP04, both located close to Sand Water, would be used.) The change in borrow pit locations can be seen in Figures A4.1.1(b) and A4.1.2(b). Table A12.6 details the distance to the closest borrow pit areas of search and the predicted maximum noise levels for each of the six receptors. Piling would not be necessary during the construction of the wind farm and has therefore been scoped out of this assessment.

Table A12.6: Predicted Construction Noise Immission Levels, LAeq, 12hours, dB

Receptor	Distance to closest borrow pits (m)		Maximum Predicted Noise Level dB LAeq, 12hr		Comments
	2009 ES	2010 Addendum	2009 ES	2010 Addendum	
Tigh-na-Binn	203	n/a	61.7	-	Derelict building
Oversound	339	339	56.1	56.1	No change
Whinnia Lea	120	388	67.4	54.9	Within acceptable limits
South Newing	425	425	57.2	56.0	Some improvement
Easterscord	296	> 1km	57.6	-	Outside study area
Southtown	254	254	59.2	59.2	No change

The predicted construction noise levels at Whinnia Lea and Easterscord are now below the 55dB (PAN50) target noise level as set in the previous ES, whilst an improvement of 1dB can be seen at South Newing.

Noise levels at three receptors, Oversound, South Newing and Southtown, are still predicted to be over the 55dB level. However, it should be noted that the noise predictions assume a worst case scenario of all equipment operating simultaneously, at the edge of the "area of search," and with no accounting for attenuation due to soft ground or screening. In reality it is likely that noise levels would be below those predicted.

A.12.7 CHANGES IN AGREED MITIGATION

Aside from the reduction in turbine numbers there are no changes in agreed mitigation in respect of the operational noise levels of the wind turbines.

The mitigating measures stated in section 12.7 of the 2009 ES, in respect of construction noise, would be reinforced by referring to the guidance found in BS5228-1:2009 prior to any construction management plans or schedules being finalised. In order to perform a check upon the effectiveness of such mitigation measures, a noise monitoring programme would be designed for use during the construction period. Whilst it is not anticipated that noise level monitoring would be required continually during the construction period, monitoring of construction noise would be undertaken at the nearest noise sensitive receptors located within 500m of active borrow pits.

A.12.8 PLANNING CONDITIONS

It is recognised that planning conditions are likely to be imposed, in respect of noise, to ensure the continuing protection of local amenity. In this respect, the following conditions, which are based partly on suggested planning conditions detailed in *"Onshore Wind Energy Planning Conditions, Guidance Note. A report for the Renewables Advisory Board and BERR"* (October 2007) and partly on experience with other similar wind farm planning applications, are proposed for consideration;

- The Wind Turbine Operator shall measure and assess, at its own expense, and following the procedures described in "The Assessment and Rating of Noise from Wind Farms, ETSU-R-97," the level of noise emissions from the wind turbines within the first year of the operation, and every two years thereafter. The frequency of measurement of the level of noise emissions will be subject to review every 2 years by the Shetland Islands Council. The results of any measurement exercise shall be forwarded to the Planning Authority as soon as is practicable.
- At the reasonable request of, and following a complaint to, the Local Planning Authority, the operator of the development shall measure and assess at its expense the level of noise emissions from the wind turbine generators following the procedures described in "The Assessment and Rating of Noise from Wind Farms, ETSU-R-97."
- The level of noise emissions from the combined effects of the wind turbine generators on the Wind Farm when measured in accordance with "The Assessment and Rating of Noise from Wind Farms, ETSU-R-97," shall not exceed, at any dwelling lawfully existing at the time of the consent:

  35dB L_{A90} or 5dB$_A$ above prevailing background, whichever is greater, between the hours of 18:00 and 23:00 on all days of the week, 12:00 and 18:00 on Saturdays and 07:00 to 23:00 on Sundays.

  43dB L_{A90} or 5dB$_A$ above prevailing background, whichever is greater, between the hours of 23:00 and 07:00 on all days of the week.

A.12.9 CHANGES IN THE IMPACT ASSESSMENT

Prior to the 2009 ES, consultation with Shetland Islands Council resulted in agreement of target noise levels based on ETSU-R-97, taking into account any low background noise levels. For the sake of clarity, these criteria are reproduced in Table A12.7.

Table A12.7 : Operational Noise Limits, ETSU-R-97 (dB(A))

Period	Time	ETSU Noise Limit dB(A)
Quiet daytime	All evenings from 18:00-23:00 hours; Saturday afternoon 13:00-18:00 hours; Sunday, 07:00-18:00 hours.	35-40 dB(A) or 'background + 5 dB', whichever is higher
Night-time	23:00-07:00 hours	43 dB(A) minimum or 'background + 5 dB', whichever is higher

These criteria remain valid. However, as the limits are based on background noise measurements, the new baseline data have been used to establish updated limits at individual receptors. These limits are detailed in Table A12.8 along with the turbine immission levels at each receptor.

Although the ETSU Quiet Daytime limit is 35 – 40dB(A) or "background + 5dB", whichever is higher, this assessment assumes the lower limit value of 35dB(A) or "background + 5dBA," given the low background noise levels associated with many areas surrounding the site.

A.12.9.1 Effects significance

Operational noise

Operational noise levels across the range of assessed wind speeds at all receptors would be below the ETSU-R-97 derived noise limits for both quiet day time and night time. Operational noise effects are therefore assessed as not being significant.

Low frequency noise and infrasound

In respect of low frequency noise, the 2009 ES states;

"Based on published research no perceptible impacts are predicted, therefore no significant effects will result."

This assessment remains unchanged. However, it has now also been backed up by the IOA Bulletin Agreement which states;

"… we conclude that there is no robust evidence that low frequency sound (including "infrasound") or ground borne vibration from wind farms, generally has adverse effects on wind farm neighbours."

Table A12.8 : Immission Levels and Operational Noise Limits.

Receptor	Wind speed m/s	4	5	6	7	8	9	10
Grutin	Predicted noise level	20.6	30.4	33.9	34.5	35.2	35.5	36.3
	ETSU Quiet daytime limit	45.2	45.2	45.3	45.4	45.5	45.8	46.0
	ETSU Night-time limit	43.0	43.0	45.1	45.4	45.6	45.9	46.2
Graven	Predicted noise level	15.4	25.2	28.7	29.3	30.0	30.3	31.1

	ETSU Quiet daytime limit	41.2	43.0	44.0	45.1	46.1	47.0	47.9
	ETSU Night-time limit	43.0	43.0	45.1	45.5	45.9	46.4	47.0
Laxobigging	Predicted noise level	18.0	27.8	31.3	31.9	32.6	32.9	33.7
	ETSU Quiet daytime limit	41.9	43.0	44.0	45.1	46.1	47.0	47.9
	ETSU Night-time limit	43.0	43.0	45.1	45.5	45.9	46.4	47.0
Moorfield	Predicted noise level	21.2	31.0	34.5	35.1	35.8	36.1	36.9
	ETSU Quiet daytime limit	39.0	40.2	41.2	42.1	42.8	43.3	43.6
	ETSU Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0
North Tararet	Predicted noise level	18.7	28.5	32.0	32.6	33.3	33.6	34.4
	ETSU Quiet daytime limit	35.4	37.9	40.2	42.5	44.7	46.7	48.7
	ETSU Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Lower House	Predicted noise level	24.6	34.4	37.9	38.5	39.2	39.5	40.3
	ETSU Quiet daytime limit	35.4	37.9	40.2	42.5	44.7	46.7	48.7
	ETSU Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Catfirth	Predicted noise level	17.8	27.6	31.1	31.7	32.4	32.7	33.5
	ETSU Quiet daytime limit	35.5	36.0	36.8	38.0	39.4	41.2	43.3
	ETSU Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Sand Water	Predicted noise level	22.8	32.6	36.1	36.7	37.4	37.7	38.5
	ETSU Quiet daytime limit	35.0	35.9	37.4	38.8	40.3	41.8	43.4
	ETSU Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Setter House	Predicted noise level	20.9	30.7	34.2	34.8	35.5	35.8	36.6
	ETSU Quiet daytime limit	35.9	37.3	38.4	39.4	40.2	40.7	41.0
	ETSU Night-time limit	43.0	43.0	43.0	43.0	43.3	45.7	48.3
Kergord	Predicted noise level	19.7	29.5	33.0	33.6	34.3	34.6	35.4
	ETSU Quiet daytime limit	35.9	37.3	38.4	39.4	40.2	40.7	41.0
	ETSU Night-time limit	43.0	43.0	43.0	43.0	43.3	45.7	48.3
Dury	Predicted noise level	16.8	26.6	30.1	30.7	31.4	31.7	32.5
	ETSU Quiet daytime limit	35.4	37.9	40.2	42.5	44.7	46.7	48.7
	ETSU Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0
South Setter	Predicted noise level	19.8	29.6	33.1	33.7	34.4	34.7	35.5
	ETSU Quiet daytime limit	35.9	37.3	38.4	39.4	40.2	40.7	41.0
	ETSU Night-time limit	43.0	43.0	43.0	43.0	43.3	45.7	48.3
East Burrafirth	Predicted noise level	19.1	28.9	32.4	33.0	33.7	34.0	34.8
	ETSU Quiet daytime limit	37.0	37.0	37.3	38.1	39.3	40.9	42.9
	ETSU Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Newing	Predicted noise level	17.7	27.5	31.0	31.6	32.3	32.6	33.4
	ETSU Quiet daytime limit	49.4	49.4	49.7	50.4	51.4	52.7	54.3
	ETSU Night-time limit	43.0	43.2	49.1	50.1	51.0	51.9	52.8

A.12.10 SUMMARY AND CONCLUSIONS

An assessment of the turbine operational noise levels has been carried out according to ETSU-R-97 guidelines. The assessment differed from the original 2009 ES in that new background monitoring locations were chosen to represent the nearest receptors to the revised site design. The assessment method was also modified to follow the recommendations of the "IOA Bulletin Agreement," and noise levels were predicted over a wider range of wind speeds, 4 to 10 m/s.

The reduction in the total number of turbines has resulted in a lower overall operational noise level. The results of the assessment show that no receptors would be exposed to noise levels above the ETSU-R-97 criteria across the range of assessed wind speeds during night-time or quiet day-time periods.

The number of proposed borrow pits has also been reduced. This has removed the possibility of receptors being exposed to noise from the concurrent or consecutive use of multiple borrow pits.

The predicted construction noise levels at previously identified NSRs have been recalculated. Three receptors, Tigh-na-Binn, Whinnia Lea and Easterscord, have now been removed from the list of receptors with potential for excessive noise exposure. The receptors at Oversound and South Newing are predicted to be 1 dB over the recommended noise limit whilst the receptor at South Town remains 4dB above the recommended noise limit. These levels can be reduced to below the target noise level by ensuring the mitigating measures detailed within BS5228 are implemented for all construction activities located close to these receptors. These effects would cease with the completion of construction activities.

A.12.11 REFERENCES

[1] Prediction and Assessment of Wind Turbine Noise

Bowdler, Bullmore, Davis, Hayes, Jiggins, Leventhall and McKenzie

Institute of Acoustics Bulletin Vol. 34 no 2, March/April 2009

[2] BS5228-1 : 2009 Code of practice for noise and vibration control on construction and open sites. Noise

British Standards Institute

BSI, December 2008

[3] Onshore Wind Energy Planning Conditions, Guidance Note. A report for the Renewables Advisory Board and BERR.

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Department for Business, Enterprise and Regulatory Reform, October 2007