CHAPTER 13: NOISE

Figures

13. NOISE

Executive Summary

13.1.1 This Chapter presents an assessment of the effects of construction and operational noise from the Proposed Varied Development on nearby dwellings. A noise assessment was carried out in the 2015 ES and 2016 FEI Report, concluding that residual operational noise impacts were not considered significant. The Proposed Varied Development includes a reduced number of turbines than the Consented Development (from fifteen to eleven) but they are of different dimensions (up to a maximum tip height of 149.9m and rotor diameter of 136m).

13.1.2 An operational noise assessment was undertaken for the Proposed Varied Development using a representative candidate turbine model that is consistent with the turbine tip height. The assessment concluded that predicted operational noise levels are below stringent criteria derived in accordance with current guidance, both for the Proposed Varied Development in isolation and cumulatively with other nearby wind farms. Operational noise effects are therefore not significant.

13.1.3 This is consistent with the conclusions of the noise assessment undertaken for the Consented Development. Furthermore, predicted operational noise levels for the Proposed Varied Development are lower than the Consented Development. Noise limit values are proposed for the Proposed Varied Development to control noise levels in practice.

13.1.4 The construction noise assessment has determined that associated levels would be lower for the Proposed Varied Development than for the Consented Development due to the reduced amount of activities and increased separation distances between construction works and noise sensitive properties. Although construction noise could be audible at various times throughout the construction programme, noise levels would remain within acceptable limits such that their temporary effects are considered slight at most and therefore not significant.

13.2 Introduction

13.2.1 This Chapter provides an assessment to consider the potential effects of construction and operational noise from the Proposed Varied Development on nearby dwellings.

13.2.2 The assessment has been carried out by Hoare Lea and in accordance with the code of conduct and best practice guidance published by the Institute of Acoustics. Hoare Lea is one of the largest and longest-established acoustics consultancies in the UK and was involved in the assessment of noise from wind farms since the earliest days of the industry. Hoare Lea engineers were involved in drafting guidance document for the assessment of wind farm noise and have worked on more than 250 wind farm developments, both in the UK and continental Europe. The main author of this report, Matthew Cand (Dipl. Eng., Ph. D.) is a member of the Institute of Acoustics.

13.3 Consented Development

Summary of Effects

13.3.1 The construction noise assessment for the Consented Development determined that associated levels remained within acceptable limits such that their effects were considered temporary and of slight effect, which is not significant. As the decommissioning phase would normally involve less intensive activities and would occur over a much shorter period than the construction phase, it was also expected to have at most a slight effect, which is also not significant.

13.3.2 The 2015 ES concluded that wind turbines of the type and size which would be installed at the Consented Development can operate within the levels deemed, by national guidance, to be acceptable for wind energy schemes. The 2016 FEI Report concluded that the reduction in the

number of turbines from 16 to 15 would further reduce operational noise levels, further reinforcing the previous conclusions.

13.3.3 Depending on a range of factors, operational noise from the Consented Development may be audible in some wind conditions. However, the predicted cumulative wind turbine operational noise levels were within the ETSU-R-97 criteria at all receptors and for all wind conditions, and as such, residual operational noise impacts were acceptable according to current guidance and are therefore not significant.

Consultation Responses

13.3.4 In their response to the 2015 ES, The Highland Council (THC) considered the potential cumulative impacts arising with the operational Gordonbush, Kilbraur and Kilbraur extension turbines. The Environmental Health Officer (EHO) suggested limits that accounted for the potential impacts and are contained within Condition 25 of the Conditions of Consent.

Relevant Conditions

13.3.5 The relevant Condition of Consent applied to the Consented Development is Condition 25 (Noise)[1]. For the Proposed Varied Development, a similar planning condition would apply but revised noise limit values are proposed, as discussed in paragraph 13.9.8 and Appendix 1.2.

13.4 Scope of Assessment

13.4.1 An assessment of operational noise has been carried out using a representative turbine model, that is consistent with the increased turbine tip height (see Section 13.6). The potential impacts of noise from construction have also been considered.

13.4.2 The study area for the assessment of construction and operational noise extends to the nearest residential dwellings neighbouring the Proposed Varied Development, which comprise the noise-sensitive receivers considered. The locations of residential properties included within the study area for the assessment are shown on Figure 13.1: Noise Assessment Locations.

Consultations

13.4.3 The pre-application advice issued by THC in September 2018 includes a section on noise prepared from the Council's Environmental Health Department (see Appendix 6.1).

13.4.4 It first requires an updated assessment of operational noise to be undertaken in accordance with both the ETSU-R-97[2] methodology and the Institute of Acoustics Good Practice Guide (IOA GPG)[3]. It refers to the relevant conditions for the Consented Development, and notes that the assessment of cumulative impacts may need to be updated. The pre-application advice also requests that a compliance monitoring scheme should be proposed to address noise complaints should they arise.

13.4.5 Furthermore, an assessment of construction noise impacts in accordance with BS 5228-1[4] is required in the event of noise from construction activities being audible or elevated at nearby residential receptors.

13.4.6 The scope of this assessment is in line with the pre-application advice[5].

[1] Please note that this was one of two conditions numbered 25 and it is therefore sought to renumber this condition as Condition 26.

[2] ETSU-R-97, the Assessment and Rating of Noise from Wind Farms. The Working Group on Noise from Wind Turbines, 1996

[3] A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise, M. Cand, R. Davis, C. Jordan, M. Hayes, R. Perkins, Institute of Acoustics, May 2013.

[4] BS 5228-1:2009-A1:2014 'Code of practice for noise and vibration control on construction and open sites – Part 1: Noise'

[5] Following issue of the pre-application advice pack, THC queried if the Balnacoil Wind Farm would be included in the cumulative noise assessment: The Balnacoil Wind Farm was refused on appeal in 2014 and is therefore not considered as part of the cumulative assessment.

13.5 Methodology

13.5.1 The prediction and assessment methodology for operational noise remains identical to that previously described in Chapter 13 of the 2015 ES, with further details set out in Appendix 13.1 of the 2015 ES: Noise and Vibration Technical Report. The assessment is carried out in accordance with the recommendations of ETSU-R-97, which is the accepted standard for such developments within the UK. Reference is also made to the IOA GPG which provides recommendations on a range of subjects relating to wind farm noise assessments.

13.5.2 This remains in line with the requirements of Schedule 9 to the Electricity Act 1989 and Schedule 4 to the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017, Scottish Planning Policy, current good practice and the pre-application advice issued by THC.

13.5.3 Operational noise criteria at neighbouring locations were determined in accordance with the guidance in ETSU-R-97 on the basis of a baseline noise survey, and the resulting noise limits were set out in Tables 13.4 and 13.5 of Chapter 13 of the 2015 ES (see Section 13.6). Additionally, ETSU-R-97 provides a simplified criterion of 35 dB L_{A90} at wind speeds up to 10 m/s, which is considered sufficient for the protection of amenity, in which case no baseline noise survey is considered to be required. The noise limits defined in ETSU-R-97 relate to the total cumulative noise levels occurring at a dwelling due to the combined noise of all operational wind turbines. Noise predictions are undertaken using the ISO 9613-2 standard[6] using the recommendations of the IOA GPG in terms of prediction parameters and additional corrections.

13.5.4 Predicted construction noise levels for the proposed construction activities were compared with 2015 ES with relevant criteria derived from guidance in BS 5228 and other reference criteria. The predictions of construction noise were made using BS 5228 guidance and on a conservative basis, based on the point for which activity would be closest to noise-sensitive properties, and with robust assumptions (including plant operation for between 75% and 100% of the working day) which will over-state noise levels in practice. The effect of construction traffic was also assessed in line using the Calculation of Road Traffic Noise[7] and BS 5228 methods and the above referenced criteria and guidance from the Design Manual for Roads and Bridges[8] as detailed in Appendix 13.1 of the 2015 ES.

13.5.5 The Proposed Varied Development comprises 11 turbines, each with a maximum tip height of 149.9m, a maximum Rotor Diameter of 136m, and a nominal hub height of 81.9m. For the purposes of the operational noise assessment, a candidate turbine has been selected which is considered to be representative (in noise terms) of the potential turbines which could be installed within the parameters noted above. The dimensions of the candidate turbine considered in this chapter may therefore vary from those considered in other chapters. The candidate turbine used in this assessment is the Vestas V126 3.45MW turbine, with a 149.9m tip height, 86.9m hub height and a 126m rotor diameter. The V126 model was selected as representative of the noise emissions for turbines of this scale. The larger Vestas V136 turbine model was considered but it has marginally lower noise emission levels. Table 13.1 summarises the parameters assessed for the Consented Development and the Proposed Varied Development.

[6] ISO 9613-2:1996 'Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation', International Standards Organisation, 1996.
[7] Calculation of Road Traffic Noise, HMSO Department of Transport, 1988.
[8] Design Manual for Roads and Bridges, Volume 11, section 3, Part 7, Traffic Noise and Vibration, The Highways Agency, Transport Scotland, Transport Wales, The Department for Regional Development (Northern Ireland)

Table 13.1: Turbine Parameters Assumed for the Purposes of Assessment

Assessment	Nominal Rotor Diameter (M)	Nominal Hub Height (M)	Maximum Tip Height (M)	Turbine Model	Comment
2015 ES	101	77.5	130	Siemens SWT-101	Based on 16 turbine layout
2019 EIA Report	126	86.9	149.9	Vestas V126	Based on 11 turbine layout

13.6 Baseline

13.6.1 The baseline site characterisation presented in the 2015 ES remains representative of the area and the noise-sensitive dwellings neighbouring the site. It was based on noise surveys at three representative locations agreed with THC. The results obtained from the survey positions were used to represent the background environment at other nearby assessment locations. A total of six properties were selected as being representative of the closest located properties to the wind farm, as set out in Table 13.2 and shown in Figure 13.1. The minimum separation distance to the closest residential property with the Proposed Varied Development is approximately 3km.

Table 13.2 – Noise Assessment Locations

Property	Easting	Northing	Survey location?
Ascoile	282388	911191	Yes
Home Cottage	283540	910178	Yes
Keepers Cottage	284462	909584	Yes
Gordonbush Lodge	284596	909817	Keepers Cottage
Moulin Cottage	282480	910888	Ascoile
Kilbraur	282377	910024	Ascoile

13.6.2 In the analysis for the 2015 ES, the measured baseline noise data was related to wind speeds standardised at 10m height, based on those derived at a height of 80m using measurements on a 70m high meteorological mast. This approach was in line with the approach recommended in the IOA GPG. Furthermore, the effective hub height of 80m used in this analysis was conservative given that the hub height of the candidate turbine considered varied between 64 and 77.5m.

13.6.3 The candidate turbine model considered in this assessment has a hub height of 86.9m and therefore consideration was given to reanalysing the previously measured data relative to a taller height of 90m: this resulted in derived background noise levels (and therefore ETSU-R-97 noise limits) which were either effectively identical or very marginally different (by no more than 0.2dB), with the previous limits being lower in these cases (and therefore more stringent). These differences are effectively negligible. The previously derived noise limits (Tables 13.4 and 13.5 of the 2015 ES) are retained on a conservative basis in the present analysis as the relevant ETSU-R-97 noise limits and are repeated below in Tables 13.3 and 13.4.

Table 13.3 - Day time L_{A90} (dB) Noise Limits Derived from the Baseline Noise Survey According to ETSU-R-97

Property	Standardised wind speed (m/s)								
	4	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Ascoile	35	35	36	38	39	41	43	44	46
Home Cottage	38	40	41	42	44	45	47	49	51
Keepers Cottage	35	37	39	40	42	43	45	46	47

Property	Standardised wind speed (m/s)								
Gordonbush Lodge	35	37	39	40	42	43	45	46	47
Newlan Cottage	35	35	36	38	39	41	43	44	46
Kilbraur	35	35	36	38	39	41	43	44	46

Table 13.4 – Night time L_{A90} (dB) Noise Limits Derived from the Baseline Noise Survey According to ETSU-R-97

Property	Standardised wind speed (m/s)								
	4	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Ascoile	43	43	43	43	43	43	43	43	43
Home Cottage	43	43	43	43	43	44	45	47	49
Keepers Cottage	43	43	43	43	43	43	44	46	48
Gordonbush Lodge	43	43	43	43	43	43	44	46	48
Newlan Cottage	43	43	43	43	43	43	43	43	43
Kilbraur	43	43	43	43	43	43	43	43	43

13.7 Potential Effects

Turbine Information

13.7.1 Manufacturer information[9] from Vestas for the Vestas V126 3.45MW turbine, providing overall sound power data as well as representative sound spectra for the turbine, was referenced. The sound power data has been derived for standardised 10m height wind speeds of 4 to 12m/s inclusive based on a turbine hub height of 87m.

13.7.2 A factor of +2dB was added to the manufacturers emission levels provided, in accordance with current good practice, as a conservative measure in the absence of specific information on uncertainty in the data provided. The Vestas V126 turbine is provided as standard with blades with Serrated Trailing Edge (STE) which is a type of noise-reduction technology which is becoming increasingly common. The resulting robust emission data for the turbine operating in its standard operational mode (Mode 0) is set out in Table 13.5 below. The corresponding representative emission spectrum is set out in Table 13.6.

13.7.3 In addition, to model the Repower (Senvion) MM82 2.05MW model turbines of the existing Gordonbush Wind Farm, updated data based on more recent manufacturer information[10] was used: this is also set out in Tables 13.5 and 13.6. In a similar way as for the Vestas V126, a factor of +2dB was added to the specified data. The emission data for the turbines of the Kilbraur Wind Farm (Nordex N90 2.5 MW) and its Extension remain as set out in Appendix 13.1 of the 2015 ES and are also included in Tables 13.5 and 13.6. No additional wind farms in the vicinity of the site require consideration.

[9] Vestas, V126-3.45 MW High Torque (HTq), third octave noise emissions, document 0055-1399_02, dated 04/09/2017.
[10] Overall levels in unconstrained operation from Senvion document SD-2.5-WT.PO.02-C-C-EN dated 20/01/2014, with spectral information from Senvion document GI-2.5-WT.PO.04-A-A-EN, dated 17/03/2014. The 2015 ES was based on data from 2010.

Table 13.5 - Wind turbine sound power levels used in the noise assessment (dB L_{Aeq})

Model	Standardised wind speed (m/s)								
	4	5	6	7	8	9	10	11	12
Vestas V126	96.9	101.3	105.1	106.4	106.4	106.4	106.4	106.4	106.4
Senvion MM82	96.1	101.7	105.6	106.0	106.0	106.0	106.0	106.0	106.0
Nordex N90	99.0	102.5	105.5	106.5	107.0	107.0	107.0	107.0	107.0

Table 13.6 - Octave band sound power spectrum (dB L_{Aeq}) for reference wind speed conditions (standardised wind speed = 8 m/s)

Model	Octave Band Centre Frequency (Hz)							
	63	125	250	500	1k	2k	4k	8k
Vestas V126	86.1	92.8	98.8	101.2	101.4	97.5	90.5	71.4
Senvion MM82	88.2	94.2	98.4	100.9	100.6	96.4	91.5	78.3
Nordex N90	92.2	96.3	100.7	101.1	99.6	98.5	94.5	87.2

13.7.4 Table 13.7 also provides the updated terrain propagation factors used in the calculations for each of the properties of Table 13.2. As previously described, the attenuation due to terrain screening accounted for in the calculations has been limited to a maximum of 2 dB(A). This shows that the residential locations considered are screened from most turbines. In situations of propagation above concave ground (i.e. across a valley), a correction of +3 dB would be added, although this was not found to be required for any of the turbines of the Proposed Varied Development (see Table 13.7). This is in accordance with the IOA GPG recommendations.

Table 13.7 - Propagation attenuation effects due to terrain (dB) – Proposed Varied Development Turbines

Turbine	Property					
	Keeper Cottage	Home Cottage	Kilbraur	Newlan Cottage	Ascoile	Gordonbush Lodge
T1	2	2	0	2	2	2
T2	2	2	0	2	2	2
T3	2	2	2	2	2	2
T4	2	2	2	2	2	2
T5	2	2	2	2	2	0
T6	2	2	2	2	2	2
T7	2	2	0	2	2	2
T8	2	2	0	2	2	2
T9	2	2	0	2	2	2
T10	2	2	2	2	2	2
T12	2	2	0	2	2	2

Operational Noise Levels and Assessment

13.7.5 The resulting predicted noise levels for the Proposed Varied Development are set out in Table 13.8. Predicted operational noise levels for the combination of the Proposed Varied Development and the existing Gordonbush Wind Farm are set out in Table 13.9. Table 13.10 sets out predicted noise levels from the the Kilbraur Wind Farm and its extension.

13.7.6 Finally, Table 13.11 sets out cumulative noise immission levels at each of the selected assessment locations, including the Kilbraur Wind Farm and its extension.

13.7.7 The predictions for the Kilbraur wind turbines and extension (Table 13.10) were made on the basis of robust emission data for the installed turbine model at this site but have not allowed for a hypothetical increase permitted under the consent conditions for that scheme. However, the cumulative predictions of Table 13.11 are made assuming that all receptors are downwind of all wind turbines at the same time. As the properties considered are located between the Kilbraur Wind Farm (and Extension) and the Gordonbush Wind Farm (and Proposed Varied Development), this represents a particularly conservative assumption. Levels in upwind conditions will be at least 10dB lower than downwind conditions: this will therefore compensate for a potential increase in emissions from Kilbraur Wind Farm and its extension.

13.7.8 Furthermore, a comparison between Tables 13.9 and 13.10 shows that the combined predictions for the Proposed Varied Development and the existing Gordonbush Wind Farm are 4 to 5dB lower than those for the Kilbraur Wind Farm and its extension for properties closest to the latter turbines. Therefore, if an uplift was added to the Kilbraur wind turbines to allow for increases allowed under their consent, this would increase the noise levels from the Kilbraur wind turbines such that, at these receivers, the noise levels from the Proposed Varied Development would be around 10dB lower than that from the Kilbraur wind turbines and would therefore be relatively negligible[11]. This further reinforces the above analysis.

Table 13.8 - Predicted noise levels (L_{A90}, dB) – Proposed Varied Development in isolation

Property	Standardised wind speed (m/s)								
	4	5	6	7	8	9	10	11	12
Ascoile	15	20	24	25	25	25	25	25	25
Home Cottage	15	19	23	24	24	24	24	24	24
Keepers Cottage	14	18	22	23	23	23	23	23	23
Gordonbush Lodge	15	19	23	24	24	24	24	24	24
Moulin Cottage	15	19	23	24	24	24	24	24	24
Kilbraur	14	18	22	23	23	23	23	23	23

Table 13.9 - Predicted noise levels (L_{A90}, dB) – Gordonbush Wind Farm and Proposed Varied Development

Property	Standardised wind speed (m/s)								
	4	5	6	7	8	9	10	11	12
Ascoile	18	23	27	28	28	28	28	28	28
Home Cottage	18	23	27	27	27	27	27	27	27
Keepers Cottage	17	22	26	27	27	27	27	27	27
Gordonbush Lodge	18	23	27	28	28	28	28	28	28
Moulin Cottage	18	23	27	27	27	27	27	27	27
Kilbraur	16	21	25	26	26	26	26	26	26

[11] The IOA GPG suggests that cumulative noise effects need not be considered where differences between existing and proposed wind farm noise levels are 10 dB or more.

Table 13.10 - Predicted noise levels (L_{A90}, dB) – Kilbraur Wind Farm and Extension

Property	Standardised wind speed (m/s)								
	4	5	6	7	8	9	10	11	12
Ascoile	24	28	31	32	32	32	32	32	32
Home Cottage	23	26	29	30	31	31	31	31	31
Keepers Cottage	19	23	26	27	27	27	27	27	27
Gordonbush Lodge	20	24	27	28	28	28	28	28	28
Moulin Cottage	24	27	30	31	32	32	32	32	32
Kilbraur	24	28	31	32	32	32	32	32	32

Table 13.11 - Predicted noise levels (L_{A90}, dB) – Cumulative – all wind farms

Property	Standardised wind speed (m/s)								
	4	5	6	7	8	9	10	11	12
Ascoile	25	29	32	33	34	34	34	34	34
Home Cottage	24	28	31	32	33	33	33	33	33
Keepers Cottage	21	25	29	30	30	30	30	30	30
Gordonbush Lodge	22	27	30	31	31	31	31	31	31
Moulin Cottage	25	28	32	33	33	33	33	33	33
Kilbraur	25	29	32	33	33	33	33	33	33

13.7.9 It can be seen that both the predictions of Table 13.8 (Proposed Varied Development in isolation) and Table 13.9 (Gordonbush Wind Farm and Proposed Varied Development) are below 30dB L_{A90} and therefore clearly below the simplified criteria of 35dB L_{A90} set out in ETSU-R-97 at all properties and at all wind speeds. This means that levels from the Proposed Varied Development in isolation are considered acceptable in line with current guidance.

13.7.10 When considering the cumulative case, it is also apparent from Table 13.11 that the cumulative noise predictions also remain below the simplified ETSU-R-97 criteria of 35 dB L_{A90}. This means that operational noise levels can be considered acceptable regardless of baseline noise levels, and a background survey would not have been required for the assessment of the Proposed Varied Development.

13.7.11 For consistency with the analysis in the 2015 ES, Table 13.12 and 13.13 show a comparison between the cumulative predictions of Table 13.11 and the ETSU-R-97 noise limits of Tables 13.3 and 13.4. Negative values mean that the predictions are below the limits, and positive values representing an excess of the noise limits. As the tables do not include positive values, this demonstrates that, for all receptors and wind speeds, the Proposed Varied Development can operate such that the previously derived ETSU-R-97 noise limits remain satisfied.

Table 13.12 - Comparison of the revised predicted cumulative operational noise levels (Table 13.11) with the ETSU-R-97 noise limit for the Wind Farm for day-time periods (Table 13.3). Negative values mean that the predictions are below the limits.

Property	Standardised wind speed (m/s)								
	4	5	6	7	8	9	10	11	12
Ascoile	-10	-6	-4	-4	-6	-7	-9	-11	-12
Home Cottage	-14	-12	-9	-10	-11	-13	-14	-16	-18
Keepers Cottage	-14	-11	-10	-10	-12	-13	-15	-16	-17
Gordonbush Lodge	-13	-10	-9	-9	-11	-12	-13	-15	-16
Moulin Cottage	-10	-7	-5	-5	-6	-8	-10	-11	-13
Kilbraur	-10	-7	-5	-5	-6	-8	-9	-11	-13

Table 13.13 - Comparison of the revised predicted cumulative operational noise levels (Table 13.11) with the ETSU-R-97 noise limit for the Wind Farm for day-time periods (Table 13.4). Negative values mean that the predictions are below the limits.

Property	Standardised wind speed (m/s)								
	4	5	6	7	8	9	10	11	12
Ascoile	-18	-14	-11	-10	-9	-9	-9	-9	-9
Home Cottage	-19	-15	-12	-11	-10	-11	-13	-15	-16
Keepers Cottage	-22	-18	-14	-13	-13	-13	-14	-16	-18
Gordonbush Lodge	-21	-16	-13	-12	-12	-12	-13	-15	-17
Moulin Cottage	-18	-15	-11	-10	-10	-10	-10	-10	-10
Kilbraur	-18	-14	-11	-10	-10	-10	-10	-10	-10

13.7.12 In conclusion the operational noise levels remain **acceptable and therefore not significant.** The assessment has demonstrated that that there are no likely significant effects due to operational noise for the Proposed Varied Development. This conclusion is the same as for the Consented Development.

Low Frequency Noise, Vibration and Amplitude Modulation

13.7.13 Low frequency noise and vibration resulting from the operation of wind farms has attracted attention over recent years and subject to detailed scrutiny at planning appeals, and which was discussed in detail in Annex A of Appendix 13.1 of the 2015 ES. This Annex explained, that ETSU-R-97 should continue to be used for the assessment and rating of operational noise from wind farms and this remains the position in current Scottish planning policy.

13.7.14 This Annex also discusses wind turbine blade swish or Amplitude Modulation (or AM) and previous published research and guidance on the subject. The IOA has since published[12] an objective method developed for quantifying AM noise. The UK Government also commissioned a review[13] on subjective response to AM noise which outlines proposals for the control of this

[12] Institute of Acoustics (IOA) Amplitude Modulation Working Group, Final Report, A Method for Rating Amplitude Modulation in Wind Turbine Noise, June 2016.

[13] Review of the evidence on the response to amplitude modulation from wind turbines, WSP for Department for Business, Energy & Industrial Strategy (Oct 2016). https://www.gov.uk/government/publications/review-of-the-evidence-on-the-response-to-amplitude-modulation-from-wind-turbines

feature based on the IOA methodology. The recommendations of this review have however not been endorsed in current Scottish planning policy.

Construction Noise

13.7.15 The reduced number of turbines in the Proposed Varied Development is associated with a reduced amount of construction activity and an increased separation distance between the nearest construction works and noise-sensitive properties. This means that construction noise levels will be lower than those assessed previously in the 2015 ES given the basis of this assessment. This means that the effects associated with the construction and decommission phase will be **slight** at most and therefore **not significant**.

13.8 Mitigation Measures

2015 ES / 2016 FEI Schedule of Mitigation

13.8.1 To reduce the potential effects of construction noise, good practice measures and restrictions on hours of noisy work and heavy goods vehicle deliveries to the site were proposed for the Consented Development. For blasting operations potentially associated with the quarrying of borrow pits, further restriction on blasting hours and testing processes for the control of vibration was proposed.

13.8.2 For operational noise, the selection of the final wind turbine to be installed at the Consented Development would be made to enable relevant noise limits to be achieved at the surrounding properties.

Relevant Conditions of Consent (2017)

13.8.3 Condition of Consent 25 for the Consented Development (see Appendix 1.1) sets out noise limits for the combination of the turbines on the Consented Development as well as those of the existing Gordonbush Wind Farm. These are therefore considered as one single extended wind farm from the point of view of this noise limit, which is consistent with good practice for wind farms.

13.8.4 The noise limits attached to Condition 25 are set out in two tables (1 and 2) attached to the Condition. These noise limits were determined based on recommendations from the Environmental Health Department of The Highland Council. Based on previous consultation with The Highland Council, these noise limits are understood to be based on predicted levels, for the combination of the Consented Development and the existing Gordonbush Wind Farm, with the addition of a margin of +2dB to allow some degree of flexibility in the selection of a final turbine model for the Consented Development. It is likely however that this was based on predictions made by The Highland Council Environmental Health Department as the resulting noise limit values were not consistent with the predictions determined in the 2015 ES, and were relatively stringent as a result. Furthermore, this approach resulted in requirements at low wind speeds which are below existing background noise levels and can therefore introduce artificial difficulties in undertaking compliance monitoring.

13.8.5 Condition 25 also describes a procedure for the monitoring of operational noise at any relevant neighbouring residential dwelling, in the event of a complaint notified by the Local Planning Authority, to ascertain the level of noise from the combination of the Consented Development and the existing Gordonbush Wind Farm against the consented noise limits. Detailed guidance notes for this monitoring are also attached to the Condition.

13.8.6 Condition 15 of the Consented Development provides restrictions on hours of any blasting associated with borrow pit quarrying to take place, as well as limits on the associated levels of vibration at nearby monitoring locations. This provides a suitable level of control of noise and vibration associated with these activities. No variation is proposed to this Condition.

Additional Mitigation Measures Relevant to Proposed Varied Development

13.8.7 In light of the conclusions of the assessment above no additional mitigation measures are proposed for the Proposed Varied Development.

13.8.8 Revised noise limit values for Condition 25 are proposed in Table 13.14 below and in Appendix 1.2. They are based on a fixed level of 30 dB L_{A90} and would apply to the combination of the Proposed Varied Development and the existing Gordonbush Wind Farm. The limits of Table 13.14 apply to both day and night periods and therefore replace the values of Tables 1 and 2 included in Condition 25 of the previous consent. They are consistent with the predictions of Table 13.9 above with the addition of a margin of +2 dB to allow some flexibility for future turbine procurement in line with current good practice.

Table 13.14 - Proposed noise limits (L_{A90}, dB) for the combination of the Proposed Varied Development and the existing Gordonbush Wind Farm

Property	Standardised wind speed (m/s)								
	4	5	6	7	8	9	10	11	12
Ascoile	30	30	30	30	30	30	30	n/a	n/a
Home Cottage	30	30	30	30	30	30	30	n/a	n/a
Keepers Cottage	30	30	30	30	30	30	30	n/a	n/a
Gordonbush Lodge	30	30	30	30	30	30	30	n/a	n/a
Moulin Cottage	30	30	30	30	30	30	30	n/a	n/a
Kilbraur	30	30	30	30	30	30	30	n/a	n/a

13.8.9 The use of a fixed value at low wind speeds avoids introducing artificial difficulties in compliance measurements in these conditions. For the same reason, as in the simplified assessment method of ETSU-R-97, no limit values are included at the highest wind speeds of 11 and 12 m/s: in these conditions, measured background noise values were in excess of 37 to 41 dB L_{A90}.

13.8.10 The rest of the wording of Condition 25 provides a compliance monitoring scheme as required to address noise complaints should they arise. Similar wording could be used, in line with current good practice, and including the values of Table 13.14.

13.9 Residual Effects

13.9.1 The construction noise assessment has determined that the works could be audible at various times throughout the construction programme, but remain within acceptable limits such that their effects are considered temporary and slight, and therefore **not significant**.

13.9.2 The predicted wind turbine operational noise levels are within the ETSU-R-97 criteria at all receptors and for all wind conditions, as such, residual operational noise impacts are acceptable according to current guidance and are therefore not significant.

13.9.3 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 may be audible. However, it is predicted that noise levels at the properties in the vicinity of the proposed wind turbines will still be within levels considered acceptable under the ETSU-R-97 assessment method and therefore **not significant**.

13.10 Comparison of effects between Proposed Varied Development and Consented Development

13.10.1 The operational noise level predictions for the Proposed Varied Development of Tables 13.8-13.11 above were compared with equivalent predictions, using the same assumptions for existing and cumulative sites, for the Consented Development. This shows that:

- the Gordonbush Extension Wind Farm in isolation is 2 to 5 dB(A) quieter for the Proposed Varied Development compared to the Consented Development;
- the combination of the Gordonbush Extension Wind Farm and the existing Gordonbush Wind Farm is up to 3 dB(A) quieter for the Proposed Varied Development compared to the Consented Development; and
- predicted cumulative levels are up to 1 dB(A) quieter for the Proposed Varied Development compared to the Consented Development.

13.10.2 Overall, in both the case of the Proposed Varied Development and the Consented Development, predicted levels are within the previously derived ETSU-R-97 criteria at all receptors and for all wind conditions. Furthermore, predicted cumulative noise levels are below the simplified criterion of 35 dB(A) included in ETSU-R-97 and would therefore be considered acceptable regardless of background noise level measurements. As such, residual operational noise impacts are clearly acceptable according to current guidance and are therefore not significant. As no likely significant effects have been identified either for the Consented Development or the Proposed Varied Development, it follows there is no difference in likely significant effects between the Consented Development and the Proposed Varied Development.

13.10.3 As described above, the assessment of construction noise impacts for the Proposed Varied Development is based on a reduced level of activity and increased distance from noise-sensitive receptors, meaning the impact would be reduced in practice and no significant levels were identified. There is therefore no difference in likely significant effects between the Consented Development and the Proposed Varied Development.

13.11 Conclusion

13.11.1 This Chapter has presented an assessment of the effects of construction and operational noise from the Proposed Varied Development on nearby dwellings.

13.11.2 Six residential properties within the vicinity of the Proposed Varied Development were selected as being representative of the closest located properties to the wind farm. The minimum separation distance between these properties and the Proposed Varied Development is approximately 3km.

13.11.3 Operational noise from the wind farm has been assessed in accordance with the methodology set out in the ETSU-R-97 Report, 'The Assessment and Rating of Noise from Wind farms'. This document provides a robust basis for assessing the operational noise of a wind farm as recommended in Scottish Planning Policy and is considered appropriate for the purpose for assessment under Schedule 9 to the Electricity Act 1989 and Schedule 4 to The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017. The operational noise assessment was undertaken based on a representative candidate turbine model, the Vestas V126, which is typical of the type and size of turbine which may be considered for this site, and assuming worst case downwind propagation.

13.11.4 The assessment demonstrates that both of the previously derived day time and night time noise limits can be satisfied at all receptors assessed across all wind speeds. Furthermore, the simplified fixed noise limit included in ETSU-R-97 was also satisfied in all cases. This assessment includes cumulative effect from other neighbouring schemes, including the existing Gordonbush turbines. Operational noise effects are therefore **not significant**.

13.11.5 Noise limit values are proposed for the Proposed Varied Development to control noise levels in practice based on previous consultation. Revised predicted operational noise levels are lower than those for the Consented Development.

13.11.6 The construction noise assessment has determined that associated levels would be lower than for the Consented Development due to the reduced amount of activities and increased separation distances between construction works and noise sensitive properties. Although construction noise could be audible at various times throughout the construction programme, noise levels would remain within acceptable limits such that their temporary effects are considered slight at most and therefore **not significant**. Various mitigation methods were previously suggested to reduce the effects of construction noise, the most important of these being suggested restrictions of hours of working, and these remain applicable.