TECHNICAL NOTE

Project	**Lyrenacarriga Wind Farm**
Subject	**ABP Further Information Response**
Author	**Dermot Blunnie**
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1.0 INTRODUCTION

AWN Consulting Ltd. (AWN) are the acoustic consultants for this project and prepared the noise and vibration chapter and assessment of the submitted Environmental Impact Assessment Report (EIAR). This document has been prepared in response to a Further Information (FI) request received from An Bord Pleanála (ABP) on specific items relating to noise.

In response to the items relating to noise in the FI, appropriate clarifications and further comments are presented in the following sections of this document to clarify, expand, and confirm previous statements within the submitted EIAR. The noise and vibration assessment carried out as part of the submitted EIAR is considered comprehensive and robust.

AWN is a multidisciplinary consultancy offering specialist design advice, expert witness, and litigation support in respect of a wide range of engineering and environmental disciplines. AWN hosts Ireland's largest acoustic consultancy team with seventeen full-time consultants working in the field. The company has extensive experience in issues relating to wind farm noise having been involved numerous wind farm projects across the island of Ireland.

This document was prepared by Dermot Blunnie (Senior Acoustic Consultant), holds a BEng (Hons) in Sound Engineering, MSc in Applied Acoustics and has completed the Institute of Acoustics (IOA) Diploma in Acoustics and Noise Control. He has been working in the field of acoustics since 2008 and is a member of the Institute of Engineers Ireland (MIEI) and the Institute of Acoustics (MIOA). He has extensive knowledge and experience in relation to commissioning noise monitoring and impact assessment of wind farms as well as a detailed knowledge of acoustic standards and proprietary noise modelling software packages. He has commissioned noise surveys and completed noise impact assessments for numerous wind farm projects within Ireland.

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2.0 ABP FURTHER INFORMATION REQUESTS

This document has been prepared in relation to specific items highlighted in correspondence received from ABP concerning the proposed wind farm development and all associated infrastructure in the townlands of Lyrenacarriga, Co. Waterford and Lyremountain, Co. Cork (ABP Ref: ABP-309121-21). The relevant extracts of the ABP correspondence that are discussed here are as follows:

> ***"Details of Proposed Turbines***
>
> *It is noted that the development description as set out in the statutory notices refers to a maximum overall blade tip height of 150 metres. To enable the Board to determine the application please confirm the nature and extent of the development for which permission is sought, by reference to plans and particulars which describe the works to which the application relates, in compliance with the relevant provisions of the Planning and Development Regulations 2001 as amended.*
>
> *If the development for which permission is sought incorporates a range of options, please indicate clearly in the application documentation the detail of all such options and confirm that each option has been fully assessed within the application documentation including within the Environmental Impact Assessment Report and Natura Impact Statement."*

The applicant has confirmed that several candidate turbines are being considered for the site with hub heights in the range from 83.5 m up to 93.5 m. It is understood that the candidate turbines represent a range of typical turbine models that would be suitable for the Proposed Development. To assist ABP, the assessments presented in Chapter 13 of the EIAR are updated and supplemented here to consider the various potential candidate turbines. Please see Section 3.0 of this correspondence for further details on this issue.

In addition, the ABP correspondence FI states the following:

> ***"Noise***
>
> *(a) Submissions received including the report from the Planning Authority (Cork County Council) and a number of reports authored by Acoustic/Related Consultants/Experts which critically assess the information provided in Chapter 13 of the EIAR and related appendices. You are requested to review the submissions and respond/clarify accordingly.*
>
> *(b) Your attention is drawn to the Draft Revised Wind Energy Development Guidelines 2019 and in particular to reference within Chapter 2 (Section 2.4.5.3.1) of the EIAR whereby it is stated that the design of the proposed development has been developed with the provisions of the draft guidelines in mind.*
>
> *Please expand."*

The submissions referred to in the ABP correspondence have been reviewed and addressed in Section 4.0 of this document.

Item 3 (b) is addressed in Section 2.3 of the main FI response document. Additional comments on the Draft Guidelines with respect to noise are presented here, as they are relevant to items 3 (b): From Section 13.4.2.1.4 of the EIAR:

> *"In December 2019, the Draft Revised Wind Energy Development Guidelines December 2019 were published for consultation and therefore have yet to be finalised. Therefore, in line with best practice, the assessment presented in the EIAR is based on the current guidance outlined in Section 5.6 of the Wind Energy Development Guidelines for Planning Authorities."*

In addition to the statements made in the EIAR, the following comments are presented in relation to the *Draft Revised Wind Energy Development Guidelines* (DRWEDG19).

As part of the public consultation several concerns relating to the proposed approach of the DRWEDG19 have been expressed by various parties. Specific concerns expressed by a group of acoustic professionals working in the field are most relevant. The group was made up of acousticians who act for wind farm developers, Councils, Government bodies and residents' groups (all of whom are members of the Institute of Acoustics, IOA[1]. The group contained several of the authors / contributors to ETSU-R-97, the IOA Good Practice Guide (IOA GPG) and the IOA Amplitude Modulation Working Group, which are all referenced extensively in the draft guidelines. A statement from the cross party group can be reviewed at:

> *https://www.ioa.org.uk/wind-energy-development-guidelines-wedg-consultation-irish-department-housing-planning-community-and*

The following statement is of note from the response (a copy of the full response is included in Appendix A):

> *"a number of acousticians working in the field have raised serious concerns over the significant amount of technical errors, ambiguities and inconsistencies in the content of the draft WEDG and these were highlighted during the consultation process by a group of acousticians"*

It is AWN's opinion that the DRWEDG19 document does not outline a best practice approach in terms of the assessment of wind turbine noise. Therefore, in line with best practice, which includes ESTU and IOA GPG methodologies as described in Section 13.4.2.1 of the EIAR, the assessment presented in the EIAR is based on the current best practice guidance outlined in Section 5.6 of the *Wind Energy Development Guidelines for Planning Authorities*, 2006 (WEDG06).

The original ETSU-R-97 concepts, on which both the WEDG06 and DRWEDG19 are based, underwent a thorough standardisation and modernisation in 2013 with the Institute of Acoustics publication of the "*A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise*" (IOAGPG) including 6 Supplementary Guidance Notes, all of which bring together the combined experience of acoustic consultants in the UK and Ireland in the application of these methods. Numerous improvements in the accuracy and robustness are described, including the treatment of wind shear and the general adaptation to larger wind turbines. The assessment in the EIAR is therefore in full accordance with the latest best-practice methods.

If updated Wind Energy Guidelines are published during the application process for the Proposed Development it is anticipated that any relevant changes affecting the noise assessment will be addressed through an appropriate planning condition, or where a supplementary assessment is necessary, through provision of additional information.

[1] The Institute of Acoustics (IOA) is the UK's professional body for those working in acoustics, noise, and vibration.

3.0 REVIEW OF CANDIDATE TURBINES

It has been advised by the Applicant that the following turbines are representative of the potential candidate models for the site, and confirmation of the upper and lower range hub height (HH) for each model is provided in Table 1.

Turbine Manufacturer	Model	MW	HH (m)
Nordex	N117	3.6	91 Note A
			91.5
			83.5
Nordex	N133	4.8	83.5
Vestas	V117	4.3	83.5
			93.5
GE	117	4.23	83.5
			93.5
Siemens	SWT 113	3.2	83.5
			93.5

Table 1 Review of Candidate Turbines

Note A: The turbine model assessed in Chapter 13 of the EIAR was a Nordex N117 3.6 MW without Serrated Trailing Edge (STE) blades at 91 m HH.

Noise prediction calculations have been prepared for all candidate turbines outlined in Table 1. The calculation methodologies outlined in Section 13.3 of the EIAR for turbine noise prediction have been followed in this updated assessment. Where additional information and clarifications are required in terms of the current predictions these have been outlined as necessary in the following sections.

3.1 Background Noise and Criteria

As the background noise criteria are a function of the hub height (HH), it has been necessary to revise the regression analysis of the background noise data presented in the EIAR where HH of 91 m was used. As the highest HH in Table 1 is 93.5 m, there is a slight shift of the noise levels at each standardised wind speed. This results in a slight reduction in the derived background noise level in some wind speed bins. This is normal as for an increased HH, the noise levels at standardised wind speeds reduce slightly. The results of this exercise are presented in Table 2, values highlighted red indicate a change in the derived background noise level.

Location	Period	Derived $L_{A90,10\ min}$ Levels (dB) at various Standardised 10m Height Wind Speed (m/s) for a HH of 93.5 m							
		3	4	5	6	7	8	9	10
A (H08 Proxy)	Day	21.9	22.4	25.1	29.0	33.4	37.4	40.2	40.8
	Night	16.6	17.5	20.0	23.8	28.5	33.7	39.0	44.2
C (H26 Proxy)	Day	23.6	25.2	27.7	30.8	34.3	38.0	41.7	45.1
	Night	16.6	17.8	20.0	22.9	26.5	30.4	34.5	38.6
D (H51)	Day	23.5	25.4	28.0	31.1	34.6	38.3	42.0	45.4
	Night	17.3	18.9	21.4	24.8	28.7	32.9	37.2	41.4
F (H45 Proxy)	Day	25.7	27.5	30.0	32.8	36.0	39.2	42.4	45.3
	Night	16.7	18.2	20.8	24.2	28.1	32.3	36.6	40.5
G (H64)	Day	23.7	25.5	27.9	30.8	33.9	37.3	40.6	43.8
	Night	17.5	18.7	20.6	23.2	26.5	30.4	34.8	39.8
H (H67)	Day	21.9	22.9	25.5	29.1	33.1	36.7	39.3	40.2
	Night	16.7	17.4	19.4	22.4	26.3	30.9	36.1	41.7

Table 2 Derived Noise Levels of $L_{A90,10min}$ for Various Wind Speeds

The derived background noise levels will be lowest for the highest hub height within the turbine range i.e., 93.5 m. To simplify the assessment, background noise levels for an assessment hub height of 93.5 m are presented for all scenarios in this review. This presents a conservative assessment as the derived background noise levels are lowest for the highest hub height in the range. The updated regression graphs are presented in Appendix B.

Based on the updated background noise levels presented in Table 2, the assessment noise criteria curves have been updated accordingly and are presented in Table 3. The same methodology as detailed in Section 13.4.2.1.1 of the EIAR has been applied here.

Location	Period	Derived $L_{A90,10\ min}$ Criteria (dB) at various Standardised 10m Height Wind Speed (m/s)							
		3	4	5	6	7	8	9	10
A (H08 Proxy)	Day	40.0	40.0	40.0	40.0	45.0	45.0	45.2	45.8
	Night	43.0	43.0	43.0	43.0	43.0	43.0	44.0	49.2
C (H26 Proxy)	Day	40.0	40.0	40.0	45.0	45.0	45.0	46.7	50.1
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.6
D (H51)	Day	40.0	40.0	40.0	45.0	45.0	45.0	47.0	50.4
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0	46.4
F (H45 Proxy)	Day	40.0	40.0	40.0	45.0	45.0	45.0	47.4	50.3
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.5
G (H64)	Day	40.0	40.0	40.0	45.0	45.0	45.0	45.6	48.8
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8
H (H67)	Day	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.2
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0	46.7

Table 3 Derived Noise Criteria Curves for Various Standardised Wind Speeds

As the change in background noise levels is small, the turbine noise criteria for the Proposed Development remain as stated in Table 13-21 in Section 13.6.3.1 of the EIAR and are based on the assigned representative background noise monitoring locations outlined in Table 13-11 and Figure 13-16 the EIAR.

In respect of locations where a resident is financially involved in the wind farm, Section 13.4.2.1.1 states, "*The ETSU-R-97 guidance allows for a higher level of turbine noise operation at properties that have an involvement in the development, both as a higher fixed level of 45 dB L_{A90} and/or a higher level above the prevailing background noise level. In line with the guidance a lower threshold of 45 dB $L_{A90,10min}$ is applicable to NSLs involved in the proposed development (H61 and H64).*"

3.2 Turbine Noise Data

The following tables outline the turbine sound power levels that have been used for the various candidate turbines identified in Table 1.

3.2.1 Nordex N117 3.6MW (83.5 m HH)[2]

Standardised 10m Height Wind Speed (m/s)	Sound Pressure Level dB(A) per Octave Band Centre Frequency (Hz)								
	63	125	250	500	1000	2000	4000	8000	dB(A)
3	72.8	80.1	86.5	86.6	85.1	84.4	81.0	75.9	92.5
4	73.5	80.2	86.2	86.4	87.6	89.0	85.8	74.1	94.4
5	79.6	86.6	89.9	90.1	92.5	94.2	93.3	83.4	99.7
6	83.2	89.5	93.1	93.7	95.8	96.9	96.4	86.9	102.8
≥7	84.2	90.4	93.3	93.8	96.6	98.0	97.0	87.7	103.5

Table 4 Noise Data Used for Nordex N117 3.6MW (83.5 m HH) Serrated Trailing Edge (STE) Blades

3.2.2 Nordex N117 3.6MW (91.5 m HH)[3]

Standardised 10m Height Wind Speed (m/s)	Sound Pressure Level dB(A) per Octave Band Centre Frequency (Hz)								
	63	125	250	500	1000	2000	4000	8000	dB(A)
3	72.8	80.1	86.5	86.6	85.1	84.4	81	75.9	92.5
4	73.6	80.3	86.3	86.5	87.7	89.1	85.9	74.2	94.5
5	79.9	86.9	90.2	90.4	92.8	94.5	93.6	83.7	100
6	83.4	89.7	93.3	93.9	96	97.1	96.6	87.1	103
≥7	84.2	90.4	93.3	93.8	96.6	98	97	87.7	103.5

Table 5 Noise Data Used for Nordex N117 3.6MW (91.5 m HH) STE Blades

3.2.3 Nordex N133 4.8MW (83.5 m HH)[4]

Standardised 10m Height Wind Speed (m/s)	Sound Pressure Level dB(A) per Octave Band Centre Frequency (Hz)								
	63	125	250	500	1000	2000	4000	8000	dB(A)
3	74.7	82.5	85.5	86.4	86.9	85.6	81.3	72.1	93.0
4	75.9	83.3	86.7	87.6	88.1	86.8	82.5	73.3	94.2
5	81.5	88.5	92.3	93.2	93.6	92.4	88.1	78.9	99.7
6	85.6	92.6	96.4	97.3	97.8	96.5	92.2	83.0	103.9
≥7	86.2	93.2	97.0	97.9	98.4	97.1	92.8	83.6	104.5

Table 6 Noise Data Used for Nordex N133 4.8MW (83.5 m HH) STE Blades

[2] Nordex Report - Octave sound power levels Nordex N117/3600 Ref: F008_256_A14_EN Revision 00, 2018-06-07

[3] Nordex Report - Octave sound power levels Nordex N117/3600 Ref: F008_256_A14_EN Revision 00, 2018-06-07

[4] Nordex Report - Octave sound power levels Nordex N133/4800 Ref: F008_272_A14_EN Revision 02, 2020-01-31

3.2.4 Vestas V117 4.3MW (83.5 m HH)[5]

Standardised 10m Height Wind Speed (m/s)	Sound Pressure Level dB(A) per Octave Band Centre Frequency (Hz)								
	63	125	250	500	1000	2000	4000	8000	dB(A)
3	71.0	79.6	85.2	87.9	87.7	84.5	78.4	69.3	93.0
4	74.6	82.7	88.0	90.6	90.4	87.4	81.7	73.1	95.8
5	79.4	87.1	92.2	94.7	94.5	91.7	86.3	78.1	100.0
6	84.0	91.2	95.9	98.2	98.1	95.5	90.5	83.0	103.7
7	86.2	93.3	98.0	100.3	100.2	97.6	92.7	85.2	105.8
≥8	86.4	93.5	98.2	100.5	100.4	97.8	92.9	85.5	106.0

Table 7 Noise Data Used for Vestas V117 4.3MW (83.5 m HH)

3.2.5 Vestas V117 4.3MW (93.5 m HH) [6]

Standardised 10m Height Wind Speed (m/s)	Sound Pressure Level dB(A) per Octave Band Centre Frequency (Hz)								
	63	125	250	500	1000	2000	4000	8000	dB(A)
3	71.1	79.7	85.3	88.0	87.8	84.6	78.5	69.4	93.1
4	74.9	83.0	88.3	90.9	90.7	87.7	82.0	73.4	96.1
5	79.7	87.4	92.5	95.0	94.8	92.0	86.6	78.4	100.3
6	84.3	91.5	96.2	98.5	98.4	95.8	90.8	83.3	104.0
7	86.4	93.5	98.2	100.5	100.4	97.8	92.9	85.4	106.0
≥8	86.4	93.5	98.2	100.5	100.4	97.8	92.9	85.5	106.0

Table 8 Noise Data Used for Vestas V117 4.3MW (93.5 m HH)

3.2.6 GE 117 4.23MW (83.5 m HH) [7]

Standardised 10m Height Wind Speed (m/s)	Sound Pressure Level dB(A) per Octave Band Centre Frequency (Hz)								
	63	125	250	500	1000	2000	4000	8000	dB(A)
3	74.2	81.9	85.9	86.7	88.4	83.7	74.5	55.6	93.0
4	75.4	83.1	87.0	87.9	89.6	84.9	76.0	57.6	94.2
5	79.7	87.4	91.3	92.2	93.9	89.2	80.4	62.5	98.5
6	83.9	91.6	95.5	96.4	98.1	93.4	84.6	66.2	102.7
7	86.2	93.5	97.6	99.0	101.5	97.7	89.3	69.2	105.7
≥8	86.5	93.8	97.9	99.3	101.8	98.0	89.6	69.5	106.0

Table 9 Noise Data Used for GE 117 4.23MW (83.5 m HH)

[5] Vestas Report - DMS 0067-7587 V02 V117-4.0&4.2 MW Third octave noise emission (Strong wind & Typhoon) – with serrated trailing edge.

[6] Vestas Report - DMS 0067-7587 V02 V117-4.0&4.2 MW Third octave noise emission (Strong wind & Typhoon) – with serrated trailing edge.

[7] GE Renewable Energy report: 20180101_Noise_Emission_NO_4.2-DFIG-117-xxHz_ 3MW_LNTE_EN_r03_R03_EN BB SO TO

3.2.7 GE 117 4.23MW (93.5 m HH) [8]

Standardised 10m Height Wind Speed (m/s)	Sound Pressure Level dB(A) per Octave Band Centre Frequency (Hz)								
	63	125	250	500	1000	2000	4000	8000	dB(A)
3	74.2	81.9	85.9	86.7	88.4	83.7	74.5	55.6	93.0
4	75.6	83.3	87.2	88.1	89.8	85.1	76.2	57.8	94.4
5	80.0	87.7	91.6	92.5	94.2	89.5	80.7	62.8	98.8
6	84.3	92.0	95.9	96.8	98.5	93.8	85.0	66.6	103.1
7	86.4	93.7	97.8	99.2	101.7	97.9	89.5	69.4	105.9
≥8	86.5	93.8	97.9	99.3	101.8	98.0	89.6	69.5	106.0

Table 10 Noise Data Used for GE 117 4.23MW (93.5 m HH)

3.2.8 Siemens Gamesa SWT113 3.2MW (83.5 m HH) [9]

Standardised 10m Height Wind Speed (m/s)	Sound Pressure Level dB(A) per Octave Band Centre Frequency (Hz)								
	63	125	250	500	1000	2000	4000	8000	dB(A)
3	76.4	80.0	83.1	83.2	84.2	83.4	80.0	70.8	90.6
4	80.7	84.3	87.4	87.5	88.5	87.7	84.3	75.1	94.9
5	85.3	88.9	92.0	92.1	93.1	92.3	88.9	79.7	99.5
6	90.1	93.7	96.8	96.9	97.9	97.1	93.7	84.5	104.3
7	91.8	95.4	98.5	98.6	99.6	98.8	95.4	86.2	106.0
≥8	91.8	95.4	98.5	98.6	99.6	98.8	95.4	86.2	106.0

Table 11 Noise Data Used for Siemens SWT113 3.2MW (83.5 m HH)

3.2.9 Siemens Gamesa SWT113 3.2MW (93.5 m HH) [8]

Standardised 10m Height Wind Speed (m/s)	Sound Pressure Level dB(A) per Octave Band Centre Frequency (Hz)								
	63	125	250	500	1000	2000	4000	8000	dB(A)
3	76.6	80.2	83.3	83.4	84.4	83.6	80.2	71.0	90.8
4	81.1	84.7	87.8	87.9	88.9	88.1	84.7	75.5	95.3
5	85.7	89.3	92.4	92.5	93.5	92.7	89.3	80.1	99.9
6	90.5	94.1	97.2	97.3	98.3	97.5	94.1	84.9	104.7
7	91.8	95.4	98.5	98.6	99.6	98.8	95.4	86.2	106.0
≥8	91.8	95.4	98.5	98.6	99.6	98.8	95.4	86.2	106.0

Table 12 Noise Data Used for Siemens SWT113 3.2MW (93.5 m HH)

As in the EIAR, the provided wind turbine sound power data in the previous tables are referenced in terms of the L_{Aeq} parameter. Best practice guidance contained within the *Institute of Acoustics Good Practice Guide* (IOA GPG) states that *"L_{A90} levels should be determined from calculated L_{Aeq} levels by subtraction of 2 dB".* Therefore, in accordance with best practice guidance, a 2 dB reduction has been applied to the predicted results in this assessment to represent L_{A90} levels.

For the purposes of all predictions presented in this report, to account for various uncertainties in the measurement of turbine source levels, a +2 dB uncertainty factor has been added to all noise emission values in line with guidance for wind turbine noise assessment contained in the Institute of Acoustics (IOA) document, *A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise* (2013) (IOA GPG).

[8] GE Renewable Energy report: 20180101_Noise_Emission_NO_4.2-DFIG-117-xxHz_3MW_LNTE_EN_r03_R03_EN BB SO TO

[9] Siemens Gamesa Renewable Energy – SWT-3.2-113 IIA R17 Developer Package rev 2

3.3 Review of Turbine Noise Predictions

Noise prediction calculations have been undertaken for each of the combinations listed in Table 1. The result of this review has confirmed that all candidate turbines with the hub height range will comply with the operational turbine noise criteria curves and no mitigation measures are required.

The full results are presented in Appendix C for the various scenarios.

If alternative turbine models, within the specified ranges, are procured for the Proposed Development an updated noise assessment will be prepared to confirm that the noise emissions will comply with the noise criteria and/or the relevant operational criteria associated with the grant of planning. As is standard for all projects, suitable curtailment strategies will be designed and implemented for alternative technologies the procured turbines to ensure compliance with the relevant noise criteria, should detailed assessment conclude that this is necessary.

There will be no change to the potential impacts or effects for operational phase of the Proposed Development and these remain as described in Section 13.7.3 of the EIAR.

4.0 RESPONSE TO OBJECTIONS & OBSERVATIONS

Several issues have been raised via submissions from third parties. A portion of the these refer to the potential environmental noise impact from the Proposed Development. The primary issues raised in respect of the noise impact of the Proposed Development refer to the following topics:

- Health concerns and WHO Guidelines.
- Amplitude modulation.
- Infrasound and Low Frequency Noise.
- Wind Turbine Syndrome.
- Quality of background noise surveys.

Comment in relation to the issues raised above is provided in the following sections.

4.1 Health Concerns and the WHO Guidelines

Several third-party submissions claim that the noise impact of the proposed development should be assessed against the criteria in the World Health Organisation (WHO) document *Environmental Noise Guidelines for the European Region* (2018), rather than the current WEDG06 guidelines.

In terms of the WHO document *Environmental Noise Guidelines for the European Region* (2018) AWN can confirm that a detailed reasoning on this matter is provided in Section 13.4.2.1.5 of the EIAR and it is concluded that:

> *"It is therefore considered that the conditional WHO recommended average noise exposure level (i.e. 45dB L_{den}) if applied, as target noise criteria for an existing or proposed wind turbine development in Ireland, should be done with caution. The L_{den} criteria has been adopted as part of this assessment, this is based upon the review set out above and the conclusion that the conditional WHO recommended average noise exposure level (i.e. 45dB L_{den}) may be a poor characterization of wind turbine noise and may limit the ability to observe associations between wind turbine noise and health outcomes."*

It is therefore considered that the WHO recommended average noise exposure level should not currently be applied as a target noise criterion for existing or proposed wind farms in Ireland.

In relation to the various observations on health effects it is noted that these issues are addressed in section 13.4.2.3 of the EIAR. This section of the EIAR concluded:

> *"The peer reviewed research outlined in the preceding sections supports that there are no negative health effects on people with long term exposure to wind turbine noise. Please refer to Chapter 5 of the EIAR for further details of potential health impacts associated with the Proposed Development."*

4.2 Amplitude Modulation

Amplitude modulation has been raised as a concern in several of the third-party submissions.

AWN can confirm that the information provided in Section 13.4.2.2.2 of the submitted EIAR presents a discussion on the issue of Amplitude Modulation noise associated with the operation of wind turbines.

In addition, the following comments are provided to confirm how the operator would address AM during the operational phase of the Proposed Development, if AM were to arise at a noise-sensitive location.

In the event of a legitimate complaint which indicates potential amplitude modulation (AM) associated with turbine operation, the operator will employ a qualified acoustic consultant to assess the level of AM . This assessment will be undertaken in accordance with the methods outlined in the Institute of Acoustics (IOA) Noise working Group (Wind Turbine Noise) Amplitude Modulation Working Group (AMWG) namely, *Institute of Acoustics IOA Noise Working Group (Wind Turbine Noise) Amplitude Modulation Working Group Final Report: A Method for Rating Amplitude Modulation in Wind Turbine Noise* (9 August 2016) or subsequent revisions.

The measurement method outlined in the IOA AMWG document, known as the 'Reference Method', will provide a robust and reliable indicator of AM and yield important information on the frequency and duration of occurrence, which can be used to evaluate different operational conditions.

4.3 Infrasound and Low Frequency Noise

The issue of infrasound and low frequency noise has been raised in the third-party submission documents.

AWN can confirm that the information provided in Section 13.4.2.2.1 of the submitted EIAR presents a discussion on the issue of low frequency noise and infrasound associated with the operation of wind turbines. The following is reiterated for clarity as per Section 13.4.2.2.1 of the EIAR:

> "*In relation to Infrasound, the following extract from 'EPA document Guidance Note for Noise Assessment of Wind Turbine Operations at EPA Licensed Sites (NG3)' is noted here:*
>
> *"There is similarly no significant infrasound from wind turbines. Infrasound is high level sound at frequencies below 20 Hz. This was a prominent feature of passive yaw "downwind" turbines where the blades were positioned downwind of the tower which resulted in a characteristic "thump" as each blade passed*

> *through the wake caused by the turbine tower. With modern active yaw turbines (i.e. the blades are upwind of the tower and the turbine is turned to face into the wind by a wind direction sensor on the nacelle activating a yaw motor) this is no longer a significant feature."*
>
> *With respect to infrasonic noise levels below the hearing threshold, the World Health Organisation (WHO) document "Community Noise" has stated that*:
>
> *"There is no reliable evidence that infrasounds below the hearing threshold produce physiological or psychological effects."*

AWN confirm that the information provided in Section 13.6.3.5 of the submitted EIAR presents an up-to-date discussion on the issue of infrasound and low frequency noise associated with the operation of wind turbines, accordingly this issue has been addressed in the application documentation which notes as follows (EIAR Page 11-9 refers).

> *"In the unlikely event that an issue on low frequency noise is associated with the proposed development, it is recommended that an appropriate detailed investigation be undertaken. Internal measurements are recommended and due consideration should be given to the guidance contained in Appendix VI "Low Frequency Noise" of the EPA document "Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)" which are in-turn based on the threshold values outlined in the Salford University document "Procedure for the assessment of low frequency noise complaints", Revision 1, December 2011."*

The Applicant has confirmed that the above will be implemented in full in the event of any such issues arising.

Additional responses are presented below in response to the third-party submissions.

Comment on Claims by Mariana Alves-Pereira

A number of the third-party submissions make reference to a presentation by Mariana Alvez-Pereira on her claims of serious negative health effects associated with wind turbine noise, in particular, infrasound. Having reviewed the presentation document included within the submissions and based on our knowledge of the claims made by Mariana Alvez-Pereira, AWN would note the distinct lack of empirical data supporting such claims.

The following comments are noted from an article published in the Institute of Acoustics Bulletin[10] by Dick Bowdler FIOA. Mr. Dick Bowdler is a Chartered Engineer, a Chartered Physicist and one of the original members of the Institute of Acoustics when it was founded in 1974. Mr. Bowdler regularly works on behalf of residents objecting to wind energy development and Councils in the UK and Ireland. The article was composed following his attendance at a similar presentation held in Glasgow on 22nd September 2017, one of the speakers at this conference was Mariana Alvez-Pereira. The following extracts are taken from the article that was published in the Institute of Acoustics Bulletin:

> "*Organised by some objectors in Scotland, it sought to counter the "misinformation" put out by governments, health services, acousticians, and the wind industry world-wide. The misinformation we were told they disseminate is*

[10] Wind turbine noise: the search for an alternative truth Acoustics Bulletin Vol 42 No 6 November/ December 2017, Institute of Acoustics

that there no evidence that infrasound causes a wide range of illnesses in humans and animals and, what is more, the probability of there being any causal effect is vanishingly small. The seminar was started by Melvin Grosvenor of the Independent Noise Working Group explaining how members of the Establishment all over the world tell us that there are no health effects from infrasound from wind turbines. People here, he said, will tell you differently because they are ill from infrasound. There was a conspiracy to hide the real facts which he likened to cover-ups in the past of asbestos, the radium girls, tobacco, Thalidomide and Primodos."

In relation to the presentation by Mariana Alvez-Pereira the article says:

"*Finally, Mariana Alvez-Pereira, a specialist in vibro-acoustic disease, explained how in a sound field we were bombarded with mechanical forces, and she demonstrated this by punching her body with her fist*."

"Readers of this publication will have noticed that certain basic technical details had been glossed over during the meeting. There was no evidence that dead animals were killed by infrasound – no post mortem."

"Mariana's example of mechanical forces pounding the body is right in principle though the fist is something of an exaggeration. In reality, it is more like a gentle fanning of the face with a sheet of paper"

"*It is a fact that turbines, like most mechanical things, produce infrasound. It is also a fact that some people living near turbines are ill. The biggest scientific flaw to the evening was that not one shred of evidence was put forward to show any causal link between the two."*

The following text is taken directly from pages 123-124 of the *Australian Administrative Appeals Tribunal Decision into the effects, if any, of ILFN on human health*, waubra-and-acnc-decision:

*"**Professor Mariana Alves-Pereira***

398. Professor Alves-Pereira provided a written report, dated 28 April 2016,278 and also gave oral evidence during the hearing.

399. We found the evidence of Professor Alves-Pereira to be of limited assistance except to the extent that it was consistent with that of other experts. However, her evidence sharply diverged from that of the other experts in two key respects.

400. Based on very limited studies, she postulated the existence of a phenomena known as "vibroacoustic disease" due to exposure to low-frequency noise, the "hallmark" of which was the thickening of the pericardium. She expressed the opinion that this thickening could only be detected through the use of forms of investigation such as echocardiography or ultrasound imaging.

401. As she acknowledged, Professor Alves-Pereira is not a medical doctor and her opinion as to the existence of this disease and its cause was not supported by any of the other experts, including those with medical qualifications. In these circumstances, we do not accept her evidence as to the existence of vibroacoustic disease being potentially related to the emissions of wind farms.

402. Professor Alves-Pereira also postulated that the phenomenon of noise annoyance was attributable to prior excessive exposure to infrasound and low-frequency noise resulting in a fusing of the cochlear cilia. Again, this theory was not supported by any of other experts and, indeed, Professor Alves-Pereira conceded that it could only be proved through extensive autopsies combined with detailed histories of the deceased's lifetime noise exposure.

403. On the evidence before us, we do not accept that the phenomena of noise annoyance is explained, in whole or in part, by prior excessive exposure to infrasound and/or low frequency noise.
404. Having regard to these and other matters, we are not prepared to attach much weight to the evidence of Professor Alves-Pereira."

4.4 Wind Turbine Syndrome

There is general reference to "Wind Turbine Syndrome" within the third-party submissions. In response to issue of "Wind Turbine Syndrome we refer the following published research.

Research by Simon Chapman and Fiona Crichton in *Wind Turbine Syndrome, A communicated disease*, published by the Sydney University Press in 2017, presents critical review of the evidence for Wind Turbine Syndrome. In this book, they present evidence that Wind Turbine Syndrome has evolved through dissemination of false claims accessed via the media or disseminated by anti-windfarm campaigners.

Their hypothesis is that the belief that wind turbine noise can impact on health may in-turn generate anxiety in some individuals causing them to needlessly worry and fear. One of the most interesting findings of this research is that the international pattern of complaints is most frequently reported in English speaking countries, the following text is taken from this book:

"The 'individual susceptibility' argument faces its biggest test when we look at the international pattern of complaints. It has been frequently noted that complaining about wind turbines is very obviously an Anglophone phenomenon. Modern multi-megawatt wind turbines have operated since 1978 in the USA and Europe. Today, there are an estimated 314,000 turbines in operation globally. European nations with windfarms include Belgium, Cyprus, Denmark, England, France, Germany, Greece, Ireland, Italy, Lithuania, the Netherlands, Poland, Portugal, Romania, Scotland, Spain, and Sweden. The turbines are often located very near cities, towns and villages (see Figures 3.1 and 3.2), thus exposing a huge number of people across Europe to their putative sickening sound emissions on a daily basis. Anyone who has spent time in these nations will have seen many of them. Yet windfarm health complaints have nearly all occurred in English-speaking nations. In Canada, parts of English-speaking Ontario have experienced many complaints while neighbouring Francophone Quebec sees little opposition. In Australia, complaints have been concentrated around farms targeted by anti-windfarm groups, suggesting the phenomenon is a 'communicated disease'."

It is AWN's opinion that these claims are not supported by scientific evidence, and we refer again to Section 13.4.2.2 of the submitted EIAR which presents a discussion on sleep disturbance and human health in relation to wind turbines. It should be noted that the relevant Guidance considered as part of this assessment have been development with cognisance of guidelines published by the World Health Organisation (WHO).

4.5 Quality of Background Noise Surveys

Section 13.5 of the EIAR outlines the baseline noise monitoring that was completed for the noise assessment outlined therein. This stage of the assessment was to determine typical background noise levels at representative NSLs surrounding the development site. The background noise survey was conducted through installing unattended sound level meters at six representative locations in the surrounding area.

All measurement data collected during the background noise surveys has been carried out in accordance with ETSU-R-97, IOA GPG and accompanying *Supplementary Guidance Note 1: Data Collection* (2014).

The noise monitoring locations were identified by preparing a preliminary noise model contour at an early stage of the assessment. Any locations that fell inside the predicted 35 dB L_{A90} noise contour was considered for noise monitoring in line with current best practice guidance outlined in the IOA GPG. The selection of the noise monitoring locations was informed by site visits and supplemented by reviewing of aerial images of the study area and other online sources of information (e.g., Google Earth).

The siting of noise measurement equipment in line with the IOA GPG was difficult due to access issues in the area e.g., reluctance of residents to participate in the background noise survey or those who did participate preferring that the equipment was not visible to the public. As a result, professional judgement was used to choose suitable proxy locations at properties and lands that were agreeable to participate in the background noise survey. The monitoring locations were deemed representative, as per the IOG GPG, of *"typical 'low' levels likely to be experienced in the vicinity of a dwelling (or group of dwellings if the measurements are intended to be applied to more than one dwelling)."*

As per the IOA GPG, due to access issues:

> *"The overriding consideration is that it can reasonably be claimed, from inspection and observation, that there are no other suitable noise-sensitive locations, in the vicinity of any selected location and close to a dwelling, where background noise levels would be expected to be consistently lower than the levels at the selected position. This is a matter of judgment: the objective is to measure 'typical' or 'indicative' not 'absolute lowest' levels of background noise (which could only be determined by extended measurements at a large number of locations over a long period which is neither necessary nor practicable)."*

As noted in SGN 2:

> *The choice of survey positions is often an area of dispute between those proposing a wind turbine development and those opposing it: with claims made that background noise levels at the selected locations are higher than at other positions for which the actual measurement position is a proxy, which leads to higher noise limits and therefore disadvantages local residents.*

All proxy measurement locations used in this project are considered typical of the lowest background noise levels as the measurement locations were sited further from the dominant noise sources e.g., road traffic noise, than the other NSLs in the area. This is a conservative scenario for the noise assessment as the criteria are based on the lowest background noise levels, and conversely is the best-case scenario for the NSLs in the area.

4.6 General Comments on MAS Report

AWN has reviewed a copy of the Noise Impact Report contained in a submission from Paddy Massey, report reference Lyrenacarriga Wind Farm Assessment and review of noise impact from proposed wind farm dated 4 March 2021 prepared by MAS Environmental (MAS Report).

The conclusions reached in the MAS Report are typically based on a difference of professional opinion and in some instances the use of alternative assessment methodologies.

As stated in Section 13.4.2.1 of the EIAR and confirmed in Section 2.0 of this document, the assessment methodology adopted in Chapter 13 of the in the EIAR for the assessment of wind turbine noise is in full accordance with the latest best-practice methods.

Some additional and specific items raised within the MAS report are addressed in the following sections.

4.6.1 Amplitude Modulation

Section 3.34 of the MAS Report states that there is no accepted methodology for predicting AM on a proposed wind farm site, while on the other hand, Section 7.32 states, there are strong indicators that AM will arise at the proposed development. It is noted that there are no calculations presented in the MAS Report to support the latter statement, and if AM were to arise, as claimed, there is no assessment or statement to quantify the significance of AM, the duration, nor the frequency of occurrence.

The review of AM presented in Section 7.0 presents examples to explain the features of AM. The review does not refer to the adopted assessment methodology or present details of the measurement context, rather the MAS Report presents four marked-up graphs showing noise measurement taken over very short durations. The information presented does not support the claim that AM will arise from Lyrenacarriga Wind Farm.

AWN confirm that the information provided in Section 13.4.2.2.2 of the submitted EIAR and Section 4.2 address the potential issue of Amplitude Modulation in respect of the proposed development.

4.6.2 Background Noise Monitoring Locations

Please refer to Section 4.5 of this document where this item is addressed.

4.6.3 Selection of Lower Threshold Level

The applicable guidelines for the proposed development are presented in Section 13.4.2.1 of the EIAR.

The WEDG06 states:

> "*However, in very quiet areas, the use of a margin of 5 dB(A) above background noise at nearby noise sensitive properties is not necessary to offer a reasonable degree of protection and may unduly restrict wind energy developments which should be recognised as having wider national and global benefits. Instead, in low noise environments where background noise is less than 30 dB(A), it is recommended that the daytime level of the $L_{A90,\ 10min}$ of the wind energy development be limited to an absolute level within the range of 35 – 40 dB(A)*."

The selection of a lower threshold of 40 dB L_{A90} is fully in accordance with the applicable guidelines for the Proposed Development.

A rationale for this justification is presented in Section 13.6.3.1 of the EIAR. Additional comments are presented below to support the justification for the lower threshold.

It is very common in Ireland for wind turbine developments of a similar scale and in a similar environment to be conditioned with lower threshold noise limit of 40 dB $L_{A90,}$ in some cases 43 dB L_{A90} has been imposed. Examples of some wind farm developments that have been permitted by An Bord Pleanala with operational turbine noise limits conditioned with a lower threshold of 40 dB L_{A90} are given below.

- Coole Wind Farm (Planning Ref. ABP-300686-18).
- Derrinlough Wind Farm (Planning Ref. ABP-306706-20).
- Clooncreen Wind Farm (Planning Ref. ABP-308171-20) (43 dB L_{A90} lower threshold conditioned).
- Meenbog Wind Farm (Planning Ref. ABP Ref: PL14.303592).

It is noted that on page 114 of the Cork County Council Planning report the suggested planning condition for noise states a lower threshold of 40 dB L_{A90} in low noise environments where background noise is less than 30 dB(A).

4.6.4 Clarification on statements made in Section 13.6.3.1 of the EIAR

The following statement in contained in Section 13.6.3.1 of the EIAR:

> *"The EPA document 'Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)' proposes a daytime noise criterion of 45 dB(A) in 'areas of low background noise'. The proposed lower threshold here is 5 dB more stringent than this level."*

AWN acknowledges and accepts that there is a difference in the two parameters, L_{Aeq} and L_{A90}. The turbine noise limits are couched in terms of the L_{A90} parameter while the NG4 daytime limit is couched in terms of the L_{Aeq}. The accepted difference between the L_{Aeq} and L_{A90} for wind turbine noise assessments is 2 dB, e.g., 45 dB L_{Aeq} equates to 43 $L_{A90.}$ This approach infers a 3 dB difference when accounting for difference parameters between the NG4 limits and the WEDG06 limits proposed in the EIAR Chapter. AWN accepts the technical point presented in the MAS Report however, the proposed lower threshold of 40 dB L_{A90} is still supported by this fact that the proposed lower threshold criterion for wind turbine noise is 3 dB more stringent than the equivalent daytime noise limit for areas of low background noise outlined in NG4.

AWN does not agree with the suggestion in the MAS Report that the NG4 comparison is taken out of context as it does not consider the evening and night-time limits stipulated in NG4. The applicable guidelines, WED06, present clear guidance for night time limits for wind turbine noise. The comparison to the NG4 daytime limits for areas of low background noise is presented in the EIAR to inform an appraisal of the selection of an appropriate daytime lower threshold turbine noise limit as required by the WEDG06 guidelines.

4.6.5 Significance of the Impact

AWN can confirm that the information provided in Section 13.7.3.1.1 of the submitted EIAR presents a description of the significance of the effects of the operation of the proposed wind turbines, the EIAR states:

> "*The predicted noise levels associated with the Proposed Development will be within best practice noise criteria curves recommended in Irish guidance 'Wind Energy Development Guidelines for Planning Authorities it is not considered that a significant effect is associated with the development.*
>
> *While noise levels at low wind speeds will increase due to the development and specifically the operation of the turbines, the predicted levels will remain low, albeit new sources of noise will be introduced into the soundscape.*
>
> *With respect to the EPA's criteria for description of effects, in terms of the operational phase, the potential worst-case associated residual effects at the nearest NSLs associated with the various elements of the operational phases are described below.*
>
> *The predicted residual operational turbine noise effects are summarised as follows at the closest NSLs to the site:*

Quality	*Significance*	*Duration*
Negative	*Moderate*	*Long-tern*

> *The above effect should be considered in terms that the effect is variable and that this assessment considers periods of the greatest potential effect.*
>
> For most of the locations assessed here the effect of the operational turbines are as follows:

Quality	*Significance*	*Duration*
Negative	*Slight*	*Long-tern"*

When assessing the significance of the potential noise impact the main factors that were considered are summarised below:

- The overall predicted turbine noise levels are within the applicable noise criteria outlined in the applicable guidelines WEDG06.
- A new audible source of noise will be introduced to the environment.
- The difference in the derived background noise level and the predicted turbine noise levels is variable and will change depending on the windspeed, direction and the levels of background noise at a given location.
- The difference between the derived background noise levels and the predicted turbine noise levels are typically higher at night compared to the day and this has been considered and factored into the WEDGO6 Guidelines and criteria (refer to section 13.4.2.1.1 of the EIAR).
- The issue of special noise characteristics i.e., amplitude modulation, low frequency noise, and infrasound have all been considered in Chapter 13 of the EIAR (additional commentary provided in this document).
- the above points apply to the assessment regardless of which turbine is selected within the proposed Turbine Range.

3.6.6 Wind Shear

Section 5.44 of the MAS report presents a comparison of the 10 m height measured wind speed against the 10 m height standardised wind speed. The comparison of the of the two parameters presented in the MAS Report is not relevant to the assessment presented in Chapter 13 of EIAR, or the additional assessments and results presented in this document. The 10 m height *standardised* wind speed is not a representation of the 10 m height wind speed.

The 10 m height standardised wind speed is defined in the IOA GPG as follows:

> "*a wind speed measured at a height different than 10 m (generally measured at the turbine hub height) which is expressed to a reference height of 10 m using a roughness length of 0.05 for standardisation purpose (in accordance with the IEC 61400-11 standard)*"

Section 4.5.1 of the IOA GPG states:

> "*Basing the predictions on sound power data tested in accordance with the IEC 61400-11 standard (or equivalent) should mean that the wind reference used corresponds to hub height wind speeds, standardised to 10 m height using a fixed correction (see Annex A). These predictions can then be compared to background levels and/or associated noise limits derived using an equivalent wind speed reference, which will have wind shear taken into account directly*"

The use of the 10 m height standardised wind speed is an industry standard to allow for comparison of wind speeds at different hub heights. In the context of the background noise levels derived in Chapter 13 of the EIAR, the assessment considers the specific hub height and the site specific wind shear.

Section 13.5.5 of the EIAR confirms the methodology adopted in the assessment of the proposed development to account for wind shear. It is confirmed that the assessment has been undertaken in full accordance with best practice guidance provided in the IOA GPG.

5.0 RESPONSE TO ISSUES RAISED BY CORK COUNTY COUNCIL

This section addresses key issues relating to the Noise and Vibration assessment raised in the Cork County Council Planners Report (CCCPR). The relevant comments are presented, and responses presented below.

CCCPR comment:

> *"The Wind Energy Guidelines outline that a maximum increase in sound of 5 dB above background noise levels in very quite* [sic] *areas will unduly restrict wind energy development. The Guidelines recommend that in very quite* [sic] *areas, i.e. where the background noise level, is less than 30 dB that the wind energy development noise is limited to a range of 35 – 40 dB. The applicant has applied the upper 40 dB(A) limit for the applicable Noise assessment set out in the EIAR. This should be further clarified and the rational explained."*

Response:

Please refer to Section 3.6.3 of this document where this issue is addressed.

CCCPR comment:

> *"The respective number and distances of all noise sensitive receptors within 500m, 1000m,1500m and 2000m of the turbines should be presented and quantified."*

Response:

This information is provided in Section 2.3 of the FI response main document.

CCCPR comment:

> *"In respect of operational phase mitigation, it is submitted as per section 13.6.3.5, that the findings of the assessment confirmed that the predicted operational noise levels will be within the relevant best practice noise criteria curves for wind farms at all but one Noise sensitive location, which is a landowner dwelling. Therefore, no mitigation measures are required. This should be clarified as this does not appear to be indicated and highlighted in Table 13.22."*

Response:

The reference to an exceedance at a landowner property is an error and the corrected text is presented below for clarification.

An assessment of the operation noise levels has been undertaken in accordance with best practice guidelines and procedures as outlined in Section 13.7.3 of this Chapter. The findings of the assessment confirmed that the predicted operational noise levels will be within the relevant best practice noise criteria curves for wind farms at all NSLs, therefore, no mitigation measures are required.