Wind Energy Project at Ascog Farm

12/02202/PP

Noise Assessment

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Date: 05/03/2013

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1 Noise Assessment

1.1 Introduction

This report will assess whether installing a three 800 kW turbines at Ascog Farm, Bute will cause noise disturbance to people living in the local area. Noise generated from a wind cluster can be divided into construction noise and operational noise. Virtually everything with moving parts will make some sound, and wind turbines are no exception. Well designed wind turbines are generally quiet in operation and compared to the noise of road traffic, trains, aircraft and construction activities in other locations, the noise from wind turbines is very low.

Noise from wind turbines consists of the sound produced by the turning blades and from the gearbox, generator and hydraulic systems within the nacelle. The most important factors affecting noise are:

- Type of noise source
- Distance from source
- Wind speed
- The presence of barriers and buildings

The factors with the most influence on noise propagation are the distance the observer is from the source and the type of noise source. This assessment considers the noise propagation from the proposed wind turbine development during normal operation. References are provided at the end of the chapter.

In order to provide a basis for comparison, a list of typical noise levels as listed in PAN 1/2011 has been provided in Table 1.1 below.

Table 1.1: Typical noise levels

Source/Activity	Indicative Noise Level (dB(A))
Unsilenced Pneumatic Drill (at 7m distance)	95
Heavy Diesel Lorry (40km/h at 7m distance)	83
Modern twin-engine jet (at take off at 152m distance)	81
Passenger car (60 km/h at 7m distance)	70
Office Environment	60
Ordinary conversation	50
Quiet Bedroom	35

1.2 Consultation

This noise assessment has been undertaken in response to a request for further information relating to the potential noise impacts of installing three turbines at Ascog Farm on Bute. The original Environmental Statement (ES) submitted contained a noise assessment based on background noise monitoring at one property. The assessment was based on the guidance current at the time. Since the original assessment was undertaken, the standards to which noise impact assessments are completed has changed. Therefore, further monitoring on site and assessment was undertaken. SAC Consulting and Argyll and Bute Environmental Health officers had a meeting on site in order to ensure that the methodology being proposed was acceptable.

1.3 Regulations, Policy and Guidance Context

The proposed wind energy project at Ascog Farm would have no significant effects in relation to operational noise and therefore is not considered to have any adverse implications with respect to prevailing development policy. The relevant local plan policy is Policy LP REN 1 (Wind Farms and Wind Turbines).

PAN 1/2011 Onshore Wind Turbines provides national planning advice for the development of renewable energy technologies, including on-shore wind energy. Recommendations are given on all aspects of wind turbine development covered in this Environmental Statement, including the assessment of noise from wind farms. This planning advice note suggests that the report "*The Assessment and Rating of Noise from Wind Farms*" (ETSU, 1997) presents a series of recommendations that can be regarded as relevant guidance on good practice.

1.4 Description of Site

The site has been described throughout the ES (APP/2012/02202). The plan in Appendix A shows the layout of the site and the locations used for the monitoring of background noise levels and the location of the meteorological mast used to collect wind speed and rain fall data.

There are no other wind turbine developments in the vicinity of the Ascog Wind Energy Project which could have a cumulative impact with the development proposed.

The development is located on open farmland / hill ground with soft ground between turbines and neighbouring properties with no intervening structures between the turbines and any property assessed.

1.5 Proximity of Neighbours

The residences in the environs of the Ascog Wind Energy Project are listed in Table 1.2 with their respective distances to the proposed turbines. Distances have been corrected to allow for the variation in height between the noise source and the receiver to provide a straight line distance between the source and the receiver. Ownership and current occupational status of each property is also noted. The properties noted represent those closest to the proposed turbine development and are not an exhaustive list of properties thought to potentially be affected. They are intended to represent a selection of properties where conformance to limit levels can be demonstrated thus properties at greater distance from the development will also conform.

Table 1.2: Closest sensitive receptors to Ascog turbine location

	Distance (m)			
Property	**Turbine 1**	**Turbine 2**	**Turbine 3**	**Owned by / Occupied by**
Duneastein	484.7	506.7	564.6	Private/Private
Braeside	444.2	502.7	592.4	Private/Private
High Bogany	421.8	592.0	768.4	Private/Private
Vineries	420.8	442.7	546.0	Private/Private
Clairemount Cottage	529.4	500.5	547.2	Private/Private
Grianan	526.1	593.8	719.1	Private/Private
Ascog Farmhouse	577.2	424.5	310.2	Developer/Developer
Ascog Lodge	566.9	445.9	390.0	Private/Private
Balmory Hall	803.1	641.9	497.2	Private/Private
Mid Ascog	936.6	764.1	589.2	Private/Private
Beech Park	800.3	629.3	460.4	Private/Private
Balmory Cottage	867.5	698.7	535.7	Private/Private

1.6 Potential Disturbance Sources

1.6.1 Construction Noise

The construction noise at this development will be of short duration and only during normal working hours. The majority of the noise will be created in the vicinity of the site as the main operations for installation take place at the turbine locations. There will be some small impact from lorries delivering components and materials to site though these activities will be of short duration and no major disturbance above normal agricultural operations noise levels is predicted.

1.6.2 Operational Noise

The operation of the wind turbines at Ascog pose the greater potential to have an impact through noise immissions at neighbouring properties. This assessment will present the predicted impacts expected through the day to day operation of the three proposed wind turbines on Ascog Hill.

1.7 Assessment Methodology

The scope of this assessment follows the ETSU R97 which is regarded as relevant guidance on noise from wind turbines. ETSU (1997) suggests that current practice on controlling wind farm noise should be by the application of noise limits at the nearest noise-sensitive properties. These noise limits should be applied to external locations and should apply only to those areas frequently used for relaxation or activities for which a quiet environment is highly desirable. The report suggests that noise limits should be set at an $L_{A90,10min}$ of no more than 5 dB(A) above background noise levels up to wind speeds at 10 m height (V_{10}) of 12 m/s, subject to a minimum of 35-40 dB(A) for daytime and 43dB(A) for night-time. However, the report also states both day and night-time lower fixed limits can be increased to 45dB (A) to increase the permissible margin above background where the occupier of the property has some financial interest in the wind farm development. Where a financial interest is present in a development the limit of 5 dB(A) above background can also be increased.

The background noise level is measured as an L90 which means that the value used is the level exceeded by 90% of the recorded noise level readings. The background level (LA90) will therefore be below the average ambient noise level (LAeq).

The noise impact of the proposed wind turbines at Ascog Farm has been assessed by means of a desk study based on a background noise survey at the closest sensitive receptors. Turbine immission levels at the identified locations have been calculated using octave band sound power levels, taking account of any tonal penalties and other geographical factors.

For purposes of this noise assessment, noise emission data was obtained for the turbine model under consideration, Enercon model E-48 at 50 m hub height. The manufacturer's quoted broadband sound power level reaches 102.5 dB(A) at 95% of rated power output, that occurs at a wind speed 10 m above ground level (V_{10}) calculated at 9.4 m/s. As the stated sound power levels derive from noise measurements carried out downwind from the turbine (in accordance with EN 61400-11:2003), these levels represent the worst case in terms of wind direction.

ISO9613-2 Attenuation of sound during propagation outdoors has been used in the calculation of predicted noise levels from the proposed turbines at Ascog. While three methods are available within ISO9613-2, the most conservative estimation method has been

used for the purpose of this assessment. This is the General Method which utilises Octave Band data for the turbine in question. The Octave Band data has been sourced from Wind Consult GmbH, this represents the fullest account of the Octave Band analysis of the proposed Enercon E-48 turbine model. Table 1.3 below shows the turbines noise output in octave bands as measured by Wind Consult. Further information relating to the octave band data can be found in Appendix B and warranty noise levels of the Enercon E-48 turbine can be found in the Appendix C.

Table 1.3: E-48 Octave band sound power data dB(A)

Freq (Hz)	Wind speed (m/s)					
	5	**6**	**7**	**8**	**9**	**10**
63	74.6	78.2	80.8	79.2	79.5	78.6
125	80.3	82.3	85.5	85.6	87.0	84.4
250	87.3	89.2	93.0	94.7	95.8	93.3
500	88.0	91.5	94.9	96.7	97.2	96.8
1000	85.6	91.3	93.3	95.1	94.8	97.9
2000	81.8	86.1	88.2	88.7	89.7	92.7
4000	78.0	82.3	85.3	85.4	88.5	87.6
8000	74.3	78.9	82.8	83.2	86.8	84.6

The use of this data is recommended to utilise a 2 dB uncertainty value, this value shall be added to each octave band value noted in Table 1.3 during the calculation of turbine noise.

As the stated sound power levels derive from noise measurements carried out downwind from the turbine (in accordance with EN 61400-11:2003), these levels represent the 'worst case' in terms of wind direction.

The above Octave band data shall be assessed using the methodology given in ISO 9613-2 General Method. This method allows for accurate air and ground attenuation levels to be calculated for each octave band before calculating a final figure. For this turbine model the General Method provides a more conservative approach to calculating expected noise levels at sensitive receptors.

The general information used in the calculation of noise at each property is contained in Table 2 and Table 3 of ISO 9613-2.

1.7.1 Atmospheric Absorption

Atmospheric absorption has been calculated as per the standard figures available in ISO 9613-2. Attenuation coefficients corresponding to 10^{o}c and 70% humidity have been used to give relatively low levels of attenuation for a more conservative approach.

1.7.2 Ground Absorption

As the site is mostly farmland from the turbine to the sensitive receptors it may be reasonable to assume that the ground is acoustically porous, however following advice from the I.O.A it will be considered mixed ground with a porosity of 50% or a ground factor of 0.5.

The Octave band general method uses the ground attenuation calculation found in 7.3.1 of ISO 9613-2. This assumes a ground factor of 0.5 for a more conservative calculation of turbine noise at sensitive receptors.

1.7.3 Receiver Height

Following guidance from the Institute of Acoustics a receiver height of 4 metres has been assumed for calculations to provide conservative predictions.

1.8 Noise Impact from Ascog Farm Turbine Development

1.8.1 Attenuations required

The use of Octave Band data requires an uncertainty value of 2 dB(A) be added to each octave band level during calculation. Once calculations are made they must be converted from an LAeq value to an LA90 value, this utilises a subtraction of 2 dB(A) as recommended by ETSU to convert the predicted noise immission levels to an LA90 value to compare against background noise levels.

The majority of properties can reliably be assessed using the general method as described in ISO 9613-2. This method allows ground absorption to be calculated effectively though is noted as only suitable for sites where the ground is approximately flat or has a continuous slope. The properties around the proposed development largely meet the criteria for this method with the exception of those to the West and North of the development where the sound will be propagating across a shallow valley region.

Due to this topography, an attenuation of 3 dB(A) must be added to the calculated values to account for potential reflected sound paths across the shallow valley. Thus, the properties of Duneastein, Braeside and High Bogany will all have a 3 dB(A) addition after the calculation of turbine noise immissions included for both Quiet Day and Night time predictions.

1.8.2 Octave Band Predictions

The results of the Octave band analysis using the octave band data give the calculated turbine noise levels at each receptor and are shown in Tables 1.4 and 1.5 below. The levels represent the predicted combined noise from all three turbines.

Table 1.4: Ascog Predicted Turbine Noise levels at Sensitive Receptors Quiet Day

Property	Wind Speed m/s					
	5	6	7	8	9	10
Duneastein	35.1	38.7	41.7	43.3	43.8	44.1
Braeside	35.3	38.9	42.0	43.6	44.1	44.4
High Bogany	34.6	38.2	41.2	42.8	43.4	43.6
Vineries	33.2	36.8	39.8	41.4	41.9	42.2
Clairemount Cottage	31.9	35.5	38.5	40.1	40.7	40.9
Grianan	30.6	34.2	37.2	38.8	39.4	39.6
Ascog Farmhhouse	34.6	38.3	41.3	42.9	43.4	43.8
Ascog Lodge	33.4	37.0	40.0	41.6	42.1	42.5
Balmory Hall	30.4	34.0	37.0	38.6	39.2	39.4
Mid Ascog	28.7	32.3	35.3	36.9	37.5	37.6
Beech Park	30.9	34.5	37.5	39.1	39.6	39.9
Balmory Cottage	29.6	33.2	36.3	37.9	38.4	38.6

Table 1.5: Ascog Turbine Noise levels at Sensitive Receptors Night

Property	Wind Speed m/s					
	5	6	7	8	9	10
Duneastein	35.1	38.7	41.7	43.3	43.8	44.1
Braeside	35.3	38.9	42.0	43.6	44.1	44.4
High Bogany	34.6	38.2	41.2	42.8	43.4	43.6
Vineries	33.2	36.8	39.8	41.4	41.9	42.2
Clairemount Cottage	31.9	35.5	38.5	40.1	40.7	40.9
Grianan	30.6	34.2	37.2	38.8	39.4	39.6
Ascog Farmhouse	34.6	38.3	41.3	42.9	43.4	43.8
Ascog Lodge	33.4	37.0	40.0	41.6	42.1	42.5
Balmory Hall	30.4	34.0	37.0	38.6	39.2	39.4
Mid Ascog	28.7	32.3	35.3	36.9	37.5	37.6
Beech Park	30.9	34.5	37.5	39.1	39.6	39.9
Balmory Cottage	29.6	33.2	36.3	37.9	38.4	38.6

Table 1.4 shows that the noise from the Ascog wind turbine development is expected to exceed the lower fixed limit value of 35 dB(A) as recommended in ETSU. It has previously been noted that the properties assessed have all been chosen as the levels will exceed the lower fixed limits and they are intended to represent all other properties at increased distance from the development. All properties noted in Table 1.4 will be assessed against background noise levels to ascertain compliance with the further guidance limit of background level + 5 dB(A).

Table 1.5 shows that only four properties highlighted exceed the lower fixed Night time limit of 43 dB(A), these four properties must be assessed against background noise levels to ascertain compliance with the further guideline limit of background level + 5 dB(A)

1.9 Description of monitoring tests of background noise

Background noise levels were initially monitored at a single location at Ascog Farmhouse. Further background noise monitoring was undertaken at three further locations agreed with Argyll and Bute Council's Environmental Health Division.

The initial monitoring at Ascog Farmhouse was conducted over the period 21st April 2011 – 11th May 2011. Further monitoring was undertaken at Duneastein, The Vineries and Mid Ascog Cottage over the period 16th January 2013 – 30th January 2013.

Wind speed and rainfall data was collected simultaneously with background noise levels over 10 minute intervals synchronised with the clock. In accordance with ETSU the $LA_{90\ (10min)}$ measure was used for background noise levels.

As rain falling on and around the microphone housing creates noise, in accordance with ETSU (1997), all 10 minute records when rain was falling are ignored. After deleting those intervals the remaining data included wind speeds covering 0.6 to 14.4 m/s for the initial 2011 data and 0.3 to 20.1 m/s for the 2013 data.

The 2011 survey utilised a single Type 1 Bruel & Kjaer 2250 (S/N:2625637) located at Ascog Farm House (NGR 210336,633011). Calibration was undertaken using a Bruel & Kjaer Type 4231 Calibrator (S/N: 2637413). A Delta-T Devices weather station with cup anemometer mounted at 10 m height, and a tipping bucket rain gauge, all with data logging facilities was located at NGR 210095,663475 to gather wind speed data (V_{10} wind speeds) which were used in this assessment.

The 2013 survey used 3 Type 1 noise meters, Bruel & Kjaer 2250's (S/N's: 2580156, 2625637 and 2579867) with outdoor microphone kits at height 1.3 m height. These were located at Duneastein (NGR 209566, 663478), The Vineries Road (NGR 201388, 663587) and Mid Ascog Cottage (NGR 210222, 662612). Calibration was undertaken using a B&K type 4231 Calibrator (S/N: 2637413). A Delta-T Devices weather station with cup anemometer mounted at 10 m height, and a tipping bucket rain gauge, all with data logging facilities was located at NGR 210105, 663505 to gather wind speed data (V_{10} wind speeds) which were used in this assessment. Further to this the data available from the tall meteorological mast on site was used for wind speed measurements at hub height.

Calibration certificates for the noise monitoring equipment were dated:

2011 monitoring

2250 SLM (2579867): 15/11/2010 Certificate no: C1009564

4231 Calibrator (2637413):15/11/2010 Certificate no: C1009528

2013 monitoring

2250 SLM (2579867): 19/11/2012 Certificate no: C1208805

2250 SLM (2580156): 10/08/2012 Certificate no: C1205984
2250 SLM (2625637): 28/02/2012 Certificate no: C1201502
4231 Calibrator (2637413): 19/11/2012 Certificate no: C1208770

The data collected by the noise meters was filtered to remove all daytime periods, leaving only those periods defined as either "Quiet Day Periods" or "Night Periods" by the ETSU guidance. "Quiet Day Periods" are those from 6 pm to 11 pm every day, plus 12 noon to 6 pm on a Saturday and all day Sunday. "Night Periods" are from 11 pm to 7 am every day. The remaining time is Daytime during which it is assumed that disturbance will be less likely than during other periods. The gathered data was filtered to remove:

- Any period during which there was more than 0.2 mm of rain or more
- Any period where the wind speed fell below 3 m/s or exceeded 13 m/s
- Any period where noise data was missing or manually excluded
- Duneastein data was filtered for directionality, instances of 82.5 – 97.5 degrees wind direction were removed to account for potential guy rope noise from the tall mast on Hill of Ascog

1.10 Background Noise Data

Once the gathered data was filtered the total data sets available for assessment were:

- Duneastein Data

Quiet day periods: 383 periods
Night periods: 524 periods

- The Vineries Data

Quiet day periods: 471 periods
Night periods: Not required

- Ascog Farmhouse

Quiet day periods: 750 periods
Night periods: 829 periods

- Mid Ascog Cottage Data

Quiet day periods: 471 periods
Night periods: Not required

Table 1.6 shows which properties are associated with which data sets to account for background noise at each property.

Table1.6: Properties associated with background noise data

Duneastein Data	**The Vineries Data**	**Ascog Farmhouse Data**	**Mid Ascog Cottage Data**
Duneastein	Vineries	Ascog Farmhouse	Mid Ascog
Braeside	Clairemount Cottage	Ascog Lodge	Beech Park
High Bogany	Grianan	Balmory Hall	Balmory Cottage

Duneastein data was deemed to represent the background noise environment at the three noted properties due to its situation in the landscape, its proximity to the water treatment and sewage works having an impact on the noise environment and also its orientation towards the turbine site.

The Vineries data is deemed to represent the Vineries property and all other properties to the north east and east of the development below the Vineries property. Many of these properties will have no view of the development and are mostly all shielded entirely by the landform. Compliance at the Vineries property is thought to best represent a conservative level to show compliance at all other properties towards the shore line.

The Ascog Farm House data is deemed to represent those properties between Ascog Farm and the shore line where more vegetation is present and a more sheltered aspect is found.

The Mid Ascog Cottage data is deemed to represent those properties to the south and south east of the turbine development in a more open aspect with less vegetation sheltering present than that found at many of the properties below Ascog Farm towards the shore.

All locations were agreed with Environmental Health Officers as to their suitability in representing the background noise environment fully in the surrounds of the proposed development.

Figures 1.1- 1.5 below show the spread of the background noise data across the wind speed range 3 – 13 m/s for Quiet day periods for each monitoring location and Night periods for Duneastein data

Figure 1.1: Quiet daytime background noise Duneastein data

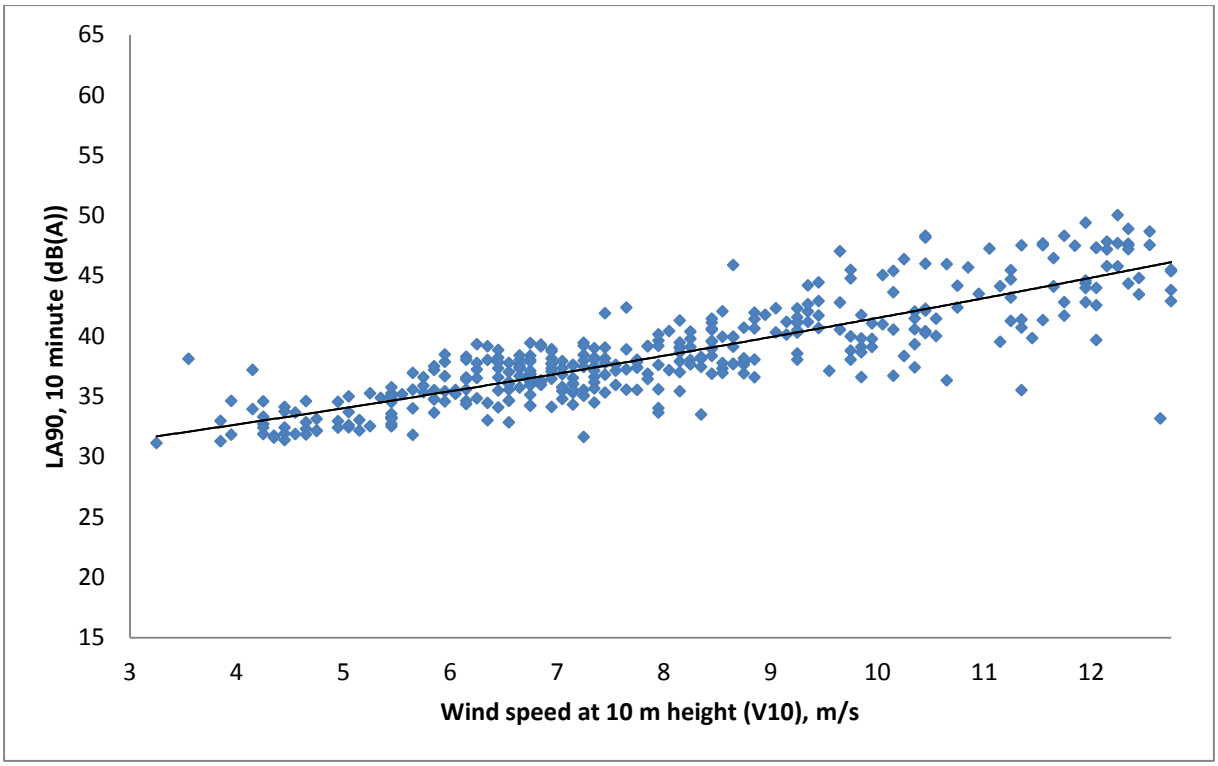


Figure 1.2: Quiet daytime background noise The Vineries data

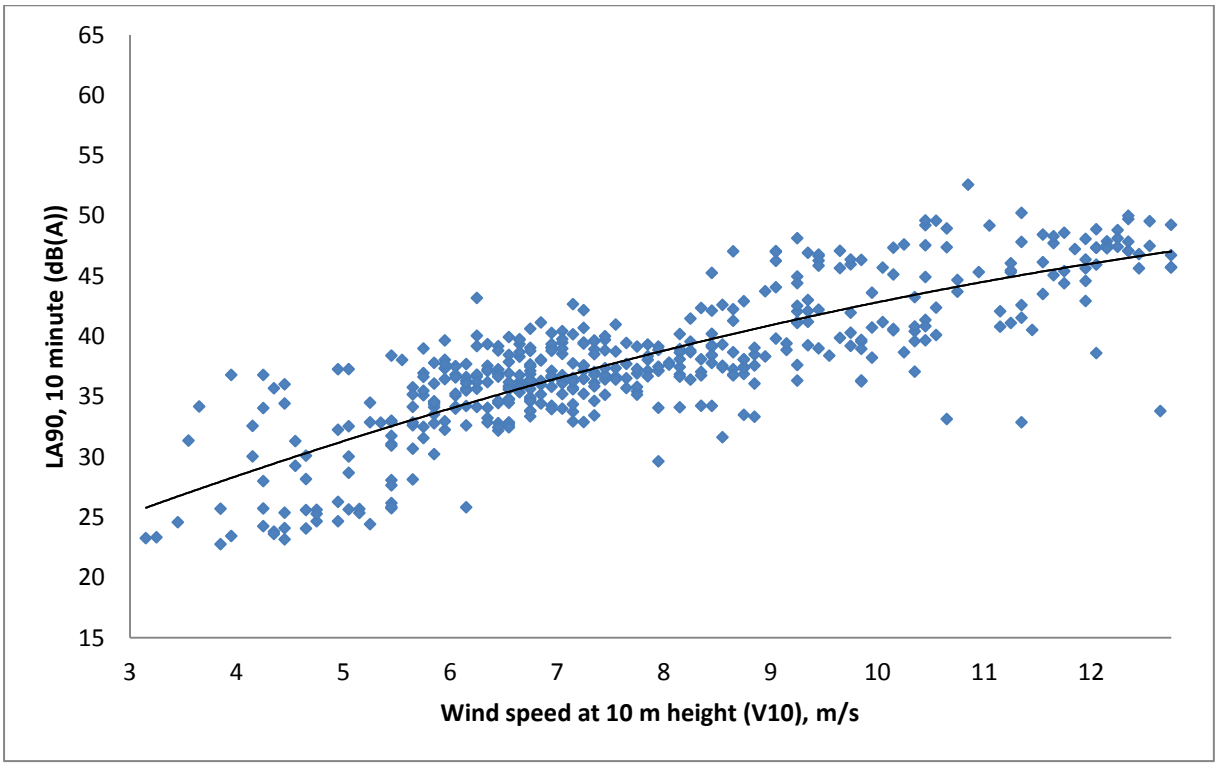


Figure 1.3: Quiet day background noise Ascog Farmhouse data

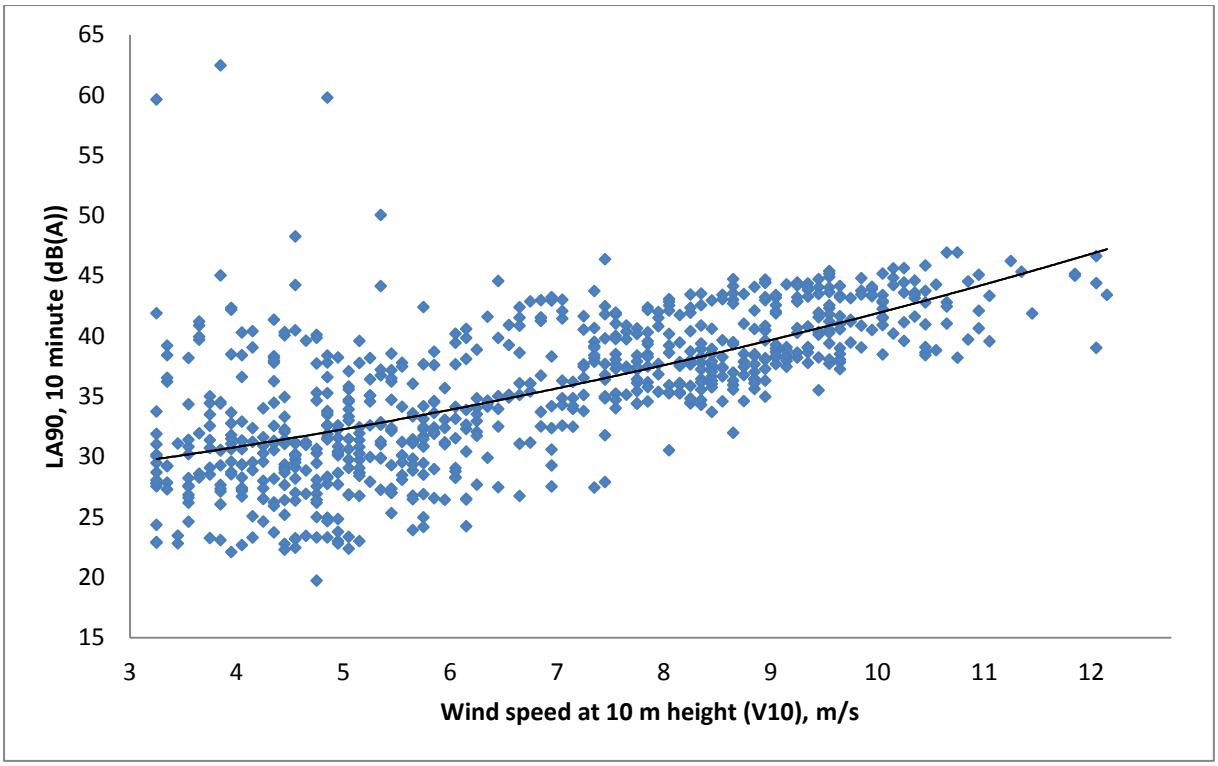


Figure 1.4: Quiet day background noise Mid Ascog Cottage data

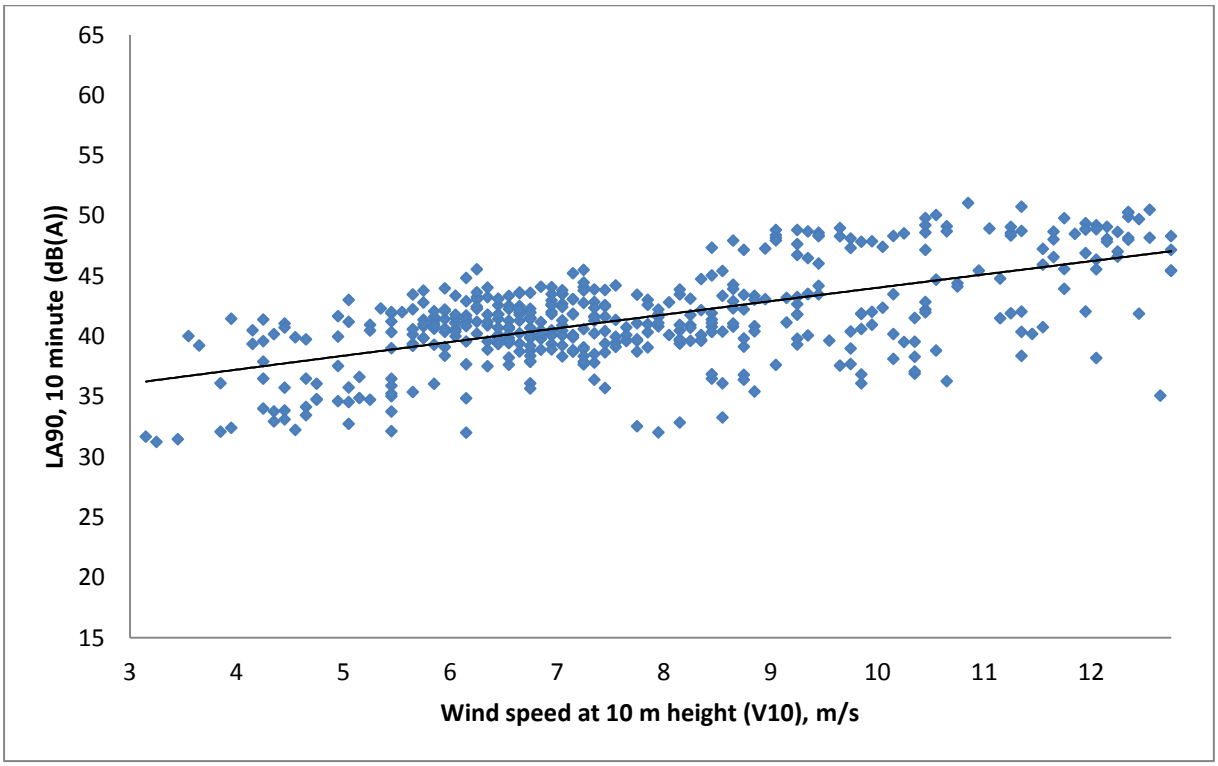


Figure 1.5: Night background noise Duneastein data

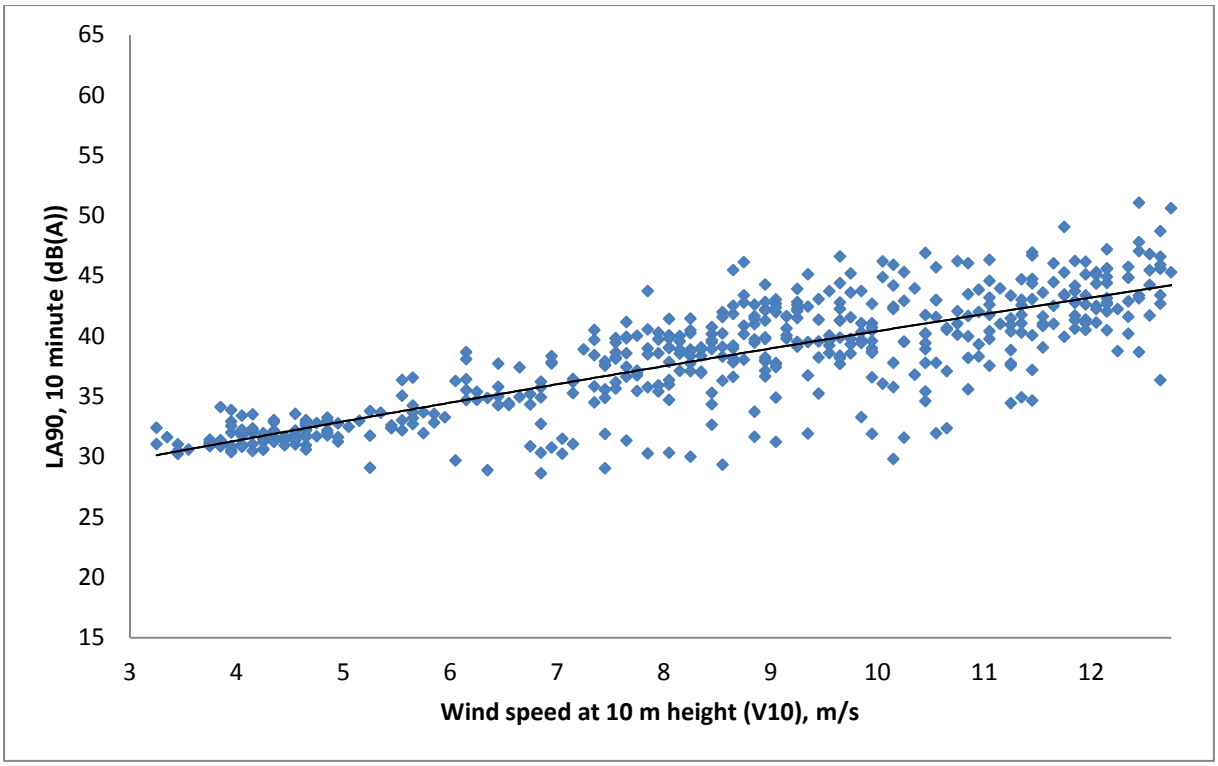
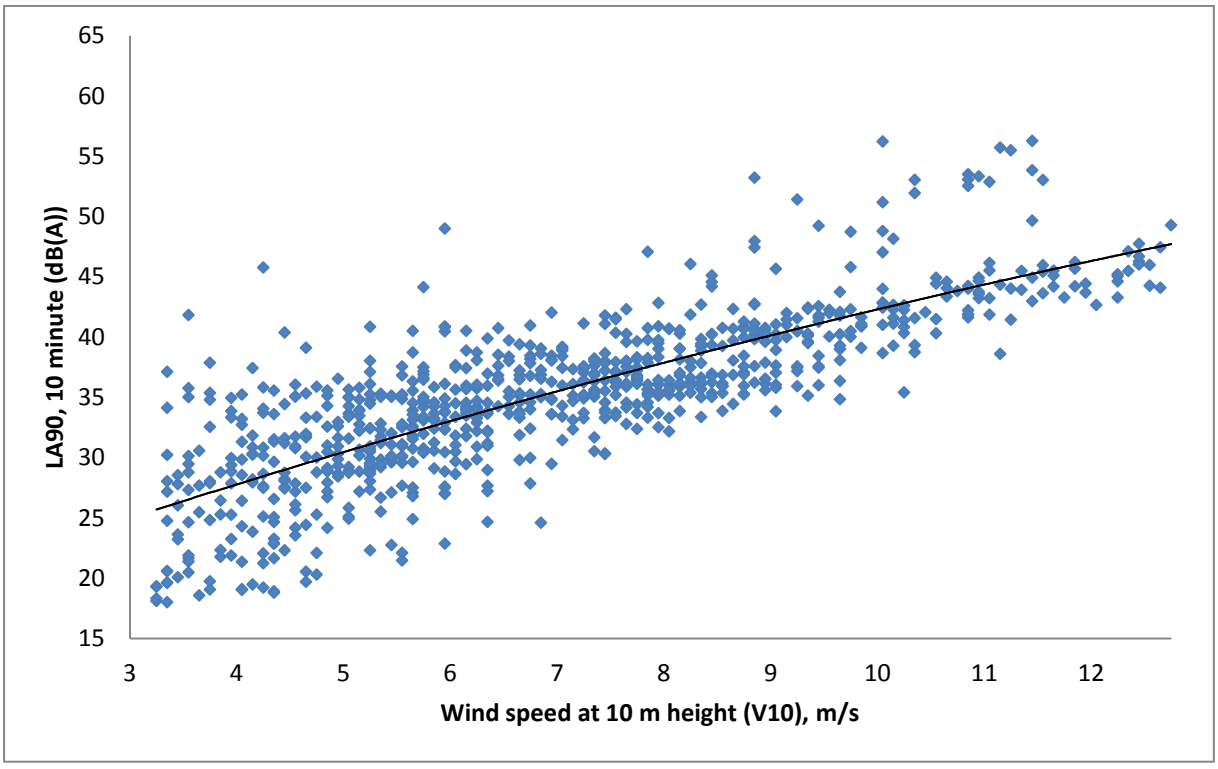


Figure 1.6: Night background noise Ascog Farmhouse data



1.11 Data Analysis / Results

Trendlines were fitted to the background noise data to show background noise and limit levels. The minimum trend line values were amended to give the limit during the Quiet Day of 35 dB (A) and at Night 43 dB (A). The equations for the trend lines are given in Table 1.7 and relate to the L_{A90} data (blue line), the red orange limit line being 5 dB (A) higher. Figures 1.7 – 1.12 show the predicted turbine noise level at each sensitive receptor property in relation to the measured background levels using the predictions in Tables 1.4 and 1.5. The symbols represent the turbine noise immission at each property while the blue trend line represents the background noise level at relative wind speeds.

Table 1.7: Trend line equations for LA_{90} data

Duneastein Data	
Quiet Day	Night
$y = 0.0239 x^2 + 1.1507 x + 28.024$	$y = -0.0149 x^2 + 1.7139 x + 25.12$
The Vineries Data	
Quiet Day	Night
$y = -0.0994 x^2 + 3.745 x + 15.747$	Not Required
Ascog Farmhouse Data	
Quiet Day	Night
$y = 0.0762 x^2 + 0.8208 x + 26.66$	$y = -0.0516 x^2 + 3.1159 x + 16.81$
Mid Ascog Cottage Data	
Quiet Day	Night
$y = -0.0036 x^2 + 1.1811 x + 32.847$	Not Required

Figures 1.7 – 1.12 show calculated noise immission from the proposed Ascog turbine development, the ETSU limit curve of background +5dB, subject to a minimum of 35 dB(A) for quiet daytime and 43 dB(A) for night periods. All figures show wind speeds commencing at V_{10} wind speed 3 m/s, no noise data is available for the turbine at V_{10} wind speeds below 5 m/s when power generation is minimal.

Figure 1.7: Background noise levels with trendlines and predicted noise Duneastein Data Quiet Day.

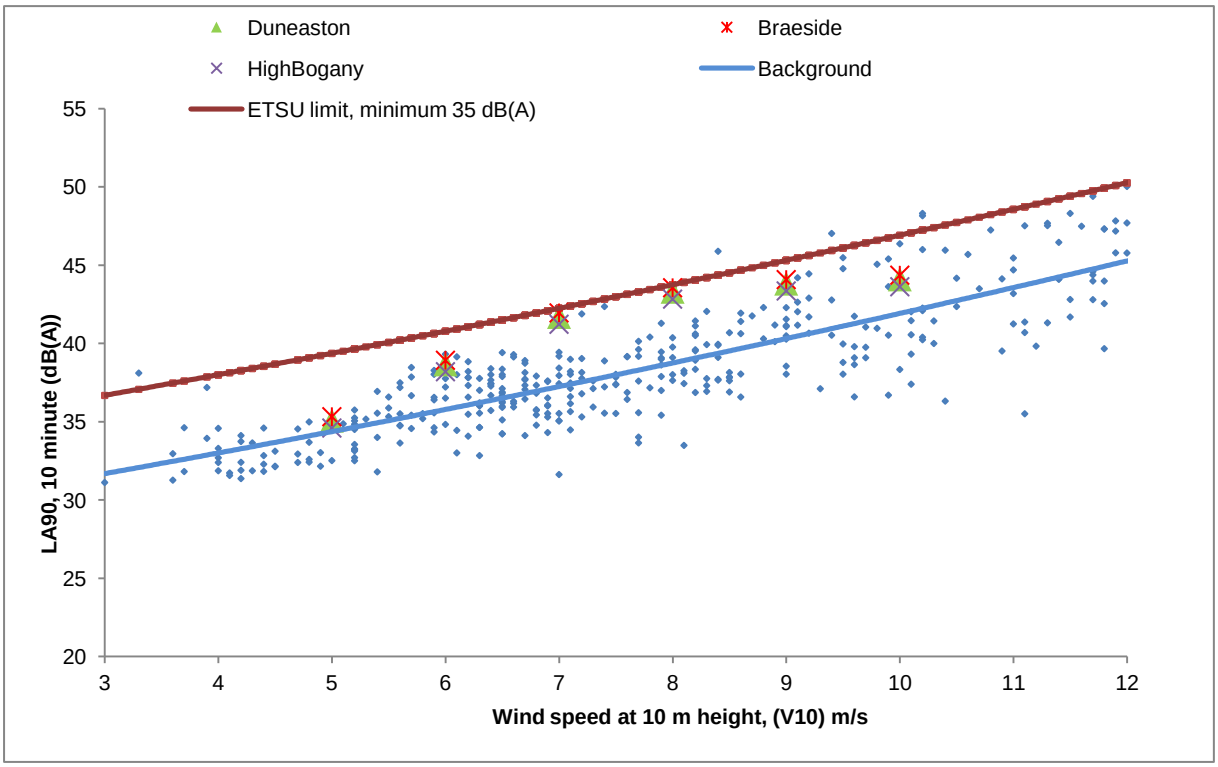


Figure 1.8: Background noise levels with trendlines and predicted noise The Vineries Data Quiet Day.

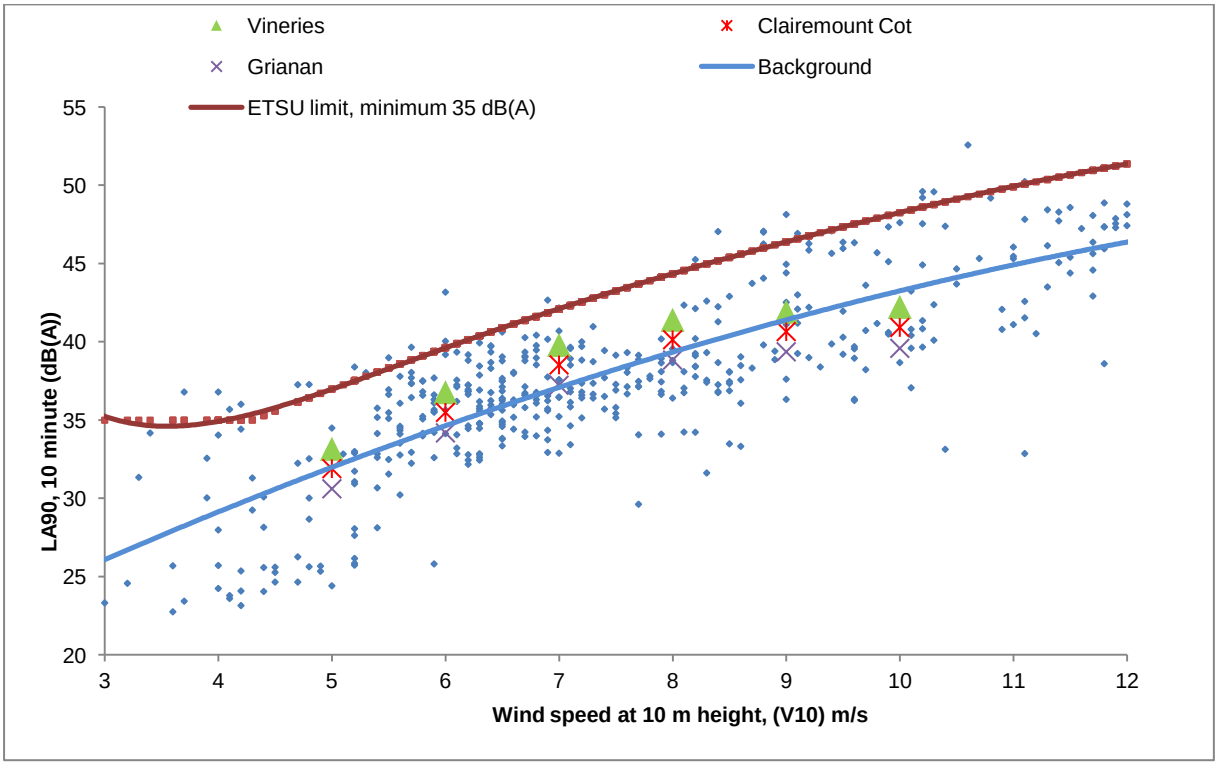


Figure 1.9: Background noise levels with trendlines and predicted noise Ascog Farmhouse Data Quiet Day.

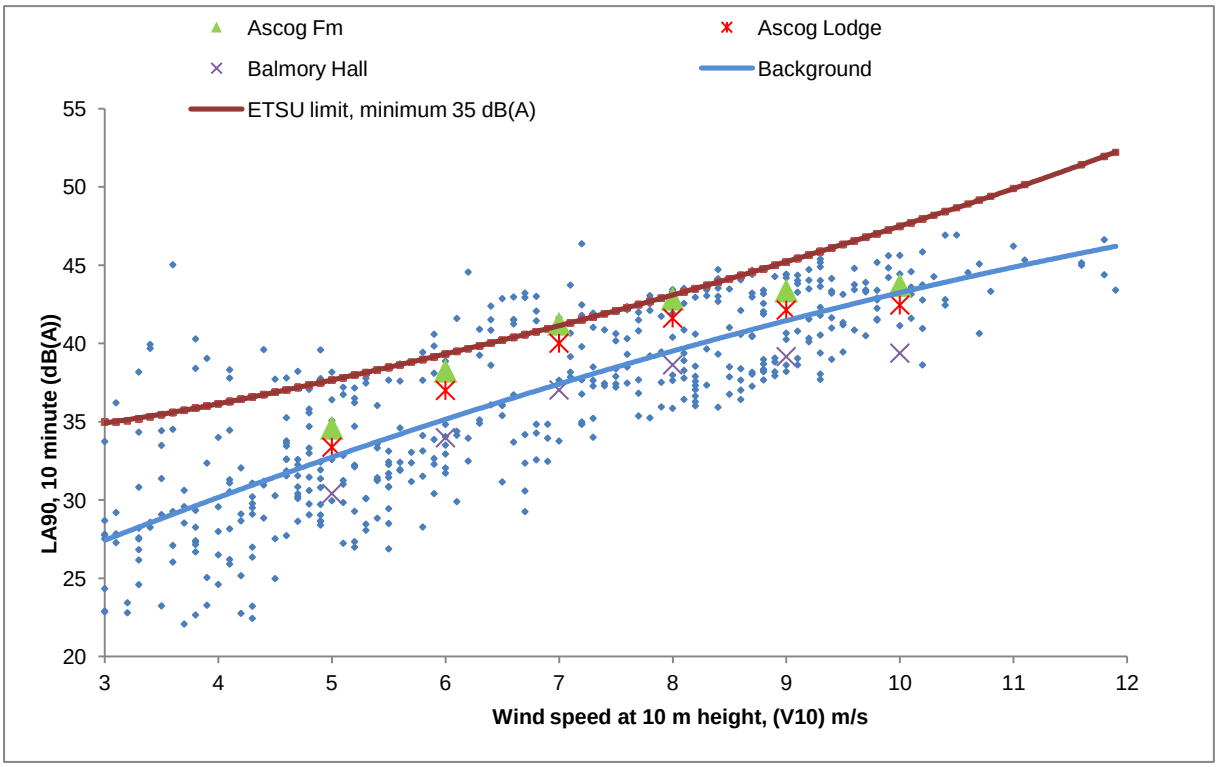


Figure 1.10: Background noise levels with trendlines and predicted noise Mid Ascog Cottage Data Quiet Day.

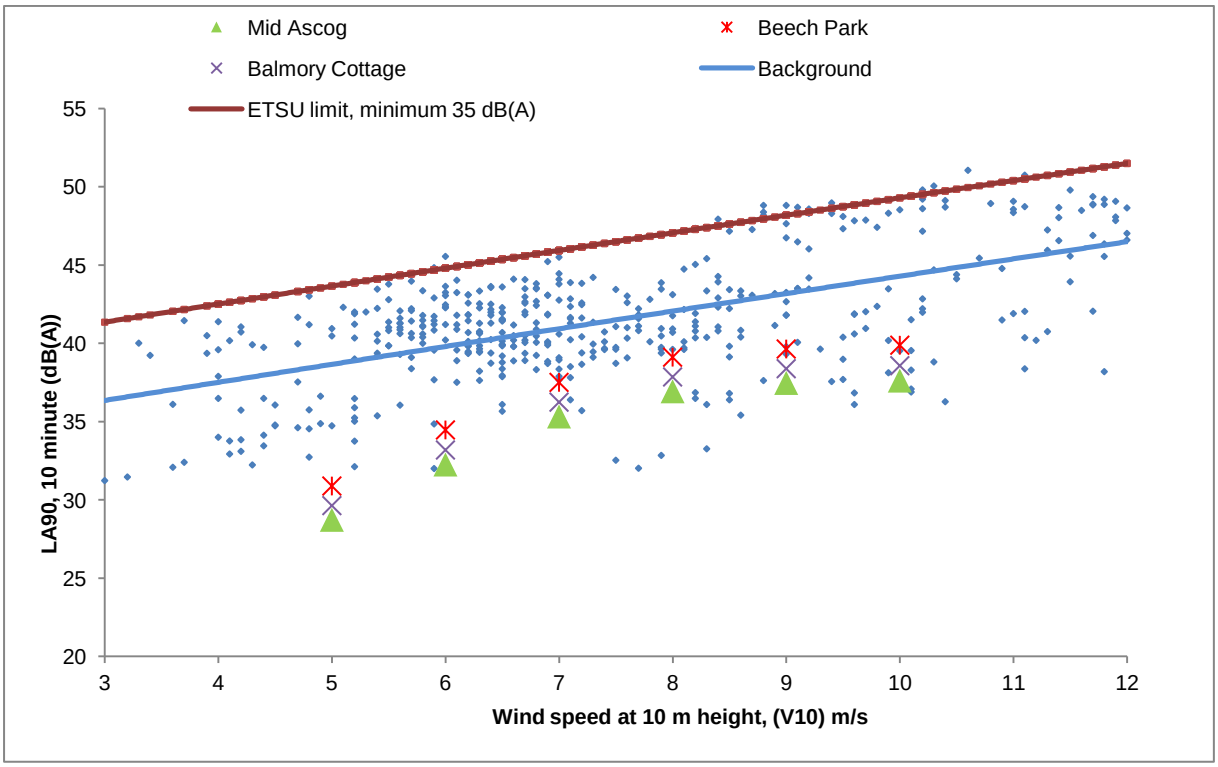


Figure 1.11: Background noise levels with trendlines and predicted noise Duneastein Data Night.

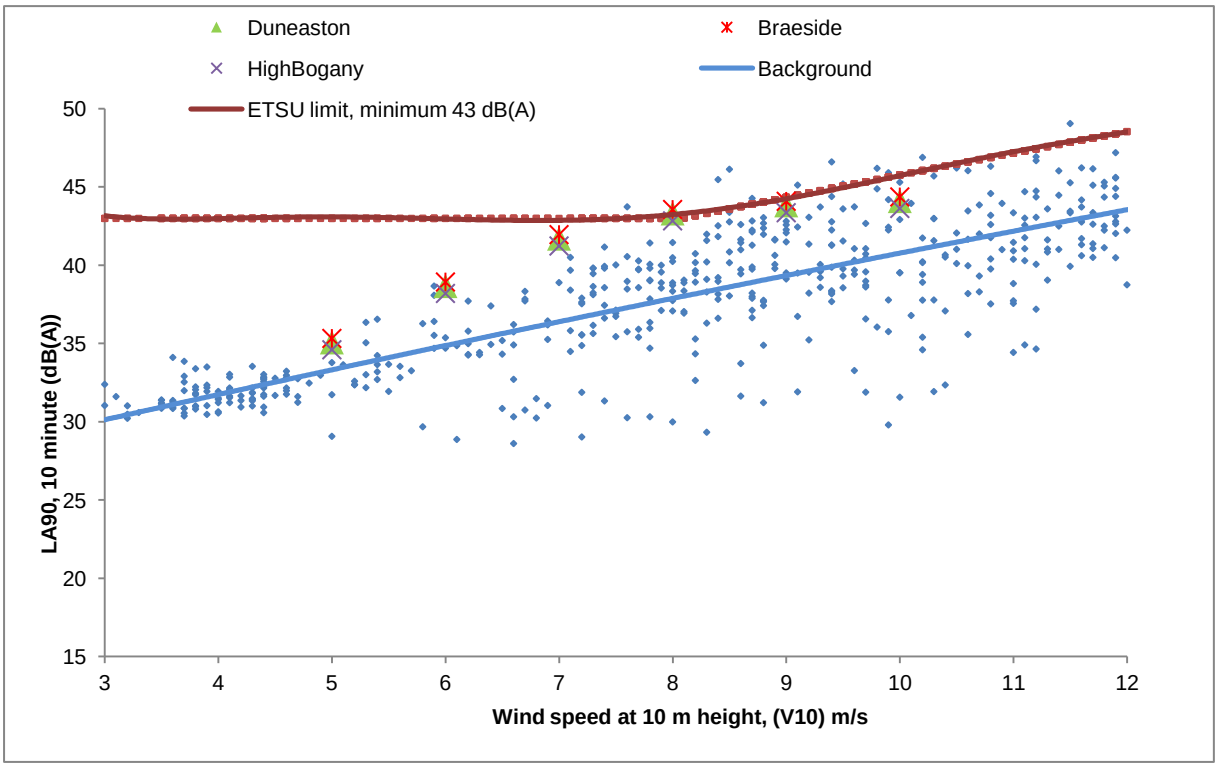
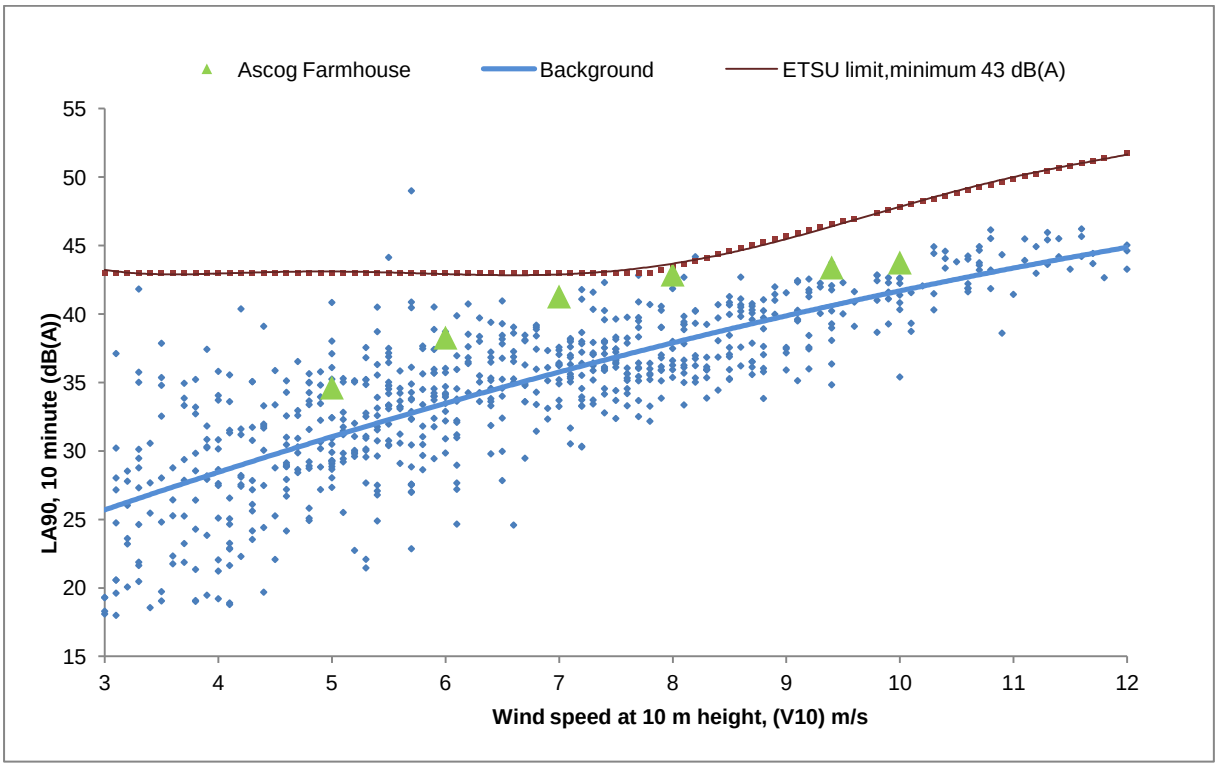


Figure 1.12: Background noise levels with trendlines and predicted noise Ascog Farmhouse Data Night.



1.12 Comparison of background levels to predicted turbine noise

Tables 1.8 and 1.9 compare the predicted turbine noise at residences closest to the turbines with the background noise data. The difference between calculated turbine noise and background noise is expressed as a positive or negative value, where the value is negative then the turbine is that much quieter than background noise levels, where the value is positive the turbine is calculated to be that much above background levels. Where the turbines are not expected to exceed lower fixed limit levels 35 dB(A) for quiet day and 43 dB(A) for night the difference value is set to 0 as the limits are not being exceeded.

Table 1.8: Quiet day Turbine Noise results for all properties exceeding 35 dB(A) compared with respective background noise data (dB(A))

	Wind speed m/s					
	5	6	7	8	9	10
Duneaston	34.4	35.8	37.3	38.8	40.3	41.9
Turbine	35.1	38.7	41.7	43.3	43.8	44.1
Difference	0.7	2.9	4.5	4.6	3.5	2.2
Braeside	34.4	35.8	37.3	38.8	40.3	41.9
Turbine	35.3	38.9	42.0	43.6	44.1	44.4
Difference	1.0	3.1	4.7	4.8	3.8	2.5
High Bogany	34.4	35.8	37.3	38.8	40.3	41.9
Turbine	34.6	38.2	41.2	42.8	43.4	43.6
Difference	0.0	2.4	4.0	4.1	3.0	1.7
The Vineries	32.0	34.6	37.1	39.3	41.4	43.3
Turbine	33.2	36.8	39.8	41.4	41.9	42.2
Difference	0.0	2.2	2.7	2.1	0.5	-1.0
Clairemount Cottage	32.0	34.6	37.1	39.3	41.4	43.3
Turbine	31.9	35.5	38.5	40.1	40.7	40.9
Difference	0.0	0.9	1.4	0.8	-0.7	-2.3
Grianan	32.0	34.6	37.1	39.3	41.4	43.3
Turbine	30.6	34.2	37.2	38.8	39.4	39.6
Difference	0.0	0.0	0.1	-0.5	-2.0	-3.7
Ascog Farmhouse	32.7	34.3	36.1	38.1	40.2	42.5
Turbine	34.6	38.3	41.2	42.9	43.4	43.8
Difference	0.0	3.9	5.0	4.8	3.2	1.3
Ascog Lodge	32.7	34.3	36.1	38.1	40.2	42.5
Turbine	33.4	37.0	40.0	41.6	42.1	42.5
Difference	0.0	2.7	3.9	3.5	1.9	0.0
Balmory Hall	32.7	34.3	36.1	38.1	40.2	42.5
Turbine	30.4	34.0	37.0	38.6	39.2	39.4
Difference	0.0	0.0	0.9	0.5	-1.0	-3.1
Mid Ascog	38.7	39.8	40.9	42.1	43.2	44.3
Turbine	28.7	32.3	35.3	36.9	37.5	37.6
Difference	0.0	0.0	-5.6	-5.1	-5.7	-6.7
Beech Park	38.7	39.8	40.9	42.1	43.2	44.3
Turbine	30.9	34.5	37.5	39.1	39.6	39.9

Difference	0.0	0.0	-3.4	-2.9	-3.5	-4.4
Balmory Cottage	38.7	39.8	40.9	42.1	43.2	44.3
Turbine	29.6	33.2	36.3	37.9	38.4	38.6
Difference	0.0	0.0	-4.7	-4.2	-4.8	-5.7

Table 1.9: Night Turbine Noise results for all properties exceeding the 43 dB(A) limit compared with respective background data (dB(A))

	Wind speed m/s					
	5	6	7	8	9	10
Duneaston	33.3	34.9	36.4	37.9	39.3	40.8
Turbine	35.1	38.7	41.7	43.3	43.8	44.1
Difference	0.0	0.0	0.0	5.4	4.5	3.3
Braeside	33.3	34.9	36.4	37.9	39.3	40.8
Turbine	35.3	38.9	42.0	43.6	44.1	44.4
Difference	0.0	0.0	0.0	5.7	4.7	3.6
High Bogany	33.3	34.9	36.4	37.9	39.3	40.8
Turbine	34.6	38.2	41.2	42.8	43.4	43.6
Difference	0.0	0.0	0.0	0.0	4.0	2.9
Ascog Farmhouse	31.1	33.6	36.1	38.4	40.7	42.8
Turbine	34.6	38.3	41.3	42.9	43.4	43.8
Difference	0.0	0.0	0.0	0.0	2.7	0.9

The assessment shows that noise from the Ascog Wind Energy Project will exceed background noise levels at a number of properties over some limited wind speeds during Quiet Day periods however will adhere to the ETSU guideline level of background plus 5 dB(A).

Two properties (Duneastein and Braeside) where the lower fixed Night limit cannot be shown to be adhered to show to exceed the ETSU guideline level of background + 5 dB(A) at 8 m/s wind speed.

All other properties adhere to the limit levels laid out in all available guidance.

1.12.1 Properties Exceeding ETSU guideline limits

Two properties, Duneastein and Braeside are predicted to exceed both the lower fixed limit of 43 dB(A) and the upper limit of background + 5 dB(A) during Night periods at a single wind speed of 8 m/s. Neither of these properties can be said to have a financial interest in the proposed development thus other mitigation measures must be taken to remove the predicted impact on both properties.

1.12.2 Mitigation Techniques

The proposed wind turbines at Ascog will have the ability to be programmed to a reduced power mode under specific conditions in order to reduce noise impact where exceedance above guideline limits is found. The turbine in question the Enercon E-48 has several reduced power modes to aid in complying with guidelines under certain conditions.

It is proposed to operate the Northern most turbine (Turbine 1) at a reduced power mode of 600 kW under the specific wind conditions when the properties effected are within 90 degress of being directly downwind of Turbine 1. This reduced power mode under these conditions would result in the figures shown below in Table 1.10. When the properties are upwind of the turbine the noise level could be assumed to be reduced by as much as 5-10 dB(A) due to directionality. Details relating to the turbines reduced power modes octave band levels can be found in appendix D and warranty levels provided by the manufacturer relating to the 600 kW power mode can be found in appendix E.

Table 1.10: Night Turbine Noise results for Duneastein and Braeside compared with respective background data 600 kW mode turbine 1 (dB(A))

	Wind speed m/s					
	5	**6**	**7**	**8**	**9**	**10**
Duneastein	33.3	34.9	36.4	37.9	39.3	40.8
Turbine	35.1	38.4	40.4	41.0	41.2	41.2
Difference	0.0	0.0	0.0	0.0	0.0	0.0
Braeside	33.3	34.9	36.4	37.9	39.3	40.8
Turbine	35.3	38.6	40.7	41.3	41.5	41.4
Difference	0.0	0.0	0.0	0.0	0.0	0.0

As can be seen from the data in Table 1.10, when Turbine 1 is restricted to power mode 600 kW under specific wind conditions the lower fixed limit guideline levels are met at all wind speeds. Therefore this technique is proposed as suitable mitigation to resolve this issue when the properties are within 90 degrees of being downwind of Turbine 1 under wind speeds of 7-9 m/s.

1.13 Further Considerations

1.13.1 Tonality and Impulsiveness

The manufacturer's data on the quality of the noise from the Enercon E-48 gives the results of tests conducted to the standards of the International Electro-technical Commission (IEC). The tonality was found to be 0-1 dB over the whole operational range. The ETSU publication states that a correction to the noise output is only required if the tonality is 2 dB or greater. The impulsiveness was also measured and a level of 0 dB is guaranteed over the whole operational range. At the time of writing there are no known issues with tonality with the other turbine models assessed in the cumulative impact assessment.

1.13.2 Wind Shear

Guidance has been issued by the I.O.A. regarding the effect of wind shear on the predicted noise output of turbines and how this should be allowed for in a noise assessment. The suggested method involves monitoring wind speed at two heights to enable the calculation of the wind shear exponent, m. This is then used to adjust the wind speed at 10 m above the ground.

The initial assessment did not have the benefit of a tall mast on-site thus wind shear could not be reliably accounted for in the initial assessment. Wind shear has however been considered for this assessment.

Using the available data from the monitoring periods and comparing derived 10 metre wind speeds with measured 10 metre wind speeds an average attenuation value of 0.1 m/s has been calculated. This figure can be used to attenuate all wind speed values against the background noise levels associated with them or alternatively used to adjust the wind speed value associated with specific turbine noise.

As this level is so low the effect of wind shear at this site is deemed to be negligible and no accounting is required due to the insignificant variation it will impose on the measured data.

1.13.3 Infrasound

Infrasound is a term used to describe sound at very low frequencies generally below 20 Hz. The potential for this to impact upon residences and individuals is of some concern to people living in the environs of wind turbine installations. However, based on all current available

information and guidance from the Institute of Acoustics there is no concern for the levels of Infrasound likely to be produced by wind turbine generators at the separation distances involved.

Institute of Acoustics Technical Note "Prediction and assessment of wind turbine noise" found in Acoustics bulletin March/April 2009 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".

Based on this statement it is not thought that there will be any cause for concern relating to infrasound from the development of three wind turbines at Ascog Farm.

1.13.4 Turbine Monitoring

It is the intention at the proposed development to monitor meteorological and power generation data over the long term and log this to be available to the local authority upon reasonable request. This data is intended to serve any required investigations into the compliance of the turbines with any potential conditioned noise limit levels

1.14 Rating Level

Utilizing the background noise data gathered, a rating level can be calculated for each property. The rating levels presented below in Tables 1.11 and 1.12 are only a recommendation and are based on the background noise level plus 5 dB(A) to present the ETSU R97 limit value for each wind speed in relation to the background noise levels. Night limit levels have been proposed for those properties where Night time compliance was assessed. All other properties found to not exceed the lower fixed limit of 43 dB(A) during Night periods have an assumed limit of 43 dB(A) as recommended by ETSU.

Table 1.11: ETSU R97 derived limit values Quiet Day periods

Property	Wind Speed							
	5	6	7	8	9	10	11	12
Duneastein	39.4	40.8	42.3	43.8	45.3	46.9	48.6	50.3
Braeside	39.4	40.8	42.3	43.8	45.3	46.9	48.6	50.3
High Bogany	39.4	40.8	42.3	43.8	45.3	46.9	48.6	50.3
The Vineries	37.0	39.6	42.1	44.3	46.4	48.3	49.9	51.4
Clairemount Cottage	37.0	39.6	42.1	44.3	46.4	48.3	49.9	51.4

Grianan	37.0	39.6	42.1	44.3	46.4	48.3	49.9	51.4
Ascog Farmhouse	37.7	39.3	41.1	43.1	45.2	47.5	49.9	52.5
Ascog Lodge	37.7	39.3	41.1	43.1	45.2	47.5	49.9	52.5
Balmory Hall	37.7	39.3	41.1	43.1	45.2	47.5	49.9	52.5
Mid Ascog	43.7	44.8	45.9	47.1	48.2	49.3	50.4	51.5
Beech Park	43.7	44.8	45.9	47.1	48.2	49.3	50.4	51.5
Balmory Cottage	43.7	44.8	45.9	47.1	48.2	49.3	50.4	51.5

Table 1.12: ETSU R97 derived limit values Night periods

Property	**Wind Speed**							
	5	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Duneastein	43.0	43.0	43.0	43.0	44.3	45.8	47.2	48.6
Braeside	43.0	43.0	43.0	43.0	44.3	45.8	47.2	48.6
High Bogany	43.0	43.0	43.0	43.0	44.3	45.8	47.2	48.6
The Vineries	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Clairemount Cottage	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Grianan	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Ascog Farmhouse	43.0	43.0	43.0	43.4	45.7	47.8	49.8	51.8
Ascog Lodge	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Balmory Hall	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Mid Ascog	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Beech Park	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Balmory Cottage	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0

1.15 Conclusion

- Consultation was undertaken with Argyll and Bute Environmental Health Division after a request for further information.
- A meeting was arranged and site visits were made to surrounding properties.
- Further monitoring to compliment the original noise assessment was agreed and locations were chosen and agreed with Argyll and Bute Environmental Health Officers.
- Background noise monitoring was undertaken at three properties intended to compliment the original monitoring data in order to assess predicted impacts.
- The predicted noise immissions at residences around the proposed turbine development have been assessed and compared to background levels.
- All properties have been found to meet ETSU guideline levels during Quiet Day periods.
- Only three properties required to be assessed for Night time compliance.
- Of the three properties assessed for Night time compliance two showed to exceed the ETSU limit of background plus 5 dB(A) at 8 m/s wind speed.
- Mitigation is possible through reduced power mode 600 kW of turbine number one under specific wind conditions resulting in conformance to ETSU limits during Night periods at all properties.
- With mitigation measures in place the proposed development meets all required noise criteria as laid out in ETSU R97.

1.16 References

BOWDLER ET AL (2009), *Acoustics Bulletin March/April, Prediction and assessment of wind turbine noise,* Institute of Acoustics

ETSU (1997), *ETSU-R-97: The assessment and rating of noise from wind farms*, the Department of Trade and Industry

PAN 1 (2011), *Planning Advice Note 1: Planning and Noise*, Scottish Government

ISO (1993), ISO 9613-1: *Acoustics – Attenuation of sound during propagation outdoors – Part 1: Calculation of the absorption of sound by the atmosphere*, International Organization for Standardization

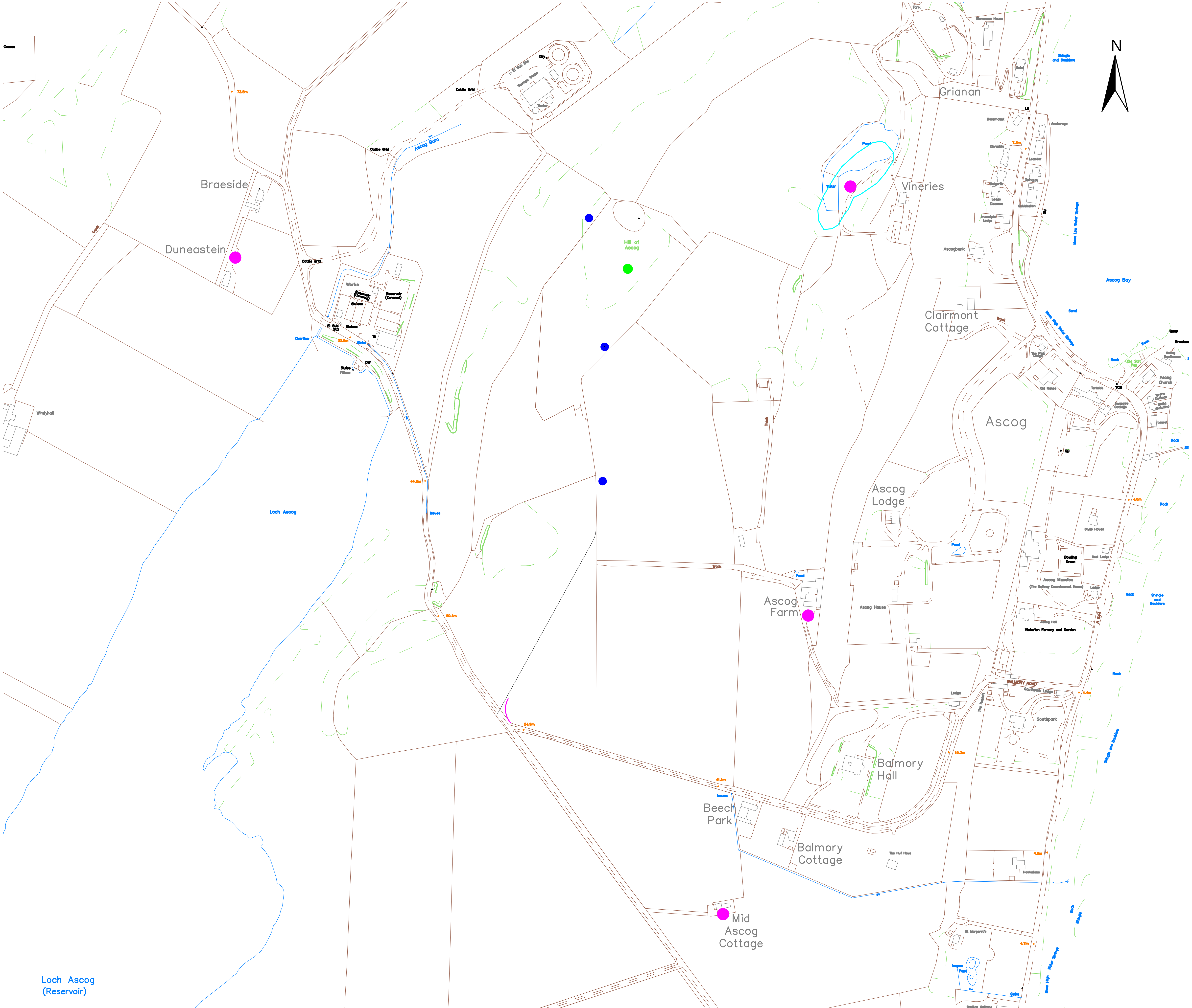
ISO (1996), ISO 9613-2: *Acoustics – Attenuation of sound during propagation outdoors - Part 2: General method of calculation*, International Organization for Standardization

Appendix A - Site Layout Plan

NOTES

LEGEND

- Turbine Positions
- 10 Metre Mast Location
- Noise Monitor Locations



Noise Plan

Ascog Wind Energy Project

A Tear / E McVey

DRAWING NO.	SCALE	DATE
11428-NOI-01	1:5000 @ A3	12 02 2013

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Appendix B – 800kW Turbine Octave Band Data

Extract II of test report

Master Information „Noise", according to "Wind turbine generator systems - Part 11: Acoustic noise measurement techniques."

IEC 61400-11 ED. 2 from 2002 (published by: Central Office of the IEC, Geneva, Switzerland)

Extract of test report WICO 439SEC04/07 regarding noise emission of wind turbine (WT) type ENERCON E-48 (Mode I), hub height 50 m

General			Technical specifications (manufacturer)	
Manufacturer:	ENERCON GmbH		Rated power (generator):	800 kW
	Dreekamp 5		Rotor diameter:	48,0 m
	D-26605 AURICH		Hub height above ground:	50 m
Serial number:	48087		Kon. Stahlrohr	Tubular steel tower
WT-location:	WP Holtriem	RW 25.95.228	Pitch	pitch/stall/active-stall
		HW 59.42.988		

Complementations of rotor (manufacturer)		Complementations of gear and generator (manufacturer)	
Manufacturer of rotor blades	ENERCON GmbH	Manufacturer of gear:	No
Type of blades:	E48/1	Type of gear:	No
Pitch angle:	variabel	Manufacturer of generator:	ENERCON GmbH
Number of blades	3	Type of generator:	E-48
Rated speed(s)/speed range:	16 – 29,5 rpm (Mode I)	Rated speed(s):	16 – 29,5 rpm (Mode I)

Report power curve: calculated power curve, date: 31.08.2004

	Reference		Noise emission parameter	Remarks
	Standardized wind speed at 10 m above ground	Electric power		
Sound power level L_{WA}	*5 ms^{-1}*	*155 kW*	*92.8* dB(A)*	*(1)*
	6 ms^{-1}	264 kW	96.5 dB(A)	
	7 ms^{-1}	418 kW	99.5 dB(A)	
	8 ms^{-1}	599 kW	101.0 dB(A)	
	9 ms^{-1}	725 kW	101.7 dB(A)	
	9.4 ms^{-1}	*760 kW*	*101.7 dB(A)*	*(2)*
	10 ms^{-1}	789 kW	102.1 dB(A)	(3)
	10.2 ms^{-1}	*794 kW*	*102.1 dB(A)*	*(4)*
Tonal components ΔL_a (near proximity)	*5 ms^{-1}*	*155 kW*	No tone	*(1)*
	6 ms^{-1}	264 kW	No tone	
	7 ms^{-1}	418 kW	No tone	
	8 ms^{-1}	599 kW	No tone	
	9 ms^{-1}	725 kW	No tone	
	9.4 ms^{-1}	*760 kW*	*No tone*	*(2)*
	10 ms^{-1}	789 kW	No tone	(3)
	10.2 ms^{-1}	*794 kW*	*No tone*	*(4)*

One third octave sound power level at reference point v_{10} = 5 m/s [dB(A)]												
Frequency	50	63	80	100	125	160	200	250	315	400	500	630
L_{WA}	66.4	70.0	71.7	73.3	76.8	75.8	78.1	83.0	84.4	83.4	83.0	83.2
L_{WA}		74.6			80.3			87.3			88.0	
Frequency	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
L_{WA}	81.4	80.8	80.2	78.0	77.3	75.4	74.0	73.6	71.9	71.2	69.7	66.2
L_{WA}		85.6			81.8			78.0			74.3	

One third octave sound power level at reference point v_{10} = 6 m/s [dB(A)]												
Frequency	50	63	80	100	125	160	200	250	315	400	500	630
L_{WA}	70.4	72.9	75.6	76.3	77.5	78.4	79.3	84.8	86.5	86.1	86.1	87.7
L_{WA}		78.2			82.3			89.2			91.5	
Frequency	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
L_{WA}	87.0	86.8	85.6	82.7	81.1	79.6	78.1	77.7	76.8	76.0	73.6	71.6
L_{WA}		91.3			86.1			82.3			78.9	

One third octave sound power level at reference point v_{10} = 7 m/s [dB(A)]												
Frequency	50	63	80	100	125	160	200	250	315	400	500	630
L_{WA}	71.9	75.3	78.5	79.7	80.1	82.1	83.5	88.4	90.4	89.9	89.7	90.7
L_{WA}		80.8			85.5			93.0			94.9	
Frequency	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
L_{WA}	89.4	88.9	87.1	84.7	83.3	81.8	80.9	80.8	79.9	79.4	78.4	75.5
L_{WA}		93.3			88.2			85.3			82.8	

One third octave sound power level at reference point v_{10} = 8 m/s [dB(A)]												
Frequency	50	63	80	100	125	160	200	250	315	400	500	630
L_{WA}	69.7	73.9	76.9	78.6	81.3	81.9	84.0	90.1	92.3	91.6	91.5	92.5
L_{WA}		79.2			85.6			94.7			96.7	
Frequency	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
L_{WA}	91.3	90.5	88.7	85.6	83.5	81.7	80.5	81.2	80.2	79.3	78.8	76.9
L_{WA}		95.1			88.7			85.4			83.2	

One third octave sound power level at reference point v_{10} = 9 m/s [dB(A)]												
Frequency	50	63	80	100	125	160	200	250	315	400	500	630
L_{WA}	71.5	74.2	76.8	79.1	82.3	83.9	86.3	91.2	93.2	92.3	92.0	92.8
L_{WA}		79.5			87.0			95.8			97.2	
Frequency	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
L_{WA}	91.1	90.2	88.4	85.9	84.7	84.0	83.6	84.1	83.6	83.4	82.2	79.8
L_{WA}		94.8			89.7			88.5			86.8	

One third octave sound power level at reference point v_{10} = 10 m/s [dB(A)]												
Frequency	50	63	80	100	125	160	200	250	315	400	500	630
L_{WA}	69.9	73.9	75.9	77.4	80.2	80.7	83.4	88.3	91.0	90.8	91.5	93.4
L_{WA}		78.6			84.4			93.3			96.8	
Frequency	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
L_{WA}	93.2	93.6	92.6	89.9	87.4	85.0	83.2	83.3	82.0	81.1	79.9	77.8
L_{WA}		97.9			92.7			87.6			84.6	

(1) Because of the signal to noise ratio laying in between 3 dB to 6 dB the sound pressure level was corrected with 1.3 dB.
(2) Sound power level at 95% of the rated power.
(3) One value was measured in the wind bin of 10 ms^{-1}.
(4) Wind speed at the maximum sound pressure level minute measured at the hub height of 75.6 m was 9.6 ms^{-1}.

This extract of test report is valid only in connection with the enclosed „Manufacturer's certificate" from 2004-08-31.

This declaration does not replace above-mentioned report.

measured by: WIND-consult GmbH
Reuterstraße 9
D-18211 Bargeshagen

- pdf - document was signed electronically -

date: 2006-01-24

Dipl.-Ing. A. Petersen

Dipl.-Ing. W. Wilke

Deutscher Akkreditierungs Rat
DAR
DAP-PL-2756.00
According to DIN EN ISO 17025 by the DAP German Accreditation System for Testing Ltd. accredited testing laboratory.
The accreditation is valid for test methods listed in the document.

Appendix C – 800kW Turbine Broadband Warranted Levels

Guaranteed Values of the Sound Power Level for the E-48 with 800 kW rated power				
V_{Wind} in 10m height \ Hub height	50 m	56 m	65 m	76 m
4 m/s	89.0 dB(A)	89.2 dB(A)	89.5 dB(A)	89.9 dB(A)
5 m/s	93.3 dB(A)	93.7 dB(A)	94.2 dB(A)	94.7 dB(A)
6 m/s	97.5 dB(A)	97.9 dB(A)	98.3 dB(A)	98.8 dB(A)
7 m/s	100.5 dB(A)	100.7 dB(A)	101.0 dB(A)	101.3 dB(A)
8 m/s	101.5 dB(A)	101.7 dB(A)	101.8 dB(A)	101.9 dB(A)
95% rated power	102.5 dB(A)	102.5 dB(A)	102.5 dB(A)	102.5 dB(A)
10 m/s	102.5 dB(A)	102.5 dB(A)	102.5 dB(A)	102.5 dB(A)

Measured values at 95% rated power				**101,9 dB(A)** WICO 439SEC04/07 **101,1 dB(A)** KCE 29349-1.003 **102,2 dB(A)** MBBM 64550/7

1. A tonality value of 0-1 dB is guaranteed over the whole operational range (valid in the near vicinity of the turbine according to IEC).
2. An impulsivity value K_{IN} of 0 dB is guaranteed over the whole operational range (valid in the near vicinity of the turbine according to IEC).
3. The sound power values given in the table are valid for the **Operational Mode I** (defined through the rotational speed range of 16 – 30 rpm). The respective power curve is the Calculated Power Curve dated August 2004 (Rev. 1.x).
4. The guarantee is based on official and internal measurements of the sound power level. The official measured values are given in this document as a reference. The extracts of the official measurements are available and are valid in combination with this guarantee document. The measurements are being carried out according to the recommended national and international standards and norms (mentioned on the respective extracts).
5. In order to account for the uncertainties of measurement and sound prediction calculations, to increase the acceptance at the authorities and to avoid eventual verification measurements ENERCON recommends a safety factor of 1 dB(A) on the guaranteed values when carrying out sound propagation calculations. In countries where safety factors are already mandatory due to local regulations, the ENERCON recommendation is not applicable.

   Should this recommendation be neglected for any reasons, it is hereby explicitly referred to 6.
6. Due to the measurement uncertainties of sound measurements the verification of the guaranteed values is successful, if the measurement result of a measurement that has been carried out according to the accepted standards is in the range of +/- 1dB(A) of the guaranteed values [guarantee fulfilled when measurement result = guaranteed value +/- 1dB(A)].
7. For noise-sensitive sites it is possible to operate the E-48 with reduced rotational speed and reduced rated power during the night. The reduced sound power levels are given in a separate document.

Appendix D – 600kW Turbine Octave Band Data

Extract of test report

Master Information „Noise", according to *"Wind turbine generator systems - Part 11: Acoustic noise measurement techniques"* IEC 61400-11 ED. 2, 2002

Extract of test report 439SEC04/03
regarding noise emission of wind turbine (WT) type Enercon E-48 (Mode 600 kW)

General		Technical specifications (manufacturer)	
Manufacturer:	ENERCON GmbH Dreekamp 5 D-26605 Aurich	Rated power (generator):	800 kW (1)
		Rotor diameter:	48 m
		Hub height above ground:	56 m (2)
Serial number:	48082	Tower design:	Tubular steel tower
WT-location:	RW 25.68.344, HW 57.55.674	Power control:	Pitch/Stall/Aktiv-Stall
Complementations of rotor (manufacturer)		**Complementations of gear and generator (manufacturer)**	
Manufacturer of rotor blades	ENERCON GmbH	Manufacturer of gear:	-
Type of blades:	E-48	Type of gear:	-
Pitch angel:	variabel	Manufacturer of generator:	ENERCON GmbH
Number of blades	3	Type of generator:	E-48
Rated speed(s)/speed range:	16 – 32 rpm (1)	Rated speed(s)/speed range:	16 – 32 rpm (1)

Report power curve: calculated

	Reference		Noise emission parameter	Remarks
	Standardized wind speed at 10 m above ground	Electric power		
Sound power level $L_{WA,P}$	6 ms^{-1}	275 kW	96.4 dB(A)	(3)
	7 ms^{-1}	404 kW	98.5 dB(A)	(3)
	8 ms^{-1}	515 kW	99.3 dB(A)	(3)
	9 ms^{-1}	590 kW	99.4 dB(A)	(3)
	10 ms^{-1}	600 kW	99.2 dB(A)	(1); (3)
Tonality (near proximity) ΔLa	6 ms^{-1}	275 kW	No tone	(4)
	7 ms^{-1}	404 kW	No tone	(4)
	8 ms^{-1}	515 kW	No tone	(4)
	9 ms^{-1}	590 kW	No tone	(4)
	10 ms^{-1}	600 kW	No tone	(1), (4)

One third octave and octave sound power level at reference point v_{10} = 6 m/s in dB(A)												
Frequency	50	63	80	100	125	160	200	250	315	400	500	630
$L_{WA,P}$	69,9	72,5	74,8	77,1	78,0	79,9	82,9	83,4	85,4	85,2	86,9	86,9
$L_{WA,P}$		77,6			83,3			88,8			91,2	
Frequenz	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
$L_{WA,P}$	87,4	87,1	86,1	84,2	81,5	78,8	76,2	73,9	71,4	68,7	64,9	63,1
$L_{WA,P}$		91,7			86,8			79,0			71,0	

One third octave and octave sound power level at reference point v_{10} = 7 m/s in dB(A)												
Frequency	50	63	80	100	125	160	200	250	315	400	500	630
$L_{WA,P}$	78,4	79,4	80,1	80,8	81,4	83,1	84,1	86,3	86,6	85,5	86,9	87,5
$L_{WA,P}$		84,1			86,7			90,6			91,5	
Frequenz	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
$L_{WA,P}$	88,7	89,1	88,8	87,3	85,3	83,4	81,3	80,3	79,1	76,1	73,9	72,3
$L_{WA,P}$		93,6			90,4			85,1			79,2	

One third octave and octave sound power level at reference point v_{10} = 8 m/s in dB(A)												
Frequency	50	63	80	100	125	160	200	250	315	400	500	630
$L_{WA,P}$	76,4	77,6	78,7	80,2	81,1	83,6	83,7	84,5	86,0	85,5	87,3	88,4
$L_{WA,P}$		82,4			86,7			89,6			92,0	
Frequenz	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
$L_{WA,P}$	89,8	90,3	90,2	89,0	87,3	85,3	83,2	82,3	81,3	77,4	75,5	73,9
$L_{WA,P}$		94,9			92,2			87,1			80,6	

One third octave and octave sound power level at reference point v_{10} = 9 m/s in dB(A)												
Frequency	50	63	80	100	125	160	200	250	315	400	500	630
$L_{WA,P}$	78,7	79,9	81,0	81,9	82,7	84,8	84,6	85,0	86,1	85,5	87,2	88,2
$L_{WA,P}$		84,7			88,1			90,1			91,9	
Frequenz	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
$L_{WA,P}$	89,5	89,9	90,1	89,0	87,4	85,4	83,4	82,3	81,3	77,2	75,3	73,9
$L_{WA,P}$		94,6			92,3			87,2			80,4	

One third octave and octave sound power level at reference point v_{10} = 10 m/s in dB(A)												
Frequency	50	63	80	100	125	160	200	250	315	400	500	630
$L_{WA,P}$	78,7	79,8	80,6	81,3	82,0	83,7	84,8	87,2	87,3	86,2	87,6	88,2
$L_{WA,P}$		84,5			87,2			91,3			92,2	
Frequenz	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
$L_{WA,P}$	89,4	89,8	89,5	88,0	86,0	84,1	82,0	81,0	79,9	76,8	74,7	73,0
$L_{WA,P}$		94,3			91,1			85,8			79,9	

This extract of test report is valid only in connection with the enclosed „Manufacturer's certificate" from 2005-04-08.
This declaration does not replace above-mentioned report.

Notes:
(1) The rated power in the Mode 600 kW is 600 kW. The maximum generator-/rotor-speed is 28.5 rpm.
(2) The hub height of the measured Turbine was 75.6 m.
(3) Calculated sound power level with the results of the measured hub height.
(4) The tonality was determined at the hub height 75.6 m.

measured by: WIND-consult GmbH
Reuterstraße 9
D-18211 Bargeshagen

date: 2005-04-18

Dipl.-Ing. R. Haevernick

Dipl.-Ing. W. Wilke

Appendix E – 600kW Turbine Broadband Warranted Levels

Guaranteed Values of the Sound Power Level for the E-48 with reduced rated power					
	$P_{N,red}$ = 700 kW n_N = 29.0 rpm	$P_{N,red}$ = 600 kW n_N = 28.5 rpm	$P_{N,red}$ = 500 kW n_N = 28.0 rpm	$P_{N,red}$ = 400 kW n_N = 26.5 rpm	$P_{N,red}$ = 300 kW n_N = 25.0 rpm
SPL at 95% rated power	**101.5 dB(A)**	**100.6 dB(A)**	**100.0 dB(A)**	**98.5 dB(A)**	**97.5 dB(A)**
Measured value at 95% $P_{N,red}$		99,6 dB(A) WICO 439SEC04/02			95,6 dB(A) MBBM M64 550/6

1. The respective SPL is given for 95% $P_{N,red}$ and is therefore valid for all hub heights.

2. A tonality value K_{TN} of 0-1 dB is guaranteed over the whole operational range (valid in the near vicinity of the turbine according to IEC).

3. An impulsivity value K_{IN} of 0 dB is guaranteed over the whole operational range (valid in the near vicinity of the turbine according to IEC).

4. If official measurement at reduced rated power have been carried out, the measurement reports are available (mostly in German language) and are valid in connection with this document. The measurements are being carried out according to the recommended national and international standards and norms (mentioned in the respective reports).

5. An interpolation is possible for values in-between the ones mentioned in the table above.

6. The values of the sound power level are valid for the respective operational parameters, which are defined by the reduced rated power $P_{N,red}$ as well as by the rated rotational speed n_N. The pre-set values of rated power and rated rotational speed are documented within the ENERCON Scada system and thus can be verified for each desired period of time.

7. The accompanying power curves for the respective operational parameters can be found on page 2 of this document. They are identical to the standard power curve at low wind speeds, but of course reflect the reduced rated power in the upper wind speed range.

8. In order to account for the uncertainties of measurement and sound prediction calculations, to increase the acceptance at the authorities and to avoid eventual verification measurements ENERCON recommends a safety factor of 1 dB(A) on the guaranteed values when carrying out sound propagation calculations. In countries where safety factors are already mandatory due to local regulations, the ENERCON recommendation is not applicable.

   Should this recommendation be neglected for any reasons, it is hereby explicitly referred to 9.

9. Due to the measurement uncertainties of sound measurements the verification of the guaranteed values is successful, if the measurement result of a measurement that has been carried out according to the accepted standards is in the range of +/- 1dB(A) of the guaranteed values [guarantee fulfilled when measurement result = guaranteed value +/- 1dB(A)].

Power curves for the operation with reduced rated power:

v [m/s]	$P_{N,red}$ = 700 kW	$P_{N,red}$ = 600 kW	$P_{N,red}$ = 500 kW	$P_{N,red}$ = 400 kW	$P_{N,red}$ = 300 kW
1	0	0	0	0	0
2	2	2	2	2	2
3	12	12	12	12	12
4	32	32	32	32	32
5	66	66	66	66	66
6	120	120	120	120	120
7	191	191	191	191	185
8	284	284	284	270	263
9	405	385	365	335	293
10	504	474	426	375	300
11	595	550	476	395	300
12	660	597	495	400	300
13	690	600	500	400	300
14	700	600	500	400	300
15	700	600	500	400	300
16	700	600	500	400	300
17	700	600	500	400	300
18	700	600	500	400	300
19	700	600	500	400	300
20	700	600	500	400	300
21	700	600	500	400	300
22	700	600	500	400	300
23	700	600	500	400	300
24	700	600	500	400	300
25	700	600	500	400	300